DESERT KNOWLEDGE CRC

Remote Community Water Management

Robyn Grey-Gardner

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Australian Government
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CRC Australia

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Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the DKCRC Remote Community Water Management project. Robyn is an environmental and social scientist and has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. She has worked for eight years with Aboriginal communities, mainly on water management programs.

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The Desert Knowledge Cooperative Research Centre is an unincorporated joint venture with 28 partners whose mission is to develop and disseminate an understanding of sustainable living in remote desert environments, deliver enduring regional economies and livelihoods based on Desert Knowledge, and create the networks to market this knowledge in other desert lands.

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Abbreviations/Acronyms/Definitions

ABS	Australian Bureau of Statistics
ADWG	Australian Drinking Water Guidelines
CAT	Centre for Appropriate Technology
CDEP	Community Development Employment Projects
CWP	Community Water Planner
CRAC	Coen Regional Aboriginal Corporation
CRC	Cooperative Research Centre
DFID	Department For International Development
DKCRC	Desert Knowledge Cooperative Research Centre
HREOC	Human Rights and Equal Opportunity Commission
NAHS	National Aboriginal Health Strategy
NHMRC	National Health and Medical Research Council
ODI	Overseas Development Institute
VET	Vocational Educational Training
WHO	World Health Organization

Definitions

Settlement	The physical cluster of dwellings that form an outstation or town.
Residents	The people who inhabit a settlement and are more or less the regular occupants of the dwellings.
Community	The collection of people who interact within and between settlements, such as a common language group across the settlements of the Ngaanyatjarra Lands.

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Rachel Gibson was the project leader for the first eight months, and she liaised to establish most of the case study settlement sites and research team. Robyn Grey-Gardner, who was appointed project leader for the remaining 16 months of the project, fulfilled the water management planning procedures with the case study settlements and is the author of this report.

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The level of involvement in the project was very high at all the case study settlements. There were, however, key people at each settlement whose leadership was integral to the success of the project. The drive and enthusiasm from Preston Thomas, Beverley Thomas, Gavin Bassani, Sunlight Bassani, Margaret Kenny-Orr, Reg Kenny, Julia Kenny, Malcolm Orr, Diedre McKenzie, Rex McKenzie and Leonie McKenzie is appreciated. The participants are happy for their water manuals and information to be shared with other settlements so that the benefits of strategic water management may be enjoyed.

1 Executive summary

In this report we describe the Desert Knowledge Cooperative Research Centre's research project: Remote Community Water Management. The two-year project was conducted between 2004 and 2006 in collaboration with the Cooperative Research Centre for Water Quality and Treatment. The Australian Government Department of Families, Community Services and Indigenous Affairs and the Centre for Appropriate Technology were core research partners.

We document the project experience of creating locally-driven water management plans in five remote Aboriginal settlements. The 2004 *Australian Drinking Water Guidelines*' Framework for the Management of Drinking Water Quality and the Sustainable Livelihoods Framework were guiding principles during the process of designing and implementing the water management plans.

In Section 1 we outline the history and current situation of remote settlement water management, briefly exploring the social and political influences and the need for the project.

In Section 2 we describe the principles of the frameworks used during the project.

In Section 3 we outline the process used to develop water management plans in five case study settlements.

In Section 4 we describe the lessons learnt and how they might be applied to other remote settlements. We identify the fundamental considerations that would need to be included in a broader or regional water management program, including whether a risk-based water management plan meets aspirations of remote settlement residents.

In Section 5 we describe the potential for improving water management in remote settlements, using a risk-based approach. We propose a stepwise approach that aligns the scale of responsibility with the level of risk. This approach builds on the available strengths in remote regions and endorses a partnership between the residents, as key decision makers, and key agencies.

We provide the fundamentals of the approach and describe, in a user-friendly way, the lessons learnt during the project. The report is intended to be accessible to a broad audience with variable levels of technical knowledge of water and understanding of risk management principles. Many of the practical concepts we outline were discussed during project workshops. The concepts we describe are those that inspired incisive questions and much head nodding from workshop participants. Practitioners should also find the implementation analysis and tips useful. Most importantly, we anticipate that the learning from this project will redirect future water management programs and funding in remote settlements toward a strategic risk-based and people-focused approach.

1.1 Key messages

- The legacy of decision making external to the residents of a settlement has disabled initiative in Aboriginal settlements – despite the existence of significant local skills. This project supported residents' capacity to decide to implement their own water management plans.
- Settlements that exhibit a clear purpose and direction, such as pursuing a range of livelihood activities, require little stimulus to assume responsibility for agreed aspects of their water supply. When working with settlements that have a purpose or livelihood, the focus is on leveraging any extra support for the practical skills they need to implement water management strategies. The focus of implementation is on 'how' rather than 'why'.
- The assets pentagon tool from the Sustainable Livelihoods Framework was crucial for enabling a holistic approach in the participatory process. Using the tool helped to establish a coherent and standard approach to decision making in remote settlements. It may be most useful as a device to enable a comparable response by support and funding agencies.
- The Australian Drinking Water Guidelines' Framework for the Management of Drinking Water Quality is applicable to remote settlement water management. The adjunct Community Water Planner provides risk management activities and user-friendly access to the principles. Much work remains to be done to broaden the knowledge and understanding of the principles of risk management among support agency personnel.
- A focus on the people involved in the project is appropriate and necessary. Through a process of prioritising residents' needs, investment was directed toward training, knowledge and information sharing. While we used some project funds for minor remedial works to secure water supplies and thereby reduce risk, we sought long-term benefits by developing water supply management skills and knowledge.
- Site-specific tools and resources can be developed to facilitate the participatory and communication processes. Some of the resources developed in this project – e.g. manuals and logbooks – are suitable for adaptation and broader use.
- Informal learning environments should not be underestimated. An evaluation showed that residents felt they had a high level of decision making and influence during the project. The most enduring outcome was the knowledge of water management gained by the participants. The majority of the knowledge was gained informally – through discussions when sharing water data; shadowing the assessment of water supply, hazards and rectifications; developing the manuals; and in meetings.
- Engagement for water management planning is most efficient at the local level. The amount of knowledge and capacity at the settlement level is largely underestimated and definitely untapped.
- Past experience of essential service delivery processes colours residents' responses to new initiatives. A project evaluation highlighted that settlements have experienced many attempted programs at the local level. New initiatives must be well planned and organised, must involve local participants, and must strive for defined and achievable outcomes that clearly benefit local participants.

1.2 Recommendations

1. Adopt as the basis for water management and program delivery in Aboriginal settlements a tiered risk-based approach that defines roles and responsibilities at settlement, regional and national levels.
2. Develop and run education and skill development workshops for service delivery agencies and government departments involved in essential service programs in remote settlements, on the principles of water risk management and how to facilitate locally-driven decision-making processes.
3. Run follow-up capacity-building sessions or make refresher visits in the case study settlements within six months of completing this project.
4. Evaluate and assess outcomes at the five case study settlements in late 2007. Focus on assessing the capacity of remote settlements to continue managing water, and identify any support required.
5. Respond to residents' requests to develop a lateral support mechanism through an Aboriginal community water network. Clarify the role of such a network and identify appropriate resources to support it.
6. Implement the Aboriginal community water network and associated activities that facilitate enhanced linkages between settlements and wider water industry networks. Investigate opportunities and requirements to strengthen linkages between residents of remote settlements and wider water industry networks, and the potential for establishing an industry support and mentoring program for residents.
7. Develop and endorse a set of water management resources and tools for use in remote settlements.

2 Introduction

2.1 Background

As part of the Remote Community Water Management project, we worked with residents in five remote Aboriginal settlements or outstations. We targeted small communities, recognising that they need a strategic approach to improving water services and management. A preventive approach to water supply management would allow outstation residents to realise the benefits of preventative maintenance.

Outstations, although difficult to define, according to Altman (2006:1), are generally understood as 'communities or infrastructure nodes, on Aboriginal land inhabited by a usually related, and always mobile, Indigenous population'. Australia has 991 remote outstations with a population less than 100, and 905 of these outstations have a population of 50 or less (ABS 2001).

Outstation living, when compared with living in more centralised settlements, appears to have more favourable health outcomes for residents with respect to mortality, hospitalisation, hypertension, diabetes and injury (McDermott et al. 1998, *National Indigenous Times* 2006). Outstation residents generally have better access to traditional food sources; greater opportunities to share language and customs across generations; and improved living conditions, environmentally, socially and psychologically. Overall, however, these communities incur high costs for water supply and management due to poor economies of scale, generally low levels of access to support through service networks, and limited information about different strategies (including low technology options) for securing their existing water supplies. The benefits of a reliable and safe water supply can be assessed meaningfully as a component of a broader strategy for Aboriginal people to thrive on traditional country.

The majority of water supplies for Aboriginal settlements are sourced from groundwater. Table 1 shows the available data for the main source of water supply for communities with a permanent population of less than 50 people.[1,2] Bore water is the main source of drinking water for 614 communities. The actual number of communities that rely on groundwater for their main drinking water source is under-represented because the majority of town supplies are also sourced from groundwater.

Table 1: Main source of drinking water for Indigenous Communities with a population less than 50

	Connected to town supply	Bore water	Rainwater tanks	River or reservoir	Well or spring	Other organised supply	No organised water supply	Total
New South Wales	8	2	-	1	-	-	-	11
Queensland	2	27	12	28	24	4	1	98
South Australia	3	53	14	-	-	-	-	70
Western Australia	13	152	2	7	6	9	13	202
Northern Territory	49	380	9	37	17	9	7	508
Australia	75	614	37	73	47	22	21	889

Source: Australian Bureau of Statistics 2001

1 Data was not available for 16 communities.

2 Tasmania and the Australian Capital Territory do not have Indigenous communities with a population less than 50 included in the data set.

As demonstrated by the Australian Bureau of Statistics (2001), small and remote communities of Aboriginal people experience significant difficulties accessing adequate and reliable supplies of water. In 1994, the Federal Race Discrimination Commissioner published *Water: A Report on the Provision of Water and Sanitation in remote Aboriginal and Torres Strait Islander communities*. The report questioned many of the fundamental assumptions that informed policies and processes for service delivery to Aboriginal and Torres Strait Islander communities.

The accessibility of sustainable water supplies for Aboriginal settlements was reviewed by the Human Rights and Equal Opportunity Commission (HREOC) in 2001. In its *Review of the Water Report,* the HREOC found that the following issues impact the provision of reliable water supplies:

- human and other resources, and the capacity and willingness of communities and institutions to support interventions both physically and financially in the long term
- the relative lack of specialised services in the majority of small remote Indigenous communities and the difficulty in accessing specialist expertise
- the weakness of a 'market' per se in small remote Indigenous communities and the limitations on the 'market' or competition model for service delivery
- [a lack of] flexibility and a [lack of] emphasis on equitable outcomes in the design of the basic infrastructure necessary for human development (HREOC 2001:71).

In this context, an emerging operational and policy challenge for funding providers has been to make sure that water supplies are affordable, safe and functioning (HREOC 2001, Bailie et al. 2002).

2.2 Water supply management in remote communities

Current water supply management in remote outstations is characterised by the lack of clearly defined decision-making processes and responsibilities among support agencies and funding bodies. This situation leaves people in remote settlements with little understanding of how to improve or plan water management in a strategic way, and little capacity building or agency support. However, it is important to note that most remote Aboriginal settlements have a service provider or resource agency that has some role in maintaining the water supply. The roles and responsibilities vary from place to place, but may range from storage of files that contain water quality data, to hands-on and systematic maintenance regimes.

The risk management approach is relevant to remote settlements because:

- response to incidents of poor water quality is slow due to the difficulty in accessing laboratories, contractors, technical advice and parts
- health facilities are usually difficult to access so there is an increased risk of waterborne disease
- regular inspection of water supply infrastructure is routine in small communities, simply for security of supply, so extra steps to protect water quality are not onerous
- incremental change to water supply systems to progressively target risk factors is more affordable than large-scale installation of 'safe' water treatment infrastructure.

2.3 Aims of this project

The aim of the Remote Community Water Management project was to enable small remote communities to thrive by securing reliable and well managed water supplies. We explored the practical possibilities available, from viewing a water supply as a resource for communities pursuing their own strategic objectives, through understanding the quality and quantity issues, and applying the practicalities of management to site-specific issues and contexts.

We used the *Australian Drinking Water Guidelines*' Framework for the Management of Drinking Water Quality, primarily to address any water quality and general supply issues such as maintaining water system integrity. We assessed other factors, such as water needs and people's capacity to maintain a water supply, using the Sustainable Livelihoods approach.

We explored the combination of the water risk management approach with the Livelihoods approach as a means of creating an incentive for communities to continue to manage their water supply beyond the completion of the project. We used participatory methods to build residents' understanding of water supply and management activities.

2.4 The Framework for the Management of Drinking Water Quality

The water risk management approach has been well researched and developed around the world in recent years (Deere et al. 2001, NHMRC 2004, NHMRC 2005, Davison et al. 2004, Ministry of Health 2005, Health Canada 2005). Risk management is widely accepted as the guiding principle for water supply management. For example, the World Health Organization developed water safety plans based on risk management principles for the management of all types of water supply systems. The International Water Association developed the Bonn Charter for Safe Drinking Water, which endorses integrated water safety plans based on risk management principles.

In Australia, the development of a flexible and proactive means of optimising drinking water quality evolved between 1997 and 2002 (Rizak et al. 2003, Naudebaum et al. 2004). In December 2004, the National Health and Medical Research Council (NHMRC) and the Natural Resources Management Ministerial Council published the 2004 *Australian Drinking Water Guidelines* (ADWG), incorporating the Framework for the Management of Drinking Water Quality.

The framework outlines a preventative approach to managing risks associated with drinking water. It provides direction for the design and implementation of comprehensive quality management systems from catchment to tap. It includes 'holistic guidance on a range of issues by documenting good practice for system management' (Rizak et al. 2003). The framework addresses four key areas:

1. Commitment to drinking water quality management (Element 1)
2. System analysis and systems management (Elements 2–6)
3. Supporting requirements (Elements 7–10)
4. Review (Elements 11–12).

The elements of the framework are listed in Table 2.

Table 2: Elements of the Framework for the Management of Drinking Water Quality

Commitment to drinking water quality management		
Element 1	**Commitment to drinking water quality management**	
		Drinking water quality policy Regulatory and formal requirements Engaging stakeholders
System analysis and management		
Element 2	**Assessment of the drinking water supply system**	
		Water system supply analysis Assessment of water quality data Hazard identification and risk management
Element 3	**Preventive measures of drinking water quality management**	
		Preventive measures and multiple barriers Critical control points
Element 4	**Operational procedures and process control**	
		Operational procedures Operational monitoring Corrective action Equipment capability and maintenance Materials and chemicals
Element 5	**Verification of drinking water quality**	
		Drinking water quality monitoring Consumer satisfaction Short-term evaluation of audits Corrective action
Element 6	**Management of incidents and emergencies**	
		Communication Incident and emergency response protocols
Supporting requirements		
Element 7	**Employee and awareness training**	
		Employee awareness and involvement Employee training
Element 8	**Community involvement and awareness**	
		Community consultation Communication
Element 9	**Research and development**	
		Investigate studies and research monitoring Validation of processes Design of equipment
Element 10	**Documentation and reporting**	
		Management and documentation of records Reporting
Review		
Element 11	**Evaluation and audit**	
		Long-term evaluation of results Audit of water quality management
Element 12	**Review and continual improvement**	
		Review by senior executive Drinking water quality management and improvement plan

Source: Naudebaum et al. (2004)

The framework's approach to drinking water quality management is based on prevention of risk events, rather than reaction after an event, as prevention has the following benefits (Cunliffe 2005):

- It fosters better understanding of drinking water quality management.
- It protects public health by ensuring safer drinking water for consumers.
- It enables the in-depth systematic evaluation of water systems, identification of hazards and assessment of risks.
- It places end-product testing in an appropriate quality assurance role.

- It introduces a common and standard approach throughout the industry, which fosters due diligence and credibility.

The framework can be applied to small systems but there are special considerations in applying it to small communities. Regular monitoring, for example, is fundamental to operational, preventive and corrective action. However, it is not practicable for remote communities to implement a regular monitoring program (Cunliffe 2002).

2.5 The *Community Water Planner*

The *Community Water Planner* (CWP), published in 2005 by the NHMRC, is a tool to help water supply managers prepare a drinking water risk management plan (MHMRC 2005). There are also a growing number of generic risk-based water management planning tools available to provide structured guidance for developing a water quality management plan (Naudebaum et al. 2004, AusAID 2005, Ministry of Health 2005, Davison et al. 2004, Health Canada 2005). The principles of Hazard Analysis and Critical Control Point have been adapted to develop principles for securing water supplies (Deere & Davison 1998, Deere et al. 2001, Howard 2002) and offer more planning tools and frameworks for creating water management plans. The frameworks and guides available provide varying degrees of information about the principles and steps required to develop and implement a site-specific water risk management plan.

The NHMRC has acknowledged the complexity of the ADWG and the limitations in technical resources for the development of water management plans. The CWP was developed to help bridge this resource gap. The CWP increases the scope of ADWG users and should broaden the adoption of comprehensive risk management of water quality. It is anticipated that uptake of the CWP throughout service provider agencies will introduce a common and standard approach, fostering due diligence and credibility throughout the industry (NHMRC 2006).

The CWP is a tool to help water supply managers prepare a drinking water risk management plan (NHMRC 2005). The elements of the Framework for the Management of Drinking Water Quality (see Table 2) that deal with system analysis and management (Elements 2–6) form the core of the CWP. These five elements are:

1. Assessment of drinking water supply system
2. Preventive measures for drinking water quality and management
3. Operational procedures and process control
4. Verification of drinking water quality
5. Management of incidents and emergencies.

The unique benefit of the CWP is that, as a software program provided on CD-ROM, it can generate the basis of a management plan from information directly input by the user, such as settlement and water system characteristics, and system-specific information drawn from supporting information contained on the CD-ROM (Cunliffe 2005). The software creates plans that provide a template for water management procedures. The template helps water supply managers and local and state/territory agencies, working with local operators, to prepare a tailored drinking water risk management plan for individual water supplies.

2.6 The Sustainable Livelihoods Framework

The Sustainable Livelihoods Framework is an analytical approach that has been extensively used internationally in community development. It has been continuously evolving since its conception by Robert Chambers and Gordon Conway. The approach is based on the principles of being people centred, sustainability focused, holistic and dynamic; implementing in partnership; linking the macro with the micro; and building on the strengths of an identifiable group of people (Chambers 1997).

The notion of 'livelihoods' is deliberately broad, non-prescriptive and flexible in application. One definition is:

> *A Livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base. (DFID & ODI 2004)*

A livelihood is considered sustainable if it can withstand shocks and maintain or improve assets.

The framework maps the necessary resources for a livelihood into five asset categories – human, social, physical, financial and natural. The five categories are represented by an assets pentagon. Figure 1 shows the framework, with the assets pentagon on the left-hand side. Table 3 describes the asset categories and the letters used to label them in the assets pentagon. The approach in practice tries to identify constraints that people face and promising opportunities that exist. It builds on people's own definitions of these constraints and opportunities where feasible, and then supports people in addressing and realising them respectively.

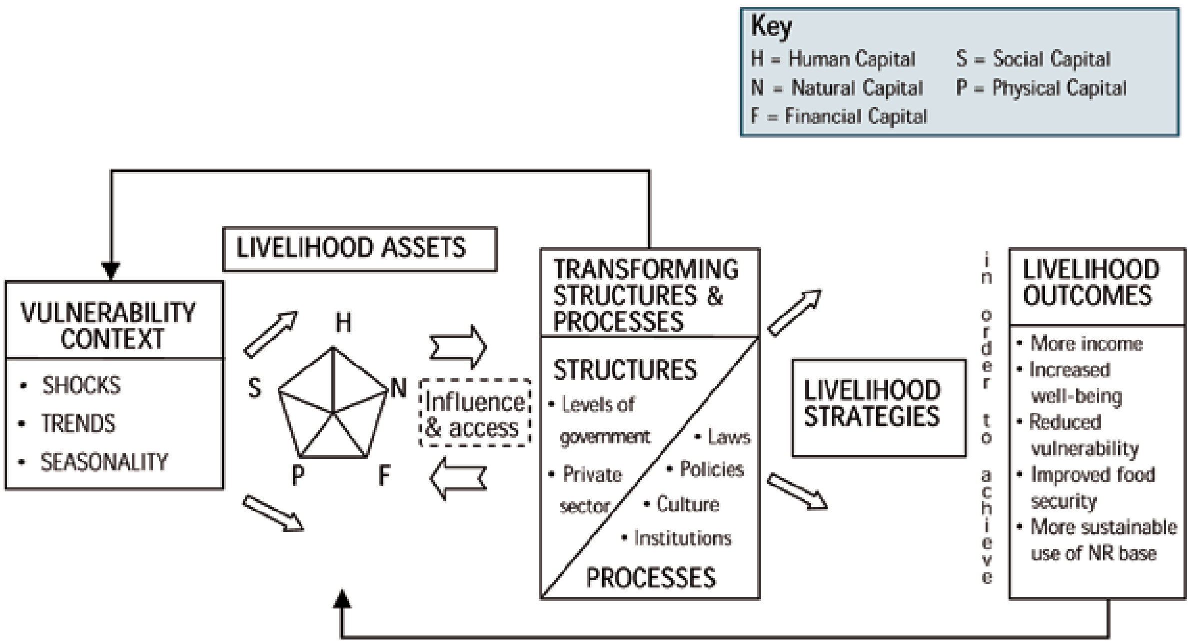

Figure 1: The Sustainable Livelihoods Framework (Source: DFID 1999)

Table 3: Description of the Sustainable Livelihoods assets pentagon

Asset	Description
N = Natural capital	Natural resources such as fuel wood, water, fruit trees
S = Social capital	Human contacts and relationships, group membership, clans etc
H = Human capital	Knowledge, skills and capacity to work
P = Physical capital	Basic infrastructure such as roads, irrigation systems, shelter and tools
F = Financial capital	Money for credit, savings, pensions etc

The international literature highlights the benefits of addressing livelihoods, rather than simply water quality or water quantity, in a water management context. Providing safe water in a settlement, by itself, will not guarantee the supply stays safe, since water can quickly become unsafe and the faecal oral transmission of diseases can occur in other ways (Nicol 2000). Linking the process to a livelihood is strategic to project outcomes since it provides the purpose or incentive for participants to understand and manage their water supply.

A livelihoods approach can shift the emphasis away from purely technical and health issues, and expand the focus to include the residents' issues and responsibilities, which have been recognised by Hearn et al. (1993) and Lammerink et al. (1999) as fundamental for sustainable water supplies. The Sustainable Livelihoods framework can be used as a tool to identify strategies to increase capacities that are critical for achieving successful livelihood or residents' aspirations.

3 Methods

This project was iterative in design. The process to engage participating communities was necessarily flexible and adaptive to suit local people, purposes and circumstances. A fundamental principle was the embedding of capacity-building initiatives throughout the project, in recognition of the strong evidence that one-off training at the end of a project will not sustain management (Grey-Gardner & Walker 2002). The project had a two-year timeline. We spent the first six months establishing the case study settlement sites and doing background research. During this phase, we also identified and negotiated stakeholder roles and project objectives. Ethics approval was granted at this time through the Central Australian Human Research Ethics Committee. During the final 12 months of the project, we developed the bulk of the hazard analysis and risk management process and achieved our outcomes.

The concept of working with communities that have a purpose or a livelihood was central to our selection of the case study communities. The premise was that a livelihood would provide the incentive to manage a settlement water supply, since the water supply would be required for the continued functioning of the settlement's business or purpose. While it is recognised that in most Australian communities plans to manage water safety are the responsibility of a service provider or supplier, the responsibility in the case study settlements rests mainly with the residents. We selected settlements using the following criteria:

- a permanent population of less than 30 people
- the primary responsibility for the water supply fell on residents
- a strong livelihood or purpose
- a willingness to be a part of the project and a commitment to making decisions about how to better manage the water supply.

One settlement was selected in Queensland (Port Stewart), one in the Northern Territory (Walkabout Bore or Mpwelarre), one in Western Australia (Kanpa) and two in South Australia (Yappala and Worro Downs). Figure 2 indicates the location of the case study settlements.

Figure 2: Location of case study settlements

A legal brief was conducted to identify any potential liabilities for a small settlement in making decisions about and managing its own water supply – specifically, whether the residents would be liable if the water being supplied did not meet the ADWG. The legal brief found no legal impediment to a resident-managed water supply (Clayton Utz 2006).

The scope of the project was to test the feasibility of applying a risk-based and strengths-based approach to water management for selected communities. In view of the project scope, our selection of settlements was based on the attributes of the communities themselves, not water quality or quantity issues. Significantly, the case study communities did not have any contentious water quality or quantity issues. It is highly likely that the availability of a reliable and safe water supply is inextricably linked to livelihood opportunities and the capacity for residents to live sustainably in their settlement.

3.1 Project process

The participation of residents in developing the local water management plans evolved in four stages. The first stage was the water source and risk management assessment. The work was directed by the water management principles outlined in the ADWG and we used the CWP to lay the foundation for the water supply assessment. We carried out the work in the field, with supporting information gathered from data research and desktop analysis.

The second stage of the project was conducted at the case study settlements so that we could relay the water quality and desktop research results back to the residents and discuss the meaning of the data and any potential implications. We analysed the Sustainable Livelihoods assets at each settlement after the initial water testing and hazard analysis had taken place. This was a suitable time to do the analysis since the communities and the project team had developed an awareness and comprehension of the project and an understanding of the types of management activities that would be required in a water management plan. The available assets or opportunities and capabilities of each resident to carry out a water management plan were assessed using worksheets (see Appendix 1 for the worksheet template). We used the Sustainable Livelihoods pentagon worksheet to identify strengths and weaknesses and better understand the most appropriate response to make sure that participants had the necessary resources to manage their water supply. Discussions were broader than simply who had the skills or available funds to maintain the system, and specifically addressed what the residents needed from a water supply system – a critical link in meeting their overall needs.

During stage three, we sought to build the capacity for remote settlement residents to identify risks in their water supplies, act to rectify them, and undergo a decision-making process to design and implement a water management process. The participants prioritised and ranked the activities and responses.

The final stage of the project focused on developing and supporting the specific skills needed to implement the plan. At each case study settlement, residents requested on-site instruction in surveillance and maintenance of their water supply. The Centre for Appropriate Technology was engaged to develop and facilitate a skills program, and a training course was run in three communities. This formal learning was in addition to informal learning and additional instruction and hands-on learning in water management practices, which ranged from dosing tanks with chlorine to deciding what kinds of information and documentation would suit their plan. The case study reports in Appendixes 2–6 describe the project activities at each settlement.

4 Project experience

4.1 The Framework for the Management of Drinking Water Quality

During the project, the ADWG and framework process provided the foundation for engaging with communities about their water supplies and management options. The basis of this approach is to promote an understanding of the entire water supply system, identify the potential hazards, identify effective preventive measures to control the hazards, and apply multiple barriers and establish critical control points to reduce exposure to hazards (Rizak et al. 2003).

As discussed in Section 2.2, a range of financial, social, technological and logistical factors demonstrate the relevance of the risk management approach to remote communities. However, there remain some limitations to the process. One limitation is the expense of carrying out a full water quality assessment in remote communities before developing a management plan that could keep to the ADWG. For this project, a complete set of water quality analyses was carried out on each water supply to meet compliance monitoring assessment requirements. This stage of the project took many months to complete. The logistics of having so many samples taken and sent to different laboratories were time consuming and very expensive. For example, in two case study settlements, the sampling, freight and analytical expenses were more than $3000 for each settlement.

The experience we gained through this project confirmed that a reliance on water testing of samples at laboratories needs to be challenged for the following reasons:

- Accredited laboratories are located as far as 2000 kilometres from some remote communities. Some regional centres have laboratories but many of their procedures are not accredited.
- Microbiological samples must be processed within 24 hours. Transport routes usually combine air and road travel so freight arrangements must be well coordinated. The many exchanges en route increase the likelihood of delays.
- Freight costs are high because water is heavy and the delivery time must be as quick as possible.
- Local area freight companies and institutions have slightly differing attitudes and policies around what goods may or may not be transported. For example, sample bottles containing trace acids have been intermittently rejected from being transported by light aircraft.

In general, it is not cost effective for a small settlement to have a complete set of analyses conducted. In most cases, there is not enough capacity in existing service delivery agencies (particularly those not linked to a water service provider or service program) to interpret and understand the data. Also, the likelihood of settlement residents having access to the information is low.

The ADWG recommendation of regular testing as a verification tool in a water management plan is therefore not suitable for remote communities. Instead, alternatives to water quality testing are preferable to reduce the cost burden on communities and reinforce local control of water management strategies. For this reason, we sought alternative verification indicators to replace regular water quality testing procedures for remote communities.

Kathryn Green (2006) reviewed the literature for possible surrogates for water quality testing that would be applicable in remote communities. Chlorine residual is a potential surrogate for water quality testing. The case study settlements, like many outstations, do not have a chlorinated water supply, so this surrogate would only apply to rainwater tanks. In one case study settlement, on-site water testing is planned to monitor any changes in the supply. The tests include pH, total dissolved solids, electrical conductivity and temperature. The on-site testing supplements other indicators, such as high rainfall or complaints, to trigger management procedures.

Although the framework is structured so that it can be integrated into an existing water quality management system (Rizak et al. 2003), there were no such existing systems in the small settlements we studied. Adapting the framework to a settlement-based approach to water management has, therefore, required a simplification of the detail and a stronger focus on the actors in the management plan.

The framework is premised on organised water service provision as the basis of water management. The overarching management and supporting structure that is essential for continuity and continual improvement for the framework simply does not exist for remote communities. This is evident in the supporting requirements component of the framework (Elements 7–10) where, for remote communities, the term ‘employee’ would need to be replaced by ‘resident’ or ‘resource agency’ for activities such as awareness training. A strategic regional or national program would need to be developed, with properly resourced supporting agencies around Elements 9–12, for the framework to be fully operational in remote Australia.

4.2 The *Community Water Planner*

In preparation for discussions, we used the *Community Water Planner* (CWP) to create a water management plan for each settlement. The CWP was a useful tool for analysing water quality and hazards, and for surveillance procedures such as prioritising methods for catchment management, creating barriers to potential contamination and securing the integrity of the water supplies. The usefulness of the CWP reflects the fact that its target audience includes operators of small systems or agencies with oversight of small systems. The expected benefits of the CWP for remote communities and their service providers are:

- access to comprehensive and rigorous information about water supply management for water quality, which the user can have confidence applying
- contact lists for further assistance or information
- information available on CD-ROM in an accessible format for most service providers and resource agencies
- a strategic and standardised approach to water management, implemented with a regional approach in the case for remote communities
- potential for the CWP plans to become the blueprint for information exchange on management practices and stepwise improvement between service providers and funding agencies
- elimination of much of the tediousness of developing a management plan from scratch, so that providers and resource agencies will be more likely to use the tool and adopt water management planning
- better storage and updating of management plans; often, resource agencies and service providers have difficulty maintaining and storing information due to frequent staff turnover; the CWP may assist with better storage and management of information.

For this project, the CWP was fundamental in developing water management plans, as it authorised the risk management approach during consultation about hazard analysis and management options, particularly with service providers and communities. The focus on implementing preventive strategies for water supply management is practical and sensible for non-specialists.

The emphasis on routine water quality testing has been reduced so that future testing can be based on verification of a functioning water maintenance plan, rather than a routine exercise, to alert managers to the need for action. A shift in emphasis to routine management, with testing conducted on a needs basis, is preferable for remote areas due to the challenges and costs associated with gathering reliable results. Having less emphasis on water quality testing gives settlement residents more control over their water supply. It also places the responsibility with the local residents to carry out surveillance and take appropriate action if a hazardous event occurs. Action could range from rectifying the problem to calling on outside assistance.

4.3 Resources developed during the project

The water management plan generated using the CWP is daunting in both format and complexity for the majority of Aboriginal settlement residents. In particular, given that the generated plan is a text-based document, most residents would not have sufficient literacy and numeracy skills to understand the information.

Because the residents in the case study settlements have primary responsibility for water safety management, it was vital that the information was accessible for them. As a result, we developed the following resources to translate the CWP information into a format suitable for the project participants:

- water supply manuals showing water supply schematics
- water quality graphs comparing the water supply with the ADWG and, where possible, with regional water supplies
- posters of instructions about water management activities, such as chlorinating a rainwater tank, understanding hazards and reducing risks
- maintenance logbooks to record when activities have been carried out.

The water supply manuals are published separately to this report. The schematics and graphs are included in the case study reports (see Appendixes 2–6).

4.4 The Sustainable Livelihoods approach

The communities participating in this project each engage in livelihood activities that are made up of a variety of jobs and small business opportunities. Aspirations in all the communities depend on a functioning water supply. Developing the aspirations further, however, was a component of the Sustainable Livelihoods approach not used in this project. It was not appropriate to embrace the approach in its entirety since this would require both deep and wide debate about the goals and visions of the residents. Instead, we focused on the water management planning to keep to the purpose of the project.

In the participatory process, we used the Sustainable Livelihoods assets pentagon as a tool to engage and enable residents' aspirations to be part of the planning process. The assets pentagon was completed with participants twice during the project – during the early identification of residents and of a settlement's assets, and as an evaluation tool to identify any changes during the project. When using the Sustainable Livelihoods worksheets, participants were able to identify, rank and analyse problems and opportunities as they perceived them. Advantages in using the assets pentagon were as follows:

- Participants were able to see the discussion parameters and be involved in creating the finished product.
- The activity allowed for broad-ranging and enthusiastic discussion.
- The pentagon shape that emerges is effective in a cross-cultural setting at showing strengths and weaknesses.

In the initial discussions to assess assets, we identified appropriate ways of building the assets and capabilities at each settlement to pursue a water management plan. For example, in the case of low physical assets, the communities could work to improve the infrastructure or apply for a grant to buy tools and equipment. In the case of low human assets, the residents could engage in a skills program. Using the completed assets pentagon, residents were in a strong position to direct further investigations related to their water supply and generate their own local water management plan.

Because the assets pentagon relies on participants' perceptions, it cannot be viewed as definitive. It is useful as a work in progress to visualise change during specific times. However, it is important that the information provided by participants is not simply taken at face value. Whenever possible, data gathered during the participatory process was triangulated with other data sources. The purpose of this triangulation was to verify the data against information from other stakeholders. It is important to make sure all stakeholders are aware and supportive of the methods and fundamental assumptions. Discrepancies between local interpretations and understandings of water use and supply and broader policy and data collection need to be resolved.

During the evaluation, the assets pentagon for each case study settlement showed an improvement in assets. In some cases the pentagon represented a fair assessment of the magnitude of change, yet, in others the pentagon did not show the apparent transformation that had occurred. A thorough Sustainable Livelihoods analysis seeks to understand the macro institutional influences on small communities and whether these can be improved. While this may apply in the international context to, for example, an emergency food relief program, in Australia the context is very different. The history of welfare programs has left a legacy of disempowerment at the settlement level, particularly in the form of what may be described as a disabling of initiative through the concentration of decision making beyond the users or communities. For example, in two of the case study settlements, the human assets – the skills and knowledge about the water supply – were high whereas the water supplies required some improvements to make sure they functioned properly. While it was feasible that the communities could have made the improvements themselves, adequate technical knowledge was not available to them. The knowledge and information-sharing process during the project was a catalyst for participants to carry out many repairs and maintenance activities, usually with their own time and money.

The importance of the participatory approach is the immersion of the outstation residents, as beneficiaries, in decision making and the water management planning process. The facilitator needs to be skilled in engagement processes and building relationships, and clear objectives are critical to make sure that the information and activities elicited are authentic to the needs of the residents while maintaining the program intent.

4.5 Capacity building

Capacity-building initiatives were embedded throughout the project, including initiatives to reinforce the water quality and hazard analysis components of the water maintenance plans. Evidence shows that a training program simply tacked on at the end of a project will not sustain management (Grey-Gardner & Walker 2002). Therefore, capacity building was staged throughout all phases of the project. During the early stages, the objective was to make sure that participants adequately understood water quality and quantity issues and the relevance of the ADWG. Later, the aim was relating the information to protecting the water supply and developing the water management plans.

Capacity-building initiatives were a primary component in developing the water management plan. Participants were involved in performing water system rectifications and creating their water management plans. They also engaged in activities to make sure that the water plan information remained available to users. Strategies included erecting signs or making logbooks to record management procedures.

A formal training program was designed and run in three of the participating settlements. The skills development program was coordinated by the Centre for Appropriate Technology and involved instruction in Vocational Educational Training (VET) accredited units in applied design and technology, measurements and calculations (such as how to dose a tank with chlorine), basic repairs and maintenance of the water supply, and basic repairs of health hardware and fixtures. However, the experience gained in this project confirms that is not necessary for capacity building to be tied to an accredited VET course. The VET course is designed for Aboriginal environmental health workers and covers a range of industry competencies that do not prioritise empowering settlement residents to understand risk management strategies or enable informed decision making about water supply operation and management. In VET courses, learning tends to be about meeting predetermined course outcomes rather than being responsive to community or individual needs.

In fact, the experience during this project supports evidence from Guenther et al. (2005) that qualifying to Australian Quality Training Framework standards tends to refocus the learning towards set curricula rather than responding to local demands and project objectives. The VET units would need to change a lot to meet the needs of settlement-based water risk management strategies. Formal accredited training needs to be supplemented by informal, learner-driven adult education and capacity development relevant to either the project or the local environment.

4.6 Impact

In all case study settlements, project objectives were achieved. However, the benefit derived from participating in the project has been much broader than the anticipated outcomes. The case study communities have been engaged and willing to take on the responsibilities associated with water management activities. In one settlement, there was an immediate impact from the knowledge-sharing process. The settlement had a water supply that had not been functioning properly for more than a year. A meeting was held with the residents, where engineering and design drawings of the water supply were presented. The drawings and supply design were discussed at length. The participants were able to understand the components of the water supply and then think through a means to fix the problem together. Within a week of the meeting, the residents had fixed the water supply themselves. This tangible impact was partly due to the sharing of information, but it also seemed that the residents just needed a mandate and encouragement from people with expertise to repair it themselves.

Furthermore, participating communities have frequently shown initiative and improved their water supplies using their own building materials, time and funding. This includes installing taps or offering to build a fence around a bore to prevent cattle access. In one case study settlement, the residents walked along the water system with the project team, to discuss the kinds of problems they experienced and the improvements required to secure the supply. A concrete apron was recommended as a high priority rectification. By the next meeting a couple of months later, the concrete apron had been built around the borehead by settlement residents. This reflects a keen self-sufficiency in remote communities.

The experience of participation over time in the project and the stepwise working towards understanding and securing their water supply had an impact on social cohesion and residents' confidence. In one settlement, for example, the water manual has been used at the Aboriginal Corporation's annual general meeting to initiate broader planning around assets and infrastructure. Residents of the settlement have also commented that the experience of this project has facilitated longer-term thinking about their settlement and the types of responsibilities and skills residents will need to work as partners with government and service agencies. At another settlement, the experience of the project has shifted horizons and inaugurated strategic thinking about new livelihood strategies that will help build the future sustainability of the settlement.

4.7 Lessons learnt

Some successful concepts and observations emerged during the participatory process:

- For each water management strategy, priorities were set based on scientific data and the discussions centred on controlling the risks to the water supply. The response from participants was generally positive, since residents were able to understand the risk management approach. Judgements on the quality and potential use of the water supply were not then based simply on compliance with the ADWG values, but also addressed local priorities. In addition, a comparative analysis, using data from other remote settlement water supplies in the region, helped participants understand why water supplies had particular qualities.
- Potential improvements in each settlement's water quality or quantity were discussed and possible changes in maintenance requirements and lifecycle costs were presented. Installing a big reverse osmosis machine, for example, would not reduce the maintenance responsibilities; rather it would increase them. The cost analysis also reinforced the focus on the management aspects of the water management plan, and on assessing what suits the needs of a small settlement and what resources are necessary for implementation.
- In each case study settlement, the communities selected strategies that were low maintenance and within their settlement's existing human and financial capacities. Their emphasis was on securing their existing system and staying self-reliant using local skills. Many skills at the local level had been either unnoticed or unrecognised by agencies and, in all but one settlement, had been untapped.
- It takes time for information to diffuse throughout the residents of a settlement. The quality of engagement with the participating communities was not necessarily apparent during initial meetings. It was crucial to leave resources behind and let people talk afterwards. In some cases,

where there had been ‘poor’ experiences of enterprise projects driven by government, there was quite a long lead time before communities were willing to really commit to the project. Once participants could see that knowledge and benefits were to be gained through participating, many more settlement members got involved.

- The communities were occupied most of the time, but all had a degree of movement of some people in and out of the outstation, sometimes for work or family caring responsibilities. The communities had leaders who were active across a broad spectrum of activities and were very much in demand. Although this delayed the project progress in some cases, it was evident that there was a deliberate focus on succession planning strategies in the communities to encourage others to take on responsibility and understand the water supply management system.
- Social capital was high[1] and all communities had one or two strong leaders or governance champions who remained involved consistently throughout the project. There was evidence during the project of strong bonding and bridging capital developing at the each of settlements. The bonding capital relates to closed networks – especially kin groups – and bridging capital relates to the overlapping of social networks (Johnson et al 2005), developed through the leaders from each settlement engaging in a range of activities external to their settlement.

1 Social capital in the communities was high, although, during the assets pentagon analysis, community members did not always consider it high with respect to the water supply.

5 A people-focused future

5.1 Decision making at scale

The water management plans have been successfully implemented at the case study settlements and there are indications that the people-focused approach has benefited residents and the settlements beyond simply water management. However, the institutional arrangements in the water management sector require significant change to accommodate a people-focused (rather than a technology-focused) approach. The key shift would be recognising the scale at which decisions are made and devolving responsibility accordingly (Wand & Stafford-Smith 2004). The roles and responsibilities of regional agencies would need to be redirected to recognise and support local-level management and provide support for interventions, as specified and agreed in the management plan.

There is the opportunity for local-level decision making to recognise and more accurately meet the needs of changing conditions. Korten (1986) observed that the link between decision and consequences is closest when decisions about the use of local resources reside with the local residents. This also implies that people to whom control is delegated should be as directly accountable as possible to those affected by the decisions made.

The risk management framework and the CWP provide the practical framework within which a range of adaptive strategies can be applied. The range of contexts in remote communities requires an adaptive approach that encompasses a range of responses for different situations, which span from just keeping a water supply functioning properly to dealing with emergencies. Local decision making also allows a more flexible and evolving process for water management through review and continual improvement.

A generic matrix that associates risk with water supplies may be an effective means of correlating management activities to water supply responsibility in a scale-based approach. Figure 3 adapts the basic risk factor matrix used to identify risk associated with each possible hazardous event for any water supply from the *Australian Drinking Water Guidelines* (NH&MRC 2004: A11) and the *Guidelines for Drinking-water Quality* (World Health Organization 2004:55). The matrix depicts the corresponding scale for the institutional level at which decision making and responsibility would reside in a structured management program. The certainty of an event is ranked in three categories:

- High – once a day or once a week
- Moderate – once a month or once every six months
- Low – once a year or once every five years.

The severity of the consequences of each event is categorised from insignificant to catastrophic with reference to the potential to cause harm to people. The severity of consequences refers to events that range from relatively insignificant or no impact (or an undetectable impact), to the most severe or catastrophic consequences, i.e. potentially lethal to a large population. A rare and low risk event for a remote settlement water supply, for example, could be cracks forming in the cement apron at the borehead. A high likelihood risk with catastrophic consequences could be a seasonal cyclone damaging a septic tank and contaminating the water supply with high counts of pathogenic bacteria.

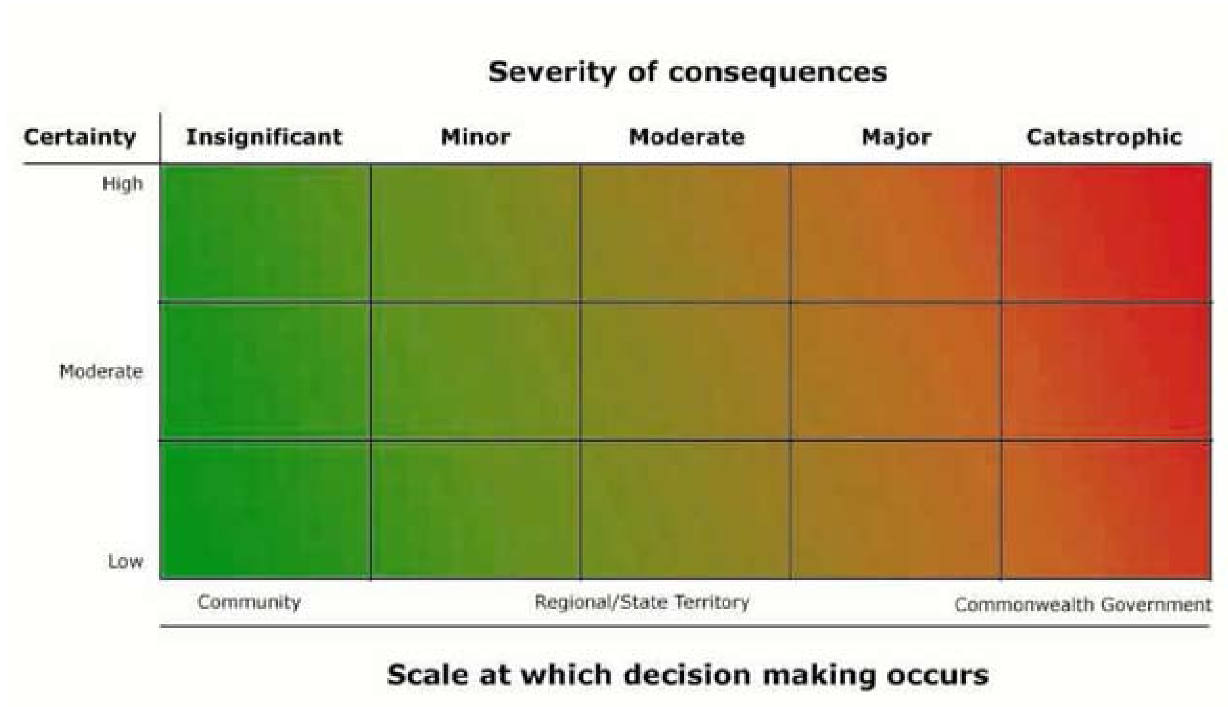

Figure 3: Risk management at scale (adapted from NH&MRC (2004:A11) and WHO (2004:55))

The core elements of a risk-based remote settlement water management model rely on clarity about the scale at which decisions are made, as follows. At the local level, residents would make decisions on affordability and levels of service as well as maintenance plans and implementation strategies. The local-level responsibilities would address low to moderate risk measures and include identification of capacity-building needs. At the regional scale, decisions and support would include on-ground advice and technical support for moderate to major severity events, such as severe infrastructure breakdown; emergency responses that require rectifications; and investment in additional surveillance assistance and reporting processes. At the national scale, support and responsibility would be for decisions about emergency responses and investment strategies for maintaining capacity-building initiatives. Accountability and reporting processes at each scale would be delineated.

The Sustainable Livelihoods assets pentagon could be modified to embrace a risk management approach and consider the degree of self-reliance among the residents of a settlement. This approach would suit the institutional arrangements in an Australian context. The matrix in Figure 3 shows how self-reliance may be estimated to indicate the position of settlement residents to make decisions about water management and act independently on those decisions. The degree of self-reliance may be directly related to the management requirements for the scale at which decision making occurs (see Table 4).

The use of a 1–5 scale (or blue – yellow – red) would also be a means for project participants to assess the degree of change that has occurred during the project. It may also link with the longevity of water management activities. It could be incorporated into the Sustainable Livelihoods assets pentagon by simply colouring the pentagon in the colour appropriate to the residents' assessment of their independence. This could be used during a participatory process to identify and assess any transformations of empowerment over time.

The self-reliance scale would also reflect the capacity for the residents to take up the level of responsibility associated with the tasks of managing the water supply, as outlined in the risk-based water management scale matrix (see Figure 3). The case study settlements that identified low levels of human capital (skills and knowledge) early in the project had increased their level of self-reliance by the end of the project. The skills development undertaken, including formal training, enabled them to carry out their own maintenance. Instead of waiting for a service provider to respond to small water supply failures, the residents can now act themselves and spend their limited funds on other activities.

Table 4: Water management self-reliance

Level of self -reliance	Example	Relationship to risk management at scale matrix	Scale	Colour for pentagon
Low	Substantial external support for all water supply activities	Unable to manage events with insignificant consequences	1	
Low to medium	Substantial external support required for most water supply activities	Able to manage events of insignificant consequences	2	
Medium	Some support required for some activities and specialist services	Able to manage events with minor consequences	3	
Medium to high	Some support required for specialist activities	Able to manage events with major consequences	4	
High	External support rarely required except for emergencies	Able to manage /prepare for events with catastrophic consequences	5	

5.2 Opportunities

With this project, we have made significant progress in developing a coherent and strategic approach to water management in remote communities. We have endorsed the available tools and strengthened the existing approach by creating an enabling process for remote communities to develop and direct their own water supply management plans. We have made significant learnings: in particular, remote settlement residents have skills and experience to contribute to water management and rectifications. Sharing their knowledge and experience with service providers and government agencies would significantly improve the corporate knowledge and subsequently the sustainability of water supply systems. In addition, developing a mechanism for residents of small settlements to share skills, knowledge and experience could provide a lateral support network. Project participants benefited from sharing ideas with each other. And they firmly believe that a formal Aboriginal water network would fulfil an important role in establishing and building effective linkages between settlements for local water managers and residents.

The opportunity for the future of water management in remote communities lies in a deliberate investment in capacity building which enables clear activity roles and functions that go beyond just providing hardware and infrastructure. Narayan (1995) suggests that when programs need to respond to the needs of hundreds of scattered communities, large centralised agencies in the public sector are neither effective nor efficient in service delivery, and suggests identifying other agencies that can serve as intermediaries. In the Australian context, formal recognition of the roles of personnel in essential service delivery agencies and non-government organisations to work in partnership with Aboriginal settlement residents would lead to greater sustainability (Carter et al. 2005). The overarching planning and funding processes would need to recognise the levels of responsibility (including accountability and responsibility according to risk) that are linked to scale. However, the ability of Aboriginal settlement residents to adopt the risk management approach and use their initiative will be constrained by the extent to which the political and policy environment can enable the devolution of decision-making responsibilities (Hobley & Shields 2000).

Employees in the relevant essential service delivery programs urgently need more capacity in risk management principles and evidence-based approaches to program management. Specifically, people working in the field should know the impact of a predominantly technological approach to water management. The current program approach is analogous to a local football team whose development strategy is limited to acquiring the latest new equipment (balls and goalposts) and improved facilities (synthetic grass) without the necessary strategies to improve game play or professional development for the coach. Most people working in program delivery can understand the gaps in such a strategy when associated to sport, but are so immersed in the complexities of remote communities that ‘fixing’ problems ‘once and for all’ becomes the misguided and short-term priority.

This project was dedicated to working with the smaller homelands and outstations that are not part of an externally operated maintenance or management program and do not have structured support from an agency such as a water corporation or a shire council. We have worked with communities that arguably already have strengths in the area of self-management. The project team’s response in each settlement was deliberately different to increase opportunities to identify new methods of communicating and building capacity. The resources we developed and the approach we refined throughout the project could be successfully transferred to other initiatives (such as housing) across diverse locations. However, a settlement without livelihood options for the residents, strong governance or leadership will require a broader approach to capacity building than the initiatives in this project.

The outcomes from this project provide a practical and adaptive approach for policy makers, planners, essential service agencies and remote communities to the analysis and design of solutions and strategies linked to water management. This will improve the delineation of the responsibilities that can be assumed by remote settlement residents and those that need to be assumed by service agencies and/or governments.

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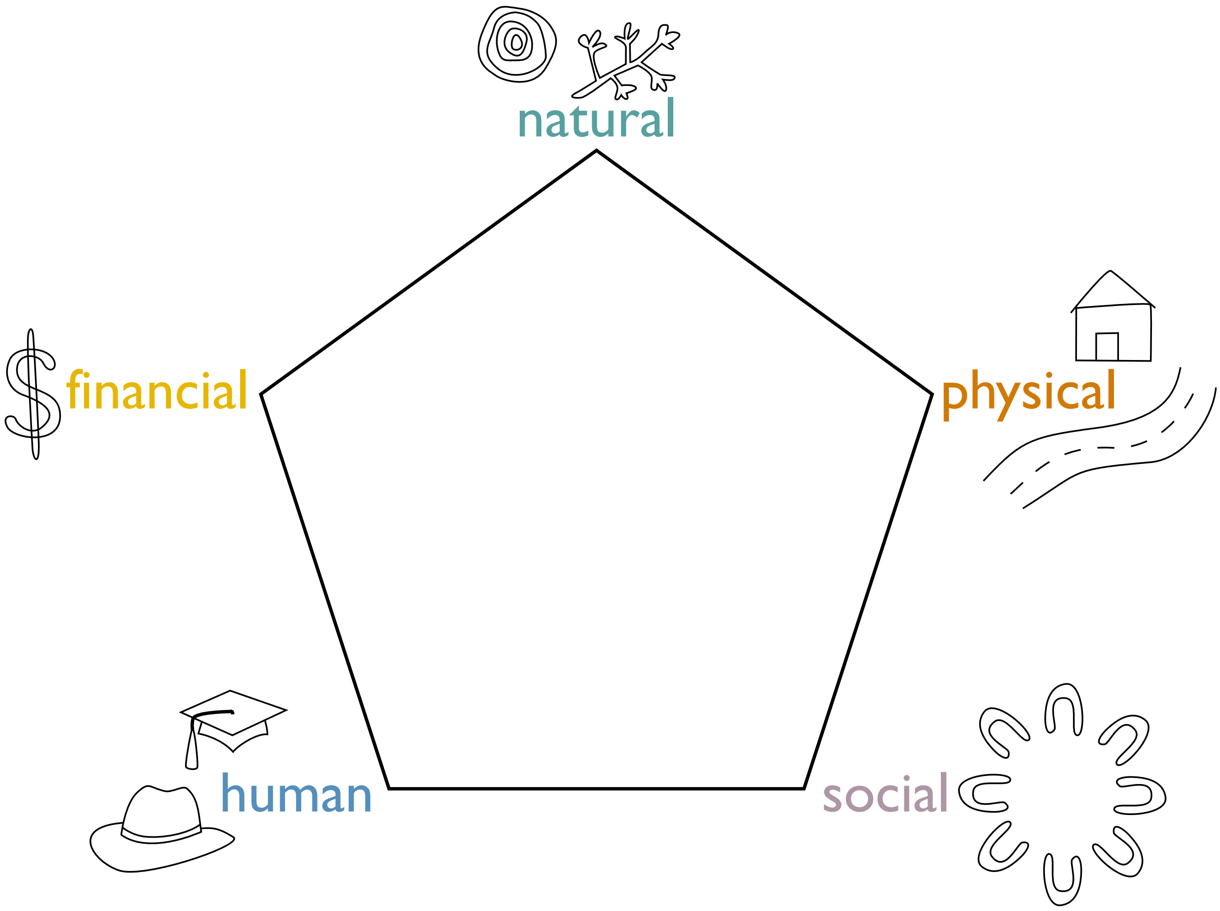
Appendix 1: Sustainable Livelihoods assets worksheet



Appendix 2: Kanpa case study

Kanpa case study

Contributing author information

Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the Desert Knowledge CRC Remote Community Water Management project. Robyn is based in Alice Springs and is an environmental and social scientist. Robyn has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. For the last seven years Robyn has worked with Indigenous communities, mainly on water management programs.

Acknowledgements

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Cover photo – Mr Preston Thomas and his grandson Abraham Thomas at Kanpa, November 2006.

Contents

1 Introduction

In this case study, we describe the information gathered for the Desert Knowledge Cooperative Research Centre (DKCRC) Remote Community Water Management project about the water supply and needs for the remote settlement of Kanpa in Western Australia.

The process included developing a water management plan for Kanpa and empowering residents through participatory involvement in making decisions about Kanpa's future water management. We also describe how the project team responded to the needs of the residents by adapting the research activities to make sure that the water management plan was tailored to the needs of residents, within the time constraints of the project.

The Kanpa water management plan was developed over the course of a year and involved the following activities:

- Describe the water supply.
- Assess livelihoods and identify the match between the water source and residents' aspirations.
- Identify a strategy to manage the water supply.
- Enact the water management plan.

The information in this case study was gathered during meetings held at Kanpa in November 2004, November 2005, April 2006, August 2006, and November 2006. Further information was derived from the workshop held in Alice Springs in September 2006 and during the training program conducted at Kanpa during October 2006. The information gathered during the visits to the settlement was supplemented by desktop research and discussions with staff at the Indigenous Coordination Centre at Kalgoorlie, the Shire of Ngaanyatjarraku and Ngaanyatjarra Council.

In this case study, we outline the outcomes of each stage of development.

2 The settlement of Kanpa

Kanpa is a remote settlement in Western Australia, located around 140 kilometres south-west of Warburton on the Great Central Road (Outback Highway). Kanpa was established in January 1994 to provide a culturally appropriate bail facility for local juvenile and adult substance abuse offenders. There is also a hostel where visitors can stay.

The Kanpa settlement houses young Aboriginal people while they are on bail or subject to a court order. The young people who come and stay at Kanpa under this program may stay under a supervision order and curfew for up to 18 months. Many other young people also come to stay at Kanpa and they are often self-referred. They may come and stay to recover or to take time out. During their stay they engage in local activities and may work on CDEP (Community Development Employment Projects).

Kanpa residents recognise that a variety of activities will strengthen the future viability of the settlement. In addition to supporting young people, the residents also host annual music festivals for people who want to enjoy themselves without drugs or alcohol. The residents are also keen to establish enterprise activities that use the available natural resources.

3 Kanpa's water supply

Photo 1: Project meeting at Kanpa, October 2005

3.1 The water source

The water system at Kanpa is a simple groundwater supply that is pumped to a header tank and gravity fed to the settlement buildings which are houses, workshops and the hostel. The header tank is pumped each day. The power supply to pump the water is manually operated. The supply meets the current needs of the settlement and residents have never experienced any water restrictions. Residents are careful to use the water conservatively to maintain a sustainable level of supply.

The bore provides all the water for the settlement – there are no rainwater tanks or facilities to store an emergency or backup water supply.

In October 2005, residents and the project team assessed the water supply. We recorded basic water supply information and sent water samples to a) the Northern Territory Environmental Laboratories for chemical and metals analysis, b) Pathwest for microbiological analysis, and c) the Australian Radiological Protection and Nuclear Safety Agency for radiological analysis (see Appendix 2A for results).

Based on information provided by Ngaanyatjarra Services, we drew a water supply schematic (Figure 1). Specific information about the assets and infrastructure and details about the location of pipes was not available. The schematic became the foundation for future discussions about managing the water supply and developing the maintenance manuals.

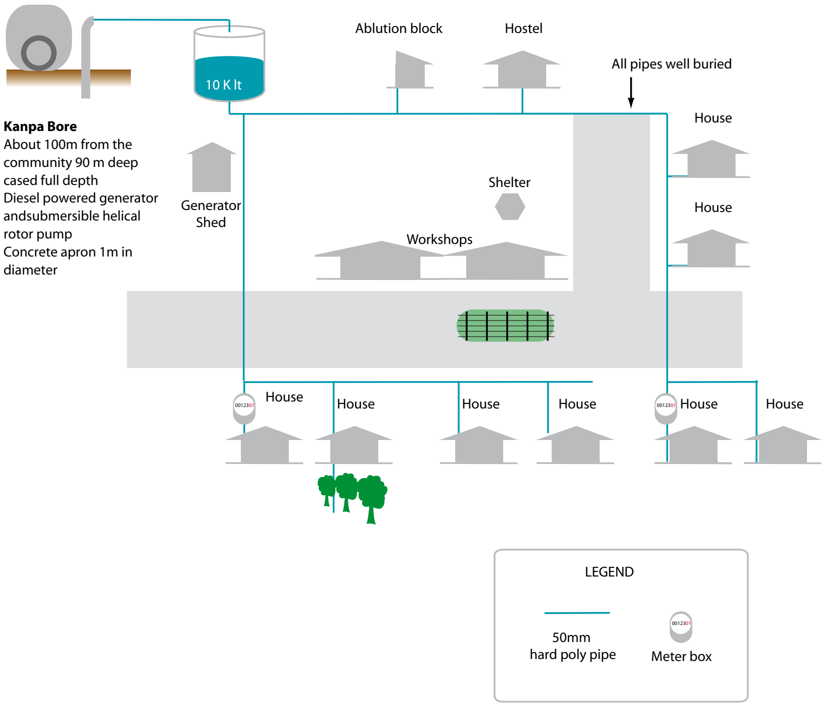

Figure 1: Kanpa water supply schematic, March 2006

3.2 Water quantity

The bore at Kanpa is legendary.

– Damian McLean Warburton Council.

The water supply bore at Kanpa draws from the Officer Basin and was originally drilled as part of a Shell oil exploration program. The following information is drawn from local residents who were on site during the drilling of the bore on 24 June 1983. The bore is 900 metres deep and gravel packed and screened at 70 metres. The bore's capacity is expected to be high. The exploration bore 'Shell number 7' was drilled nearby and delivered 30 000 gallons an hour during the pump test, which showed no drawdown after 24 hours. The capacity of 'Shell number 7' is indicative of the Kanpa bore capacity.

We approached the following organisations to gather formal data and information about the bore:

- Western Australia Water Sources Division
- The Water Information Branch of the Western Australian Department of Water
- Shell Development (Australia) Pty Ltd
- Geological Survey Division of the Western Australian Department of Industry and Resources
- Ngaanyatjarra Council
- Shire of Ngaanyatjarraku
- Parsons Brinkerhoff Pty Ltd
- Sinclair Knight Merz Pty Ltd
- The Australian Government Department of Families, Settlement Services and Indigenous Affairs.

No recorded data were located for the Kanpa water bore.

3.3 Water quality

The Kanpa water quality tests showed that the bore water was of good quality. There was no microbiological contamination and low levels of chemical, metal and radiological constituents. The key constituents are shown in the water quality graph in Figure 2. The graph shows water quality data as a percentage of each value used in the Australian Drinking Water Guidelines (ADWG). Traffic light icons indicate the level of management the water supply may require according to the constituents. The doctor icon indicates that the ADWG value is derived from a health parameter; all other values are aesthetic. Where available, median water quality data from remote settlements in the region are shown as a yellow bar. This allows a crude comparison of the local water quality with that of other communities in the region.

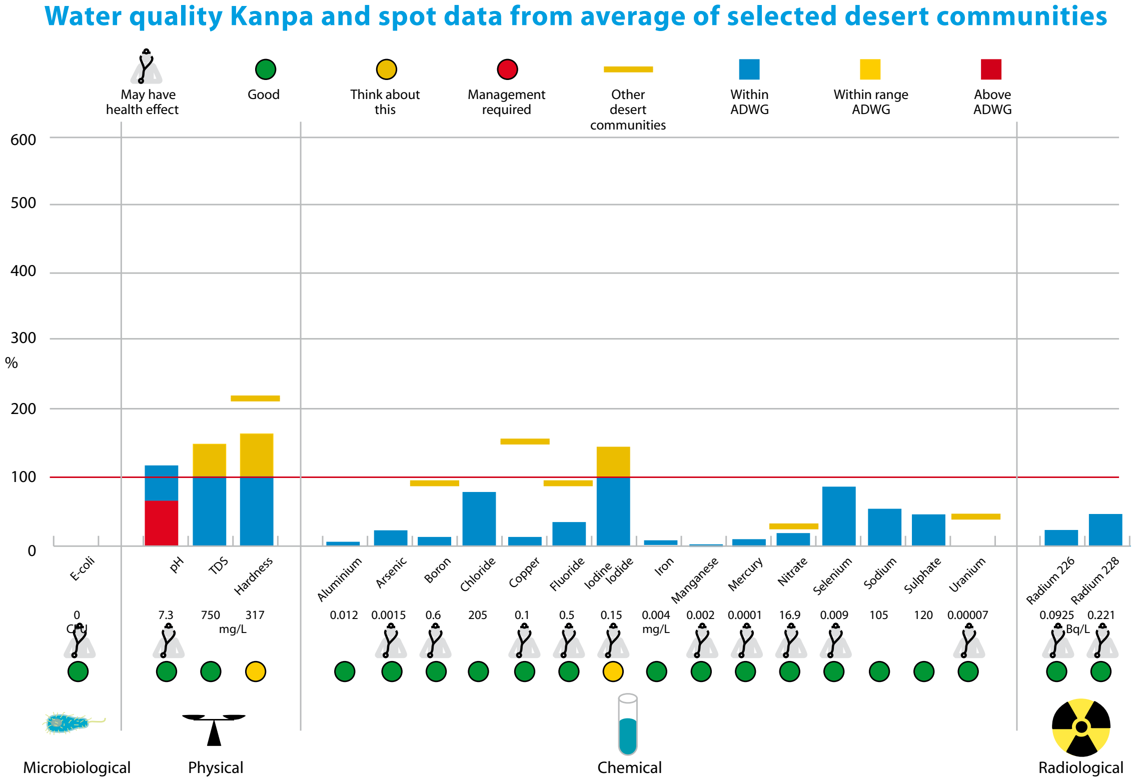

Figure 2: Water quality data for Kanpa, March 2006

4 Livelihoods activity

4.1 Participants

The permanent population at Kanpa ranges between 10 and 20 people. There are regular visitors who may stay for extended periods of time. The meetings at Kanpa were always fully inclusive of residents and often had up to 20 participants.

4.2 Livelihoods assessment

We used the Sustainable Livelihoods assets pentagon to better understand the participants' capacity to implement a water management plan, and to identify current and planned activities at Kanpa. The settlement has some plant equipment and a well equipped and maintained workshop. A couple of people are 'water trained'; however, they are not permanent residents and often leave the settlement for extended periods for work. There can be times when there is no-one at Kanpa with adequate water management skills and knowledge. Like most remote communities, people move in and out all the time. Newcomers do not know how to manage the water supply. The pentagon is shown in Figure 3. The assets are described in Table 1. The Sustainable Livelihood asset pentagon shows that the residents are in a good position to manage their own supply but stability may be enhanced in the future with some strategic capacity building.

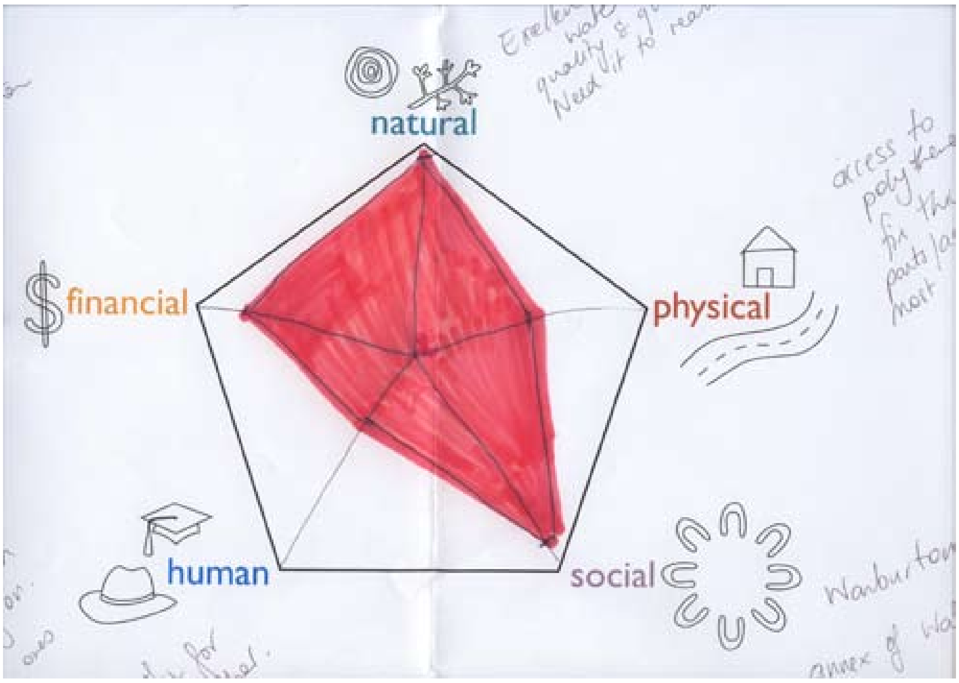

Figure 3: Kanpa assets pentagon, April 2006

Table 1: Kanpa livelihood assets

Asset	Description
Natural capital	• Excellent water – good quality and plenty of it. The water is needed to realise livelihood plans. • There is a small orchard and a few horses on the settlement that require watering, but the demand is quite low. • The quality of the bore is adequate for the purposes. Drinking water quality is good – palatable and easily managed.
Social capital	• Residents have strong relationships with local settlements and family. • Young people are coming and going all the time.
Human capital	• Knowledge and skills related to the water supply are high with the older residents but low with the youth. Older residents have high ability to solve problems and rectify damage to the water supply. • There are reliable support services 90 mins away at Warburton.
Physical capital	• The bore and tanks are in good condition and designed to suit the needs of the settlement. The system is 'simple' and easily managed. Other basic infrastructure on the property is in good condition. • Tools and equipment to make rectifications are available on site. There is a very well maintained workshop. • The main difficulty is getting replacement parts to a remote location.
Financial capital	• Kanpa is in a good position to finance small equipment failures. • Ngaanyatjarra Council can provide assistance for large equipment failures. • Fuel costs are subsidised through Warburton.

5 Site-specific plans

The Kanpa residents are happy with their water supply and were keen to understand the results from the water testing and desktop research. The information would allow them to make firm plans for the future, and be confident that the settlement could be sustainable. We presented the findings from the *Community Water Planner* document and suggested some immediate rectifications to the water supply and ongoing management activities that would help keep the water safe. Immediate rectifications included creating a concrete apron around the borehead, building fencing around the borehead and capping unused bores.

The assets pentagon showed that the settlement already has many assets to manage its water supply, including confidence in the water resource itself, and plenty of support from social networks and agencies. We identified that the best investment would be to help develop the skills and knowledge of the younger people at the settlement. Kanpa residents were enthusiastic about receiving on-site training in water management. They also wanted ‘a manual of what to do, that anyone can read’.

The residents decided that regular laboratory water testing was not an activity that they felt was practical; however, they were interested in doing some regular water testing themselves if possible. The purpose of the testing was to check for any changes in the water quality. They appreciated that the risk management activities would help to maintain the integrity of the water system.

The residents had little appreciation of how much water was being used in the settlement each day. There were differing opinions on how frequently the water tanks required filling. The discussion centred on the reasons why the water use may change from time to time. A change in water demand could be seasonal or at times when there are more people at Kanpa. It was decided that water meters would help residents to understand the demand for water and that meters should be installed at the borehead and at each house. Other activities discussed included lobbying for a bigger storage tank and installing a shut-off valve at the main tank.

6 Enacting the plan

The training program at Kanpa included eight young participants. The residents of Kanpa felt the training provided an opportunity for permanent and temporary residents to work together and make immediate rectifications to the water supply. It was also an opportunity to invest in the future and spread the word about water management since ‘the young people [temporary residents] will go back to their own communities and will be able to do good work there’.

6.1 Kanpa skills development

Photo 2: Kanpa residents concreted around the borehead and covered the cables before the skills program started.

Photo 3: Water meters were fitted at the bore and at each house.

Photos 4 and 5: Participants learnt about plumbing fixtures and fixed leaking taps.

Photos 6 and 7: The area under the storage tank was often flooded and participants built an outflow pipe and concrete trough.

Photos 8 and 9: Participants concreted around the base of the storage tank and created a channel to direct any overflow away from the settlement. A flow valve was fitted to the main tank.

Photo 10: Kanpa residents can carry out their own water testing. The maintenance procedures manual contains record sheets for water meter readings and water quality results. Maintenance schedules were drawn up and people volunteered for water maintenance activities.

7 Conclusion

We assessed the project at Kanpa in November 2006. We used the Sustainable Livelihoods assets pentagon to identify areas of change in the settlement's assets at completion of the project (see Figure 6). The pentagon remains the same general shape; however, there is some increase in human assets due to the capacity building, and some improvements in the infrastructure due to the rectifications. The improvements to the infrastructure were not considered substantial although residents recognised the benefits in reducing the risk for contamination and maintaining the good water quality.

During the assessment meeting, participants were more inclined to describe the impacts of the project rather than the direct outcomes. The residents' view is firmly of the future. Preston Thomas said that participating in the project has 'helped to turn the outlook in a new direction for the betterment of the community'. The information and capacity building has helped the residents to understand what aspirations are realistic and the limits to growth for Kanpa.

The most significant change from the project for the participants was the shift in focus and attitude. The people at Kanpa feel a greater pride and are now more inclined to see what they already have, rather than what is lacking. There is a greater potential to seek new social networks and build the livelihood opportunities for Kanpa. There is a sense of 'coming together' to achieve a better future.

Some changes in behaviour relate specifically to the water supply. The young people at Kanpa are now aware of the water supply. The water quality is known to be good and so they are drinking more of it. Apparently, before the project the young people would buy four or five soft drinks a day. Now they freeze water in containers to drink most of the time and only buy one or two soft drinks a day from the shop. Another impact from the raised awareness is that water is not wasted – taps are now always turned off.

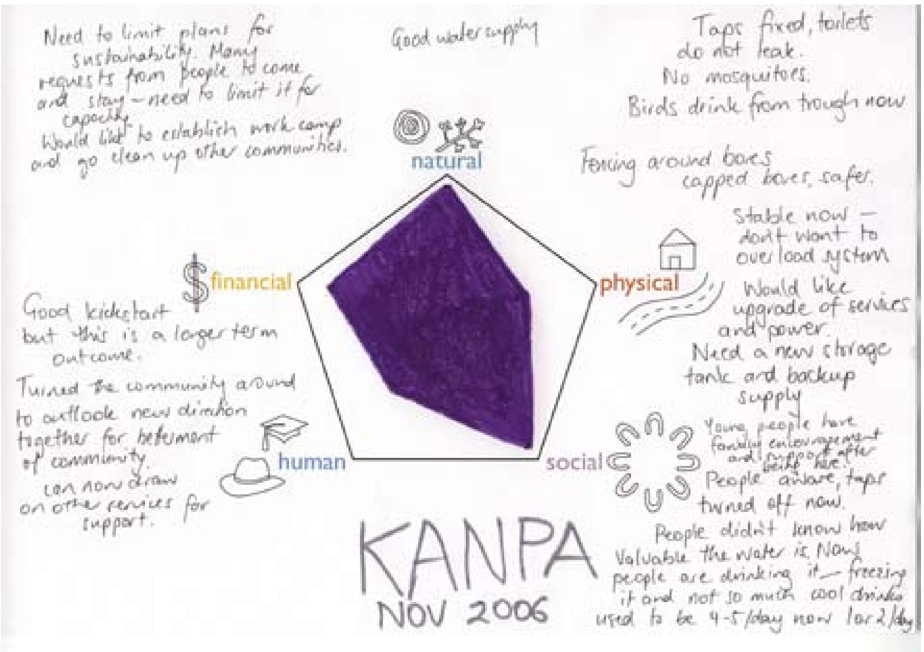

Figure 6: Kanpa assets pentagon, November 2006

The project has facilitated safe water management for the future of the Kanpa settlement. While it has been a great kick start for the settlement, water management is a long-term project. There is still more that the residents can do to secure their water supply; for example, establishing a backup supply, such as rainwater tanks, and continuing to build capacity so that the knowledge and understanding of the water management plan is continued despite changing residents.

The end-of-project assets pentagon is a realistic appraisal – particularly considering the long-term nature of water management and the short timeframe of the project. The project at Kanpa had limitations – there were strict timeframes and a fairly narrow focus in the training program. Nevertheless, the risk management outcomes have been effective and the impact has been noticeable. The impacts discussed during the meeting are not all represented in the pentagon analysis. In essence, there has been an increase in social capital for Kanpa, both with project participants (including participants from other settlements) and with water agencies. The residents have a good understanding of their water supply and can identify hazards and risks. They are able to manage the everyday operation and maintenance of the supply and know where to go for help.

Relevant supporting documentation

Warburton Community 2004, 'We can write our own Plan', Community Development Plan 2004/05 – 2008/09.

Human Rights and Equal Opportunity Commission 1997, *Report of the National Inquiry into the Separation of Aboriginal and Torres Strait Islander Children from Their Families*, the report, juvenile justice policy and program responses, http://www.austlii.edu.au/au/special/rsjproject/rsjlibrary/hreoc/stolen/stolen55.html#Heading228.

Appendix 2A: Kanpa water quality data

Water quality chemical and radiological test results, June 2006:

Constituent	Abbreviation	Units	Kanpa bore supply	Notes
Electrical Conductivity	EC	µS/cm	1150	
pH	pH	units	7.3	
Bicarbonate	HCO3	mg/L	37	
Alkalinity	Alkalinity	mg/L	37	
Calcium Carbonate	CO3	mg/L	<1	
Turbidity	Turbidity	NTU	<1	
Total Dissolved Solids	TDS	mg/L	750	
Total Dissolved Solids	TDS	mg/L	630	calculated
Hardness		mg/L	317	
Nitrite	NO2_N	mg/L	<0.005	
Nitrate	NO3_N	mg/L	16.9	
Chloride	Cl	mg/L	216	
Phosphate	PO4_P	mg/L	0.06	
Fluoride	F	mg/L	0.5	
Calcium	Ca_F	mg/L	67.2	
Potassium	K_F	mg/L	24	
Magnesium	Mg_F	mg/L	36.3	
Sodium	Na_F	mg/L	97.2	
Sulphate	SO4_F	mg/L	150	
Silicon	SiO2	mg/L	47.2	
Iron	Fe_F	µg/L	40	
Silver	Ag_T	µg/L	<10	
Aluminium	Al_T	µg/L	<20	
Arsenic	As_T	µg/L	1.5	
Boron	B_T	µg/L	600	
Barium	Ba_T	µg/L	<50	
Beryllium	Be_T	µg/L	<1	
Bromine	Br_T	µg/L	1370	
Cadmium	Cd_T	µg/L	<0.2	
Chromium	Cr_T	µg/L	<5	
Copper	Cu_T	µg/L	<10	
Total iron	Fe_T	µg/L	130	
Iodine/Iodide	I_T	µg/L	150	
Manganese	Mn_T	µg/L	<5	
Molybdenum	Mo_T	µg/L	<5	
Nickel	Ni_T	µg/L	<2	
Lead	Pb_T	µg/L	<1	
Antimony	Sb_T	µg/L	<0.2	
Selenium	Se_T	µg/L	9	
Tin	Sn_T	µg/L	<10	
Uranium	U_T	µg/L	0.07	
Zinc	Zn_T	µg/L	10	
Mercury	Hg_T	µg/L	<0.1	
Radium 226	Ra	Bq/L	0.0925	
Radium 228	Ra	Bq/L	0.221	
E. coli		CFU/100ml	0	

Appendix 3: Mpwelarre case study

Mpwelarre case study

Australian Government
Department of Families, Community Services and Indigenous Affairs

Centre for Appropriate Technology

CRC AUSTRALIA

DESERT KNOWLEDGE CRC

Contributing author information

Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the Desert Knowledge CRC Remote Community Water Management project. Robyn is an environmental and social scientist and has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. She has worked for seven years with Aboriginal communities, mainly on water management programs.

Nerida Beard is a water researcher and environmental engineer based at the Centre for Appropriate Technology (CAT) in Alice Springs, NT. Nerida has five years' experience in hydrology, hydrochemistry and geochemistry, and water quality management research. In the past two years, as part of her role as a water research engineer at CAT, Nerida has worked with Aboriginal people in remote Australia to understand and improve access to water supplies, drawing from their local knowledge and a network of water research and health scientists through the CRC for Water Quality and Treatment.

Kathryn Green is a water quality scientist with the Northern Territory Power and Water Corporation. Kathryn works on water quality and treatment issues that arise in the diverse environments of the Territory. She has spent most of her life in the Territory, in a number of different locations. After getting her Bachelor of Science degree from the University of the Sunshine Coast, Queensland, Kathryn was able to pursue her interest in remote communities and water supply management through her current graduate position at Power and Water Corporation.

Acknowledgements

Thanks to all the residents of Mpwelarre who participated in the project. In particular we would like to thank Margaret, Peter, Julia and Reg Kenny for their contributions and Malcolm Orr for his generosity. Thanks also to Harry Scott at Titjikala Outstations Resource Centre.

Figure 2 is provided with permission from Burdon Torzillo and Associates. The graphical layouts, icons and water quality graphs were designed by and are the intellectual property of Burdon Torzillo and Associates Pty Ltd.

Contents

1 Introduction

In this case study, we describe the information gathered for the Desert Knowledge Cooperative Research Centre (DKCRC) Remote Community Water Management project about the water supply and water requirements for the remote settlement of Mpwelarre, south of Alice Springs.

We describe the implementation process that evolved during the project, the development of the water management plan and the participatory process through which the resident family made their water management plans. We also present project information and activities carried out to make sure that the best possible outcome for the settlement was achieved within the time constraints of the project.

The Mpwelarre water management plan was developed over the course of a year and involved meetings and research activities. The plan was developed in four stages:

1. Assess the water source and risk management – understand the water system and local catchment characteristics.
2. Assess livelihoods – identify the match between the water source and the residents' assets and aspirations.
3. Localise water supply risk management – develop a local approach to risk management of the water supply to meet the needs and context of the settlement.
4. Enacting the plan and strategies – identify appropriate local strategies for water management into the future.

The information we present in this case study was gathered during meetings held at Mpwelarre in November 2005, May 2006, June 2006, August 2006, and October–December 2006. Further information was derived from a workshop held in Alice Springs in September 2006. We supplemented the information gathered during the visits to the settlement with information from desktop research and discussions with the Titjikala Outstations Resource Centre and government agencies.

2 The settlement of Mpwelarre

Mpwelarre is an outstation located around 100 kilometres south of Alice Springs, on the Stock Route west of the Maryvale/Titjikala road. It is home to the Kenny family who were granted land title for the area more than 20 years ago. The land had previously been an old stock reserve and is commonly known as Walkabout Bore. Around 10 family members live at Mpwelarre and visitors stay at different times during the year for varying periods.

3 Mpwelarre's water supply

3.1 The water source

The water supply was originally part of the Orange Creek Station. The irrigation bore (RN 2894) was drilled in 1962 but the infrastructure in the bore is failing and so this bore is not now used. The Mpwelarre bore, located near the houses, was drilled in 1990 (RN 15625). A third bore, which supplements the Mpwelarre bore supply, is known as the 'solar bore' (RN 16814). These two bores together supply the settlement's storage tank (although the solar bore at a much lower flow rate), which feeds the reticulation system.

The everyday maintenance is provided mainly by resident Malcolm Orr with some assistance from other residents and the Titjikala Outstations Resource Centre. Titjikala is 55 kilometres from Mpwelarre and provides backup assistance for essential services.

In May 2006, project participants and the project team assessed the water supply through a series of photographs, water quality sampling and recording basic water supply information including a schematic of the system layout, key nodes (e.g. tanks, sources) and the number of connections. We developed a descriptive map of the water supply layout (see Figure 2) and the key details of the water supply were entered into the *Community Water Planner* (CWP). The risks and rectifications identified by the CWP guided the meetings and direction for building the Mpwelarre water management plan with the residents.

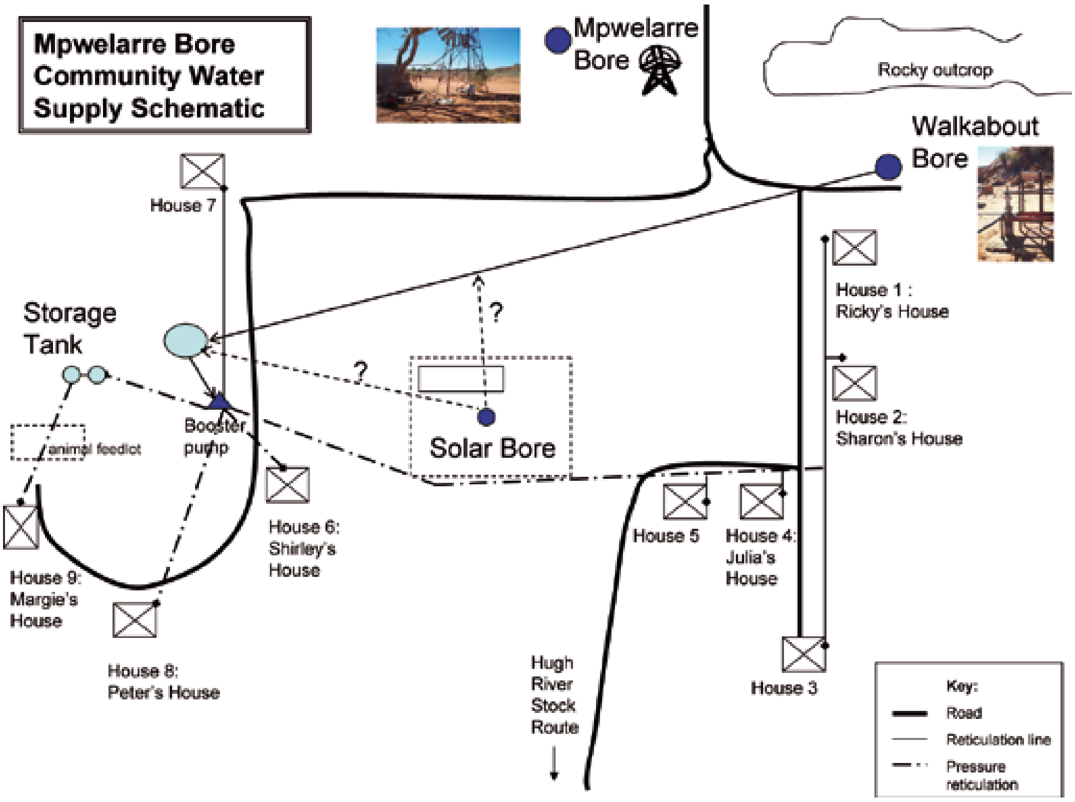

Figure 2: Mpwelarre water supply schematic

3.2 Water quantity

The water supply at Mpwelarre is a simple system that meets the quantity needs of the settlement. Most houses also have at least one rainwater tank. Residents of Mpwelarre have experienced water restrictions twice in the last five years. These restrictions were attributed to failures of large pieces of the infrastructure (the storage tank liner and a generator) and appeared to be related to the age of the infrastructure.

3.3 Water quality

Chemical and microbiological water quality analyses were run on water samples at the Northern Territory Environmental Laboratories. Radiological analysis was done at the Australian Radiological Protection and Nuclear Safety Agency. See Appendix 3A for the full results. The water quality tests indicated that the bore water was of good quality. The key constituents are shown in the water quality graph in Figure 2. The graph shows water quality data as a percentage of each value used in the *Australian Drinking Water Guidelines* (ADWG). Traffic light icons indicate the level of management the water supply may require according to the constituents. The doctor icon indicates that the ADWG value is derived from a health parameter; all other values are aesthetic. Where available, median water quality data from remote communities in the region are shown as a yellow bar. This allows a crude comparison of the local water quality to that of other communities in the region.

The bore water was tested for microbiological contamination. One *E. coli* (per 100 ml) was detected at the end of the distribution line, ending at the piggery. The line was flushed and re-sampled. The result of the subsequent test was clear. We discussed the potential causes of the contamination with the project participants and regular flushing was the preferred response for the settlement.

The stored rainwater was tested for microbiological contamination. A high level of *E .coli* was detected in one of the rainwater tanks. The resident had been aware that the water in the tank was not good quality. The resident had not been drinking water from the tank and had tried to clean it out. The appropriate treatment methods would later form a component of the water management plan.

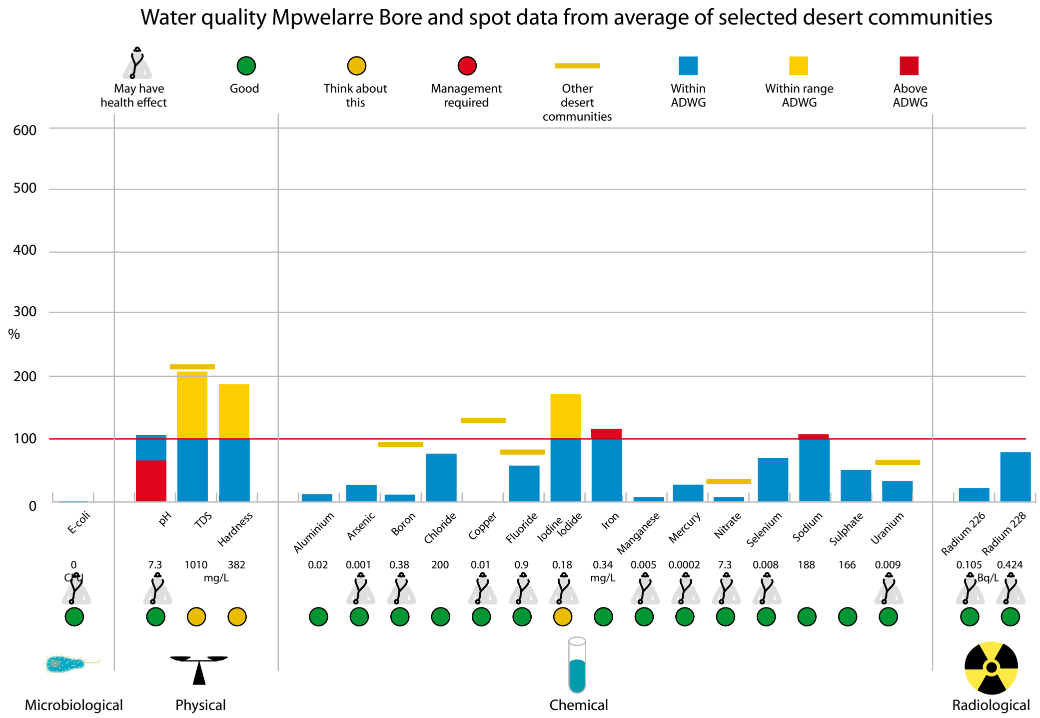

Figure 3: Water quality graph for Mpwelarre, March 2006

4 Livelihoods activity

4.1 Participants

A core of six people from Mpwelarre attended meetings and contributed to the water supply assessment and rectifications. A number of other residents also attended meetings and learnt about the water supply and its management.

On the whole, the permanent residents have a firm understanding of the water supply and maintenance requirements. Before the project, the participants had not accessed much information about their water quality; however, they were confident that it was sound. They had a good understanding of the design and maintenance requirements, evidenced by the following actions:

- The rainwater tank at house number 6 had been cleaned out because the water quality was poor.

- The low-flow issues in the reticulation system were a result of poor pressure and steps had already been taken to retrofit the existing system with header tanks to increase pressure.

4.2 Livelihoods assessment

During a meeting with residents at Mpwelarre, we used the Sustainable Livelihoods assets pentagon analysis, as relevant to the Mpwelarre water supply, to identify and discuss residents' current activities and plans for the future. The assets pentagon was used to represent the different resources available to the residents in the five capital categories shown in Table 1. It shows that the residents are well placed to manage their own supply (Figure 4).

The residents consider their water supply to be of good quality. One participant said, when sitting down to a fresh cup of tea after a meeting, 'Mmmmm, the tea tastes good with this water … you can drink it all day!'

Residents plan to breed camels for sale on the property, maintain a vegetable garden and fruit orchard, and keep livestock such as pigs, goats, fowl and cattle. The primary concerns are the way the water is used and augmenting the secondary supply for stock and settlement backup.

Table 2: Mpwelarre livelihood assets

Asset	Description
Natural capital	There is adequate irrigation for the fruit trees and vegetable garden. There are numerous animals including goats, camels, pigs and fowl on the outstation that require water.
Social capital	The residents have strong relationships with neighbours and they work on local properties.
Human capital	The knowledge and skills related to the water supply are high. There is a high ability to solve problems and rectify any damage to the water supply. Alice Springs is just over an hour from Mpwelarre and offers access to reliable services, as does Titjikala. For specialist skills, the residents would require a contractor, but most services are available at Alice Springs.
Physical capital	The bore and tanks are in good condition and designed to suit the needs of the settlement. The system is 'simple' and easy to manage. Other basic infrastructure on the settlement is in good condition. The supplementary water supply from the old bore is not functioning. The residents would like to have the old windmill operational again. Tools and equipment to make rectifications are available on site.
Financial capital	In general the residents are in a good position to finance small equipment failures. Applications to fund larger equipment failures can be made through the Titjikala Outstations Resource Centre. Mpwelarre residents pay rent to Titjikala. Titjikala then provides fuel for the pump and other basic maintenance.

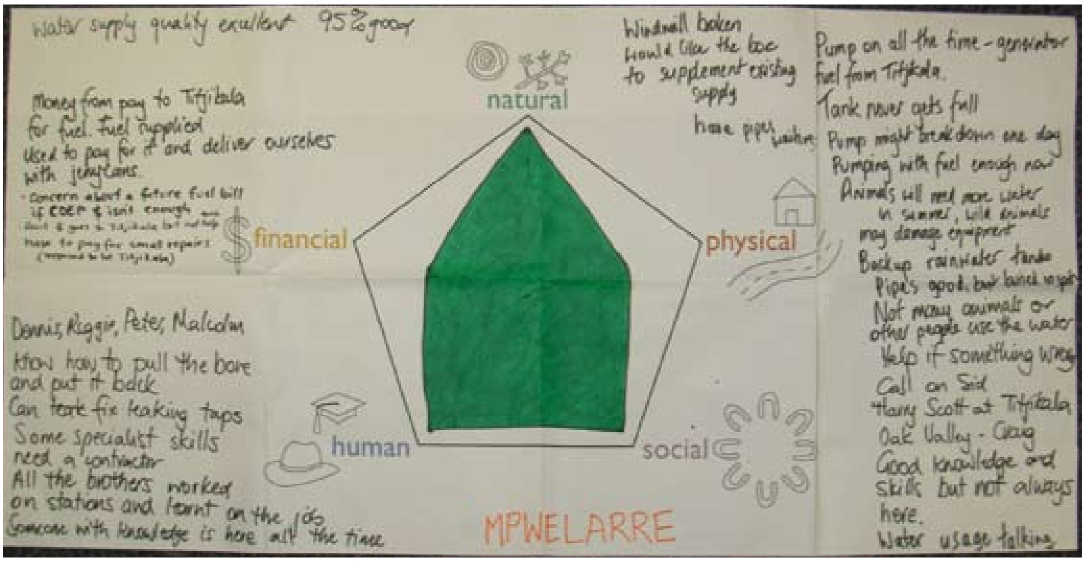

Figure 4: Mpwelarre assets pentagon, September 2006

5 Site-specific plans

During meetings about water management for the future, participants were enthusiastic about making rectifications to the water supply themselves. They saw it as an opportunity to work together and make some significant improvements to the water supply. They considered it necessary to work together so that everyone on the outstation could understand who has responsibility for what and so that the tools and equipment are organised. It was important to them that there are more people to watch out for the water supply and to support Malcolm.

A poster was suggested as a means to keep some information and directions available for the residents. A manual was not identified as a central requirement – just something like a poster to remind people of the activities required to keep the water safe.

The rectifications to the Mpwelarre water supply described in Table 2 were identified during the background research and presented for discussion during the meetings. The residents agreed that improvements to the Mpwelarre bore and the solar bore would take priority, and with some help from the project team to get materials, the residents would get together to make the improvements.

We discussed the potential to get the irrigation bore working again. Apparently there has already been some initiative toward this with Titjikala. Participants agreed to check the current status of the project with Titjikala.

There is no way of measuring water consumption at Mpwelarre, so participants recommended installing a water meter at the bore. They considered it important for residents to better understand their water use.

Table 3: Suggested rectifications to Mpwelarre water supply

Water system component	Suggested rectifications
Mpwelarre bore and the solar bore (and Walkabout Bore if used for drinking water supply)	- Build a protective concrete apron around borehead. - Build bunding underneath the diesel fuel tank and engine at Mpwelarre bore to catch any oil and fuel spills. - Fence the bore area.
Bulk storage tank	- Fit a secure lid on the storage tank. - Cover or fence pipes leading to and from the storage tank.
Reticulation system	- Bury the reticulation system pipes deeper from Mpwelarre bore to the solar bore and storage tank, to protect them from fire, stock and cars. - Mark reticulation pipeline routes with coloured stakes to avoid car damage where at risk. - Check pipeline under animal feedlot from header tanks 1 and 2 to House 9, to make sure there are no leaks and there is adequate pressure.
Rainwater tanks (if used for drinking water)	- Fit lids securely. - Maintain mosquito-proof mesh on outflows. - Check integrity and condition of gutters and repair if necessary.

6 Enacting the plan

A ‘working bee’ was initially planned; however, due to extreme heat and competing commitments, the idea was abandoned and the project participants agreed to ‘just get on with it’. Residents completed the following activities:

- concreting the borehead
- installing a water meter and creating logbooks to record data
- fencing off the bore and surrounds
- dosing rainwater tanks with chlorine, as necessary
- burying exposed reticulation pipes.

Water management posters were created and displayed in key locations, including around the bore and on sheds around the settlement. The participants learnt how to disinfect rainwater tanks and have posters detailing the chlorine dosage rates specific to their tanks.

Photo 1: Reg and Peter Kenny install a water meter at the Mpwelarre borehead.

Photo 2: Reg disinfects a rainwater tank.

Photos 3 and 4: A fence was built around the bore and pump to protect it from cars and wandering stock.

7 Conclusion

The project was evaluated at different points during the concluding months of the project and at the completion of enacting the plan. The evaluation occurred in a series of four discussions, comprising two phone calls and two meetings, with project participants. We used the assets pentagon as a means to discuss and describe the changes participants identified during the project. In September 2006, the assets pentagon had showed that residents would benefit from some investment in ways to improve their financial and physical assets. During the evaluation, participants felt that there was definite benefit and improvement to the management of the water supply. The post-project pentagon shows some improvement in the capacity to manage the Mpwelarre water supply, mostly in the areas of financial and physical assets.

The increase in financial assets reflects the improved arrangement with the resource agency to maintain and service the supply in recognition of the skills and work that the residents, in particular Malcolm, carry out. The increase in physical assets stems from the targeted rectifications that were identified through the risk management approach and the works carried out during the project by the residents. There are further improvements that can be made – for example, installing a new windmill at the Walkabout Bore. The residents have plans to pull the Walkabout Bore to check infrastructure and determine what parts would be required to get it up and running properly again. On the whole, the water supply functions well and provides adequately for the residents and their aspirations.

The project participants felt that the project focused the attention of residents on the water supply and created a space for much discussion. Opportunities from participating in the project have also become apparent. For example, one participant has completed a solar energy course to provide backup maintenance if required. The residents have also increased their social network through DKCRC partners and may now benefit from participating in other projects. Community members are already involved with the DKCRC and the Waltja Training Nintiringtjaku program. Further opportunities that may arise through these networks are tour groups that can come to Mpwelarre to learn about water management.

The participants were disappointed that the young people living at Mpwelarre had not participated more in the project. However, they are confident in the young people’s technical skills – they have ‘worked all their lives’ – and believe that when the need arises, the young people will be able to take on the water management responsibilities.

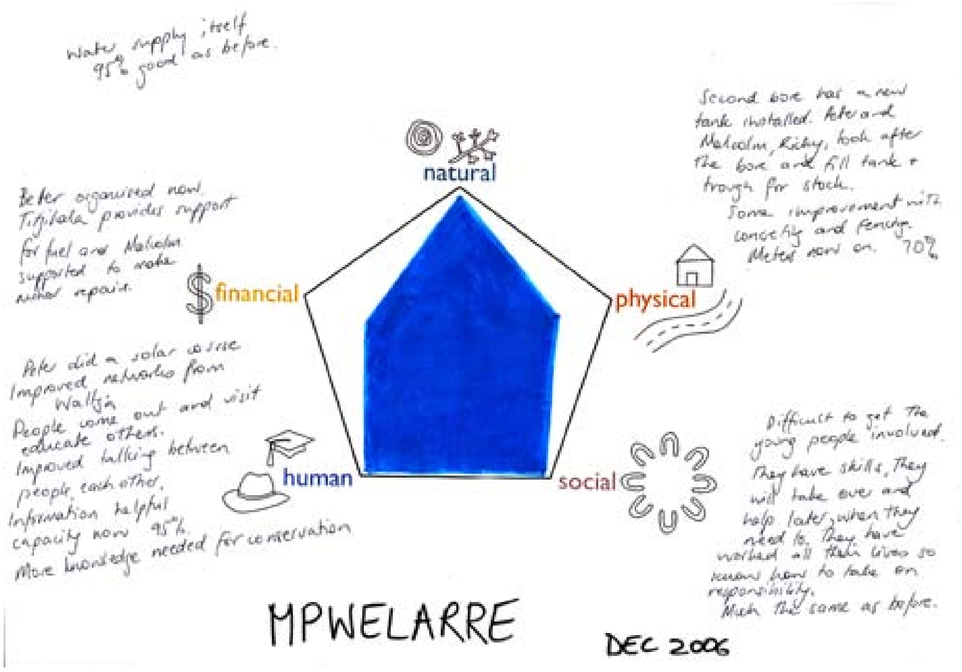

Figure 5: Mpwelarre assets pentagon, December 2006

The Mpwelarre residents’ participation in the water project has been an opportunity to secure the supply and provide information and guidance for best water management practice. The residents will continue to manage their water supply themselves and make improvements as required. They understand the hazards to the water supply and the management requirements to maintain water system integrity. This should allow them to better manage risks to their water supply and know which actions to take to protect it in the long term.

Appendix 3A: Mpwelarre water quality data

Constituent	Abbreviation	Units	HOUSE NUMBER 9	WALKABOUT BORE	MPWELARRE BORE
SAMPLE DATE			30/05/06	30/05/06	30/05/06
Electrical conductivity	EC	µS/cm	1690	1640	1690
pH	pH	units	7.8	7.7	7.3
Bicarbonate	HCO3	mg/L	201	230	200
Hydroxide	OH	mg/L	<1	<1	<1
Alkalinity	Alkalinity	mg/L	201	230	200
Calcium Carbonate	CO3	mg/L	<1	<1	<1
Turbidity	Turbidity	NTU	<1	1	1
Total Dissolved Solids	TDS	mg/L	1050	970	1010
Total Dissolved Solids (calculated)	TDS	mg/L	980	920	970
Hardness	Hardness	mg/L	385	378	382
Nitrite	NO2_N	mg/L	<0.005	<0.005	<0.005
Nitrate	NO3_N	mg/L	7.3	8.62	7.36
Chloride	Cl	mg/L	348	330	346
Phosphate	PO4_P	mg/L	0.015	0.01	0.01
Fluoride	F	mg/L	0.9	0.9	0.9
Calcium	Ca_F	mg/L	81.8	70.2	81.7
Potassium	K_F	mg/L	20.4	27.6	20.9
Magnesium	Mg_F	mg/L	44	49.2	43.3
Sodium	Na_F	mg/L	191	174	188
Sulphate	SO4_F	mg/L	167	124	166
Silicon	SiO2	mg/L	29	26	29
Iron	Fe_F	µg/L	<20	<20	<20
Silver	Ag_T	µg/L	<10	<10	<10
Aluminium	Al_T	µg/L	<20	<20	<20
Arsenic	As_T	µg/L	<0.5	1.5	1
Boron	B_T	µg/L	400	520	380
Barium	Ba_T	µg/L	100	100	50
Beryllium	Be_T	µg/L	<1	<1	<1
Bromine	Br_T	µg/L	1220	1010	1300
Cadmium	Cd_T	µg/L	<0.2	<0.2	<0.2
Chromium	Cr_T	µg/L	<5	<5	<5
Copper	Cu_T	µg/L	<10	<10	<10
Total iron	Fe_T	µg/L	140	770	340
Mercury	Hg	µg/L	<0.2	<0.2	<0.2
Iodine/Iodide	I_T	µg/L	190	160	180
Manganese	Mn_T	µg/L	<5	15	5
Molybdenum	Mo_T	µg/L	<5	<5	<5
Nickel	Ni_T	µg/L	2	<2	2
Lead	Pb_T	µg/L	1	<1	6
Antimony	Sb_T	µg/L	<0.2	<0.2	<0.2
Selenium	Se_T	µg/L	7	7	8
Tin	Sn_T	µg/L	<10	<10	<10
Uranium	U_T	µg/L	9.26	2.22	9.31
Zinc	Zn_T	µg/L	20	10	100
Escherichia coli	E.coli	CFU/100ml	1	0	0
Radium 226	Ra	Bq/L			0.105
Radium 228	Ra	Bq/L			0.424

Appendix 4: Port Stewart case study

Port Stewart case study

Australian Government
Department of Families, Community Services and Indigenous Affairs

Centre for Appropriate Technology

CRC Australia

DESERT KNOWLEDGE CRC

Contributing author information

Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the Desert Knowledge CRC Remote Community Water Management project. Robyn is based in Alice Springs and is an environmental and social scientist. She has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. For the last seven years Robyn has worked with Indigenous communities, mainly on water management programs.

Tania Cobham is a project manager with Arup, based in the Cairns office. She has a Bachelor in Environmental Engineering and a Diploma of Project Management. Tania's field of expertise is the application of water, wastewater and environmental knowledge and technologies to a community context. Soon after graduating, Tania lived and worked in the mountains of Northern Pakistan assisting a community with eco-tourism initiatives. In Queensland, she has worked with Aboriginal and Torres Strait Islander communities to design a viable housing project and to assess and upgrade infrastructure for new and established townships. She is a member of the Queensland Community Development Network and has been involved in a range of conferences and projects aimed at building local capacity.

Acknowledgements

The project team would like to thank the Coen Regional Aboriginal Council and the residents of both camps at Port Stewart for their involvement during the project. Special thanks go to Vera and Keith Liddy, Rex Liddy, Joan and David Liddy, and especially Sunlight Bassani and Gavin Bassani for their tremendous support.

The project team is also thankful for the support provided by Russell Cassidy, Terena Hopkins, Marc Siedel and Nerida Beard.

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Contents

1 Introduction

In this case study, we describe the information gathered for the Desert Knowledge Cooperative Research Centre (DKCRC) Remote Community Water Management Project about the water supply and management opportunities for the remote settlement of Port Stewart on Queensland's Cape York Peninsula. We visited the settlement between August 2005 and December 2006.

We describe the implementation process that evolved during the project. The process included developing a water management plan for Port Stewart and empowering residents through participatory involvement in making decisions about Port Stewart's future water management. We also describe how the project team responded to the needs of the settlement by adapting the research activities to make sure that the best possible outcome for the project participants was achieved within the time constraints of the project.

The Port Stewart water management plan was developed over the course of a year and involved meetings and research activities. The plan was developed in four stages:

1. Analyse water source hazards and assess risk.
2. Assess livelihoods and identify the match between the water source and the residents' aspirations.
3. Create site-specific plans to manage risks to the water supply and meet the needs of the residents.
4. Enact the plan and identify strategies for future water management.

The information we present in this case study was gathered during meetings held at Port Stewart in November 2005 and August 2006. Further information was gathered during workshops held in Alice Springs in September 2005 and September 2006. We supplemented the information gathered during visits to the settlement with desktop research and discussions with government agency personnel who have worked with the residents of Port Stewart and the Coen Regional Aboriginal Corporation.

2 The settlement of Port Stewart

Port Stewart is located around 50 kilometres south-west of Coen on Queensland's Cape York Peninsula. It is made up of two distinct camps commonly known as Top Camp (Moojeeba) and Bottom Camp (Theethinji). The residents are traditional owner descendants of the Lamalama language group and comprise the Liddy and Bassani families.

Port Stewart has been involved with participatory planning processes through the Centre for Appropriate Technology (CAT) in the mid-1990s and more recently with the Bushlight project. The CAT planning document is titled 'Moojeeba, Theethinji, Planning for a Healthy, Growing Community, Project Report, 1997'. This document contains planning information about housing, livelihoods, environmental health, and settlement water and sewage infrastructure. It formed the basis for a project to upgrade the water system to the current state, under the National Aboriginal Health Strategy (NAHS) Capital Works Program.

Bushlight installed a solar power system at each of the settlement areas in November 2005. The residents had participated in the process to establish clear settlement/resource agency and contractor responsibilities for the ongoing maintenance of the energy supply.

During this project, Port Stewart was hit by Tropical Cyclone Monica, a category 3 cyclone which crossed the coast just north of Port Stewart in the Lockhart River district on 19 April 2006. The cyclone caused significant flooding at Port Stewart, requiring the emergency evacuation of all residents. Due to the poor condition of the roads, residents were unable to return to Port Stewart for more than five months.

3 Port Stewart's water supply

3.1 The water source

The Stewart River runs along the southern boundary of the Port Stewart settlement and is the 'run-of-river'[1] source of the settlement's water supply. The catchment is in good condition with no intense agriculture or urban development. It is primarily low-density cattle grazing properties. The river water source is backed up by rainwater tanks at each house and an unequipped bore.

Preliminary inspection indicated that there were few unmanaged hazards in the system. General maintenance of the rainwater tanks was required, namely the installation of screens, cleaning of guttering and replacement of dripping taps. When the water level is low, the river in-take is fenced to prevent human or animal contamination. When the river is flowing or the in-take cylinder is adequately equipped, a fence is not required.

The water infrastructure installed as part of the NAHS project is not operating as originally designed:

- A fire damaged the pipe system flowing from the river in-take to the irrigation system. This has not been a significant issue as the plantation work for which the irrigation was intended is no longer being conducted.
- The same fire potentially damaged the electrical connection between the solar and diesel generation arrays and the pumps in the river.
- The lid on the river in-take cylinder was removed during a wet season. This caused the cylinder to fill with sand, covering the spear pumps originally used for extracting water.

The as-built drawings for the system are not available, so the location of the buried reticulation system is unknown. The reticulation system is 50 millimetre poly pipe (not blue line).

River water is pumped up to the settlement header tank using a fire-fighting fuel pump. This is an interim arrangement until the spear pumps can be reconnected to the solar/diesel generation array. The water is gravity fed from the storage tank to the houses. The header tank has an approximate head of 7 metres.

1 'Run of river' means the natural flow of the river is the water source. Water is pumped directly from the riverbed.

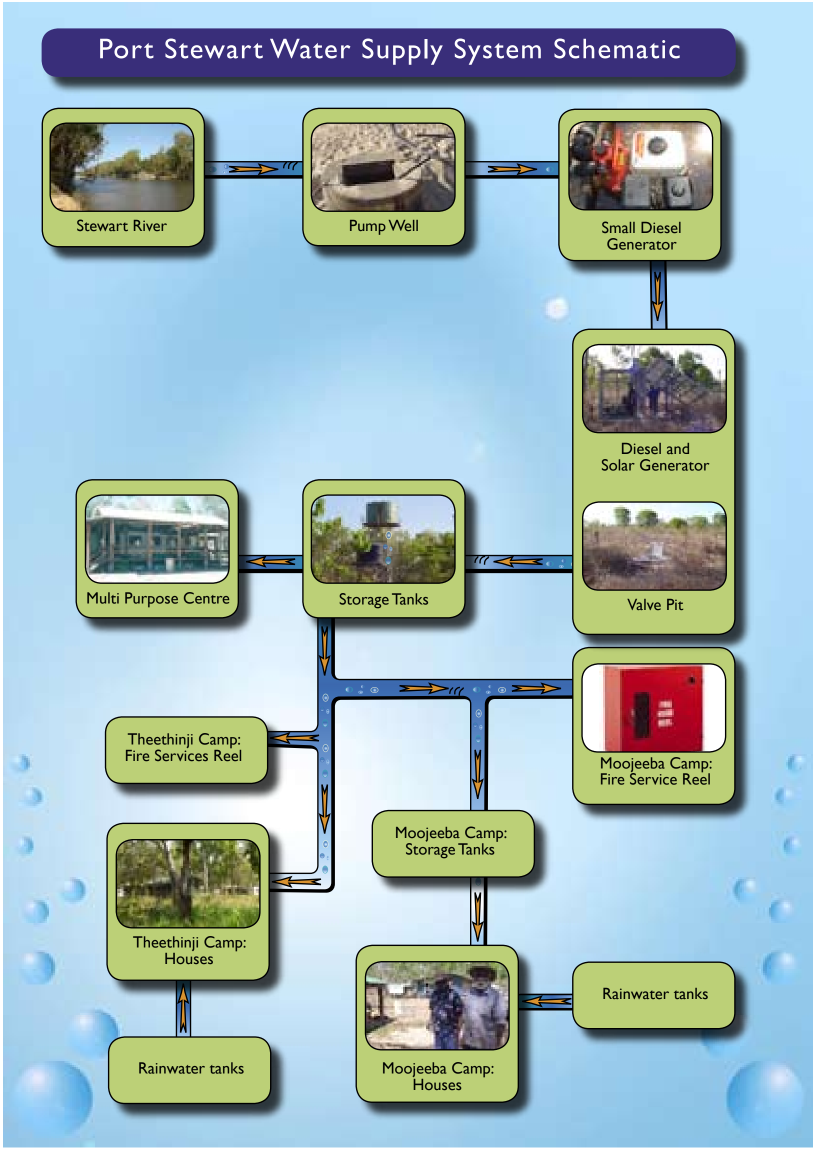

Figure 1: Port Stewart water supply schematic

3.2 Water quantity

The water supply is pumped for the sole use of the Port Stewart outstation residents and for tourists that sometimes make use of settlement facilities. The residents have not experienced water restrictions. They are unable to measure the amount of water they are using.

The river is a reliable water source despite significant fluctuations in river water level. During the dry season, the residents have been digging a well into the sand overlaying the river bed, which allows access to the base flow. When the in-take cylinder is operational, it will allow the entire height of the base flow to be accessible to the settlement as it is seated on the bedrock.

Climate change is expected to alter the rainfall patterns for north Queensland while maintaining the same annual total rainfall. This will occur through more severe storms in a shorter period of time with longer dry seasons. The settlement may need a water storage mechanism, such as a weir, to overcome these changing weather patterns.

3.3 Water quality

Port Stewart elder Sunlight Bassani described the water at Port Stewart as 'bright' and the residents are very happy with the quality of the water supply. To inform the risk analysis phase of this project, the supply was sampled on two occasions. It was sampled at the river intake, at the header tanks and at sample taps at the end of the pipeline. The samples were sent to Cairns Water for chemical, microbiological and metals analysis. See Appendix 4A for the results. The water quality graph used during meetings with the project participants is shown in Figure 2. The graph shows water quality data as a percentage of each value used in the *Australian Drinking Water Guidelines* (ADWG). Traffic light icons indicate the level of management the water supply may require according to the constituents. The doctor icon indicates that the ADWG value is derived from a health parameter; all other values are aesthetic. Where available, median water quality data from remote communities in the region are shown as a yellow bar. This allows a crude comparison of the local water quality to that of other communities in the region.

The river water quality is likely to be variable. The climatic conditions of the region bring seasonal rainfall and cyclonic periods. The residents have developed a response to this variability through changing water use patterns based on visible parameters. As an example, Vera Liddy (resident) said residents preferred to drink rainwater when the river water was very turbid.

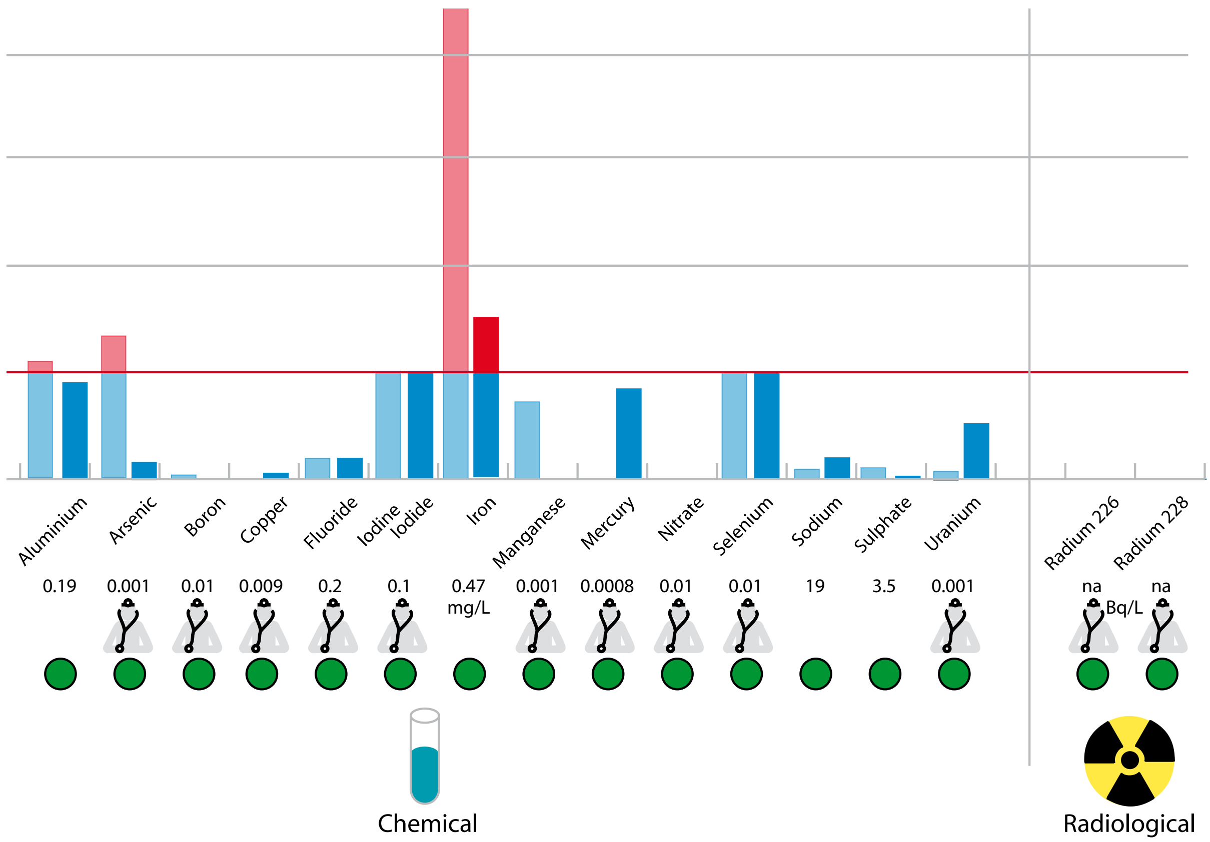

Figure 2: Water quality graph for Port Stewart

The water supply was sampled on 8 November 2005 (low-flow period) and again on 30 August 2006 (high-flow period). The microbiological water quality on both occasions improved while in transit through the distribution system. The river samples showed high levels of E. coli present in the source water; however, the counts were significantly reduced at the consumer's tap. Maintaining the integrity of the water supply system is a priority for managing risk, along with adaptive behaviours to accommodate seasonal fluctuations. Evidence from the two samples coupled with experience and judgements from the residents have informed a general seasonal picture of water quality trends and management.

During the dry season, when there is lower water flow, it is likely that the chemical constituents of the water supply increase; in times of high water flow, it is likely that they decrease. A general guide to drinking-water quality was drawn up for the manual or water guide book (Figure 4).

4 Livelihoods activity

4.1 Participants

The permanent population of the Port Stewart settlement ranges between four and 10. The settlement also has regular visitors and tourists that come on adventure tours, such as fishing or bull catching. The extra visitors place some additional demand on the water supply but it is fairly predictable since there are clear seasonal opportunities in the Cape.

Photo 1: (From left) Sunlight Bassani and Keith Liddy fix the broken water pipeline at Top Camp.

4.2 Livelihoods assessment

During a meeting with residents at Port Stewart on 29 August 2006, we developed the Sustainable Livelihoods assets pentagon as relevant to the water supply. The pentagon showed that, while the physical assets are the lowest (at 70 per cent), the water resource itself was rated at 100 per cent. The settlement has a couple of permanent residents who manage the everyday activities of fixing pipes and maintaining the settlement's access to the supply. There are many people who the residents can rely on for help with everyday maintenance issues and there are spare parts for small repairs on site.

The residents have a high awareness of water supply and management issues. Illustrations of this awareness include the following:

- Residents had fenced the river inlet to protect it from animal contamination.
- Ella (resident) had flushed the rainwater tank because it was discoloured and had poor taste.
- Residents had repaired the water mains that had been damaged by contractors during our site visit in late 2005.
- Residents had established alternative water pumping and shared responsibility for management with the tourist operators to respond to the in-take cylinder being out of operation.
- Residents were emptying the in-take cylinder of sand during the dry season in an attempt to make the system operational.
- Residents had installed a screen at the base of the fire-fighting pump to protect the system from solids.
- Residents had temporarily installed an alternate mains pipe to the high-level tank to respond to the inlet pipes being inaccessible after the flood.

Table 1: Port Stewart livelihood assets

Asset	Description
Natural capital	The water quality is excellent and may be used for drinking. The water quantity requirements are met for both the residents and the tourist operation.
Social capital	There is good support from the Coen Regional Aboriginal Corporation and there are numerous people who the residents are confident to call on. Silver Plains residents are close by and know the water supply well.
Human capital	Rex and Keith run the day-to-day water supply operations.
Physical capital	The water supply is well designed and meets the needs of the settlement. After the 2006 cyclones, the water supply infrastructure remains intact. There had been some talk of putting in a bore to respond to the maintenance issues with the current supply system. Some rectifications which are beyond everyday maintenance are required to the infrastructure. There is no asset list or infrastructure layout plans.
Financial capital	Profits from the tourism operations are put towards maintenance and operation of settlement services such as water supply. Bushlight has organised a contribution process for the energy system which is having some early teething problems but should be a successful maintenance plan. This may be a good model for water supply management.

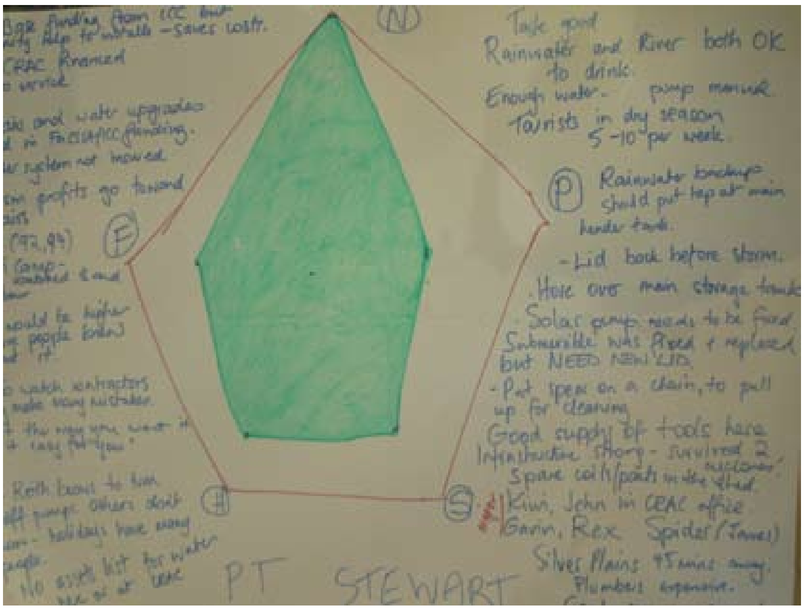

Figure 3: Port Stewart assets pentagon, August 2006

5 Site-specific plans

Gavin Bassani and Keith Liddy are key people for the main settlement water supply. Individual householders are responsible for rainwater tank management. There was demonstrated effort to maintain the rainwater tanks at the settlement. Tanks had recently been cleaned out and the option of chlorinating the tanks or boiling the water when necessary was readily accepted by project participants.

While the water supply is sufficient, it requires some rectifications:

- Install a sampling tap at the main tank.
- Overhaul the river in-take.
- Install a float switch on the high-level tank to prevent overflow of water when full.
- Install meters at pump and at distribution end points (houses and tourist camp).
- Place mosquito screens in rainwater tanks.
- Fix dripping taps.

The Coen Regional Aboriginal Corporation (CRAC) is the resource agency for Port Stewart. It provides on-going support to the settlement in many aspects of livelihoods, housing and infrastructure. Its responsibility for organising funding and co-ordinating capital works and maintenance between a series of outstations was clear. The Port Stewart residents access support from CRAC for significant water supply issues.

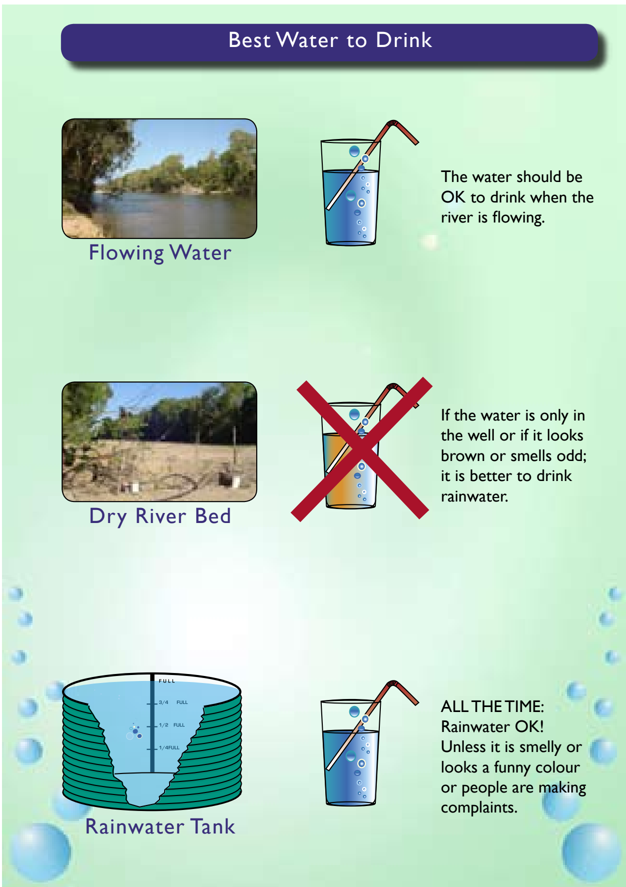

Figure 4: General guide to drinking-water quality

6 Enacting the plan

The following key areas of development were identified by the residents and CRAC representatives during this project:

- Clarify the 'duty of care' responsibilities for the water supply for external people, such as tourists and local visitors.
- Install meters to monitor how much water is used by tourists and residents.
- Repair the existing in-take infrastructure to reduce risk to the water system and to reduce operational requirements.
- Clarify with the Queensland Department of Natural Resources and Water the extraction permits required and held by the settlement. This is particularly important given the proposed Wild Rivers legislation.
- Consider the limitations to growth of tourism enterprises imposed by the current water supply system.
- Build linkages and efficiencies between the management plan developed for Bushlight and the management required of the water system. This may include resident contributions that cover both systems.

7 Conclusion

The project has provided a sense of security for the Port Stewart settlement. The residents are now clear about the water quality and water supply maintenance requirements. Furthermore, the information has assisted with their livelihood since tourists have had access to the water quality and management information. The tour operator is now more confident in bringing clients to stay at Port Stewart.

A general guidebook or manual for maintaining the water supply was developed for Port Stewart. Gavin Bassani took the manuals to Top Camp and Bottom Camp and discussed the details with residents. Residents could see and understand from the manuals what maintenance was required and when.

The project was evaluated on 14 December 2006. The participants felt that the project had not significantly changed any assets in the pentagon but the residents have a heightened awareness and more knowledge of their water supply system. The residents are more self-reliant in carrying out basic water maintenance although they felt that their situation highlights the deficiencies generally in the essential service program delivery. The water supply system at Port Stewart was developed, and money was spent on the water system, but there was no maintenance training provided. The residents felt that their water supply had simply declined into a state of disrepair because there have not been local capacity building initiatives linked to essential services. This project has helped with the knowledge and information but further ongoing support may be required in future.

Relevant supporting documentation

Centre for Appropriate Technology 1997, *Port Stewart Lamalama, Moojeeba, Theethinji, Planning for a Healthy Growing Community*, Project Report, 1997, CAT, Alice Springs.

Coen Regional Aboriginal Corporation 2004, *Service Agreement between the Coen Regional Aboriginal Corporation and the Coen Homelands, 1/12/04 to 01/12/09*, CRAC, Coen.

Appendix 4A: Port Stewart water quality data

Constituent	Units	River Well	Tank	Bottom Camp House	Top Camp Rainwater	River well	Bottom Camp House
Sample date		**8/11/05**	**8/11/05**	**8/11/05**	**8/11/05**	**30/8/06**	**30/8/06**
General							
TDS	mg/L	100	120	95	55	100	
EC	us/cm	120	140	120	72	150	
pH		6.7	6.7	6.7	6.4	7.6	
Colour - Apparent	Pt-Co	>70	-	-	-	27	
Colour - True	Pt-Co	>70	-	-	-	11	
Turbidity	NTU	18	7.6	1.4	1.1	3.8	
Hardness - Total CaCO3	mg/L	12.3	17.3	16.1	9.5	18.9	
Alkalinity - Total CaCO3	mg/L	30	40	33	5.8	33	
Fluoride	mg/L	0.2	-		-	0.2	
Silica - Reactive	mg/L	25	24	23	0.1	26	
Nutrients							
Nitrate	mg/L	0.121	-	-	0.594	<0.01	
Nitrite	mg/L	0.044	-	-	0.019	<0.01	
Total Oxidised Nitrogen (NO3+NO2)	mg/L	0.17	-	-	0.61	<0.01	
Micro							
E. coli	CFU/100mL	>80	<1	7	>80	5	<1
Algae - Blue Green		<100	-	-	-		
Major Ions							
Sodium	mg/L	12	13	11	5.4	19	
Potassium	mg/L	1.5	1.8	1.4	3.1	1.4	
Calcium	mg/L	2	2.9	2.8	1.8	4.1	
Mg	mg/L	1.8	2.4	2.3	1.2	2.1	
Chloride	mg/L	17	-	-	-		
Sulphate	mg/L	11	7.1	2.7	6		
Metals – total unless otherwise stated							
Aluminium	mg/L	0.21	-	<0.01	-	0.19	
Antimony	mg/L	<0.001	-	<0.001	-	<0.001	
Arsenic	mg/L	0.009	-	0.003	-	0.001	
Barium	mg/L	0.054	-	0.037	-	0.030	
Beryllium	mg/L	<0.001	-	<0.001	-	<0.001	
Boron	mg/L	<0.1	-	<0.1	-	<0.1	
Bromine Filtered	mg/L	<0.1	-	-	-	<0.1	
Cadmium	mg/L	<0.0001	-	<0.0001	-	0.0002	
Chromium	mg/L	0.001	-	<0.001	-	<0.001	
Copper	mg/L	0.002	-	0.028	-	0.009	
Iodine Filtered	mg/L	<0.1	-	-	-	<0.1	
Iron Filtered	mg/L	2.99	-	0.71	-	0.25	
Iron Total	mg/L	6.26	-	0.85	-	0.47	
Lead	mg/L	<0.001	-	0.002	-	<0.001	
Manganese	mg/L	0.372	-	0.246	-	0.030	
Mercury - Total	ug/L	<0.5	-	<0.5	-	0.8	
Molybdenum	mg/L	<0.001	-	<0.001	-	<0.001	
Nickel	mg/L	0.008	-	0.002	-	<0.001	
Selenium	mg/L	<0.01	-	<0.01	-	<0.01	
Silver	mg/L	<0.001	-	<0.001	-	<0.001	
Tin	mg/L	0.003	-	<0.001	-	<0.001	
Uranium	mg/L	<0.001	-	<0.001	-	<0.001	
Zinc	mg/L	0.015	-	0.065	-	<0.005	

Appendix 5: Yappala case study

Yappala case study

Australian Government
Department of Families, Community Services and Indigenous Affairs

Centre for Appropriate Technology

CRC AUSTRALIA

DESERT KNOWLEDGE CRC

Contributing author information

Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the DKCRC Remote Community Water Management project. Robyn is an environmental and social scientist and has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. She has worked for seven years with Aboriginal communities, mainly on water management programs.

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Support was also gratefully received from Dene Cuthbertson and Kirstie Jamieson from Yartawarli Resource Agency, and Peter Herraman and Maralyn Leverington from Port Augusta Indigenous Coordination Centre. The well-received skills development program at Yappala was run by Robyn Ellis from the Centre for Appropriate Technology.

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Contents

1 Introduction

In this case study, we describe the information gathered for the Desert Knowledge Cooperative Research Centre (DKCRC) Remote Community Water Management project about the water supply and needs for the remote settlement of Yappala in the Flinders Ranges, South Australia.

We describe the implementation process that evolved during the project. The process included developing a water management plan for Yappala and empowering residents through participatory involvement in making decisions about Yappala's future water management. We also describe how the project team responded to the needs of the settlement by adapting the research activities to make sure that the best possible outcome for the project participants was achieved within the time constraints of the project.

The Yappala water management plan developed over the course of a year and involved meetings and research activities. The plan was developed in four stages:

1. Describe the water supply including analyse hazards and assess risk management.
2. Assess livelihoods and identify the match between the water supply and residents' aspirations.
3. Identify a strategy to manage the water supply.
4. Enact the plan.

The information in this case study was gathered during meetings held at Yappala in January 2005, October 2005, March 2006, June 2006, August 2006 and October 2006. Further information was gathered during workshops held in Alice Springs in September 2005 and September 2006. We supplemented the information gathered during the visits to the settlement with information from desktop research and from discussions with government agencies, Yartawarli Aboriginal Corporation Resource Agency and contractors that had worked at Yappala.

In this case study, we outline the outcomes from each stage of development.

2 The settlement of Yappala

Yappala is home to the McKenzie family, who participated in the Remote Community Water Management Project. Yappala is located 10 kilometres north-west of Hawker in the Flinders Ranges, South Australia. The property was bought by the Indigenous Land Corporation in 2000 and handed over to the Viliwarina Yura Aboriginal Corporation.

Yappala is the main homestead on a large property which includes three sections – Yappala, Worro Downs and Codabena. Members of Viliwarina Yura live at both Yappala and Worro Downs, and Codabena is leased out to a neighbouring landholder. Yartawarli Aboriginal Corporation Resource Agency, located at Hawker, provides technical support and advocacy for the homelands and communities in the region.

The property at Yappala had been a pastoral property before being bought by the Indigenous Land Corporation. The land has previously been used to run sheep and other stock such as pigs and chooks.

The property at Yappala has a main station house, shearers' quarters and four units or flats. The film *The Lighthorsemen* (1987) was shot on site at Yappala. Two dwellings – the flat roofed fibro shelter and the concrete flats – were built to house the film crew.

During this project, there were usually about 10 people living at Yappala. The number of people at Yappala frequently varies between 10 and 15, and the numbers increase at particular times. There can be up to 25 people during times of meetings (such as the Viliwarina Yura Annual General Meeting) and when family and friends visit on long weekends or in spring and summer when there can be plenty of bush tucker around – such as fat kangaroos.

3 Yappala's water supply

3.1 The water source

Water at Yappala is a resource that requires careful management. The rainfall at Hawker is 175–300 millimetres a year and the climatic zone is described as arid. Before this project, the water supply had been shared with the neighbour. Before 2001, Yappala had an agreement to share water from a very productive bore with a neighbour. The agreement stated that the water was to be used for domestic purposes only. The bore was on a property three kilometres away from Yappala and the water was supplied to Yappala via a 25 millimetre poly pipe. The bore was apparently also supplying three or four other properties in the area.

The agreement to share water with the neighbour limited the opportunities for the residents of Yappala to use water for other purposes, such as watering stock or engaging in enterprise activities. The agreement was tested when a bush tucker initiative was established on the property in 2003.

The bush tucker plot was designed with a water-saving irrigation system but it clearly used more water than expected for 'domestic purposes only'. Apparently the storage tanks were regularly drained. As a consequence of the high water needs of the bush tucker plot, both the neighbour and Yappala had their water supply restricted.

On 22 June 2004, a new bore was sunk at Yappala to relieve issues around management of the shared water supply. The new bore was funded by ATSIS and the project was managed by Yartawarli. The bore is located about two kilometres west of the main homestead, near the rocky ridge. The bore has a depth of 91 metres, a standing water level of 40 metres and the estimated yield is 400 gallons per hour.

Apparently, Yappala residents can still access the bore on the neighbour's property for domestic purposes but it is unlikely that they will need to. Clearly, having a productive bore on their own property has benefits. It allows the people of Yappala to manage their own water supply and to support any plans for local enterprise or business ventures.

Photo 1: Drilling the bore at Yappala, June 2004

3.2 Water quantity

Since Yappala residents have been using the new bore, there have been no water restrictions for any purpose. The rainwater tanks also store enough water so that there has been no shortage of water.

Water samples were taken and sent to the Australian Water Quality Centre for physical, chemical and microbiological analysis. The results yielded nothing of particular interest except that the bore water is very hard/has high salt content which residents already knew. The Australian Radiation Protection and Nuclear Safety Association Water ran radiological tests on samples at Yappala..

Three rainwater tanks (between 15 000 and 22 000 litres) provide water for drinking purposes. Two tanks are located at the main house and one is located near the shearers' quarters. One tank is piped into the kitchen at the main house but water needs to be tapped and carried from the other two tanks.

There are supplementary water sources at Yappala but they are not used as water supplies. There is a permanent spring west of the Yappala homestead and there are eight capped bores on the property. Yappala residents have no means to measure the amount of water used. There are no water meters on the property and the main storage tanks are filled continuously during the day by the solar pump.

3.3 Water quality

Yappala residents drink the rainwater and use the bore water for other uses, such as washing and gardening. They are happy to drink the rainwater. There was one incident of sickness that was attributed to the rainwater but the cause of the illness was never confirmed.

Water samples were taken on 2 November 2006. The key constituents are depicted in the water quality graph in Figure 2. The graph shows water quality data as a percentage of each value used in the *Australian Drinking Water Guidelines* (ADWG). Traffic light icons indicate the level of management the water supply may require according to the constituents. The doctor icon indicates that the ADWG value is derived from a health parameter; all other values are aesthetic. Where available, median water quality data from remote communities in the region are shown as a yellow bar. This allows a crude comparison of the local water quality to that of other communities in the region.

The bore water and all rainwater tanks were free of *E. coli*. See Appendix 5A for details of the bore water quality. The bore water does contain high levels of salt but this presents no health risks because the residents use it primarily for washing and gardening purposes.

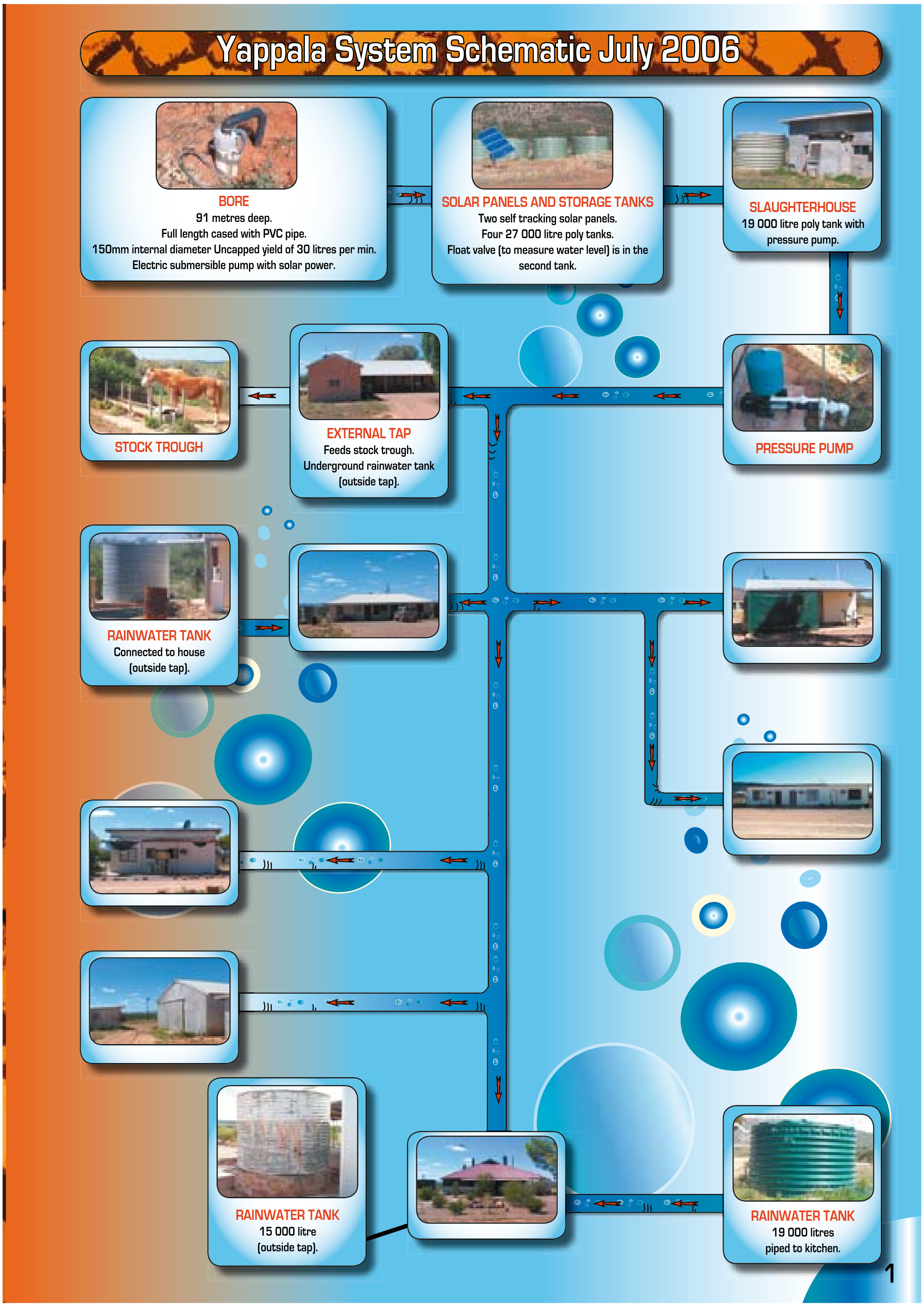

Figure 1: Yappala water supply schematic, March 2005

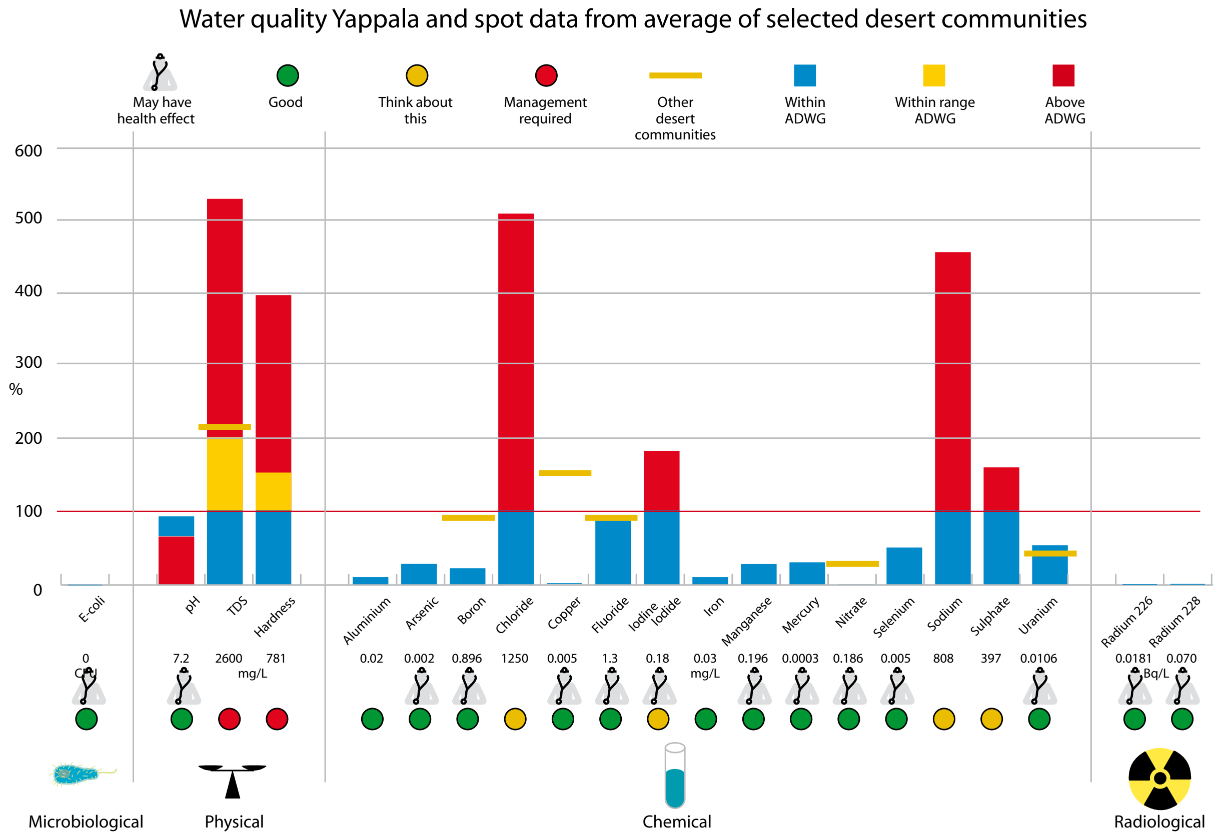

Figure 2: Water quality graph for Yappala, March 2006

The data gathered in the first meetings with residents was entered into the *Community Water Planner* (CWP). The CWP is a software program developed by the National Health and Medical Research Council to help people identify the hazards and risks of a settlement water supply.

This information, supplemented by the technical advice from the project team, enabled the residents at Yappala to identify what improvements should be made to the water supply.

Photo 2: Diedre McKenzie, Robyn Grey-Gardner and Dainis Skabe at Yappala, October 2005

4 Livelihoods activity

4.1 Participants

There are usually about 10 people living at Yappala with frequent population fluctuations due to visitors staying for varying periods of time. During this project, the number of participants increased steadily. In the early stages there were one or two people who were participating fully in the project but, as time went on, the numbers increased until all residents were actively involved.

4.2 Livelihoods assessment

We used the Sustainable Livelihoods assets pentagon as a tool to understand the residents' strengths and weaknesses for managing their water supply. Figure 3 shows that the residents felt that their water supply was adequate for their needs but the social, human and financial assets needed some boosting for them to effectively manage the supply.

Issues raised during discussion include finding strategies to manage the horses and any future stock (such as cattle) that may be on the property, and ensuring the infrastructure and management strategies can cope with peak populations during, for example, public holiday weekends and family business meetings.

Some enterprise plans for the future include the possible re-establishment of the bush tucker plot and further development of their arts enterprise, such as converting the old piggery into an art studio.

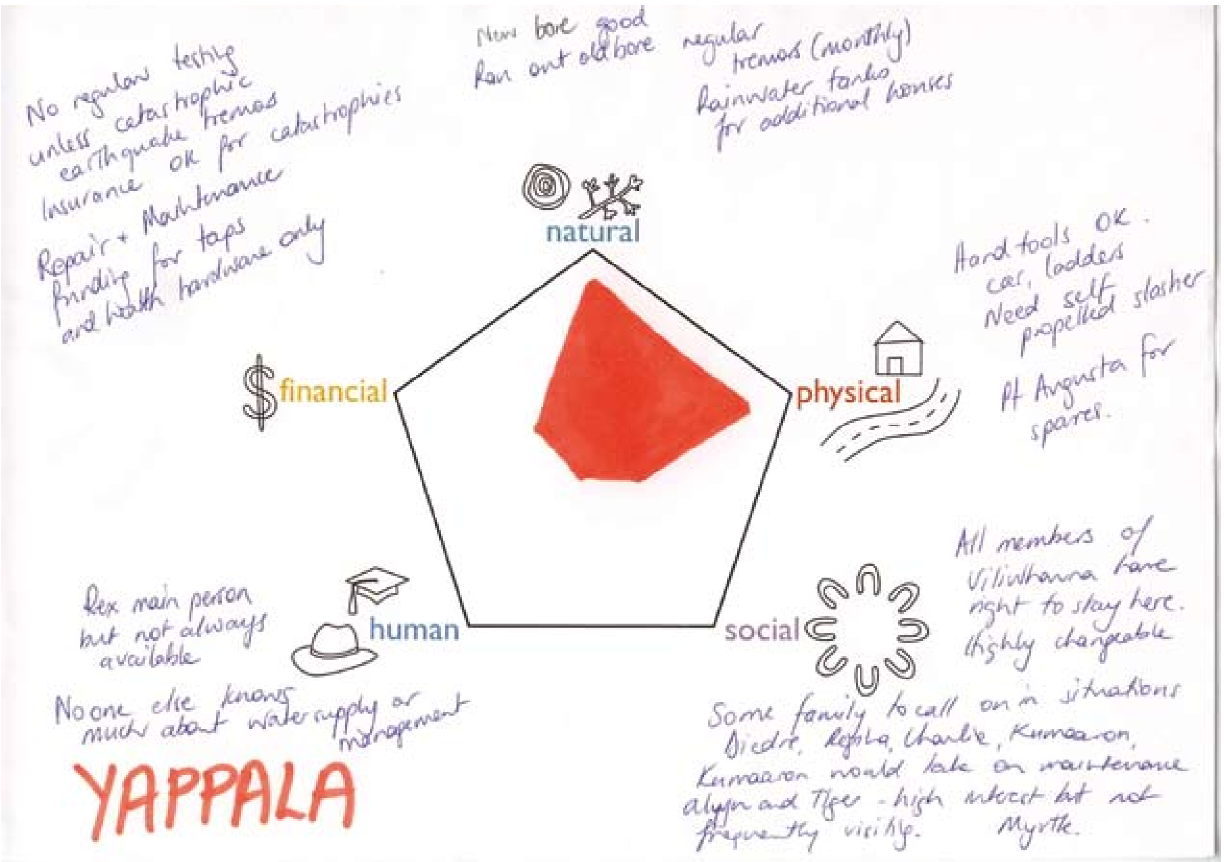

Figure 3: Yappala assets pentagon, March 2006

Table 1: Yappala livelihood assets, March 2006

Asset	Description
Natural capital	The water supply is adequate for the settlement. The demand for water is variable because Yappala has regular visitors staying for extended periods of time; however, there have been no water restrictions. There are no plans for irrigation – the bush tucker plot is no longer irrigated. There are 5–8 horses on the property that require watering. The water quality from the bore is good enough for household purposes. The drinking water supply is rainwater from tanks. The rainwater supply has been sufficient but the residents would prefer to have backup tanks on each house.
Social capital	The residents have a strong relationship with family members at Worro Downs and rely on their support to keep the water supply functioning. Residents have limited knowledge about how to look after the water supply. There is a heavy reliance on Yartawarli Resource Agency and contractors.
Human capital	The residents do not have enough access to information and technical advice to confidently manage the water supply themselves. Electrical and plumbing contractors are located at Hawker.
Physical capital	The bore and tanks are in good condition and designed to suit the needs of the settlement. The low-technology system is designed to require minimal maintenance. All other basic infrastructure on the settlement is in good condition. Tools and equipment to make rectifications are available at Worro Downs.
Financial capital	The Viliwarina Yura Aboriginal Corporation can source funding for large equipment failures. It is in a good position financially and there is a 10-year lease arrangement for a section of the property that supports the functioning of the settlement (providing funds for rates etc). Bungala runs a CDEP program at Yappala with 10 participants.

5 Site-specific plans

The assets pentagon shows that the Yappala residents are in need of people with technical skills and financial planning expertise. The project participants had suggestions to address the knowledge gap, including an infrastructure asset register to help with financial planning, water manuals to help with maintenance, and technical information and a training program on the water supply maintenance requirements to empower the residents.

Discussion centred on adapting the CWP water management plan to suit the residents' needs, and identifying and developing the skills, resources and tools. The residents wanted information available for visitors, such as posters saying what to do if there is an emergency, who should be contacted, and a step-by-step guide on what to do if there is no water pressure. The project participants wanted a guide that demonstrates the infrastructure lifecycles – knowing when big items may need replacing and what small items need to be replaced regularly would help with financial planning.

6 Enacting the plan

6.1 Yappala skills development program

A 4-week skills development program was delivered on-site at Yappala. The project participants drew up the following list of works to be completed during the program:

- Fit new valves on stock troughs.
- Fit bores with water meters.
- Build concrete aprons around boreheads and securely fence off the area.
- Clean up rubbish around the storage tank.
- Secure the lid on the storage tank.
- Fix leaks in hardware including taps, showerheads and toilets.
- Fix leaks in the distribution pipeline.

- Hang posters in key locations around the settlement. Posters included how to chlorinate the tanks and what to do when there is no water pressure.

During the program, the participants made their own ‘How to fix a tap’ book and logbooks for recording water maintenance activities and meter readings.

Photos 3 and 4: Leaks in toilet cisterns were fixed and scale was removed from outlets.

Photos 5: Residents removing rubbish around the storage tank

Photo 6: Residents using the manuals to carry out water management tasks and learn about maintenance

7 Conclusion

The project was evaluated on 30 November 2006 to assess the changes in the settlement over the duration of the project and whether the project aims were met. We used the assets pentagon (Figure 4) to identify the residents' capacity to manage their water supply after the completion of the project.

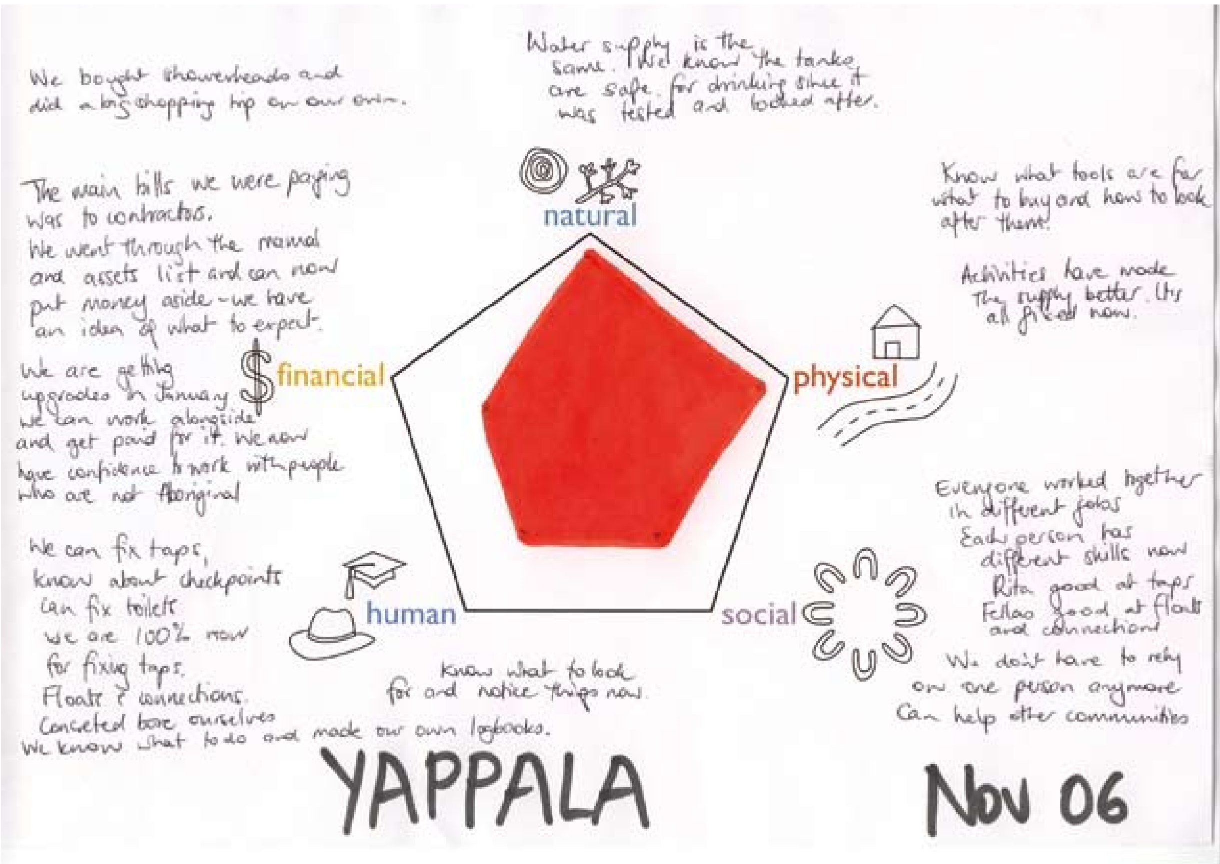

Figure 4: Yappala assets pentagon, November 2006

The assets pentagon in Figure 4 shows a significant increase in the human capital compared with at the start of the project (Figure 3). The residents stated that they are confident to make all small repairs and ongoing risk management checks. This is largely due to the training program and also the confidence and skills they have gained through the participatory project process.

There has been a significant increase in the level of skills for all residents. Residents felt that during the training program each person 'found their niche'. They discovered during the project that each person has a skill area and that, if they worked together, they could carry out all the maintenance activities. There was also a change in morale for residents – with the confidence gained during the project, participants who were shy were able to 'come out of their shells'.

Participants in the project bought their own spare parts and organised the work areas. There is now a shed with maintenance schedules and facilities for storing tools. The residents anticipate that the skills gained from the water project will flow over into other activities because everyone is motivated, working and willing to learn more to increase their independence and control. There was great pride in the completion of the project and, in particular, the achievements made during the training program. The residents are confident they will be able to identify and manage the everyday water management activities.

The benefits from the project have broader reach than the Yappala settlement. Project participants have been able to identify hazards and risks with water supplies in nearby settlements and tell other Aboriginal people of recommended minor rectifications. Recently, for example, a project participant from Yappala visited a nearby settlement and noticed that the bore did not have a concrete apron – the only protection was a sheet of iron covering the bore. They told the residents of the settlement of the hazard and potential risk to the water supply. This example demonstrates that project participants, from their own learning process, are able to identify hazards and can now convey to others the types of remedial steps that should be followed.

Some additional areas for comprehensive water management were beyond the scope of the project. There has been a longstanding idea to move the storage tank up the hill and away from the slaughterhouse. The idea has two advantages: a) if the small pressure pump breaks down, water can be gravity fed to the houses, and b) it removes any risk to the water quality of contamination from activities at the slaughterhouse.

Residents' involvement in this project has been remarkable. During the training program and at meetings during the final six months of the project, all residents participated actively. It took time for them to gain confidence in the project and overcome the preconceived ideas of 'another government representative' visiting and talking about yet another program. The engagement process was critical to the success of the project at Yappala. Ongoing support from the regional agencies is needed to sustain activity in this settlement.

Appendix 5A: Yappala water quality data

Constituent	Abbreviation	Units	Yappala bore supply	Notes
Electrical Conductivity	EC	µS/cm	2600	
pH	pH	units	7.2	
Bicarbonate	HCO3	mg/L	428	
Alkalinity	Alkalinity	mg/L	351	
Colour - True		Pt-Co	<1	true
Calcium Carbonate	CO3	mg/L	781	
Turbidity	Turbidity	NTU	0.15	
Total Dissolved Solids	TDS	mg/L	2940	calculated
Hardness		mg/L	781	
Nitrogen	TKN	mg/L	<0.05	
Nitrate + Nitrite	N	mg/L	0.186	
Chloride	Cl	mg/L	2060	
Phosphate	PO4_P	mg/L	1250	
Fluoride	F	mg/L	1.3	
Calcium	Ca_F	mg/L	136	
Potassium	K_F	mg/L		
Magnesium	Mg_F	mg/L	107	
Sodium	Na_F	mg/L	808	
Sulphate	SO4_F	mg/L	397	
Silicon	SiO2	mg/L	14	
Iron	Fe_T	µg/L	<0.030	
Silver	Ag_T	µg/L	<0.0020	
Aluminium	Al_T	µg/L	<0.020	total
Aluminium	Al	µg/L	<0.020	soluble
Arsenic	As_T	µg/L	0.002	
Boron	B_T	µg/L	0.896	
Barium	Ba_T	µg/L	0.0212	
Beryllium	Be_T	µg/L	<0.0005	
Cadmium	Cd_T	µg/L	<0.0005	
Chromium	Cr_T	µg/L	0.008	
Copper	Cu_T	µg/L	0.005	
Total iron	Fe_T	µg/L	<0.030	
Cyanide	CN-T	mg/L	<0.05	
Iodine/Iodide	I_T	µg/L	0.18	
Manganese	Mn_T	µg/L	0.1865	
Molybdenum	Mo_T	µg/L	<0.00050	
Nickel	Ni_T	µg/L	0.0010	
Lead	Pb_T	µg/L	<0.0005	
Antimony	Sb_T	µg/L	<0.0005	
Selenium	Se_T	µg/L	0.005	
Tin	Sn_T	µg/L	<0.0005	
Uranium	U_T	µg/L	0.0106	
Zinc	Zn_T	µg/L	<0.003	
Mercury	Hg_T	µg/L	>0.0003	
Radium 226	Ra	Bq/L	0.0181	
Radium 228	Ra	Bq/L	<0.070	
E. coli		CFU/100ml	0	
Pesticides				
Aldrin		µg/L	<0.01	
Chlorthal-Dimethyl (Dacthal)		µg/L	<0.05	
Dieldrin		µg/L	<0.01	

Constituent	Abbreviation	Units	Yappala bore supply	Notes
Endosulphan 1		µg/L	<0.05	
Endosulphan2		µg/L	<0.05	
Chlorothalonil		µg/L	<0.05	
Chloropyrifos		µg/L	<0.05	
4,4-DDD (TDE)		µg/L	<0.05	
4,4 DDE		µg/L	<0.05	
4,4 DDT		µg/L	<0.05	
Simazine		µg/L	<0.5	
Endosulphan Sulphate		µg/L	<0.05	
Atrazine		µg/L	<0.5	
Lindane		µg/L	<0.05	
Azinphos-Methyl		µg/L	<0.5	
Heptachlor		µg/L	<0.05	
Diazinon		µg/L	<0.5	
Heptachlor Epoxide		µg/L	<0.05	
Fenitrothion		µg/L	<0.5	
Trifluralin		µg/L	<0.05	
Hexazinone		µg/L	<0.5	
Chlordane –a		µg/L	<0.01	
Malathion		µg/L	<0.5	
Chlordane-g		µg/L	<0.01	
Parathion		µg/L	<0.5	
Endrin		µg/L	<0.05	
Parathion-Methyl		µg/L	<0.3	
Methoxychlor		µg/L	<0.05	
Prometryne		µg/L	<0.5	
Vinclozolin		µg/L	<0.05	

Appendix 6: Worro Downs case study

Worro Downs case study

Australian Government
Department of Families, Community Services and Indigenous Affairs

Centre for Appropriate Technology

CRC Australia

DESERT KNOWLEDGE CRC

Contributing author information

Robyn Grey-Gardner is from the Australian Government Department of Families, Community Services and Indigenous Affairs and is the project leader for the DKCRC Remote Community Water Management project. Robyn is an environmental and social scientist and has a range of water industry experience that includes monitoring environmental and urban water supplies and analysing water in chemical and microbiological laboratories. She has worked for seven years with Aboriginal communities, mainly on water management programs.

Dainis Skabe is a project officer working with the South Australian communities involved in the Desert Knowledge CRC Remote Community Water Management project. Dainis is from the South Australian Water Corporation and works in SA Water's Environmental Management and Remote Communities Groups. Dainis has a Degree in Environmental Management (Hons) from Flinders University, South Australia.

Acknowledgements

The project team would like to thank everyone at Worro Downs for their time and commitment to the project – especially Rex and Leonie McKenzie.

Many thanks for the support provided by Dene Cuthbertson and Kirstie Jamieson from Yartawarli Resource Agency and Peter Herraman and Maralyn Leverington from Port Augusta Indigenous Coordination Centre. The much-appreciated skills development program conducted at Worro Downs was delivered by Robyn Ellis from the Centre for Appropriate Technology.

Figure 2 is provided with permission from Burdon Torzillo and Associates. The graphical layouts, icons and water quality graphs were designed by and are the intellectual property of Burdon Torzillo and Associates Pty Ltd.

Contents

1 Introduction

In this case study, we describe the information gathered for the Desert Knowledge Cooperative Research Centre (DKCRC) Remote Community Water Management project about the water supply and water needs for the remote settlement of Worro Downs in the Flinders Ranges, South Australia.

We describe the implementation process that evolved during the project. The process included developing a water management plan for Worro Downs and empowering the family through participatory involvement in making decisions about Worro Downs' future water management. We also describe how the project team responded to the needs of the settlement by adapting the research activities to make sure that the best possible outcome for the project participants was achieved within the time constraints of the project.

2 Background

Worro Downs is a homestead on a large property that includes three sections – Worro Downs, Yappala and Codabena. Members of Viliwarina Yura live at both Worro Downs and Yappala. Codabena is an uninhabitable section of land that is leased out to a neighbouring landholder.

Worro Downs was bought by the Indigenous Land Corporation in 2001. Rex and Leonie McKenzie and their children moved to the property that same year. There are now six family members who live there permanently and visitors who stay at different times for varying periods of time.

A host of agencies and organisations are involved in the activities at Worro Downs. The water supply has had little improvement since the property was bought. Rex McKenzie performs everyday operations and maintenance and Yartawarli Resource Centre provides additional help. Yartawarli is located at Hawker, 25 kilometres away, and helps with some essential services for Worro Downs, such as waste removal. The Aboriginal Housing Authority has provided support and funding for improvements to the house. CDEP workers have also helped with minor works such as fitting gutters to the house.

The water management plan for Worro Downs developed over the course of a year through meetings and research activities. The plan was developed in four stages:

1. Assess the water source and risk management.
2. Assess livelihoods and identify the match between the water source and residents' aspirations.
3. Identify the best approach to manage risks to the water supply and meet the needs of the settlement.
4. Enact the plan and identify strategies for future water management.

The information in this case study was gathered during meetings held at Worro Downs in January 2005, October 2005, March 2006, June 2006, August 2006 and October 2006. Further information was gathered during workshops held in Alice Springs in September 2005 and September 2006. We supplemented the information gathered during the visits to Worro Downs with information from desktop research and from discussions with government agencies, Yartawarli Aboriginal Corporation Resource Agency and contractors who had worked at Worro Downs.

3 Worro Downs' water supply

Photo 1: Meeting to establish water supply and needs at Worro Downs, October 2005.
From left, Robyn Grey-Gardner, Leonie McKenzie, Becky McKenzie, Rex McKenzie and Dainis Skabe.

3.1 The water source

The water supply at Worro Downs is a simple system that meets the needs of the residents. Rainwater is piped to the kitchen and is used for drinking and cooking. Bore water is used for all purposes other than drinking such as washing, watering the garden and stock.

3.2 Water quantity

During the relatively short period of time that the McKenzies have been at Worro Downs, they have not experienced any water restrictions. In late 2006, however, during a year of drought and low rainfall, the main rainwater tank was getting low.

There are a couple of bores near the homestead that can be used for stock. There are windmills and stock troughs. During the time of the project, the stock trough was not being used.

3.3 Water quality

In October 2005, the project participants and the project team assessed the water supply. Basic water supply information was recorded and water samples were collected then sent to the Australian Water Quality Centre for microbiological, chemical, pesticide and metals analysis. Water samples were also taken for radiological analysis and sent to the Australian Radiological Protection And Nuclear Safety Agency in Melbourne.

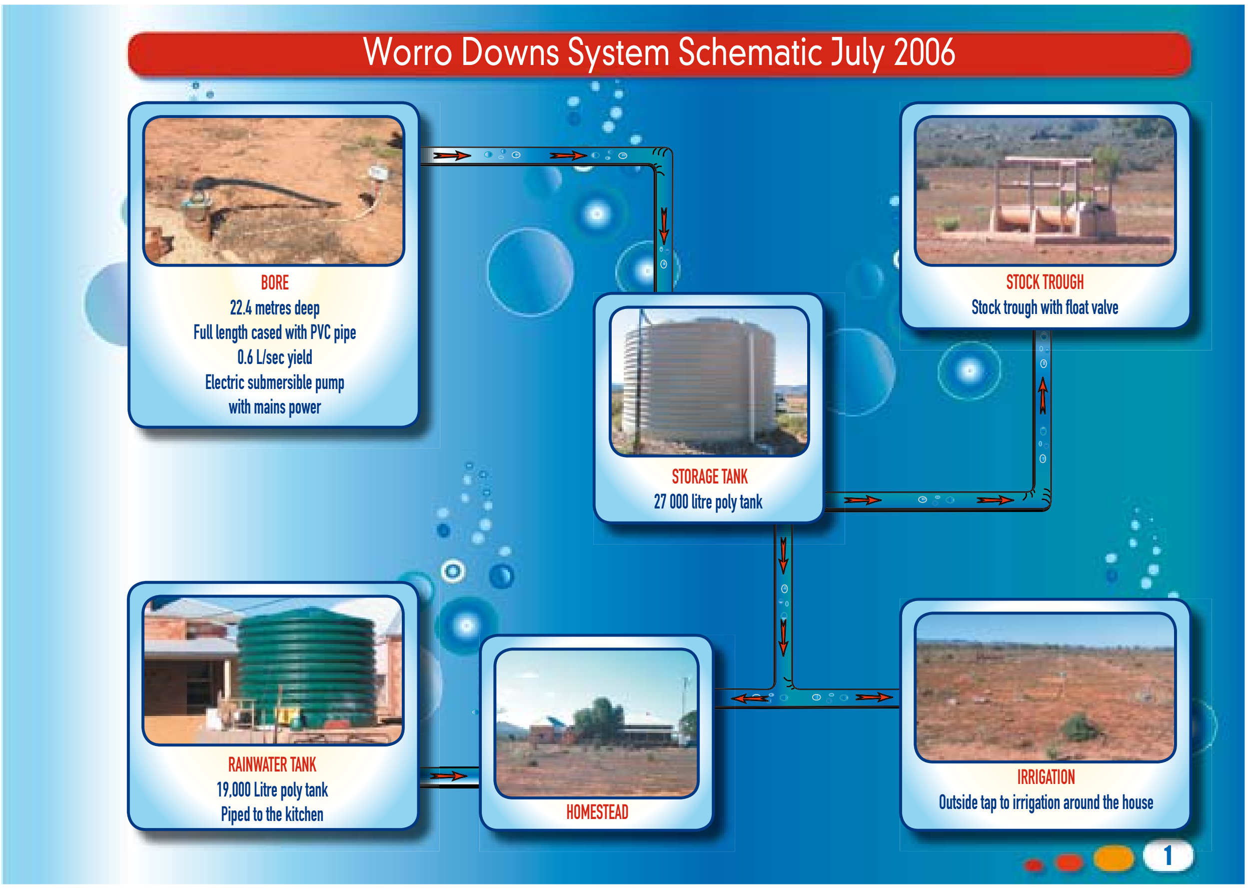

Figure 1: Worro Downs' water supply schematic, March 2005

A water supply schematic was drawn (Figure 1) and became the foundation for discussions about the water supply management and strategies.

The water quality tests showed that the bore water was of good quality, although it does have a high salt content. The project participants were not at all surprised by the results, since the bore water was not palatable and was causing scaling on hardware such as taps and showerheads. The key constituents are depicted in the water quality graph in Figure 2. The graph shows water quality data as a percentage of each value used in the *Australian Drinking Water Guidelines* (ADWG). Traffic light icons indicate the level of management the water supply may require according to the constituents. The doctor icon indicates that the ADWG value is derived from a health parameter; all other values are aesthetic. Where available, median water quality data from remote communities in the region are shown as a yellow bar. This allows a crude comparison of the local water quality to that of other communities in the region. See Appendix 6A for full results.

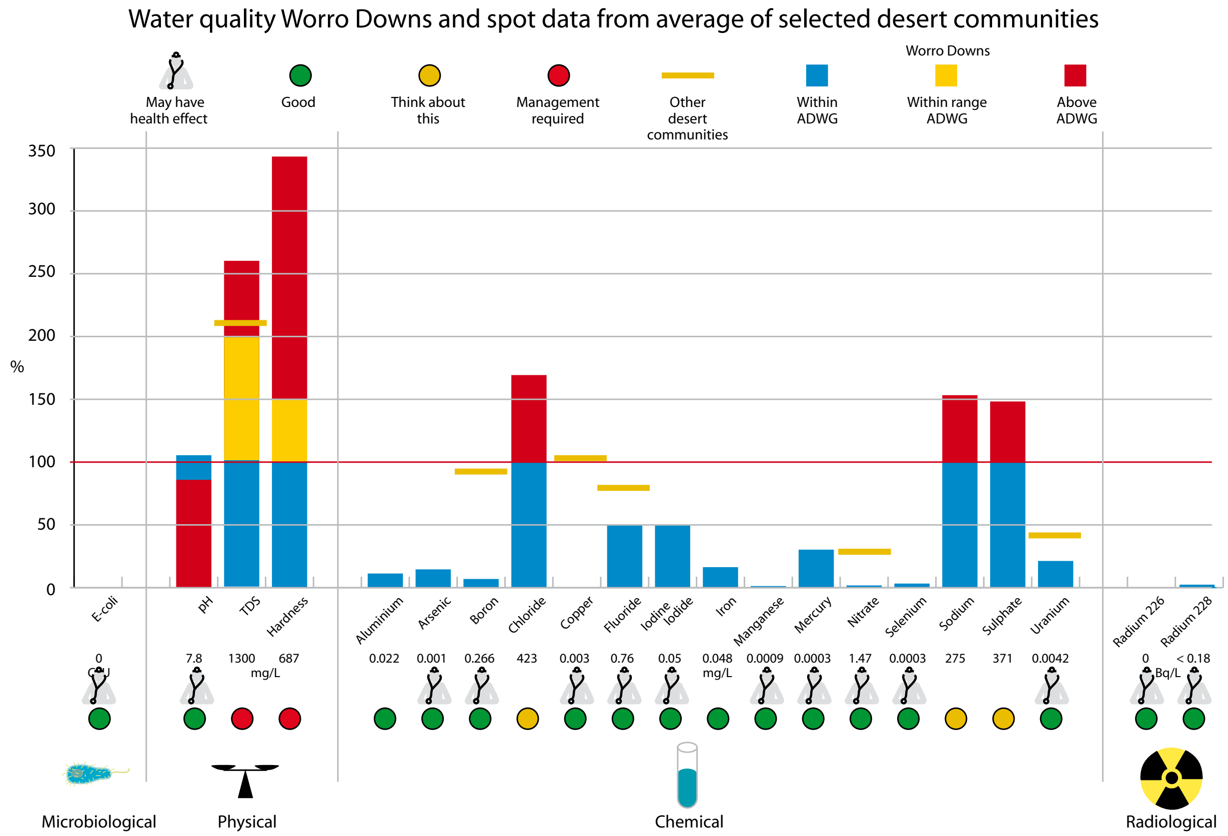

Figure 2: Water quality graph for Worro Downs, March 2006

The rainwater was tested for microbiological contamination. A low level of *E. coli* was detected in the tank. Management options were presented to the McKenzies, such as cleaning up the catchment area (roof and gutters), boiling the water and chlorinating the tanks. The McKenzies felt that they had not become sick from drinking the water and had cleaned up the roof area after the water had been tested. They were happy to boil the water if necessary but felt that it was not a situation that warranted chlorinating the tank.

4 Livelihoods activity

4.1 Participants

The project participants at Worro Downs were primarily a family of six. The homestead has visitors who stay for varying periods of time and there is a lot of interaction with the homestead at Yappala.

4.2 Livelihoods assessment

We used the Sustainable Livelihoods assets pentagon (Figure 3) to better understand the residents' capacity to carry out a water management plan and to identify current and planned activities on the property. The pentagon shows that the residents are well placed to manage their own supply.

Plans for the future include running cattle on the property, maintaining the native fauna populations (Yellow-footed Rock-wallaby), and possibly controlling the feral goat population. The McKenzies have firm plans to keep the number of cattle at a sustainable level and fence off areas for the protection of native fauna.

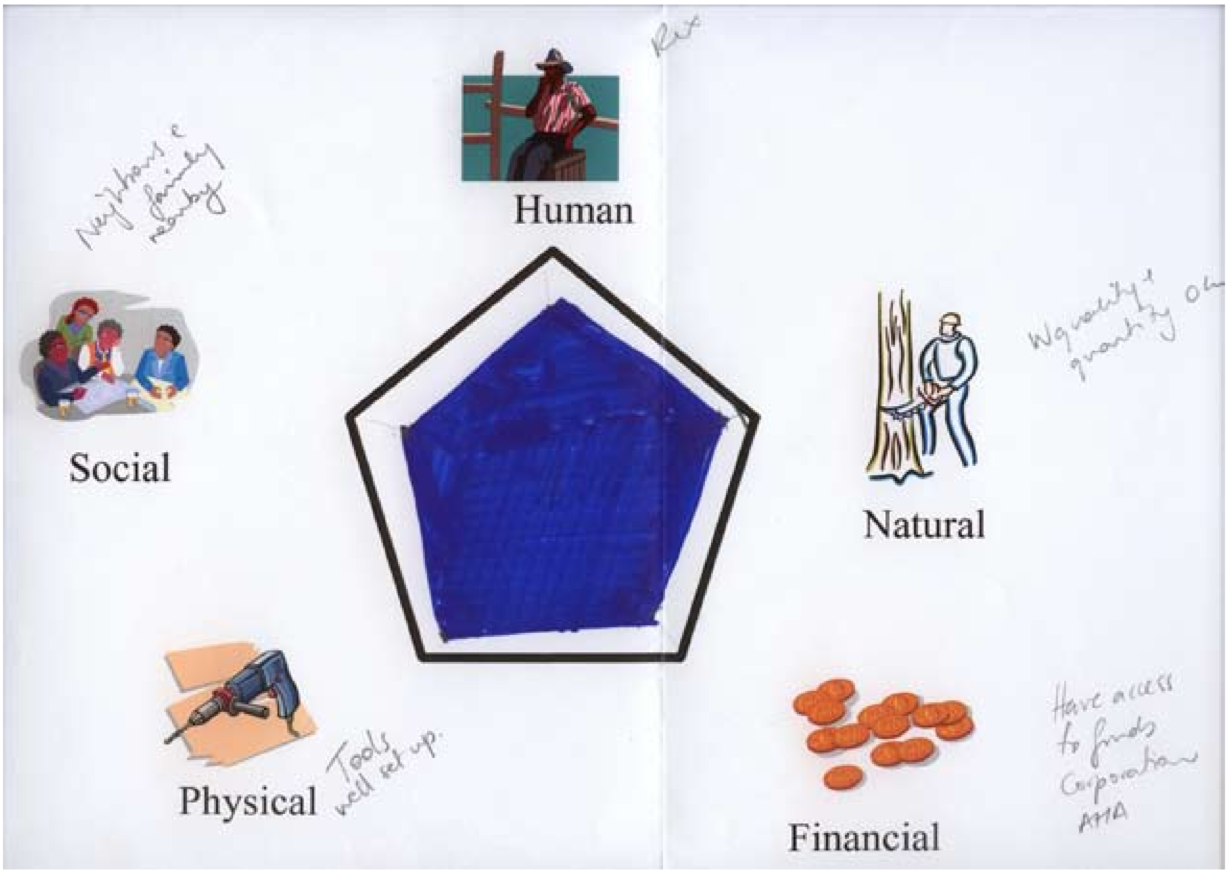

Figure 3: Worro Downs assets pentagon, March 2006

Table 1: Worro Downs livelihoods assets, March 2006

Asset	Description
Natural capital	• The water supply has the capacity to meet the property's needs. There are no plans that would require large quantities of water, such as for irrigation. There are about 10 horses on the property that require watering. Recent drought has raised the need for more drinking water storage (rainwater tanks). • The quality of the bore is adequate for the purposes. Drinking-water quality is good – palatable and easily managed.
Social capital	• The residents have strong relationships with neighbours and a history of working on local properties. • The residents have a strong relationship with the family at Yappala.
Human capital	• Knowledge and skills related to the water supply are high. Residents have a high ability to solve problems and rectify damage to the water supply. • There is access to reliable services at Hawker. approximately 25 kilometres from the property.
Physical capital	• The bore and tanks are in good condition and designed to suit the needs of the settlement. The system is simple and easily managed. Other basic infrastructure on the property is in good condition. • Tools and equipment to make rectifications are available on-site.
Financial capital	• The Viliwarina Yura Aboriginal Corporation is in a position to source funding for large equipment failures. The Corporation is in a good position financially and there is a 10 year lease arrangement for a section of the property that supports the functioning of the settlement (providing funds for rates etc).

5 Site-specific plans

During the meetings about future water management, participants were keen to participate in the training program with Yappala. It was seen as an opportunity to work together and make some significant improvements to the property's water supply. It was also considered an important opportunity to clarify management roles and responsibilities for tools and equipment.

Rectifications to the water supply at Worro Downs were identified during the development of the CWP management plan. The project participants tried to make the recommended improvements themselves, including cleaning the roof and gutters and fixing leaks in the main pipeline, before the training program started.

The residents wanted a small booklet-sized water supply manual that they could keep in the kitchen or somewhere central. The manual would include information about tasks to maintain the water supply and asset information to help with maintenance/replacement regimes and financial planning. The rectifications identified during the development of the management plan were included in the manual.

6 Enacting the plan

The training program at Worro Downs had three participants. It was seen as an opportunity to share knowledge with the residents at Yappala and work together to make immediate rectifications to secure the water supply. The training activities were based on the water manuals and included the following:

- building a concrete apron around the borehead
- building a fence around the borehead
- fixing pipes and leaks, including installing new float valves in stock troughs, cleaning scale from hardware, and fixing leaking taps, showerheads and toilets
- installing a water meter at the bore
- developing booklets on how to read a water meter and disinfection practices
- developing logbooks for recording maintenance activities.

6.1 Worro Downs skills training program

The training program in Worro Downs focused on increasing the skills of residents in identifying hazards and understanding the risks to the water supply. Skills were built to make sure residents could solve problems and maintain the water supply themselves. To supplement the learning, residents also learnt how to secure the water supply and fix leaks.


Photos 2 and 3: A concrete apron and fence were built to protect the borehead. A water meter was also installed at the bore. Leaking pipes were fixed.


Photos 4 and 5: Leaking taps, toilets and showers were fixed.

Conclusion

> *What we learned from the project is that little things can turn into big things.*
>
> – Rex McKenzie.

The project was evaluated on 30 November 2006. We used the Sustainable Livelihoods assets pentagon to assess changes in the residents' capacity for managing their own water supply after the project was completed. The residents showed a solid understanding of the hazards to the water supply and a realistic understanding of the limitations of the water supply. The most important learning expressed by the participants was that 'small things need to be fixed because they can have severe consequences sometime later on'. An example that Rex McKenzie gave was that a small 10- or 20-minute time investment to fix valves or inspect the water supply system could save the residents hundreds of dollars in contractor fees. The residents feel that they may save money now that they have the skills to maintain the water supply.

More people at Worro Downs and Yappala are now able to identify problems and have the skills to make basic repairs and maintenance. The responsibility can be shared and managed more consistently. The most significant change at Worro Downs is the understanding of the responsibilities associated with water management and the willingness to take responsibility for the everyday maintenance activities. Residents take pride in understanding the water supply and everyone is more involved now.

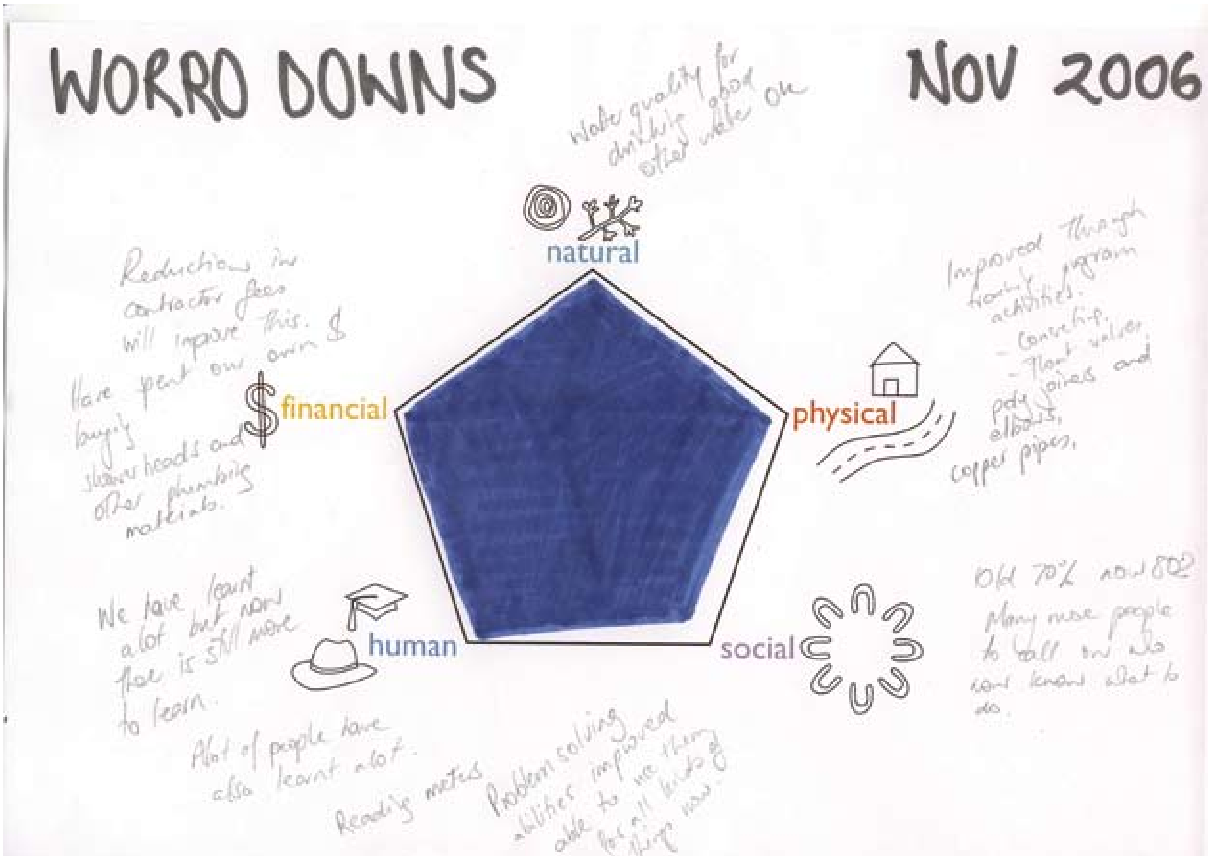

Figure 4: Worro Downs assets pentagon, November 2006

The assets pentagon in Figure 4 shows improvements, particularly in the human, financial and social capital. The training program had a great influence on the skills and capabilities of the residents to identify and repair basic problems with their water supply. Although the financial and social capital shows an overall increase, there has in fact been a significant transformation. Before the project, the financial and social capital was external to the settlement. Although the people and funding were considered reliable, the residents are now empowered to make their own decisions and act quickly on any hazard to the water supply. Worro Downs residents can now assess whether they can tackle a problem themselves or whether it requires contractors or external assistance. As beneficiaries of the new management regime, residents have independence and the confidence to manage the water supply themselves.

Appendix 6A: Worro Downs water quality data

Constituent	Abbreviation	Units	Worro Downs bore 2/11/05	Notes
Electrical Conductivity	EC	µS/cm	1300	
pH	pH	units	7.8	
Bicarbonate	HCO3	mg/L	340	
Alkalinity	Alkalinity	mg/L	279	
Colour - True		Pt-Co	<1	true
Calcium Carbonate	CO3	mg/L	687	
Turbidity	Turbidity	NTU	0.58	
Total Dissolved Solids	TDS	mg/L	1480	calculated
Hardness		mg/L	687	
Nitrogen	TKN	mg/L	0.60	
Nitrate + Nitrite	N	mg/L	1.47	
Chloride	Cl	mg/L	423	
Phosphate	PO4_P	mg/L		
Fluoride	F	mg/L	0.76	
Calcium	Ca_F	mg/L	129	
Potassium	K_F	mg/L	8.7	
Magnesium	Mg_F	mg/L	88.6	
Sodium	Na_F	mg/L	275	
Sulphate	SO4_F	mg/L	371	
Silicon	SiO2	mg/L	18	
Iron	Fe_T	µg/L	0.048	
Silver	Ag_T	µg/L	<0.0020	
Aluminium	Al_T	µg/L	0.022	total
Aluminium	Al	µg/L	<0.020	soluble
Arsenic	As_T	µg/L	<0.01	
Boron	B_T	µg/L	0.266	
Barium	Ba_T	µg/L	0.212	
Beryllium	Be_T	µg/L	<0.0005	
Cadmium	Cd_T	µg/L	<0.0005	
Chromium	Cr_T	µg/L	0.005	
Copper	Cu_T	µg/L	0.003	
Total iron	Fe_T	µg/L	0.048	
Cyanide	CN-T	mg/L	<0.05	
Iodine/Iodide	I_T	µg/L	<0.05	
Manganese	Mn_T	µg/L	0.0009	
Molybdenum	Mo_T	µg/L	0.0010	
Nickel	Ni_T	µg/L	0.0009	
Lead	Pb_T	µg/L	<0.0005	
Antimony	Sb_T	µg/L	<0.0005	
Selenium	Se_T	µg/L	<0.003	
Tin	Sn_T	µg/L	<0.0005	
Uranium	U_T	µg/L	0.0042	
Zinc	Zn_T	µg/L	0.004	
Mercury	Hg_T	µg/L	<0.0003	
Radium 226	Ra	Bq/L	<0.0069	
Radium 228	Ra	Bq/L	<0.18	
E .coli		CFU/100ml	0	
Pesticides				
Aldrin		µg/L	<0.01	
Chlorthal-Dimethyl (Dacthal)		µg/L	<0.05	
Dieldrin		µg/L	<0.01	

Endosulphan 1		µg/L	<0.05	
Endosulphan2		µg/L	<0.05	
Chlorothalonil		µg/L	<0.05	
Chloropyrifos		µg/L	<0.05	
4,4-DDD (TDE)		µg/L	<0.05	
4,4 DDE		µg/L	<0.05	
4,4 DDT		µg/L	<0.05	
Simazine		µg/L	<0.5	
Endosulphan Sulphate		µg/L	<0.05	
Atrazine		µg/L	<0.5	
Lindane		µg/L	<0.05	
Azinphos-Methyl		µg/L	<0.5	
Heptachlor		µg/L	<0.05	
Diazinon		µg/L	<0.5	
Heptachlor Epoxide		µg/L	<0.05	
Fenitrothion		µg/L	<0.5	
Trifluralin		µg/L	<0.05	
Hexazinone		µg/L	<0.5	
Chlordane –a		µg/L	<0.01	
Malathion		µg/L	<0.5	
Chlordane-g		µg/L	<0.01	
Parathion		µg/L	<0.5	
Endrin		µg/L	<0.05	
Parathion-Methyl		µg/L	<0.5	
Methoxychlor		µg/L	<0.05	
Prometryne		µg/L	<0.5	
Vinclozolin		µg/L	<0.05	

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