Evaluating scenarios for the Howard catchment: summary report for workshop participants and stakeholders

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Tropical Rivers and Coastal Knowledge

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1. EXECUTIVE SUMMARY

The Howard River catchment covers approximately 1,500km^2 in the rural Darwin region of the Northern Territory (NT). Over the past decade, increased demand from Darwin residents and residential and agricultural development in the rural Darwin region has increased competition for groundwater, thus generating tensions between different user groups, including those concerned about the health of groundwater dependent ecosystems.

The NT Government is turning to statutory water planning processes to regulate, share and sustain local water resources. In this, it is driven and guided by the national program of water reform introduced by the Council of Australian Governments (COAG), the National Water Initiative (NWI). These water planning processes include mechanisms to guarantee water allocations to the aquatic environment and the water accounting systems to underpin monitoring, trading, environmental and on-farm management. However, water planning in the NT is in its infancy and managers, planners and members of the community face a number of challenges.

One of the key questions to arise in water planning is how to allocate scarce water resources to meet the needs of multiple stakeholders holding multiple and sometimes conflicting objectives. One of the key questions for water planning processes is thus how to explore, weigh and negotiate the different and sometimes competing values and uses for water. This research was thus designed as part of a Commonwealth Government National Heritage Trust project to assist in water planning for the rural Darwin region by trialling social research and socio-economic decision support tools that can help explore and settle trade-offs between competing outcomes. To do this, a combination of methods was used to build understanding of the values, uses and issues for the Howard catchment, explore the conflicts and potential trade-offs, and evaluate several scenarios for the future. These methods included stakeholder consultations and workshops.

We brought together a group of stakeholder representatives in a structured and guided process of deliberation and evaluation, called a deliberative multi-criteria evaluation. It was found that there are multiple and sometimes competing values and uses for the water resources of the Howard catchment and a range of existing and emerging conflicts. The deliberative multi-criteria evaluation process organised different outcomes for each value and use into scenarios and then enabled information to be shared and positions discussed as the workshop participants evaluated the set of scenarios for the future of the catchment.

While there was a range of opinions about the importance of certain criteria to the desired outcome for the catchment there was overwhelming agreement among participants in wanting to see the catchment's environmental and recreational values maintained and improved. It was also acknowledged that the more likely scenario would include a combination of development and environmental/passive recreational outcomes. Participants concluded that the responsibility for sustainable water use is shared between users, managers and suppliers, and that maintaining environmental and recreational values in the face of population and other pressures will likely require authorities to begin a program of demand management for household water consumption in both the rural and urban regions. They also raised the importance of the need to coordinate land use and water planning.

The deliberative multi-criteria evaluation provided a structure for organising values, uses, preferences and scenarios and for participants to hear information from local experts on a range of issues. This information and the ability to ask questions of presenter and talk things through with the other participants dissolved some myths around water use and management in the catchment and from this emerged a new appreciation for the complexity of water planning and management and that responsibility must be shared by all. This kind of outcome, while not easily measurable, may serve to improve stakeholder consultations around future water planning in the NT.

As for the effectiveness of the deliberative multi-criteria evaluation in helping to explore, weigh and negotiate the different and sometimes competing values and uses for water in the Howard River catchment, there was a moderate degree of success as described above; however, two factors probably impeded a more effective process. First, a lack of data and modelling limited the extent to which the scenarios and evaluation matrix were based on scientific understanding of the key relationships. Second, confusion about the weighting process limited the extent to which participants we able to engage with the scenarios and evaluation matrix. There are solutions for these problems: evaluation matrices can be developed based on better information and the weighting process can be explained more clearly. These learnings will be taken up in the next application of this method.

Based on the results of our work we suggest that the NT Government focus attention on gaining and providing more information on:

- condition of aquatic habitat and populations of aquatic species;
- new industry in the catchment;
- risks to water quality; and
- condition of terrestrial habitat and populations of terrestrial species

as the four most important criteria both before and after deliberation. These are the things that people care about and will look at to know how well things are going in the catchment. Our work also shows that providing further information and opportunities for deliberation can improve the level of agreement about what is important; a useful tool for bringing about some level of consensus in a water planning process.

This report is primarily for the participants of the workshops and for stakeholders who were contacted throughout the workshop process. It is not a complete report of the project and does not cover a substantial amount of the findings from the literature reviews and stakeholder consultations. The full report will be made available shortly[1].

2. INTRODUCTION

The Howard River catchment covers approximately 1,500km^2 in the rural Darwin region of the Northern Territory (NT). At the time of the research the delineation of the Howard water

[1] Please contact Sue Jackson of CSIRO Darwin for a copy on (08) 8944 8415 or sue.jackson@csiro.au.

planning area was yet to be finalised so, for the purposes of this study, the Howard catchment is defined to encompass the main subsurface dolomite aquifer (the only aquifer in the Darwin rural area) and stretches east from the outskirts of Darwin's suburbs at Knuckey Lagoons to the Adelaide River floodplain, and north from the Arnhem Hwy to the coast. It includes McMinns and Lambell's Lagoon to the south and the coastal reaches of Gunn Point to the north (see Fig. 1).

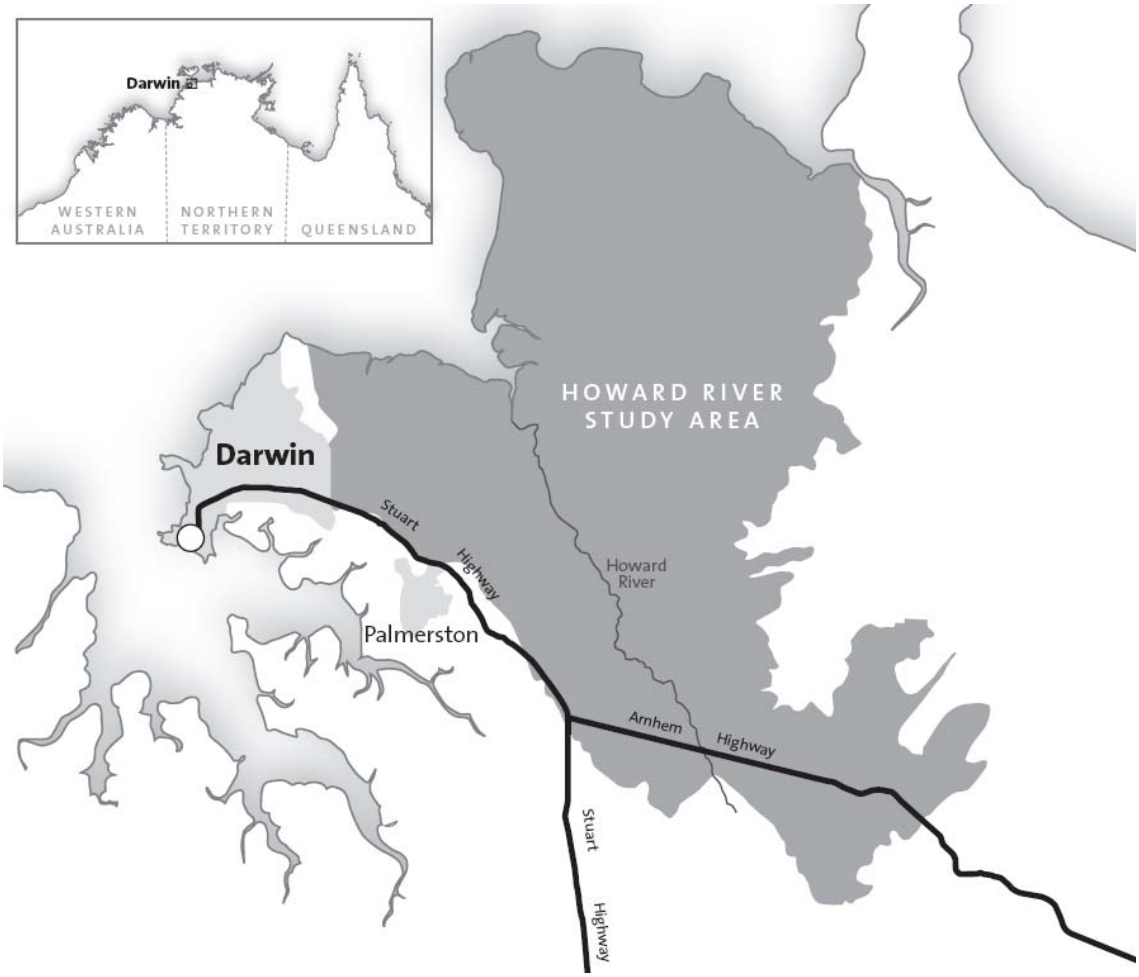

Figure 1: Map of the Howard catchment as defined for this study (study area shaded in grey)

The major settlements and features of the area, which falls entirely within the Litchfield Shire, include Humpty Doo, Howard Springs, Girraween, Lambell's Lagoon and Koolpinyah Station. Both Fogg Dam and Harrison Dam were excised from the area and so have not been considered in this study. The full report will provide a detailed description of this area, its vegetation and landscape types, water features, land tenure and uses, conservation values and demographic trends.

Over the past decade, residential and agricultural development in the rural Darwin region has increased competition for groundwater from the aquifer that supplements the Darwin metropolitan water supply, thus generating tensions between different use groups. Evidence of tension over water use is seen in the concerns expressed over water flows in popular springs and the impacts of lower water flows on groundwater dependent ecosystems.

The NT Government is turning to statutory water planning processes to regulate, share and sustain local water resources, driven and guided also by the national program of water reform introduced by the Council of Australian Governments (COAG), the National Water Initiative (NWI). These water planning processes include mechanisms to guarantee water allocations to the aquatic environment and the water accounting systems to underpin monitoring, trading, environmental and on-farm management. However, water planning in the NT is in its infancy. Managers, planners and members of the community are grappling with a low knowledge-base about how river systems work, high variability in water supply, complex social and cultural dynamics, and limited capacity within stakeholder and management organisations.

In 2005, CSIRO, Charles Darwin University (CDU) and the NT Department of Natural Resources, Environment and the Arts (NRETA) received funding from the Commonwealth Government's National Heritage Trust to assist in this process by recommending:

> *cultural and environmental water requirements for wetlands and surface and groundwater resources within the Howard River sub-catchment (NHT 2005/151).*

The project was divided into two largely independent components that would:

1. assess the social and cultural values and requirements as well as impacts of water use options (undertaken by CSIRO); and

2. assess the environmental flow requirements based on aquatic plants and fish (undertaken by a team from CDU, Griffith University, NT Department of Fisheries and NRETA).

This report provides a brief summary of literature reviews, stakeholder consultations, workshops and evaluation results for the first component. The research was developed and designed to provide input into the NT Government's water planning process. In particular, this project sought to trial social research and socio-economic decision support tools that can help explore and settle trade-offs between competing outcomes, an area about which little is said in the *Water Act 1992 (NT)*. A combination of methods was used to build understanding of the values, uses and issues for the Howard catchment, explore the conflicts and potential trade-offs, and evaluate several scenarios for the future.

This report is primarily for the participants of the workshops and for stakeholders who were contacted throughout the workshop process. It is not a complete report of the project and does not cover a substantial amount of the findings from the literature reviews and stakeholder consultations. The full report will be made available shortly[2].

The following section briefly discusses the stakeholder consultations and summarises key findings. Section 4 describes the first workshop held in April 2008 and introduces the method: deliberative multi-criteria evaluation. Section 5 describes the second workshop held in May 2008, including summary of key discussion points, and discusses the results of the evaluation performed at that workshop. Section 6 talks about some implications and future research directions.

[2] Please contact Sue Jackson of CSIRO Darwin for a copy on (08) 8944 8415 or sue.jackson@csiro.au.

3. SUMMARY OF STAKEHOLDER CONSULTATIONS: VALUES AND ISSUES FOR THE HOWARD CATCHMENT

The first part of the CSIRO component of the project involved significant literature reviews and consultation with stakeholders to build understanding of the values, uses and issues for the Howard catchment. The following summarises this process and key findings. A complete description can be found in the full report of the project.

3.1 How did we consult with stakeholders?

We searched for literature relating to the Howard region in the NT Library Collection and National Archives of Australia including their image/photo collections. This literature was reviewed for information about the history of the Howard region, including Reserve Management Plans, and reports from government agencies, consultants and non-government organisations.

We raised awareness of the research project and invited people to become involved through placing advertisements in local newspapers, the NT News and the Darwin Sun. We produced a poster, which was placed at popular community locations, and a pamphlet, which was sent out to key user groups and individuals along with a letter of introduction. These user groups and individuals were identified through web searches, the local phonebook and the snowball method, where initial respondents were asked to nominate other people to be interviewed.

Interviews were organised and undertaken with several interest group representatives and individuals. A meeting was also held with the Larrakia Harbour Committee supporting the Darwin Harbour Advisory Committee. These interviews were recorded and transcribed, some with the help of a research assistant from the Larrakia Nation. The interviews covered:

- The importance of water and water places to people, including hunters, recreational fishers, environmental groups such as bird watchers and people who like plants or visit springs and jungles;
- Which water places are used by people and when;
- What environmental changes people have observed, including changing use over time, and their perceptions of waterway and wetland health; and
- People’s views about the pressures these places may be under, current management and future use.

The following sections provide a very brief overview of the findings of the consultations of this stage of the research. Refer to the full report for a complete description of findings from the literature review and consultations.

3.2 What are the values of the Howard catchment?

The key social and cultural activities related to water are:

- Fishing;
- Hunting;
- Motorbike and quad-bike riding;
- Orienteering and rogaining;
- Off-road biking (mountain biking);
- Aesthetics – observation and appreciation;
- Swimming, snorkelling; and
- Bird watching.

Other social and cultural values that are attributed at least in part to water are:

- Sense of community and cohesion;
- Education, teaching and the transfer of knowledge;
- Appreciation of nature;
- Exercise areas for people, pets, and horses;
- Bushwalking;
- Exploring;
- Gathering (e.g. seed collection);
- Boating/canoeing/kayaking;
- Camping;
- Historical and archaeological appreciation;
- Cultural obligation;
- Inspiration for art and craft;
- Photography; and
- Research interest.

Values and activities specific to Larrakia people are:

- Hunting and collecting a wide variety of foods, e.g. long-neck turtle, goose, milky plum, freshwater prawns, water lilies, barramundi, catfish, yabbies, file snake, goanna, cockles, crabs, stingray, wallaby, kangaroo, possum, bandicoot;
- Sharing the food collected, sharing with family;
- Jungles – important places for fruit, other foods and medicines;
- Maintaining historical connections – visiting places that have connections with the past, e.g. Tamarind trees and Macassans;
- Sharing and passing on knowledge, name places and stories;
- Remembering – old people singing with clapsticks and didgeridoo at Whitestone (50 years ago);
- Visiting places in order to notice change; and
- Gaining inspiration for painting and other expression.

3.3 Stakeholder views on the water issues in the Howard catchment

Some of the key water use issues and potential conflicts are:

- The impacts of new housing developments on land for hunting and other forms of recreation;
- Competition for groundwater between urban Darwin households, rural households, growers, recreational users, industrial users and groundwater dependent ecosystems;
- Amount of water extraction from Power and Water Corporation's Stage 1 borefield;
- The impacts of domestic pets on habitat and wildlife;
- The impacts of quad-bikers and motorbikers on tracks, roads, other users, habitat and wildlife;
- Reduced or lost access to certain places and experiences;
- Reduced quality of places for recreation;
- Increased numbers of feral pigs and other introduced species;
- Decreased native vegetation;
- Uncontrolled access to certain places;
- Perceived lack of coordinated planning, management and enforcement;

- Insufficient understanding of the hydrological system, e.g. recharge rates and perceived unreliability of water use data; and

- Increased risks to groundwater quality from increased numbers of sewerage systems in the area.

Key questions that arise from these values, uses and issues for water planners are how much water can be extracted from the system by some users, and to what extent can water quality be compromised, before other users and values are negatively impacted? Addressing these questions requires a thorough understanding of the hydrological resources and the requirements of each water user group, including groundwater dependent ecosystems. The forthcoming water allocation plan for the Howard East water resource will undertake this important task.

The role that this study played in contributing to the planning process was to employ socio-economic decision-support tools that aim to both improve public participation and reveal and assist in the settling of trade-offs between competing outcomes. Rather than seek to quantify the water requirements of industry, social or cultural groups, or those of the ecological features that sustain the economic, social and cultural values identified above, this part of the research instead used a process in which stakeholders and water planners were provided information to assist discussion and deliberation on their preferred water use futures and the criteria for evaluating water use options. This participatory process sought to explore one way of gaining greater understanding and agreement amongst a small group of important stakeholders on the preferred future for the catchment and the criteria against which future water use options could be evaluated.

As previously mentioned, statutory water allocation planning in the NT is yet to employ such techniques (Tan *et al.* 2008; Jackson 2006). Similarly socio-economic impact assessment of various water use options has not yet been considered in any NT water plan (Hamstead *et al.* 2008). As water use pressures intensify and competition and conflict over water increase there will be an even greater need to ensure stakeholders (a) understand the rationale behind water use options and eventual decisions, (b) gain a deeper understanding of the physical resource and the variety of values, needs and interests in it, and (c) contribute to the selection of criteria for trade-offs to improve the legitimacy of decision-making. Such a process will also ensure greater acceptance of the resulting water plan through the involvement of and increased understanding by the stakeholders. The process outlined below sought to make a contribution to those pre-requisites to effective water planning.

4. WORKSHOP 1: SETTING UP THE EVALUATION

4.1 Workshop setting and participation

The first workshop was held on April 22nd 2008 at CSIRO's Tropical Ecosystems Research Centre. Letters of invitation were initially sent to an inclusive sample of the stakeholders interviewed for the consultation stage of the research. The sample was chosen to cover the range of issues and interests held. Seven people attended, representing a range of groups and interests summarised in Table 1.

Table 1: Organisations and interests represented at the first workshop

Organisation	Interests
Holtze Landcare Group	Local environmental interests
McMinns Lagoon Reserve Association	Local environmental interests
NT Firearms Council	Recreational interests
NT Field and Game	Recreational and environmental interests
Amateur Fishermen's Association of the Northern Territory	Recreational interests
Top End Native Plant Society	Local environmental interests
Larrakia Nation	Indigenous interests

The interests represented didn't cover the full range relevant to the Howard catchment. In particular, horticultural, mining and pastoral interests were not represented. This signalled to the researchers that further attempts needed to be made to engage these sectors. Such attempts were made in organising the second workshop and are described in Section 4.4.

On arrival to the first workshop, participants were given background information on the project, the water planning process for the Northern Territory, and how the research project and workshops relate to this process. The findings of stakeholder consultations were presented in order to get some feedback and ratification of this part of the research. Participants were asked if they had any issues they wanted to add to the findings, and a set of maps were used to help focus discussion around particular places of interest. The substance of these discussions was incorporated into findings of the first stage of the research and is described in the full report.

4.2 The method: deliberative multi-criteria evaluation

Participants were then introduced to the method, called a deliberative multi-criteria evaluation (DMCE). This method is a combination of two techniques: multi-criteria analysis and the citizens' jury. Multi-criteria analysis (MCA) is a body of techniques that structure decision problems in ways that improve their auditability and transparency (Romero *et al.* 1987, Dunning *et al.* 2000). MCA has its origins in military planning (Eckenrode 1965) and operations research but is today used in a variety of fields and disciplines including natural resource management (Hajkowicz *et al.* 2007).

In a MCA a set of alternatives, for example, investment portfolios, scenarios, or programs/projects, are described using the same set of criteria. The criteria represent the key factors that indicate how well the different alternatives perform towards the achievement of an overall goal, for example, to ensure a sustainable water allocation. Criteria are represented in the most appropriate unit and may be of multiple types, describing multiple components/facets of each alternative, for example, economic, social, cultural, technical and ecological. The values that each criterion will take under each alternative are set out in an evaluation matrix. Stakeholders then weight the criteria in terms of how important they are to a particular goal or

outcome. The values criteria take in the evaluation matrix and their weights are then aggregated in a utility function that returns a utility or benefit score for each alternative; the higher the score, the better the performance of an alternative. The utility score can therefore be used to distinguish between superior/inferior and more preferable/less preferable alternatives or to establish a ranking of alternatives.

There are a few shortcomings of the MCA process as it is often applied. One is that while different stakeholders may, and often do, weight the criteria differently, the process of aggregating different stakeholders' weightings into one set of average weights means that a range of information about different attitudes and preferences is lost (Proctor *et al. 2006)*.

A different approach is to use individual weightings to evaluate alternatives, and then compare the weightings and evaluation results across stakeholders. This provides the basis and a starting point for discussion and negotiation between stakeholders about their different weightings, preferences and trade-offs. Proctor *et al.* (2006) make use of a group deliberation technique called the citizens' jury to assist in this process. Emerging from research in Germany (Dienel *et al.* 1995) and the United States (Crosby *et al.* 1986), the citizens' jury is now being used in various parts of the world as a viable framework for public participation in community-relevant decision-making (James *et al.* 2000, Kenyon *et al.* 2001). Similar to a Western-style court of law, a citizens' jury involves a small, randomly selected group (representative or inclusive of interests of the broader public) – the 'jury' – coming together to 'hear evidence' from 'witnesses' on a particular issue, about which they will deliberate in order to answer a pre-specified 'charge', or question. The citizens' jury is moderated by an impartial facilitator and usually meets over two to four days.

The citizens' jury opens up the possibility for stakeholders to hear from and ask questions of experts. This input of information can assist in their deliberation and negotiation. It can also be useful to ask participants to re-weight criteria after information has been shared and positions negotiated. The MCA can be performed again and any changes in weightings and individual/aggregated utility scores noted. The range of weightings given to each criterion (and changes in this range over the course of the DMCE) can shed light on where opinion is either divided or coalescing, and where trade-offs may be challenging to negotiate for policy-makers.

This combination of the MCA with a citizens' jury into the DMCE method brings together the benefits of the MCA approach to structuring problems and integrating multiple criteria into decision problems, and the benefits of interaction and deliberation between stakeholders, thus making up for some shortcomings of each method when used on its own. The 'charge' for the jury in the DMCE process can be to come to consensus on the criteria weightings. With jury members almost always having different weightings and priorities, this charge provides a general direction for the deliberation process as those with widely varying weights are asked to support their positions through facilitated deliberation and discussion. Actually reaching consensus may not be required, however, so the charge can be modified to suit the situation.

To date, the DMCE method has been applied to complex issues around tourism management in the Goulburn-Broken catchment in Australia (Proctor *et al.* 2006), assessing the threat of exotic plant pests (Cook *et al.* 2007) and managing environmental and health risks from a lead and zinc smelter in South Australia (Proctor *et al.* 2006). As far as we know, this is the first time it has been applied in Australia in a non-coastal water management context.

4.3 Developing the scenarios and criteria

Once the method had been described and discussed, participants were involved in setting up the DMCE, first by visioning some potential scenarios for the Howard catchment. They were asked to describe how the catchment would look in 20 years if the best possible outcome was reached, and similarly, if the worst possible outcome was reached. These formed the basis for the scenarios in the evaluation matrix and are summarised in Table 2.

Table 2: Scenarios developed by workshop participants

"Best case" scenario	"Worst case" scenario (seen as the situation if business continues as usual)
• Maintain population and density of living at current levels • Maintain or improve environmental quality (e.g. water quality and levels; populations of barramundi and magpie geese; decrease weeds, ferals and vegetation clearing) • Decrease agriculture • Improve access to favourite recreation sites • Stop water extraction from Power and Water Corporation bores • Improve planning and consultation • Develop small-scale, non-water-intensive economic activity • Decrease daily water use rate in Darwin • Increase passive tourism • Limit further development of mines	• Population and density continues to increase • Environmental health continues to decrease (e.g. Howard Springs stop flowing more frequently; populations of birds and fish decrease; vegetation clearing, weeds and ferals populations increase) • Agriculture increases • Subdivision continue and increase • Power and Water Corporation extracts more water for Darwin households • Planning continues uncoordinated and without consultation • Access to favourite sites continues to decrease • Darwin households don't reduce their consumption of water • More land leased for mines

The ways in which each scenario was described, for example, the words and indicators used, formed the basis for the set of criteria by which each scenario would be evaluated. Participants were also asked directly what they look for in their surroundings to assess how things are going. These responses were used to fill out the list of criteria (Table 3).

Table 3: List of criteria developed by workshop participants

Hectares of wetlands	"Naturalness"
Hectares of weeds	Water levels
Openness of consultation and planning process	Amount and rate of water used by Darwin residents
Water quality	Crowding at favourite sites
Population of barramundi	Population of frogs
Population of magpie geese	Number of mines
Population of people	Sediment in creeks making them shallower
Hectares of land zoned for dense suburban living	Number of places that can no longer be accessed
Hectares of land zoned for industry	Coordination of planning process
Hectares of land cleared	Extent of extractive economic activity
Extent of non-extractive economic activity	Number of motorbikes and quad bikes
Amount of water extracted from bore fields	

Participants were then asked to do an initial weighting of this preliminary list of criteria. For this they were told, "You have 100 points to allocate across all of the criteria according to how important you think they are. Give more points to the criteria that you think are most important in terms of the future of the catchment and less to those you think are less important. You may give some criteria zero points if they are not at all important to you. The total for all criteria must add up to 100 points." The initial weightings were collected by the researchers[3].

Finally, participants were asked what kind of information they would need to be able to adequately evaluate the different scenarios. This was used to guide the choice of which 'experts' to ask to present for the citizens' jury at the second workshop.

4.4 Workshop follow-up

Following this initial workshop, several tasks were undertaken in preparation for the second workshop. First, the participants were contacted a few days after the workshop to ask if they had any further comments and whether they thought others should be invited to the second workshop. As previously mentioned, the participants at the first workshop did not represent or raise the full range of interests in the catchment, so it was decided to invite people with other, predominantly commercial, interests along to the second workshop, in particular horticultural and land-owner interests. Suggestions were also made to invite members from the local government authority and the NT Parliament. As such, representatives of the Litchfield Shire

[3] As the set of criteria was modified between the first and second workshop, this initial set of weightings was not further used and so is not reported here.

Council and the NT Horticultural Association were approached and invited to attend the workshop, as were the local Member of Parliament for the Darwin rural area and the Leader of the Opposition of the NT Government. Most of these stakeholders had already been contacted and/or interviewed for the stakeholder interviews (see the full report).

Second, the scenarios identified by participants in the first workshop were written up into 'narratives' or stories describing each of the visions for the future of the catchment. Two other scenarios were constructed based on some issues that had been raised in the stakeholder consultations. All scenarios were reviewed by NT Government staff and members of the research team before being used to develop the evaluation matrix. The scenarios were:

(a) development mix;

(b) environmental and passive recreation haven;

(c) rural living haven; and

(d) development mix plus more intensive rainfall and a longer dry season.

The development mix describes a scenario of increased population, similar rates of water consumption, increased water extraction from borefields in the Howard region, continued subdivision and rural residential development of land, relatively stable horticultural production, increased industrial development and negative impacts on recreation, Indigenous interests and environmental quality. This is one vision of the 'worst case' scenario described by participants at the first workshop (see Table 2).

The environmental and passive recreation haven is one vision of the 'best case' scenario described by participants in the first workshop. This scenario involves the same population increase but decreased daily water use and extraction from the Howard borefields. There are limitations on further subdivision, horticultural activity and industrial development, and also on active, noise-creating recreational activities. There has been expansion of recreation and tourism sites and residents and Indigenous people are generally happy with the level of consultation and planning.

The rural living haven sees the same population increase, a slight decrease in daily water use, but stable extraction from the Howard borefields. Subdivision and residential development has increased substantially and the build up in population has increased demand for services and retail outlets and has also increased pressure on and risks to the groundwater system through increased numbers of septic systems. Horticulture has decreased and there is increased pressure on recreation sites through over-crowding, although some pressures are managed.

The development mix plus more intensive rainfall and a longer dry season adds a climate change scenario to the development mix scenario, resulting in lower water levels at the end of the dry season and increased pressure on recreation sites and habitat. The narratives are included in full in Appendix A.

Third, the initial list of criteria was consolidated into a second list that was more complete, operational, independent, non-redundant and minimal than the first (Table 4). Some initial criteria were combined into one final criterion and one was separated into two.

Table 4: Relationship between initial and final criteria

Initial criteria	Final criteria
Environmental	
Hectares of wetlands Population of barramundi Population of magpie geese Population of frogs Sediment in creeks making them shallower	Condition of aquatic habitat and populations of aquatic species
Hectares of weeds Hectares of land cleared	Condition of terrestrial habitat and populations of terrestrial species
Water quality	Risks to water quality
Water levels	ML of water pumped from horticultural bores/year ML of water pumped from residential bores/year
Amount of water extracted from bore fields	ML of water pumped from Power and Water Corporation borefield Stage 1
Social	
	Number of times per dry season that stock and domestic bores 'fail'
Hectares of land zoned for dense suburban living	Increase in number of rural residential and rural living blocks
Number of places that can no longer be accessed	Number of sites accessible for hunting, fishing and shooting
Crowding at favourite sites	Crowding at favourite sites
Openness of consultation and planning process	Openness of consultation and planning process
Coordination of planning process	Coordination of planning process
Number of motorbikes and quad bikes	Number of motorbikes and quad bikes
Economic	

Extent of non-extractive economic activity	Extent of new commercial/retail businesses
Gross value of Primary Industries production in the catchment	Gross value of Primary Industries production in the catchment
Hectares of land zoned for industry	
Extent of extractive economic activity	New industry in the catchment
Number of mines	

Fourth, the evaluation matrix was developed for the scenarios and new list of criteria using a range of source material, guesstimates and expert opinion (Table 5). Estimates of the total number of megalitres of water that would be pumped from the Power and Water Corporation's Stage 1 borefield under the different scenarios were based on current and potential daily water use figures and volumes of water reported in *The Darwin Water Story* (Power and Water Corporation 2006). Estimates of the numbers of horticultural and residential bores were based on current figures and garnered from discussions with NT Government staff about what was reasonable given current trends. Estimates of the total number of megalitres (ML) of water that would be pumped from each type of bore were based on the NT Government's figures of 5ML/ha/year for horticultural bores and 3.5ML/year for residential bores. Estimates of the number of rural residential and rural living blocks were based on discussions with NT Government staff. Levels for all other criteria were based on guesstimates of what might happen under different scenarios based on general trends reported in existing research where available (for example, Cook *et al.* 1998; Schult and Welch 2006). The final evaluation matrix was reviewed by Government staff and members of the research team. The DMCE process allows for the scenarios, criteria and matrix to be modified by participants in the citizen's jury, so these were all seen as starting points rather than final, fixed versions.

Table 5: Evaluation matrix

No	Criteria	Scenarios			
		A	B	C	D
	Environmental				
1	Condition of aquatic habitat and populations of aquatic species	2 (degraded)	5 (close to natural)	3 (degraded)	1 (very degraded)
2	Condition of terrestrial habitat and populations of terrestrial species	2 (degraded)	4 (close to natural)	2 (degraded)	1 (very degraded)
3	Risks to water quality	2 (medium)	1 (low)	4 (high)	3 (medium-high)
4	ML of water pumped from horticultural bores/year	12800	6250	2500	12800
5	ML of water pumped from residential bores/year	8750	7000	12250	8750
6	ML of water pumped from PWC borefield Stage 1	8420	0	3000	8420
	Social				
7	Number of times per dry season that stock and domestic bores 'fail'	3 (often)	1 (very seldom)	4 (regularly)	4 (regularly)
8	Increase in number of rural residential and rural living blocks	750	0	2000	750
9	Number of sites accessible for hunting, fishing and shooting	3 (less than now)	1 (much less than now)	1 (much less than now)	3 (less than now)
10	Crowding at favourite sites	2 (large increase)	1 (medium increase)	2 (large increase)	2 (large increase)

11	Openness of consultation and planning process	1 (little consultation)	3 (extensive consultation)	2 (some consultation)	1 (little consultation)
12	Coordination of planning process	1 (piecemeal)	3 (very coordinated)	2 (coordinated)	1 (piecemeal)
13	Number of motorbikes and quad bikes	2 (more than now)	1 (less than now)	2 (more than now)	2 (more than now)
	Economic				
14	Extent of new commercial/retail businesses	1 (more than now)	1 (more than now)	3 (many more than now, centralised hubs)	1 (more than now)
15	Gross value of Primary Industries production in the catchment	$55 million	$24 million	$10 million	$40 million
16	New industry in the catchment	4 (rubbish dump, transport corridor, defence support hub, sand and gravel mines/pits)	1 (none)	2 (rubbish dump)	4 (rubbish dump, transport corridor, defence support hub, sand and gravel mines/pits)

Note:

A – development mix

B – environmental and passive recreation haven

C – rural living haven

D – development mix plus more intensive rainfall and a longer dry season

Finally, experts able to provide the information identified at the first workshop were approached and invited to attend and present at the second workshop.

5. WORKSHOP 2: SCENARIO EVALUATION

5.1 Workshop setting and participation

The second workshop was held on May 15th 2008 at Charles Darwin University and was run as a citizen's jury structured around two multi-criteria analysis evaluations of the evaluation matrix. Nine people attended (see Table 6 for the list of organisations and interests represented by participants) and five experts were called as witnesses (see Table 7 for a list of expertise and topics presented).

Table 6: Organisations and interests represented by participants at the second workshop

Organisation	Interests
Holtze Landcare Group	Local environmental interests
McMinns Lagoon Reserve Association	Local environmental interests
NT Firearms Council	Recreational interests
NT Field and Game	Recreational and environmental interests
Amateur Fishermen's Association of the Northern Territory	Recreational interests
Top End Native Plant Society	Local environmental interests
Larrakia Nation	Indigenous interests
Girraween Landcare Group	Local environmental interests
Local Member of Parliament	General public interests

Attempts were made to secure the attendance of a representative of the NT Horticultural Association (NTHA), however, due to miscommunication and competing commitments they could not attend. Instead, a researcher visited the President of the NTHA to talk about the project, the workshops and his opinions for inclusion in the write-up of the stakeholder consultation stage of the research (see the full report). A pastoral representative was also confirmed to attend, however did not make it to the workshop on the day.

5.2 The deliberative multi-criteria evaluation process

The citizen's jury workshop started with an introduction and a description of the project, how it might inform water planning for the Howard catchment, and what had happened to date (including the original stakeholder interviews and the first workshop). The scenario narratives,

criteria and evaluation matrix (Table 5) were presented to participants for their feedback and were approved as a starting point for the process. As the set of criteria was slightly different to the preliminary list, participants were shown how the two lists corresponded (Table 4), and were asked to weight the new set. Researchers found it challenging to communicate the weighting process and some participants expressed frustration with some ambiguities at this stage. These participants found it difficult to assess the 'importance' of criteria without having a distinct end goal to assess them against. This challenge is acknowledged by the researchers, but on further consideration was believed to not compromise the results and as the process continued most participants became more comfortable.

The 'charge' for the DMCE process was for the participants to share information about and negotiate the criteria and their importance in moving towards a position of greater understanding and possibly agreement. Total consensus on the weights is very rarely reached and is not always necessary as stakeholders will always have differing views and perspectives with regards to decision criteria and what is important. However, the charge to move towards greater understanding and agreement is a natural way to begin the deliberations and discussions as those with widely differing weights are asked to defend and explain their positions. An initial assumption of this process is that a possible reason for widely varying weights is lack of information and knowledge, so a starting point for the process is to bring in experts that can give factual information and answer questions relating to those criteria with widely varying weights.

The group heard presentations from the first three experts before lunch (Table 7 summarises the expertise and topics presented). The first weightings of the new set of criteria were entered into software called the Multi-Criteria Analysis Tool (MCAT) and on reconvening after lunch participants were shown all nine sets of weightings, and what each of their individual weightings meant in terms of the performance of each scenario. All results are presented in Section 6.

Table 7: Expertise and topics presented at the second workshop

Expertise	Topic
Ecohydrologist	Summary and recommendations from a hydrological investigation at Howard East
Rural Planner	Land use planning for the Howard region
Water Modeller	Groundwater in the Darwin rural area and groundwater modelling
Environmental Geochemist	Bio-physical impacts of mining
Water Utility Services Manager	Providing water for Darwin and the rural area: current and future trends and issues

This was followed by presentations from the final two experts and a facilitated discussion on some of the criteria, particularly those that participants had weighted significantly differently. Participants were asked to provide a final weighting of the set of criteria once all presentations had been heard and discussed. It was decided that, based on the results of the first weighting

showing that one particular scenario was strongly preferred by all participants and on the fact that there had been substantial discussion already, asking for one agreed weighting would not yield further benefits. Hence, participants were asked to re-weight the criteria on their own. Finally, participants were asked to suggest another scenario that was both desirable and realistic.

6. FINDINGS AND DISCUSSION

6.1 Results of the deliberative multi-criteria evaluation

6.1.1 Multi-criteria analysis round 1

A multi-criteria analysis (MCA) was performed for each of the 9 participants' sets of weights before the information sharing and discussion. The results of the associated individual evaluations were then combined and visualised. Figure 2 displays the utility or benefit scores showing how desirable each scenario was to each participant according to their weighting of the criteria (participants are here identified by a letter from A to I to protect anonymity).

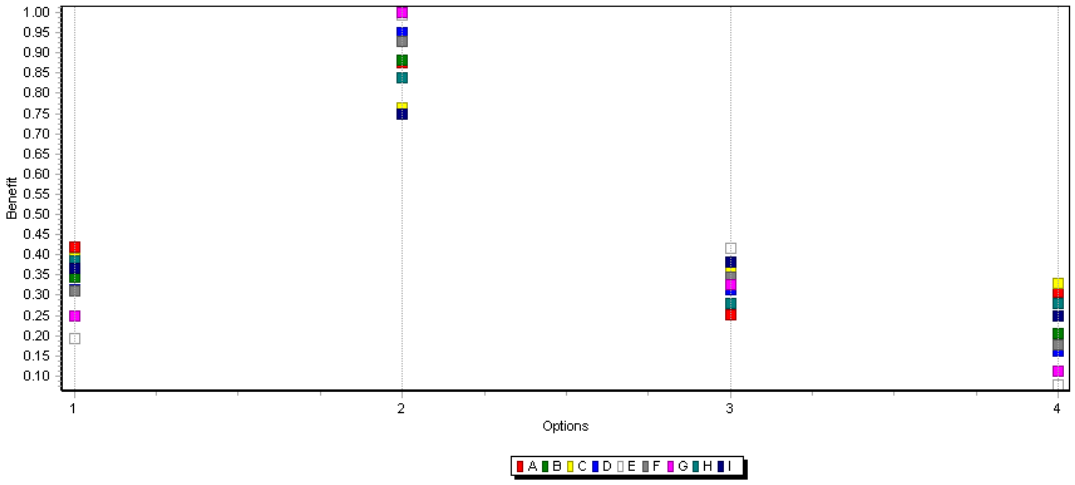

Figure 2: Utility/Benefit scores as computed for each participant's set of criteria weights; round 1

Figure 2 shows that Option 2 (Scenario B) is the most preferable development scenario as it obtained the highest score across all participants. This scenario is an 'environmental and passive recreation haven' that corresponds to the 'best-case' scenario described by participants at the first workshop (see Table 2, left-hand column) and is described briefly above and in Appendix A. In short, this scenario is one of minimal development and significant protection for environmental and recreational interests. It also includes a situation where Power and Water Corporation are no longer extracting water from their borefields in the region.

The raw weightings for each criterion are illustrated in Figure 3, which shows all participants' weightings of all criteria. As some participants assigned some criteria an identical weight, these points overlay each other and some are not visible. However, each of the 9 participants assigned a weight to each criterion.

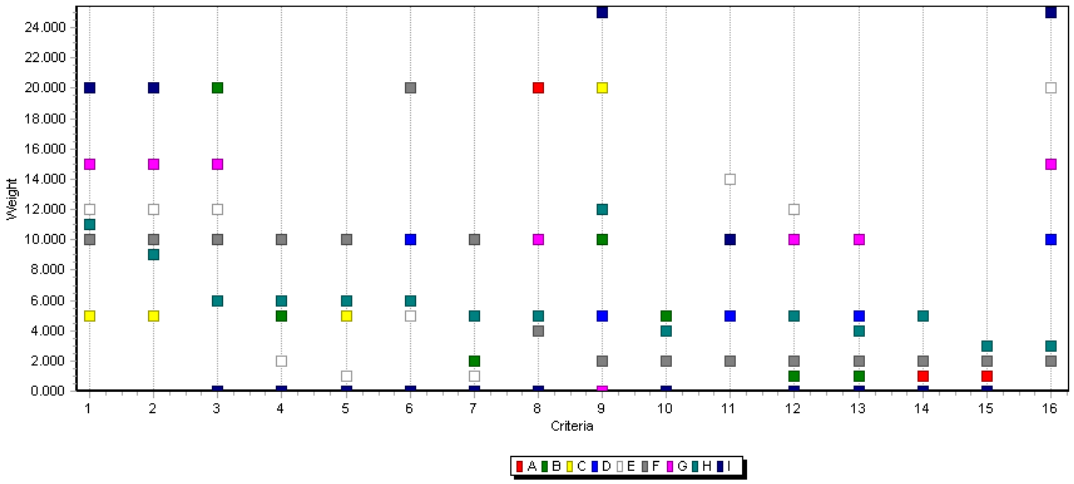

Figure 3: Criteria weights as assigned by the participants in round 1

Figure 3 allows us to see the difference in weighting technique and the range of raw weights given by representatives of different interest groups (refer to Table 8 for the list of criteria and their number). The representative of a recreational hunting and shooting group weighted the number of sites accessible for hunting, fishing and shooting (Criterion 9) highly in terms of importance, while a representative of the recreational fishing group weighted risks to water quality as more important (Criterion 3). Representatives of local landcare or reserve groups weighted the increase in number of rural residential and rural living blocks (Criterion 8) or new industry in the catchment (Criterion 16) as most important. Local groups with both recreational and environmental interests weighted the number of sites accessible for hunting, fishing and shooting (Criterion 9) or ML of water pumped from Power and Water Corporation borefield Stage 1 (Criterion 6) highly.

Table 8 summarises the mean, median, standard deviation (in brackets) and the maximum and minimum numbers for each criterion weight. The table also ranks criteria in terms of importance based on their mean.

Table 8: Mean and standard deviation of the criteria weights for round 1 (number of participants is 9)

No.	Criterion	Mean (std. dev.)	Median	Min	Max	Ranking
1	Condition of aquatic habitat and populations of aquatic species	13.67 (5.41)	12.00	5.00	20.00	1
2	Condition of terrestrial habitat and populations of terrestrial species	10.67 (4.69)	10.00	5.00	20.00	4
3	Risks to water quality	10.89 (5.73)	10.00	0.00	20.00	3
4	ML of water pumped from horticultural bores/year	4.22 (4.02)	5.00	0.00	10.00	10
5	ML of water pumped from residential bores/year	3.11 (3.55)	1.00	0.00	10.00	11
6	ML of water pumped from Power and Water Corporation borefield Stage 1	6.22 (6.00)	5.00	0.00	20.00	8
7	Number of times per dry season that stock and domestic bores 'fail'	3.11 (3.41)	2.00	0.00	10.00	11
8	Increase in number of rural residential and rural living blocks	7.67 (5.72)	5.00	0.00	20.00	6
9	Number of sites accessible for hunting, fishing and shooting	9.33 (8.76)	10.00	0.00	25.00	5
10	Crowding at favourite sites	1.44 (1.94)	0.00	0.00	5.00	12
11	Openness of consultation and planning process	7.00 (4.15)	5.00	2.00	14.00	7
12	Coordination of planning process	4.67 (4.06)	5.00	0.00	12.00	9
13	Number of motorbikes and quad bikes	3.11 (3.14)	2.00	0.00	10.00	11
14	Extent of new commercial/retail businesses	0.89 (1.69)	0.00	0.00	5.00	13
15	Gross value of Primary Industries production in the catchment	0.67 (1.12)	0.00	0.00	3.00	14
16	New industry in the catchment	13.33 (7.81)	15.00	2.00	25.00	2

The standard deviations for most criteria are large relative to the mean, which demonstrates in part the main critique of the MCA method that an average weighting for criteria is relatively meaningless. However, for the four criteria that are the most important to participants on average, the standard deviation is less than 0.6 the size of the mean. These most important criteria are:

1. Criterion 1: Condition of aquatic habitat and populations of aquatic species;
2. Criterion 16: New industry in the catchment;
3. Criterion 3: Risks to water quality; and
4. Criterion 2: Condition of terrestrial habitat and populations of terrestrial species.

This indicates that these criteria are those that people may be looking to when they evaluate how things are going in the catchment and it may be worthwhile for water planners to focus on them when providing more information to stakeholders and the community about different water allocation scenarios and their potential impacts.

The four least important criteria on average are:

1. Criterion 15: Gross value of Primary Industries production in the catchment;
2. Criterion 14: Extent of new commercial/retail businesses;
3. Criterion 10: Crowding at favourite sites; and
4. A tie between Criterion 13: Number of motorbikes and quad bikes, Criterion 5: ML of water pumped from residential bores/year, and Criterion 7: Number of times per dry season that stock and domestic bores 'fail'.

However, the standard deviations for these criteria are all large relative to the mean, so an ‘average’ weighting is relatively meaningless. We also acknowledge that these results may have been different had there been some representation from primary industry, commercial or retail groups or motor/quad bike riders.

The spread of opinion about the importance for each criterion will be explored shortly using another measure – the coefficient of variation – and to draw some inferences about where information sharing and deliberation during the workshops may have impacted on the level of agreement about what is important. We now turn to the nature of the discussions had during the workshop as stimulated by the expert presentations and question and answer sessions. Section 6.1.3 then reports on the results of the second multi-criteria analysis.

6.1.2 Key points of discussion in Workshop 2

The following summarises discussions had in Workshop 2. These discussions arose in response to the expert presentations, question and answer sessions with each expert, and discussion

amongst workshop participants. These summaries are based on notes taken by researchers at the workshop and are yet to be ratified by workshop participants. Where there is a corresponding criterion from the MCA, this is noted to enable assessment of criteria for which the discussion may have influenced the second round weightings. This summary also provides insight into some of the key issues and factors that may not have been captured through the multi-criteria analyses.

Participants all acknowledged and expressed concern about the impacts of changes in Darwin's rural zone on the quality of life and lifestyle of residents, as well as on the resource base and environmental condition of the area. They noted the fragmentation of landscapes, privatisation of some wetlands and stress on groundwater resources resulting from rapid development of rural lifestyle blocks and small horticultural holdings.

Participants discussed the major stresses on groundwater quantity as coming from PWC's extraction (Criterion 6), the increase in number of bores sunk in the passed few decades, the increasing rate of sub-division of properties into rural living blocks (Criteria 5 and 8), and demand from small horticultural holdings (Criterion 4). PWC's extraction of water from the catchment for predominantly urban users was a source of great concern as some participants believed that use by urban users was less legitimate than that of rural users living and working in the Howard catchment. The discussion thus began with a belief that rural use should not be traded against urban use based on an argument for citizen rights to water. Further, participants expressed distrust in the PWC's reporting of water extraction from their borefields in the region.

The presentation by the Water Utility Services Manager was able to dispel concern about PWC's reporting and further, to clarify the critical role of borefields in the Howard region in the future water supply strategy for the Darwin region. This was important in light of the fact that extraction by PWC was a significant factor in the definition of best and worst case scenarios. By the end of the discussion participants recognised that managing water use and quality is a shared responsibility. One participant said, "*I think we all have to take responsibility for the water we are using. Power and Water are only using 16%*."

Participants discussed the current rates of consumption by users in the NT, which are significantly higher than for anywhere else in Australia. They raised the fact that there is a common perception that water is never scarce in the Top End of the NT because of the significant rainfall during the wet season. This perception was acknowledged as being incorrect due to the long dry seasons experienced every year and the increasing pressure on groundwater resources as surface water dries up, particularly towards the end of the dry season. Demand by households and many horticultural enterprises is often highest at this time of year. Participants recognised that demand management may need to be implemented as part of a water management strategy, acknowledging that current daily water consumption could be traded to achieve better outcomes for the environment and recreational users. If this meant that extraction by PWC from borefields in the Howard catchment would not need to increase significantly and may even decrease, then many current pressures on the groundwater resource may decrease.

The key impacts of increased pressure on groundwater quantity were seen in reduction or cessation of flow at certain places (springs) and from bores (Criterion 7) and corresponding impacts on people's ability to swim, native vegetation and habitat for species such as birds and fish (Criteria 1 and 2). Discussion about the stress on groundwater quality (Criterion 3) focussed

on the impacts of increasing numbers of septic systems in the region, use of pollutants by horticultural enterprises, and current and potential industry in the catchment (Criterion 16). The inclusion of Criteria 1, 2, 3 and 16 in the list of most important criteria suggests that stakeholders are not likely to support any major trade-off of these criteria against other benefits.

Water quantity and quality issues were seen as impacting on recreational uses such as hunting and fishing. The many lagoons of the area sustain bird life favoured by hunters. Larrakia traditional owners use the area for hunting, gathering and cultural activities. The quality of fishing in the catchment is also affected by water quantity and quality (Criterion 3). Representatives of these groups also stressed that they are impacted significantly by increasing limits to access that come about through: (a) changes in land tenure that concentrate multiple and sometimes competing recreational activities (e.g. passive bushwalking and bird watching are combined in areas where motorbiking is allowed) (Criterion 10 and 13); (b) reduction in available land due to housing and industry developments (Criterion 9); and (c) changes in management structures (e.g. when land is designated a protected area or is privatised and this then excludes certain activities) (Criterion 9).

Participants acknowledged that a challenge that sits behind all of these issues and conflicts is the need for coordination between land and water use planning (Criterion 12). They stated that the zoning of land determines water use and impacts on groundwater recharge rates and water quality to a large extent. Participants spent some time discussing specific development proposals and the management instruments available to planners (land and water) to regulate resource use.

Participants concluded that continuation of the status quo was a risky strategy that would likely generate more severe environmental, social and cultural impacts. One participant said, "*We can't keep subdividing as we have in the past.*" There is a belief that if all horticultural and rural blocks are developed to capacity there is likely to be a 'system collapse'. Alongside this, participants also stressed the need to know precisely how much water is available, how the hydrological system works, and how much water can be extracted without negative impacts.

Participants were asked if they had any concerns about two of the criteria that had not been discussed – Criteria 14 and 15. They responded that environmental and recreational outcomes were more important to them. This confirms the bias in representation of our participant group and indicates that engagement with these other interests will be required in the next phase of community consultation.

Following the discussion, participants were asked to return to the scenarios, criteria and evaluation matrix. Participants commented that, based on the issues just discussed, their preferred scenario was unlikely given current trends of development. They were asked to re-weight the criteria and then to suggest another scenario that was both desirable and realistic.

6.1.3 Multi-criteria analysis round 2

Following the presentations by experts and the discussion as summarised above, the participants were again asked to weight the criteria. As with round 1, the assigned weights were entered into the MCAT and visualised on a chart. One participant (G) was not present for the second weighting due to a previous commitment. We used the set of weights that this participant used

in round 1 for their round 2 result. Figure 4 shows that Scenario B, environmental and passive recreation haven, again obtained the highest benefit scores across all participants.

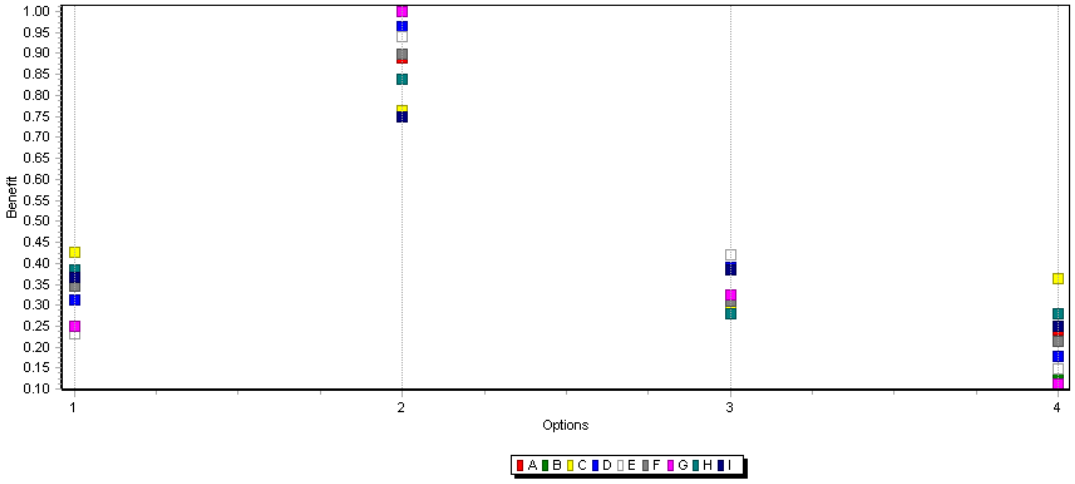

Figure 4: Utility/Benefit scores as computed for each participant's set of criteria weights; round 2

A sensitivity analysis of the 'superiority' of Scenario B to different weightings of the criteria shows that it consistently receives the highest benefit score for changes in weightings of most criteria. This position is only sensitive to changes in the weights given to Criterion 4: ML of water pumped from horticultural bores/year; Criterion 9: Number of sites accessible for hunting, fishing and shooting; and Criterion 15: Gross value of Primary Industries production in the catchment. This is tested by giving each of the criteria a weight of 0 and recording how the benefit score of each Scenario changes as the weight is increased steadily (and as the weights of all other criteria are decreased accordingly). For Criteria 4, 9 and 15, the benefit score of Scenario B decreases as their weights are increased.

As with the sets of weights for round 1, the round 2 raw criteria weights show a range of opinions about criteria importance (Fig. 5).

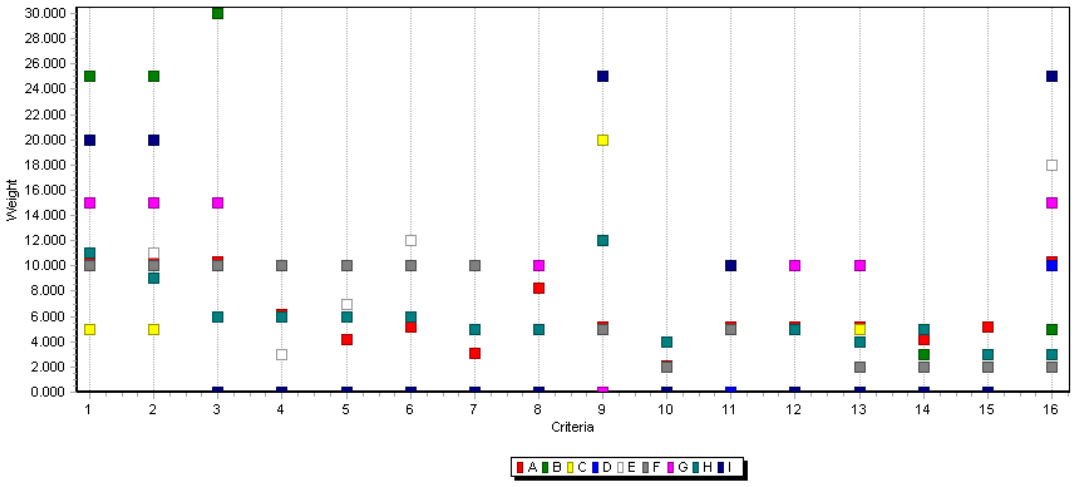

Figure 5: Criteria weights as assigned by the stakeholders in round 2

Overall, participants reduced the number of criteria that they gave high weights to, focussing in this second round on the condition of aquatic habitat and populations of aquatic species, condition of terrestrial habitat and populations of terrestrial species, risks to water quality, number of sites accessible for hunting, fishing and shooting, and new industry in the catchment. The criteria, ML of water pumped from Power and Water Corporation borefield Stage 1, increase in number of rural residential and rural living blocks and openness of consultation and planning process didn't receive such high weightings as in round 1.

Table 9 summarises the mean, median, standard deviation (in brackets) and the maximum and minimum numbers for each criterion weight. The table also ranks criteria in terms of importance based on their mean.

Table 9: Mean and standard deviation of the criteria weights for round 2 (number of participants is 9)

No.	Criterion	Mean	Median	Min	Max	Ranking
1	Condition of aquatic habitat and populations of aquatic species	14.15 (6.35)	11.0	5.00	25.00	1
2	Condition of terrestrial habitat and populations of terrestrial species	12.81 (6.18)	10.3	5.00	25.00	2
3	Risks to water quality	11.37 (8.41)	10.0	0.00	30.00	3
4	ML of water pumped from horticultural bores/year	5.02 (4.42)	6.0	0.00	10.00	11
5	ML of water pumped from residential bores/year	5.24 (4.41)	6.0	0.00	10.00	10
6	ML of water pumped from Power and Water Corporation borefield Stage 1	5.91 (4.91)	6.0	0.00	12.00	8
7	Number of times per dry season that stock and domestic bores 'fail'	2.01 (3.50)	0.0	0.00	10.00	13
8	Increase in number of rural residential and rural living blocks	5.92 (4.00)	5.0	0.00	10.00	7
9	Number of sites accessible for hunting, fishing and shooting	8.02 (9.13)	5.0	0.00	25.00	5
10	Crowding at favourite	0.90	0.0	0.00	4.00	16

	sites	(1.46)				
11	Openness of consultation and planning process	6.13 (4.16)	5.2	0.00	10.00	6
12	Coordination of planning process	5.57 (3.00)	5.0	0.00	10.00	9
13	Number of motorbikes and quad bikes	3.35 (3.13)	2.0	0.00	10.00	12
14	Extent of new commercial/retail businesses	1.57 (2.03)	0.0	0.00	5.00	14
15	Gross value of Primary Industries production in the catchment	1.13 (1.87)	0.0	0.00	5.15	15
16	New industry in the catchment	10.92 (7.45)	10.0	2.00	25.00	4

Criteria 1, 2, 3 and 16 are again the highest ranked in terms of importance on average although the order of ranking is slightly different. As stated for the results for round 1, from this we can surmise that Criteria 1, 2, 3 and 16 are those that that people may be looking to when they evaluate how things are going in the catchment. Participants care about impacts on these criteria and will look to these criteria to know how things are going (more likely for Criteria 1, 2 and 3) or perhaps they believe that these criteria will be significant in driving outcomes in the catchment (more likely for Criterion 16). This result indicates that more planning and/or research are required for these criteria, including monitoring and evaluation systems and regulation of impacts, and it indicates that participants may be less willing to trade-off desirable conditions for these criteria against other benefits.

Criteria 10, 15, 14 and 7 are again considered the least important although again, their standard deviations are large relative to their means so the notion of an ‘average’ weighting is meaningless.

To explore how the spread of opinion has changed for each criterion between rounds 1 and 2, we need to compare each criterion in terms of their coefficient of variation (CoV) in rounds 1 and 2. The CoV is defined as the standard deviation divided by the mean value and as such it measures the spread of opinion but standardises it across the values of the weights so that any differences in the actual numbers participants used to weight criteria between rounds are accounted for. Table 10 summarises the CoV for all criteria across rounds 1 and 2, the percentage change in CoV between rounds 1 and 2 and ranks criteria for which the spread increased and decreased. The higher the CoV, the higher the variation within the data. If the CoV has increased (decreased) between rounds, this means that there has been an increase (decrease) in the spread of opinion. However, where the mean is equal or close to zero, the CoV is not defined and may be high even though the spread may not actually be that large. Criteria 10, 14 and 15 have means close to zero in either the first or second rounds and so are not included in the ranking of change in spread of opinion.

Table 10: Coefficient of variation for rounds 1 and 2 (number of participants is 9)

No.	Criterion	CoV (Round 1)	CoV (Round 2)	Change in CoV [%]	Increase spread ranking	Decrease spread ranking
1	Condition of aquatic habitat and populations of aquatic species	0.40	0.45	12.50	5	
2	Condition of terrestrial habitat and populations of terrestrial species	0.44	0.48	9.09	6	
3	Risks to water quality	0.53	0.74	39.62	2	
4	ML of water pumped from horticultural bores/year	0.95	0.88	-7.37		5
5	ML of water pumped from residential bores/year	1.14	0.84	-26.32		2
6	ML of water pumped from Power and Water Corporation borefield Stage 1	0.96	0.83	-13.54		3
7	Number of times per dry season that stock and domestic bores 'fail'	1.10	1.74	58.18	1	
8	Increase in number of rural residential and rural living blocks	0.75	0.68	-9.33		4
9	Number of sites accessible for hunting, fishing and shooting	0.94	1.14	21.28	3	
10	Crowding at favourite sites	1.35	1.63	20.74		
11	Openness of consultation and planning process	0.59	0.68	15.25	4	
12	Coordination of planning process	0.87	0.54	-37.93		1
13	Number of motorbikes and quad bikes	1.01	0.94	-6.93		6
14	Extent of new commercial/retail businesses	1.90	1.29	-32.11		
15	Gross value of Primary Industries production in the catchment	1.68	1.66	-1.19		
16	New industry in the catchment	0.59	0.68	15.25	4	

Note:

Criteria shaded in grey have means close to 0 for round 1 and/or round 2.

Criteria shaded in green were chosen as the most important criteria in both rounds 1 and 2.

The four criteria for which there was the greatest increase in the spread of opinion (increase in disagreement about importance) are:

1. Criterion 7: Number of times per dry season that stock and domestic bores 'fail'
2. Criterion 3: Risks to water quality
3. Criterion 9: Number of sites accessible for hunting, fishing and shooting
4. Criterion 10: Crowding at favourite sites

There could be a number of reasons why the spread of opinion about these criteria has increased. Participants' weighting strategies may have changed, or the information sharing and discussion may have created more uncertainty than clarity about these criteria, all of which were discussed during the citizens' jury except for Criterion 11. This could reflect that little is currently known about these criteria and that either more information is required about these criteria generally or that more expertise was required at the workshops to explain the role of these criteria in the catchment and how they could change under different scenarios. Importantly, the increase in spread of opinion indicates also that these criteria are very important to some, and hence less negotiable or able to be traded-off against other benefits, while others believe that they can be traded-off against other outcomes. There is likely to be debate and contention around these criteria in the future.

The four criteria for which there was the greatest decrease in the spread of opinion (increase in agreement about importance) are:

1. Criterion 12: Coordination of planning process
2. Criterion 14: Extent of new commercial/retail businesses
3. Criterion 5: ML of water pumped from residential bores/year
4. Criterion 6: ML of water pumped from Power and Water Corporation borefield Stage 1

This result suggests that the process of information sharing and discussion had some impact in terms of bringing participants closer together in their assessment of the importance of these criteria to outcomes in the catchment. There was substantial discussion about the need for a coordinated planning process, the potential for demand management strategies to decrease household use of water, PWC's extraction and the impacts of sub-division during the citizens' jury. The coalescence of opinion about the importance of these criteria may be due to the extent of this discussion. It could also have been affected by the presentation style of presenters, and group dynamics, for example, coalition building. Even though the rankings of the perceived importance of these criteria didn't change significantly from rounds 1 and 2, and we cannot

assess exactly which information or discussion influenced opinion, this result provides support for the assumption that information sharing and discussion can contribute to increased agreement about the importance of some criteria.

However, agreement decreased for one more criterion than it increased and these criteria were also discussed during the jury. As suggested above, the nature of the discussion may have increased uncertainty for those criteria for which there is an increase in the spread of opinion, whereas it stimulated a coalescence of positions for those criteria for which there is a decrease in this spread. It is difficult to assess this based on the record of discussions during the workshop and there may have been a number of other factors at play, however, we assume that positions coalesced for criteria where the information provided and discussion provided more clarity and certainty.

For example, the Water Utility Services Manager provided participants with up-to-date information on the state of water extraction from PWC bores. This was a criterion around which there had been some concern expressed previously in terms of the accuracy of these figures. We can say with some degree of confidence based on stakeholder comments that the information presented about these figures and subsequent discussion contributed to increased agreement among participants about the weighted importance of this criterion.

6.1.4 ‘Most realistic’ desired scenario

At the end of the workshop, participants spoke about the most realistic scenario given current development trends and that would also be likely to maintain environmental and recreational values. This was seen as a combination of Scenarios A (development mix) and B (environmental and passive recreation haven) in recognition of the opinion of some participants that development can be done in a way that limits negative impacts, especially if it is not based on substantial water extraction. This scenario would require clear knowledge and enforcement of limits on water extraction. However, some participants expressed a lack of confidence in the NT Government’s decision-making about industry and managing risks to water supplies and other users, and did not believe that development would be undertaken in a way that minimised risks, even despite the best intentions.

Participants generally agreed that there is an amount of water that would need to remain in the hydrological system to maintain certain values, and that this water would need to be of a certain quality. These requirements should then define what is available for extraction and how much impact on water quality is acceptable. Some participants appeared more willing to trade-off other developmental or recreational benefits up to these levels than others, who believed that further declines in environmental quality were not desirable under any circumstance.

6.2 Discussion

While there is a range of opinions about the importance of certain criteria to the outcome, there is overwhelming agreement among participants in wanting to see the catchment’s environmental and recreational values maintained and improved. The list of the four most important criteria to participants reflects this with three of them describing aspects of environmental condition. The

fact that these four criteria remain the most important after the citizens' jury suggests that community members will be watching them closely. Information sharing and discussion in the citizens' jury served to both increase and decrease agreement about criteria importance. This could be due to a number of reasons not tested for during the DMCE. The four criteria for which there was the greatest increase in the spread of opinion are those about which there may be future contention within the community. Finally, participants acknowledged that Scenario B is unlikely if current trends for water use, land sub-division and uncoordinated planning are to continue, and they expressed that the reality would more likely be a combination of Scenarios A and B, although there were some reservations about the propensity or capacity of the Government to guide development in a way that minimises negative impacts.

The deliberative multi-criteria evaluation provided a structure for organising values, uses, preferences and scenarios and for participants to hear information from local experts on a range of issues. This information input and the ability to ask questions of presenters and deliberate with the other participants dissolved some myths around water use and management in the catchment and from this emerged a new appreciation (a) for the complexity of water planning and management and (b) that responsibility must be shared by all. This kind of outcome, while not easily measurable, may serve to improve stakeholder consultations around future water planning in the NT. Several of the participants in this process are likely to be invited by the NT Government to sit on a committee to consider water allocation plans for the Greater Darwin region. Their participation in this DMCE has likely contributed to building their capacity to engage with that process. Also, the results of the MCAs and citizens' jury discussion will provide the NT Government's water planners with significant background knowledge and an awareness of where attention may need to be focussed to bring stakeholders and the community along with any decision-making.

There were a few issues that arose in the implementation of the DMCE. First, there did seem to be a slight disconnect between the MCA evaluation matrix and the citizens' jury discussions. Even though presenters were selected based on information needs identified by the participants at the first workshop, a general lack of evidence about ecological, socio-economic and institutional interactions in the catchment meant that they could not always present information that could guide discussion or support conclusions about the scenarios described in the evaluation matrix. Second, this lack of available information also meant that the values of each criterion in the matrix were largely estimates and weren't developed based on scientific modelling. Third, it may also be that the final list of criteria was not as complete or well-specified as it could have been. Despite this, the discussions during the citizens' jury were lively and useful in clarifying some criteria and enabling participants to explore a wide range of issues.

Fourth, the lack of representation from the full range of interest groups has already been identified as an issue to be rectified in future such consultations. Fifth, the difficulties experienced with the weighting process have also been mentioned and this part of the process can be improved upon. An application of this method in the same water planning context that is planned for the near future will establish an evaluation matrix based on alternative water allocation scenarios and will ask participants to weight sectors according to their preferred allocation of a sustainable yield of water. This demonstrates that the tool can be modified to suit the stage of planning and engagement and the level of information available.

A deliberative multi-criteria evaluation is a useful tool in water planning. It can be designed to suit the level of information available and the stage of water planning. For example, this application at an early stage of the planning process performed well in stimulating information sharing and assessing the current state of opinion and understanding. The MCAT software is particularly useful because it allows rapid calculation and visualisation of the results of each MCA round. The deliberative aspect of a DMCE is highly beneficial as it enables information to be shared and for people to be engaged and 'brought along' in the planning process. In this case the research team witnessed an increase in participant awareness of the need for sound hydrological knowledge of the limits to water use scenarios. Greater acceptance of the need for government regulation and long term water planning and monitoring resulted. The MCA provides a useful structure and enabled the identification of criteria that are important to participants in their decision-making. The DMCE method has been identified for use in the next iteration of the water planning process, which will likely see further discussion around some of the important trade-offs identified through this exercise.

7. WHERE TO FROM HERE?

Several of the participants in this research process, either the consultations and/or the workshops, are likely to be invited by the NT Government to sit on a committee to consider water allocation plans for the Greater Darwin region. Members of the research team have funding through the Tropical Rivers and Coastal Knowledge (TRaCK) research program to provide research support to the Government's process in the form of water planning tools, including deliberative multi-criteria evaluation. This study for the Howard catchment has provided the researchers, stakeholders and participants with an opportunity to learn about some of the issues, trial the methods and learn where improvements can be made for future iterations and applications.

Improvements around the explanation of the weighting process have been noted. The method could also be usefully applied in the NT Government's water planning process such that distinct options for the allocation of water between multiple uses are the scenarios that are evaluated.

First, however, further feedback on this research must be sought from stakeholders and participants. The purpose of this report is to provide stakeholders and participants with a record that they can comment on to enable continued learning from the whole exercise. To this end, please send your comments and feedback to Sue Jackson:

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APPENDIX A – SCENARIO NARRATIVES

Scenario A – development-mix

The population of Darwin and the rural area has increased by about 50,000. Daily water use doesn't decrease significantly, so Power and Water Corporation (PWC) needs to supply more water. As part of their solution, they decided to use the Howard Stage 1 borefields to the full extent of their license, which means 8,420 ML/year (as compared to the 3,000 ML/year extracted currently).

There is continued subdivision of land and the building of houses on blocks zoned 'rural living' (2 hectares) and 'rural residential' (1 hectare). The overall number of these blocks increases by 750. Some of the water needs for these new properties are supplied by PWC, but some are supplied by private bores, so the overall number of private residential bores increases from 2,000 to 2,500.

Rural horticulture has not developed significantly because of increasing land prices, although 12 additional horticultural bores have come on line pumping an average of 5 ML/hectare/year. At an average crop size of 5 hectares, that's an additional 300 ML/year of water and an additional 60 hectares of crops in the catchment.

There has been an increase in industrial development in the catchment, with a new rubbish dump, transport corridor and defence support hub being built as well as some new sand and gravel mines/pits. These new uses place additional demands on water and there are some concerns about their release of pollutants back into the environment. Several new commercial and retail businesses have been established to service the needs of the increased number of residents in the catchment.

The use of the catchment as a place for recreation has been affected. Those engaged in active, noise-creating recreation such as trail and quad bike riding are still able to find places to undertake their activity although this is now more intensive in some areas due to expanding housing developments. Activities that are more passive, such as picnicking and bird watching are still undertaken but the quality of the experience has diminished. A decline in water quality due to insufficient spring flow/flushing has meant that people no longer swim. Habitat for birds and animals outside of conservation reserves has been damaged and reduced by increased development. This is impacting negatively on people who enjoy the Howard for its natural features and on people who fish recreationally and hunt in the area as access to some sites is now further limited by expanding housing developments. The increased population means that more people now visit spots like Howard Springs, so they are often over-crowded.

The Larrakia traditional owners have found it difficult to find the peace, quiet and space they once enjoyed when Darwin was smaller. Greater use of their estates by other groups has pushed them out. While recreational groups might move on to a less congested site, the Larrakia want to maintain connections with specific places they have known all their lives and feel obligated to care for under their law.

Long term residents of the Howard catchment are frustrated by the seeming lack of planning for development – to them it looks like 'death by a thousand cuts' – and a lack of consultation and transparency in the decisions that have been made.

Scenario B – environmental and passive recreational haven

The population of Darwin and the rural area has increased by about 50,000. Daily water use has decreased steadily and is now equivalent to other Australian cities, so overall PWC doesn't need to supply more water than in 2008. In planning for the future, however, they have decided to invest in another source of water for Darwin, so the Howard Stage 1 borefields have been turned off and the 3,000 ML/year that did come from them is no longer extracted.

The Dept of Planning and Infrastructure has put a limit on further subdivision of the Howard catchment, so the number of private residential bores stays constant at 2,000.

Of the 500 horticultural bores, 250 are turned off as significant limitations have been put on some horticultural activity due to crop disease outbreaks. This means approximately 6,250 ML/year is no longer extracted. People once in horticulture have diversified into other forms of business activity that do not rely so intensively on water use.

Limitations have been placed on industrial and mining development in the catchment in response to concerns raised about impacts on water quality in the catchment and in Darwin Harbour.

Limitations have also been placed on active, noise-creating recreation such as trail and quad bike riding. Only more passive forms of recreation are allowed, including recreational fishing. Some restrictions have also been placed on hunters and shooters, in that the sites available have decreased. The decrease in water extraction and the limit on further residential and industrial development has meant that it is possible to swim in the Howard Springs more often. Even though there are more people living in Darwin now and more people visiting the region for recreation, effort has been put into the appropriate development of more recreation sites and eco-tourism operations, so impact has been managed and over-crowding is not too bad. The Larrakia have had a strong say in this management approach and in some places their preferences are given priority. Habitat for birds and animals is managed as part of this.

Residents of the Howard catchment are pleased at how well coordinated the planning process has been and about the good environmental and recreational outcomes this has brought about. They have found the Government to be very open and willing to talk about how decisions have and are being made. Developers are not so happy, however, as they've been restricted from activity in the catchment.

Scenario C – rural living haven

The population of Darwin and the rural area has increased by about 50,000. Daily water use decreases a little, but PWC still needs to supply more water. They invest in another source, but decide to maintain the Howard Stage 1 borefields at their current levels of extraction, being 3,000 ML/year.

The catchment has been opened to residential developers. There is extensive subdivision of land and the building of houses on blocks zoned ‘rural living’ (2 hectares) and ‘rural residential’ (1 hectare). Some of the water needs for these new properties are supplied by PWC, but some are supplied by more private bores, so the overall number of private residential bores increases from 2,000 to 3,500, each of the additional 1,500 pumping 3.5 ML/year making it an additional 12,250 ML extracted per year. The build up of higher density housing in certain areas has driven demand for more commercial and retail outlets, schools and other services, most of which also have water demands. The increase in septic systems increases pressure on the groundwater system of the catchment and increases the costs of water treatment and management.

Rural horticulture has ceased to be a dominant industry in the catchment. There are still some nurseries, cut flower farms and vegetable farms, but the number of horticultural bores has decreased from 500 to 100. This means that approximately 2,500 ML/year is extracted for horticultural use as opposed to 12,500 ML/year when there were 500 bores.

There has been only a slight increase in industrial development in the catchment, mainly in the form of a new rubbish dump.

People still visit the area for recreation, now even more so as there are more people living in the area. There are many more quad bikes and motorbikes out on the weekends and this activity is now more intensive in some areas due to expanding housing developments. With the increased number of people living in the catchment, effort has been put into the appropriate development of more recreation sites and eco-tourism operations, so impact has been managed. Many sites are still quite over-crowded despite this. Some places are suffering from lower water levels and water quality due to increased residential bores and septic systems in the catchment. Bird-watching and hunting aren’t as good as they used to be and there are fewer sites now due to expanded housing developments. Habitat for some fish species has been impaired and populations of some species fished recreationally have decreased.

Original residents of the catchment are frustrated at the decline in the peacefulness of the area and the change in landscape with so many more houses. Some like the additional shopping opportunities, services and job opportunities that are now close by.

Scenario D – scenario A plus more intensive rainfall and longer dry season

At the same time as Scenario A has been rolling out, climate patterns have changed to involve more intensive rainfall and a longer dry season. This means that water levels are lower by the end of the dry season, increasing pressure on recreation sites and habitat for aquatic and terrestrial vegetation and species. Some places are no longer accessible for recreational fishing at certain times of year.

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