Collaborative Water Planning: Groundwater Visualisation Tool Guide

Sharna Nolan, Poh-Ling Tan and Malcolm Cox

April 2010

TRaCK
Tropical Rivers and
Coastal Knowledge

Australian Government
Department of the Environment, Water, Heritage and the Arts
Land & Water Australia
National Water Commission

CSIRO

Griffith UNIVERSITY

TRaCK brings together leading tropical river researchers and managers from Charles Darwin University, Griffith University, University of Western Australia, CSIRO, James Cook University, Australian National University, Geoscience Australia, Environmental Research Institute of the Supervising Scientist, Australian Institute of Marine Science, North Australia Indigenous Land and Sea Management Alliance and the Governments of Queensland, Northern Territory and Western Australia.

TRaCK receives major funding for its research through the Australian Government's Commonwealth Environment Research Facilities initiative; the Australian Government's Raising National Water Standards Program; Land and Water Australia; the Fisheries Research and Development Corporation and the Queensland Government's Smart State Innovation Fund.

Nolan, S., Tan, P-L., and Cox, M. (2010). Collaborative Water Planning: Participatory Groundwater Visualisation Tool Guide. Charles Darwin University, Darwin.

For further information about this publication:
Poh-Ling Tan, Griffith University
Email: p.tan@griffith.edu.au

Or to find out more about TRaCK
Visit: http://www.track.gov.au/
Email: track@cdu.edu.au
Phone: 08 8946 7444

ISBN: 978-1-921576-17-1
Published by: Charles Darwin University
Printed by: Uni Print, Griffith University

Executive Summary

The 'Howard East' Groundwater Visualisation Tool (GVT) was developed in 2009 as part of the Tropical Rivers and Coastal Knowledge (TRaCK) 'Collaborative Water Planning' project. The Project aimed to support water planning processes by providing best practice guidelines for collaborative planning, based on lessons learned from the trial of various planning tools. These guidelines also drew upon previous work undertaken through retrospective case studies in Queensland and Western Australia.

This is a companion guide to the general case-study report (Nolan 2010). It specifically presents information for water planners considering the use of a GVT for the communities where they work. Based on the experience of a participatory process developed for the Howard East aquifer in rural Darwin, Australia, it provides an overview of the Howard East GVT, the process of development and financial resources that were required. In doing so, this guide aims to give planners the confidence to assess whether a similar application would be useful for their planning situation. The structure adopted for this guide is as follows: why developing a participatory groundwater visualisation model was considered useful; the steps taken for developing that model with community input; the outcomes achieved in the short term; finally a discussion of the strengths and weaknesses of the process.

This GVT addresses stakeholder concerns identified in an extended stakeholder analysis (Nolan 2009). Within community groups there was a widespread lack of understanding of groundwater systems and processes, leading to misconceptions about the management, extraction amounts and origins of local groundwater resources. Findings also showed that there was a legacy of mistrust of government-driven planning processes as rural residents were concerned that water planning would lead to new charges for domestic bore water. Coupled together, these attitudes had a potential detrimental impact on the willingness and ability of local stakeholders to engage in forthcoming water planning processes.

In response to the analysis the GVT was constructed to communicate hydrogeological dynamics, allowing stakeholders access to common information and aiding mutual understanding in the planning process. The visualisation tool was built on an in-house software package, Groundwater Visualisation System (GVS), developed by the Groundwater Systems Research Group of the Queensland University of Technology (QUT).

The Groundwater Visualisation System software uses agency bore-monitoring data, bore drillers' logs and a range of data sourced from within the local community to construct a visualisation model. Community information used in Howard East was generated through an engagement strategy which encouraged community, stakeholder and agency input into the model at key stages of its development. Stakeholder feedback sourced during the GVT's development also enabled the tool to be tailored to meet local educational needs, and give stakeholders a sense of ownership of the final product. To facilitate stakeholder and community involvement, project researchers adopted a 'joint fact finding' approach that led to the development of a number of activities capable of generating a wide range of community data. Activities included local rainfall data collection by Landcare groups, participatory mapping exercises and interviews held with local bore drillers and community 'experts', individual bore surveys, and stakeholder and agency workshops generating feedback. Key stakeholders were also invited to review and give feedback on the accuracy and useability of the model when it was three quarters completed in a series of half-day workshops held at CSIRO, Darwin.

The modelling component took seven months to complete. Updates and project information were disseminated widely through two public meetings, regular electronic newsletters,

project information sheets, a dedicated project website, local print and radio channels and information posters displayed in public areas and events. Stakeholder groups were kept informed through personal communication and meetings which sought specific input. The community information strategy was a real strength of this project, drawing high levels of community engagement in local water planning processes.

A final visualisation model was presented to the Howard East community in a public forum held in early September 2009. Training sessions were also held for invited stakeholders and agency staff in a ‘Training of the trainers’ format, attended by representatives of the Department of Natural Resources, Environment, the Arts and Sport (NRETAS), local government, Shire Councils, Landcare groups, Power & Water, local school teachers and bore-drilling representatives. Compact discs housing both the GVT application and training manuals were distributed to trainees for uploading onto community and local government websites. In all cases, trainees nominated themselves as volunteers to assist other community members in learning to use the GVT application, potentially increasing its impact.

Finally, the GVT approach was evaluated with stakeholders and agency staff through staged surveys and a focus group. Results showed that the vast majority of participants considered the model to be a useful educational tool that could improve the ability of the community to make informed decisions about groundwater management. The independence of the model construction by Queensland University of Technology, the treatment of NRETAS as equal to other stakeholders and the involvement of stakeholders throughout the modelling process increased the perceived public ‘trust’ of the model accuracy and increased the willingness of the public to utilise it.

Between August and October 2009, the Howard East GVT was distributed to 15 leading community and local government stakeholders, presented on five local radio programs and uploaded onto four community websites. The model was presented in three public meetings, a water planners’ conference and three half-day stakeholder participation and training sessions. Overall, the research team spent over 120 hours conducting meetings, undertaking mapping exercises with government water planners and community experts and interviewing leading stakeholders. The results of the evaluation suggest that the GVT was useful in bridging gaps in the consultation process, and advanced the planning process through a common understanding of groundwater dynamics, limits to development, and specifically how the drawdown and aquifer recharge interplay over time.

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Table of Acronyms

AFANT	Amateur Fishermen's Association of Northern Territory
CSIRO	Commonwealth Scientific and Industrial Research Organisation
GVT	Groundwater Visualisation Tool
NT	Northern Territory
NTHA	Northern Territory Horticultural Association
NRETAS	Department of Natural Resources, Environment, The Arts and Sport
QUT	Queensland University of Technology

1. Case study background

The work for this guide was undertaken as part of a larger project on Collaborative Water Planning in North Australia. In the first part of the project, the team worked with participants from government, industry and the wider community in case-studies in the Ord River in Western Australia and the Gulf catchments of Queensland. Our earlier findings included results from a survey of water planners; a review of water planning literature, law and policy; and management of water disputes. During the second and final phase of our project, from August 2008 to November 2009, we primarily worked in the Howard East groundwater system near Darwin in the Northern Territory and in catchments in Queensland's Cape York

The Howard East water allocation planning process was selected as a case study in 2008. A research collaboration developed between agency staff (Water Resource Management Branch of the Department of Natural Resources, Environment, the Arts and Sport) (NRETAS) and the research project team based at Griffith University and CSIRO. An objective of the collaboration was to work closely with members of the Howard East Water Advisory Committee and planning staff to support their efforts to engage the broader community in water planning. In doing so, the work built upon previous work undertaken by CSIRO (Woodward et al 2008) that identified the social and cultural values for water resources in the region.

Over the course of the next twelve months, the research project trialled, promoted and evaluated planning tools. In November and December 2008, the first tool, a stakeholder analysis was performed to examine values, interest and knowledge levels of various stakeholder groups affected by water planning in the Howard East region. After confirming key findings from the stakeholder analysis, two specific concerns were prioritised for the Howard East community. These were: a widespread lack of understanding of groundwater systems or planning frameworks and, a lack of trust in the science underpinning decision making and government-driven management of the Howard East aquifer. More details of the extended stakeholder analysis and of changes in time-table for the water plan can be found in the main case-study report (Nolan 2010).

Identifying these priorities led to the proposal of the second planning tool - a participatory groundwater model to assist the community to 'visualise' changes in groundwater levels over time and seasons, and to answer questions based on their concerns about the system. With participation from stakeholders in a range of sectors, data was collected and used in a groundwater modelling system. This visualisation tool also formed the basis of a community engagement strategy.

1.1 The Howard East borefield

The Howard East borefield is a small yet high yielding aquifer system that is located approximately 20 kilometres from Darwin and Palmerston. Its groundwater provides for peri-urban communities in Howard Springs, Humpty Doo and Girraween lagoon areas, as well as 97% of the Northern Territory's horticultural and vegetable industries (ABS 2001. In addition, the aquifer supplies 15% of Darwin's town water (Power & Water 2008). Its boundaries can be seen in Figure 1.

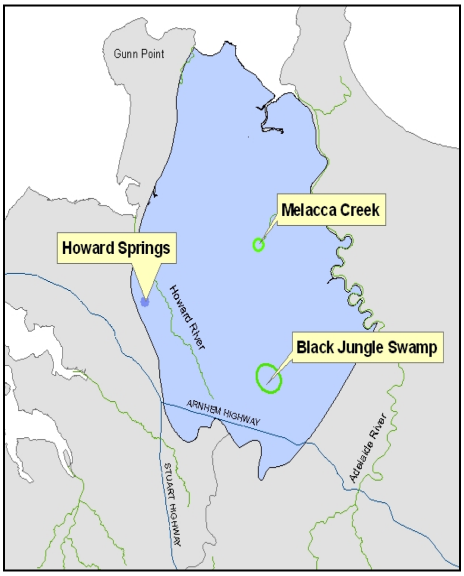


Figure 1: Map showing the boundaries of the Howard East aquifer, known as the Koolpinyah Dolomite Aquifer (Source: NRETAS 2008)

The area's close proximity to Darwin and relative abundance of land has led to prolific development over the past 15 years.[1] Extrapolating from the total amount of groundwater extracted over a one-year period (20,000 GL), recent government estimates put rural domestic bore consumption of groundwater at 30% of the total extraction from the aquifer, with local horticultural irrigation extracting 50%. The remaining water extracted (between 15 and 20%) augments the reticulated drinking water supply required for the City of Darwin. Demand for water is predicted to rise from between 100% to 200% over the next forty years[2], largely from growth in the residential and industrial sectors, necessitating the development of a Howard East water allocation plan.

The Howard East Aquifer has no previous history of water planning and the responsible state agency (NRETAS) is now required to engage the community in a planning process and establish a locally representative Water Advisory Committee. In early interviews with stakeholder representatives, few demonstrated knowledge of key groundwater concepts or how the aquifer worked at a regional level. An issues analysis revealed that the points raised below were amongst those of most concern to the local community and therefore needed to be considered in the development of any educational tool. In doing so, the tool became far more interesting for stakeholders and specifically addressed their knowledge needs. The key issues were:

- The effect of current and future bore extraction on valued surface water discharges, such as Howard Springs, and local lagoon systems and rivers. Rural residents had observed changes in the bore performances of the area's older, shallower bores and the quantity and quality of water available to recharge lagoons and groundwater-dependent ecosystems, such as the Howard Springs;
- A misconception in the community that water planning would lead to the government charging rural residents for 'stock and domestic' water use;
- A lack of faith in the data used by the government in its decision making for water allocations. The majority of private residential bores remain unregulated and unmetered, raising questions over the integrity of government data.

[1] Large scale projects in Northern Australia now make up for 83% of new investment in Australia (ABS 2008)
[2] Power and Water Corporation presentation at the *Water in the Bush Symposium*, Australian Water Association, Crowne Plaza Hotel, October 2009. Also refer to Power and Water, 2008.

Historically, rural landholders in the area have had to construct their own bores.[3] The complexity of the aquifer has meant that many have had to sink numerous bores on their property to source adequate water. As demonstrated in the cross section below, there are two layers in the Howard East aquifer, an upper Cretaceous layer and a deeper, locally fractured dolomite layer.

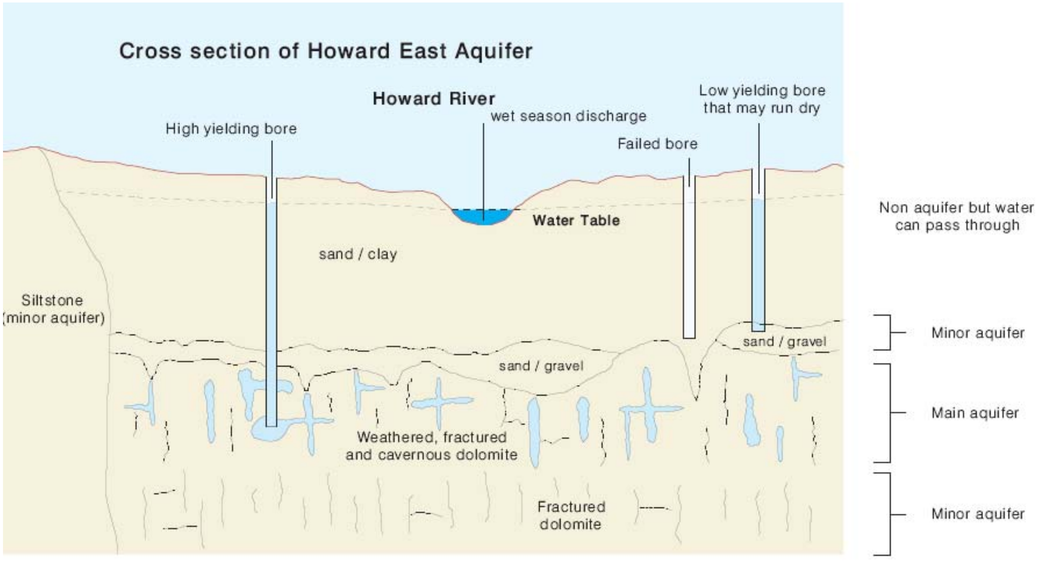


Figure 2: Conceptual cross section of Howard East showing upper (minor) Cretaceous aquifer (sand and gravel) and lower dolomite aquifer. Source: NRETAS 2009

While NRETAS models have shown that both the upper aquifer and underlying dolomite aquifer are still recharging in years of good rainfall, regional drawdown effects from bore extraction are becoming more pronounced in line with the increase in residential development. Older, shallower bores are now under threat of running dry earlier in the dry season. Sections of the community have blamed this locally on the four large production bores which supplement Darwin's urban and reticulated water supply, despite the fact that extraction from these bores accounts for only a proportion of the total extracted (15-20%). In fact, most water extracted from the aquifers (65-70%) services local residential or horticultural needs. Most community members are now aware of the composite drawdown effect, leading to growing concern in the rural community about planned future development, the potential pricing of bore water, and the need to address the trade-offs involved in securing water for both rural and urban needs.

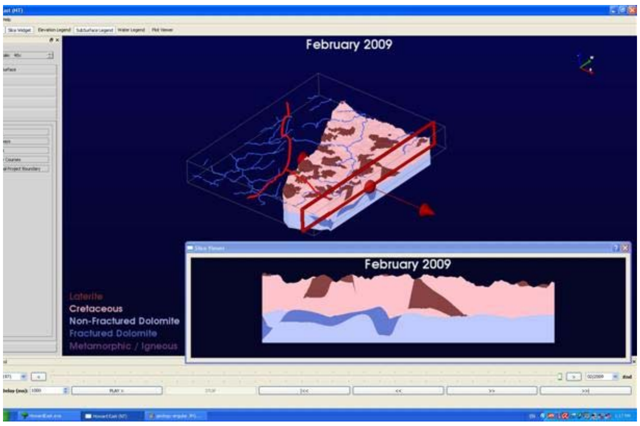
More detail regarding the context of water planning in Howard East area may be found in Woodward et al 2008 and Nolan 2009, Nolan 2010.

[3] Each bore costs approximately between $12,000 and $20,000 dollars. This price is the average given from interviews with local bore drillers (Bores NT), agency staff and ex-NRETAS staff.

2. Developing a participatory GVT – why is it useful?

It is recognised that people have difficulty in understanding or ‘visualising’ groundwater processes. In Howard East Aquifer, the complex and locally fractured (occasionally cavernous) nature of the geological strata layer referred to as the *dolomite* means that bore yields are highly variable over a given area (from 0-60 litres per second), giving rise to a number of myths about the origins and amount of groundwater available for consumption. As part of the GVT a visualisation model was therefore developed to help the Howard East community to ‘see’ and understand local groundwater processes. It also aimed to answer a number of questions around common issues of concern and facilitate informed decision making about water management in forthcoming planning processes.

Similar applications have been created for other catchments in Queensland and Victoria (see http://iwater.sci.qut.edu.au/). The visualisation software system uses a combination of patented and open source software to create a 3D hydrogeological framework to represent an area’s aquifers. Additional features can be built into the visualisation to add new functionality and allow users to slice the ground in a given area, rotate the result and view a cross section illustrating what is happening underground. Thus, users can interrogate the model, by slicing sites near monitoring bores and even animate the standing water levels in the bore (if that monitoring data is available), presenting a visual record of changes in groundwater levels and demonstrating the relationship between rainfall and recharge over seasons and longer time periods. The GVT is *not* intended, however, to be a predictive groundwater dynamics model, but rather a useful tool for agency staff wanting to show regional and local drawdown trends.



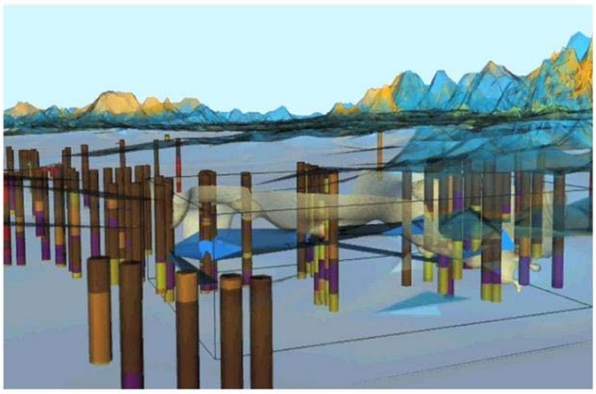


Figure 3: Two examples of Groundwater Visualistion System outputs; *Left*: the slicing capability with the Howard East 3D visualisation model. *Right*: An image taken from the Lockyer Valley, Queensland, Visualisation Model, shows an animation of groundwater water levels (taken from standing water level measurements). Bores and their corresponding geology (taken from drillers’ logs) are represented by the coloured cylinders. Source: Howard East GVT, QUT http://iwater.sci.qut.edu.au/)

In the Howard East experience, the GVT helped people gain a regional perspective of the groundwater system, the number of bores within the field and their locations and depths. The relationships between bores, aquifers and rainfall are also visualised, plus the difference between local and regional drawdown effects. An animation was also added to illustrate the number of bores that had been drilled over time, giving users a regional perspective about the impact of residential bores. The GVT was also overlain with a range of data layers (e.g. topographical maps, hydrological maps, soil types, local landmarks and identifiers), making it easy for users to identify local landmarks, find their own bores and use the GVT to answer a range of questions about different processes in the local system. Adding these functions gave the GVT appeal to a wide range of stakeholders who could each use it in different ways.

These groundwater visualisation techniques represent relatively new technology and are now being produced by Queensland University of Technology (QUT) for coastal delta systems (Bundaberg), confined valleys (Samford), extensive alluvial systems (Lockyer; Upper Condamine), basaltic catchments (Maleny and Mount Tamborine) and sand islands (North Stradbroke Island, Bribie Island).[4] Of these, the Upper Condamine project is linked to this current study.

[4] Malcolm Cox, Pers comm.

3. How to develop a participatory GVT model

3.1 Setting aims and objectives

A decision to build a GVT was made in a series of meetings between the project researchers and the Director of the Department of the Water Resource Management Branch, NRETAS. The meetings culminated in a research collaboration being forged in February 2009, between the project team and NRETAS staff at the Water Resource Management Branch.

The overall aim of the collaboration was to develop a 3D visualisation tool that was cost effective, easy to use and able to be installed on household and public computers from a CD. More broadly speaking, a groundwater educational tool would have the following objectives:

- improve understanding of local groundwater systems by the Howard East community and Howard East Water Advisory Committee
- assist community members to become more comfortable with modelling, the science underpinning it and the limitations of current data sources
- have an independent agency produce the visualisation (Queensland University of Technology located in Brisbane)
- provide meaningful public participation, improving the community's trust in the tool and the likelihood of it being used
- generate understanding and momentum within the Howard East community to support future water planning processes.

In achieving these objectives, the GVT model would need to demonstrate the following:

- the geological structure and boundaries of the aquifer in easy-to-understand cross sections
- local and regional drawdown effects of bore extraction over time and season
- the relationship between rainfall and aquifer recharge over time and season, displayed using animation software
- the growing number of productive bores in the area
- the relationship between bore depth and yield.

3.2 Determining the technical specifications of the GVT

Determining technical specifications depends on several factors: firstly the area covered by the model; secondly the information the model requires; and thirdly, the type of data available and whether its quality is trusted by participants. This is explained further below.

The boundaries of the area to be visualised were defined as an 8 x 20 kilometre area of the south-western corner of the Howard East aquifer, initially chosen to capture the majority of Howard residential bores (and therefore most of the available bore drillers' logs) around local lagoon systems and highways. The area also captured the town water supply bores operated by Power and Water Corporation and the iconic Howard Springs, thereby addressing many of the key concerns held by the community. In the course of the GVT's development, the boundaries for the model were slightly expanded and extended to the east in order to incorporate significant bores, including observation bores, and the river system which had initially been outside of the visualisation area.

When creating the Howard East GVT, a technical team (in this case a modeller and hydrogeologist based at QUT) needed to review and input existing bore data into software that could construct a 3D 'mesh' or hydrogeological framework. The objective was to visualise the physical geological structure with water drawing down and being recharged over time. This framework forms the basic visualisation (i.e. the local geology and hydrogeology) that can be manipulated using open source software tools, such as a splicing widget or the animation of specific features.

To address the quality assurance of data and to encourage trust, a community engagement strategy was designed to stimulate public interest in the model, encouraging Howard East residents to contribute their bore information into the 'mesh' and give feedback on the final features of the model. The objective was to collect the best quality data on location of extraction and engender trust in the use of the data through participatory research.

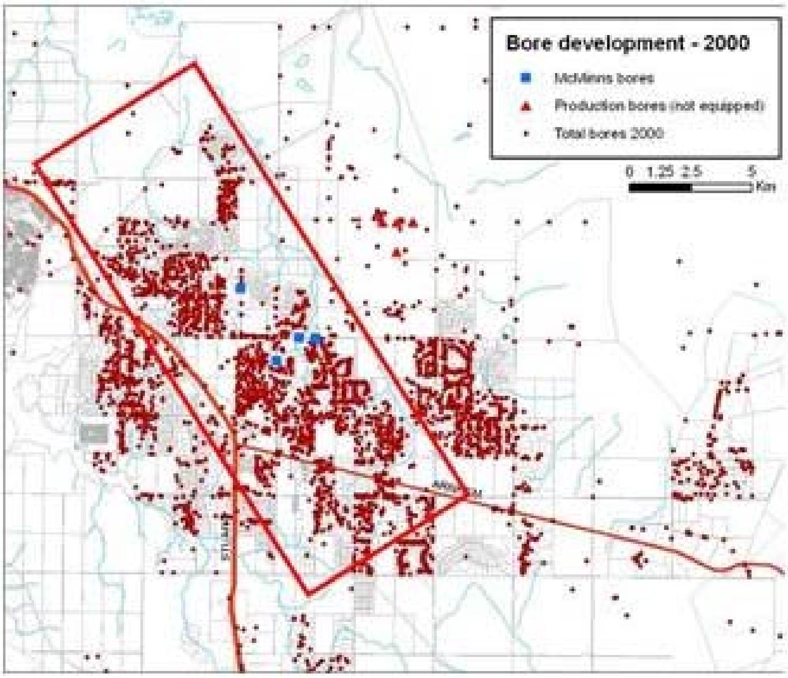


Figure 4: **Area initially proposed for 3D visualisation. Source: Power and Water Corporation 2009**

The accuracy of the GVT is dependent on the quality of data used to create it. For QUT modellers, the most valuable types of data are collected and stored by government or research agencies, such as a Digital Elevation Model (DEM), bore drillers' descriptions, bore monitoring data and government reports featuring detailed cross sections of the area of interest. In the case of the Howard East, good quality data was also sourced from the community. Over the first three months of the GVT development, the following types of information were made available to the QUT team:

- Bore monitoring data from NRETAS bores in the area (totalling 47)
- Monitoring data from Power and Water town water supply bores (measured quarterly for past thirty years)
- Records from bores monitored through NRETAS volunteer bore monitoring project
- Local rainfall data collected by individuals and researchers
- An accurate and updated digital elevation model (SRTM 90m Digital Elevation Data)
- Information contained in bore drillers' logs (NRETAS had records for the area of more than 3,000 bores with 22,000 geological description entries)
- Final and project reports about the hydrology of the area by NRETAS and other consultants (e.g. Jolly 1998, EHA 2006)

- Google maps for aerial texture and recent cadastre overlays
- Hydrological and topographical maps
- Maps showing wetland inundation sites
- Evapotranspiration and water balance data from researchers at Charles Darwin University
- Bore monitoring data held by commercial-scale growers affiliated with the Northern Territory Horticultural Association
- Information from participatory mapping exercises showing productive and non-productive zones of the aquifer
- Transcriptions from interviews with local experts and bore drillers
- Details about specific private bores contributed by the community via a bore survey.

3.3 Time considerations

A work plan was proposed which would complete the model in four months. Due to delays in receiving the data, delays caused by the need to 'clean' bore drillers' logs to a format that could be used by the software, and delays in scheduling qualified modelling staff to work full-time on the project, the GVT took seven months to build. An amended work plan reflecting this timeframe is presented below.

Table 1: Work plan for GVT development by QUT

Activity in 2009	Mar	Apr	May	June	July	Aug	Sept
MoU signed, basic data shared (DEM, bore drillers' logs, collaborative agreements in place							
Bore drilling logs and data 'cleaned' and sorted by QUT student for inputting into software							
Compilation of initial database and incorporation of 2-D layers (Google maps, wetland maps, cadastral maps etc) of properties of the region							
2.5-D contoured surfaces developed (mainly topography and drainage systems, with draped geology)							
3D hydrogeology model representing the physical framework of the aquifers completed – water levels and educational features (GVT is approximately 70% complete)							
GVT is presented to stakeholders and agency staff for comment							
Comments and feedback are incorporated into final GVT which is then burnt onto CD and ready to be distributed to the public							
Modellers develop an owner's operational manual for using GVT							
A final GVT and owner's manual is presented to the broader community in public meeting. The GVT is then ready for distribution by CD or uploading onto various stakeholder websites							
A training session is held to teach community and agency how to use the GVT							

3.4 Tailoring a communication engagement strategy

Planners should first determine the communication preferences for different stakeholders and community groups.[5] In the Howard, an extended stakeholder analysis showed that the majority of Howard residents were online and regularly received electronic mail and

[5] For methods on how to determine stakeholder preferences, refer to the Stakeholder Analysis undertaken for this case study between October 2008 to May 2009: Nolan, S. 2009, Collaborative Water Planning Project: Rural Darwin Case: Analysis of Stakeholder Interests in the Groundwater Resources of the Howard East Aquifer, CSIRO, Darwin.

newsletters. While many wanted to learn more about groundwater processes, stakeholders were time poor and did not want to commit to attending a working group or travel long distances to meetings. They wanted a dynamic educational tool that had appeal to a broader audience that allowed them to learn at their own pace. For the horticultural industry, a key stakeholder for water planning, this was particularly important:

> "It has to be something that can be done in 2 or 3 hours and is not patronising. People are busy; they don't like to go to an evening meeting too late." (Cut Flower Grower)

As previously discussed, the Howard East GVT had the twin objectives of improving community understanding and creating trust in the community of the science underlying the model. A number of targeted information dissemination activities were therefore undertaken to ensure that local stakeholders were aware of, and updated about, the progress of the GVT. These activities were based on stakeholder preferences, and included the following:

1. Organising two public meetings on rural water with explanatory presentations by a QUT modeller and a hydrogeologist.
2. Distribution of newsletters and meeting minutes in electronic form and hardcopy mail-out.
3. Creation of and uploading project documentation on a dedicated project website. The project website was then linked to other popular websites that were used by the Howard community.
4. Using commentary and talkback radio shows on popular programs, such as ABC Rural Country Hour, and Territory FM, to generate community discussion and interest.
5. Creation of information sheets and posters, and displaying these in prominent locations throughout the community.

A community engagement strategy was developed to complement the information dissemination activities and encourage the community to contribute their information about local groundwater systems. This included the TRaCK personnel as well as those from QUT. The main tools used for capturing this information were a bore survey (available for downloading and submitting electronically), semi structured interviews with local experts and the outputs of a number of participatory mapping exercises undertaken with bore drillers in the community. These activities were undertaken at different stages of the GVT's development to optimise public participation and 'feed' community knowledge back into the model at specific times, as outlined in the diagram below:

Groundwater Visualisation Tool progress

% complete	0%	30%	50%	70%	100%
Activity	• Research collaboration discussed and MoU drafted • Shared objectives and work plan agreed • Data sharing and transfers begin • Community engagement strategy agreed • Staff assigned	• Initial community meeting • Bore Surveys • Project website • Project info posters displayed around community • Model discussed on local radio • NRETAS meetings, field trips	• Participatory Bore mapping exercises with bore drillers • Local experts and geographers consulted individually to ‘ground truth’ models early interpretations of local geology • Project newsletters to growing mailing list	• Half day workshops to show model to stakeholders and agency staff. • Feedback sought to finalise key features of the model to make it as user friendly as possible.	• Final community meeting held showcasing the model • Local radio show featuring researchers and modellers • Final project report disseminated to stakeholders, agency staff and project team • Half-day workshop teaching people to use model in ‘Training of the Trainers approach” • Publications

Figure 5: Community engagement activities undertaken at different stages of the model’s development

The level or intensity of communication sought with various stakeholders depended on the amount of local bore information held by each stakeholder, their capacity for public outreach and their likely influence or inclusion in forthcoming water planning processes. This is clearly reflected in the table below, which outlines the hours spent in consultation with various local stakeholders over the development of the GVT. Data collection and quality assurance took up the majority of consultation time, which was largely spent checking data quality through meetings, field trips, mapping exercises and interviews. Presenting the final model and training stakeholders in its use took up the remaining consultation time on the project.

Table 2. Key modes of face-to-face communication and hours spent between CSIRO researchers and stakeholders to develop the Howard GVT

Modes of Consultation	Participants	Hours spent
Meetings between collaborative partners	CSIRO, NRETAS, Power & Water, Griffith University, Queensland University of Technology	35
Participatory mapping exercises with local bore drillers and experts	Bores NT, ex-NRETAS staff, H2O bores, Charles Darwin University, NTHA	20
Interviews with local experts	Charles Darwin University, ex-NRETAS staff, Bores NT, NTHA	25
Meetings with local council members	Nelson electorate, Goyder electorate	15
Field trips in Howard East	CSIRO, NRETAS, QUT, Power & Water, Griffith University	8
Workshop with community stakeholders to gain feedback on model	NRETAS, CSIRO, NTHA, AFANT, Landcare groups, ex-NRETAS staff, Bores NT, H20 Bores, Goyder council representative	4.5
Workshop with government stakeholders to gain feedback on model	NRETAS, Power & Water, CSIRO, Griffith University, Charles Darwin University	4.5
Two public meetings in Howard East	All stakeholders	5
Final workshop to teach stakeholders to use the model	All stakeholders	4.5
Total hours		121.5

3.5 Communication products and use of media

In the Howard case study, a number of hardcopy or electronic information products were developed by project staff to raise community awareness of the GVT process and encourage public participation in its development. These were:

- Project newsletters
- Project information sheets
- Posters
- Invitations to public meetings
- A dedicated project website.

Communication products were professionally designed to develop a ‘theme’ or ‘brand’ for GVT-related information aimed at the community. The design and colour scheme was used consistently for each product, incorporating photos of highly valued recreational areas or of respected community members speaking to project staff. The text used in each product was non-technical, direct, and emphasised the capacity of the tool to answer questions related to the issues of key concern raised previously by the community. A sample of the communication products appears in Appendix A.

Some products worked better than others. Researchers and community members had the most positive response to project newsletters, emailed twice during the course of the project to more than 60 stakeholder representatives and agency staff. This response is demonstrated by one stakeholder:

> ”the emails and newsletter updates were fantastic, a quick and easy way to see how the project was progressing”.

Emailed information was found to be very useful for getting key messages or invitations to a large stakeholder audience quickly, once it was determined that the majority of certain stakeholder organisations (for example the NT Horticultural Association and the NT Cattlemen's Association) were on-line. A project mailing list was initiated and maintained, with feedback suggesting that project emails were widely passed throughout the Howard community.

Other products were less successful, with few people crediting them for providing quality information. This feedback was mainly related to large posters that were displayed in prominent shopping locations or community events in the Howard area. As well as being expensive to design and print, they were only really considered useful if a project team member was on hand to answer questions. When areas displaying the posters were observed by project staff, it was found that the majority of people walked past project posters without stopping to read them, despite being displayed in community shopping centres with a lot of foot traffic.

A dedicated website was also created for the Howard East project on the TRaCK website. Regularly updated, it contained a permanent record of project information and activities; and, a news page with photos of the team and project activities with access to a range of project documents, such as newsletters, the stakeholder analysis, and community surveys.

Like the hardcopy information products described above, web text was kept simple and enthusiastic, with invitations for the community to get involved. The site, along with its text, was reviewed by stakeholders in a questionnaire, and the project team recorded web statistics. Stakeholders agreed that the website added to the professionalism of the project and provided an easily accessible and convenient way for people to access important information in their own time. Analysis of the website revealed that, from the 2,547 total number of visitors to the website over the development of the project, the vast majority (over 800 visitors) visited the site between August 12th and 14th, 2009. These visits followed an intensive period of media engagement and promotion of the GVT on two local, and two national ABC radio programs (Bush Telegraph[6] and Rural Country Hour), as well as a number of stories featured in stakeholder newsletters and websites following a series of stakeholder and agency workshops. The large number of visitors during this time demonstrates the power of using local media channels to raise community interest.

Promoting the GVT through local and national radio networks was found to be the most effective method to reach a broad local audience. Eighty percent of attendees at public meetings (see below) relayed that they were attending because they had heard the GVT being discussed on the radio. Generating media interest in the model, however, was challenging, and advice needed to be sought from professional communications staff.

It was important to write targeted and interesting media releases about the GVT and steer clear of local, contentious issues around water use. Media releases focused on the positive aspects of the GVT's utility to local water planning processes and the community engagement process. However, this was not an exciting enough story to keep journalists interested, as they were after a 'headline'. Inviting local, long standing community members to be interviewed about their involvement in the project and local water issues was a better strategy to keep journalists interested. This took the pressure off the project team to take sides in local issues.

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[6] ABC Radio interviews featuring the GVT can be listened to by following these links http://www.abc.net.au/rural/telegraph/content/2009/s2679760.htm
http://www.abc.net.au/rural/nt/content/200909/s2681142.htm

3.6 Public meetings

Two public meetings were held in Howard East at the beginning and completion of the GVT's development (being April and September, 2009). The purpose of these meetings was to introduce the project; encourage community involvement in the GVT; communicate key findings from the research; and use the model's outputs to present groundwater concepts and processes to the community to improve their understanding. It was important that a QUT hydrogeologist was present at these meetings to explain the basics of the groundwater systems, how they operated, and the role of data in groundwater system management.

The meetings were well attended in both instances, with approximately 35 people attending the first and over 40 in the second. Each was advertised in a number of ways: through local and national radio programs, in stakeholder newsletters, through the project or stakeholder websites and via hardcopy or emailed invitations.

Both public meetings followed similar agendas – a factual presentation explaining the groundwater processes of the local system aimed to address questions around local contentious issues. Then a demonstration of the model was given with examples of the types of questions it may be able to answer. Meetings were designed to be interactive, with people encouraged to stop the presentation and indicate where they needed more information or clarity on a point. Their questions were first answered by the project team and then with supplementary responses from local experts and bore drillers.

This Question and Answer format requires strong facilitation skills – the first meeting was facilitated by a local member for Parliament, Gerry Wood. Consulted during the development of the GVT since inception, Gerry Wood had spoken on radio several times about the project. The support of a respected member of the local community was very important to generate a sense of legitimacy and trust among the local community. Gerry was also able to deflect more politically charged questions away from the project's hydrogeologist during meetings, as such questions were outside his role. Referring to local and reputable bore drillers for answers, and showing photos of them being consulted throughout the GVT development also helped build trust and legitimacy into the model.


Figure 6: ***From Top left*: First Public Forum held April 2009; *Top Right*: Meeting held between modellers and NTHA representative; *Bottom Left*: Meetings held with key stakeholder groups to gain input into model when 70% complete, *Bottom right*: Second Public Forum held in September 2009**

3.7 Participatory mapping exercises

Local bore drillers and horticulturalists with long standing local experience were invited to participate in the development of the GVT through a participatory bore-mapping exercise. Drawing on local knowledge within the community was beneficial in a number of ways. Firstly, it helped ensure that the GVT matched local observations of the dolomitic aquifer. Due to the complexity of the system as a whole, many anomalies about the recharge of this system had been reported by community members however these anomolies were difficult to capture in NRETAS data sets.

Project researchers visited the drillers with topographical maps (1:10 000) and asked a series of questions about the local aquifer (see Appendix B for a list of questions). Using a number of coloured markers, drillers were asked to mark the areas they had drilled previously, indicate the areas with production potential from the cretaceous and the dolomite (deeper) aquifer and indicate the areas where they thought recharge may be happening to the deeper layer. A series of secondary questions was also asked about the aquifer, which can be read in Appendix B.

At public meetings introducing the GVT, bore drillers were invited to speak about their experiences. Drillers were also asked to participate in a stakeholder meeting that was held when the model was mostly completed, and comment on the accuracy and functionality of the GVT. Photos taken throughout these consultations were found to add legitimacy to the model by demonstrating that local members of the community had been represented.

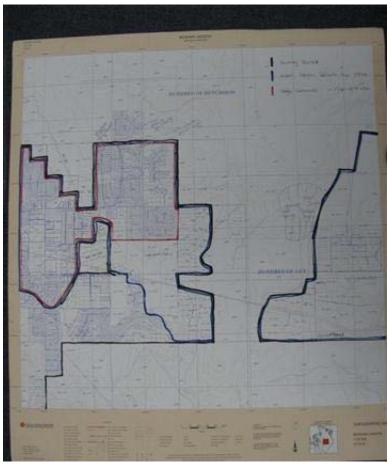

Figure 7: ***Left*****: Mapping exercise meeting with bore driller, Henry Van Tilburg and hydrogeologist, Mal Cox;** ***Right*****: Examples of outputs of participatory mapping exercise**

3.8 Stakeholder and agency workshops

The complex nature of the dolomite system in the Howard East aquifers made it important to seek feedback on the accuracy of the GVT and determine ways to maximize its usefulness in meeting local needs. Two workshops were held when the model was 70% complete, inviting stakeholders from the local councils, key stakeholder associations, bore drilling association and NRETAS agency staff. Workshops were three hours in duration and aimed to 'road test' the GVT to generate insights as to which features of the model would be most helpful to community members. Feedback was also sought for the planned training program intended to teach stakeholders how to use the model.

A questionnaire was distributed at both workshops to evaluate the communication techniques used to engage the community, and gauge the effectiveness of the GVT in building understanding of groundwater systems. The results are discussed in the following section.

3.9 The final model: presentation and training

Finalised in September 2009, the GVT for the Howard aquifer was presented to the community in a public forum held on the 9th of September, already referred to in 3.6. At this forum community members could apply to receive a copy of the model and register their interest in receiving information about future project activities.

In addition, a half-day training session was held at Charles Darwin University, to teach interested stakeholders and agency staff (who at this point had participated in many of the project's activities) how to use the visualisation model and data sets. Community participants were selected for training based on the sector they represented and their ability to increase the model's outreach.

Figure 8: Photo of training session for the visualisation model with stakeholders

The following observations may be helpful:

- Having an interpretive presentation and using visual aids (PowerPoint - photos and graphs) was essential. After displaying these, the project team would often then pose questions to the group and ask them to interpret the trend based on their new knowledge. As people’s knowledge grew, more were able to participate in the discussion and the conversation was able to cover more technical matters.
- The project hydrogeologist presented simple or broad trends of the local system, or interesting examples of local processes using pictures from the model and then put the question to the local experts in the group. Local experts and the project hydrogeologist would then be encouraged to work together, in a manner which everyone could follow, to come up with a local technical explanation of a problem.
- The training session was mixed, consisting of agency staff and stakeholder representatives. While initially tense (because attendees did not usually work together and had different professional status), agency staff and local bore drillers soon enjoyed explaining groundwater concepts to others. The training session seemed to create a safe space for people to ask questions.
- Having two local bore drillers in the room was invaluable as people seemed to trust their answers sometimes more than agency staff members. It was of note that these drillers immediately recognised and commented on the value of the tool.

4. Evaluation of the GVT process

The GVT process and outcomes were evaluated in two ways. The first was by way of a brief questionnaire administered twice during the tool's development process. The first time at the end of the community and agency workshop held in August, and the second time at the end of the model's training session held in September. The evaluations aimed to generate feedback on the following:

- Satisfaction with the final GVT model (its ability to improve general understanding of groundwater systems)
- Satisfaction with the engagement process during the GVT's construction
- The use of visualisation to influence changes in thinking about groundwater systems
- Suggestions for improvements to the model, its utility or the engagement process.

Participants in the questionnaires relayed that the participatory elements of the model (surveys, mapping exercises, newsletters and meetings) had increased the level of trust many had in the science underlying the GVT and, consequently in NRETAS models. Giving members of the community regular updates on the model's progress and a range of options to get involved significantly improved the uptake and understanding of the final GVT. Stakeholders also stated that they would be more likely to use the model as an educational tool as it took into account the questions that the community were concerned about in the local area.

The second method of evaluation was through a focus group which was led by the project team at the completion of the model's development process, in order to elicit discussion around key points and draw lessons for future GVTs. This focus group consisted of the project team, stakeholders and agency staff. The aim was to compare the GVT's performance against its original objectives (improving trust and understanding around water planning and groundwater management). Below, quotes from the focus group discussions, are provided to illustrate stakeholder responses to questions around each objective.

The first objective of the GVT was to improve the understanding of groundwater systems among stakeholders and the broader community. In response to this question, stakeholders determined that the GVT was a useful tool for creating a space for agency staff and stakeholders to come together and discuss groundwater management. This sentiment was put forward by one Northern Territory Horticultural Association (NTHA) representative:

> "I think that the greatest value is the visualisation - a picture tells a thousand words. You can talk to people/owners who have little concept of the system if you can show them or run them through a tool like this…I mean it's a great tool for drillers, or any horticulturalist thinking of developing"

Similar statements were made by NRETAS staff and Power Water engineers.

> "Yes, this model will help people want to engage with water planning. We all have a very centric view of our immediate surrounds. Very few have a holistic view of what is going on over the full scale and what impacts what and how integrated it all is."

> "It's a great tool from a Power and Water perspective. I will be able to show the engineers at work how the system works and be able to have a conversation with colleagues from different areas."

Others referred to the fact that it gave people a holistic, more regional perspective of the system:

> "It's going to give a holistic view to people who should think "my bore is going to have an impact into the flows into Howard Springs. That could be why we have bacteria issues there and they have closed it for swimming"
>
> "It can show people all the data through a system that helps people relate a particular bore to its location and to the number of bores around it. People have to start thinking not in my own back yard – but rather 20 blocks around them – that's the sort of impact your activity can have."

A second objective of the GVT was to improve the sense of trust stakeholders had in the science and generate a willingness among the public to become engaged in government driven water planning processes.

A running sheet of questions is provided in Appendix C, and a small example is given below:

- What do you like about the model? What don't you like? Was it easy to use?
- Are there any messages or characteristics of the aquifer systems that you think could have been communicated more clearly?
- Do you think some groups in Howard Springs will find this model more useful than others? Why or why not?

Has the fact that the model has been created by an independent group of modellers made any difference to the way you think that the community will perceive or 'trust' its outputs?
Other comments given in focus groups indicated that the GVT had increased the likelihood of the public getting involved in water planning. Comments such as; "*I am now thinking bigger than my own backyard*" were common, often leading stakeholders to the conclusion that "*the geology is complex and needs to be managed carefully*".

5. Analysis of the strengths and weaknesses of the participatory GVT process

5.1 Overview of strengths

From the above evaluations, the main strength of the GVT process in the Howard East was that participants had a sense of ownership and acceptance of the tool. They trusted the sources of information upon which it was based, and indicated that they felt included within its development. Interestingly, 90% of survey respondents indicated that they 'trusted' the science behind the model, knowing that local experts had been consulted in its development.

Additional strengths lay within its ability to be cheaply and quickly downloaded and installed onto desktop computers. Stakeholders appreciated that users could examine the GVT in their own time and at their own pace with the guidance of an easy-to-follow operational manual. Lastly, users valued the interactive capacity of the GVT, which could be consulted by a range of users from different interest groups and was thus able to answer a number of questions about the system and its resources.

5.2 Considerations for adopting use of GVT

Community engagement involved in GVT development can be expensive and time-consuming. During this pilot, a full time researcher worked on the engagement process for seven months. In a water planning process, if the use of a GVT is adopted, it is likely that a lesser amount of time would be required.

To give an indication of other costs: the GVT cost approximately $54,000 to build which includes about $6,000 on four visits by QUT staff. About $4,000 was spent on graphic design and communication products.

Ongoing knowledge and adoption issues also need to be considered. At the end of a GVT process, resources need to be provided to sustain the community educational process, and to update the GVT once better information is sourced. As one researcher commented:

> "with a model of this type, it's not usually an overnight success and most stakeholders need to work with it for some months".

Ideally a GVT can be delivered over a longer period by dedicated agency staff that can establish long-standing links with the community and use the GVT to its full educational potential for the long term.

Another consideration is that the quality of the model is only as accurate as the data supporting it. Not all of the data sourced from NRETAS or the community was able to be incorporated into the model, as relayed in the matrix below.

Table 3: Modeller's evaluation of locally sourced data provided for GVT development

Type of data source	Evaluation
Government and consultant reports	Very useful for providing detailed cross sections and descriptions of sub-surface geology.
Maps from participatory exercises	Good in the beginning to give a general overview of the variability in the area. Used to build general understanding rather than incorporated directly into model. 2009 cadastral layers most useful.
One-on-one interviews with local experts	Useful for interpreting broad trends however not incorporated directly into the model.
Community and agency input into model when mostly finished	Very useful feedback was received at this meeting which led to the tailoring of the GVT to meet the specific educational needs of different stakeholder groups
Rainfall data collected by community members	Too much data was provided, and could only incorporate two sites from ten
Community bore surveys	Unable to incorporate data as GPS position of bores not included. Good for interpreting broad trends only
NRETAS bore drilling records	Difficult to incorporate or interpret sub-surface geological descriptions based on inconsistent descriptions given by various bore drillers over time.
NRETAS voluntary bore metering data	Excellent resource
Power & Water Corporation water monitoring data	Excellent resource however only 5 bores are monitored at any time
NRETAS water monitoring data	Difficult to accurately ascertain standing water levels over selected area based on the quarterly monitoring data provided by 47 bores. There are too few data points for the GVT to be accurate.

5.3 Further analysis of the application of GVT

More in-depth analysis of the applicability of the GVT was made possible through a framework that addresses the process, delivery and potential long term use of the GVT (for a discussion of monitoring and evaluation of public participation in water planning see Mackenzie, Nolan and Whelan 2009). Comments and feedback relayed during the focus group meeting and surveys at the conclusion of the GVT, have been coded accordingly and are presented in the following matrix.

- **Process:** Evaluates the strengths and weaknesses of model's process and engagement strategy
- **Stakeholder Learning:** Evaluates the changes in stakeholder behaviour and relationships during and after the GVT's development.
- **Outcomes:** Evaluates the change that is occurring or has occurred as a direct result of the GVT's development.
- **Technical Quality:** Evaluates the technical aspects of the model and its resulting credibility to community.

The strengths and weaknesses in the areas of process, stakeholder learning and outcomes are fairly evident from the Table 4 below.

As this project concentrated on the collaborative nature of the Groundwater model, information on the technical aspects of the GVT is available from Hawke et al 2009. A number of points may be made:

- Ensuring that technical quality of the GVT was maintained was the responsibility of QUT and NRETAS.
- A substantial amount of communication and goodwill was required between the QUT modeling/hydrogeology team and the NRETAS and Power and Water agency personnel. This was required to obtain data, develop an understanding, exchange information, and also for technical verification.
- It was material to the success of the project that QUT's status as independent experts be maintained. Within this framework QUT personnel needed to also be aware of the experience and knowledge base held by the local agencies.
- NRETAS data was amalgamated with local knowledge (see Table 3 above). Of the local knowledge available, general information from bore drillers was useful for giving an understanding of the context and background while more detailed records from voluntary metering of individual bores within the community, and monitoring data from Power and Water Corporation bores, were found to be reliable and relevant.

Suggestions for improving the accessibility of technical information are given in Table 4 below.

Table 4: **Compiled evaluations of the GVT**

Process	**Stakeholder Learning**
Strengths: • Independence: In the review questionnaire, all respondents relayed that they were satisfied with the independent development of the GVT model by QUT, Griffith Uni and CSIRO staff. Many indicated that this fact would make them be more likely to use the model. • Improved community trust in scientific information: Interestingly 90% of survey respondents indicated that they 'trusted' the science behind the model, knowing that local experts had been consulted in its development • Multiple opportunities for involvement in the model led many to relay that they believed that this improved the potential for transparency in future decision making around water resources. • It was agreed that the model was able to be significantly improved through continued stakeholder engagement. • During training sessions and community meetings, it was observed that there was the creation of a safe space for questions and dialogue • NRETAS staff relayed that they had adopted what was learned about community engagement for future water planning from the GVT process Weaknesses: • The community requested for a plain English version of the GVT. Due to time and resource constraints this request has not yet been met. • Community expectations of the GVT need to be managed, as it is not able to deliver real time information • Bore survey data was difficult to incorporate due to inconsistent driller descriptions • Getting initial data for the model was difficult and the approvals took more time than originally anticipated, lengthening the models timeframe from four to seven months. • Short term project timelines imposed pressures on communication	Strengths: • Changed public perceptions towards management of water resources. "We all have a very centric view of our immediate surrounds. Very few have a holistic view of what is going on over the full scale and what impacts what and how integrated it all is. We need to get the community and the stakeholders to communicate. This model will help" • Stakeholder interest in using GVT. (Bore drillers, teachers). "I am keen to see this in the schools as well." "Great platform on which a lot can be built – can look at it from a residential point of view, from a technical and also a scientific point of view. Can be utilised as a tool for those different areas - a picture tells a thousand words." • Improved willingness to engage in a planning process "Model is excellent - to be able to educate rural people about the number of bores in the area and how important it is to regulate usage and to have a plan to conserve water would be very good" • Improved understanding and regional perspective: "It shows people all the data through a system that helps people relate a particular bore to its location and to the number of bores around it. People have to start thinking not in my own back yard – but rather 20 blocks around them – that's the sort of impact your activity has". • Improved ability to communicate difficult and complex concepts • Improved interaction and trust created between agency and community • Self-nominated and informed community volunteers have come forward to offer to disseminate and teach others in the community how to use the GVT. Weaknesses: • Some stakeholders dominated the focus group session and

<table>
<tr>
<td>between key personnel.</td>
<td>workshop more than others. Without careful facilitation of group dynamics, it was often easy for less powerful stakeholders to remain silent in meetings and subsequently lose interest.
Without a neutral facilitator or tutor to teach users how to use the GVT, it was easy for less informed or less computer literate stakeholders to feel left behind.</td>
</tr>
<tr>
<td>Outcomes
Strengths:

A 3D model that is able to be distributed freely to community
Influences changes to future community engagement strategy used by NRETAS and other agency staff
The model has been uploaded on several websites
Improved planning process
Agreed strategy to improve model outreach
Creation of a ‘living’ record that will be used. In focus groups, it was noted:
“It is a great initial platform – a permanent record it’s not a report that gets on the shelf and gets lost – people can come back and refer to this…”

Weaknesses:

Short term project timelines make it difficult to maintain relationships with people or ask them to invest in a project. Many times, people asked “Well you have started something good, but what do we do next.” The model is best built and delivered by a permanent staff member of a government agency or research institute who is able to maintain relationships.
Lack of follow up – with project deadlines, no one is employed to measure if the model is still being used in the future or answer any of the community’s questions around the model.
</td>
<td>Technical Quality
Strengths:

Community acceptance of technical quality
Integration of local and scientific knowledge

Weaknesses:

No surface water interactions were shown in the model, which represented a key concern to the community
Not all of the Howard East aquifer is represented affecting the credibility of the model or its ability to give a holistic view.
An interpretative manual is needed to guide users and this is the next step for the GVT’s development.
A lack of a web front page, users will have to go onto the site and download it for themselves. The file size is also too large for older computers.
Home computers may need a video card to make the model look its best and improve its operational speed.
Users downloading the model will need to have broadband internet connections rather than dial up.
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Conclusion

Overall, the research team spent over 120 hours consulting stakeholders and the broader community in the development of the Groundwater visualisation tool. Evaluations suggest that developing a GVT in consultation with a local community was useful for many reasons. Specifically, these were to bridge gaps in the consultation process; engender trust between stakeholders; and improve the common understanding of groundwater dynamics, limits to development, specifically how the drawdown and aquifer recharge interplay over time. An appropriate consultation process however needs to account for stakeholder communication preferences and requires an awareness of the interests and capacity of stakeholders to contribute to a GVT. Therefore we recommend an extended stakeholder analysis as a prerequisite for GVT development in order to ascertain whether this is an appropriate planning tool for a water planning process given that it is time and resource intensive.

6. Electronic Resources

URL: http://iwater.sci.qut.edu.au/

This web resource is owned and operated by the Groundwater Visualisation Unit at QUT. It provides a number of resources and links to past and current groundwater visualisation planned for a number of catchments across the Northern Territory and Queensland.

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Appendix A

Communication products used in GVT development

An invitation for Howard residents to attend a public meeting, is provided below to demonstrate the ‘theme’ designed for the Howard case study.

Appendix B

Participatory Mapping Exercise with Bore Drillers

Name	
Company	
Length of time drilling bores:	
Length of time drilling in the modelled area:	

Mapping exercise
For this exercise, topographical maps of scale 1:25 000 will be used that are up to date.

1. Mark the areas you have drilled previously

2. Using another colour, mark the areas that have potential for production in (a) in L/sec, (b) depth **for the dolomite (deeper) aquifer**.

3. If possible, using another colour, mark the areas that have potential for production in (a) in L/sec, (b) depth **for the cretaceous (shallow) aquifer**.

4. If possible, please indicate if there are 2 aquifers in the cretaceous layer? If so, where are they? Is there a shallow lateritic one (that is the red weathered material) and a deeper one (20-30 m??) that may be semi-confined?

Questions for drillers
A. Cretaceous formation (i.e. the upper sediments)

1. Are there one or two aquifers? (detail in what material)
2. Do the Cretaceous aquifer/s water levels drop by the end of the dry season?
3. What is the usual length of screens used?
4. In your opinion, is there leakage down bore casings from Cretaceous aquifer to dolomite aquifer?
5. What are typical yields from Cretaceous aquifer bores (L/sec)
6. Which lakes/lagoons are connected to Cretaceous aquifer, and which are not?
7. What is the condition of the Cretaceous aquifer (very good, good, fair, poor, stressed), at the end of the dry season?

B. Dolomite aquifer (the deeper confined one)

1. Where is the most productive zone in the aquifer?
2. What features produce the zones of high porosity (e.g. fractures, solution cavities, bedding, coarse grained material)?
3. Are there continuous zones of good porosity? Where are they?

4. What is the usual length of screens used?
5. Are all the bores under some pressure head (i.e. water rises up pipe)?
6. Does the pressure (potientiometric surface) decrease at the end of the dry season?
7. Where is the source of the dolomite aquifer recharge?
8. Which direction does the groundwater flow OR what is the direction of the gradient?
9. Where are springs that show dolomite discharge?

Finally, in your opinion, do you think the Cretaceous aquifer is showing signs of stress or can have more bores drilled into it?

Appendix C

Evaluation Focus Group for Howard East Participatory Groundwater Model
10th September, 1:30 – 2:45pm

Purpose:

To gain feedback from Howard East stakeholders and government agency staff on the following:

- Satisfaction with the final model (its ability to improve general understanding of groundwater systems)
- Satisfaction with the engagement process during the model's construction
- The model's influence on changes in thinking about groundwater systems
- Suggestions for improvements for the model, its utility or the engagement process

Attendees:

- Water Planner, Rural Darwin
- Head modeller, Rural Darwin
- Leading bore driller, Rural Darwin (community)
- Executive Officer, Recreational Fishing Group
- Researcher, Charles Darwin University
- Executive Officer and Development Officer (NT Hort. Assoc)
- Trish – Goyder Electorate
- David George, Power & Water Corporation

Facilitator – Sharna Nolan (CSIRO)
Observers – Malcolm Cox and Amy Hawke (GVU, QUT)
Note taker – Hannah Brodie-Hall, NT Communications and Engagement Officer, TRaCK

Resources Required:

- Classroom
- Whiteboard and markers
- Questionnaire handouts
- Digital voice recorder
- Notebook and pens
- Tea, coffee and cake

Agenda:

Introduction facilitator	10 minutes	Purpose of focus group Consent Objectives Any ground rules
Individual work	20 minutes	Participants fill out an open-ended questionnaire (see below). Answers remain confidential.
Group work	20-30 minutes	Sharna to facilitate open discussion, using questions and trigger points.
Summary facilitator	10-15 minutes	Gives each group member an opportunity for a concluding remark Outlines how feedback will be adopted in project/tool Outlines how people can stay in touch with project

Evaluating the Groundwater visualisation model: Review Questionnaire

This questionnaire has been designed to assist our final evaluation of the Groundwater visualisation model for the Howard East aquifer, undertaken as part of the 'Collaborative Water Planning Tools Project'.

Please take 15 minutes to complete the following questionnaire. Your answers will be used to evaluate the models utility, its engagement process and make suggestions that improve the process for future modelling and engagement processes. Your response will remain confidential.

1. The model aimed to create an educational tool to build understanding of groundwater resources among a wide audience. Do you think that the model clearly represents the characteristics of the groundwater system in the Howard East? Is there anything missing?

2. What three messages do you think a resident of the area would take away from an interaction with the model?

3. The project team tried to get the community involved in the modelling process using a number of different forms of communication, using face to face meetings, community meetings, workshops, emails, mail outs, website, newsletters, posters, radio show, sending reports etc.

Representing yourself and your stakeholder group, please comment on the forms of communication you found the most informative or convenient and why.

4. Are there any forms of communication that didn't work for you or could have been improved? Do you have suggestions for future models?

5. Has your understanding of other stakeholder's perspectives and interests changed as a result of this modelling process?

6. Has the fact that the model has been created by an independent group of modellers made you trust the model more or less? Please tell us why.

7. Is there any aspect of the model (content, presentation etc.) that you would change for use in a future water planning process? How?

Thank you for your time

By signing below, I acknowledge that my identity not be attributed to any of the responses given in this questionnaire. The responses may however be anonymously reproduced in a publication or tool kit to inform water planners in future projects or research.

Name: ____

Signature:____

Date:______________________

Talking points to facilitate discussion for evaluation of GWV model

The project team had 2 basic goals for the model:

- To build understanding of groundwater resources among a wide audience.
- To build trust among community members in the science behind models and help people to feel comfortable using them

Let's discuss the first point:

1. What do you like about the model? What don't you like? Was it easy to use? (Why)
2. Are there any messages or characteristics of the aquifer systems that you think could have been communicated more clearly?
3. Do you think some groups in Howard Springs will find this model more useful than others? Why or why not?
4. Finally, if you had to give the model a score out of ten to indicate how well it fulfilled its objective of being a useful educational tool (1 poor to 10 excellent), I'd like you to write it on this piece of paper and pass it back to me. I will tally them up after this meeting.

I'd like to move on to the second objective and explore how well the model has engaged the community and built trust in the model, its process or the science behind it.

1. Efforts were made to engage people in the community using a number of ways of communication. Is there any one method that appealed to you or made it easy to pass on news about the model?
2. Is there any method that didn't work for you?
3. Do you think that by trying to engage and inform the community about this models development, that people are more likely to use the model?
4. Do you think people are more likely to trust the model?
5. Has the fact that the model has been created by an independent group of modellers made any difference to the way people will perceive or trust the model?