SRDC Research Project Final Report

Title of the Project: **Building grower capacity to better understand and manage groundwater**

Project Reference Number: **BBF001**

Name(s) of the Research Organisation(s): **Burdekin Bowen Integrated Floodplain Management Advisory Committee**

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Australian Government
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UHWB Final Report - Recommendations for improved management of irrigation and groundwater

Background

The Upper Haughton Water Balance Study - *Building grower capacity to understand and better manage groundwater* commenced in July 2006 after growers expressed concerns at the rising groundwater table in the Burdekin River Irrigation Area (BRIA) and in particular the Upper Haughton sugar growing area (Figure 1). Several cane farmers approached BBIFMAC to develop a grower driven project to look at identifying and quantifying the groundwater rise in the area in order to raise awareness within the farming community of this issue.

The lower Burdekin region is part of the dry tropics, characterised by a short intense wet season usually occurring from January to March, where two-thirds of its annual rainfall occurs (Petheram et al., 2006). The average annual rainfall for Ayr is approximately 1000mm but is highly variable, ranging from 100mm to nearly 2000mm. In recent years annual rainfall has exceeded the long term average for the area, with 1055mm in 2007, 1280mm in 2008 and 1653mm to October 2009. Almost all of the rain in 2009 fell from January to April with the remainder of the year being very dry. 2009 is currently the second wettest year on record for Ayr.

The above average rainfall over the past 3 years has had a major influence on rising groundwater in the BRIA. Previous studies have shown that groundwater levels have remained relatively constant in the BRIA during dry years (since the area was opened to intensive irrigation in 1988), however in wetter than average years, groundwater levels have increased significantly (Petheram et al., 2006). Prior to intensive irrigation in the BRIA, groundwater levels would drop during dry years and rise in wet years. This indicates there has been a change in groundwater behaviour since excess water has been introduced to the system through farm irrigation and SunWater supply channels.

From looking at DERM records for various bores across the BRIA, this theory is supported, with most bores showing an upward trend since the area was opened to intensive irrigation in the late 1980's and early 1990's (PPK, 2001).

Results from the UHWB study have shown groundwater levels rising quickly and consistently, averaging 0.36m per year for the past two years. In some areas groundwater came to within 0.5m of the surface during the 2009 wet season. This poses numerous issues for landholders in this area, including lost production from water logging and the possibility of secondary salinisation in areas of poor water quality. This is currently only occurring in relatively small patches but if the rising trend is allowed to continue across the region, it could affect a much greater area and put the entire industry at risk, costing industry and landholders many millions of dollars and creating huge socio-economic problems.

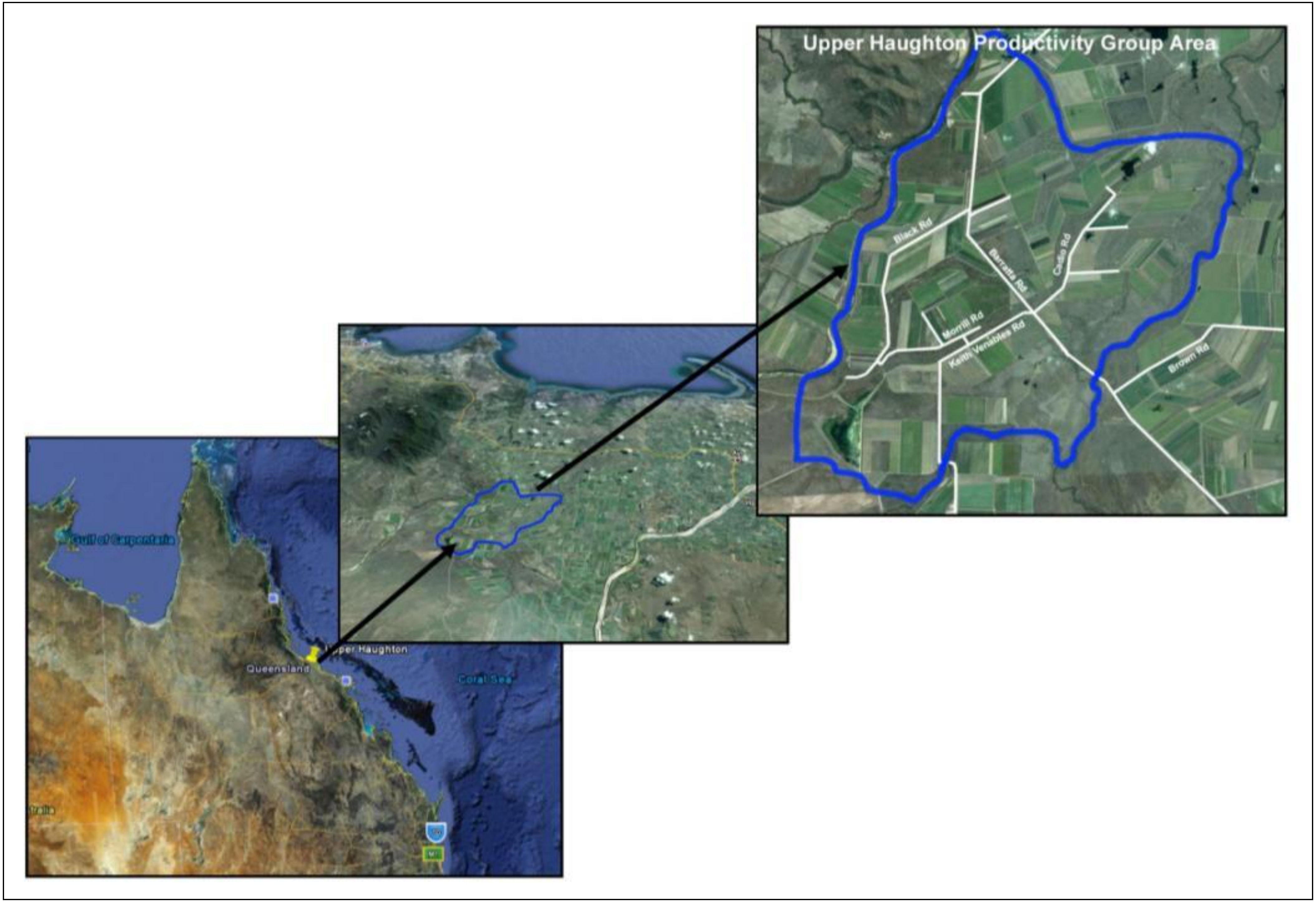


Figure 1. Upper Haughton Productivity Group - Area Map

Groundwater issues in the BRIA

The BRIA is a highly productive, intensively irrigated area in the lower Burdekin floodplain. It is characterised by heavy cracking clay soils and sodic duplexes (Shannon and Raine, 1996). The area under irrigation in the BRIA is estimated to be around 40,000ha of which the majority is furrow irrigated sugarcane. There is a small percentage of horticulture, cotton and grain cropping in the area and some farmers utilise trickle irrigation (mostly in horticulture) and overhead low pressure sprinkler systems (cane, horticulture, grains, cotton).

The Burdekin Haughton Water Supply Scheme (BHWSS) supplies irrigation water to the area, which is pumped from storages in the Burdekin River through predominately open channels. This scheme is managed by SunWater.

In many areas of the BRIA there is very little groundwater extracted for irrigation. There are several reasons for this, including:

- Many areas do not yield commercial quantities of groundwater due to heavy soil types resulting in low hydraulic conductivity.
- Groundwater quality is an issue for many areas of the BRIA with high salinity areas requiring water to be mixed with channel water before being used for irrigation.
- Using saline groundwater can add to the sodicity of soils and further increase infiltration of irrigation water to the water table, making irrigation less efficient and affecting productivity.
- SunWater’s pricing policy means extracting groundwater is more costly than using channel water and does not encourage efficient water use.
- DERM’s conjunctive use policy only allows 1 part groundwater to be used to every 8 parts channel water. However this policy has been relaxed somewhat in response to the rising water table.
- The inhibitive cost of installing new bores and pumping infrastructure limits groundwater use in areas where it is viable.

The issue of rising groundwater has been acknowledged by all stakeholders for many years but due to several factors little is yet to be done about it, with the blame often being passed from one stakeholder to the next. There have been numerous studies and papers commissioned over the past decade on the issue. These studies have all produced similar recommendations for action, however little action is yet to be taken in regards to sustainably managing the water resources of the area.

It seems the problem is well known, the actions to be taken are well described, there is consensus from all parties that action is needed immediately, but there has been a lack of coordination or commitment to taking the first step. Without a concerted effort from all parties to rectify the problem it will soon become a much more expensive and potentially crippling problem for landholders in the BRIA.

Some actions for tackling the groundwater problem in the BRIA have now commenced but most are still in their infancy. These include:

- The BRIA irrigators Committee, in partnership with CANEGROWERS and BSES, are conducting a study to develop a set of recommendations for growers on irrigation applications and scheduling. This study is performing SIRMOD modelling on several representative soil types to identify the optimum irrigation methods for BRIA farms in an aim to reduce deep drainage to the aquifer. It is also looking at automation of furrow irrigation to improve efficiencies and reduce labour costs.

- The Lower Burdekin Groundwater Science Plan has recently been released which outlines the steps needed to be taken to create a sustainable groundwater system for the Lower Burdekin. The plan was developed over a series of meetings involving all relevant stakeholders from the region, including BBIFMAC. This plan will be used to help attract further funding for projects to help better understand and implement activities to improve the health of the system.
- DAVCO has commenced their project - Managed Utilisation of Saline Groundwater to Control Rising Water Tables. This project is utilising existing and new production bores to pump large volumes of groundwater for irrigation purposes in an effort to stem the rising groundwater table. The groundwater pumping commenced in May 2009.

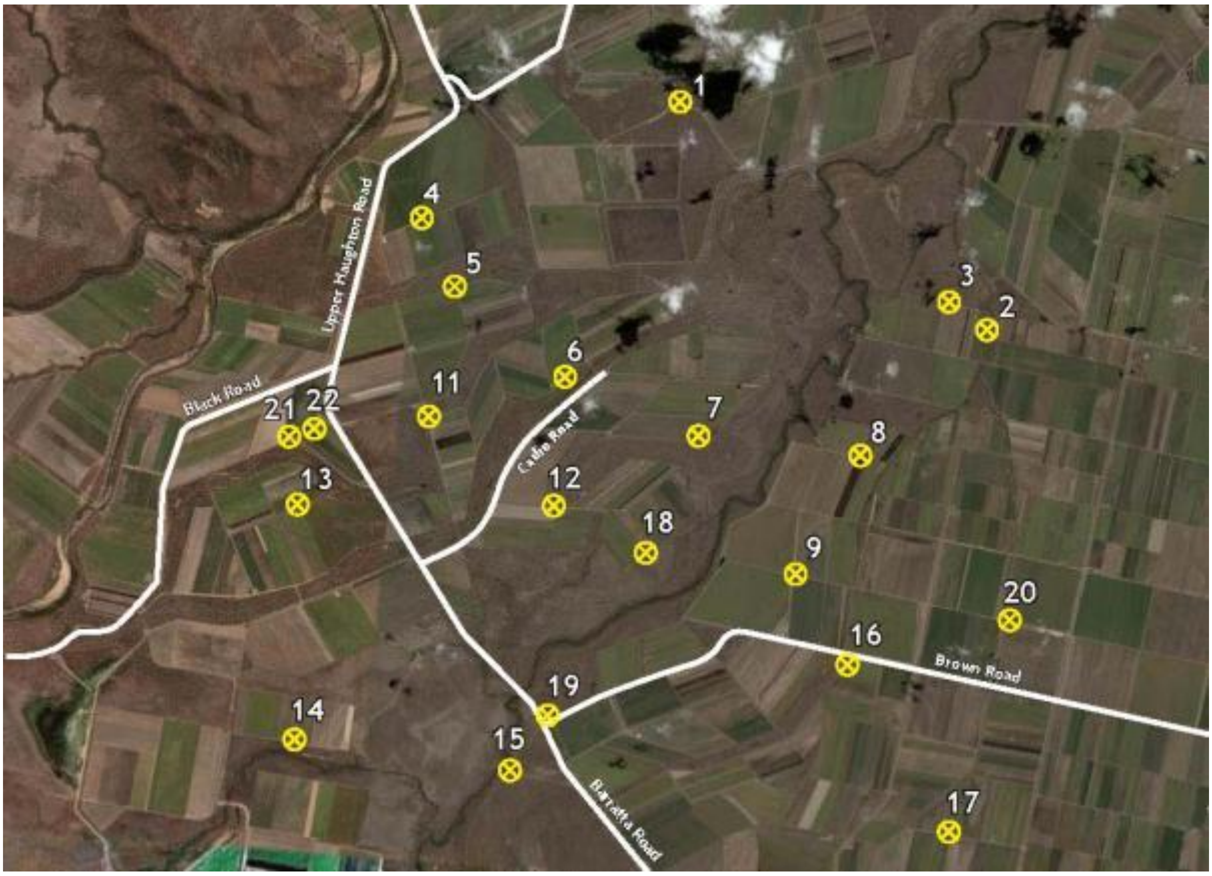
Other efforts have been made in the past to encourage growers to increase their groundwater usage, such as providing incentives to install production bores, with little success.

The Upper Haughton Water Balance Study

In 2006 the local farming community identified a need to monitor and evaluate the rising water table before it became a major issue in their area and try to identify the influence of various contributors to the system so it can best be managed. This is the purpose of the Upper Haughton Water Balance Study - *Building grower capacity to understand and better manage groundwater.*

Groundwater levels in the Upper Haughton area have been identified as rising rapidly in recent years with levels rising close to 1m per year in some areas. Prior to this study little was known about the behaviour of the shallow aquifer in the BRIA. Most of the groundwater data being collected by DERM is only measured on a bimonthly or quarterly basis. This meant that subtle changes in the groundwater level, especially over the wet season, may not be detected due to the sampling frequency.

The installation of 20 shallow piezometers in the Upper Haughton area (Figure 2) allowed farmers to gain a better understanding of the behaviour of the shallow aquifer and identify contributions to the rising groundwater table. In addition to regular manual readings of groundwater height, several of the piezometers had automatic loggers installed to allow closer evaluation of the groundwater behaviour. This was especially important throughout the wet season when access to the piezometers was limited for several months at a time.



Methodology

Project initiation

The project was initiated by the Upper Haughton CPI group as a response to DERM information on groundwater levels and quality in their area. The growers identified the need to work with DERM to identify sites and learn the protocols for piezometer installation and data collection.

A steering committee was formed for the project which involved 3 growers from the Upper Haughton area as well as the BBIFMAC Project Manager.

BBIFMAC was approached to help manage the project and take on the role of increasing the understanding of the wider community of the groundwater issues in the BRIA. Project data collection, reporting and promotion of the project were managed through BBIFMAC.

The project aims were to:

- Identify potential salinity problems,
- Identify changes in groundwater levels,
- Create a model of the aquifer for the Upper Haughton area from the data collected, and
- Provide grower information and resources to better manage groundwater.

BSES Ltd and CSIRO were involved in the project through assisting growers develop on-farm irrigation improvement programs that aim to reduce infield deep drainage. This included modelling through the SIRMOD application and various on-farm extension activities.

Rob Lait from Australasian Groundwater and Environmental (AGE) Consultants was contracted to analyse the existing groundwater data in the Upper Haughton area to allow a better understanding of its behaviour. AGE, in partnership with the local growers, identified sites suitable for installation of piezometers and used the available science and local knowledge to identify where the most likely recharge areas were located. Ayr Boring Company was contracted to sink the 22 piezometers to the DERM standards.

Data collection and management

The growers in the steering committee were provide with groundwater monitoring kits and trained in monitoring groundwater height and quality according to DERM protocols. One of these growers took on the role of measuring the piezometers approximately each fortnight for height and salinity. Presentations were done on a regular basis at CPI meetings to keep the region informed of how the project was progressing. Project progress was also presented at BBIFMAC general meetings on a regular basis.

After a year of monitoring AGE was asked to review and analyse the data collected for the project and develop a numerical model to improve the knowledge of growers and industry in the local area to help them plan for the future. Once the draft report was completed it was passed onto the Project Manager who communicated it to all project stakeholders and asked for comments on the draft report. Comments were then reported back to AGE who were expected to complete the final version prior to the project end date. However this is yet to be done and is unlikely to be completed until mid 2010.

The BBIFMAC website was developed to present groundwater information to stakeholders and the wider community. The website has been displaying the results from the project since August 2008. Graphs of groundwater AHD heights from each piezometer are updated after each monitoring date. Project updates, photos, and a video of a lysimeter installation are also on the Upper Haughton project page on the website.

Piezometer 10 was damaged early in the project and was not able to be repaired so was not used in this study. Piezometer 19 was monitored on each occasion but has never had water in it so was not included in the analysis.

<u>Results</u>

Piezometers

Most of the shallow aquifer bores show a similar trend in groundwater behaviour. Most bores show a rapid response to rainfall during the wet season with a sharp rise in water levels followed by a slow decline throughout the dry season. In 75% of bores, groundwater levels are significantly higher (> 15cm increase per year) than the previous year, indicating a rising water table. In 15% of bores there was no significant change to groundwater levels over the two year period and in 10% of bores there was a lowering of the water table. On average groundwater levels rose by 0.36m per year over the two years when levels were compared in late August/early September (Table 1).

Figure 2 shows the two year change in groundwater heights from late August 2007 to early September 2009. Figure 3 shows the groundwater heights and AHD heights (height above sea level) for the piezometers in October 2009. The August - October period was chosen for making comparisons as it falls toward the end of the usually predictable dry season where groundwater levels have had time to settle after the wet season deluge. This allows a more accurate depiction when comparing annual groundwater levels. As can be seen from the piezometer graphs in figure 4, wet season measurements can fluctuate wildly.

The maps in figures 2 and 3 show clear trends in groundwater behaviour, including:

- Groundwater is rising over much of the area with the exception of a small pocket in the western area comprising piezometers 11, 13, 21 and 22. This area shows a slowly falling trend (Figure 2).
- Piezometers on the western side of Barratta creek (which runs down the middle of the map) are rising more sharply on average than those on the eastern side (with the exception of the small pocket mentioned previously), with the largest rises seen in piezometers 1, 6, 7 and 18 (Figure 2).
- AHD heights show a large bulge around piezometers 11, 13, 21 and 22 where levels are close to the surface (Figure 3). This coincides with the only area that is showing a falling trend (Figure 2), indicating the aquifer is at capacity in this area and groundwater is escaping as surface water via adjacent drainage channels and creeks.
- In bores where the groundwater level is lower, a more rapid rise has been observed with most of the deeper bores rising over 1m during the two year period (Figure 3 - piezometers 1, 4, 6, 7, 15, 17 and 18). This may indicate the aquifer in these areas is not yet saturated and is still filling.
- Piezometer 2 shows a localised bulge, when compared to piezometer 3, which is nearby (Figure 3). Piezometer 2 is located adjacent to a natural drain that is constantly flowing with tail water. The bulge may be indicating the drain is providing a recharge point to the groundwater in this area.
- 55% of piezometers are within 4m of the surface and 20% or bores are within 2m of the surface (Figure 3). This is concerning considering the rate of groundwater rise across the area.

The fact that levels are rising slower on the eastern side of Barratta creek may be linked to the fact that there is more groundwater extracted on the eastern side than the west, especially from the Mona Park area.

Table 1 shows the average change in groundwater height was 0.36m per year and was consistent across two years. If this trend were to continue levels would rise 3.6m in the next 10 years meaning more than half the bores would be at, or close to, the surface within the next 5 to 10 years. Although there has been above average rainfall for the past 3 years, and it is unlikely levels would rise as significantly in dryer years, this figure is still very concerning for landholders and industry involved in the area.

During the wet season several bores also show sharp increases in groundwater levels which drop slowly during the dry season. Piezometers 1, 4, 6 and 7 showed spikes of 2m or more during the 2009 wet season, with most of the other bores rising more than 1m for a short period of time (Figure 4).

Figure 5 shows the electrical conductivity (EC) changes over two years. Electrical conductivity is a measure of salt in the groundwater. Values above 1.5ms/cm are considered detrimental to sugarcane production.

The majority of the area has relatively low salinity with a few patches recording high EC values. There is no clear trend evident, but there is a tendency for higher values around the central Barratta area and also in piezometers 13 and 21 to the west, which show the highest readings.

The majority of piezometers show little change in EC over the two year period with only 15% showing a significant increase and 15% showing a decrease. Piezometer 4 displayed the largest change in EC going from 4.7ms/cm in 2007 to 1.8ms/cm in 2009.

Only 20% of the piezometers currently exceed the productivity threshold for sugarcane of 1.5ms/cm.

Table 1: Yearly groundwater height changes - 2007-2009

	Sept 07 - Sept 08	Sept 08 - Sept 09	Two years combined
Average change in groundwater height	+ 0.35m	+ 0.36m	+ 0.71m
Largest rise	+ 0.99m (Piezo 1)	+ 1.01m (Piezo 6)	+ 1.68m (Piezo 6)
Largest drop	- 0.27m (Piezo 13)	- 0.50m (Piezo 22)	- 0.33m (Piezo 13 + 22)

Figure 2: Two year change in piezometer height – September 2007 – September 2009.

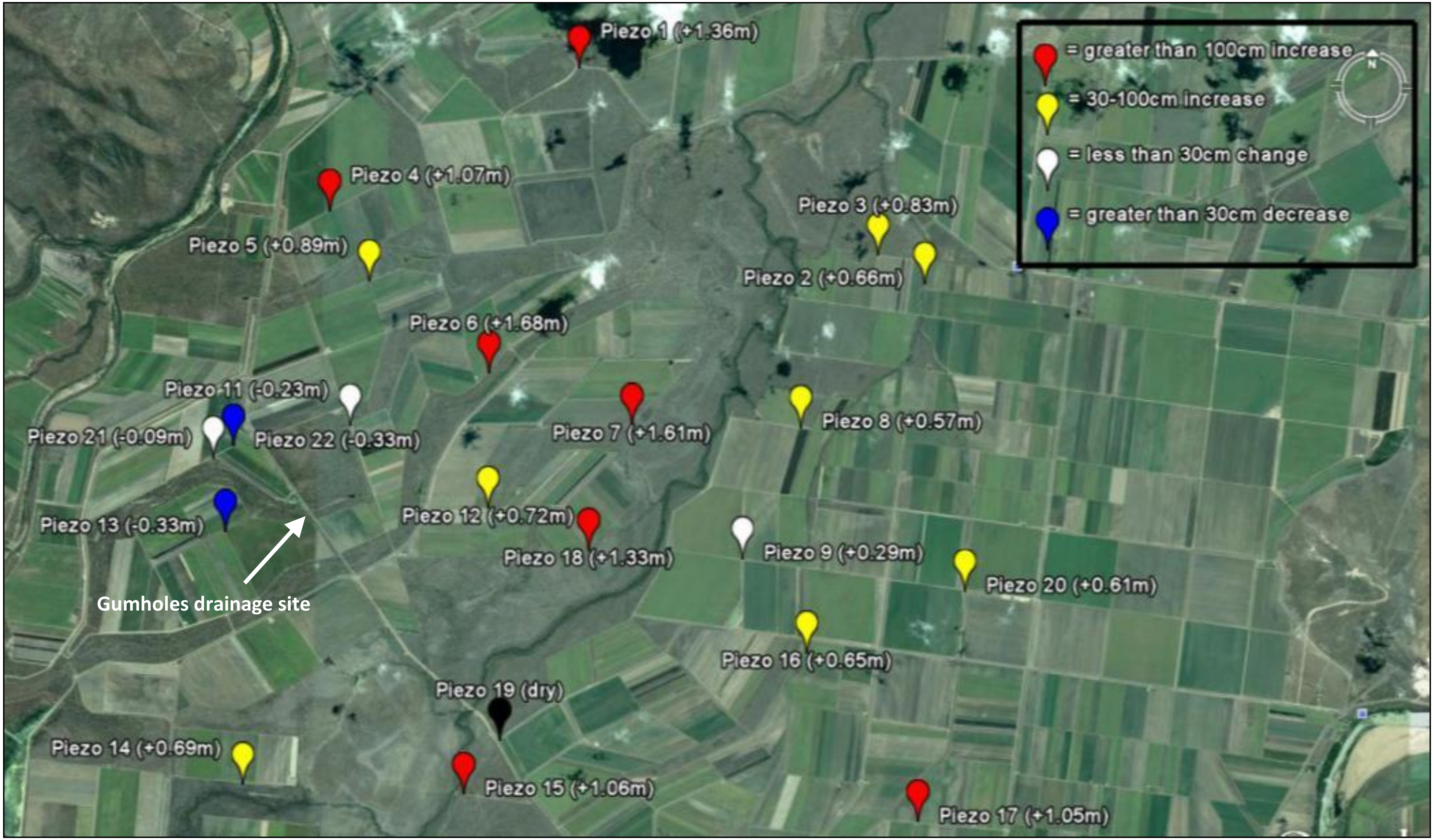


Figure 3: Groundwater heights below surface and AHD heights (height above sea level) for October 2009 for all piezometers (AHD heights in brackets).

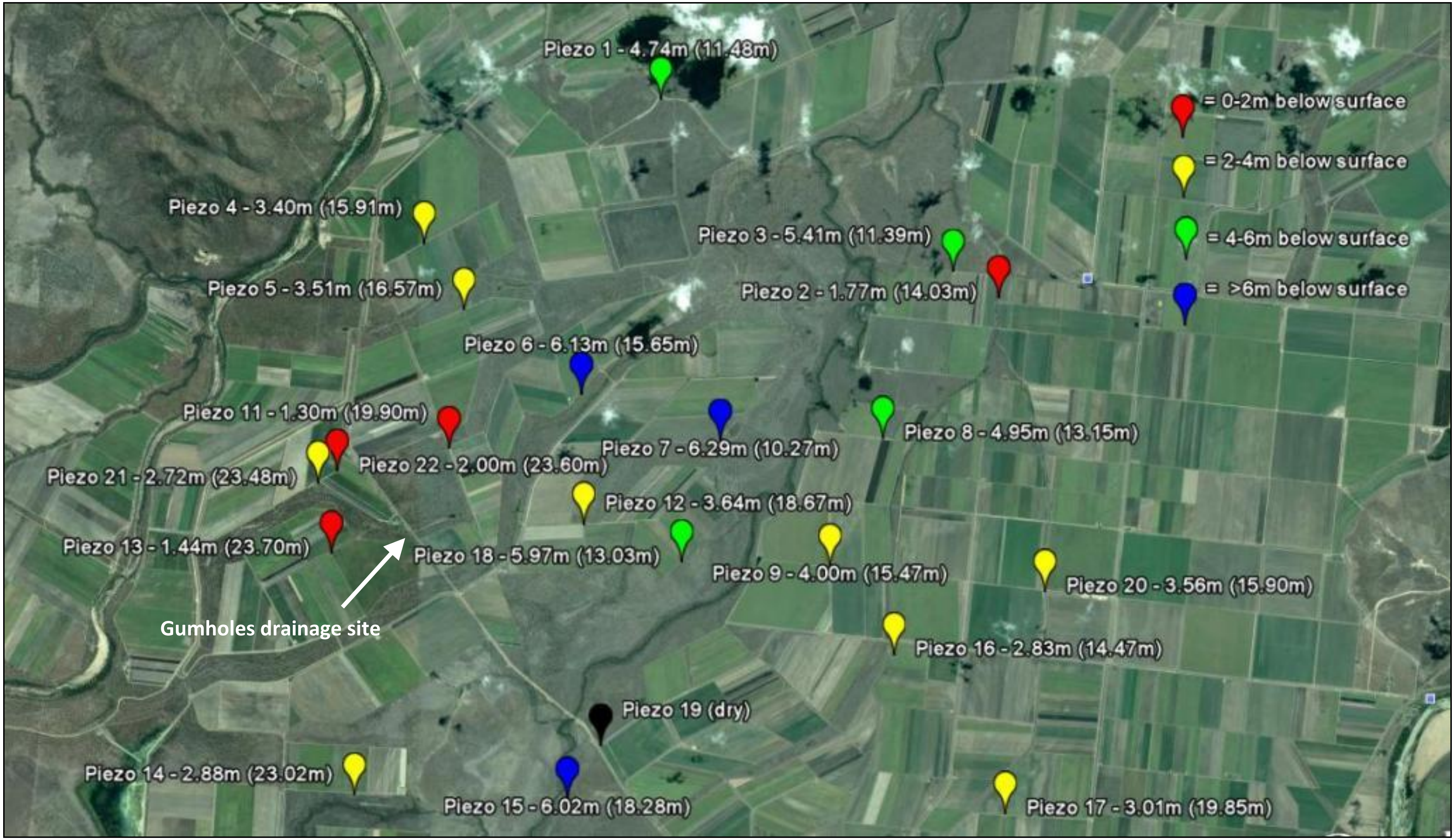
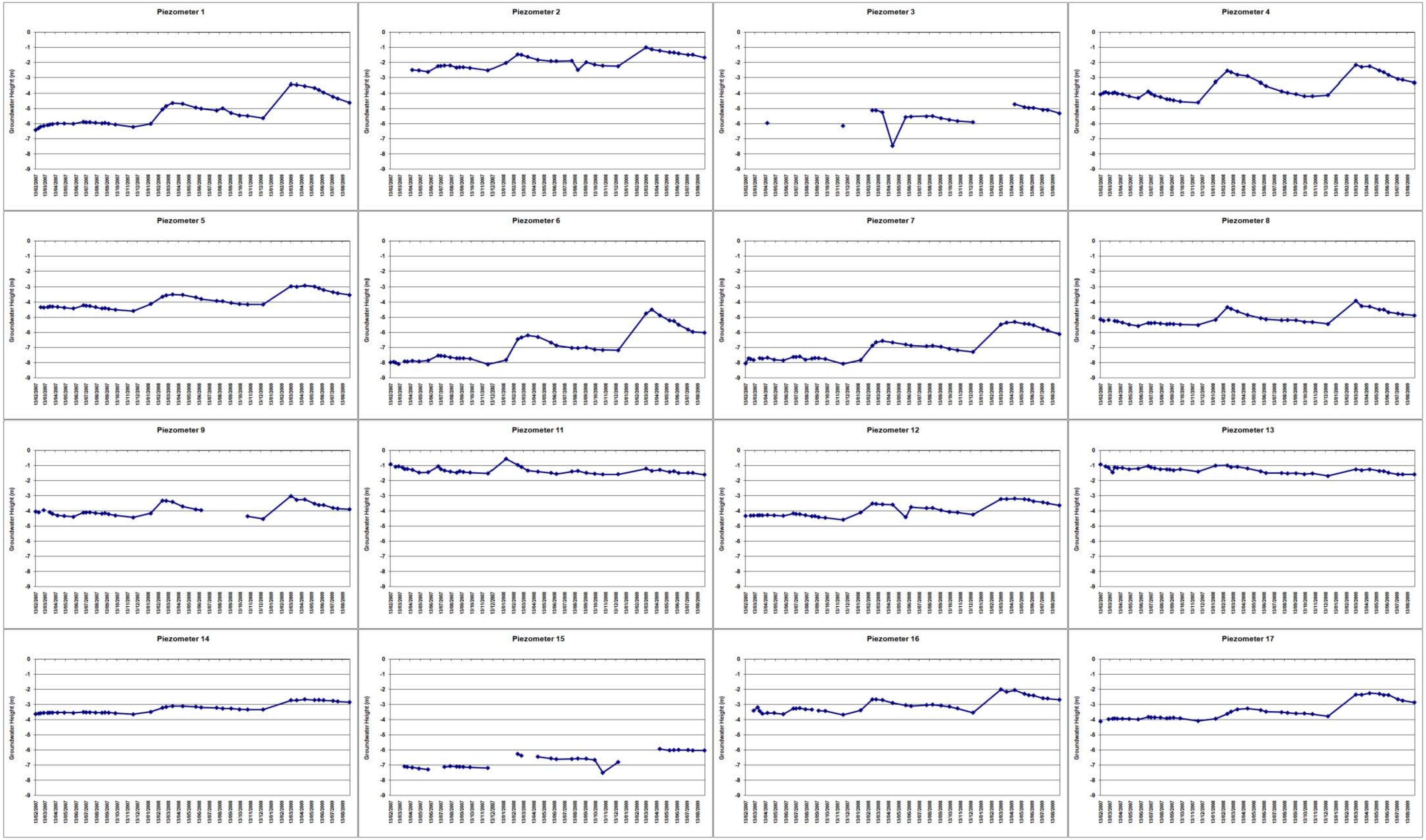
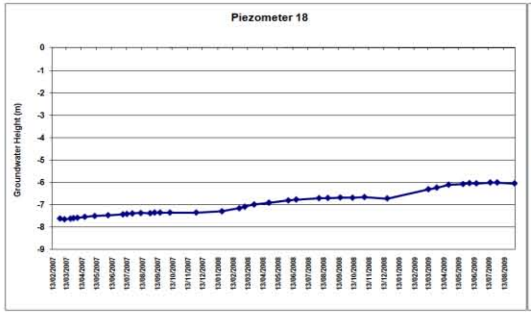


Figure 4: Groundwater height measurements from surface for each piezometer from February 2007 to October 2009. Each graph is on the same scale with the top being the surface (0m) down to 9m.




Piezometer 18
Groundwater Height (m)
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
13/02/2007
13/03/2007
13/04/2007
13/05/2007
13/06/2007
13/07/2007
13/08/2007
13/09/2007
13/10/2007
13/11/2007
13/12/2007
13/01/2008
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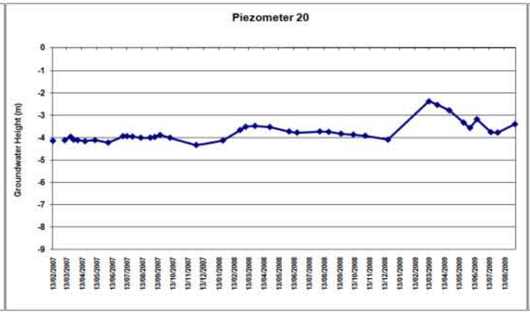
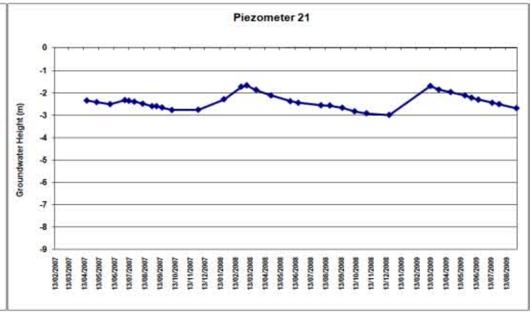

Piezometer 20
Groundwater Height (m)


Piezometer 21
Groundwater Height (m)

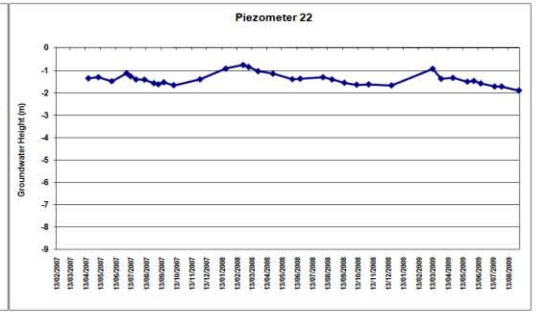
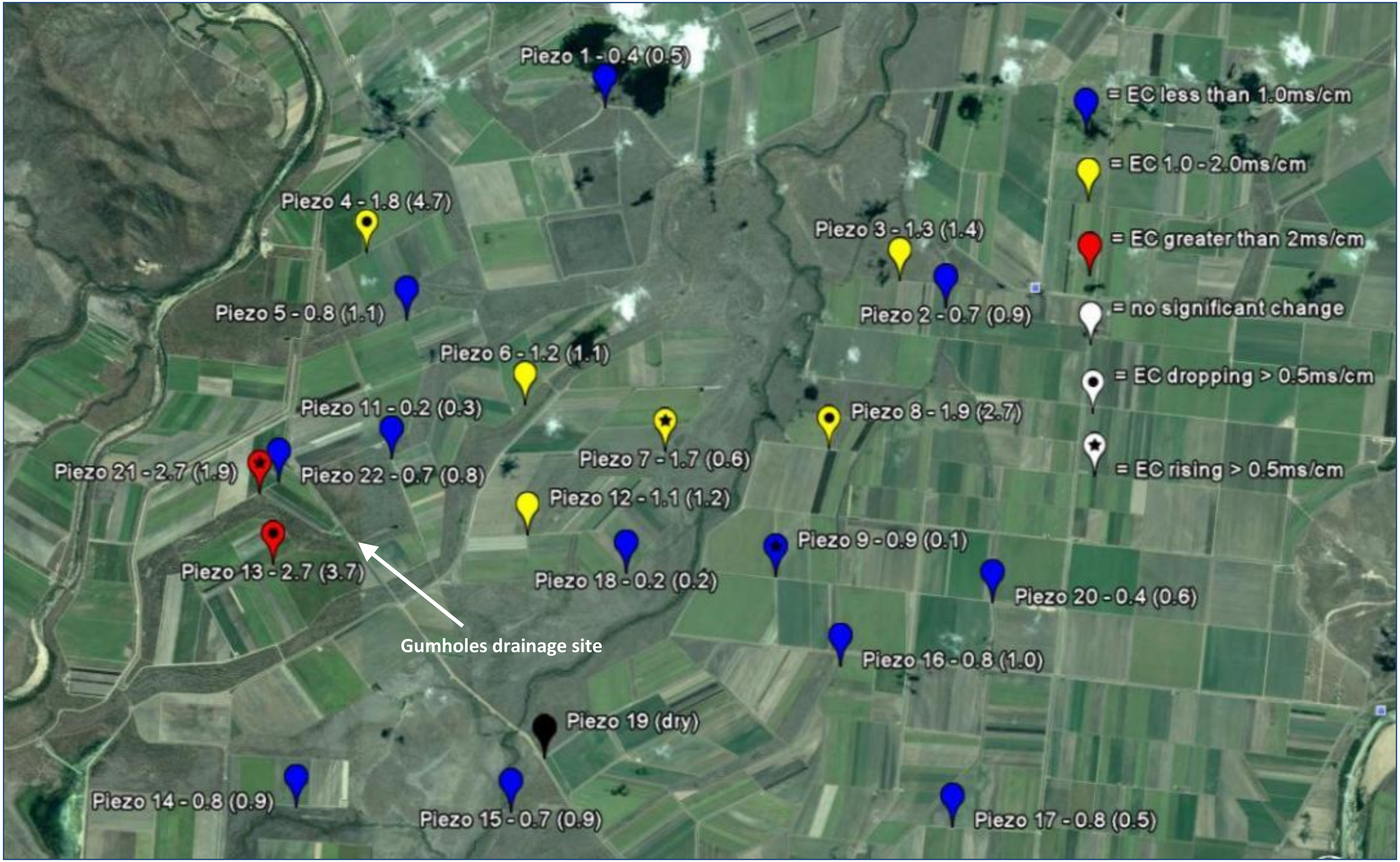

Piezometer 22
Groundwater Height (m)

Figure 5: Two year change in Electrical Conductivity – October 2007 – October 2009. The first number represents the EC for October 2009 and the number in brackets is the EC for October 2007.



Automatic height data loggers

The odyssey water height automatic data loggers proved to be a valuable asset to the project. Most of the loggers were placed in DERM bores as these were monitored less regularly than the project bores. This allowed us to gain a better understanding of groundwater behaviour across a greater number of bores.

Three of the project piezometers had odyssey loggers inserted. The loggers recorded groundwater height at 1 hour intervals which allowed a much closer look at groundwater behaviour than the fortnightly manual monitoring. It also helped to verify the sampling frequency was sufficient to evaluate the changes in groundwater heights.

Graphs 1 and 2 show the odyssey data from Bores 21 and 22 compared to the manual readings for groundwater height.

Bore 21 shows there was little difference between the manual readings and the auto loggers other than a small amount of data missed during the 2009 wet season, where no readings were collected for over 3 months due to the inaccessibility of the bores (Graph 1). During this time the water level went above the logger, meaning it was also ineffective in recording groundwater levels through much of this period. This could be counteracted by installing loggers with longer measuring cords.

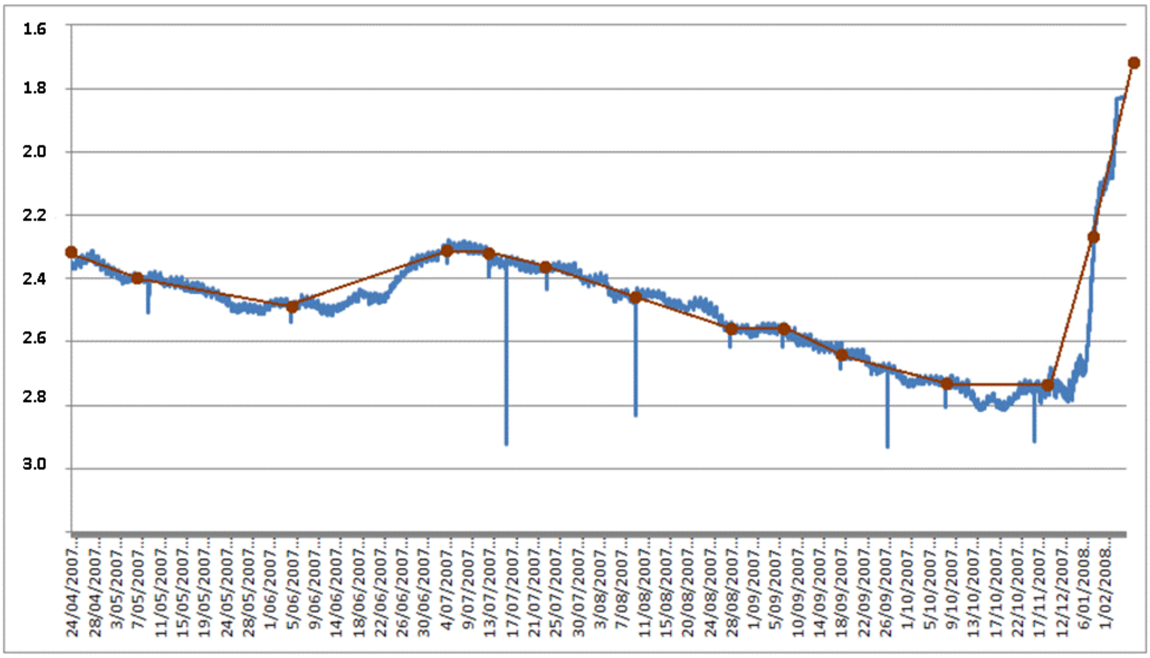
Bore 22 shows significant changes occurred throughout the auto logger recording period that were not picked up by the manual measurements (Graph 2). Most of the peaks missed by manual readings can be attributed to rainfall events where the bore was inaccessible. However, some of the smaller peaks, especially after April 2009, cannot be attributed to rainfall and must be from another source such as irrigation deep drainage or leakage from adjacent areas or water storages. Closer examination of water management in areas adjacent to bores containing auto loggers could yield a better understanding of the influences to the groundwater levels in dry periods such as is currently being experienced.

Graph 2a shows that during the 2009 wet season groundwater levels were very close to the surface and for a short period of time, exceeded the level of the auto logger at approximately 0.4m. The shallowest manual reading recorded was on 13th March 2009 of 0.9m below the surface. Thus there is a large gap between the graph for the manual recordings and the data logger. This emphasises the effectiveness of the data loggers to record valuable information when access to the area is not possible.

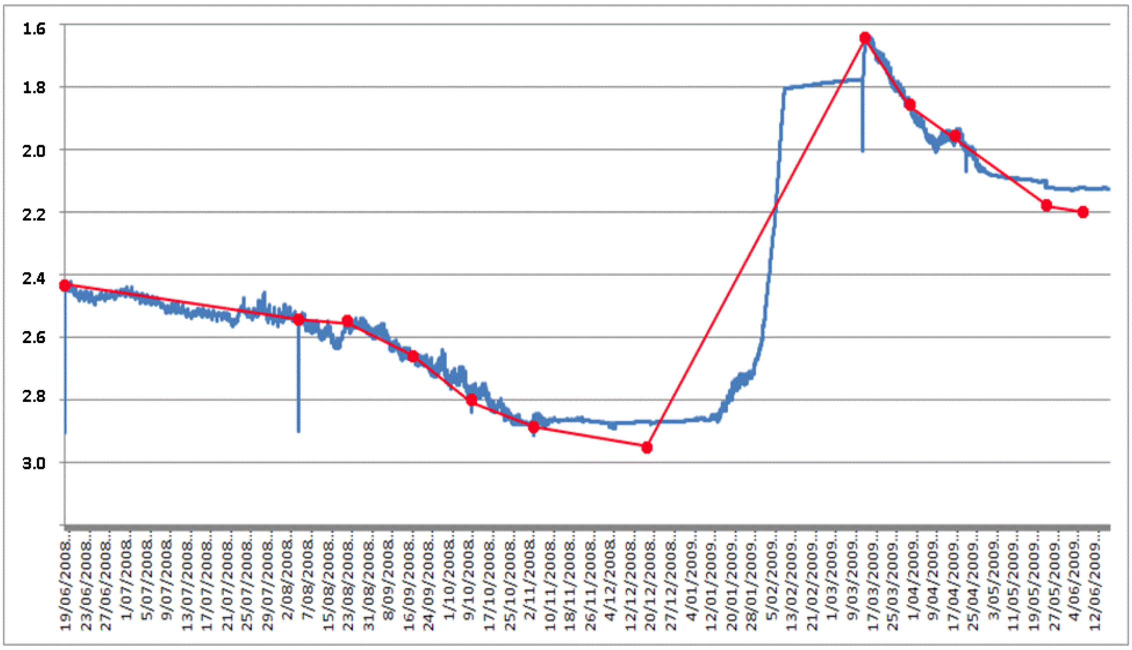
Unfortunately some of the odyssey data was lost between February 2008 and June 2008 in bores 21 and 22 as well as several other bores.

Graph 1: Bore 21 - Odyssey logger data (blue) vs manual recording (red) (y-axis shows height below surface)

a) **24/4/07 to 25/2/08**

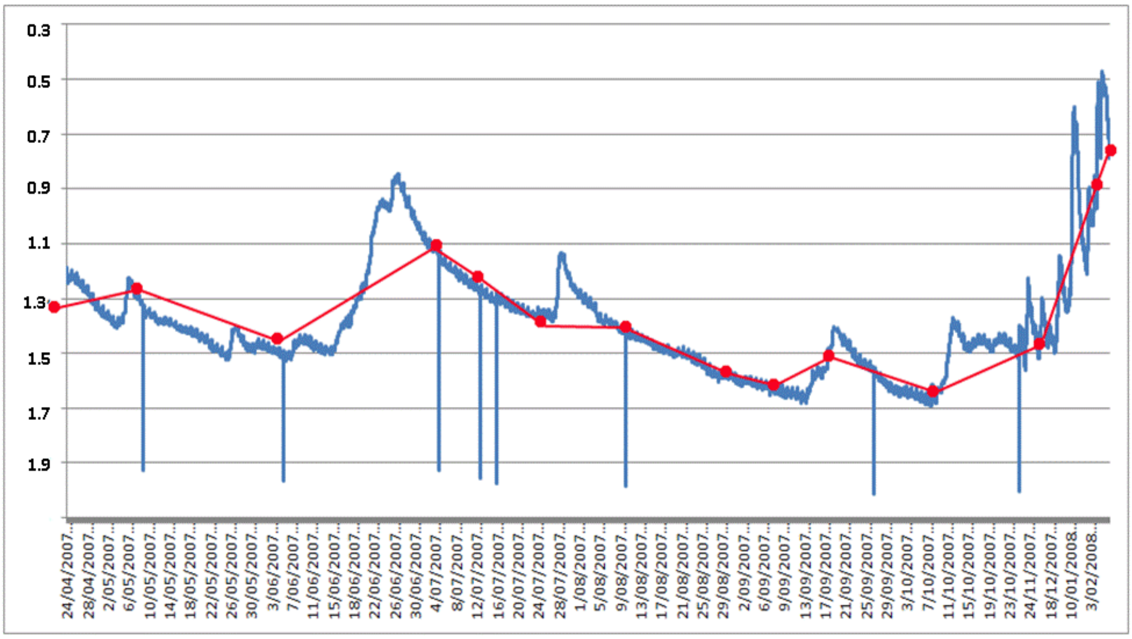


b) **19/6/08 to 11/6/09**

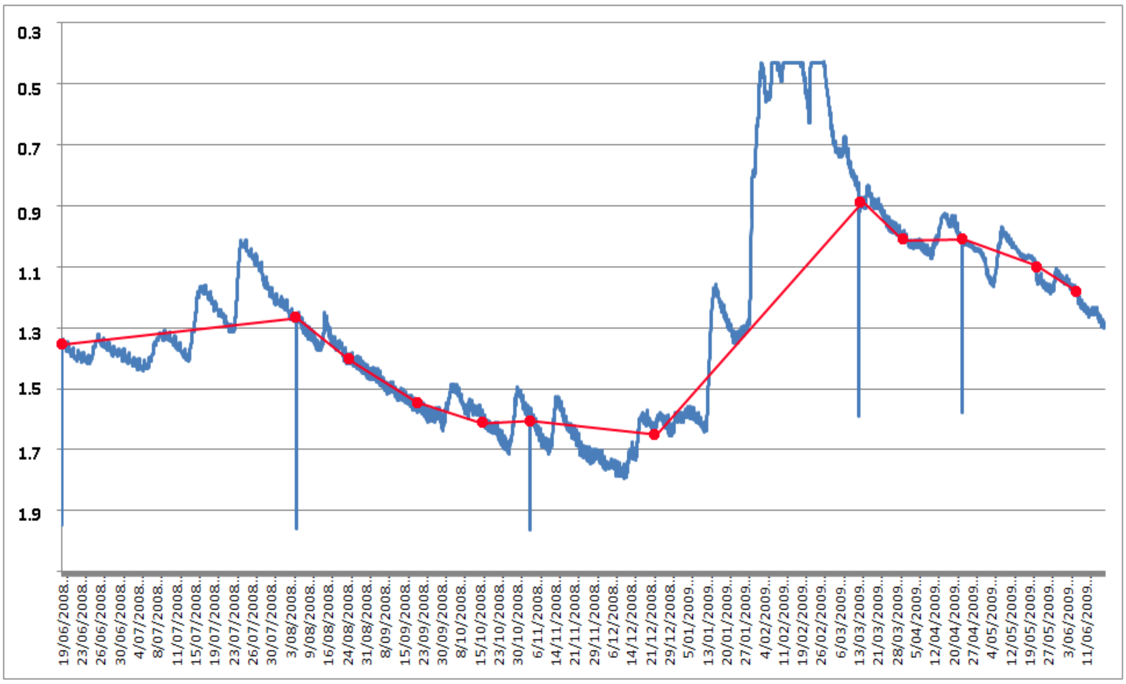


Graph 2: Bore 22 - Odyssey logger data (blue) vs manual recording (red) (y-axis shows height below surface)

a) 24/4/07 to 25/2/08



b) 19/6/08 to 11/6/09



AGE model report

AGE released the draft version of the model report in April 2009. The report was very technical and modelled the groundwater behaviour in the BRIA area using the data from the UHWB project along with DERM's historical data. Some of the relevant information from the model is included in this report.

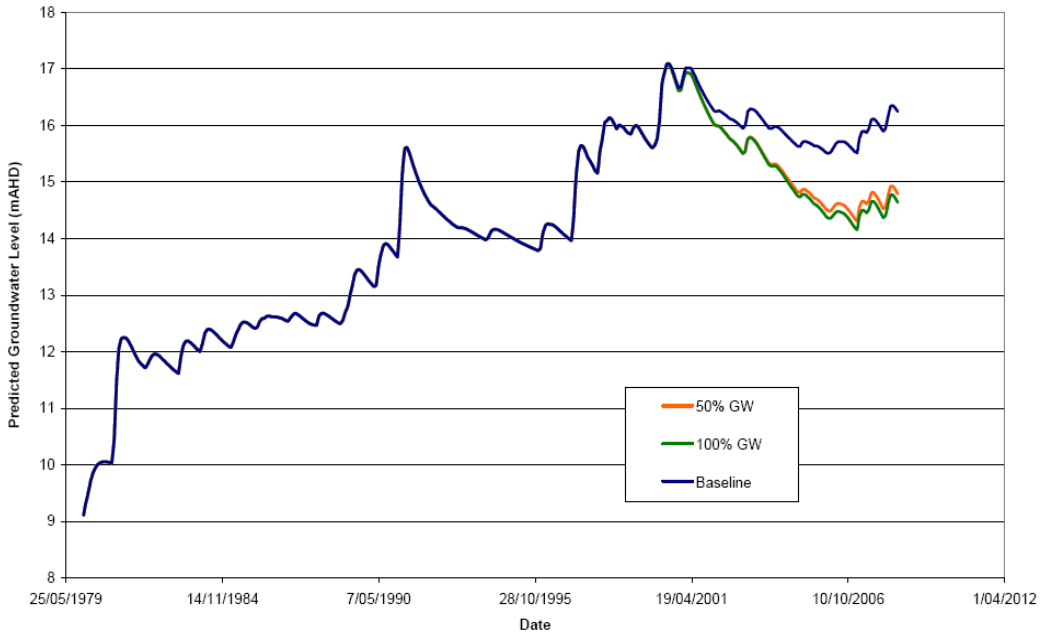
The AGE report was supposed to run several scenarios that model the behaviour of the groundwater if a certain management practice change occurred. The two scenarios used were unrealistic for the Upper Haughton area and thus provide little value to the report. The scenarios looked at the effect on the water table if all farms in the study area utilised 100% and 50% groundwater in place of surface water. This was modelled as if the extractions were taking place from 2000, so presents a "what if" type scenario based on historical data.

Due to the low soil porosity in much of the Upper Haughton area these extraction rates are not possible. Therefore the scenarios are flawed and provide little value. BBIFMAC has approached AGE about this issue and has suggested some more appropriate scenarios to be run in the final version of the report.

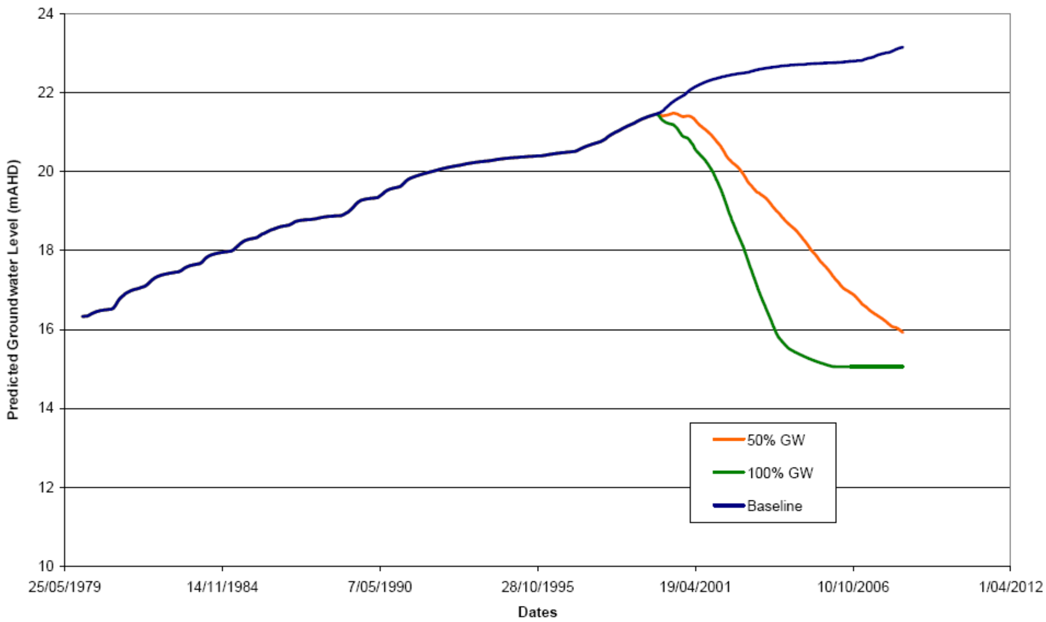
Graph 1 shows the hydrograph for Bore 4, with the predicted effect on the groundwater level if groundwater was used for irrigation at 50% and 100%. The blue line is the actual water level, with the green and red lines showing the effect of 50% and 100% groundwater pumping for irrigation respectively. The same is seen in Graph 2 for Bore 13.

The difference in behaviour of the two bores can be explained by the differences in connectivity between the deep and shallow aquifers. Bore 13 shows good connectivity between the aquifers indicated by the steepness of the drawdown. The flattening of the red line in bore 13 indicates the shallow aquifer is becoming desaturated.

Graph 1: Bore 4 hydrograph showing the effect of utilising 50% and 100% groundwater for irrigation.



Graph 2: Bore 13 hydrograph showing the effect of utilising 50% and 100% groundwater for irrigation.



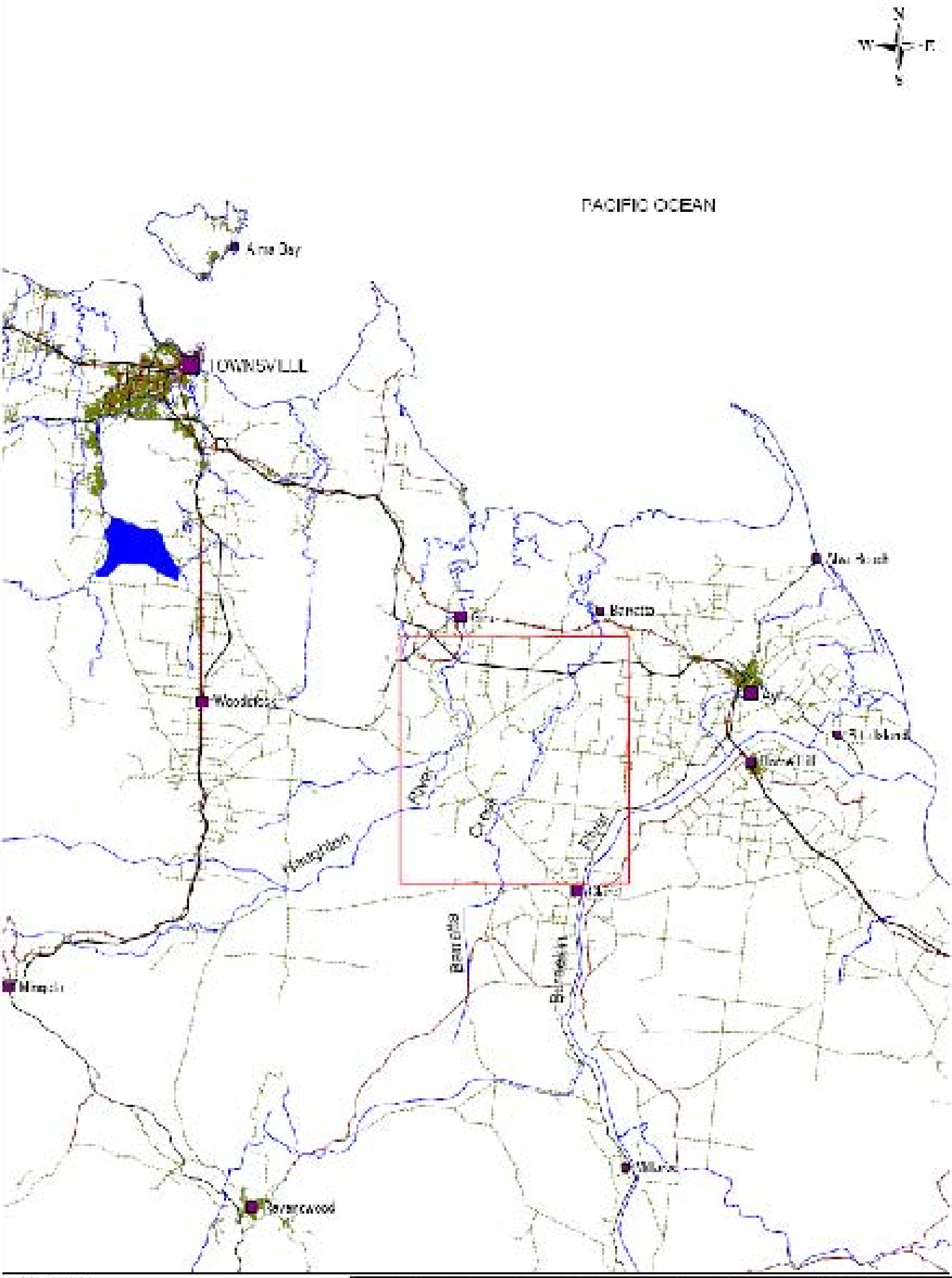
The model also provides several maps of the area displaying different characteristics. Figure 6 shows the study area for the modelling exercise. Figure 7 displays the contours for the shallow and deep aquifers. The Upper Haughton area is located in the middle to lower left of the map. This area shows some elevated areas in both the shallow and deep aquifers.

Figure 8 shows the hydraulic conductance for the shallow and deep aquifers. This refers to the ease at which water can be extracted from the ground. It is obvious that most of the Upper Haughton area has limited conductance as shown by the lighter areas. Closer to the coast there is greater conductance which is consistent with the use of groundwater in these areas.

Figure 9 demonstrates the modelling of the two scenarios and shows the predicted change in groundwater height if 50% and 100% groundwater was used for irrigation for the farms highlighted in figure 9a.

Although figure 9 shows some impressive reductions in groundwater levels through the pumping of groundwater for irrigation, this is practically impossible due to the low extraction rates possible across the area.

Figure 6: Map of study area for AGE report



LEGEND

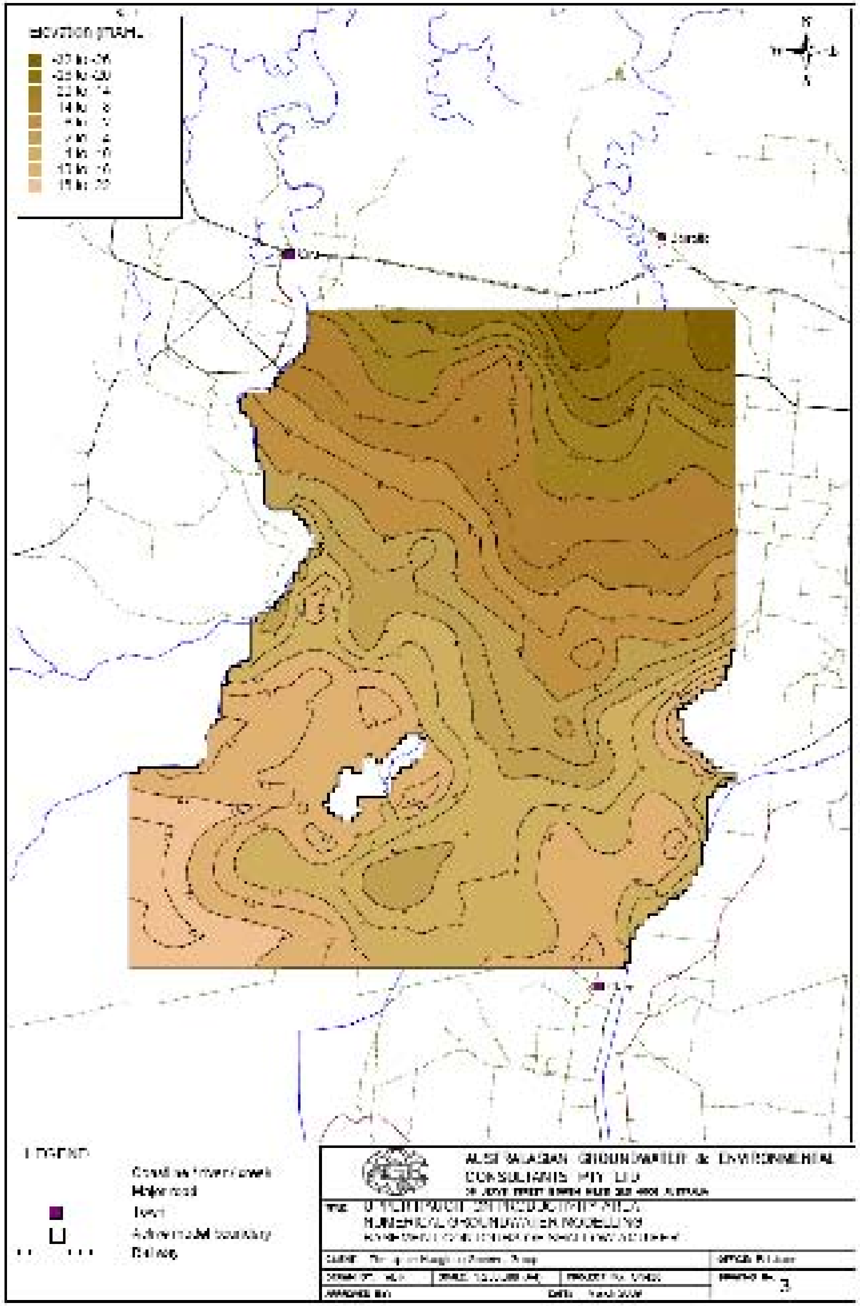
	Coastline / river / creek
	Major road
	Town
	Study boundary

AUSTRALASIAN GROUNDWATER & ENVIRONMENTAL CONSULTANTS PTY LTD

TITLE: UPPER HAUGHTON PRODUCTIVITY AREA
NUMERICAL GROUNDWATER MODELLING
LOCALITY MAP OF UPPER HAUGHTON PROJECT AREA

CLIENT: The Upper Haughton Steering Group			
DRAWN BY:	SCALE:	PROJECT No:	DRAWING No: 1
APPROVED BY:		DATE: March 2007	

Figure 7: Contour maps of a) the shallow aquifer, and b) the deep aquifer



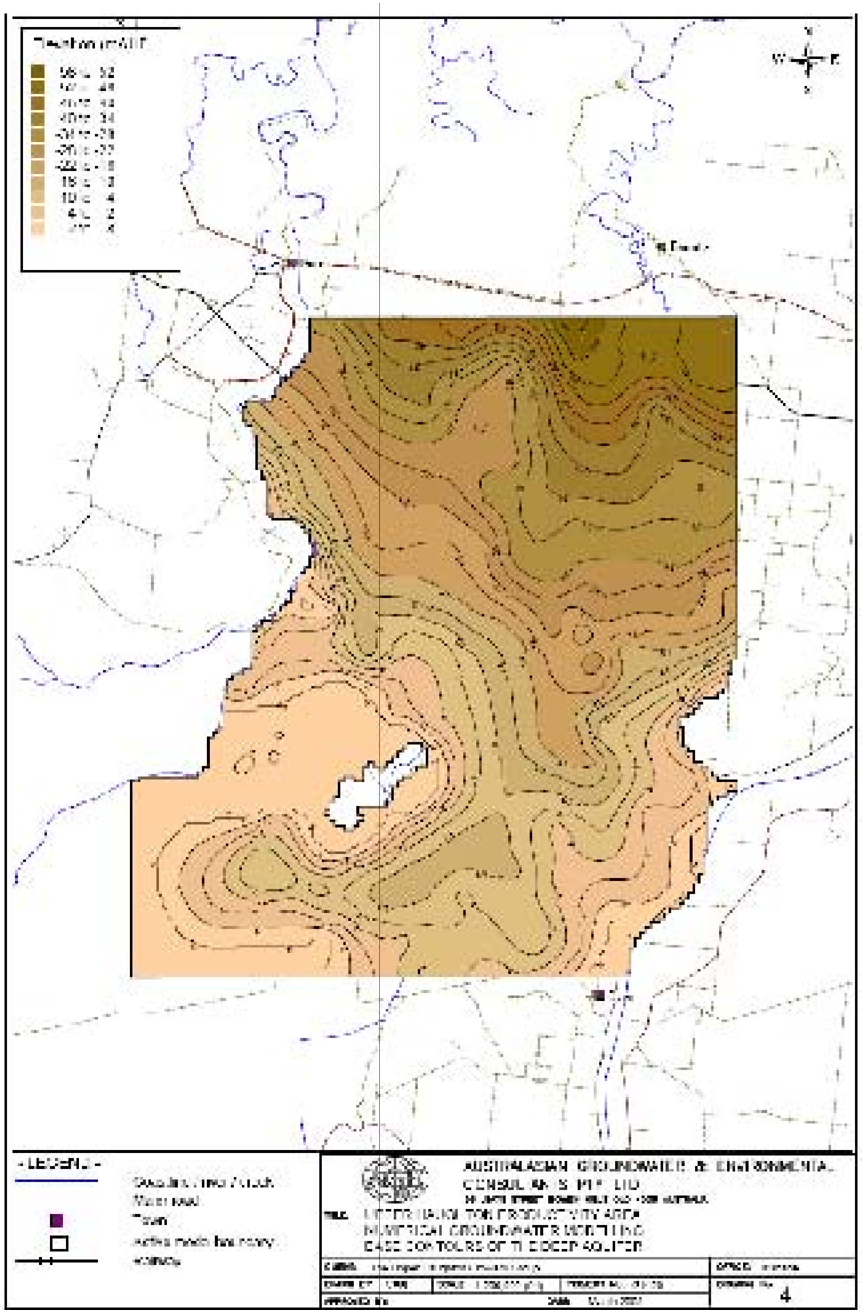
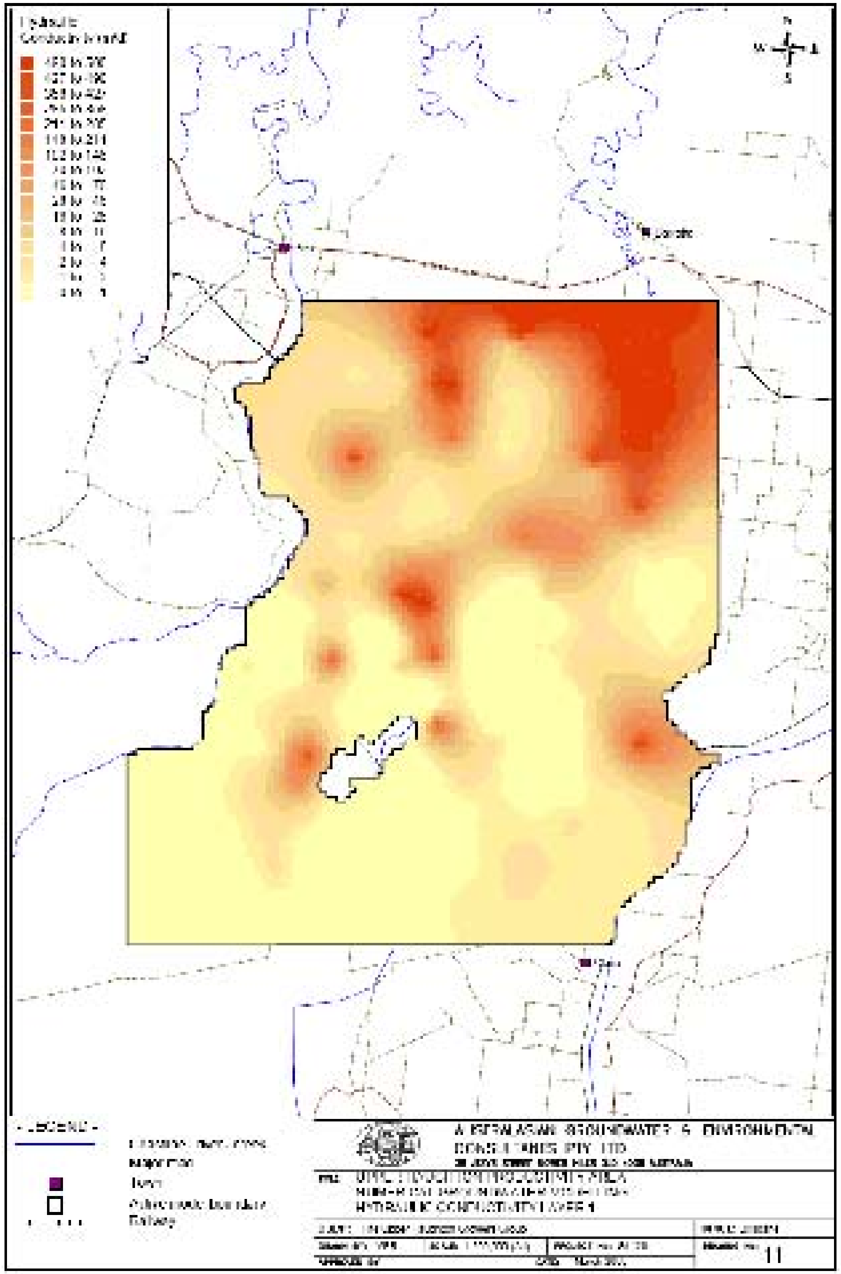


Figure 8: Hydraulic Conductivity of a) the shallow aquifer, and b) the deep aquifer



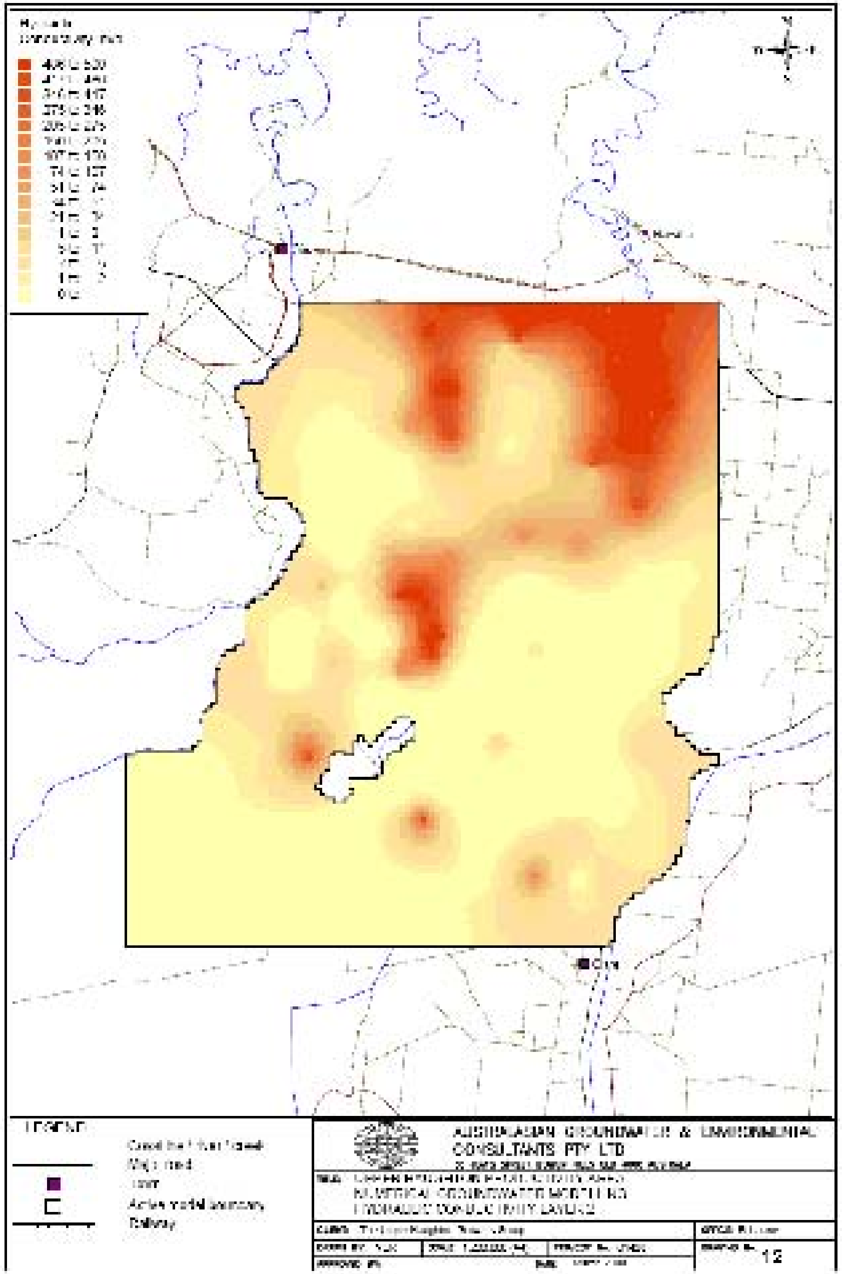
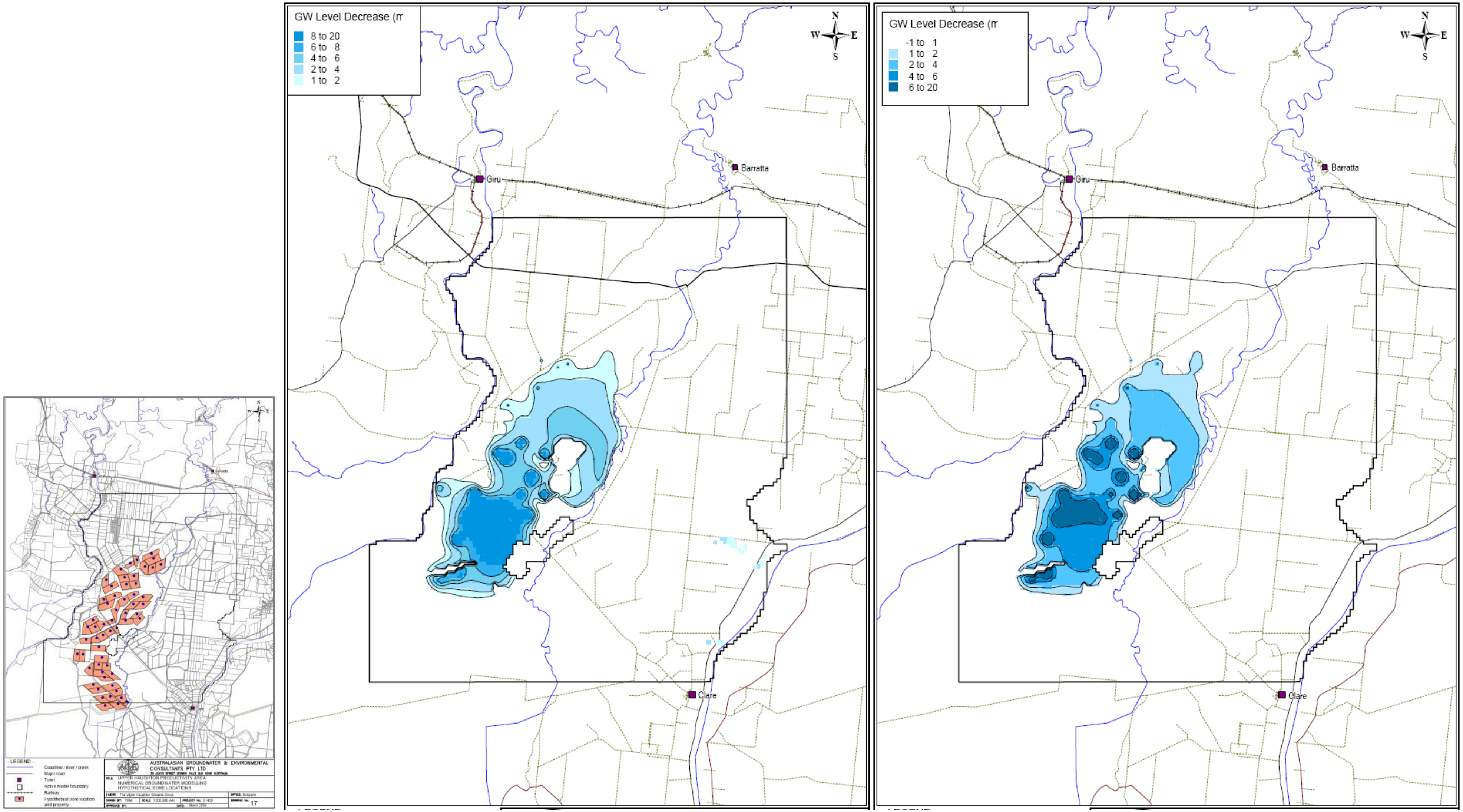


Figure 9: a) Map of farms used for scenario, b) change in groundwater levels from 2000 to 2008 with 100% groundwater use, and c) change in groundwater levels from 2000 to 2008 with 50% groundwater use



Discussion

The results found from this study show the value in developing an area wide monitoring program for the BRIA utilising the existing piezometers in conjunction with DERM's piezometers. Along with the 20 piezometers from this project, DAVCO also has 20 monitoring bores across the Mona Park area and a previous study by Petheram et al. (2006) indicates there are another 5 shallow observation bores in the Mona Park region. This would provide an extensive network of observation bores across much of the region and further monitoring would assist in understanding the aquifer characteristics and evaluating the effects of any future management changes.

The results from this project have provided an indication of what is happening in the shallow aquifer over a small area but a better understanding of the aquifer as a whole is required. The results from the UHWB project are discussed below.

The bores with groundwater levels close to the surface (within 2m) generally show no rise over the course of a year, and in several cases (Piezometers 11, 13, 21 and 22) levels have dropped slightly despite two years of above average rainfall in the area. Interestingly, these four bores all show similar behaviour (they are the only bores recording a drop in levels) and are located in close proximity to each other (Figure 2). This indicates there may be local maxima reached in this area, with the groundwater appearing to dissipate more rapidly than in other areas where the water table is lower. This could be due to more discharge points into drainage channels and natural waterways or an underground barrier being overcome, with water now able to "spill" out of the area more readily.

The improvement to drainage in the gumholes area may also be a possible reason for dropping water levels in this area (discussed later). During the previous wet season groundwater levels were high enough to leach into the adjacent drains and creeks, providing a much greater area for the groundwater to be leached (pers. obs). Whether these levels can remain sustainable in the long term is currently unknown and further monitoring over future wet seasons is required to gain a better understanding of the groundwater behaviour in this area.

Funding is the major issue for developing a comprehensive monitoring program for the BRIA. As recommended by Willams et al., (2008) to gain maximum benefit, any study should encompass the entire area of concern not just a small pocket such as the Upper Haughton area. This is endemic of the problems encountered with the groundwater issues of the BRIA. The scale of the problem means fixing it will be very expensive and no one is committed to spending the money or coordinating the effort required to find the appropriate solution.

Unfortunately groups applying for funding must comply with limited budgets and restrictive guidelines and therefore are limited in the effectiveness their studies can have. A broader scale study and greater input/partnerships with other stakeholders would have provided better information and may have yielded a more useful and powerful model for the entire BRIA.

With all the money spent on numerous strategies and studies over the past decade little on-ground progress has been made to finding a solution to the issue of rising groundwater tables in the BRIA. It seems the solution is right there in front of us but it will take a concerted and focused effort from all stakeholders to implement all the recommendations that have been put forward. All the previous reports on the issue have come up with different versions of the same solutions.

These include:

- Improve irrigation efficiency
- Reduce leakage from SunWater infrastructure
- Change NRM and SunWater policy to encourage efficient water use and greater groundwater use
- Improve drainage from the system
- Increase groundwater usage by pumping it into the SunWater channel system or providing incentives for farmers to increase groundwater use
- Remove excess groundwater by pumping it out of the system through drainage lines/creeks/rivers

The challenge is for all the stakeholders to acknowledge the urgency of the issue and stop putting it in the "too hard" basket, otherwise it may have devastating impacts on the local environment and economy of all stakeholders involved.

As mentioned previously, several organisations and farmers have started making some important progress in addressing these issues such as the groundwater science plan and the BRIA irrigators committee in collaboration with BSES and CANEGROWERS.

The DAVCO groundwater pumping project has also made some good progress in utilising large quantities of groundwater in the BRIA for irrigation which is explained in detail in a later section.

Overhead Low Pressure Irrigator Trial

The Mulgrave Area Farm Integrated Action (MAFIA) grower group's *Evaluating Alternative Irrigation for a Greener Future* project, funded through SRDC, aligns closely with this study. The project aims to evaluate the environmental benefits of an overhead low pressure (OHLP) lateral move irrigator in terms of water use as well as any economic and productivity benefits. As part of the project, lysimeters have been installed to measure deep drainage in the OHLP block as well as the reference furrow irrigated block.

Results from the first two crop seasons show the furrow irrigated block had an average of 6.5ML/ha lost to deep drainage for an average crop yield of 140 tonne/ha. Of this 61% of deep drainage can be attributed to irrigation. There was a significant decrease in the deep drainage from the plant to the first ratoon crop. After analysis of the plant crop results, the grower decided to change his irrigation management to reduce losses to deep drainage. A SIRMOD analysis was carried out which identified the most efficient irrigation method for the paddock. This suggested increasing flow rates to push water down the sets faster, thus reducing deep drainage. However, due to the logistics of the paddock and heavy soil type this would mean greater run-off volumes. This was acceptable due to the fact the grower has a recycle pit which captures and re-uses 100% of the water from irrigation run-off it.

This method appeared to work with a reduction of 1.7ML lost to the underground during the 1st ratoon crop (although this is only a 3% reduction from total irrigation water applied). With the change in practice, irrigation run-off increased significantly (1.2ML or +12%) and the overall irrigation efficiency dropped (58% compared to 67% in plant cane). However, considering all irrigation run-off can be re-used on the farm, the effective irrigation efficiency remained the same as the plant crop (75%) while reducing the fraction of water lost to deep drainage (1.7ML or -3%).

Table 2: Furrow and OHLP irrigator water use for the plant and 1st ratoon crops

	Furrow		OHLP	
	Plant cane	1st Ratoon	Plant cane	1st Ratoon
Total Irrigation (mm)	2144 (69%)	1580 (52%)	1096 (52%)	N/A
Total Rainfall (mm)	955 (31%)	1466 (48%)	1026 (48%)	N/A
Total Water Use (mm)	3099	3046	2122	N/A
Irrigation DD (mm)	487 (23%)	313 (20%)	0	N/A

Rainfall DD (mm)	192 (20%)	303 (21%)	221 (22%)	N/A
Total DD (mm)	679 (22%)	616 (20%)	221 (10%)	N/A
Irrigation RO (mm)*	223 (10%)	346 (22%)	0	N/A
Rainfall RO (mm)	327 (34%)	571 (39%)	119 (12%)	N/A
Total RO (mm)	550 (18%)	917 (30%)	119 (6%)	N/A
ETc (mm)	1986 (64% efficiency)	1530 (50% efficiency)	1878 (89% efficiency)	N/A
% Efficiency of Irrigation	67%	58%	100%	N/A
% Efficiency of Rainfall	46%	40%	67%	N/A
% Efficiency of Irrigation after recycling RO water	75%	75%	N/A	N/A

*All irrigation run-off is recycled on the farm.

The EAI project shows approximately 20% of water is lost to deep drainage both from irrigation and rainfall for this study. This would vary significantly across farms in the BRIA depending on soil type, farm layout and irrigation management. However, if we use these figures as a rough guide some calculations can be made to give a rough estimate of deep drainage for the BRIA.

The figures from this study are thought to be excessive in terms of water use. However, from past studies in the BRIA some basic calculations can be done to give a rough indication of the levels of water being lost through deep drainage.

Holden and Mallon (1997) indicate that BRIA farms average about 10 tonnes of cane per ML of applied water (or 12t/ML when water is recycled). Taking into account that water use efficiencies should have improved in the past 12 years, a figure of 12t/ML could be used as a rough estimate for the BRIA.

Taking the average crop yield of 102t/ha for the BRIA in 2008, this equates to an average of 8.5ML of water applied per hectare from rainfall and irrigation.

The average rainfall for Ayr is 1000mm and assuming 40% (or 4ML) of this is used by the crop, this leaves 4.5ML to be utilised from applied irrigation. Assuming 20% (or 0.9ML) of this is lost to deep drainage across the 36,000ha of sugarcane production area the BRIA for 2008, this equates to 32,400ML of irrigation water lost to deep drainage annually across the BRIA.

Assuming 20% of rainfall is also lost to deep drainage this equates to an average of 0.8ML/ha or 28,800ML across the sugarcane farms of the BRIA (this does not include other land uses in the BRIA).

Thus, the amount of water lost to the deep drainage has more than doubled on areas in the BRIA that are subject to furrow irrigation, bringing the total recharge volume to around 61,200ML. These figures are similar to those estimated in the paper “Proposed Groundwater Management Strategy” by PPK (2001), indicating a recharge in wet years of around 73,000ML/yr.

By contrast the OHLP system recorded no water lost to deep drainage from irrigation and 2.2ML/ha lost from rainfall. This is a third of the deep drainage recorded from the furrow block, meaning a reduction of 4ML/ha in this system. The figure for the OHLP block is entirely from rainfall deep drainage and no significant deep drainage occurred as a result of human influenced irrigation. Thus the OHLP system provides a massive benefit to reducing water lost to deep drainage and allows greater control over the irrigation by the farmer.

However, these systems are costly and cannot be utilised by many farms due to their layout and economic constraints. Large, well designed farms would be the ideal candidate for this type of system.

The EAI project has identified there are many teething problems associated with OHLP systems and the first ratoon crop saw a reduction in productivity under the system. This, combined with the high initial outlay for the system, is the reason why more of these systems have not been established in the region.

Providing an incentive for installing these systems, such as the Federal Government's Reef Rescue program, would mean farmers are more likely to purchase an OHLP irrigator, helping to reduce the impact on the groundwater system. However, more work needs to be done on system optimisation so that crop yields are not affected as has been seen in this trial.

In this trial the OHLP system is much more efficient than furrow irrigation. However, this is not always the case. The OHLP allows better control than the furrow system but it ultimately relies on the individual farmer to manage the system properly to gain maximum efficiency. It can just as easily become as inefficient as a furrow irrigated system if not managed properly.

DAVCO groundwater pumping project

DAVCO are using existing bores and installing new bores to utilise the groundwater resources across their extensive property in the Mona Park area. Large scale pumping commenced in May 2009 and up to September 2009, over 2700ML of water had been extracted from the bores. This number is expected to rise significantly in coming months when new bores are installed and irrigations increase.

DAVCO is also monitoring 28 piezometers located on and around the farm, and many of these have Odyssey loggers installed. Several of the UHWB project piezometers are also located on or adjacent to DAVCO's property.

Early results are showing a large drawdown in the water table near production bores during pumping, with water levels returning to similar levels when pumps are turned off. Since April 2009, when monitoring commenced, water levels have dropped close to 1m in piezometers adjacent to production bores. However, in a piezometer further from the pumping site little change has occurred in groundwater levels since April 2009. This indicates that the changes may only be localised and that larger volumes of water may need to be extracted to have any effect on the wider aquifer.

To date DAVCO's groundwater extraction levels have been relatively small and they intend to increase their extraction levels over the coming months and years to volumes that may have an effect on the groundwater table.

Piezometer 20 is located near one of the DAVCO bores which has been in operation since April 2009. Figure 4 shows the variability in this piezometer in 2009 since pumping has commenced.

Figure 10: One of the new production bores installed at DAVCO

Recommendations for improved groundwater management

There is a lot of room for farmers to improve their efficiency on a furrow irrigated system and this provides a relatively inexpensive and convenient method to irrigate sugarcane. Reducing deep drainage from furrow irrigated systems can be done easily in many cases with a few small changes. This was seen in the 1st ratoon crop for the EAI project where an increase in flow rate and closer management of the furrow system meant a large reduction in deep drainage from irrigation. This may increase run-off somewhat, however this farmer captured all run-off in a clay lined recycle pit for reuse on the farm. Given the issues with rising groundwater tables in the area, an increase in run-off at the expense of reduced deep drainage is warranted, especially if the run-off is captured for re-use.

Several farmers have utilised SIRMOD to evaluate their irrigation efficiencies. This program uses a mixture of in-field measurements and assumptions to model the water efficiency of a given paddock. It allows the grower to calculate the water use efficiency and attributes lost water to deep drainage or run-off. It then allows the farmer to run scenarios that model different paddock lengths and flow rates to maximise irrigation efficiency. SIRMOD can be a powerful tool for growers and has been shown to greatly improve irrigation efficiency in some cases.

The use of groundwater for irrigation is recommended to lower the water table however this needs to be managed properly. Using straight groundwater may have a detrimental effect on crops if salinity levels are high. Thus, it needs to be mixed with channel water to a desirable level. Salty groundwater can also increase infiltration in soils and thus increase deep drainage. Growers need to take this into account when irrigating and make sure they maximise their efficiency. In some poor draining areas of the BRIA this may have a beneficial effect on soils and there may be some benefit in transporting groundwater to these areas. It may also reduce the need for gypsum additions, reducing the additional salt contributions to the underground by utilising salts already in the system.

In other areas, such as the sodic duplex soils, this added salt level can further increase infiltration and many growers have indicated problems with getting water to the end of the rows due to high infiltration levels. The use of pure groundwater can be detrimental in these circumstances and other options may need to be addressed such as pumping groundwater out of these areas or mixing with channel water to the desired level.

All of these issues and the corresponding solutions have been known for some time, however little is yet to be done in response to them. Across the BRIA there is still much opportunity for growers to improve irrigation efficiencies in terms of furrow irrigation techniques. There is also the opportunity for SunWater to reduce leakage from their channel system through channel lining and upgrades to the system. Although the local division of SunWater acknowledges this is a priority and is willing to work with other stakeholders on the issue there is a lack of funding from the State Government in supporting these works.

Project participation

Grower involvement in the project has dwindled over time. Initially the Upper Haughton CPI group had several growers interested in increasing their capacity to monitor and manage the groundwater. There have been several reasons for this loss of interest.

Toward the beginning of the project some growers were alienated from the project after an interview was broadcast on ABC radio talking about the project. These growers felt that talking about the issue publicly and releasing the data from the project meant their farms could be devalued and thus pulled out of their role in the project. Although this may look like growers are avoiding the issue at hand, it shows the effect poor media publicity can have on stakeholders. Over time this hostility toward media publicity dwindled as growers took more ownership and acknowledged the issue in their area.

Another reason for the loss of interest was due to the changes in Project Managers at BBIFMAC. Three different managers have worked on the project and the handover between each manager was rushed or non-existent, meaning the successor had to re-learn all the information from the project. The project then became somewhat disjointed and information was lost from one manager to the next, reducing the effectiveness of the project. This demonstrates the importance of consistency in Project Managers and spending time to pass on project information if there is a changeover.

A similar issue was seen for the UHWB steering committee, with only one of the original committee members still currently involved with the project. One of the original members left due to disagreement with the Project Manager over the media publicity discussed earlier and another two moved out of the sugar industry, meaning they were no longer involved in the area. These losses were unavoidable but still caused disruption to the project.

Trevor Haller who was the original farmer monitoring the groundwater levels, left the project in January 2008 and Russel Jordan took over the duties. Since this time Russel has been closely involved with the project and has shown a keen interest in the monitoring of the piezometers. Russel's involvement has been the reason for much of the success of the groundwater monitoring side to the project.

AGE model

AGE was contracted to produce a model for the UHWB study in August 2006. The original consultant was Rob Lait who had a good understanding of the BRIA and made several trips to the area in the initial stages of the project to scope out and plan the groundwater monitoring sites. In mid-2008 Rob Lait left AGE and Andrew Durick took over as the principle consultant. Andrew had less knowledge of the area and it appeared he had lost much of the project knowledge in the handover from Rob.

Throughout the course of the project much of the problems experienced have been due to lengthy delays in AGE's development and reporting of the model. BBIFMAC was asked to provide AGE with information on the piezometers for development of the model. Although there were some delays in obtaining some of this information, it was all provided by August 2008. AGE indicated the draft report for the groundwater model would be presented to the steering committee by November 2008 however it was not received until April 2009. The reason given for the delay was lack of staff and that the Upper Haughton model was a low priority project compared to larger mining contracts. AGE also indicated that the model had run well over budget and therefore some of the items in the contract could not be fulfilled.

In the following months BBIFMAC made the draft report available for comment via the BBIFMAC website and several hard copies housed at BBIFMAC. The response to the draft report was somewhat disappointing with BBIFMAC only receiving responses from five individuals, the Lower Burdekin Water futures group and the three UHWB steering committee members.

Part of the reason for this may have been the technical nature of the report which would have alienated many growers. This was not the original intention of contracting the consultant and it is disappointing AGE presented the report in such a technical nature. The report contained very little substance in terms of recommendations or scenarios that could be used by growers to evaluate the groundwater behaviour and how they could better manage it. Thus, it has little benefit to growers and industry for use in improving water management in the BRIA.

BBIFMAC is currently pursuing AGE to finish the final version of the report, including the running of more realistic scenarios and providing a more user friendly report that can be utilised by growers in the Upper Haughton area.

BBIFMAC website

The BBIFMAC website has been one of the most successful features of the project in terms of relaying information to growers and the wider community. Groundwater heights are displayed for each piezometer and are updated regularly. These are linked to a map of the study area showing the location of each piezometer. This allows anyone to access the information in an easy to understand format. Project updates and photos also help to report information about the project back to growers.

Feedback from growers, industry and the wider community has been positive, with many people showing interest in the results from the project and commenting on the website's benefits. The website has also been mentioned at Lower Burdekin Groundwater Science Plan working group meetings and is often brought up at BBIFMAC general meetings.

Website statistics show that the graphs for the groundwater heights on the website have been viewed 376 times since August 2008.

Looking to the future

One of the downfalls of the project is that it was only done on a relatively small area of the BRIA and there was little consultation with other groundwater experts in the initial stages of the project. One of the comments received from stakeholders involved in the project since its inception is that very few of the partners knew much about groundwater in the BRIA at the time and thus the project was not designed as best it could. Since the inception of this project knowledge of the groundwater system in the BRIA has increased significantly, however there are still many knowledge gaps that need to be addressed if the problem is to be managed successfully.

It is important to remember that this project was designed to be a pilot scale project and if successful it could be scaled up to be carried out over a larger area such as the BRIA. Looking at the project from this angle, there is a lot of benefit that could be taken from a similar project over a larger scale. Regular monitoring of piezometers over a larger area would be beneficial to the entire area, especially if they were reported online for the wider public. The use of odyssey loggers over a larger area would provide valuable data that could be used to create more accurate models of the groundwater system in the future. The loggers were not used to their full capacity in this project but where they were used they yielded invaluable data, especially during the wet season when bores could not be accessed for several months.

Recently several new loggers have been purchased and installed into the project piezometers. Placing loggers strategically across the entire BRIA bore network would mean reduced labour in terms of manual monitoring and more valuable data collected, as the loggers can record data at any interval required, from seconds to hours to days. This would impart a significant initial outlay but would reduce long term costs involved with manual monitoring. Each logger costs approximately $200 and can be expected to last several years without maintenance. Loggers would rarely require checking if installed correctly. Data could be downloaded on a quarterly or half yearly basis along with a manual reading to verify the logger is functioning properly. At the same time loggers could be adjusted if required.

The continuation of this project is recommended to keep growers informed of the groundwater behaviour in the BRIA. Expansion of the project to encapsulate a larger area of the BRIA would be beneficial, and the infrastructure is already in place for this to happen, without any need for expensive outlays for piezometer installations.

DAVCO's network of observation bores in the Mona Park area could be used to supplement the data collected from other sites. These bores also have automatic loggers installed. The results from this property will be valuable as DAVCO has recently commenced pumping large quantities of groundwater from the area in an attempt to lower the water table.

DERM groundwater model

DERM has been endeavouring to produce a groundwater model for the BRIA region for some time now using its extensive data records from hundreds of monitoring bores located across the region. Originally DERM intended to develop this model some years ago and it was indicated it would be ready by the time AGE was ready to produce the model for the UHWB project. The main limitation for DERM in producing a model is attracting an experienced hydrogeologist in a time where they are in high demand in the private sector where salaries are more attractive.

From recent discussions with DERM officers the likely timeframe for development of a model for the BRIA region is at least two years away. In the original project outline for the UHWB project it was intended AGE would piggy back on the DERM model, reducing the workload on model development and allowing more time for the consultants to work with the newly acquired data. Considering this was the original intention, AGE struggled to produce the required model within the budget and timeframe allocated to this project and this may be part of the reason for the lack of substance in the AGE report.

Lack of continuity in staff and steering committee

Project management was an issue within this project. The main problem stemmed from the changeover between Tom McShane and Bryce Davies, where much of the project knowledge and relationships were partly or completely lost. This was due to the fact there was a 4 week gap between Tom leaving and Bryce starting with BBIFMAC. This left Bryce to have to relearn every aspect of the project with little guidance or outside knowledge. Although meeting records and project reports were kept on file, there was still a lot of information lost during this changeover and the project suffered considerably. It is imperative that consistency in project management be maintained where possible and if any changes need to take place there needs to be sufficient changeover time so that the successor can learn the project sufficiently to keep it running smoothly.

This lack of continuity was also an issue with the steering committee with members leaving for various reasons. Some of these reasons were unavoidable however other could have been managed better. One of the steering committee members resigned early in the project due to a dispute over a media report on the project which was released without consultation with the steering committee.

This resulted in arguments among the committee and the resignation of one of the original members. Other committee members and stakeholders appear to have lost interest in the project over time and other members had to leave due to selling of farms or moving from the area. This all provided disruptions to the project which affected its effectiveness.

Deep drainage lysimeters

The deep drainage lysimeters that were installed for the project never became fully operational during the project life due to several factors. The main factor was the on-going illness of the lysimeter inventor and manufacturer who was a Burdekin local and is the only person with the knowledge of how to produce and install the lysimeters.

Rainfall also played a part in delaying the lysimeter installation, with rain falling intermittently throughout the 2008 dry season when the lysimeters were due to be installed. This combined with the unavailability of the drilling rig and having to work around irrigation and harvest times, all confounded the problem.

Two sets of lysimeters were finally installed in the ground in July-August 2008. However the control towers were only installed on one of these sites and it was faulty at the time so did not collect any data. In October 2009 two of the lysimeter sites finally became operational and will be used by the growers to monitor deep drainage under their paddocks on future irrigations.

Gumholes drainage

The lowering of the pipeline under Barratta Rd in the Upper Haughton study area draining the gumholes area was completed in August 2008. The pipeline was lowered by 1.5m where it crosses under Barratta Rd in response to concerns the pipeline was acting as a blockage for surface water to escape from the gumholes area. This was thought to be contributing to the elevated water table in this area. Although the pipeline was completed in August 2008, it took over 6 months for the downstream drain to be cleared of weeds and sediment so that water could start to escape from the area. It was thought that the UHWB monitoring may identify any response from the surrounding aquifer to the gumholes drainage works.

Results so far are inconclusive although levels do seem to be dropping slightly in some of the nearby bores where groundwater levels are close to the surface (Figure 2). The occurrence of above average rainfall for the last two years, along with a change in ownership of surrounding farm land, resulting in different irrigation management, means that any increased drainage as a result of the pipeline may be hard to identify from recent data. Continued monitoring over the following months and years will give a better indication of the effectiveness of this project, especially if the drainage lines are kept clean and rainfall returns to average levels.

Odyssey loggers

One of the successes from this project was the use of the Odyssey data loggers to measure groundwater levels automatically. The data loggers are inexpensive, relatively easy to use (once users are familiar with the program) and provide valuable data with little maintenance required. The loggers were set to measure the water height at 1 hour intervals and they can be left in the piezometers for many months at a time to log groundwater heights.

The value of the loggers is that they can pick up much finer detail in terms of groundwater height changes than manual monitoring. This is especially useful during the wet season when large changes in groundwater levels occur over a short period of time and piezometers are inaccessible for months at a time.

It is also useful for identifying any influences from irrigation or channel water in adjacent areas which may not be detected from manual monitoring on a fortnightly basis. By having irrigation records for adjacent farms, the influence of irrigation on groundwater can be investigated by looking at the automatic logger data. Currently this has not been performed to a large extent but the potential is there for this to occur in the future.

Initially one metre data loggers were used but problems were observed during the wet season when large rainfall events would increase the groundwater level significantly. The short length of the logger cord meant data was lost when groundwater heights rose or fell significantly, meaning the logger became fully immersed or went dry and could no longer log heights without being adjusted. Future loggers were purchased at 1.5m or 3m lengths to account for this problem.

Some loggers that became fully immersed for long periods of time had water damage due to damaged seals and had to be returned for service. In some cases data was lost from these loggers.

For the majority of the project the loggers were only installed in two project piezometers and a few DERM monitoring bores. Toward the end of the project more loggers were sourced and installed in project piezometers to improve the data collection. This only occurred in April 2009, so little data has currently been logged from these sites. The loggers will continue to be downloaded on a quarterly to six-monthly basis.

Figure 9: Odyssey logger used in piezometers of the UHWB project

Awareness raising activities

Results from the UHWB project have been presented to several groups of stakeholders. On October 26th BBIFMAC organised the BRIA Groundwater Forum at the Clare Club, Clare to report the results from the UHWB project as well as gain a wider perspective of the groundwater activities and monitoring occurring in the BRIA.

Evan Shannon, farm manager at DAVCO, was invited to present the preliminary results from DAVCO's project – Managed Utilisation of Saline Groundwater to Control Rising Water Tables.

Grahame Herbert was also invited to give an update of DERM's current groundwater monitoring program. DERM do extensive monitoring of groundwater levels across the BRIA on a 2 monthly basis. The results presented gave a good historical perspective on groundwater behaviour over several decades and clearly show the influence of the introduction of irrigation to the area on groundwater rise. The results from this monitoring mirrored those found in the UHWB project but gave a larger perspective without the finer detail obtained from the UHWB project.

The data from the UHWB project along with DAVCO and DERM's monitoring data provide solid evidence of the rising groundwater table. The main issue now is to identify and quantify the contribution to the groundwater from different sources such as irrigation, channels, drains, dams, weirs, rivers, creeks and rainfall. The finer detail of the UHWB data from both manual monitoring and the automatic loggers allows the possibility of helping to understand the recharge sources and their effects on the groundwater and this data closely complements that of DERM.

About 40 people attended the forum with about 50% being growers from the BRIA. The remainder were made up of industry and government and NRM representatives.

The UHWB project was also presented to the Lower Burdekin Water Futures (LBWF) group on 29th October 2009. The LBWF group consists of stakeholders and experts from industry, government and the community who have an interest in the water resources of the Lower Burdekin.

The group was very interested in the results from the project and gave positive feedback as to the findings. The group also expressed their disappointment at the quality and content of the AGE model report and offered to provide assistance to BBIFMAC in requesting the required information in the final version of the report, including running appropriate and realistic scenarios through the model.

Other awareness raising activities included several presentations at Upper Haughton CPI meetings, presentations and reports at BBIFMAC general meetings, which are held bi-monthly, along with a presentation at a field day for the MAFIA group's Evaluating Alternative Irrigation for a Greener Future project in April 2008. Information and results from the project are also available on the BBIFMAC website, which is updated regularly.

Changes in knowledge, attitudes, skills and aspirations of all project participants and key stakeholders in DERM, SunWater and BBIFMAC

Due to factors already discussed many of the original project participants are no longer involved in the project. Those that have been involved over several years

DERM has recently worked closely with BBIFMAC on project activities and there has been a close relationship with sharing of data and results. BBIFMAC has had automatic loggers installed in DERM bores for the majority of the project and this data has been used by both BBIFMAC in assisting with the development of the groundwater model and DERM in validating and providing a greater understanding of the groundwater behaviour for their bores.

The current version of the model is disappointing and this has been reflected by DERM in their comments on the draft version of the AGE report.

SunWater has been helpful in supplying information to BBIFMAC for integration into the AGE model, however this data was not eventually used by AGE. Other than this, there has been very little interaction between SunWater and BBIFMAC on this project. The provision of data by SunWater on their estimations for water losses from supply channels and water storages to the underground would be helpful in calculating volumes of recharge to the aquifer.

Many growers too are keeping their head in the sand about the seriousness of the issue facing them. Although some are taking heed of the rising groundwater levels and looking to ways to reduce their impact, the inefficient practices of many other growers may be impeding the good work being done by the conscientious growers.

This project has helped to raise awareness within the farming community of the seriousness of the issue. Prior to the project very few growers knew about the groundwater issues facing the Upper Haughton area and the BRIA. By reporting the project results at field days, forums and CPI meetings it allows growers to gain an understanding of the problem in first person. The BBIFMAC website has been heavily promoted to these growers as an information source as it allows growers to stay updated with the current groundwater heights and is a timely reminder for growers of the seriousness of the issue at hand.

There is definitely a better understanding of the groundwater issue within the grower community as a result of this project, as well as several others, compared to 3 years ago when the project originated.

Management actions taken as a result of UHWB project findings

The BRIA irrigators committee have acknowledged the rising groundwater table issue faced by growers in the BRIA and have recently commenced a study on seven representative farms in the area. The study will carry out SIRMOD modelling to understand the most efficient irrigation methods for varying soil types and paddock layouts. The committee has already given a recommendation of 12 hour irrigation sets to all growers in the BRIA as a way to reduce deep drainage and improve irrigation efficiency, resulting in reductions to irrigation losses to deep drainage.

The project is also looking at trialling an automated irrigation system to improve efficiency and reduce labour costs.

The Lower Burdekin Groundwater Science Plan has recently been released by SKM and has been under development since 2007. BBIFMAC was invited to be one of the advisors to the plan due to the UHWB study work. The results from the project were submitted to SKM in early 2009 for use in development of the plan.

The plan will give recommendations on the way forward for the Lower Burdekin in tackling the groundwater issues and will be used as a basis to attract funding for future projects. The AGE model report and results from the piezometer monitoring were consulted as part of the planning process of this report.

The Rural Water Use Efficiency program has been assisting growers to improve their irrigation management practices for several years now. It has made good progress in raising awareness and providing extension support to Burdekin growers in improving irrigation practices but still has a long way to go.

Some of the easiest solutions to improving irrigation efficiencies that can be implemented immediately or in the near future include:

- Managing flow rates to optimise irrigation. This may require changes to cup sizes or optimisation of pumps.
- Changing furrow shape to reduce infiltration in well draining soils.
- Attending workshops and field days to learn what other growers are doing.

- Change field designs to optimise irrigation efficiency for the grower's specific parcel of land.
- Automation of irrigation (still being developed).
- Perform a SIRMOD analysis to identify most efficient irrigation method.
- Use irrigation scheduling tools such as evaporation mini-pans, enviroscans, or soil moisture probes.
- Utilise groundwater for irrigation where possible.
- Keep recycle pits empty whenever possible to reduce recharge to groundwater.
- Reduce losses to run-off.

What the growers think

Growers have expressed their concern about the rising groundwater levels in the BRIA on many occasions. The most recent occasion was at the BRIA groundwater forum where growers expressed their concern at the inaction of SunWater to acknowledge and address the issue even though growers are making some effort to reduce their irrigation volumes.

Growers also expressed their concern over the current AGE model report, specifically the scenarios that have been run through the model that are unrealistic. The growers were concerned that the report could be taken out of context by government in regards to the scenarios of utilising groundwater to reduce the water table.

The report runs scenarios showing the effect on groundwater if 50% and 100% of the irrigation water is sourced from groundwater. Although the model shows a large reduction in groundwater levels over several years, this scenario is unrealistic and would be impossible to implement in the region due to the low extraction rates for groundwater in the Upper Haughton area.

The growers were worried government may not take this into account if they read the report and could try to enforce pumping of groundwater for irrigation rather than the use of channel water. This however would prove impossible in this area of the BRIA.

Grower case study

Russell Jordan has been on the UHWB steering committee since early 2007. He owns a small farm in the Upper Haughton area and is heavily involved in various boards and committees within the sugar industry.

Russell has been involved in monitoring the piezometer network since February 2008 and has an excellent knowledge of the groundwater behaviour as a result of this. He is passionate about sustainable farming and works closely with BBIFMAC and other industry groups to reduce his environmental impact.

He is concerned about the rising groundwater levels on and around his farm and the observation bore located on his property has shown a sharp rise since monitoring began in February 2007 (Bore 6). In order to try and identify the reasons for this rise Russell installed a nest of lysimeters in his paddock adjacent to the bore to identify what contribution his irrigation was having to the groundwater rise. Currently no data has been captured from the lysimeters however they have recently become operational and Russell will continue to monitor them over the coming years.

Russell has also performed a SIRMOD analysis on his paddock adjacent to the piezometer, which indicated his efficiency was very good with very little water being lost to deep drainage. He captures all ofthe water that runs off his paddocks in a recycle pit and re-uses it on the farm.

Russell is concerned that the SunWater drainage channel adjacent to the block is contributing to the groundwater rise. The drain is used as an overflow and discharge drain for the adjacent SunWater channel and has been clogged with weeds for the majority of the project timeline. This has meant water has been constantly sitting in the drain, unable to escape freely due to blockages and constant refilling from the SunWater channel. As the drain is not lined it may be contributing to the recharge of the aquifer in the area.

An odyssey logger installed in the piezometer on Russell's property also helps us to understand what the influences are on the groundwater in this area. Being so close to the paddock as well as the adjacent drain, there is a good chance that the odyssey logger will pick up any influences on the groundwater level. These can be identified by comparing the logger readings to the practices on the adjacent land. The lysimeters will help to provide a backup to the odyssey logger data in identifying deep drainage losses from the paddock.

Conclusion

Due to the proximity of the groundwater table to the surface and its continued rising trend in the Upper Haughton area and other parts of the BRIA there is urgency required for action to reduce the groundwater table in these areas. Continued monitoring is essential to help growers manage their enterprises effectively and allow management of the groundwater into the future. What path this monitoring takes is currently undecided, however BBIFMAC recommends that at a minimum, monitoring using the automatic loggers continue indefinitely and installation of loggers into all project bores be funded. This would be very cost effective as loggers would only require checking and downloading every 3-4 months. Logger prices are cheap and they are reliable if maintained correctly. The data obtained could continue to be reported through the BBIFMAC website and also reported to DERM to allow a better understanding of the groundwater behaviour in the BRIA.

As has been demonstrated from this project, it is critical to address the issue of rising groundwater now. For the problem to be successfully tackled it will require a concerted effort from all stakeholders involved including growers, DERM, SunWater, Government, NRM groups and industry. The seriousness of the issue should make it a first priority for all involved so that it can be addressed immediately and effectively. This will help reduce the potential for an environmental and economic disaster occurring in the BRIA and will ensure the livelihood of the region can be maintained sustainably into the future.

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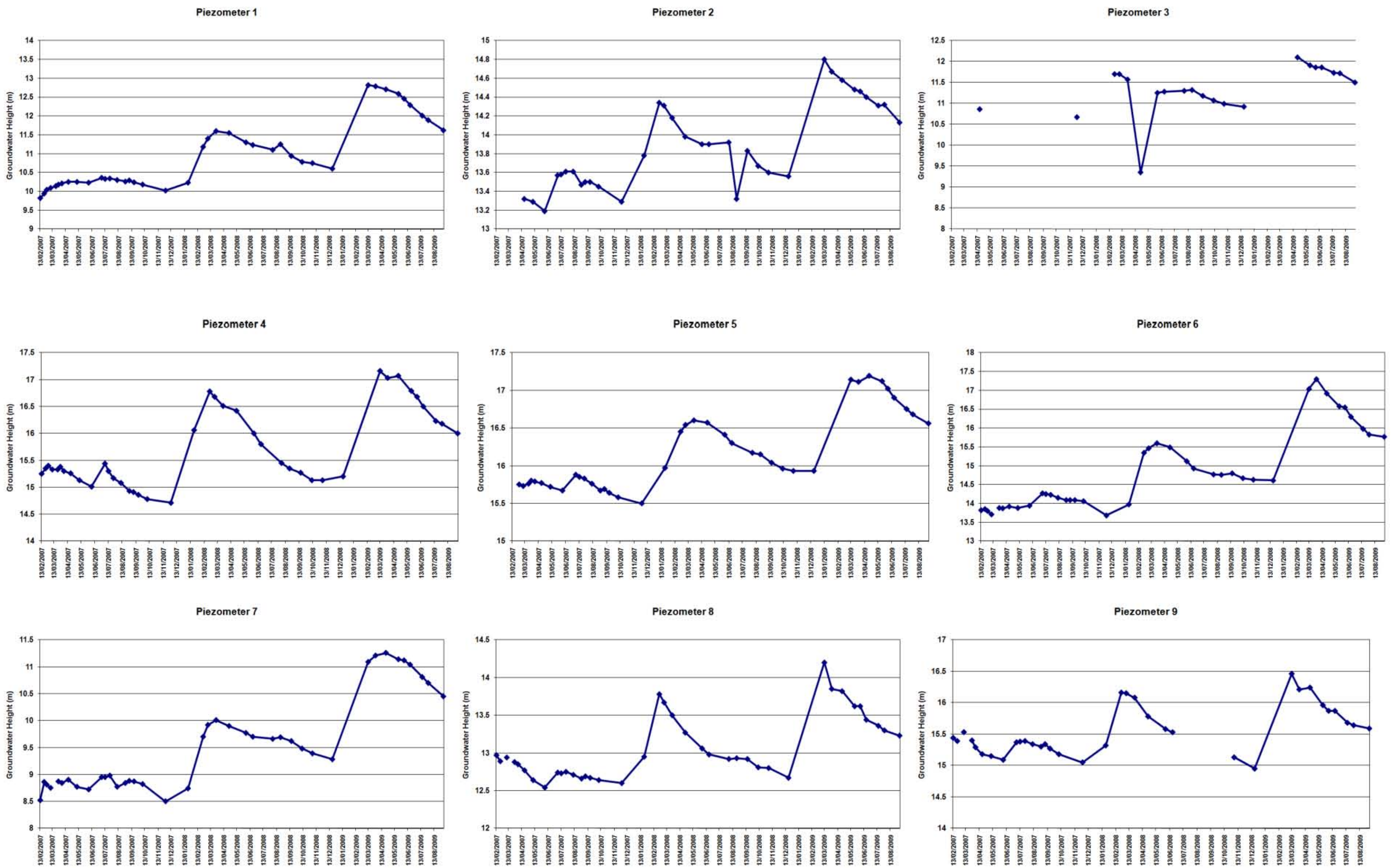
Appendix

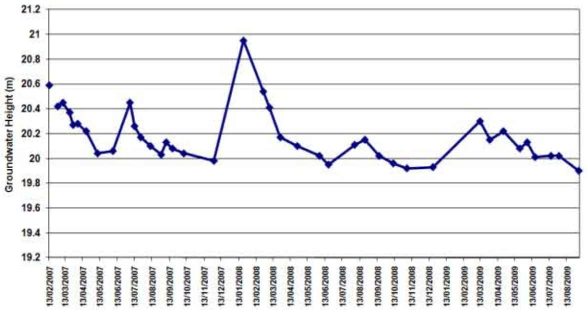
Table 2. Annual changes in groundwater levels over two years of monitoring for each piezometer.

	Groundwater level below surface in metres (change since previous year) ↑= rise, ↓ = fall			
Piezometer number	**Date**			**Change since 29/8/2007 (m)**
	29/8/07	**22/8/08**	**3/9/09**	
1	5.96	4.97 (↑ 0.99)	4.60 (↑ 0.37)	**↑ 1.36**
2	2.33	2.48 (↓ 0.15)	1.67 (↑ 0.81)	**↑ 0.66**
3	6.13*	5.48 (↑ 0.65)	5.3 (↑ 0.18)	**↑ 0.83**
4	4.38	3.96 (↑ 0.42)	3.31 (↑ 0.65)	**↑ 1.07**
5	4.41	3.93 (↑ 0.48)	3.52 (↑ 0.41)	**↑ 0.89**
6	7.69	7.02 (↑ 0.67)	6.01 (↑ 1.01)	**↑ 1.68**
7	7.72	6.87 (↑ 0.85)	6.11 (↑ 0.76)	**↑ 1.61**
8	5.44	5.17 (↑ 0.27)	4.87 (↑ 0.3)	**↑ 0.57**
9	4.17	4.34* (↓ 0.17)	3.88 (↑ 0.46)	**↑ 0.29**
11	1.37	1.35 (↑ 0.02)	1.60 (↓ 0.25)	**↓ 0.23**
12	4.35	3.80 (↑ 0.55)	3.63 (↑ 0.17)	**↑ 0.72**
13	1.24	1.51 (↓ 0.27)	1.57 (↓ 0.06)	**↓ 0.33**
14	3.53	3.25 (↑ 0.28)	2.84 (↑ 0.41)	**↑ 0.69**
15	7.09	6.56 (↑ 0.53)	6.03 (↑ 0.53)	**↑ 1.06**
16	3.33	3.00 (↑ 0.33)	2.68 (↑ 0.32)	**↑ 0.65**
17	3.90	3.54 (↑ 0.36)	2.85 (↑ 0.69)	**↑ 1.05**
18	7.37	6.69 (↑ 0.68)	6.04 (↑ 0.65)	**↑ 1.33**
20	3.99	3.73 (↑ 0.26)	3.38 (↑ 0.35)	**↑ 0.61**
21	2.58	2.55 (↑ 0.03)	2.67 (↓ 0.12)	**↓ 0.09**
22	1.55	1.38 (↑ 0.17)	1.88 (↓ 0.50)	**↓ 0.33**
Avg. change	**-**	**↑ 0.35**	**↑ 0.36**	**↑ 0.71**

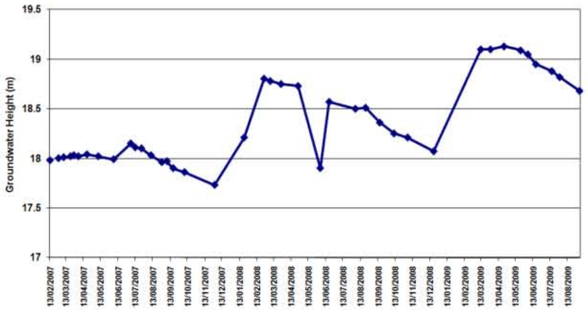
Figure 11: AHD heights (height above sea level) for all piezometers



Piezometer 11



Piezometer 12



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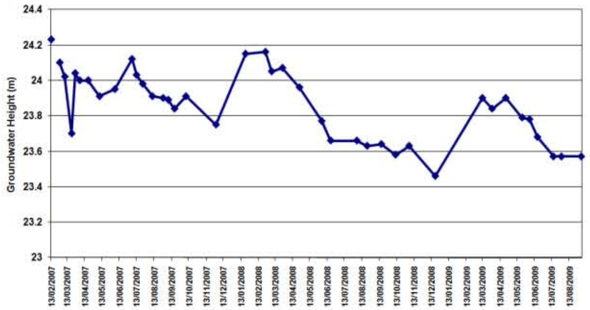

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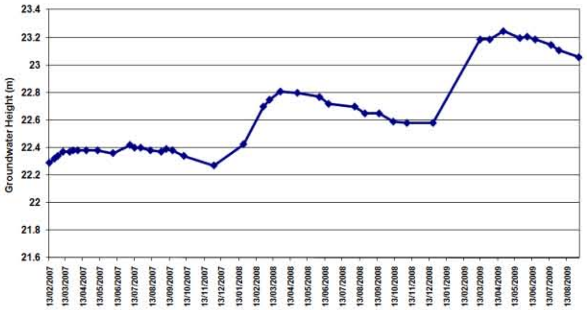
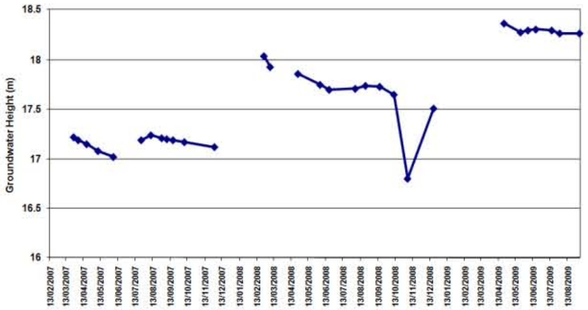
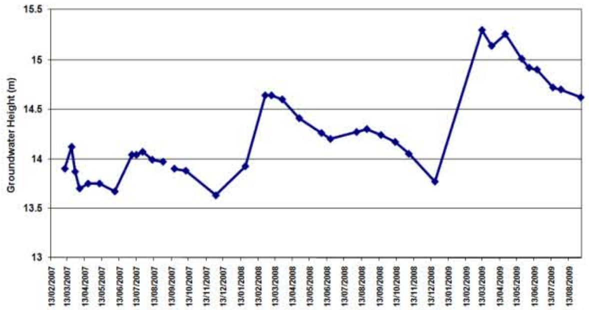
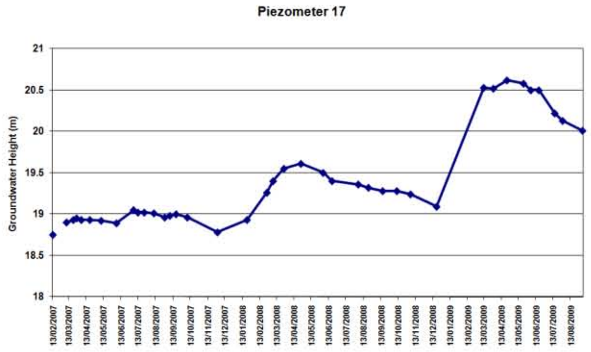


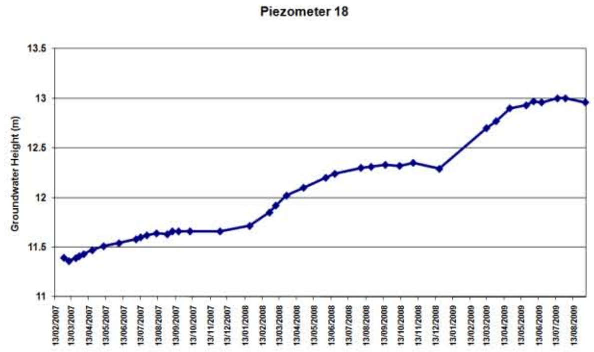
Piezometer 15

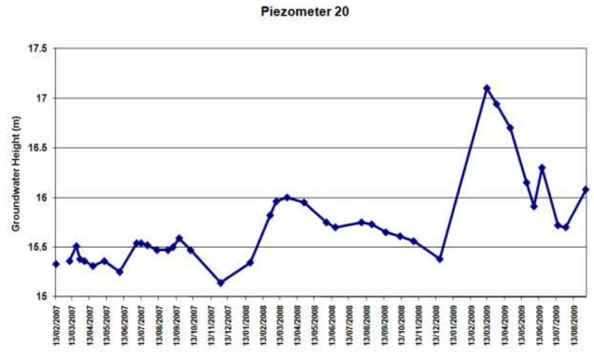


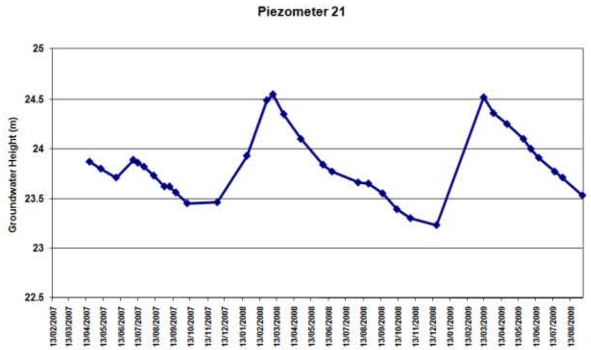
Piezometer 16

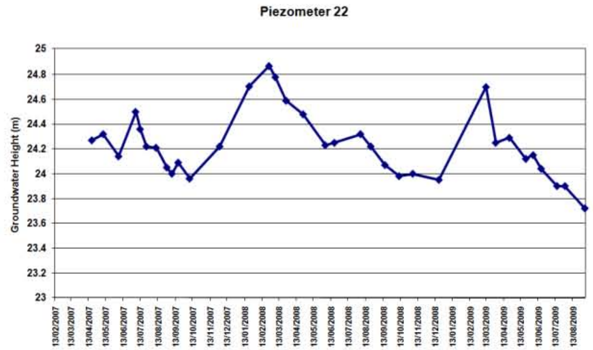



Piezometer 17
Groundwater Height (m)


Piezometer 18
Groundwater Height (m)


Piezometer 20
Groundwater Height (m)


Piezometer 21
Groundwater Height (m)


Piezometer 22
Groundwater Height (m)