

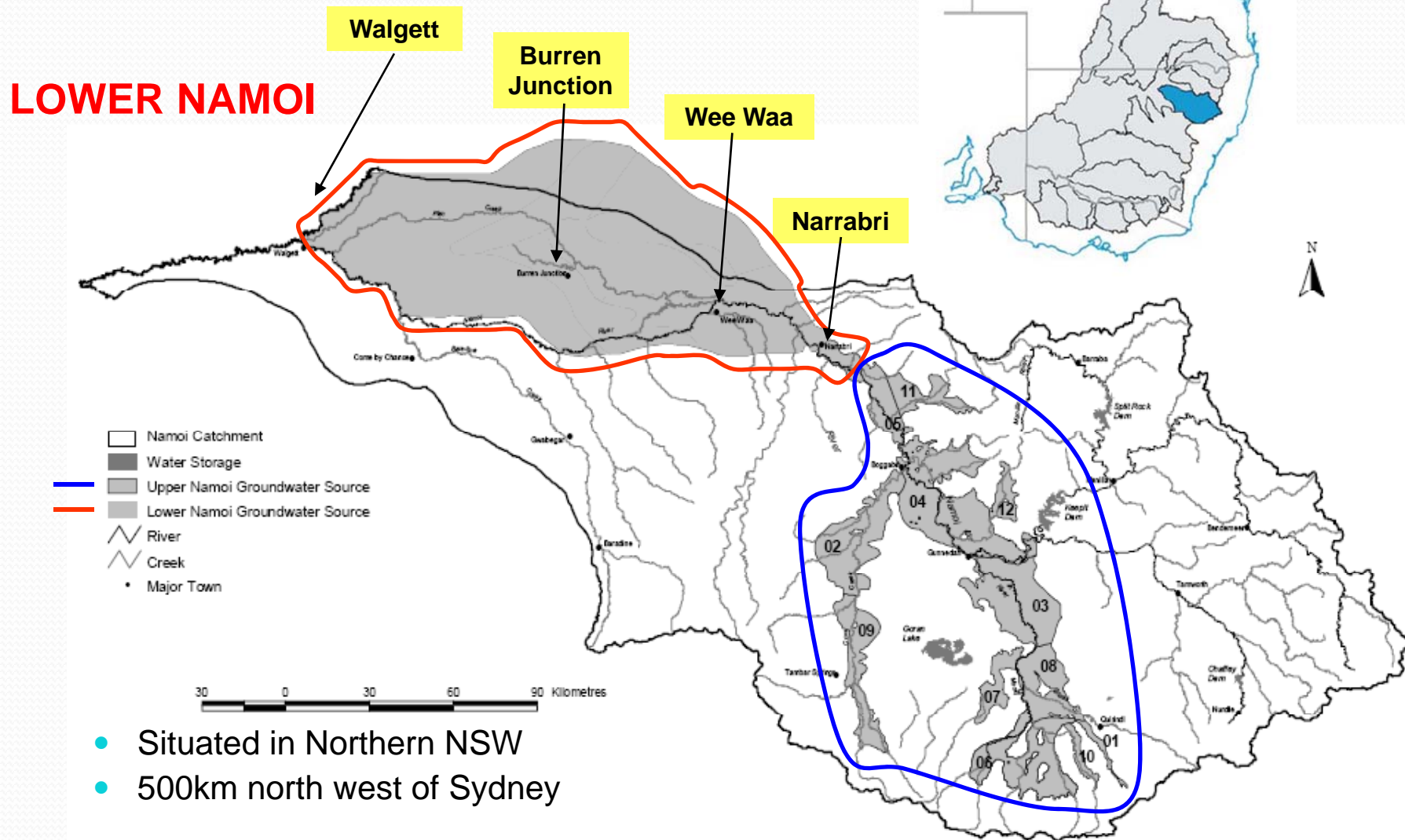
IAH-NSW presentation Oct-08

3D Spatial Analysis of Bore Hydrograph Data in the Lower Namoi

Cynthia The

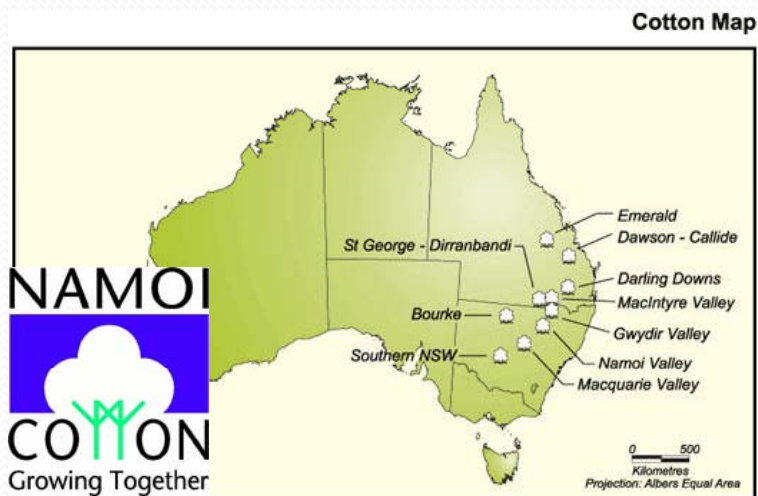
Supervisor: Associate Prof. Bryce Kelly

Study Area - Namoi Catchment



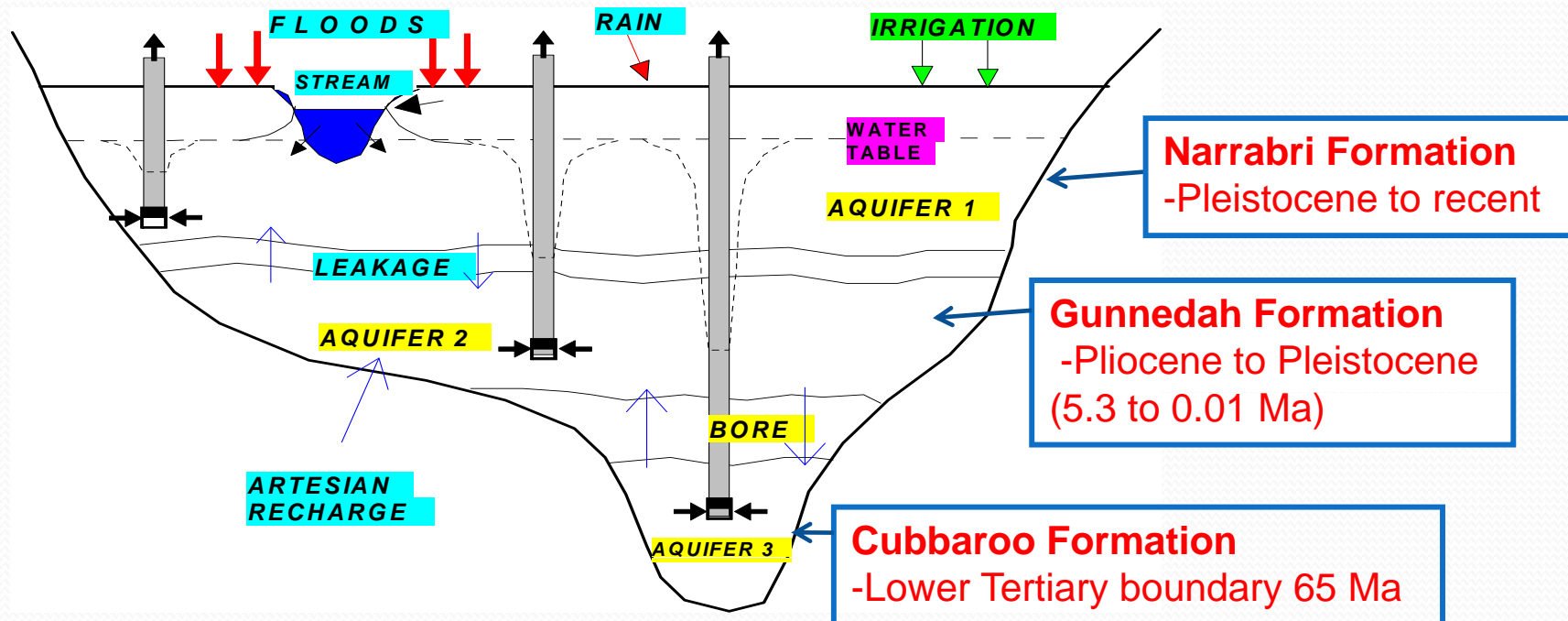
Why Is This Site Of Interest?

- One of the most stressed aquifer in NSW
- Groundwater considered high risk
 - Demand for extraction by water users is high relative to recharge
- NSW cotton industry relies on groundwater supplies



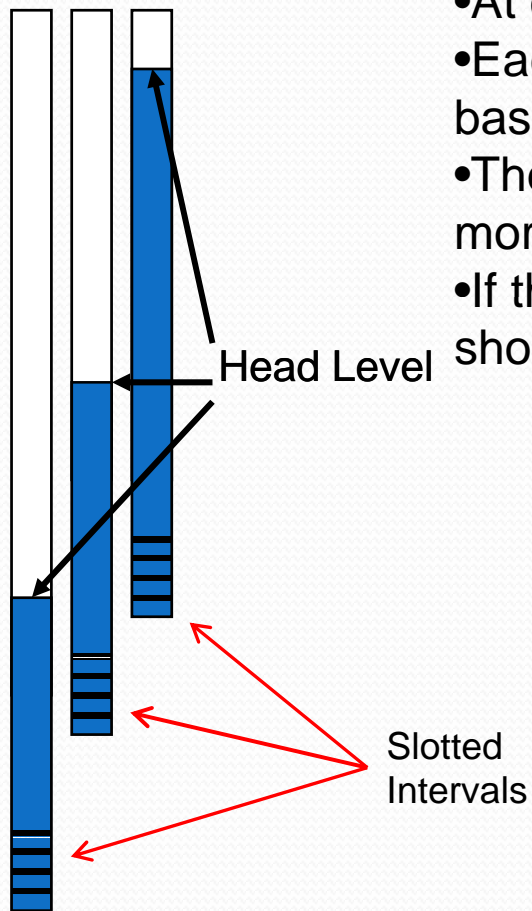
Conceptual Model of Lower Namoi Valley Aquifers

- Conceptual model for the region is simplistic
- Can we advance our understanding of the conceptual model to improve groundwater management

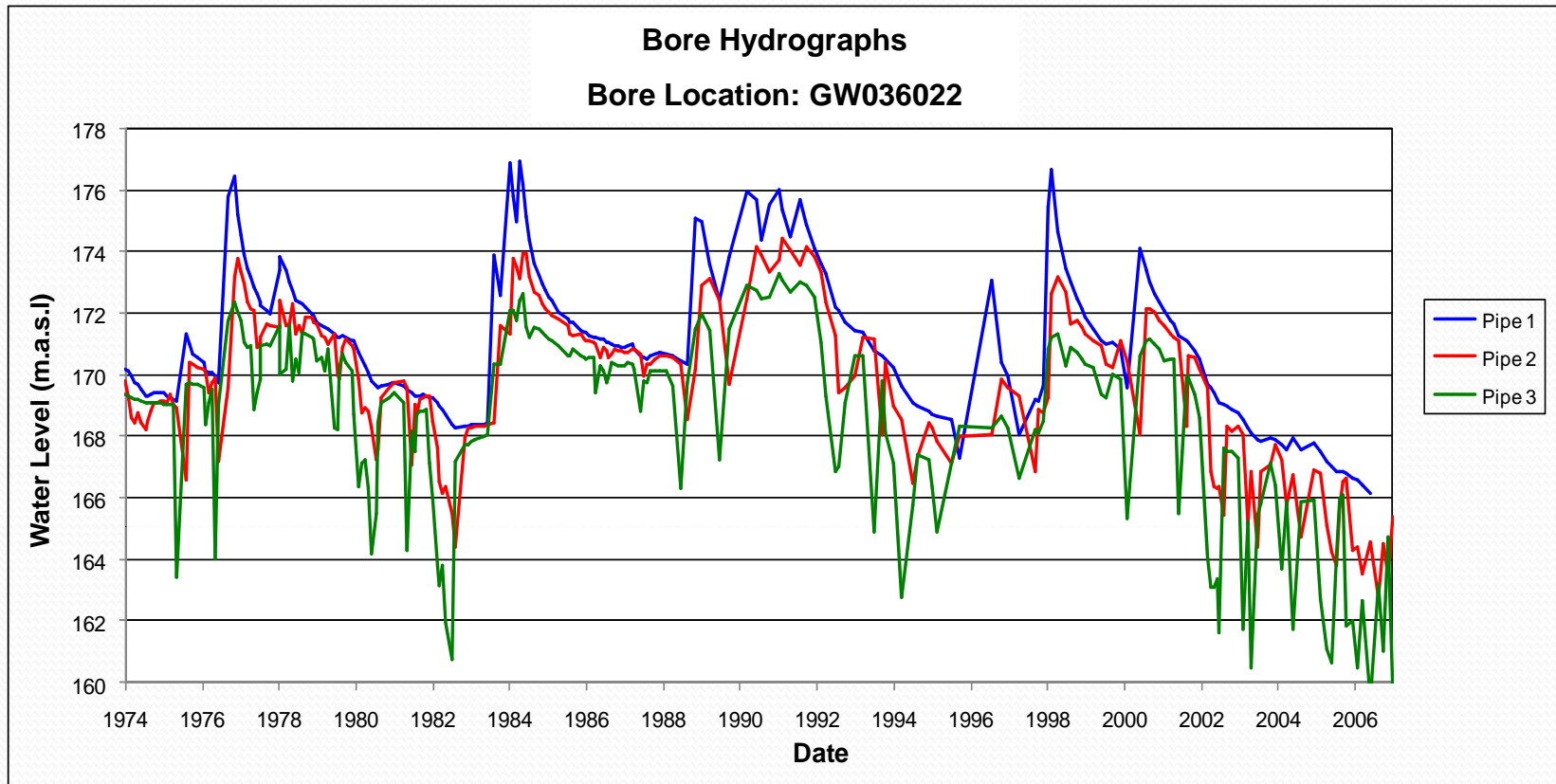


Groundwater Monitoring Bores

- 358 sites in Lower Namoi
- At each location there are 1-7 pipes
- Each pipe is slotted over a small interval at the base
- These government monitoring bores indicate a more complex system.
- If there are 3 separate aquifer systems the heads should behave differently

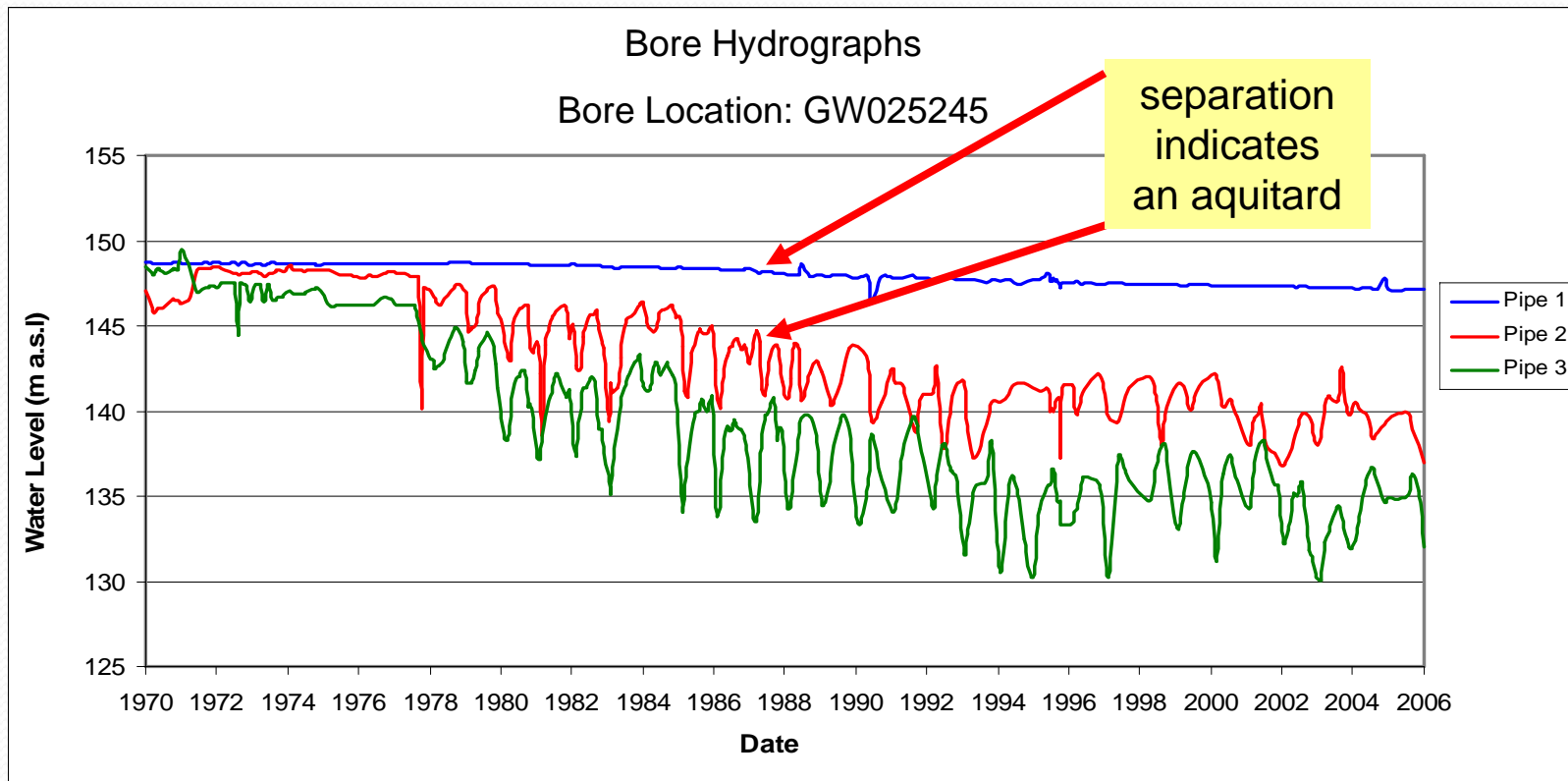


Bore Hydrographs



All levels of the aquifer connected.

Bore Hydrographs



Compared to the lowest aquifer the upper aquifer is semi isolated, indicating the existence of an aquitard.



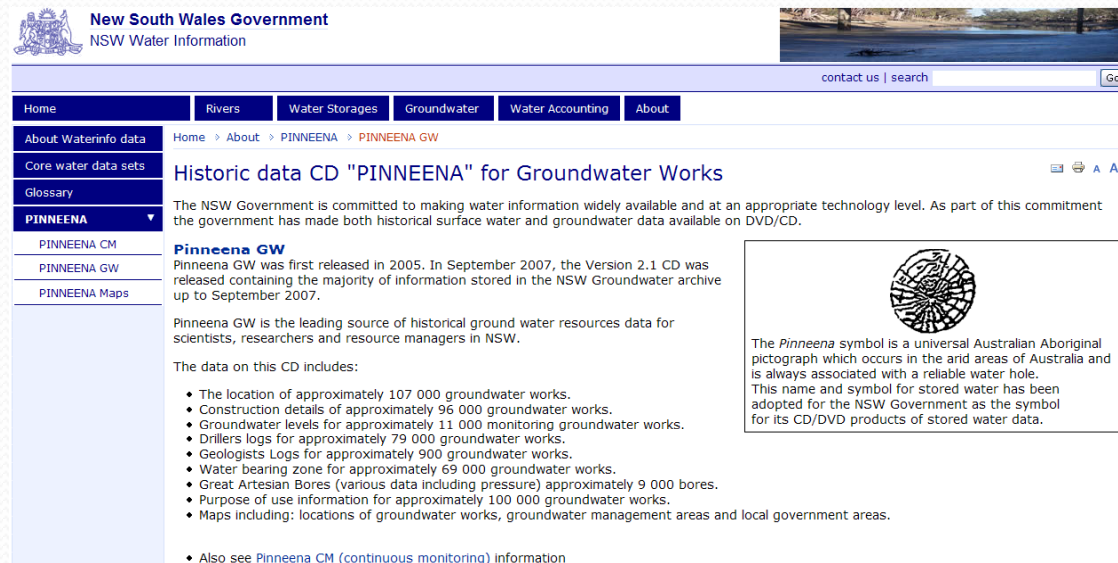
What was Investigated?

Aim - to map hydraulic connection by examining:

- Head change due to groundwater extraction
 - long and short term
- Head change due to flood events
- Groundwater chemical properties
 - pH
 - temperature
- The correlation between rainfall and aquifer recharge

Data Source

- All bore data is obtained from the NSW PINNENNA groundwater and surface flow archive



The screenshot shows the NSW Water Information website. The header includes the New South Wales Government logo and the text 'NSW Water Information'. A navigation menu contains links for Home, Rivers, Water Storages, Groundwater, Water Accounting, and About. The main content area is titled 'Historic data CD "PINNENNA" for Groundwater Works'. It features a breadcrumb trail: Home > About > PINNENNA > PINNENNA GW. The page text states: 'The NSW Government is committed to making water information widely available and at an appropriate technology level. As part of this commitment the government has made both historical surface water and groundwater data available on DVD/CD.' Below this, a section titled 'Pinneena GW' explains that the data was first released in 2005 and that a Version 2.1 CD was released in September 2007, containing the majority of information from the NSW Groundwater archive up to September 2007. It identifies Pinneena GW as the leading source of historical ground water resources data for scientists, researchers, and resource managers in NSW. A list of data included on the CD is provided: approximately 107,000 groundwater works, 96,000 construction details, 11,000 groundwater levels, 79,000 drillers logs, 900 geologists logs, 69,000 water bearing zones, 9,000 Great Artesian Bores, and 100,000 purpose of use information items. A note at the bottom suggests also seeing Pinneena CM (continuous monitoring) information. To the right, there is a circular Aboriginal pictograph symbol and a text box explaining that the Pinneena symbol is a universal Australian Aboriginal pictograph associated with a reliable water hole, adopted by the NSW Government for its CD/DVD products.

- Water chemistry data used was previously collected by McLean (2000) in 1999-2000 and from a survey of irrigator bores 2006/2007

3D Models

- **Bore Hydrographs**

- Multidecadal Head Change
- One Year Pumping Stress
- Flood response models

KRIGING

- **Water Chemistry**

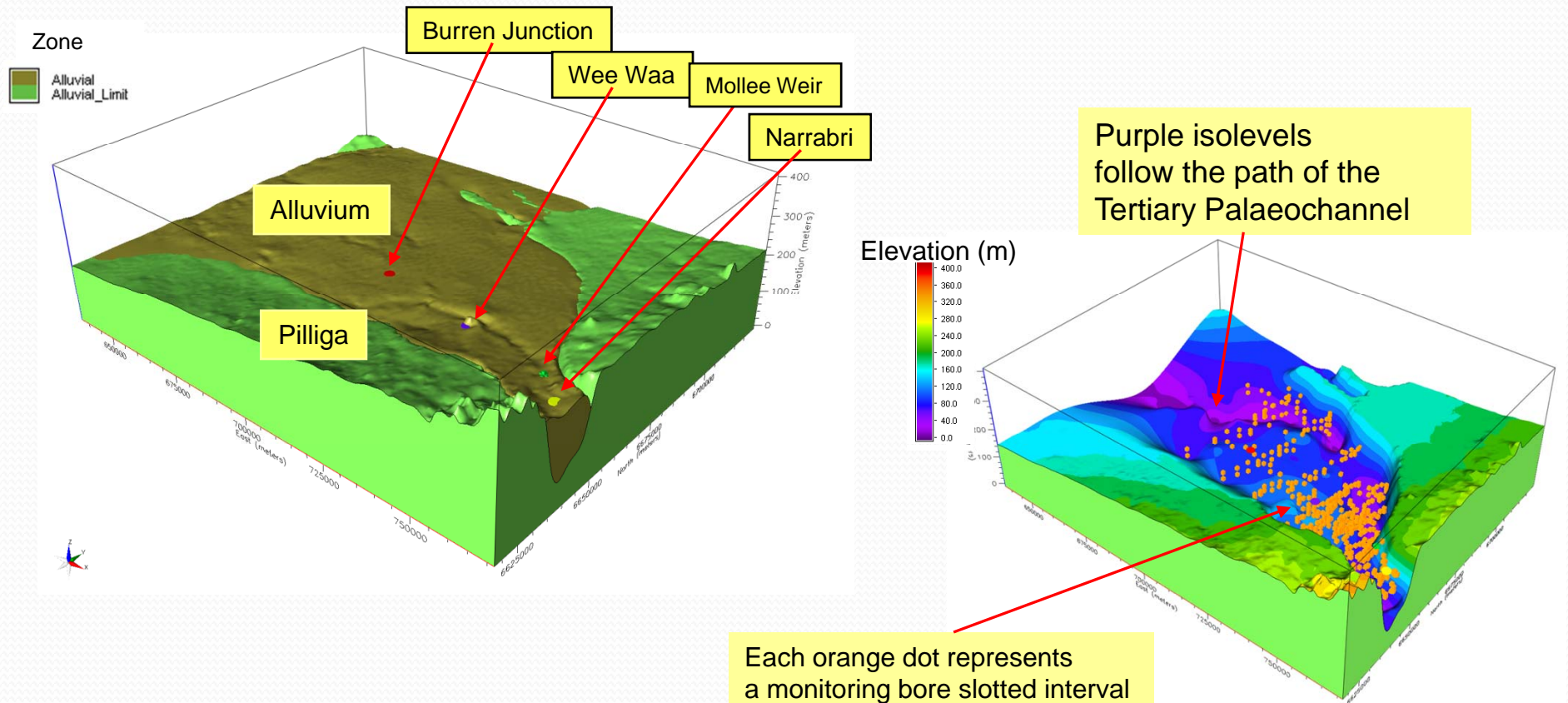
- pH
- Temperature

MINIMUM TENSION

- All models provide insight into the aquifer geometry, hydraulic connection and pathways of recharge

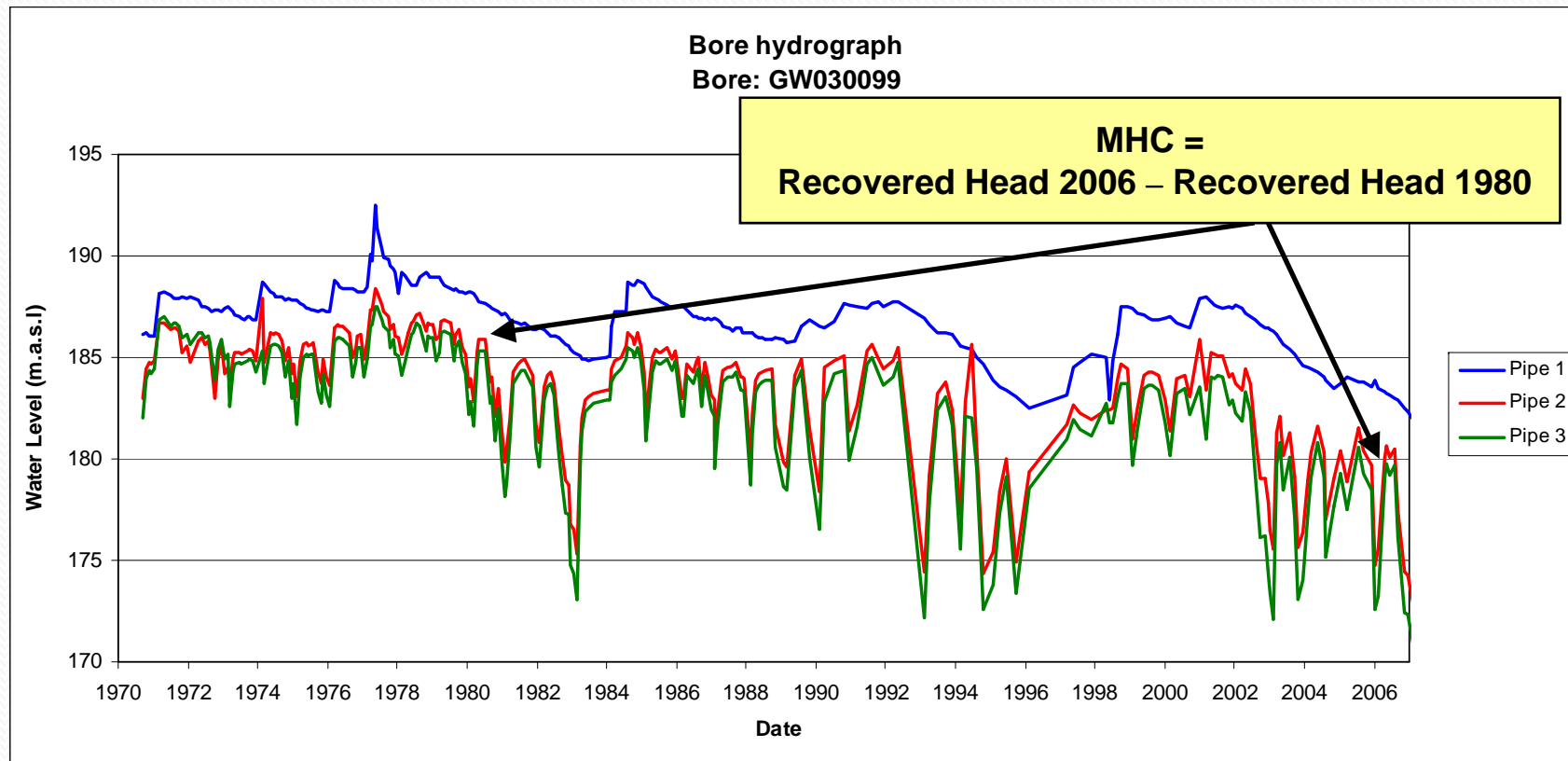
Methodology

- Zone block model
 - A DEM was used to generate the top surface of the model
 - Aquifer limit – base of alluvium approximated by adding 10 m to the base of deep bores



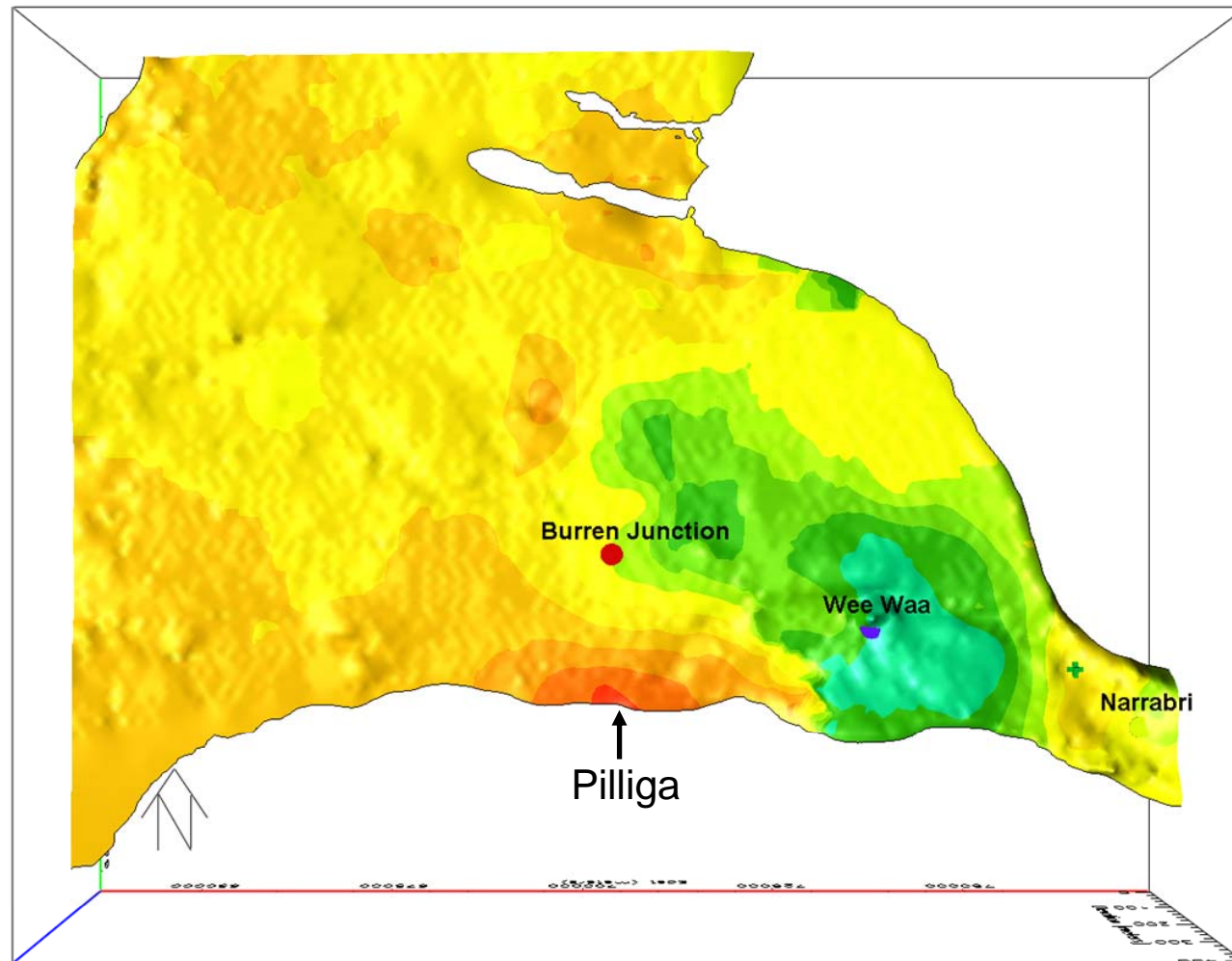
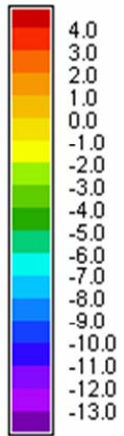
Methodology

- Bore hydrograph analysis
 - Data was processed in python scripts
 - **Multidecadal Head Change model**



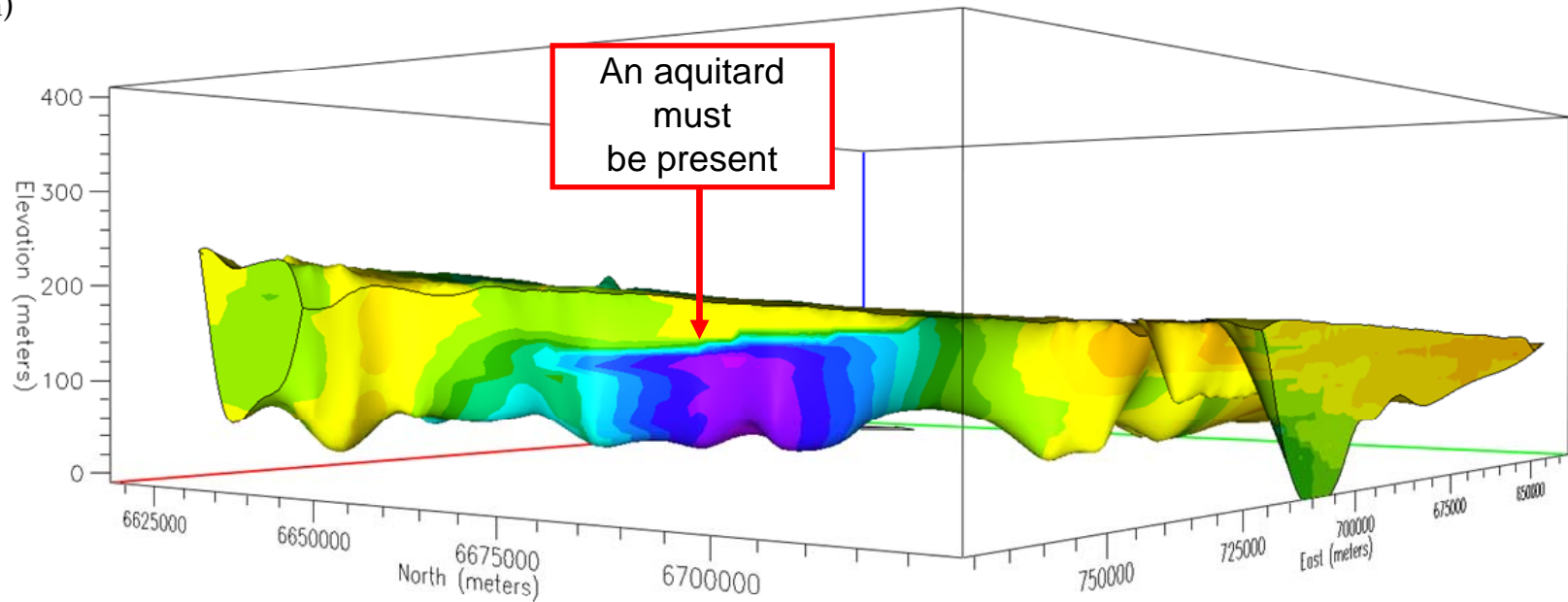
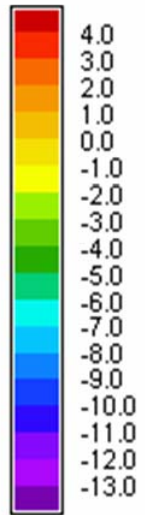
Multidecadal Head Change

Head Change (m)
(1980-2006)



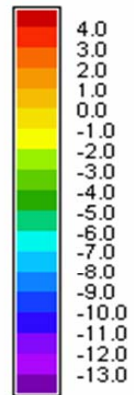
Multidecadal Head Change

Head Change (m)
(1980-2006)



Multidecadal Head Change

Head Change (m)
(1980-2006)



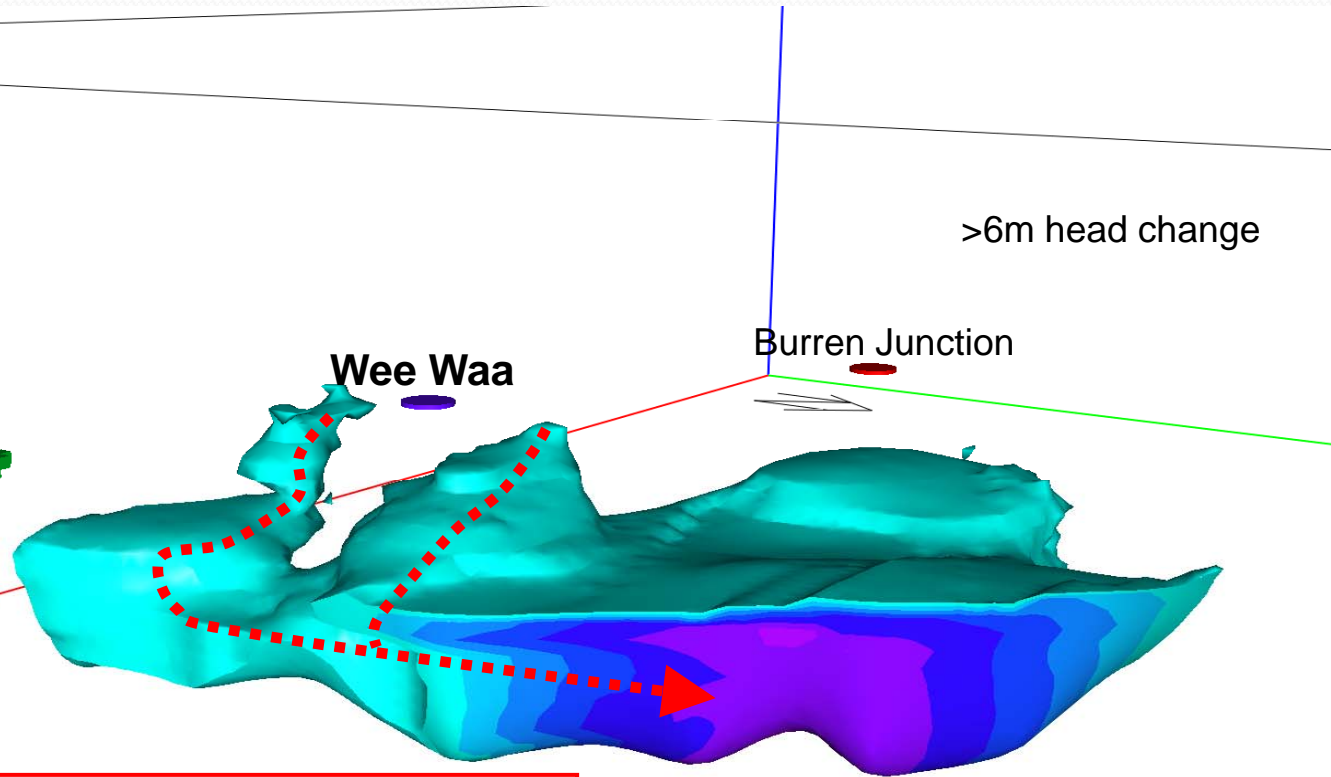
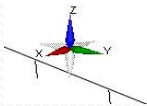
Narrabri

Wee Waa

Burren Junction

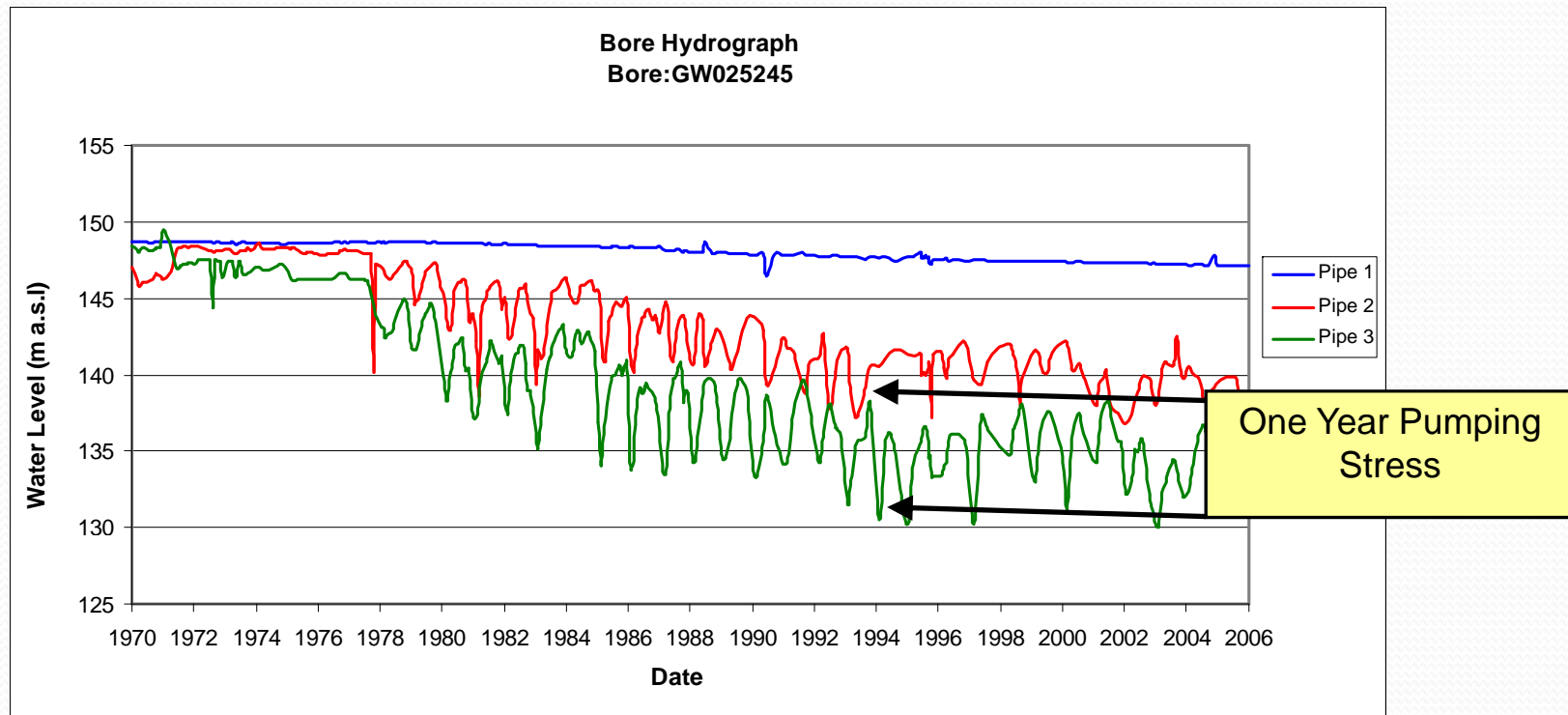
>6m head change

Pathways of hydraulic
connectivity from surface to depth



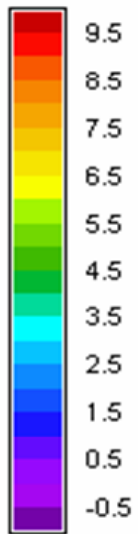
Methodology

- One Year Pumping Stress



One Year Head Change

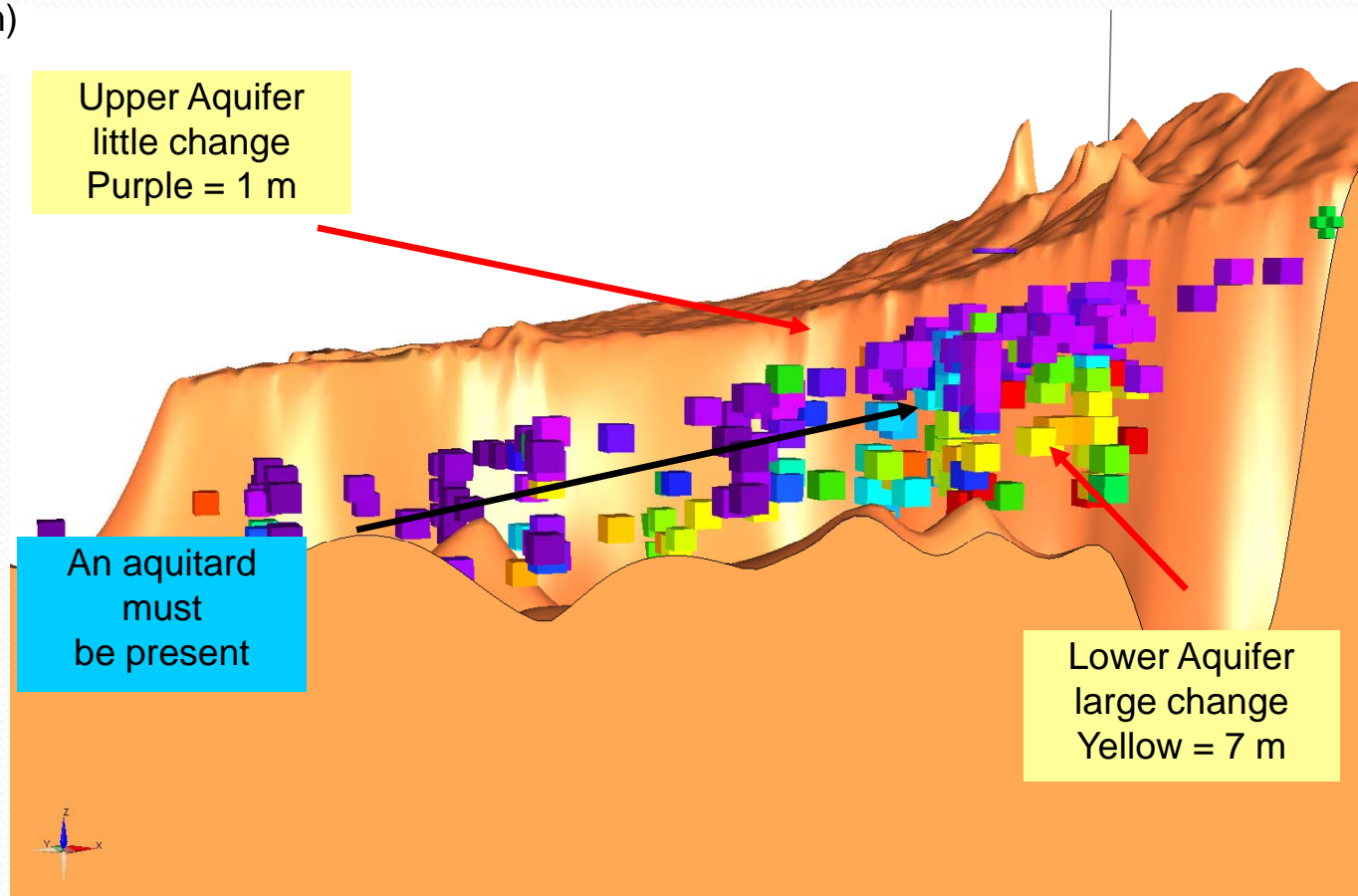
Head Change (m)
(1993)



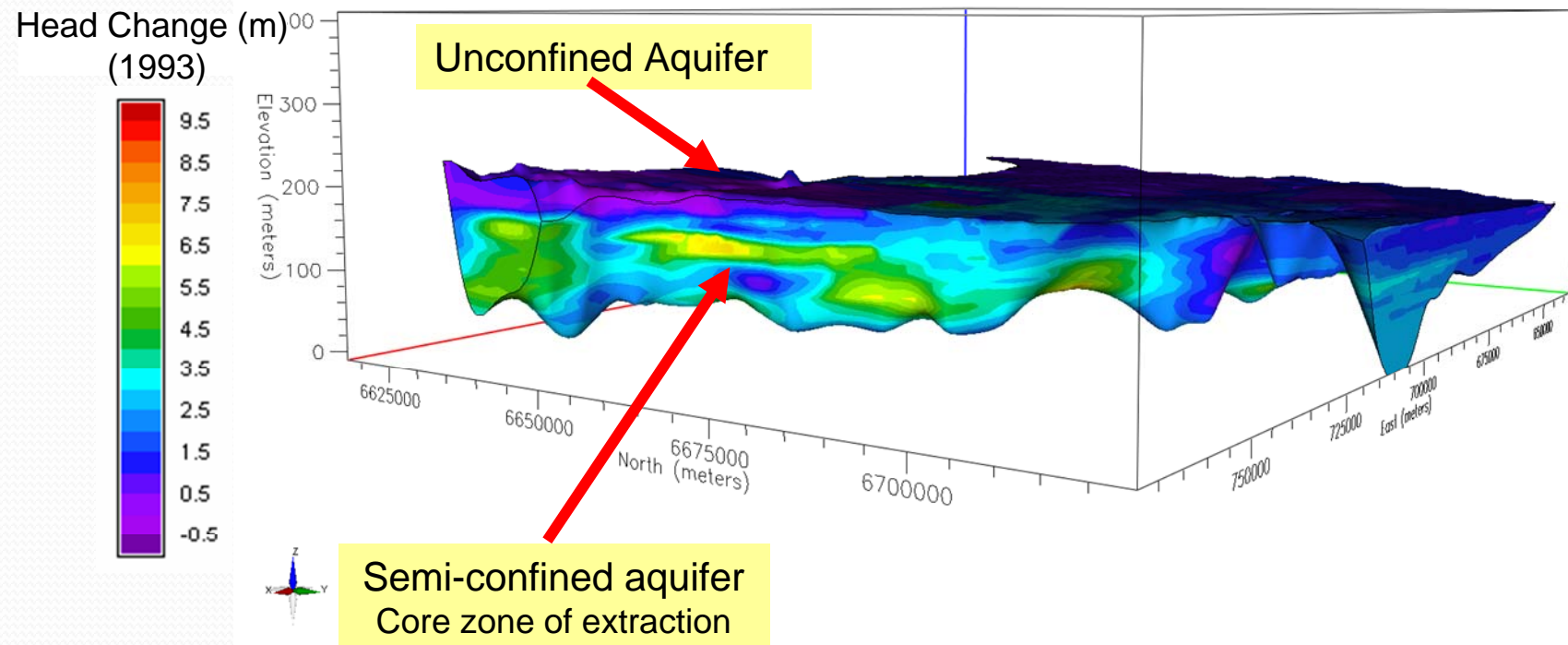
Upper Aquifer
little change
Purple = 1 m

An aquitard
must
be present

Lower Aquifer
large change
Yellow = 7 m

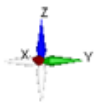
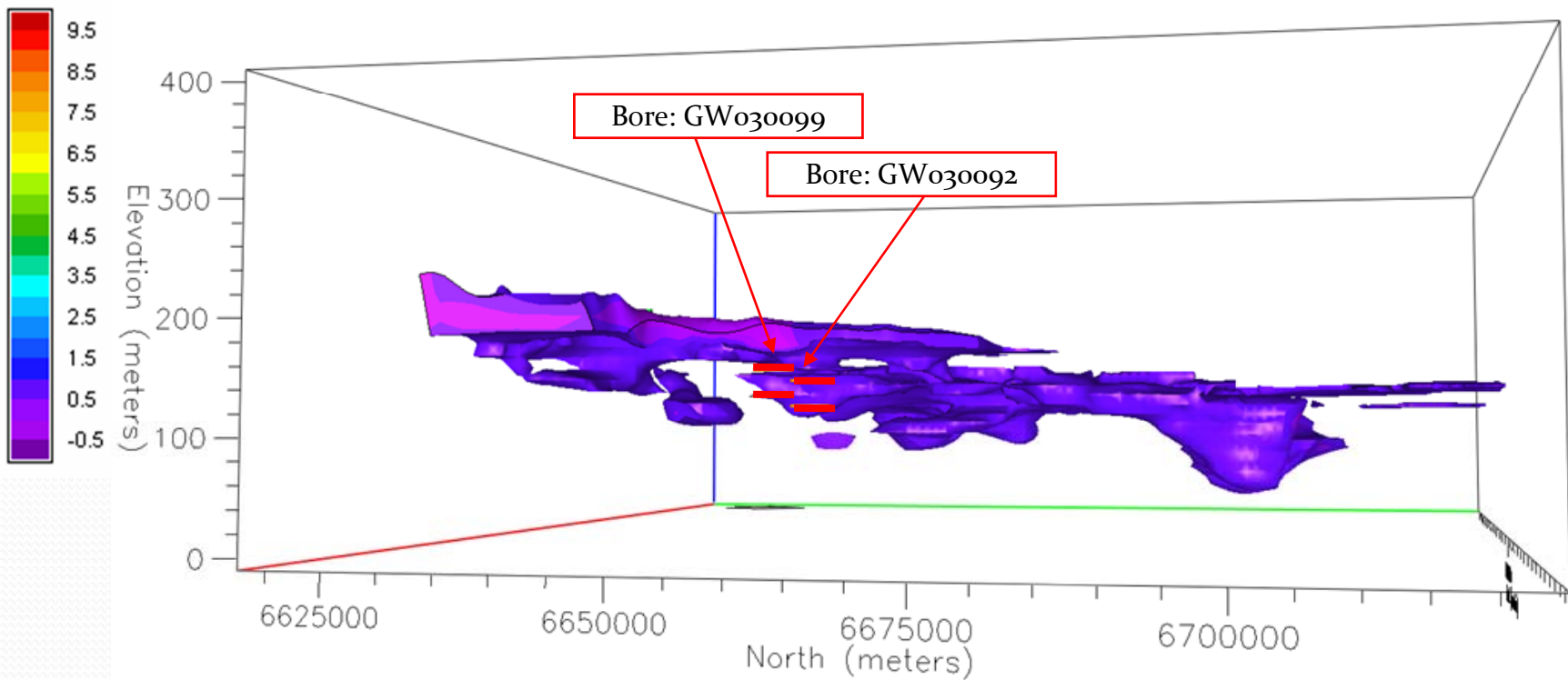


One Year Head Change



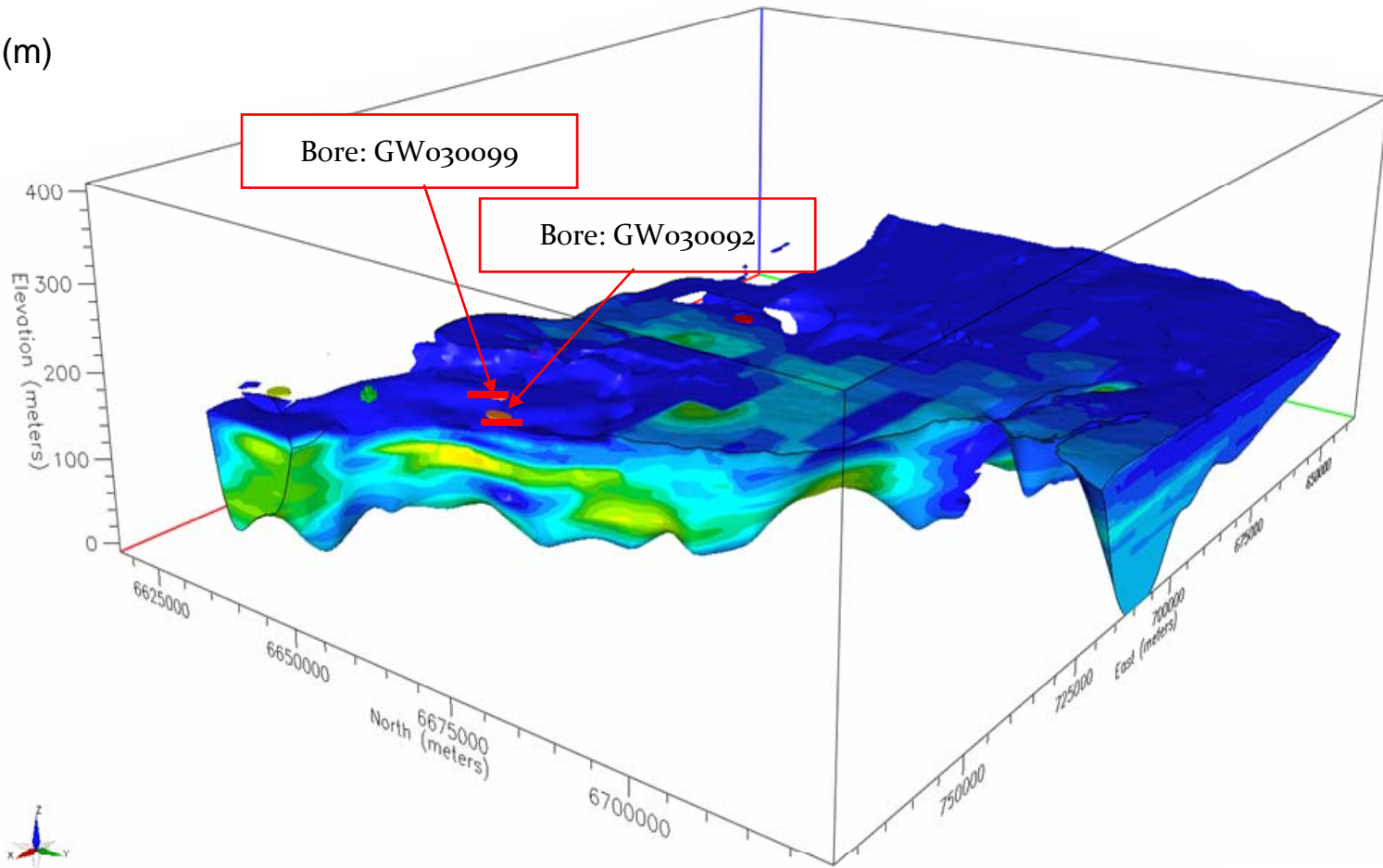
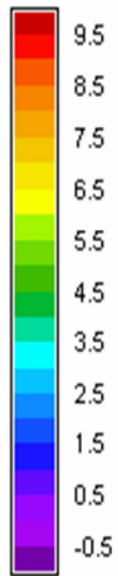
Unconfined Shallow Aquifer

Head Change (m)
(1993)



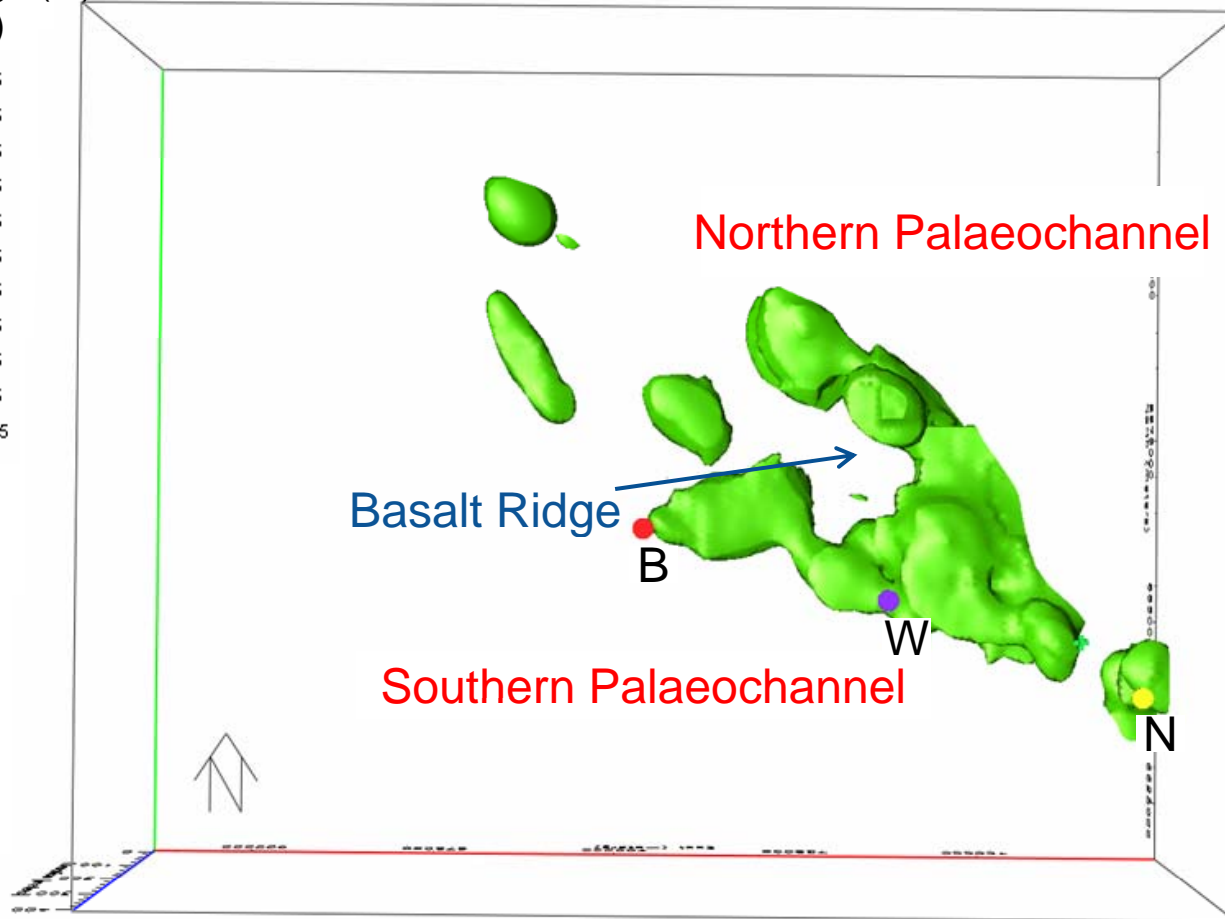
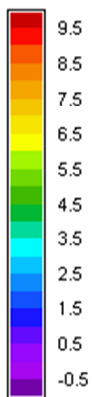
Semiconfined Deep Aquifer

Head Change (m)
(1993)



Head Change Follows the Palaeochannels

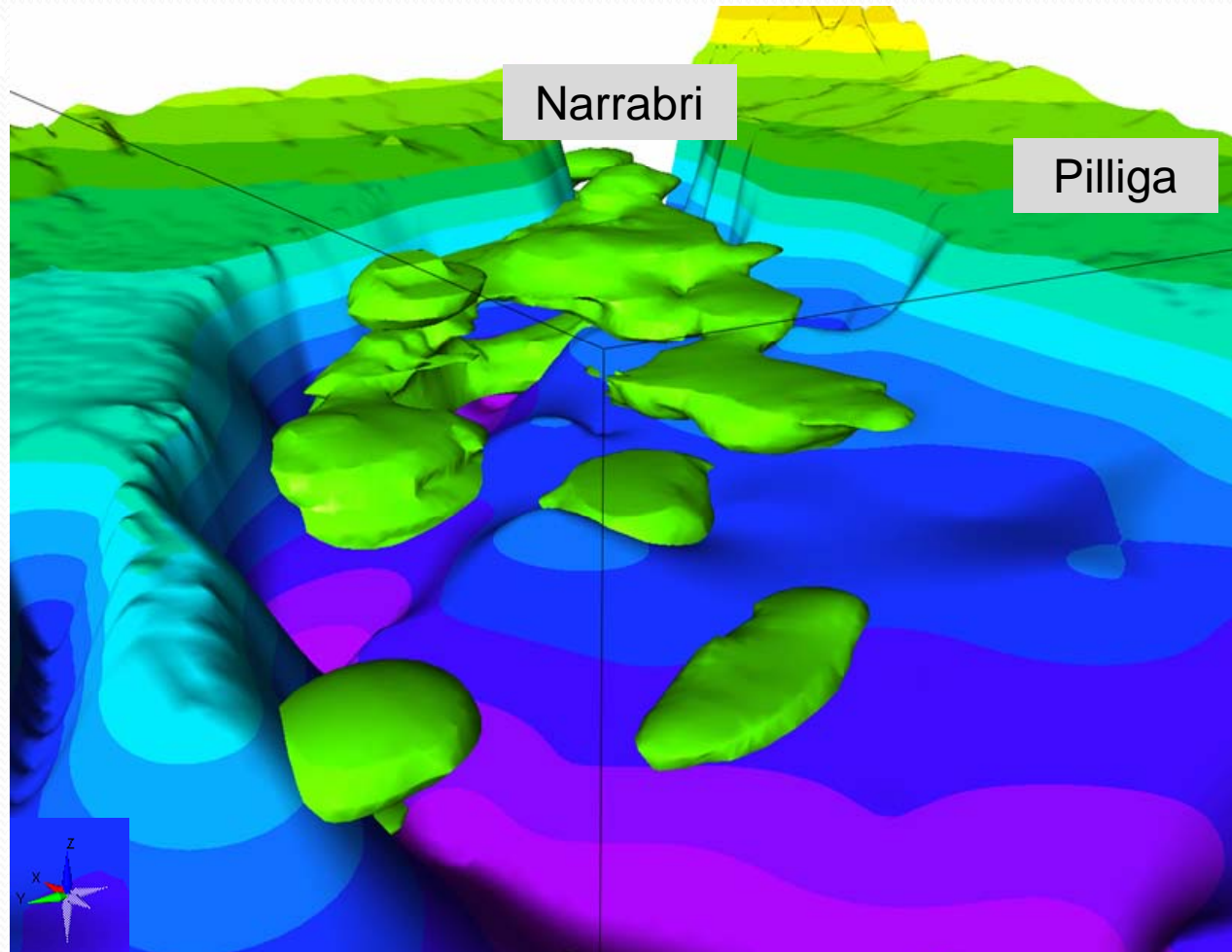
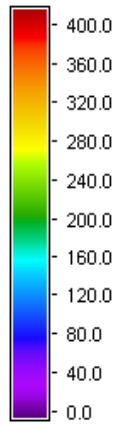
Head Change (m)
(1993)



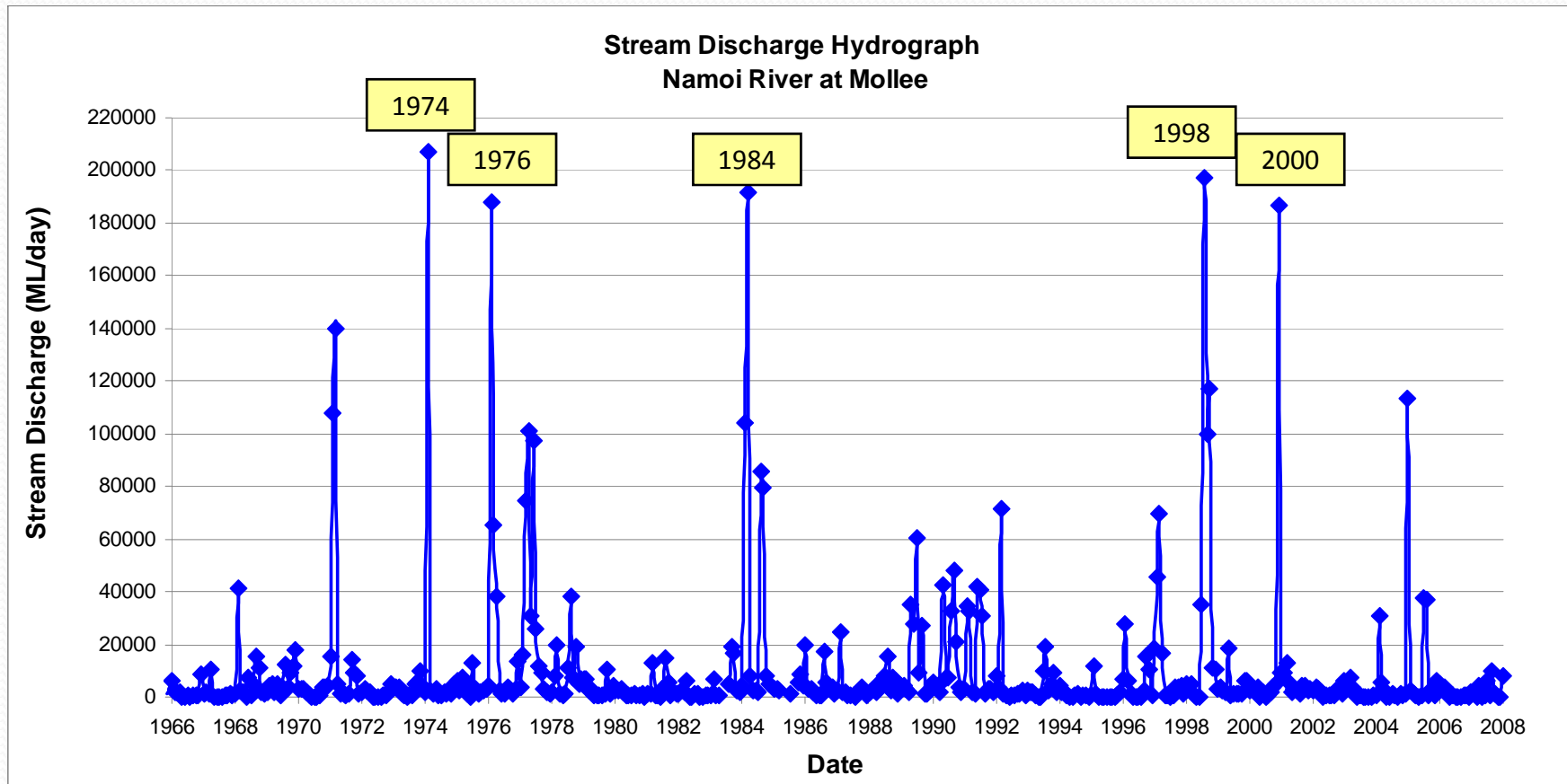
Delineates aquifer geometry

Northern Palaeochannel Divided into Upper and Lower

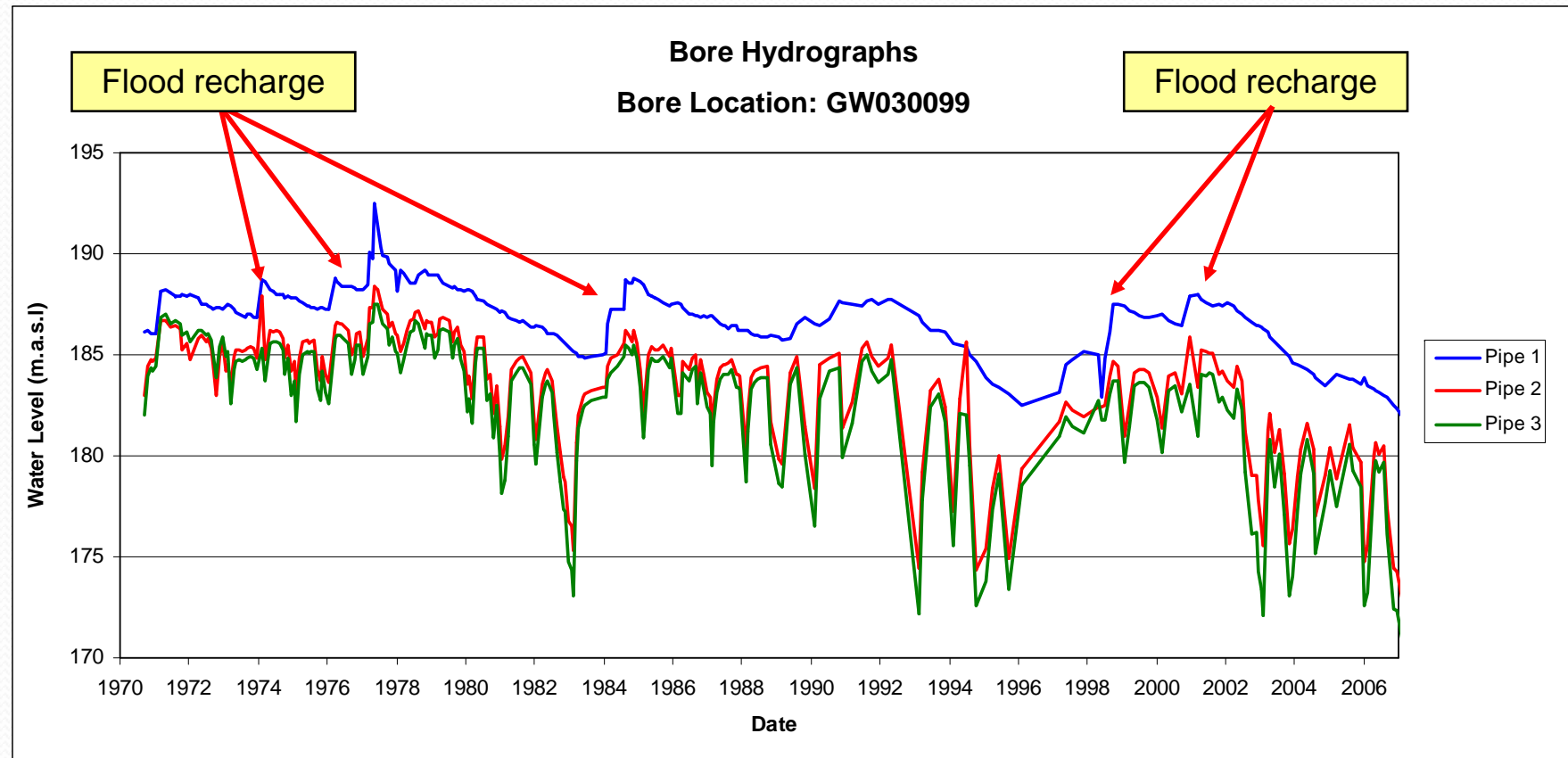
Elevation (m)



Mollee Stream Hydrograph



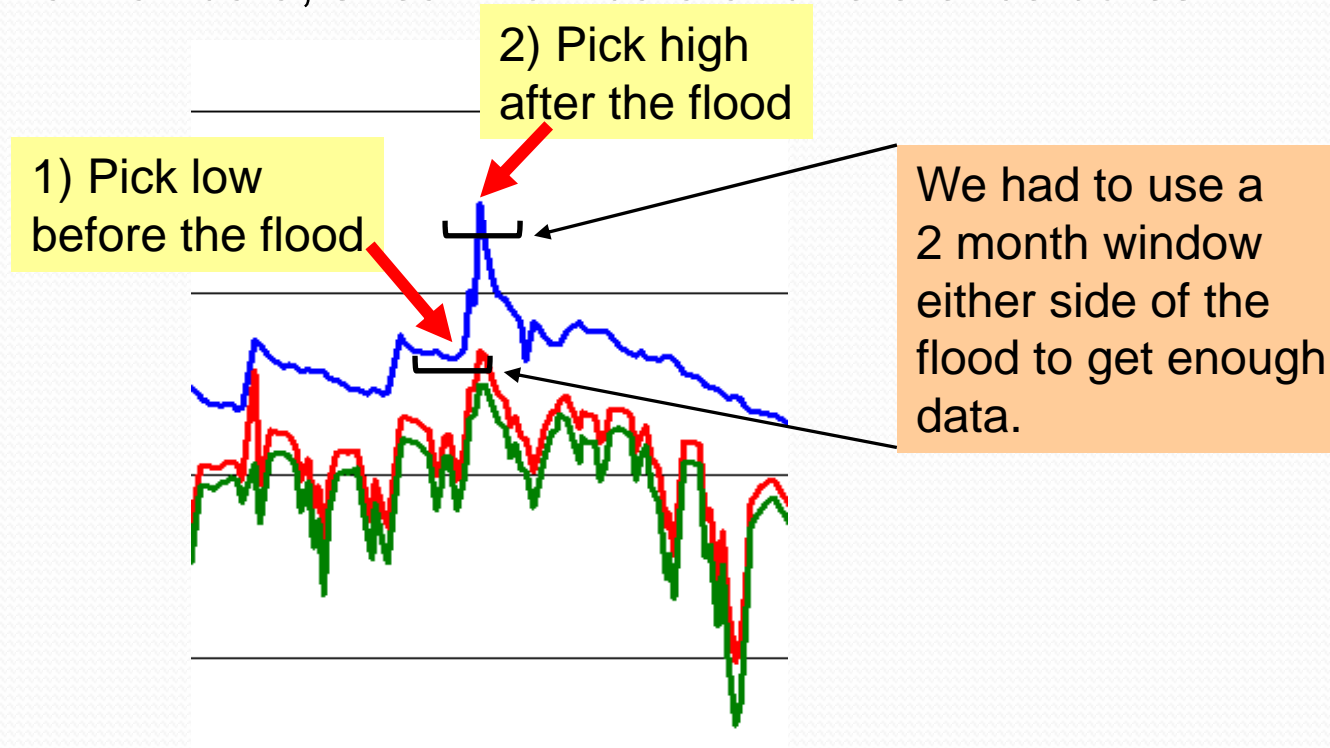
Reference Bore Showing Floods



At this location there are three pipes, the lower two are strongly influenced by pumping

Flood Recharge

- Used a window to pick out flood dates to analyse the recharge from floods
- Used rainfall data, streamflow data and reference bores



3) Grid the flood rise data = High - Low



What Does Flood Recharge Go?

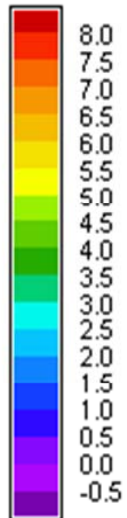
- **KEY OBSERVATION**

- All floods show a shallow and deep aquifer response
- There are seasonal variations in aquifer response

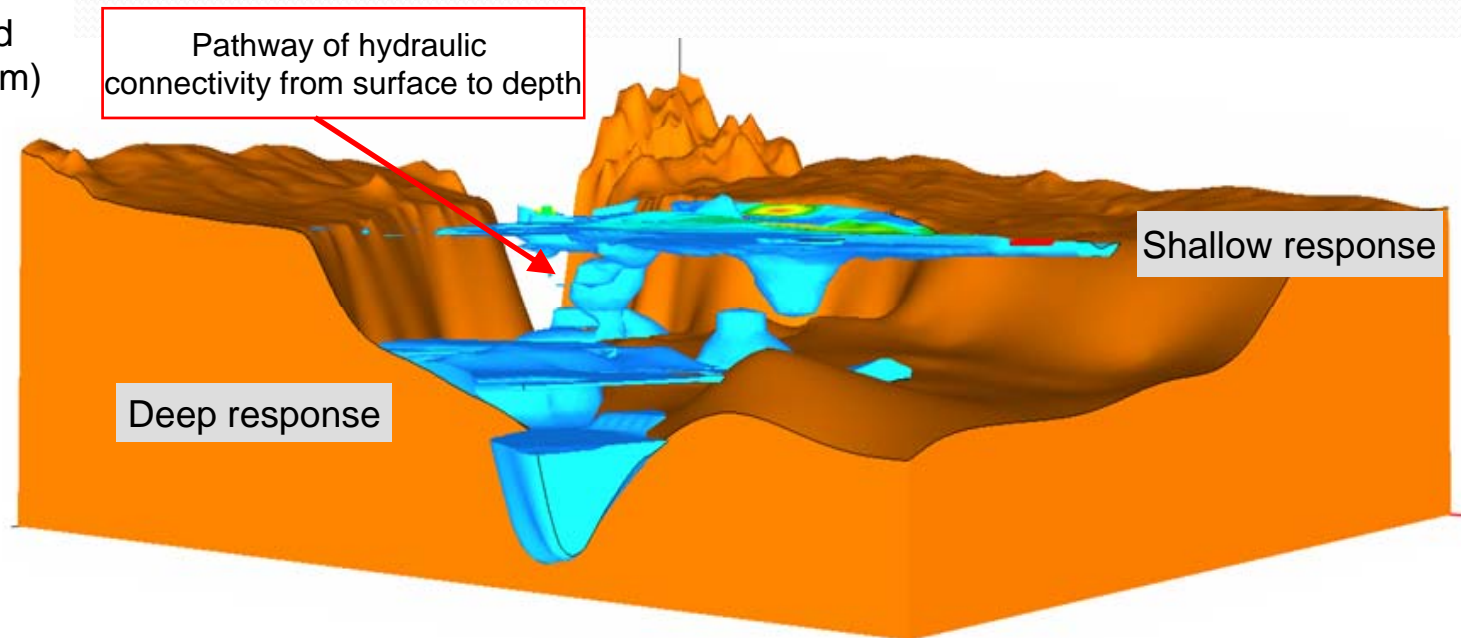
Winter Flood - 1998

Clear separation between the unconfined shallow aquifer and deep palaeochannel

1998 Flood
Response (m)

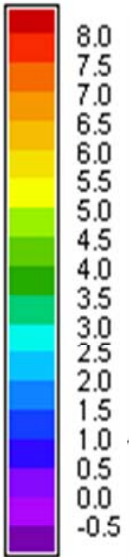


Pathway of hydraulic
connectivity from surface to depth

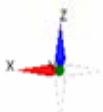
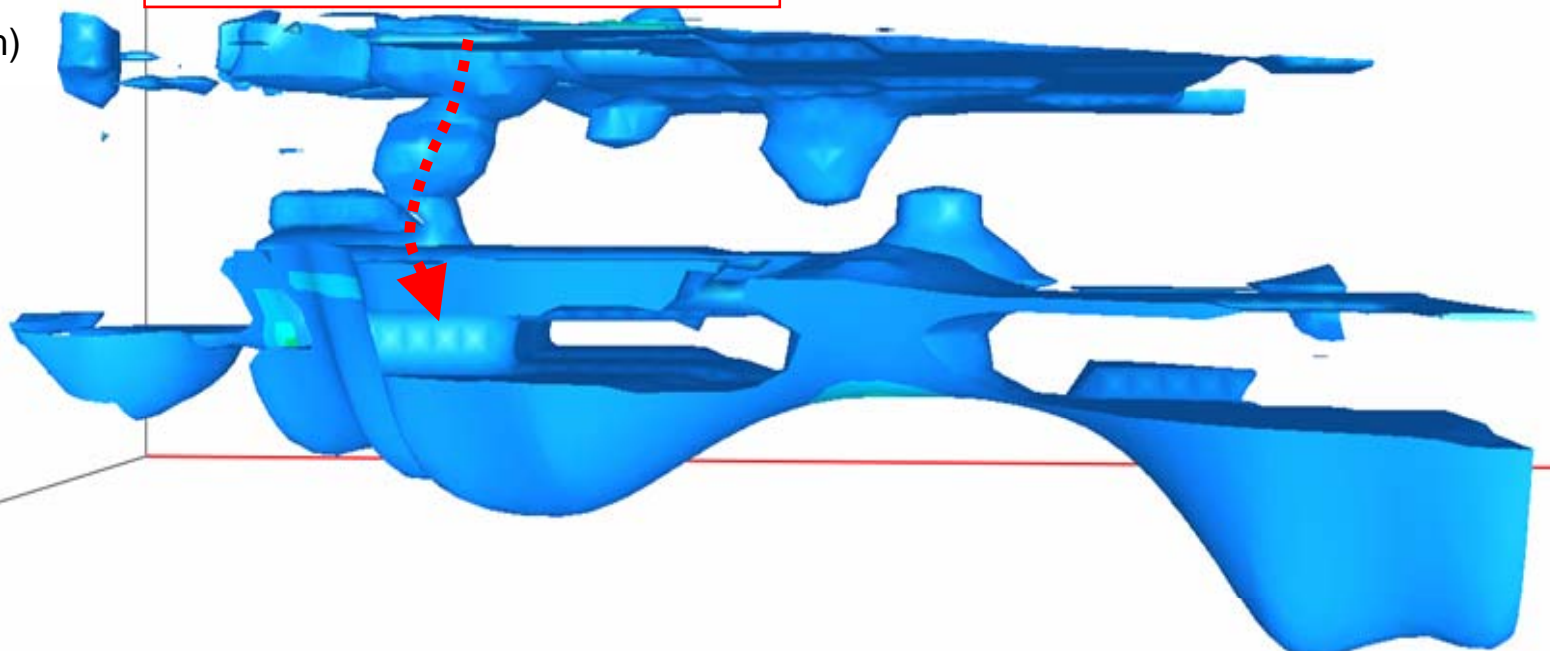


Winter Flood 1998

1998 Flood Response (m)



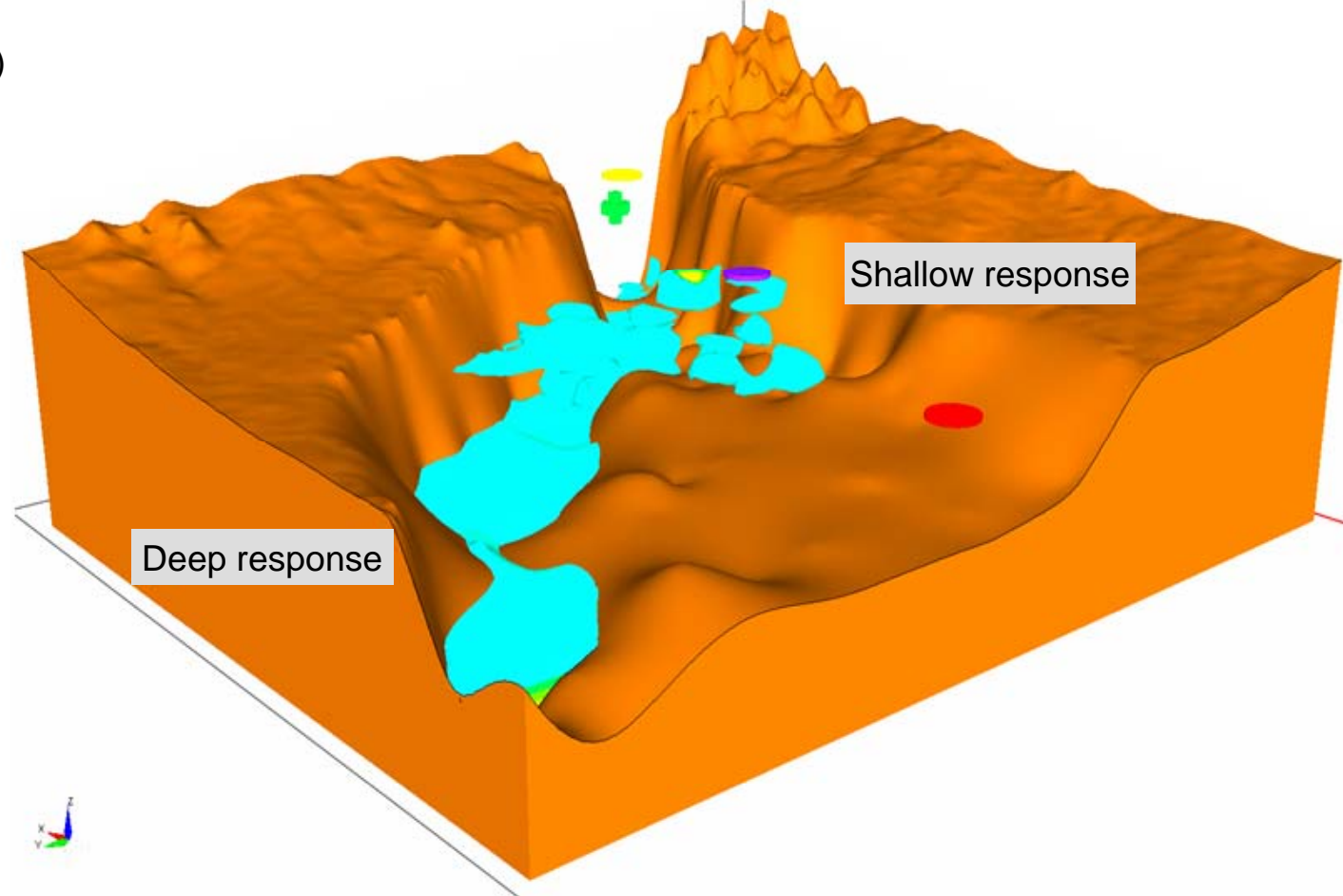
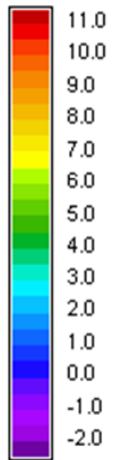
Pathways of hydraulic connectivity from surface to depth



Summer Flood - 1976

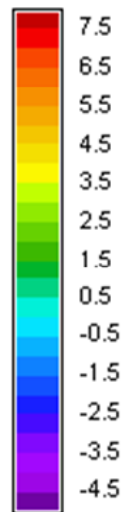
Clear separation between the unconfined shallow and deep aquifer

1976 Flood Response (m)



Primary Recharge Area

1984 Flood
Response (m)

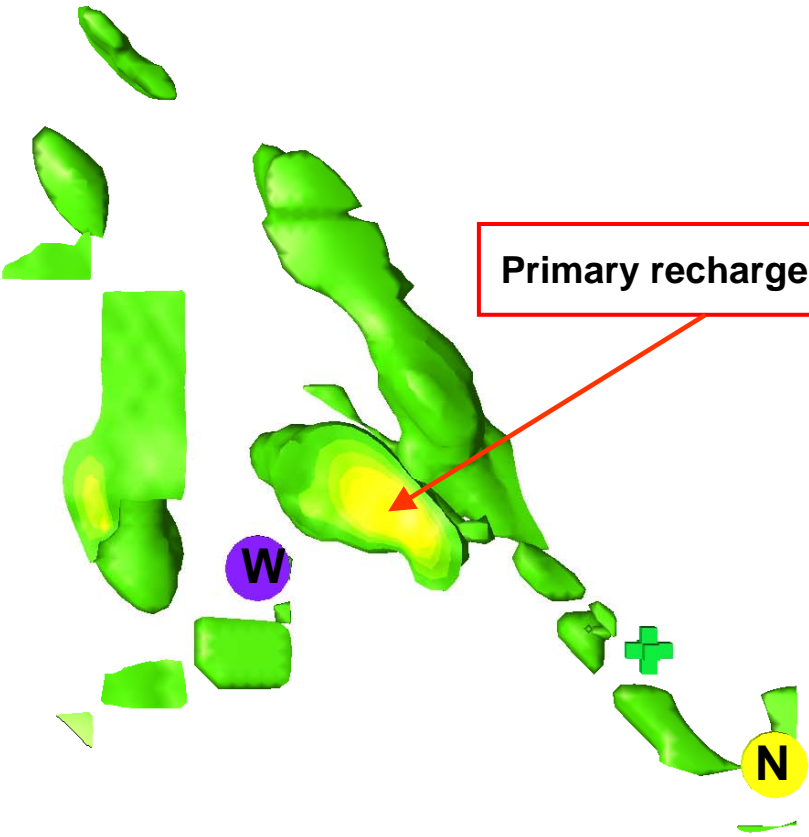


B

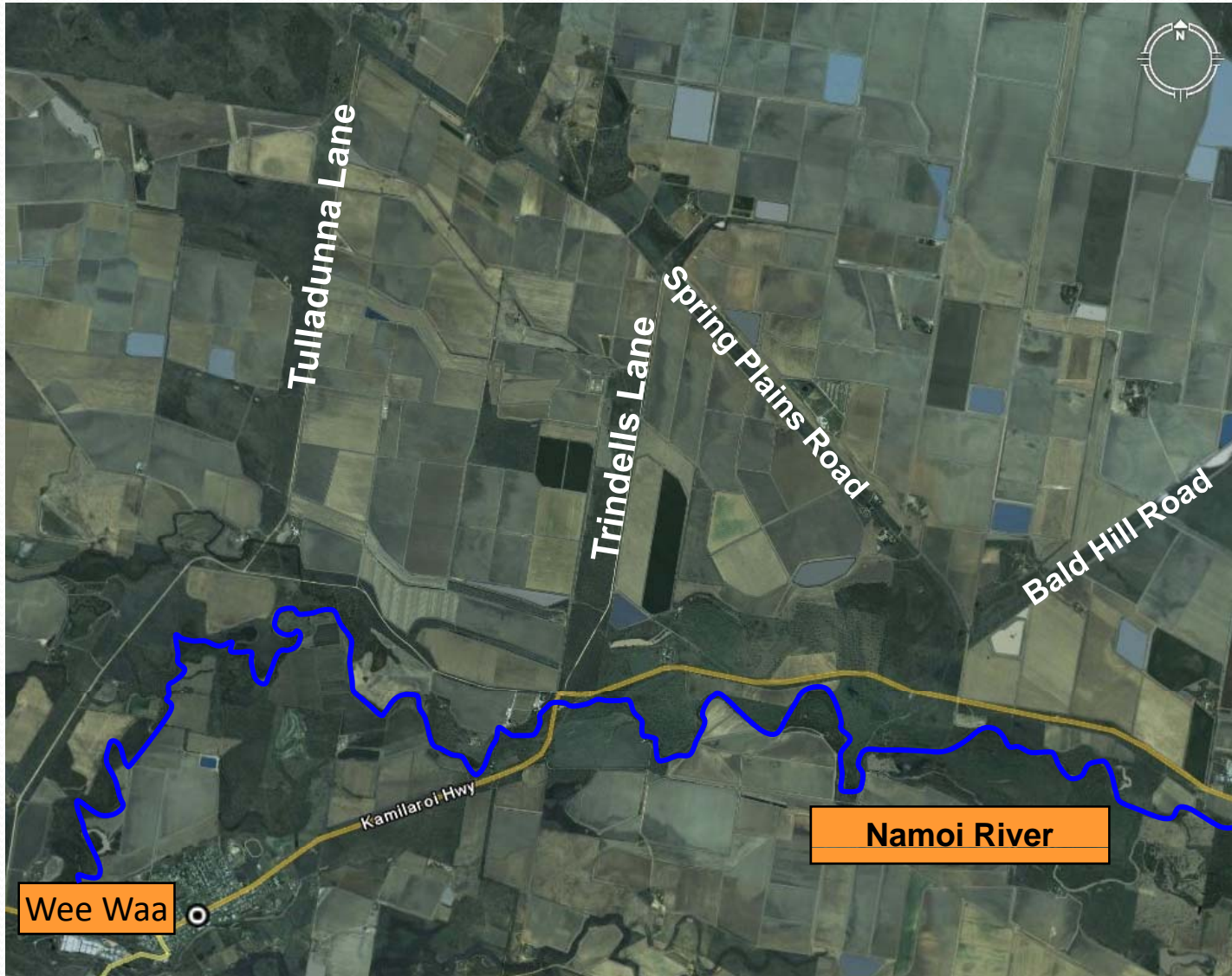
W

N

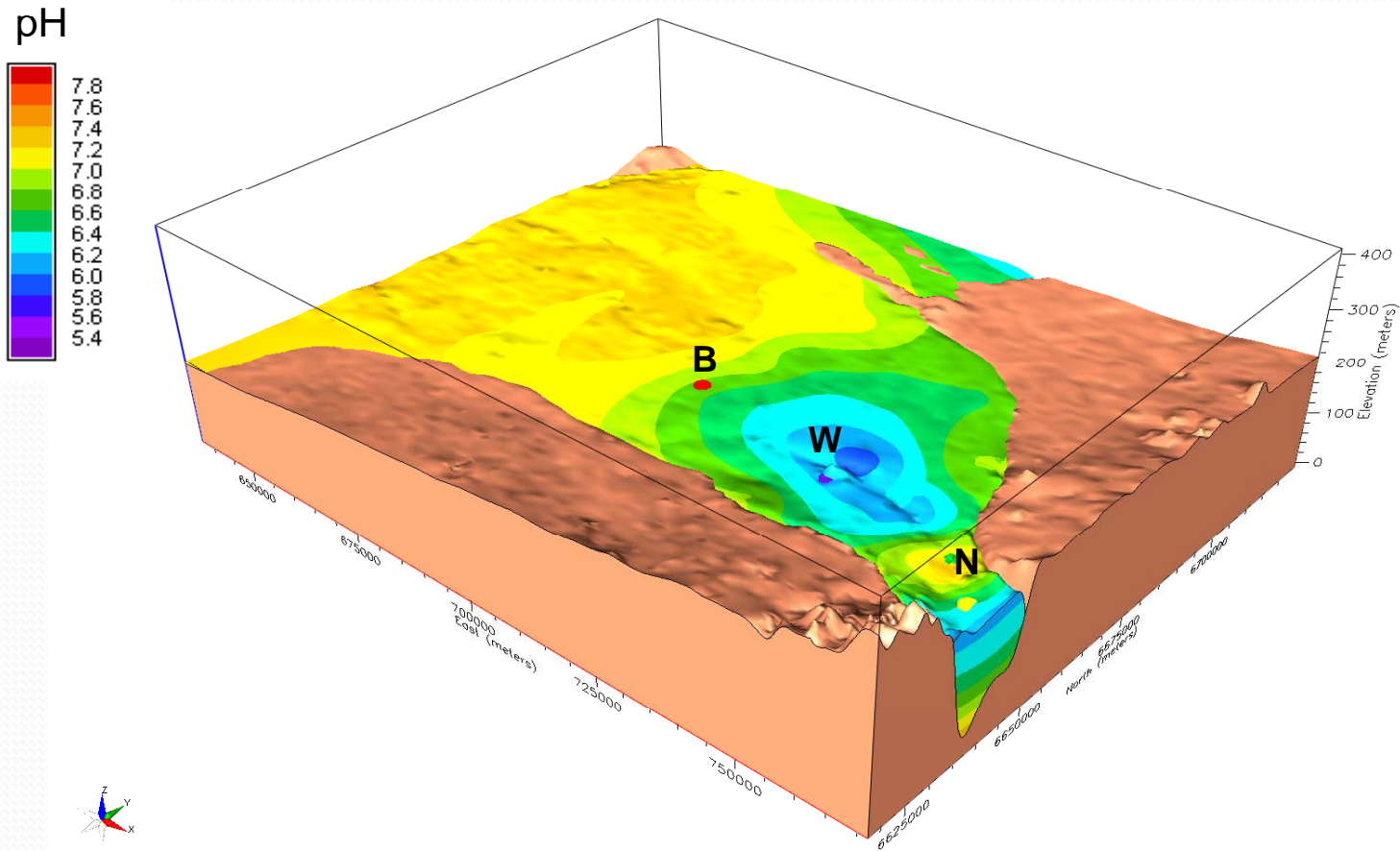
Primary recharge area



Primary Recharge Area



pH

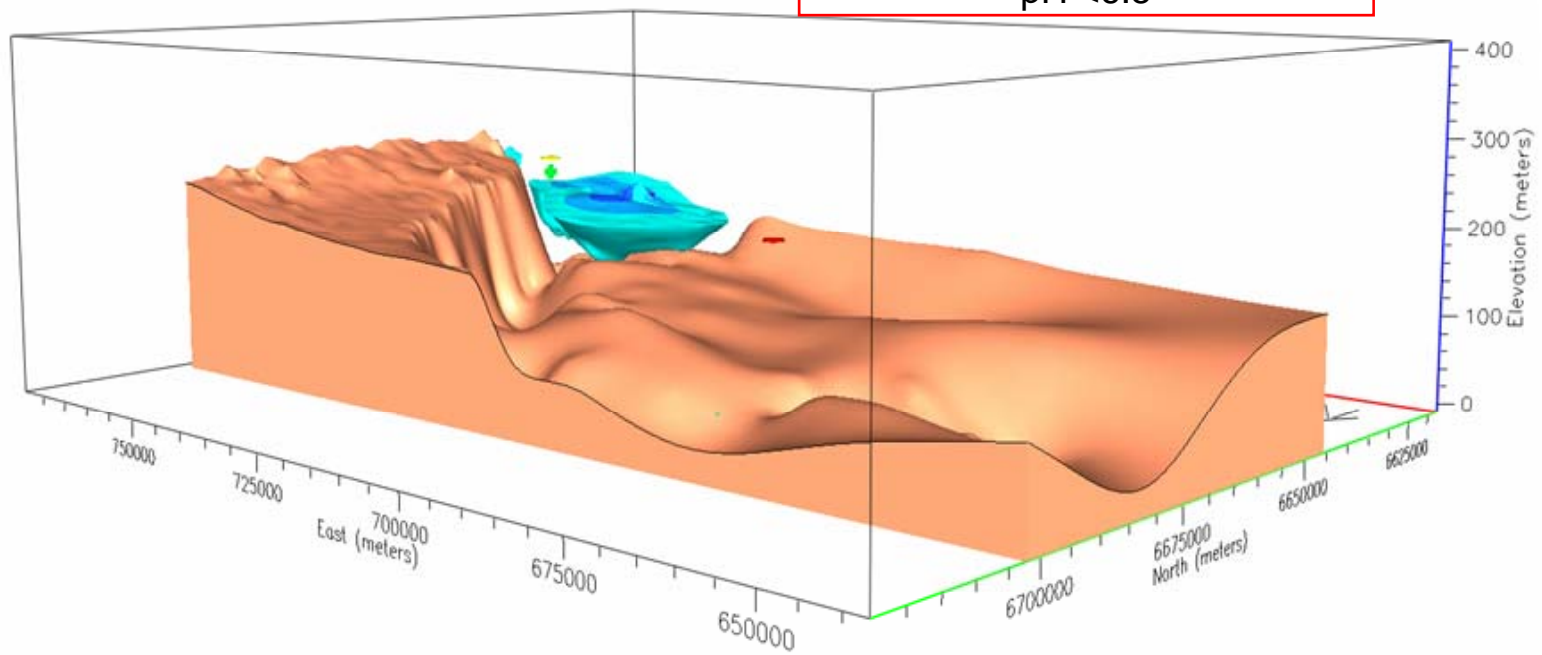
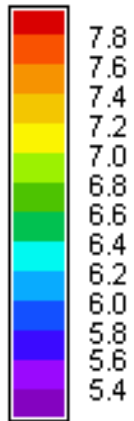


pH is lower in the recharge zone due to CO_2 equilibrium processes

pH

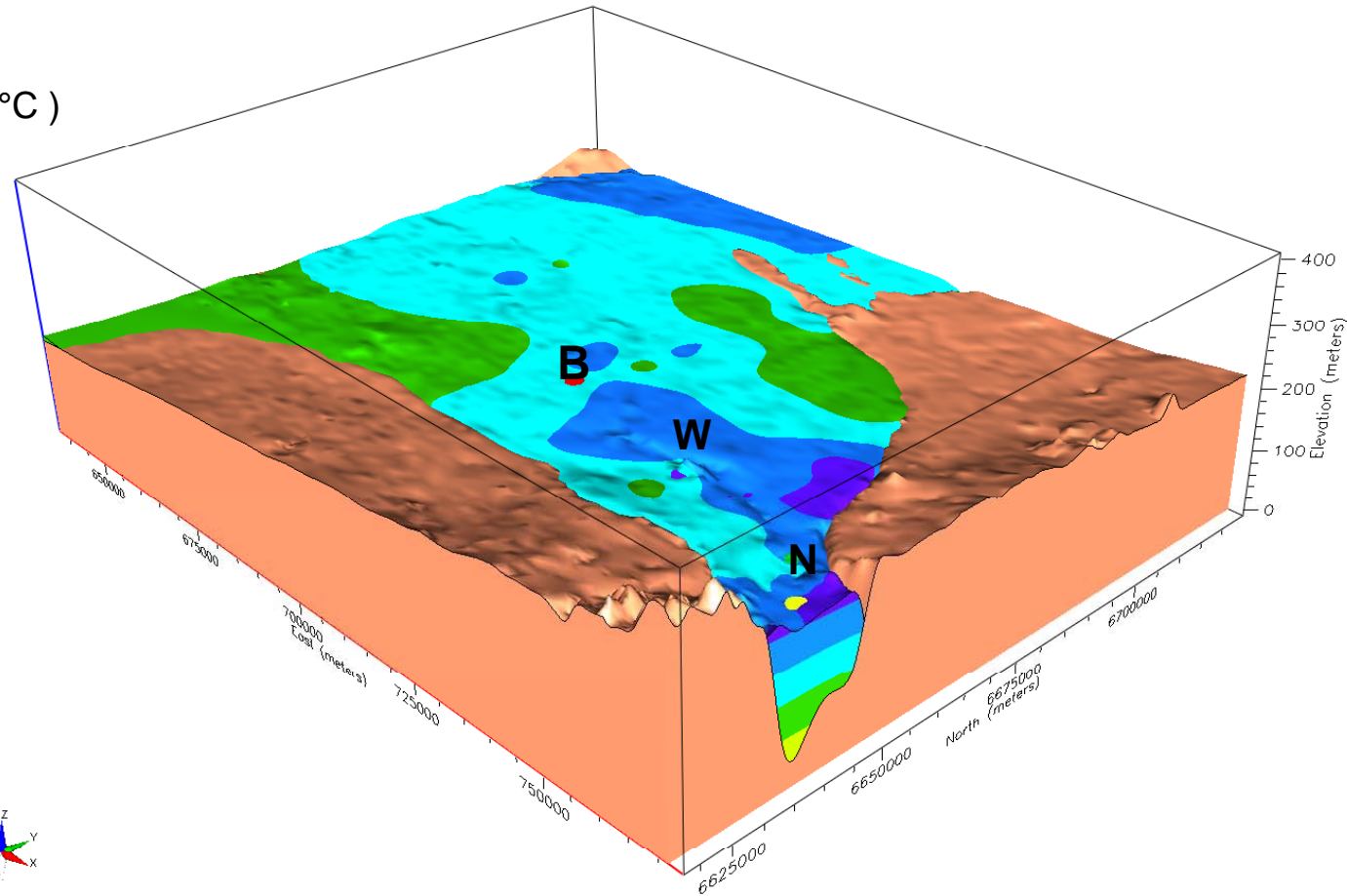
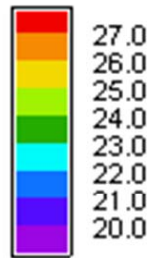
Low pH values occur only
in the shallow aquifer
 $\text{pH} < 6.5$

pH



Temperature

Temperature (°C)

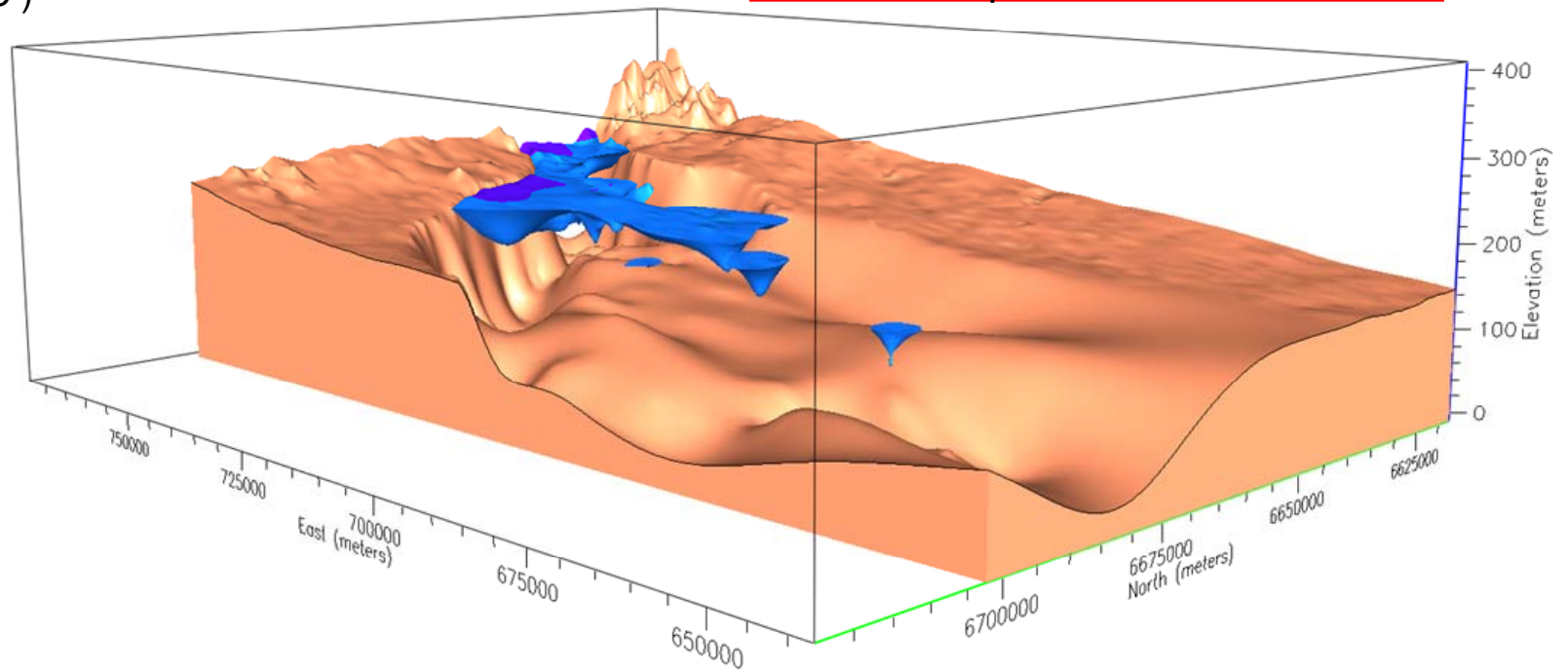
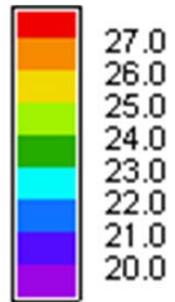


River water is cooler than long term resident aquifer water

Temperature

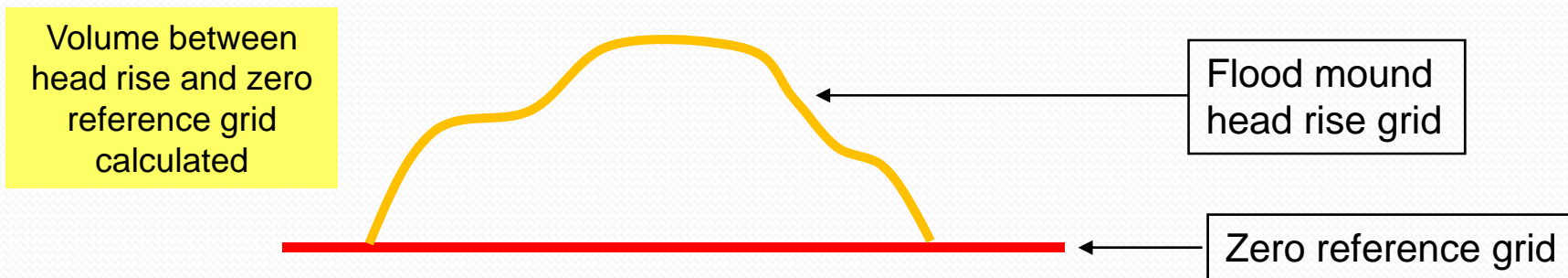
Cool temperature signals
occur only in the upper aquifer
Temperature $< 22^{\circ}\text{C}$

Temperature ($^{\circ}\text{C}$)



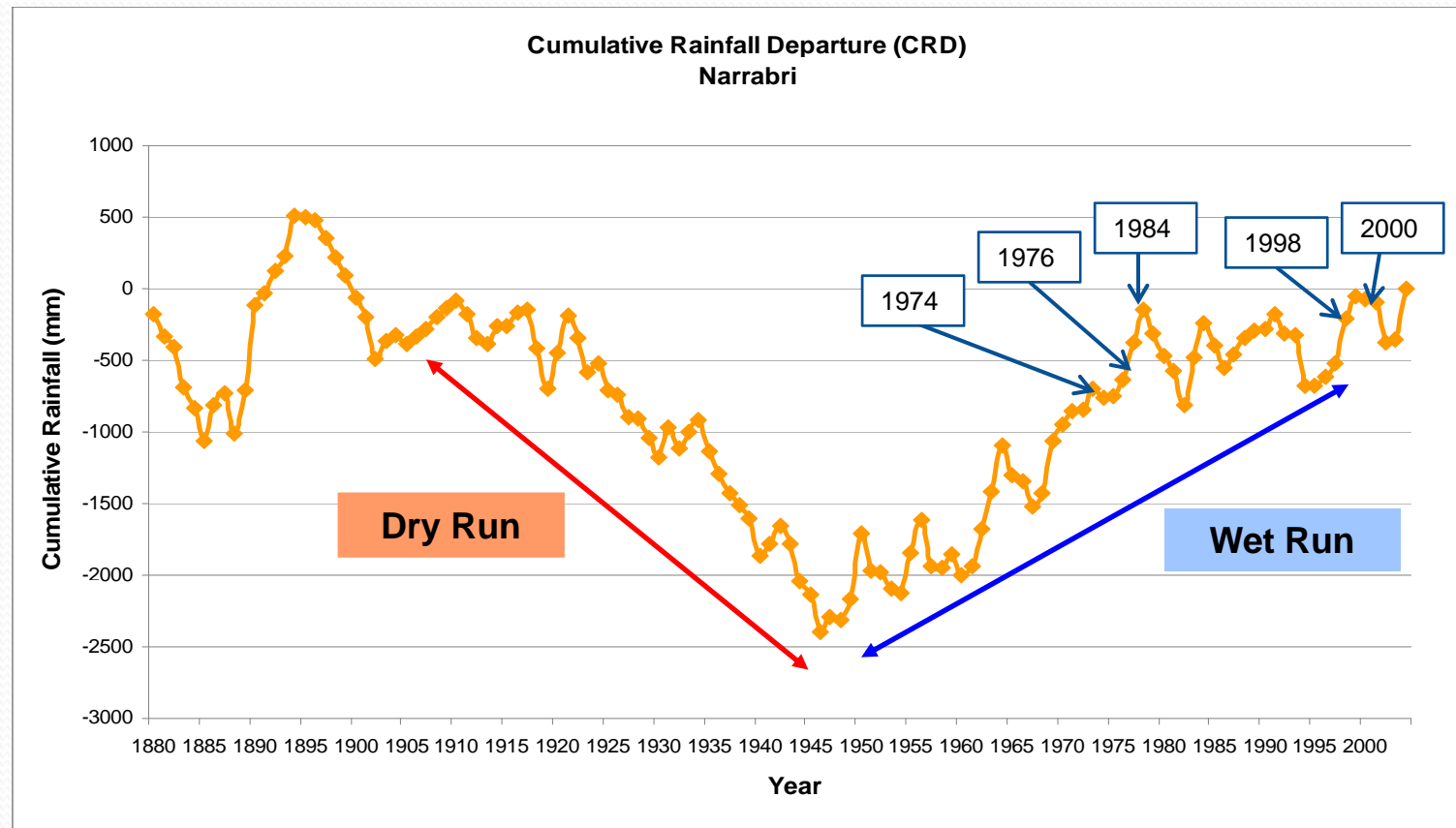
Recharge Estimates

- Recharge estimated for the shallow unconfined aquifer



- Values lie in the range of 3140ML - 70200ML (4%-82% current sustainable yield estimates)
- Specific yield values used (0.01, 0.05, 0.1)
- Cannot calculate TOTAL recharge as:
 - The deep aquifer has a complex geometry – need higher level model
 - Need to know the storage co-efficient for the deep semi-confined aquifer

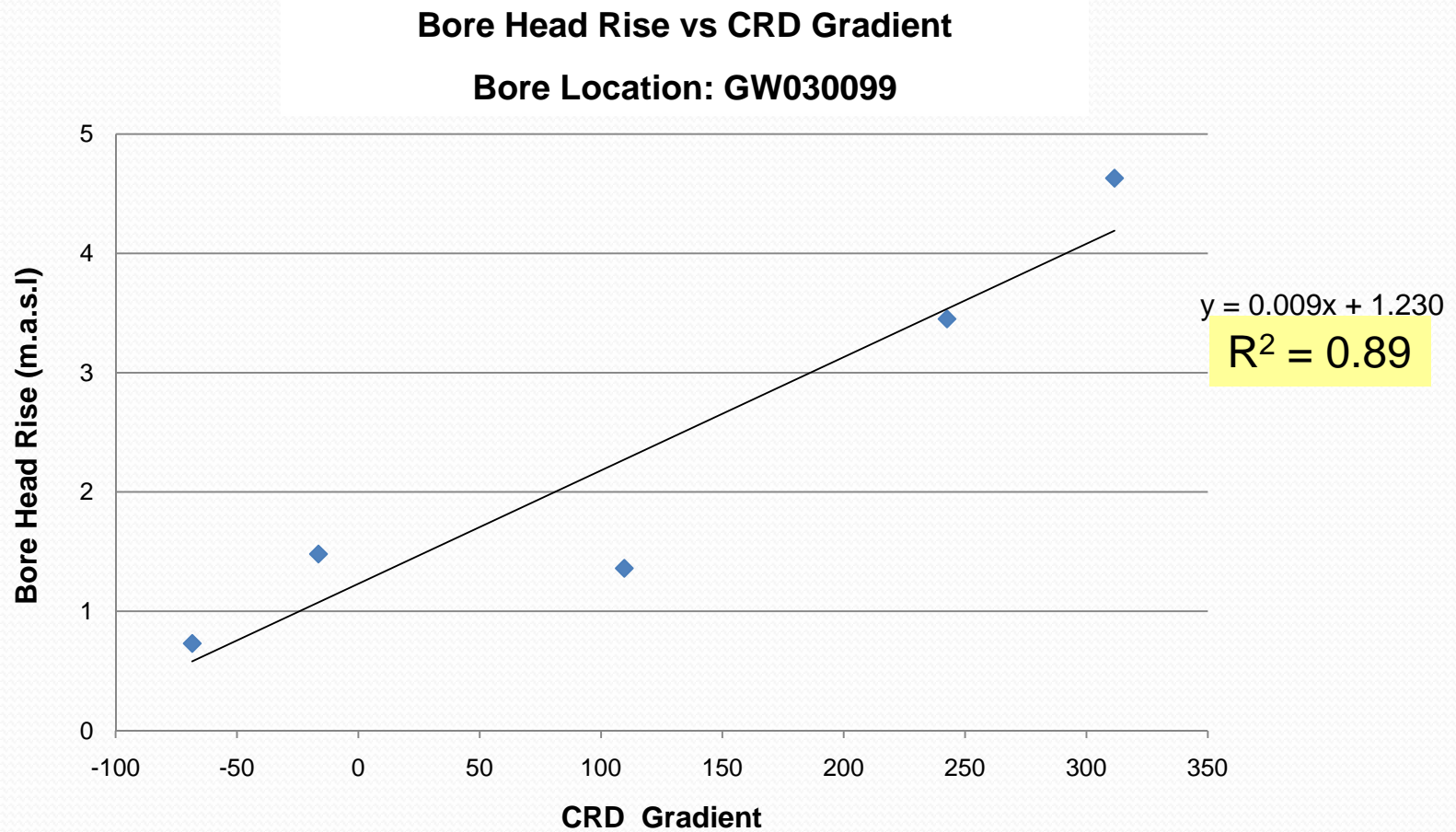
Cumulative Rainfall Departure (CRD)



To generate a Cumulative Rainfall Departure (Residual Mass) graph:

- 1) Subtract the average rainfall from the yearly total
(the average is determined from complete rainfall record range)
- 2) Keep a running tally of the residuals

CRD slope vs Bore Head Rise



Recharge is dependant on the wetting history of the vadose zone

Conclusions

- 3D bore hydrograph analysis delineates pressure & hydraulic pathways of connection
- The primary recharge zone for the unconfined aquifer is near Trindell's Lane.
- There is a weak connection between the shallow unconfined aquifer and the semiconfined aquifer supported by all the models.
- There is no evidence of a strong connection between the palaeochannels running along the northern side of Spring Plains Rd and the Namoi River. Recharge may be by deep aquifer inflow
- Aquifer recharge depends on the wetting and drying history of the unsaturated zone. It is not linearly correlated to rainfall.
- Water budget modelling needs to reflect the complex hydraulic pathways, in particular the tubular nature of the palaeochannels



THANK YOU

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www.connectedwaters.unsw.edu.au

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Welcome to the University of New South Wales Connected Waters web site

Australia is often said to be the driest inhabited continent on Earth - but that's only because of its low rainfall. In fact, while the surface of the land is dry, we have massive reserves of this most precious of resources right beneath our feet: groundwater.

Bore water, for example, from the Great Artesian Basin made it possible to open up vast inland areas for cattle-grazing. Natural springs are the source of the millions of bottles of mineral water we consume every year. Groundwater makes it possible to grow much of our irrigated crops and pastures. And water

