IAH-NSW presentation Oct-08

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

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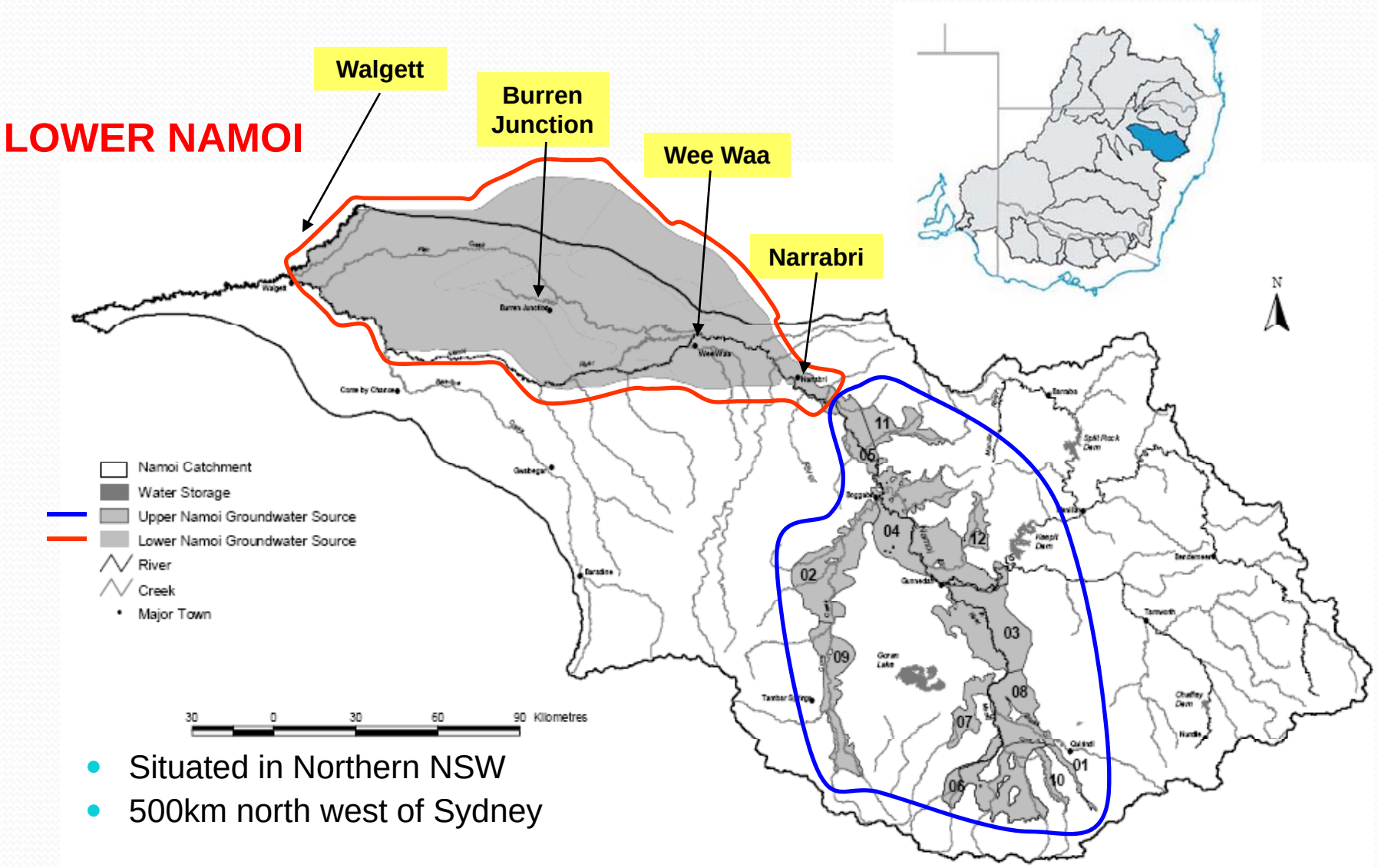
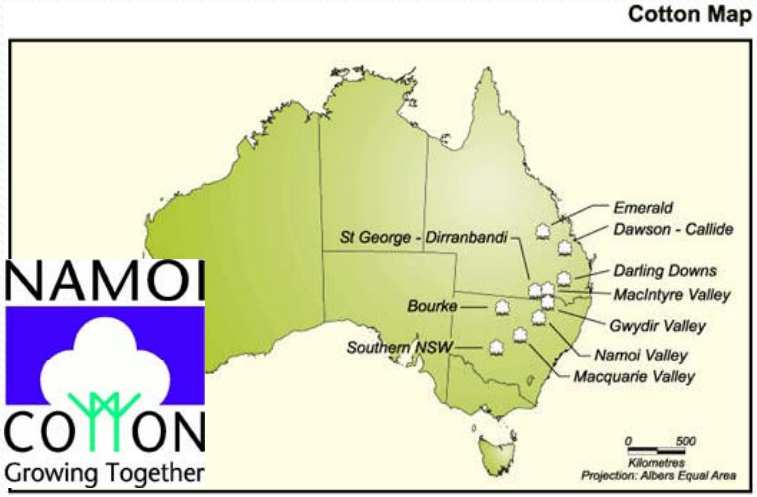
Study Area - Namoi Catchment



- Situated in Northern NSW
- 500km north west of Sydney

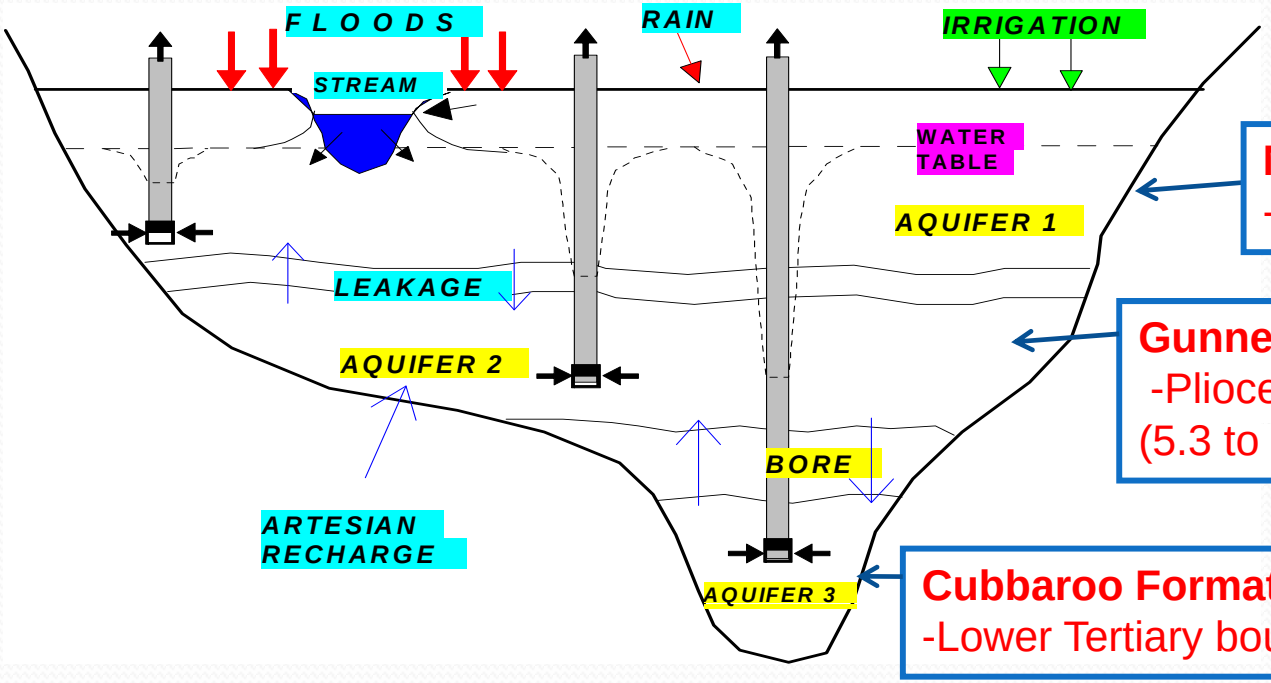
Why Is This Site Of Interest?

- 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

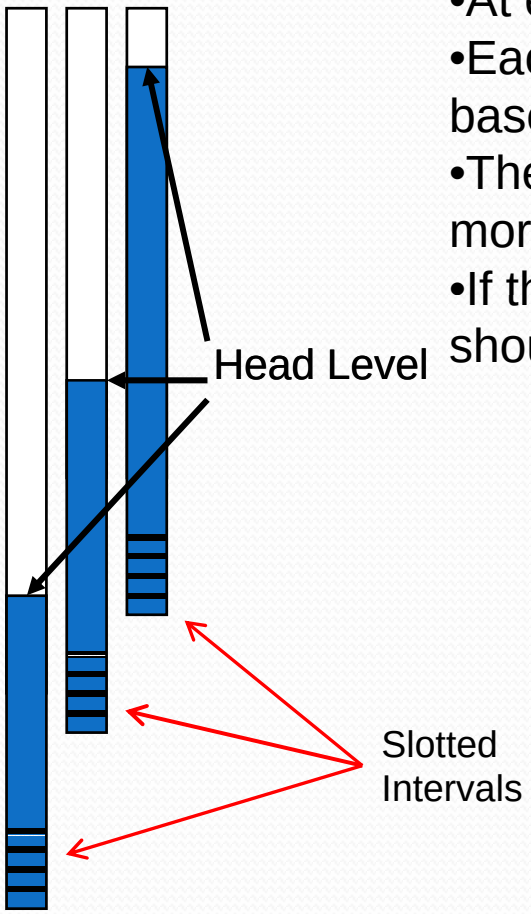


Narrabri Formation
-Pleistocene to recent

Gunnedah Formation
-Pliocene to Pleistocene (5.3 to 0.01 Ma)

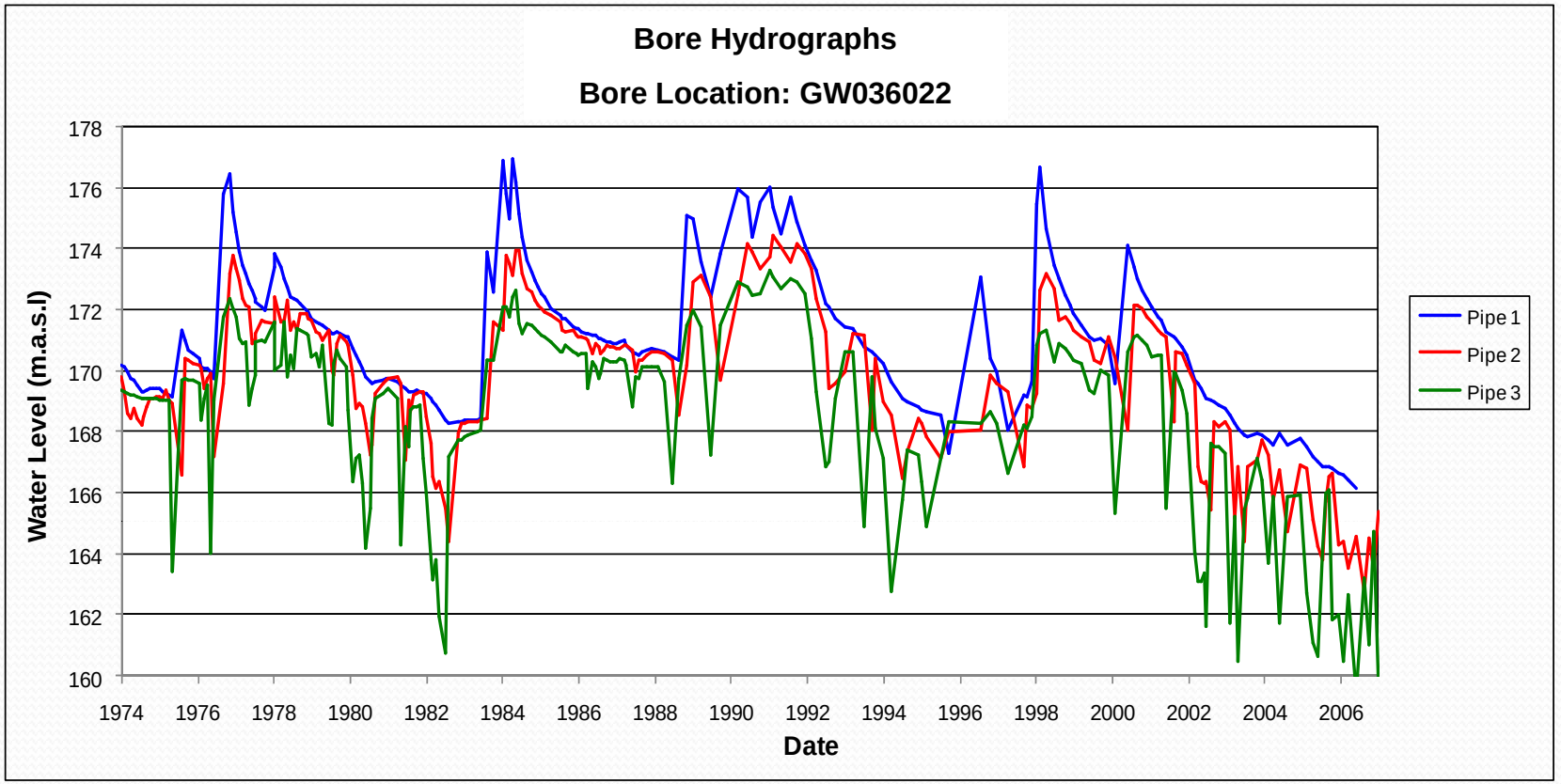
Cubbaroo Formation
-Lower Tertiary boundary 65 Ma

Groundwater Monitoring Bores



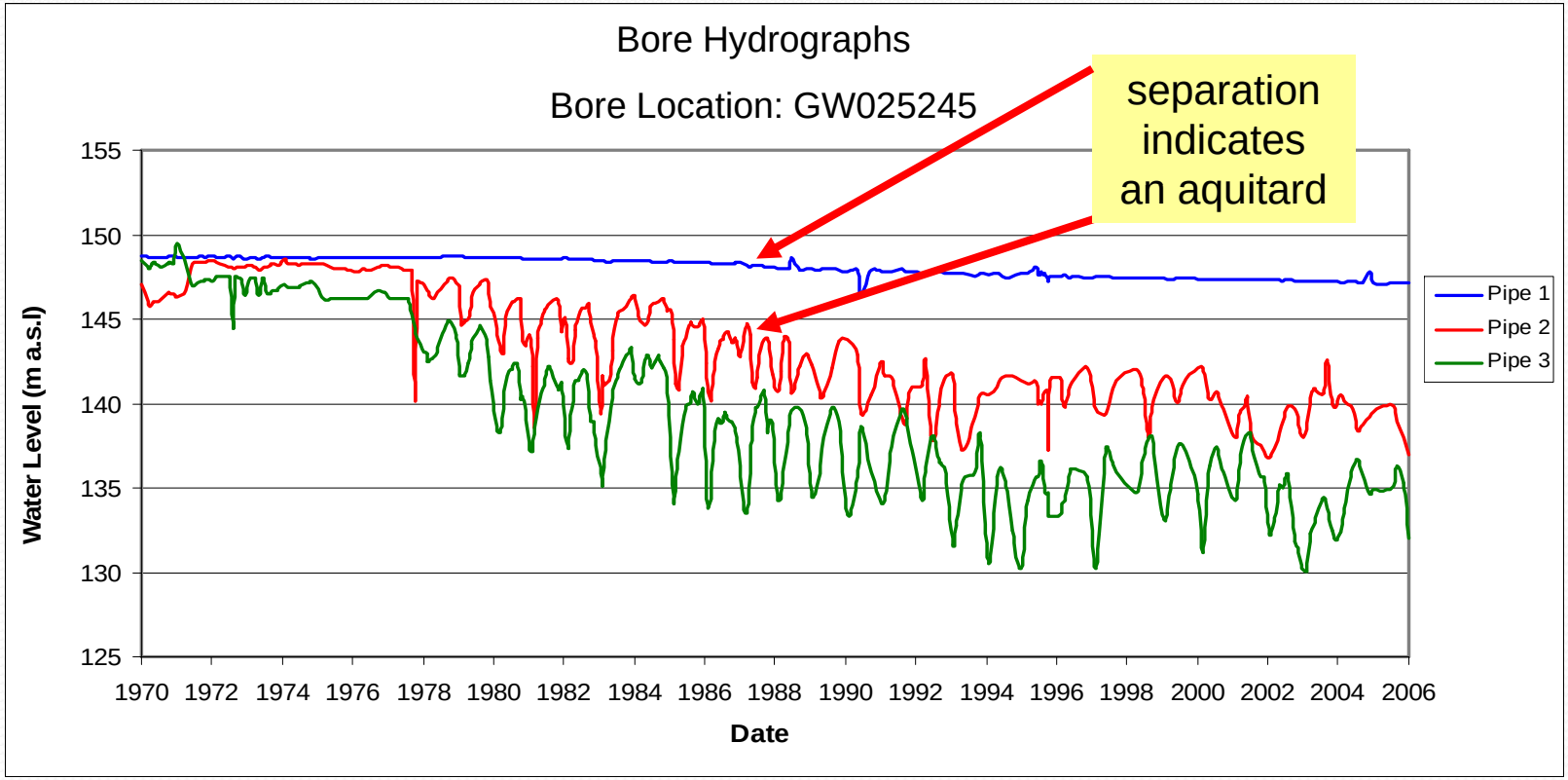
- 358 sites in Lower Namoi
- At each location there are 1-7 pipes
- Each pipe is slotted over a small interval at the base
- These government monitoring bores indicate a more complex system.
- If there are 3 separate aquifer systems the heads should behave differently

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.

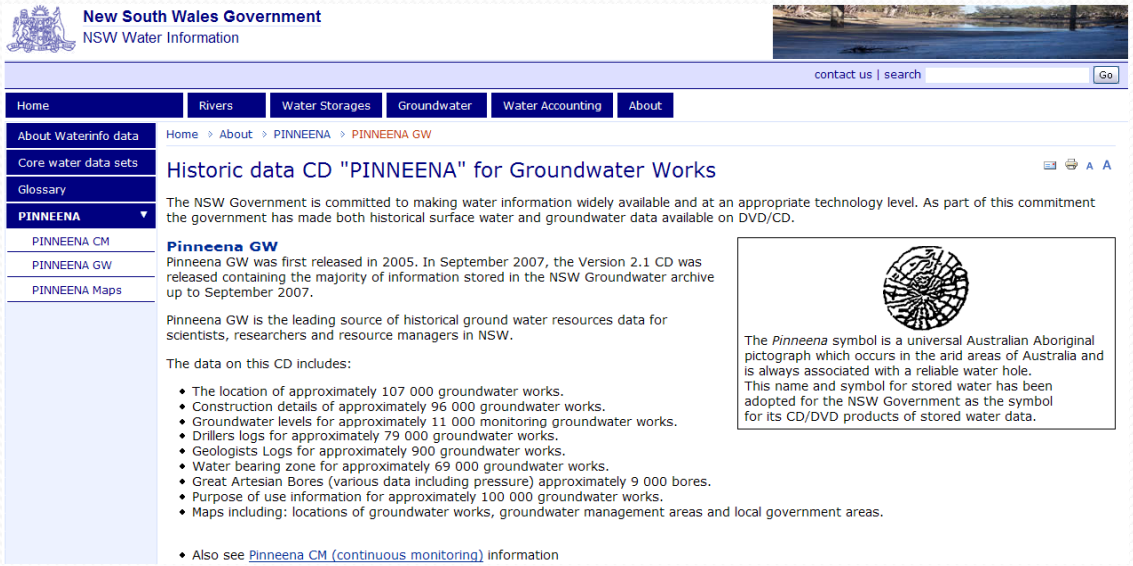
What was Investigated?

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



- 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

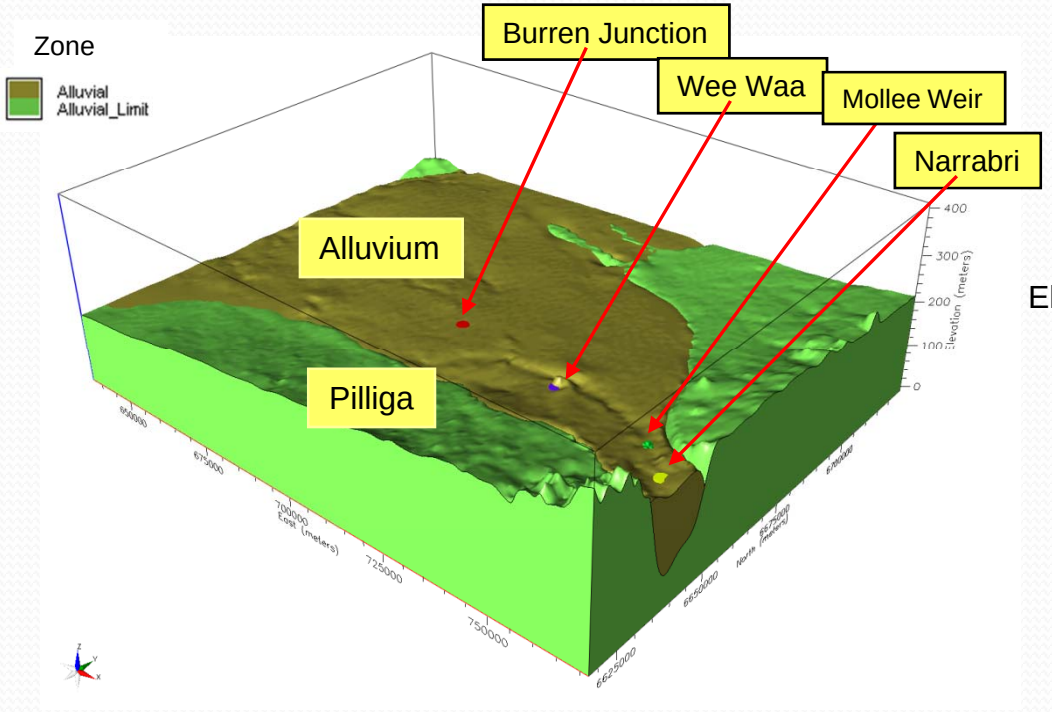
- **Water Chemistry**
  - pH
  - Temperature

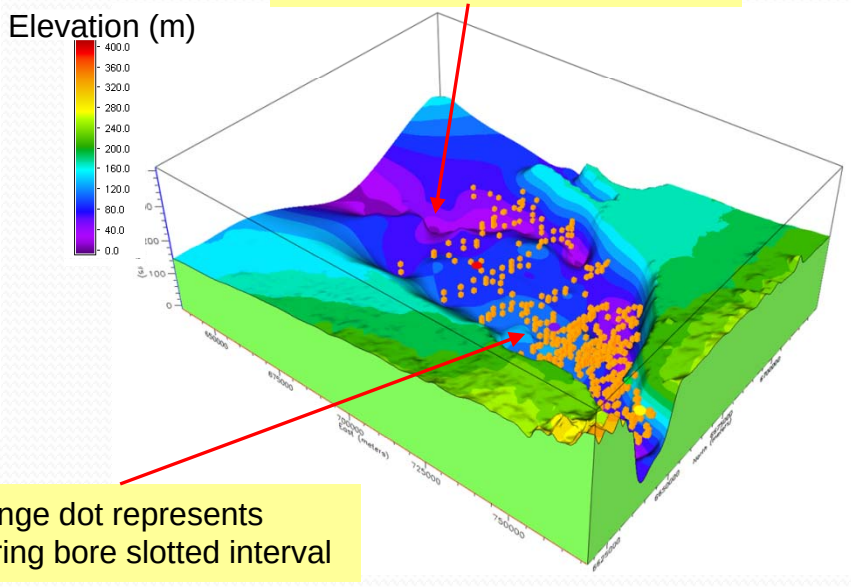
MINIMUM TENSION

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

Methodology

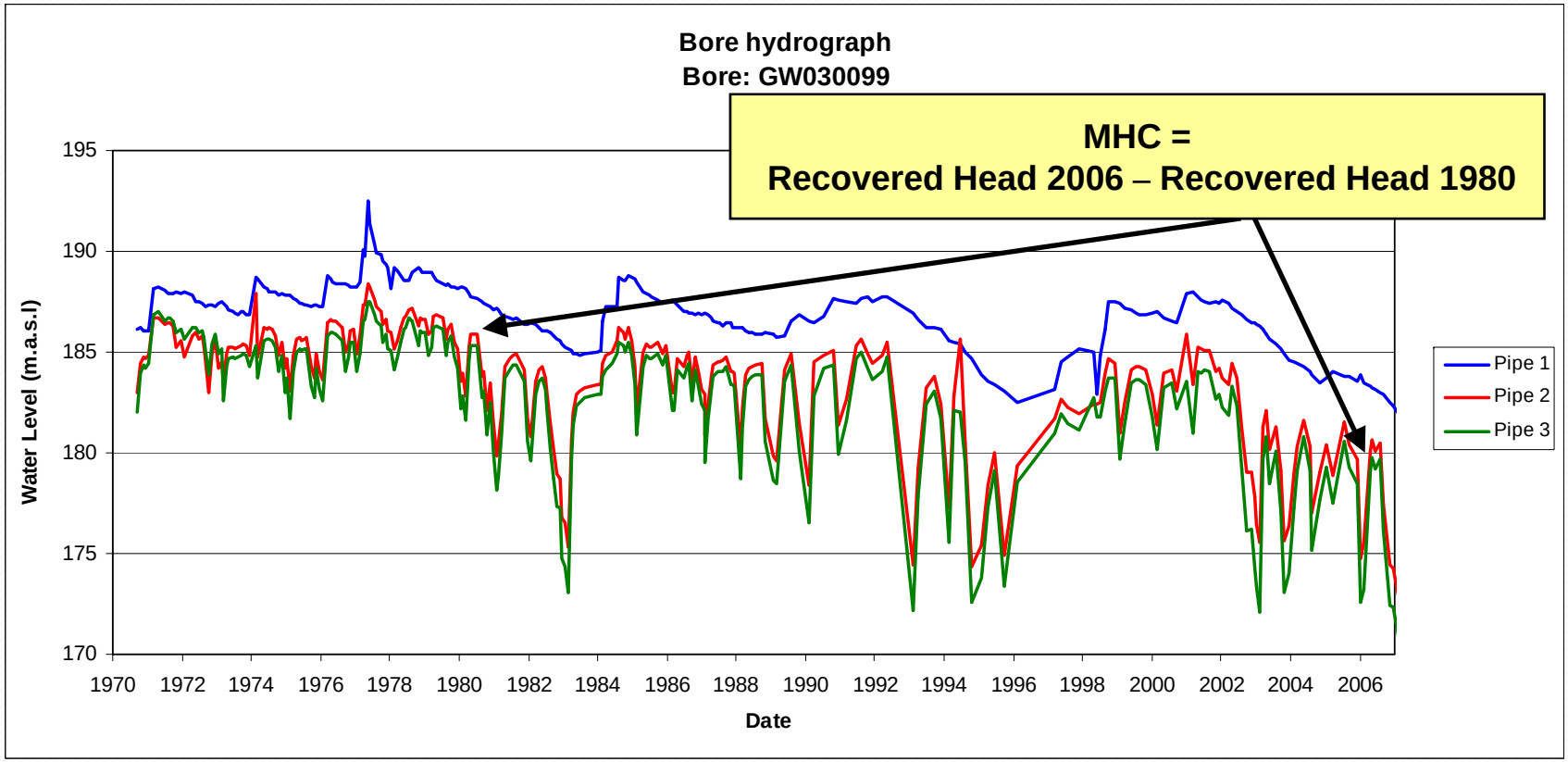
- Zone block model
  - A DEM was used to generate the top surface of the model
  - Aquifer limit – base of alluvium approximated by adding 10 m to the base of deep bores



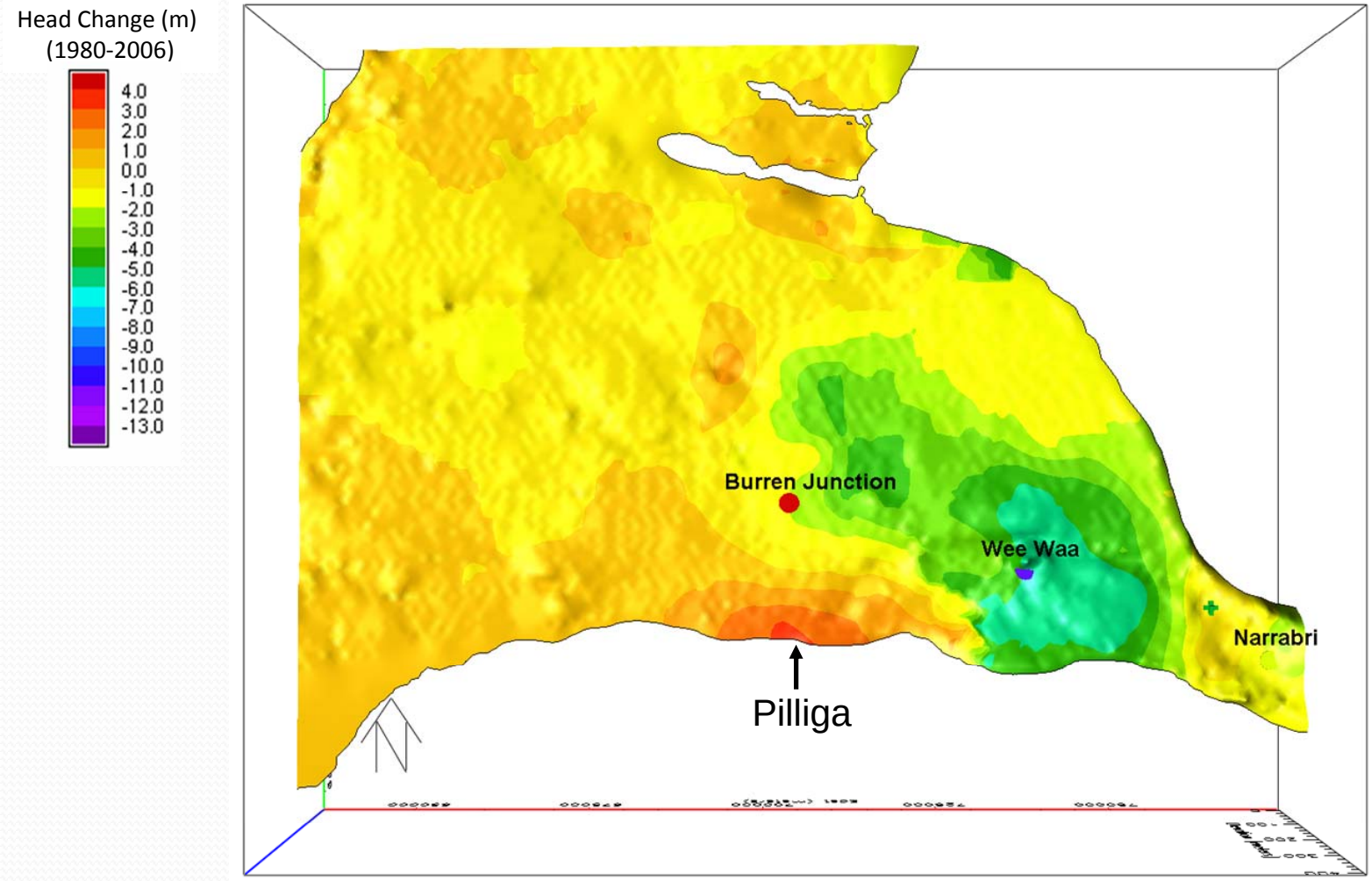


Methodology

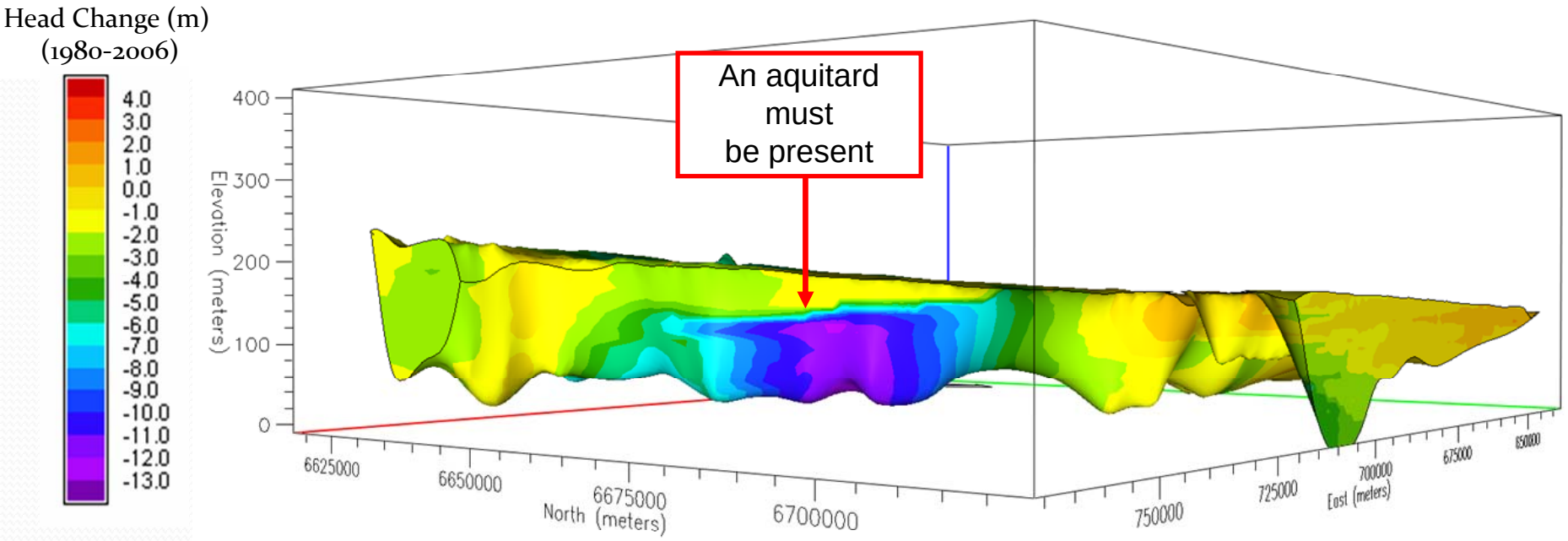
- Bore hydrograph analysis
  - Data was processed in python scripts
  - **Multidecadal Head Change model**



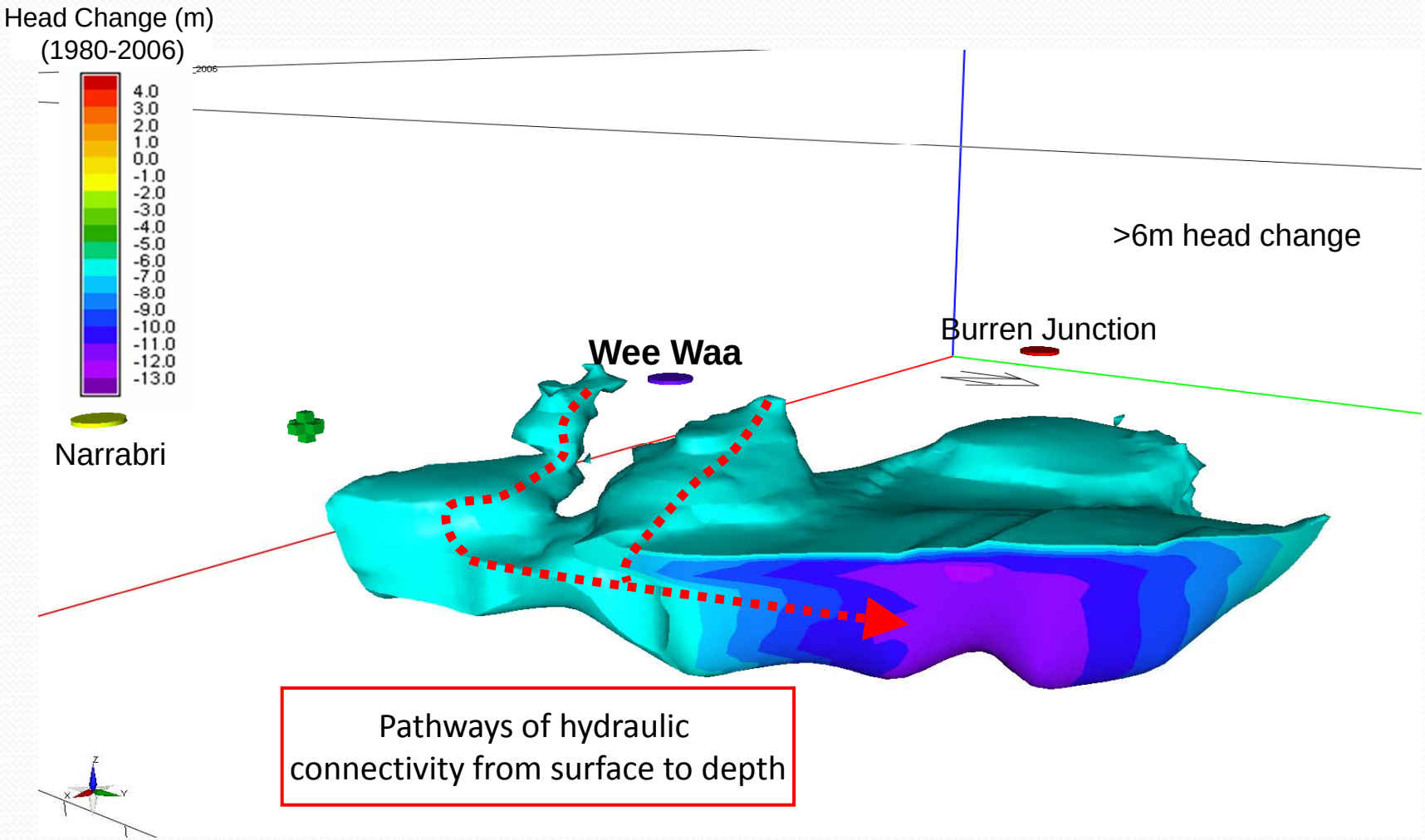
Multidecadal Head Change



Multidecadal Head Change

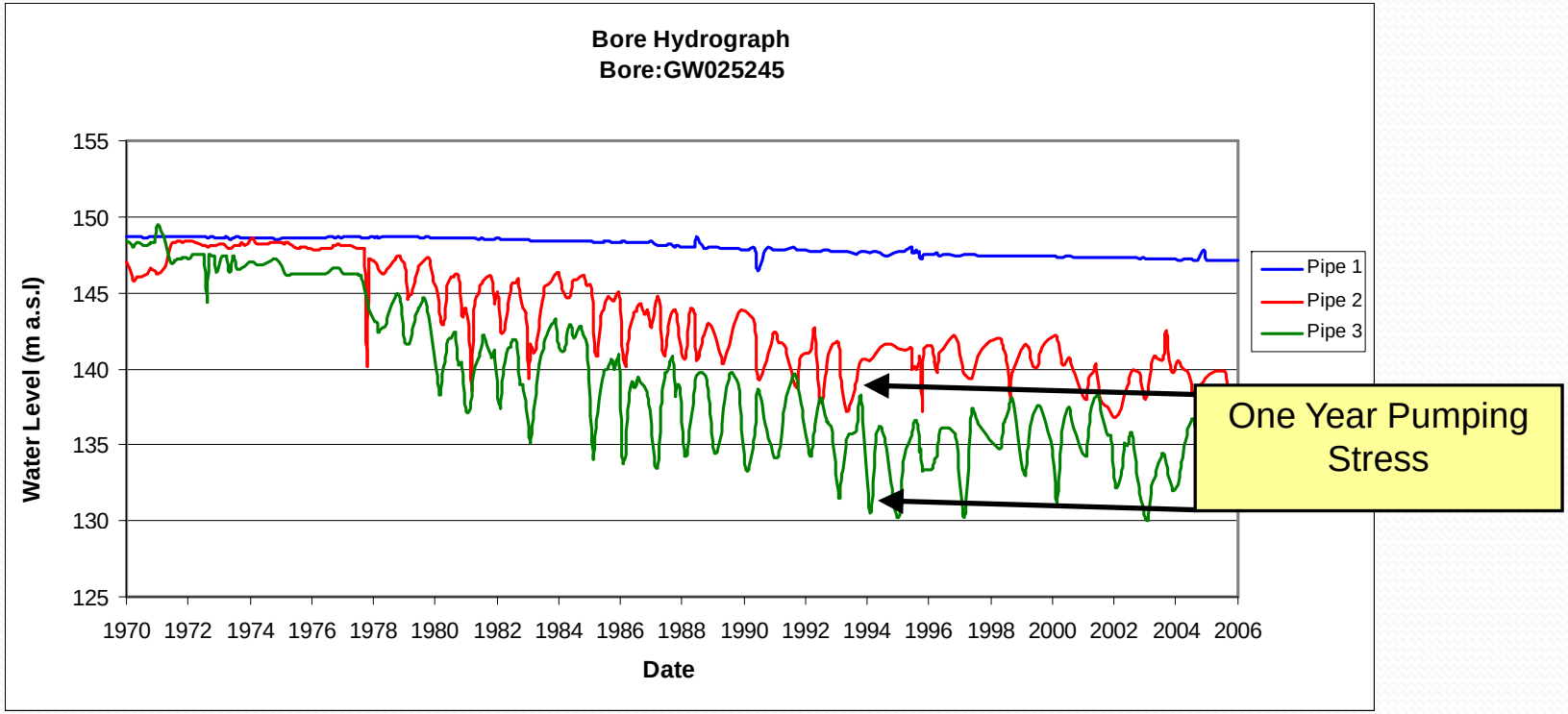


Multidecadal Head Change

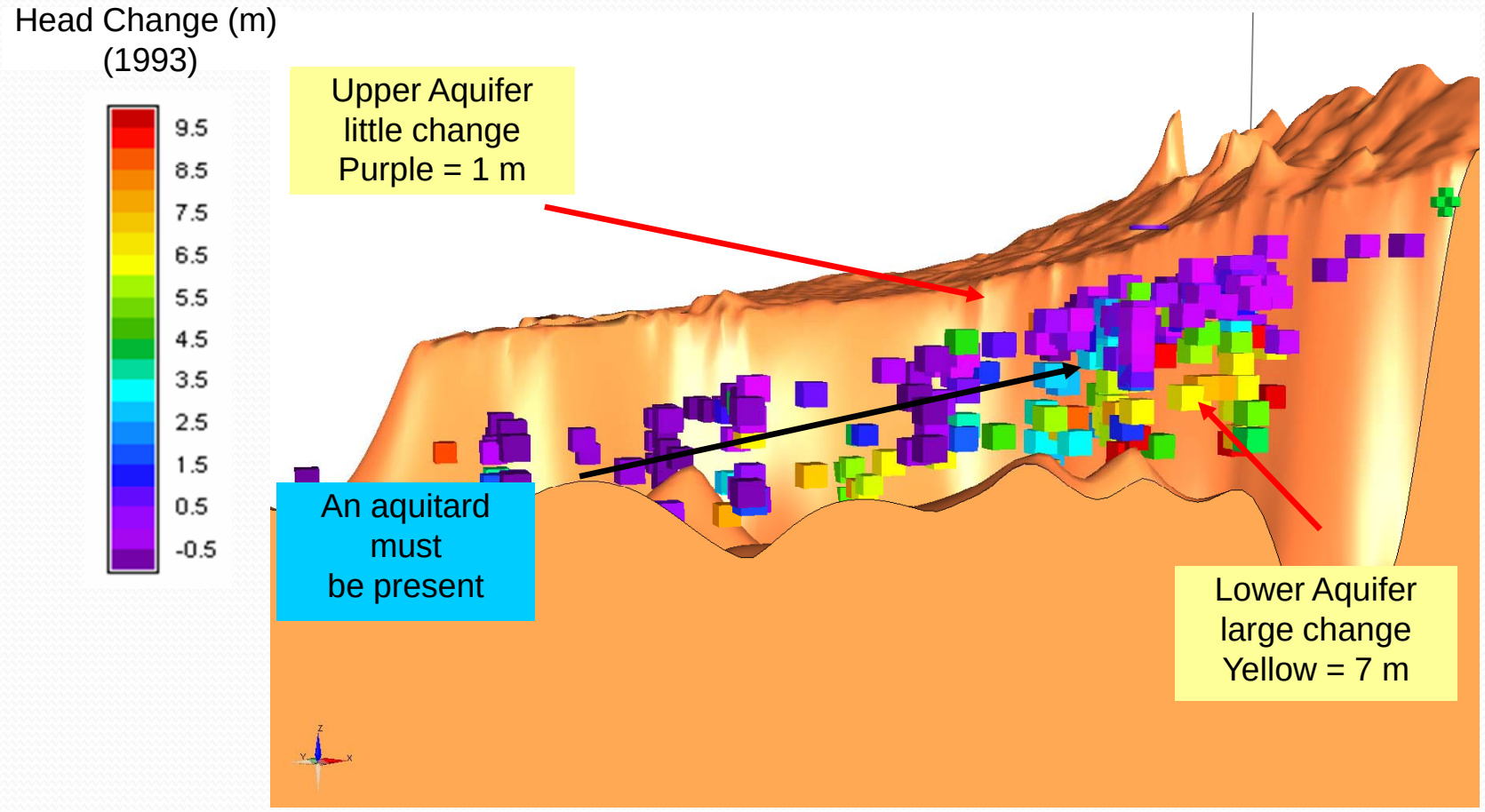


Methodology

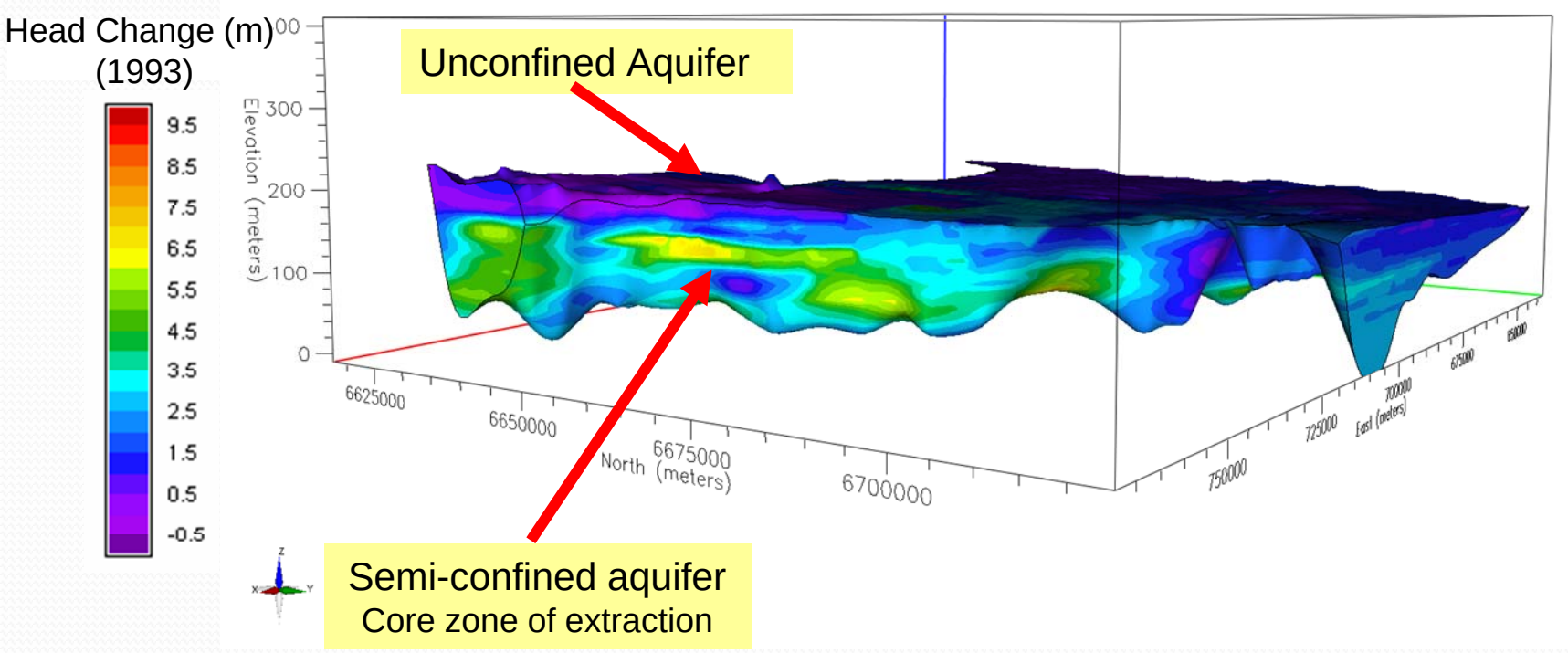
- **One Year Pumping Stress**



One Year Head Change

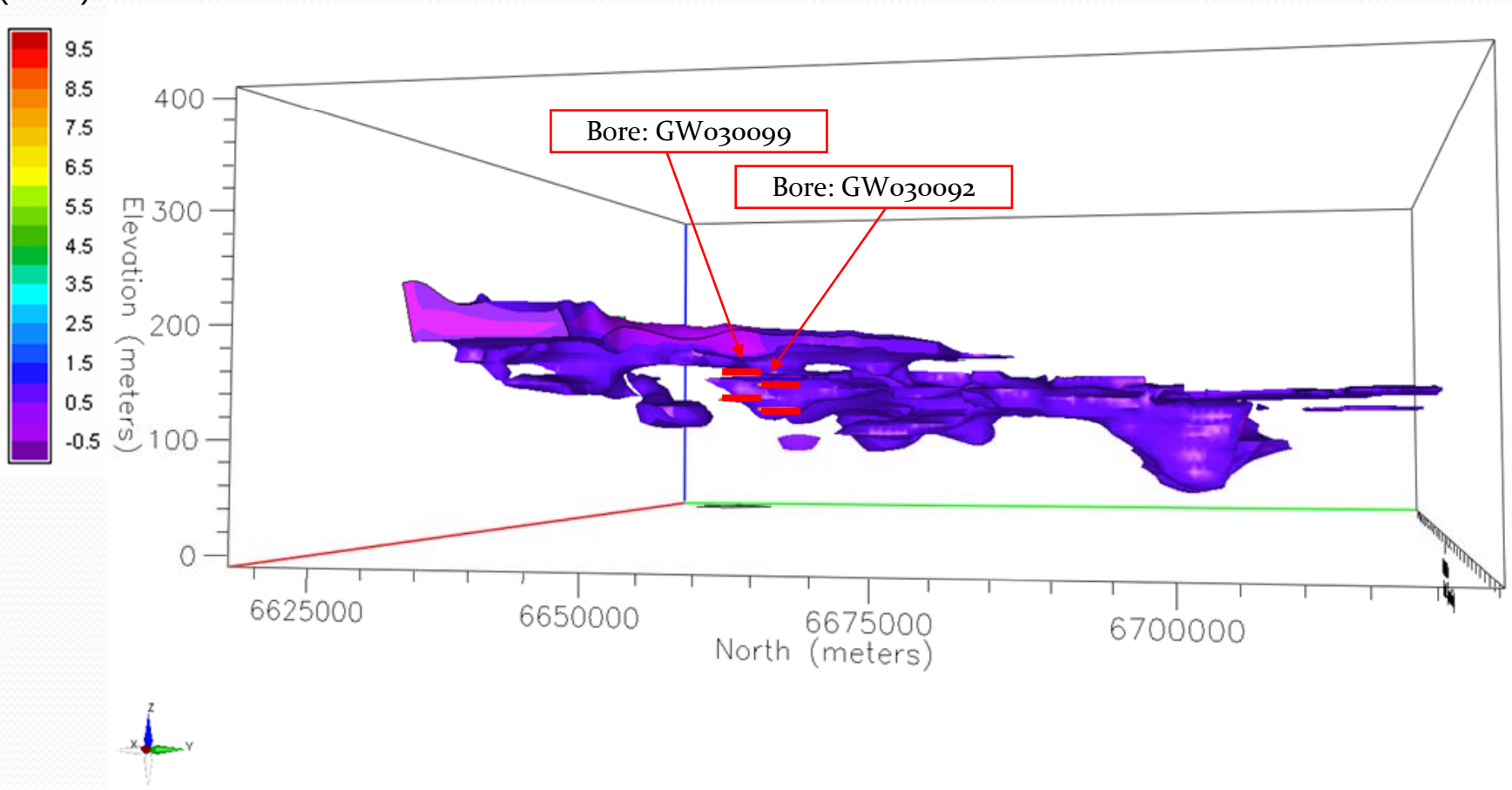


One Year Head Change

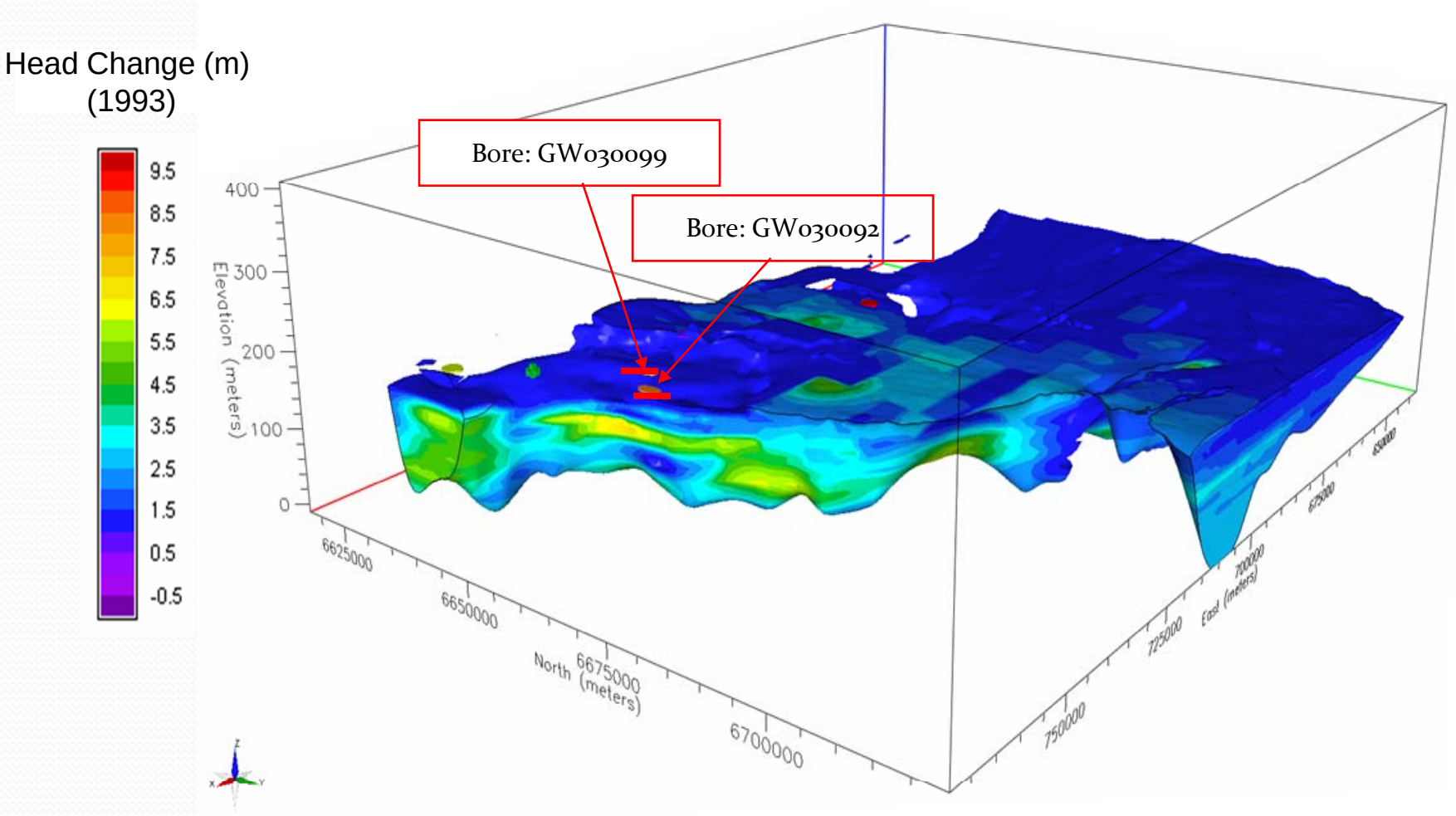


Unconfined Shallow Aquifer

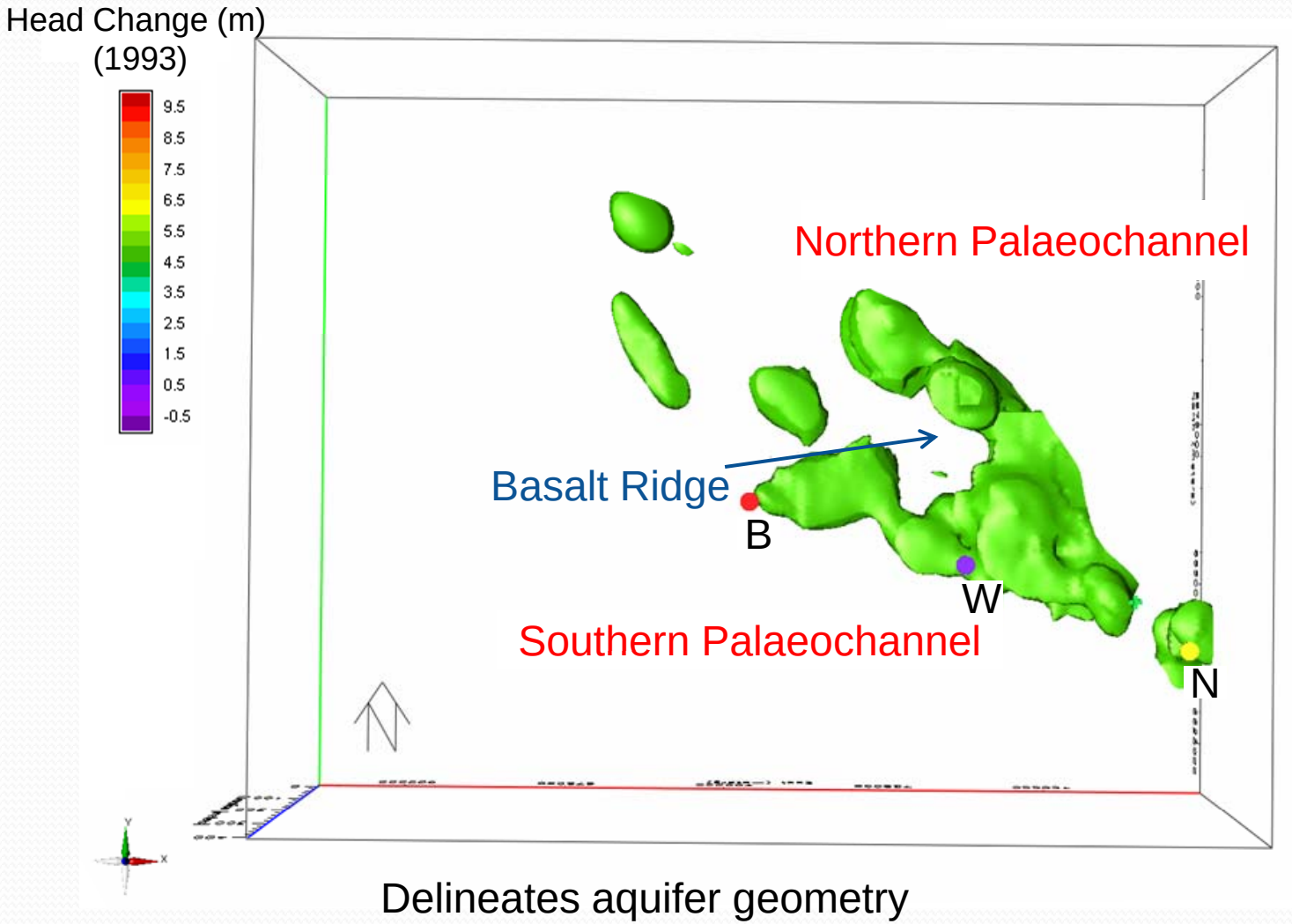
Head Change (m)
(1993)



Semiconfined Deep Aquifer

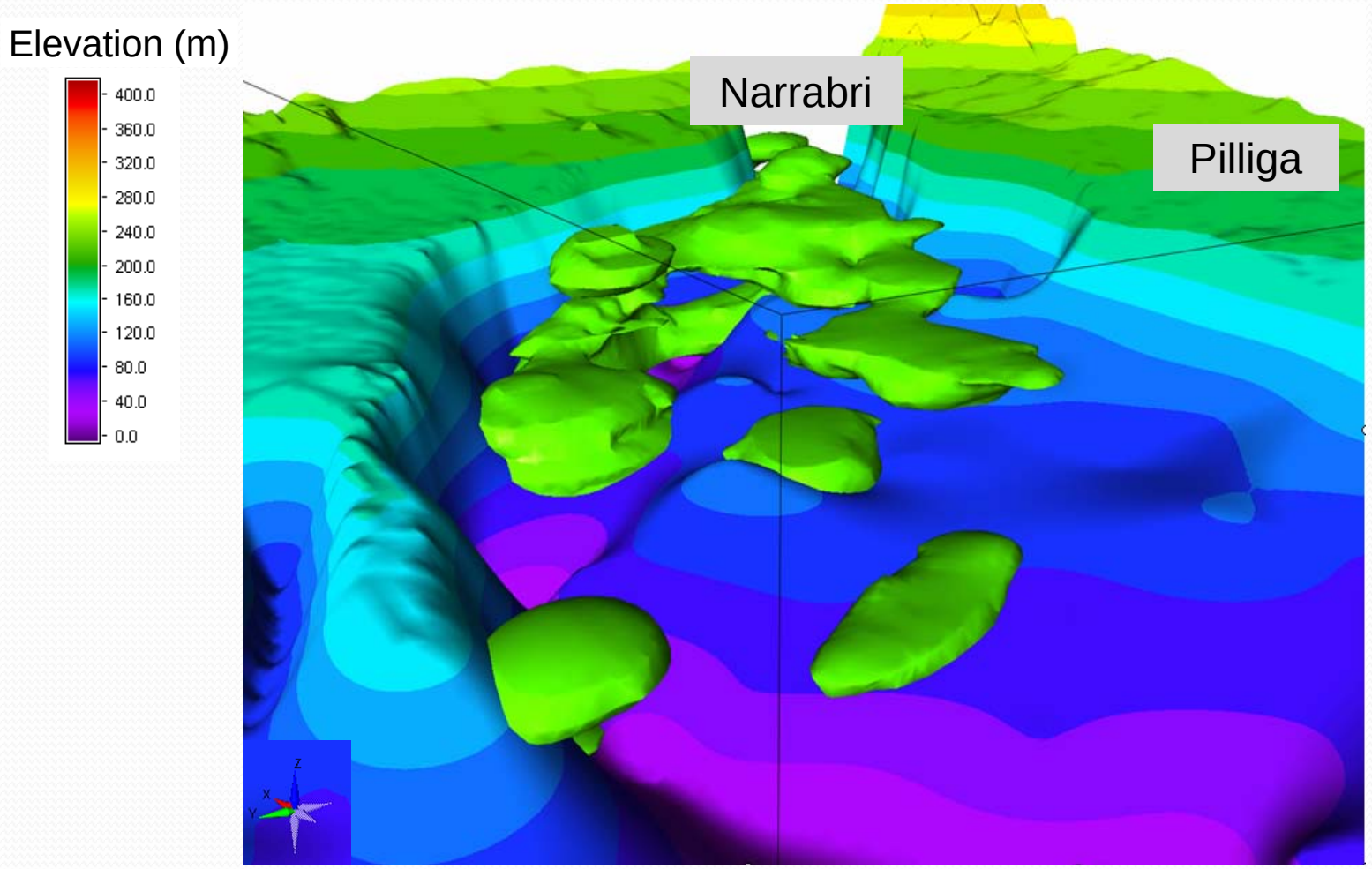


Head Change Follows the Palaeochannels

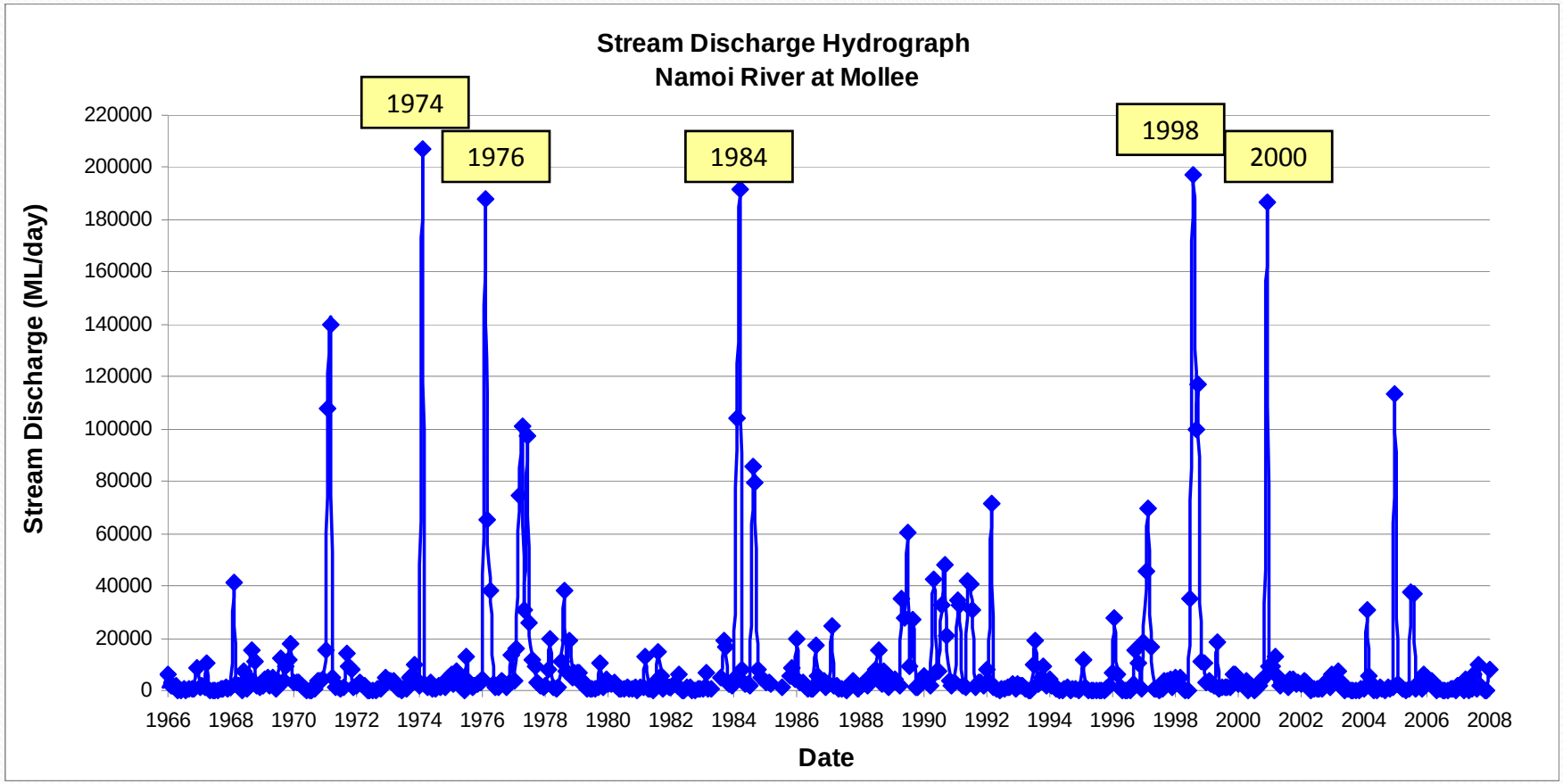


Delineates aquifer geometry

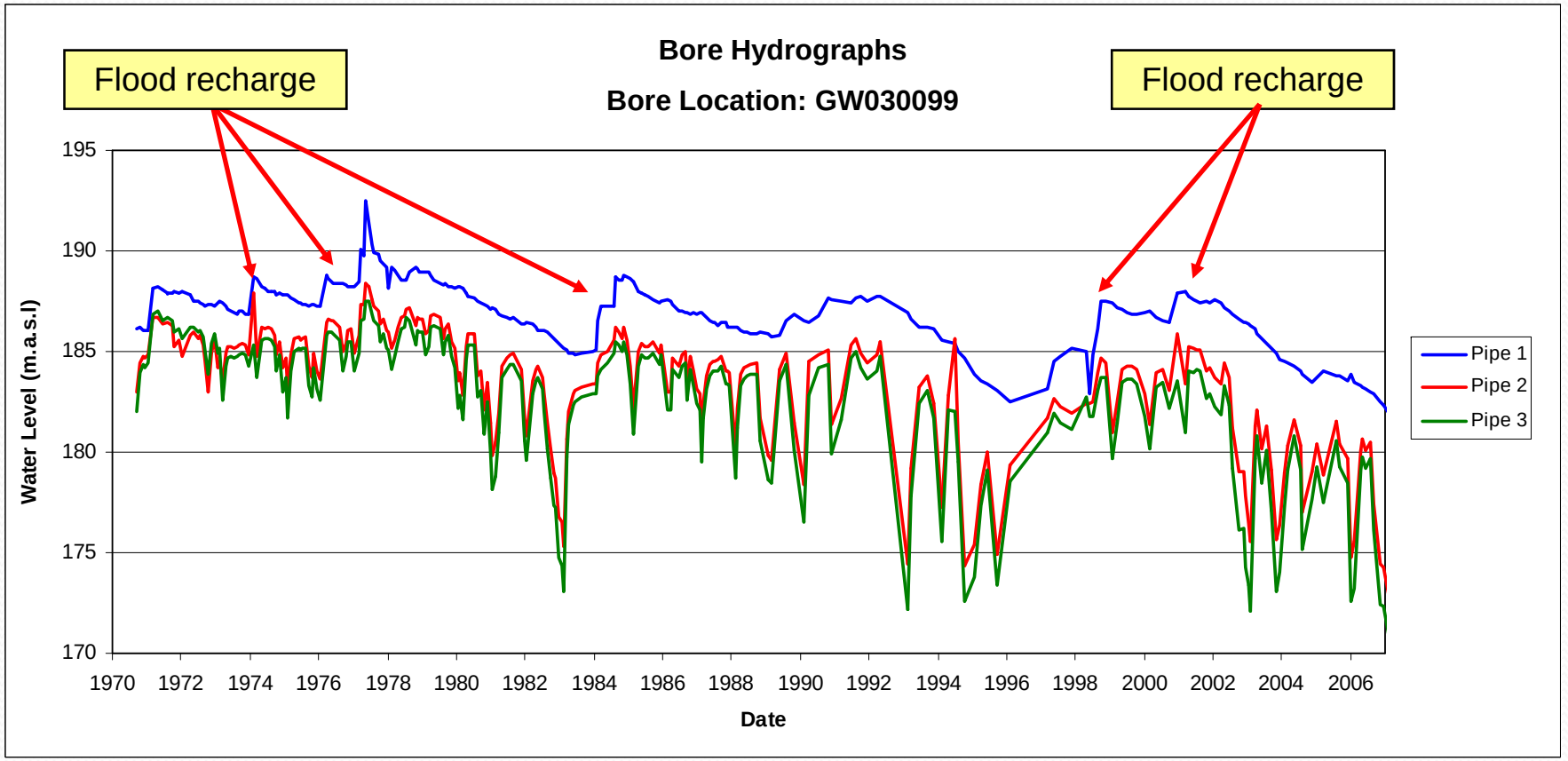
Northern Palaeochannel Divided into Upper and Lower



Mollee Stream Hydrograph



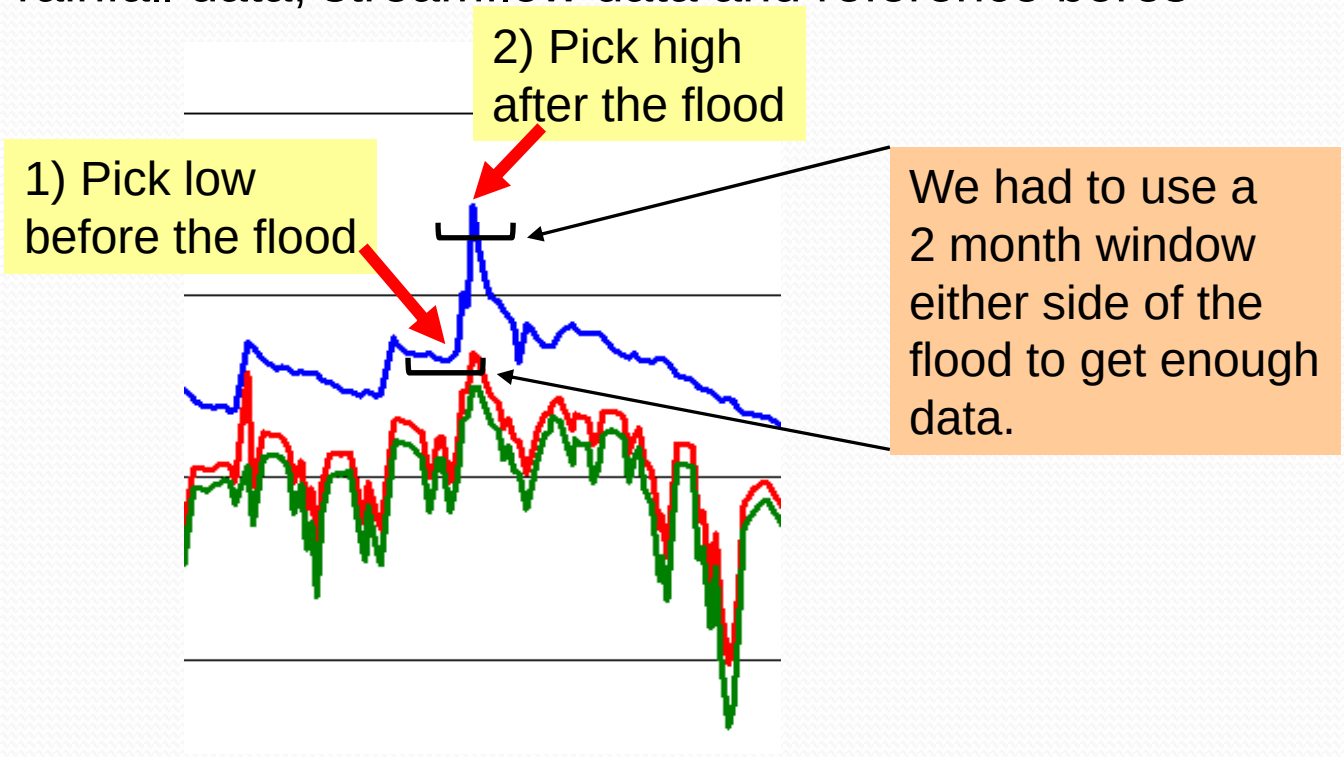
Reference Bore Showing Floods



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



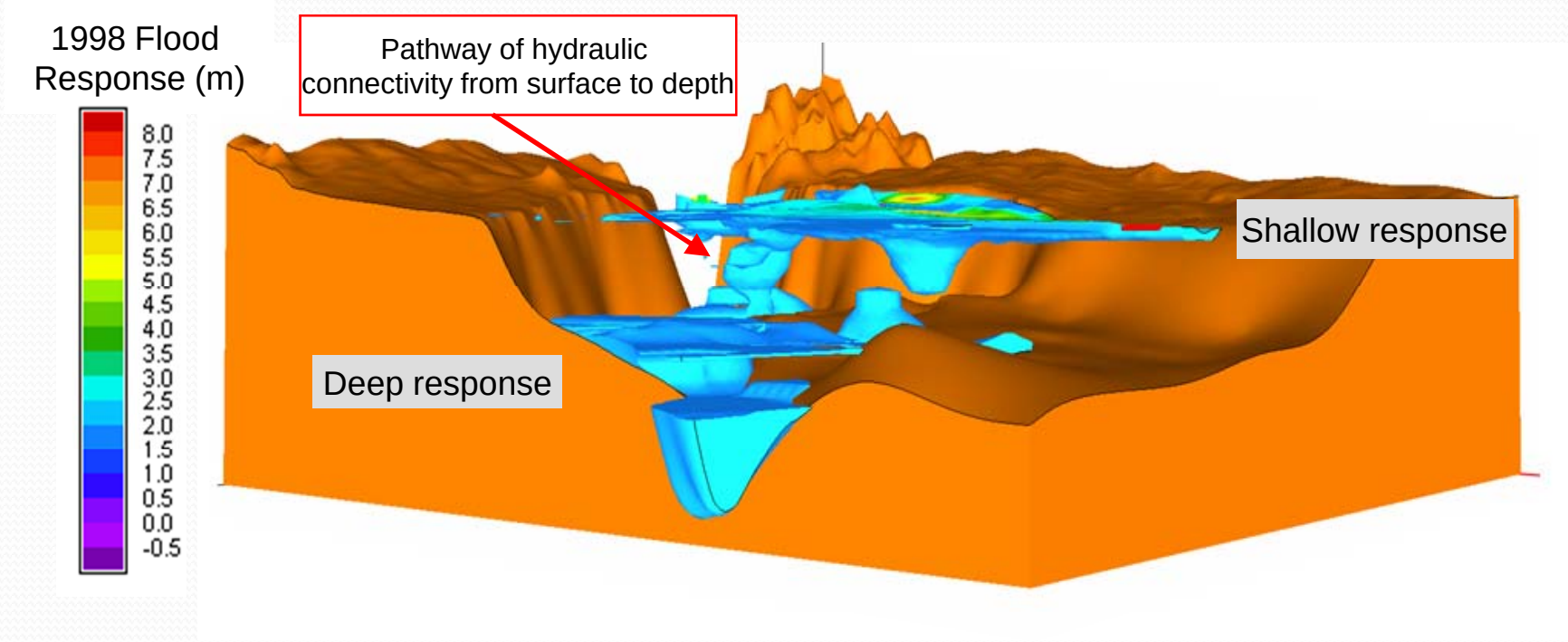
3) Grid the flood rise data = High - Low

What Does Flood Recharge Go?

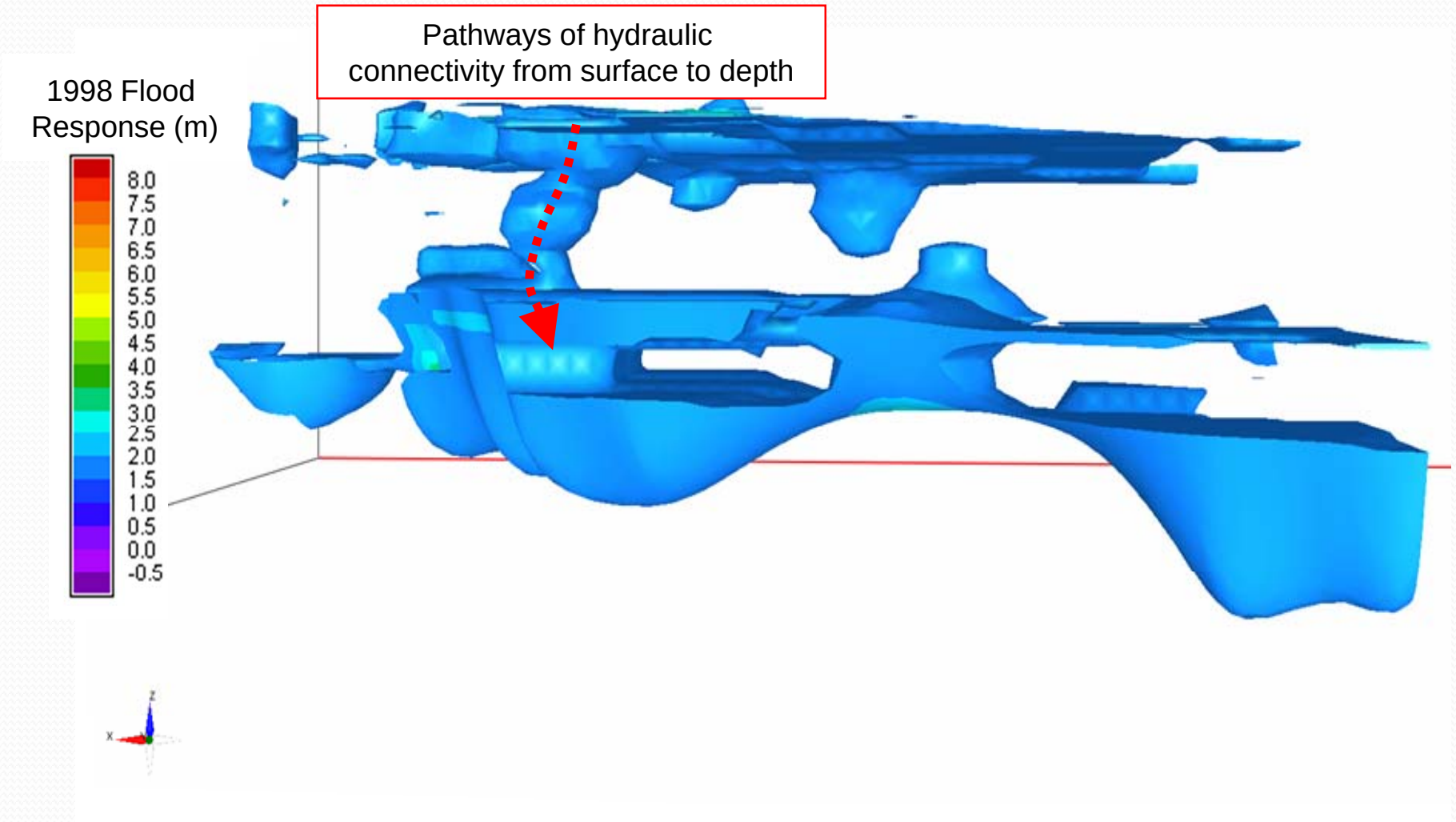
- **KEY OBSERVATION**
  - All floods show a shallow and deep aquifer response
  - There are seasonal variations in aquifer response

Winter Flood - 1998

Clear separation between the unconfined shallow aquifer and deep palaeochannel

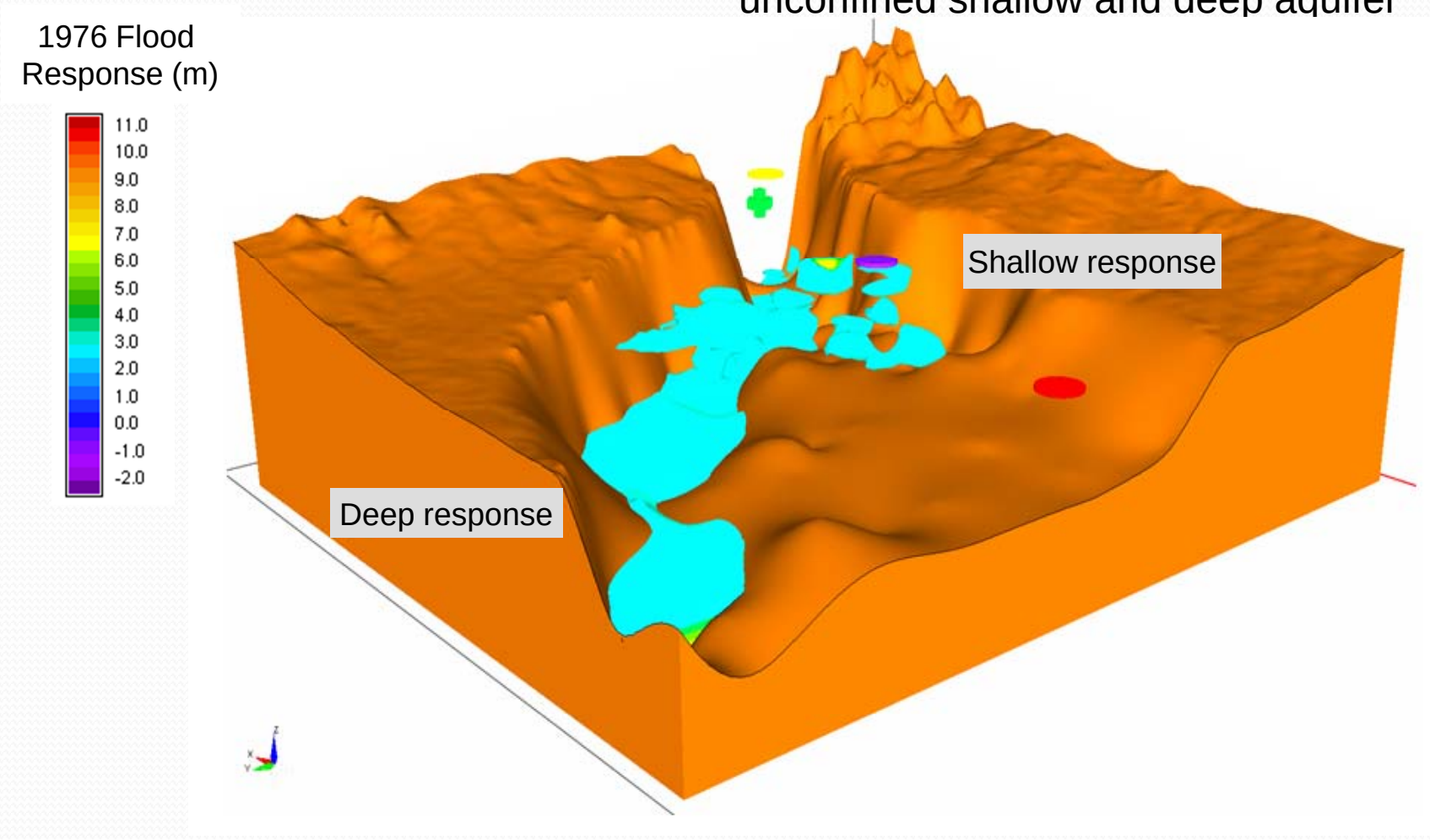


Winter Flood 1998

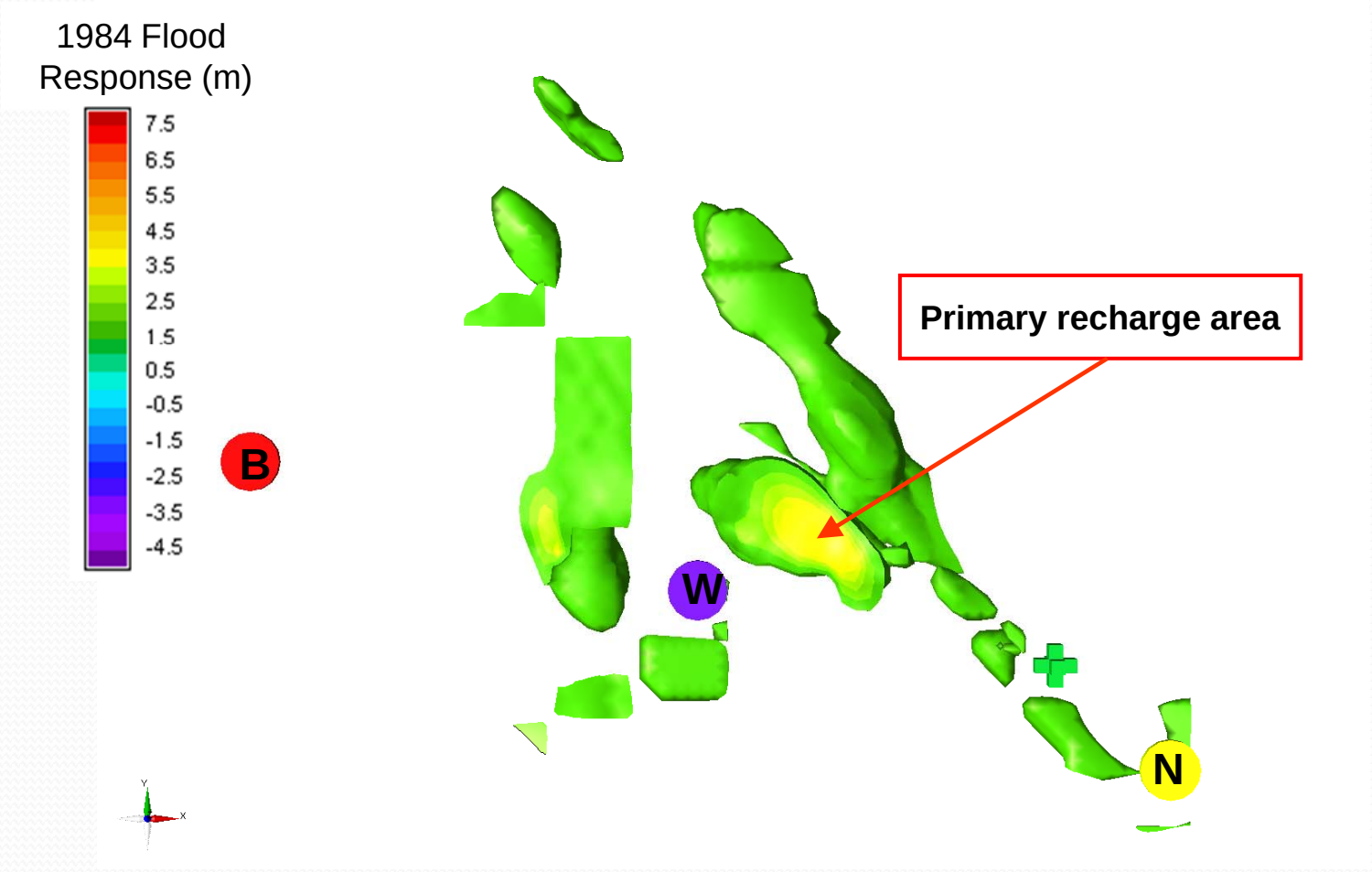


Summer Flood - 1976

Clear separation between the unconfined shallow and deep aquifer

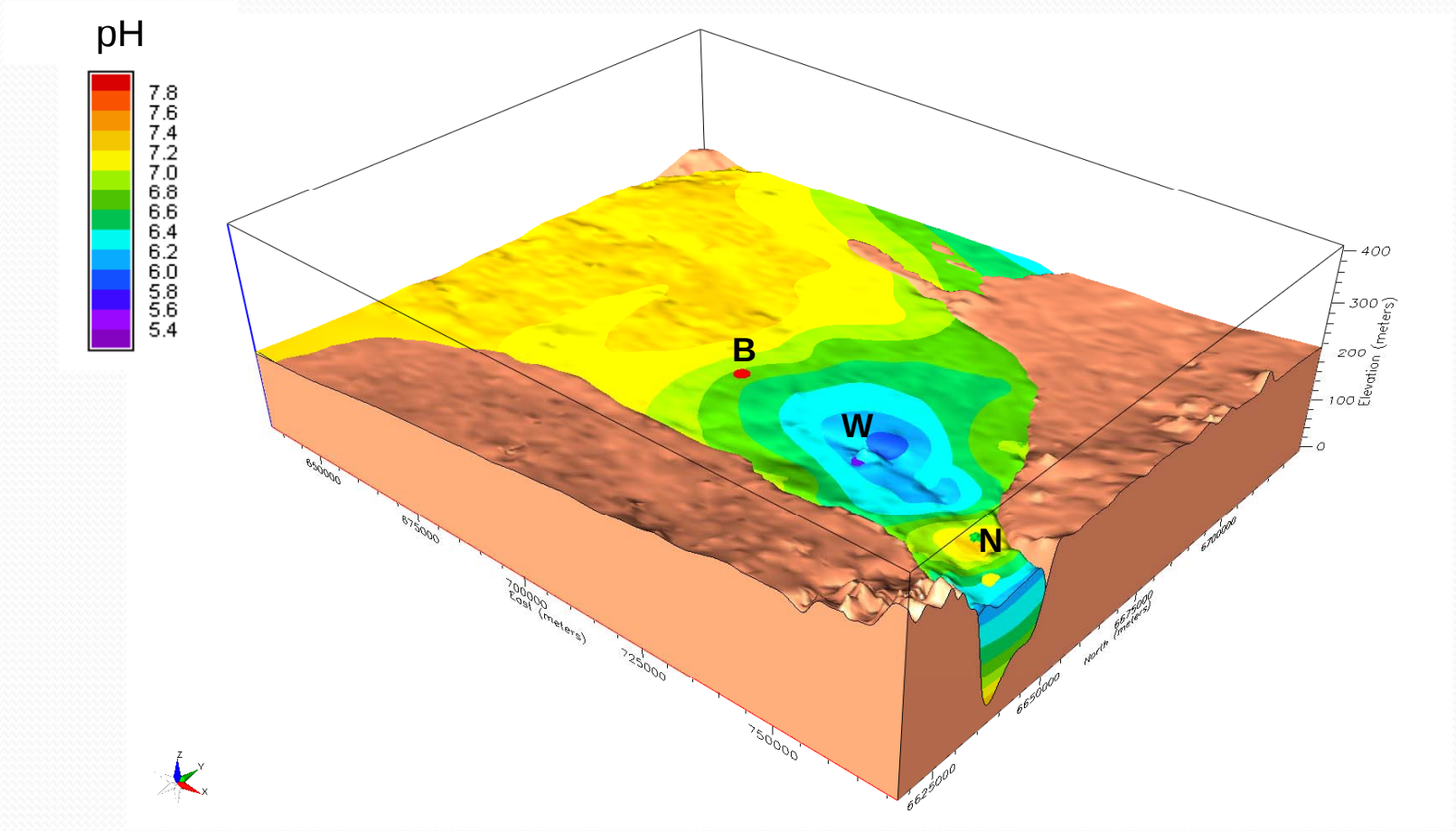


Primary Recharge Area



Primary Recharge Area

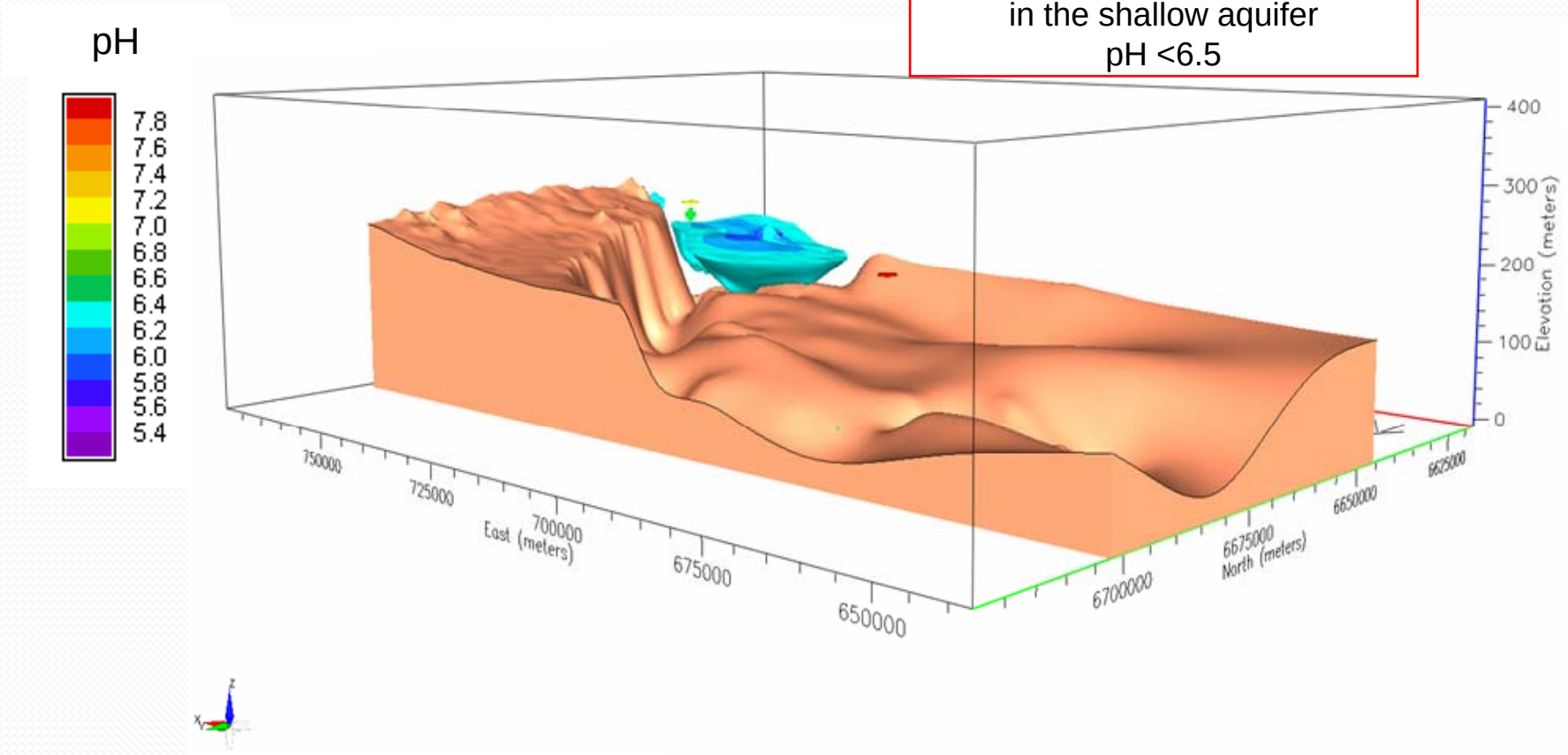
pH



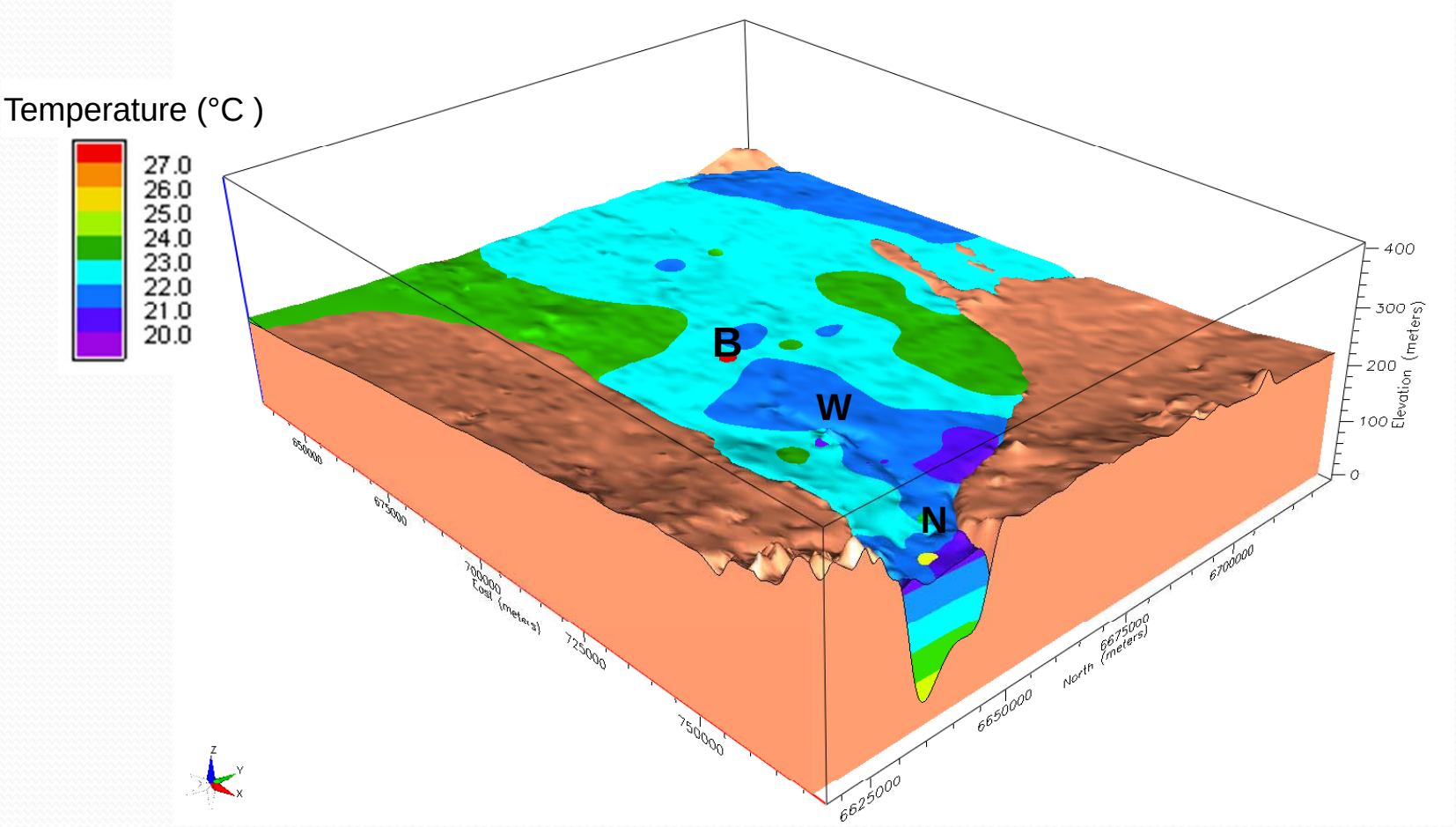
pH is lower in the recharge zone due to $C0_2$ equilibrium processes

pH

Low pH values occur only
in the shallow aquifer
pH <6.5



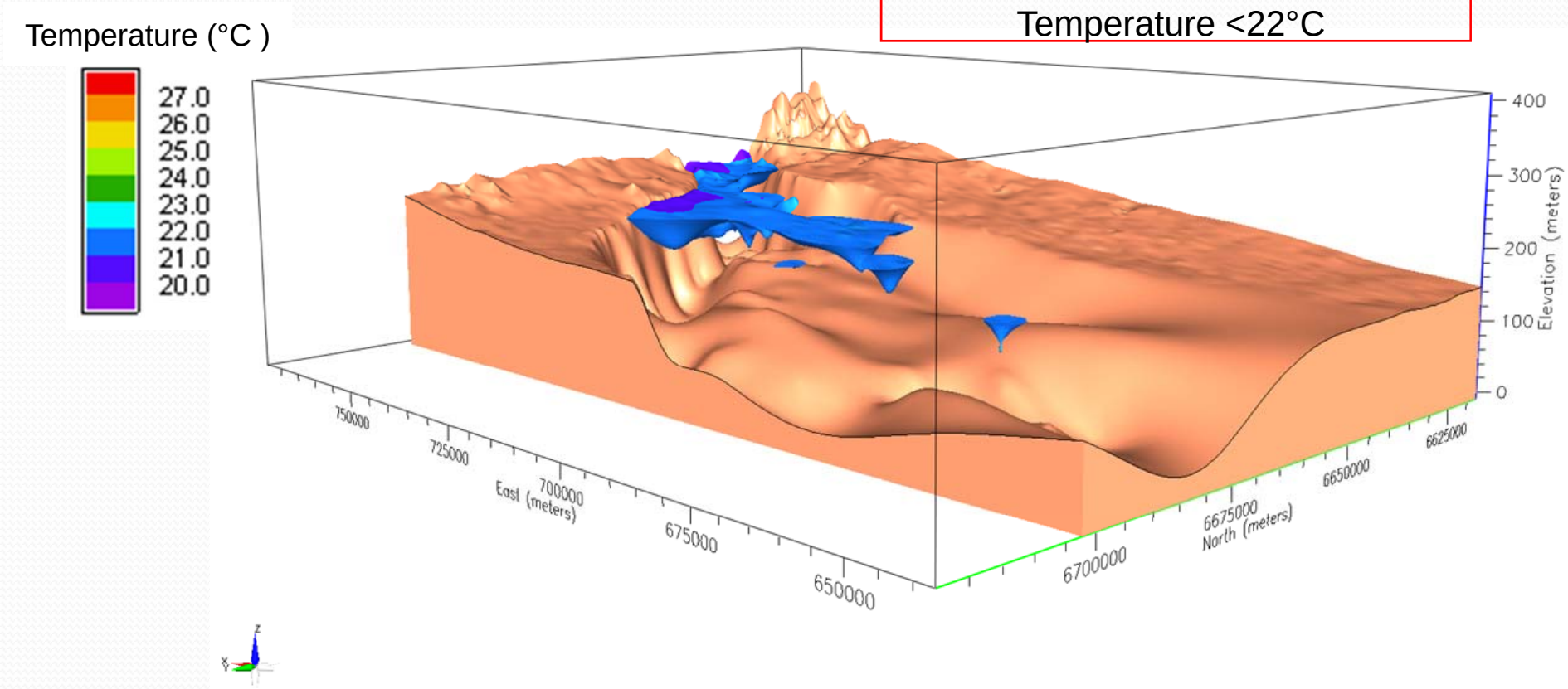
Temperature



River water is cooler than long term resident aquifer water

Temperature

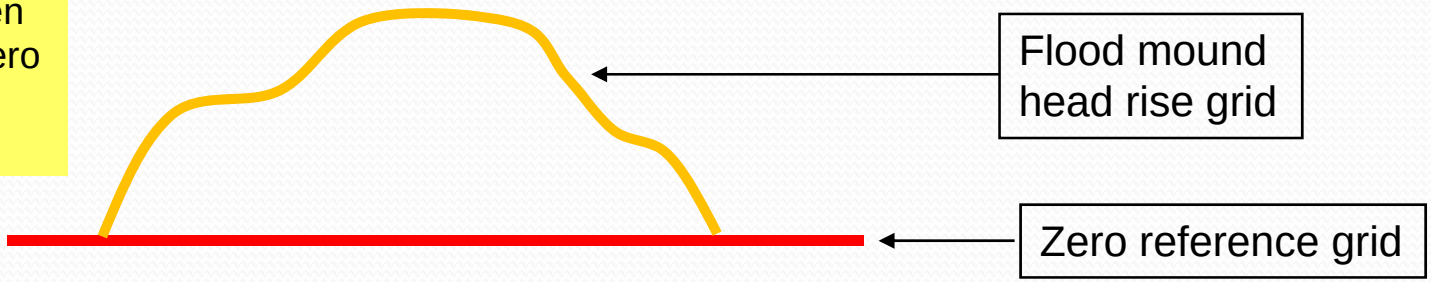
Cool temperature signals
occur only in the upper aquifer
Temperature <22°C



Recharge Estimates

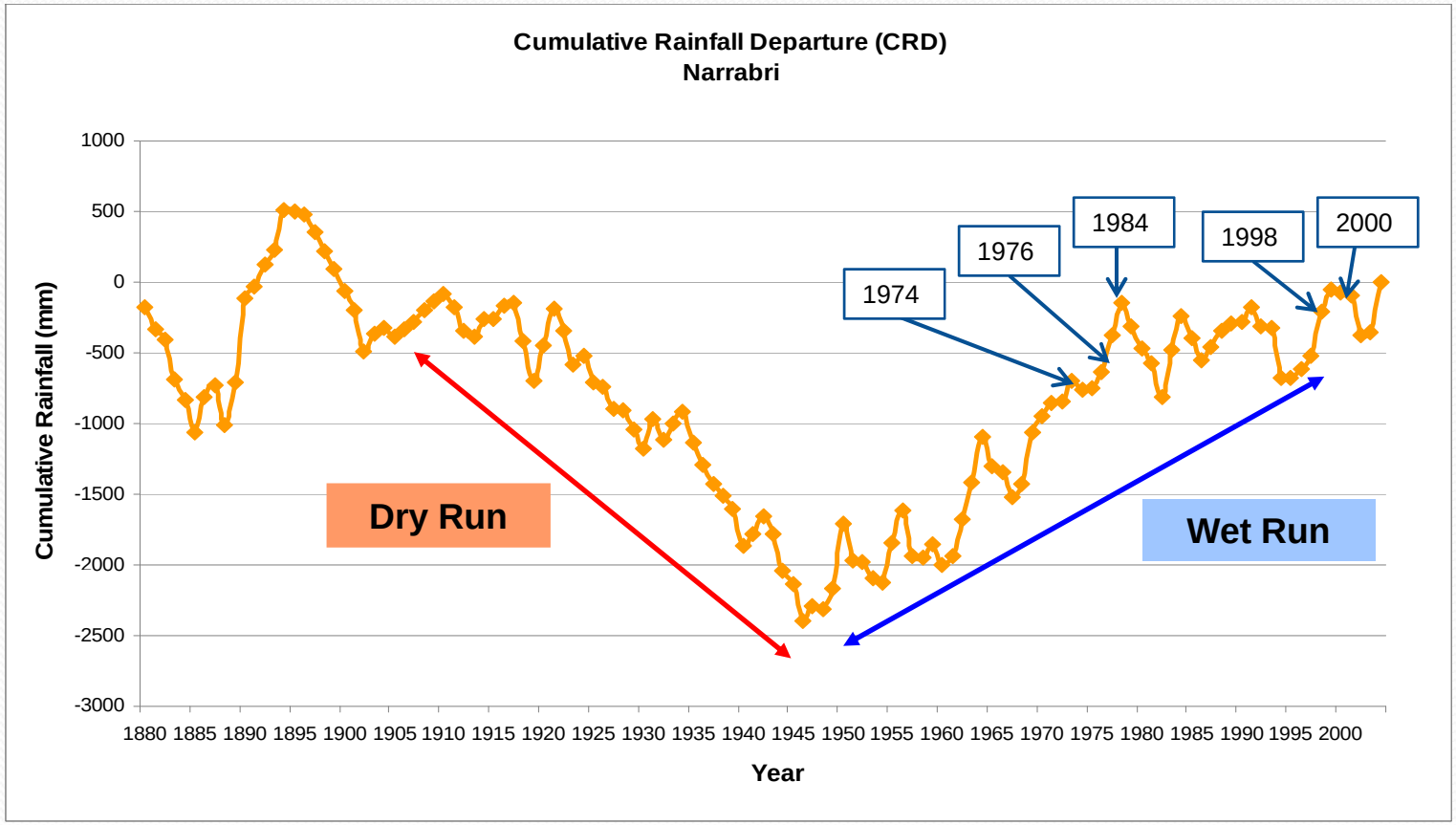
- Recharge estimated for the shallow unconfined aquifer

Volume between head rise and zero reference grid calculated



- 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

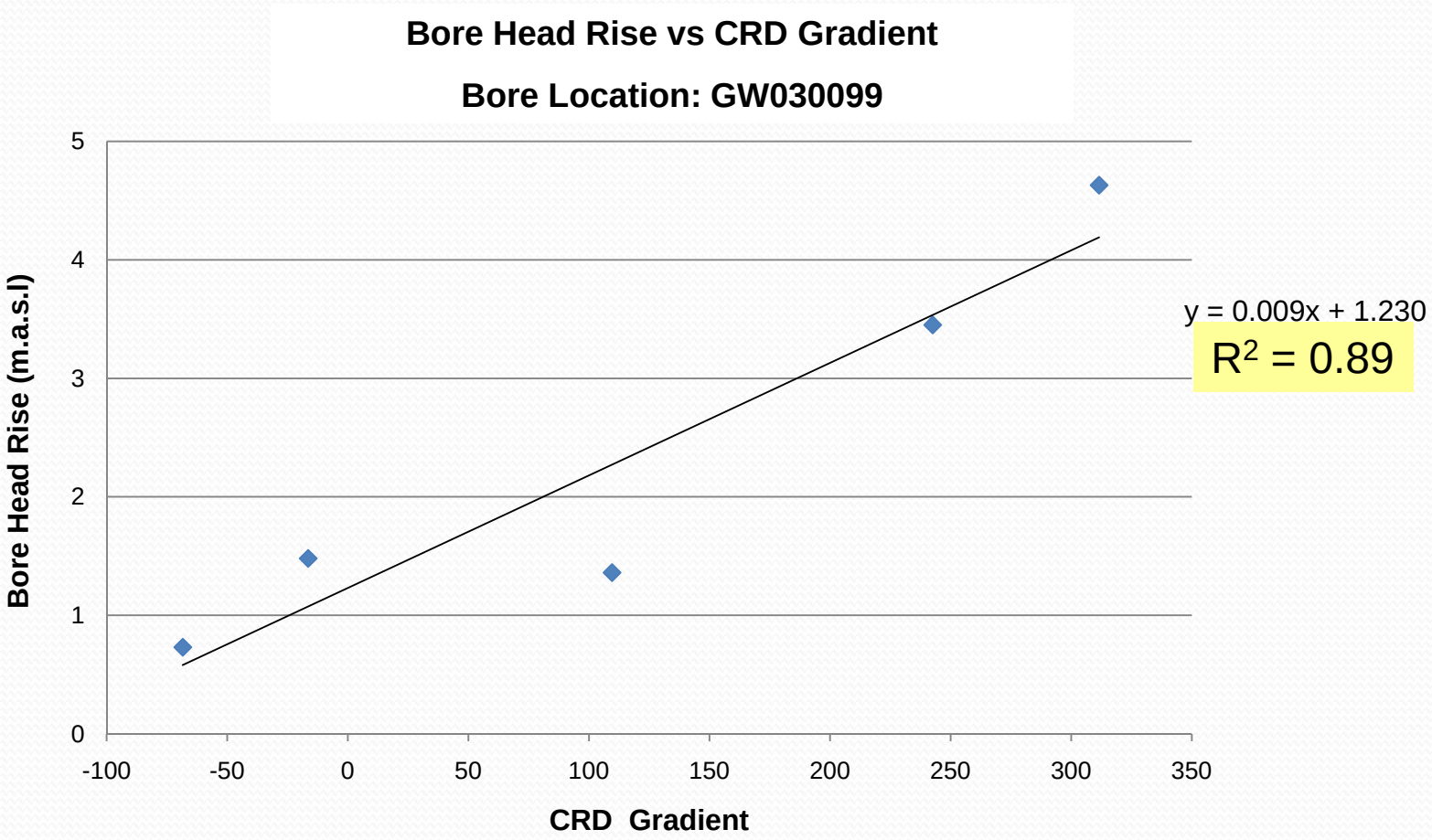
Cumulative Rainfall Departure (CRD)



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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