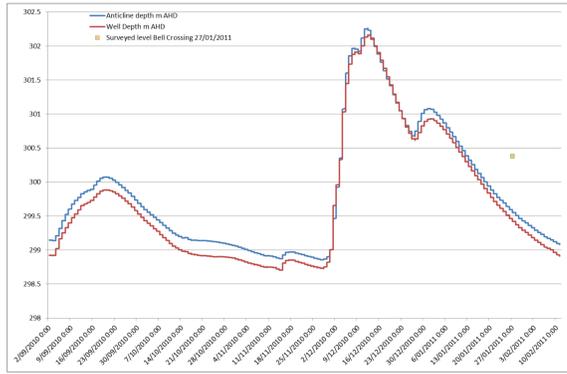


# Hydrogeological Response of the Wellington Caves System to the 2010 Floods

As part of the long term monitoring at Wellington, scientists from the University of New South Wales are monitoring water level and temperature within the Cathedral Cave (The Well) and Anticline Cave. The response of the system to the December 2010 flooding event was captured by this monitoring and the results are shown below.



**Figure 1:** Water levels in Anticline Cave and The Well from September 2010 to February 2011. The horizontal axis is the date and the vertical axis is the water level in m AHD. Note the similar response of each location to rainfall events, demonstrating that the two systems are likely to be interconnected. Note also the surveyed level of the Bell crossing taken on 27/01/2011. The actual level is 0.8 metres higher than those measured in Anticline and The Well. As the surveyed location is upstream, this suggests close relationship between cave water levels and the Bell River.

## Relative Water Levels

A survey of the water levels within Anticline, The Well and Bell River has been referenced to the Australian Height Datum system (AHD) and using the results of the survey we are able to compare the levels within Anticline, The Well and Bell River. Previously, the relative height of these water bodies could only be speculated on. However, it can be seen that the water level in each location is very similar. This suggests that the groundwater in the area is interconnected.

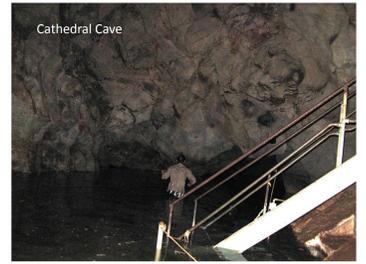


Figure 1 shows the water levels in Anticline and The Well as measured over a period of five months.

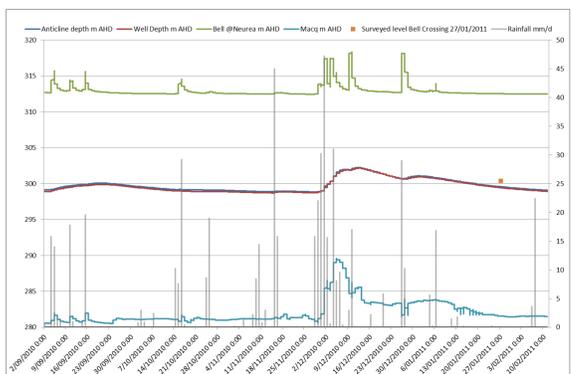
## Climatic Controls on Cave Water Levels

Comparison of the monitoring data with Bureau of Meteorology(BOM) daily rainfall values and NSW Office of Water (NOW) Water level Gauging Stations on the Macquarie River (at the Wellington Bridge) and the Bell River (at Neurea) give some insight into the climatic conditions which are required to raise the water levels in Anticline Cave and The Well.

Figure 2 shows the gauged water levels in the Macquarie and Bell in relation to rain fall events. This graph also shows the response of the Anticline and Well water levels in relation to these events. The key events are:

Several days of high precipitation at the end of November/ start of December resulted in flooding in both the Macquarie and the Bell Rivers. This caused flooding of the river alluvium along the Bell River and an increase in water levels within the caves event which resulted in an increase in water levels within the caves of over 2.5 metres during a 2 day period.

High rainfall events around 14 October also resulted in a flood in the Bell River, however not to an extent to flood the alluvial plain and significantly influence the Caves water level.



**Figure 2:** Relative water levels in the Macquarie River at Wellington (light blue line), Bell River at Neurea (green line), Anticline Cave (dark blue line) and The Well (red line). These levels are in m AHD as notated on the left axis. In addition daily rainfall data for the BOM station in wellington is included (grey bars), the units are in mm/day and are notated on the right axis.

## Water Temperature Variations

Data collection undertaken by UNSW included water temperature monitoring within Anticline Cave and The Well. Generally the water temperature in both locations is relatively stable, as shown in Figure 3. This is typical of deeper groundwater with a long residence time and as a consequence the mean groundwater temperature becomes the same as the average annual surface temperature.

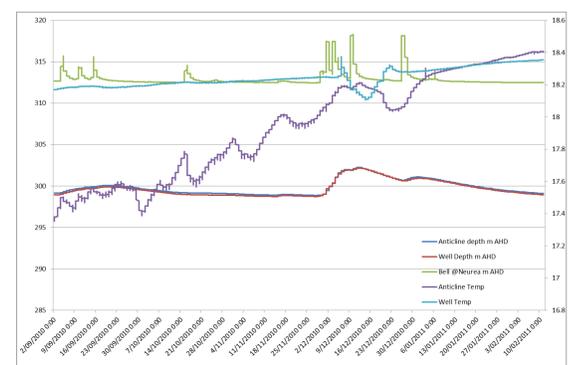
If a finer scale is applied to the left axis of the graph (17.2 to 18.4 °C) the temperature variation in Anticline and The Well becomes more apparent (Figure 4). The temperature in The Well is stable with a slight increase of approximately 0.2 °C over five months, whereas the water in Anticline Cave demonstrates greater variability. Ground water at Anticline Cave is close to the cave entrance, and a greater influence of surface climate is to be expected. However, the temperature variability is still relatively small, with a total change of 1 °C over a period of five months.

Of interest is the temperature response during the December 2010 floods. Figure 3 shows a comparison of the temperature change with the water level change. A rapid rise and then drop in water temperature was noted in The Well which seems to coincide with the increase in water level. In Anticline Cave, the temperature response to flooding is less clear. Without temperature data on rain and floodwaters we can only speculate on these temperature responses. Importantly though, these rapid changes in the otherwise stable ground water temperatures in Cathedral Cave indicate that we are seeing a significant event of groundwater recharge due to the December 2010 floods. Further research is needed to fully explain the temperature response and how it may be related to groundwater recharge.

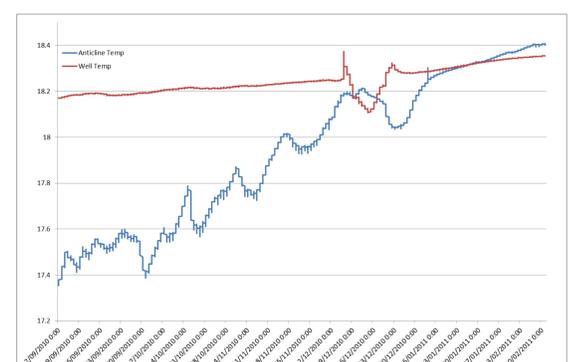
For further information please visit: [www.connectedwaters.unsw.edu.au](http://www.connectedwaters.unsw.edu.au)

## ACKNOWLEDGEMENTS

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**Figure 3:** Comparison of water temperature data to water level variations. Left axis is water level in m AHD and right axis is water temperature in degrees Celsius. Note the rapid drop in water temperature in The Well (light blue line) compared to the rise in water level in The Well (red line). Also note the lag in water temperature decline observed in Anticline (purple line) which follows the water level drop in Anticline (dark blue line).



**Figure 4:** Water temperature as measured in Anticline Cave (blue line) and The Well (red line) over the period September 2 to February 10. Note the temperature response in Anticline shows a seasonal and daily temperature influences. In contrast, the water temperature in The Well looks to have little or no seasonal variations.