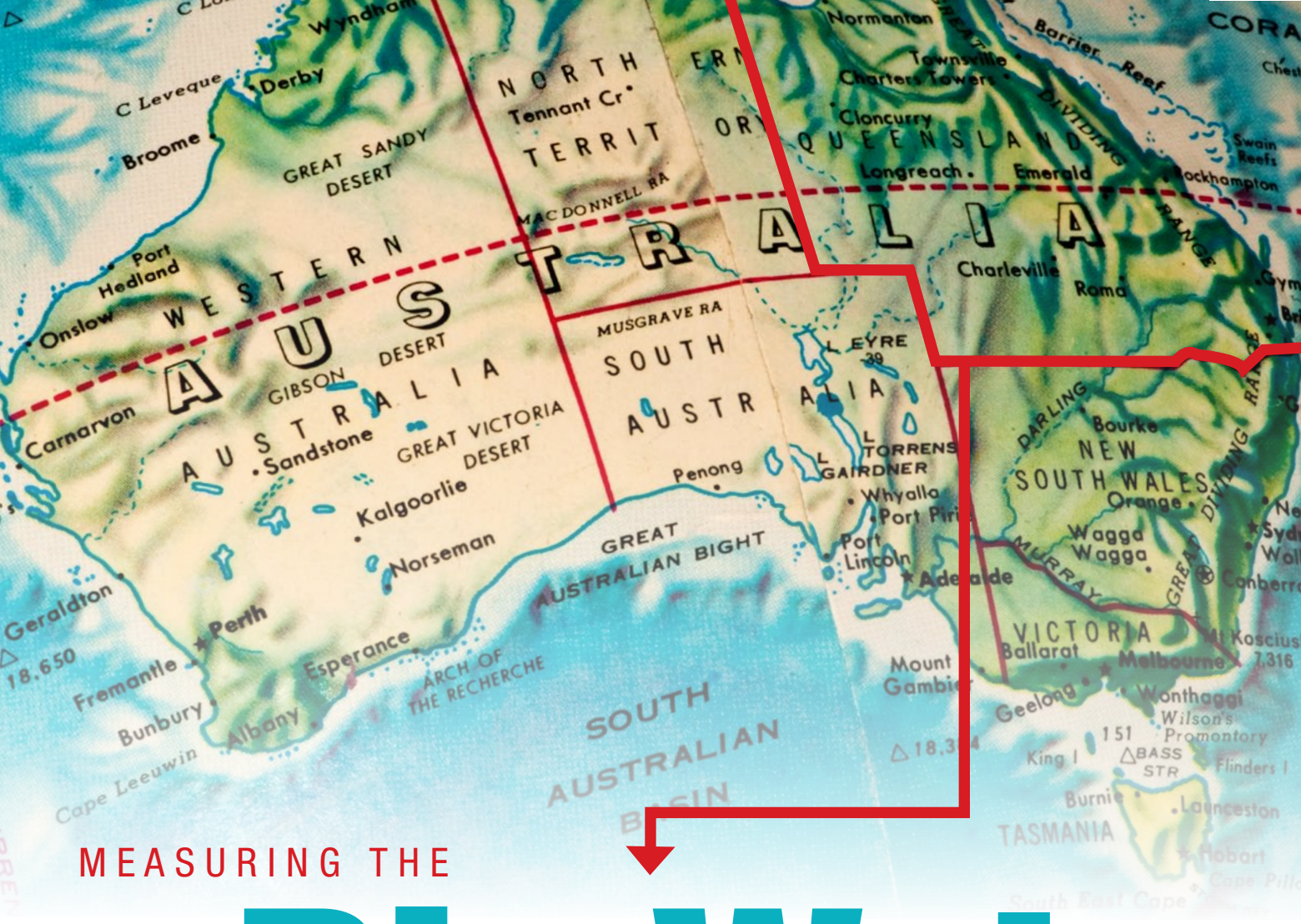


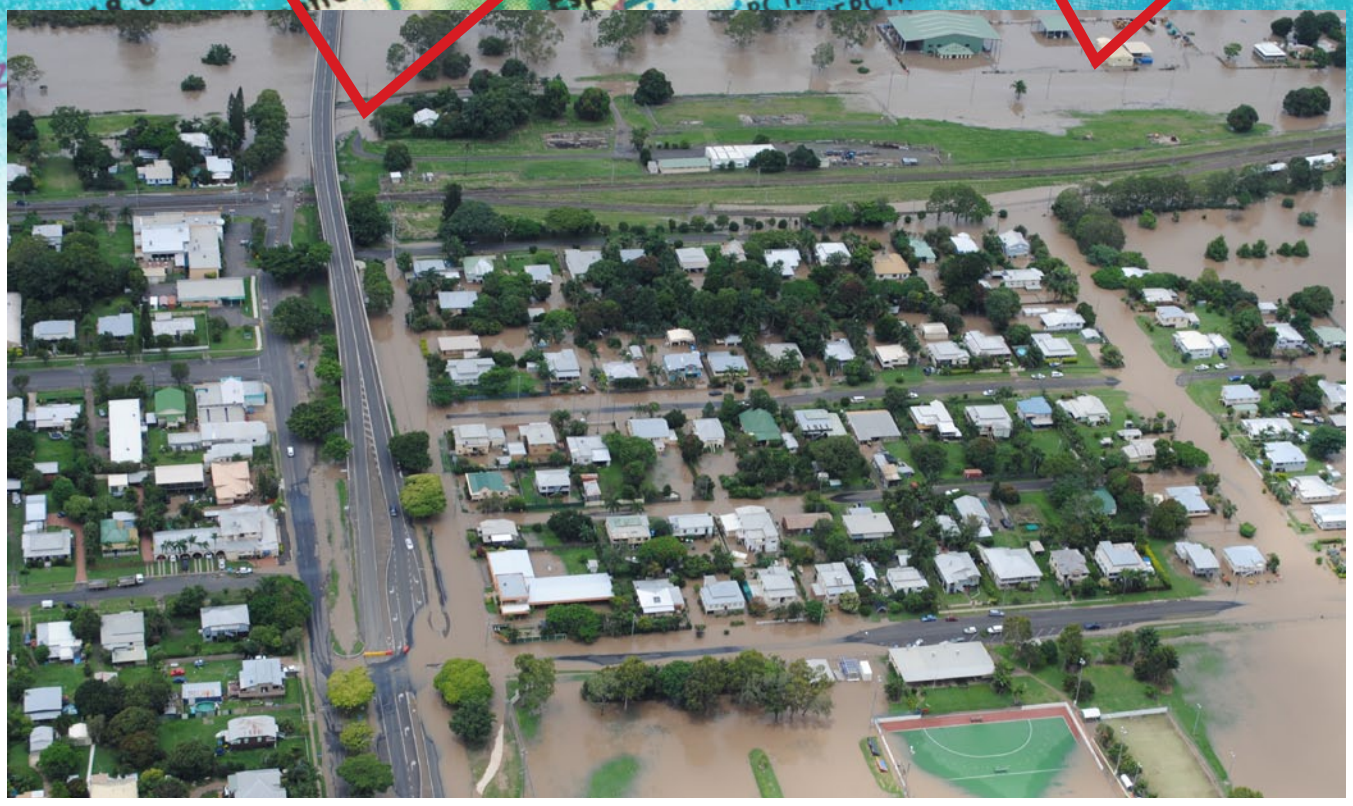
MEASURING THE

Big Wet

The rain in December 2010 was not unexpected. Every year, the climate in northeastern Australia features six months of dry weather followed by a long rainy period known as the "Big Wet." But this season's Big Wet would be wetter than any other. By the end of the month, the state of Queensland had seen its soggiest December on record–new record rainfall totals were measured at more than 100 locations. The torrential rains overwhelmed rivers and drainage systems, producing weeks of widespread flooding. Sitting astride the Burnett River on Australia's east coast, the city of Bundaberg was hit by two major floods in three weeks.

Bundaberg residents were first alerted to the potential for flooding after weeks of heavy rain fell across the Burnett's 33,000 km^2 (13,000 mi^2) watershed. Minor flood levels had already been exceeded by late December, when an additional 100 mm (4 in) of rain fell over three days. The river rose rapidly, and on December 30 it peaked at 7.92 m (26.0 ft) above the Australian Height Datum (AHD)–a level not seen since 1942.

>> John Clucas



Floodwaters inundate a Bundaberg neighbourhood. Advance warnings and evacuation plans prevented injury and loss of life.

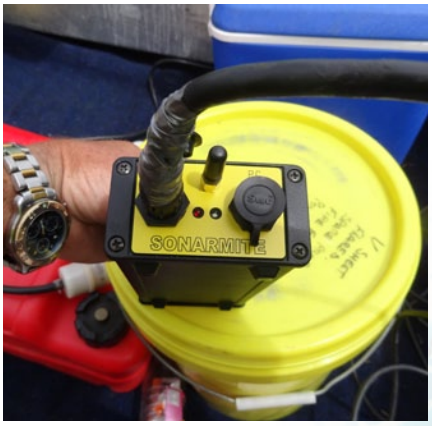
The city was prepared. As the first flood approached, emergency crews had activated disaster plans and evacuated hundreds of residents. But the city's surveyors looked beyond the looming devastation. They viewed the floods as an opportunity to capture data that could assist with flood modelling and inundation studies, future flood prediction, emergency management and town planning. To do so, they needed to measure 3D locations of the peak flood levels, as well as the date and time of the peaks.

The Regional Council Responds

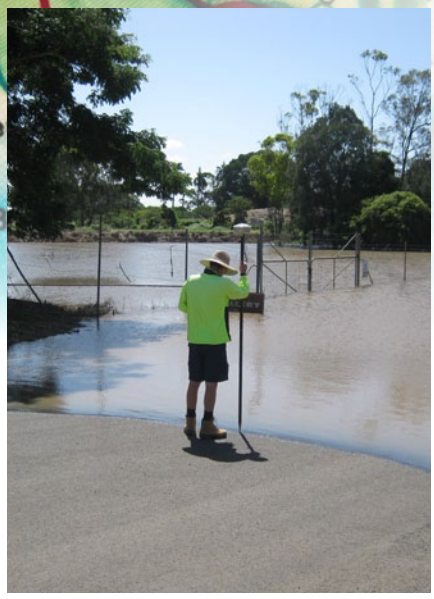
In addition to being responsible for its approximately 90,000 residents, the Bundaberg Regional Council manages surveying, mapping and engineering for assets including roads, drains and services for the region's businesses. In 2008, the Council decided to establish a permanent geodetic framework to support the region's surveying and mapping needs. Partnering with Geosciences Australia (the government body that manages Australia's spatial data infrastructure), the Council installed a Trimble® NetR5™ Reference Station equipped with a Trimble TRIMMARK™ Radio Modem at the Bundaberg airport. A radio repeater was built on The Hummock, a low hill overlooking Bundaberg. Working together, the reference station and repeater delivered the RTK corrections over a wide area. In addition to three Trimble R8 GNSS receivers used as RTK and mapping base/rovers, the council operates a Trimble S6 Total Station. All of the survey systems utilize TSC2® Controllers.

In planning their work during the flood, council surveyors faced the dilemma of how they could capture the needed data over such a large area in the limited time available. Their goal was to capture as much accurate data as possible along the road networks and rivers. The surveyors needed high data density in Bundaberg's urban areas, and uniform coverage along the length of the Burnett towards Paradise Dam.

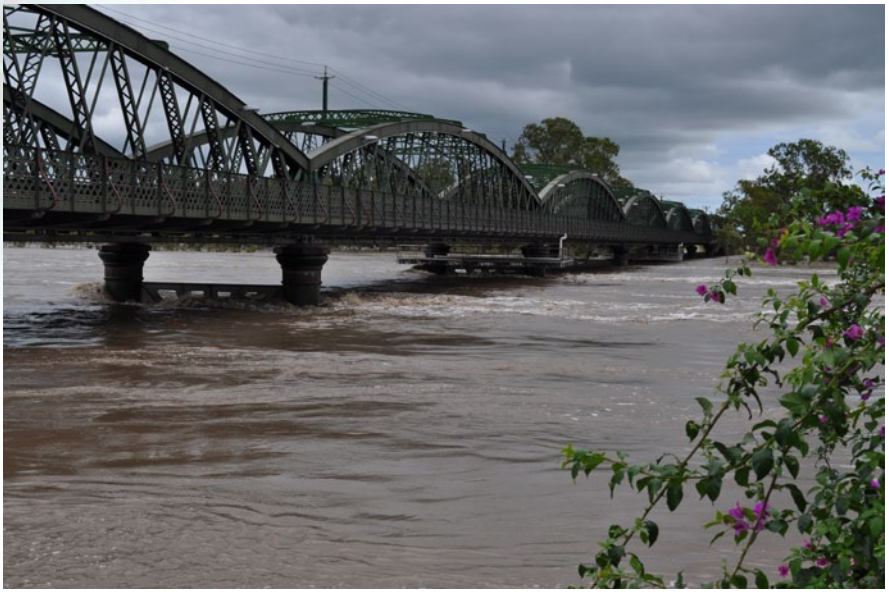
But resources were limited; many staff members were away for their Christmas/New Year holidays, and the flood surveys needed to cover more than 50 km² (19 mi²). The solution: Get the community involved. Through local radio, television, newspapers and the council's website, the region's citizens were asked to mark the flood's highest extents on their properties. Residents set markers indicating high water locations, often writing the time data on lath or stakes in the ground. In the days after the flood's peak, council surveyors set



The SonarMite Echo Sounder will survey to depths of 75m.



A Bundaberg surveyor measures the highwater mark on a roadway. Teams made periodic visits to key locations to monitor the flood's progress.



First opened August 24th 1900 the Burnett River Traffic Bridge located in the heart of Bundaberg has seen many floods in its time. On December 30th 2010 it once again stood in defiance of the floodwaters.

about measuring flood extents marks on each property and indicators such as flood debris in trees and fences. Most of this work was done with two Trimble R8 GNSS receivers acting as rovers using RTK corrections from the airport base station. Outside the City of Bundaberg, the Trimble R8 GNSS receivers were used as a mobile base/rover combination to cover those areas outside the permanent base station range.

Just five days after the first flood had dropped below the "minor flood level" of 3.5 m (11.5 ft) AHD, the southern part of the Burnett catchment received another pounding. In four days, an additional 300 mm (12 in) of rain fell onto the waterlogged landscape. Still reeling from the initial surge, Bundaberg received a new set of flood warnings.

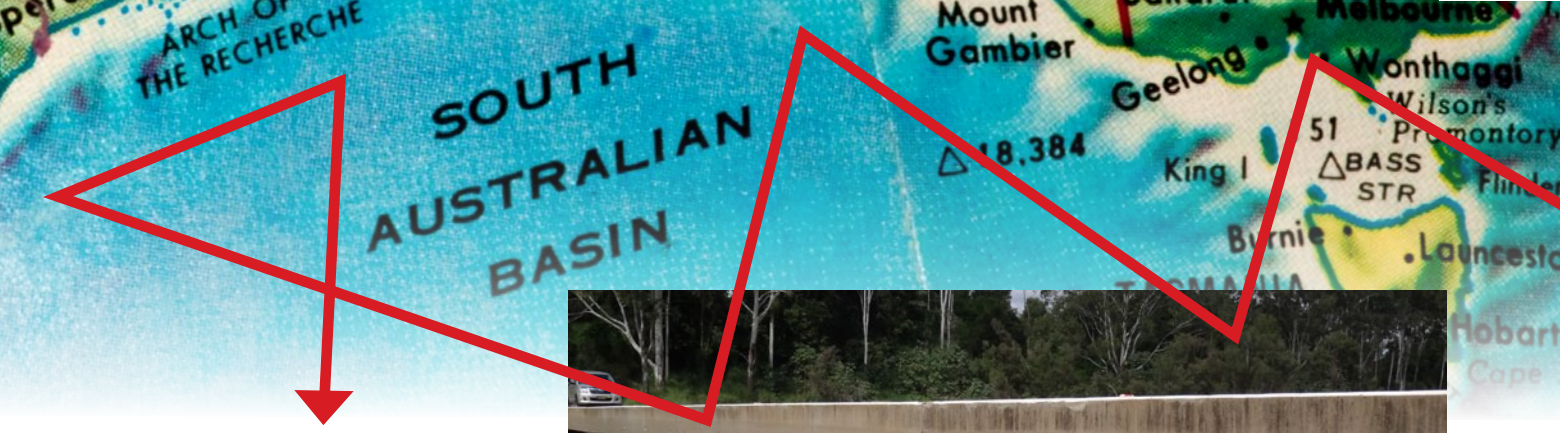
While gathering data on peak water levels in the first flood was extremely valuable, Bundaberg Regional Council's Manager of Design Dwayne Honor knew that a time stamp for water levels would be crucial to create accurate models of flood extents and behavior. Survey crews switched their focus from the first flood and concentrated on the second. Having the benefit of data collected from the first flood, the Council could direct the teams to critical locations during the second inundation. At regular intervals, survey teams visited the key points to gather 3D data of flood water levels leading up to the peak.

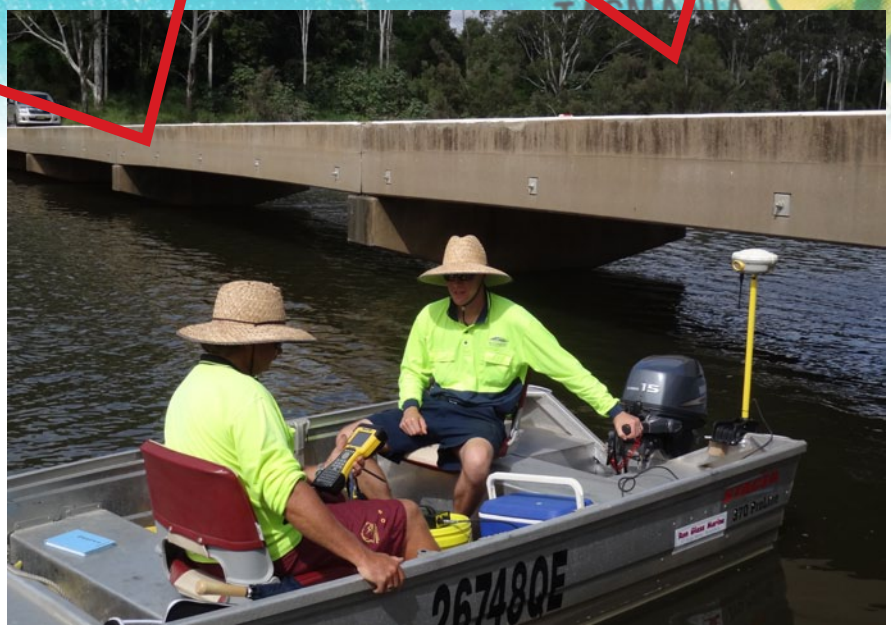
Once again, assistance came from the catchment's broader community. With communication channels already established, the council asked residents between Bundaberg and Paradise Dam, 100 km (63 miles) upstream to record changes in water levels over time.

Luckily, at the time of this second flood, an aerial survey and mapping company had an aircraft within reach of Bundaberg. The council engaged the firm to capture data upstream of the city as the flood approached. The firm gathered additional aerial data as the flood peaked in Bundaberg at 5.76 m (18.9 ft) AHD on January 13, 2011.

> **"While it might not have been considered at the time, the residents' aid in marking flood levels leaves a legacy of high-quality data."**

After the flood subsided, council surveyors conducted extensive bathymetric work to capture cross sections of the riverbed and to augment the land and aerial surveys. A boat was equipped with a SonarMite Echo Sounder





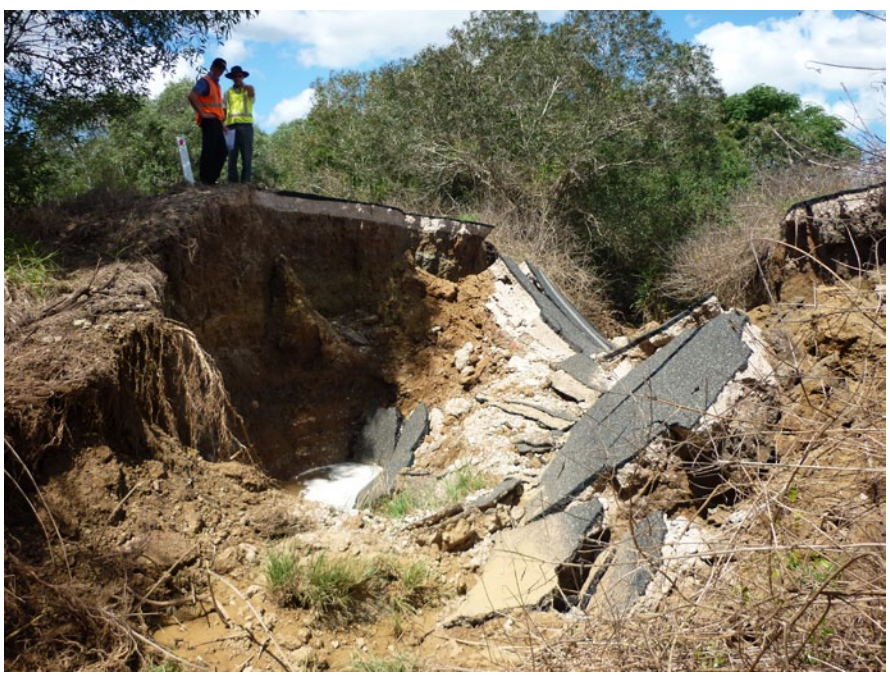
Council surveyors conduct post-flood bathymetric surveys on the Burnett River. Sonar and GNSS positions provide cross section data for riverbed analysis and flood modelling.

connected via Bluetooth to a TSC2 Controller and Trimble R8 GNSS rover, which received RTK corrections from a second Trimble R8 GNSS set up as a mobile base station on the river bank. Working in difficult terrain and on stretches of river with no boat-launch points, the crews were able to minimize relocations of the base station.

The teams surveyed approximately 113 km (70 mi) of the river, collecting cross sections at an average interval of 200 m (650 ft). A config file applied to the TSC2 converted recorded levels to AHD for output as XYZ ASCII files. The results of the bathymetric surveys allowed the Council to assess the post-flood shape of the Burnett riverbed. The information was also passed into Tuflow software for use in developing 1D/2D flood models.

Three months after the floods, the fieldwork was complete. Each piece of data carried a date and time stamp as well as XYZ coordinates relative to AHD. The dataset has been vital in consultants' work in calibrating the new flood study.

"The floods gave us an extremely hectic couple of weeks," Honor said.



Teams inspect a road washout. Floodwaters reached the highest levels in 60 years.

"When you're under pressure like that you can't afford to have issues with the technology and bugs to sort out with the gear. The Trimble equipment didn't let us down once. That allowed us to plan our work efficiently and gave us certainty that we could capture what we needed within the time frames available."

The assistance from local residents proved invaluable. Several homeowners suffered great losses, yet they found time to meet and talk to Council staff. One resident lost everything when floodwaters came up to the eaves of his house, but he still assisted the survey staff and supplied valuable information in order to help others in the future. While it might not have been considered at the time, the residents' aid in marking flood levels leaves a legacy of high-quality data. Because the surveyors were able to collect so much data, the council and community can have high confidence in the results of the flood modelling. It will work to everyone's benefit by helping to mitigate flooding from the next "Big Wet."

John Clucas is a freelance writer in Australia's construction industry.