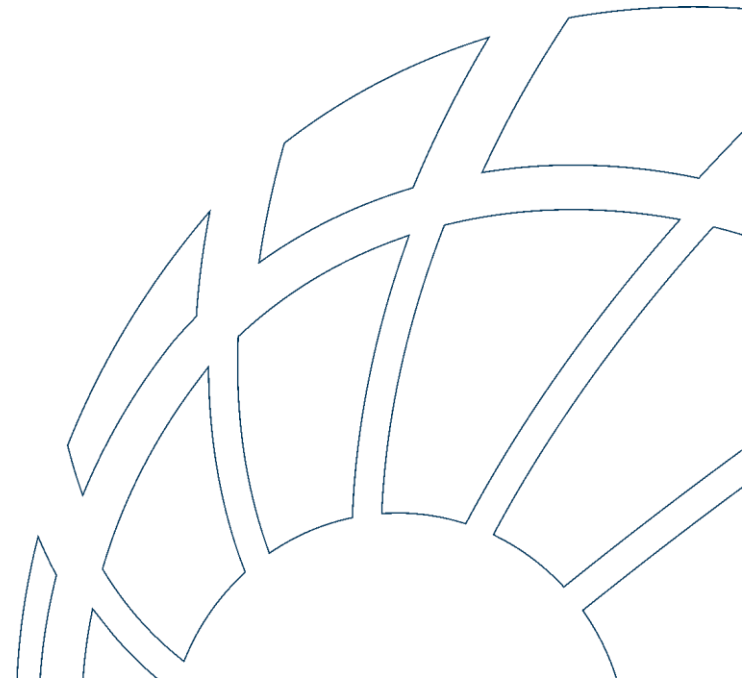




"Where will our knowledge take you?"

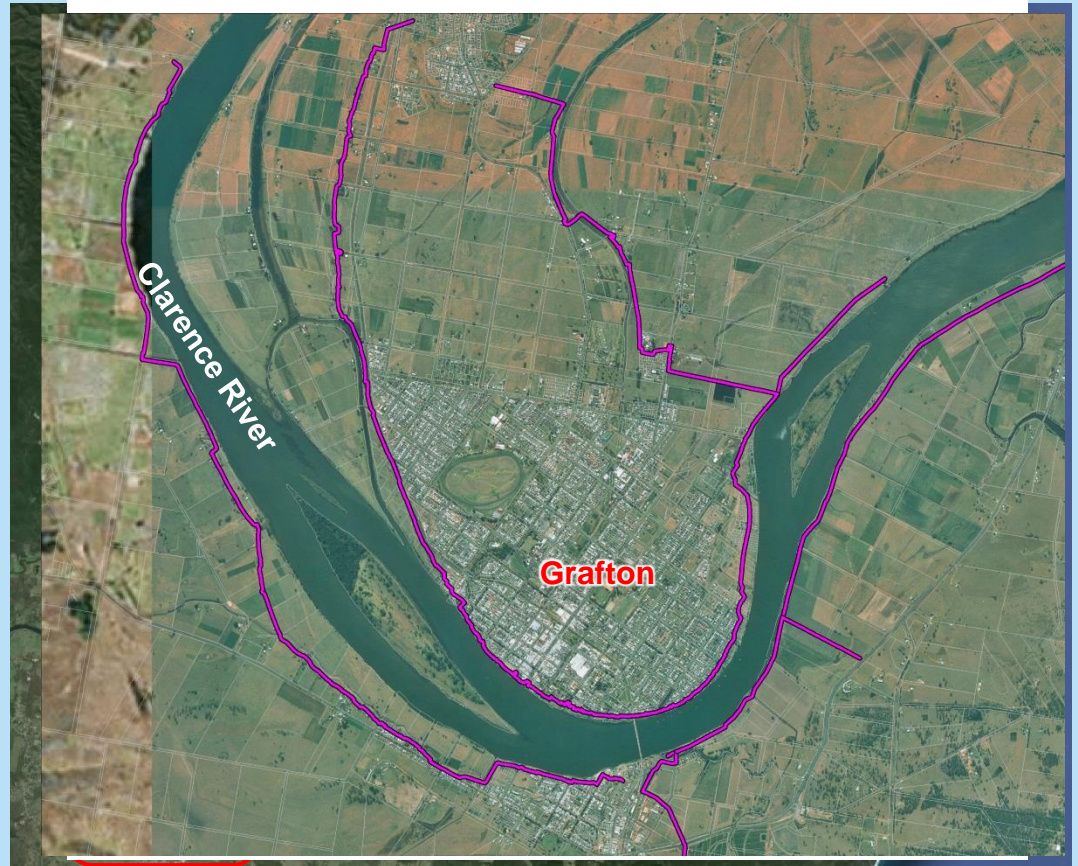
# Flooding Disaster Averted in Grafton, the Result of Good Planning, Not Luck

Arid Regions Conference, Arizona  
**October 2013**



# Study Area

- Grafton, NSW (Australia)
- Located within the Clarence River catchment (13,000 square miles)
- Population: approximately 15,000
- Protected by over 15 miles of levees



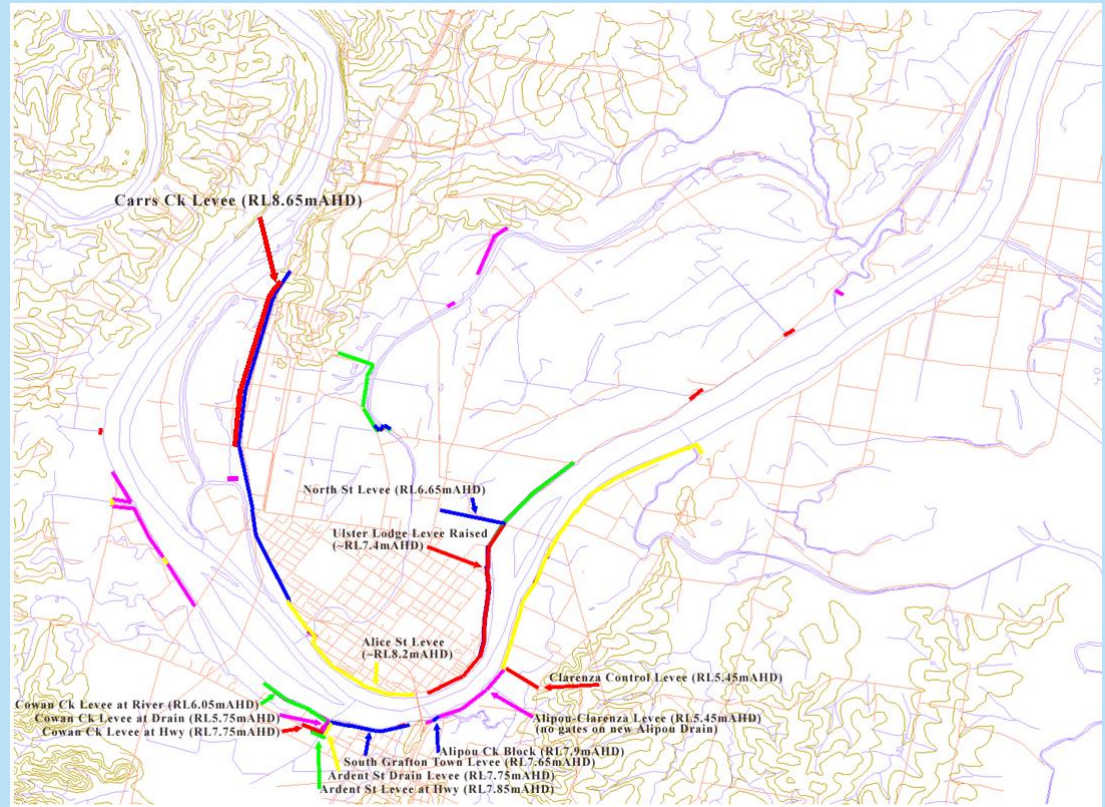
# Historic Levee Development

## Major Flood

- 1864, 1876
- 1887, 1890, 1893
- 1950, 1954, 1963
- 1967, 1968
- 1974, 1976
- 2001, 2009, 2011, 2013

## Levee Construction/Upgrade

- 1884
- 1902
- 1964
- 1970
- 1976 and 1996
- Study currently underway



# Community Perception of Flood Risk

## 2001 Resident Survey

- Residents are aware of the possibility of levee overtopping
- During a flood, tend to behave as if levee will protect them (unwilling to evacuate)
- Have experienced few direct effects of flooding since the construction of levees and are unaware of the consequences of levee overtopping (1970's)
- Survey highlights that levees can increase flood risk by providing a false sense of security. When overtopping occurs catastrophic consequences may result!

### Floodplain Risk Management Study Questionnaire

Name: \_\_\_\_\_ Date: \_\_\_\_\_  
(Optional)

Address: \_\_\_\_\_  
(Optional)

Telephone: \_\_\_\_\_  
(Optional)

How many years have you lived in the area? \_\_\_\_\_

Are you concerned about the following:

Flooding of your property  
Evacuation during flood time in an emergency  
Flooding of your building  
Damage after the flood peak  
Whether you are well prepared for a flood

Strongly Agree	Agree	N/A	Disagree	Strongly Disagree

Other concerns you may have (please specify):  
\_\_\_\_\_  
\_\_\_\_\_

Do you think Council could consider flood  
modification measures such as:

Levees to provide more protection  
Removal of sand from the river channel  
Improved drainage

Strongly Agree	Agree	N/A	Disagree	Strongly Disagree

Other flood related works (please specify):  
\_\_\_\_\_  
\_\_\_\_\_

#### Response Modification Measures

Do you believe the following are worth considering?

Raising Community Awareness. For example:

- A regular community campaign to educate about flooding?
- Flood Warning & Emergency Planning. For example:
- Could flood warnings be improved?

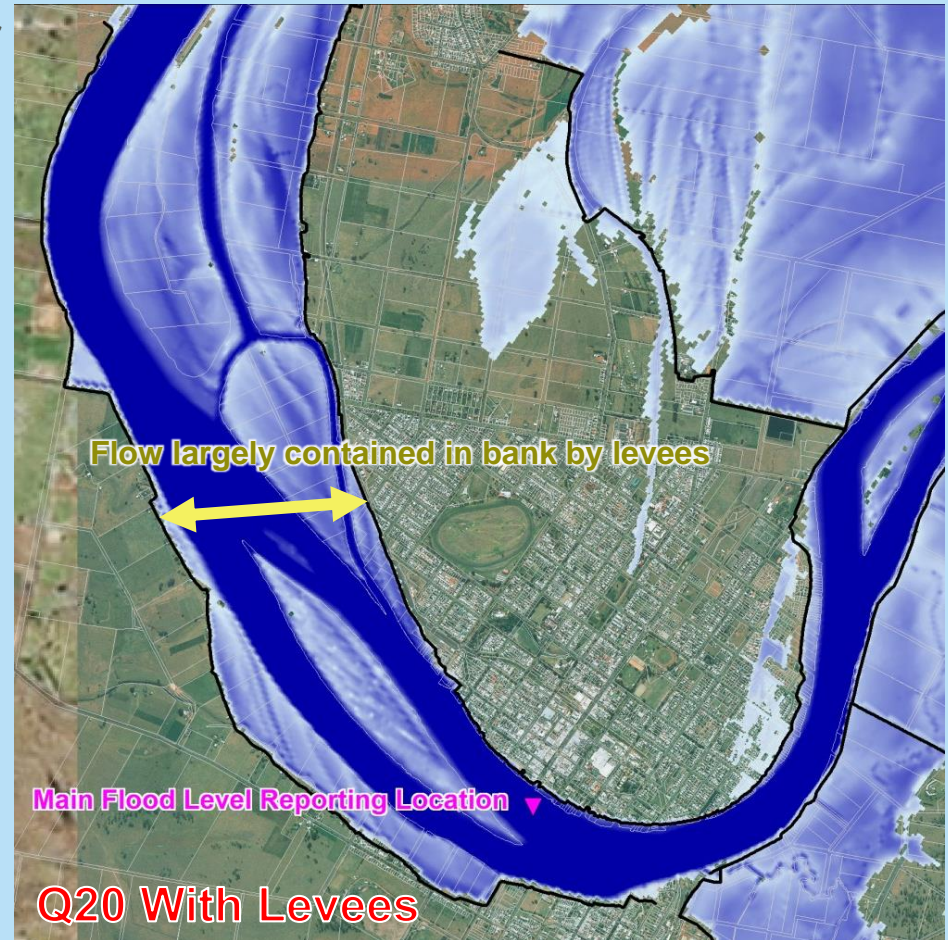
Strongly Agree	Agree	N/A	Disagree	Strongly Disagree

Other measures (please specify):  
\_\_\_\_\_  
\_\_\_\_\_



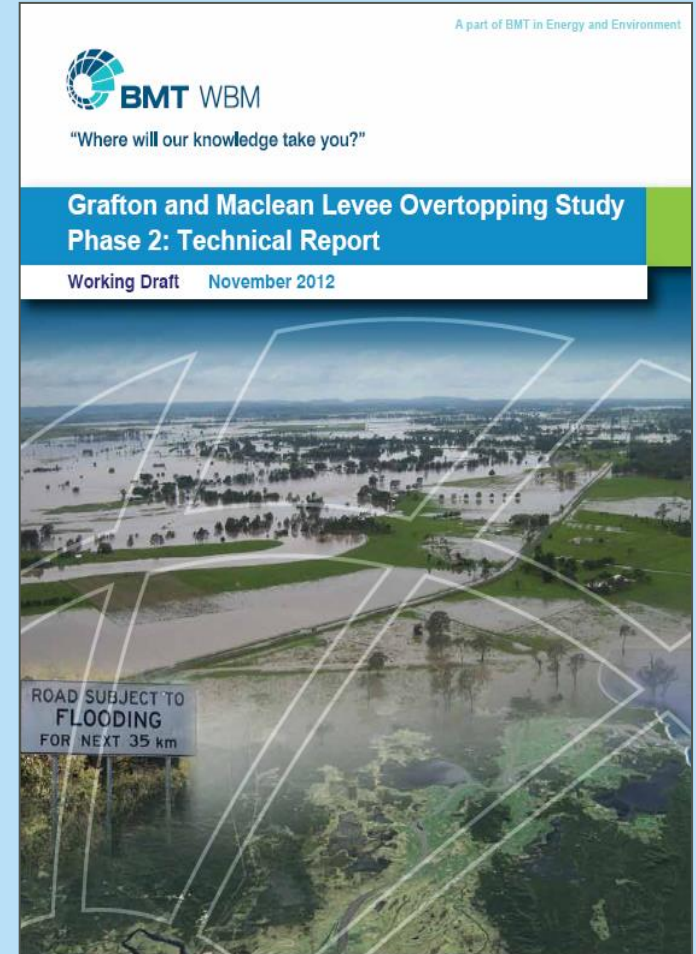
# Levee Impact on Flood Behaviour

- Levees have changed the flood behaviour significantly
- Raising flood levels within the river by up to a foot
- This creates a false idea about the severity of recent flood events, such as the flood in January 2013
  - 2<sup>nd</sup> highest recorded level
  - 8<sup>th</sup> ranked peak flow accounting for impact of levees on flood behaviour
- As a result, the community has too much confidence in the protection given by the levee system.
- The risk of a levee overtopping flood is therefore much greater than the community perceives



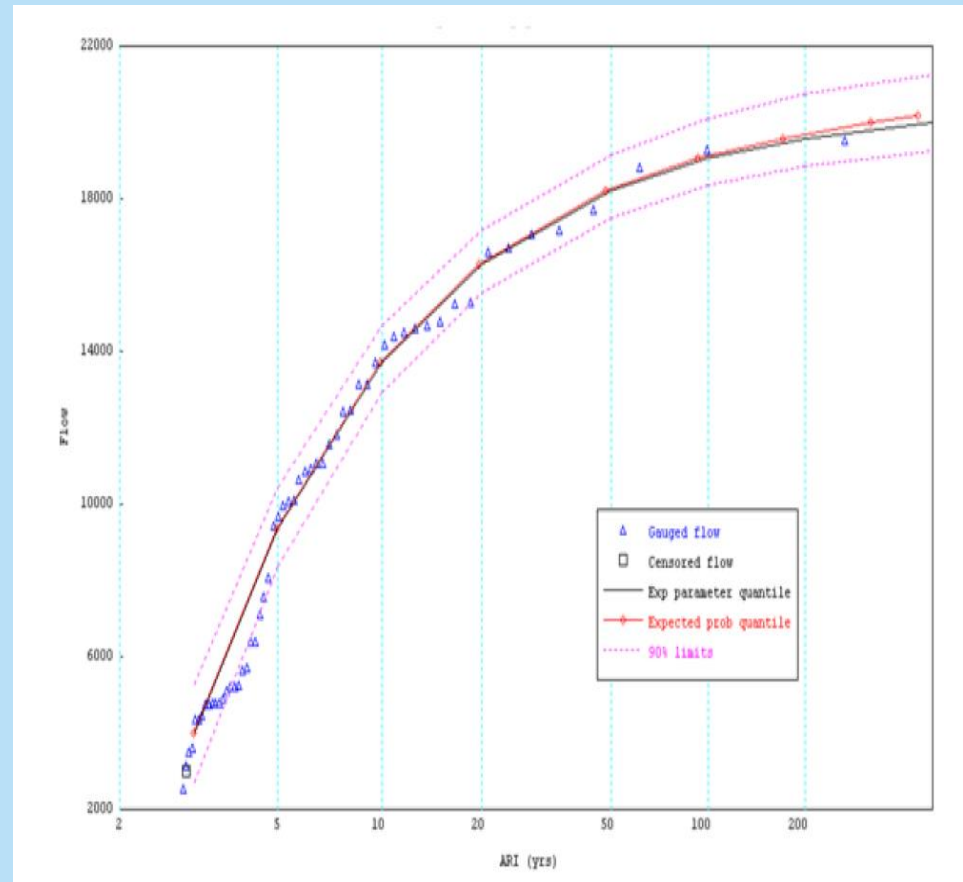
# Grafton Levee Overtopping Study

- Lower Clarence River Flood Model update (TUFLOW)
- Model calibration
- Define existing flood risk
- Grafton Levee overtopping regime (location/time/progression)
- Definition of a preferred overtopping regime
- Mitigation scenario testing
- Flood planning level review
- Emergency response planning review



# Lower Clarence TUFLOW Flood Model

- ALS ground or surveyed bathymetric data
- Model Resolution - Nested Grids: 60m, 30m, 10m
- Land-Use definition
- Geometry Modifications
  - Detailed levee survey
- 1D network
  - Urban Drainage
- Model Boundaries:
  - Recorded Data (Calibration)
  - Flood Frequency Analysis (150 years)



# Lower Clarence TUFLOW Flood Model

## March 2001 Calibration:

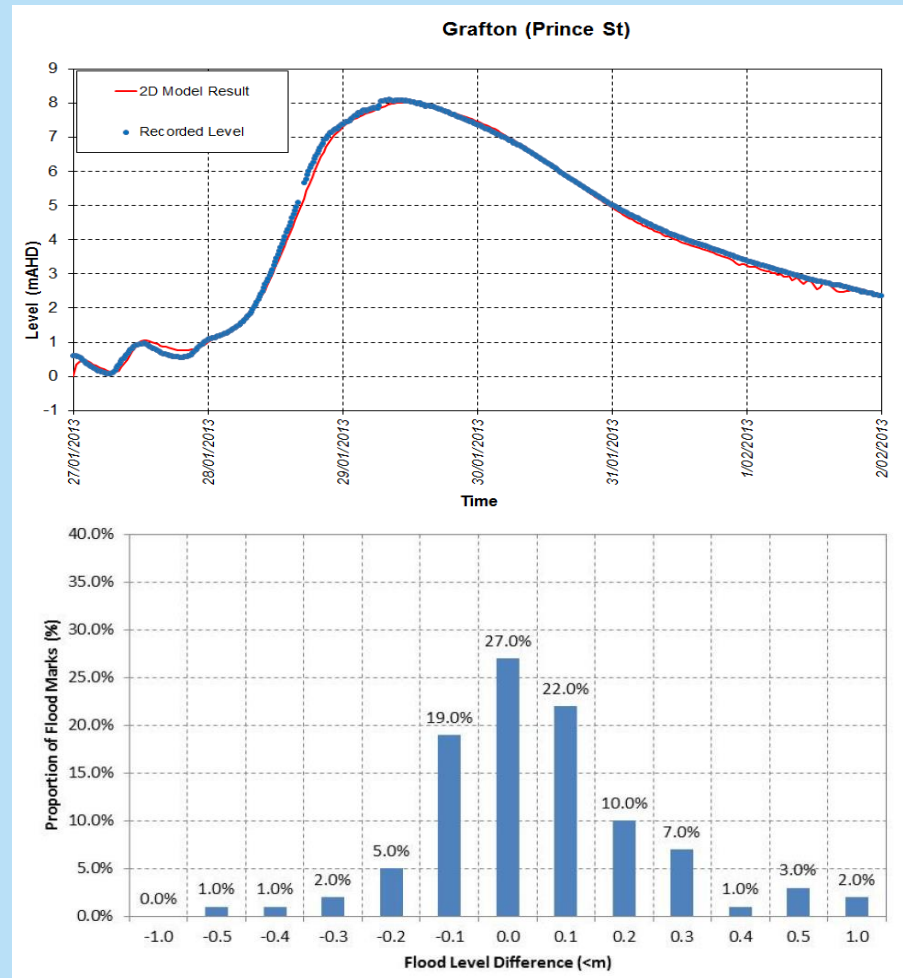
144 recorded flood levels surveyed

- 83% of marks were within 200mm of modeled flood level
- 68% of marks were within 100mm of modeled flood levels

## January 2013 Calibration:

79 recorded flood levels surveyed

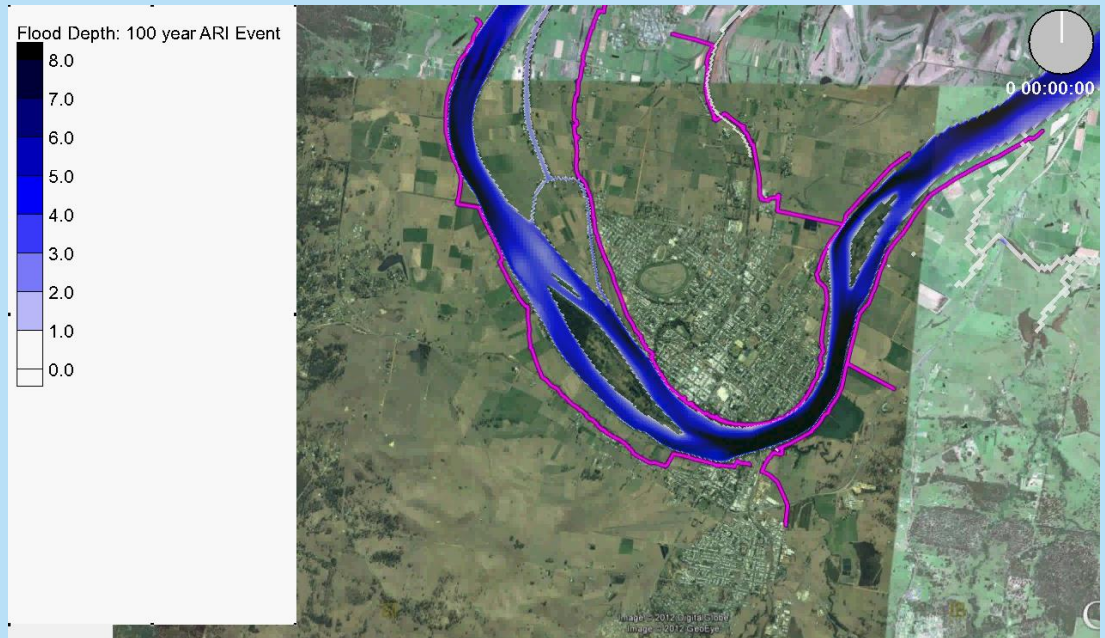
- 86% of marks were within 200mm of modeled flood level
- 55% of marks were within 100mm of modeled flood levels





# The Actual Flood Risk in Grafton

- Levee overtopped in 5% AEP event (20 Year ARI)
- 90% inundated in 1% AEP event (100 Year ARI)
- 100% inundated in PMF event: Average depth = 4m
- Levee overtops into urban areas
- Flow velocity depth product = extreme
- Evacuation route:  
Inundated 1 hour post levee overtopped
- Flooding poses a major risk
- Disconnect between public perception and actual risk!!!

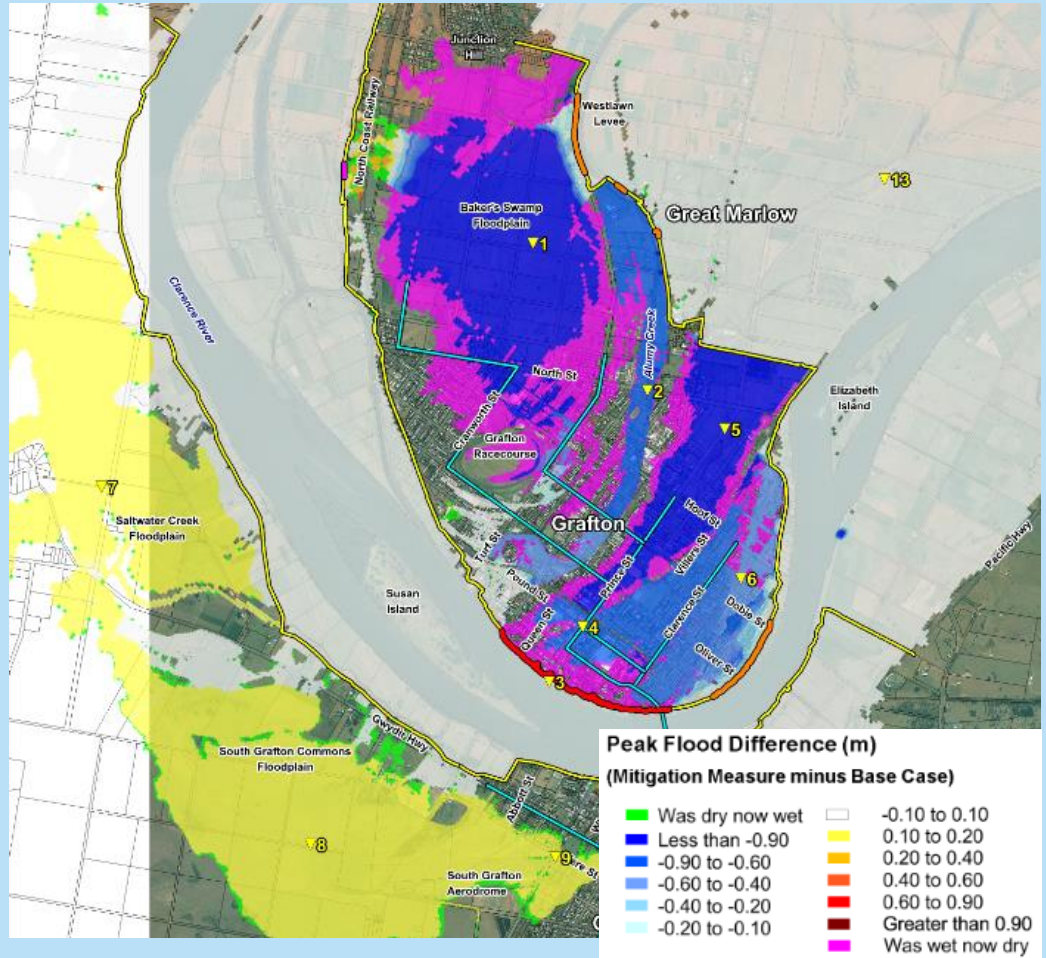


# Preferred Levee Overtopping Regime

- TUFLOW flood modeling used to inform Levee mitigation assessment
- Four Scenarios tested

## Aims:

- Increase the flood immunity of critical evacuation routes
- Defined a controlled levee overtopping location for each levee (rural location)
- Backwater inundation if/when overtopping occurs



# January 2013 Flood Event

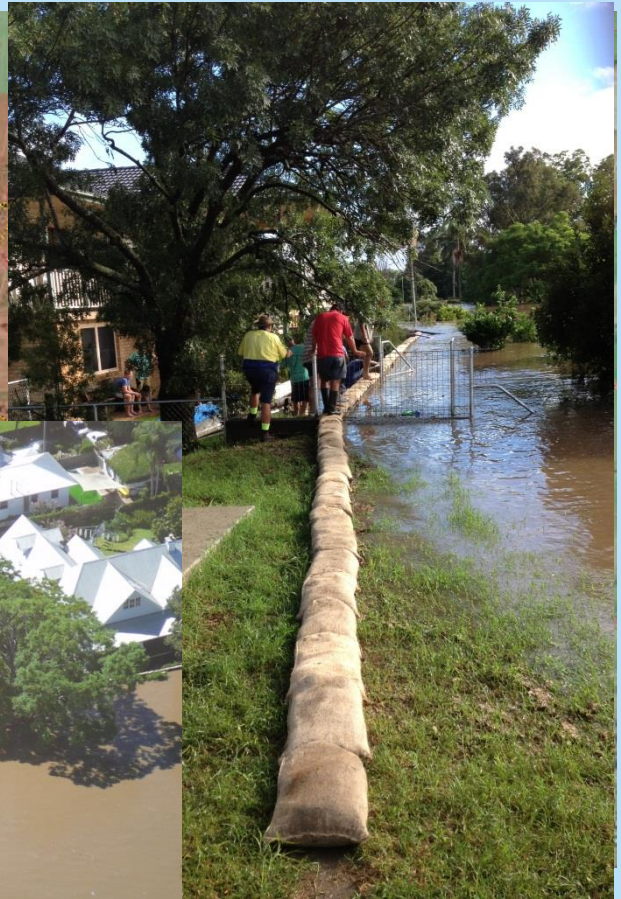
- Extreme weather event: Tropical Cyclone Oswald occurred in January 2013
- Flood levels were forecast by the BoM to 8.2m on the Prince St gauge. This was an overtopping event!!!
- Flood levels reached 8.08m on the Prince St gauge.
- Flood modeling indicates, without mitigation, this event would overtop a  $\frac{3}{4}$  mile portion of the Grafton levee by a depth of 1 foot, inundating half the town





# January 2013 Flood Event

- The detailed TUFLOW flood modeling results were used to inform:
  - Targeted evacuation warnings to high risk sectors of Grafton
  - The strategic placement of sandbags along the levee crest
- As a result, the levee did not overtop! Grafton was saved.





# Conclusions

The Grafton Levee Overtopping Study highlights how accurate flood modeling is a useful tool to inform Floodplain Risk Management:

- Existing flood risk definition
- Future flood modification measure planning (structural mitigation)
- Emergency response planning
- Development controls

However, increased flood education of the community is needed to further improve the effectiveness of existing flood risk mitigation measures in Grafton.

An informed educated community understands their level of risk, and how to respond during an emergency situation

Thankyou