

FLOODPLAIN RISK MANAGEMENT IN PRACTICE

THE BURNETT RIVER EXPERIENCE

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Abstract

On Saturday the 26th of January 2013, ex-Tropical Cyclone Oswald crossed the Burnett River catchment causing a series of natural disasters to occur in the vicinity of Bundaberg, Queensland. A total of five (5) tornadoes struck the coastal fringe to the east of the city causing damage to the adjacent townships of Bargara and Burnett Heads. On Sunday the 27th of January, following significant rainfall across the catchment - the Burnett River broke its banks and the city of Bundaberg began to experience its largest flood in recorded history.

The events of January 2013 were preceded by moderate levels of flooding in the city of Bundaberg during December 2010 and January 2011. Following completion of a comprehensive two-year flood modelling and mapping study of the Burnett River floodplain, a floodplain risk management study was initiated in August 2013. As part of the study, a detailed flood mitigation options assessment was undertaken to identify the top five (5) floodplain management options that would improve the region's flood resilience and preparedness. This paper provides a summary of the floodplain risk management process undertaken in Bundaberg, some of the key challenges involved in undertaking such a study in an area recently affected by a major flood, key outcomes and learnings.

Key Words: Ex Tropical Cyclone Oswald, Bundaberg Floods, Burnett River, Flood Modelling, Floodplain Risk Management.

Introduction

In late January 2013, tropical cyclone Oswald formed in the Gulf of Carpentaria before moving down the east coast of Australia in the form of a tropical low. As a result, most of the east coast of Queensland, and parts of the New South Wales coast experienced very heavy rainfall during the period from 22nd to 29th January. This rainfall resulted in severe flooding in many areas within 200 kilometres of the east coast, with the city of Bundaberg experiencing its largest flood in recorded history. The flood reached a height of 9.53

metres at the Targo Street flood gauge in Bundaberg, approximately 7.34 meters above the Highest Astronomical Tide (HAT) level of 2.19m AHD.

A large number of people were evacuated due to flooding, including approximately 5,000 residents from North Bundaberg. In addition, the January 2013 flood resulted in a significant amount of flood damage including inundation of over 4,000 homes, significant scour and scour induced building damage, and widespread impacts to both public infrastructure (including bridges, roads, sewerage and water lines) and

agricultural activities (sugar cane cropping, livestock, small crops and fishing).

The scale of the event required a recovery effort larger than any other natural disaster in Bundaberg's history. Council initiated the *Burnett River Floodplain Action Plan* in August 2013 to consider short, medium and long term responses for reducing the impacts of future events. A large part of this plan was development of a Floodplain Risk Management Study. Importantly, this study was underpinned by extensive community consultation and development of an independent Community Reference Group (CRG).

Burnett Catchment Overview

The Burnett River catchment is one of the largest catchments in Queensland. At Bundaberg, the upstream catchment area is approximately 32,820 km². By comparison, the Brisbane River has a catchment area of approximately 13,600 km² (GHD 2014). Figure 1 illustrates the location and extent of the catchment.

The Burnett River originates in the Dawes Range to the north of Monto and flows in a southerly direction through Eidsvold and Mundubbera.

Upstream of Mundubbera, the Burnett River is joined by the Nogo and Auburn Rivers which drain large areas of the western part of the catchment, and the Boyne River which drains the basin area to the south. Downstream of Mundubbera, the Burnett River flows in a north-easterly direction towards the coast. Between Gayndah and Mt Lawless the Barker-Barambah Creek system joins the Burnett River.

There are a number of dams in the Burnett River catchment with the larger dams including Cania Dam, Wuruma Dam, Boondoonba Dam, Bjelke-Peterson Dam and Paradise Dam.

Annual average rainfall throughout the Burnett River catchment is highly variable based on the distance from the coast, ranging from 1200 millimetres in the east to 800 millimetres further inland. There is also

a high degree of variability in regard to monthly rainfall. Records show that the summer months dominate rainfall totals within the catchment.

Different patterns of rainfall over the catchment can give rise to different types of floods. Floodwaters can originate from the upper catchment as far away as Kingaroy or Monto, and may take days to reach Bundaberg. In other cases, significant amounts of rain can fall on catchments such as the Perry River and St Agnes Creek downstream of Paradise Dam, causing flood levels in Bundaberg to rise in less than a day. In general terms, the worst floods will occur when a large weather system causes significant rainfall over widespread, rather than localised, areas.

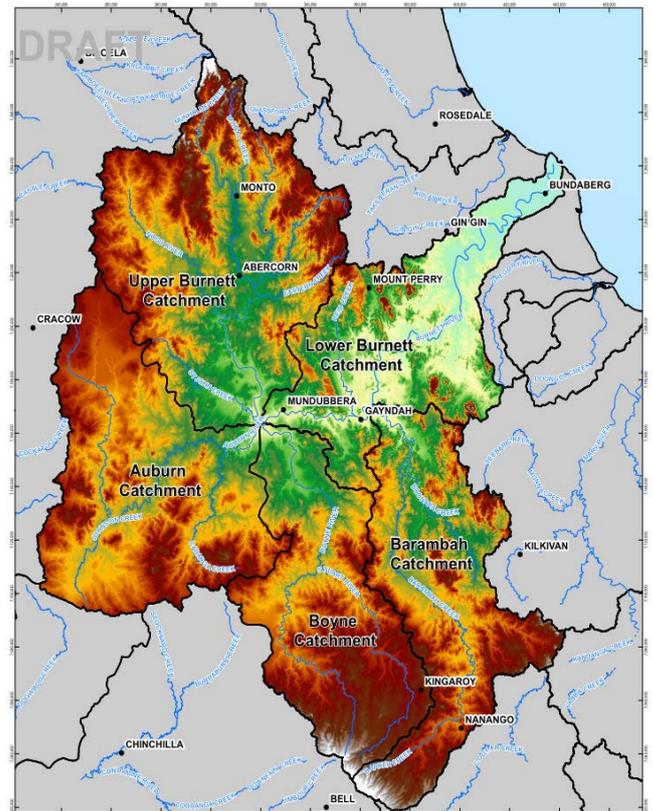


Figure 1 – Burnett River Catchment

Burnett River Flood Study

In preparation for the drafting of a new regional planning scheme and to help inform future planning decisions with respect to flooding issues, GHD was commissioned in 2011 by Bundaberg

Regional Council (BRC) to prepare an updated flood study of the Burnett River. This updated flood study superseded the original Burnett River Flood Study (September, 2004).

As part of the study, a detailed (360-sub-catchment) hydrologic model (URBS) of the Burnett River catchment was developed to simulate the rainfall-runoff process and estimate discharge hydrographs at key locations. In order to simulate the propagation of floodwater across the floodplain, an integrated 1D/2D Tuflow hydraulic model was also developed for the river reach located between Paradise Dam (AMTD 130km) and the river mouth. The hydraulic model was developed with a 15 metre cell size using recently obtained topographic and bathymetric survey. Finer scale hydraulic models were also nested within the model domain to assess local flooding behaviour. The extent of the hydraulic model is provided in Figure 2.

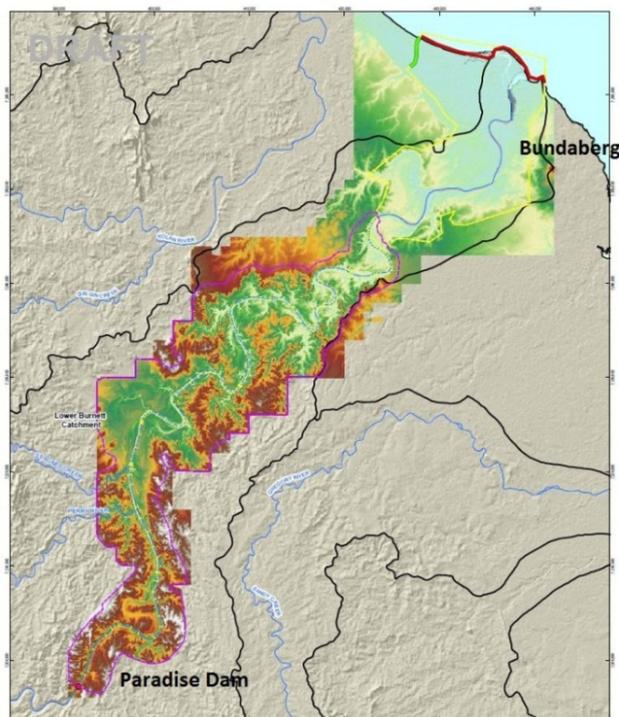


Figure 2 – Burnett River 2D Hydraulic Model Extent

Computer-based modelling undertaken as part of the Flood Study was able to complement the community's knowledge, highlighting the different factors that contribute to flooding along the river. It

provided a sound understanding of the river's catchment, hydraulic capacity and constraints, floodplain flow patterns and helped focus attention on efficient and effective flood mitigation measures.

Floodplain Risk Management Process

There are a number of good references on floodplain risk management process in Australia. Historically, "Floodplain management in Australia: best practice principles and guidelines" was developed for the former Standing Committee on Agriculture and Resource Management (SCARM) of the former Agriculture and Resource Management Council of Australia and New Zealand (SCARM Report No. 73, 2000).

This guideline has been recently replaced by the Australian Emergency Management Handbook Series (2011-), *Handbook 7 – Managing the Floodplain: a guide to best practice in flood risk management in Australia* (2013), refer Figure 3 below.

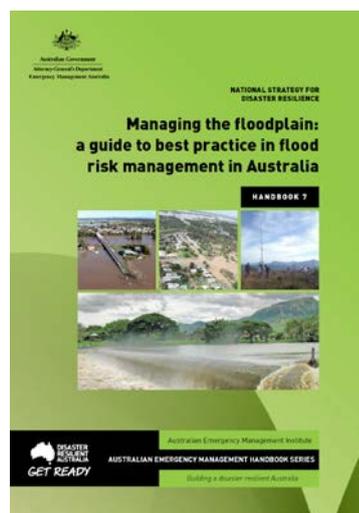


Figure 3 – Australian Emergency Management Handbook Series (2011-), Handbook 7

The handbook was developed with consideration to *the National Strategy for disaster resilience* (COAG 2011) and findings of recent State and national reviews following the wide spread flood events of 2010 to 2012. It provides a practical reference for floodplain practitioners on the

flood risk management framework provided in Appendix A.

In addition to this, detailed information on applying this framework can be found in the “NSW Floodplain Development Manual – the Management of Flood Liable Land” (DIPNR, 2005). Although the document is NSW based, aside from legislative protocol it can be directly applied in a Queensland context.

Key Challenges

The key challenges in the floodplain risk management process included:

- Politically driven expectations and (short) timeframes;
- Managing a range of stakeholders;
- Managing conflicting community expectations and heightened emotional responses;
- The need to consider a large number of flood mitigation options;
- Communicating detailed technical investigations in simple ways;
- Managing sensationalised media reporting;
- Balancing the views of vocal community groups with technically based information;
- Building public confidence in the process and results.

These key challenges were largely addressed through:

- Establishment of an independent Community Reference Group;
- Establishment of a Technical Working Group; and
- Extensive community consultation.

Establishment of an Independent Community Reference Group

An essential component of best practice flood risk management is communication and consultation with the public. There were approximately 6,500 flood affected properties across 275km² of the lower Burnett River floodplain, some reaching flood depths over 27 metres. Given the scale of impacts to people and property, Council considered it necessary to form an independent Community Reference Group (CRG) to consolidate public opinions and expected outcomes.

Terms of reference¹ were drafted and pivotal to the ultimate success of this group

In summary, the voluntary roles of the CRG were to:

- *Provide input into the development of the Burnett River Floodplain Action Plan;*
- *Gather the collective thoughts and ideas from their respective networks to help to identify and assess a range of suitable Burnett River floodplain management options;*
- *Communicate information and update their respective networks to ensure they were kept informed of the project's progress;*
- *Act as a conduit for community feedback on the plan's development to the consultant (GHD) and Bundaberg Regional Council;*
- *Participate in the project's public consultation program to help encourage the gathering of ideas and feedback from the community, in order to confirm a filtered set of options to test during a Multi-Criteria Assessment (MCA);*
- *Collectively agree to the floodplain management options assessment criteria*

¹ [Burnett River Floodplain Action Plan – Community Reference Group – Terms of Reference](#)

and weighting used during the Multi-Criteria Assessment (MCA). The MCA was the primary tool used to confirm the top options to undergo detailed assessment if required; and

- *Represent the community by submitting a report to Council in early December 2013 detailing the CRG's preferred list of floodplain management options. This was facilitated by the chairperson and required 70% consensus of the CRG members.*

The CRG were to report and provide feedback on issues raised during development of the Burnett River Floodplain Action Plan. There were ten (10) members and they held five (5) formal meetings along with countless informal communications. *Of importance, Council made available GHD flood engineers for direct discussions at each of the five CRG meetings. This enabled robust debate to be had on factual information. It also provided transparency of information and fostered trust amongst the group.*

This group also facilitated community access to information on the project as well as supporting the opportunity for the community to contribute to, and comment on, the development of the Burnett River Floodplain Action Plan.

The requirement to achieve 70% consensus amongst all members on the CRG final report was important to this project and ensured robust debate and discussion. Mr Rowan Bond (retired Bundaberg Police Superintendent) was appointed Chairperson by Council and to his great credit (and that of all the CRG members) the group was able to achieve 100% consensus on their final report to Council.

Establishment of Technical Working Group

In parallel to the CRG, a Technical Working Group was also established by Council to provide informal input from key stakeholders. This included representatives from:

- *Bundaberg Regional Council and GHD (Project Lead Consultant);*
- *Burnett Mary Regional Group;*
- *Bureau of Meteorology;*
- *Queensland Police Service;*
- *Queensland Reconstruction Authority;*
- *Port of Bundaberg;*
- *Department of Community Safety;*
- *Sunwater; and*
- *Department of Transport and Main Roads.*

Community Consultation Approach

To ensure a meaningful and successful consultation program, all activities were designed to achieve Councils overarching project goal, which was:

To identify and assess a set of preferred floodplain risk management options that build flood resilience, foster community preparedness, and ultimately save lives.

To drive this goal, the project team set out to achieve the following objectives:

- *Engage highly interested individuals to build confidence in the process and progress;*
- *Motivate and inspire wide participation to better understand the community's floodplain resilience preferences and opinions;*
- *Build community-wide awareness of the various floodplain resilience options/measures; and*
- *Clearly and widely communicate the top five options once confirmed in December 2013.*

It is considered best-practice to develop easily understood and simple project key

messages that form the broad themes woven into verbal and written project communication. This is essential to ensure the community receives clear and consistent information. These key messages included:

1. *Council's Burnett River Floodplain Action Plan will confirm the top five floodplain management options and strategies to improve flood resilience and preparedness;*
2. *Council is seeking ideas and feedback from members of the community to better understand what options and strategies they would like Council to consider as part of the project; and*
3. *This work will give Council a solid plan to assist in reducing the devastating effects of flooding to the region.*
4. *We can't stop floods from occurring but we can work to reduce their impacts.*

The key messaging is important throughout all public communications to reinforce the project goals and ensure the communities expectations are aligned with Councils actions.

Summary of Consultation

From mid-September to early October 2013, Bundaberg Regional Council sought ideas and feedback from the community to better understand what options and strategies they would like Council to consider as part of the Burnett River Floodplain Action Plan (refer to the Consultation Timeline in Appendix B). This was entirely a "community driven" exercise.

Council was working to a fixed timeline of December 2013 for determination of the top five (5) resilience options at the direct request of the Qld Government. To meet these timeframes a project plan was established to deliver the top five flood modification options by December while still working to deliver a final report by June 2014. The December timeline led to multiple activities being undertaken in parallel which added very significant complexity and time specific stresses to the project. It was also

reflective of the highly political nature of these types of projects in a post disaster environment. Accordingly, this *must* be accounted for and closely managed as a key project risk for any floodplain management practitioner.

To encourage community-wide interest and participation, Council undertook a range of activities in the lead-up to the public consultation phase including:

- *Media relations leading to interviews on ABC Wide Bay, 4BU and Seven and editorial coverage in the Bundaberg NewsMail newspaper;*
- *Updates on the Council website in prominent locations;*
- *Re-establishment of the dedicated email address for feedback floods@bundaberg.qld.gov.au;*
- *Stakeholder briefings and presentations;*
- *Advertisements in three local papers; and*
- *Facebook posts and Tweets reaching 4,000+ people.*

There were over 280 people who participated at ten (10) Community Information Sessions at six (6) locations including North Bundaberg Progress Hall, East State School Hall, St George Hall, Wallaville Hall, Avoca State School Hall and Goodnight Scrub Hall. The atmosphere was open, informative, engaging and relaxed, and allowed people to access project information in a number of ways such as formal presentations, one-on-one enquiries with project team members and by viewing the visual materials available around the room (refer Figure 4 below).



Figure 4 – Introductory presentation and Display Boards at Public Information Sessions

Uniquely, Council integrated disaster management personnel and the “Get Ready” campaign, Uniting Care Lifeline Services and Burnett Mary Regional Group into each of the public sessions. This created synergy of information and allowed these groups to interact with the same target audience along with Council.

A final round of five (5) public information sessions was held in March 2014 to “close the loop” on progress and outcomes. These were well received by the community and all presentation materials were provided on Councils website².

² [Burnett River Floodplain Action Plan Website](#)

Consultation Results

There were four (4) main ways for people to get involved:

- *Public submissions received via floods@bundaberg.qld.gov.au;*
- *Community questionnaire (hardcopy);*
- *Anecdotal feedback at the Information Sessions; and*
- *Community Reference Group as a portal to their communities.*

There were a total of 328 ideas and feedback received via these four (4) main mechanisms as shown in Table 1 below.

Method	Responses
Public submissions received from January to August (prior to formal consultation period)	44
Public ideas received during formal consultation period, including via the CRG Members (Sept-October)	114
Anecdotal feedback received at the Information Sessions (received by both BRC and GHD team members)	57
SUBTOTAL	215
Questionnaires	82
Post-it note ideas (from Information Session whiteboard)	31
TOTAL	328

Table 1 – Feedback Received

Some of the authors key observations made throughout the consultation phase are highlighted below:

- *There was significant contrast in tolerance to flooding between urban and rural communities. Urban areas expected much higher levels of flood mitigation and “flood prevention” than their rural counterparts. There was strong focus on*

the importance of “government” to evacuate and “flood proof” urban areas.

- *Rural communities were more comfortable in making decisions themselves on self-evacuation but strongly requested factual information, reliable and constant communications to assist the quality and timeliness of their decision making. They were not expecting “government” to stop floods from occurring and generally expected some isolation for short durations (1-2 days). They requested information on flood behaviour and evacuation routes so they could use this to help themselves in future events. Commonly, many had unaccounted for the duration of time for telecommunications and electricity to be reconnected causing significant distress and discomfort. At times these periods were up to eleven (11) days around Bungadoo and the Perry River localities.*
- *It was of absolute importance to build and maintain public confidence in the floodplain risk management process. Essential to this process was the role of good quality calibrated flood modelling to produce maps and animations of the 2013 flood extent across the entire lower Burnett River. These results were first released to the public on completion of the calibrations at the public information sessions (not in earlier draft) and made available on Councils website. There was broad consensus between urban and rural communities on the accuracy and validity of the mapping. By providing tangible maps of the flood, individuals could check and verify the impact to their properties. This ultimately provided a high degree of confidence that the models could be used to test various flood modification measures.*

Further details on the consultation results, approaches and supporting facts are available in the Burnett River Floodplain Action Plan Consultation Report (GHD 2013a).

Improved Flood Warning Deliverables

To assist the consultation process a number of key deliverables were released to the community through the public information sessions. This included:

- *Incremental flood gauge mapping, time to peak flood maps and graphed relationships of upstream gauge levels to Bundaberg;*
- *Burnett River flood mapping and animations of the 2013 event³;*
- *An upgrade and expansion of the Burnett River Early Flood Warning System operated by the Bureau of Meteorology⁴; and*
- *Draft evacuation route mapping. An example for Bundaberg is provided in Appendix C.*

The most significant of these was the Burnett River Flood Gauge Mapping System⁵. Development of this system was fast tracked to meet community demand and was released 23rd December 2013 prior to the Cyclone season. System development occurred over a two (2) week timeframe, but the mapping products originated from Councils disaster management lessons following 2010/2011 flooding and the culmination of almost two (2) years of technical work from the Burnett River Flood Study (GHD 2013c).

With a high level of flood anxiety still evident within the local community, the common question requiring an answer was “*What does a given flood gauge level mean to me on my block of land?*”. The flood gauge mapping system answers this question for all residents living along the Lower Burnett River. It covers approximately 300km² of flood affected land and maps three (3) key

³ [Burnett River Flood Mapping](#)

⁴ [Burnett River Early Flood Warning System](#)

⁵ [Burnett River Flood Gauge Mapping System](#)

flood warning gauges to provide redundancy during flood events.

Flood warning performance is dependent not only upon the efficiency and effectiveness of a warning system (by the Bureau of Meteorology), but also the preparedness and ability of a community to respond to flood warning. Focus upon improving flood response is important, since effective response may be the only defence against extreme floods (Gissing 2003). The flood gauge mapping system plays a large role in improving local community response and is being used extensively by UnitingCare Lifeline to address flood affected anxiety amongst flood affected residents. It is the first of its kind in Australia and unique to the Southern Hemisphere.

A screen shot of the mapping system is shown below in Figure 5.



Figure 5 – Flood Gauge Mapping System screen shot.

Multi Criteria Assessment

In order to identify a set of preferred floodplain mitigation options from the comprehensive list of potential options identified by GHD, Council and the CRG – a Multi Criteria Assessment (MCA) was undertaken. The primary purpose of the MCA is to discriminate between the various options and allow future efforts to focus on those options that may be most viable and best address the concerns of the community. Importantly, the MCA process is not intended to be definitive, but serves as a useful tool to differentiate between more and less promising options.

Extensive discussion was held with the CRG to determine appropriate assessment criteria and weightings for the MCA as provided in Appendix D. No options analysis was undertaken until the MCA matrix was first finalised and agreed with the CRG, this was important to the transparency of the final outputs. The process was used to assess large scale flood modification projects.

Refinement of Options

On completion of the MCA an overall table of projects based on their viability was produced (refer Appendix E). In consultation with Council, the following list underwent further detailed assessment prior to final recommendations:

- *East levee and floodgate (Option 2);*
- *North levee (Option 1);*
- *Low levee North Bundaberg levees (Option 10);*
- *Town reach dredging (Option 23);*
- *Millaquin bend widening works (Option 24);*
- *Regional bridge upgrades (Option 38);*
- *Gardens channel 2 (Option 19); and*
- *Bundaberg North evacuation route upgrades (Option 39).*

For each of the above options, a concept design was developed to help determine expected flood mitigation impacts, high level cost estimates, identify key project risks and implementation issues, and outline the potential environmental impacts that would have to be managed if these options were taken forward.

Flood Modification Measures - Recommendations

A framework for options assessment had been established which ultimately allowed Council to determine which large scale flood modification measures would be recommended to the Queensland Government. This framework is provided in Appendix F.

Of importance, a number of key reports were delivered around this framework for accountability and transparent decision making. These included:

- *Burnett River Floodplain Action Plan - Consultation Report (GHD 2013a);*
- *Final Report of the Deliberations of the Burnett River Floodplain Action Plan – Community Reference Group (CRG 2013); and*
- *Burnett River Floodplain Action Plan – Preliminary Options Assessment Report (GHD 2013b).*

These reports allowed democracy to play its role allowing Council to make decisions based on the CRG's views while also considering the professional perspectives of engineers. The consultation report provided succinct summary of the engagement process with the public and formed an integral part of Government briefings and information requests.

Council's final recommendations for flood modification measures on the Burnett River are included in Appendix G.

Key Lessons

There have been many lessons gained from this project and indeed far too many for the authors to include in this paper. However, some of the key lessons are outlined below.

- *Undertake a detailed Flood Study prior to a FRMS;*

- *Where possible, ensure flood models are calibrated with best available information prior to public release. This builds trust and confidence in results;*
- *Develop a clear project goal and communication strategy at onset;*
- *Make the process accessible. Aspirations of the entire community and those who were directly impacted by the flooding is important;*
- *Make the process transparent. Views were considered by the project team and an independent Community Reference Group;*
- *Directly connect the CRG with Engineers to provide facts for informed debate under the control of a Chairperson. Develop the MCA matrix with their approval prior to assessment of options;*
- *It's imperative that factual flood information is provided in easily understood language to avoid anxiety in the community.*
- *Report back to the public and be very clear on how the public ideas and the CRG can have influence over the project outcomes;*
- *Integrate social services (i.e UnitingCare Lifeline) into public sessions in a post disaster environment. It allows them to connect with people most at need and also assists Council with ongoing public education on flood risk management;*
- *Project teams can be faced with intense personal criticism and emotional distress when undertaking these projects in a post disaster environment. It's important to look after each other and self throughout the entire process.*

Conclusion

Following the disastrous flood event of January 2013 along the Burnett River,

Council took a proactive approach towards best practice floodplain risk management in order to reduce future flood impacts.

Significant community consultation was undertaken with the primary goal to ***identify and assess a set of preferred floodplain risk management options that build flood resilience, foster community preparedness, and ultimately save lives.***

Ultimately, a high degree of success and positive public feedback was achieved as a result of the Burnett River Floodplain Action Plan. Critical to the success of this project was a structured and well considered engagement process, an independent Community Reference Group, a Multi Criteria Assessment process and clearly defined options assessment framework. This allowed Council to make open and transparent decisions on large scale flood modification measures in the public interest.

Many lessons have been gained throughout the project. The community engagement strategy outlined in this paper was developed in a post disaster context. It is the authors' opinions that each community will have its own unique needs and concerns that must be closely managed and addressed throughout the floodplain risk management process.

By developing a community driven options assessment process supported by sound engineering and scientific principle, Council has been able to build stronger relationships, enhance community wellbeing and develop solutions to reduce the future impacts of flooding.

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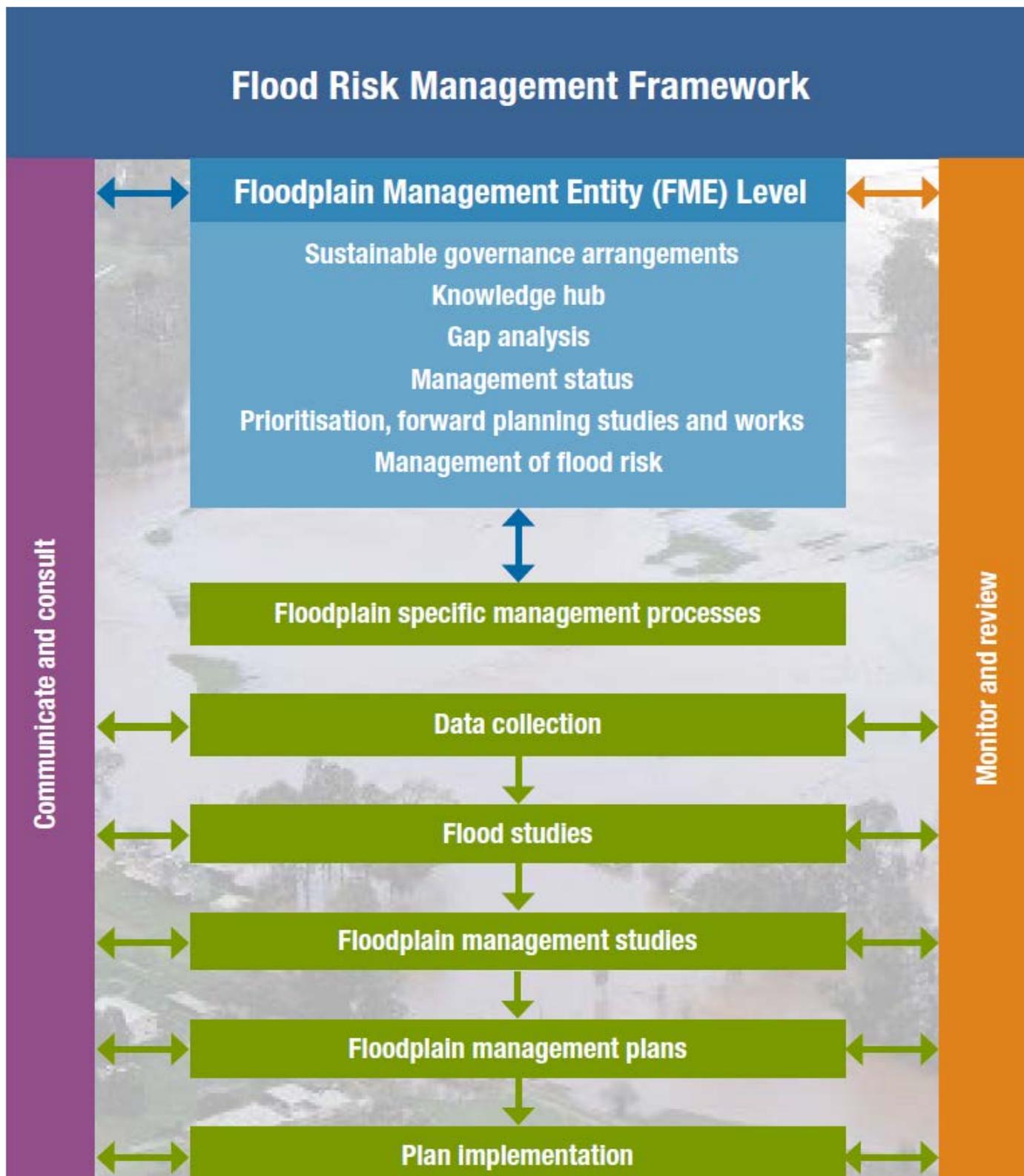
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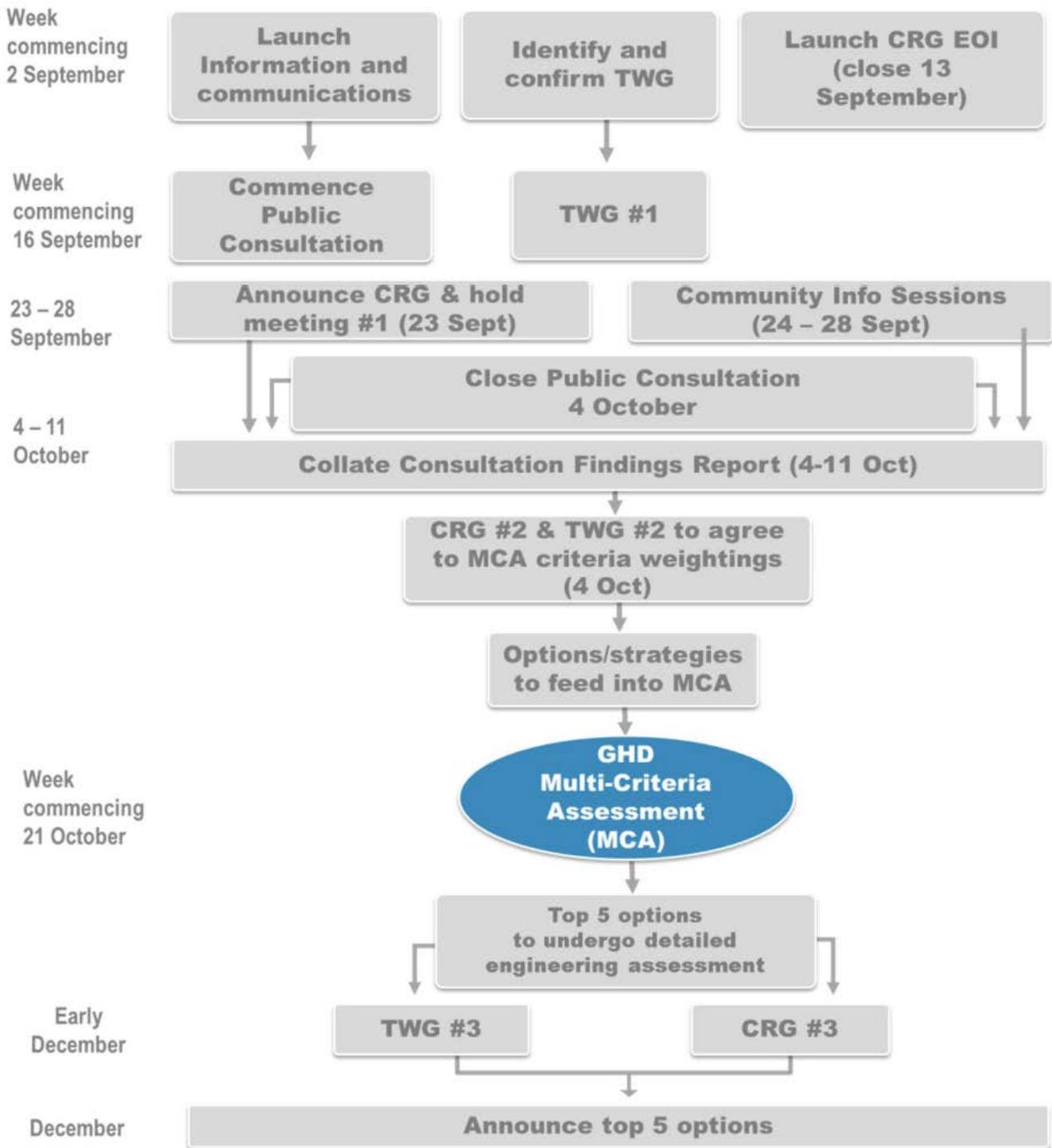
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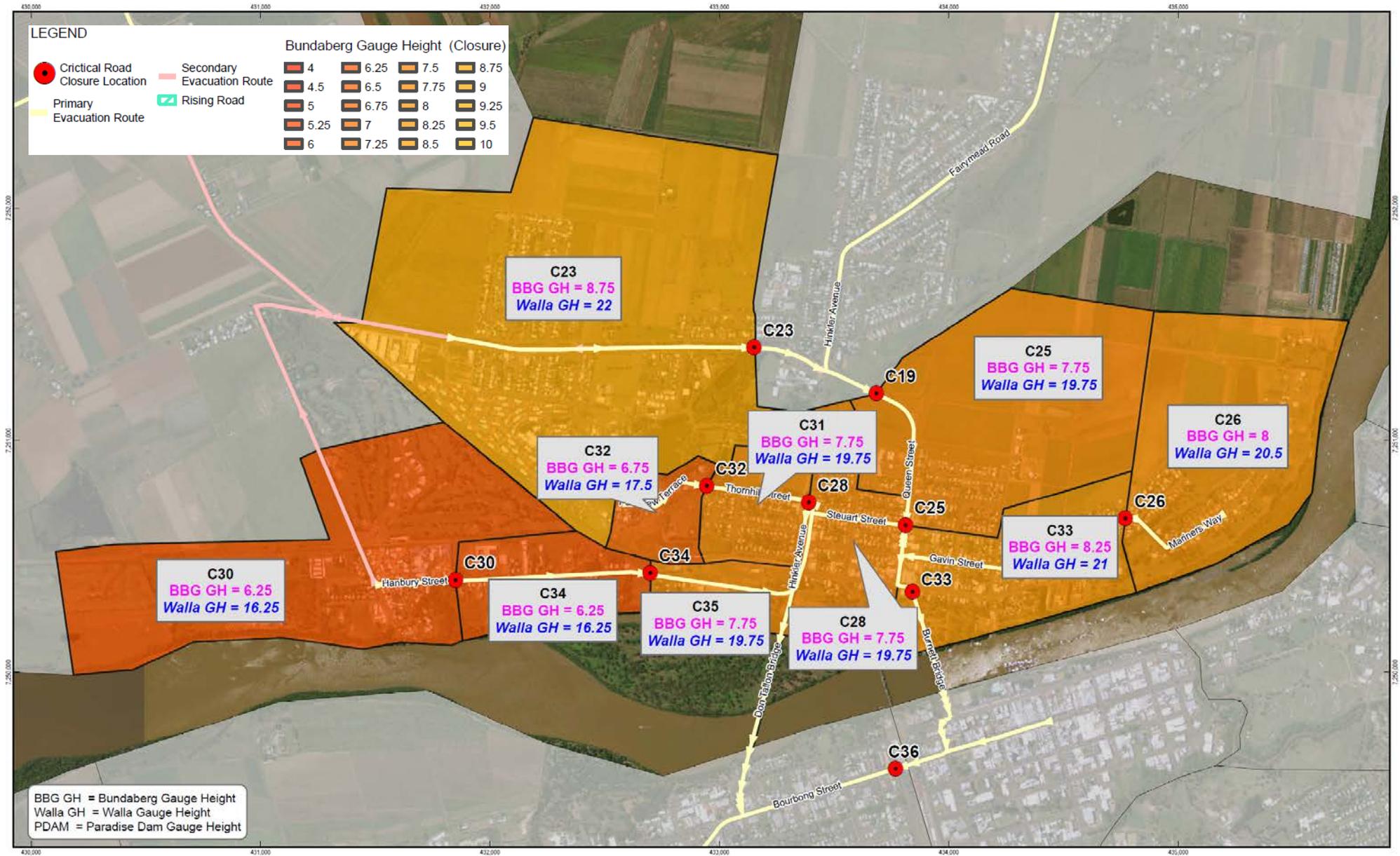
Source: Handbook 7 – Managing the Floodplain: a guide to best practice in flood risk management in Australia (2013)

Appendix B - Consultation Timeline – Burnett River Floodplain Action Plan



Source: Burnett River Floodplain Action Plan Consultation Report (GHD 2013)

Appendix C - Example Evacuation Route Map – Bundaberg North



Appendix D - Multi Criteria Assessment (MCA) - Assessment Criteria and Weightings

Category	Criteria	Criteria Weight	Category Weight	Overall Contribution to Final Score
Social	Communication / notification during a flood event	18%	40%	7.2%
Social	Flood warning time	17%	40%	6.8%
Social	Frequency and duration of flooding or isolation / effects of isolation	17%	40%	6.8%
Social	Impact on direct exposure to flood hazard / safety	14%	40%	5.6%
Social	Visual amenity	1%	40%	0.4%
Social	Cultural heritage	3%	40%	1.2%
Social	Impact on community infrastructure	5%	40%	2.0%
Social	Impact on evacuation routes	11%	40%	4.4%
Social	Impact on recovery / accommodating the displaced victims of a flood	14%	40%	5.6%
Environmental	Impact on terrestrial environment (flora / fauna)	19%	35%	6.7%
Environmental	Impact on aquatic / riparian environment (flora / fauna)	29%	35%	10.2%
Environmental	Difficulty of environmental approvals	4%	35%	1.4%
Environmental	Impact on river stability / sedimentation	29%	35%	10.2%
Environmental	Erosion / scour to floodplain	19%	35%	6.7%
Economic	Overall cost-benefit	8%	25%	2.0%
Economic	Cost of implementation	3%	25%	0.8%
Economic	Cost of maintenance / upkeep	6%	25%	1.5%
Economic	Inundation of agriculture land	15%	25%	3.8%
Economic	Impact on local business / commercial land	17%	25%	4.3%
Economic	Impact on residential properties	22%	25%	5.5%
Economic	Impact on municipal infrastructure / utilities	14%	25%	3.5%
Economic	Impact on fisheries	11%	25%	2.8%
Economic	Impact on tourism	1%	25%	0.3%
Economic	Impact on developable land	3%	25%	0.8%

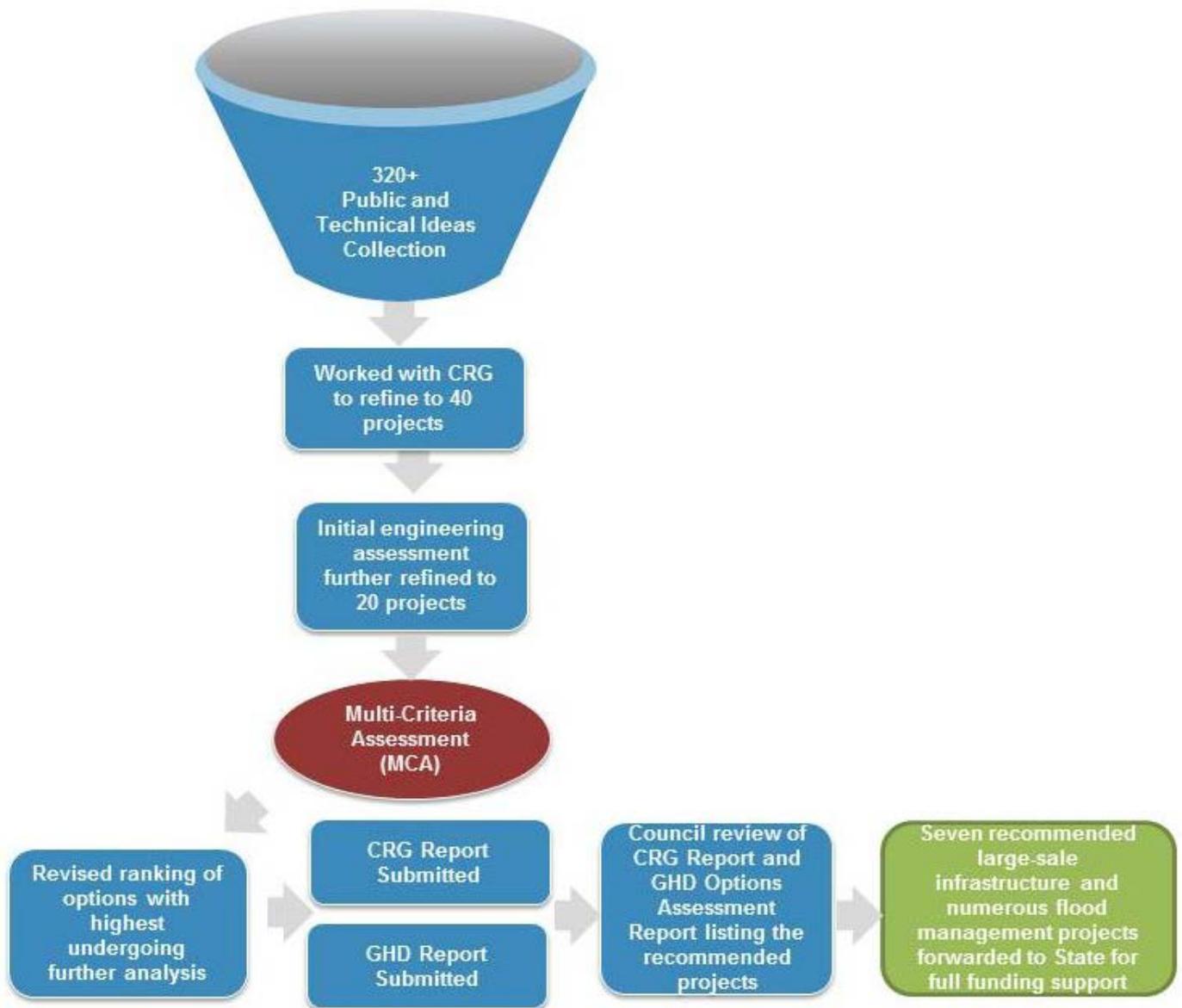
Note: the Category Weight refers to the weight assigned to the social, environmental and economic categories with a criteria's Overall Weight determined by multiplying the Criteria Weight by the Category Weight.

Appendix E - Overall rankings based on Adopted Weightings

Option Number	Description	Viability
2	East Levee & Floodgate	V
38	Regional Bridge Upgrades	V
39	Bundaberg North Evacuation Route Upgrades	V
40	Funding for house raising / restumping	V
1	North Levee	V
23	Town Reach Dredging	V
10	Low Level North Bundaberg Levees	V
31	Millaquin Bend widening (north bank)	V
12	Wallaville Levee	MV
25	Selective dredging at foundry, Miliquin Bend and Fairymead Bend	MV
31	Town reach widening (north bank)	MV
24	Barrage to Port Dredging	MV
11	Port of Bundaberg Levee	MV
19	Gardens Channel 2	MV
29	Removal of sediment from north bank and Harriet Island	MV
26	Removal of Fairymead Levees	UV
27	Removal of mangroves from town reach	UV
30	Reopen Skyringville Passage	UV
20	Rubyanna Bypass Channel	UV
41	Fairymead Diversion Channel 3	UV

Note: V=Viable, MV=Marginally viable, UV=unviable.

Appendix F - Flood Modification Measures - Options Assessment Process



Appendix G - Bundaberg Regional Councils final recommendations to the Queensland Government for large scale Flood Modification Measures

Category	Recommendation	Description
FLOOD MITIGATION PROJECTS	Millaquin Bend Dredging and Widening Works	Reductions in flood levels for both north and south sides of the Burnett River in Bundaberg. In East, South and Central Bundaberg (-0.58 m in 1% AEP event) and North Bundaberg (-0.2 to -0.31 m in 1% AEP event). <i>436 properties would no longer experience above floor flooding in a 1% AEP event.</i>
	East Levee and Floodgate	Protects East, South and Central Bundaberg from Burnett River flooding up to the levee design event (currently 0.5% AEP + 0.6 m freeboard). <i>741 properties would no longer experience above floor flooding in a 1% AEP flood event.</i>
EVACUATION ROUTES TO REDUCE THE THREAT TO LIVES	Hinkler Avenue Upgrade	Greatly improved evacuation routes, access to evacuation centres and provides reliable and critical link for emergency access between north and south sides of the Burnett River in Bundaberg. Reduced strain on emergency and recovery services, improved public safety.
	Mount Perry Rd and Fairymead Rd Upgrades	Upgrade strategic road sections to 0.5% AEP flood immunity. Provide critical evacuation routes, access to evacuation centres and emergency access for Bundaberg North. Reduced strain on emergency and recovery services, improved public safety.
ISOLATION REDUCING EVACUATION ROUTES	Bartholdt Drive alternative evacuation route	Evacuation route for approximately 1150 people off Branyan Drive, Bartholdt Drive, Arcardia Drive and surrounding local roads. Reduced strain on emergency and recovery services, improved public safety. Growth corridor connecting Branyan to Bundaberg West.
	Pine Creek, Givelda and Electra alternative evacuation route	Improved evacuation routes via 4WD for the local community. Reduced strain on emergency and recovery services, improved public safety and resupply route. Reduction in isolation from extreme flood depths reaching 27m in January 2013.
	Goodnight Scrub alternative route (<i>in lieu of Perry River Bridge upgrade</i>)	Improved evacuation routes for approximately 400 – 600 people in the Goodnight Scrub, Perry River and Morganville areas. Reduced strain on emergency and recovery services, improved public safety and resupply route. Benefits both Bundaberg and North Burnett Regional Council residents.
OTHER FLOOD MANAGEMENT MEASURES	Various Flood Management Measures	Multiple benefits related to community preparedness, education and resilience from improved flood information, flood warning, and emergency response. Potential for improved public safety and reduction in flood damages. Includes implementation of flood level markers, marking evacuation routes/zones, electronic information boards, disaster management portal, additional rain gauges and improvements for early flood warning. Broad benefits across the Lower Burnett River.

Author Biography



Dwayne Honor is the Design Manager for the Bundaberg Regional Council and has been working in local government for over 10 years.

In preparation for a new regional planning scheme he was Project Manager for the Burnett and Kolan River Flood Studies and Floodplain Risk Management Studies. He was working out of the Local Disaster Coordination Centre for ten days assisting in planning and logistics while supporting Urban Search and Rescue (USAR) teams during the January 2013 floods. Dwayne is deeply entrenched in recovery projects for the foreseeable future to assist the Bundaberg regions flood recovery.

Educated at Central Queensland University (Rockhampton), he has degrees with Distinction in Engineering Technology and Business Administration and is a committee member of the Central Queensland Branch, Queensland Division, Institute of Public Works Engineering Australasia (IPWEA).

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Ben Regan is a senior engineer at GHD Pty Ltd. Ben has over 13 years' experience in the delivery of flood related projects to private and public sector clients. Ben was the project director for the Burnett River and Kolan River Flood Studies and Floodplain Risk Management Studies and assisted Council during the January 2013 event. Ben's qualifications include a Bachelor of Engineering (Hons), Master of Applied Finance, and a Master of Business Administration from the University of Queensland.

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Dan is a civil engineer with 10 years' experience specialising in flooding and urban stormwater management. At GHD, Dan has delivered a range of projects including flood studies, stormwater management plans and drainage investigations. His project experience ranges from WSUD and stormwater drainage design, urban and large-scale flood studies, site-based stormwater management plans and civil design. Dan's involvement as job manager was integral to the delivery of the Burnett River Flood Study and the Burnett River Floodplain Risk Study.

Dan has extensive experience with a wide range of industry-standard software including TUFLOW, MIKE FLOOD (MIKE 11 & MIKE 21), WaterRIDE, HEC-RAS, XP-RAFTS, XP-SWMM, WBNM, PC-DRAIN, DRAINS, MUSIC, ArcGIS & MapInfo.

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