



02/02/1971 Railway Viaduct, Quirindi
Looking West.



Liverpool Plains Shire Council
Report for Quirindi Township and
Surrounding Areas
Floodplain Risk Management Study
and Plan

October 2011



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Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

Climate change is an emerging issue and the effects are, at this stage, complex to quantify. The assumptions about projected climate change conditions are estimates only, based on stakeholder policies.



Executive Summary

Quirindi and Jacob and Joseph Creeks discharge through much of the residential areas of Quirindi. The two creeks confluence downstream of Gurton Street and upstream of the Whitaker Street bridge. During large flood events, the two creeks have the potential to surcharge and flood a significant portion of town located on the floodplain. Major storms occurred in 1955, 1971, 1984 and 2000 and it would appear that the February 1955 flood equated approximately to the 100-year ARI event. It was noted at the time to be the largest flood “in living memory”. Significant flooding occurred during these events, and numerous houses were inundated.

In this context, it was the requirement of this study to undertake a Floodplain Risk Management Study and develop a Management Plan that addresses existing future and continuing flooding associated with Quirindi Creek and tributaries. The study was to be undertaken in accordance with the NSW Floodplain Development Manual, 2005, and was to use information produced by the 2005 Quirindi Creek Flood Study (Lyll & Associates Consulting Engineers, 2005).

This 2005 flood study produced flood maps, which show that there are significant areas of high hazard flooding throughout the floodplain. From a review of the Quirindi Creek Flood Study it was concluded that the study provides the best currently available estimates of flood levels at Quirindi. However, the model should be simulated with the updated survey information for the Milner Parade levee.

A number of community consultation activities were undertaken as part of this study, to introduce the project and to advise residents and key stakeholders of investigations. Regular meetings were held with the Flood Plain Management Committee and community/stakeholder events were well attended. Events included community information sessions and an open shop day held at the Quirindi Library.

A socio-economic analysis was undertaken of Quirindi town and social and economic effects of flooding were investigated. The Annual Average Damage from flooding was estimated at \$1.5 million. Over a 20-year period, this was estimated to have a net present value of \$17.5 million.

Floodplain Management Measures were investigated under categories of property modification, response modification and flood modification in accordance with the NSW Floodplain Development Manual (2005). A number of floodplain risk management measures were found to be applicable to Quirindi. Social, environmental, capital cost and cost benefit were considered for a number of the more favourable flood plain management measures, and an assessment of options was undertaken. The assessment found that after considering the results of the social and environmental ranking, capital cost and the economic assessment, a combination of voluntary purchase and house raising was the preferred measure to reduce flood risk in Quirindi. This option should be supported by landuse planning across Quirindi, a flood warning system, evacuation plans and public flood awareness scheme. Flood conveyance assessments, in particular management of sedimentation/vegetation and investigation of the impacts of the Whittaker Street footbridge, formalising Henry Street as an evacuation route in a easterly direction and providing flood immunity by preventing floodwaters from backing up the stormwater systems should also be investigated at a local level.

Considering the assessment of the options, it is considered that a combination of voluntary purchase and voluntary house raising is the most desirable option for the village of Quirindi. This option:

- ▶ Promotes the long-term community sustainability;



- ▶ Can be implemented in a step-wise manner, focussing on acquiring and raising the most severely affected houses first;
- ▶ Can be implemented over a longer time frame, and thus Council could put a plan in progress, supported by a budget. It therefore does not present a single significant upfront cost to Council; and
- ▶ Offers a level of protection to the community reducing overall damage costs.

A Floodplain Risk Management Plan has been prepared nominating key actions and prioritising these actions. The key actions, priorities, indicative budgets and cost benefits are noted in the table below.

Action	Priority	Indicative Budget	Cost Benefit
Nominate 13 dwellings for voluntary purchase	High	\$2.1M	0.82
Nominate 145 dwellings inundated in a 100-year ARI event for voluntary house raising	High	\$14.5M	0.67
Implement land use planning limits and controls associated with flooding, to managing flood risk across Quirindi	High	na	na
Undertake a feasibility investigation into an appropriate flood warning system for Quirindi	High	\$15k	na
Install flood warning system as determined by the feasibility study and communicate to the public	Medium	Up to approx. \$50k plus \$10/ann	na
Prepare a flood warning and evacuation plan for Quirindi and communicate to the community. Develop a public awareness scheme for Quirindi and implement. Formalise Henry Street as a designated evacuation route.	High	\$80k \$4/ann	na
Undertake a geomorphological and ecological assessment of Quirindi and Jacob/Joseph Creeks and formulate a Vegetation Management Plan. Thereafter Undertake creek rehabilitation on the basis of the Vegetation Management Plan.	High	\$200k	na
The Floodplain Management Committee is to remain convened and meet every 4 months verse the implementation of this plan	High	na	na
Local Flood Works:			
<ul style="list-style-type: none"> • Investigate opportunities to raise the levee around the sewer pump station near Whittaker Street, by undertaking a flood impact assessment 	Low	\$30k	na
<ul style="list-style-type: none"> • Investigate options to structurally enhance the new footbridge upstream of the Whittaker Street bridge 	Low	\$30k	
<ul style="list-style-type: none"> • Provide flood gates at key stormwater outlets to prevent backwater flooding in the vicinity of Whittaker Street 	High	\$30k	



Glossary

100-year flood - A flood that occurs on average once every 100 years. Also known as a 1% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).

50-year flood - A flood that occurs on average once every 50 years. Also known as a 2% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).

20-year flood - A flood that occurs on average once every 20 years. Also known as a 5% flood. See annual exceedance probability (AEP) and average recurrence interval (ARI).

Afflux - The increase in flood level upstream of a constriction of flood flows. A road culvert, a pipe or a narrowing of the stream channel could cause the constriction.

Annual exceedance probability (AEP) - AEP (measured as a percentage) is a term used to describe flood size. AEP is the long-term probability between floods of a certain magnitude. For example, a 1% AEP flood is a flood that occurs on average once every 100 years. It is also referred to as the '100 year flood' or '1 in 100 year flood'. The terms 100-year flood, 50-year flood, 20-year flood etc, have been used in this study. See also average recurrence interval (ARI).

Australian Height Datum (AHD) - A common national plane of level approximately equivalent to the height above sea level. All flood levels; floor levels and ground levels in this study have been provided in meters AHD.

Average annual damage (AAD) - Average annual damage is the average flood damage per year that would occur in a nominated development situation over a long period of time.

Average recurrence interval (ARI) - ARI (measured in years) is a term used to describe flood size. It is a means of describing how likely a flood is to occur in a given year. For example, a 100-year ARI flood is a flood that occurs or is exceeded on average once every 100 years. The terms 100-year flood, 50-year flood, 20-year flood etc., have been used in this study. See also annual exceedance probability (AEP).

Catchment - The land draining through the main stream, as well as tributary streams.

Development Control Plan (DCP) - A DCP is a plan prepared in accordance with Section 72 of the *Environmental Planning and Assessment Act, 1979* that provides detailed guidelines for the assessment of development applications.

Design flood level - A flood with a nominated probability or average recurrence interval, for example the 100-year flood.

DECCW (formerly DECC, DNR, DLWC, DIPNR) - Department of Environment, Climate Change and Water. Covers a range of conservation and natural resources science and programs, including native vegetation, biodiversity and environmental water recovery to provide an integrated approach to natural resource management. This department was formed in April 2007.

Discharge - The rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second (m³/s). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving.

DP (formerly DUAP) – Department of Planning NSW.

DC – Department of Commerce NSW.

OEHS (formerly DECCW, DNR & DEUS) – Office of Environment Heritage, Department of Water and Environment NSW. This department was formed in April 2007.

Ecologically sustainable development (ESD) - Using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local Government Act 1993.



Effective warning time - The time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

Emergency management - A range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.

EP&A Act - Act Environmental Planning and Assessment Act, 1979

Extreme flood - An estimate of the probable maximum flood (PMF), which is the largest flood likely to occur.

Flood - A relatively high stream flow that overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

Flood awareness - An appreciation of the likely effects of flooding and knowledge of the relevant flood warning, response and evacuation procedures.

Flood hazard - The potential for damage to property or risk to persons during a flood. Flood hazard is a key tool used to determine flood severity and is used for assessing the suitability of future types of land use.

Flood level - The height of the flood described either as a depth of water above a particular location (e.g. 1m above a floor, yard or road) or as a depth of water related to a standard level such as Australian Height Datum (e.g. the flood level was 7.8m AHD). Terms also used include flood stage and water level.

Flood liable land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood prone land. Note that the term flood liable land now covers the whole of the floodplain, not just that part below the flood planning level, as indicated in the superseded Floodplain Development Manual (NSW Government, 2005).

Flood Planning Levels (FPLs) - The combination of flood levels and freeboards selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. The concept of flood planning levels supersedes the designated flood or the flood standard used in earlier studies.

Flood Prone Land - Land susceptible to flooding up to the Probable Maximum Flood (PMF). Also called flood liable land.

Flood Proofing - A combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate damages during a flood.

Flood stage see flood level.

Flood Study - A study that investigates flood behaviour, including identification of flood extents, flood levels and flood velocities for a range of flood sizes.

Floodplain - The area of land that is subject to inundation by floods up to and including the Probable Maximum Flood event, that is, flood prone land or flood liable land.

Floodplain Risk Management Study – Studies carried out in accordance with the Floodplain Development Manual and assess options for minimising the danger to life and property during floods.

Floodplain Risk Management Plan - The outcome of a Floodplain Management Risk Study.

Floodway - Those areas of the floodplain where a significant discharge of water occurs during floods. Floodways are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.



Freeboard - A factor of safety expressed as the height above the design flood level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such as wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as “greenhouse” and climate change.

High Flood Hazard - For a particular size flood, there would be a possible danger to personal safety, able-bodied adults would have difficulty wading to safety, evacuation by trucks would be difficult and there would be a potential for significant structural damage to buildings.

Hydraulics Term - given to the study of water flow in waterways, in particular, the evaluation of flow parameters such as water level and velocity.

Hydrology Term - given to the study of the rainfall and runoff process; in particular, the evaluation of peak discharges, flow volumes and the derivation of hydrographs (graphs that show how the discharge or stage/flood level at any particular location varies with time during a flood).

LGA - Local Government Area, or Council boundary.

Local catchments - Local catchments are river sub-catchments that feed river tributaries, creeks, and watercourses and channelised or piped drainage systems.

Local Environmental Plan (LEP) – A Local Environmental Plan is a plan prepared in accordance with the *Environmental Planning and Assessment Act, 1979*, that defines zones, permissible uses within those zones and specifies development standards and other special matters for consideration with regard to the use or development of land.

Local overland flooding - Local overland flooding is inundation by local runoff within the local catchment.

Local runoff - local runoff from the local catchment is categorised as either major drainage or local drainage in the NSW Floodplain Development Manual, 2005.

Low flood hazard - For a particular size flood, able-bodied adults would generally have little difficulty wading and trucks could be used to evacuate people and their possessions should it be necessary.

Flows or discharges - It is the rate of flow of water measured in terms of volume per unit time.

Merit approach- The principles of the merit approach are embodied in the *Floodplain Development Manual* (NSW Government, 2005) and weigh up social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State’s rivers and floodplains.

Overland flow path - The path that floodwaters can follow if they leave the confines of the main flow channel. Overland flow paths can occur through private property or along roads. Floodwaters travelling along overland flow paths, often referred to as ‘overland flows’, may or may not re-enter the main channel from which they left — they may be diverted to another watercourse.

Peak discharge - The maximum flow or discharge during a flood.

Planning NSW - Formerly the Department of Urban Affairs and Planning (NSW) and the Department of Planning (NSW), at present DNR (since March 2003).

Present value - In relation to flood damage, is the sum of all future flood damages that can be expected over a fixed period (usually 20 years) expressed as a cost in today’s value.

Probable Maximum Flood (PMF) - The largest flood likely to ever occur. The PMF defines the extent of flood prone land or flood liable land, that is, the floodplain.

Reliable access - During a flood, reliable access means the ability for people to safely evacuate an area subject to imminent flooding within effective warning time, having regard to the depth and velocity of floodwaters, the suitability of the evacuation route, and other relevant factors.

REP - Regional Environmental Plan. A plan prepared in accordance with the EPA Act that provides objectives and controls for a region, or part of a region. For example, the Georges River REP.



Risk - Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.

RORB/RAFTS - The software programs used to develop a computer model that analyses the hydrology (rainfall–runoff processes) of the catchment and calculates hydrographs and peak discharges. Known as a hydrological models.

Runoff - the amount of rainfall that ends up as flow in a stream, also known as rainfall excess.

SES - State Emergency Service of New South Wales

Stage–damage curve - A relationship between different water depths and the predicted flood damage at that depth.

Velocity - the term used to describe the speed of floodwaters, usually in m/s (metres per second). $10\text{km/h} = 2.7\text{m/s}$.

Water surface profile - A graph showing the height of the flood (flood stage, water level or flood level) at any given location along a watercourse at a particular time.



1. Background

1.1 Key Issue

Quirindi Creek confluences with Jacob and Joseph Creek, downstream of Gurton Street and upstream of Whitaker Street, in the township of Quirindi. During large flood events, the two creeks have the potential to surcharge and flood a significant portion of town located on the floodplain. Bank overflows to two “flood runners” linking the two creeks north of Milner Parade, can lead to widespread inundation of the built-up area between the two creeks. In addition, widespread inundation on the edges of the floodplain could be expected.

Major storms occurred in 1955, 1971, 1984 and 2000 and it would appear that the February 1955 flood equated approximately to the 100-year ARI event. It was noted at the time to be the largest flood “in living memory”. The January 1984 flood equated approximately to the 50-year ARI event, while the 1971 event was between the 20- and 50-year ARI event. More recently, the November 2000 flood was between the 5- and 10-year ARI event. Significant flooding occurred during these events, and numerous houses were inundated.

Flood mapping produced as part of the Quirindi Creek Flood Study (Lyll & Associates Consulting Engineers, 2005) show that there are significant areas of high hazard flooding throughout the floodplain.

Liverpool Plains Shire Council intends to undertake a Flood Plain Management Study (FMS) and Plan in accordance with the NSW Government’s Floodplain Development Manual (2005) to determine and assess flood management options for Quirindi and prepare the Floodplain Risk Management Plan.

In our discussions with Council, specific issues were identified as follows:

- ▶ Council is particularly interested in flooding impacts to key assets;
- ▶ Flooding related to the eastside estate area or any other recent development areas where flood planning levels and flood risk are critical should be assessed;
- ▶ The study was to be undertaken in consideration Council’s expected growth and any revised planning documents;
- ▶ Council required direction on Planning Controls for input to planning documents;
- ▶ Consideration to existing flood warning systems and procedures should be given, and any work undertaken by the SES as documented in the Local Flood Plan;
- ▶ Consideration of funding mechanisms for any mitigation works should be considered;
- ▶ Appropriateness of floodplain filling should be assessed;
- ▶ The prioritisation of management and mitigation options should be supported by cost benefit analysis and social and environmental considerations;
- ▶ Consideration of future climate should be given; and
- ▶ Changes due to siltation and vegetation removal, and enhancement of the riparian value through vegetation planning should be considered.



1.2 Past Studies

A number of studies and plans are of relevance. Key documents include:

- ▶ Quirindi Creek Flood Study, 2005, Lyall & Associates Consulting Engineers;
- ▶ Council Flood Area Observation Map;
- ▶ Liverpool Plains Growth Management Study and Strategy;
- ▶ SES, Local Flood Plan, 2008; and
- ▶ Other available documentation such as the Flood Observations Plan prepared by LPSC staff.

This information has been used as background to the present study.

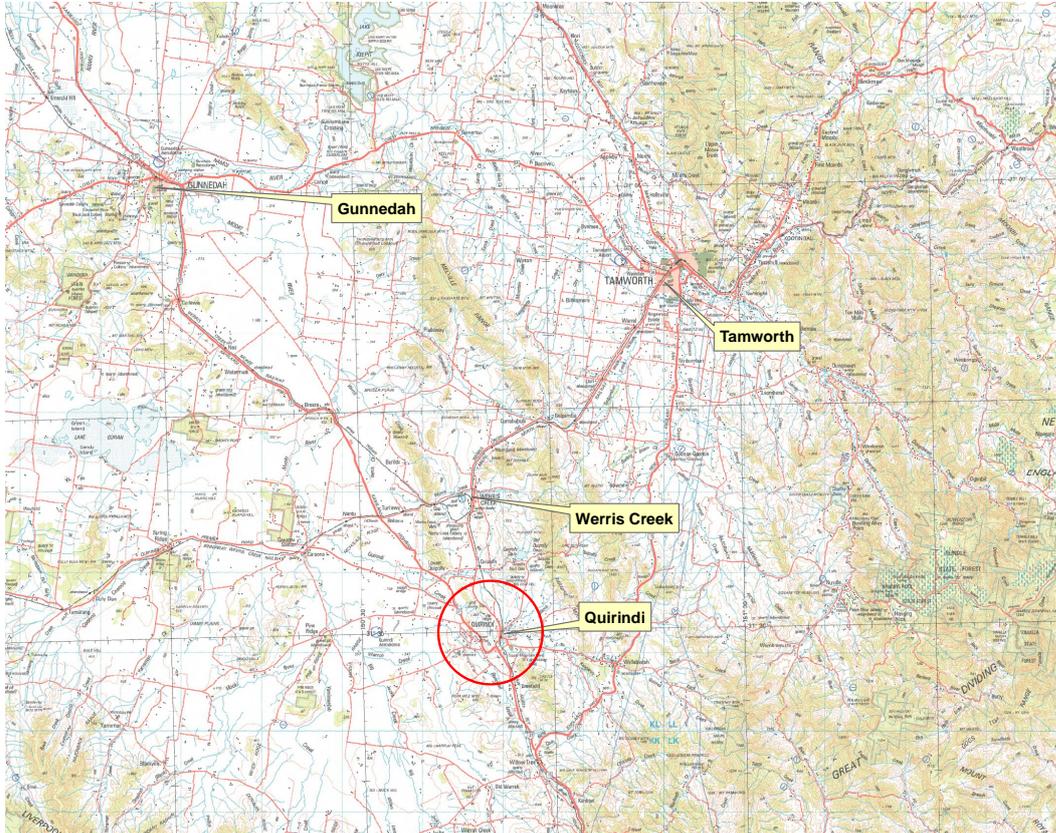
1.3 Objectives of the Project

Key objectives are summarised in the table below.

Table 1 Key Objectives and Outcomes

Key Objective	Specific Considerations
<ul style="list-style-type: none">▶ Undertake a Floodplain Risk Management Study and develop a Management Plan that addresses existing future and continuing flooding associated with Quirindi Creek and tributaries;▶ Undertake the study and develop the plan in accordance with the NSW Floodplain Development Manual, 2005;▶ Engage the community and stakeholders to solicit feedback, understanding and support of the Floodplain Risk Management Study and Plan; and▶ Ensure consultation with the key stakeholders including Council, the Flood Risk Management Committee and the community are undertaken in a thorough manner throughout the project.	<ul style="list-style-type: none">▶ Address flooding issues along Quirindi Creek and tributaries;▶ Develop the Study and Plan in close consultation with Council and stakeholders, presenting and evaluating/floodplain mitigation measures;▶ Consider issues and specific requirements raised by Council in discussion about this project; and▶ Provide Council with a plan to implement appropriate planning controls and provide a strategy to reduce the impact and damages caused by flooding.

Figure 1 Location Plan



1.4 NSW Government's Floodplain Management Process

The prime responsibility for planning and management of flood prone lands in NSW rests with local government. The NSW Government provides assistance with state-wide policy issues and technical support. Financial assistance is also provided to undertake flood behaviour and floodplain management studies and for the implementation of works identified in these studies.

A Flood Prone Land Policy and a Floodplain Development Manual (NSW Government, 2005) forms the basis of floodplain management in NSW. The objectives of the Policy include:

- ▶ Reducing the impact of flooding and flood liability on existing developed areas by flood mitigation works and measures, including ongoing emergency management measures, voluntary purchase and house raising programs, flood mitigation works, and development controls; and
- ▶ Reducing the potential for flood losses in new development areas by the application of ecologically sensitive planning and development controls.

The policy provides some legal protection for Councils and other public authorities and their staff against claims for damages resulting from their issuing advice or granting approvals on floodplains, provided they have acted substantially in accordance with the principles contained



in the Floodplain Development Manual (2005). The implementation of the Flood Prone Lands Policy generally culminates in the preparation and implementation of a Floodplain Management Plan.

To support this Policy and provide guidelines on sustainable use of the floodplain, a Floodplain Development Manual has been established (2005) which identifies the four main stages in the floodplain risk management process. These are:

- ▶ Flood Study: Determines the nature and extent of flooding behaviour;
- ▶ Floodplain Risk Management Study: Identifies, develops and compares various floodplain management options utilising the results of the Flood Study as well as assessment of social, economic, ecological and cultural issues;
- ▶ Floodplain Risk Management Plan: Formalises outcomes of the previous studies and present the necessary information to enable relevant Authorities to plan for the future; and
- ▶ Plan Implementation: Includes construction of structural floodplain management measures as well as incorporation of non-structural measures into existing Local Authority Environmental and Development Control Plans.

A Flood Study for Quirindi has been completed (Quirindi Creek Flood Study, 2005, Lyall & Associates Consulting Engineers). This report provides information for the Floodplain Risk Management Study and Plan.

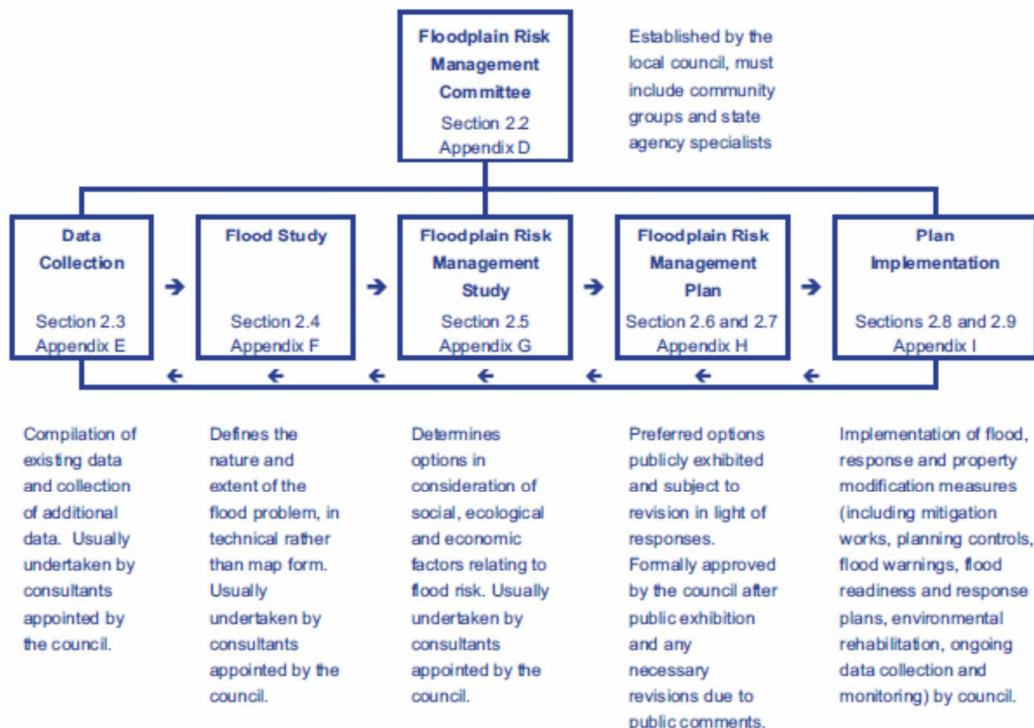


Figure 2 Flood Plain Risk Management Process (NSW Government, 2005)



2. Review of Flood Study for Quirindi

2.1 Background

The Quirindi Creek Flood Study undertaken by Lyall & Associates Consulting Engineers in 2005 (L&A, 2005) prepared the base data for the present study. This study produced flood mapping for a range of flood events including determination of flood hazard.

The flood study had three main components (L&A, 2005):

- ▶ Review of available hydrologic and hydraulic data and previous investigations. Rainfall and flood level data were supplied by Liverpool Plains Shire Council and the Bureau of Meteorology (BOM). This information was used to test the hydrologic and hydraulic models.
- ▶ A brief was prepared for cross sectional survey of the streams, floodplains and features influencing flooding patterns in the study area. Gallagher Odell & Garey Consulting Surveyors & Engineers undertook the survey. Council supplied a contour plan of the floodplain in the vicinity of the town, as well as a Digital Terrain Model of the Quirindi Creek catchment prepared by the Central Mapping Authority.
- ▶ A hydrologic component, which included development and testing of the hydrologic model of Quirindi Creek catchment, the estimation of design storms and their application to the hydraulic model.
- ▶ A hydraulic component, which comprised the development of the hydraulic model of the streams and floodplain and the definition of the water surface profiles, flows and velocities for the historic and design floods.

2.2 Flood Hydrographs

The flood hydrographs for Quirindi and Jacob Joseph Creeks were calculated using a RORB model of the catchment. Since the creeks are ungauged, detailed calibration to observed storm events was not possible. Comparisons were thus made to the Probabilistic Rational Method and a Regional Flood Frequency Analysis based on a ratio approach. The peak flows for January 1984 and November 2000 storms were subsequently calculated and the RORB model parameters listed in Table 2 were adopted.



Parameter	Recurrence Interval year ARI				
	5	10	50	100	PMF
Initial Loss	30	30	20	15	0
Continuing Loss	2.5	2.5	2.5	2.5	0
kc	20.7	20.7	20.7	20.7	2.0
m	0.8	0.8	0.8	0.8	1.0

Table 2 RORB Model parameters (ref L&A, 2005)

Design storm hyetographs for the range of frequencies up to and including the PMF and durations up to 18 hours were derived from Australian Rainfall and Runoff. These hyetographs were applied to the RORB model to obtain discharge hydrographs at the catchment outlet. The 18 hour storm was generally found to be critical, producing the highest discharges. Key flood peaks at a number of critical locations are provided in Table 3.

Location	Peak Flow (m ³ /s)				
	5 yr ARI	10 yr ARI	50 yr ARI	100 yr ARI	PMF (1)
Wallabadah	152[18]	196[18]	399[6]	518[6]	2,678
Quirindi Creek at Austins Bridge	234[18]	323[18]	682[18]	835[18]	4,498
Jacob and Joseph Creek at Young Street	113[18]	151[18]	300[18]	370[6]	2,250
Quirindi Creek d/s Loder Street Bridge	314[18]	433[18]	96[18]	1199[18]	6,100

Notes : Figures in square brackets represent the critical storm duration.

(1) These flows were derived assuming linear hydrologic model behaviour. However, discharges equal to 3x100 year ARI discharges were adopted in Chapter 6 for defining PMF levels.

Table 3 Peak flows at critical durations (ref L&A, 2005)

2.3 Flood Levels

Flood peaks for Quirindi and Jacob Joseph Creeks were calculated using a HECRAS model, operated in hydro-dynamic mode. This would account to some extent for flood plain storages. The model was compiled from a number of cross-sections through the flood plain, which determined critical conveyance paths such as the creeks and the flood runners between the creeks. Overflows to the flood runners were configured in the model, using side spillway structures to mimic bank overflows.



It appears that limited topographical information was made available to L&A for their study. This would affect the accuracy of the modelling and the production of mapping. With more topographical information, possibly a 2D hydraulic model would have been more appropriate, that more accurately simulates the complex distribution of flows in the Quirindi and Jacob & Joseph floodplains.

Sensitivity assessments were undertaken on roughness values and bridge blockages, and flood profiles were produced for the 5, 10, 50, 100 year ARI and PMF design events. In general it was found by L&A that:

- ▶ *Floods up to the 5 year ARI would be conveyed within the creek channels, although there would be a breakout from Quirindi Creek to Jacob and Joseph Creek via a flood runner near Fairmont Street. There would be no flows emanating from the main creeks to the flood runners in the Pollock Street area, although there is likely to be some local runoff from the floodplain conveyed in these drainage lines;*
- ▶ *Significant surcharges from the two creeks into the flood runners would commence for floods greater than the 10 year ARI, with the floodplain progressively conveying a larger proportion of flows for the major floods;*
- ▶ *At the 100 year ARI, all of the floodplain between Quirindi and Jacob and Joseph Creek would be inundated and there would be a progressive transfer of flow via the flood runners from the former to the latter stream. On Quirindi Creek, the peak discharge would progressively reduce from 830 m³/s at Austins Bridge to 380 m³/s at the Henry Street bridge and 295 m³/s conveyed through the Railway bridge. Corresponding peak flows on Jacob and Joseph Creek would increase from 360 m³/s upstream of Young street to 855 m³/s at Henry Street and 950 m³/s through the Railway Bridge;*

At the Loder Street bridge, downstream of the confluence of the two creeks, the combined peak discharge in Quirindi Creek would be 1,200 m³/s. The combined peak discharge from the two streams at the upstream end of the modelled area amounts to 1,190 m³/s, indicating that there is little attenuation of peak flows in the two streams due to the effects of floodplain storage as the flood wave traverses the extent of the hydraulic model.

Flood mapping was produced, together with hydraulic and flood hazard categorisation mapping. These results are provided in Appendix A. The results show that many properties east and downstream of the railway line are located in high hazard areas of the floodplain. In addition, many of these properties are located in the flood ways associated with Jacob and Joseph and Quirindi creeks.

2.4 Bridge Assessment

The Lyall & Associates study noted the flooding associated with each bridge as listed in Table 4 below. With respect to bridge blockages, L&A concluded that the risk of blockage is low, given most structures have opening widths in excess of 5m to 8m, or are low bridges with surcharge. The L&A bridge blockage assessment is provided in Table 5.

In July 2011 a pedestrian footbridge was installed upstream of the Whittaker Street bridge. This pedestrian footbridge is not included in any flood assessments. GHD understand that the waterway opening is larger than the waterway opening of the Whittaker Street Bridge.



Austins Bridge	Bridge deck above 100 year ARI flood level. Western approach road overtopped by 1 m by 5 year ARI flood.
Henry Street Bridge, Quirindi Creek	Bridge deck is above the 100 year ARI flood level. Henry Street between two creeks would be flooded due to overland flows which break over the right bank of Quirindi Creek upstream of Henry Street. These breakouts commence at 10 year ARI flood level.
Railway Bridge, Quirindi Creek	Railway Bridge over Quirindi Creek is above 100 year ARI flood level.
Young Street Bridge, Jacob and Joseph Creek	Bridge deck is above the 100 year ARI flood level. The eastern approach road (Young Street) would be overtopped at the intersection with "Flood Runner 2" for floods greater than 10 year ARI.
Pryor Street Bridge, Jacob and Joseph Creek	Bridge deck is overtopped by floods greater than 5 year ARI. Depth of overtopping would be about 200 mm for 10 year ARI flood.
Henry Street Bridge, Jacob and Joseph Creek	Bridge deck is overtopped by floods greater than 10 year ARI. Depths of overtopping of Henry Street east of the bridge would be about 600 mm for the 50 year flood.
Gurton Street Bridge, Jacob and Joseph Creek	This is a low level structure. Deck would be inundated by 2 m for 5 year ARI flood.
Railway Bridge, Jacob and Joseph Creek	100 year ARI flood would be on the point of overtopping the Railway Bridge.
Loder Street Bridge, Quirindi Creek	Bridge deck would be overtopped by 400 mm for the 100 year ARI. The 10 year ARI flood would be on the point of overtopping the western approach road.

Table 4 Bridge Flood Assessment (ref L&A, 2005)



Austins Bridge	This is a high level 5 span structure with each span about 10 - 11 m. There is very little chance of significant blockage.
Henry Street Bridge, Quirindi Creek	This is a high level 4 span structure with the underside of deck well above major flood level. The smallest span is 9 m and the others are considerably wider, with the widest about 28 m. There is little chance of significant blockage.
Railway Bridge, Quirindi Creek	Railway Bridge over Quirindi Creek is a 3 span structure with each span about 8.5 m. There is very low risk of significant blockage and if blockage did occur, there is ample redundancy in the adjacent 7 span structure over Jacob and Joseph Creek.
Young Street Bridge, Jacob and Joseph Creek	Bridge is a 5 span structure with each span about 10 m. There is only a very low risk of significant blockage. If such blockage did occur, there would be a transfer of flows onto the adjacent floodplain and escape over Young Street with very little increase in upstream flood levels.
Pryor Street Bridge, Jacob and Joseph Creek	Bridge is a 3 span structure, with a minimum span of 10 m. Accordingly, the likelihood of partial blockage is very small.
Henry Street Bridge, Jacob and Joseph Creek	Bridge is a 3 span structure with a minimum span of 13 m and consequently, little likelihood of significant blockage.
Gurton Street Bridge, Jacob and Joseph Creek	This is a low level structure. Blockage would not significantly increase upstream flood levels.
Railway Bridge, Jacob and Joseph Creek	Railway Bridge is a seven span structure with each span about 10 m. Accordingly, the likelihood of partial blockage is very small.
Loder Street Bridge, Quirindi Creek	Bridge is a 3 span structure with each span about 12.5 m. There is very low risk of significant blockage.

Table 5 Bridge Blockage Assessment (ref L&A, 2005)



2.5 Assessment

2.5.1 Flood Warning Times

The flood hydrographs determined by L&A and used as boundary conditions for the modelling are presented in Figure 3.

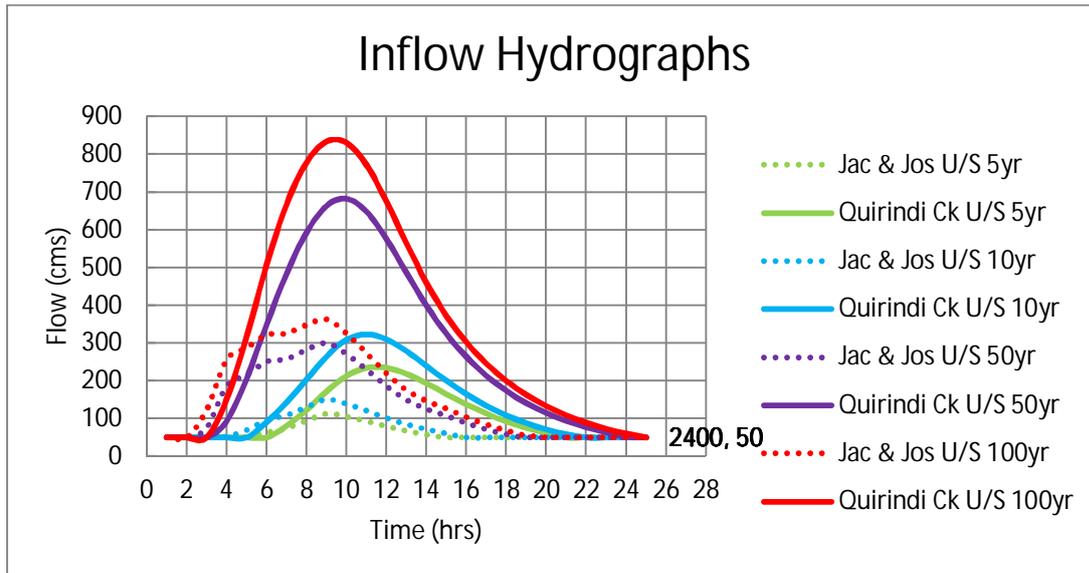


Figure 3 Flood Hydrographs (ref L&A, 2005)

From Figure 3, the following is noted:

- ▶ For both creeks the hydrograph peak occurs some 8 hours to 10 hours after the storm (for a range of events);
- ▶ If surcharge occurs in a 10-year ARI event, which is approximately 320 m³/s in Quirindi Creek, this flow would occur within 1 to 2 hours in a 50- or 100-year event.

The nature of flooding at Quirindi is thus flash flooding, which provides little time to evacuate.

2.5.2 Onset of bank overflow to flood runners

From the L&A work, it is apparent that Quirindi is subject to considerable flow distribution across the flood plain in events less frequent than the 10-year ARI event (i.e. with peaks greater than the 10-year ARI event), when bank overflows occur from Quirindi Creek to Jacob and Joseph Creek via the flood runners. It is thus critical to ensure the model adequately simulates the onset of bank overflow.

A small informal levee exists along Milner Parade, which controls the bank full overflow. To confirm that this small levee is accurately represented in the HECRAS model, additional survey was collected along the levee crest. The comparison for a short portion of this levee crest is shown in Figure 4.

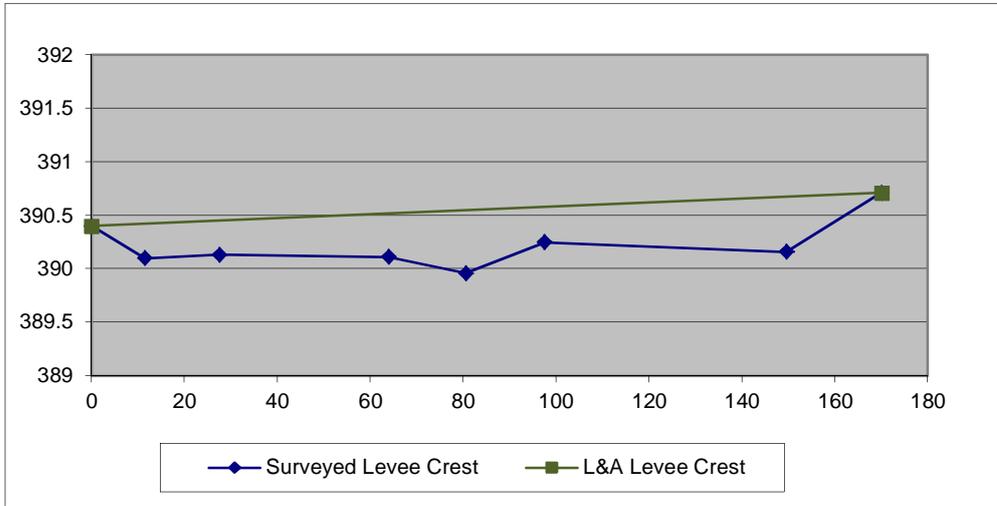


Figure 4 Milner Parade Levee Comparison

From Figure 4 the following is noted:

- ▶ The Milner Parade levee is mostly represented in the HECRAS model by the elevations at the two endpoints, and a linear assumption between; and
- ▶ The levee crest surveyed varies in height along the length and could in some instances result in bank overflows occurring earlier than simulated by the L&A HECRAS model. Thus discharges from Quirindi Creek to Jacob and Joseph Creek could occur earlier and flood runner discharges could be underestimated.

To determine the impact on flood levels, all L&A simulations were redone, with the more accurate surveyed levee configured in the HECRAS model. A comparison of changes to flood levels in the 100-year ARI event is shown in Appendix B. From the Figure B.1 in the appendix, the following is noted:

- ▶ The lowered berm results in more flood waters overflowing the right bank of Quirindi Creek to the flood runners;
- ▶ This increased overflow, particularly at the upstream end, will result in decreased flows in the Quirindi flood plain together with a lowering of flood levels in the order of approximately 100 mm to 350 mm in the upper areas;
- ▶ Commensurate with this, is increased flood discharges in the flood runners and an increase in flood levels, predominantly upstream of Hendry Street; and
- ▶ The above effect is diminished downstream of Henry Street where the creeks confluence.

2.5.3 Climate Change impacts on Flooding

Climate change could have a significant impact on Australia, affecting amongst others, storminess, changes in rainfall climate, changes in temperature and at the coast, leading to sea level rise. Increases in storminess with respect to extreme weather events, are likely to lead to



increased flooding resulting in a great deal of distress to people's lives and damage to property and infrastructure.

An assessment of the impact of climate change on existing conditions 100-year ARI design event flood levels in the Quirindi floodplain was undertaken using the existing HECRAS model developed in the L&A 2005 Flood Study. Given that climate change is likely to increase rainfall intensities and catchment runoff in this region, the assessment has been undertaken by assessing the impact of increased flow rates in Quirindi and Jacob & Joseph creeks. Due to uncertainty in climate change predictions, a future climate scenario was simulated, generally in accordance with the guideline, Practical Consideration of Climate Change, NSW Department of Environment & Climate Change (NSW DECC 2007). This guideline recommends considering 10%, 20% and 30% increases in rainfall intensity and volume for future climate scenarios. The flood model was re-simulated assuming a 30% increase in rainfall intensity and an approximately 10% increase in rainfall volume during a large flood event. The impact on flood levels has been mapped in Figure B.2 in Appendix B, from which it is noted that flood levels could increase in the order of 500 mm to 700 mm across the Quirindi flood plain under a future climate flooding scenario. In a number of isolated areas, particularly if flood peaks arise simultaneously impacts could be in the order of 1 to 1.2 metres, under the scenario model.

2.5.4 Summary

For the purposes of this Floodplain Management Study:

- ▶ In the absence of flow gauging to more accurately calibrate the hydrological models, the L&A estimates of flood hydrographs are considered acceptable; and
- ▶ Given limited topographical information was made available to L&A for their study, the HECRAS model is considered to provide the best currently available estimates of flood levels at Quirindi. However, the model should be simulated with the updated survey information for the Milner Parade levee.



3. Community Consultation

A community consultation plan for the project was developed identifying stakeholders to be consulted, the timing of that consultation, and activities to facilitate a process of open, effective and appropriate consultation.

The purpose of community and stakeholder involvement was to ensure information is presented and received clearly and unambiguously, that all key community and other stakeholder groups are reached through a selection of activities, and that their views are sought and become an integral part of the process.

Copies of relevant community information distributed as part of the study and records of the Floodplain Management Meeting minutes are provided in Appendix C.

3.1 Inception Meeting

At the inception meeting, held with the Quirindi Floodplain Management Committee, a general outline of the proposed community consultation activities was provided, as well as a detailed discussion about Quirindi and its community. A site visit was also undertaken as part of the inception meeting.

3.2 Identification of Key Stakeholders

The identification of stakeholders is treated as an ongoing process, with stakeholders being added to the stakeholder database and mailing lists throughout the project. This occurred when the project team made contact with stakeholders or when stakeholders made contact with Council/the project team about the study.

Stakeholders identified during the community consultation process included all residents and landowners within Quirindi, Council, Floodplain Management Committee (FPMC) representatives, the SES and the Office of Environment and Heritage.

3.3 Consultation Activities

The first round of consultation activities undertaken, focused on introducing the project, advising residents and key stakeholders of investigations that were to take place over the initial stages of the study, and to gather as much historical information about flooding as possible. Community consultation is ongoing and tasks undertaken to date are described below.

3.3.1 Contact Mechanisms

A free call information line (1800 810 680) and free post address was established at the start of the project, to ensure all stakeholders had access to the project team and information about the study. These contact mechanisms were advertised through the newsletter, media release, advertisement, flyer, and the project website (Council).

A project email address (communityinput@ghd.com.au) was also established to encourage community feedback.



3.3.2 Community Newsletter & Feedback Survey

A community newsletter was prepared and posted to residents in Quirindi. The newsletter provided stakeholders with an overview to the project; why it was being undertaken, what is being undertaken and timing. It provided information on the Floodplain Management Committee, as well as highlighting where and how stakeholders could contribute to the process.

A reply-paid feedback survey was also included in the newsletter. This survey was designed to examine the degree of flood awareness and preparedness by the local community, identify flood related issues of concern, and canvass options for flood protection.

3.3.3 Media Release

A Media Release was prepared for inclusion in the local media. It was also designed to reach stakeholders who no longer live in Quirindi, but may have lived there previously and experienced a flood.

3.3.4 Regular Meetings with the Floodplain Management Committee

An initial Floodplain Management Committee (FPMC) meeting was held on Tuesday 14 May 2010, at Liverpool Plains Shire Council Chambers. At the meeting the project team received valuable information about past flooding in Quirindi. Regular FMC meetings have occurred throughout the project and minutes are provided in Appendix C.

3.3.5 Community Information Session – 13 October 2010

Fourteen local residents attended the Community Information Session. The information the residents provided was consistent with the information discussed at the FPMC meeting.

The aim of the information session was to provide the local community with information about the project, and to receive information from the community about flooding in Quirindi.

Minutes from the Community Information Session can be viewed in Appendix C.

3.3.6 Community Workshop – 7 July 2011

A total of 40 attendees (residents, stakeholders and FMC) were present at the community workshop on 7 July 2011. At this meeting the status of the project was presented. As part of the presentation, options for managing flood risk in Quirindi were discussed and presented to the community.

The aim of the community workshop was to provide the local community and stakeholders with information about the project, and to receive comments from the community about potential floodplain measurement measures.

3.3.7 Open Shop Day – 15 September 2011

An Open Shop Day to promote the Draft Quirindi Township and Surrounding Areas Floodplain Risk Management Study and Plan was held on the 15th September 2011 from 11am until 1pm in the Quirindi Library Courtyard. The community was asked to come along and provide input to the study. In addition, to become further informed about the work which had been undertaken and the findings to date.



A number of community members came along and met with the study team on the day.

3.3.8 Summary of Community and Stakeholder comments

Below is a summary of the feedback received from the Quirindi Flood Risk Management Study Community Survey as noted at the public meetings. This feedback was provided by the community and stakeholders.

- ▶ Survey respondents have lived in Quirindi for various degrees of time from 1.5 years to 81.5 years. Respondents have lived in Quirindi for an average of 35.3 years. There was an even spread of male and female respondents, however judging by the length of time residents stated they have lived in Quirindi, the demographic of the respondents is heavily skewed to those aged over 55 years. The median age of Quirindi was 44 years at the 2006 census, which supports the age demographic survey results.
- ▶ 55 of the 66 residents who completed the survey had experienced a flooding event whilst living in the area. Those who had not been exposed to flooding had been living in the region for less than 10 years. Of those who have lived in Quirindi for more than 10 years, nearly all experienced the flooding event of 2000. The other most common floods mentioned by respondents occurred in 1955, 1971 and 1984. One resident claimed to recall floods that occurred in 1921 and 1941, while another commented that they experienced flooding as recently as August 2010.
- ▶ 44 of the 66 respondents described some sort of negative effect on their property as the result of flooding in the area. The most common property effects include:
 - Damage to fences, stables and sheds;
 - Floodwaters flowing into yards and under houses;
 - Forced movement of stock and vehicles to higher ground;
 - Deposit of mud and silt on property;
 - Soil erosion; and
 - Water flowing into respondents houses during earlier floods of 1955 and 1971.
- ▶ A non-direct property impact mentioned by respondents is the impact flooding has on local roads and crossings, resulting in people becoming isolated from population centres. Different instances of isolation lasting anywhere between a few hours to nearly a week were outlined in the surveys.
- ▶ 24 of the 66 respondents stated that they do not take any specific measures to prepare for a flooding event. The main reasons given for this include that respondents have not experienced flooding, have houses built on high ground or away from flood prone areas, or in one case feel it is not necessary to take precautions as a levee bank was put in place years ago.
- ▶ For those that do take preventative measures, the most commonly listed include:
 - Monitoring creek levels;
 - Moving stock and vehicles to higher ground;
 - Raising equipment, furniture and other valuables off the ground;
 - Ensuring sufficient levels of food are stocked up; and



- Ensuring that all drains around the property are cleared.
- ▶ When asked what Council should focus on to reduce the effects of flooding, approximately 85% of respondents suggested Council should focus on multiple options and areas rather than one specific means to minimise flooding. Educating people how to prepare for a flood in conjunction with other means was the most common response followed by flood modifications and property modifications.
- ▶ A general trend that emerged was that property modification was not a favourable option as it would not be feasible for a large majority of residents living in flood prone areas due to the high associated financial costs.
- ▶ Survey respondents are divided on the subject of flood modifications, specifically levees. Half of the respondents who commented on levees were of the belief that they were beneficial in protecting properties from floodwaters, while the other half stated that the levees worsened the flooding for areas without this type of protection in place. One resident in the Gurton Street area was particularly concerned about any additional levees around the Whittaker Street pump station;
- ▶ Other areas that were particularly important to residents, were the suggestions that Council should focus their efforts on include clearing both Jacob and Joseph's creeks of any vegetation and debris to improve water flow and reduce the impacts of flooding at an early stage, the implementation of a creek monitoring and early warning system, and prohibiting or encouraging people not to build on the flood plain;
- ▶ When asked to list any other issues to be taken into consideration the major issue (already discussed) concerned the amount of weeds, leaf litter and rubbish in local waterways. Residents perceive this to be a major issue and the most logical first step to minimising the negative impacts from flooding. Other issues mentioned include the importance of correctly sealing, grading and ensuring suitable drainage is present on local roads, the potential for a specific high point in each locale, the possibility of assistance with flood recovery and clean-up operations and general interest in attending the September Community Information Sessions to find out more information and provide further feedback;
- ▶ Residents noted that during times of flooding, onlookers often drove vehicles along local flooded roads, which resulted in waves. This at time exacerbated the flooding at a local scale. In addition the availability of sand bags was an ongoing issue;
- ▶ Residents in the Whittaker Street area were particularly concerned about backup through the local stormwater drainage pipes during flood events. In addition, a new footbridge has been located upstream of the Whittaker Street bridge and concern has been raised about the impact of this bridge on local flooding. Concerns were also raised regarding the risk of this footbridge collapsing during a flood event, resulting in partial blockage of the Whittaker Street bridge waterway opening; and
- ▶ The SES noted the preference to investigate flood warning systems, which could be located upstream of Quirindi. A number of options should be investigated to determine if a suitable flood warning system could be implemented.



4. Socio-Economic Effects

4.1 Social Setting and Characteristics

Quirindi is a small rural town located on the North West Slopes of New South Wales and Queensland, 354 km northwest of Sydney. The town is known as the gateway to the North West because of its close proximity to Gunnedah (83km to the northwest) and Tamworth (70km to the north).

Located in the heart of the Liverpool Plains the area is regarded as the richest agricultural area in NSW and this supports the local economy. Broad acre farming dominates on the black soil plains to the west and livestock grazing is in the hilly eastern part of the district.

The name of Quirindi is derived from the Kamilaroi Aboriginal language. The town itself was established in 1856 and is steeped in rural history. The Quirindi Historical Cottage and Museum is located in the middle of town in a building constructed in 1887. In addition, the Rural Heritage Village is 3 kilometres from town. Other heritage sites are noted in the Office of Environment and Heritage AHIMS Web Services (AWS), when doing a search with a 1 km buffer around the Quirindi town. In addition a search of the Australian Heritage Database noted a number of heritage sites in the vicinity of Quirindi.

Until 2004, Quirindi had its own local government area that was governed by the Quirindi Shire Council. This Council was dissolved and the area has been incorporated into the Liverpool Plains Shire Local Government Area.

4.1.1 Population profile

Analysis of the study area population was drawn from the Australian Bureau of Statistics, 2006, Population and Housing Census. The Quirindi "State Suburb" covering the Quirindi town and surrounds has been used for comparative analysis against the Liverpool Plains Shire Local Government Area (LGA). It should be noted that the accuracy of data decreases at the suburb level due to the lower population numbers.

According to the 2006 Census, the Quirindi Suburb has a residential population of approximately 2,924 people, this is approximately 38% of the population living in the Liverpool Plains Shire Local Government Area. In 2006 19.2% of the population usually residing in Quirindi were children aged between 0-14 years, and 36.3% were persons aged 55 years and over. The median age of persons in Quirindi was 44 years, compared with 37 years for persons in Australia. These figures are consistent with that of the Liverpool Plains LGA where the median age was 43 years.

The agricultural importance of the area is clearly demonstrated in the statistics for employment by industry. In the 2006 census of people in full or part time employment in Quirindi, the majority were employed in the sheep, beef cattle and grain farming industry (8.8%), although this figure is lower than the Liverpool Plains employment industry figure of 23.6% it is significantly higher than the Australian average of 1.5%. Other industries in the area include school education (7.5%) and local government administration (5.1%).



4.1.2 Land use, Business and Community Facilities

The Quirindi Area is categorised primarily by residential and small business development. Under the Quirindi LEP, 1991, the township area is classed 2(v) Village Area. This zoning allows for a range of housing types and aims to make provision for a range of suitable land uses such as commercial and retail development.

Surrounding the township is land zoned 1(a) General Rural and 4(a) Industrial (general) zone. The 1(a) General Rural zone generally includes agricultural land, forest, ecologically sensitive land and land with mineral deposits.

In 2006, there were approximately 1,176 private dwellings occupied in Quirindi. Approximately 44% of these dwellings were fully owned by the residents, 22% were being purchased and 27% were rented. The key businesses located in the township include a local pub, RSL, a couple of cafes and restaurants, Quirindi royal theatre and a petrol station. Support services located in Quirindi include the library, council offices, tourist information and Quirindi Hospital and health services.

4.2 Social-Economic Impact of Flooding

4.2.1 Social Impacts

Major flooding typically causes a great deal of distress to people's lives. Social costs are often intangible damages and relate to changes to social networks, lifestyles, community activities and individual state of well-being. The degree of disruption to people's lives depends on the severity of flooding and the ability of the community and individuals to recover from the flood event.

Flooding impacts of Quirindi are predominantly concerned with residential areas of the township and the associated loss and damages caused by flooding of residential homes and properties. Social impacts may include stress for community members related to the loss of sentimental and personally valuable items including stock and vehicles. These social costs are particularly difficult to quantify as the personal and emotional value of the loss often exceeds that of material value. Anxiety, panic and insecurity may also increase amongst the community as a response to the possibility of future flood events.

Damages to local businesses pose economic impacts for the local Quirindi community. Flooding has the potential to cause disruption to business activities such as trading capacity and employment routines due to the isolation caused by floodwaters. Residential damages may also have the potential to cause lifestyle changes as members of the community adjust personal activities to address flood damages.

It is generally acknowledged that the degree of social impact caused by flooding is likely to reduce if the community is prepared for a flood event and has adequate access to support services. Given the risk of flooding in Quirindi over the past fifty years and the relatively high level of flood 'awareness' and flood 'readiness' within the community, it can be estimated that the potential social impacts in Quirindi are marginally lower than a community that is not flood aware.



Responses from the community indicate that the community is flood aware, and therefore may have a better knowledge of how to deal with flooding when it occurs, both on a practical basis, and psychologically.



5. Economic Impacts

Whilst consideration of direct economic impacts is important, it is not unusual to proceed with flood mitigation schemes on largely social grounds such as intangible costs and social disruption. Economic costs would depend on the level of physical flood damage, the nature of the premises impacted, level of community flood 'readiness', and the level of readily available assistance.

In addition to damages to individual properties, there may also be disruptions to infrastructure such as roads, electricity, telephones and water supply. A summary of the key potential impact on the socio-economic workings of the community is summarized in Table 6.

Table 6 Potential Socio-Economic Impacts

Direct	Indirect	Intangible
Residential Areas:		
Structural Damages	Relocation costs	Stress and Anxiety
Contents Damages	Loss of ability to work	Loss of sentimental items
Garden damages	Changes to work routines	Lifestyle changes
Clean-up costs	Disruption to social capital	Loss of amenity
Replacement and repairs	Restricted access	
Commercial Businesses and Community Facilities:		
Structural Damages	Loss of revenue/profit	Stress and Anxiety
Contents Damages	Loss of productivity	Loss of sentimental items
Outside Damages	Disruption to employment	Lifestyle changes
Clean-up costs	Loss of patronage	Loss of amenity
Infrastructure damages	Drop in property values	
Restricted Access	Disruption to community services and social capital	



6. Damage Cost Estimates

6.1 Flood Damage Extents

In order to provide a benefit-cost assessment of floodplain management options, it is necessary to estimate the costs of flood damages. Flood damages are determined by assessing the numbers of flood affected properties and then estimating a direct damage cost for a range of flooding events (in terms of flood depth). The resulting depth-damage curves are used as a basis for estimating other direct and indirect costs from flooding, such as those listed in Table 6.

Flood affected properties were estimated from the results of hydraulic simulations from the flood study, together with floor level survey data collected as part of this study. For each design flood, flood levels were determined at each property location based on these surveyed floor levels. Numbers of inundated properties are shown in Table 7, and flood inundation mapping is provided in Appendix D. This mapping shows the depth of floor level inundation for a range of events. From the mapping the following is noted:

- ▶ In a 5-year ARI event (Figure D.1) only 4 properties are inundated across the floodplain. One of these is the cellar of the pub and another is the swimming pool;
- ▶ In a 10-year ARI event (Figure D.2) only a number of additional properties are inundated, particularly in the Gurton Steet and downstream of Henry Street;
- ▶ In a 50-year ARI event (Figure D.3) numerous properties in the Quirindi floodplain are inundated. Of these, selected properties downstream of the railway line, between Quirindi and Jacob Joseph Creek are severely inundated. Other properties in and around Rose and Henry Street are also severely inundated;
- ▶ In a 100-year ARI event (Figure D.4) inundation levels become severe with many properties downstream of Henry Street being inundated by over 1.5 m to 2.0m depth; and
- ▶ PMF flood depths (Figure D.5) are well over 2 m in depth an many areas, with depths exceeding 4 m noted downstream of the railway bridge.



Table 7 Flood Affected Properties

Flood Event	Number of Residential Dwellings Inundated
5-year	3
10-year	4
50-year	107
100-year	145
PMF	292

6.2 Depth-Damage Relationship

For most residential dwellings, flood damage increases with the depth of flooding. The Floodplain Management (FDM) and Coastal Support Section of the Department of Natural Resources (DNR, now Office of Environment and Heritage) has developed relationship between flood depth and damage based on various parameters for house and contents value, and flooding characteristics. A spreadsheet supplied by OEH was used for the flood damage calculation.

The resulting relationship is illustrated in Figure 5. Parameters used to derive this relationship are shown below in Table 8.

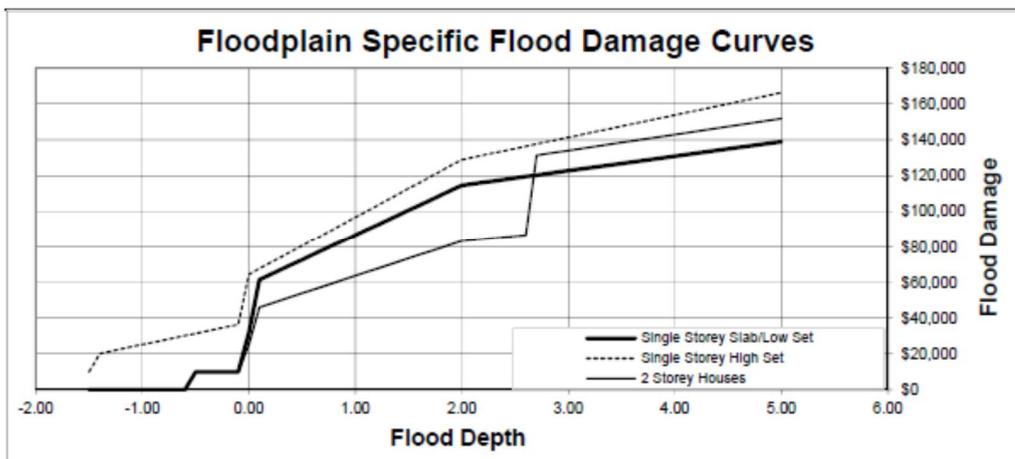


Figure 5 Typical Depth Damage Relationships (OEH, 2007)



Table 8 Parameters for Depth-Damage Relationship

Parameter	Value
Additional accommodation/ loss of rent	\$220 per week
Average contents value	\$50,000
Average house size	180 m ²
Clean up costs	\$4,000
External damage	\$6,700
Typical duration of inundation	10 hour
Typical table/bench height	0.9 m
Design Life of Options	20 year
Discount factor for Cost Calculations	7 %

6.3 Flood Damage Calculations

The following methodology was used to estimate the Average Annual Damage (AAD) and present value (PV) of the AAD over a 20-year period:

- ▶ The properties affected by flooding for a range of ARI events was estimated from the flood simulations and floor level survey. This calculation was undertaken for two options, namely by including and by excluding commercial properties;
- ▶ The cost of damage for the flooding was estimated for each flood event and depth range, using typical house and contents damage cost and the percentage of damage for the particular depth;
- ▶ A direct damage bill for each storm event was calculated;
- ▶ Flood recurrence interval was plotted against total damage and integrated to find the area under the graph, which provides the AAD; and
- ▶ A present value for the AAD was estimated based on a 7% discount rate over a 20-year period.

For Quirindi the Annual Average Damage Curve for residential properties is shown in Figure 6. The Annual Average Damage is estimated at \$1.5 million. Over a 20-year period, this has a Net Present Value of \$17.5 million. If commercial properties were to be included (approximately 24), the Net Present Value of flood damages in Quirindi could be around \$19.7 million, however this is highly dependent on the type of commercial enterprise and possibly, affected stock in the case of retail.

Figure D.6 in Appendix D shows the net present value damage costs for individual houses across the flood plain, over a 20-year period. The map shows only properties with damage costs greater than \$55,000, which was arbitrarily chosen as approximately half the cost raising a house (\$100,000). The figure also notes the actual damage estimates for the 20 properties



with the highest damage costs. In total approximately 122 properties are expected to experience NPV damage costs in excess of \$55,000.

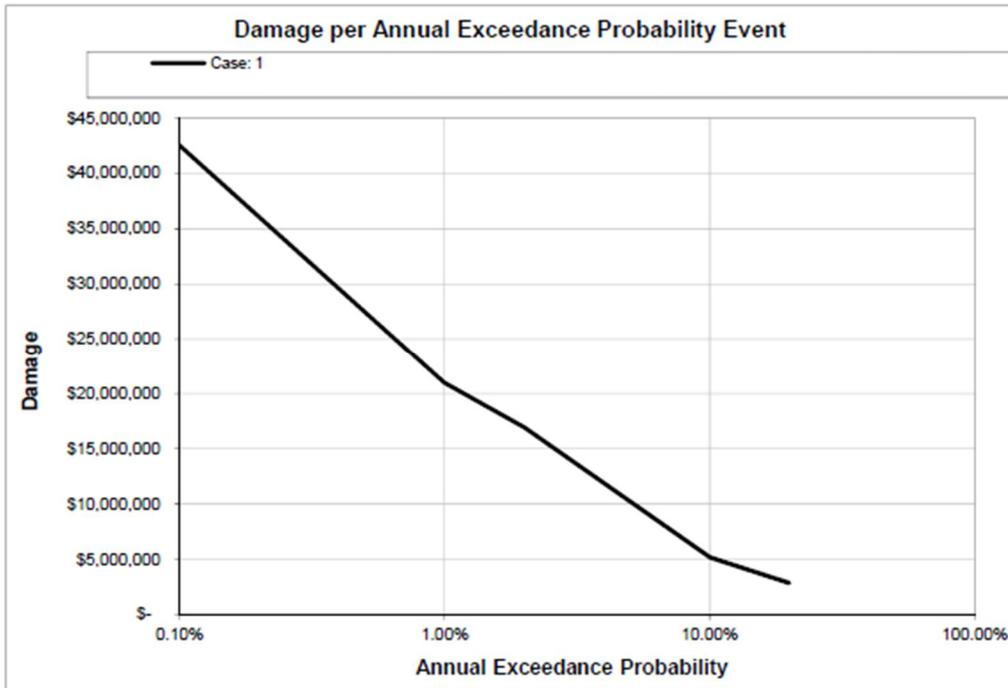


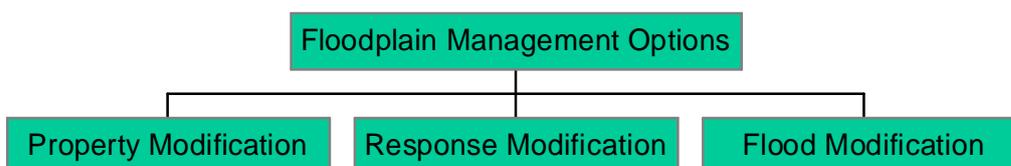
Figure 6 Quirindi Damage Curve (residential)



7. Flood Plain Management Measures

In accordance with the NSW Government Floodplain Development Manual (2005), this report considers various floodplain risk management measures. Risk management measures can be broadly categorised into three categories as shown in Figure 7.

Figure 7 Floodplain Management Measures



Each of the above floodplain management options is examined in the following sections. An additional “do nothing” option is also considered.

7.1 Property Modification

Property modification measures are approaches to floodplain management that apply to existing properties and proposed developments. While these modifications will reduce damages and risk to life and property, they will not prevent floods entering Quirindi. Thus they will not necessarily address all the social impacts of flooding.

7.1.1 Land Use Planning

Land use planning limits and controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Planning not to develop land within high flood hazard or land that has the potential to impact flood behaviours in other areas is a valuable long-term solution. This can be achieved through zoning in the Liverpool Plain Shire Council Local Environment Plan (LEP) and the associated Development Control Plan (DCP).

Council is currently compiling a new LEP, which includes information determined through the Quirindi Creek Flood Study (L&A, 2005) and developed by the current study. This LEP will include a Flood Planning Line, which identifies areas where regard must be taken for residential floor levels located above the 100-year ARI flood line plus 0.5m freeboard. This LEP is due to be gazetted by the end of the year. This LEP will support the DCP and it will be important to obtain consistency of the wording in these documents, the s149 Certificated and any other Planning Instruments dealing with flooding matters.

Planning documents can be used as a floodplain management tool by controlling floor levels, freeboard, fill or excavation in the floodplain, site access during flood events, location of utilities and services, building materials and structural fitness of buildings when subject to flooding.

Of particular importance is the Flood Planning Level, which is an important tool in the management of flood risk. The Flood Planning Level is made up of either a historic flood event



or a flood event of a suitable ARI plus a freeboard. In NSW the 100-year event is often used, together with a 0.5m freeboard to define the Flood Planning Level for residential development. However, Flood Planning Levels based on more frequent events together with a freeboard could be considered for commercial and or other land uses.

Land Use Planning and Flood Planning Levels should be adopted and defined as a Floodplain Management measure in Quirindi.

7.1.2 Voluntary House Raising or Flood Proofing of Buildings

House raising is a voluntary structural solution to lift buildings above the flood planning level to avert damage to buildings, improve personal safety and reduce stress and post-flood trauma. House raising is a popular solution to flooding in rural areas. Consideration must be given to the type of house being raised (timber frame is cheaper than slab on ground), the level of hazard to be avoided, the duration of the flooding expected. An important consideration is that house raising will not mitigate flood risk entirely, since the effects of a flood of greater magnitude than the design flood (potentially up to the PMF) could still result in risk and damage.

House raising is considered an attractive option for Quirindi as it would promote the long-term sustainability of the town. In addition it could be implemented in a step-wise manner over a longer time-frame, and would thus not present a single upfront cost. House raising often attracts incentive funding from State Government, with the balance of funding provided by the home owner.

Flood proofing of buildings involves designing and constructing buildings with appropriate water resistant building materials to reduce flood damage. This solution reduces damage to the building structure but in most cases does not protect building contents. In this situation, flood proofing will need to be retro fitted to existing buildings or included as a development control.

Due to the predominant house type of timber in Quirindi, and relatively low house prices, flood proofing is not considered a floodplain management measure.

7.1.3 Voluntary Purchase of High Hazard Properties

To avoid the economic and social expenses of flooding in high hazard areas, it may be viable for Council to purchase flood affected properties at an equitable price, where voluntarily offered. The property should then be rezoned to a flood compatible use, such as open space. This will have little impact on reducing flood hazards but will reduce annual flood damage to the affected properties. Voluntary Purchase will likely impact the Councils rates base. It furthermore could impact the long term sustainability of the town, which is often not desirable.

Voluntary Purchase is considered an attractive option for Quirindi for selected properties. As with house raising, it could be implemented in a step-wise manner over a longer time-frame, and would thus not present a single upfront cost to Council.

House raising attracts two-thirds funding from State Government, with the balance of funding provided by Council. The property value would be based on a determination by the State Valuer.



7.2 Response Modification

Response modification measures are reactions to flooding that reduces potential social, economic and environmental damages from flooding. While response modifications will reduce the risk to life, they will not prevent floods entering Quirindi. Thus they will not address all the social impacts and reduce damages associated with flooding.

7.2.1 Flood Warning Systems, Evacuation Plans, and Public Flood Awareness

Flood warning systems and evacuation plans are used to prepare a community for an impending flood. Depending on warning time and resources available, flood warning systems and evacuation plans can be used to protect buildings, evacuate people, provide relief to evacuees and recover the flood affected areas. In 2008, the SES developed the Liverpool Plains Shire Local Flood Plan (SES 2008), a sub-plan of the Liverpool Plains Shire Local Disaster Plan (DISPLAN).

The flash flooding nature (see 2.5.1) and quick arrival time of the flood hydrograph at Quirindi provides a little warning time to implement flood evacuation plans. Nevertheless flood warning systems suitable to Quirindi should be investigated, in conjunction with police, SES, and other flood authorities.

A public awareness scheme will assist in raising flood awareness and readiness, and increase the appreciation of the flood problem and prevention activities. Implementation of a flood awareness scheme will also assist in minimizing the social and economic impacts of flooding at Quirindi. Measures to increase flood awareness could include:

- ▶ The dissemination of a Flood Information Pack that could be sent to all owners, business operators and residents of potential flood impacted properties;
- ▶ The dissemination of flood certificates on a regular basis which would inform each property owner of the flood situation at their particular property, flood data and advice (this information should be provided in a range of different languages); and
- ▶ Signage in flood prone areas giving notification of potential and historic flood levels, for example along the new creek walkway.

A public flood awareness scheme should be developed for the Quirindi residents.

Evacuation planning is critical for the flood affected area, in particular from the Henry, Pryor, Rose Street area. In this regard it may be advantageous to consider designating and formalising Henry Street to the east as an evacuation route.

Flood warning and evacuation should be planned for Quirindi, in particular to focus on the areas which are quickly isolated by rising flood waters. In addition, a formalised evacuation route along Henry Street to the east should be explored. Any plan for the safe evacuation of residents during a flood event should be prepared in conjunction with police, SES, and other flood authorities. This plan should also be integrated with the Liverpool Plains Shire Local Flood Plan (SES 2008), which would need to be updated.



7.2.2 Flood Insurance and Recovery

Insuring properties against flooding is a method of transferring the financial flood risk to the insurer. There is limited benefit in this flood risk management option because insurance does not mitigate flooding. Therefore, issues of community disruption, property values, flood hazards and safety remain.

Flood insurance can also be difficult to purchase as many insurance companies are unwilling to insure against floods. In addition the insurance premiums are likely to be excessive for properties in high hazard areas.

Flood Insurance is not considered a viable option for Quirindi.

7.3 Flood Modification

Flood modification measures are those that alter the flood conditions to reduce the flood hazard or change the flood behaviour. Flood modification is generally the only measures that will minimise both the social impacts and the risk to property and life, by designing mitigation measures, which provide a design level of service. These mitigation measures would prevent floods from entering specific areas in town. However, it is often not viable to design for the PMF (the upper envelope of floods) and thus there is always a residual risk associated with floods occurring that exceed the design level of service.

7.3.1 Flood Mitigating Dams or Detention Basins

Flood mitigation dams and detention basins attenuate the peak discharge in a storm by temporarily storing the stormwater and discharging it a slower rate.

The flood hydrographs in Quirindi and Jacob & Joseph creeks (Figure 3) have a flood volume of 30.4 GL and 14.2 GL respectively. A detention basin of 1.5 m depth, which is customary from a safety perspective, would require a surface area of approximately 5.5 km by 5.5 km to store this volume. However it is estimated that the basin would be able to release approximately 300 m³/s, to prevent inundation. Notwithstanding, this would still require a significant area to store the flood and any release structure would require careful design.

On the basis of the magnitude of the floods, flood detention basins are not considered a viable option for Quirindi.

7.3.2 Levees and Berms to Divert Flow

The purpose of levees is to mitigate flooding and associated economic and social consequences of flooding, by preventing floodwaters from entering areas of the town. Of all the previously discussed management measures, a flood levee can provide the best protection against property damage, economic and social impacts associated with flooding. For Quirindi, there is an opportunity to construct a levee around parts of the town to reduce the impact of flooding. However it will be important to ensure that no residents are adversely affected by the levee and flood is not increased outside of the levee area. In addition, consideration should be given to the following when deciding to build a levee:

- ▶ The level of flood protection sought for the town (from frequent floods to extreme floods);



- ▶ Extent of the levee (which houses are protected and which houses are not protected by the levee);
- ▶ Protection of future development areas;
- ▶ Impact of levee on local flood behaviour, in particular with regard to impacts on adjacent land;
- ▶ Aesthetic impact of the levee;
- ▶ What happens when the levee is overtopped;
- ▶ Maintenance of the levee;
- ▶ Possible increases in flood hazard when the levee is overtopped;
- ▶ Environmental impact of levee;
- ▶ Emergency response when levee is overtopped; and
- ▶ Local drainage from behind the levee.

To investigate the impact of a levee, simulations were undertaken assuming the Milner Parade levee would be raised by 0.5m and 1.0m. The aim of this assessment was to determine the redistribution of flows across the Quirindi flood plain and to protect the properties in the vicinity of Henry Street, Milner Parade and Rose Street. Flood impact mapping is provided in Appendix E. Referring to Figure E.1 in the appendix, it is noted that even a small berm in the flood plain can result in considerable redistribution of flows. This has the effect of adversely affecting some residents while benefitting others, and is not considered an equitable outcome.

The Quirindi floodplain is subject to complex distribution, where floodwaters are diverted to flood runners and between Quirindi and Jacob & Joseph creek. As demonstrated, small diversion berms within the floodplain have the risk of raising flood inundation in other locations, which is not permissible. For this reason, it is considered that flood levees and berms are not considered a viable option, for Quirindi.

In isolated areas, it may be advantageous to raise local flood immunity by local embankments. An example is the area around the sewage pumping station at Whittaker Street. It must however be noted that the community has raised concerns regarding local flood effects that may raise the risk of flooding to their properties, and such initiatives should be supported by detailed flood impact assessments.

7.3.3 Flood Conveyance

Flood conveyance would focus on matters which maintain the conveyance of flood waters in their current status or improve them. Typical conveyance improvements could relate to:

- ▶ Flood bypass channels;
- ▶ Improving conveyance associated with structures in the floodplain;
- ▶ Maintaining waterways and managing vegetation;
- ▶ Minimising risk of obstructions to the flood conveyance such as by new structures in the flow path; and
- ▶ Managing backwater effects up the stormwaters system.



As with levees and berms, conveyance must be treated with caution, since the upstream improvement of conveyance could disadvantage residents downstream who may have increased flood levels.

Given the high degree of flood inundation in Quirindi, and the existing flood runners, additional flood bypass channels are not considered viable. In addition, the increased conveyance associated with bridge structures would likely result in flood problems being transferred downstream. These two options are thus not considered viable.

Minimising risk of obstructions to the flood conveyance and managing backwater effects in the stormwater system should be examined as these are issues raised by the community, particularly in relation to the new pedestrian bridge upstream of Whittaker Street and the stormwater system in this location. In terms of the pedestrian bridge upstream of Whittaker Street, it may be important to consider the risk of the collapse of this bridge and potentially resulting in blockages to the Whittaker Street bridge waterway openings.

To investigate the impact of sedimentation, simulations were undertaken assuming the bed levels in Quirindi and Jacob & Joseph creek are raised by 0.5 m. The aim of this assessment was to determine the redistribution of flows across the Quirindi flood plain that may occur with increased sedimentation and vegetation. Flood impact mapping is provided in Appendix E. Referring to Figure E.2 and Figure E.3 in the appendix, the following is noted:

- ▶ Sedimentation in the channel has a more pronounced effect during more frequent flooding, such as the 5-year ARI event shown in Figure E.2. Here a 0.5m increase in sediment accumulation in the creeks, could raise flood levels by around 150 mm near the creeks; and
- ▶ In a 100-year event the large flood volume would diminish the effect of sedimentation in the creek channels, resulting in only minor increases in flood levels.

Given that sedimentation and vegetation could impact future inundation, management of this aspect is considered a viable option.



8. Review and Assessment of Floodplain Management Measures

8.1 Costing of Floodplain Management Options

From the above discussion, the following were identified as plausible options for Quirindi:

- ▶ Do nothing;
- ▶ House raising;
- ▶ Voluntary purchase of high hazard properties;
- ▶ Flood warning system, evacuation plans and public flood awareness scheme; and
- ▶ Flood conveyance, in particular management of sedimentation, vegetation and flow obstructions.

A note on costs:

The preliminary cost estimates presented in this report have been developed for the purposes of comparing options and may be used for preliminary budgeting. They are not to be used for any other purpose. The scope and quality of the works has not been fully defined and therefore the estimates are not warranted by GHD. These estimates are typically developed based on cost curves, budget quotes for some equipment items, extrapolation of recent similar project pricing and GHD experience. A functional design is recommended for budget setting purposes.

8.1.1 Base Case (Do Nothing)

There is no present cost associated with doing nothing, nor is there any future benefit. Flood damage is a future cost of doing nothing, and is estimated in Section 6. All floodplain management measures are assessed against the “do nothing” flood damage cost, where the benefits of the option are measured as the difference between “do nothing” damages, and the damages estimated for the option.

$$B = C_E - C_F$$

Where:

B = Benefits of the floodplain management measure being assessed;

C_E = Cost of existing “Do Nothing” flood damages; and

C_F = Cost of future floodplain management measure flood damages.

8.1.2 Voluntary Purchase of High Hazard Properties

High hazard properties are those that are exposed to floodwaters with significant depth or velocity. In accordance with the Floodplain Development Manual (2005), high hazard floodwaters are defined in accordance with Figure L2 of the manual.

Including negotiation fees, legal fees, survey and demolition, the cost of purchasing existing residential properties in Quirindi for removal has been estimated as approximately \$180,000 each. This was based on the recent 6 year median sale prices (RPDATA.COM) of \$161,500.



Voluntary purchase generally attracts two-thirds funding from State Government, with the balance of funding provided by Council. The property value would be based on a determination by the State Valuer.

From Figure D.6 in Appendix D, 13 houses are identified as likely candidates for voluntary purchase, as follows:

- ▶ Properties along Gurton and Fortune Street, located between the creeks. These properties have excessive damage costs associated and become isolated in larger events. Evacuation of residents is a problem, in historic floods these residents were evacuated across the railway bridge; and
- ▶ Properties along Fitzroy, Blairmont and Fortune streets.

The cost to purchase these properties would be approximately \$2.5 million.

The flood damage curve was revised, assuming the high hazard properties were purchased and no longer contribute to flood damages. The NPV reduction in flood damage was estimated at \$2.1 million. The cost benefit ratio for this option is thus 0.82.

[Cost benefit ratios greater than 1, mean that the savings in damages are greater than the cost of the option. Ratios less than 1 mean that the savings in damages are less than the cost of the option. The latter is common in floodplain management situations, and thus options with cost benefit ratios closest to 1 are generally more favourable from an economic perspective]

8.1.3 Voluntary House Raising

The estimated cost of house raising depends on the following factors:

- ▶ Existing building type (timber, slab-on-ground, brick);
- ▶ Depth of flooding;
- ▶ Access to the house after raising;
- ▶ Car parking after raising; and
- ▶ Whether or not the house has an attached garage.

Although house raising generally elevates the floor level to above the 100-year ARI flood plus an allowance of 0.5m freeboard, the property is still subject to damage from the 1% AEP flood. Flooding below the floor level is of greater concern for raised houses than for low set houses if residents store possessions at ground level underneath the house floor and are unable to relocate these possessions before floodwaters arrive. The typical cost for raising a house is approximately \$100 000. House raising often attracts incentive funding from State Government, with the balance of funding provided by the home owner. In some instances, Councils waiver DA fees to assist house owners who wish to proceed with the raising of houses. An important consideration is that house raising will not mitigate flood risk entirely, since the effects of a flood of greater magnitude than the design flood (potentially up to the PMF) could still result in risk and damage.

A key advantage of house raising is that it supports the long-term sustainability of the Quirindi community, and while short term disruption may occur, the town can remain sustainable in the



future. In addition, house raising can occur in a step by step manner as funding becomes available, and houses with greater risk of inundation can be raised first.

Identifying houses to be raised in an equitable manner is often a challenge. Options to identify properties could be on the basis of:

- ▶ Whether properties are in a floodway or high flood hazard location within the floodplain;
- ▶ Whether properties are inundated to a particular depth; and
- ▶ Whether properties are inundated in a particular event.

Each of these methods have advantages and disadvantages. For this study it has been assumed that all properties inundated in a 100-year ARI event will be eligible for incentive funding from the State Government.

From Figure F.1 in Appendix F 145 houses are identified as likely candidates for raising, taking into consideration those 13 houses identified for purchase. The price to raise these houses would be approximately \$14.5 million.

The flood damage curve was revised, assuming the 145 houses had been raised above the 100-year ARI flood levels plus 0.5 m freeboard. The NPV reduction in flood damage was estimated at \$9.8 million, in consideration that there would still be a damage costs, associated with a raised house, since residents store items under the houses. The cost benefit ratio for this option is thus 0.67.

8.1.4 Flood Warning System, Evacuation Plans and Public Flood Awareness Scheme

As part of this study, the SES have requested to undertake a feasibility study to provide a flood warning system for Quirindi. This flood warning system could be a basic system such as the Bureau of Meteorology free flood warning service communicated by internet, radio and television, and possibly supported by sirens and loudspeakers in flood prone areas. More complex warning systems could comprise a number of options such as pluvio-rainfall gauges and/or river gauges. These systems could be linked to the existing Council telemetry system and provide flood warning. A feasibility study into appropriate flood warning systems has been estimated at \$15,000. Depending on the type of warning system the capital cost could be as much as \$50,000, with ongoing annual maintenance cost of up to \$10,000.

The preparation of a flood warning and evacuation plan can be assumed at around \$25,000, plus Council administration and updating the plan every few years (assumed at an average of \$2,000 per annum). This flood warning and evacuation plan needs to be disseminated to residents and should prioritise those areas of the floodplain which have a high risk of being isolated and inundated. These areas should include all parts of the floodplain potentially inundated in event up to the PMF. Any flood warning and evacuation plan for the safe evacuation of residents during a flood event should be prepared in conjunction with police, SES, and other flood authorities. The plan would address amongst other matters, the collapse of the railings on the Pryor Street bridge and cricket oval fence during a flood, evacuation routes, priority areas for evacuation and trigger levels for initiating evacuation.

A public flood awareness scheme is more effective where residents have an understanding of flood risk and have the benefit of an awareness scheme. For the purpose of this study it is estimated that the scheme would cost approximately \$20,000 to implement and \$4,000 per



annum to maintain. The awareness scheme could comprise regular community updates and signage to raise awareness. For example placement of notice boards along the new Quirindi Creek walkway, demonstrating historic flood levels would be a good way of raising awareness. A public flood awareness scheme will assist the public prepare for flooding and reduce the potential flood damages. If residents are prepared for a flood and have procedures for protecting their assets, damages to furniture and belongings can be reduced.

From Section 2.4 it is noted that most of the bridges that cross Jacob & Joseph creek are inundated in more frequent events, while those that cross Quirindi Creek are generally above the 100-year ARI flood level. While parts of Henry Street would be inundated, due to the flood runners, Henry Street in an easterly direction could thus be a good option for evacuation of the Rose Street, Milner Parade and Pryor Street surrounds. It may thus be an option to dedicate Henry Street eastwards as a primary evacuation route from this area. Access to hospitals could be in Murrurundi and Tamworth via Wallabadah, and the TAFE could be used as a muster area. Dedication as an evacuation route could include signage, public awareness and should form part of the flood warning and evacuation plan.

To simulate the effect of these schemes, parameters in the Depth-Damage calculation were modified to have a high level of flood awareness and increased effective warning time. This could have the effect of reducing damage costs in the depth-damage curve. However, for Quirindi, the anticipated savings in flood damage by having increased awareness is negligible since flood arrival times are rapid, and houses are mostly single story. The benefit of awareness should thus not be measured in terms of damage costs, but rather in terms of evacuation, response and safety to residents.

8.1.5 Flood Conveyance (in particular management of sedimentation, vegetation and flow obstructions)

The issue of sedimentation and vegetation build-up in the creek has been noted by the community and the Floodplain Management Committee on a number of occasions. This is thus a 'front of mind' matter for the Quirindi community.

Vegetation management would need to investigate 'introduced' vegetation, and mitigation would need to be done in a way that does not result in degradation of the creeks from an ecological and geomorphological perspective. In addition the works would need to be considered under the Water Management Act. Key mitigation tasks would:

- ▶ Undertake a geomorphological review of the bank conditions;
- ▶ Ecological review to determine 'introduced' and native vegetation;
- ▶ Flood review to interpret flood assessment;
- ▶ Determine what is suitable vegetation and planting density; and
- ▶ Formulation of a Vegetation Management Plan.

The preparation of the above information for Quirindi is estimated at \$100 000. Depending on the findings, the rehabilitation of the immediate riparian zone (banks and 20m buffer) could be approximately \$6000/ha. Assuming the lengths of Jacob & Joseph and Quirindi creeks, between Young Street and Henry Street are rehabilitate, the costs could be approximately \$100 000.



The flood damage curve was revised, assuming 0.5m of sediment would be deposited in Quirindi and Jacob & Joseph Creeks, raising bed levels. The NPV increase in flood damage was estimated at \$0.7 million. The cost benefit ratio for this option is thus 3.6.

Minimising risk of obstructions to the flood conveyance and managing backwater effects up the stormwater system have been raised by the community, particularly in relation to the new pedestrian bridge upstream of Whittaker Street and the stormwater systems in this location.

For the pedestrian bridge, the opportunity to structurally enhance the new bridge should be investigated, in order to identify options which would lessen the risk of the bridge collapsing in a flood event and blocking the Whittaker Street bridge waterway.

In the case of the stormwater backup, flood gates could be provided at relevant locations, to prevent backup of floodwaters through the stormwater system in time of flooding.

8.2 Assessment of Options

Options were assessed by considering social/environmental issues, economic and financial costs and overall cost benefit of the option. Key issues considered are listed in Table 9. Intangible Social and Environmental issues were rated with a score of 1 to 5 (where 5 is the most preferred outcome). A weighting (Table 10) was applied to the issue and multiplied against the rating.

The assessment of options is provided in Table 11. From the table, the following is noted:

- ▶ The outcome of the social and environmental ranking scores shows that the voluntary house raising option has the most desirable social and environmental outcome, mostly due to the level of protection and benefit to the long-term community sustainability. Flood preparedness and evacuation planning together with addressing the sedimentation and vegetation in the creek is ranked next favourably. Voluntary Purchase is less desirable considering the long-term community of Quirindi, and the disruption to the residents whose properties are being voluntarily purchased. The local works (which includes the Whittaker Street pump station, pedestrian footbridge and stormwater backup) scores slightly lower, since this only benefits the immediate local area;
- ▶ The outcome of the economic assessment shows that the house raising and voluntary purchase options would be the most expensive options. Flood warning and public awareness together with addressing the sedimentation and vegetation in the creeks is considerably less costly than the house raising and voluntary purchase options. The local works option is the cheapest ; and
- ▶ The benefit-cost ranking shows that addressing the sedimentation and vegetation of the creeks provides the best cost benefit, with potentially considerable long term benefit. The cost benefit of the voluntary purchase is better than house raising, as once the properties are purchased and demolished, no residual damages remain. Flood Warning and Public Awareness and the formalised evacuation route along Henry Street have not been shown as they do not provide a damage reduction.



Table 9 Social, Economic and Environmental Issues for Assessing Options

Category	Issues
Social	<p>The capacity of the option to reduce flood hazards and personal safety risks to the community,</p> <p>How the option will influence property values;</p> <p>The capacity of the option to promote community growth; and</p> <p>The level of disruption to the community, either through implementing the option or through the resulting floodplain behaviour.</p>
Economic and Financial	<p>The capital costs associated with implementing the option;</p> <p>The ongoing or maintenance costs of the option; and</p> <p>The costs or savings of flood damage after the option is implemented.</p>
Environmental	<p>Change to ecology, habitats, riparian vegetation, and the “natural state” of the river;</p> <p>Pollution;</p> <p>Energy and resources required to implement the option</p> <p>Energy and resources required for maintaining and decommissioning the option.</p>

Table 10 Intangible Weightings

Intangible Issue	Weighting
<i>Social</i>	
Flood hazard reduction	10
Flood risk reduction	20
Long term community disruption	5
Community sustainability	15
Amenity	10
Short term community disruption	5
Stress, anxiety and health impacts	15
Increase in property values	10
<i>Environmental</i>	
Environmental impact to implement	5
Environmental impact to maintain	5
TOTAL	100



Table 11 Assessment of Options

Issues	Intangible weightings	Options					
		Do nothing	Voluntary House Raising	Voluntary Purchase	Flood Preparedness & Evacuation	Address sedimentation and vegetation	Local Works
Social							
Flood hazard reduction	10	3	3	3	3	4	4
Flood risk reduction	20	1	4	4	4	4	3
Long term community disruption	5	1	4	2	3	3	1
Community sustainability	15	2	5	2	4	3	1
Amenity	10	1	4	2	3	3	1
Short term community disruption	5	5	2	2	3	2	3
Stress, anxiety and health impacts	15	1	4	2	3	2	3
Property values	10	1	4	2	3	3	3
Environmental							
Environmental impact associated with implementation	5	3	3	2	3	2	3
Environmental impact associated with maintenance	5	3	3	3	3	2	3
Intangible Score	100	35%	77%	51%	67%	60%	50%
Rank		6	1	4	2	3	5
Economic							
<i>Costs</i>							
Present Value Capital Costs			\$14.5M	\$2,5M	\$0.2M	\$0.2M	\$90k
Rank (Cheapest)		1	6	5	4	3	2
<i>Benefits</i>							
Present Value Damage Savings			\$ 9.8M	\$ 2,1M		\$0.7M	
Benefit/ Cost Ratio			0.67	0.82		3.59	
Rank			3	2		1	



8.3 Summary

Considering the assessment of the options, it is considered that a combination of voluntary purchase and voluntary house raising is the most desirable option for the village of Quirindi.

These options:

- ▶ Promotes the long-term community sustainability;
- ▶ Can be implemented in a step-wise manner, focussing on acquiring and raising the most severely affected houses first;
- ▶ Can be implemented over a longer time frame, and thus Council could put a plan in progress, supported by a budget. It therefore does not present a single significant upfront cost; and
- ▶ Offers a level of protection to the community reducing overall damage costs.

This option should be supported by

- ▶ Implementation of land use planning limits and controls associated with flooding, to manage flood risk across Quirindi;
- ▶ Assess and implement a flood warning system, evacuation plans and public flood awareness scheme, for events up to and including the PMF. This could entail designating Henry Street in a easterly direction as an evacuation route;
- ▶ Undertake assessments to manage sedimentation and vegetation in the creeks; and
- ▶ On a local scale, investigate the Whittaker Street footbridge, provide further flood immunity to the Whittaker Street pump station and investigate options to prevent backup of flooding in the stormwater system.



9. Floodplain Risk Management Plan

9.1 Plan Objectives

The key objectives of this plan are addressing existing, future and continuing flooding associated with Quirindi Creek and tributaries and to reduce the social and economic impact of flooding to occupiers of flood prone lands.

9.2 Plan Location

This plan applies to the town of Quirindi generally between south of Allnutt Street in the vicinity of Young Street and shortly downstream of the Whittaker Street bridge. It does not cover the rural areas beyond the Quirindi town.

9.3 Flooding History and Risk

Major storms occurred in 1955, 1971, 1984 and 2000 and it would appear that the February 1955 flood equated approximately to the 100-year ARI event. Significant flooding occurred during these events, and numerous houses were inundated. There is thus a high risk of flooding at Quirindi.

9.4 Floodplain Management Measures

In accordance with the NSW Government Floodplain Development Manual (2005), risk management measures were assessed on the basis of three categories, namely property modification, response modification and flood modification. Under these categories the following measures were identified as options for Quirindi.

9.4.1 Land Use Planning

Land use planning limits and controls are an essential element in managing flood risk and the most effective way of ensuring future flood risk is managed appropriately. Planning not to develop land within high flood hazard or land that has the potential to impact flood behaviours in other areas is a valuable long-term solution.

9.4.2 Voluntary House Raising

House raising is a voluntary structural solution to lift buildings above the flood planning level to avert damage to buildings, improve personal safety and reduce stress and post-flood trauma. House raising is a popular solution to flooding in rural areas. House raising is considered an attractive option for Quirindi as it would promote the long-term sustainability of the town. In addition it could be implemented in a step-wise manner over a longer time-frame, and would thus not present a single upfront cost. House raising often attracts incentive funding from State Government, with the balance of funding provided by the home owner.



9.4.3 Voluntary Purchase of High Hazard Properties

To avoid the economic and social expenses of flooding in high hazard areas, it may be viable for Council to purchase flood affected properties at an equitable price, where voluntarily offered. The property should then be rezoned to a flood compatible use, such as open space. Voluntary Purchase is considered an attractive option for Quirindi for selected properties. As with house raising, it could be implemented in a step-wise manner over a longer time-frame, and would thus not present a single upfront cost to Council.

9.4.4 Flood Warning Systems, Evacuation Plans, and Public Flood Awareness

Flood warning systems and evacuation plans are used to prepare a community for an impending flood. Depending on warning time and resources available, flood warning systems and evacuation plans can be used to protect buildings, evacuate people, provide relief to evacuees and recover the flood affected areas. The flash flooding nature and quick arrival time of the flood hydrograph at Quirindi provides little warning time to implement flood evacuation plans. Nevertheless flood warning systems suitable to Quirindi should be investigated, in conjunction with police, SES, and other flood authorities.

A public awareness scheme will assist in raising flood awareness and readiness, and increase the appreciation of the flood problem and prevention activities. Implementation of a flood awareness scheme will also assist in minimizing the social and economic impacts of flooding at Quirindi.

Evacuation planning is critical for the flood affected area, in particular from the Henry, Pryor, Rose Street area. In this regard it may be advantageous to consider designating and formalising Henry Street to the east as an evacuation route.

9.4.5 Levees and Berms to Divert Flow

The Quirindi floodplain is subject to complex distribution, where floodwaters are diverted to flood runners and between Quirindi and Jacob & Joseph creek. Small diversion berms within the floodplain have the risk of raising flood inundation in other locations, which is not permissible. For this reason, it is considered that flood levees and berms are not considered a viable option, for Quirindi. In isolated areas, it may be advantageous to raise local flood immunity by local embankments. An example is the area around the sewage pumping station at Whittaker Street. It must however be noted that the community has raised concerns regarding local flood effects that may raise the risk of flooding to their properties, and such initiatives should be supported by detailed flood impact assessments.

9.4.6 Flood Conveyance

Flood conveyance would focus on matters which maintain the conveyance of flood waters in their current status or improve them. As with levees and berms, conveyance must be treated with caution, since the upstream improvement of conveyance could disadvantage residents downstream who may have increased flood levels.

Minimising risk of obstructions to the flood conveyance and managing backwater effects in the stormwater system should be examined as these are issues raised by the community, particularly in relation to the new pedestrian bridge upstream of Whittaker Street and the



stormwater system in this location. In terms of the pedestrian bridge upstream of Whittaker Street, it may be important to consider the risk of the collapse of this bridge and potentially resulting in blockages to the Whitaker Street bridge waterway openings. In addition, a number of local works have been identified which are recommended to be implemented.

Sedimentation and vegetation has been an important factor throughout the study, highlighted by the community. Since this could impact future inundation and flooding, management of this aspect is recommended.

9.5 Floodplain Risk Management Plan

The floodplain risk management plan has been provided in Table 12, with actions and dwellings shown on the plan in Appendix F. Some of these options may not be eligible for State Government funding.

In discussing the plan in the Floodplain Management Committee meeting of 5/10/2011, it was agreed that the Floodplain Management Committee remain convened and meet every 4 months to oversee the implementation of this Floodplain Management Plan. This action has been included in the plan below.

Table 12 Floodplain Risk Management Plan

Action	Priority	Indicative Budget	Cost Benefit
Nominate 13 dwellings for voluntary purchase	High	\$2.1M	0.82
Nominate 145 dwellings inundated in a 100-year ARI event for voluntary house raising	High	\$14.5M	0.67
Implement land use planning limits and controls associated with flooding, to managing flood risk across Quirindi	High	na	na
Undertake a feasibility investigation into an appropriate flood warning system for Quirindi	High	\$15k	na
Install flood warning system as determined by the feasibility study and communicate to the public	Medium	Up to approx. \$50k plus \$10/ann	na
Prepare a flood warning and evacuation plan for Quirindi and communicate to the community. Develop a public awareness scheme for Quirindi and implement. Formalise Henry Street as a designated evacuation route.	High	\$80k \$4/ann	na
Undertake a geomorphological and ecological assessment of Quirindi and Jacob/Joseph Creeks and formulate a Vegetation Management Plan. Thereafter Undertake creek rehabilitation on the basis of the Vegetation Management Plan.	High	\$200k	na
The Floodplain Management Committee is to remain convened and meet every 4 months to oversee the implementation of this plan	High	na	na
Local Flood Works:			



Action	Priority	Indicative Budget	Cost Benefit
<ul style="list-style-type: none">Investigate opportunities to raise the levee around the sewer pump station near Whittaker Street, by undertaking a flood impact assessment	Low	\$30k	na
<ul style="list-style-type: none">Investigate options to structurally enhance the new footbridge upstream of the Whittaker Street bridge	Low	\$30k	
<ul style="list-style-type: none">Provide flood gates at key stormwater outlets to prevent backwater flooding in the vicinity of Whittaker Street	High	\$30k	



10. Summary and Conclusions

- ▶ Quirindi Creek confluences with Jacob and Joseph Creek, downstream of Gurton Street and upstream of Whitaker Street. During large flood events, the two creeks have the potential to surcharge and flood a significant portion of town located on the floodplain. Major storms occurred in 1955, 1971, 1984 and 2000 and it would appear that the February 1955 flood equated approximately to the 100-year ARI event. It was noted at the time to be the largest flood “in living memory”. Significant flooding occurred during these events, and numerous houses were inundated.
- ▶ Flood map produced as part of the Quirindi Creek Flood Study (Lyll & Associates Consulting Engineers, 2005) show that there are significant areas of high hazard flooding throughout the floodplain. From a review of the Quirindi Creek Flood Study it was concluded that the study provide the best currently available estimates of flood levels at Quirindi. However, the model should be simulated with the updated survey information for the Milner Parade levee;
- ▶ A number of community consultation activities have been undertaken, to introduce the project and to advise residents and key stakeholders of investigations. Regular meetings were held with the Flood Plain Management Committee and community/stakeholder events were well attended;
- ▶ A socio-economic analysis was undertaken of Quirindi, and social and economic effects of flooding are investigated. The Annual Average Damage is estimated at \$1.5 million. Over a 20-year period, this has a net present value of \$17.5 million;
- ▶ Floodplain Management Measures are discussed under the categories of property modification, response modification and flood modification. A number of measures were found to be applicable to Quirindi;
- ▶ Social, environmental, capital cost and cost benefit were considered for a number of flood plain management measures, and an assessment of options was undertaken. The assessment found that after considering the results of the social and environmental ranking, capital cost and the economic assessment, a combination of voluntary purchase and house raising was the preferred solution. This option should be supported by landuse planning across Quirindi, a flood warning system, evacuation plans and public flood awareness scheme, flood conveyance assessments, in particular management of sedimentation and vegetation and investigation of the impacts of the Whittaker Street footbridge, formalising Henry Street as an evacuation route in a easterly direction and providing flood immunity by preventing floodwaters from backing up the stormwater systems;
- ▶ Considering the assessment of the options, it is considered that a combination of voluntary purchase and voluntary house raising is the most desirable option for the village of Quirindi. This option:
 - Promotes the long-term community sustainability;
 - Can be implemented in a step-wise manner, focussing on acquiring and raising the most severely affected houses first;



- Can be implemented over a longer time frame, and thus Council could put a plan in progress, supported by a budget. It therefore does not present a single significant upfront cost to Council; and
 - Offers a level of protection to the community reducing overall damage costs.
- ▶ A Floodplain Risk Management Plan has been prepared nominating key actions and prioritising these actions.



11. References

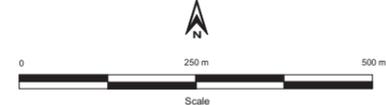
- ▶ Australian Bureau of Statistics, 2006, Population and Housing Census. Australian Bureau of Statistics;
- ▶ L&A 2005, Quirindi Creek Flood Study, Lyall & Associates Consulting Engineers, 2005;
- ▶ SES, 2008, Liverpool Plains Shire Local Flood Plan, a sub-plan of the Liverpool Plains Shire Local Disaster Plan (DISPLAN);
- ▶ NSW Government, 2005, Floodplain Development Manual, Management of Flood Liable Land;
- ▶ NSW DECC 2007, Practical Consideration of Climate Change, NSW Department of Environment & Climate Change;
- ▶ AR&R, Australian Rainfall and Runoff, 2001;



Appendix A
Flood Study Information from L&A 2005



NOTE
 THE EXTENTS OF INUNDATION SHOWN WERE DETERMINED FROM SURVEYED CROSS SECTIONS OF THE CREEK AND FLOODPLAIN AND AVAILABLE DATA AND ARE APPROXIMATE ONLY. THE EXTENT OF INUNDATION OF INDIVIDUAL ALLOTMENTS NEAR THE FLOOD FRINGE SHOULD BE CONFIRMED BY SITE SPECIFIC SURVEY.



LEGEND

	5 YEAR ARI EXTENT
	ADDITIONAL AREA INUNDATED BY 100 YEAR ARI
	ADDITIONAL AREA INUNDATED BY PMF

PEAK FLOOD LEVELS

	PMF
	100 YEAR ARI
	5 YEAR ARI

SURVEYED CROSS SECTION

QUIRINDI CREEK FLOOD STUDY
 Figure 6.7
 EXTENTS OF FLOODING
 5 and 100 year ARI and PMF



JACOB and JOSEPH CREEK

THIS AREA SUBJECT TO INUNDATION AT 5 YEAR ARI FLOOD
 DEPRIVED OF FLOODWAY/FLOOD STORAGE
 AREAS NOT POSSIBLE DUE TO ABSENCE
 OF SURVEY DATA

YOUNG STREET

Flood Runner 1

MILLER PARADE

QUIRINDI CREEK

AUSTINS BRIDGE

OVERLAND FLOW

HENRY STREET

FORTUNE STREET

CURTON STREET

LODER STREET

FRYOR STREET

POLLACK STREET

Flood Runner 2

BOWLING CLUB

-1

0

1

2

3

4

5

7

6

8

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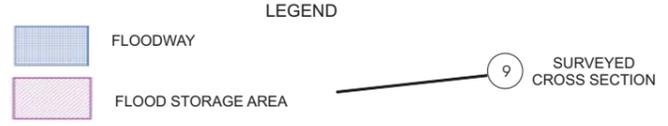
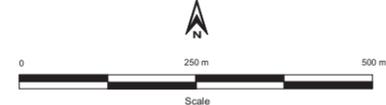
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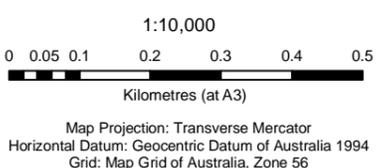
14



QUIRINDI CREEK FLOOD STUDY
 Figure B.1
 100 Year ARI
 HYDRAULIC CATEGORISATION



Appendix B
GHD Further Flood Study Assessment
Mapping



Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

100yr ARI UPDATED Milner Parade Berm (Flood Level Change (mm))

- less than 200mm
- -200 - -100 mm
- -100 - -50mm
- -50 - 50 mm
- 50 - 100mm
- greater than 100 mm

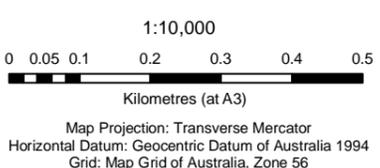
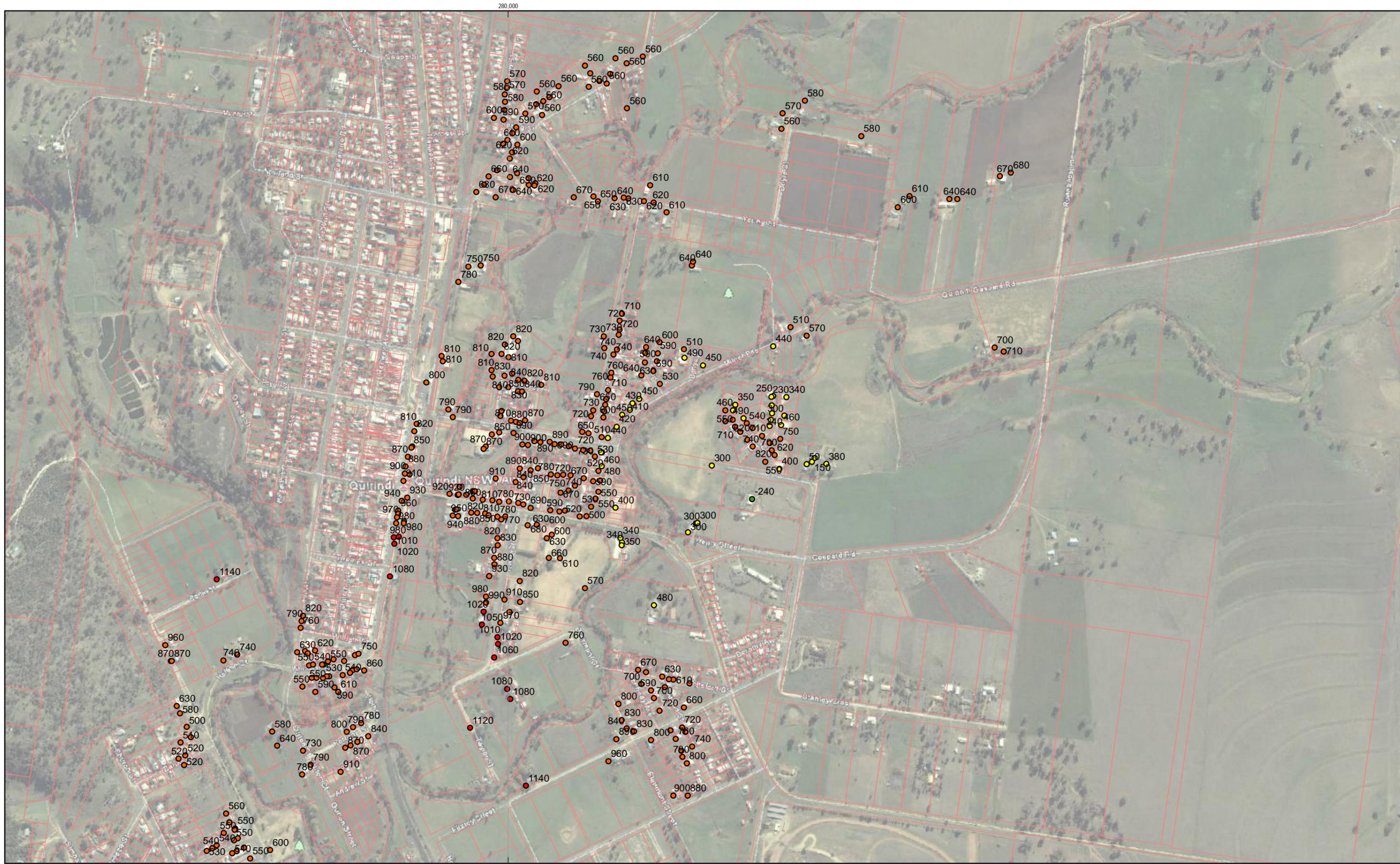


Liverpool Plains Shire Council
Quirindi Floodplain Management Study

Job Number | 22-15085
Revision | A
Date | 07-06-2011

Figure B.1 - Milner Parade Berm Assessment

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Data source: Data Custodian, Data Set Name/Title, Version/Date. Created by: C Pappin



- 100yr ARI Climate Change (Flood Level Change (mm))**
- less than 250mm
 - -250mm - -200mm
 - -200mm - 0
 - 0 - 500mm
 - 500mm - 1m
 - more than 1m



Liverpool Plains Shire Council
Quirindi Floodplain Management Study

Job Number | 22-15085
Revision | A
Date | 10-10-2011

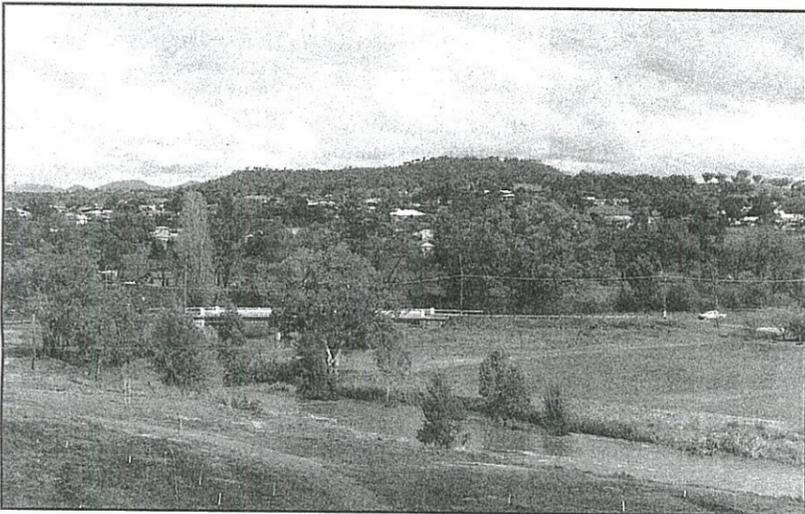
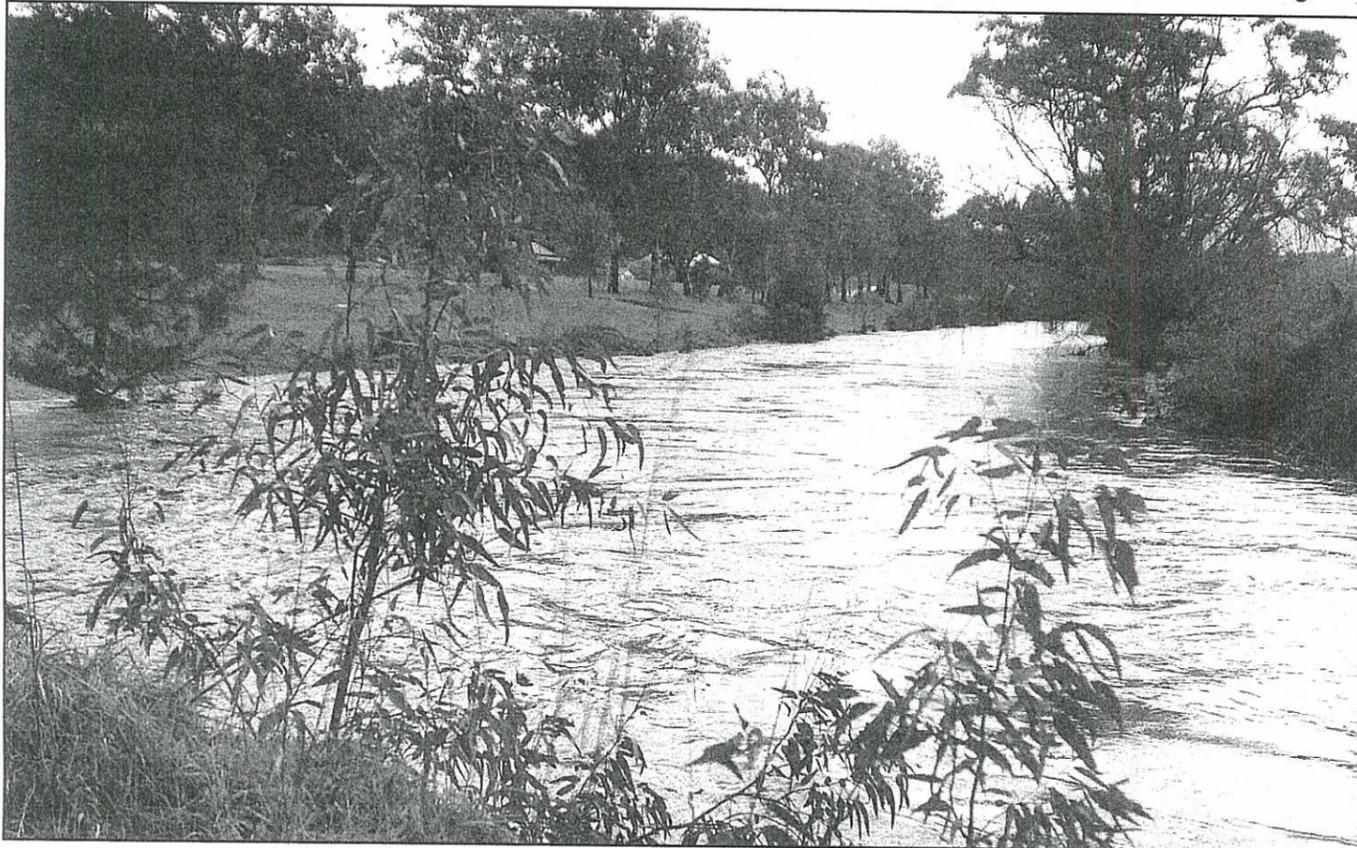
Figure B.2 - Climate Change Assessment

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Appendix C
Community Consultation Information

Floodplain Management Study for Quirindi



Recent rains saw flooding in rivers, creeks and causeways around the district leaving some locals stranded and unable to get in and out of their properties.

Above and left: Water was flowing rapidly under the Whittaker St bridge and through Roselea Park in Quirindi.

Pictures by Sally Alden.

Floodplain Risk Management Study, which includes community consultation and a number of environmental and engineering investigations.

The first phase of the investigations involves reviewing the previous flood study and researching information on the flood levels and flood flows for Quirindi. As part of these investigations, GHD will be liaising with the local community to get an understanding of the history of flooding in the area, and undertaking a number of activities throughout Quirindi.

The project team is keen to learn when and where past flooding has occurred in Quirindi, how residents and properties were affected, and how people prepare for a flood. The team is also interested in getting an understanding of community feelings towards particular flood management options, such as building a levee or house-raising.

A number of activities are planned to seek the communities input. This includes a survey questionnaire, which will be distributed to Quirindi residents next week and a Community Information Session, where the

community will be able to get involved.

"We encourage the community to return the survey questionnaire and attend the Community Information Session (planned for early September) so they can meet the study team, find out more about the project and provide historical information about past flooding in Quirindi," Mr van Katwyk said.

Mr van Katwyk said that a Floodplain Management Committee (FMC) had been formed to assist the project team with the investigations. The group will meet regularly and is an important way in which the community can provide input into the development of the project. To know more about the FMC, residents can call the project's community information line on freecall 1800 810 680.

To register your interest in attending the Community Information Session, or to find out more about the Floodplain Risk Management Study, please call the community information line 1800 810 680, email: communityinput@ghd.com.au, or visit the Council website: www.lpsc.nsw.gov.au

Liverpool Plains Shire Council Director of Environmental Services has invited Quirindi residents to get involved in Council's study into local flooding.

"Council is currently undertaking a Floodplain Risk Management Study to determine and assess flood management options for Quirindi and its residents," Mr van Katwyk said.

GHD Pty Ltd (GHD) have been contracted by Council to carry out the

Murray-Darling tales

People with a connection to the Murray-Darling Basin are being asked to share memories and photos, for a new oral history project.

"Many different groups of people including fishers, indigenous communities, tourists and landholders have developed unique relationships with rivers and their associated environments," Industry & Investment NSW's Conservation Manager, Scott Nichols said.

"Accessing and recording this information will make a significant contribution to our knowledge of the Murray Darling Basin, and help shape the management decisions of the future to achieve improved river health outcomes."

If you have a story or photos you would like to share contact Scott Nichols on 02 8437 4909 or email scott.nichols@industry.nsw.gov.au

Complex rules catch irrigation operator

The Australian Competition and Consumer Commission (ACCC) has taken its first action to protect water trade markets, accepting legal undertakings from Murray Irrigation Limited (MIL) for breaches of the Water Charge (Termination Fees) Rules 2009.

MIL, an irrigation infrastructure operator servicing more than 2,400 farms in southern NSW, was found to have charged more than the legally permissible termination fees.

"These are complex and new rules and are an increasingly large part of the working environment for irrigator operators and therefore irrigators," Mr

Anthony Couroupis, General Manager of MIL told the Quirindi Advocate.

"We are working with the ACCC to correct an error in the calculation of one fee and the inappropriate levying of another," Mr Couroupis said.

From September 1, 2009, irrigation infrastructure operators may impose termination fees up to ten times the amount of the total network access charge payable by customers for the year they give notice of termination.

MIL did not consider a customer discount it had offered, in calculating the termination fee on 64 occasions and an

additional \$220 fee for the surrender of delivery entitlements in 112 instances.

MIL has issued refunds of over \$115,000 to affected customers and will issue further refunds for the \$220 fee.

ACCC chairman Graeme Samuel said, "The termination fee rules have been developed to balance the interests of irrigators who are exiting an irrigation district and irrigators who wish to remain."

"The ACCC is now actively monitoring compliance with these Rules and we will continue to take enforcement action where appropriate," Mr Samuel said.

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QUIRINDI TOWNSHIP AND SURROUNDING AREAS FLOODPLAIN RISK MANAGEMENT STUDY

COMMUNITY NEWSLETTER

No.1

August 2010

About the project

Quirindi is subject to wide spread flooding and inundation, as has been the case in previous major flood events. Major storms occurred in 1955, 1984 and 2000. It would appear that the 1955 and 1984 floods were approximately 60 to 70% of the estimated 1 in 100 year event predicted by the Average Recurrence Interval design.

Liverpool Plains Shire Council (Council) has engaged engineering and environmental consultants GHD Pty Ltd (GHD) to undertake a Floodplain Risk Management study to determine what mitigation measures, if any, could be considered for implementation to provide protection to the town.

Over the coming months, GHD will be investigating flooding in the town and will be compiling options for floodplain management.

Council and GHD are committed to listening to the concerns and issues of the community and stakeholders, and strategies are in place to ensure that this information is integrated into the study. Throughout the study there will be opportunities for the local community and stakeholders to provide feedback on their concerns and issues.

Floodplain Management Committee

A Floodplain Management Committee (FMC) has been formed as part of the Quirindi and Surrounding Areas Floodplain Risk Management Study.

The FMC will provide a link between the flood study team and the community throughout the various stages of the project. The FMC will meet throughout the course of the project.

Further information about the FMC can be obtained by calling the community information telephone number over the page.



Survey

Quirindi Floodplain Risk Management Study

Name: _____

Address: _____

Telephone: _____ Email: _____

Please include my details in the stakeholder database to receive further information on the project (Tick here)

1. How long have you lived (or did you live) in Quirindi? _____ Years _____ Months

2. Have you ever seen or experienced a flood while living in Quirindi? Yes No (Please tick)

3. If yes, in what years did the flood/s take place?

4. What affects did the flood have on you and your property?

5. How do you prepare for a flood?

6. To reduce the affects of flooding, do you believe Council should focus its efforts on:

- Encouraging residents to make property modifications (e.g. house-raising)
- Undertaking flood modifications (e.g. building a levee)
- Educating people about how to prepare for a flood
- All of the above

Other: _____

7. Are there any other issues you would like us to take into consideration?

Thank you for taking the time to complete this survey.

Your feedback is invaluable in assisting the project team develop flood management options for Quirindi.



Floodplain Risk Management and Quirindi Creek Floodplain Committee Meeting Minutes

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Thursday 6 August 2009 / 6.00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Todd	Cr Andrew Laurie
	Luke Scanlon	Ron Van Katwyk (Director Environmental Services)
	Robert Terry	Greg Tory (Director Works)
	Tony Carter	Merv Prendergast (Manager Health & Development)
	Neal Albert (DECC)	Frank Turner (SES)
	Andrew Galvin (SES)	Samantha Baines (minutes)
Apologies:	Andrew Faulkenmire (DECC)	Cr Colleen Wills
	Cr Col Stewart	

Minutes

Welcome	
1.	The meeting opened at 6.15pm. Mr Van Katwyk welcomed everyone and thanked them for attending.
Election of Chairperson	
2.	Mr Van Katwyk called for nominations to the position of Chairperson.
3.	Cr Laurie nominated Mr Carter and was seconded by Mr Turner.
4.	Mr Terry nominated Cr Stewart and was seconded by Mr Scanlon.
5.	A ballot was held with five votes for each nominee, so it was agreed to draw one nominee from a hat. Mr Carter was the successful candidate and was therefore elected Chairman.
Background briefing from the Director Environmental Services	
6.	Mr Van Katwyk explained briefly why a floodplain committee was necessary and how the information gathered from the committee would be used to advise Council and ultimately feed into the LEP and the DCP (being strategic planning tools for minimising adverse impacts of flooding).
7.	Mr Albert confirmed that there is some funding available for the second stage of the process – being the management stage.
Background briefing by Neal Albert (DECC) and outline of forthcoming tasks and direction	
8.	Mr Albert delivered a PowerPoint presentation and advised that the next step is to engage a consultant to assist in the preparation of the Management Plan.
9.	A discussion followed about whether to start with Quirindi township or whether to include the whole shire. The committee agreed to start with Quirindi as the Quirindi Creek Floodplain Study has already been completed and is a comprehensive document. Once Quirindi management plan is complete the committee will continue with other townships.
10.	Mr Albert advised that the same consultants who drafted the Floodplain Study need not be used for the management plan. A list of consultants is available. Action: Mr Albert to provide the list of consultants to Samantha to email to the committee.

Floodplain Risk Management and
Quirindi Creek Floodplain Committee
Meeting Minutes (Continued)

Background briefing by Neal Albert (DECC) and outline of forthcoming tasks and direction (continued)...	
11.	The tendering process was discussed and it was advised that if the cost of the management plan does not exceed \$150,000 then a tender is not necessary.
12.	Mr Tory suggested that quotations could be invited from five suitably qualified consultants and they would need to be provided with a detailed brief.
13.	Mr Albert advised that DECC has a standard brief that can be put forward and any issues specific to Quirindi can be included. Action: Mr Albert to provide the standard brief to Samantha to email to the committee.
14.	The Floodplain Development Manual and the Quirindi Creek Flood Study were discussed and it was agreed that all committee members should read both documents by the next meeting. Action: Samantha to post hard copies of both documents to all committee members.
Next meeting	
15.	It was proposed that meetings are held monthly on the first Wednesday of the month at 6pm.
16.	Next meeting: Wednesday 2 September 2009.

Meeting closed at 7.15pm.



Floodplain Risk Management and Quirindi Creek Floodplain Committee Meeting Minutes

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Wednesday 2 September 2009 / 6.00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter	Cr Andrew Laurie
	Luke Scanlon	Cr Col Stewart
	Robert Terry	Cr Colleen Wills
	Neal Albert (DECC)	Ron Van Katwyk (Director Environmental Services)
		Merv Prendergast (Manager Health & Development)
		Frank Turner (SES)
	Samantha Baines (minutes)	
Apologies:	Tony Todd	
Absent:	Andrew Galvin (SES), Greg Tory (Director Works)	

Minutes

Welcome and apologies	
1.	The meeting opened at 6.10pm. Mr Carter welcomed everyone and thanked them for attending.
Adoption of previous minutes	
2.	The minutes of the August meeting were adopted. Moved: Seconded:
Business arising from previous minutes	
3.	Nil.
Review of Floodplain Development Manual and Quirindi Creek Flood Study	
4.	Mr Prendergast explained that the information contained in the manual is quite technical and committee members are not expected to understand all of it – just the maps and the basic facts.
5.	Mr Laurie suggested that people in the community could contribute their knowledge to the whole process of developing the management plan and should be consulted.
6.	Mr Prendergast agreed and explained that the Study is a computer model and needs to be ground tested. The document should be exhibited for public submission.
Discussion on Consultancy Agreement	
7.	The Agreement was discussed and it was agreed that Mr Prendergast and Mr Albert would polish up the document and submit it to the committee prior to the next meeting for review.
8.	It was suggested to seek Expressions of Interest from the five consultants on the list provided by Mr Albert and then narrow it down to two consultants to give a presentation. The consultants should be asked for an estimated completion time as some of them will be unable to complete the work within our requirements.

Floodplain Risk Management and
Quirindi Creek Floodplain Committee
Meeting Minutes (Continued)

Discussion on project timeline	
9.	<p>The timeline was discussed and it was agreed to aim for a total project length of two years. Stages of the project will include: EOI, preparation, selection, (Christmas holidays), draft report to committee, exhibition, revision, completion.</p> <p>Motion: Prepare a consultants brief and send it to five consultants seeking quotations – Cr Stewart.</p> <p>Second: Cr Wills.</p>
10.	<p>A discussion was held regarding the cost of the project and whether it should be a tender or quotation. It was advised that a tender is necessary for projects over \$150,000 and as the budget for the floodplain project is less than \$100,000 then a quotation will be acceptable.</p>
Identification of ancillary and existing flood related reports	
11.	<p>The following flood related reports were identified:</p> <ul style="list-style-type: none">- Murrurundi, Blandford and Willow Tree Floodplain Management Study- Warrah Creek Draft Floodplain Management Plan- Blackville Floodplain Management Plan- Upper Coxs Creek Floodplain Management Plan- Caroon Breeza Floodplain Management Plan- Upper Yarraman Creek Floodplain Management Plan- Coeypolly Dambreak Study 1998
12.	<p>It was agreed to get the Quirindi Management Plan underway before applying for funding for other urban areas.</p>
Correspondence received	
13.	<p>Funding received totals \$63,000 on a two-for-one basis. So LPSC will contribute \$31,500 to the project bringing total budget to \$94,500 for this financial year.</p>
General business with prior notice	
14.	<p>Nil.</p>
Next meeting	
15.	<p>Next meeting: Wednesday 7 October 2009.</p>

Meeting closed at 7.03pm.

Floodplain Risk Management and
Quirindi Creek Floodplain Committee
Meeting Minutes (Continued)

Review of Consultancy Agreement	
4.	<p>Page 3 – Clause 1.2 – Change Murrurundi Ranges to Liverpool Ranges.</p> <p>Page 4 – 2nd paragraph; Study Area. Change Green Crescent to Eastside Estate and add “of similar level or lower”.</p> <p>Page 4 – Clause 3.1 – Point 6 delete last part.</p> <p>Page 5 – Under Specific Issues identify Council assets including pump stations and Sewer Treatment Works in first dot point.</p> <p>Page 5 – Change Green Crescent to “Eastside Estate and areas of similar level or lower” - 3rd dot point.</p> <p>Page 5 – Add a dot point “Assess information contained in Annexure A & B of the LPSC Flood Plan”.</p> <p>Page 5 – Add a dot point “Examine sensitivity impact in change of vegetation and siltation of creeks causing shallowing of creeks”.</p> <p>Page 7 – Add a diamond point referring to the redrafting of Annexures A & B of the LPSC Flood Plan”.</p> <p>Page 7 – Under deliverables add PMF</p> <p>Page 8 – Section 8.1 – Stage 3 – Add “and interim report for Eastside Estate”</p> <p>Page 22 – Change Department of Lands to LPSC and again on pages 29 and 32.</p>
5.	<p>Discussion</p> <ol style="list-style-type: none">1. Community Consultation and timeframes. Chairman and Mr Albert explained that it is part of brief and formal documentation.2. Draft Consultant Brief. <p>Action: Mr Van Katwyk to ensure that latest version of the draft brief is distributed to committee members with maximum notice so that suggested changes can be considered at the next meeting in anticipation of obtaining quotations as soon as possible.</p>
Next meeting	
6.	Next meeting: Wednesday 11 th November 2009.

Meeting closed at 7.03pm.

Floodplain Risk Management and
Quirindi Creek Floodplain Committee
Meeting Minutes (Continued)

Correspondence received	
5.	Mr Van Katwyk advised that LPSC has applied for the Floodplain Management Grant Program 2010/11. The application is for \$20,000 on a 2 dollar to 1 dollar basis.
General Business with prior notice	
6.	The chairman announced that early in the New Year the committee will be advising the community of what progress is being made and what has been achieved to date.
7.	The committee has commenced sourcing photographic material from previous floods.
8.	The committee should prepare a list of people knowledgeable on the subject of flooding in Quirindi so that the consultant's interview process can be facilitated.
Next meeting	
9.	Next meeting: Wednesday 2 December 2009.

Meeting closed at 6.40pm.

Floodplain Risk Management and
Quirindi Creek Floodplain Committee
Meeting Minutes (Continued)

Review of Consultant's Brief (Continued)																					
6.	<p>Project Plan:</p> <table border="1"> <thead> <tr> <th style="text-align: left;">Date</th> <th style="text-align: left;">Action</th> </tr> </thead> <tbody> <tr> <td>9 Dec 2009</td> <td>Complete report with recommendation in accordance with item 5 above for presentation to Council meetings of 16 December 2009.</td> </tr> <tr> <td>18 Dec 2009</td> <td>Send out Consultant's Brief to the seven nominated consultants in line with Council's determination.</td> </tr> <tr> <td>19 Feb 2010</td> <td>EOI and Quotations close.</td> </tr> <tr> <td>22 Feb 2010</td> <td>Evaluate quotations and coordinate consultant presentations to committee members (if necessary).</td> </tr> <tr> <td>25 Feb 2010</td> <td>Conduct consultant presentations to committee members.</td> </tr> <tr> <td>1 Mar 2010</td> <td>Complete report on quotations received and consultant presentations and send out to committee members.</td> </tr> <tr> <td>10 Mar 2010</td> <td>Discuss / endorse recommendation in report for presentation to Council.</td> </tr> <tr> <td>11 Mar 2010</td> <td>Submit report to Council Committees business paper for next meeting. (Committees meeting on 17 March 2010 and March Ordinary Meeting on 24 March 2010).</td> </tr> <tr> <td>26 Mar 2010</td> <td>Formally advise successful consultant.</td> </tr> </tbody> </table>	Date	Action	9 Dec 2009	Complete report with recommendation in accordance with item 5 above for presentation to Council meetings of 16 December 2009.	18 Dec 2009	Send out Consultant's Brief to the seven nominated consultants in line with Council's determination.	19 Feb 2010	EOI and Quotations close.	22 Feb 2010	Evaluate quotations and coordinate consultant presentations to committee members (if necessary).	25 Feb 2010	Conduct consultant presentations to committee members.	1 Mar 2010	Complete report on quotations received and consultant presentations and send out to committee members.	10 Mar 2010	Discuss / endorse recommendation in report for presentation to Council.	11 Mar 2010	Submit report to Council Committees business paper for next meeting. (Committees meeting on 17 March 2010 and March Ordinary Meeting on 24 March 2010).	26 Mar 2010	Formally advise successful consultant.
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7.	<p>The committee asked to view the previous Consultant's Brief that was provided for EOI process for the Flood Study in 2005. Action: Samantha to see if previous brief is available.</p>																				
Correspondence received																					
8.	Nil																				
General Business with prior notice																					
9.	Nil																				
Next meeting																					
10.	Next meeting: Thursday 25 February 2010 – to be confirmed.																				

Meeting closed at 6.40pm.



Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To review the Consultant Presentations and select the Consultant for the Floodplain Risk Management Study and Plan.	
Date / Time:	Wednesday 3 March 2010 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Luke Scanlon	Cr Colleen Wills
	Tony Carter	Cr Andrew Laurie
	Frank Turner (SES)	Greg Tory (Director Works)
	Andrew Galvin (SES)	Ron Van Katwyk (Director Environmental Services)
		Merv Prendergast (Manager Health & Development)
Apologies:	Tony Todd, Neal Albert (DECC), Cr Col Stewart, Kathleen Cain (SES), Samantha Baines	
Absent:	Robert Terry, Andrew Faulkenmire (DECC)	

Minutes

Welcome and apologies	
1.	The meeting opened at 6.10pm. Mr Carter welcomed everyone and thanked them for attending. The apologies were read out and accepted. Moved: Cr Wills Seconded: Luke Scanlon Carried
Adoption of previous minutes	
2.	The minutes of the December 2009 meeting were adopted. Moved: Cr Wills Seconded: Luke Scanlon Carried
Business arising from previous minutes	
3.	Any additions to the list of people with knowledge of previous floods within the Shire should be forwarded to the Chairman.
Selection of Consultant to prepare the Floodplain Risk Management Study and Plan	
4.	The committee reviewed the report and made the following recommendation: That the draft recommendations prepared by the Director Environmental Services be presented to the March Council Meeting for adoption with the addition of the words “Department of Environment, Climate Change and Water Guidelines titled “SES Requirements from the FRM Process” dated 15 August 2007” to recommendation b). Moved: Cr Wills Seconded: Luke Scanlon Carried
Correspondence received	
5.	Three submissions from Consultants were received and distributed with the meeting agenda.
General Business with prior notice	
6.	Nil
Next meeting	
7.	Next meeting: Wednesday 7 April 2010.

Meeting closed at 6.50pm.

LIVERPOOL PLAINS SHIRE COUNCIL

REPORT TO ENVIRONMENTAL SERVICES COMMITTEE MEETING TO BE HELD ON WEDNESDAY 24TH MARCH 2010

DIRECTOR ENVIRONMENTAL SERVICES

REPORT NO: DES

SUBJECT: FLOODPLAIN RISK MANAGEMENT STUDY
AND PLAN CONSULTANT SELECTION

FILE NO: 13.6.1

BACKGROUND:

Following extensive analysis of the project parameters a Consultant Brief was finalised in December 2009 (attached as Appendix "A"). The brief was distributed to seven suitably qualified and experienced firms with an invitation to submit an expression of interest (EOI) for the work. By the cut-off date three of these firms had submitted EOIs and in turn all three were invited to make a formal presentation to Council's Floodplain Risk Management and Quirindi Creek Floodplain Committee.

ISSUES:

The Floodplain Risk Management and Quirindi Creek Floodplain Committee has undertaken an evaluation and review of both the submission and presentation in the case of all three prospective consultants with a view to finalising a recommendation for Council's consideration.

FINANCIAL CONSIDERATIONS:

A summary and overview of the three presentations is attached as Appendix "B" with only the Bewsher proposal being outside of Council's budget limitation of approximately \$120,000.

ENVIRONMENTAL CONSIDERATIONS:

Project will increase environmental knowledge and awareness.

LINKS TO STRATEGIC PLANS:

Management Plan Principal Objectives

"To develop strategies that facilitate growth and guide Council toward ecological sustainability through responsible management of both the natural and built environments. To be recognised as a leader in environmental management".

Strategic Plan – Planning and Economic Development

"Participate as an active partner in regional natural resource issues and projects such as water sharing, native vegetation, noxious weeds, catchment management and flood plain management".

Floodplain Risk Management Study and Plan Consultant Selection (Continued)

RECOMMENDATION

THAT:

- a) **Director Environmental Services Report No.???** be received and noted.
- b) **Council accept the project proposal of GHD Pty Ltd as outlined by Council's project brief (dated December 2009), the formal GHD Pty Ltd proposal document dated 19 February 2010 (attached as Appendix "C").**
- c) **Council delegate authority to the Mayor and General Manager to sign and affix the Common Seal to all relevant documents.**

**R S (Ron) Van Katwyk,
Director Environmental Services**

Floodplain Risk Management Study and Plan

Expression of Interest Overview Summary and Evaluation Form (Section 12 of Consultant Brief)

Section 12 Consideration	Bewsher	Cardno	GHD
Demonstrated level of understanding what is required to produce a quality outcome.	Comprehensive and professionally presented response to brief.	Comprehensive and professionally presented response to brief.	Comprehensive and professionally presented response to brief.
Value for money, including additional data costs compared to the benefits to be obtained.	2D model Upper fixed limit fee of \$136,100 (excl GST). Includes \$7,500 of additional survey and \$1,500 data acquisition from Lyall & Associates.	2D model Lump sum fee \$97,770 (excl GST).	3D terrain model Total upper limit fee \$88,700.
The quality of the Consultant's team in terms of demonstrated experience in the field. Of particular importance is the presence of sufficient depth of experience to cover the broad range of skills needed to prepare a relevant and achievable management plan.	In depth CVs provided.	In depth CVs provided.	In depth CVs provided.
The proposed methodology and depth of understanding that it is likely to produce.	Pages 18-39 of proposal.	Pages 12-20 of proposal.	Pages 4-16 of proposal.
The Consultant's current capacity and resources to work to the program as presented by the consultant.	Gant Chart provided in Table 4 (52 weeks) Section 2 of the proposal.	Gant Chart provided in Appendix B (64 weeks) Section 3 and Appendix C.	Gant Chart provided 1 March 2010 to 19 January 2011 (44 weeks) and Chapter 3 of proposal.
A program of consultation adequate to ensure the considered views of the Floodplain Risk Management Committee and all other interested parties are taken into account as part of the preparation of the management study and management plan.	Section 3 Part 2 pages 25-30.	Section 4.2 Part 4 pages 14-15.	Section 2.7 Part 2 pages 6-12.



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To review the site inspection observations and discuss future project timeline.	
Date / Time:	Tuesday 6 July 2010 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Luke Scanlon	Cr Colleen Wills
	Tony Carter	Cr Andrew Laurie
	Glenn Jones (SES)	Cr Col Stewart
	Tony Todd	Cr Ian Lobsey
	James McPherson (GHD)	Ron Van Katwyk (Director Environmental Services)
	Rainer Berg (GHD)	Merv Prendergast (Manager Health & Development)
	John Cowley	Tim Watts (Namoi CMA)
	Kay Devine	Bill Devine
	Neal Albert (DECCW)	Brooke Jacobs
	Gary Roworth	Owen Love
	Robert Terry	
Apologies:	Andrew Galvin (SES), Kathleen Cain (SES), Samantha Baines	
Absent:	Andrew Faulkenmire (DECC)	

Minutes

Welcome and apologies	
1.	The meeting opened at 4:10pm. Mr Carter welcomed everyone and thanked them for attending.
Adoption of previous minutes	
2.	To be adopted at next meeting.
Business arising from previous minutes	
3.	Nil
Correspondence received	
4.	Nil
General Business with prior notice	
5.	<p>- Review project timeline</p> <p>GHD Consultants gave a short presentation which:</p> <ul style="list-style-type: none"> • Promoted the need for community involvement and consultation. • Outlined the process of developing a Floodplain Risk Management Plan and Study. • Explained that GHD would not be revisiting the Flood Study but will use it to derive base data. GHD would spend some time satisfying themselves that the Flood Study is appropriate and extend it to suit if required. Once satisfied with the Flood Study, GHD will move on to developing the Floodplain Risk Management Plan and Study.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

5.	<ul style="list-style-type: none">• Discussed possible management options that could come from the study including property modifications, response modifications and flood modifications.• Explained that GHD will now spend some time working with flood models, modelling proposed measures, collecting and analysing data and reviewing options in respect to cost benefit analysis to then develop a report.• Envisaged that a draft of the report will be available by end of November/early December 2010, assuming that the Flood Study is usable.• Would like a survey distributed to the Quirindi public as well as media releases, advertising in the Mayoral Column as well as a television and/or radio advertising campaign. This would be to build awareness of the Floodplain Risk Management Plan and Study with view to then conduct public workshops and meetings. This should occur prior to the Draft Floodplain Risk Management Plan and Study being presented to the public. <p>The venue for the proposed community meetings was discussed. A final venue was not decided by the Committee. The Chairman is to decide the venue location closer to the time that the community meetings will be held.</p> <p>All contact to GHD from the committee should be through Ron Van Katwyk and Brooke Jacobs. The committee was encouraged to bring forward information and ideas. The general public are encouraged to utilise the 1800 number to provide GHD with any information and ideas they feel relevant.</p> <p>- Discussion of site inspection observations Not discussed.</p> <p>- Development of future meeting schedule</p> <p>Meetings to be held on the first Tuesday or Wednesday of each month at 6:00pm in the Council Chambers, however if there is no business to discuss then a meeting will not be held.</p>
Next meeting	
6.	Next meeting: Wednesday 4 August 2010, 6:00pm

Meeting closed at 5:30pm



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Wednesday 1 September 2010 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter	Cr Colleen Wills
	Luke Scanlon	Cr Col Stewart
	Rainer Berg (GHD)	Ron Van Katwyk (Director Environmental Services)
	James McPherson (GHD)	Merv Prendergast (Manager Health & Development)
	Andrew Galvin (SES)	Brooke Jacobs
	Frank Turner (SES)	John Cowley
	Ted Worboys	John McNamara
	Ken Worboys	Gary Roworth
Apologies:	Owen Love, Kathleen Cain (SES), Neal Albert (DECCW), Tim Watts (Namoi CMA), Tony Todd, Robert Terry.	
Absent:	Andrew Faulkenmire (DECCW), Dawn Cronin (QCC), Greg Tory, Bill and Kay Devine.	

Minutes

Welcome and apologies	
1.	<p>The meeting opened at 6:10pm. Mr Carter welcomed everyone and thanked them for attending.</p> <p>Apologises were accepted.</p> <p>Moved: Cr Col Stewart</p> <p>Seconded: Luke Scanlon</p>
Adoption of previous minutes	
2.	<p>Minutes from 6 July 2010 meeting accepted.</p> <p>Moved: Cr Colleen Wills</p> <p>Seconded: Luke Scanlon</p> <p>Minutes from 14 May 2010 Inception accepted.</p> <p>Moved: Cr Colleen Wills</p> <p>Seconded: Luke Scanlon</p>
Business arising from previous minutes	
3.	Nil

Floodplain Risk Management Committee
Meeting Minutes (Continued)

Correspondence received

4. Nil

General Business with prior notice

5. GHD addressed Committee:

- It was requested that Committee membership be finalised. Visitors to the meeting would be welcome to join the Committee, at the Committee and Council's discretion. This was required in order to progress the project without re-briefing new members.

[Action: Paperwork for joining the Committee to go to non Committee members in attendance at meeting. \(Brooke\)](#)

1. Results of Community Flood Survey.

- GHD issued a Memorandum (Appendix "A") summarising the preliminary results of the 51 surveys received as at 27 August 2010.
- It was decided to allow ongoing submission of the surveys.

2. Summary of Floodplain Management Study Progress.

GHD presented a PowerPoint presentation (Appendix "B") to the committee.

Within the presentation GHD provided:

- An overall progress summary as follows:
 - i. Inception Meeting - done
 - ii. Site Visit – done, but more intended
 - iii. Flood Model Review – 90% done, additional sensitivity simulations undertaken
 - iv. Data Collection Review Report - started
 - v. Community Involvement Plan – done & submitted
 - vi. Questionnaire Survey, Newsletter, Media – done, and being compiled
 - vii. Flood Damages – not started, need floor survey
- A summary of historic flooding
- A summary of their assessment of the Lyall and Associates flood Study for Quirindi

Within the presentation GHD discussed the data submitted by Lyall and Associates (Slides 4 – 12).

GHD:

- Are 90% through testing the models produced by Lyall and Associates.
- Have performed a sensitivity analysis on aspects of the modelling.
- Outlined some of the sensitivity assessments that they had put into the models, such as removing Whittaker Street Bridge, and the affects that these had.
- Feel that the models give comparable results to other methods.
- Are confident that estimates of how much water would come down in a flood are reasonable and sufficient.
- Explained about the "roughness factor" which reflects the landscapes vegetation and topography and how it had to be increased within the models to achieve the historical flood levels. Flooding in the area is quite sensitive to vegetation and it will potentially be a recommendation that riparian areas are kept clean.

General Business with prior notice (continued)

- Discussed silt levels and the roughness of the channels and their affect on flood levels.
- Believe that the Levy bank was included in the models.
- Require a survey of the overflow berm/levy to be performed.
- Require additional cross sections to be surveyed to cover some areas which are lacking information or are questionable including Green Crescent.
Action: GHD to create a brief for surveyors and obtain quotes.
- Assessed that the new LEP area appears to be adequately covered.
Action: Ron to confirm.
- Discussed the difficulty involved in predicting the affects of debris.
- Discussed the affect the timing of the two creeks has on the impact and magnitude of flooding and the difficulties involved in predicting this.

Action : GHD to provide Executive summary of Data Collection Review Report, once report is available.

3. Update of Floodplain Risk Management Plan and Study progress.

GHD outlined their progress on the second slide of the PowerPoint presentation (Appendix "B").

- A summary of Community Consultation activities, being the community announcements in the newspaper, community newsletter and survey.
- Provided a précis of the 51 responses received from the community to date
- Described the next steps being
 - i. Survey brief & survey
 - ii. Information Session and Agency focus group
 - iii. Flood damages calculations
 - iv. Options development

The progress was accepted.

Moved: Merv Prendergast

Seconded: Frank Turner

4. Confirmation of Progress Report prepared for submission to DECCW.

A Progress Report is submitted to DECCW each month from the Council and is created in conjunction with GHD.

The Progress Report for August 2010 (Appendix "C") was accepted.

Moved: Colleen Wills

Seconded: Merv Prendergast.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

Next meeting

6. Next meeting: Wednesday 13 October 2010, 6:00pm followed by a Public Meeting to be held at Quirindi RSL at 7:00pm.

Meeting closed at 7:35pm.



Memorandum

30 August 2010

To	Rainer Berg		
From	Michael Robertson	Tel	02 9239 7385
Subject	Preliminary Survey Results	Job no.	22/15085

Below is a summary of the feedback received to date from the Quirindi Flood Risk Management Study Community Survey. As of Friday 27 August 2010, GHD had received 51 completed surveys from local community members.

- Survey respondents have lived in Quirindi for various degrees of time from 1.5 years to 74 years. Respondents have lived in Quirindi for an average of 32 years.
- There was an even spread of male and female respondents, however judging by the length of time residents stated they have lived in Quirindi, the demographic of the respondents is heavily skewed to those aged over 55 years. The median age of Quirindi was 44 years at the 2006 census, which supports the age demographic survey results.
- 41 of the 51 residents who completed the survey had experienced a flooding event whilst living in the area. Those who had not been exposed to flooding had been living in the region for less than 10 years.
- Of those who have lived in Quirindi for more than 10 years, nearly all experienced the flooding event of 2000. The other most common floods mentioned by respondents occurred in 1955, 1971 and 1984. One resident claimed to recall floods that occurred in 1921 and 1941, while another commented that they experienced flooding as recently as August 2010.
- 32 of the 51 respondents described some sort of negative effect on their property as the result of flooding in the area. The most common property effects include:
 - Damage to fences, stables and sheds;
 - Floodwaters flowing into yards and under houses;
 - Forced movement of stock and vehicles to higher ground;
 - Deposit of mud and silt on property;
 - Soil erosion; and
 - Water flowing into respondents houses during earlier floods of 1955 and 1971.
- A non-direct property impact mentioned by respondents is the impact flooding has on local roads and crossings, resulting in people becoming isolated from population centres. Different instances of isolation lasting anywhere between a couple of hours to nearly a week were outlined in the surveys.
- 20 of the 51 respondents stated that they do not take any specific measures to prepare for a flood. The main reasons given for this include that respondents have not experienced flooding, have houses built on high ground or away from flood prone areas, or in one case feel it is not necessary to take precautions as a levee bank was put in place years ago.
- For those that do take preventative measures, the most commonly listed include:
 - Monitoring creek levels;
 - Moving stock and vehicles to higher ground;



- Raising equipment, furniture and other valuables off the ground;
 - Ensuring sufficient levels of food are stocked up; and
 - Ensuring that all drains around the property are cleared.
-
- When asked what Council should focus on to reduce the affects of flooding, more than 80% of respondents suggested Council should focus on multiple areas rather than one specific means to minimise flooding. Educating people how to prepare for a flood in conjunction with other means was the most common response followed by flood modifications and property modifications.
 - A general trend that emerged was that property modification was not a favourable option as it would not be feasible for a large majority of residents living in flood prone areas due to the high associated financial costs.
 - Survey respondents are divided on the subject of flood modifications, specifically levees. Half of the respondents who commented on levees were of the belief that they were beneficial in protecting properties from floodwaters, while the other half stated that the levees worsened the flooding for areas without this type of protection in place.
 - Other areas that residents suggested Council should focus their efforts on include clearing both Jacob and Joseph's creeks of any vegetation and debris to improve water flow and reduce the impacts of flooding at an early stage, the implementation of a creek monitoring and early warning system, and prohibiting or encouraging people not to build on the flood plain.
 - When asked to list any other issues to be taken into consideration the major issue (already discussed) concerned the amount of weeds, leaf litter and rubbish in local waterways. Residents perceive this to be a major issue and the most logical first step to minimising the negative impacts from flooding. Other issues mentioned include the importance of correctly sealing and grading roads, the potential for a specific high point in each locale and general interest in attending the September Community Information Sessions to find out more information and provide further feedback.



CLIENTS|PEOPLE|PERFORMANCE

Quirindi Floodplain Risk Management Study

Progress update to FRMC

01/09/2010

Progress Snapshot

- Inception Meeting - done
- Site Visit – done, but more intended
- Flood Model Review – 90% done, additional sensitivity simulations undertaken
- Data Collection Review Report - started
- Community Involvement Plan – done & submitted
- Questionnaire Survey, Newsletter, Media – done, and being compiled
- Flood Damages – not started, need floor survey



Flood History

- Major flooding Feb 1955, 1971, Jan 1984
- Feb 1955 largest “in living memory” up to that date
- Flood levels similar @ Confluence: 1984 >100mm 1955 and >200mm 1971
- Nov 2000 approx = 10yr event
- Jan 1984 approx = 50yr event

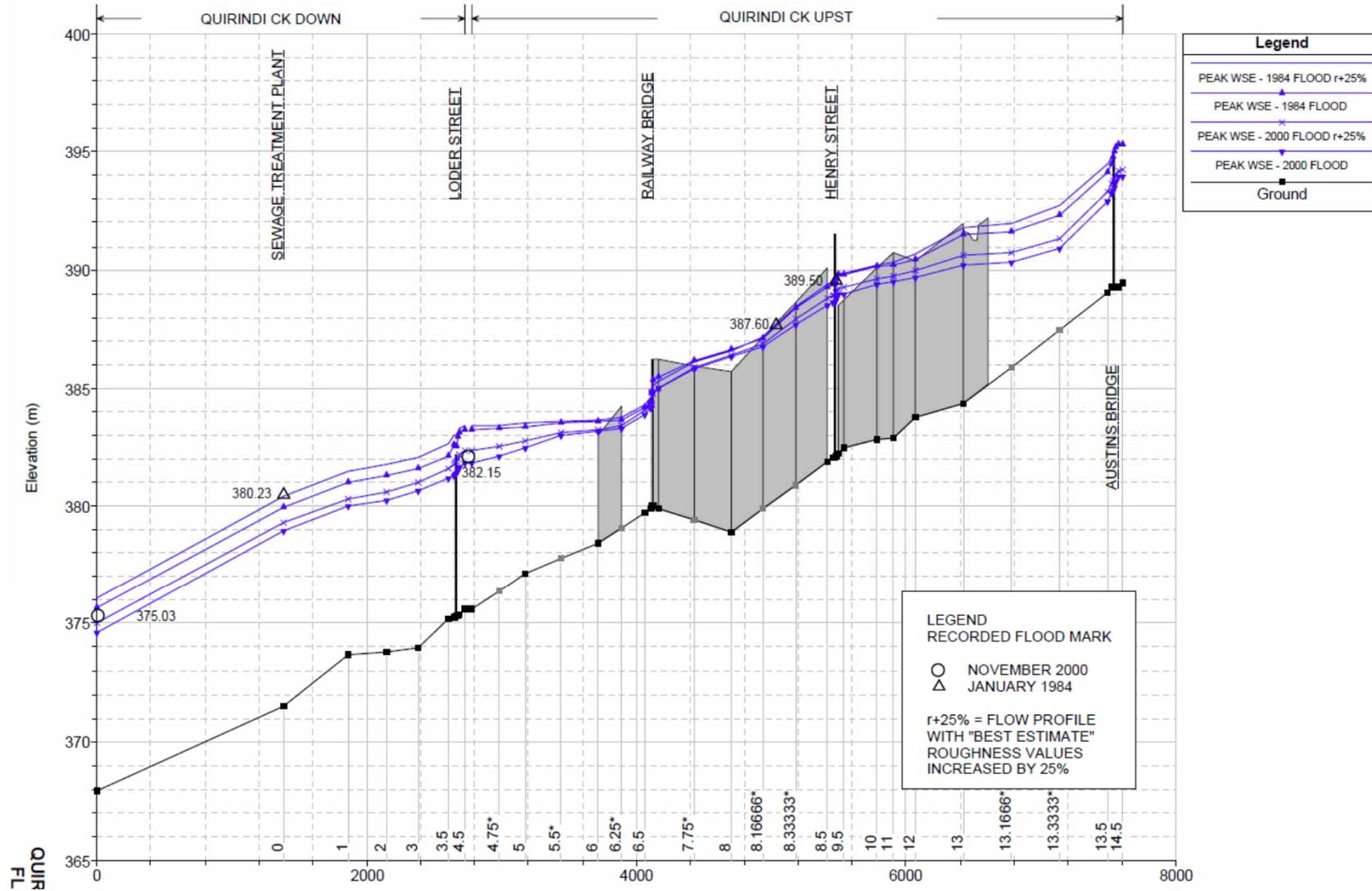


Calibration - Hydrology

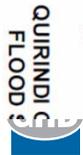
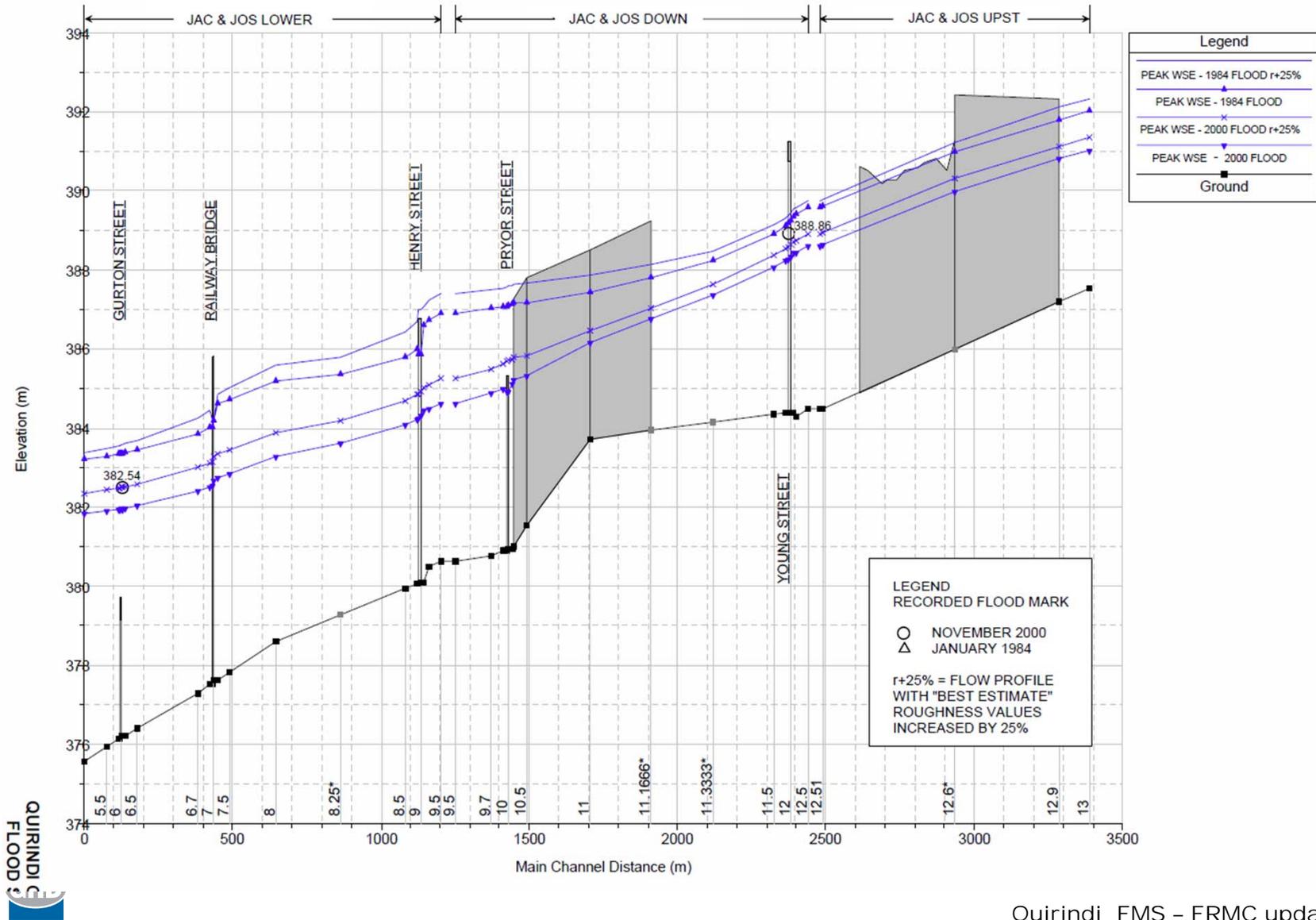
Method	5 yr ARI	10 yr ARI	50 yr ARI	100 yr ARI
Regional Flood Frequency	230	380	830	1018
Probabilistic Rational Method	179	256	582	811
RORB kc=20.7 (Equation 3.5)	252	355	845	1095
RORB kc=23.5 (Equation 3.6)	219	311	758	989
RORB kc=41.0 (Equation 3.4)	114	164	417	554



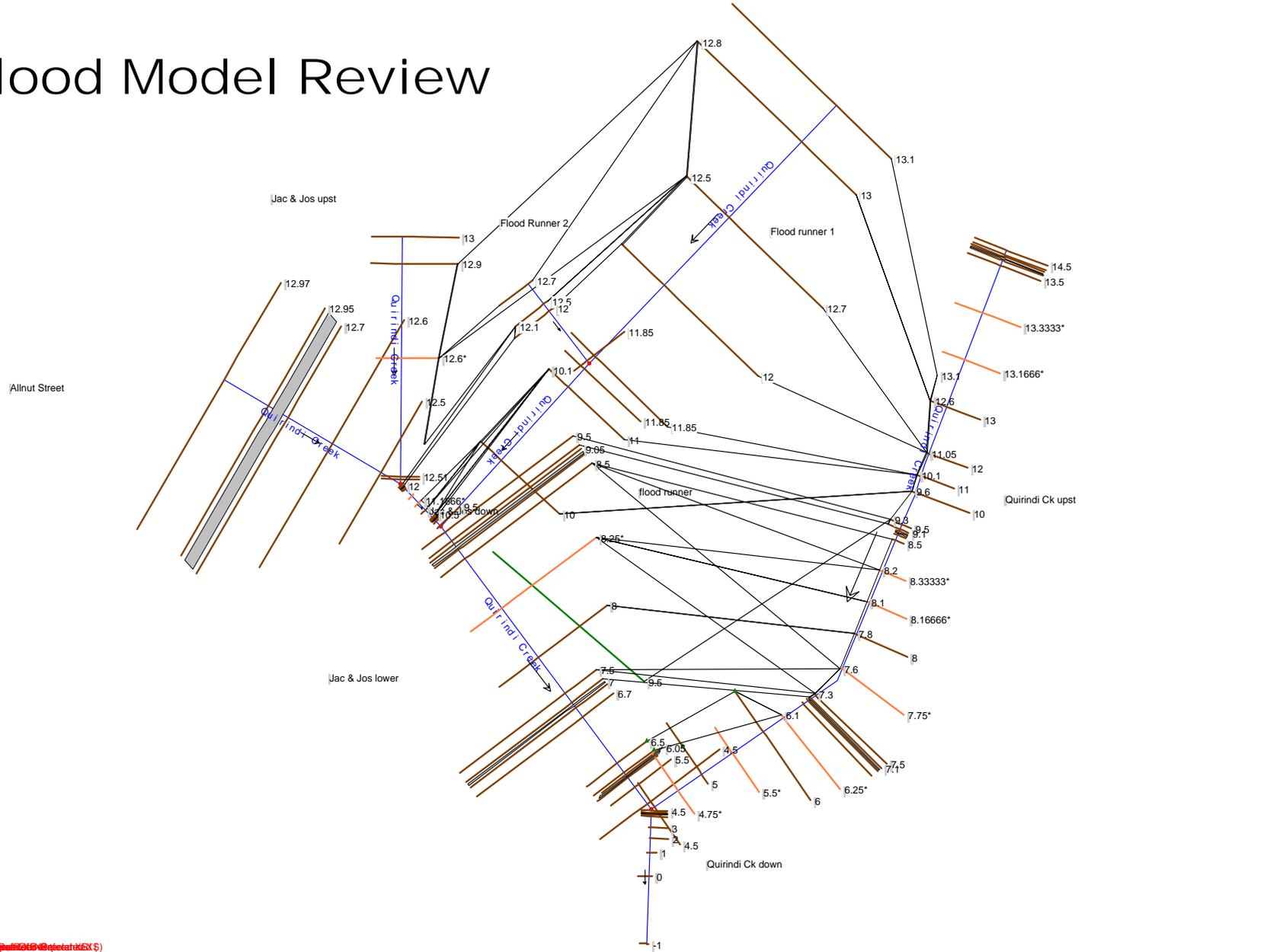
Calibration - Hydraulics



Calibration - Hydraulics



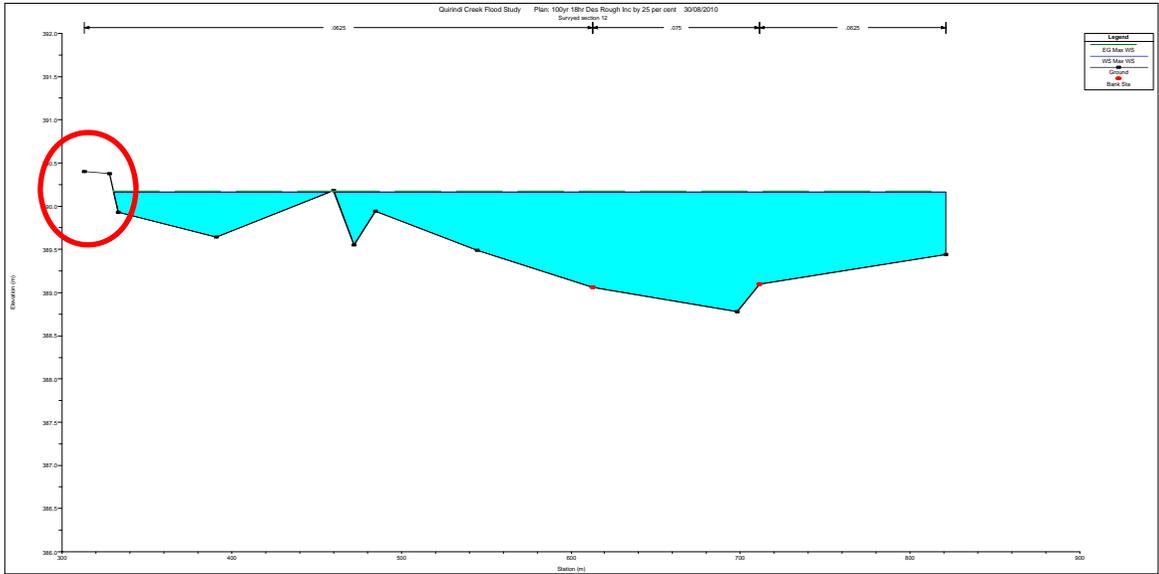
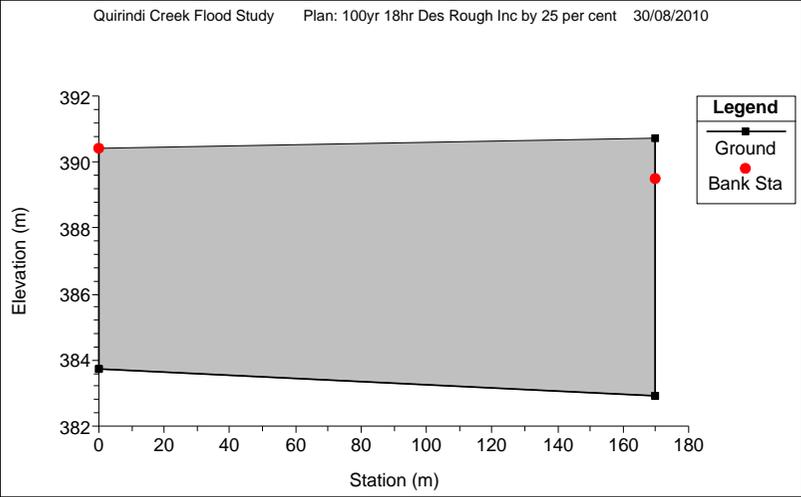
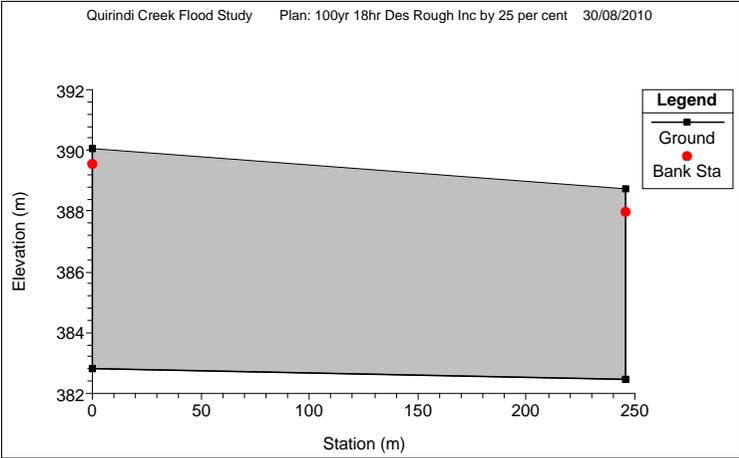
Flood Model Review



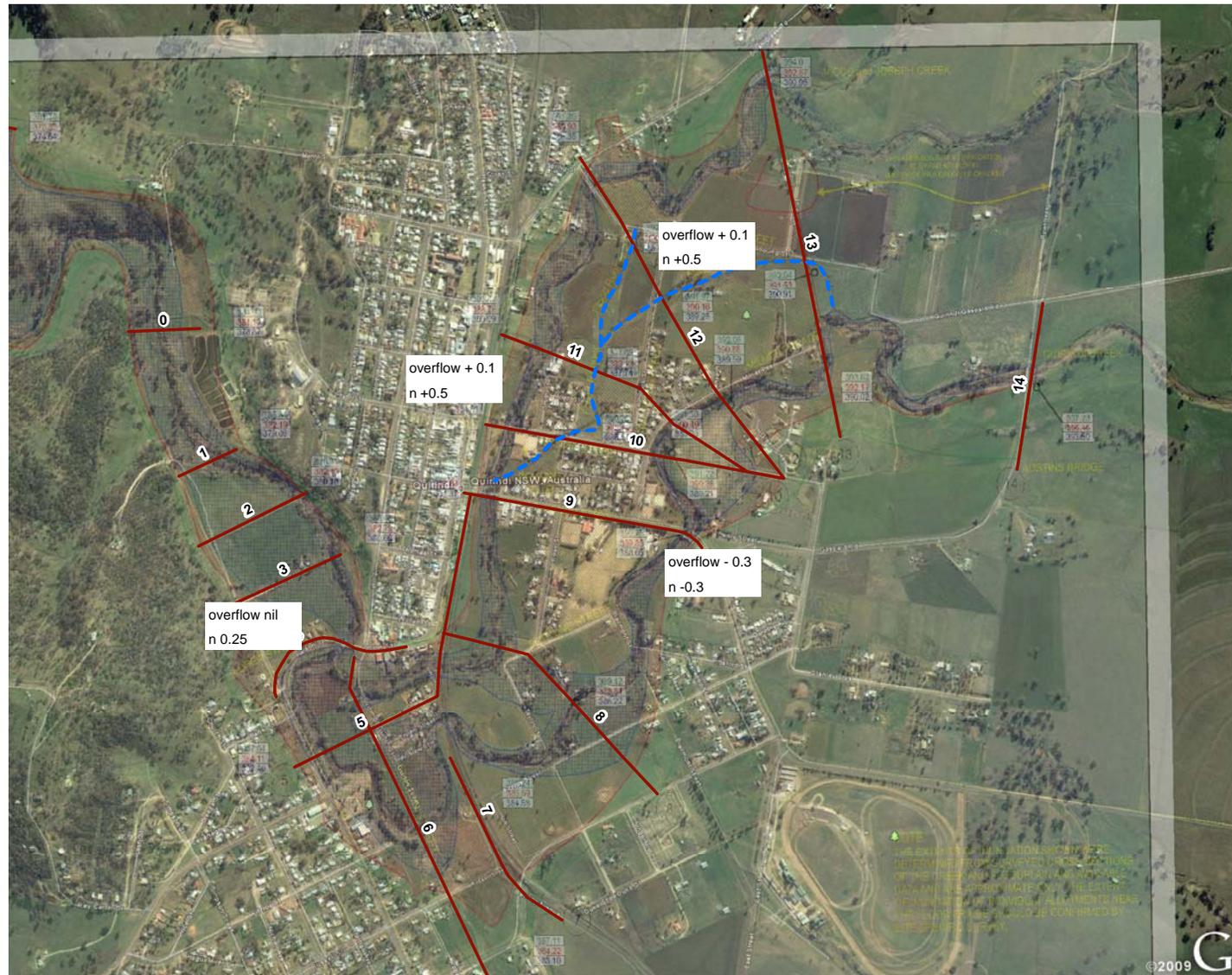
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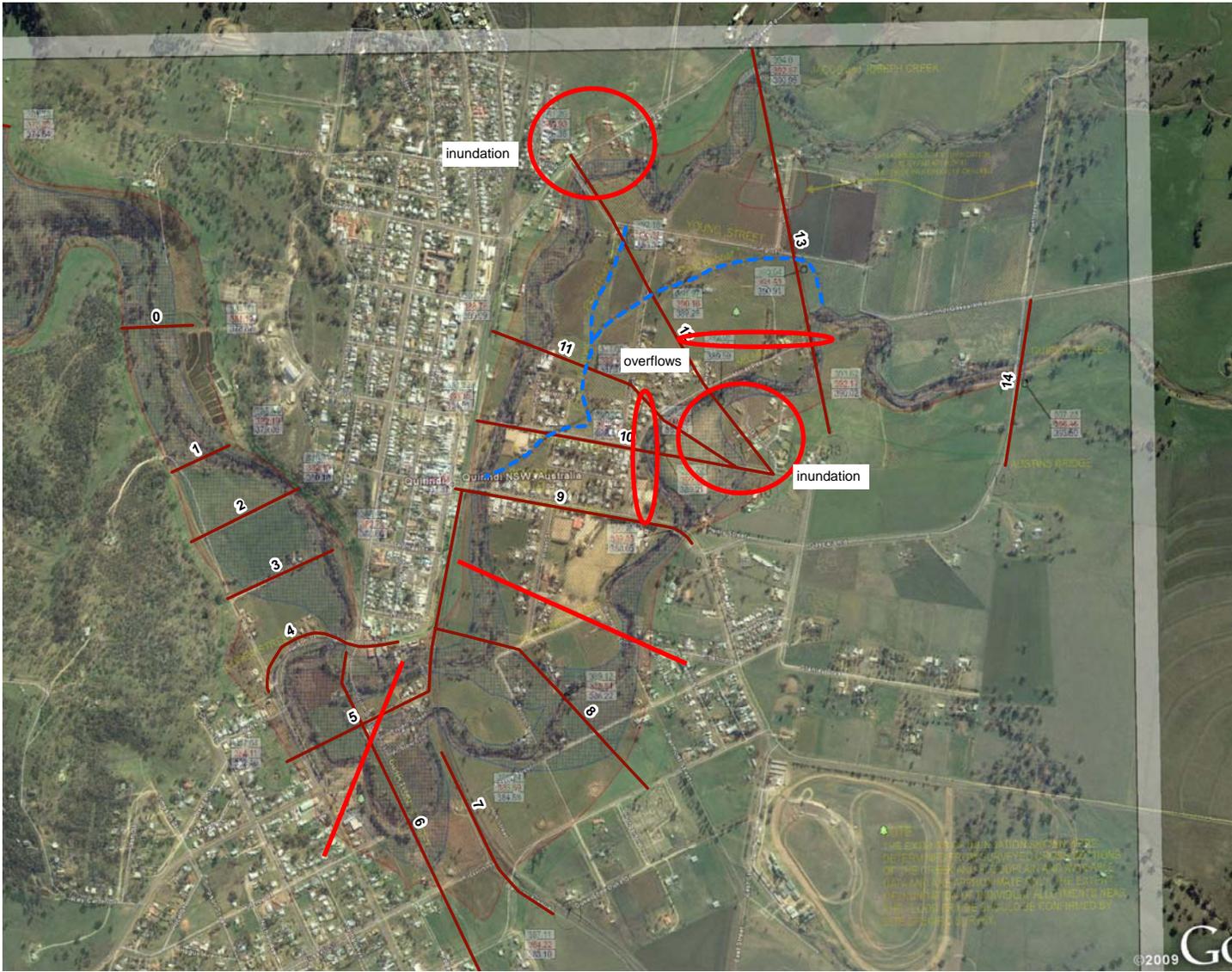
Flood Model Review



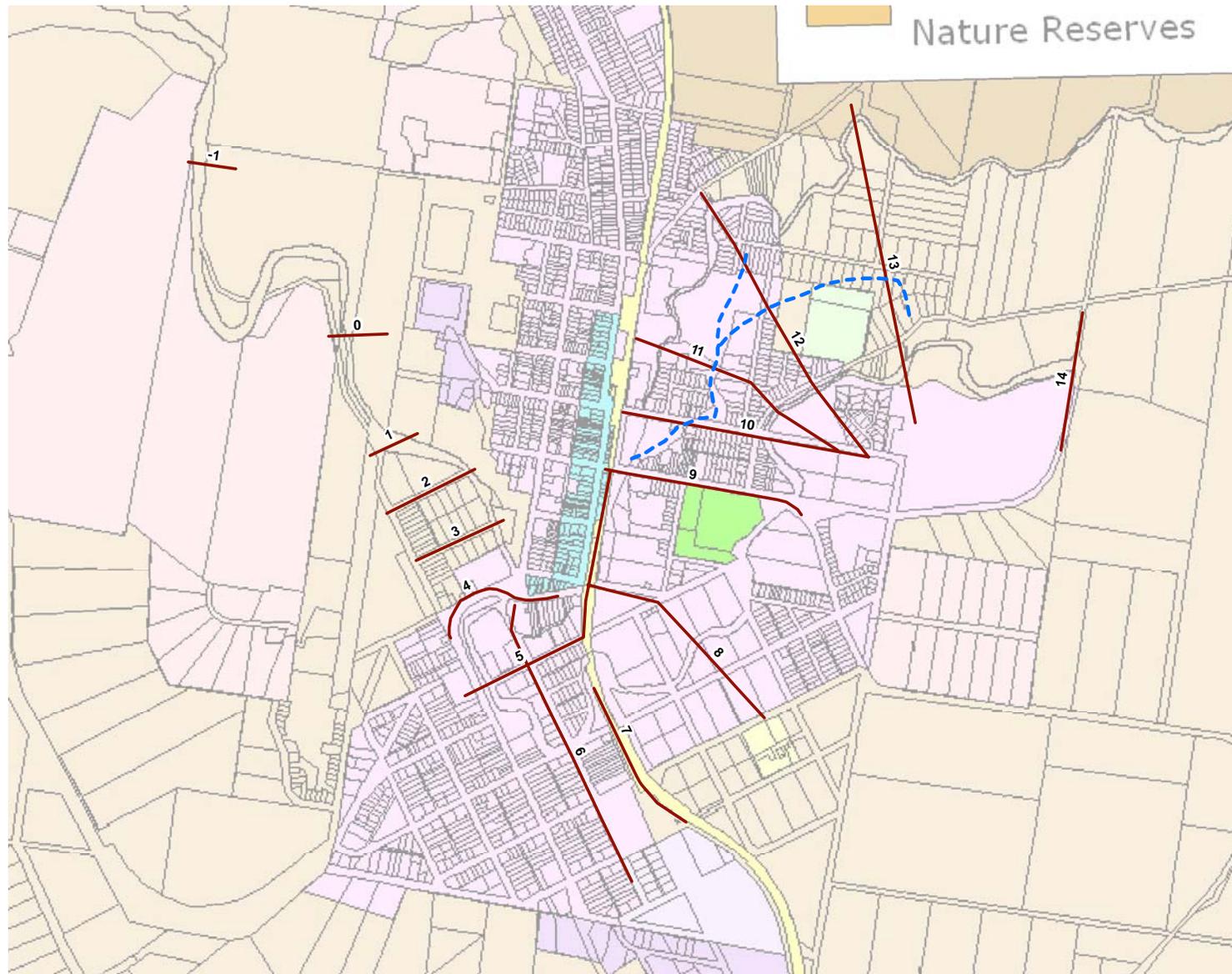
Sensitivity Assessment



Further Checks



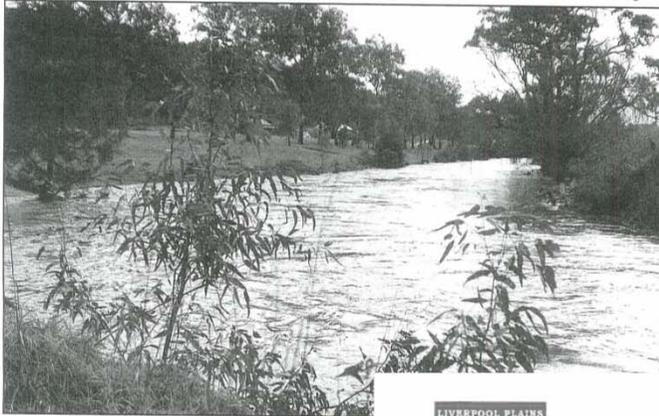
LEP



Community Announcements

NEWS

Floodplain Management Study for Quirindi



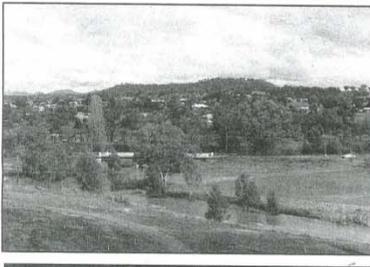
Floodplain Risk Management Study, which includes community consultation and a number of environmental and engineering investigations.

The first phase of the investigations involves reviewing the previous flood study and researching information on the flood levels and flood flows for Quirindi. As part of these investigations, GHD will be liaising with the local community to get an understanding of the history of flooding in the area, and undertaking a number of activities throughout Quirindi.

The project team is keen to learn when and where past flooding has

community will be able to get involved. "We encourage the community to return the survey questionnaire and attend the Community Information Session (planned for early September) so they can meet the study team, find out more about the project and provide historical information about past flooding in Quirindi," Mr van Katwyk said.

Mr van Katwyk said that a Floodplain Management Committee (FMC) had been formed to assist the project team with the investigations. The group will meet regularly and is an important way in which the community can provide input into the



Survey Quirindi Floodplain Risk Management Study

Name: _____

Address: _____

Telephone: _____ Email: _____

Please include my details in the stakeholder database to receive further information on the project (Tick here)

1. How long have you lived (or did you live) in Quirindi? _____ Years _____ Months
2. Have you ever seen or experienced a flood while living in Quirindi? Yes No (Please tick)
3. If yes, in what years did the flood/s take place?

4. What affects did the flood have on you and your property?

5. How do you prepare for a flood?



QUIRINDI TOWNSHIP AND SURROUNDING AREAS FLOODPLAIN RISK MANAGEMENT STUDY

COMMUNITY NEWSLETTER

No.1

August 2010

About the project

Quirindi is subject to wide spread flooding and inundation, as has been the case in previous major flood events. Major storms occurred in 1955, 1984 and 2000. It would appear that the 1955 and 1984 floods were approximately 60 to 70% of the estimated 1 in 100 year event predicted by the Average Recurrence Interval design.

Liverpool Plains Shire Council (Council) has engaged engineering and environmental consultants GHD Pty Ltd (GHD) to undertake a Floodplain Risk Management study to determine what mitigation measures, if any, could be considered for implementation to provide protection to the town.

Over the coming months, GHD will be investigating flooding in the town and will be compiling options for floodplain management.

Council and GHD are committed to listening to the concerns and issues of the community and stakeholders, and strategies are in place to ensure that this information is integrated into the study. Throughout the study there will be opportunities for the local community and stakeholders to provide feedback on their concerns and issues.



Key Messages – 51 respondents

- Average respondents in Quirindi = 32 yrs
- 41 out of 51 had experienced flooding
- Most experienced 2000 flooding, most others mentioned 1955, 1971 & 1984
- 32 out of 51 described negative effect
- Non-direct = isolation, damage to roads
- Preventative measures typically:
 - Monitor creek levels
 - Move stock and vehicles
 - Raise equipment & furniture
 - Sock up food
 - Clear drains around property
- 80% in favour of focussing on a number of options, educating residents followed by flood and property modifications
- General trend = property modification not favoured
- Divided on levees
- Clearing of Jacob and Joseph Creek
- Concern about weeds, leaves & rubbish



Next steps

- Survey brief & survey
- Information Session and Agency focus group
- Flood damages calculations
- Options development





www.ghd.com



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Tuesday 19 October 2010 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter Luke Scanlon Tony Todd John Cowley Ted Worboys Gary Roworth Andrew Galvin (SES) Neal Albert (DECCW)	Cr Colleen Wills Cr Col Stewart Cr Andrew Laurie Greg Tory (Director Works) Ron Van Katwyk (Director Environmental Services) Merv Prendergast (Manager Health & Development) Rainer Berg (GHD) James McPherson (GHD) Brooke Jacobs (LPSC)
Apologies:	Frank Turner (SES), Robert Terry, Ken Worboys	

Minutes

Welcome and apologies	
1.	<p>The meeting was opened at 6:05pm. Mr Carter welcomed everyone and thanked them for attending.</p> <p>Apologies were received and accepted.</p> <p>Moved: Cr Wills</p> <p>Seconded: Cr Stewart</p>
Adoption of previous minutes	
2.	<p>The Minutes of the 1 September 2010 meeting were adopted.</p> <p>Moved: Cr Stewart</p> <p>Seconded: Cr Wills</p>
Business arising from previous minutes	
3.	<p>1. GHD brief for surveyors</p> <ul style="list-style-type: none"> i. The surveyor's brief has been distributed by GHD. ii. Quotes are expected next week. iii. GHD will check that the survey covers the area indicated on the LEP map especially the eastern urban release area. iv. Clarification regarding "fringe and storage" and "floodway" is essential for future use in the DA process.

Business arising from previous minutes (continued)

- v. One contractor has asked for additional information/clarification on technical components of the survey brief and GHD will provide this.
 - vi. Dr Berg queried whether the area in the east of the Liverpool Plains Growth Management Study and Strategy map marked for first release needed additional survey information.

Action: Add this additional area into the brief.
 - vii. The Green Crescent area and the other side of the creek will gain clarification from the survey. Elsewhere won't receive better definition of the "black line" as this is only possible by surveying the entire floodplain. This would be very expensive and GHD don't believe this is necessary.
2. LEP update.
- i. Mr Van Katwyk distributed the map from the Liverpool Plains Growth Management Study and Strategy and commented on the implications of flooding on future development areas.

Correspondence received

- 4.
- 1. Funding agreement for Financial Assistance under the 2010/11 NSW Floodplain Management Program
 - i. Funding has been granted for up to an additional \$10,000 and will act as a "top up" if needed.
 - 2. Applications to join Committee (for approval by Council)
 - i. Applications have been received from John Cowley, Gary Roworth and Ted Worboys.
 - ii. These applications will go to the next Council Committee meeting for approval.
 - iii. It was moved that the nominations be accepted by the Committee.

Moved: Cr Will

Seconded: Cr Stewart

General Business with prior notice

5. Submissions to DECCW as part of Floodplain Management Program:
- 1. Progress Report for September
 - 2. Work Plan
 - 3. Acquittal Certificate
- These documents are submitted to DECCW to ensure that the project is going to schedule and to ensure that the project is within budget.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

Next meeting

6. The Public Meeting was discussed. Dr Berg explained that he would give an overview of the projects history and discuss some management options.

Next meeting: Wednesday 1 December 2010, 6:00pm in the Council Chambers.

Meeting closed at 5:35pm.



MEMORANDUM

TO: Floodplain Risk Management and Quirindi Creek Floodplain Committee and GHD Pty Ltd

FROM: Brooke Jacobs, Environmental Services Administration Officer (Minute Taker)

DATE: 27 October 2010

SUBJECT: Key Points from the Public Information Evening held 19 October 2010

The follow key items where raised and discussed during the Public Information Evening held on 19 October 2010:

- The impact of fencing on flood level around Pryor Street.
- Sandbags:
 - Council should assist the SES and keep a stock of around 1,000 bags and sufficient sand on hand at all times.
 - The sandbagging machine should be able to be utilised if necessary on short notice.
 - The SES Evacuation Plan should include information regarding above sandbagging arrangements.
- The white picket fence around at Number 1 Oval, Henry Street, Quirindi:
 - The fence could inhibit flood waters from getting away quickly and therefore increase flood levels
 - The fence is supposed to be easily dismantled as is held together with tech screws
 - When it was erected it was said that in the event of an impeding flood the fence was to be dismantled and sections laid down
 - The SES should be authorised to do this work if considered necessary.
- The condition of the creek including reeds, silt, grass cuttings, rubbish, logs and trees was identified as a serious issue.
 - Green waste (grass clippings) are abundant in the creek and views were expressed regarding the fees involved with disposing of green waste at the tip needing to be deleted
 - The reeds/weeds growing in the creek are seen as detrimental to the creeks health and appearance and its removal was seen as a high priority in order to assist with the free flow of flood waters.



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Wednesday 2 February 2011 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter Cr Andrew Laurie Andrew Galvin (SES) Frank Turner (SES) John Cowley Rainer Berg (GHD) James McPherson (GHD)	Ron Van Katwyk (Director Environmental Services) Cr Colleen Wills Luke Scanlon Tim Watts (Namoi CMA) Neal Albert (DECCW) Andrew Faulkenmire (DECCW) Tony Todd Brooke Jacobs (LPSC) - Minute Taker
Apologies:	Ted Worboys, Cr Col Stewart, Greg Tory (Director Works) and Merv Prendergast (Manager Health & Development)	

Minutes

Welcome and apologies	
1.	<p>The meeting was opened at 6:10pm. Mr Carter welcomed everyone and thanked them for attending.</p> <p>Apologies were received and accepted.</p> <p>Moved: Cr Laurie</p> <p>Seconded: Frank Turner</p>
Adoption of previous minutes	
2.	<p>The Minutes of the 19 October 2010 meeting were adopted.</p> <p>Moved: Cr Wills</p> <p>Seconded: Cr Laurie</p>

Business arising from previous minutes

3.

Items raised at Public Information Session 19 October 2010

- The following key items were raised and discussed during the Public Information Evening held on 19 October 2010:

- Sandbags
 - Sandbags rot if left filled
 - 1000 sandbags would build a wall 1m high by 20-25m long
 - Due to warning time of approximately 45 minutes there would not be enough time to fill, deliver and lay sandbags.
 - There are 3-4,000 empty bags and a stock pile of sand at the depot on hand and 2 sandbagging machines – 1 in Quirindi, 1 in Currabubula
 - Sandbags are kept for severe storm and storm protection rather than flooding
- The impact of fencing on flood level around Pryor Street
- The white picket fence around at Number 1 Oval, Henry Street, Quirindi
 - No 1 Oval Fence is collapsible and wouldn't take long to collapse.
 - Cr Laurie felt that reeds would be more of a problem than the fences.
- The condition of the creek including reeds, silt, grass cuttings, rubbish, logs and trees
 - Dr Berg thought that weeds may affect the flooding patterns but would not increase the speed or level of flood waters.
 - Tim Watts felt that removal of the reeds would be detrimental and said that the reeds provide stability for the creek.
 - Cr Laurie stated that the reeds cause the water to "weir up" under the bridge.
 - Tim Watts felt that the reeds slowed the water down, are part of a natural process and that the removal of them would be defying natural process.
 - Tim thinks that the reeds are part of the solution not the problem.
 - Vegetation management and removal of weeds such as privet and blackberry should be focused on.
 - Cr Wills stated that Council is aware of the issue but solutions are cost prohibitive and funding is being sourced.
 - The issue often comes up and is high on the community's agenda.

GHD Project Update

4. Dr Berg distributed an update handout (Appendix A) then addressed the committee
- Studies such as this need to rely on survey information
 - For the project to progress an idea of the floor or house levels is needed
 - The information is not on hand and this was identified at the beginning of the project
 - Survey quotes were called for so that this information could be gathered
 - Surveyor has been commissioned
 - The project has stalled to a certain extent. The survey information will enable the project to move forward.

Ron Van Katwyk spoke about the LEP.

- The Draft Liverpool Plains LEP has been exhibited
- 28 submissions have been received. Some related to flooding and these have been forwarded to GHD.
- The LEP is produced from a Template Model
- The LEP stipulates that there must be a flood planning line/level which included a 0.5 metre freeboard.
- This could cause community concerns and confusion with identifying flood liable/prone land on Section 149(2) Certificates (certificate which details planning requirements and zoning of land)
- Including the half metre freeboard broadens the area of impact
- A lot more land would be indicated as flood affected than had historically been affected.
- Other LEPs have been gazetted with this clause and the standard flood clause is turning up lots of problems
- The Flood Risk Management Plan field work is being accelerated in order to help to solve this issue
- Discussions with Department of Planning (DoP) staff have been held to establish the best way to deal with the issue.
- May end up with 3 lines on a map – 1% flood, flood way and 1% flood + 0.5m (Flood level).
- This issue is impacting on when the LEP will get gazetted.
- DoP say that Council must use the best available information about flooding and to date the Lyall and Assoc. Flood Study, 2005 is the most current.
- DoP say that realistically the survey work must be done now, however there isn't funding available to do the work required to cover the whole Quirindi Flood liable area.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

GHD Project Update (continued)

These issues were discussed by the committee. The committee moved to recommend to Council:

“The Floodplain Risk Management and Quirindi Creek Committee have identified the need for additional survey work to establish, over and above the scope of the Flood Risk Management Plan and recommends to Council the allocation of extra funding in order to map the required Flood Planning line.”

Moved: Frank Turner
Seconded: Tim Watts

John Cowley and Luke Scanlon were opposed to this motion.

Possibility that extra works could take place in addition to the current survey work being undertaken and this would save on costs.

Dr Berg feels that this would be a good move as Council need the line and it can't currently be drawn.

Dr Berg continued with the update and ran through the different sections of the hand out.

Cost estimate and social and economic impacts are beginning to be looked at.

Ron felt it was important to keep moving with the survey work and does not want the project to stop whilst an amended survey brief is prepared and implemented. The Committee motion will be brought forward at the February Council meeting.

Correspondence received

5. Nil

General Business with prior notice

6. Nil

Next meeting

7. Next meeting: To be advised

Meeting closed at 7:40pm.



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Wednesday 6 April 2011 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter Luke Scanlon James McPherson (GHD) Rainer Berg (GHD) Neal Albert (DECCW) Frank Turner (SES) John Cowley Gary Roworth Ted Worboys	Cr Colleen Wills Cr Andrew Laurie Cr Col Stewart Greg Tory (Director Works) Ron Van Katwyk (Director Environmental Services) Brooke Jacobs (LPSC)
Apologies:	Tim Watts (Namoi CMA), Andrew Galvin (SES)	

Minutes

Welcome and apologies	
1.	<p>The meeting was opened at 6:05pm. Mr Carter welcomed everyone and thanked them for attending.</p> <p>Apologies were received and accepted.</p> <p>Moved: Frank Turner</p> <p>Seconded: Ron Van Katwyk</p>
Adoption of previous minutes	
2.	<p>The Minutes of the 2 February 2011 meeting were adopted.</p> <p>Moved: Frank Turner</p> <p>Seconded: Ron Van Katwyk</p>
Business arising from previous minutes	
3.	Nil
GHD Project Update	
4.	<ol style="list-style-type: none"> 1. Surveyors have completed work and plan and GHD received 4 working days ago. GHD are now working with the data to progress the Plan. 2. Yellow dots (on plan) - floor levels of dwellings 3. Green dots – detail in Green Crescent area and area for urban expansion under the LEP and Growth Management Strategy. 4. The “green” line will help to confirm critical area flood levels. 5. Starting to firm up data and determine flood line in Green Crescent.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

GHD Project Update (continued)

6. Flood level and floor level will be used to work out damage and costs to factor into flood mitigation options
7. Study by Lyall and Associates will always be the starting point of the Plan.
8. Process from here – Draft Plan given to Committee then Public Meeting then Public Exhibition. There is also a budget allowance for an “open shop” day.
9. Gunnedah Council has just gone through this process.
10. Narrabri Council have also been through process however faced issues as future planning was not appropriate and have now had to adopt a piece meal approach. LPSC shouldn't face these issues as proposed future expansion areas are generally on higher ground.

Correspondence received

5. Nil

General Business

6. General discussion:
 1. Gary Roworth commended the attendance at the Public meeting back in October.
 2. Issues raised (by Committee and community) need to be addressed and solutions to these issues should become part of recommendations made in the Risk Management Plan and should become part of Displan.
 3. Warning systems such as auto stream gauges or rain gauges could be part of recommendations made.
 4. “Sunset” of committee discussed. Committee can be kept open and should meet a year after completion to monitor progress on commitments made.
 5. Clearing of creek (weeds) discussed at length included the planting of trees to shade out the weeds and to replace bank stability provided by weeds . Office of Environment and Heritage advised that it would be best to say that a “holistic rehabilitation” was required as far as receiving funding. It would need to be recommendation of this Committee that funding for this sort of work was sourced.

Next meeting

7. Next meeting: To be advised
Meeting closed at 7:10pm



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Thursday 16 June 2011 / 6:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter Luke Scanlon Tony Todd James McPherson (GHD) Rainer Berg (GHD) Neal Albert (DECCW) Andrew Galvin (SES) Frank Turner (SES)	Cr Colleen Wills Cr Col Stewart Ron Van Katwyk (Director Environmental Services) Brooke Jacobs (LPSC) John Cowley Ken Worboys Tim Watts (Namoi CMA)
Apologies:	Greg Tory (Director Works)	

Minutes

Welcome and apologies	
1.	<p>The meeting was opened at 6:10pm. Mr Carter welcomed everyone and thanked them for attending.</p> <p>Apologies were received and accepted.</p> <p>Moved: Ken Worboys</p> <p>Seconded: John Cowley</p>
Adoption of previous minutes	
2.	<p>The Minutes of the 6 April 2011 meeting were adopted.</p> <p>Moved: Cr Colleen Wills</p> <p>Seconded: Frank Turner</p>
Business arising from previous minutes	
3.	<p>1. Item 6.4 from previous minutes – “<i>Sunset</i>” of committee discussed. Committee can be kept open and should meet a year after completion to monitor progress on commitments made.” was discussed as follows:</p> <p>Thought should be given to “sunset” of committee as once the final report is adopted by Council, it is Council’s choice to whether recommendations of this committee are adopted.</p>

Floodplain Risk Management Committee
Meeting Minutes (Continued)

GHD Project Update	
4.	<p>Dr Rainer Berg addressed the committee and delivered a PowerPoint presentation regarding the progress of the project to date and the Flood Damages and Management Options report.</p> <p>Discussion:</p> <ul style="list-style-type: none">• Project is getting to the hard edge and challenges to various draft recommendations should be made as necessary.• The community consultation process and future events that are required to ensure successful completion of the project. <p>Cr Colleen Wills moved that a community meeting be held as the next step in the process. Tim Watts seconded the motion.</p> <ul style="list-style-type: none">• Dates and times for the community meeting and the time frame of other necessary events such as the distribution of the draft plan to the committee were discussed. Budgetary and time constraints must be taken into consideration. It was proposed that the community meeting be held on Thursday 7th July 2011 at the Quirindi RSL Club. <p>Action: Ron, Rainer and Brooke to finalise dates and notify committee of upcoming schedule of events.</p>
Correspondence received	
5.	Nil
General Business	
6.	<p>General discussion:</p> <ol style="list-style-type: none">1. Creek improvement works near Whittaker street bridge has commenced. There are more creek improvement works to be undertaken and Council has a standing resolution to pursue funding for future improvements/ rehabilitation.2. Impact of levy bank along Milner Parade.3. Committee identified a need for river and/or rain gauges in the area as a potential response modification required.4. Public awareness is a key issue. SES are the lead agency for flooding and this should be promoted. Evacuation routes and places to go during flood need to be designated and promoted.5. SES felt that a colour coded map identifying accessibility of roads during different level of flood events would be beneficial to their operations.6. Sedimentation in the creek channel has a more pronounced effect during more frequent flooding and maintenance of the creek is considered to be a key to success.7. Option of constructing a channel parallel with the section of creek in the Whittaker Street area running north to south. Thought that this option was cost prohibitive and that the cost to benefit ration didn't warrant this type of work.8. Doing nothing is not a real option.
General Business (continued)	
6.	9. Residents in the Gurton Street area may need to be targeted specifically with notifications regarding flooding issues including public exhibition of the plan, evacuation plans etc.
Next meeting	
7.	Next meeting: To be advised Meeting closed at 9:05pm

Note: Tim Watts recommended the following publication:

Guidelines for Growing Phragmites for Erosion Control, 1997
Author Judy Frankenberg



MEMORANDUM

TO: Floodplain Risk Management and Quirindi Creek Floodplain Committee and GHD Pty Ltd

FROM: Brooke Jacobs, Environmental Services Administration Officer (Minute Taker)

SUBJECT: Key Points from the Community Information Session held 7 July 2011

Tony Carter acknowledged the contribution to the Committee of the late Owen Love.

The follow key items where raised and discussed during the Community Information Session held on 7 July 2011:

- New footbridge next to Whittaker Street bridge:
 - Residents in the area felt that the footbridge would have a detrimental effect on flooding and would increase the level of flood water.
 - The pylons of the new footbridge do not appear to line up with the existing bridge and it is thought that this will cause debris to back up around the bridge.
 - Upset by lack of consultation.
- Need for a warning system to alert Quirindi including suggestion that monitoring points be located upstream in the Wallabadah vicinity.
- History of the Milner Parade levy bank was questioned including the reason for putting it in place.
- Levy bank around Whittaker Street pump station:
(Was put there privately without consultation after 1971 and was contested in Court with Court deciding to leave it in place and see what happened.)

1971 flood was 40-60cm higher than any flood since in this area.



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.	
Date / Time:	Wednesday 3 August 2011 / 5:00pm	
Venue:	Liverpool Plains Shire Council Chambers	
Participants:	Tony Carter Luke Scanlon Rainer Berg (GHD) Neal Albert (DECCW) Andrew Galvin (SES) Frank Turner (SES)	Cr Col Stewart Ron Van Katwyk (Director Environmental Services) Brooke Jacobs (LPSC) John Cowley Ken Worboys Ted Worboys Gary Roworth
Apologies:	Tim Watts (Namoi CMA), Tony Todd, Cr Colleen Wills	

Minutes

Welcome and apologies	
1.	The meeting was opened at 5:10pm. Mr Carter welcomed everyone and thanked them for attending. Apologies were received and accepted. Moved: Ted Worboys Seconded: John Cowley
Adoption of previous minutes	
2.	The Minutes of the 16 June 2011 meeting were adopted. Moved: Ron Van Katwyk Seconded: Frank Turner
Business arising from previous minutes	
3.	Item 4 from previous minutes – “Action: Ron, Rainer and Brooke to finalise dates and notify committee of upcoming schedule of events.” Schedule of events has been distributed to committee and is attached as Appendix “A”.
Correspondence received	
4.	From Andrew Galvin, SES Deputy Regional Controller re the Floodplain Risk Management Study. (Appendix “B”) Letter is a submission to be included with the draft. Moved that committee accept letter: Gary Roworth Seconded: Luke Scanlon

Floodplain Risk Management Committee
Meeting Minutes (Continued)

General Business

5. 1. Review of Draft Floodplain Risk Management Study and Plan and Public exhibition of Draft Floodplain Risk Management Study and Plan
- Dr Berg gave an overview of the report.
- The follow issues were discussed:
- a. The pedestrian bridge at Whittaker Street:
 - i. It was commented that it was a shame that the bridge had been put in without consultation of this committee. The bridge pylons appear to be skewed off the road bridge.
 - ii. Dr Berg commented that the effect of the bridge on flooding is unknown and that he cannot say with certainty the effect it may have in differing flood scenarios.
 - iii. The structure integrity of the pedestrian bridge may be enhanced to prevent potential collapse and subsequent impedance of water flow associated with such a bridge collapse in front of the main bridge.
 - b. Another example of the need for a stormwater flood gate is present in Cox Street, however it was thought that this had been installed.
 - c. House raising was discussed. It was thought that a list of priority premises may need to be produced but handled in confidence.
 - d. The raising of Henry Street was not seen as a realistic and viable options and it should be removed from the plan.
 - e. Recommendation regarding a Vegetation Management Plan should be made a high priority.
Moved: Luke Scanlon
Seconded: John Cowley
 - f. Flood gates should also be made a high priority.
 - g. Preparation of an Evacuation Plan and development of a public awareness scheme should become a combined recommendation and made a high priority.
 - h. Properties identified as high hazards will not be individually identified in the plan due to confidentiality and privacy issues. Any such information will be handled in a confidential appendix.
- Motion: The Committee recommend that the Draft Floodplain Risk management Plan be put to Council for Public Exhibition.
Moved: Ted Worboys
Seconded: Luke Scanlon
Nil opposed.
- The effect of the plan on section 149 planning certificates was discussed.
- Dr Berg will make suggested amendments to the Draft Plan and provide to Mr Van Katwyk by Tuesday 9 August 2011 for consideration at the August Council Meeting.

Next meeting

7. Next meeting: Wednesday 5th October 2011
Meeting closed at 7:15pm

**Schedule of upcoming events of the
Floodplain Risk Management and Quirindi Creek Floodplain Committee
2011**

Date and time	Event	Explanation	Location	Who is involved?
Thursday 7 July 6pm	Community Information Session	Need 3 weeks lead time to organise letterbox drop and to advertise.	Tony Caine Room, Quirindi RSL	Committee and community
Thursday 21 July	Draft report distributed to Committee	Rainer will update and complete report in line with Community meeting outcomes. Committee members will have 2 weeks to study draft report.	Post	Rainer and Brooke
Wednesday 3 August 6pm	Committee meeting	Hopefully Committee will adopt report and recommend to Council that the report is placed on exhibition.	Council Chambers	Committee
Tuesday 9 August 5pm	Deadline for submission of Council reports	Ron's explanation to Council.	N/A	Ron
Thursday 25 August 2pm	Council meeting	Hopefully Council will resolve to place report on exhibition.	Council Chambers	Councillors and Senior Staff
Wednesday 31 August 8:30am	Public Exhibition of Report starts	Required to be exhibited for 3 weeks.	Quirindi Library and Council's office and website	Rainer and Brooke
Thursday 15 September (Time to be advised)	"Open shop day"	Rainer available to explain and answer questions.	Quirindi Library	Rainer
Friday 23 September 5pm	Public Exhibition of Report ends	Any formal submissions to be reviewed by Rainer with recommendations to Committee.	N/A	Brooke
Wednesday 5 October 6pm	Committee meeting	Committee to review Rainer's recommendations.	Council Chambers	Committee
Tuesday 11 October 5pm	Deadline for submission of Council reports	Ron's explanation to Council.	N/A	Ron
Thursday 27 October 2pm	Council meeting	Council formally adopts report.	Council Chambers	Councillors and Senior Staff

21 July 2011

Namoi Region
28 Borthistle Rd
PO Box 465
GUNNEDAH NSW 2380
Phone: (02) 6740 2300
Fax: (02) 6740 2333
nmr.admin@ses.nsw.gov.au

The General Manager
Liverpool Plains Shire Council
PO Box 152
Quirindi NSW 2343

Dear Sir

Re Quirindi Floodplain Risk Management Study

Following recent Floodplain Risk Management Committee meetings and presentations by council's consultants it has become increasingly clear that there could be significant benefits in improved flood warnings for Quirindi.

At present the catchment relies on broad generalised warnings issued by the Bureau of Meteorology such as Severe Weather Warnings which are usually issued to cover one or more a forecast districts such as the North West Slopes & Plains. Flood Bulletins providing specific warnings for the catchment are issued by the State Emergency Service primarily based on the observations of local SES volunteers. The difficulty with this system is the uncertainty in estimating the extent of flooding and the ability to provide meaningful warning times.

Flood warning is a three phase process that involves the collection of data and the preparation of warnings, dissemination of warnings and the reaction to warnings.

The installation of an automated flood warning system for the Jacob & Joseph and Quirindi Creek catchments could facilitate more timely collection of data relating to the catchment and ultimately the issue of warnings and the communities response.

There are a number of variations that an automated flood warning system could comprise, this could range from a couple of automated rainfall gauges to a system that incorporated rainfall gauges as well as automated water level and flow gauges on these creeks.

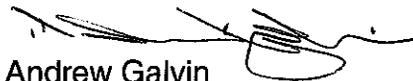


Obviously the completion of any flood warning system also needs to address the dissemination of warnings and the community response to these warnings.

Given the above I would urge that the Quirindi Floodplain Risk Management Study recommends that the issue of Flood Warnings be investigated and the feasibility, costs and benefits associated with such systems be made available so that the Floodplain Risk Management Committee, Council and ultimately the community can make an informed decision on the management of their flood risk.

I have attached for reference of council and its consultants, the Floodplain Risk Management Guidelines detailing the SES requirements. A copy of this was also provided prior to the commencement of this study.

Yours sincerely

A handwritten signature in black ink, appearing to read 'Andrew Galvin', with a stylized flourish at the end.

Andrew Galvin
Deputy Region Controller



MINUTES

Floodplain Risk Management and Quirindi Creek Floodplain Committee

Objectives:	To follow the guidelines established in the Floodplain Development Manual and advise Council on the management of flood liable land by developing a Management Plan and its implementation strategy.
Date / Time:	Wednesday 5 October 2011 / 6:00pm
Venue:	Liverpool Plains Shire Council Chambers
Participants:	Neal Albert (DECCW) Rainer Berg (GHD) Tony Carter (Chairperson) John Cowley Brooke Jacobs (LPSC) – Minute taker Cr Andrew Laurie Frank Turner (SES) Ron Van Katwyk (Director Environmental Services) Tim Watts (Namoi CMA) Cr Colleen Wills Ken Worboys Ted Worboys
Apologies:	Andrew Galvin (SES), James McPherson (GHD) and Greg Tory (LPSC)

Minutes

Welcome and apologies	
1.	The meeting was opened at 6:05pm. Chairperson Mr Tony Carter welcomed everyone and thanked them for attending. Apologies were received and accepted. Moved: Cr Colleen Wills Seconded: Mr Frank Turner
Adoption of previous minutes	
2.	The Minutes of the 5 August 2011 meeting were adopted. Moved: Mr Ted Worboys Seconded: Mr John Cowley
Business arising from previous minutes	
3.	Nil.
Correspondence received	
4.	Nil.

General Business

5.

1. The future of the Committee was discussed with the key points raised as follows:
 - It is felt that the Committee has achieved a lot to date
 - There is a lot more to do especially regarding management of creek vegetation and silt
 - Who would monitor this work if Committee is closed?
 - Committee's job to date has been to make recommendation to Council
 - Council then decides to source funding of these recommendations etc.
 - Committee can recommend that it continues or that another Committee (with a similar purpose/function) is established
 - Quirindi Catchment Committee is about to fold up
 - A Committee has a better ability to source funding than an individual
 - Important to encourage Council to continue to look at the issues surrounding the creeks

Motion: That it be requested that Council invite the Floodplain Risk Management and Quirindi Creek Floodplain Committee to continue (as a s355 Committee if appropriate).

Moved: Cr Colleen Wills.

Seconded: Cr Andrew Laurie

Motion: That the Floodplain Risk Management and Quirindi Creek Floodplain Committee continue to meet every 3-4 month (or more frequently if required).

Moved: Cr Andrew Laurie

Seconded: John Cowley

Carried unanimously.

2. The public exhibition period of Draft Floodplain Risk Management Study and Plan:
 - a) Included an "Open Shop Day" held 15 September 2011.
 - Members of the public who attended were Alan Greenland, Len and Joan Shaw and George Kelly.
 - Main concerns raised at "Open Shop":
 - Green Crescent area and future zoning
 - Activities and works in Gurton and Whittaker Street Area
 - New footbridge on Whittaker Street
 - Lowering of road/causeway
 - b) Submissions received from Neal Albert, Office of Environment and Heritage and Andrew Galvin, SES:
 - Office of Environment and Heritage submission (Appendix A) raises 21 points.
 - Rainer Berg will address issues raised in the
 - SES submission is recommending a warning system and evacuation plan and these items have been included in recommendations of the plan.
 - SES also seeks support in education of community on how to reduce risk to person and property. Aim to assist to increase warning time. Require Council's assistance to help promote initiatives such as "FloodSafe for Communities", a program which will eventually have a brochure specific to Quirindi.

3. Committee is happy to accept variance that are to be made to the final version of Report and for this report to then be put to Council. Upon delivery of the final version of Report, Dr Berg has fulfilled his contractual agreement.

Floodplain Risk Management Committee
Meeting Minutes (Continued)

Conclusion

7. Chairperson Tony Carter thanked the following people for their contributions and commitment to the Committee and the Quirindi Township and Surrounding Areas Floodplain Risk Management Study and Plan:

- Dr Rainer Berg and the GHD team
- Community members of the Committee
- Departmental representatives
- Community members who attended Public Meetings etc.
- Mrs Samantha Baines
- Miss Brooke Jacobs

Meeting closed at 7:15pm

To be confirmed

Brooke Jacobs

From: Albert Neal <Neal.Albert@environment.nsw.gov.au>
Sent: Tuesday, 9 August 2011 6:15 PM
To: Rainer.Berg@ghd.com
Cc: Brooke Jacobs
Subject: Quirindi FRMS

Hi Rainer

Please find comments on the FRMS as discussed.

1. An executive study is usually included at the beginning.
2. Need to check the climate change guidelines – the 20% was used at say Boggabilla due to its location however there are guidelines for areas such as Quirindi.
3. The map and location plan may need some re thinking.
4. Its typical to put the flood plain management process into the document (flow chart).
5. Is there any heritage etc issues around the area.
6. Results of any assessment of the community responses.
7. Is it worth explaining the damages (indirect etc) a bit more and was commercial properties included.
8. Was the economic assessment carried out using treasury guidelines? Which discount rate was used.
9. What is the breakup of the present value of damages at the differing ARI. Fig 5 has a number of cases in the legend.
10. Is there any information or comments on the PMF and the performance of the measures in large floods.
11. Comments on the s149 certificate.
12. Any critical infrastructure that needs moving or changing.
13. Doesn't seem to include current and future land zoning.
14. Should have some discussion on FPL
15. Residential vers commercial issues
16. 100yr for VHR etc & not 50yr
17. Need more detail regards to planning and emergency management. The study should provide more information. Stating that another study should be done does not provide enough guidance for SES etc. Flood warning gauges is an example as in previous studies the plan has stated that a xyz gauge should be considered and this was proven to not be the case. We need sufficient information to seek guidance for the next step.
18. Henry St as an evacuation route is an issue esp the hydraulic impact. (probably already covered in the committee meeting). Need more detail in respect to when roads shut, options and timing etc
19. Ranking in Table 11 ?
20. Has maintenance been considered in any of the costs.
21. Probably need a couple more paragraphs in the Draft plan section. This will need to be extracted for Council use.

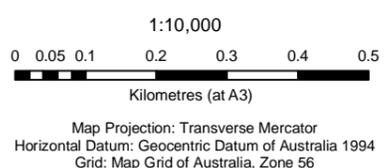
Regards

Neal Albert

OEH
Tamworth
67019624



Appendix D
Flood Damage Mapping



Liverpool Plains Shire Council
Quirindi Floodplain Management Study

Job Number | 22-15085
Revision | A
Date | 07-06-2011

Figure D.1 - Flood Damage Assessment

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 Kilometres (at A3)
 Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Floor Levels Inundated in a 10yr ARI Event

- Floor not inundated
- Floor not inundated
- Floor inundated up to 0.8m
- Floor inundated up to 1.2m
- Floor inundated > 1.2 m

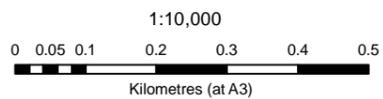
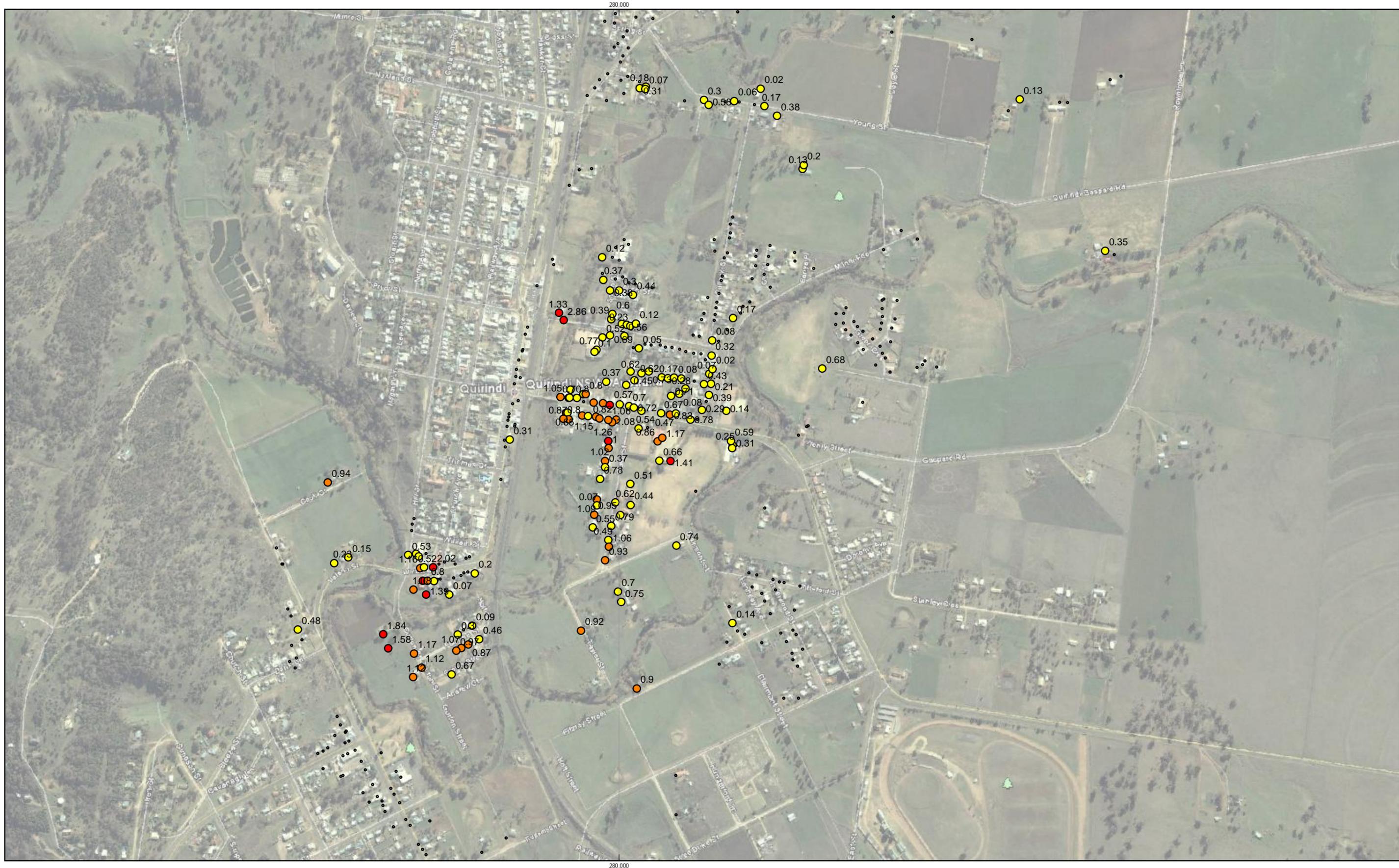


Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

Job Number | 22-15085
 Revision | A
 Date | 07-06-2011

Figure D.2 - Flood Damage Assessment

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Map Projection: Transverse Mercator
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 Grid: Map Grid of Australia, Zone 56



Floor Levels Inundated in a 50yr ARI Event

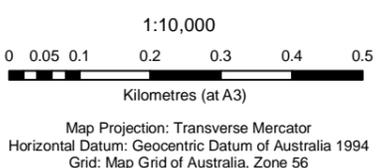
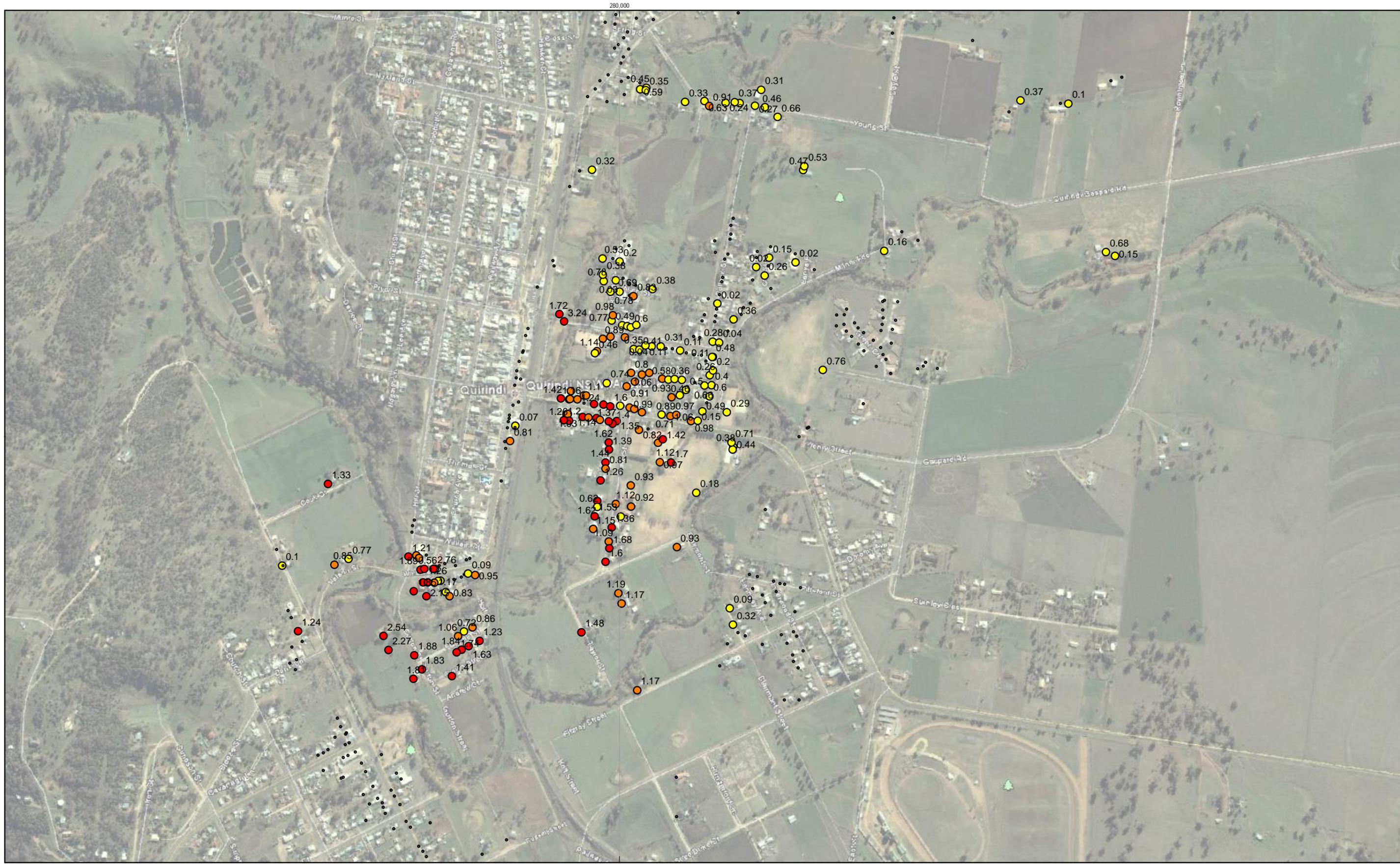
- Floor not inundated
- Floor not inundated
- Floor inundated up to 0.8m
- Floor inundated up to 1.2m
- Floor inundated > 1.2m



Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

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Figure D.3 - Flood Damage Assessment



Floor Levels Inundated in a 100yr ARI Event

•	Floor not inundated
•	Floor not inundated
•	Floor inundated up to 0.8m
•	Floor inundated up to 1.2m
•	Floor inundated > 1.2m

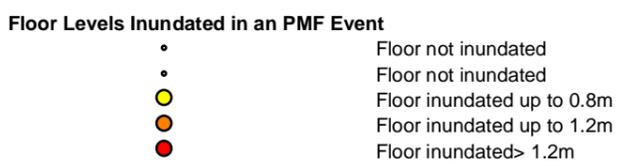
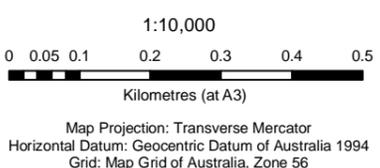
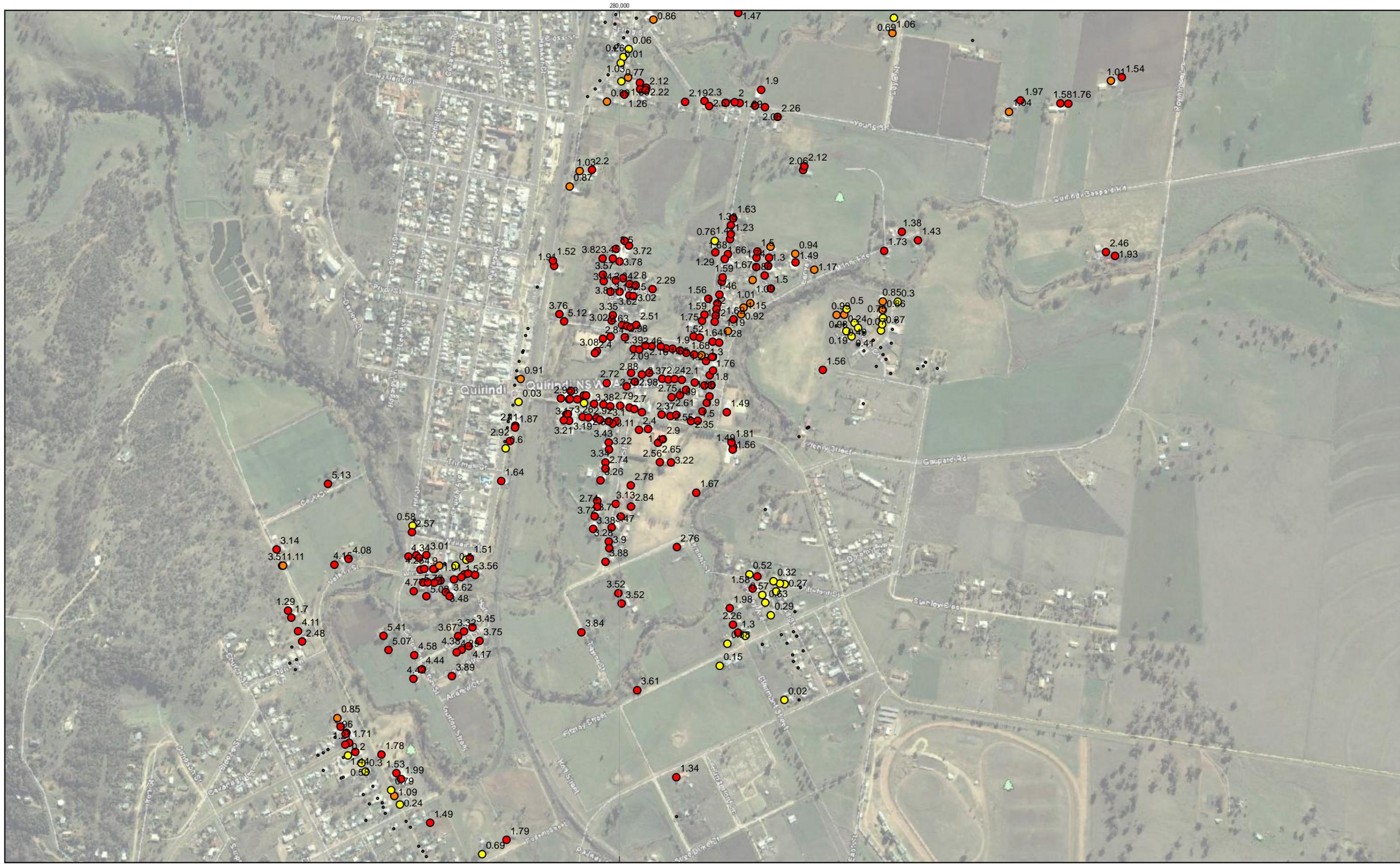


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 Quirindi Floodplain Management Study

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Figure D.4 - Flood Damage Assessment

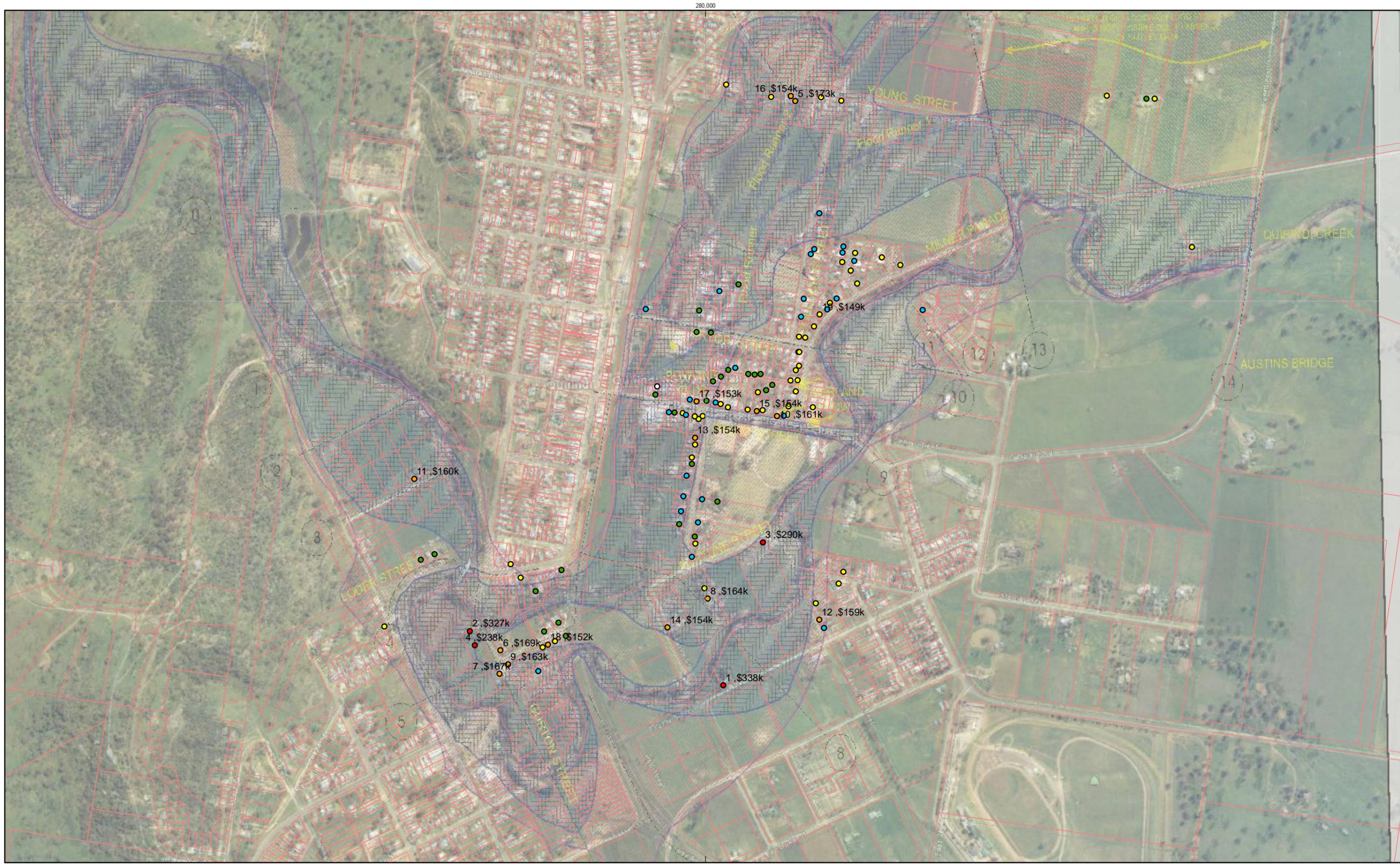
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 Quirindi Floodplain Management Study

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Figure D.5 - Flood Damage Assessment



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 Kilometres (at A3)
 Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



NPV Damages (over 20years)
 Up to \$55k not shown
 ● \$55k - \$80k
 ● \$80 - \$100k
 ● \$100k - \$150k
 ● \$150k - \$200k
 ● over \$200k

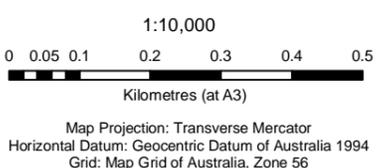
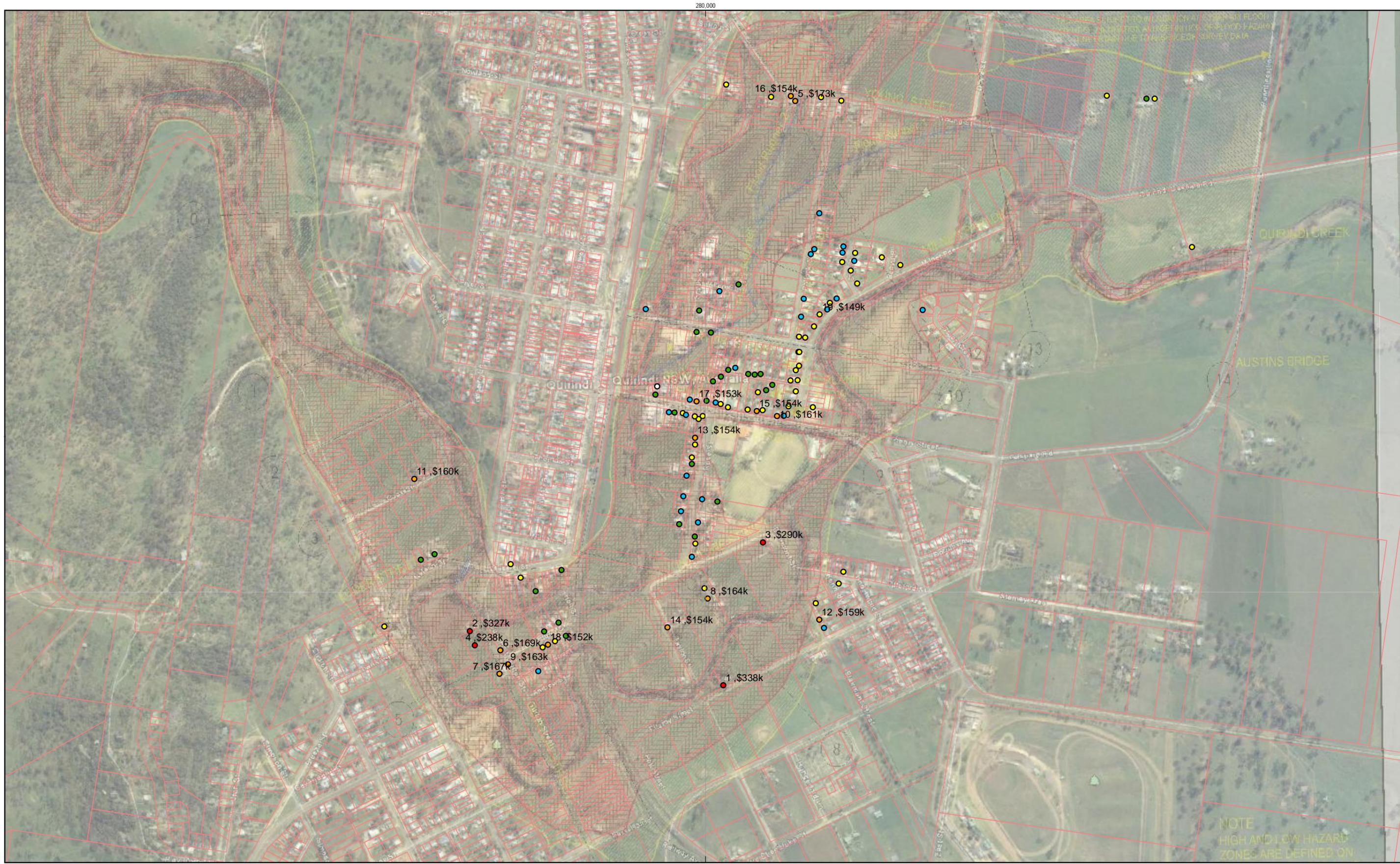
Labels show top 20 properties wrt Damage Cost
 Shaded area = Floodway & Storage after Lyall and Associates



Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

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Figure D.6 - NPV Flood Damage Assessment



- NPV Damages (over 20years)**
 Up to \$55k not shown
 ● \$55k - \$80k
 ● \$80 - \$100k
 ● \$100k - \$150k
 ● \$150k - \$200k
 ● over \$200k

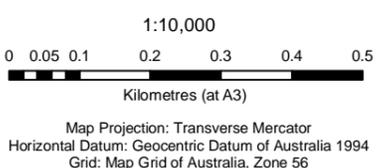
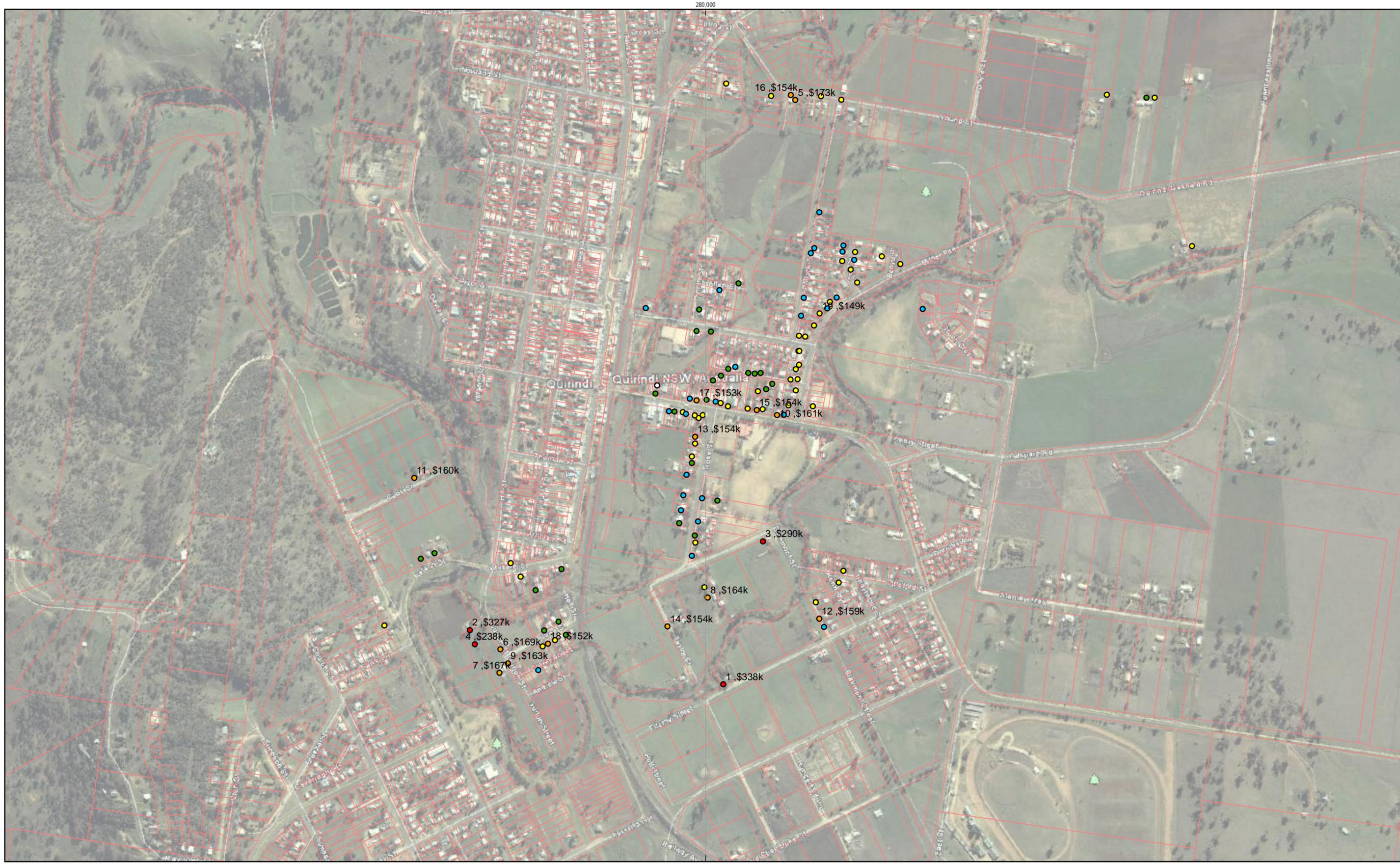
Labels show top 20 properties wrt Damage Cost
 Shaded area = Hazard Categories after Lyall and Associates



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 Quirindi Floodplain Management Study

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Figure D.6 - NPV Flood Damage Assessment



- NPV Damages (over 20years)**
 Oup to \$55k not shown
 ● \$55k - \$80k
 ● \$80 - \$100k
 ● \$100k - \$150k
 ● \$150k - \$200k
 ● over \$200k

Lables show top 20 properties wrt Damage Cost



Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

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Figure D.6 - NPV Flood Damage Assessment



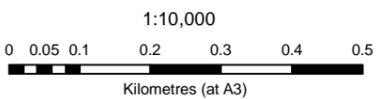
Appendix E

Flood Mapping Mitigation Option Assessments



100yr ARI with Berm at 10yr along Milner Parade (Flood Level Change (mm))

- less than 200mm
- -200 - -100 mm
- -100 - -50mm
- -50 - 50 mm
- 50 - 100mm
- greater than 100 mm



Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

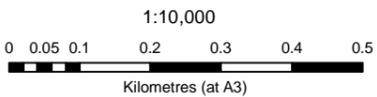
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Figure E.1 - Flood Mitigation Assessment



5yr ARI with 0.5m sediment along Quirindi and Jacob Joseph creeks (Flood Level Change (mm))

- less than 200mm
- -200 - -100 mm
- -100 - -50mm
- -50 - 50 mm
- 50 - 100mm
- greater than 100 mm



Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



Liverpool Plains Shire Council
 Quirindi Floodplain Management Study

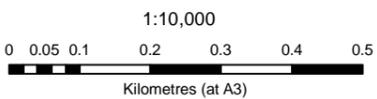
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Figure E.2 - Flood Mitigation Assessment



100yr ARI with 0.5m sediment along Quirindi and Jacob Joseph creeks (Flood Level Change (mm))

- less than 200mm
- -200 - -100 mm
- -100 - -50mm
- -50 - 50 mm
- 50 - 100mm
- greater than 100 mm



Map Projection: Transverse Mercator
 Horizontal Datum: Geocentric Datum of Australia 1994
 Grid: Map Grid of Australia, Zone 56



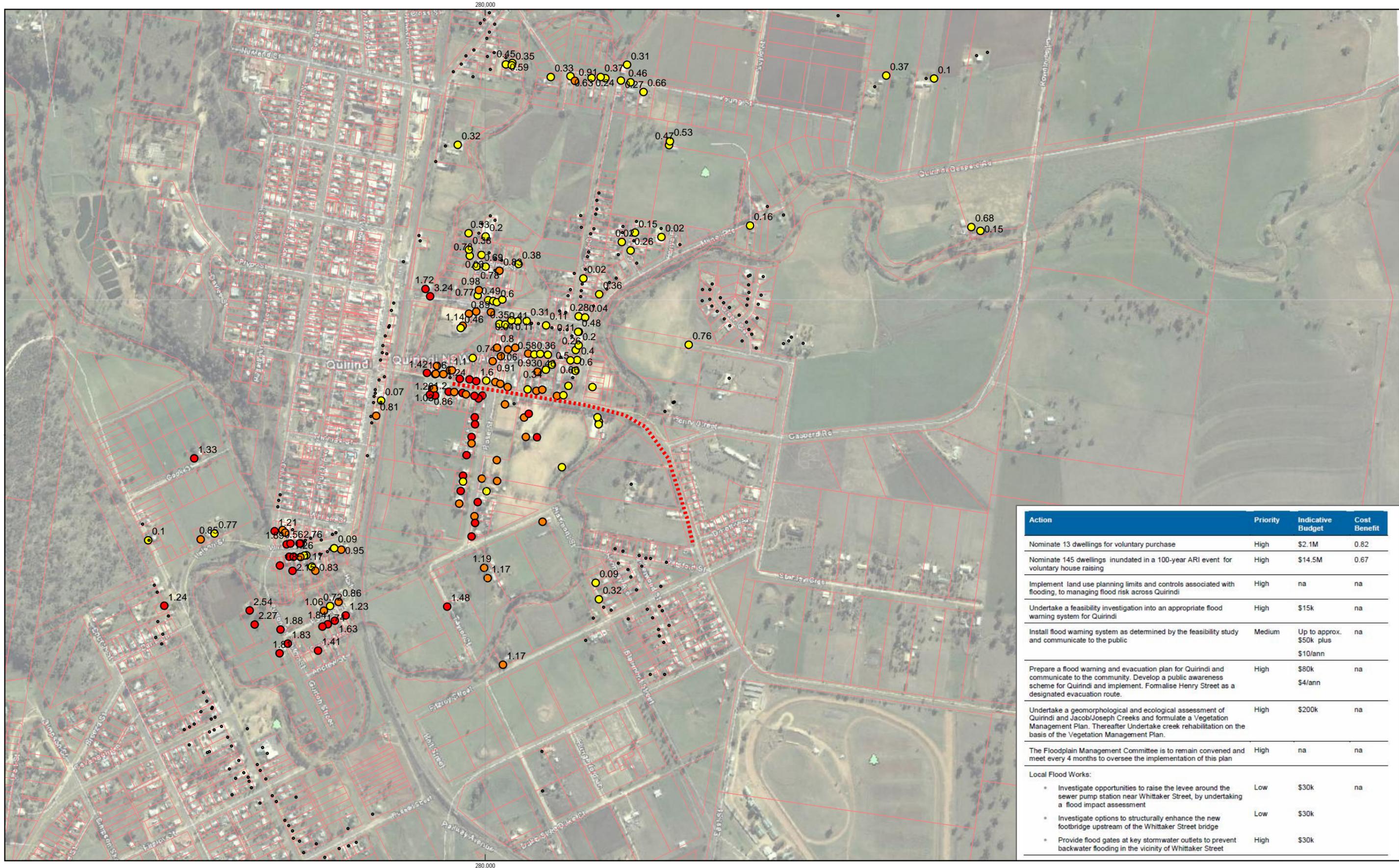
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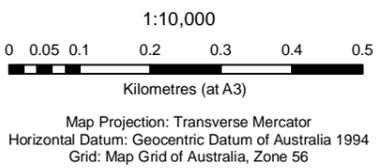
Figure E.3- Flood Mitigation Assessment



Appendix F
Quirindi Floodplain Risk Management Plan



Action	Priority	Indicative Budget	Cost Benefit
Nominate 13 dwellings for voluntary purchase	High	\$2.1M	0.82
Nominate 145 dwellings inundated in a 100-year ARI event for voluntary house raising	High	\$14.5M	0.67
Implement land use planning limits and controls associated with flooding, to managing flood risk across Quirindi	High	na	na
Undertake a feasibility investigation into an appropriate flood warning system for Quirindi	High	\$15k	na
Install flood warning system as determined by the feasibility study and communicate to the public	Medium	Up to approx. \$50k plus \$10/ann	na
Prepare a flood warning and evacuation plan for Quirindi and communicate to the community. Develop a public awareness scheme for Quirindi and implement. Formalise Henry Street as a designated evacuation route.	High	\$80k \$4/ann	na
Undertake a geomorphological and ecological assessment of Quirindi and Jacobi/Joseph Creeks and formulate a Vegetation Management Plan. Thereafter Undertake creek rehabilitation on the basis of the Vegetation Management Plan.	High	\$200k	na
The Floodplain Management Committee is to remain convened and meet every 4 months to oversee the implementation of this plan	High	na	na
Local Flood Works:			
Investigate opportunities to raise the levee around the sewer pump station near Whittaker Street, by undertaking a flood impact assessment	Low	\$30k	na
Investigate options to structurally enhance the new footbridge upstream of the Whittaker Street bridge	Low	\$30k	
Provide flood gates at key stormwater outlets to prevent backwater flooding in the vicinity of Whittaker Street	High	\$30k	



Floor Levels Inundated in a 100yr ARI Event

- Floor not inundated
- Floor not inundated
- Floor inundated up to 0.8m
- Floor inundated up to 1.2m
- Floor inundated > 1.2m

----- Potential Evacuation Route along Henry Street



Liverpool Plains Shire Council
Quirindi Floodplain Management Study

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Figure F.1 - Floodplain Risk Management Plan

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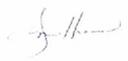
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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
DRAFT	R Berg	J Macpherson		R Berg		20/7/2011
DRAFT2	R Berg	J Macpherson		R Berg		5/8/2011
Final	R Berg	J Macpherson		R Berg		10/10/2011