YOUNG SHIRE COUNCIL

THE TOWN OF YOUNG
FLOODPLAIN RISK MANAGEMENT
STUDY AND PLAN

VOLUME 1 -REPORT

NOVEMBER 2015

December 2010 Floods in Young

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FOREWORD

NSW Government's Flood Policy

The NSW Government's Flood Policy is directed at providing solutions to existing flooding problems in developed areas and to ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.

Under the Policy, the management of flood liable land remains the responsibility of local government. The State subsidises flood mitigation works to alleviate existing problems and provides specialist technical advice to assist councils in the discharge of their floodplain management responsibilities. The Policy provides for technical and financial support by the Government through the following four sequential stages:

1.	Data Collection and Flood Study	Collects flood related data and undertakes an investigation to determine the nature and extent of flooding.
2.	Floodplain Risk Management Study	Evaluates management options for the floodplain in respect of both existing and proposed development.
3.	Floodplain Risk Management Plan	Involves formal adoption by Council of a plan of management for the floodplain.
4.	Implementation of the Plan	Construction of flood mitigation works to protect existing development. Use of Local Environmental Plans to ensure new development is compatible with the flood hazard.

Presentation of Study Results

The results of the flood study investigations commissioned by Young Shire Council have been presented in three separate reports:

- *Data Collection Report,* May 2013.
- *Flood Study Report,* April 2014, which was adopted by Council on 19 February 2014.
- ***Floodplain Risk Management Study & Plan (this present report)***

The studies have been prepared under the guidance of the Floodplain Management Committee comprising representatives Young Shire Council, the Office of Environment and Heritage, NSW SES and Community Representatives.

ACKNOWLEDGEMENT

The studies have been prepared with financial assistance from the NSW Government's Floodplain Management Program and the technical support of Office of Environment and Heritage (OEH). This document does not necessarily represent the opinions of the NSW Government.

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ABBREVIATIONS

AEP	Annual Exceedance Probability (%)
AHD	Australian Height Datum
ARF	Areal Reduction Factor
ARI	Average Recurrence Interval (years)
ARR	Australian Rainfall and Runoff (1998 Edition)
BOM	Bureau of Meteorology
CBD	Central Business District
DSC	Dam Safety Committee
DSEP	Dam Safety Emergency Plan
FDM	Floodplain Development Manual, 2005
FMC	Floodplain Management Committee
FPL	Flood Planning Level (100 year ARI flood level + freeboard)
FPA	Flood Planning Area (area inundated at the FPL)
FRMS	Floodplain Risk Management Study
FRMP	Floodplain Risk Management Plan
FDM	Floodplain Development Manual, 2005
LEP	Local Environment Plan
LiDAR	Light Detection and Ranging
MOF	Major Overland Flow
NSW SES	New South Wales State Emergency Service
OEH	Office of Environment and Heritage
PMF	Probable Maximum Flood
STP	Sewage Treatment Plant
VP	Voluntary Purchase
YSC	Young Shire Council

SUMMARY

S1 Study Objectives

Young Shire Council commissioned the *Floodplain Risk Management Study and Plan* for the town of Young. The overall objectives of the *Floodplain Risk Management Study (FRMS)* were to assess the impacts of flooding, review existing Council policies as they relate to development of land in flood liable areas bordering Burrangong Creek and its tributaries, consider options for management of flood affected land and to develop a *draft Floodplain Risk Management Plan (FRMP)* which:

i) Proposes modifications to existing Council policies to ensure that the development of flood affected land is undertaken so as to be compatible with the flood hazard and risk.

ii) Proposes *Flood Planning Levels* for the various land uses in the floodplain.

iii) Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding.

iv) Provides a program for implementation of the proposed works and measures.

The *FRMS* focusses on Main Stream flooding from Burrangong Creek and its major tributary streams (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek), Minor Tributary flooding caused by high flows in the minor un-named tributaries which drain to Burrangong Creek and its main tributaries, and Major Overland Flow (MOF) areas which occur in the three urban sub-catchments on the northern slopes (Railway Drain, Chance Gully and Golf Course Drain) which discharge to Burrangong Creek through the Central Business District (CBD) – **Figures 2.1** and **2.2**. Flooding problems on the MOF paths arise from surcharges of the trunk drainage systems, which comprise a mix of pipes, culverts and open drains.

The solutions of problems resulting from surcharges of minor drainage lines in streets or in individual allotments remote from the MOF paths, are matters for stormwater management by Council and are outside the scope of the present investigation.

S2 Study Activities

The activities undertaken in this *FRMS* included:

1. Review of flooding patterns in Burrangong Creek drainage system at Young for flood events up to the Probable Maximum Flood (PMF), as determined in the companion investigation *The Town of Young Flood Study, 2014* (**Chapter 2**).
2. Undertaking a consultation program over the course of the study to ensure that the Young community was informed of the objectives, progress and outcomes over the course of the study (**Appendix C**).
3. Assessment of the economic impacts of flooding, including the numbers of affected properties and estimation of damages (**Chapter 2** and **Appendix B**).
4. Review of current flood related planning controls for Young and their compatibility with flooding conditions and preparation of a draft *Flood Policy* to guide future development in flood prone areas of the town (**Chapter 2**, **Appendix A** and **Appendix D**).
5. Strategic review of potential floodplain management works and measures aimed at reducing flood damages, including an economic assessment of the most promising measures (**Chapter 3**).

6. Ranking of works and measures using a multi - objective scoring system which took into account economic, financial, environmental and planning considerations (**Chapter 4**).
7. Preparation of a draft *FRMP* for Young (**Chapter 5**).

S3 Summary of Flood Impacts

The study area comprises the Burrangong Creek floodplain within the urban area of Young and its environs. The catchment area of Burrangong Creek and its tributaries at the Sewage Treatment Plant (STP), the downstream end of the study area, is 77 km^2 (ref. **Figure 2.1**). This catchment area includes the three sub-catchments which drain the urban area on the northern side of the creek: Railway Drain, Chance Gully and the Golf Course Drain (ref. **Figure 2.2**). Flows are conveyed by the trunk drainage systems of these three Major Overland Flow (MOF) paths which are of relatively low capacity and surcharge at the 5 year Average Recurrence Interval (ARI) level of flooding, resulting in overland flows through adjacent residential development, as well as flooding in the CBD.

Main stream flooding on Burrangong Creek, its tributary streams and along the MOF paths is "flash flooding" in nature. On the main arms of the creek system, flood levels peak about two hours after the commencement of heavy rainfall. On the smaller, urban catchments the time to peak on the MOF paths is less than one hour. **Figure 2.3** shows the indicative extent of inundation for the 100 year ARI design flood. **Figure 2.4** shows times of rise of floodwaters at representative locations in the drainage system.

The channels of Burrangong Creek and its major tributary streams are incised and have a comparatively large hydraulic capacity, with flood events up to the 100 year ARI generally being conveyed without significant surcharges of the channels. Damages to urban development bordering the main creeks would not be significant at that level of flooding. However, significant damaging flooding would be experienced in existing residential and commercial – industrial development bordering the trunk drainage systems of the three MOF paths in the event of a 5 year ARI flood. Damages would progressively increase as shown in **Table 2.2** of the report. Above-floor flooding is predicted to occur in 19 residences, 54 commercial – industrial properties and two public buildings at the 100 year ARI level of flooding. Predicted damages to these categories of development would be about $3.73 Million. Depths of above-floor inundation in residential properties would be shallow in most cases; the median depth of inundation at the 100 year ARI would be about 250 mm. However, a depth of up to 600 mm would be experienced in two residences.

S4 Flood Risk and Development Controls

A draft *Flood Policy* has been prepared to guide future development in flood prone areas in Young (ref. **Appendix A)**. The policy is based on the presence of the three flow mechanisms: the deep and relatively fast moving flow in the Main Streams, the shallower and slower moving flow in the Minor Tributaries which drain to the Main Streams and the shallow and slow moving flow in the MOF paths. Controls over development are graded according to the flood risk. The delineation of flood risk zones is based on the proximity to flow paths, depths and velocities of flow, the rate of rise of floodwaters and ease of evacuation from the floodplain in the event of a flood emergency.

For Main Stream flooding, the floodplain has been divided into flood risk zones for areas inundated up to the Flood Planning Level - FPL (100 year ARI flood level plus an allowance of 500 mm for freeboard). The extent of the Flood Planning Area (FPA) in areas affected by Main Stream flooding has been defined as land which lies below the FPL.

For Minor Tributary flooding, a threshold depth of inundation greater than 150 mm at the 100 year ARI has been used to define the extent of the FPA in recognition of the shallower and slower moving nature of flow on the overbank areas of these streams. Similar to Main Stream flooding, a freeboard allowance of 500 mm for defining minimum floor levels has been set.

On the three MOF paths (Railway Drain, Chance Gully and the Golf Course Drain), the extent of flooding and associated controls are defined on an "allotment basis" rather than by the traditional Flood Planning Area (the area inundated by the 100 year ARI plus 500 mm freeboard). Properties located within the area defined as the Major Overland Flow Urban Precinct and with a threshold depth of inundation greater than 150 mm at the 100 year ARI are classed as "flood affected". However, the freeboard for defining minimum floor levels has been set at 300 mm in recognition of the shallow and slow moving nature of flow.

An Outer Floodplain has also been defined comprising the additional land flooded between the extent of the FPL and the PMF, as shown on the *Flood Planning Map* (refer **Figure A1.1** in **Appendix A**).

S5 The Floodplain Risk Management Plan

The draft *FRMP* showing recommended flood management measures for the Burrangong Creek floodplain is presented in **Table S1**. They have been given a provisional priority ranking, confirmed by the Floodplain Management Committee, according to a range of economic, social, environmental and other criteria set out in **Table 4.1** of the report.

The draft *FRMP* includes three "non-structural" management measures of a planning nature which could be implemented by Council with the assistance of New South Wales State Emergency Service (NSW SES), using existing data and without requiring Government funding.

The measures are as follows:

- **Measure 1** - The application of the graded set of planning controls for future development that recognise the location of the development within the floodplain; to be applied through the draft *Flood Policy* for Young, included in the report as **Appendix A**. Application of these controls by Council will ensure that future developments in flood liable areas in Young are compatible with the flood risk.
- **Measures 2** and **3** - Improvements in the NSW SES's emergency planning, including use of the flood related information contained in this study to assist with the preparation of the *Local Flood Plan* for the Young Shire. Information in this present report and in the companion report *The Town of Young Flood Study, 2014* which would be of assistance to NSW SES in the preparation of the *Local Flood Plan* includes data on the nature and extent of flooding in Young, times of rise of floodwaters and properties affected by flooding.

The fourth measure, which will need to be funded by Council, comprises the preparation of the *Dam Safety Emergency Plan (DSEP)* for the Chinaman's Dam located on Sawpit Gully a major tributary of Burrangong Creek. As the owner of the dam, which was overtopped in the December 2010 flood, Young Shire Council is required by the NSW Dam Safety Committee to prepare the *DSEP.*

- **Measure 4** is the preparation of the *DSEP,* which will provide a detailed assessment of the likelihood and consequences of a dam-break failure of the Chinaman's Dam and will assist NSW SES in the development of evacuation procedures in the event of an emergency. It will require survey, geotechnical investigation and hydraulic modelling, and could contain a recommendation for instrumentation to allow YSC to monitor storage levels and rainfall in the catchment.

  Preliminary hydraulic modelling undertaken in the *Flood Study* showed that a sudden failure of the dam in conjunction with the occurrence of a 100 year ARI flood would result in peak flood levels on Burrangong Creek along the frontage of the town which were about 1.5 m above natural flood levels. The consequences of a "Sunny Day" failure of the dam in the absence of significant flows in Sawpit Gully will also be evaluated.

The above measures have been given a **Priority 1** assessment and are considered to be an essential part of the *FRMP*.

The next two measures included in the draft *FRMP* relate to the mitigation of existing flooding in the three MOF paths on the northern side of Burrangong Creek:

- **Measure 5** – Drainage Feasibility Study to advance the concepts developed in this *FRMS* for improvements to the trunk drainage systems. The works would comprise increasing the capacity of the drainage systems of the Railway Drain, Chance Gully and Golf Course Drain. The works would involve the construction of new detention basins, as well as major diversion pipelines to capture overland flows and convey them to Burrangong Creek.

  A provisional "Combined Trunk Drainage Upgrade Scheme" comprising the above elements has been prepared as part of the *FRMS*. However, further technical investigation is required to refine this scheme than is possible in this study, which is strategic in nature. This investigation is required to confirm the engineering feasibility of the scheme, determine a program for staging the works, review options for funding the works and provide documentation to the standard necessary to support an application for Government funding for the detailed design and construction of the project. The study would refine the design concept and cost estimates developed in this report and would include additional survey, geotechnical investigation, engineering and economic analysis. Because it is needed in the short term to confirm requirements for upgrading the trunk drainage system, **Measure 5** has also been given a **Priority 1** ranking.

- **Measure 6** – Depends on the results of the Drainage Feasibility Study, **Measures 5**, and would comprise the preparation of the detailed design and documentation of the drainage upgrade scheme, followed by its staged construction as funding becomes available. Because of its medium to long term nature, this measure has been given a **Priority 2** ranking.

S6 Timing and Funding of FRMP Measures

The total estimated cost to implement the preferred floodplain management strategy (the non-structural measures, plus the Drainage Feasibility Study, followed by detailed design and construction) is $17.85 Million, exclusive of Council and NSW SES Staff Costs. The timing of the measures will depend on Council's overall budgetary commitments and the availability of Council and Government funds.

Assistance for funding qualifying projects included in the *FRMP* may be available upon application under the Commonwealth and State funded floodplain management programs, currently administered by Office of Environment and Heritage (OEH). Potential sources of funding Council's contribution to the upgrade of the trunk drainage system are reviewed in **Section 3.9.3**.

S7 Council Action Plan

1. Council finalises the *FRMS* report and approves the draft *FRMP* according to the procedure recommended in **Section 5.16**.
2. Council and NSW SES commence work on the "non-structural" measures in the *FRMP (***Measures 1** *to* **3***)*.
3. Council prepares the *Dam Safety Emergency Plan (DSEP)* for the Chinaman's Dam as required by the NSW Dam Safety Committee (**Measure 4**).
4. Council applies for Government Funding for the Drainage Feasibility Study comprising **Measure 5** of the *FRMP*.
5. Council establishes the program for staged construction of the measures comprising the Combined Trunk Drainage Upgrade Scheme as confirmed by the Drainage Feasibility Study.
6. Council to upgrade its stormwater management policy to mitigate the impacts of future development, in particular by developing an On Site Detention Storage Policy (ref. **Section 3.9.6**) and management measures in "Local Drainage" areas (ref. **Section 3.10**).

TABLE S1
RECOMMENDED MEASURES FOR INCLUSION IN
THE TOWN OF YOUNG DRAFT FLOODPLAIN RISK MANAGEMENT PLAN

Measure	Required Funding	Features of the Measure	Priority
1. Implement flood related controls over future development in flood prone areas in Young.	Council's staff costs	• Control development in floodplain as summarised in the draft *Flood Policy* (ref. **Section 3.10** and **Appendix A**). • *Flood Policy* caters for three types of flooding (ref. **Section 2.6** and **Appendix D**): **Main Stream** (Burrangong Creek and its main tributaries – Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek); **Minor Tributary** (minor un-named tributaries which drain to Burrangong Creek and its main tributaries) and **Major Overland Flow** through the urban part of town (Railway Drain, Chance Gully and Golf Course Creek). • Graded set of flood controls based on location within the *Flood Planning Area (FPA). For* **Main Stream** and **Minor Tributary** flooding, *FPA* is defined as land inundated by the 100 year ARI flood plus 500 mm. For areas affected by **Major Overland Flow**, *FPA* is defined as all allotments with depth of inundation greater than 300 mm. • Minimum floor levels for residential development to be 100 year flood level plus 500 mm in areas subject to **Main Stream** and **Minor Tributary** flooding; and 300 mm for areas affected by **Major Overland Flow**. Critical services and flood-vulnerable residential development (e.g. housing for aged persons and persons with disabilities) to be subject to more stringent controls than other land uses. • Council's evaluation of development proposals to use data presented in *The Town of Young Flood Study* and in this *FRMS.*	**Priority 1**: this measure is designed to mitigate the flood risk to future development and has a high priority for inclusion in the *FRMP*. It does not require Government funding.
2. Ensure flood data in *this Floodplain Risk Management Study and Plan* are available to the NSW SES for improvement of flood emergency planning.	NSW SES costs	• NSW SES should prepare the *Local Flood Plan for Young Shire* using information on flooding patterns, times of rise of floodwaters and flood prone areas identified in *The Town of Young Flood Study* and in this *FRMS.* • *Dam Safety Emergency Plan* for Chinaman's Dam (ref. **Measure 4** below) should be included as an Annex to the *Local Flood Plan*.	**Priority 1**: this measure would improve emergency response procedures and has a high priority. It does not require Government funding.
3. Implement flood awareness and education program for residents bordering the creeks.	Council staff costs	• Council to inform residents of the flood risk, based on the information presented in the *FRMS*. (e.g. displays of flood mapping at Council offices, preparation of flood awareness brochure for distribution with rate notices, etc).	**Priority 1**: this measure would improve the flood awareness of the community and has a high priority. It does not require Government funding.
4. *Dam Safety Emergency Plan* for Chinaman's Dam in Chinese Garden Reserve on Sawpit Gully.	$150,000	• The *DSEP* involves the following tasks (ref. **Table 3.11** for indicative budgets): • Geotechnical testing and reporting on the dam embankment. • Survey of the reservoir area to assess volume of storage. • Hydraulic modelling of "Sunny Day" and "Flood Induced" failure scenarios to assess consequences at Young.	**Priority 1:** this measure is required by the NSW Dam Safety Committee and will have to be funded by Council.
5. Drainage Feasibility Study for upgrading the trunk drainage systems on the three **Major Overland Flow** paths through the urban part of town.	$200,000	• Surveys of trunk drainage systems to confirm key details, including potholing to confirm levels of critical services. • Hydraulic modelling to confirm sizes of elements of the "Combined Trunk Drainage Upgrade Scheme". • Refine concept designs and cost estimates prepared in this *FRMS* to the Preliminary Design Stage. • Cost-benefit analysis to confirm the economic feasibility of the schemes and establish priorities for implementation. • Prepare a submission for Council and Government funding for detailed design and construction.	**Priority 1**: this measure would mitigate existing flooding problems. It would require Council and Government funding.
6. Detailed design and construction of the Combined Trunk Drainage Upgrade Scheme as recommended by **Measure 5** for upgrading the trunk drainage systems on the three **Major Overland Flow** paths.	$17.5 Million	• Tasks involved are as follows: • Prepare detailed design and documentation for drainage upgrade according to the priority list of elements established in Measure 5. • Prepare a submission for Council and Government funding. • Construct drainage improvements, staged as funds become available.	**Priority 2**: the works comprising this measure and their likely staging depends on the results of **Measure 5** above. This measure would mitigate existing flooding problems. It would require Council and Government funding. Note the required funding is an indicative present worth cost based on preliminary analyses undertaken in this *FRMS*. In recognition of Council's financial constraints, the works would need to be staged over the next 10 – 15 years.
Total Estimated Cost	**$17.85 Million**		

1 INTRODUCTION

1.1 Study Background

Young Shire Council, commissioned the preparation of the *Floodplain Risk Management Study and Plan* (*FRMS&P*) for Young in accordance with the New South Wales Government's Flood Prone Land policy. This report sets out the findings of the *FRMS&P* investigation, which uses information on flooding patterns under present day conditions set out in *The Town of Young Flood Study (*the *Flood Study),* which was adopted by Council in February 2014.

The *Floodplain Risk Management Study (FRMS)* reviewed baseline flooding conditions, including an assessment of economic impacts and the feasibility of potential measures aimed at reducing the impact of flooding on both existing and future development. This process allowed the formulation of the draft *Floodplain Risk Management Plan* (*FRMP*) for Young.

1.2 Background Information

The following documents were used in the preparation of this report.

- *The Town of Young Flood Study*, *2014*.
- *Young Local Environmental Plan 2010*.
- *Young Strategic Land Use Study – Towards 2030*.
- *Floodplain Development Manual, 2005.*

1.3 Overview of FRMS Report

The results of the *FRMS* and the draft *FRMP* are set out in this report. Contents of each Chapter of the report are briefly outlined below:

- **Chapter 2**, **Baseline Flooding Conditions**. This Chapter includes a description of the drainage system of the Burrangong Creek catchment and a review of existing flood behaviour in Young, as derived by the *Flood Study*. The Chapter summarises the economic impacts of flooding on existing urban development, reviews Council's flood planning controls and management measures and NSW SES's flood emergency planning for Young.
- **Chapter 3**, **Potential Floodplain Management Measures**. This Chapter reviews the feasibility of floodplain management options for their possible inclusion in the *draft FRMP.* The list of measures considered is based on input from the Community Consultation process, which sought the views of Young residents in regard to potential flood management measures which could be included in the *FRMP*. The measures are investigated at the strategic level of detail, including indicative cost estimates of the most promising measures and benefit/cost analysis. The Chapter also assesses the impacts of future urbanisation in the catchments, as envisaged by the *Young Strategic Land Use Study – Towards 2030* and the *Young Local Environmental Plan 2010.*
- **Chapter 4**, **Selection of Floodplain Management Measures**. This Chapter assesses the feasibility of potential floodplain management strategies using a multi-objective scoring procedure which was developed in consultation with the Floodplain Management Committee and outlines the preferred strategy.

- **Chapter 5** presents the ***draft Floodplain Risk Management Plan***. The *Plan* comprises a mix of investigation and construction of structural works aimed at increasing the capacity of the trunk drainage system, as well as non-structural measures aimed at increasing the flood awareness of the community and ensuring that future development is undertaken in accordance with the local flood risk.
- **Chapter 6** contains a list of References.

Five technical appendices provide further information on the study results:

Appendix A – **Draft Flood Policy** presents guidelines for the control of future urban development in flood prone areas in Young. The guidelines cater for both Main Stream and Minor Tributary flooding on the creek system, as well as overland flooding resulting from surcharging of the trunk drainage systems in the three overland flow paths draining the urban areas of Young on the northern side of Burrangong Creek.

Appendix B – **Flood Damages** is an assessment of the economic impacts of flooding to existing residential, commercial and industrial development in Young. These damages have been assessed using the results of the *Flood Study* and an estimate of floor levels and characteristics of affected development derived from a "drive-by" property survey, as well as data from the LiDAR aerial laser scanning survey used in the *Flood Study*.

Appendix C – Community Newsletter and Responses to Questionnaire summarises residents' views on potential flood management measures which could be incorporated in the *FRMP*.

Appendix D – Planning Controls in Land Subject to Major Overland Flow identifies land in urban areas of Young inundated by overland flow and recommends flood related planning controls over future development in those areas.

Appendix E – Peak Flows in the Trunk Drainage System contains peak flow data derived from the hydraulic modelling of measures to upgrade the system, using the TUFLOW model developed for the *Flood Study.*

1.4 Community Consultation

Following the Inception Meeting of the Floodplain Management Committee which included Council, Community, OEH and other Government agency representatives, a Community Newsletter was prepared by the Consultants and distributed to residents by Council. The Newsletter contained a Flood Questionnaire seeking details from the community of flood experience and attitudes to potential floodplain management options. Community responses are summarised in **Chapter 3** of the report, with supporting information in **Appendix C.**

Responses to the Flood Questionnaire provided information on the historic floods and flow patterns, in particular those resulting from severe storms which occurred in December 2010 and March 2012, but the data were mainly of a qualitative nature. The information was taken into account in the preparation of the *Flood Study*, which was adopted by Council after public exhibition of the draft report in February 2014. The views of the community on potential flood management measures to be considered in the study were also taken into account in the assessment presented in **Chapter 3** of the report.

The Floodplain Management Committee reviewed the potential flood management measures developed in **Chapter 3** and assessed the measures using the proposed scoring system of **Chapter 4**. The *draft FRMS* and accompanying *draft FRMP* were reviewed by the Committee and amended prior to public exhibition.

The draft report was placed on public exhibition over a 28 day period commencing 21 September 2015, with no submissions received by the closing date of 19 October 2015.

1.5 Flood Frequency and Terminology

In this report, the frequency of floods is referred to in terms of their Average Recurrence Interval (ARI). The frequency of floods may also be referred to in terms of their Annual Exceedance Probability (AEP).

The approximate correspondence between these two systems is:

Annual Exceedance Probability (AEP) – %	Average Recurrence Interval (ARI) – years
1	100
5	20
20	5

The AEP of a flood represents the percentage chance of its being equalled or exceeded in any one year. Thus a 1% AEP flood, which is equivalent to a 100 year ARI, has a 1% chance of being equalled or exceeded in any one year and would be experienced, on the average, once in 100 years; similarly, a 20 year ARI flood has a 5% chance of exceedance, and so on.

The 100 year ARI flood (plus freeboard) is usually used to define the ***Flood Planning Level*** (**FPL**) and ***Flood Planning Area*** (**FPA**) for the application of flood related controls over residential development. While a 100 year ARI flood is a major flood event, it does not define the upper limit of possible flooding. Over the course of a human lifetime of, say 70 years, there is a 50 per cent chance that a flood at least as big as a 100 year ARI will be experienced. Accordingly, a knowledge of flooding patterns in the event of larger flood events up to the "Probable Maximum Flood" (PMF), the largest flood that could reasonably be expected to occur, is required for emergency management purposes. In the *Flood Study*, flooding patterns were assessed for design floods ranging between a 5 year ARI event and the PMF.

2 BASELINE FLOODING CONDITIONS

2.1 Physical Setting

The town of Young has a population of about 7000 and is located in the South West Slopes region of NSW near the southern boundary of the Lachlan River catchment. It is the main town of the Young Shire Local Government Area and is the service centre to the surrounding rural community. At the 2011 census there were 3214 private dwellings in Young, of which 2730 were occupied.

Young has natural and built boundaries to urban development including the Blayney – Demondrille Railway Corridor and Burrangong Creek which flows through the centre of town (**Figure 2.2**). The town is dominated by a commercial grid on the northern side of Burrangong Creek surrounded by a variety of land uses including industrial, retail, and tourist uses, as well as health and medical services. Low to medium density residential subdivisions surround the commercial centre to the north, east and south, with large lot residential subdivisions in the outer ring of the urban structure. Horticulture and viticulture are mixed with the large lot residential subdivisions. The expansion of Young is occurring generally on the southern side of Burrangong Creek. There is also potential for residential growth in the presently rural areas on the northern side of Burrangong Creek to the north of Orchard Street.

2.2 Drainage System

Figure 2.1 is a plan of the urban part of Young showing the main drainage lines running through the town. Young is drained by streams which have their headwaters in the foothills surrounding the town and flow in a generally south to south-westerly direction through the urban area. Burrangong Creek is the main stream and traverses the town urban area, flowing westwards and eventually discharging to Bland Creek. Burrangong Creek has a catchment area of 77 km^2 at the Sewage Treatment Plant (STP) located about 2 km downstream of town. The STP was the downstream boundary of *The Town of Young Flood Study, 2014* (the *Flood Study),* which defined flooding patterns in the town. Garibaldi Gully and Victoria Gully drain the foothills to the east and north-east. Sawpit Gully and Petticoat Gully have their headwaters to the south of town. Two other tributary streams Big Spring Creek and Little Spring Creek approach Burrangong Creek from the south and join just upstream of the Milvale Road bridge crossing.

There are three small catchments: the Railway Drain, Chance Gully and Golf Course Drain catchments, which drain the northern side of town and flow through residential areas and the CBD before discharging to Burrangong Creek (**Figure 2.2**). Runoff from these catchments, which range between 10 ha and 1 km^2 in area, is conveyed to Burrangong Creek via trunk drainage systems. The systems are of limited capacity and are frequently surcharged during periods of heavy rainfall, with the resulting overland flows causing damaging flooding to residential, commercial and industrial development in the town. Measures aimed at upgrading their hydraulic capacity and mitigating the effects of surcharging by the construction of upstream detention basins, channel improvements, levees and diversion pipelines are reviewed in **Chapter 3** of the report.

Under the land use strategy developed in the *Young Strategic Land Use Study – Towards 2030* and subsequently incorporated in the Young LEP 2010, the rural areas bordering the streams on the southern side of Burrangong Creek are likely to be developed for residential use in future years, with the potential for an increase in downstream flood peaks. On the northern side of the creek, urbanisation is likely to occur in the area north of Orchard Street which would place further pressure on the already under-capacity trunk drainage systems. The potential increase in flood

flows and levels resulting from increased development in the catchments was modelled and strategies for managing impacts were considered. These results are presented later in **Chapter 3**.

2.3 Recent Flood Experience in Young

2.3.1 Main Stream Flooding

Significant flood events have occurred in Young, most recently in December 2010 and March 2012. The December 2010 was the more severe of the two events and occurred after heavy prior rainfall over the previous two weeks had saturated the catchments. Farm dams located on Sawpit Gully upstream of Chinese Gardens Reserve and on the other tributaries failed or were overtopped. The dam located at the Chinese Gardens Reserve (Chinaman's Dam) was overtopped and the NSW State Emergency Service (NSW SES) evacuated houses in the Boyds Street area about 0.5 km downstream, as a precaution against dam failure. Damage to infrastructure was experienced at several of the in-stream weirs across Burrangong Creek and at the Lachlan Street culvert on Victoria Gully. However, no significant damage to urban development was reported, as most of the flows were conveyed within the channels of the creeks. The mainstream channels are incised and capable of conveying major flood flows without significant overbank flow.

Representatives of the NSW Dam Safety Committee visited Young during the flood of December 2010 to inspect the dams and instructed the Council to prepare a *Dam Safety Emergency Plan* for Chinaman's Dam. To provide initial data on the consequences of a failure of the embankment during severe flooding, a preliminary dam-break analysis was included in the scope of work for the *Flood Study.* The analysis showed that a sudden failure of the dam during a major flood would significantly increase flood levels on Burrangong Creek along the frontage of the town. In the event of a dam failure occurring in conjunction with a 100 year ARI design flood, peak levels on Burrangong Creek would be up to 1.5 m higher than corresponding "natural" flood levels on the reach of Burrangong Creek between the McKenzie Street and Wombat Street bridge crossings. Additional areas of Young bordering the northern bank would be inundated, principally between Short Street and Wombat Street, where depths of inundation in urban development on the floodplain would exceed 1.3 m.

2.3.2 Overland Flooding from the Trunk Drainage Systems

The trunk drainage systems of Railway Drain, Chance Gully and Golf Course Drain have a comparatively low capacity and have suffered numerous surcharges in recent years, with resulting overland flows leading to flooding in adjacent residential areas and in commercial development to the south of the railway in the Central Business District (CBD) area (ref. **Figure 2.2**).

In the December 2010 flood, significant overland flows were reported due to surcharging of the three trunk drainage systems, which comprise a mix of piped and open channel reaches, as well as a detention basin on the Railway Drain upstream of Brock Street. (Several other basins are located within the drainage systems. However, their storages are too small to provide a significant reduction in downstream flows and are not shown on **Figure 2.2**). The area bordering Railway Drain downstream of the detention basin experienced extensive overland flows through residential allotments, across William Street, along Zouch Street and through Young Caravan Park. Overland flooding through residential allotments was also experienced on Chance Gully between William Street and Nasmyth Street.

The Railway Drain system joins that of Chance Gully to the south of Nasmyth Street and runs southwards beneath the railway. The hydraulic capacity of the combined system is controlled by the culvert south of the railway, which continues beneath the Tyrepower property, crossing Lovell Street, Lighting Lane and Boorowa Street and eventually joining Burrangong Creek at Thornhill Street. The limited hydraulic capacity of the culvert resulted in overland flooding in the areas south of the railway including the Young CBD. The local piped drainage system in the CBD is of limited capacity, generally comprising pipes between 450 and 600 mm in diameter and was not capable of capturing these overland flows, which caused flooding in numerous commercial properties.

2.4 Design Flooding Patterns

The *Flood Study* was an investigation of flooding in the Burrangong Creek system and defined flooding under present day conditions. The study involved computer modelling of the catchments and floodplains to assess flow patterns and indicative extents of inundation for a range of design floods from 5 year ARI up to the Probable Maximum Flood (PMF). The design storms used to determine flows in the drainage system were determined using accepted procedures set out in Australian Rainfall and Runoff (ARR, 1998). They assumed that *rainfall intensities were uniform over the areal extent of the contributing catchments*, although intensities varied over the duration of the storm event. Rainfall depths experienced during historic storms on the other hand can vary considerably over the catchment areas. This is the reason for the variation between patterns of flooding derived for design floods and patterns actually experienced during historic events.

Figure 2.3 shows the extents of inundation for the 100 year ARI design flood. The flood extents were defined from LiDAR (Light Detection and Ranging) aerial survey and field survey of the creeks, which were used to develop the hydraulic model of the drainage system developed in the *Flood Study*. The hydraulic analysis employed two-dimensional technology (in plan) and was based on a geometric model of the floodplain based on grid points of natural surface levels at 5 m grid spacing. The extents of inundation shown on **Figure 2.3** are “indicative” reflecting the accuracy of the LiDAR survey (68 per cent of the points lie within +/- 150 mm of the true elevation).

In order to create realistic results which remove most of anomalies caused by inaccuracies in the LiDAR, a filter is sometimes applied to remove depths of inundation over the natural surface less than 50 - 150 mm. This has the effect of removing the very shallow depths which are more prone to be artifacts of the model. However, in the present case, modelled depths of inundation less than 50 mm have been displayed to allow a clearer representation to the reader of the three overland flow paths in the urban areas on the northern side of Burrangong Creek; as well as the pattern of shallow overland flow approaching the main arms of the creek system in the rural areas (for example, the shallow overland flow heading westwards from the Olympic Highway to Big Spring Creek – ref. **Sheet 1** of **Figure 2.3**).

It is to be noted that while the flood level and velocity data derived from the analyses are consistent throughout the model, the flood extent diagrams should not be used to give a precise determination of depth of flood affectation in individual allotments. Site survey would be required to confirm the degree of flood affectation or otherwise of individual allotments.

Flooding on the main streams is “flash flooding” in nature, with water levels on the rising to their peaks within 2 hours after the commencement of heavy rainfall. The three urban catchments on the northern side of town respond more quickly to heavy rainfall and peak within 30 to 60 minutes

of the commencement of the storm. The stage and discharge hydrographs on **Figure 2.4** show the times of rise of floodwaters at representative locations for the "critical" design storms of 100 year ARI. The critical storm is the storm duration which maximises flood levels at the particular location on the drainage system.

2.5 Flood Hazard and Hydraulic Categorisation of the Floodplain

According to Appendix L of the *Floodplain Development Manual, (FDM, 2005)*, in order to achieve effective and responsible floodplain risk management, it is necessary to divide the floodplain into areas that reflect:

1. The impact of flooding on existing and future development and people. To examine this impact it is necessary to divide the floodplain into *"flood hazard"* categories, which are provisionally assessed on the basis of the velocity and depth of flow. This task was undertaken in the *Flood Study* where the floodplain was divided into *low hazard* and *high hazard zones*. In this present report, a *final determination* of hazard was undertaken which involved consideration of a number of additional factors which are site specific to the urban area of Young. **Section 2.5.1** below provides details of the procedure adopted.
2. The impact of future development activity on flood behaviour. Development in active flow paths (i.e. *"floodways"*) has the potential to adversely re-direct flows towards adjacent properties. Examination of this impact requires the division of flood prone land into various *"hydraulic categories"* to assess those parts which are effective for the conveyance of flow, where development may affect local flooding patterns. Hydraulic categorisation of the floodplain of Burrangong Creek, its main tributaries and the overland flow paths was also undertaken in the *Flood Study* and was reviewed in this present investigation. **Section 2.5.2** below summarises the procedure adopted.

2.5.1 Flood Hazard Categorisation

As mentioned above, flood prone areas may be *provisionally* categorised into *Low Hazard* and *High Hazard* areas depending on the depth of inundation and flow velocity. A flood depth of 1 m in the absence of significant flow velocity represents the boundary between *Low* and *High Hazard* conditions. Similarly, a flow velocity of 2.0 m/s but with a small flood depth around 200 mm also represents the boundary between these two conditions. Interpolation may be used to assess the hazard for intermediate values of depth and velocity. Flood hazards categorised on the basis of depth and velocity only are *provisional*. They do not reflect the effects of other factors that influence hazard.

These other factors include:

1. Size of flood – major floods though rare can cause extensive damage and disruption.
2. Effective warning time – flood hazard and flood damage can be reduced by sandbagging entrances, raising contents above floor level and also by evacuation if adequate warning time is available.
3. Flood awareness of the population – flood awareness greatly influences the time taken by flood affected residents to respond effectively to flood warnings. The preparation and promotion by Council of Flood Studies and Floodplain Risk Management Studies and Plans increases flood awareness, as does the formulation and implementation of response plans by NSW SES (Local Flood Plans) for the evacuation of people and possessions.

4. Rate of rise of floodwaters – situations where floodwaters rise rapidly are potentially more dangerous and cause more damage than situations in which flood levels increase slowly.
5. Duration of flooding – the duration of flooding (or length of time a community is cut off) can have a significant impact on costs associated with flooding. This duration is shorter in smaller, steeper catchments.
6. Evacuation problems and access routes – the availability of effective access routes from flood prone areas directly influences flood hazard and potential damage reduction measures.

Provisional hazard categories may be reduced or increased after consideration of the above factors in arriving at a final determination. A qualitative assessment of the influence of the above factors on the *provisional flood hazard* (i.e. the hazard based on velocity and depth considerations only) is presented in **Table 2.1**, over the page. Factors which would increase the flood hazard in **Table 2.1** are balanced by considerations reducing the hazard. Consequently, on balance there would be no reason to adjust the *provisional f*lood hazard determined in the *Flood Study.*

2.5.2 Hydraulic Categorisation of the Floodplain

According to the *FDM, 2005*, the floodplain may be subdivided into the following zones:

- ***Floodways*** are those areas where a significant volume of water flows during floods and are often aligned with obvious natural channels. They are areas that, even if partially blocked, would cause a significant increase in flood level and/or a significant re-distribution of flow, which may in turn adversely affect other areas. They are often, but not necessarily, areas with deeper flow or areas where higher velocities occur.
- ***Flood Storage*** areas are those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. If the capacity of a flood storage area is substantially reduced by, for example, the construction of levees or by landfill, flood levels in nearby areas may rise and the peak discharge downstream may be increased. Substantial reduction of the capacity of a flood storage area can also cause a significant redistribution of flood flows.
- ***Flood Fringe*** is the remaining area of land affected by flooding, after floodway and flood storage areas have been defined. Development in flood fringe areas would not have any significant effect on the pattern of flood flows and/or flood levels.

In determining appropriate hydraulic categories, it is important that the *cumulative* impact of progressive development be evaluated, particularly with respect to floodway and flood storage areas. Whilst the impact of individual developments may be small, the *cumulative* effect of the ultimate development of the area can be significant and may result in unacceptable increases in flood levels and flood velocities elsewhere in the floodplain.

The procedure adopted for hydraulic categorisation is discussed in more detail in the *Flood Study*. It was based on the experience of the flood modellers, together with consideration of the findings of previous investigators who have defined floodway areas mainly on the basis of velocity and depth of flow. The ability of the TUFLOW hydraulic model to show both the directions and magnitudes of flow as scaled vector arrows also assisted with the assessment of the significance of the various flow paths.

TABLE 2.1
INFLUENCE OF FLOOD RELATED PARAMETERS ON PROVISIONAL FLOOD HAZARD

Parameter	Influence on Provisional Hazard	Flood Characteristics
Size of flood	0	Inundation in the three overland flow paths on the northern side of Burrangong Creek is comparatively shallow (up to 500 mm deep) and slow moving, with no sudden increases in depth of flow, islands, or alternative flow paths developing with increasing severity of flooding. Main Stream flooding in Burrangong Creek and its main tributaries is contained within the extent of the incised channels even for major flood events. There are no islands formed on the floodplain which would present evacuation difficulties during major floods.
Effective warning time	1	There is presently no formal flood warning system in Young. Due to the rapid response of the catchments a system based on the commencement of heavy rainfall would only provide a short warning time limited to one to two hours. The short warning time would tend to increase the provisional flood hazard.
Flood awareness	-1	Flood awareness appears to be quite high due to the occurrence of the recent storms of December 2010 and March 2012, as well as the historic record of frequent surcharges of the trunk drainage system.
Rate of rise and velocity of floodwaters	1	Flooding is of a "flash flooding" nature, with the main streams rising to a peak within two hours of the commencement of heavy rainfall and around one hour on the overland flow paths. This would tend to increase the flood hazard, although the hazard could be reduced by educating the community about flood risk.
Duration of flooding	0	The duration of the flood peak is quite short. On the main streams the flood peak lasts for three to four hours. On the three overland flow paths the flood recedes less than one hour after the cessation of heavy rainfall (ref. **Figure 2.4**).
Evacuation problems	– 1	Access across Burrangong Creek in the urban areas of Young during major flooding is maintained via the high level bridges located along the frontage of town. On the three overland paths, the flow is comparatively shallow and there is easy evacuation by foot from the residential areas to higher ground. Vehicular access would be interrupted for up to an hour due to several streets acting as floodways. Similarly, vehicular access may be interrupted in the CBD area due to flooding in the streets. (ref. **Figure 2.3**, **Sheet 3**). Evacuation problems would not be significant.

Legend 0 = neutral impact on provisional hazard
1 = tendency to increase provisional hazard
– 1 = tendency to reduce provisional hazard

2.6 Recommended Sub-Division of the Floodplain

The draft *Flood Policy* for Young (**Appendix A**) used the concepts of *flood hazard* and *hydraulic categorisation* outlined in the previous sections to develop flood related controls for future development in flood prone land at Young. The *Flood Policy* caters for the three types of flooding in the Young area:

- **Main Stream** flooding resulting from overflows of the channels of Burrangong Creek and its major tributaries. These flows may be several metres deep in the channels and relatively fast moving. Main Stream flooding occurs when flows surcharge the channels of Burrangong Creek and its main tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek).
- **Minor Tributary** flooding caused by high flows in the minor un-named watercourses which drain to Burrangong Creek and its main tributaries. While the depth of flow in the inbank area of the channels is typically greater than 500 mm, flow on the overbank area is generally shallow and slow moving in nature.
- **Major Overland Flow** (**MOF**) on the flow paths of the three urban catchments on the northern side of Burrangong Creek (Railway Drain, Chance Gully and Golf Course Drain), which travels southwards as shallow, slow moving flow over the natural surface in these ill-defined watercourses and eventually joins Burrangong Creek. Flows on the MOF paths would typically be around 300 - 500 mm deep, travelling over the surface at velocities less than 0.5 m/s. Shallow overland flow also results from surcharge of the un-named minor watercourses in the rural parts of the floodplain which drain to the Main Stream system.

The *Flood Policy* is supported by the Working Paper included as **Appendix D** in this report, which was prepared to identify areas in the urban part of town which are inundated by overland flows and recommend flood related Planning Controls for future development in those areas. **Appendix D** also sets out recommendations for amendments to the Flood Planning Clause 6.6 in the LEP 2010, as well the inclusion of a new clause entitled “Floodplain risk management” (ref. **Section 2.7** below).

Figures A1.1 in **Appendix A** is the *Flood Planning Map* for Young. The figure includes flooding in the main streams and minor tributaries in the presently rural part of the study area, which extends to the east and south of the developed part of town, and continues downstream to the Sewage Treatment Plant. The extent of the FPA (the area subject to flood related development controls) is shown in a solid red colour in **Figure A1.1** and has been defined as follows:

- In areas subject to **Main Stream** flooding, the FPA is based on the traditional definition of the area inundated by the 100 year ARI plus 500 mm freeboard.
- In areas subject to **Minor Tributary** flooding, the FPA is defined as the extent of the High and Low Hazard Floodway zones, in combination with areas where depths of inundation in a 100 year ARI event exceed 150 mm.
- In areas subject to **MOF**, the FPA is defined as the extent of the High and Low Hazard Floodway zones, in combination with areas where depths of inundation in a 100 year ARI event exceed 150 mm. Properties that are intersected by the extent of the Floodway zones or are subject to depths of inundation greater than 150 mm have also been defined as FPA.

It is proposed that properties intersected by the extent of the FPA would be subject to S149 flood affectation notification and planning controls graded according to flood hazard (dependent on depth of inundation and flow velocity). **Annexures 2.1** and **2.2** in **Appendix A** set out the graded set of flood related planning controls which have been developed for Young. **Annexure 2.1** deals with areas subject to both Main Stream and Minor Tributary flooding, while **Annexure 2.2** deals with areas in the Major Overland Flow Urban Precinct that are subject to MOF. **Figure A1.2** in **Appendix A** is the *Development Controls Matrix Map* for Young and shows the area over which both **Annexures 2.1** and **2.2** apply.

Figures A1.3 in **Appendix A** is the *Flood Hazard Map* for Young. The figure shows the sub-division of the floodplain into the following four categories which have been used as the basis for developing the graded set of planning controls for Young:

- **High** and **Low Hazard Floodway** zones which are shown in **Figure A1.3** in solid red and yellow colour, respectively. Future development in these areas is not permitted, with the exception of the Low Hazard Floodway areas located within the Major Overland Flow Urban Precinct, where residential, business and commercial/industrial type development can occur subject to compliance with a prescribed set of flood related development controls.
- **Intermediate Floodplain**, which is shown in solid blue in **Figure A1.3**. The extent of the Intermediate Floodplain, excluding Floodway zones matches the extent of the FPA. Development of all types is permitted in this area subject to compliance with a prescribed set of flood related development controls.
- **Outer Floodplain**, which is shown in **Figure A1.3** in solid cyan. The Outer Floodplain is defined as the area which lies between the extent of the PMF and the FPA.[1] While flood related development controls would not apply to residential, business and commercial/industrial type development in this area, controls would still apply to development with particular evacuation or emergency response issues (e.g. residential care facilities, group homes, hospitals, etc).

In properties subject to S149 flood affectation notification, minimum floor level requirements have been set equal to the 100 year ARI flood level plus 500 mm freeboard in areas subject to Main Stream and Minor Tributary flooding, while in areas subject to MOF the freeboard provision has been reduced to 300 mm in recognition of the low hazard nature of this type of flooding.

2.7 Council's Existing Planning Instruments and Policies

The Young Local Environmental Plan (LEP 2010) is the principal statutory planning document used by Young Shire Council for controlling development by defining zoning provisions, establishing permissibility of land use and regulating the extent of development in the town. The *Young Shire Strategic Land Use Study - Towards 2030* which was prepared in 2008, examined the economic, social and environmental settings of the Shire and prepared land use strategies for the benefit of the LEP.

[1] The extent of the PMF at Young has been trimmed to include areas where the depth of inundation exceeds 150 mm.

2.7.1 Land Use Zoning – Young LEP 2010

Figure 2.5 shows the zonings incorporated in LEP 2010 superimposed on the various sub-catchments of the drainage system of Burrangong Creek and its tributaries.

On the northern side of Burrangong Creek the area of Young zoned *R1 General Residential* extends beyond the currently urbanised limits to the northern boundaries of the Railway Drain and Chance Gully catchments. Urbanisation of currently rural land is likely to result in an increase in downstream flood peaks in those catchments which will need to be managed. Similarly, increased development in and adjacent to the CBD area (in land zoned *B4 Mixed Use*) has the potential to exacerbate existing flooding problems, although to a lesser extent (ref. **Section 3.9.4** and **Figures 3.20** and **3.21** for the results of hydraulic modelling of the impacts of urbanisation and consideration of flood management measures).

On the southern side of Burrangong Creek increased flows are likely to occur due to future development in currently rural land zoned *R1 General Residential* in the catchments of Big Spring Creek, principally on the eastern side of the catchment between Purchas Street and Burrangong Creek, and in the Petticoat Gully catchment, where the largely undeveloped area between Burrangong Creek southwards towards Tierney Street is zoned *R1 General Residential*. The western side of the Sawpit Gully catchment downstream of Chinaman's Dam has also been zoned *R1 General Residential*.

Future urbanisation, particularly in land zoned *R1 General Residential,* is likely to result in changes in the existing drainage system. Existing minor watercourses are likely to be retained and formalised in drainage reserves. However, piped drainage systems associated with urban sub-divisions will result in significant amendments to existing overland flow paths leading to the watercourses. As noted previously, Council will need to upgrade its stormwater management policy to cater for future development in areas of the rural floodplain classified as "Local Drainage".

The zonings of land elsewhere in the drainage system comprise *R5 Large Lot Residential*, *RU4 Rural Small Holdings* and other uses where potential development will be less intense in terms of increase in impervious area and is not likely to result in significantly increased flood flows.

2.7.2 Flood Provisions - Young LEP 2010

Clause 6.6 of LEP 2010 entitled "Flood Planning" outlines its objectives in regard to development of flood prone land. It is similar to the standard Flood Planning Clause used in recently adopted LEPs in other NSW country centres and applies to land beneath the Flood Planning Level (FPL).

The FPL referred to is the 100 year ARI flood plus an allowance for freeboard of 500 mm. The area encompassed by the FPL is known as the Flood Planning Area (FPA) and denotes the area subject to flood related development controls, such as locating development outside high hazard areas and setting minimum floor levels for future residential development. It is now standard practice for the residential FPL to be based on the 100 year ARI flood plus appropriate freeboard unless exceptional circumstances apply.

Whilst appropriate for Main Stream flooding, the present clause 6.6 would have resulted in a large part of the urban area which is affected by shallow overland flow being subject to flood affectation notification on Planning Certificates issued under S149 of the EP&A act. It would have also resulted in flood related development controls being applied to land which is presently rural in nature where the flood risk is very low.

To implement the approach recommended in **Appendix D** and outlined in **Section 2.6** above, clause 6.6 of LEP 2010 would require amendment to simply state that flood related development controls for Young apply to land identified as FPA on the *Flood Planning Map* or other land at or below the FPL. Suggested amendments are given in **Appendix D**. The revised LEP would need to be supported by the *Flood Policy* in **Appendix A** of the *FRMS&P* report which sets out specific requirements for development in flood liable areas based on the flood extent and hazard mapping contained in the *Flood Study*. **Figure A1.1** of **Appendix A** shows the proposed *Flood Planning Map* referred to in the revised clause 6.6.

It is also recommended that a new floodplain risk management clause be include in the Young LEP. The objectives of the new clause are as follows:

- in relation to development with particular evacuation or emergency response issues (e.g. group homes, residential care facilities, hospitals, etc) to enable evacuation of land subject to flooding in events exceeding the flood planning level; and
- to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land identified as Outer Floodplain (i.e. land which lies between the FPA and the PMF). Suggested wording in relation to this new clause is given in **Appendix D**.

2.8 Impacts of Climate Change

Consideration was given to the impacts on design flood levels of future climate change when estimating freeboard requirements on minimum floor levels of future development (Flood Planning Levels).

Office of Environment and Heritage (OEH) recommends that its guideline *Practical Consideration of Climate Change, 2007* be used as the basis for examining climate change in projects undertaken under the State Floodplain Management program and the *FDM, 2005*. The guideline recommends that until more work is completed in relation to the climate change impacts on rainfall intensities, sensitivity analyses should be undertaken based on increases in rainfall intensities ranging between 10 and 30 per cent.

On current projections the increase in rainfalls within the service life of developments or flood management measures is likely to be around 10 per cent, with the higher value of 30 per cent representing an upper limit which may apply near the end of the century. Under present day climatic conditions, increasing the 100 year ARI design rainfall intensities by 10 per cent would produce a 200 year ARI flood; and increasing those rainfalls by 30 per cent would produce a 500 year ARI event.

By inspection of the afflux data (i.e. increase in peak flood levels compared with present day conditions) derived from the hydraulic modelling undertaken in the *Flood Study*, the impact of climate change on Main Stream flooding patterns in Burrangong Creek and its tributaries; as well as in the three overland flow paths may be summarised as follows:

2.8.1 Main Stream Flooding in Burrangong Creek and its Major Tributaries

1. For the 10 per cent increase in 100 year ARI rainfalls, there would be an increase of between 200 and 500 mm in flood levels on Burrangong Creek along the frontage of the town between the junction with Victoria Gully and the STP. There would be a small increase in the extent of inundation in the developed area on the northern bank in the Marina Street area between Wombat Street and Short Street. However, in general the

widening of the extent of inundation along the main arm of Burrangong Creek and the impacts to properties would not be significant due to the incised nature of the creek and the ability of the channel to convey major flood events. For the 30 per cent increase in rainfalls the increase in flood levels may increase beyond 500 mm, with a corresponding increase in the extent of inundation between Wombat Street and Short Street. Otherwise the increases in flood extents would generally be confined to undeveloped areas bordering the creek downstream of the confluence with Little Spring Creek.

2. On the tributaries in the areas zoned for future development on the southern side of town (bordering Little Spring Creek, Big Spring Creek and Petticoat Gully), the increase in 100 year ARI flood levels due to 10 per cent increase would be limited to between 100 and 200 mm; because of the incised nature of the creek channels, the increase in flood extent would not be significant. For the 30 per cent increase, the corresponding increases in flood levels could reach between 300 and 500 mm, with lesser increases applying further upstream along these streams. With a 30 per cent increase in rainfalls, rises in flood levels of up to 100 mm could be expected on the minor watercourses draining westwards as shallow overland flow from the Olympic Highway to Big Spring Creek in the Habermans Lane area. Similar rises in the watercourses draining eastwards to Big Spring Creek would be expected. The additional area of land flooded at the 100 year ARI is not significant. Future climate change is not likely to significantly reduce land available for future development.

3. A small increase in flow velocities within the inundated area running along the main arms, could occur but no sudden increase in the provisional flood hazard due to increased flood depths and flow velocities would be experienced.

4. No islands or new flow paths would be created. Flow would continue to follow its existing course along the central threads of the creeks.

5. There may be a small reduction in the time of rise of the floodwaters. Burrangong Creek and its tributaries are “flash flooding” streams (**Figure 2.4**). On-going community education of the nature of flooding via Council and NSW SES is required to limit risks to people and property. NSW SES should also improve its emergency planning by the completion of the *Local Flood Plan* for the Young Shire (ref. **Section 2.10**).

2.8.2 Minor Tributary Flooding in Un-named Watercourses Draining to Burrangong Creek and its Major Tributaries

1. For the 10 per cent increase in 100 year ARI rainfalls, there would be an increase of between 10 and 50 mm, with only a very limited increase in the extent of inundation. For the 30 per cent increase, the rise in flood levels would generally not exceed 50 mm, with the exception of few isolated areas where increases of greater than 500 mm could be expected, namely on the upstream side of major hydraulic structures.

2. Similar to areas subject to Main Stream flooding, the additional area of land flooded at the 100 year ARI is not significant. Future climate change is also not likely to significantly reduce land available for future development in areas subject to Minor Tributary flooding.

3. A small increase in flow velocities within the inundated area running along the inbank area of the minor watercourses could occur but no sudden increase in the provisional flood hazard due to increased flood depths and flow velocities would be experienced.

4. No islands or new flow paths would be created. Flow would continue to follow its existing course along the central threads of the minor watercourses.

2.8.3 Major Overland Flow - Northern Side of Burrangong Creek

1. For the 10 per cent increase in 100 year ARI rainfalls, the corresponding increase in flood levels in the urban areas bordering the three principal overland flow paths (Railway Drain, Chance Gully and Golf Course Drain) would be in the range 20 to 100 mm, with only a very limited increase in the extent of inundation, principally on Railway Drain. For the 30 per cent increase, the rise in flood levels would be in the 200 to 300 mm range in isolated areas of Chance Gully downstream of William Street. There would be a similar increase in flood levels in the Lovell Street area between Main Street and Clarke Street.
2. Principally for the 30 per cent increase in rainfalls, there would be a widening in the extent of inundation along the three arms, extending from their headwaters as far as the railway, with a corresponding increase in flood extents within the CBD area.
3. A small increase in flow velocities in the overland flow paths would be experienced due to the increased discharges and depths of inundation.
4. No new flow paths would be created. The overland flows would continue to follow their existing courses through the urban areas of Young.

Given the current uncertainties in the estimation of increased rainfalls resulting from climate change and its timeframe, it is considered that its impacts on peak flood levels in areas subject to flooding could reasonably be catered for within the proposed freeboards (500 mm for Main Stream and Minor Tributary flooding and 300 mm on Major Overland Flow paths), with a reasonable margin remaining for other uncertainties such as local hydraulic effects and wave action.

2.9 Economic Impacts of Flooding

The economic consequences of floods are discussed in **Appendix B**, which assesses flood damages to residential, commercial and industrial property and public buildings in the floodplain. There are no data available on historic flood damages to the urban sectors in the study area. Accordingly it was necessary to use data on damages experienced as a result of historic flooding in other urban centres. The residential flood damages were based on the publication *Floodplain Guideline Number 4, 2007* published by DECCW (now OEH). Damages to industrial and commercial development and public buildings were evaluated using data from previous floodplain management investigations in NSW.

It is to be noted that the principal objectives of the damages assessment were to gauge the severity of urban flooding likely to be experienced at Young and also to provide data to allow the comparative economic benefits of various flood mitigation measures to be evaluated in **Chapter 3** of the report. As explained in **Appendix B**, it is not the intention to determine the depths of inundation or the damages accruing to *individual properties*, but to obtain a reasonable estimate of damages experienced over the extent of the urban area of Young for the various design flood events. The estimation of damages using *Floodplain Guideline Number 4* (in lieu of site specific data determined by a loss adjustor) also allows a uniform approach to be adopted by Government when assessing the relative merits of measures competing for financial assistance in flood prone centres in NSW.

Damages were estimated for the design flood levels determined from the hydraulic model set up for the *Flood Study*. Elevations of the floors of affected properties were estimated by a field inspection which assessed the height of floors above local natural surface elevations. These

natural surface elevations were derived from the LiDAR survey used to construct the hydraulic model. The numbers of properties predicted to experience "above-floor" inundation, together with estimated flood damages are listed on **Table 2.2**.

TABLE 2.2
ECONOMIC IMPACTS OF FLOODING
AT YOUNG - PRESENT DAY DEVELOPMENT

Flood Event ARI	Properties Flooded Above-Floor Level and Flood Damages						Total Flood Damages
	Residential		Commercial /Industrial		Public Buildings		
	No.	$ Million	No.	$ Million	No.	$ Million	$ Million
5	2	0.26	10	0.12	1	Neg.	0.38
20	8	0.91	29	0.59	1	Neg.	1.50
100	19	1.86	54	1.85	2	0.03	3.73
200	23	2.17	65	2.21	3	0.03	4.41
PMF	75	7.11	157	41.91	9	1.44	50.46

Note: Damages are based on *design flood levels*, as computed in *The Town of Young Flood Study, 2014,* and floor levels as estimated in a "drive by" survey of the urban areas.

The *Flood Study* showed that surcharges of the trunk drainage system on the northern side of town would occur in some areas at the 5 year ARI level of flooding, with overland flooding extending into adjacent residential allotments. It is predicted that 70 residential properties bordering the three overland flow paths on the northern side of Burrangong Creek would be flood affected (that is, with water in their allotments) in the event of a 100 year ARI flood, of which 19 residences would experience above-floor inundation. Eleven of those residences are located on Chance Gully, five on Railway Drain and three on Golf Course Drain.

Flooding to commercial/industrial development in the CBD area would also occur due to overland flooding. At the 100 year ARI, 54 commercial/industrial properties are predicted to experience above-floor inundation.

Total predicted damages to urban development due to overland flooding at the 100 year ARI amount to $3.73 Million. Damages to urban development due to main stream flooding from Burrangong Creek and its tributaries would not be significant.

The design flood levels used for computing the economic impacts shown in **Table 2.2** assume that the trunk drainage drainage system is operating at optimum capacity and do not allow for increased levels resulting from wave action, debris build-ups in the channels which may result in partial blockage of culverts, as well as other local hydraulic effects. These factors are usually taken into account by adding a factor of safety (freeboard) to the nominal flood level when assessing the true "level of protection" of a particular property against flooding. Freeboard is related to the velocity of flow, which is itself dependent on the bed slope and hydraulic roughness of the drainage system. Flow velocities tend to increase with peak flow and therefore increasing the freeboard with increase in flood magnitude could be justified. For the present analysis, a freeboard allowance was adopted which increased from 300 mm for the 20 year ARI to 500 mm for the 100 year ARI flood. No freeboard was allowed for the 5 year ARI event.

Flood damages were also computed for flood levels based on the design flood levels plus the above freeboards. The numbers of flooded properties and flood damages are listed on **Table B8.1 of Appendix B**. In the event of a 100 year ARI flood, 82 residential properties are predicted to experience above-floor inundation and the total predicted flood damages to urban development amount to $17.98 Million; about 4.8 times the value of total damages computed for design flood levels.

2.10 Flood Warning and Flood Preparedness

2.10.1 Flood Response Planning at Young

The New South Wales State Emergency Service (NSW SES) is nominated as the principal combat and response agency for flood emergencies in NSW. NSW SES is responsible for the issuing of relevant warnings (in collaboration with the Bureau of Meteorology - BOM), as well as ensuring that the community is aware of the flood threat and how to mitigate its impact. The BOM operates a flood warning system which provides predictions of gauge heights at a number of towns in the Lachlan Valley, but does not provide specific warning information for Young. However, there are no flood gauges on the Burrangong Creek system.

There is presently no Local Flood Plan which covers preparedness measures, the conduct of response operations and the coordination of immediate recovery measures for all levels of flooding within the Young Shire area. The draft *FRMP* set out in **Chapter 5** includes a recommendation that NSW SES prepare a Local Flood Plan for Young which incorporates information contained in this report, as well as the recently completed *Flood Study*.

The *Young Local Flood Plan* would be administered by the Young NSW SES Local Controller who controls flood operations within the YSC area, which is located within the Southern Highlands NSW SES Region. It would be divided into the following parts according to the standard NSW SES template:

- ***Introduction****;* this section of the *Local Flood Plan* will identify the responsibilities of the Young NSW SES Local Controller and NSW SES members and supporting services such as the Police, BOM, Ambulance, Country Energy, Fire Brigades, Department of Community Services, Young Shire Council, etc. In addition to providing emergency management services for normal flood events, Council will maintain and operate the Dam Safety Emergency Plan for Chinaman's Dam which it has been instructed to prepare by the Dam Safety Committee following the December 2010 storms. The *Local Flood Plan* will identify the importance for NSW SES and Council to coordinate the development and implementation of a public education program to advise the population of the flood risk. **Annex A – The Flood Threat** will use data contained in the *Flood Study* and this present report to describe the nature of flooding in Young.
- ***Preparedness****;* this section will deal with activities required to ensure the *Local Flood Plan* functions during the occurrence of the flood emergency. The *Plan* will devote considerable attention to flood alert and emergency response procedures to be followed in the event of imminent failure of Chinaman's Dam.
- ***Response***. The Young NSW SES maintains an operation centre at the Local NSW SES Headquarters at Rockdale Road which is located on the western side of town north of the railway. Response operations will commence: on receipt of a severe weather warning for flash flooding from BOM; on receipt of a dam failure alert for Chinaman's Dam; or when other evidence leads to an expectation of flooding within the Shire. Sources of Flood Intelligence identified will include the BOM, Southern Highlands Region headquarters and YSC.

The Burrangong Creek system has no monitored flood gauges and therefore no flood warnings are issued by BOM for Young Shire. The NSW SES and YSC monitor the potential problem areas. **Annex B – Effects of Flooding on the Community** will list the flood affected areas at Young.

- ***Recovery,*** involving measures to ensure the long term welfare for people who have been evacuated, recovery operations to restore services and clean up and de-briefing of emergency management personnel to review the effectiveness of the *Local Flood Plan.*

2.10.2 Incorporation of Flood Data from FRMS&P Report in Local Flood Plan

NSW SES should ensure information contained in this report on the impacts of flooding on urban development, as well as recommendations regarding flood warning and community education are incorporated in the *Local Flood Plan*, specifically in **Annexes A** and **B** therein:

Annex A – The Flood Threat includes the following sub-sections:

A1 Land Forms and River Systems – ref. **Sections 2.1** and **2.2** of the report for information on these topics.

A2 Characteristics of Flooding – Indicative extents of inundation and areas subject to high hazard during major floods are presented in the *Flood Study* and in this report (**Figure 2.3** and **Figure A1.2** of **Appendix A**). Typical times of rise of floodwaters at key locations on both the Main Stream and overland flow paths are shown on **Figure 2.4**.

A3 Flood History – Recent flood experience at Young is discussed in **Section 2.3** of the report, while the results of modelling the two recent storms of December 2010 and March 2012 are presented in the *Flood Study.*

A4 Flood Mitigation Systems – The only significant flood mitigation system on the drainage system is the retarding basin on the Railway Drain located upstream of Brock Street. This basin was incorporated in the flood modelling discussed in the *Flood Study*. Discharge and stage hydrographs at Brock Street for a range of flood events are presented in **Figure 2.4** of the report and the mitigating effects of upgrading the basin are presented in **Section 3.7.2**.

A5 Extreme Flood Events – The Probable Maximum Flood was modelled and the indicative extent and depth of inundation presented in the *Flood Study*.

Annex B – Effects of Flooding on the Community

B1 Specific Risk Areas – Information on properties affected by the 100 year ARI design flood has been supplied to Council under separate cover. As floor level data used in this assessment were estimated from the LiDAR survey and “drive by” survey they are indicative only. While fit for use in estimating the economic impacts of design floods, the data should not be used to provide specific details of the degree of flood affectation of individual properties.

Table F1 in **Appendix F** contains the following information in relation to the inundation of existing road and pedestrian crossings at Young:

- assessed minimum road/bridge deck level;
- time to commencement of overtopping following the onset of heavy rain;

- time to peak following the onset of heavy rain; and
- maximum depth of inundation.

The above flood related information is given for design storms with ARI's of 5, 20 and 100 years as well as the PMF. By inspection of the values set out in **Table F1**, floodwater first commences to overtop the majority of the road and pedestrian crossings at Young between about 3-4 hours following the onset of heavy rain during a 5 year ARI event, reducing to about 2 hours in a 100 year ARI event. Depths of overtopping vary at each location, but exceed 1 m at several locations during floods larger than about 20 year ARI.

Figures 2.6 and **2.7** show the flood emergency response planning classifications for the 100 year ARI and PMF events, respectively based on the definitions set out in the Floodplain Risk Management Guideline – *Flood Emergency Response Classification of Communities* (DECC, 2007).

A key feature of flood behaviour at Young is the confined nature of hazardous type flooding along Burrangong Creek and its major tributaries for flood events up to 100 year ARI, with damaging flooding generally confined to the Major Overland Flow Urban Precinct for events up to this magnitude. Depths of above-floor inundation in existing residential development located in this area are generally less than 0.4 m, with the exception of a single dwelling which is located in Brock Street on Railway Drain, where the depth of above-floor inundation would be in the range 0.4 to 0.6 m in a 100 year ARI event (refer **Figure 2.3**, sheet 3).

While the flood hazard in the Major Overland Flow Urban Precinct south of the railway corridor increases significantly during more extreme events when the area is affected by main stream flooding, development in this area is primarily of a commercial nature (refer **Figure 2.8**). The exception is a number of residential properties which are located along Lovell Street where the depth of above-floor inundation in a PMF would exceed 1.5 m. Evacuation of these properties during an extreme flood event would be difficult given Lovell Street and the adjacent railway underpass act as a floodway (albeit of a low hazard nature) during events which surcharge the local stormwater drainage system. There are also a number of dwellings which are located along the various overland flow paths north of the railway corridor where hazardous above-floor flooding would occur during a PMF event (refer **Figure 2.8**)

B2 Flooding of Streets and Overland Flow Paths – Figure D3.1, **Sheets 1** to **7** in **Appendix D**, shows the locations of the main flow paths, as well as depths of inundation in properties and along the local street system resulting from overland flooding in the urban area on the northern side of Burrangong Creek during major flooding, in this case the 100 year ARI event.

Separate Annex – Effects of Dam Failure on Downstream Flooding

Information on the increase in natural flood levels and areas inundated, by a dam-break of Chinaman's Dam is included in the *Flood Study*. This information will be supplemented by data on the population affected and travel times of the dam-break flood wave, following completion by Council of the *Dam Safety Emergency Plan* for Chinaman's Dam.

2.11 Environmental Considerations

Chapter 3 of the report examines the potential for detention basins in the upper reaches of the Railway Drain, Chance Gully and Golf Course Drain catchments to mitigate downstream flooding problems in the urban area of Young on the northern side of Burrangong Creek. Several sites are identified in currently rural areas on the northern side of Orchard Street and William Street where implementation of the basins would involve land clearing and major earthworks. However, controls over erosion during the construction phase would mitigate adverse environmental impacts.

Downstream of the basin sites the original characteristics of these watercourses have been altered by the construction of piped drainage systems to convey flows through the developed part of town. Typically the routes follow the old creek lines, and encroaching development precludes upgrading the system via the construction of new lines or lines in parallel with the existing system, without major impacts on adjacent urban allotments. To minimise these impacts, the improvements in hydraulic capacity considered in **Chapter 3** of the report have focussed on routes for pipe upgrades which follow the existing street system.

3 POTENTIAL FLOODPLAIN MANAGEMENT MEASURES

3.1 Range of Available Measures

A variety of floodplain management measures can be implemented to reduce flood damages. They may be divided into three categories, as follows:

Flood modification measures change the behaviour of floods in regard to discharges and water surface levels to reduce flood risk. This can be done by the construction of levees, detention basins, channel improvements and upgrades of piped drainage systems in urban areas. Such measures are also known as "structural" options as they involve the construction of engineering works.

Property modification measures reduce risk to properties through appropriate land use zoning, specifying minimum floor levels for new developments, voluntary purchase of residential property in high hazard areas, or raising existing residences in the less hazardous areas. Such options are largely planning (i.e. "non-structural") measures, as they are aimed at ensuring that the use of floodplains and the design of buildings are consistent with flood risk. Property modification measures could comprise a mix of structural and non-structural methods of damage minimisation to individual properties.

Response modification measures change the response of flood affected communities to the flood risk by increasing flood awareness, by the installation of flood warning systems and the development of emergency response plans for property evacuation. These options are wholly non-structural.

3.2 Community Views

Comments on potential flood management measures were sought from the Young community by way of the Community Questionnaire distributed at the commencement of the companion *Flood Study*. The responses are summarised in **Appendix C** of this *FRMS* report. Question 9 in the Questionnaire outlined a range of potential flood management options. The responses are shown on **Table 3.1**, together with initial comments on the feasibility of the measures. The measures are discussed in more detail in later sections of this Chapter.

The Community favoured the following measures:

- Management of vegetation and sedimentation in the Burrangong Creek system to maximise the hydraulic capacity of the creek channels and minimise the likelihood of blockages due to flood debris at the local road crossings.
- Enlarging the creek channels to increase hydraulic capacity.
- Detention basins to store floodwaters and reduce downstream flood peaks.
- Improvements in the trunk drainage system in the urban part of town.
- Flood related controls over future development in flood liable areas.
- Improved flood warning, evacuation and flood response procedures.
- Community education to promote flood awareness.
- Advice of flood affectation via Planning Certificates for properties located within the *Flood Planning Area*.

3.3 Outline of Chapter

The above measures, as well as several others included in the Questionnaire which did not receive a favourable response were examined at the strategic level of detail in **Chapter 3** and where appropriate, tested for feasibility on a range of assessment criteria in **Chapter 4.** Following consideration of the results by the Floodplain Management Committee, selected measures were included in the draft *FRMP* in **Chapter 5**.

Figure 3.1 shows the locations of potential structural improvements to the trunk drainage system which are considered in this Chapter. They include improvements to the trunk drainage system and piped diversion of flows to Burrangong Creek, as well as detention basins in the upper reaches of the catchments. **Table 3.2** shows the indicative sizes of the various elements considered as well as a preliminary "screening" of likely performance. Following this initial screening, the more promising structural elements were grouped into a number of improvement schemes which were modelled using the TUFLOW model developed for the *Flood Study.* Indicative cost estimates were prepared and economic (benefit – cost) analysis undertaken.

In the economic analysis, the damages prevented by a flood mitigation scheme represent its benefits. The damages were computed for present day and post-scheme conditions for a range of flood events from 5 year ARI to the PMF. By integrating the area beneath the damages – frequency curve up to the "design standard" of the particular flood mitigation scheme (e.g. the 100 year ARI), the long term "*average annual" value* of benefits were calculated (by subtraction of post-scheme from present day damages). These *average annual* benefits were then converted to an equivalent *present worth value* for each of the three discount rates nominated by NSW Treasury Guidelines for the economic analysis of public works (i.e. 4, 7 and 10 per cent), over an economic life of 20 years. These present worth values of benefits were then divided by the capital costs of the schemes to give benefit – cost ratios for the three discount rates.

3.4 Channel Improvements

3.4.1 Burrangong Creek and its Tributaries

The hydraulic capacity of a stream may be increased by widening, deepening or straightening the channel, clearing the banks of obstructions and management of tree and vegetation cover on the floodplain. The scope of such improvements can vary from: schemes which do not increase the waterway area but ensure the creek is maintained in a condition which maximises hydraulic capacity; to major channel excavations. Careful attention to design is required to ensure stability of the channel is maintained and scour or sediment build-up is minimised. The potential for large scale improvements to increase downstream flood peaks also needs to be considered. In general, channel improvements need to be carried out over a substantial stream length to have any significant effect on flood levels. Proposals also need to conform with Government Policies in regard to retention of native vegetation, maintenance of fish habitat and other environmental considerations.

The main stream system in Young comprises natural watercourses discharging from the hilly upslope areas and running through the developed part of town, with numerous road crossings of various hydraulic capacities which raise upstream flood levels and influence the pattern of flooding. Due to the incised nature of the channels and the confined nature of the floodplain the extent of overbank flooding is quite small even for major flood events. There are no residential properties which would be affected by main stream flooding at the 100 year ARI and the impact on industrial development would be limited to an isolated instance of overbank flooding on Victoria Gully upstream of the railway crossing.

TABLE 3.1
COMMUNITY VIEWS ON POTENTIAL FLOOD MANAGEMENT MEASURES

Flood Management Measure		Classification	Respondents' Views		Comments
			Yes	No	
a)	Maintenance programs to clear creeks of vegetation and debris impeding flows at road crossings.	FM	79	4	This option is very strongly favoured by the community and would have an application in the main streams of Burrangong Creek and its tributaries. It is reviewed in **Section 3.4**. It is aimed at ensuring that the existing drainage system functions at maximum capacity during floods.
b)	Enlarge the creek channels	FM	43	19	This option is strongly favoured by the community. The results of the *Flood Study* have shown that It has little application for the incised channels of Burrangong Creek and its tributaries, which are capable of conveying major flood flows. However, for completeness, it is reviewed in **Section 3.4**.
c)	Construct permanent levees to contain floodwaters.	FM	34	26	The community is evenly divided on this option. In any case, the results of the *Flood Study* have shown that it has no practical application on Burrangong Creek, due to the ability of the channel to convey major flood flows without surcharging. Similarly, it has no application on the overland flow paths of Railway Drain, Chance Gully and Golf Course Drain due to the encroachment of development into the flow paths and the replacement of the original watercourses by piped drainage systems. A discussion of this measure is given in **Section 3.5**.
d)	Construct detention basins to store floodwaters.	FM	48	9	The community strongly favours implementing detention basins on the drainage system to throttle flood flows and mitigate existing flooding problems. The feasibility of constructing basins, in conjunction with an augmentation of the capacity of the trunk drainage system in the urban area of Young (ref. Item e) below is considered in **Section 3.7** to **3.9**.
e)	Improve the capacity of the trunk drainage system	FM	81	1	This measure applies to the trunk system draining the urban area of town on the northern side of Burrangong Creek. Improvements are very strongly supported by the community and would be an essential part of the *FRMP.* The feasibility of upgrading the system is considered in **Sections 3.7** to **3.9,** leading to the formulation of several schemes for more detailed consideration. **Appendix E** also provides a comparison of present day and post-scheme peak flows derived from hydraulic modelling of staged upgrade schemes.

Legend: FM = Flood Modification Option PM = Property Modification Option RM = Response Modification Option

TABLE 3.1
COMMUNITY VIEWS ON POTENTIAL FLOOD MANAGEMENT MEASURES
(Continued)

Flood Management Measure		Classification	No of Respondents		Comments
			Yes	No	
f)	Voluntary purchase of residential property in **high hazard** areas.	PM	30	22	The community is fairly evenly divided on this option, which is often adopted to remove residential property in high hazard areas of the floodplain. The *Flood Study* results have shown that it has no application on Burrangong Creek, as major flood flows are conveyed within the channel. Similarly, **Low Hazard** conditions generally apply in the overland flow paths of Railway Drain, Chance Gully and Golf Course Drain due to the shallow and slow moving nature of flow. However, for completeness, this option is reviewed in **Section 3.11**.
g)	Provide funding or subsidies to raise houses above 100 year ARI flood level in **low hazard** areas.	PM	20	30	The community is not in favour of this option. House raising is applicable to timber framed residences only, usually located in **Low Hazard** zones. This option would have application for timber framed houses located in low hazard areas on the overland flow paths and is reviewed in **Section 3.12**.
h)	Controls over future development in flood-liable areas. (e.g. controls on location in the floodplain, minimum floor levels, etc.).	PM	63	2	Controls over development in flood prone land are very strongly supported by the community and would be an essential part of the *FRMP*. This issue is covered in the *draft Flood Policy*, referenced in **Section 3.10** and presented in **Appendix A**.
i)	Improve flood warning and evacuation procedures.	RM	55	3	Flooding is of a "flash flooding" nature, with sudden rises in water levels after the onset of heavy rainfall. NSW SES responds to flood occurrences but there presently is no formal "Young Shire Local Flood Plan". Improvements to flood emergency response planning (using information contained in this study) are very strongly supported by the community and are considered in **Section 3.13**.
j)	Community education, participation and flood awareness programs.	RM	64	9	Promotion of awareness of the flood risk would be very strongly favoured among the community. This option is reviewed in **Section 3.14**.
k)	Notation of flood affectation of properties on Planning Certificates.	RM	70	3	Provision of information on flood affection of properties is strongly favoured by the community. This may be achieved by notation of flood affectation of allotments on Section 149 Planning Certificates. This option is reviewed in **Section 3.10**

Legend: FM = Flood Modification Option PM = Property Modification Option RM = Response Modification Option

In the December 2010 flood, damages to infrastructure due to scour were experienced at several of the in-stream weirs across Burrangong Creek and at the Lachlan Street culvert on Victoria Gully. Although there was a considerable build-up of debris at several crossings, the creek system continued to function at near its optimum hydraulic capacity. Consequently a formal Creek Management Scheme is not a priority measure in the main streams, at least on flood mitigation grounds. However, as noted below, cleaning out the open channel of Railway Drain, coupled with regular inspection of the trunk drainage system would be a cost-effective measure, as it would ensure the existing drainage infrastructure functions at its hydraulic capacity.

3.4.2 Urban Catchments on Northern Side of Burrangong Creek

Hydraulic modelling undertaken in the *Flood Study,* confirmed by historic flood experience, showed that the trunk drainage systems of the urban catchments on the northern side of Burrangong Creek have a limited hydraulic capacity. As it runs through the urban part of town, the system mainly comprises pipes following the routes of the former watercourses of Railway Drain, Chance Gully and Golf Course Drain, which are now closely bounded by residential development. Conversion of the piped system to a more efficient open channel system is therefore not feasible without major impacts on existing urban development.

Apart from the section of the Railway Drain running along the northern side of the railway between Lynch Street and Main Street (labelled CE1 on **Figure 3.1**) there are no open channels in the trunk drainage system. Improvements to achieve a substantial increase in its conveyance capacity would require a significant widening of this channel, which may result in disturbance to the stability of the railway tracks. YSC are presently considering options for re-opening the railway line. Consequently, the modest improvement in hydraulic capacity obtained by cleaning out the drain, which is heavily overgrown, is probably all that could practically be achieved.

The hydraulic modelling of improvements to the trunk drainage system included analysis of upgrades to the piped sections of the Railway Drain system, and is introduced in **Section 3.6**. That analysis showed that flood levels in the open channel section are controlled by the capacity of the 1900 mm x 1400 mm culvert which commences at the downstream end of the channel at Main Street. As a consequence, the channel lies in a backwater zone. Therefore increasing its waterway area without also upgrading the downstream system would not achieve an increase in the hydraulic capacity of the overall system.

3.4.3 Conclusion

From the above discussion, large scale improvements to the channels of the drainage system are either not warranted (in the main streams) or not feasible (in the trunk drainage system) and have not been considered further in this report.

3.5 Levees

3.5.1 Technical Requirements

Levees are an effective means of protecting flood affected properties up to the design flood level. In designing a levee it is necessary to take account of three important factors: potential re-distribution of flood flows, the requirements for the collection and disposal of internal drainage from the protected area and the consequences of overtopping the levee in floods greater than the design event. A freeboard between the design flood level and the crest level of between 0.5 and 1 m would be required, based on an assessment of site specific flooding conditions.

Reinforced concrete and concrete block walls are often used in situations where there is insufficient land available for earth banks. Such walls are provided with reinforced concrete footings of sufficient width to withstand overturning during flood events.

3.5.2 Levees on Burrangong Creek and its Tributaries

The following factors militate against a levee scheme on the main arms of the creek system:

- A levee would not be desirable on environmental grounds as it would adversely affect the visual amenity of the existing creek system; nor would it be feasible on economic grounds, as under 100 year ARI conditions impacts on existing development from main stream flooding are not significant.
- There would be disruption to the local road crossings, which would need to grade over the top of the levee for continuity, as well as difficulties associated with the management of runoff from the local sub-catchments within the "protected" areas. It may not practicable to re-route the local drainage system so that drainage is maintained from those areas without back-flooding into protected areas when creek levels rise during flood events.
- Because of the incised nature of the creek system and its large hydraulic capacity there is limited overbank flow and resulting impact on existing property, even for major flood events. Consequently, the provision of a levee with its large capital cost would not be economically viable.
- The management of the future flood risk (i.e. due to future development) in the presently rural areas bordering the minor un-named watercourses which drain to the main stream system would best be carried out by flood related development controls using the draft Flood Policy presented in **Appendix A**, rather than by constructing expensive structural flood mitigation works.

3.5.3 Levees on Urban Catchments on Northern Side of Burrangong Creek

The only opportunity for a levee in the urban part of town is along the southern (railway) side of the open channel section of Railway Drain, with the objective of preventing overflows into Lovell Street and the CBD area between Lynch Street and Main Street. At present the railway tracks are surcharged by even minor flood events. However, any attempt to retain those presently escaping flows within the confines of the open channel section would increase flood levels along its length. This would in turn increase the escapes of flow into the street system at Lynch Street and also the risk of flooding in residential property on the northern side of the channel in Nasmyth Street.

A previous strategic drainage investigation (French, 2010) considered the feasibility of providing an earth levee about 900 mm high on the southern side of Railway Drain running westwards from Zouch Street to the confluence with the Chance Gully system on the western side of Clarke Street. This scheme was intended to function as a combined levee - detention basin. The levee was intended to be constructed on the southern side of the rail corridor and would therefore require the railway authority's agreement to proceed, as the tracks would be inundated during major flood events. To maintain continuity of the levee, Main Street where it crosses the route would also have to be raised.

Flood levels in the open channel are controlled by the capacity of the culvert which commences at Main Street at the downstream end of the open channel section of channel, as well as by the capacity of the 1900 x 1400 mm culvert which commences at the Tyrepower property on the

southern side of the railway to the west of Clarke Street. This culvert carries the combined flows from the Railway Drain and Chance Gully and is capable of conveying only minor flood flows without surcharge into the streets. The attenuation in peak flows achieved by the temporary flood storage behind the levee, as proposed by French, 2010 would not be sufficient to reduce them to the capacity of the downstream drainage system. Consequently, in order to reduce overland flows in the downstream commercial area, increasing the capacity of the piped system downstream of Tyrepower would be required.

3.5.4 Conclusion

As discussed above, there is no justification for a levee scheme on Burrangong Creek or its major tributaries. The technical difficulties associated with the levee scheme on Railway Drain in isolation are major and its likely benefits would not justify its implementation. Additional works to upgrade the drainage system downstream of Tyrepower would also be required, or flows would need to be diverted via a new line to Burrangong Creek. Further, there is the intention of Council to re-open the railway, as well as the requirement to gain the permission of the railway authority which would need to be considered. Levees are not considered worthy of further consideration in the *FRMS.*

In **Section 3.8** of the report the diversions of flows via pipelines running southwards along Zouch Street and Clarke Street to Burrangong Creek are evaluated. These diversions are labelled D3 and D2 respectively on **Figure 3.1**.

3.6 Upgrading the Trunk Drainage System

Figure 3.1 shows the locations of measures evaluated in following sections of the report for upgrading the trunk drainage systems in the three urban catchments (Railway Drain, Chance Gully and Golf Course Drain). They include:

- Detention basins on the headwaters of the streams draining to the urban area of town. These basins have been sized for *present day conditions* in their respective catchments and to mitigate *existing flooding problems*. Future urbanisation in their catchments, particularly in the Railway Drain catchment above Orchard Road will increase peak flows and volumes of runoff. Council's Stormwater Management Policies will need to be upgraded to incorporate requirements for On Site Detention Storage (OSD) to ensure the impacts of future development are mitigated, otherwise the performance of the basins will degrade over time. **Section 3.7** outlines initial concepts for the basins and summarises the results of hydraulic modelling undertaken using the TUFLOW model developed for the *Flood Study*. Diagrams showing the reductions in flood levels achieved by the basins are bound in **Volume 2** of the report.
- Upgrades of the piped trunk drainage system. It is generally not practicable to upgrade the system with lines in parallel with the existing pipelines, which follow the lines of the original creek system, due to the presence of encroaching development. Consequently, the upgraded lines have in general been located to follow the street system. The exception to this rule applies for a section of the Golf Course Drain between William Street and Nasmyth Street where the existing pipeline is located in a drainage easement (**Figure 2.2**). The proposed upgrade along this section comprises a new pipeline (U1 on **Figure 3.1**), to be laid in parallel with the existing line. As mentioned, consideration has also been given to providing major diversions along the streets running southwards and discharging to Burrangong Creek. **Section 3.8** outlines concepts, with additional information on longitudinal sections and the results of hydraulic modelling shown in the figures contained in **Volume 2** of the report.

Preliminary costing and indicative economic analyses are presented in **Section 3.9**. In keeping with the scope of a *FRMS&P* investigation, the measures have been evaluated at the strategic level of detail, using existing sources of survey and data regarding the locations and elevations of services which may impact on the pipe upgrades. The *FRMP* includes a *Drainage Feasibility Study* (**Measure 5** of **Table S1**) which is aimed at refining the design concepts and costs presented herein and establishing priorities for construction of the various elements of the scheme.

3.7 Detention Basins

3.7.1 Technical Requirements

Detention basins provide a temporary storage of floodwaters additional to that contained in the floodplain, with the objective of reducing the flood peak in downstream reaches of the drainage system. "Offline" basins, remote from the stream, with intake and outlet channels to and from the stream, are preferred over embankments constructed across the channel in order to maintain the continuity of the creek. The basin should also be located in the middle or lower reaches of the catchment, sufficiently close to the area intended to be protected, that its attenuating effects over flood peaks is not negated by downstream tributary inflows. Typically the basin should command in excess of 60 to 70 per cent of the total catchment at the urban centre to be protected.

Another requirement is that the basin be of sufficient size to store a significant percentage of runoff from the design storm. Basins attenuate the flood peak (i.e. reduce the downstream peak rate of runoff) by temporarily storing the incoming discharge hydrograph and releasing it at a controlled rate. To be effective, basins storing a minimum of 50 per cent of the volume of runoff of the incoming flood event are required.

Flows up to the 100 year ARI are usually controlled by low level pipes. Larger flows are conveyed by a combination of flow through the low level outlets together with flow over an emergency spillway, usually constructed by excavating a channel and broad crested weir in one of the abutments. The spillway crest is usually armoured with reno-mattress or equivalent erosion resistant material to prevent scour.

For optimum performance in reducing downstream flows, the design flood should be conveyed through the basin via the low level outlets without the spillway operating. To achieve this objective often requires a large storage. Small basins are quickly overwhelmed by the incoming flood waters, with the result that the level of stored water quickly rises to the level of the emergency spillway. Because the spillway is able to pass a large rate of flow, with little rise in level, the rate of outflow rapidly rises to the rate of inflow, negating the main purpose of the basin.

3.7.2 Basins on Railway Drain

The piped system of Railway Drain commences at Orchard Street, where east and western arms run southwards down Taylor Road and Bendick Street respectively and enter the Brock Street detention basin on the southern side of Prospect Street. The low level outlet of the detention basin controls flows up to 5 year ARI, with a minor overland flow over Brock Street evident at that frequency at location Q16 (ref. **Table E1** of **Appendix E,** in **Volume 2** of the report and **Figure 3.7**). The basin surcharges for larger floods, with progressively greater flows conveyed over the spillway and across Brock Street. At the 100 year ARI, overland flow over Brock Street reaches 8.4 m^3/s for the "critical" 60 minute storm, which maximises flows in the Railway Drain catchment.

As the piped drainage system is of limited capacity, most of the flow south of Brock Street is conveyed overland through residential allotments, the Young Caravan Park and along the street system, in particular along Zouch Street and Nasmyth Street to the open channel section on the northern side of the railway. Flows surcharge the open channel at Lynch Street, with an overflow of 7.7 m^3/s entering that street at location Q17 for the 100 year ARI.

The feasibility of constructing two detention basins on the Railway Drain catchment on the northern side of Orchard Street as well as upgrading the Brock Street basin has been reviewed. These sites are labelled B1, B2 and B5 respectively on **Figure 3.1**.

A. Basins B1 and B2

The storage characteristics of the basins were estimated from the LiDAR survey data. For preliminary screening, the basins were sized to store runoff to a peak depth of about 2 to 3 m. An allowance of 0.5 m in height would be provided between the 100 year ARI storage level and the embankment crest elevation. This freeboard incorporates allowances for the head over the spillway crest necessary to convey floods larger than the 100 year ARI, plus an allowance for wave action. Embankments up to 3.5 m in height would therefore be required.

Catchment flows approach the basin as overland flows as the watercourses are not well defined. Therefore creation of the necessary storage would require extensive excavation to reduce the peak depth of storage.

Figures 3.2 and **3.3** show design concepts yielding storage volumes of 5,000 m^3 for the 36 ha catchment upstream of Basin B1 and 1,650 m^3 for the 19 ha catchment of Basin B2.

B. Basin B5

Two alternative concepts were considered for Basin B5, where the total upstream catchment amounts to 96 ha.

1. Increasing the storage volume by raising the embankment to a peak storage level of RL 450.5 m AHD. This would achieve a storage volume of about 8,500 m^3, compared with 4,000 m^3 under present day conditions. However, hydraulic modelling showed that the additional storage is insufficient to provide major reductions in overland flows downstream of Brock Street.

2. Excavate within the storage area to provide the necessary fill for the raised embankment. At the raised spillway level of RL 450.5 m AHD, a storage volume of about 14,000 m^3 would be achieved. This concept has been adopted.

Figure 3.4 shows a design concept for the excavated Basin B5 along with peak storage levels for the 20 year ARI and 100 year ARI storms of 60 minutes duration.

3.7.3 Basins on Chance Gully

Two existing basins are located on Chance Gully. Natural surface levels within their areas are included in the LiDAR survey of the floodplain and therefore their storage characteristics are taken into account by the TUFLOW hydraulic model. However, the basins are too small to provide significant reductions in downstream flows.

Overflows of the piped drainage system of Chance Gully commence at the 5 year ARI and progressively increase for larger events. At the 100 year ARI, the peak overland flow from the 98 ha upstream rural catchment over Edwards Street (location Q21) reaches 15 m^3/s. These surcharges continue as overland flow across Nasmyth Street and combine with overflows from the Railway Drain system on the northern side of the railway. Some of the flow continues westwards along the northern side of the railway and combines with overflows of Golf Course Drain before flowing under the railway bridge at location Q24 to Lovell Street (**Figure 3.7**). The balance flows into the commercial area of Lovell and Boorowa Streets and eventually discharges to Burrangong Creek.

A. Single Basin at William Street

A design concept was developed for a basin in the rural area on the northern side of William Street, to the east of Cram Avenue (at the site labelled Basin B3a on **Figure 3.1**). The area is surrounded by residential development. Preliminary calculations showed that a storage volume of 21,000 m^3 would be required to reduce 100 year ARI flows to the capacity of the 1050 mm RCP conveying flows through residential allotments south of William Street.

A design concept prepared for the basin required a storage area in excess of 1 ha and a maximum depth of 3.7 m. To achieve this area resumption of more than four residential properties bordering the site would be required. The single basin concept was not retained for inclusion in the *FRMP.*

B. Cascading Basins Upstream of William Street

As an alternative to a single basin, development of several sites in the rural area upstream of William Street was considered. **Figure 3.5** shows a concept for four separate basins, labelled Basin 3a to 3d in the catchment headwaters. Basin 3d is located in private property and the others on public land. The sizes of the individual storages of the Basin B3 cascade are preliminary only and would be optimised in the Drainage Feasibility Study proposed as **Measure 5** of the *Floodplain Risk Management Plan* set out in **Table S1**. Preliminary calculations show that a total storage volume of about 26,000 m^3 could be achieved from the excavated storage areas, equivalent to about 26 mm of runoff from the catchment.

From **Figures 3.6** and **3.7**, which model the impact of basins on Railway Drain and Chance Gully, the four basins (B3a – B3d) comprising the Basin B3 cascade would achieve substantial reduction in flooding on Chance Gully as far as the junction with Railway Drain for floods up to the 100 year ARI.

These figures, which apply for the 20 and 100 year ARI floods respectively, are “afflux” diagrams showing the reductions in depths and extents of inundation achieved (post-basin conditions are compared with present day conditions). Land rendered “flood free” by the basins is shown in a magenta colour.

There are no basin sites downstream of William Street. Accordingly, further reductions in overland flow will require an upgrade to the piped system. As for Railway Drain, the proximity of urban development precludes upgrades following the existing route without major impacts. The concept for upgrading the system described in **Section 3.8** comprises a diversion drain (D2 on **Figure 3.1**) which captures overflows from the combined Railway Drain - Chance Gully System and runs southwards along Clarke Street to outfall at Burrangong Creek.

3.7.4 Basins on Golf Course Drain

Surcharges of the Golf Course Drain system reach 3.5 m^3/s at Edwards Street (location Q23 of **Figure 3.7**), increasing to 8.9 m^3/s at the railway bridge (location Q24) and 12.3 m^3/s at Boorowa Street (location Q25). The area upstream of William Street is occupied by the Young Golf Course. However, there are no basin sites which could be connected to the piped drainage system of Golf Course Drain, which commences at William Street.

Reductions in overland flow will require an upgrade to the piped system. The concept for upgrading the system described in **Section 3.8** comprises diversion drains labelled U1 and D4 on **Figure 3.1**, which capture overflows from the existing system and run southwards through the street system to outfall at Burrangong Creek.

3.7.5 Results of Hydraulic Modelling Basins B1, B2, B5 and B3a – B3d

Figures 3.6 and **3.7** show the results of the hydraulic modelling of the 20 and 100 year ARI floods with the basins in place. The distribution of post-basin peak flows over the study area is shown on **Table E1** of **Appendix E** in **Volume 2** of the report.

A. <u>Railway Drain Catchment</u>

The basins have the greater effect for the 20 year ARI event, rendering the area between Orchard Street and William Street flood free at that frequency.

The increase in flows due to tributary inflow below William Street progressively reduces the impact of the basins, although they achieve significant reductions in overland flows as far as Edwards Street, where runoff enters the system from sub-catchments to the east. Downstream of Edwards Street the basins achieve a small reduction in flood levels in the open channel section of railway Drain, but not sufficient to prevent escapes of flow into the street system at Lynch Street.

There are no basin sites downstream of Brock Street. Accordingly, further reductions in overland flow will require an upgrade to the piped system. Due to the proximity of urban development it is not practicable to achieve upgrades which follow the existing route without major impacts. The concepts for upgrading the system which are described in **Section 3.8** comprise major diversion drains which follow the street system and outfall at Burrangong Creek.

B. <u>Chance Gully Catchment</u>

The four basins mitigate downstream flooding as far as the railway. At the 100 year ARI, post-basin flows are generally within the capacity of the existing piped drainage system with overland flows at William Street and Edwards Street reduced to zero and 0.6 m^3/s respectively.

3.8 Pipe Upgrades and Diversions to Burrangong Creek

3.8.1 Upgrade of Railway Drain

Figures 3.8 and **3.9** show preliminary longitudinal sections for Elements U3 and D3. Element U3 commences at Brock Street and runs southwards along McLerie Street to Edwards Street and then westwards to the intersection of Edwards and Zouch Streets, a total distance of 480 m. To capture tributary inflows from the urban sub-catchments below Brock Street, the pipe size progressively increases in size from twin 750 m diameter RCP's to a single 3000 mm x 1200 mm RCBC.

Element D3 is a diversion line which commences at the outlet of U3 and continues southwards along the eastern side of Zouch Street over a distance of 665 m and outfalls to Burrangong Creek. The need to grade under the railway and the presence of several sewer lines control the grade of the line which consists of a single 3600 mm x 1200 mm RCBC and requires a depth of excavation of up to 4.5 m.

Figures 3.10 and **3.11** show the results of modelling the detention basins, plus the upgrade of the Railway Drain comprising Elements U3 and D3. The diversion drains eliminate breakouts from Railway Drain at Lynch Street and Main Street into the street system of the commercial area for floods up to the 100 year ARI. The peak discharges conveyed in U3 and D3 amount to 7.1 m^3/s and 9.6 m^3/s respectively.

3.8.2 Upgrade of Chance Gully

Consideration was given to an upgrade of the piped system which followed William Street and Clarke Street to the confluence with the Railway Drain system on the northern side of the railway. This upgrade would be an alternative to the basins upstream of William Street. The route is labelled U2 on **Figure 3.1** and a preliminary longitudinal section is shown on **Figure 3.12**. However, as a depth of excavation of up to 6 m would be required to grade the line across a high point in Clarke Street, the pipe upgrade was abandoned in favour of the implementation of the cascade of Basins 3a – 3d.

3.8.3 Diversion Line D2

Element D2 is an 1800 mm x 900 mm RCBC about 380 m in length which commences at the intersection of the Railway Drain and Chance Gully on the northern side of the railway and continues south along Clarke Street to Burrangong Creek. Its purpose is to capture flows which surcharge the capacity of the culvert running south beneath the Tyrepower property. The peak 100 year ARI discharge conveyed in line D2 amounts to 2 m^3/s.

Figure 3.13 is a preliminary longitudinal profile of line D2 along Clarke Street and **Figures 3.14** and **3.15** show the results of modelling the basins and elements U3, D3 and D2 for the 20 year ARI and 100 year ARI floods.

3.8.4 Upgrade of Golf Course Drain

The proposed upgrade of Golf Course drain between William Street and Burrangong Creek is shown on **Figure 3.1** in two sections. Element U1 runs southwards along Stoneridge Street to Edwards Street and then follows the alignment of the existing trunk drainage pipeline to Nasmyth Street. Element D4 runs southwards from the railway bridge over Stoneridge Street, along Lovell Street and Possum Lane to Boorowa Street and Mackenzie Street and outfalls at the northern bank of Burrangong Creek. Longitudinal profiles along these routes are shown on **Figures 3.16** and **3.17**.

There are a number of sewers and existing drainage pipes which control the grade of line D4 which is about 720 m in length. The maximum depth of excavation for the proposed 1800 x 900 RCBC would be about 3 m.

3.9 The Combined Trunk Drainage Upgrade Scheme

Table 3.2 over the page shows details of the elements provisionally incorporated in the scheme, which comprises the detention basins and the diversion lines U3, D3 and D2 in the Railway Drain – Chance Gully trunk drainage system, as well as lines U1 and D4 on Golf Course Drain.

TABLE 3.2
PRELIMINARY EVALUATION OF ELEMENTS OF COMBINED TRUNK DRAINAGE UPGRADE SCHEME

Element	Description	Objectives	Evaluation of Results
B1	Detention Basin on Western Arm of Railway Drain north of Orchard Street. • Excavate in storage area to obtain fill for embankment. • Provide 750 RCP low level outlet pipe to throttle flows. • Provide high level spillway to cater for floods greater than 100 year ARI.	• Reduce flows from 36 ha catchment upstream of basin to capacity of downstream piped drainage system.	• Impact of Basin B1 is limited to the area upstream of Basin B5. • Indicative cost of Basin B1 is $ 0.7 Million • Preliminary concept shown in **Figure 3.2.** • Basin B1 is recommended for incorporation in the strategy to reduce flows on Railway Drain, in conjunction with Basins B2 and B5.
B2	Detention Basin on Eastern Arm of Railway Drain north of Orchard Street. • Excavate in storage area to obtain fill for embankment. • Provide 600 RCP low level outlet pipe to throttle flows • Provide high level spillway to cater for floods greater than 100 year ARI.	• Reduce flows from 19 ha catchment upstream of basin to capacity of downstream piped drainage system.	• Impact of Basin B2 is limited to the area upstream of Basin B5. • Indicative cost of Basin B2 is $ 0.33 Million. • Preliminary concept shown in **Figure 3.3**. • Basin B2 is recommended for incorporation in the strategy to reduce flows on Railway Drain, in conjunction with Basins B2 and B5.
B5	Increase storage capacity of existing detention basin on Railway Drain north of Brock Street. • Raise embankment crest level to RL 451 m AHD. • Excavate in storage area to increase storage volume. • Provide new low level outlet to throttle flows. • Provide high level spillway to cater for floods greater than 100 year ARI.	• Reduce flows from 94.8 ha catchment upstream of basin in conjunction with new Basins 1 and 2 above to capacity of drainage system south of Brock Street.	• Impact of Basins B1, B2 and B5 is limited to the area north of Edwards Street. • Indicative cost of Basin B5 is $ 0.38 Million. • Preliminary concept shown in **Figure 3.4**. • Basins B1, B2 and B5 are recommended in conjunction with pipe upgrade works from Brock Street to Burrangong Creek (ref. Elements U3 and D3 below).
U3	Upgrade Railway Drain from Brock Street via McLerie Street and Edwards Street to Zouch Street. • Provide pipe upgrades increasing from twin 750 RCPs to 1200 RCP and 3000 mm x 1200 mm RCBC over 480 m length of upgrade.	• In combination with upstream Detention Basins B1, B2 and B5, reduce flows to capacity of drainage system for 100 year ARI.	• Indicative cost of U3 is $ 2.49 Million. • Preliminary grading shown in **Figure 3.8**.
D3	Continue upgrade of Railway Drain with a diversion line from end of U3 above, along Zouch Street to outfall at Burrangong Creek. • Provide 3600 mm x 1200 mm RCBC over 665 m length of diversion line.	• In combination with upstream Detention Basins B1, B2, B5 and pipe upgrade U3, reduce flows to capacity of drainage system for 100 year ARI.	• Indicative cost of D3 is $ 5.88 Million. • Preliminary grading shown in **Figure 3.9**.
B3a –B3d	Detention Basins on Chance Gully north of William Street (B3a – B3d). • Excavate in storage areas to obtain fill for embankments. • Provide 450 mm low level outlet pipes and 900 mm orifice plate to throttle flows. • Provide high level spillway to cater for floods greater than 100 year ARI.	• Reduce flows from 92 ha catchment upstream of basin to capacity of downstream piped drainage system.	• Impact of Basins is limited to the area from William Street to the Railway. • Indicative cost of Basins B3a – B3d is $ 0.99 Million • Preliminary concept shown in **Figure 3.5** • Basins B3a – B3d are recommended to reduce flows on Chance Gully.
D2	Upgrade Railway Drain by diversion line from junction of Railway Drain and Chance Gully, along Clarke Street to outfall at Burrangong Creek. • Provide 1800 mm x 900 mm RCBC over 360 m length of diversion line.	• Capture overflows from Railway Drain and Chance Gully at the confluence of these two systems on the northern side of the railway line.	• Indicative cost of D2 is $ 2.0 Million. • Preliminary grading shown in **Figure 3.13**
U1	Upgrade drainage system of Golf Course Drain from William Street to Nasmyth Street • Provide 1200 mm RCP over 450 m length in parallel with existing pipeline.	• Convey 100 year ARI flows within the upgraded system.	• Indicative cost of U1 is $ 1.44 Million. • Preliminary grading shown in **Figure 3.16**
D4	Upgrade drainage system of Golf Course Drain from Nasmyth Street to Burrangong Creek. • Provide1800mm x 900 mm RCBC over 700 m length.	• Convey 100 year ARI flows within the upgraded system.	• Indicative cost of D4 is $ 3.29 Million. • Preliminary grading shown in **Figure 3.17**

Figures 3.18 and **3.19** show the results of modelling the 20 year ARI and 100 year ARI floods, with all elements of the scheme in place.

The scheme eliminates all of the overland flow in the urban area to the north of Burrangong Creek for the 20 year ARI storm, apart from a minor surcharge of Railway Drain near its confluence with the creek (ref. **Table E1** of **Appendix E** in **Volume 2** of the report). For the 100 year ARI, there are also several overland flows of a minor nature in several of the streets in the Railway Drain and Chance Gully systems, as well as a minor overland flow at the western end of Boorowa Street. The scheme mitigates damaging flooding for events up to the 100 year ARI (ref. economic analysis of **Section 3.9.2**).

3.9.1 Indicative Cost Estimates

Indicative capital costs of the elements of the Scheme are summarised on **Table 3.3** over the page. In addition to the supply, delivery and construction of the various items, the cost estimates include allowances for

- Land acquisition, in the case of Basins B1 and B2 on Railway Drain and B3d in the upper reaches of Chance Gully, which are situated on private land. Upgrades of the piped drainage system are located in the road reserve, apart from the section of Golf Course Drain between Edwards Street and Nasmyth Street where the proposed new pipeline would be laid in the drainage reserve in parallel with the existing pipe.
- Geotechnical investigations of foundation conditions and sources of material for the detention basins and test boring along the routes of the drainage upgrades. For the purposes of the costings, it has been assumed that all trenches will be excavated in "other than rock".
- Potholing along the pipe upgrades to locate services. Generally the sewer system is the main constraint over grading the lines and sometimes a less than optimum height of box culvert is required to miss the sewer lines.
- Traffic control for construction within the street system. This could become a significant cost item, particularly if the diversion line in Zouch Street D3 proceeds.
- Allowance for un-estimated items and contingencies (25%)
- Allowance for survey, investigation and design (between 10% and 15% depending on the cost of the Element and its complexity).

3.9.2 Indicative Benefit – Cost Analysis

Table 3.4 over the page provides an indicative economic assessment of the Combined Drainage Upgrade Scheme.

The benefit/cost ratio of the upgrade scheme at the 7 per cent discount rate is only 0.2 and therefore the scheme could not be justified solely on economic grounds. However, the scheme has considerable merit on social grounds. It would mitigate flooding in 70 residential properties which are currently flood affected (i.e. have water in their allotments), of which 19 properties would be subject to shallow above-floor inundation at the 100 year ARI. Under corresponding post-scheme conditions the numbers are reduced to 9 flood affected residential properties, of which one would be subject to shallow above-floor inundation.

TABLE 3.3
INDICATIVE COST OF COMBINED TRUNK DRAINAGE UPGRADE SCHEME

Element	Cost $ Million
Basin B1 Railway Drain - North of Orchard Street	0.70
Basin B2 Railway Drain - North of Orchard Street	0.33
Upgrade Existing Basin B5 - Railway Drain Brock Street	0.38
Pipe Upgrade U3 Railway Drain McLerie – Edwards Street	2.49
Diversion Drain D3 Railway Drain Zouch Street - Creek	5.88
Basins B3a – B3d Chance Gully - North of William Street	0.99
Diversion Drain D2 Railway Drain Clarke Street - Creek	2.00
Upgrade U1 Golf Course Drain - William to Nasmyth Street	1.44
Upgrade D4 Golf Course Drain - Nasmyth Street - Creek	3.29
Total Cost	**17.5**

TABLE 3.4
ECONOMIC ANALYSIS – COMBINED TRUNK DRAINAGE UPGRADE SCHEME
ANALYSIS BASED ON DESIGN FLOOD LEVELS

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) $ Million	4.24	3.3	2.7
Cost of scheme $ Million	17.5	17.5	17.5
Benefit/Cost Ratio	0.25	0.2	0.15

If the economic analysis of the scheme were based on damages resulting from the design flood levels plus freeboard (ref. **Section 2.9 and Section B8** of **Appendix B**), then a larger capital cost could be justified. **Table 3.5** shows the results of the economic analysis with flood damages based on design flood levels plus freeboard.

TABLE 3.5
ECONOMIC ANALYSIS – COMBINED TRUNK DRAINAGE UPGRADE SCHEME
ANALYSIS BASED ON DESIGN FLOOD LEVELS PLUS FREEBOARD

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) $ Million	17.26	13.45	10.81
Cost of scheme $ Million	17.5	17.5	17.5
Benefit/Cost Ratio	0.99	0.77	0.62

The Combined Trunk Drainage Upgrade Scheme has been retained for further consideration in the multi-objective analysis of **Chapter 4**.

3.9.3 Staging and Funding the Trunk Drainage Upgrade Scheme

A. First Stage – Detention Basins

The Combined Trunk Drainage Upgrade Scheme is a long term strategy for upgrading the drainage system in Young. In recognition of budget constraints, it is appropriate to evaluate the economic benefits of staging the works. From the results of the hydraulic modelling presented in **Figures 3.6** and **3.7**, it is clear that early implementation of the detention basins would achieve significant benefits. The modelling showed that above-floor inundation would be reduced from 19 residences under present day conditions to 5 residences subject to shallow above-floor inundation. Significant reduction in damages to the commercial sector would also be achieved.

Table 3.6 shows the results of the economic analysis.

TABLE 3.6
ECONOMIC ANALYSIS – STAGING TRUNK DRAINAGE UPGRADE
(DETENTION BASINS ONLY)
ANALYSIS BASED ON DESIGN FLOOD LEVELS

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) $ Million	3.05	2.38	1.91
Cost of scheme $ Million	2.41	2.41	2.41
Benefit/Cost Ratio	1.25	1.0	0.8

Note: This Scheme comprises Basins B1, B2, B5 and B3a – B3d

B. Funding the Scheme

Funding will be required for the Drainage Feasibility Study (**Measure 5** of the FRMP) which will confirm the staging of the various elements of the scheme, as well as for their subsequent detailed design and construction. Potential sources of funding include:

i. Funding from the NSW Government's Floodplain Management Program. This funding will be the main source of funding;

ii. Council's storm water levee of $25 / resident (the maximum allowable) in Young Township. However this source raises very little money;

iii. Section 94 Developer Contributions Plan – Again there will be limited funds raised from this source.

iv. Council will fund the proposed works through the accumulated funding from (i), (ii) & (iii) above and through borrowings.

The staged capital works funding required will be included in Council's long term financial plan.

3.9.4 Impacts of Future Urbanisation

Urbanisation of rural lands results in an increase in downstream flood peaks due to an increase in impervious area and the formalisation of existing natural flow paths by engineered drainage systems. From the *Young LEP, 2010* zoning maps shown on **Figure 2.5**, most of the impacts will be felt within and downstream of areas zoned *General Industrial* (*IN1*) and *General Residential* (*R1*).

In other zonings such as *Large Lot Residential* (*R5*) and *Rural Small Holdings* (*RU5*) the "urbanisation" as characterised by impervious area is not likely to be directly connected to new drainage systems. Consequently, the additional runoff due to the increase in impervious area is likely to pond or infiltrate into surrounding pervious portions of the allotments.

Flood modelling was carried out to assess likely increases in flows and depths of inundation following urbanisation of the catchments. The effects of urbanisation were simulated by increasing the impervious area assigned to the various sub-catchments of **Figure 2.5** according to the zoning, with values between 35% and 40% of imperviousness assigned to areas zoned for *General Industrial* (*IN1*) and *General Residential* (*R1*).

Figure 3.20, Sheets 1 to 3, show the impacts for the 100 year ARI flood in terms of increase in peak flood levels (afflux) under post-urbanisation conditions, compared with present day conditions.

Figure 3.21, Sheets 1 and 2, show discharge and stage hydrographs at representative locations within the urban part of town and **Table E2** of **Appendix E** in **Volume 2** of the report shows peak discharges in the study area. Considering the tributaries on the southern side of Burrangong Creek:

1. Big Spring Creek and Little Spring Creek catchments are predominately zoned for *Rural Small Holdings* (*RU4)* land use and there is likely to be only a small increase in peak flows.
2. Petticoat Gully catchment is mainly zoned *Rural Small Holdings* (*RU4)* and *Large Lot Residential* (*R5*) to Tierney Street, then *General Residential* (*R1)* to the confluence with Burrangong Creek. Peak flows are likely to increase near the confluence.
3. Sawpit Gully catchment is zoned *General Residential* (*R1*) downstream of Chinaman's Dam. The main impact of future urbanisation appears to be a reduction in the time of rise of the flooding on the main arm. The catchment will become more "flash flooding" than at present.
4. Victoria Gully and Garibaldi Gully headwaters are zoned for *Rural Small Holdings* (*RU5*) and are not likely to experience significant increases in peaks as a result of future development.
5. Significant increases in flood peaks are likely to be experienced on the overland flow paths on the northern side of Burrangong Creek, particularly in the Railway Drain and Chance Gully catchments, which are zoned *General Residential* (*R1)* to the northern boundary at Iandra Street. Increased flood affectation would occur in residential areas in the overland flow paths and in the Young CBD.

3.9.5 Mitigation of Impacts of Future Urbanisation

The elements of the Combined Trunk Drainage Upgrade Scheme outlined in **Section 3.9** have been sized to cater for existing rates of runoff from the catchments. Unless provision is made to mitigate the effects of the increased rates of runoff, their performance will degrade over time with increasing urban development. Two types of detention storage strategies could be considered to mitigate the impacts of future urbanisation.

1. Provision of large developer-financed detention basins located at the downstream boundaries of proposed multi-site residential or commercial-industrial developments, which are sized to reduce peak flows to no greater than present day rates.

2. Use of On-Site Detention (OSD) in individual sites or allotments using tanks or surface depressions as storage devices to temporarily store runoff from major storm events which is then discharged to Council's drainage system at a controlled rate. To ensure that the system of OSD devices operates correctly, the maximum flow rate allowed to discharge from a particular site (Permissible Site Discharge or PSD) should be controlled by a restriction such as an orifice plate.

   The sizes of storages required and the allowable PSD would depend on both the size of the allotment and the percentage of impervious area and would be specified in requirements for OSD to be incorporated in an upgrade of Council's Stormwater Management Policies. The RAFTS-DRAINS rainfall-runoff catchment model developed for the *Flood Study* could be used to develop relationships for assessing OSD requirement. The OSD storages would control flows discharged from storms up to the 100 year ARI magnitude. OSD can be used in conjunction with other water management systems such as rainwater tanks or retention ponds. When OSD is used in combination with rainwater tanks and other Water Sensitive Urban Design (WSUD) systems, the total volume of runoff would be reduced. This in turn assists in improving water quality and reducing scour in the local waterways.

   OSD would have application in areas zoned *General Industrial* (*IN1*) and *General Residential* (*R1*) where the impacts of future development would be most severe.

3.9.6 Upgrading Council's Stormwater Management Policy

An upgrade of Council's stormwater management policy is required to mitigate the impacts of future development and also to complement the proposed planning controls outlined in **Section 3.10**. In particular:

- Prepare the OSD Policy along the lines outlined in **Section 3.9.5**.
- Include provisions for stormwater management and minimum floor levels in the areas outside the Flood Planning Area, defined as "Local Drainage" (ref. **Section 3.10**).

3.10 Property Modification Measures –Controls over Future Development

3.10.1 Considerations for Setting Flood Planning Level

Selection of the **Flood Planning Level** (*FPL*) for an area is an important and fundamental decision as the standard is the reference point for the preparation of floodplain management plans. It is based on adoption of the peak level reached by a particular flood plus an appropriate allowance for freeboard. It involves balancing social, economic and ecological considerations against the consequences of flooding, with a view to minimising the potential for property damage and the risk to life and limb. If the adopted *FPL* is too low, new development in areas above the *FPL* (particularly where the difference in level is not great) may be inundated relatively frequently and damage to associated public services will be greater. Alternatively, adoption of an excessively high flood planning level will subject land that is rarely flooded to unwarranted controls.

Councils are responsible for determining the appropriate *FPL*'s within their local government area. The Young LEP 2010 nominates the 100 year ARI plus 500 mm freeboard as the residential *FPL*. However, the LEP does not presently distinguish between the two flood producing mechanisms at Young; namely Main Stream flooding from Burrangong Creek and its principal tributaries and the slow moving and shallow overland flow from the three catchments draining the urban part of Young (Railway Drain, Chance Gully and Golf Course Drain).

3.10.2 Current Government Policy

The circular issued by the Department of Planning on 31 January 2007 contained a package of changes clarifying flood related development controls to be applied on land in low flood risk areas (land above the 100 year ARI flood). The package included an amendment to the Environmental Planning and Assessment Regulation 2000 in relation to the questions about flooding to be answered in Section 149 planning certificates, a revised ministerial direction (Direction 15 – now Direction 4.3 issued of 1 July 2009) regarding flood prone land (issued under Section 117 of the EP&A Act, 1979) and a new Guideline concerning flood-related development controls in low flood risk areas. The Circular advised that Councils will need to follow both the FDM, 2005 as well as the Guideline to gain the legal protection given by Section 733 of the Local Government Act.

The Department of Planning Guideline confirmed that unless exceptional circumstances applied, councils should adopt the 100 year ARI flood with appropriate freeboard as the FPL for residential development. In proposing a case for exceptional circumstances, a Council would need to demonstrate that a different FPL was required for the management of residential development due to local flood behaviour, flood history, associated flood hazards or a particular historic flood. Unless there were exceptional circumstances, Council should not impose flood-related development controls on residential development on land with a low probability of flooding, that is land above the residential *FPL*.

Nevertheless, the safety of people and associated emergency response management needs to be considered in low flood risk areas, which may result in:

- Restrictions on types of development which are particularly vulnerable to emergency response, for example, developments for aged care.
- Restrictions on critical emergency response and recovery facilities and infrastructure. These aim to ensure that these facilities and the infrastructure can fulfil their emergency response and recovery functions during and after a flood event. Examples include evacuation centres and routes, hospitals and major utility facilities. There are currently no critical developments of this nature in the floodplain.

3.10.3 Proposed Planning Controls for Young

Proposed planning controls for flood prone areas in Young, along with a draft *Flood Policy* for future development in those areas, are presented in **Appendix D** and **Appendix A** respectively. They are based on the proposed sub-division of the floodplain and amendments to the Young LEP 2010 introduced in **Section 2.6** of the report. The two Appendices deal with the following issues:

1. The preparation of flood mapping to separately identify land subject to Main Stream and Minor Tributary flooding, as well as areas subject to the shallower and slower moving flow associated with Major Overland Flow. The need for the sub-division of flood prone land into these three categories arises from recently developed practice which aims at minimising community concerns when land subject to relatively shallow slow moving overland flow (with the addition of the traditional 500 mm of freeboard) is subject to flood-related development controls and attracts a flood affection notice on Planning Certificates issued under Section 149 of the EP&A Act 1979.

2. Data presented in Table 3.1 of **Appendix D** which show that a considerable reduction in the number of properties in Major Overland Flow areas classified as "flood affected" would result by the adoption of a threshold depth of inundation under 100 year ARI conditions of 150 mm as the criterion for flood affectation, compared with the traditional approach. Properties with depths of inundation 150 mm or greater, or in a floodway (i.e. traversed by significant overland flows) would be considered to be flood affected and lie within the Flood Planning Area. Properties with depths of inundation under 100 year ARI conditions of less than 150 mm would be classified as "Local Drainage". This approach is supported by the FDM, 2005 and would not adversely impact on Council's duty of care in regard to management of flood prone lands. The proposed categorisation of the floodplain, terminology and controls are shown on **Table 3.7**.

TABLE 3.7
PROPOSED CATEGORISATION OF THE FLOODPLAIN

Category (FDM, 2005)	Proposed Terminology used to define inundation in FRMS&P report	Are Development Controls Required?	Is Section 149 Notification Warranted?
Main Stream Flooding	"Main Stream Flooding"	Yes	Yes
	"Minor Tributary Flooding"	Yes	Yes
Local Overland Flooding - Local Drainage - Major Drainage	 "Local Drainage" "Major Overland Flow"	 No (ref. footnote 1). Yes (ref. footnote 2).	 No (ref footnote 1) Yes (ref footnote 3)

Footnotes

1. Inundation in Local Drainage areas is accommodated by the minimum floor level requirement of 150 mm above finished surface level contained in the BCA and does not warrant a flood affectation notice in S149 Planning Certificates.
2. These are the deeper flooded areas with higher flow velocities. Development controls are specified in the draft *Flood Policy* of **Appendix A**.
3. Depth and velocity of inundation in Major Overland Flow areas are sufficient to warrant flood affectation notice in S149 Planning Certificates. Inundation is classified as "flooding".

3. The *Flood Planning Map* supporting the approach recommended in **Appendix D** is shown on **Figure A1.1** of the draft *Flood Policy* of **Appendix A**.

4. Notations to be provided on flood mapping and S149 Planning Certificates. The recent practice also differentiates between Major Overland Flow areas subject to deeper depths of inundation or traversed by significant flows (which should be subject to S149 flood affectation notification and flood related controls over future development) and the shallower inundated land on the Major Overland Flow fringe. In the latter case, inundation may be classified as "Local Drainage", with development subject to controls

such as BCA requirements, rather than attracting a flood affectation notice. Suggested wording for S149 Planning Certificates is presented in **Section 4.6.2** of **Appendix D**.

5. Implementation of the approach recommended in **Appendix D** to recognise the three flood mechanisms (Main Stream, Minor Tributary and Major Overland Flow) will also require Council's amending clause 6.6 of LEP 2010. Suggested wording is presented in **Section 4.5.2** of **Appendix D**.

3.10.4 Revision of LEP 2010 by Council

Implementation of the approach recommended in **Appendix D** for distinguishing between Main Stream and Minor Tributary flooding, as well as Major Overland Flow will require a revision of LEP 2010.

The steps involved in Council's amending LEP 2010 following the finalisation and adoption of the *FRMS&P* are:

1. Council Planning Staff consider the conclusions of the *FRMS&P* and suggested amendments to LEP 2010.
2. Council resolves to amend LEP 2010 in accordance with the *FRMS&P*.
3. Council prepares a Planning Proposal in accordance with NSW Planning and Environment Guidelines. Planning Proposal submitted to NSW Planning and Environment in accordance with section 55 of the EP & A Act.
4. Planning Proposal considered by NSW Planning and Environment and determination made in accordance with section 56(2) of the EP & A Act as follows:
   (a) whether the matter should proceed (with or without variation),
   (b) whether the matter should be resubmitted for any reason (including for further studies or other information, or for the revision of the planning proposal),
   (c) community consultation required before consideration is given to the making of the proposed instrument (the community consultation requirements),
   (a) any consultation required with State or Commonwealth public authorities that will or may be adversely affected by the proposed instrument,
   (e) whether a public hearing is to be held into the matter by the Planning Assessment Commission or other specified person or body,
   (f) the times within which the various stages of the procedure for the making of the proposed instrument are to be completed.
5. Planning Proposal exhibited for public comment.
6. Planning Proposal reviewed following public submissions and submissions from relevant State and Commonwealth authorities.
7. Final Local Environmental Plan with proposed amendments drafted.
8. Amending Local Environmental Plan made by the Minister and gazetted.

3.11 Property Modification Measures - Voluntary Purchase of Residential Properties

Removal of housing from high hazard floodway areas in the floodplain is generally accepted as a cost effective means of correcting previous decisions to build in such areas. The voluntary purchase (VP) of residential property in hazardous areas has been part of subsidised floodplain management programs in NSW for over 20 years. After purchase, land is subsequently cleared and the site re-developed and re-zoned for public open space or some other flood compatible use. A further criterion applied by State Government agencies in assessing eligibility for funding is that the property must be in a high hazard area such as floodway, that is, in the path of flowing floodwaters where the depth and velocity at the peak of the flood are such that life could be threatened, damage of property is likely and evacuation difficult.

Under a voluntary purchase scheme the owner is notified that the body controlling the scheme, Young Shire Council in the present case, is prepared to purchase the property when the owner is ready to sell. There is no compulsion whatsoever to sell at any time. The price is determined by independent valuers and the Valuer General, and by negotiation between Council and the owners. Valuations are not reduced due to the flood affected nature of the site.

Hydraulic calculations described in **Chapter 2** showed that strictly speaking, none of the residences flooded on the three urban overland flow paths (Railway Drain, Chance Gully and Golf Course Drain) was located in the high hazard portion of the floodway. Flow velocities are low and the principal impact of flooding would be a relatively short duration of shallow, above-floor inundation in affected properties.

Given the nature of the flood risk, implementation of a VP scheme is less justified than at other flood prone centres where more hazardous conditions may occur. In addition, the Young community were fairly evenly divided in their response to the suitability of this measure, preferring the alternative approach of structural improvements to the capacity of the trunk drainage system. However, for completeness a scheme was assessed for the 10 properties in the floodway subject to the deepest depths of flooding. **Table 3.8** over the page shows general locations of the properties and maximum depths of inundation for 100 and 20 year ARI magnitude of flooding.

An economic analysis was carried out on a VP scheme which would involve the purchase of the 10 properties. An average purchase price of $350,000 per property was adopted. **Table 3.9** over the page shows the results of the economic analysis which was carried out for the three discount rates nominated by NSW Treasury Guidelines for the economic analysis of public works. The benefits of the scheme comprise the present worth value of the flood damages to the properties which would be saved by their purchase.

It is clear from the data shown in **Table 3.9** that a voluntary purchase scheme would not be justified on economic grounds. VP schemes do not necessarily have to be economically feasible, as their main purpose is to remove unwise residential development in high hazard zones of the floodplain. However, although the urban floodplains are subject to “flash flooding” with little warning time, flooding is relatively shallow, of short duration and there is ready access to higher ground. Accordingly, it is considered that a voluntary purchase scheme would not be justified on social grounds. In addition, the improvements to the trunk drainage system associated with the Combined Trunk Drainage Upgrade Scheme of **Section 3.9** would render a VP scheme redundant.

TABLE 3.8
VOLUNTARY PURCHASE SCHEME
FOR TEN RESIDENCES SUBJECT TO ABOVE–FLOOR INUNDATION

Location	Flooded by 100 Year ARI Flood		Flooded by 20 Year ARI Flood	
	No. of Residences in Sample	Max Depth of Inundation – m	No of Residences in Sample Flooded	Max Depth of Inundation – m
Railway Drain	2	600	2	400
Chance Gully	7	400	6	200
Golf Course Drain	1	100	-	-
Total	**10**	**600**	**8**	**400**

TABLE 3.9
ECONOMIC ANALYSIS – VOLUNTARY PURCHASE SCHEME
FOR TEN RESIDENCES SUBJECT TO ABOVE–FLOOR INUNDATION

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) $ Million	1.40	1.09	0.88
Cost of scheme $ Million	3.5	3.5	3.5
Benefit/Cost Ratio	0.40	0.31	0.25

3.12 Property Modification Measures - Raising Floor Levels of Residential Properties

This term refers to procedures undertaken, usually on a property by property basis, to protect structures from damage by floodwaters. The most common process is to raise the affected house by a convenient amount so that the floor level is at or above the *Flood Planning Level* (*FPL)*. For weatherboard and similar buildings this can be achieved by jacking up the house, constructing new supports, stairways and balconies and reconnecting services. Alternatively, where the house contains high ceilings, floor levels can be raised within rooms without actually raising the house. It is usually not practical to raise brick or masonry houses. Most of the costs associated with this measure relate to the disconnection and reconnection of services. Accordingly, houses may be raised a considerable elevation without incurring large incremental costs.

State and Federal Governments have agreed that flood mitigation funds will be available for house raising, subject to the same economic evaluation and subsidy arrangements that apply to other structural and non-structural flood mitigation measures. In accepting schemes for eligibility, the Government has laid down the following conditions:

- House raising should be part of the adopted *Floodplain Risk Management Plan*.
- The scheme should be administered by the local authority.

The Government also requires that Councils carry out ongoing monitoring in areas where subsidised voluntary house raising has occurred to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level. In addition, it is expected that Councils will provide documentation during the conveyancing process so that subsequent owners are made aware of restrictions on development below the design floor level.

Council's principal role in subsidised voluntary house raising would be to:

- Define a habitable floor level, which it will have already done in exercising controls over new house building in the area
- Guarantee a payment to the builder after satisfactory completion of the agreed work
- Monitor the area of voluntary house raising to ensure that redevelopment does not occur to re-establish habitable areas below the design floor level

The current cost to raise a medium sized (150 m^2) house is about $100,000 based on recent experience in other centres.

Table 3.10 is an economic analysis of a house raising strategy for the three discount rates, assuming 7 properties out of those identified in **Table 3.8**, as well as 4 others not considered for VP were timber framed and could be raised. Eight of the properties are located on Chance Gully and the remaining 3 on Golf Course Drain. The benefits of the scheme comprise the present worth value of the flood damages for the residential properties which would be saved by their raising. If the houses were raised to at least the 100 year ARI flood level plus freeboard then the scheme's benefits would comprise the damages up to that flood.

TABLE 3.10
ECONOMIC ANALYSIS – RAISING FLOORS
OF ELEVEN TIMBER FRAMED RESIDENCES
TO 100 YEAR LEVEL PLUS FREEBOARD

Discount Rate %	4	7	10
Present Worth Value of Benefits (Damages Prevented) $ Million	1.19	0.93	0.75
Cost of scheme $ Million	1.10	1.10	1.10
Benefit/Cost Ratio	1.08	0.84	0.68

Note; 500 mm of freeboard on design flood levels was adopted for this illustration.

This strategy is marginally economically feasible, but was not favoured by the community in the responses to the Questionnaire. As mentioned, there is ready access to high ground for all of these properties. Accordingly, it is considered that a scheme for raising flood prone houses could be justified on social grounds and would in any case be made redundant by the Combined Trunk Drainage Upgrade Scheme. It has not been considered further.

3.13 Response Modification – Flood Forecasting and Warning

3.13.1 General

Flood forecasting and warning can be an effective flood management measure if there is sufficient warning time for the community to react to the warning. An effective flood warning system has three key components, i.e. a flood forecasting system, a flood warning broadcast system and a response/ evacuation plan. All systems need to be underpinned by an appropriate public flood awareness program.

Funding to establish local flash flood warning systems has traditionally been made available on the basis of no Council contribution to the initial capital cost in recognition of the high maintenance costs which Council would have to meet. The costs of maintaining the system would include such items as rain and river gauges, warning communication systems and ongoing public awareness/education programs. The maintenance obligations need to be identified and included in any initial funding grant. Upon installation of the local flash flood warning system, the NSW SES Local Flood Plan (yet to be prepared) for the area could be used to document the operation and maintenance specifications of the system, including the public education/awareness components.

3.13.2 Application to Burrangong Creek

The BOM's flood warning system for the Lachlan Valley uses rainfall and stream flow data recorded at gauges in the catchment to provide quantitative predictions of river heights at towns along the river, with Cowra being the most upstream location. Together with rainfall data from other stations in the Lachlan Valley, the system uses rainfall data recorded at the Young AWS which is located the airport about 4 km to the north of town. There are no stream gauges or rain gauges in the Burrangong Creek catchment and warning to NSW SES regarding approaching storms or flood producing rainfall is limited to the the BOM's regional severe weather alerts and valley wide flood watches.

Stream gauging stations provide valuable information on the response of the catchment to heavy rainfall, although the application of telemetered flow data from a stream gauge in the catchment headwaters in any future flood warning system for Burrangong Creek would be constrained by the short travel time of the floodwave from the gauge site to town.

Depending on the results of future hydraulic modelling, a rain gauge installed on the headwaters of Sawpit Gully with telemetered reporting of rainfall depths, together with reporting of storage levels in Chinaman's Dam to Council, may be a recommendation of the Dam Safety Emergency Plan (DSEP) required by the Dam Safety Committee (ref. **Section 3.15**). It is expected that analysis will be undertaken of the consequences of a dam-break using the flood models developed in the *Flood Study.* These analyses would be aimed at developing relationships between catchment rainfall intensities and dam-break flood levels in Young which will be incorporated in warning procedures included in the DSEP and the NSW SES's future Local Flood Plan for the Young Shire.

3.13.3 Application to Urban Overland Flow Paths

As noted previously, the impacts of flooding to existing urban development in Young are restricted to areas on the northern side of Burrangong Creek which are subjected to overland flows from the three local catchments (Railway Drain, Chance Gully and Golf Course Drain). Response times from these catchments are too short for implementation of an effective warning system based on rainfalls *recorded* during the storm event. However, emergency management procedures based on *predicted* rainfalls could be considered for inclusion in the NSW SES's future Local Flood Plan for the Young Shire

Relationships between predicted rainfall depths and consequences within the three catchments could be developed using the flood models developed in the *Flood Study,* which considered the responses of the drainage system to a range of design floods between a 5 year ARI event and the PMF. The prior wetness of the catchment could be included as an additional variable.

Figure D3.1 relates rainfall to flood consequences within the urabn area of Young for the design 100 year ARI flood.

The success of this approach depends on the lead time and accuracy of rainfall predictions. At present the accuracy of making quantitative predictions of rainfall especially in the case of localised thunderstorms is limited by lack of radar cover especially in rural areas of the state. Consequently in the short term the main application of diagrams such as **Figure D3.1** would be to test the sensitivity of flooding problems over the study area to estimated future rainfall intensities.

3.14 Response Modification Measures - Public Awareness Programs

Community awareness and appreciation of the existing flood hazards in the floodplain would promote proper land use and development in flood affected areas. A well informed community would be more receptive to requirements for flood proofing of buildings and general building and development controls imposed by Council.

One aspect of a community's preparedness for flooding is the "flood awareness" of individuals. This includes awareness of the flood threat in their area and how to protect themselves against it. It is fair to assume that the level of awareness drops as individuals' memories of previous experience dim with time. The improvements to flood warning arrangements described above, as well as the process of disseminating this information to the community, would represent a major opportunity for increasing flood awareness throughout the urban part of Young.

Means by which community awareness of flood risks can be maintained or may be increased include:

1. Displays at Council offices using the information contained in the present study and photographs of historic flooding in the area.
2. Talks by NSW SES officers with participation by Council and longstanding residents with first-hand experience of flooding in the area.

3.15 Dam Safety Emergency Plan for Chinaman's Dam

3.15.1 Dam Safety Committee Role and Requirements

The Dam Safety Committee (DSC) under its statutory obligations of the Dam Safety Act, 1978 ensures that al dams are designed and operated to a standard to minimise the risks to the community. The DSC requires all prescribed dams where persons may be at risk if the dam failed to be covered by a Dam Safety Emergency Plan (DSEP). The DSEP for Chinaman's Dam will cover preparedness in relation to the occurrence of an emergency condition at the dam and provide information necessary for emergency agencies, in particular the NSW SES, to manage a downstream evacuation in the event of a potential dam failure. The DSEP will be prepared in line with the requirements of the DSC's publication DSC2G, Emergency Management for Dams, 2010.

The DSC assigns "Consequence Categories" to a dam according to the seriousness and magnitude of the adverse consequences affecting a community which could be expected from that failure. The procedure for assessing Consequence Categories is set out in the DSC's publication DSC3A Consequence Categories for Dams, 2010 and ANCOLD Guidelines on the Consequence Categories for Dams,2012. Two types of dam failure are recognised for the purposes of determining a dam's Consequence Category, as follows:

- Failures that occur without attendant natural flooding, giving rise to the "Sunny Day" Consequence Category.
- Failures that occur in association with a natural flood, giving rise to the "Flood" Consequence Category.

There are seven possible Consequence Categories for a particular dam ranging between Very Low, through Significant and High, to Extreme. Consequences are based on the "Population at Risk" and probable "Loss of Life". The DSC uses the Consequence Category to determine whether the dam is "prescribed". Owners of High Consequence and Extreme Consequence dams are to have in place automatic telemetered monitoring of the storage levels and preferably rainfall and seepage. Measurements of seepage are required to monitor potential piping incidents.

The DSC requires dam-break studies for Significant, High and Extreme Consequence Category dams for the assessment of consequences (i.e. sunny day and flood dam-breaks for events up to the PMF).

For Extreme and High Consequence Category dams having a serious deficiency in safety, NSW SES has agreed with DSC that the future Local Flood Plan for the Young Shire will contain specific arrangements for dealing with a dam failure usually in the form of a Dam Failure Annex.

3.15.2 Preparation of a DSEP for Chinaman's Dam

There is no information available regarding the design and construction of the Chinaman's Dam, in particular the material used to form the embankment and its standard of compaction. The results of the *Flood Study* showed that the embankment would be overtopped by major floods and that in the event of a dam-break occurring in conjunction with a 100 year ARI flood, peak levels in Young could rise to 1.5 m higher than the natural flood level.

Consequently there is a high risk of failure in the event of a major flood and there may also be a significant risk of a Sunny Day failure due to internal piping of the embankment. Therefore, the Population at Risk is likely to be sufficiently high to justify apportionment of at least a "Significant" Consequence Category and probably a "High C" category (ref. Table 2 of DSC3A) to Chinaman's Dam.

Given the above, there is justification for the inclusion of the preparation of a DSEP for Chinaman's Dam as a priority measure in the FRMP. As noted previously, the flood models developed in the *Flood Study* could be used for the dam-break analyses.

Depending on the assessment of the Consequence Category for the dam it may also be appropriate to recommend the installation of a rain gauge on the headwaters of Sawpit Gully with telemetered reporting of rainfall depths, together with reporting of storage levels to Council. The indicative cost of this instrumentation would be around $30,000, with annual maintenance costs of $5,000. **Table 3.11** over the page gives an indicative budget for the data collection activities analysis and possible instrumentation components of the DSEP.

3.16 Summary

The findings of the review of potential measures for incorporation in the draft *Floodplain Risk Management Plan* are summarised in **Table 3.11** at the end of this Chapter.

This Chapter has reviewed a number of potential floodplain management measures. Preliminary hydraulic modelling of the Flood Modification measures (i.e. involving the construction of upgrades to the trunk drainage system) has been undertaken, along with the preparation of

indicative cost estimates and economic analysis. A Combined Trunk Drainage Upgrade Scheme comprising detention basins and piped diversions of flows to Burrangong Creek has been developed along with staging of the works.

TABLE 3.11
INDICATIVE COST OF DAM SAFETY EMERGENCY PLAN

Item	Budget - $
Survey of Storage Area to determine volume impounded	15,000
Geotechnical testing and reporting embankment conditions	25,000
Hydraulic analysis and preparation of DSEP Documentation, including a Flood Annex for future Local Flood Plan for Young Shire.	80,000
Rainfall and water level recording instrumentation at the dam (provisional item)	30,000
Total Cost	**150,000**

The detention basins on the headwaters of the local urban catchments, which form part of the scheme, could be justified on economic grounds. However, it is not possible to justify the additional pipe upgrades included in the Combined Trunk Drainage Upgrade Scheme on economic grounds alone, although consideration of the scheme using the design flood levels plus freeboard to compute economic benefits substantially increases its economic performance. As the Combined Trunk Drainage Upgrade Scheme will eliminate the frequent incidences of surcharging of the trunk drainage system which presently occur, together with flooding of downstream residential and commercial properties, they may be justified on social grounds. Accordingly, further consideration of the scheme via a Drainage Feasibility Study is a justified measure for inclusion in the *Floodplain Risk Management Plan*.

Property Modification measures involving planning controls for future development in flood prone areas, as well as removal or flood proofing existing residential property were also considered. Planning controls are an essential component of the FRMP. Introduction of a Flood Policy to guide future development in Young is recommended; a draft of the policy is presented in **Appendix A**.

Response Modification measures aimed at improving emergency management procedures and increasing the flood awareness of the population were also evaluated. Response Modification measures which are supported comprise promotion by Council of flood awareness and incorporation of flood data included in this FRMS in the NSW SES's future Local Flood Plan for the Young Shire.

In view of the potential increases in flood levels on Burrangong Creek resulting from a failure of the Chinaman's Dam, preparation of the DSEP, as required by the Dam Safety Committee, should be included in the FRMP. However, funding would need to be provided by Council as preparation of the DSEP would not qualify for funding under the NSW Government's floodplain management program.

TABLE 3.11
SUMMARY OF REVIEW OF
POTENTIAL FLOODPLAIN MANAGEMENT MEASURES
FOR INCLUSION IN THE DRAFT FLOODPLAIN RISK MANAGEMENT PLAN FOR YOUNG

MEASURE	PURPOSE	COMMENT
FLOOD MODIFICATION		
Creek Management Scheme	Ensure the existing drainage system functions at its optimum capacity.	• Existing flooding problem on the main streams does not justify inclusion of this measure in the draft *Floodplain Risk Management Plan (FRMP)* on flood mitigation grounds.
Channel Improvements	Increase hydraulic capacity of the creeks to reduce flood levels.	• Channel improvements are not justified on the main streams and are not feasible in the overland flow paths of the three urban catchments: Railway Drain, Chance Gully and Golf Course Drain.
Levees	Contain floodwaters within stream channel.	• Levees are not feasible on technical, economic and environmental grounds and should not form part of the draft *FRMP*.
Upgrade the Trunk Drainage System	Reduce overland flows in the three arms: Railway Drain, Chance Gully and Golf Course Drain.	• Detention Basins on the headwaters of Railway Drain and Chance Gully would significantly reduce flows discharging to the downstream residential areas and in the CBD area. They are recommended for consideration in the FRMP as the first stage of the Combined Trunk Drainage Upgrade Scheme. • The remaining elements of the Combined Trunk Drainage Upgrade Scheme comprising pipe upgrades of the trunk drainage system downstream of the basins would capture post-basin flows for major flood events and are worthy of further consideration in the draft *FRMP* as a long term strategy for improving the trunk drainage system. • A Drainage Feasibility Study should be included in the draft *FRMP* to refine the design concepts and indicative costs prepared in this *FRMS*, which has evaluated the Scheme at the strategic level of detail.
PROPERTY MODIFICATION		
Planning and building controls	Reduce potential flood hazard and losses in future developments in flood liable areas.	• Mainly applies to re-development of existing sites and future developments in floodplain; adoption of controls nominated in the draft Flood Policy of **Appendix A** is supported for inclusion in the draft FRMP.
Voluntary Purchase of Residential Property	Purchase and removal of residential properties in high hazard zones of the floodplain.	• Mainly applies to high hazard areas. Such a scheme is not economically justified and is not justified on social grounds due to the absence of affected properties in high hazard areas in Young (high hazard areas are mainly confined to the street system).
Flood Proofing by House Raising	Prevent flooding of individual residences	• Mainly applies to low hazard areas. Flood proofing achieved by house raising (wooden frame only). House raising scheme is not justified economically and is not justified on social grounds in Young.
RESPONSE MODIFICATION		
Improve emergency planning	Allow actions to be taken by NSW SES during a flood to reduce the risk to the population.	• Incorporate data from the *Flood Study* and FRMS in the NSW SES's future Local Flood Plan for the Young Shire. This measure was strongly supported by the Community. Include an Annexe in the Local Flood Plan on monitoring Chinaman's Dam (based on the results of the Dam Safety Emergency Plan – to be prepared by Young Shire Council).
Community education and public awareness programs	Educate the public of the nature of the flood risk	• A cheap, effective method, which should be incorporated in the draft FRMP, using data on flooding patterns and consequences contained in this *FRMS* and the Flood Study. Council and NSW SES should co-ordinate activities.
Flash Flood Warning System	Provides advance warning of flooding to allow residents to take action in removing/lifting contents above flood level.	• A Flash Flood Warning System for Burrangong Creek or its main tributaries is not justified for natural flooding but may be required to mitigate the risk to downstream areas resulting from a dam-break (depending on the results of the Dam Safety Emergency Plan) . There is insufficient warning time for a formal Warning System on the small urban catchments on the northern side of town.

4 SELECTION OF FLOODPLAIN MANAGEMENT MEASURES

4.1 Background

The FDM, 2005 requires a Council to develop a Floodplain Risk Management Plan (FRMP) based on balancing the merits of social, economic and environmental considerations which are relevant to the community. This chapter sets out a range of factors which need to be taken into consideration when selecting the mix of works and measures that should be included in the FRMP.

The community will have different priorities and, therefore, each needs to establish its own set of considerations used to assess the merits of different options. The considerations adopted by a community must, however, recognise the State Government's requirements for floodplain management as set out in the FDM, 2005 and other relevant policies. A further consideration is that some elements of the FRMP may be eligible for subsidy from State and Federal Government sources and the requirements for such funding must, therefore, be taken into account.

Typically, State and Federal Government funding is given on the basis of merit, as judged by a range of criteria:

- The magnitude of damage to property caused by flooding and the effectiveness of the option in mitigating damage and reducing the flood risk to the community.
- Community involvement in the preparation of the FRMP and acceptance of the option.
- The technical feasibility of the option (relevant to structural works).
- Conformance of the option with Council's planning objectives.
- Impacts of the option on the environment.
- The economic justification, as measured by the benefit/cost ratio of the option.
- The financial feasibility as gauged by Council's ability to meet its commitment to fund its part of the cost.
- The performance of the option in the event of a flood greater than the design event.
- Conformance of the option with Government Policies (e.g. FDM, 2005 and Catchment Management objectives).

4.2 Ranking of Options

A suggested approach to assessing the merits of various options is to use a subjective scoring system. The chief merits of such a system are that it allows comparisons to be made between alternatives using a common "currency". In addition it makes the assessment of alternatives "transparent" (i.e. all important factors are included in the analysis). The system does not, however, provide an absolute "right" answer as to what should be included in the plan and what should be left out. Rather, it provides a method by which the Council can re-examine its options and if necessary, debate the relative scoring given to aspects of the plan.

Each option is given a score according to how well the option meets the considerations discussed above. In order to keep the scoring simple the following system is proposed:

+2 Option rates very highly

+1 Option rates well

0 Option is neutral

- 1 Option rates poorly

- 2 Option rates very poorly

The scores are added to get a total for each option.

Based on considerations outlined in this chapter, **Table 4.1** presents a suggested scoring matrix for the options reviewed in **Chapter 3**. This scoring has been used as the basis for prioritising the components of the draft FRMP. ***The proposed scoring and weighting shown in Table 4.1 should be carefully reviewed by the Committee as part of the process of finalising the overall draft FRMP****.*

4.3 Summary

Table 4.1 indicates that there are good reasons to consider including the following elements into the draft FRMP:

- Planning Controls via a Flood Policy for future development in Young.
- Preparation by NSW SES of the Local Flood Plan for the Young Shire.
- Incorporation of the catchment specific information on flooding impacts contained in this Study in NSW SES Response Planning and Flood Awareness documentation for the study area.
- Undertaking the preparation of a Dam Safety Emergency Plan for Chinaman's Dam and inclusion of an Annexe on emergency management procedures in the event of a dam failure in the NSW SES's future Local Flood Plan for the Young Shire.
- Improvements to the trunk drainage systems of the Railway Drain, Chance Gully and Golf Course Drain to mitigate overland flooding in adjacent and downstream residential and commercial areas of Young.

Property modification measures such as voluntary purchase of residential property or house raising schemes were not considered justified.

TABLE 4.1
THE TOWN OF YOUNG
ASSESSMENT OF POTENTIAL FLOODPLAIN MANAGEMENT MEASURES FOR INCLUSION IN THE FLOODPLAIN RISK MANAGEMENT PLAN

Option	Impact on Flooding/ Reduction in Flood Risk	Community Acceptance	Technical Feasibility	Planning Objectives	Environ. Impacts	Economic Justification	Financial Feasibility	Extreme Flood	Government Policies and TCM Objectives	Score
Flood Modification										
Maintenance of creek channels and structures (debris clearing and vegetation control) to maintain hydraulic capacity.	0	+2	+1	+1	+1	-2	-1	0	0	+2
Enlarge the trunk drainage channel (Railway Drain only)	0	+2	-2	0	0	-2	0	0	0	-2
Construct permanent levees	0	+2	-2	0	0	0	0	0	0	0
Upgrade trunk drainage systems (Railway Drain, Chance Gully and Golf Course Drain)	+2	+2	+1	+1	0	+1	+1	0	+1	+9
Property Modification										
Flood Related Controls over future development (via draft Flood Policy);	+2	+2	+2	+2	0	0	0	+1	+2	+11
House Raising in Low Hazard Areas	0	-1	0	0	0	-2	0	0	+1	-1
Voluntary Purchase of Residential Property	0	+1	0	0	0	-2	-1	+1	+1	-1
Response Modification										
Improved Emergency Planning and Response	+1	+2	+1	0	0	+1	0	+1	+2	+9
Community Education and Flood Awareness	+1	+2	+1	0	0	+1	0	+1	+2	+9

5 DRAFT FLOODPLAIN RISK MANAGEMENT PLAN

5.1 The Floodplain Risk Management Process

The *Floodplain Risk Management Study (FRMS)* and draft *Floodplain Risk Management Plan* (*FRMP*) have been prepared for the Town of Young as part of a Government program to mitigate the impacts of major floods and reduce the hazards in the floodplain. The draft *FRMP* which is set out in this Chapter has been prepared as part of the Floodplain Risk Management Process in accordance with NSW Government's Flood Prone Land Policy.

The first steps in the process of preparing the draft *FRMP* were the collection of flood data and the review of the *Town of Young Flood Study* adopted by Young Shire Council on 19 February 2014. That *Flood Study* was the formal starting process of defining management measures for flood liable land and represented a detailed technical investigation of flood behaviour.

5.2 Purpose of the Plan

The overall objectives of the *FRMS* were to assess the impacts of flooding, review policies and options for management of flood affected land and to develop an *FRMP* which:

- Sets out the recommended program of works and measures aimed at reducing over time, the social, environmental and economic impacts of flooding and establishes a program and funding mechanism for the *FRMP*.
- Proposes amendments to Council's existing policies to ensure that the future development of flood affected land at Young is undertaken so as to be compatible with the flood hazard and risk.
- Ensures the *FRMP* is consistent with NSW SES's local emergency response planning procedures.
- Ensures that the *FRMP* has the support of the community.

5.3 The Study Area

The study area for this *FRMP* comprises the floodplains of Burrangong Creek and its tributary streams, extending from the Chinaman's Dam on Sawpit Gully to the Sewage Treatment Plant about 2 km downstream of town. The *FRMP* applies in areas affected by the two flood producing mechanisms that occur at Young: Main Stream flooding on Burrangong Creek and its principal tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek), as well as the shallower and slower moving Major Overland Flow experienced due to surcharge of the trunk drainage systems of the three catchments draining the urban area of Young (Railway Drain, Chance Gully and Golf Course Drain).

The solution of problems resulting from surcharges of the minor stormwater drainage systems in individual allotments remote from the Major Overland Flow paths or in the local street system, which may occur during localised storms, is outside the scope of the present investigation.

5.4 Community Consultation

The Community Consultation process provided valuable direction over the course of the investigations, bringing together views from key Council staff, other departments and agencies, and importantly, the views of the community gained through:

- The delivery of a Community Newsletter and Questionnaire to property occupiers located in the floodplain, as well as inclusion of the documentation on Council's web site to allow the wider community to gain an understanding of the issues being addressed as part of the study.
- Meetings of the Floodplain Management Committee to discuss results as they became available.
- Exhibition of the draft *Flood Study* and *FRMS* reports to give the community the opportunity to comment on the study findings.

5.5 Economic Impacts of Flooding

Table 5.1 shows the number of properties which would be flooded to above-floor level and the damages experienced for the various classes of property in the town. Damages in Young for a range of design flood events are evaluated in **Appendix B** of the *FRMS.*

TABLE 5.1
ECONOMIC IMPACTS OF FLOODING
AT YOUNG - PRESENT DAY DEVELOPMENT

Flood Event ARI	Properties Flooded Above-Floor Level and Flood Damages						Total Flood Damages
	Residential		Commercial /Industrial		Public Buildings		
	No.	$ Million	No.	$ Million	No.	$ Million	$ Million
5	2	0.26	10	0.12	1	Neg.	0.38
20	8	0.91	29	0.59	1	Neg.	1.50
100	19	1.86	54	1.85	2	0.03	3.73
200	23	2.17	65	2.21	3	0.03	4.41
PMF	75	7.11	157	41.91	9	1.44	50.46

Note: Damages are based on *design flood levels*, as computed in *The Town of Young Flood Study, 2014,* and floor levels as estimated in a "drive by" survey of the urban areas.

5.6 Indicative Flood Extents

Figure 2.3 shows the indicative extent of flooding for the 100 year ARI design flood which has been adopted as the "planning flood" for the purposes of specifying flood related controls over future development. The extent of flooding is indicative only, being based on the hydrologic model of the catchment and hydraulic model of the drainage system developed in the *Flood Study*. Floor levels of properties were estimated from a "drive by" survey of the urban part of Young. Consequently the results should not be used to identify the degree of flood affectation or otherwise of individual properties, for which a site specific survey would be required.

This level of accuracy in the flood mapping is supported by Office of Environment and Heritage (OEH), as the costs associated with undertaking of detailed ground survey in each flood affected property lies outside the scope of the NSW Government's floodplain program. Under the program, it is Council's responsibility to identify the flood risk within the floodplain and prepare

maps showing indicative flood extents (i.e. the mapping presented in this *FRMS* report), with the onus being on the property owner to carry out sufficient survey to allow a more accurate picture of flood affection to be described in his allotment.

To allow Council to assess individual development proposals for the purposes of the draft *Flood Policy* (ref. **Section 5.8** below), a detailed site survey would be required to allow the extent of flooding and the flood hazard to be evaluated using the results of the *Flood Study*. For this reason, proponents will be required to submit a detailed survey plan of the site for which development is proposed.

5.7 Structure of Floodplain Risk Management Study and Plan

The *FRMS* and draft *FRMP* are supported by Appendices which provide additional details of the investigations. A summary of the draft *FRMP* proposed for the study area along with broad funding requirements for the recommended measures are shown in **Table S1** at the commencement of the *FRMS report*. These measures comprise a program of engineering investigations and capital works, preparation of planning documentation by Council, community education on flooding by Council and NSW SES to improve flood awareness and response, as well as the preparation of a *Dam Safety Emergency Plan* for the Chinaman's Dam on Sawpit Gully. The measures will over time, achieve the objectives of reducing the flood risk to existing and future development for the full range of floods.

The draft *FRMP* is based on the following mix of measures which have been given a provisional priority ranking according to a range of economic, social, environmental and other criteria set out in **Table 4.1** of the report:

- Planning and development controls for future development in flood prone areas – **Measure 1**.
- Improvements in flood emergency response planning and awareness in the Young community, including preparation Shire by NSW SES of the Local Flood Plan for the Young Shire – **Measures 2** and **3**.
- Preparation by Council of the *Dam Safety Emergency Plan* for Chinaman's Dam on Sawpit Gully, required by the NSW Dam Safety Committee following the major flood of December 2010 – **Measure 4**.
- Upgrading the trunk drainage systems of the overland flow paths in the urban area on the northern side of Burrangong Creek (i.e. Railway Drain, Chance Gully and Golf Course Drain) to reduce the incidence of damaging flooding in adjacent residential areas and commercial development in the Young CBD – **Measures 5** and **6**.

5.8 Planning and Development Controls

The results of the *FRMS* indicate that an important measure for Young Shire Council to adopt in the floodplain would be strong floodplain management planning applied consistently by all branches of Council.

5.8.1 Flood Policy

The draft *Flood Policy* proposed for Young (**Appendix A**) used the concepts of *flood hazard* and *hydraulic categorisation* outlined in **Section 2.5** of the report to develop flood related controls for future development in flood prone land at Young. The Flood Policy caters for the three types of flooding in the Young area:

- **Main Stream** flooding resulting from overflows of the channels of Burrangong Creek and its major tributaries. These flows may be several metres deep in the channels and relatively fast moving. Main Stream flooding occurs when flows surcharge the channels of Burrangong Creek and its main tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek).
- **Minor Tributary** flooding caused by high flows in the minor un-named watercourses which drain to Burrangong Creek and its main tributaries. While the depth of flow in the inbank area of the channels is typically greater than 500 mm, flow on the overbank area is generally shallow and slow moving in nature.
- **Major Overland Flow** (**MOF**) on the flow paths of the three urban catchments on the northern side of Burrangong Creek (Railway Drain, Chance Gully and Golf Course Drain), which travels southwards as shallow, slow moving flow over the natural surface in these ill-defined watercourses and eventually joins Burrangong Creek. Flows on the MOF paths would typically be around 300 - 500 mm deep, travelling over the surface at velocities less than 0.5 m/s. Shallow overland flow also results from surcharge of the un-named minor watercourses in the rural parts of the floodplain which drain to the Main Stream system.

The *Flood Policy* is supported by the Working Paper included as **Appendix D** in this report, which was prepared to identify areas in the urban part of town which are inundated by overland flows and recommend flood related Planning Controls for future development in those areas. **Appendix D** also sets out recommendations for amendments to the Flood Planning Clause 6.6 in the LEP 2010, as well the inclusion of a new clause aimed at addressing potential flood evacuation issues on in parts of Young (ref. **Section 5.9** below).

Figures A1.1 in **Appendix A** is the *Flood Planning Map* for Young. The figure includes flooding in the main streams and minor tributaries in the presently rural part of the study area, which extends to the east and south of the developed part of town, and continues downstream to the Sewage Treatment Plant. The extent of the FPA (the area subject to flood related development controls) is shown in a solid red colour in **Figure A1.1** and has been defined as follows:

- In areas subject to **Main Stream** flooding, the FPA is based on the traditional definition of the area inundated by the 100 year ARI plus 500 mm freeboard.
- In areas subject to **Minor Tributary** flooding, the FPA is defined as the extent of the High and Low Hazard Floodway zones, in combination with areas where depths of inundation in a 100 year ARI event exceed 150 mm.
- In areas subject to **MOF**, the FPA is defined as the extent of the High and Low Hazard Floodway zones, in combination with areas where depths of inundation in a 100 year ARI event exceed 150 mm. Properties that are intersected by the extent of the Floodway zones or are subject to depths of inundation greater than 150 mm have also been defined as FPA.

It is proposed that properties intersected by the extent of the FPA would be subject to S149 flood affectation notification and planning controls graded according to flood hazard (dependent on depth of inundation and flow velocity). **Annexures 2.1** and **2.2** in **Appendix A** set out the graded set of flood related planning controls which have been developed for Young. **Annexure 2.1** deals with areas subject to both Main Stream and Minor Tributary flooding, while **Annexure 2.2** deals with areas in the Major Overland Flow Urban Precinct that are subject to MOF. **Figure A1.2** in **Appendix A** is the *Development Controls Matrix Map* for Young and shows the area over which both **Annexures 2.1** and **2.2** apply.

Figures A1.3 in **Appendix A** is the *Flood Hazard Map* for Young. The figure shows the sub-division of the floodplain into the following four categories which have been used as the basis for developing the graded set of planning controls for Young:

- **High** and **Low Hazard Floodway** zones which are shown in **Figure A1.3** in solid red and yellow colour, respectively. Future development in these areas is not permitted, with the exception of the Low Hazard Floodway areas located within the Major Overland Flow Urban Precinct, where residential, business and commercial/industrial type development can occur subject to compliance with a prescribed set of flood related development controls.
- **Intermediate Floodplain**, which is shown in solid blue in **Figure A1.3**. The extent of the Intermediate Floodplain, excluding Floodway zones matches the extent of the FPA. Development of all types is permitted in this area subject to compliance with a prescribed set of flood related development controls.
- **Outer Floodplain**, which is shown in **Figure A1.3** in solid cyan. The Outer Floodplain is defined as the area which lies between the extent of the PMF and the FPA.[2] While flood related development controls would not apply to residential, business and commercial/industrial type development in this area, controls would still apply to development with particular evacuation or emergency response issues (e.g. residential care facilities, group homes, hospitals, etc).

In properties subject to S149 flood affectation notification, minimum floor level requirements have been set equal to the 100 year ARI flood level plus 500 mm freeboard in areas subject to Main Stream and Minor Tributary flooding, while in areas subject to MOF the freeboard provision has been reduced to 300 mm in recognition of the low hazard nature of this type of flooding.

5.9 Revision to LEP 2010

Clause 6.6 of LEP 2010 entitled “Flood Planning” outlines its objectives in regard to development of flood prone land. It is similar to the standard Flood Planning Clause used in recently adopted LEPs in other NSW country centres and applies to land beneath the Flood Planning Level (FPL). The FPL referred to is the 100 year ARI flood plus an allowance for freeboard of 500 mm. The area encompassed by the FPL is known as the Flood Planning Area (FPA) and denotes the area subject to flood related development controls, such as locating development outside high hazard areas and setting minimum floor levels for future residential development.

Whilst appropriate for Main Stream flooding, the present clause 6.6 would have resulted in a large part of the urban area which is affected by shallow overland flow being subject to flood affectation notification on Planning Certificates issued under S149 of the EP&A act.

[2] The extent of the PMF at Young has been trimmed to include areas where the depth of inundation exceeds 150 mm.

To implement the approach recommended in **Appendix D** and outlined in **Section 2.6** above, clause 6.6 of LEP 2010 would require amendment to simply state that flood related development controls for Young apply to land identified as FPA on the *Flood Planning Map* or other land at or below the FPL. Suggested amendments are given in **Appendix D**. The revised LEP would need to be supported by the *Flood Policy* in **Appendix A** of the *FRMS&P* report which sets out specific requirements for development in flood liable areas based on the flood extent and hazard mapping contained in the *Flood Study*. **Figure A1.1** of **Appendix A** shows the proposed *Flood Planning Map* referred to in the revised clause 6.6.

It is also recommended that a new floodplain risk management clause be include in the Young LEP. The objectives of the new clause are as follows:

- in relation to development with particular evacuation or emergency response issues (e.g. group homes, residential care facilities, hospitals, etc) to enable evacuation of land subject to flooding in events exceeding the flood planning level; and
- to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

The new clause would apply to land identified as Outer Floodplain (i.e. land which lies between the FPA and the PMF). Suggested wording in relation to this new clause is given in **Appendix D**.

5.10 Improvements in Emergency Planning and Flood Awareness

Two measures are proposed in the *FRMP* to improve flood emergency planning and maintain awareness in the community of the threat posed by floods:

Measure 2 involves the preparation by NSW SES of the *Local Flood Plan for Young Shire* using information on flooding patterns, times of rise of floodwaters and flood prone areas identified in the report. Figures have been prepared showing indicative extents of flooding, high hazard areas, expected rates of rise of floodwaters in key areas and locations where flooding problems would be expected. A table has been prepared identifying critical times of overtopping and maximum depths of inundation of existing road and pedestrian crossings at Young (refer **Appendix F**). The floodplain has also been divided into a series of zones based on the definitions contained in the Floodplain Risk Management Guideline – *Flood Emergency Response Planning Classification of Communities*. **Section 2.10.2** references the locations of key data within the *Flood Study* and the report.

Council should also take advantage of the information on flooding presented in the *Flood Study* and the *FRMS*, including the flood mapping, to inform residents of the flood risk (included as **Measure 3** of the *FRMP*). This information could be included in a Flood Information Brochure to be prepared by Council with the assistance of NSW SES containing both general and site specific data and distributed with the rate notices. The community should also be made aware that a flood greater than historic levels or the planning level can, and will, occur at some time in the future. The *FRMP* should be publicised and exhibited in Council offices and at community gathering places to make residents aware of the measures being proposed.

NSW SES's *Local Flood Plan* could also include information on the consequences of a dam-break of the Chinaman's Dam located on Sawpit Gully in the Chinese Gardens Reserve. The dam-break study would form part of the *Dam Safety Emergency Plan* to be prepared by Council *as* required by the NSW Dam Safety Committee and included as **Measure 4** of the *FRMP*.

Preliminary hydraulic modelling undertaken in the *Flood Study* showed that a sudden failure of the dam in conjunction with the occurrence of a 100 year ARI flood would result in peak flood levels on Burrangong Creek along the frontage of the town which were about 1.5 m above natural flood levels.

5.11 Upgrading the Trunk Drainage System

Experience with the performance of the trunk drainage systems in the three urban catchments on the northern side of Burrangong Creek (Railway Drain, Chance Gully and Golf Course Drain), most recently in December 2010, has shown that the system is under capacity and should be upgraded to mitigate existing flooding problems in residential and commercial development in Young. Strategic analysis undertaken in **Chapter 3** of the *FRMS* has resulted in the development of a scheme for upgrading the drainage system extending from the commencement of the piped systems at the northern limits of the urban area of town to Burrangong Creek (denoted the Combined Drainage Upgrade Scheme). Two measures which would require Government funding support have been proposed in the *FRMP* to advance the scheme.

Measure 5 – Drainage Feasibility Study of the Combined Drainage Upgrade Scheme. The upgrade would involve the construction of new detention basins on the headwaters of the catchment, enlargement of the existing detention basin on the Railway Drain to the north of Brock Street, augmentation of existing pipelines and major diversion pipelines to capture overland flows and convey them to Burrangong Creek. The elements of the scheme and indicative costs are listed in **Table 3.3** and shown on **Figure 3.1** of the report.

Further technical investigation is required than is possible in this report, which is strategic in nature. This investigation is required to confirm the engineering feasibility of the scheme, establish priorities for implementation of its elements and provide documentation to the standard necessary to support an application for Government funding for the detailed design and construction. The feasibility study would refine the design concept and cost estimates developed in this report and would include additional survey, geotechnical investigation, engineering and economic analysis.

Measure 6 – Depending on the results of the feasibility study, **Measures 6** would be implemented. This measure comprises preparation of the detailed design and documentation of the Combined Drainage Upgrade Scheme, followed by its staged construction as funding becomes available.

5.12 Mitigating Effects of Future Development

The program of improvements to the trunk drainage system outlined in the previous section is intended to mitigate *existing flooding problems*. Under the zoning associated with Young LEP 2010, future residential development is envisaged in the currently rural areas to the north of Orchard Street as well as areas bordering the tributary streams on the southern side of Burrangong Creek. Hydraulic analysis described in **Chapter 3** showed that the resulting urbanisation would result in significant increases in downstream flood peaks and exacerbation of existing flooding problems.

Preparation by Council of an On Site Detention policy for areas zoned for future residential and industrial development is required to ensure that developments incorporate measures which ensure that post-project peak flows are no greater than present day values.

5.13 Voluntary Purchase of Residential Property

Removal of housing is a means of correcting previous decisions to allow buildings in high hazard areas in the floodplain. The voluntary purchase of residential property in hazardous areas has been part of subsidised floodplain management programs in NSW.

The review undertaken in the *FRMS* showed that implementation of a Voluntary Purchase (VP) scheme was not economically viable and could not be justified on social grounds as there are no properties located in high hazard areas of the floodplain. In any case a VP scheme would be redundant after the completion of the elements of the Combined Drainage Upgrade Scheme.

5.14 Raising Floor Levels of Residential Property

The analysis undertaken in the *FRMS* showed that the implementation of a voluntary house raising program which is sometimes adopted as a management measure for reducing risk in low hazard areas of the floodplain was not economically viable, could not be justified on social grounds and would be redundant after the completion of the elements of the Combined Drainage Upgrade Scheme.

5.15 Implementation Program

The steps in progressing the floodplain management process from this point onwards are:

1. Floodplain Management Committee to consider and adopt recommendations of this study. In particular, the Committee should review the basis for ranking floodplain management measures (as set out in **Table 4.1** of the *FRMS* and the proposed works and measures to be included in the proposed *FRMP* as set out in **Table S1**); exhibit the *draft FRMS* and *FRMP* and seek community comment.
2. Consider public comment, modify the document if and as required, and submit to Council.
3. Council adopts the *FRMP* and submits an application for funding assistance. Assistance for funding qualifying projects included in the *FRMP* may be available upon application under the Commonwealth and State funded floodplain management programs currently administered by Office of Environment and Heritage (OEH).
4. Assistance for funding qualifying projects included in the *FRMP* may be available upon application under the Commonwealth and State funded floodplain management programs, currently administered by OEH.
5. As funds become available from Government agencies and/or Council's own resources, implement the measures in accordance with the established priorities.

The *FRMP* should be regarded as a dynamic instrument requiring review and modification over time. The catalysts for change could include new flood events and experiences, legislative change, alterations in the availability of funding, reviews of Council's planning strategies and importantly, the outcome of some of the studies proposed in this report as part of the *FRMP*. In any event, a thorough review every five years is warranted to ensure the ongoing relevance of the *FRMP*

6 GLOSSARY OF TERMS

Note: For expanded list of definitions, refer to Glossary contained within the NSW Government Floodplain Development Manual, 2005.

TERM	DEFINITION
Average Recurrence Interval (ARI)	The average return period between the occurrence of a particular flood event. For example, a 100 year ARI flood has an average recurrence interval of 100 years.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Flood Affected Properties	Properties that are either encompassed or intersected by the **Flood Planning Area (FPA)**.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* referred to in the Young Local Environmental Plan 2010 and presented as **Figure A1.1** in **Appendix A**.
Flood Planning Level (FPL) (General Definition)	The combinations of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans.
Flood Planning Level (FPL)	For land within the Flood Planning Area subject to Main Stream and Minor Tributary flooding in Young, the Flood Planning Level (FPL) is the level of the 100 year Average Recurrence Interval (ARI) flood event plus 500 mm freeboard. For land within the Flood Planning Area subject to Major Overland Flow in Young, the FPL is the level of the 100 year ARI flood event plus 300 mm freeboard. For areas outside the study area in Young, the FPL is the level of the 100 year ARI flood event plus 500 mm freeboard.
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They 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.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.

TERM	DEFINITION
Freeboard	A factor of safety used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted FPL and the flood used to determine the FPL. 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. Freeboard is included in the FPL.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Intermediate Floodplain	For Main Stream flooding it is the strip of land on each side of the Floodway encompassing the zone between the Floodway and the line defining the indicative extent of flooding resulting from the occurrence of the 100 year ARI flood plus 500 mm (i.e. the FPA). For Major Overland Flow it is the land (defined on an allotment basis) where the depth of inundation during the 100 year ARI storm event is greater than 300 mm, or is in a floodway.
Local Drainage	Land on an overland flow path where the depth of inundation during the 100 year ARI storm event is less than 150 mm.
Main Stream Flooding	The inundation of normally dry land occurring when water overflows the natural or artificial banks of a major stream; for Young, the main streams are Burrangong Creek, Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek.
Minor Tributary Flooding	The inundation of normally dry land occurring when water overflows the natural or artificial banks of a minor stream; for Young, the minor streams are those unnamed watercourses that drain to Burrangong Creek and its major tributaries outside the Major Overland Flow Urban Precinct.
Major Overland Flow	Land (defined on an allotment basis) located on an overland flow path where the depth of inundation during the 100 year ARI storm event is greater than 150 mm, or is in a floodway. An allotment where these conditions apply is located in the FPL.
Outer Floodplain	This is defined as the land between the FPA and the extent of the PMF.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. For Young, the extent of the PMF has been trimmed to include depths greater than 150 mm.

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APPENDIX A

DRAFT FLOOD POLICY

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ANNEXURES

FIGURES
(BOUND IN VOLUME 2)

A1. INTRODUCTION

This Flood Policy has been prepared to provide specific controls to guide development of land in flood prone areas in the Burrangong Creek drainage system at Young.

The Flood Policy incorporates the findings of *The Town of Young Floodplain Risk Management Study & Plan, 2015* (FRMS&P) and the procedures set out in the NSW Floodplain Development Manual (FDM, 2005).

The FRMS&P identified the occurrence of two types of flooding in the Young area:

- **Main Stream** flooding resulting from overflows of the channels of Burrangong Creek and its major tributaries. These flows may be several metres deep in the channels and relatively fast moving with velocities up to 2 m/s. Main Stream flooding, occurs when flows surcharge the channels of Burrangong Creek and its main tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek).
- **Minor Tributary** flooding resulting from overflows of the minor watercourses which drain the relatively steep hillsides bordering Burrangong Creek and its major tributaries. While flow in the inbank area of the minor watercourses is generally greater than 0.5 m, overbank flow is relatively shallow and slow moving with velocities typically less than 0.5 m/s.
- **Major Overland Flow (MOF)** on the flow paths of the three urban catchments on the northern side of Burrangong Creek (Railway Drain, Chance Gully and Golf Course Drain), which travels southwards as shallow, slow moving flow over the natural surface in these ill-defined watercourses and eventually joins Burrangong Creek. Flows on the MOF paths would typically be around 300 - 500 mm deep, travelling over the surface at velocities less than 0.5 m/s. Shallow overland flow also results from surcharge of the un-named minor watercourses in the rural parts of the floodplain which drain to the Burrangong Creek system.

The Flood Policy takes into account the "*Guideline on Development Controls on Low Flood Risk Areas*" and Ministerial Direction No 4.3 issued by the Department of Planning on 1 July 2009. As a consequence, residential areas within the extent of the **Flood Planning Area** (**FPA**) shown on the attached **Figure A1.1**, **Flood Planning Map**, are subject to flood related development controls in this Flood Policy. Within the FPA, the controls over residential development reflect the nature of the flood risk. The sub-division of the floodplain into hazard areas is shown on **Figure A1.3**, **Flood Hazard Map**.

The Policy recognises the need for controls over commercial and industrial development within the FPA to balance the flood risk against the requirement for continuing the long term viability of this sector of Young. The Policy also recognises that the safety of people and associated emergency response planning need to be considered and imposes restrictions on vulnerable development (for example, aged care facilities) and critical emergency response and recovery facilities and infrastructure (evacuation centres, hospitals and utilities).

A1.1 What does the Policy do?

The Flood Policy provides information to assist people who want to develop or use land affected by potential flooding in Young. Development may include, among other things:

- dwelling construction, including additions to existing dwellings;
- filling land to provide building platforms above flood level;
- commercial and industrial development;
- sub-dividing land.

A1.2 Objectives

The objectives of this Flood Policy are:

(a) To provide detailed flood related development controls for the assessment of applications on land affected by floods in accordance with the provisions of Young LEP 2010 and the findings of *The Town of Young Floodplain Risk Management Study and Plan, 2015*.

(b) To alert the community to the hazard and extent of land affected by floods.

(c) To inform the community of Council's policy in relation to the use and development of land affected by the potential floods in Young.

(d) To reduce the risk to human life and damage to property caused by flooding through controlling development on land affected by floods.

(e) To ensure new development is consistent with the flood response strategies adopted by the State Emergency Service (SES) and does not impose additional burdens on, or risk to, SES personnel during flood emergencies.

Definitions of flood related terms used herein are provided in the **Glossary** in **Section 3** of this document.

A1.3 Will the Policy affect my Property?

The Policy applies to all development permissible with the consent of Council on land:

i) to which Young LEP 2010 applies; and

ii) that lies within the extent of the FPA, as shown in **Figure A1.1**;

iii) land that lies on the floodplain but outside the extent of the FPA (refer area identified as "Outer Floodplain" in **Figure A1.1**).

A1.4 How to Use This Policy

The Policy provides criteria which Council will use for the determination of development applications in areas within the extent of the FPA in Young. The criteria recognise that different controls apply to different land uses and levels of potential flood inundation or hazard.

The procedure Council will apply for determining the specific controls applying to proposed development within the FPA is set out below. Upon enquiry by a prospective applicant, Council will make an initial assessment of the flood affectation and flood levels at the site using the following procedure:

i) Determine which part of the floodplain the development is located in from **Figure A1.1**.

ii) Determine which Development Controls Matrix applies to the development from **Figure A1.2**.

iii) Determine the flood hazard zone(s) applies to the development from **Figure A1.3**.

iv) Identify the category of the development from **Annexure 1: Land Use Category**.

v) Determine the flood level at the site using information contained in *The Town of Young Floodplain Risk Management Study and Plan, 2015,* as well as the appropriate **Flood Planning Level** defining the minimum floor level and flood related development controls for the category of development from **Figure A1.3** and **Annexure 2: Development Controls Matrices**.

vi) Confirm that the development conforms with the controls in **Annexure 2**.

With the benefit of this initial information from Council, the Applicant will prepare the Documentation to support the development application according to **Annexures 2** and **4**.

A survey plan showing natural surface levels over the site will be required as part of the Development Application Documentation. Provision of this plan by the applicant at the initial enquiry stage will assist Council in providing flood related information relevant to the site.

Further information on flooding in Young and the controls over development imposed by this Policy are available by discussion with and upon written application to Council.

A1.5 Other Documents Which May Need to be Read in Conjunction with this Plan

- Young Local Environmental Plan 2010;
- The Town of Young Floodplain Risk Management Study and Plan, 2015;
- The Town of Young Flood Study, 2014;
- NSW Government Floodplain Development Manual, 2005; and associated Guideline on Development Controls on Low Flood Risk Areas; and Ministerial Direction No. 4.3, 1 July 2009; and
- Relevant Council policies, development control plans and specifications.

A2. WHAT ARE THE CRITERIA FOR DETERMINING APPLICATIONS?

A2.1 General

Development controls on flood prone land are set out in **Annexure 2** of this Flood Policy. The controls recognise that different controls are applicable to different land uses, the location within the floodplain and levels of potential flood inundation and flood hazard.

The controls applicable to proposed development depend upon:

- The type of development.
- The part(s) of the floodplain where the development is located.
- Peak flood levels at the site of the development.

A2.2 Sub-Division of the Floodplain

Figure A1.3 shows the division of the floodplain into a number of flood hazard zones in areas subject to Main Stream and Minor Tributary flooding, as well as Major Overland Flow within the Major Overland Flow Urban Precinct.

A2.3 Main Stream Flooding

In the areas subject to Main Stream flooding:

The **High Hazard Floodway** is the most flood affected land and the area where the highest flow velocities would be expected in the event of a 100 year Average Recurrence Interval (ARI) flood. For Main Stream flooding, this zone is confined to the channels of Burrangong Creek and its main tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek). There are also isolated areas in these channels which have been categorised as **Low Hazard Floodway** where the depth of flow is less. **Flood Storage Areas** on Burrangong Creek and its major tributaries are generally confined to existing farm dams, including Chinaman's Dam on Sawpit Gully. There are presently no properties located in these zones on the main streams and they should be kept clear of future development.

The **Intermediate Floodplain** for Main Stream flooding is the remaining land lying outside the extent of the floodway and flood storage zones, but within the FPA (land which lies below the 100 year ARI flood level plus 500 mm freeboard). Within this area, there would only be the requirement for minimum residential floor levels to be set at 100 year ARI flood levels plus 500 mm. All land uses would be permitted in this zone. However, Essential Community Facilities, Critical Utilities and Flood Vulnerable development such as housing for aged and disabled persons would be subject to additional controls, which are identified in subsequent sections and in **Annexure 2.1**.

The **Outer Floodplain** is the remainder of the floodplain between the Intermediate Floodplain and the extent of the Probable Maximum Flood - PMF (that is, the extent of the floodplain). This area is outside the extent of the FPA. However, controls on Essential Community Facilities, Critical Utilities and Flood Vulnerable development identified in **Annexure 2.1** would apply in this area.

A2.3 Minor Tributary Flooding

In the areas subject to Minor Tributary flooding:

High and Low Hazard Floodway areas are generally confined to the inbank area of the minor watercourses which drain the relatively steep hillsides bordering Burrangong Creek and its major tributaries. Flood Storage Areas along these watercourses are generally confined to existing farm dams. There are presently no dwellings located in these zones and they should be kept clear of future development.

The Intermediate Floodplain for Minor Tributary flooding is the remaining land lying outside the extent of the floodway and flood storage zones, but where depths of inundation in a 100 year ARI flood will exceed 150 mm. Within this area, there would only be the requirement for minimum residential floor levels to be set at 100 year ARI flood levels plus 500 mm. All land uses would be permitted in this zone. However, Essential Community Facilities, Critical Utilities and Flood Vulnerable development such as housing for aged and disabled persons would be subject to additional controls, which are identified in subsequent sections and in **Annexure 2.1**.

The Outer Floodplain is the remainder of the floodplain between the Intermediate Floodplain and the extent of the PMF. This area is outside the extent of the FPA. However, controls on Essential Community Facilities, Critical Utilities and Flood Vulnerable development identified in **Annexure 2.1** would apply in this area.

A2.4 Major Overland Flow Urban Precinct

The zone entitled the **Major Overland Flow Urban Precinct** has been used to identify the area in which allotments subject to Major Overland Flow lie. It borders the three urban catchments Railway Drain, Chance Gully and Golf Course Drain and its boundaries are shown on **Figures A1.1**, **A1.2** and **A1.3**.

The Floodway has been subdivided into high hazard (shown as a solid red colour) and low hazard (shown in solid yellow colour) areas and identifies the zone where significant flows occur. Properties intersected by the extent of the floodway or subject to depths of inundation greater than 300 mm are located in the FPA. These allotments are identified by solid red lines around their boundaries.

Flood related controls are specified in **Annexure A2.2**. In the Major Overland Flow Urban Precinct, the Intermediate Floodplain is defined by the area outside the Floodway and Flood Storage zones where depths of flow would exceed 150 mm in a 100 year ARI event. The Outer Floodplain is the area outside the Floodway, Flood Storage and Intermediate Floodplain where depths of flow would exceed 150 mm in a PMF event.

Low Hazard conditions will occur in most of the floodway, even during major flood events, due to the shallow depth and low velocities. Council discourages new residential development within the High Hazard portion of the floodway, but may permit development in the Low Hazard Floodway, provided it is capable of withstanding hydraulic forces and is sited within the allotment to minimise adverse re-directions of flow towards adjacent properties. There are restrictions on site filling in this zone to prevent blockage of flows (ref. **Section A2.15**). Similar controls exist for commercial and industrial development. Council may require a *Flood Risk Report* for development proposals in this zone (typically for larger scale commercial or industrial developments).

High Hazard areas on the Major Overland Flow paths are confined to the streets and undeveloped land, apart from a localised residential area on Chance Gully between William Street and the railway. Minor additions to existing residences and small outbuildings in that zone may be permitted by Council, subject to conformance with the controls specified in **Annexure 2.2** and the provision of a satisfactory *Flood Risk Report* demonstrating that the development is capable of withstanding hydraulic forces and is sited to minimise adverse re-directions of flow to adjacent properties. Site filling in this zone will not be permitted (ref. **Section A2.15**).

Controls on Essential Community Facilities, Critical Utilities and Flood Vulnerable development identified in **Annexure 2.2** would apply to development located in the Outer Floodplain.

A2.6 Local Drainage

At the lower end of the scale, drainage problems are typically caused by direct surface runoff, surcharges and overflows from low points in kerbs, or overflows from the smaller pipes in the stormwater drainage system. They typically involve depths of inundation up to 300 mm. In the FDM, 2005, these situations are categorised as **Local Drainage**.

The Manual recognises that Local Drainage problems are not always amenable to rigorous analysis and therefore Council is **not** obliged to convey information on Planning Certificates under Section 149 of the EP&A Act. Local Drainage problems involve shallow depths of inundation with generally little danger to personal safety. Problems due to property inundation generally arise because of deficiencies in stormwater management controls or building practice where floor levels are near finished ground levels.

In Young, the threshold between Major Overland Flow and Local Drainage has been reduced to 150 mm in recognition that depths of flow greater than this value could result in above floor inundation if appropriate controls are not imposed on new development.

A2.7 Land Use Categories and Flood Planning Levels

Eight land use categories have been adopted. The specific land uses, in each category are listed in **Annexure 1**.

The "**Flood Planning Level**" **(FPL)** is the minimum floor level for the land uses:

- For new residential development in Young, the FPL is the peak 100 year ARI flood level at the particular development site, plus an allowance for freeboard. Within the Main Stream and Minor Tributary FPA's the freeboard is 500 mm. For residential allotments in the FPA of the MOF paths, the freeboard is 300 mm.
- For commercial and industrial development the FPL is the peak 100 year ARI flood level plus freeboard. Within the Main Stream and Minor Tributary FPA's, the freeboard is 500 mm. For allotments in the FPA of the MOF paths, the freeboard is 300 mm. Council may at its discretion allow an amendment to this FPL, subject to local conditions (refer **Section A2.8**).
- For Essential Community Facilities and Critical Utilities the FPL is the peak 100 year ARI flood level plus freeboard. Within the Main Stream and Minor Tributary FPA's, the freeboard is 500 mm. For allotments in the FPA of the MOF paths, the freeboard is 300 mm. In addition, these uses are to be designed to be able to continue to function and suffer minimal damage to structure and valuable contents in the event of a PMF (refer **Section A2.9**).

- For Flood Vulnerable Residential Development (nursing homes, aged care facilities and the like) the FPL is the peak 100 year ARI flood level plus freeboard. Within the Main Stream and Minor Tributary FPA's, the freeboard is 500 mm. For allotments in the FPA of the MOF paths, the freeboard is 300 mm. Council will require an area at a higher level (to be nominated by Council) for the storage of valuable equipment and will also require the applicant to demonstrate that there is safe access to the site in the event of a flood emergency (refer **Section A2.10**).

A2.8 Assessing Commercial and Industrial Development Proposals

The Flood Policy nominates the same FPL as for residential development. However, where it is not practicable to achieve this level, Council may approve a lesser level commensurate with the local streetscape. In this eventuality, the applicant is to provide an area within the development for the storage of goods at a minimum level equal to the FPL. This area should be at least 20% of the gross floor area, or as nominated by Council.

A2.9 Critical Utilities and Essential Services

The Flood Policy nominates the same FPL as for residential development. It also recognises that critical utilities and essential services necessary for emergency management need to be designed to be capable of operating during extreme flood events and constructed of flood resistant materials so as to suffer minimal damages at a higher level of flooding than the FPL. Development proposals are to ensure that valuable equipment necessary for the operation of the facility is located at or above the PMF, or otherwise protected from extreme flooding. Council will also require development proposals to provide safe and reliable access to facilities during major flooding.

A2.10 Vulnerable Residential Development

The Flood Policy nominates the same FPL for Flood Vulnerable Residential Development (which includes nursing homes, aged care facilities and the like) as for residential development. The applicant is also to ensure that valuable equipment necessary for the operation of the facility is located above the FPL *(at a level to be nominated by Council)*. Council will also require development proposals to provide safe and reliable access to developments to the FPL during major flooding.

A2.11 Minor Additions (Residential)

Council has nominated the floor levels of minor additions to residences to be no lower than the FPL. However, where it can be demonstrated by the applicant that this is not practicable, Council at its discretion may allow a reduction in minimum floor levels, provided that the level is at least 300 mm above natural surface level, or as otherwise nominated by Council so as to be above the level of frequent flooding.

A2.12 Checking of Completed Finished Floor Height

After the building has been built to the relevant FPL, Council officers will check compliance with this requirement at the relevant inspection stage. The applicant is to provide a benchmark on the site, levelled to Australian Height Datum (AHD).

A2.13 Fencing

Any proposed fencing is to be shown on the plans accompanying a development application to allow Council to assess the likely effect of such fencing on flood behaviour.

In the Floodway zones**,** where flow velocities may be significant, fences which minimise obstructions to flow are to be adopted. Where impermeable fences such as Colorbond, galvanised metal, timber or brush are proposed, fencing panels should be either:

a) removable so that panels can be laid flat; or

b) horizontally hinged where a portion of at least 1 m high is capable of swinging open to allow floodwater to pass. Trees/landscaping and other structures are not to impede the ability of a hinged fence to open.

A2.14 Other Uses and Works

All other development, building or other works within any of the categories that require Council's consent will be considered on their merits. In consideration of such applications, Council must determine that the proposed development is in compliance with the objectives of this Policy.

A2.15 Land Filling and Obstructions to Flow

No filling or alteration of the land surface is permissible in the High Hazard Floodway due to the potential for filling or obstructions to flow to adversely re-direct flows. Any minor extensions or repairs permitted by Council should be located on piers to minimise obstructions to the passage of flow, with the underside of any structure supporting the buildings to be above the 100 year ARI flood level.

Council may permit building pads for residential blocks in the Low Hazard Floodway and Flood Storage Areas, provided it is satisfied that the proposal will not significantly obstruct or adversely re-direct flows towards adjacent developments. (As a general rule, the fill and other obstructions are not to extend across more than 30% of the width of the allotment at right angles to the direction of flow). In order not to significantly obstruct flows, Council may require part of the development to be located on piers to minimise obstructions to the passage of flow, with the underside of any structure supporting the buildings to be above the 100 year ARI flood level. Sub-surface drainage of building pads is required.

A2.16 Flood Related Information to be Submitted to Council

A2.16.1 Survey Details – Existing Site and Proposed Development

A Survey Plan prepared by a Registered Surveyor is required to be lodged with the Development Application for properties located on flood affected land as shown on **Figure A1.1**. The Survey Plan will enable Council to assess extents and depths of inundation over the site (at existing natural surface levels) and must indicate the following:

- The location of existing building or structures;
- The floor levels and ceiling heights of all existing buildings or structures to be retained;

- Existing and/or proposed drainage easements and watercourses or other means of conveying flood flows that are relevant to the flood characteristics of the site;
- 100 year ARI **Flood Level(s)** over the site (to be provided by Council); and flood extents; and
- 0.2 metre natural surface contour intervals across the entire property (existing and proposed). Note: All levels must be relative to Australian Height Datum (AHD).

Annexure 4 outlines requirements for survey data required by Council for the proposed development.

A2.16.2 Evaluation of Development Proposals

The Applicant will need to demonstrate, using Council supplied flood information, that:

1. The development conforms with the requirements of this Policy for the particular Flood Hazard zone in which it is located.

2. Depending on the nature and extent of the development and its location within the floodplain, Council may request the Applicant to prepare a *Flood Risk Report* to demonstrate that its construction does not increase the flood hazard to existing and future occupiers of the floodplain (see Section A2.16.3).

Council will make its evaluation and confirm requirements regarding the proposed site development, based on the Survey Plan and accompanying data on the proposed development (see Annexure 4); and according to the conformance of the proposal with the performance requirements of the Development Controls Matrix – Annexures 2.1 and 2.2 and Chapter A2.

A2.16.3 Flood Risk Report – High and Low Hazard Floodways, including Flood Storage Areas

A. <u>Scope of Work – General</u>

Council will require a Flood Risk Report for any (minor) residential development located in the High Hazard Floodway. Depending on its nature and scale, Council may also require a Flood Risk Report for a development situated in:

- Flood Storage Areas, where depths of inundation may be significant and a partial filling may restrict flow; and
- Low Hazard Floodways, where lesser but still significant flow velocities may be expected.

Typically, such a report may be required for a large commercial or industrial development which Council considers has the potential to adversely re-direct flows. This report is to be prepared by a suitably qualified Consulting Engineer and must address the following:

a) Confirm the FPL for the particular category of development (FPL to be determined through enquiries of Council).

b) Specify proposed floor levels (and existing floor levels where they are to be retained) of habitable and non-habitable structures.

c) Include a site-specific flood assessment that may require flood modelling to demonstrate that there will be no adverse impact on surrounding properties as a result of the development, up to the 100 year ARI flood.

d) Propose measures to minimise risk to personal safety of occupants and the risk of property damage, addressing the flood impacts on the site of the 100 year ARI flood. These measures shall include but are not limited to the following:

- Types of materials to be used, up to the FPL to ensure the structural integrity for immersion and impact of velocity and debris.
- Waterproofing methods, including but not limited to electrical equipment, wiring, fuel lines or any other service pipes and connections.

e) Confirm the structural adequacy of the development, taking into account the following:

- all piers and all other parts of the structure which are subject to the force of flowing waters or debris have been designed to resist the stresses thereby induced.
- all forces transmitted by supports to the ground can be adequately withstood by the foundations and ground conditions existing on the site.
- the structure will be able to withstand stream flow pressure, force exerted by debris, and buoyancy and sliding forces caused by the full range of flooding up to the FPL.

f) all electrical connections to be located above the FPL. Council will also require all electrical circuit connections to be automatically isolated in the event of flood waters having the potential to gain access to exposed electrical circuits, either internal or external of the building (see also **Annexure 3A**).

g) all materials used in the construction to be flood compatible to a minimum level equivalent to the FPL (**Annexure 3B**).

B. <u>Additional Items (Commercial and Industrial Development)</u>

h) For commercial and industrial developments (in the Low Hazard Floodway and Flood Storage Areas*)*, include flood warning signs/depth indicators for areas that may be inundated, such as open car parking areas.

A3. DESCRIPTION OF TERMS

Note: For expanded list of definitions, refer to Glossary contained within the NSW Government Floodplain Development Manual, 2005.

TERM	DEFINITION
Average Recurrence Interval (ARI)	The average return period between the occurrence of a particular flood event. For example, a 100 year ARI flood has an average recurrence interval of 100 years.
Australian Height Datum (AHD)	A common national surface level datum corresponding approximately to mean sea level.
Flood Affected Properties	Properties that are either encompassed or intersected by the **Flood Planning Area (FPA)**.
Floodplain	Area of land which is subject to inundation by floods up to and including the Probable Maximum Flood event, that is, flood prone land.
Flood Planning Area	The area of land that is shown to be in the Flood Planning Area on the *Flood Planning Map*.
Flood Planning Map	The *Flood Planning Map* referred to in the Young Local Environmental Plan 2010 and presented as **Figure A1.1** in **Appendix A**.
Flood Planning Level (FPL) (General Definition)	The combinations of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans.
Flood Planning Level (FPL)	For land within the Flood Planning Area subject to Main Stream and Minor Tributary flooding in Young, the Flood Planning Level (FPL) is the level of the 100 year Average Recurrence Interval (ARI) flood event plus 500 mm freeboard. For land within the Flood Planning Area subject to Major Overland Flow in Young, the FPL is the level of the 100 year ARI flood event plus 300 mm freeboard. For areas outside the study area in Young, the FPL is the level of the 100 year ARI flood event plus 500 mm freeboard.
Flood Prone/Flood Liable Land	Land susceptible to flooding by the PMF. Flood Prone land is synonymous with Flood Liable land.
Floodway	Those areas of the floodplain where a significant discharge of water occurs during floods. They 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.
Flood Storage Area	Those parts of the floodplain that may be important for the temporary storage of floodwaters during the passage of a flood. Loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation.

TERM	DEFINITION
Freeboard	A factor of safety used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted FPL and the flood used to determine the FPL. 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. Freeboard is included in the FPL.
Habitable Room	In a residential situation: a living or working area, such as a lounge room, dining room, kitchen, bedroom or workroom. In an industrial or commercial situation: an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.
Intermediate Floodplain	For Main Stream flooding it is the strip of land on each side of the Floodway encompassing the zone between the Floodway and the line defining the indicative extent of flooding resulting from the occurrence of the 100 year ARI flood plus 500 mm (i.e. the FPA). For Major Overland Flow it is the land (defined on an allotment basis) where the depth of inundation during the 100 year ARI storm event is greater than 300 mm, or is in a floodway.
Local Drainage	Land on an overland flow path where the depth of inundation during the 100 year ARI storm event is less than 150 mm.
Main Stream Flooding	The inundation of normally dry land occurring when water overflows the natural or artificial banks of a major stream; for Young, the main streams are Burrangong Creek, Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek.
Minor Tributary Flooding	The inundation of normally dry land occurring when water overflows the natural or artificial banks of a minor stream; for Young, the minor streams are those unnamed watercourses that drain to Burrangong Creek and its major tributaries outside the Major Overland Flow Urban Precinct.
Major Overland Flow	Land (defined on an allotment basis) located on an overland flow path where the depth of inundation during the 100 year ARI storm event is greater than 150 mm, or is in a floodway. An allotment where these conditions apply is located in the FPL.
Outer Floodplain	This is defined as the land between the FPA and the extent of the PMF.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. For Young, the extent of the PMF has been trimmed to include depths greater than 150 mm.

ANNEXURE 1
LAND USE CATEGORIES

Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Subdivision	Minor Additions (Residential)
Building that may provide an important contribution to the notification and evacuation of the community during flood events; Hospitals; Institutions; Educational establishments.	Telecommunication facilities; Public Utility Installation that may cause pollution of waterways during flooding, or if affected during flood events would significantly affect the ability of the community to return to normal activities after the flood events. Hazardous industry; Hazardous storage establishments.	Group home; Housing for aged or disabled persons; and Units for aged persons.	Dwelling; Residential flat building; Home industry; Boarding house; Professional consulting rooms; Public utility undertakings (other than critical utilities); Utility installation (other than critical utilities); Child care centre.	Bulk Store; Bus depot; Bus station; Car repair stations; Club; Commercial premises (other than where referred to elsewhere); General store; Health care professional; Hotel; Intensive livestock keeping; Junkyard; Liquid fuel depot; Motel; Motor showroom; Place of Assembly (other than essential community facilities; Place of public worship; Public building (other than essential community facilities); Recreation facility; Refreshment room; Road transport terminal; Rural industry; Service station; Shop; Tourist facilities; Warehouse.	Retail nursery; Recreation area; Roadside stall; Outbuildings (Sheds, Garages) up to 40 m^2 area.	Subdivision of land involving the creation of new allotments for residential purposes; Earthworks or filling operations covering 100 m^2 or more than 0.3 m deep.	An addition to an existing dwelling of not more than 30 m^2 (habitable floor area)

ANNEXURE 2.1

DEVELOPMENT CONTROLS MATRIX - MAIN STREAM AND MINOR TRIBUTARY FLOODING

	Outer Floodplain								**Intermediate Floodplain**							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level	1	1	1	1	1		1	1	1	1	1	1	1		1	1
Building Components	2	2							2	2	1	1	1		1	1
Structural Soundness	2	2							2	2	1	1	1		1	1
Flood Affectation																
Evacuation / Access	1	1	1						1	1	1					
Management and Design	2,3	2,3	5						2,3	2,3	5		4		1	6

	Low Hazard Floodway and Flood Storage Areas								**High Hazard Floodway**							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level																
Building Components																
Structural Soundness																
Flood Affectation						1								1		
Evacuation / Access																
Management and Design						3,7								3,7		

Not Relevant   Unsuitable Land Use

Main Stream Flooding applies for inundation of land bordering Burrangong Creek and its major tributaries (Sawpit Gully, Victoria Gully, Petticoat Gully, Little Spring Creek and Big Spring Creek).

Minor Tributary Flooding applies for inundation of land bordering the minor watercourses which drain the relatively steep slopes boring Burrangong Creek and its major tributaries.

The Intermediate Floodplain is defined by the area between the Floodway and Flood Storage zones and the Flood Planning Area (FPA). The Outer Floodplain is the area between the FPA and the Probable Maximum Flood.

See Notes over page:

ANNEXURE 2.1 (CONT'D)
DEVELOPMENT CONTROLS MATRIX - MAIN STREAM AND MINOR TRIBUTARY FLOODING

Floor Level

1. Floor levels to be equal to or greater than the FPL (100 year ARI flood level plus 500 mm freeboard).

Building Components

1. All structures to have flood compatible building components below FPL.
2. All structures to have flood compatible building components below PMF flood level (where PMF level is higher than FPL).

Structural Soundness

1. Structure to be designed to withstand the forces of floodwater, debris and buoyancy up to FPL.
2. Structure to be designed to withstand forces of floodwater, debris and buoyancy up to PMF flood (where PMF level is higher than FPL).

Flood Affection in Adjacent Areas

1. A Flood Risk Report may be required to demonstrate that the development will not increase flood hazard (see Item 7 Management and Design below).
   Note: When assessing Flood Affectation the following must be considered:
   i. Loss of conveyance capacity in the floodway or areas where there is significant flow velocity.
   ii. Changes in flood levels and flow velocities caused by the alteration of conveyance of floodwaters.

Evacuation/ Access

1. Reliable access for pedestrians or vehicles required in the event of 100 year ARI flood.

Management and Design

1. Applicant to demonstrate that potential developments as a consequence of a subdivision proposal can be undertaken in accordance with this Policy and the Plan.
2. Applicant to demonstrate that facility is able to continue to function in event of PMF.
3. No external storage of materials which may cause pollution or be potentially hazardous during PMF.
4. Where it is not practicable to provide floor levels to FPL, applicant is to provide an area to store goods at that level.
5. Applicant is to provide an area to store valuable equipment above FPL (level to be advised by Council) – see **Section A2.8**.
6. Where it is not practicable to provide floor levels to FPL, Council may allow a reduction for minor additions to habitable areas – see **Section A2.11.**
7. Flood Risk Report may be required prior to development of this nature in this area – see **Sections A2.16.2** and **A2.16.3.**

NOTE: THESE NOTES ARE TO BE READ IN CONJUNCTION WITH REMAINDER OF THE FLOOD POLICY, IN PARTICULAR CHAPTER 2.

ANNEXURE 2.2
DEVELOPMENT CONTROLS MATRIX – MAJOR OVERLAND FLOW URBAN PRECINCT

	Outer Floodplain							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level	2	2	2	2	2		2	2
Building Components	2	2						
Structural Soundness	2	2						
Flood Affectation								
Evacuation / Access	1	1	1					
Management and Design	2,3	2,3	5					

	Intermediate Floodplain							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level	2	2	2	2	2		2	2
Building Components	2	2	1	1	1		1	1
Structural Soundness	2	2	1	1	1		1	1
Flood Affectation								
Evacuation / Access	1	1	1					
Management and Design	2,3	2,3	5		4		1	6

	Low Hazard Floodway and Flood Storage Areas							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level				1	1		1	1
Building Components				1	1		1	1
Structural Soundness				1	1		1	1
Flood Affectation				1	1		1	1
Evacuation / Access								
Management and Design				7	4,7		1,7	6

	High Hazard Floodway							
	Essential Community Facilities	Critical Utilities and Uses	Flood Vulnerable Residential	Residential	Business & Commercial/Industrial	Non-Urban and Outbuildings	Residential Sub-Division	Minor Additions (Residential)
Floor Level								1
Building Components								1
Structural Soundness								1
Flood Affectation						1		1
Evacuation / Access								
Management and Design						3,7		6,7

Not Relevant   Unsuitable Land Use

Major Overland Flow applies for inundation of land on the three urban flow paths: Railway Drain, Chance Gully and Golf Course Drain. The Major Overland Flow Urban Precinct identifies the area in which allotments subject to Major Overland Flow lie.

The Intermediate Floodplain is defined by the area between the Floodway and Flood Storage zones and the Flood Planning Area (FPA). The Outer Floodplain is the area between the FPA and the Probable Maximum Flood.

See Notes over page:

ANNEXURE 2.2 (CONT'D)
DEVELOPMENT CONTROLS MATRIX - MAJOR OVERLAND FLOW URBAN PRECINCT

Floor Level

1. Floor levels to be equal to or greater than the FPL (100 year ARI flood level plus 300 mm freeboard).
2. Floor levels to be equal to or greater than the FPL (100 year ARI flood level plus 300 mm freeboard) or 300 mm above natural surface levels, whichever is the higher.

Building Components

1. All structures to have flood compatible building components below FPL.
2. All structures to have flood compatible building components below PMF flood level (where PMF level is higher than FPL).

Structural Soundness

1. Structure to be designed to withstand the forces of floodwater, debris and buoyancy up to FPL.
2. Structure to be designed to withstand forces of floodwater, debris and buoyancy up to PMF flood (where PMF level is higher than FPL).

Flood Affection in Adjacent Areas

1. Residential development may be "deemed to comply" provided it conforms with the requirements of **Section A2.15**. A Flood Risk Report may be required for development in Floodway zones to demonstrate that the development will not increase flood hazard (see Item 7 Management and Design below).

   Note: When assessing Flood Affectation the following must be considered:

   iii. Loss of conveyance capacity in the floodway or areas where there is significant flow velocity.
   iv. Changes in flood levels and flow velocities caused by the alteration of conveyance of floodwaters.

Evacuation/ Access

1. Reliable access for pedestrians or vehicles required in the event of 100 year ARI flood.

Management and Design

1. Applicant to demonstrate that potential developments as a consequence of a subdivision proposal can be undertaken in accordance with this Policy and the Plan.
2. Applicant to demonstrate that facility is able to continue to function in event of PMF.
3. No external storage of materials which may cause pollution or be potentially hazardous during PMF.
4. Where it is not practicable to provide floor levels to FPL, applicant is to provide an area to store goods at that level.
5. Applicant is to provide an area to store valuable equipment above FPL (level to be advised by Council) – see **Section A2.8**.
6. Where it is not practicable to provide floor levels to FPL, Council may allow a reduction for minor additions to habitable areas – see **Section A2.11.**
7. Flood Risk Report may be required prior to development of this nature in this area – see **Sections A2.16.2** and **A2.16.3.**

NOTE: THESE NOTES ARE TO BE READ IN CONJUNCTION WITH REMAINDER OF THE FLOOD POLICY, IN PARTICULAR CHAPTER 2.

ANNEXURE 3A

GENERAL BUILDING MATTERS

Electrical and Mechanical Equipment

For dwellings constructed on land to which this policy applies, the electrical and mechanical materials, equipment and installation should conform to the following requirements.

Main Power Supply

Subject to the approval of the relevant authority the incoming main commercial power service equipment, including all metering equipment, shall be located above the FPL. Means shall be available to easily isolate the dwelling from the main power supply.

Wiring

All wiring, power outlets, switches, etc, should be, to the maximum extent possible, located above the FPL. All electrical wiring installed below this level should be suitable for continuous underwater immersion and should contain no fibrous components. Earth leakage circuit breakers (core balance relays) must be installed. Only submersible type splices should be used below the FPL. All conduits located below the relevant designated flood level should be so installed that they will be self-draining if subjected to flooding.

Equipment

All equipment installed below or partially below the FPL should be capable of disconnection by a single plug and socket assembly.

Reconnection

Should any electrical device and/or part of the wiring be flooded it should be thoroughly cleaned or replaced and checked by an approved electrical contractor before reconnection.

Heating and Air Conditioning Systems

Where viable, heating and air conditioning systems should be installed in areas and spaces of the house above the FPL. When this is not feasible, every precaution should be taken to minimise the damage caused by submersion according to the following guidelines:

i) Fuel

Heating systems using gas or oil as a fuel should have a manually operated valve located in the fuel supply line to enable fuel cut-off.

ii) Installation

The heating equipment and fuel storage tanks should be mounted on and securely anchored to a foundation pad of sufficient mass to overcome buoyancy and prevent movement that could damage the fuel supply line. All storage tanks should be vented to the FPL.

iii) Ducting

All ductwork located below the FPL should be provided with openings for drainage and cleaning. Self-draining may be achieved by constructing the ductwork on a suitable grade. Where ductwork must pass through a watertight wall or floor below the relevant flood level, a closure assembly operated from above the FPL should protect the ductwork.

Sewer

All sewer connections to properties in flood prone areas are to be fitted with reflux valves.

ANNEXURE 3B

FLOOD COMPATIBLE MATERIALS

Building Component	Flood Compatible Material	Building Component	Flood Compatible Material
Flooring and Sub Floor Structure	• Concrete slab-on-ground monolith construction. Note: clay filling is not permitted beneath slabo-on-ground construction which could be inundated. • Pier and beam construction or • Suspended reinforced concrete slab	**Doors**	• Solid panel with waterproof adhesives • Flush door with marine ply filled with closed cell foam • Painted material construction • Aluminium or galvanised steel frame
Floor Covering	• Clay tiles • Concrete, precast or in situ • Concrete tiles • Epoxy formed-in-place • Mastic flooring, formed-in-place • Rubber sheets or tiles with chemical set adhesive • Silicone floors formed-in-place • Vinyl sheets or tiles with chemical-set adhesive • Ceramic tiles, fixed with mortar or chemical set adhesive • Asphalt tiles, fixed with water resistant adhesive • Removable rubber-backed carpet	**Wall and Ceiling Linings**	• Brick, face or glazed • Clay tile glazed in waterproof mortar • Concrete • Concrete block • Steel with waterproof applications • Stone natural solid or veneer, waterproof grout • Glass blocks • Glass • Plastic sheeting or wall with waterproof adhesive
Wall Structure	Solid brickwork, blockwork, reinforced, concrete or mass concrete	**Insulation**	• Foam or closed cell types
Windows	Aluminium frame with stainless steel or brass rollers	**Nails, Bolts, Hinges and Fittings**	• Galvanised • Removable pin hinges

ANNEXURE 4

DEVELOPMENT APPLICATION REQUIREMENTS

Step 1

Check with Council staff to see whether or not the proposal:

- Is located on *Flood Prone Land*
- Is permissible in the Flood Hazard zone and determine the *FPL* for the particular category of land use.
- Note: an existing site survey (see **Section A2.16.1** of the Policy) is to accompany development proposals to confirm the flood affectation of the allotment and its location within the flood risk zoning system.

Step 2

Plans – A Development Application should include the following plans showing the nature of the proposed development and its extent within the allotment:

- A locality plan identifying the location of the property.
- Plan of the existing site layout including the site dimensions (in metric), site area, contours (0.20 m intervals), existing trees, other natural features, existing structures, north point, location of building on adjoining properties (if development involves a building), floor plans located on a site plan, roof plan, elevations and sections of the proposed building, finished levels of floors, paving and landscaped areas, vehicular access and parking.
- Plans should indicate:
  a) The existing ground levels to Australian Height Datum around the perimeter of the proposed building; and
  b) The existing or proposed floor levels to Australian Height Datum.
- Minor additions to an existing dwelling must be accompanied by documentation from a registered surveyor confirming existing floor levels.
- In the case of subdivision, four (4) copies of the proposed site layout showing the number of lots to be created (numbered as proposed lot 1, 2, 3 etc), the proposed areas of each lot in square metres, a north point, nearest roads and the like.

Council require plans presented on A3 sheets as a minimum

A scale of 1:200 is recommended for site plans

Extent of Cut and Fill – All areas subject to cut and fill require the depths of both to be shown as well as the measures proposed to retain both. Applications shall be accompanied by a survey plan (with existing and finished contours at 0.20 m intervals) showing relative levels to Australian height datum.

Vegetation Clearing – Landscaping details including a description of trees to be removed existing and proposed planting, retaining walls, detention basins, fences and paving.

Stormwater Drainage – Any existing and all proposed stormwater drainage to be indicated on the site plan.

APPENDIX B

FLOOD DAMAGES

TABLE OF CONTENTS

Page No.

FIGURES
(BOUND IN VOLUME 2)

SUMMARY

Estimation of flood damages to urban development at Young was carried out to assess the impact of flooding on the community. The objectives were to allow an economic assessment of various flood management measures to be carried out in the *FRMS&P* report at the strategic level of detail. Damages were assessed for floods ranging between the 5 Year ARI and PMF events. The 5 year ARI is the threshold flood at which significant damages are experienced in the urban portion of Young. Assessment of urban flood damages was carried out for the two categories of development on the floodplain: "Residential" and "Commercial/Industrial". A third category of development, "Public Buildings", was included in the damages model.

There were no quantitative data available on historic flood damages at Young. The analysis was carried out using the residential flood damages model attached to *"Floodplain Risk Management Guideline No 4 - Residential Flood Damages".* This publication was prepared by DECCW (now OEH) to allow a consistent assessment of residential damages across NSW for the economic comparison of flood management projects.

In *Guideline No 4*, damage assessments undertaken after major flooding in other urban centres were adjusted and used to estimate damages likely to be experienced to typical residential development in NSW. Data for the flood damages model at Young comprised the peak water surface elevations over the extent of the study area as determined from the *Town of Young Flood Study, 2014*, as well as information on the unit values of damages to residential property. The depths of above-floor inundation of properties were determined from the results of the hydraulic modelling described in the *Flood Study* and from estimated floor levels of each residence. The elevations of building floors were assessed by adding the height of the floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from the LiDAR survey used in the *Flood Study*. The type of structure and potential for property damage were also assessed from a visual inspection.

The procedures in *Guideline Number 4* allow for the estimation of structural damage to the building, damage to internals and contents, external damages and clean up costs. The level of flood awareness and available warning time are taken into account by factors which are used to reduce "potential" damages to contents to "actual" damages. "Potential" damages represent losses likely to be experienced if no action were taken by residents to mitigate impacts. A reduction in the potential damages to "actual" damages is usually made to allow for property evacuation and raising valuables above floor level, which would reduce the damages actually experienced. The ability of residents to take action to reduce flood losses is mainly limited to reductions in damages to contents, as damages to the structure and clean up costs are not usually capable of significant mitigation.

No specific information is given in *Guideline Number 4* in relation to commercial and industrial properties. Damages to the non-residential sector depend on the nature of the enterprise, the depth of inundation over the floor area and the time available for owners to take action to mitigate losses to contents. A spreadsheet model was used to assess flood damages which was similar to the residential model in terms of estimation of depths of inundation, but used typical unit damage data which had been adopted in similar *FRMS&P* studies in NSW in recent years.

The number of flood affected properties and the estimated damages which could occur for various flood recurrence intervals are summarised in **Tables BS1** and **BS2** below. The results shown in **Table S1** represent the damages predicted if the "nominal" flood levels determined from the hydraulic modelling were to occur for the various design floods. The damages in **Table S2** apply for the nominal flood levels plus an allowance for freeboard to account for wave action, increased flood levels due to debris build-up and other local effects which could occur in the creek system. The freeboard allowance varied from 500 mm for the 100 year ARI and larger floods to 300 mm for the 20 year ARI. For lesser events such as the 5 year ARI, where shallow and slow moving flow would be experienced, no allowance was made for freeboard.

From **Table BS1**, at the 100 year ARI level of flooding, 70 residential properties would be flood affected (i.e. water has entered the allotment). Nineteen of those properties would experience above-floor inundation up to 600 mm in the event of a 100 year ARI flood. Fifty-four commercial properties and two public buildings would be flooded above floor level in the event of a 100 year ARI flood.

Significant flood damages would be expected to occur due to surcharges of the stormwater drainage system in the urban area to the north of Burrangong Creek, commencing at the 5 year ARI level of flooding and rising to a total of $3.73 Million in the event of a 100 ARI flood. There are three principal flow paths in this area which are responsible for the flooding: Railway Drain, Chance Gully and Golf Course Drain (ref. **Figure B8.2** for locations). No significant damages would be expected due to main stream flooding from Burrangong Creek or its tributaries.

For damages assessed on the basis of nominal flood levels, the "present worth value" of damages resulting from all flood events up to the magnitude of the PMF at a 7% discount rate would be $4.17 Million (see **Chapter 8** for a definition of terms). The present worth of damages up to the 100 year ARI would be $3.2 Million. This value represents the amount of capital spending which would be justified if a particular flood mitigation measure prevented flooding up to the 100 year ARI event.

From **Table BS2**, at the nominal 100 year ARI level of flooding plus the freeboard allowance, 125 residential properties would be flood affected of which 82 would experience above-floor inundation. One hundred and thirty-eight commercial properties would be flooded above floor level. The "present worth value" of damages resulting from all floods up to the magnitude of the 100 year ARI at a 7% discount rate would be $12.96 Million.

Additional information on the damages is presented in the tables attached to **Section B8** and in the figures attached to this Appendix.

TABLE BS1
FLOOD DAMAGES IN YOUNG
NOMINAL DESIGN FLOOD LEVELS

Average Recurrence Interval Year ARI	Number of Properties						Total Damage ($ Million)
	Residential		Commercial		Public		
	Flood Affected	Flooded Above-Floor Level	Flood Affected	Flooded Above-Floor Level	Flood Affected	Flooded Above-Floor Level	
5	20	2	20	10	1	1	0.38
20	46	8	46	29	3	1	1.50
100	70	19	82	54	4	2	3.73
200	78	23	92	65	4	3	4.41
PMF	123	75	159	157	11	3	50.46

TABLE BS2
FLOOD DAMAGES IN YOUNG
DESIGN FLOOD LEVELS PLUS FREEBOARD

Average Recurrence Interval Year ARI	Number of properties						Total Damage ($ Million)
	Residential		Commercial		Public		
	Flood Affected	Flooded Above-Floor Level	Flood Affected	Flooded Above-Floor Level	Flood Affected	Flooded Above-Floor Level	
5	20	2	20	10	1	1	0.38
20	83	41	109	94	7	4	8.22
100	125	82	151	134	10	4	17.98
200	126	85	155	141	11	5	19.17
PMF	148	125	159	159	11	10	78.88

Note: Freeboard allowance is 500 mm for 100 year ARI and greater floods, 300 mm for 20 year ARI flood and zero for 5 year ARI.

B1. INTRODUCTION AND SCOPE

B1.1 Introduction

Damages from flooding belong to two categories:

- **Tangible Damages**
- **Intangible Damages**

Tangible damages are defined as those to which monetary values may be assigned, and may be subdivided into direct and indirect damages. Direct damages are those caused by physical contact of floodwater with damageable property. They include damages to commercial and residential building structures and contents as well as damages to infrastructure services such as electricity and water supply. Indirect damages result from the interruption of community activities, including traffic flows, trade, industrial production, costs to relief agencies, evacuation of people and contents and clean up after the flood.

Generally, tangible damages are estimated in dollar values using survey procedures, interpretation of data from actual floods and research of government files.

The various factors included in the **intangible damage** category may be significant. However, these effects are difficult to quantify due to lack of data and the absence of an accepted method. Such factors may include:

- inconvenience
- isolation
- disruption of family and social activities
- anxiety, pain and suffering, trauma
- physical ill-health
- psychological ill-health.

B1.2 Scope of Investigation

In the following sections, tangible damages to residential, commercial and industrial properties and public buildings have been estimated resulting from flooding at Young. Intangible damages have not been quantified. The threshold floods at which damages may commence to infrastructure and community assets have also been estimated, mainly from site inspection and interpretation of flood level data. However, there are no data available to allow a quantitative assessment of damages to be made to this category.

B1.3 Terminology

Definitions of the terms used in this Appendix are presented in **Chapter 8** which also summarises the value of Tangible Flood Damages.

B2. DESCRIPTION OF APPROACH

The damage caused by a flood to a particular property is a function of the depth of flooding above floor level and the value of the property and its contents. The warning time available for residents to take action to lift property above floor level also influences damages actually experienced. A spreadsheet model which had been developed for previous investigations of this nature was used to estimate damages on a property by property basis according to the type of development, the location of the property and the depth of inundation.

Using the results of the *Flood Study,* a peak flood elevation for each event was interpolated at each property. The interpolated property flood levels were input to the spreadsheet model which also contained property characteristics and depth-damage relationships. The depth of above-floor flooding was computed as the difference between the interpolated flood level and the floor elevation at each property. The elevations of building floors were assessed by adding the height of floor above a representative natural surface within the allotment (as estimated by visual inspection) to the natural surface elevation determined from LiDAR survey used in the *Flood Study*. The type of structure and potential for property damage were also assessed during the visual inspection.

The depth-damage curves for residential damages were determined using procedures described in *"Floodplain Management Guideline No 4. Residential Flood Damage Calculation"*, *2007* published by DECCW. Damage curves for other categories of development (commercial and industrial, public buildings) were derived from previous floodplain management investigations.

Damages to the non-residential sector depend on the nature of the enterprise, the depth of inundation over the floor area and the time available for owners to take action to mitigate losses to contents. A spreadsheet model was used which was similar to the residential model in terms of estimation of depths of inundation, but used typical unit damage data which had been adopted in similar studies in NSW in recent years.

It should be understood that this approach is not intended to identify individual properties liable to flood damages and the values of damages in individual properties, even though it appears to be capable of doing so. The reason for this caveat lies in the various assumptions used in the procedure, the main ones being:

- the assumption that computed water levels and topographic data used to define flood extents are exact and without any error;
- the assumption that the water levels as computed by the hydraulic model are not subject to localised influences;
- the estimation of property floor levels by visual inspection rather than by formal field survey;
- the use of "average" stage-damage relationships, rather than a unique relationship for each property;
- the uncertainties associated with assessing appropriate factors to convert *potential damages* to *actual flood damages* experienced for each property after residents have taken action to mitigate damages to contents.

The consequence of these assumptions is that some individual properties may be inappropriately classified as flood liable, while others may be excluded. Nevertheless, when applied over a broad area these effects would tend to cancel, and the resulting estimates of overall damages, would be expected to be reasonably accurate.

For the above reasons, the information contained in the spreadsheets used to prepare the estimates of flood damages for the catchments should not be used to provide information on the depths of above-floor inundation of individual properties.

B3. SOURCES OF DATA

B3.1 General

To estimate A*verage Annual Flood Damages* for a specific area it is necessary to estimate the damages for several floods of different magnitudes, i.e. of different frequencies, and then to integrate the area beneath the damage – frequency curve computed over the whole range of frequencies up to the Probable Maximum Flood. To do this it is necessary to have data on the damages sustained by all types of property over the likely range of inundation. There are several ways of doing this:

- The ideal way would be to conduct specific damage surveys in the aftermath of a range of floods, preferably immediately after each. An example approaching this ideal is the case of Nyngan where surveys were conducted in May 1990 following the disastrous flood of a month earlier (DWR, 1990). This approach would not be practicable at Young, as the most recent occurrence of major flooding in the drainage system occurred over two years ago in December 2010.
- The second best way is for experienced loss adjusters to conduct a survey to estimate likely losses that would arise due to various depths of inundation. This approach is used from time to time, but it can add significantly to the cost of a floodplain management study (LMJ, 1985). It was not used for the present investigation.
- The third way is to use generalised data such as that published by CRES (Centre for Resource & Economic Studies, Canberra) and used in the Floodplain Management Study for Forbes (SKM, 1994). These kinds of data are considered to be suitable for generalised studies, such as broad regional studies. They are not considered to be suitable for use in specific areas, unless none of the other approaches can be satisfactorily applied.
- The fourth way is to adapt or transpose, data from other flood liable areas. This was the approach used for the present study. As mentioned, the *DECCW Guideline No 4, 2007* procedure was adopted for the assessment of residential damages. The approach was based on data collected following major flooding in Katherine in 1998, with adjustments to account for changes in values due to inflation, and after taking into account the nature of development and flooding patterns in the study area. The data collected during site inspection in the flood liable areas assisted in providing the necessary adjustments. Commercial and industrial damages were assessed via reference to recent floodplain management investigations of a similar nature to the present study (L&A, 2007).

B3.2 Property Data

The properties were divided into three categories: residential, commercial/industrial and public buildings.

For residential properties, the data used in the damages estimation included:

- the location/address of each property
- an assessment of the type of structure
- representative natural surface level of the allotment
- floor level of the residence

For commercial/industrial properties, the required data included:

- the location of each property
- the nature of each enterprise
- an estimation of the floor area
- natural surface level
- floor level

The property descriptions were used to classify the commercial developments into categories (i.e. high, medium or low value properties) which relate to the magnitude of likely flood damages.

Properties lying within the extent of the PMF were included in the database. The total number of residential properties was 163; there were 159 commercial and industrial properties and 11 public buildings.

B3.3 Flood Levels Used in the Analysis

Damages were computed for the design flood levels determined from the hydraulic models set up for the *Flood Study*. The design levels assume that the drainage system is operating at optimum capacity. They do not allow for any increase in levels resulting from wave action, debris build-ups in the channels which may cause a partial blockage of culverts and which may result in conversions of flow from the supercritical to the subcritical flow regime, as well as other local hydraulic effects. These factors are usually taken into account by adding a factor of safety (freeboard) to the "nominal" flood level when assessing the "level of protection" against flooding of a particular property. Freeboard could also include an allowance for the future effects of climate change.

A particular level of protection could not be ascribed to a development unless it were protected against the nominal flood level of a particular return period plus the freeboard allowance. For this reason, damages assessments were also carried out with the design flood levels increased by the freeboard allowance. Freeboard is related to the velocity of flow, which is itself dependent on the bed slope and hydraulic roughness of the drainage system. Flow velocities tend to increase with peak flow and therefore increasing the freeboard with increase in flood return period could be justified. For the present analysis, a 500 mm freeboard allowance was adopted for assessing damages for the 100 year ARI and greater floods, reducing to 300 mm for the 20 year ARI. No freeboard was assumed for the 5 year ARI flood, as the flow on the overland flow paths where the damages would be experienced (Railway Drain, Chance Gully and Golf Course Drain) is shallow and slow moving.

B4. RESIDENTIAL DAMAGES

B4.1 Damage Functions

The procedures identified in *DECCW Guideline No 4, 2007* allow for the preparation of a depth versus damage relationship which incorporates structural damage to the building, damage to internals and contents, external damages and clean-up costs. In addition, there is the facility for including allowance for accommodation costs and loss of rent. Separate curves are computed for three residential categories:

- Single storey slab on ground construction
- Single storey elevated floor
- Two storey residence

The level of flood awareness and available warning time are taken into account by factors which are used to reduce “potential” damages to contents to “actual” damages. “Potential” damages represent losses likely to be experienced if no action were taken by residents to mitigate impacts. A reduction in the potential damages to "actual" damages is usually made to allow for property evacuation and raising valuables above floor level, which would reduce the damages actually experienced. The ability of residents to take action to reduce flood losses is mainly limited to reductions in damages to contents, as damages to the structure and clean up costs are not usually capable of significant mitigation.

The reduction in damages to contents is site specific, being dependent on a number of factors related to the time of rise of floodwaters, the recent flood history and flood awareness of residents and emergency planning by the various Government Agencies (Bureau of Meteorology and State Emergency Service).

Flooding on Burrangong Creek, its tributaries and the overland flow paths is “flash flooding” in nature with a time of rise of floodwaters on the main arms limited to only two hours and to less than an hour in the urban area on the northern side of the creek subject to overland flooding. The duration of peak flooding is similarly quite short. There is no catchment specific flood warning system operated by the Bureau of Meteorology and no specific response procedures for Burrangong Creek developed by SES, which has to date not completed the *Local Flood Plan* for the town. Consequently, there would be very limited time in advance of a flood event in which to warn residents and for them to take action to mitigate flood losses.

Provided adequate warning were available, house contents may be raised above flood level to about 0.9 m, which corresponds with the height of a typical table/bench height. The spreadsheet provides two factors for assessing damages to contents, one for above and one for below the typical bench height. The reduction in damages is also dependent on the likely duration of inundation of contents, which would be limited to no more than an hour for most flooded properties.

Table B4.1 below shows total flood damages estimated for the three classes of residential property using the procedures identified in *Guideline No 4,* for typical depths of above-floor inundation of 0.1 m and 0.5 m. (The maximum depth of above-floor inundation in Young is about 600 mm at the 100 year ARI level of flooding.) A typical ground floor area of 240 m^2 was adopted for the assessment. The table allows for damages to buildings and contents, as well as external damages, clean-up costs and provision for alternative accommodation.

TABLE B4.1
DAMAGES TO RESIDENTIAL PROPERTIES

Type of Residential Construction	0.1 m Depth of Inundation Above Floor Level	0.5 m Depth of Inundation Above Floor Level
Single Storey Slab on Ground	$65,060	$78,930
Single Storey High Set	$74,470	$91,070

Note: These damages include allowances for structural, contents, externals, clean-up and alternative accommodation.

B4.2 Total Residential Damages

Table B8.1 summarises damages to all sectors for a range of floods. The damage estimates were carried out for floods between the 5 Year ARI and the PMF. For nominal flood levels, damages of $1.86 Million are predicted in the residential sector for the 100 year ARI flood, increasing to $7.11 Million at the PMF level.

Allowing for an increase in nominal flood levels of 500 mm for freeboard, residential damages of $7.17 Million are predicted for the 100 year ARI flood.

B4.3 Locations of Flooded Residential Properties

Table B4.2 shows the numbers of flooded residential properties on the overland flow paths for the nominal flood levels case, **Figure B8.1** shows corresponding damages and **Figure B8.2** shows their locations. No residential properties would be flood affected due to main stream flooding on Burrangong Creek and its tributaries.

TABLE B4.2
LOCATIONS OF FLOODED RESIDENTIAL PROPERTIES
NOMINAL DESIGN FLOOD LEVELS
100 YEAR ARI

Total Number of Properties Flooded Above Floor Level	Burrangong Creek and Tributaries	Railway Drain North of Railway	Railway Drain South of Railway	Chance Gully to Junction with Railway Drain	Golf Course Drain
19	0	5	0	11	3

B5. COMMERCIAL AND INDUSTRIAL DAMAGES

B5.1 Direct Commercial and Industrial Damages

The method used to calculate damages requires each property to be categorised in terms of the following:

- damage category
- floor area
- floor elevation.

The damage category assigned to each enterprise may vary between "low", "medium" or "high", depending on the nature of the enterprise and the likely effects of flooding. Damages also depend on the floor area.

It has recently been recognised following the 1998 flood in Katherine that previous investigations using stage damage curves contained in proprietary software tends to seriously underestimate true damage costs (*DECCW Guideline No 4, 2007*). DECCW are currently researching appropriate damage functions which could be adopted in the estimation of commercial and industrial categories as they have already done with residential damages. However, these data were not available for the Young study.

On the basis of previous investigations (LACE, 2007) the following typical damage rates are considered appropriate for potential external and internal damages and clean up costs for both commercial and industrial properties They are indexed to a depth of inundation of 2 metres. At floor level and 1.2 m inundation, zero and 70% of these values respectively were assumed to occur:

Low value enterprise	$\$280/m^2$	(e.g. Commercial: small shops, cafes, joinery, public halls. Industrial: auto workshop with concrete floor and minimal goods at floor level, Council or Government Depots, storage areas.)
Medium value enterprise	$\$420/m^2$	(e.g. Commercial: food shops, hardware, banks, professional offices, retail enterprises, with furniture/fixtures at floor level which would suffer damage if inundated. Industrial: warehouses, equipment hire.)
High value enterprise	$\$650/m^2$	(e.g. Commercial : electrical shops, clothing stores, bookshops, newsagents, restaurants, schools, showrooms and retailers with goods and furniture, or other high value items at ground or lower floor level. Industrial: service stations, vehicle showrooms, smash repairs.)

The factor for converting potential to actual damages depends on a range of variables such as the available warning time, flood awareness and the depth of inundation. Given sufficient warning time a well prepared business will be able to temporarily lift property above floor level. However, unless property is actually moved to flood free areas, floods which result in a large depth of inundation, will cause considerable damage to stock and contents.

For the Young study, the above potential damages were converted to actual damages using a multiplier which ranged between 0.5 and 0.8 depending on the depth of inundation above the floor. As shown on **Figure B8.1**, the maximum depth of above-floor inundation experienced at the 100 year ARI level of flooding for commercial – industrial property is about 600 mm, with a median value of about 150 mm. At these relatively shallow depths it would be expected that owners may be able to take significant action to mitigate damages even allowing for the flash flooding nature of inundation. Consequently, the multiplier of 0.5 was adopted to convert potential to actual damages for depths of inundation up to 1.2 m, increasing to 0.8 for greater depths.

B5.2 Indirect Commercial and Industrial Damages

Indirect commercial and industrial damages comprise costs of removal of goods and storage, loss of trading profit and loss of business confidence.

Disruption to trade takes the following forms:

- The loss through isolation at the time of the flood when water is in the business premises or separating clients and customers. The total loss of trade is influenced by the opportunity for trade to divert to an alternative source. There may be significant local loss but due to the trade transfer this may be considerably reduced at the regional or state level.
- In the case of major flooding, a downturn in business can occur within the flood affected region due to the cancellation of contracts and loss of business confidence. This is in addition to the actual loss of trading caused by closure of the business by flooding.

Loss of trading profit is a difficult value to assess and the magnitude of damages can vary depending on whether the assessment is made at the local, regional or national level. Differences between regional and national economic effects arise because of transfers between the sectors, such as taxes, and subsidies such as flood relief returned to the region.

Some investigations have lumped this loss with indirect damages and have adopted total damage as a percentage of the direct damage. In other cases, loss of profit has been related to the gross margin of the business, i.e. turnover less average wages. The former approach has been adopted in this present study. Indirect damages have been taken as 50% of direct actual damages. A clean up cost of \$15/m^2 of floor area of each flooded property was also included.

B5.3 Total Commercial and Industrial Damages

Table B8.1 summarises estimated commercial and industrial damages within the flood liable portion of Young. For the case of nominal flood levels, 54 properties would be flooded above floor levels and damages of \$1.85 Million would be expected for the 100 year ARI flood. With the 500 mm freeboard allowance, 134 properties would be flooded above floor level with predicted damages of \$10.49 Million.

B6. DAMAGES TO PUBLIC BUILDINGS

B6.1 Direct Damages – Public Buildings

Included under this heading are government buildings, churches, swimming pools and parks. Damages were estimated individually on an areal basis according to the perceived value of the property. Potential internal damages were indexed to a depth of above floor inundation of 2 m as shown below. At floor level and 1.2 m depth of inundation, zero and 70% of these values respectively were assumed to occur.

Low value	\$280/m^2	
Medium value	\$420/m^2	(eg. council buildings, SES HQ, fire station)
High value	\$650/m^2	(eg. schools)

These values were obtained from the Nyngan Study (DWR, 1990) as well as commercial data presented in the Forbes Water Studies report (WS, 1992). External and structural damages were taken as 4 and 10% of internal damages respectively.

B6.2 Indirect Damages – Public Buildings

A value of \$15/m^2 was adopted for the clean-up of each property. This value is based on results presented in the Nyngan Study and adjusted for inflation. Total "welfare and disaster" relief costs were assessed as 50% of the actual direct costs.

B6.3 Total Damages – Public Buildings

Eleven properties classified as public buildings were included in the damages model. Two of those buildings would be flooded above floor level for the 100 year ARI flood.

B7. DAMAGES TO INFRASTRUCTURE AND COMMUNITY ASSETS

No data are available on damages experienced during historic flood events. However, a qualitative matrix of the effects of flooding on these categories is presented in **Table B7.1**.

No infrastructure such as electrical and telephone supply, sewerage and water supply systems, would be prone to damaging flooding up to the 100 year ARI level. Assets such as local roads, the bridges and weirs on Burrangong Creek; parks and other recreational amenities in the urban area on the northern side of Burrangong Creek would be affected by flooding at the 20 year ARI.

TABLE B7.1
QUALITATIVE EFFECTS OF FLOODING ON INFRASTRUCTURE AND COMMUNITY ASSETS AT YOUNG

Damage Sector	Flood Event ARI				
	5	20	50	100	PMF
Electricity	0	0	0	X	X
Telephone	0	0	0	X	X
Roads	0	X	X	X	X
Bridges/Weirs	0	X	X	X	X
Sewerage	0	0	0	X	X
Water Supply	0	0	0	X	X
Parks and Gardens	0	X	X	X	X

Notes: 0 = No significant damages likely to be incurred.
X = Some damages likely to be incurred.

B8 SUMMARY OF TANGIBLE DAMAGES

B8.1 Tangible Damages

Flood damages under existing conditions have been computed for a range of flood frequencies from 5 year ARI to the PMF (refer **Table B8.1**). For the purposes of assessing damages, the 2 year ARI was adopted as the "threshold" flood at which damages commence in the drainage system. At the 5 year ARI residential and commercial properties on the northern side of Burrangong Creek would experience above-floor inundation due to surcharge of the trunk stormwater systems of the Railway Drain, Chance Gully and Golf Course Drain.

The residential damages on the three drainage lines for each flood event are shown on **Figure B8.1**. This figure also shows the corresponding commercial - industrial frequency curve and the cumulative distribution of above-floor depths of inundation for residential and commercial - industrial properties. **Figure B8.2** shows the locations of properties predicted to be flooded by the 100 year ARI event. All of these figures relate to properties inundated at the nominal flood levels.

TABLE B8.1
DAMAGES IN CREEK SYSTEM

Category	Flood Event ARI – years	Nominal Flood Levels			Nominal Flood Levels Plus Freeboard		
		No of Allotments Flood Affected	No of Properties Flooded Above Floor Level	Damages $ Million	No of Allotments Flood Affected	No of Properties Flooded Above Floor Level	Damages $ Million
Residential	5	20	2	0.26	20	2	0.26
	20	46	8	0.91	83	41	3.65
	100	70	19	1.86	125	82	7.17
	200	78	23	2.17	126	85	7.56
	PMF	123	75	7.11	148	125	12.23
Commercial	5	20	10	0.12	20	10	0.12
	20	46	29	0.59	109	94	4.48
	100	82	54	1.85	151	134	10.49
	200	92	65	2.21	155	134	11.32
	PMF	159	157	41.91	159	159	63.91
Public	5	1	1	0.002	1	1	0.002
	20	3	1	0.005	7	4	0.09
	100	4	2	0.03	10	4	0.23
	200	4	3	0.03	11	5	0.28
	PMF	11	9	1.44	11	10	2.74

B8.2 Definition of Terms

Average Annual Damages (also termed "expected damages") are determined by integrating the area under the damage-frequency curve. They represent the time stream of annual damages, which would be expected to occur on a year by year basis over a long duration.

Using an appropriate discount rate, average annual damages may be expressed as an equivalent "*Present Worth Value"* of damages and used in the economic analysis of potential flood management measures.

A flood management scheme which has a design 100 year ARI level of protection, by definition, will eliminate damages up to this level of flooding. If the scheme has no mitigating effect on larger floods, then damages from the 100 year ARI flood represent the upper limit of the benefits of the scheme. These benefits may be expressed on an average annual basis and converted to the Present Worth Value via the discount rate.

Under current NSW Treasury guidelines, economic analyses are carried out assuming a 20 year economic life for projects and discount rates of 7% pa. (best estimate) and 10% and 4% pa. (sensitivity analyses).

B8.3 Present Worth of Damages in Young

The *Present Worth Values* of damages likely to be experienced in the study area for all flood events, a 20 year economic life and discount rates of 4, 7 and 10 per cent are shown on **Table B8.2** over the page.

From **Table B8.2**, for a discount rate of 7% pa, the *Present Worth Value* of damages for all flood events up to the 100 year ARI flood is about $3.2 Million for a 20 year economic life (based on the nominal flood levels case). Therefore one or more schemes costing up to $3.2 Million could be economically justified if they eliminated damages for all flood events in the creek system up to this level. The *Present Worth Value* of damages for all flood events up to the PMF flood at 7 per cent discount rate is about $4.17 Million.

Similar data for damages assessed with the freeboard allowance are shown on **Table B8.2**. For the 7% discount rate, a scheme providing a 100 year ARI level of protection to properties could be economically justified if it cost up to $12.96 Million. The *Present Worth Value* of damages for all flood events up to the PMF flood at that discount rate is about $15.64 Million.

More expensive schemes would have a benefit/cost ratio less than 1, but may still be justified according to a multi-objective approach which considers other criteria in addition to economic feasibility. Flood management measures are considered on a multi-objective basis in **Chapter 4** of the Main Report.

TABLE B8.2
PRESENT WORTH VALUE OF DAMAGES

Case	Discount Rate %	Nominal Flood Levels $ Million	Nominal Flood Levels Plus Freeboard $ Million
All Floods Up to PMF	4	5.35	20.06
	7	4.17	15.64
	10	3.35	12.56
All Floods Up to 100 Year ARI	4	4.11	16.63
	7	3.20	12.96
	10	2.57	10.42

B9. REFERENCES AND BIBLIOGRAPHY

Lyall and Associates Consulting Water Engineers (2007) ***"Conargo Floodplain Risk Management Study and Plan"***. Report prepared for Conargo Shire Council and DECCW.

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Water Studies (1986) ***"The Sydney Floods of September 1986"***, Volume I Residential Flood Damage Survey, Report prepared for CRCE Water Studies Pty Ltd for the NSW PWD.

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APPENDIX C

RESPONSES TO COMMUNITY QUESTIONNAIRE

TABLE OF CONTENTS

ATTACHMENTS

C1. INTRODUCTION

At the commencement of the *Town of Young Flood Study and Floodplain Risk Management Study & Plan,* the Consultants prepared a *Community Information Flyer* and a *Community Questionnaire* which were distributed by Council to residents bordering the main creek system and overland flow paths in the town (refer to **Attachment 1**). These documents were also placed on Council's Website.

The purpose of the *Community Information Flyer* was to introduce the objectives of the study and set the scene on flooding conditions so that the community would be better able to respond to the *Community Questionnair*e and contribute to the study process.

The *Information Flyer* contained the following information:

- A Plan of the creek system in Young.
- A statement of the objectives and methodology of the *Flood Study* component of the investigation, namely the definition of flooding patterns for a range of design flood events using computer-based models of the catchment and its drainage system. The two most recent flood events (December 2010 and March 2012) were identified and information was sought from the community to assist the Consultants verify their models.
- A statement of the objectives of the *Floodplain Risk Management Study & Plan*; namely the development of a strategy for reducing the flood risk and minimising the long-term impact of flooding on the community at Young.

The *Community Questionnaire* was structured with the objectives of:

- Obtaining local information on flood experience and behaviour at residents' properties.
- Determining residents' attitudes to controls over future development in flood liable areas in Young.
- Inviting community views on possible flood management options which could be considered for further investigation in the *Floodplain Risk Management Study* and possible inclusion in the resulting *Management Plan*.
- Obtaining feedback on any other flood related issues and concerns which the residents cared to raise.

This **Appendix** to the *Floodplain Risk Management Study & Plan* report discusses the responses to the 10 questions included in the Questionnaire and comments made by respondents.

Chapter C2 deals with the residents' experience with historic flooding, as well as determining residents' views on the relative importance of classes of development over which flood-related controls should be imposed by Council.

Chapter C3 identifies residents' views on the suitability of the various options which could be considered in more detail in the *Floodplain Risk Management Study & Plan.*

Chapter C4 discusses the best methods by which the community could provide feedback to the consultants over the course of the study.

C2 RESIDENT PROFILE AND FLOOD AWARENESS

C2.1 General

Residents were requested to complete the *Community Questionnaire* and return it to the Consultants by 8 March 2013. Due to the large response, the deadline was extended to 18 March. By that date the Consultants had received 107 responses relating to residential properties and 19 to a supplementary Questionnaire forwarded to the commercial/business sector. Seventy-five residential respondents (optionally) provided their addresses, which allowed the Consultants to cross reference information they provided about flooding on their properties to the layout of the stormwater drainage system.

The Consultants have collated the responses, which are shown in graphical format at **Attachment 2**.

C2.2 Experiences of Flooding

The first six questions of the *Community Questionnaire* canvassed resident information such as length of time at the property, the type of property (e.g. house, unit/flat), whether the respondent had any experience of flooding and if so which particular flood and whether they had experienced above-floor inundation. Of those who replied to the question, 47 respondents had lived in Young for between 5 and 20 years and 28 for more than 20 years (**Question 2**). Seventy-three respondents occupied a house, with a small number of villa/townhouse or unit/apartment occupiers (**Question 3**).

Thirty respondents reported that they had information about flooding on their property (**Question 4**), with 21 citing their own experience and one stating that Council had provided a flood level. Eight reported having photographs of flooding (several respondents attached photographs of the December 2010 flood to their completed Questionnaires).

In response to **Question 5**, 29 respondents reported that they had experienced flooding on their property, with 19 nominating flooding as a result of the December 2010 flood and 13 reporting flooding as a result of the March 2012 flood. Nine residents advised that they had experienced above-floor inundation in the largest flood which they had experienced (**Question 6**).

As far as the source of flood warnings to the Young population is concerned (**Question 7**), 46 respondents advised that they had received no warnings of imminent flooding; seven respondents advised being warned by TV or radio16 by their own observations, two by SES, and one by police.

These results are characteristic of situations where flooding is of a “flash flooding” nature with little warning time being available for the dissemination of warnings by the authorities. Most of the flooding problems appear to have been caused by “overland flows” resulting from a lack of hydraulic capacity in the local piped stormwater system, or flows being directed down driveways into allotments due to surcharges of the street gutters.

Flooding due to Burrangong Creek or its tributaries breaking their banks does not appear to have been a major problem to existing residential development in Young. However, several respondents to the Business Questionnaire reported instances of main stream flooding (see **Section C5**).

C2.3 Controls over Development in Flood Prone Areas

The respondents were also asked to rank from 1 to 4 the classes of development which they consider should receive protection from flooding (**Question 8**). Rank 1 was the most important and rank 4 the least.

The four classes, in decreasing order of importance to respondents, ranged from: vulnerable residential development (e.g. aged persons accommodation); residential property; essential community facilities (e.g. schools, evacuation centres) and lastly, commercial business. These results gave a guide to the Consultants as to the appropriate location of future developments of the various classes within the floodplain. For example, on the basis of community views vulnerable residential development would receive the highest level of protection by locating future development of this nature outside the floodplain, or at least on the outer floodplain where flooding is very infrequent and of shallow nature.

C3 POTENTIAL FLOOD MANAGEMENT MEASURES

The respondents were also asked for their opinion on potential flood management measures which could be evaluated in the *Floodplain Risk Management Study & Plan* (and if found to be feasible included in the Plan), by ticking a "yes" or "no" to the 11 potential options identified in **Question 9**.

The options comprised a range of *structural flood management measures* (e.g. programs by Council to manage vegetation in the creek system to maintain hydraulic capacity; channel enlargements to increase capacity; detention basins to reduce downstream flood peaks; improving the stormwater system; levees to contain floodwaters); as well as various *non-structural management measures* (e.g. voluntary purchase of residential properties in high hazard areas; raising floor levels of houses in low hazard areas; flood related controls over new developments; improvements to flood warning and evacuation procedures; community education on flooding; and flood advice certificates). The options were not mutually exclusive, as the *Floodplain Risk Management Plan* adopted could, in theory, include all of the options set out in the Questionnaire, or indeed, other measures to be nominated by the respondents or the Floodplain Management Committee.

The most popular measure was improving the stormwater system to capture and convey overland flows travelling to the creek system more efficiently than at present. Another highly popular structural measure was maintenance of the hydraulic capacity of the creek system by the management of vegetation in the channels and the removal of debris following storm events. Other favoured structural measures were enlarging the creek channel to increase capacity and the construction of detention basins on the upstream reaches of the creeks to reduce downstream flood peaks. Levees to contain floodwaters were not viewed as favourably as the other structural management measures.

The implementation of flood-related controls over future development (e.g. by Council nominating minimum permissible floor levels; excluding future development from high hazard areas of high velocity and deep inundation); Council's provision of advice regarding flood affectation of existing properties to prospective purchasers (e.g. via Section 149 Certificates); improved flood warning procedures and evacuation and emergency plans; community education and flood awareness programs were strongly favoured by the respondents.

Respondents were relatively evenly divided on the implementation of a residential Voluntary Purchase scheme (to be administered by Council and designed to allow residents on a wholly voluntary basis to vacate high hazard areas in the floodplain). A mildly negative response was given to the provision of subsidies for raising the floor levels of existing residential properties located in less hazardous zones of the floodplain.

C4 INPUT TO THE STUDY AND FEEDBACK FROM THE COMMUNITY

At **Question 10** residents were asked for their view on the best methods of their providing input to the Study and feedback to the Consultants over the course of the investigation. Articles in the local newspaper and communication via through Council's Floodplain Management Committee were the two most popular methods.

C5 LOCAL FLOODING ISSUES

C5.1 General

Numerous respondents complained about the inadequacies of the current stormwater system in place in residential areas. There was a consistent view that the drainage system is not adequate to capture and dispose of stormwater in a high intensity rainfall event. Furthermore, many residents believe that the street gutters are too low in capacity or mis-aligned, allowing water to be directed into their allotments.

Several respondents cited debris in the creeks as a problem, with water unable to be dispersed as quickly as a free flowing creek would achieve. Debris in the drains was also mentioned to be a problem, with a resulting loss of hydraulic capacity. Some residents complained about new upstream development projects increasing runoff or re-directing flows.

Residents also commented on the exacerbation of flooding caused by the failure of farm dams on the various tributaries of Burrangong Creek in the December 2010 flood. While the Study Brief acknowledged the occurrence of such failures, it only called for a preliminary assessment of the incremental effect (on "natural" flood events) of a failure of the Chinamans Dam, which is located in the upper reaches of Sawpit Gully. The possible extension of the analysis to incorporate other dams in the flood assessment was discussed at the first meeting of the Floodplain Management Committee. It was considered that it would not be practicable to include the failures of multiple dams into the scope of work for the *Flood Study* component of the project, due to both a lack of survey data to ascertain the storage and spillway characteristics of each storage, as well as uncertainties regarding the type of fill and compaction characteristics of their embankments.

Most of the respondents to the supplementary *Questionnaire for Business Owners* (who are mainly located in the CBD area in and to the north of Boorowa Street) reported flooding problems due to overland flow emanating from surcharges of the drainage line downstream of the Brock Street detention basin and from surcharges of Chance Gully further to the west. Major overland flooding was experienced downstream of the detention basin, with flows travelling through the caravan park and into Zouch Street, which acted as a floodway. A lack of capacity in the heavily overgrown Railway Drain near the Railway Station resulted in overflows into the downstream street system; in particular, into Clarke Street, Main Street, Lynch Street and Lovell Street.

One industrial property was severely affected by main stream flooding from Victoria Gully as well from overland flows originating from the local catchment to the north. This property was reported to have suffered several hundred thousand dollars worth of damages. The Consultants intend to undertake a site inspection with the owner during the next visit to Young. Another industrial property located on Burrangong Creek near the Temora Road bridge was also flooded, apparently due to main stream flooding.

C5.2 Scope of Investigation

The *Floodplain Risk Management Study & Plan* is intended to cover main stream flooding issues resulting from surcharges of the creek channels when catchment-wide major storms occur, as well as major drainage (overland flow) problems resulting from surcharge of the trunk drainage system. Local drainage problems resulting from overflows of the minor pipes and gutters in the stormwater system are, strictly speaking, outside the scope of the present investigation.

Main stream flooding and surcharges of the piped stormwater system both occur as a result of intense rainfalls on the respective catchments and are therefore, likely to be closely correlated. When considering measures which could be incorporated in the *Floodplain Risk Management Study & Plan* to resolve main stream and major drainage problems, the Consultants will, due to budget constraints, have to give lesser consideration to measures aimed at improving the performance of the minor stormwater system.

C6 SUMMARY

One hundred and twenty six responses were received to the *Community Questionnaire* distributed by Council to residents and business owners. The responses amounted to about 10 per cent of the total distributed. The responses indicated a considerable interest by the Young community in the study. The respondents identified the two most recent flood events as occurring in December 2010 and March 2012 and provided useful information on the source and pattern of both main stream and overland flows. However, there was little information of a quantitative nature; such as data on the temporal pattern of storm rainfalls and flood levels along the main flow paths, which would have assisted the Consultants in testing their catchment and floodplain models.

C6.1 Issues

The issues identified by respondents in their responses to the *Community Questionnaire* support the objectives of the study, as nominated in the attached *Community Information Flyer,* and the activities nominated in the Study Brief. No new issues were identified in regard to main stream and major overland flooding. The major problem of interest to residents is overland flow in the urban area to the north of Burrangong Creek Several residents did, however, provide information on surcharges of the minor stormwater drainage system which will be of assistance to Council in planning future upgrades of pipes and gutters.

C6.2 Flood Management Measures

Of the *structural measures* which could be incorporated in the *Management Plan*, the most popular were: maintenance programs for the control of vegetation and clearing the creek system of debris following flood events, improving the capacity of the stormwater system, and construction of detention basins to reduce downstream peak flood flows. Planning controls over new development in flood liable areas, as well as flood advice certificates appear to be the most popular of the potential *non-structural measures* set out in the Questionnaire. There do not appear to be any new measures raised by the respondents in their responses to **Question 9**.

ATTACHMENT 1

COMMUNITY INFORMATION FLYER
AND
COMMUNITY QUESTIONNAIRE

The Town of Young Flood Study and Floodplain Risk Management Plan

Community Information

To Residents of Young:

To assist the Young community prepare for future floods, Young Shire Council is preparing a *Flood Study* and *Floodplain Risk Management Plan* for the town. Please see the back of this page for the approximate area of the study.

The *Flood Study* will define flooding patterns and flood levels in the creeks and overland flow paths in and around the town under present day conditions. Options for mitigating flooding problems will then be considered for incorporation by Council in the *Floodplain Risk Management Plan*.

Council has engaged the services of Lyall and Associates Consulting Water Engineers to:

- Survey the creeks and overland flow paths in the vicinity of the town and collect historic flooding data.
- Develop computer based hydrological models of the catchments to determine flows for both historic storms and hypothetical design floods.
- Develop computer based hydraulic models of the creek and floodplain to determine flooding patterns, flood levels and velocities of flow.

Following the December 2010 floods, the State Emergency Service (SES) distributed questionnaires to residents and received over 60 responses in the Young area.

Significant flooding was also experienced in Young during the wet period of March 2012. As part of the present *Flood Study*, Council intends to distribute a Community Questionnaire to allow residents who did not receive an SES Questionnaire or who have additional information on the more recent flooding to contribute. Council would like any information from community members about how the floods impacted upon their properties, including photos or videos of the flood events.

The Community Questionnaire will also contain a list of options for mitigating flooding which could be investigated and, if found to be feasible by the Consultants, incorporated in the *Floodplain Risk Management Plan*. Residents will be asked to list their references.

Please contact Council using the contact details below.

Please note that all information received will remain confidential.

Young Shire Council

Contact: **Peter Grove**

Phone: **6380 1221**

Email: **peter.grove@young.nsw.gov.au**

The Town of Young Flood Study and Floodplain Risk Management Plan

Office of Environment & Heritage

NSW GOVERNMENT

YOUNG SHIRE COUNCIL

Community Information

Lyall & Associates

The Town of Young Flood Study and Floodplain Risk Management Plan

Community Questionnaire

TO THE RESIDENTS OF YOUNG

This questionnaire is part of *The Town of Young Flood Study and Floodplain Risk Management Plan*, currently being undertaken by Consultants on behalf of Young Shire Council. It will help us determine the flood issues that are important to you. The study area is shown on page 4 at the back of this Questionnaire.

Please return your completed questionnaire in the reply paid envelope provided by **8 March 2013.** No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers
Reply Paid 78855
NORTH SYDNEY NSW 2060

Your name and address (optional):_____

_____

ABOUT YOUR PROPERTY

1. Please tick as appropriate:

a. I am a resident ❑
b. Other (please specify_____) ❑

2. How long have you owned or lived at this address?

a. 1 year to 5 years ❑
b. 5 years to 20 years ❑
c. More than 20 years (… years) ❑

3. What is your property?

a. House ❑
b. Villa/Townhouse ❑
c. Unit/Flat/Apartment ❑
d. Vacant land ❑
e. Other (_____) ❑

YOUR FLOOD EXPERIENCE

(If you have experienced a flood, please answer Questions 4 to 7, otherwise go to Question 8)

4. Do you have any information about flooding at the property?

a. Yes ❑
b. No ❑
If yes, what information do you have?
c. Own experience ❑
d. Flood levels from Council ❑
e. Council planning certificate ❑
f. Information from State Emergency Service (SES). ❑
g. Photographs ❑
h. Other (_____) ❑

5. Have you ever experienced flooding, either as a result of the creeks breaking their banks or due to shallow overland flow through the property?

a. Yes ❑
b. No ❑
If yes, which floods?
c. December 2010 ❑
d. March 2012 ❑
e. Other (_____) ❑

6. In the biggest flood you have experienced, was the property flooded above floor level of the main residence?

a. No ❑ b. Yes ❑

If yes, what was the depth of water over the floor? .

What year? _____

7. In this biggest flood, did you receive any warning, and if so, from where?

(Tick one or more boxes)

a. No warning whatsoever ❑
b. TV ❑
c. Radio ❑
d. Own observations ❑
e. Police ❑
f. State Emergency Service (SES) ❑
g. Neighbours, relatives or friends ❑
h. Other (_____) ❑

YOUR ATTITUDES TO COUNCIL'S DEVELOPMENT CONTROLS

8. Please rank the following development types according to which you think are the most important to protect from floods (1=highest priority to 4=least priority)

a. Commercial/Business ❑

b. Residential ❑

c. Vulnerable residential development (e.g. aged persons accommodation) ❑

d. Essential community facilities (eg. schools, evacuation centres) ❑

YOUR OPINIONS ON FLOODPLAIN RISK MANAGEMENT MEASURES

9. Below is a list of possible options that may be looked at to try to minimise the effects of flooding on the Burrangong Creek system and in the area to the north of Boorowa Street where overland flows flood the CBD on their way to Burrangong Creek (see plan at page 4).

This list is not in any order of importance and there may be other options that you think should be considered. For each of the options listed, please indicate "yes" or "no" to indicate if you favour the option. Please leave blank if undecided.

		Yes	*No*
a.	Maintenance programs to clear creeks of vegetation and debris impeding flows.	❑	❑
b.	Enlarge the creek channels.	❑	❑
c.	Construct detention basins to the north of Boorowa Street .	❑	❑
d.	Improve the stormwater system to the north of Boorowa Street.	❑	❑
e.	Construct permanent levees along the creeks to contain floodwaters.	❑	❑
f.	Voluntary scheme to purchase residential property in high hazard areas.	❑	❑
g.	Provide funding or subsidies to raise houses above major flood level in low hazard areas.	❑	❑
h.	Specify controls on future development in flood-liable areas (eg. controls on extent of filling, minimum floor levels.)	❑	❑
i.	Improve flood warning and evacuation procedures both before and during a flood.	❑	❑
j.	Community education, participation and flood awareness programs.	❑	❑
k.	Provide a certificate to purchasers in flood prone areas, stating that the property is flood affected and to what extent.	❑	❑

OTHER INFORMATION

10. What do you think is the best way for us to get input and feedback from the local community about the results and proposals from this study? (Tick one or more boxes)

a. Council's website ❑

b. Articles in local newspaper ❑

c. Open days or drop-in days ❑

d. Through Council's Floodplain Risk Management Committee ❑

❑ e. Other (please specify) ❑

11. If you wish us to contact you so you can provide further information, please provide your details below:

Name: _____

Address: _____

_____

Phone (Home) _____

Best time to call is _____

Fax No. ___

Email: _____

WHO CAN I CONTACT FOR FURTHER INFORMATION?

Young Shire Council
Peter Grove
Phone: 6380 1221
Email: peter.grove@young.nsw.gov.au

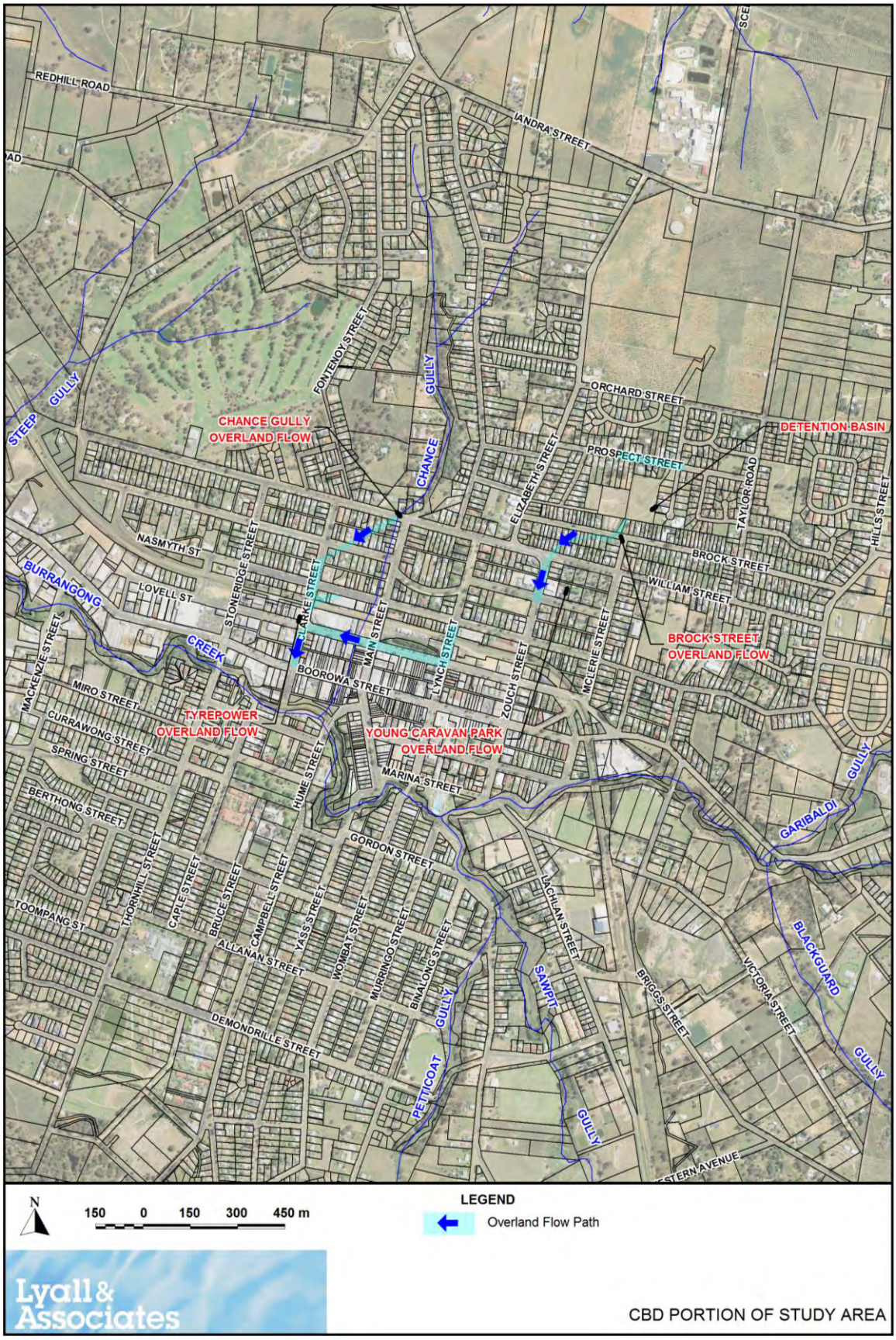
Copies of this questionnaire can be obtained from:

www.young.nsw.gov.au

COMMENTS

Please write your comments here:

Thank you for your participation in this study


REDHILL ROAD
IANDRA STREET
FONTENOY STREET
GULLY
STEEP
CHANCE GULLY
OVERLAND FLOW
CHANCE
ORCHARD STREET
DETENTION BASIN
PROSPECT STREET
ELIZABETH STREET
TAYLOR ROAD
HILLS STREET
NASMYTH ST
BURRANGONG
LOVELL ST
STONERIDGE STREET
CLARKE STREET
MAIN STREET
LYNCH STREET
BROCK STREET
WILLIAM STREET
BROCK STREET
OVERLAND FLOW
MACKENZIE STREET
CREEK
BOOROWA STREET
ZOUCH STREET
MCLERIE STREET
MIRO STREET
CURRAWONG STREET
TYREPOWER
OVERLAND FLOW
YOUNG CARAVAN PARK
OVERLAND FLOW
SPRING STREET
HUME STREET
MARINA STREET
GULLY
BERTHONG STREET
GORDON STREET
GARIBALDI
THORNHILL STREET
CAPLE STREET
BRUCE STREET
CAMPBELL STREET
YASS STREET
WOMBA STREET
MURRINGO STREET
BINALONG STREET
LACHLAN STREET
TOOMPANG ST
ALLANAN STREET
SAWPIT
BRIGGS STREET
VICTORIA STREET
BLACKGUARD
DEMONDRILLE STREET
GULLY
PETTICOAT
GULLY
GULLY
ESTERN AVENUE
N
150 0 150 300 450 m
LEGEND
Overland Flow Path
Lyall & Associates
CBD PORTION OF STUDY AREA

The Town of Young Flood Study and Floodplain Risk Management Plan

Community Questionnaire

FOR BUSINESS OWNERS AT YOUNG

This questionnaire is part of The Town of Young Floodplain Risk Management Study, currently being undertaken by Consultants on behalf of Young Shire Council. It will help us determine the flood issues that are important to you.

Please return your completed questionnaire in the reply paid envelope provided by the 8 March 2013. No postage stamp is required. If you have misplaced the supplied envelope or wish to send an additional submission the address is:

Lyall & Associates Consulting Water Engineers
Reply Paid 78855
NORTH SYDNEY NSW 2060

1. Name and address of Business:

_____

_____

2. Which of the following best describes the type of building you operate your business from?

a Industrial unit in larger complex ❑
b Stand alone warehouse or factory ❑
c Shop ❑
d Office ❑
e Club ❑
f Community building ❑
g Other (please specify_____) ❑

3. What is the approximate floor area of these premises? _____m^2

4. How many employees are there normally working at your premises?

a. 1-5 ❑
b. 5-10 ❑
c. 10-20 ❑
d. More than 20 employees ❑

If you have not experienced a flood at this property, please skip the remaining questions and go to the next page where you may provide any additional comments you wish to make.

5. In the biggest flood you have experienced, what action did you take to protect your property against flood damage?

a. Took no action ❑
b. Moved vehicles ❑
c. Lifted carpet, stock, equipment ❑
d. Used sandbags to try to prevent water entering the premises ❑
e. Other action ❑
❑ please specify:_____

6. In the biggest flood, was your business or facility closed or disrupted in any way (including any clean up)?

a. No ❑ b. Yes ❑

If yes, for how long was your business or facility closed or disrupted?

c. Less than 1 day ❑
d. 1 to 2 days ❑
e. 2 days to 1 week ❑
f. More than 1 week ❑

7. During the biggest flood, were your premises flooded above the floor level of the main work area?

a. No ❑ b. Yes ❑

If yes, what was the depth of the water over the floor? _____

8. During the biggest flood, what was damaged by floodwaters? (Tick one or more boxes)

a. No damage occurred ❑
b. Vehicles ❑
c. Electrical equipment, machinery, tools ❑
d. Stock and other goods ❑
e. Carpet, furniture, fittings and/or office equipment ❑
f. Your premises (paint, structurally, etc) ❑
g. Other part of your property ❑
Please specify _____

9. During the biggest flood, what was the approximate cost to you (at the time) from the damage caused by the flood?

$_____

10. As a result of the biggest flood, did you experience any problems during or after the flood? (Tick one or more boxes)

a. No problems experienced ❑
b. Loss of business / trade ❑
c. Higher employee absenteeism ❑
d. Higher insurance premiums ❑
e. Considered selling/moving the business ❑

WHO CAN I CONTACT FOR FURTHER INFORMATION?

Young Shire Council
Peter Grove
Phone 6380 1221

Copies of this questionnaire can be obtained from:

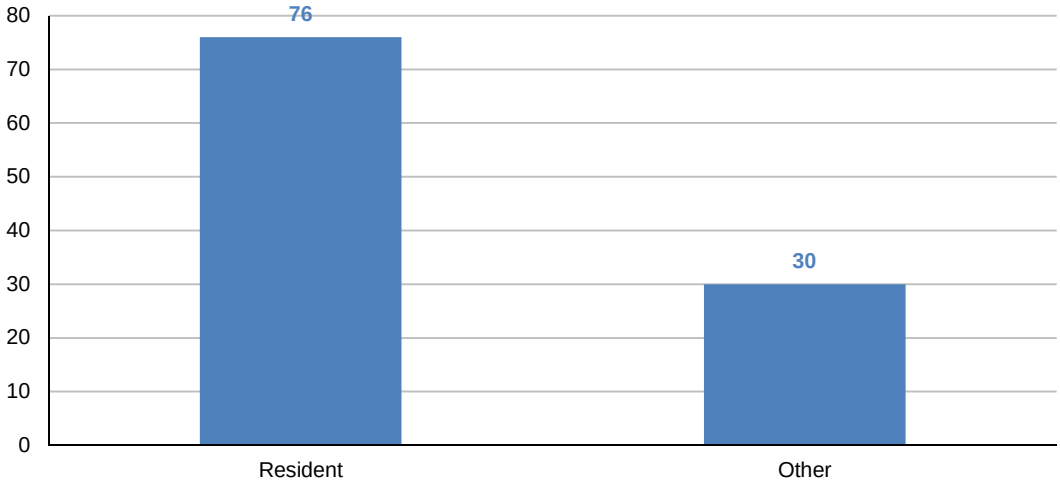
www.young.gov.au

Please write your comments here: _____

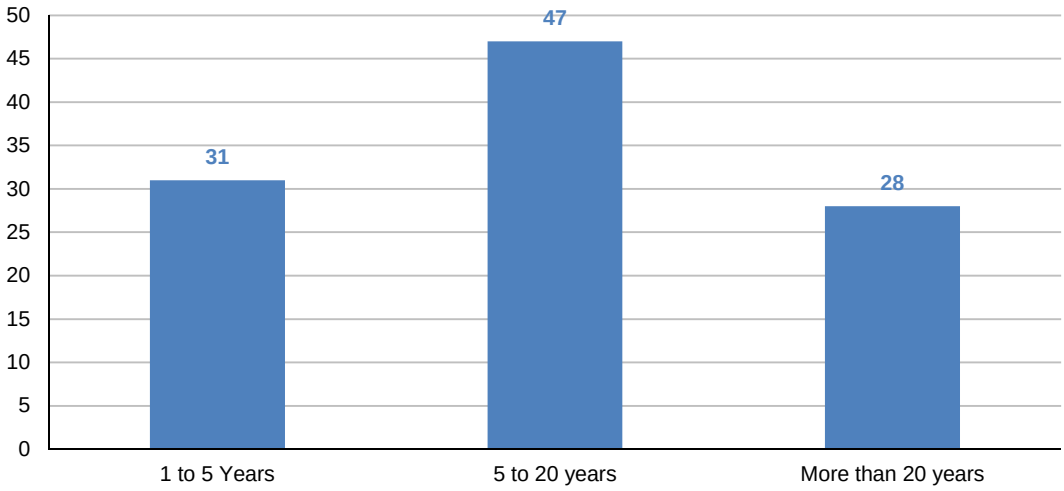
ATTACHMENT 2

RESPONSES TO COMMUNITY QUESTIONNAIRE

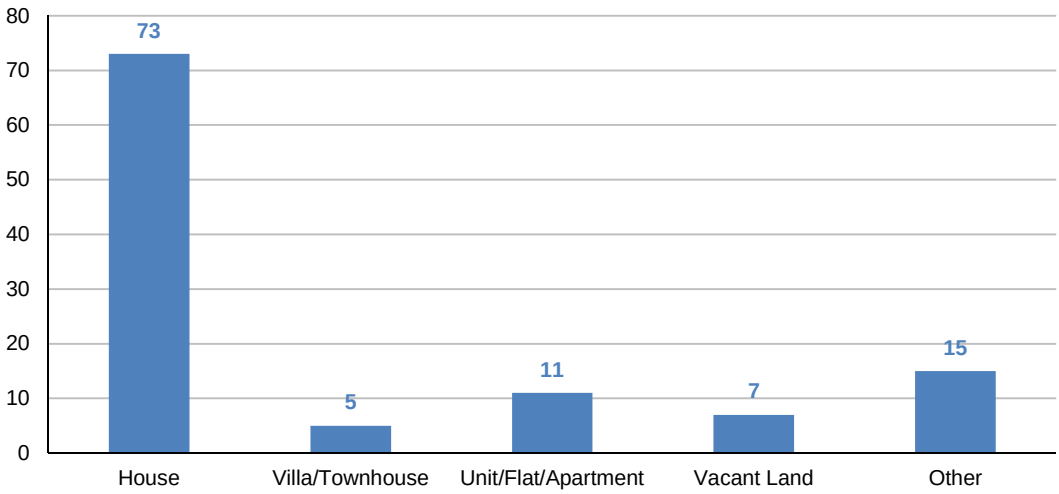
Question 1 - Residential Status?



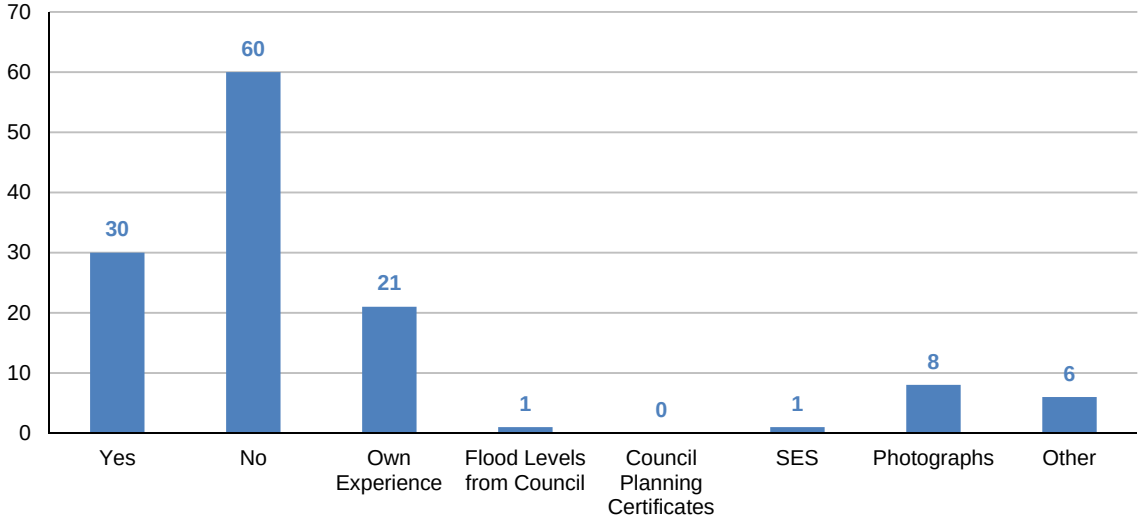
Question 2 - Time at this Address?



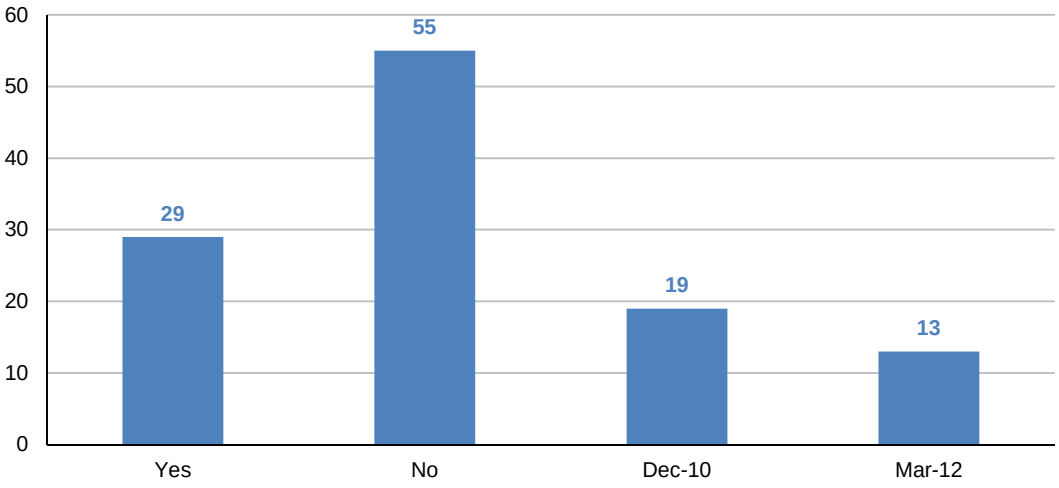
Question 3 - Type of Property?



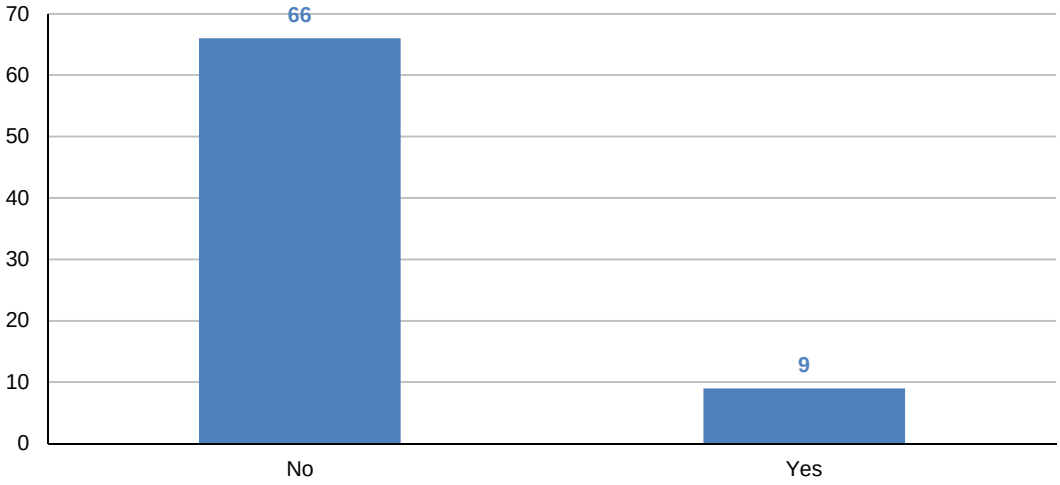
Question 4 - Information about Flooding?



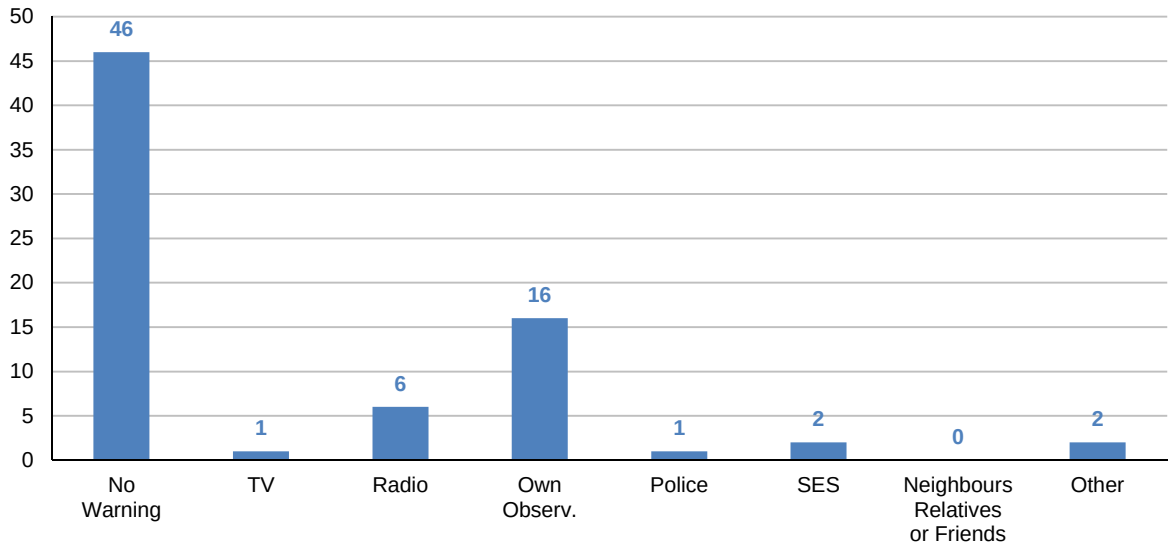
Question 5 - Flood Experienced on Property?



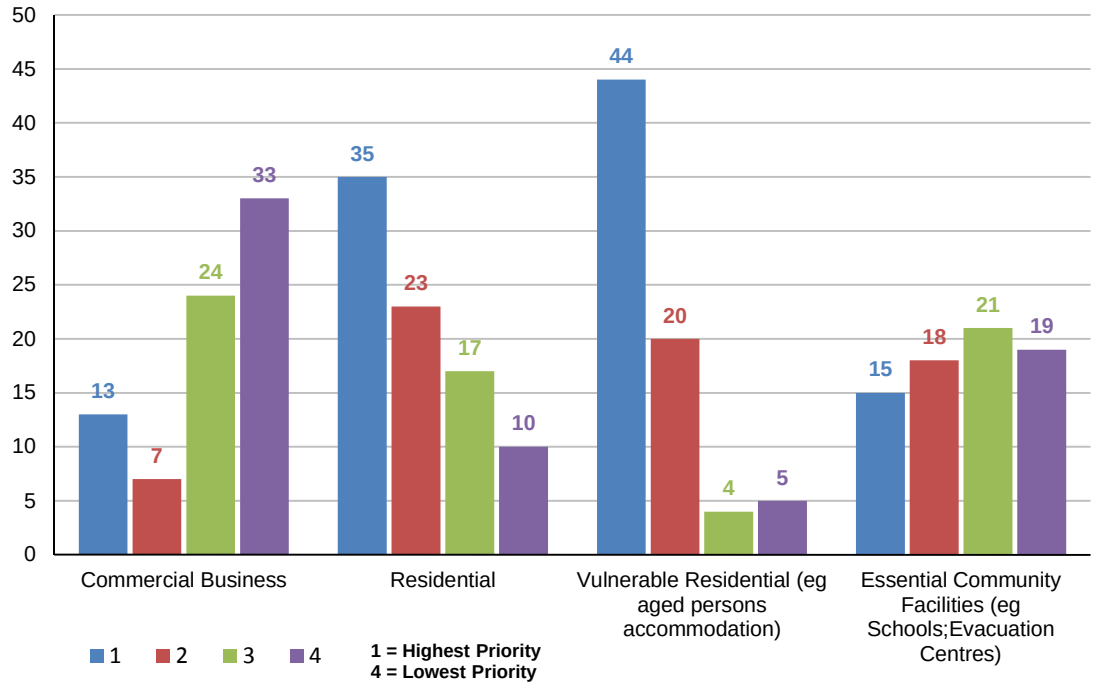
Question 6 - Flooding Above Floor Level?

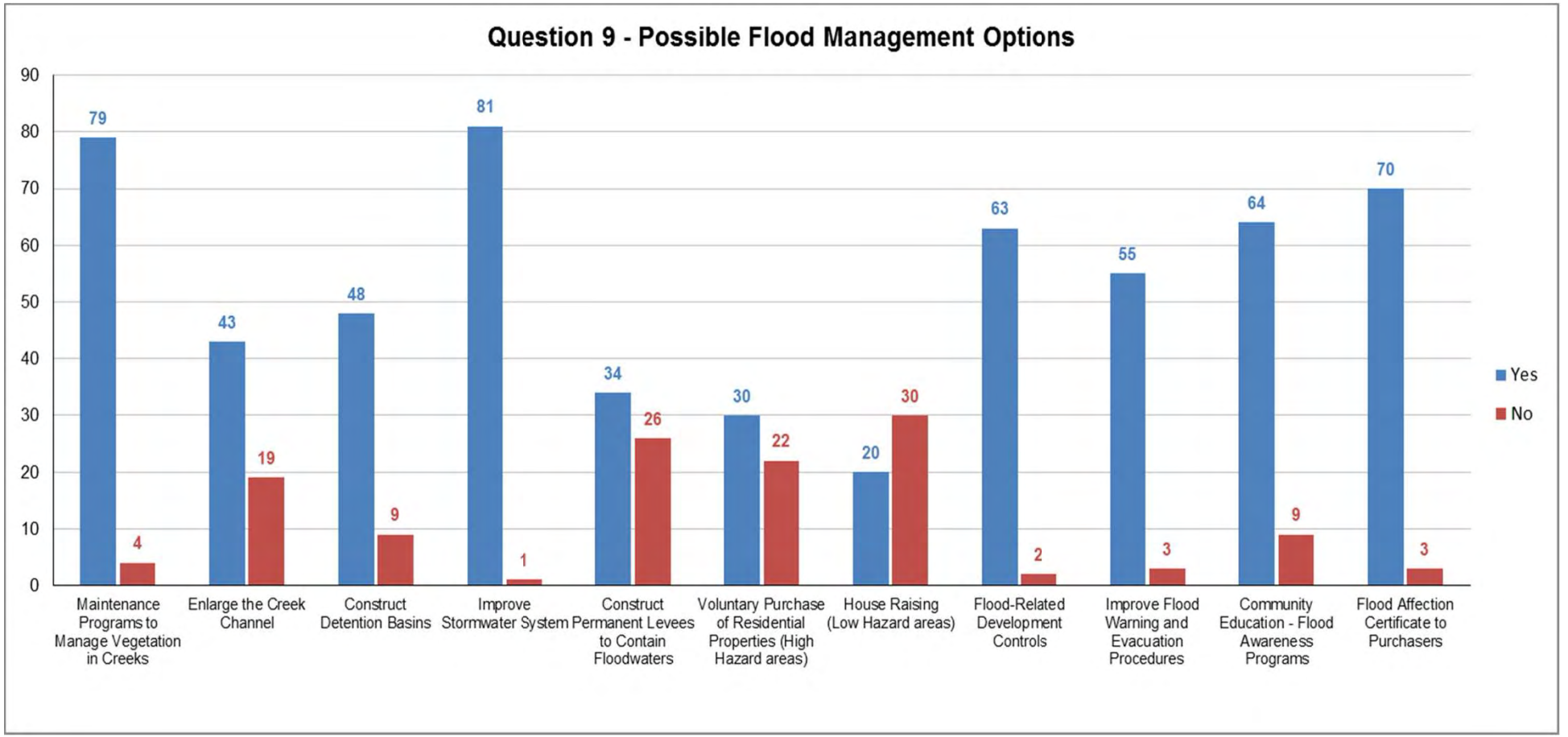


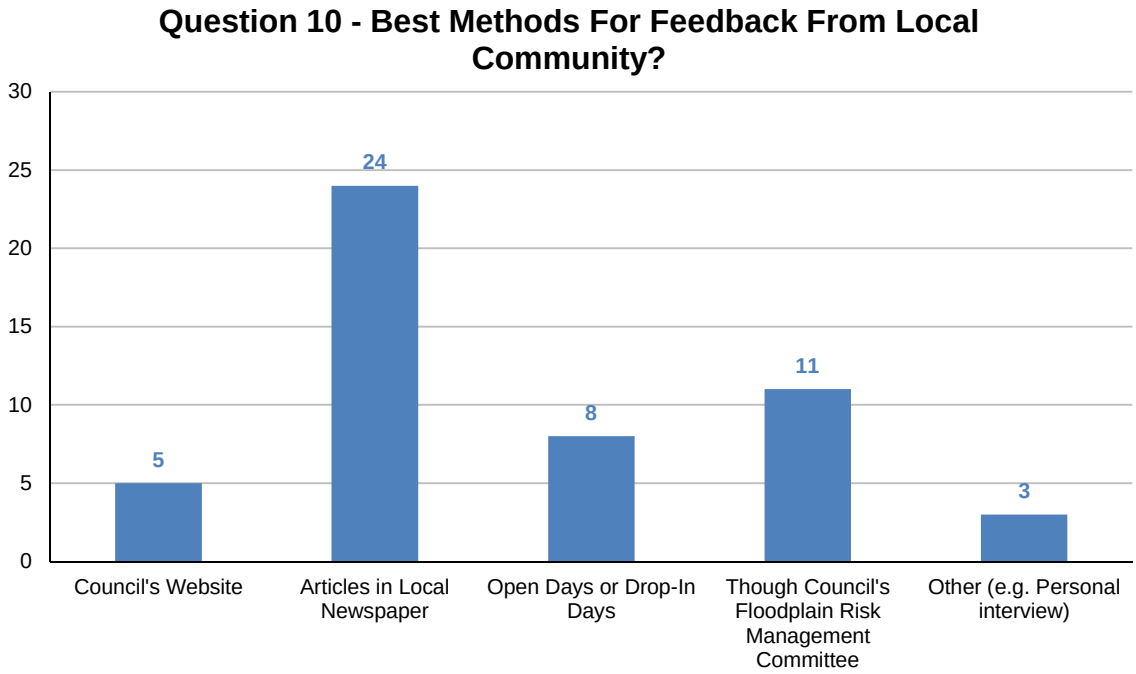
Question 7 - Where Did the Flood Warning Come From?



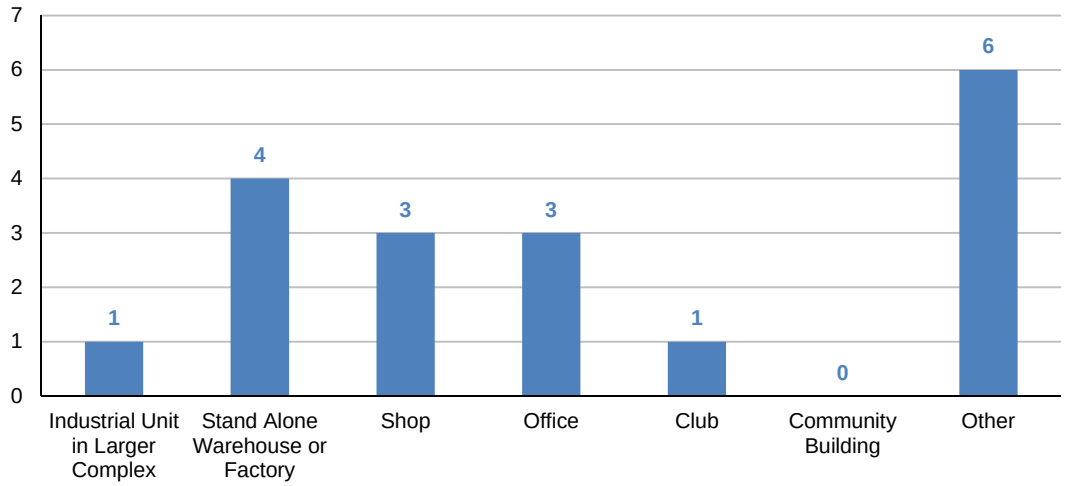
Question 8 - Ranking Development For Protection



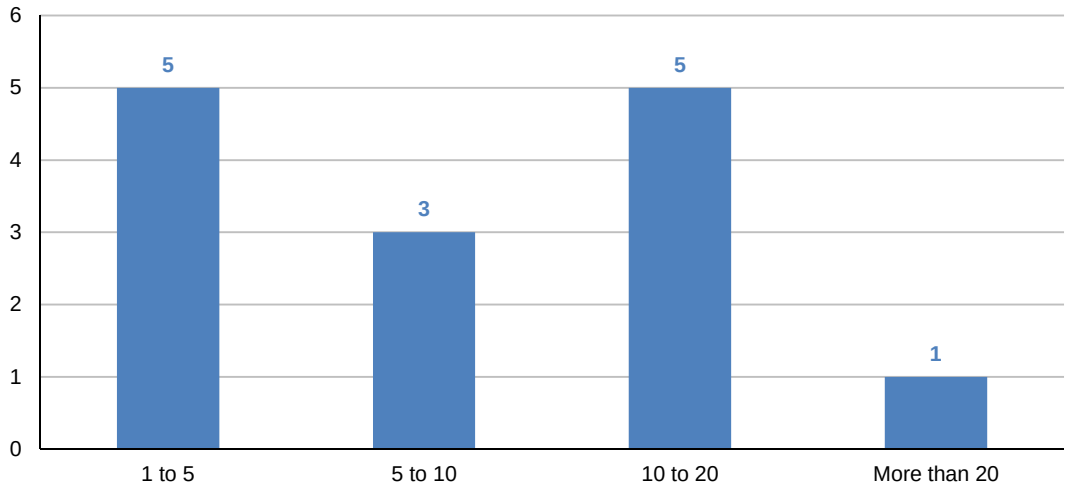

Question 9 - Possible Flood Management Options
90
80
70
60
50
40
30
20
10
0
79
4
43
19
48
9
81
1
34
26
30
22
20
30
63
2
55
3
64
9
70
3
Maintenance Programs to Manage Vegetation in Creeks
Enlarge the Creek Channel
Construct Detention Basins
Improve Stormwater System
Construct Permanent Levees to Contain Floodwaters
Voluntary Purchase of Residential Properties (High Hazard areas)
House Raising (Low Hazard areas)
Flood-Related Development Controls
Improve Flood Warning and Evacuation Procedures
Community Education - Flood Awareness Programs
Flood Affection Certificate to Purchasers
Yes
No


Question 10 - Best Methods For Feedback From Local Community?
30
25
20
15
10
5
0
5
24
8
11
3
Council's Website
Articles in Local Newspaper
Open Days or Drop-In Days
Though Council's Floodplain Risk Management Committee
Other (e.g. Personal interview)

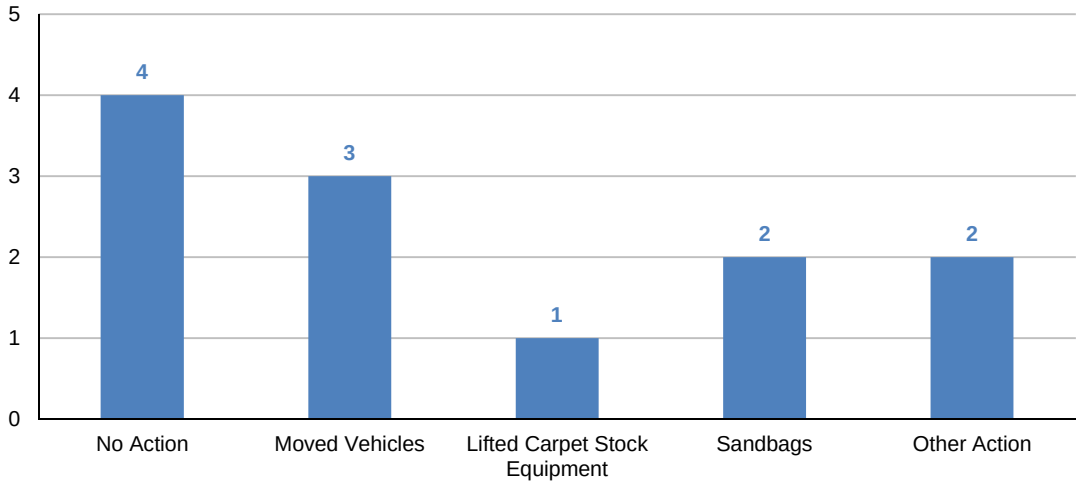
Question 1 - Type of Business



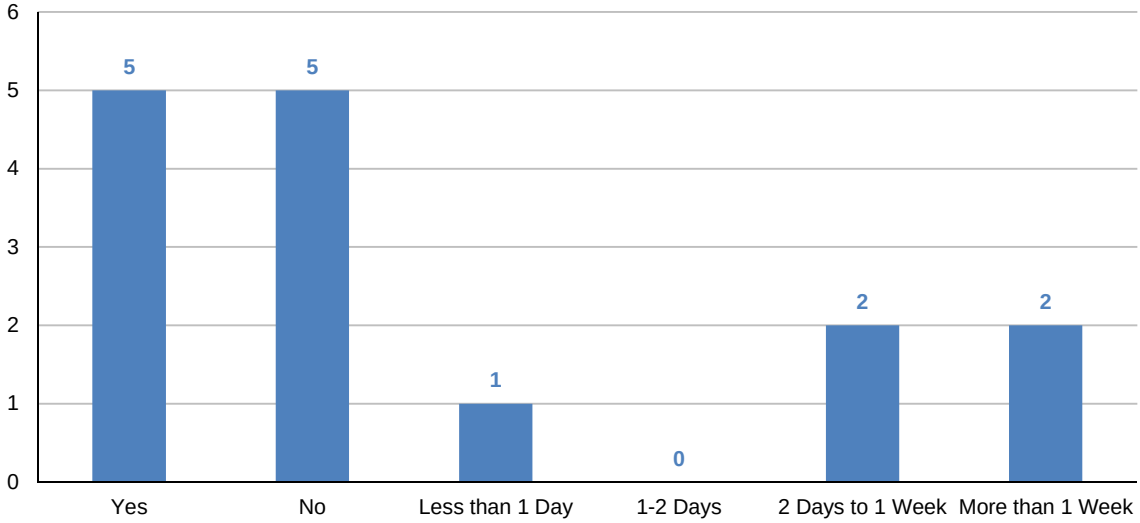
Question 2 - Number of Employees



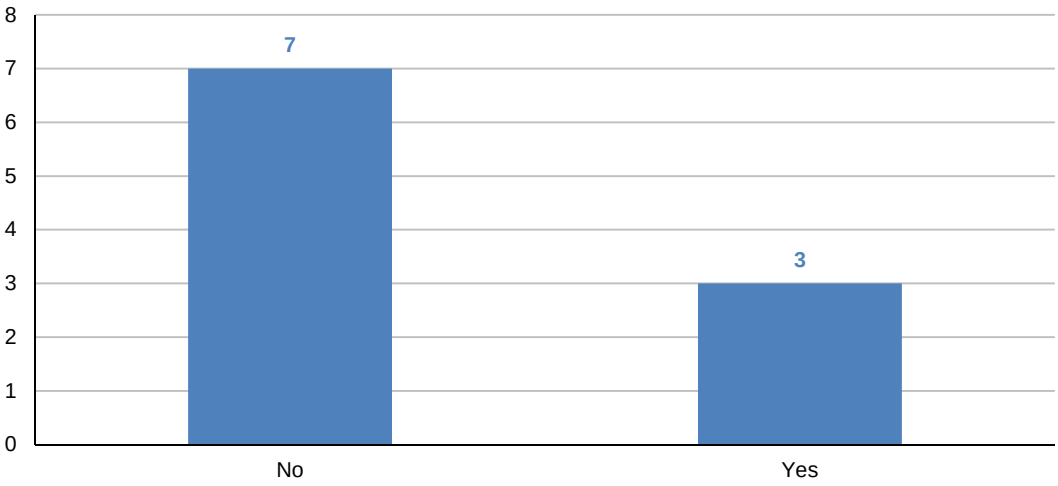
Question 3 - Action Taken to Protect Property



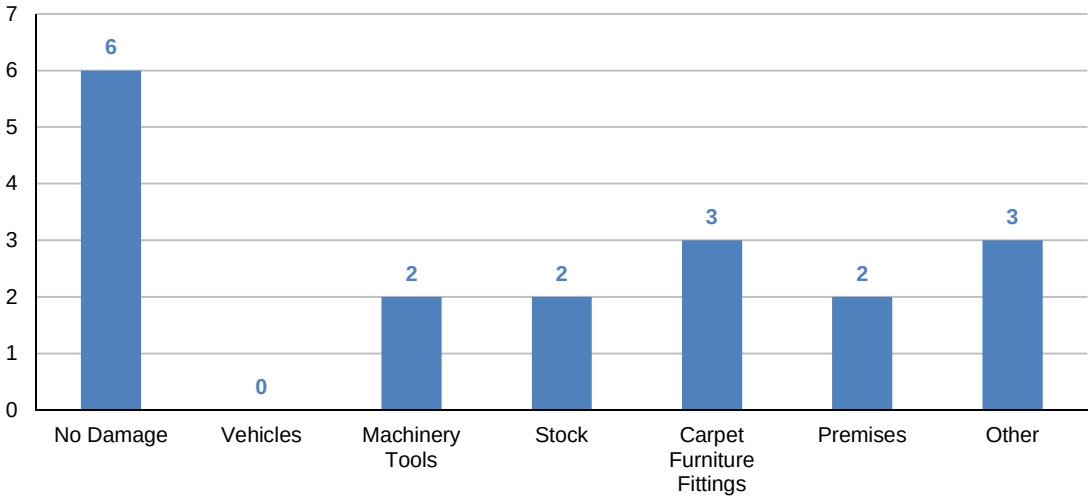
Question 4 - Disruption to Business

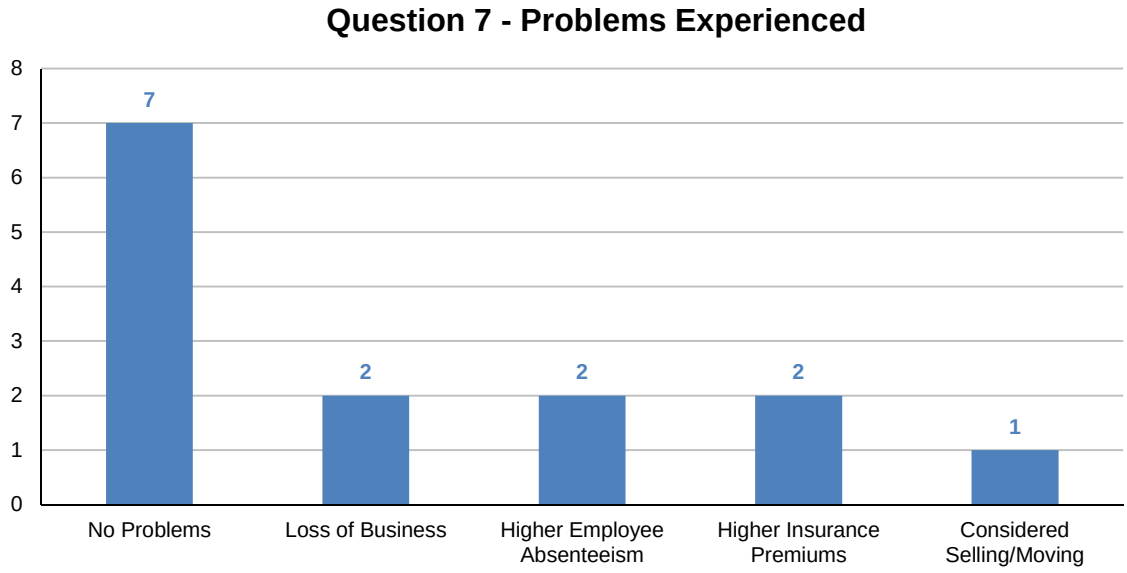


Question 5 - Flooding Above Floor Level



Question 6 - Damaged by Floodwaters




Question 7 - Problems Experienced
8
7
6
5
4
3
2
1
0
7
2
2
2
1
No Problems
Loss of Business
Higher Employee Absenteeism
Higher Insurance Premiums
Considered Selling/Moving

APPENDIX D

PLANNING CONTROLS IN LAND SUBJECT TO MAJOR OVERLAND FLOW

TABLE OF CONTENTS

Page No.

FIGURES
(BOUND IN VOLUME 2)

D1. INTRODUCTION

D1.1 Scope

This Appendix has been prepared for the *Town of Young Floodplain Risk Management Study and Plan (FRMS&P)* project to identify areas in the urban part of town which are inundated by overland flows and specify flood related Planning Controls over future development in those areas.

Flow in the overland flow paths is shallow and velocities are less than along the main creeks (referred to as "**Main Stream flooding"**) and their minor un-named tributaries (referred to as "**Minor Tributary flooding"**). However, depths of inundation up to 500 mm may be experienced, along with significant flow velocities in some areas. These more affected areas are referred to in this report as being subject to **"Major Overland Flow"** and are classified as being **"flood affected"** to distinguish them from the shallow inundation at the fringes of the overland flow paths.

The Appendix initially focusses on the three overland flow paths running southwards from the Olympic Highway through the urban areas of Young: Railway Drain, Chance Gully and Golf Course Drain (ref. **Sheet 3** of **Figure D1.1**). In later sections of the Appendix, consideration is also given to mapping overland flows resulting from the surcharging of the minor watercourses which discharge to the main creek system in rural areas of the floodplain.

The Appendix covers the following items:

- The preparation of flood mapping to separately identify land subject to Main Stream and Minor Tributary flooding and areas subject to Major Overland Flow. The need for the sub-division of flood prone land into these two categories arises from recently developed practice which aims at minimising community concerns when urbanised land subject to overland flow lying within the extent of 100 year ARI flood levels plus the traditional 500 mm of freeboard (defined herein as the "**Traditional Flood Planning Area" – TFPA**) is subject to flood-related development controls; and attracts a flood affectation notice on Planning Certificates issued under Section 149 of the EP&A Act 1979. **Figure D1.1** shows the extent of the TFPA. Under this traditional approach, most of the urban part of Young would lie within the extent of the TFPA.

- The terminology to be adopted in the *FRMS&P* report to describe these two categories of inundation to residents of Young located in areas subject to inundation under 100 year ARI flood conditions.

- Justification for the adoption of a variable freeboard approach to defining Flood Planning Levels (**FPL's**) at Young (as opposed to the traditional approach referred to above). The adoption of this approach resulted in a reduction in the number of properties which would be subject to flood related development controls and S149 notification. The extent of the resulting **"Flood Planning Area" – FPA** is shown on the *Flood Planning Map* (refer **Figure A1.1** in **Appendix A**). The *Flood Planning Map* forms part of the draft *Flood Policy* which has been developed for Young, details of which are contained in **Appendix A**.

- The notations to be provided on flood mapping and S149 Planning Certificates. The recent practice also differentiates between those zones subject to deeper depths of inundation or traversed by significant flows i.e. Major Overland Flow areas (which should be subject to S149 flood affectation notification and flood related controls over future development) and the shallower inundated land on the flood fringe. In the latter case, inundation may potentially be classified as "**Local Drainage**", with development subject to Building Code of Australia (BCA) requirements, without the property attracting a flood affectation notice.

D1.2 Hydraulic Studies

The results presented in **Chapters D2** and **D3** of the Appendix are based on the TUFLOW two-dimensional hydraulic modelling undertaken in *The Town of Young Flood Study, 2014*. For the purpose of defining land inundated by Major Overland Flow versus Local Drainage, sensitivity studies have been undertaken with alternative threshold depths of inundation and mapping prepared.

Following the selection of the criteria for distinguishing between Major Overland Flow and Local Drainage conditions, it was necessary to prepare flood maps.

These maps show the areas subject to Main Stream flooding and Major Overland Flow and confirm land use planning controls to be incorporated in the draft Flood Policy which has been prepared to provide specific controls to guide development of land in flood prone areas in Young.

A draft Flood Policy was included in the initial draft of the *FRMS&P* report of May, 2014 (and based on the mapping shown on **Figure D1.1**). However, at that time proposed planning controls were based on the TFPA and did not differentiate between areas affected by Main Stream / Minor Tributary flooding and Major Overland Flow.

D1.3 Planning Input

Planning input was required to support the proposed sub-division of the floodplain into Main Stream and Major Overland Flow zones, as the Young LEP 2010 does not distinguish between these two types of flooding. This work is discussed in **Chapter D4** of the Appendix and involved the following activities:

- Liaison with Council's Planning Staff and Department of Planning and Environment concerning the implications of the proposed land use controls on the current planning situation at Young.
- Site inspection, review of the flood mapping data and the *draft FRMS&P* reporting and attendance at a meeting of the Technical Review Committee for the project.
- Preparation of a draft Flood Clause defining the separate land use controls for lands subject to Major Overland Flow and Main Stream flooding which could be included in the *FRMS&P* report as a recommendation for future inclusion by Council in the Young LEP.
- Review of the draft Flood Policy. The draft of this document was amended to provide controls applying for lands subject to the two types of inundation.

D2. HYDRAULIC ANALYSIS

D2.1 Methodology – The Town of Young Flood Study, 2014

In the *Town of Young Flood Study, 2014*, flood behaviour at Young was defined using a computer based hydrologic model of the catchments to generate flood flows and a hydraulic model of the stream channels and floodplains to convert flows into peak flood levels, flow patterns and extents of inundation.

A network hydraulic model was adopted to model the passage of flows in the main streams and overland flow paths. A two-dimensional (in plan) model was chosen based on the TUFLOW software, which allowed for the interaction of flows between the channels and the floodplains, flow through culverts and flow over control structures such as weirs and road embankments. TUFLOW also routed flows through the urban piped and open channel trunk stormwater system and modelled the passage of overland flow over the natural surface.

D2.2 Flood Mechanisms

There were three mechanisms of flooding in Young which needed to be evaluated (refer **Figure D1.1, Sheets 1** to **3** for locations):

- **Main Stream** flooding caused by high flows from major storm events in the catchments of Burrangong Creek and its major tributaries upstream of Young. These flows follow the central threads of the streams in a generally westerly direction through the town. Several major tributaries drain the rural area to the south of Young and flow northwards to join Burrangong Creek. Due to the incised nature of the creek channels, most of the flow in the creek system is contained within the immediate proximity of the creeks even for major flood events.

  Main Stream flooding includes inundation in Burrangong Creek and its major tributaries: Sawpit Gully, Victoria Gully, Garibaldi Gully, Petticoat Gully, Big Spring Creek and Little Spring Creek.

- **Minor Tributary** flooding caused by high flows in the minor un-named tributaries which drain to Burrangong Creek and its main tributaries. While the depth of flow in the inbank area of the channels is typically greater than 500 mm, flow on the overbank area is generally shallow and slow moving in nature.

  Flooding in these areas is generally confined to land which while zoned *R1 – General Residential*, is primarily rural in nature.

- **Major Overland Flow** in the drainage systems of the urbanised sub-catchments on the northern side of town resulting from surcharges of the trunk stormwater system, which comprises sections of piped and open drains.

  There are three urbanised overland flow catchments which drain southwards to Burrangong Creek: Railway Drain, Chance Gully and Golf Course Drain.

  Due to a lack of capacity in the trunk drainage systems of the Railway Drain and Chance Gully, surcharging has occurred relatively frequently, resulting in shallow overland flow heading southwards from the catchment boundary at the Olympic Highway and Henry Lawson Way to Burrangong Creek. The Golf Course Drain, which is piped downstream of William Street is also a source of overland flooding. The flood affected areas include both residential areas and commercial development in the Central Business District (CBD) of Young.

There are also numerous minor un-named watercourses and overland flow paths in presently rural areas of the floodplain which drain as shallow, sheet-like flow to the main arms of the creek system. Inundation in those areas has also been mapped, although it is recognised that future development under the Young LEP 2010 zoning provisions may alter their drainage characteristics. (Zoning maps are presented in **Figure 2.5**, Sheets 1 and 2 of the *draft FRMS&P* report.)

D2.3 Definition of Flood Planning Area – Traditional Approach

As set out in FDM, 2005, the area encompassed by the Flood Planning Level (FPL) is denoted as the Flood Planning Area (FPA). The FPL for residential development is traditionally based on the peak level of the planning flood (i.e. the 100 year ARI event) plus an allowance of 500 mm for freeboard.

For the purposes of specifying controls over future development, the floodplain was sub-divided according to hazard and hydraulic categorisation, using accepted procedures which are mainly related to depth and velocity of flow and the importance of the flow paths. However, as mentioned, there is presently no distinction between Main Stream flooding and inundation in Major Overland Flow areas, and a common 500 mm of freeboard has been adopted for defining what has been termed for the purpose of this Appendix the TFPA. **Figure D1.1**, **Sheets 1** to **3** shows the extent of the TFPA based on this approach.

Accordingly, the TFPA (the extent of which is shaded red in **Figure D1.1**) occupies a large extent of land, particularly in the urban areas subject to overland flow on the northern side of Burrangong Creek, where the overland flow paths are relatively indistinct. The addition of 500 mm of freeboard to the 100 year flood level when defining the FPA results in the potential for many properties remote from the flow paths to be classified as “flood affected”, thereby triggering the application of planning controls.

A similar situation applies for the minor un-named watercourses in the rural areas of the floodplain bordering the town (i.e. in areas subject to Minor Tributary flooding), where the addition of 500 mm of freeboard would add significantly to the area defined as the FPA.

D2.4 When is Inundation “Flooding”?

When the general public uses the term “flooding” they usually imply a depth of inundation which has a consequence; whether an impact on property or on public safety. They may accept that at the edge of a flooded creek or river, even relatively shallow depths of inundation could be referred to as flooding.

However, it is difficult for them to accept such terminology if the inundation is not associated with a significant watercourse, but has the appearance of shallow, sheet-like flow or ponding. Addition of a relatively large freeboard such as 500 mm when specifying planning areas and minimum floor levels in such situations can further reduce the chances of community acceptance.

Consequently, other terminology such as “drainage”, “overland flow” or “ponding” may be more appropriate where the inundation is not associated with a major watercourse. In addition, it may also be appropriate to consider a reduction in freeboard in situations when the flow (even if classified as “flooding”) is comparatively shallow and slow moving.

D2.5 Guidance in the NSW Floodplain Development Manual

The FDM, 2005 recognises two types of inundation (ref. extract below):

*"**Main Stream Flooding**, defined as the inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.*

***Local Overland Flooding**, inundation by local runoff rather than overbank discharge from a stream, river, estuary lake of dam"*

Local Overland Flooding results from runoff which travels as sheet flow over grassed and paved surfaces in individual allotments, or along roads en-route to the main streams, or surcharges the minor pipes in the catchment headwaters and the lateral sub-catchments bordering the main streams. Local Overland Flooding is more often associated with sheet-like flow, where depths and velocities are not sufficient to result in high hazard conditions applying.

At the interface, there may be interactions between the two mechanisms. For example, depending on the magnitude and pattern of flow from individual flood events, high flood levels on the Main Stream may extend as a backwater into an area also influenced by Local Overland Flooding. Therefore, it is often difficult to define precisely the boundary between the two categories.

Note that for Young, the term "***Minor Tributary flooding***" has been used and is defined as the inundation of normally dry land occurring when water overflows the un-named watercourses draining to Burrangong Creek and its main tributaries outside the Major Overland Flow Urban Precinct. The need to differentiate between Main Stream and Minor Tributary flooding arose due to the decision to adopt a non-traditional approach to the definition of the FPA in areas affected by the latter type of flooding.

D2.6 Local Overland Flooding

The FDM, 2005 also recognises two levels of **Local Overland Flooding** problems, which are distinguished by the depths of inundation and the potential danger to personal safety.

D2.6.1 Local Drainage

At the **lower** end of the scale, the drainage problems would typically be caused by direct surface runoff, surcharges and overflows from low points in kerbs, or overflows from the smaller pipes in the stormwater drainage system. They typically involve depths of inundation up to 300 mm. In the FDM, 2005, these situations are categorised as **Local Drainage**.

The Manual recognises that Local Drainage problems are not always amenable to rigorous analysis and therefore Council is **not** obliged to convey information on Planning Certificates under Section 149 of the EP&A Act. Local Drainage problems involve shallow depths of inundation with generally little danger to personal safety. Problems due to property inundation generally arise because of deficiencies in stormwater management controls or building practice where floor levels are near finished ground levels.

Local Drainage problems can generally be minimised by applying controls requiring finished habitable floor levels to be set above finished ground levels to cope with shallow water depths, as well as by ensuring adequate site drainage which minimise obstructions to the passage of flow.

Whilst not always amenable to rigorous evaluation, it is important that local drainage problems are recognised and that Council, when assessing development proposals, considers:

- the impact of upstream catchment change on downstream areas;
- the need to ensure that any upgrading works consider:
  - the consequence of translating the problem from one location to another;
  - the potential to alter flow paths; and
  - the consequences for downstream properties
- setting standards for development that address local drainage issues.

D2.6.2 Major Drainage

At the **upper** end of the scale, Local Overland Flooding includes the flow paths of original drainage lines whether natural or altered (piped, channelised, diverted or restricted by urban development) and may be categorised as **Major Drainage**. Water depths are generally in excess of 300 mm (in the storm event used to derive the FPL). These conditions may result in danger to:

- personal safety and damage to property (both premises and vehicles); and/or
- major overland flow paths through developed areas outside of defined drainage reserves; and/or
- the potential to flood a number of buildings along the major flow paths.

Good building practice can reduce flood frequency and damages. However, due to the relative depth of inundation, general building controls cannot control all problems.

Strategies to address Major Drainage problems will normally be similar to those used to manage Main Stream flooding.

D2.7 Proposed Approach for Young

While the FDM, 2005 specifies that a Council can exercise discretion in setting criteria to determine what constitutes Major Drainage, it is clear that the Manual considers inundation from "Major Drainage" to be "flooding", with the resulting requirement for development controls and S149 notification.

The suggested approach developed in this Appendix for Young is consistent with the Manual in these respects, but refers to inundation resulting from Major Drainage as "**Major Overland Flow**".

It is proposed that land subject to Main Stream and Minor Tributary flooding, as well as Major Overland Flow will have flood related development controls and S149 flood notification. However, development in the less affected Local Drainage areas will be subject to BCA requirements and would **not** have S149 flood notification.

Issues to be considered in the determination of the boundary between Major Overland Flow and Local Drainage include:

- The hydraulic criteria used to determine the boundary. The FDM, 2005 does not provide a prescriptive depth but suggests a 300 mm threshold could be adopted. It suggests that factors such as damage potential and risks to personal safety should also be considered. The adopted criteria would typically be depth and velocity of flow dependent. Due to the fact that properties not subject to S149 affection notification will default to the minimum floor level controls set out in the BCA, it is suggested that the threshold depth used to define the boundary between Major Overland Flow and Local Drainage areas be reduced to 150 mm.
- Consideration of floods rarer than the 100 year ARI flood standard. Significant increases in depth and velocity of flow and adverse re-directions of flow for the rarer events could influence the choice of design variables.
- The reaction of the community. The classification of public property, with all its financial and emotional implications is a sensitive issue which must be carefully managed by Council, consistent with its responsibilities under the FDM, 2005.

The next Chapter of the Appendix deals with the selection of the boundary between Major Overland Flow and Local Drainage.

D3. DEFINITION OF THE FLOOD PLANNING AREA IN YOUNG

D3.1 The Urban Part of Young (Northern Side of Burrangong Creek)

D3.1.1 Major Overland Flow versus Local Drainage

Figure D3.1, Sheets 1 to **7** are colour-coded diagrams which show indicative depths of inundation for 100 year ARI conditions in the three overland flow paths traversing the urban area of Young on the northern side of Burrangong Creek (Railway Drain, Chance Gully and Golf Course Drain). The figure shows the "Floodway" zone, which conveys most of the flow (the boundaries of the Floodway zone are shown as solid yellow lines), as well as the extent of the TFPA.

The Floodways define the portions of the overland flow paths which convey a significant discharge of water and are broadly aligned with the natural pre-development watercourses. They are areas that, even if partially blocked, would cause a significant re-distribution of flood flow or a significant increase in flood levels. Flow velocities are not significant in the remainder of the inundated areas and the depths of inundation generally reduce towards the fringes of inundation.

The distribution of depths of inundation within each property may be assessed by reference to **Figure D3.1**. Generally depths of inundation are in the range 50 to 500 mm, although there are isolated cases in residential allotments where the depth increases to 700 mm. The diagrams also show the following information, proceeding from the shallowest to the deepest zones of inundation:

- The boundaries of properties which lie within the TFPA, but where the depth of inundation is no greater than 150 mm are not labelled. If a threshold depth of inundation of 150 mm were selected as the boundary between Local Drainage and Major Overland Flow, then these unlabelled properties would not be classified as "flooded" (because the depth of inundation within these allotments does not exceed 150 mm). They would <u>not</u> attract S149 flood affectation notification. They would, however, be categorised as being in a Local Drainage zone.
- The boundaries of allotments where the depth of inundation is between 150 - 300 mm in part of the property are shown in blue. If a threshold depth of 300 mm were selected as the boundary between Local Drainage and Major Overland Flow, then those properties as well as the un-labelled properties on the flood fringe would be categorised as being in the Local Drainage zone (because the depth of inundation within these allotments does not exceed 300 mm).

  If this approach was to be adopted, then there is the potential for future residential development to be subject to up to 150 mm of above-floor inundation, as a development could proceed based on the minimum floor level requirement set out in the BCA (i.e. a floor level set a minimum 150 mm above finished ground level). On this basis, it is recommended that properties subject to depths of inundation between 150 – 300 mm be classified as Major Overland Flow, thereby attracting a S149 flood affectation notification.
- The boundaries of allotments where the depth of inundation exceeds 300 mm are shown in red. Some of those properties are also traversed by significant flows (i.e. located in the zone labelled "Floodway"). Allotments with boundaries shown red would be categorised as being subject to Major Overland Flow and would attract S149 flood affectation notification.

- A zone entitled the **"Major Overland Flow Urban Precinct"** could be used to identify the area in which allotments subject to Major Overland Flow lie. It borders the Railway Drain, Chance Gully and Golf Course Drain watercourses and its boundaries are shown on **Figure D3.2**.
- Allotments bordering Burrangong Creek (shown on **Figure D3.1**, **Sheets 6** and **7**) would be categorised as being affected by Main Stream flooding. The traditional definition of the FPA (the area encompassed by the 100 year ARI flood level plus 500 mm and bounded by dashed magenta lines) would apply to Main Stream flooding.

D3.1.2 Variation in the Number of "Flood Affected" Properties

Table D3.1 over the page summarises the approximate numbers of properties in the Major Overland Flow Precinct which would be identified as "flood affected" and subject to flood related development controls under the various threshold depth scenarios

For example, under the traditional approach of defining the Flood Planning Area as all of the land inundated by the 100 year ARI flood plus 500 mm (Column 3), 146 residential properties on the Railway Drain flow path partly or wholly lying within the extent of the TFPA shown on **Figure D3.1** would be "flood affected".

However, if depths of inundation greater than 300 mm were adopted as defining the boundary between Local Drainage and Major Overland Flow (Column 5), only the 29 worst flood affected residential properties on the Railway Drain flow path (boundaries shown in red) would be categorised as flood affected and subject to flood related development controls.

If depths of inundation greater than 150 mm were adopted then those 29 worst affected properties, together with properties inundated by 150 – 300 mm (boundaries shown in blue) would be categorised as flood prone. They total 52 residential properties on Railway Drain (Column 4).

Significant reductions in properties categorised as "flood affected" would also result from adopting threshold depths of inundation for the Chance Gully and Golf Course overland flow paths, compared with the traditional approach of defining the FPA.

Consideration of flooding patterns of rarer floods would not alter the adoption of the 100 year ARI flood as the design event. In *The Town of Young Flood Study, 2014,* floods up to 500 year ARI were modelled. Although peak flows increased with flood magnitude, it was clear that no new flow paths would be created and there would be only a modest increase in peak levels due to the slow moving and shallow characteristics of the flow.

D3.1.3 Conclusion

While the adoption of 100 year ARI depths of inundation greater than 300 mm in properties as the boundary between Local Drainage and Major Overland Flow would not appear to compromise Council's responsibilities in regard to satisfying the requirements of the FDM, 2005 and is supported by the Manual, the potential for above-floor inundation to occur in properties where the depth of overland flow is between 150-300 mm (i.e. because only BCA controls would apply to future development in these areas), means that a threshold depth of 150 mm should be used for defining areas subject to S149 affectation notification.

There are also two residual issues which must be addressed:

- What building controls should apply to properties in the less affected Local Drainage areas?
- What flood related controls should apply in properties affected by Major Overland Flow?

These issues are considered in the next two sections of this Chapter.

TABLE D3.1
NUMBER OF ALLOTMENTS IN
MAJOR OVERLAND FLOW URBAN PRECINCT
ASSESSED AS "FLOOD AFFECTED"
(VARIOUS SCENARIOS OF INUNDATION)

Overland Flow Path (1)	Allotment Type (2)	Properties within Traditional Flood Planning Area (Young LEP 2010) (3)	Properties with Depths of Inundation > 150 mm (4)	Properties with Depths of Inundation > 300 mm (5)
Golf Course Drain	Residential	20	16	10
	Commercial	33	30	21
	Public	0	0	0
	Total	**53**	**46**	**31**
Chance Gully	Residential	58	31	27
	Commercial	55	33	28
	Public	7	7	7
	Total	**120**	**71**	**62**
Railway Drain	Residential	146	52	29
	Commercial	127	84	57
	Public	4	3	3
	Total	**277**	**139**	**89**
Total		**450**	**256**	**182**

Notes:

(a) The numbers of flood affected properties in Columns (3) to (5) apply for 100 year ARI conditions.

(b) Properties in Column (3) include all allotments lying within the "Traditional Flood Planning Area", as defined by the area beneath the 100 year ARI flood plus 500 mm. (ref. red dashed lines **Figure D3.1**).

(c) Properties in Column (4) include all allotments where depth of inundation exceeds 150 mm (properties bounded by blue and red solid lines in **Figure D3.1**).

(d) Properties in Column (5) include allotments where depth of inundation exceeds 300 mm and/or lie within "Floodway" (properties bounded by solid red lines in **Figure D3.1**).

D3.2 Building Controls in the "Local Drainage" Area

Controls required to minimise the likelihood of above-floor inundation in Local Drainage areas should also be considered. There are two potential sources of controls to address this issue:

- **Council Controls over future development.** The *Young Shire Council Minimum Building Requirements Policy, 2009* (although not currently used by Council) could be updated to incorporate drainage-related requirements and re-issued. This Policy document notes that certain areas may be subject to flooding and that therefore special requirements will apply. The document also notes that enquiries should be made at the Environmental Services Division regarding Council's policy relating to building on flood liable land prior to the preparation of plans and specifications.

  Following the preparation of *The Town of Young Flood Study, 2014* it is now possible for Council to identify land subject to inundation within the extent of the hydraulically modelled area, which is shown bounded by black dashed lines on **Figure D1.1**. Following the adoption of the recommended 150 mm threshold depth of inundation, it is possible to identify land bordering the overland flow paths subject to the Local Drainage classification. While Council is in a position to develop the "special requirements" referred to in its *Minimum Building Requirements Policy, 2009* (or in an equivalent drainage related document to be prepared by Council) and to upgrade its policy on stormwater management, it is noted that even then, residential development not subject to S149 affectation notification could proceed under the Codes SEPP (State Environmental Planning Policy (Exempt and Comply Condes) 2008) without heed of Council's flood and stormwater management related policies.

- **BCA Controls over minimum floor levels.** The BCA requires that slab-on-ground floor levels should be a minimum of 150 mm above finished floor levels. However, as noted by Bewsher et al, 2010 this requirement only applies to Class 1 buildings (i.e. single dwellings) and does not include other types of residential buildings or non-residential buildings. Further, while the BCA recognises that the slab height might need to be varied to account for "run-off from storms", "local topography", "the effect of excavation on a cut and fill site" and the "possibility of flooding", in the absence of Council's policies, it is unlikely that requirements for minimum floor levels above 150 mm would be adhered to.

  Consequently there is limited confidence that the BCA's provisions are sufficient to avoid above-floor inundation where depths exceed 150 mm and then only for single residential dwellings. The FDM, 2005 states that inundation depths up to 300 mm can normally be managed by the application of "general urban building controls". However, if the 300 mm threshold were adopted for Young, this would only be the case if such controls were formalised in Council's *Minimum Building Requirements Policy* or in a Council policy for stormwater management, noting that even then, residential development not subject to S149 affectation notification could proceed under the Codes SEPP (State Environmental Planning Policy (Exempt and Comply Condes) 2008) without heed of Council's flood and stormwater management related policies.

D3.3 Minimum Floor Levels in Major Overland Flow Areas

Minimum floor levels in flood affected properties are based on design flood levels plus freeboard. The purpose of freeboard is to provide a reasonable certainty that the risk exposure associated with a particular design flood (in this case the 100 year ARI event) is actually provided. Freeboard is made up of a number of components which are largely related to the depth of inundation and the velocity of flow. (At Young, wave action is not significant due to the lack of "fetch" for the generation of wind driven waves.). Future climate change and the uncertainties of the estimate of peak flood level associated with hydraulic modelling should also be considered. These factors were considered in *The Town of Young Flood Study, 2014*.

The main streams are incised and quite steep and with sufficient hydraulic capacity that the extent of inundation is generally limited to a narrow strip bordering the channels. Flow velocities are relatively high approaching 2- 3 m/s in some streams. Consequently, after consideration of the above factors, it is considered that a freeboard of 500 mm is justified when setting the FPL for land subject to Main Stream flooding.

In the case of land subject to Major Overland Flow both the depth of inundation and velocity of flow are less. Inspection of flow velocities in the three overland flow paths of **Figure D3.1** showed that in the Floodway zone, the depth of inundation and velocity of flow through allotments averaged about 400-500 mm and 1m/s respectively. Freeboard could be derived by an addition of the following components to design flood levels:

- Uncertainty in hydraulic modelling precision	100 mm
- Increase in levels due to future climate change	50 mm
- Localised increase in levels due to pipe blockage	50 mm
- Localised increase in levels due to surges	50 mm
- Total increase in design flood levels	250 mm

A freeboard in the range 250 – 300 mm on 100 year ARI flood levels would therefore be appropriate when setting minimum floor levels in allotments subject to Major Overland Flow. For this Appendix, a 300 mm freeboard is recommended.

D3.4 Recommended Sub-Division of the Floodplain

Figure D3.2 (**Sheets 1** to **3**) shows the flood planning data in a similar manner to **Figure D3.1** for all of the floodplain included in the hydraulic modelling, the extent of which is shown by the black dashed lines. It includes flooding in the main streams, minor watercourses and overland flow paths in the presently rural part of the study area, which extends to the east and south of the developed part of town, and continues downstream to the Sewage Treatment Plant.

As mentioned, the traditional approach to defining the FPA (denoted herein as the TFPA) has not been adopted at Young. Rather, the FPA has been defined based on the adoption of freeboard provisions which reflect the variable nature of the flood hazard on the floodplain. The extent of the FPA which has been developed for Young is shown on the *Flood Planning Map* (refer **Figure A1.1** in **Appendix A**). The *Flood Planning Map* forms part of the draft *Flood Policy* which has been developed for Young, details of which are contained in **Appendix A**.

D3.4.1 Main Stream Flooding

In the areas subject to flooding due to overflows from Burrangong Creek and its main tributaries:

1. The extent of the Floodway zone is shown in a solid yellow colour with scaled vectors showing the direction and relative magnitude of the velocity of flow.
2. The extent of flood storage areas, which are generally confined to farm dams, including Chinaman's Dam on Sawpit Gully, are shown in cyan.
3. The extent of the Intermediate Floodplain zone is shown in a solid magenta colour and is defined as the strip of land outside floodway and flood storage areas which lies below the 100 year ARI flood plus 500 mm.
4. The FPA is based on the traditional definition of the area inundated by the 100 year ARI flood plus 500 mm freeboard.
5. It is proposed that properties intersected by the extent of the FPA would be subject to S149 flood affectation notification and planning controls graded according to flood hazard (dependent on depth of inundation and flow velocity). A graded set of controls is included in the draft Flood Policy.

D3.4.2 Minor Tributary Flooding

In areas subject to flooding due to overflows from the minor un-named watercourses which drain to Burrangong Creek and its main tributaries:

1. The extent of the Floodway zone is shown in a solid yellow colour with scaled vectors showing the direction and relative magnitude of the velocity of flow. This zone defines the main flow path.
2. The extent of flood storage areas, which are generally confined to farm dams, are shown in cyan.
3. Land outside the Intermediate Floodplain (Main Stream flooding only), Floodway and Flood Storage areas where depths of inundation will exceed 300 mm in a 100 year ARI event are shown in a solid pink colour.
4. Land outside the Intermediate Floodplain (Main Stream flooding only), Floodway and Flood Storage areas where depths of inundation will range between 150 and 300 mm in a 100 year ARI event are shown in a solid green colour.
5. The FPA is defined as the land where the depth of inundation during the 100 year ARI storm event is greater than 150 mm, or is in a floodway or flood storage area.
6. It is proposed that properties intersected by the extent of the FPA would be subject to S149 flood affectation notification and planning controls graded according to flood hazard (dependent on depth of inundation and flow velocity). A graded set of controls is included in the draft Flood Policy.
7. Areas subject to depths of inundation less than 150 mm are classified as "**Local Drainage**" and therefore not subject to S149 affectation notification. Minimum floor level requirements in these properties would therefore be subject to the BCA requirement of 150 mm above finished surface level.

D3.4.3 Major Overland Flow

For the Major Overland Flow areas:

1. The extent of the Floodway zone is shown in a solid yellow colour with scaled vectors showing the direction and relative magnitude of the velocity of flow. This zone defines the main flow path.
2. The extent of the flood storage area in the Brock Street Detention Basin is shown in cyan.
3. Land outside Floodway and Flood Storage areas where depths of inundation will exceed 300 mm in a 100 year ARI event are shown in a solid pink colour.
4. Land outside Floodway and Flood Storage areas where depths of inundation will range between 150 and 300 mm in a 100 year ARI event are shown in a solid green colour.
5. Properties intersected by the extent of the Floodway or subject to depths of inundation greater than 150 mm during the 100 year ARI storm event (boundaries of those allotments are shown as either solid red or blue lines) would be subject to S149 flood affectation notification and planning controls graded according to flood hazard (dependent on depth of inundation and flow velocity). The boundaries of those properties therefore define the extent of the FPA.
6. Areas subject to depths of inundation less than 150 mm are classified as "**Local Drainage**" and therefore not subject to S149 affectation notification. Minimum floor level requirements in these properties would therefore be subject to the BCA requirement of 150 mm above finished surface level.

D4. PLANNING CONSIDERATIONS

D4.1 Young Local Environmental Plan 2010

The Young Local Environmental Plan (LEP 2010) is the principal statutory planning document used by Young Shire Council for controlling development, by defining zoning provisions, establishing permissibility of land use and regulating the extent of development in the town and Shire.

D4.2 Land Use Zoning

Sheets 1 and 2 of **Figure 2.5** of the *draft FRMS&P* report show the zonings incorporated in LEP 2010 superimposed on the various sub-catchments of the drainage system of Burrangong Creek and its tributaries.

On the northern side of Burrangong Creek the area of Young zoned *R1 General Residential* extends beyond the currently urbanised limits to the northern boundaries of the Railway Drain and Chance Gully catchments. Urbanisation of currently rural land is likely to result in an increase in downstream flood peaks in those catchments which will need to be managed. Similarly, increased development in and adjacent to the CBD area (in land zoned *B4 Mixed Use*) has the potential to exacerbate existing flooding problems, although to a lesser extent (ref. Section 3.9.4 and Figures 3.20 and 3.21 of the *draft FRMS&P* report for the results of hydraulic modelling of the impacts of urbanisation and consideration of flood management measures).

On the southern side of Burrangong Creek increased flows are likely to occur due to future development in currently rural land zoned *R1 General Residential* in the catchments of Big Spring Creek, principally on the eastern side of the catchment between Purchas Street and Burrangong Creek, and in the Petticoat Gully catchment, where the largely undeveloped area between Burrangong Creek southwards towards Tierney Street is zoned *R1 General Residential*. The western side of the Sawpit Gully catchment downstream of Chinaman's Dam has also been zoned *R1 General Residential*.

Future urbanisation, particularly in land zoned *R1 General Residential,* is likely to result in changes in the existing drainage system. Existing minor watercourses are likely to be retained and formalised in drainage reserves. However, piped drainage systems associated with urban sub-divisions will result in significant amendments to existing overland flow paths leading to the watercourses. As noted previously, Council will need to upgrade its stormwater management policy to cater for future development in areas of the rural floodplain classified as "Local Drainage".

The zonings of land elsewhere in the drainage system comprise *R5 Large Lot Residential*, *RU4 Rural Small Holdings* and other uses where potential development will be less intense in terms of increase in impervious area and is not likely to result in significantly increased flood flows.

D4.3 Flood Provisions of Young LEP 2010

Clause 6.6 of the LEP entitled ***"Flood Planning"*** outlines its objectives in regard to development of flood prone land. It is similar to the standard Flood Planning Clause used in recently adopted LEPs in other NSW country centres and is reproduced below:

"(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to land that is at or below the flood planning level.

(3) Development consent must not be granted for development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the NSW Government's Floodplain Development Manual published in 2005, unless it is otherwise defined in this clause.

(5) In this clause:

***flood planning level** means the level of a 1:100 ARI (average recurrent interval) flood event plus 0.5 metre freeboard."*

D4.4 Comments on the Flood Provisions of Young LEP 2010

The incorrect inclusion of the word "recurrent" instead of "recurrence" in the term "average recurrence interval" is noted. In addition, there is no inclusion of flood related terminology in the dictionary attached to the LEP other than the term "flood mitigation work". However, the LEP does state that meanings of words and terms used therein are equivalent to those in the FDM, 2005.

Clause 6.6 of the LEP applies to land beneath the FPL. The FPL referred to is the 100 year ARI flood plus an allowance for freeboard of 500 mm. The area encompassed by the FPL is known as the Flood Planning Area (FPA) and denotes the area subject to flood related development controls, such as locating development outside high hazard areas and setting minimum floor levels for future residential development. It is now standard practice for the residential FPL to be based on the 100 year ARI flood plus appropriate freeboard unless exceptional circumstances apply. LEPs usually refer to a "flood map" which identifies the FPA. However, in the case of the Young LEP 2010, this was not possible because until the adoption of the recent Flood Study in February 2014, no quantitative data were available on design flood levels to define the FPA.

The LEP 2010 conforms with the merit based approach to development in flood prone areas set out in the FDM, 2005 as it requires Council to be satisfied prior to granting development consent that the development:

- Is compatible with the flood hazard, thereby recognising the gradation of hazard across the flood liable area.
- Adopts the 100 year ARI as the design event for defining FPLs.
- Will not adversely affect flood behaviour in adjacent areas.
- Incorporates measures to manage the risk to loss of life.
- Includes social and economic costs of flooding as a criterion for gaining development approval.

However, to implement the approach recommended in the Appendix, clause 6.6 of LEP 2010 would require amendment. Suggested amendments are given in the next section of the Appendix. The revised LEP would need to be supported by a flood policy which sets out specific requirements for development in flood liable areas based on the flood extent and hazard mapping contained in the Flood Study. Such a flood policy is presented in draft form in **Appendix A** of the *FRMS&P* report.

D4.5 Revision to LEP 2010

D4.5.1 Additional Definitions and Terminology

Notwithstanding the statement in LEP 2010 that words and terms used therein are equivalent to those in the FDM, 2005, in order to ensure that readers have a good understanding of the terminology applying to floodplain risk management and hence Flood Planning, it is recommended that a number of additional definitions be included in the revised LEP, as follows:

flood planning area — means an area of land that is shown to be in a flood planning area on the *Flood Planning Map* and is subject to either main stream flooding or major overland flow.

Flood Planning Map — means the *Flood Planning Map* referred to in the Young Local Environmental Plan 2010.

flood prone land — is land susceptible to flooding by the largest flood that could conceivably occur at a particular location, as estimated from the probable maximum precipitation.

Clause 6.6 of LEP 2010 currently applies to land beneath the FPL. The FPL referred to is the 100 year ARI flood plus an allowance for freeboard of 500 mm. If the approach recommended in the Appendix is adopted, terminology in clause 6.6 of LEP 2010 will vary over the Young Shire as follows:

(a) For flood prone land that has been the subject of *The Town of Young Flood Study, 2014* and is classified as **Main Stream** and **Minor Tributary** flooding as well as **Major Overland Flow**, reference would simply be made to the **flood planning area** as shown on the ***Flood Planning Map***.

(b) For flood prone land that is outside the boundaries of *The Town of Young Flood Study, 2014*, reference would be made to the current FPL which would be the level of the 100 year ARI flood event plus 500 mm freeboard.

D4.5.2 Revised Flood Planning Clause 6.6

To implement the approach recommended in the Appendix, clause 6.6 of LEP 2010 would require amendment. It is recommended that the following clause replaces the existing clause 6.6 of LEP 2010:

"**6.6 Flood planning**

(1) The objectives of this clause are as follows:

(a) to minimise the flood risk to life and property associated with the use of land,

(b) to allow development on land that is compatible with the land's flood hazard, taking into account projected changes as a result of climate change,

(c) to avoid significant adverse impacts on flood behaviour and the environment.

(2) This clause applies to:

(a) land identified as "*flood planning area*" on the *Flood Planning Map*; and

(b) other land at or below the flood planning level.

(3) Development consent must not be granted for development on land to which this clause applies unless the consent authority is satisfied that the development:

(a) is compatible with the flood hazard of the land, and

(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

(c) incorporates appropriate measures to manage risk to life from flood, and

(d) is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and

(e) is not likely to result in unsustainable social and economic costs to the community as a consequence of flooding.

(4) A word or expression used in this clause has the same meaning as it has in the NSW Government's Floodplain Development Manual published in 2005, unless it is otherwise defined either in this clause or elsewhere in this plan.

(5) In this clause:

For land not defined as either *Outer Floodplain* or *Flood Planning Area* on the *Flood Planning Map*, the *flood planning level* is the level of the 100 year Average Recurrence Interval (ARI) flood event plus 500 mm freeboard.

D4.5.3 New Floodplain Risk Management Clause

Floodplain risk management

(1) The objectives of this clause are as follows:

(a) in relation to development with particular evacuation or emergency response issues, to enable evacuation of land subject to flooding in events exceeding the flood planning level,

(b) to protect the operational capacity of emergency response facilities and critical infrastructure during extreme flood events.

(2) This clause applies to:

(a) land identified as *Outer Floodplain*.

(3) Development consent must not be granted to development for the following purposes on land to which this clause applies unless the consent authority is satisfied that the development will not, in flood events exceeding the flood planning level, affect the safe occupation of, and evacuation from, the land:

(a) caravan parks,

(b) commercial premises,

(c) correctional centres,

(d) emergency services facilities,

(e) group homes,

(f) hospitals,

(g) industries,

(h) residential accommodation,

(i) residential care facilities,

(j) tourist and visitor accommodation.

(4) A word or expression used in this clause has the same meaning as it has in the NSW Government's Floodplain Development Manual published in 2005, unless it is otherwise defined either in this clause or elsewhere in this plan.

(5) In this clause:

The O*uter Floodplain* is land which lies between the *Flood Planning Area* and the *Probable Maximum Flood*.

D4.6 Section 149 Planning Certificates

D4.6.1 General

Adoption of the *FRMS&P* and the associated draft Flood Policy will enable Council to provide advice on Planning Certificates under Section 149(2) of the Environmental Assessment and Planning Act 1979 as to whether the property is flood affected to the extent that Council applies development controls such as minimum floor levels (for properties within the Flood Planning Area - FPA). At present no such advice is provided by Council as the necessary flood data were not available prior to the completion of the Flood Study.

The *Guideline on Development Controls on Low Flood Risk Areas* issued by the NSW Department of Planning (DOP, 2007) notes that Councils should not include a notation for residential development on Section 149 Planning Certificates in low flood risk areas (areas outside the FPA) if no flood related development controls apply to that land. However, Council could include a notation for critical infrastructure or flood vulnerable development in low risk areas, but only if flood related development controls apply to such development. For example, it would be consistent with the *Guideline* to have flood related development controls and therefore Section 149 notation for land uses such as evacuation centres, hospitals, electricity sub-stations, nursing homes and aged persons accommodation located in flood prone land above the residential FPL.

D4.6.2 Suggested Wording for S149 Planning Certificates

The FDM, 2005 suggests wording on S149 (2) Planning Certificates along the following lines:

"Council considers the land in question to be within the Flood Planning Area and therefore subject to flood related development controls. Information relating to this flood risk may be obtained from Council. Restrictions on development in relation to flooding apply to this land as set out in Council's Flood Policy which is available for inspection at Council offices or website."

D4.7 Flood Policy for Young

The types of controls identified in the draft Flood Policy have been graded relative to the severity and frequency of potential floods, having regard to the location within the floodplain, the flood mechanism (Main Stream flooding or Major Overland Flow), as well as the type of land use proposed.

The draft Flood Policy is supported by the results of the Flood Study, which defined flood levels, flood extents and the hydraulic and hazard categorisation of the floodplain.

For land subject to Main Stream flooding, the FPA will be defined as land which lies below the peak 100 year ARI flood level plus 500 mm, while for land subject to Minor Tributary flooding, the FPA will be defined as land which will be inundated to depths greater than 150 mm during a 100 year ARI storm event. Within the extent of the FPA, the floodplain will be divided into the following three zones; **"High Hazard Floodway**"; **"Low Hazard Floodway and Flood Storage Areas"**; and the "**Intermediate Floodplain**". In an additional zone, which extends to the limit of inundation of the PMF (and is denoted the "**Outer Floodplain**"), flood related development controls will be imposed over critical utilities and infrastructure, as well as flood-vulnerable residential development.

For land subject to Major Overland Flow, the FPA will be defined on an allotment basis. Within the extent of the FPA, the floodplain will be divided in the following four zones; **"High Hazard Floodway"**; **"Low Hazard Floodway and Flood Storage Areas"**; and the "**Intermediate Floodplain"**. However, minimum floor levels of residential property will be set with 300 mm of freeboard on the 100 year ARI flood level (versus 500 mm for Main Stream flooding). Similar to areas affected by Main Stream flooding, an additional zone which extends to the limit of inundation of the PMF (also denoted the "**Outer Floodplain**") is proposed, with flood related development controls imposed over critical utilities and infrastructure, as well as flood-vulnerable residential development.

Figure A1.1, ***Flood Planning Map*** of **Appendix A** shows the extent of the Flood Planning Area, while **Figure A1.3**, ***Flood Hazard Map*** (also of **Appendix A**) shows the sub-division of the floodplain into flood hazard zones.

D5. SUMMARY AND REVISION OF LEP 2010

D5.1 Summary

This Appendix has been prepared for *The Town of Young Floodplain Risk Management Study and Plan* and deals with the following:

- The preparation of flood mapping to separately identify land subject to Main Stream flooding and areas subject to the shallower and slower moving flow associated with Major Overland Flow. The need for the sub-division of flood prone land into these two categories arises from recently developed practice which aims at minimising community concerns when land subject to Major Overland Flow (with the addition of the traditional 500 mm of freeboard) is subject to flood-related development controls and attracts a flood affection notice on Planning Certificates issued under Section 149 of the EP&A Act 1979.
- Data presented in **Table D3.1** show that a considerable reduction in the number of properties in Major Overland Flow areas classified as "flood affected" would result by the adoption of a threshold depth of inundation under 100 year ARI conditions of 150 mm as the criterion for flood affectation, compared with the traditional approach. Properties with depths of inundation 150 mm or greater, or in a floodway (i.e. traversed by significant overland flows) would be considered to be flood affected and lie within the Flood Planning Area. Properties with lesser depths of inundation under 100 year ARI conditions would be classified as "Local Drainage". This approach is supported by the FDM, 2005 and would not adversely impact on Council's duty of care in regard to management of flood prone lands. The proposed categorisation of the floodplain, terminology and controls are shown on **Table D5.1**.
- The ***Flood Planning Map*** supporting the approach recommended in this Appendix is shown on **Figure A1.1**, Sheets 1 and 2 in **Appendix A**.

TABLE D5.1
PROPOSED CATEGORISATION OF THE FLOODPLAIN

Category (FDM, 2005)	Proposed Terminology used to define inundation in FRMS&P report	Are Development Controls Required?	Is Section 149 Notification Warranted?
Main Stream Flooding	"Main Stream Flooding"	Yes	Yes
	"Minor Tributary Flooding"	Yes	Yes
Local Overland Flooding - Local Drainage - Major Drainage	"Local Drainage" "Major Overland Flow"	No (ref. footnote 1). Yes (ref. footnote 2).	No (ref footnote 1) Yes (ref footnote 3)

Footnotes

1. Inundation in Local Drainage areas is accommodated by the minimum floor level requirement of 150 mm above finished surface level contained in the BCA and does not warrant a flood affectation notice in S149 Planning Certificates.
2. These are the deeper flooded areas with higher flow velocities. Development controls are specified in the draft *Flood Policy* of **Appendix A**.
3. Depth and velocity of inundation in Major Overland Flow areas are sufficient to warrant flood affectation notice in S149 Planning Certificates. Inundation is classified as "flooding".

- Notations to be provided on flood mapping and S149 Planning Certificates. The recent practice also differentiates between Minor Tributary flooding and Major Overland Flow areas subject to deeper depths of inundation or traversed by significant flows (which should be subject to S149 flood affectation notification and flood related controls over future development) and the shallower inundated land on the fringe. In the latter case, inundation may be classified as "Local Drainage", with development subject to controls such as Council's stormwater management policies or BCA requirements, rather than attracting a flood affectation notice. Suggested wording for S149 Planning Certificates is presented in **Section D4.6**.
- Implementation of the approach recommended in the Appendix to recognising the variable flood hazard on the floodplain at Young will also require Council's amending clause 6.6 of LEP 2010. Suggested wording is presented in **Section D4.5.2**.

D5.2 Revision of LEP 2010 by Council

The steps involved in Council's amending LEP 2010 following the finalisation and adoption of the FRMS&P are:

- Council Planning Staff consider the conclusions of the FRMS&P and suggested amendments to LEP 2010.
- Council resolves to amend LEP 2010 in accordance with the FRMS&P.
- Council prepares a Planning Proposal in accordance with NSW Planning and Environment Guidelines. Planning Proposal submitted to NSW Planning and Environment in accordance with section 55 of the EP & A Act.
- Planning Proposal considered by NSW Planning and Environment and determination made in accordance with section 56(2) of the EP & A Act as follows:

  (a) whether the matter should proceed (with or without variation),

  (b) whether the matter should be resubmitted for any reason (including for further studies or other information, or for the revision of the planning proposal),

  (c) community consultation required before consideration is given to the making of the proposed instrument (the community consultation requirements),

  (e) any consultation required with State or Commonwealth public authorities that will or may be adversely affected by the proposed instrument,

  (e) whether a public hearing is to be held into the matter by the Planning Assessment Commission or other specified person or body,

  (f) the times within which the various stages of the procedure for the making of the proposed instrument are to be completed.

- Planning Proposal exhibited for public comment.
- Planning Proposal reviewed following public submissions and submissions from relevant State and Commonwealth authorities.
- Final Local Environmental Plan with proposed amendments drafted.
- Amending Local Environmental Plan made by the Minister and gazetted.

D6. REFERENCES

Bewsher et al (2010). ***"Mapping Overland Flowpaths – Good Practice or Political Suicide?"*** 50th Annual Floodplain Management Authorities Conference 2010.

Lyall and Associates Consulting Water Engineers (2014) ***"The Town of Young Flood Study"***.

New South Wales Government, 2005. ***"Floodplain Development Manual: the Management of Flood Liable Land"***.

The Institution of Engineers, Australia, (1998)**.** ***"Australian Rainfall and Runoff – A Guide to Flood Estimation"*****,** Volumes 1 and 2.

Young Shire Council, ***"Young Local Environmental Plan 2010"***.

Young Shire Council, ***"Minimum Building Requirements Policy, 2009"***.