Violet Town Flood Study

Study Report

Report No. J209/R02

Final

May 2007

WATER TECHNOLOGY
WATER, COASTAL & ENVIRONMENTAL CONSULTANTS

Michael Cawood and Associates

Coomes Consulting

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ACKNOWLEDGEMENTS

The Violet Town Flood Study has been prepared drawing on the support and contribution of number of groups and individuals. Without this support the study would not have so readily achieved its outcomes and delivered upon the study objectives.

Water Technology's study team acknowledges the contribution of the Community Reference Committee members:

Graeme Pollard	Strathbogie Shire Council
Guy Tierney	Goulburn Broken Catchment Management Authority
Cr. Robyn Machin	Deputy Mayor, Honeysuckle Ward
Tom Crocker	Local Resident
Reg Davis	Local Resident
Neil Garrett	Local Resident
Howard Myers	Local Resident

and numerous other local residents also contributed ancillary information and historical flood recollections through the Community Reference Committee that assisted in the flood model calibration.

GLOSSARY

AAD	Average Annual Damage
AEP	Annual Exceedance Probability: the likelihood of occurrence of a flood of given size or larger occurring in any one year. AEP is expressed as a percentage (%) risk and may be expressed as the reciprocal of ARI (Average Recurrence Interval).
AHD	Australian Height Datum: the adopted national height datum that generally relates to height above mean sea level. Elevation is in metres.
ARI	Average Recurrence Interval: the likelihood of occurrence, expressed in terms of the long-term average number of years, between flood events as large as or larger than the design flood event. For example, floods with a discharge as large as or larger than the 100-year ARI flood will occur on average once every 100 years.
BTE	Bureau of Transport and Economics
DHI	Danish Hydraulic Institute
DoI	Department of Infrastructure
DSE	Department of Sustainability and Environment
DTM	Digital Terrain Model
FO	Floodway Overlay
GBCMA	Goulburn Broken Catchment Management Authority
IFD	Intensity Frequency Duration
k_c	Variable used for RORB relating to storage characteristics of a catchment
LSIO	Land Subject to Inundation Overlay
m	Variable used for RORB relating to non-linearity of a catchment
MAR	Mean Average Rainfall
NRE	Natural Resources and Environment (predecessor to DSE)
PMF/PMP	Probable Maximum Flood/Probable Maximum Precipitation
RoC	Runoff Coefficient
RORB	Hydrologic model (Run Off Routing on Burroughs)
SSC	Strathbogie Shire Council
Study Team	Water Technology's study team
U/S	Upstream
UFZ	Urban Floodway Zone

EXECUTIVE SUMMARY

Violet Town has been subject to flooding on a number of occasions causing significant inundation of the township resulting in evacuations, property damage, road closures and associated hardship to the local community.

Strathbogie Shire Council and the Goulburn Broken Catchment Management Authority commissioned Water Technology to undertaken a risk based flood analysis of Violet Town to more precisely determine the flood risks in Violet Town.

The Violet Town Flood Study investigated the flood behaviour of Honeysuckle and Long Gully Creeks within the township of Violet Town, in four major stages; hydrology, hydraulics, existing flood risk assessment, and preliminary mitigation options risk assessment. Key findings of these four stages are summarised below.

Hydrologic Analysis

Design flood hydrographs were calculated for the 10, 20, 50, 100, 200 and 500-year ARI floods as well as the Probable Maximum Flood (PMF). Hydrographs were calculated for Honeysuckle Creek (upstream of the Hume Highway), Long Gully Creek (upstream of the Hume Highway), and for two small sub catchments upstream of the Hume Freeway.

The catchment hydrologic model, RORB, was the principal tool for the design flood hydrograph estimation. The RORB model is an event based conceptual runoff routing model in which rainfall is routed through a network of lumped storages to the catchment outlet.

A RORB model was constructed for the Honeysuckle Creek catchment upstream of the Hume Highway. A second detailed RORB model was constructed for the Long Gully Creek catchment.

Various hydrological methodologies have been employed in order to gain some guidance on the expected magnitudes of the design flows at Violet Town. The October 1993 flood in Honeysuckle and Long Gully Creeks was considered representative of a 100-year ARI flood.

The RORB model parameters used for the estimation of design flows were developed by scaling the RORB models parameters adopted in previous flood studies at Euroa. The adopted model parameters are considered to be broadly representative of the catchment characteristics and regional setting of catchments located in the northwestern slopes of the Strathbogie Ranges.

A regional prediction equation was used to estimate the PMF, this method provides an approximation of the PMF.

Table 1 shows the design peak flows determined at Violet Town.

Table 1 - Design Peak Flows at Violet Town

Location	Design Peak Flow (m^3/s)						
	10-year ARI	20-year ARI	50-year ARI	100-year ARI	200-year ARI	500-year ARI	PMF
Honeysuckle Creek U/S Hume Highway	65	79	97	113	129	152	1,598
Wodonga-bound on-ramp Culvert	7	9	11	12	14	17	198
Long Gully Creek	14	17	22	25	30	36	397
SubCatchment U/S Balmattum Road	0.8	1.0	1.4	1.7	1.9	2.3	16

Hydraulic Analysis

MIKEFLOOD was the principal tool for the hydraulic analysis, it is a two-dimensional unsteady hydraulic model. MIKEFLOOD is a state of the art tool for floodplain modelling that has been formed by the dynamic coupling of DHI's well proven MIKE 11 river modelling and MIKE 21 fully two-dimensional modelling systems.

The MIKEFLOOD model parameters were determined through calibration of the modelled flood levels with observed flood levels with estimated historical inflow flood hydrographs as input. Calibration was carried out using the October 1993 flood. The results of the calibration showed that the model predicted flood levels generally within 150 mm of the observed levels and no systematic errors in modelled flood levels occurred across the study area. This is considered quite a reasonable degree of agreement considering the uncertainty inherent in a number of the model inputs and the recorded peak flood levels.

Once calibrated the MIKEFLOOD model was applied to estimate design flood levels with design inflow hydrographs as input.

Hydraulic analysis shows that the railway line embankment through Violet Town imposes a significant obstruction to the passage of flood flows through the town. Flood flows are forced to pass through a limited number of openings in the embankment causing extensive ponding of floodwaters on the upstream side during large floods.

The existing levee on the right bank of Long Gully upstream of Balmattun Road limits the breakout from Long Gully in this reach. Local runoff from the upslope catchment is directed by the levee through culverts under the Hume Freeway to the north of the Long Gully crossing. This flowpath continues in a north west direction towards Murray and Meakin Streets.

A quantitative assessment of the Long Gully levee influence on flood behaviour is warranted. Such quantitative assessment would underpin consideration of management arrangements for the levee.

Existing Flood Risk Assessment

A flood damages assessment was undertaken for the study area under existing (2006) conditions. The flood damages assessment determined the monetary flood damages for design floods. The Average Annual Damage (AAD) was also determined as part of the flood damage assessment.

The flood damage assessment was based on the RAM (NRE, 2000) and current best practice. The Bureau of Transport Economics report '*Economic Costs of Natural Disasters in Australia'* (BTE, 2001), provides an excellent source of information regarding methodology and cost estimates for flood damage assessments.

The flood damage assessment first estimated costs associated with direct flood damage (e.g. structural building, contents, external property, and infrastructure damage), then considered the costs associated with indirect flood impacts (e.g. emergency services, clean-up costs, alternative accommodation costs).

The flood damages assessment for existing conditions showed that a 100-year ARI design flood results in a total flood damage of approximately $1,761,000. The AAD is a measure of the flood damage per year averaged over an extended period, and was calculated to be approximately $121,000.

Mitigation Measures Assessment

Two structural mitigation options were selected for analysis in the hydraulic model based on discussions with the project steering committee. The analysis of these options is considered preliminary but provides a basis from which a comprehensive floodplain management study could be undertaken considering the full range of mitigation options available at Violet Town.

The study team recommends Strathbogie Shire Council (SSC) and Goulburn Broken Catchment Management Authority (GBCMA) apply for funding to undertake a floodplain management plan for Violet Town.

The preliminary mitigation options comprised the following main components:

Option 1 – Construction of a levee(s) and uni-directional gate structures to prevent flows breaking out of Honeysuckle Creek and impacting properties in Violet Town.

Option 2 – The enlargement and straightening of the Long Gully Creek channel below High Street and enlargement of the cross sectional area available through the Long Gully Creek railway culvert.

Table 2 displays a comparison of the property inundation statistics compared to existing conditions for the two flood mitigation options modelled. These comparisons relate only to non-vacant properties, ie, those properties with an existing residential or commercial building.

Table 2 Comparison of Non-vacant Properties Subject to Inundation Statistics

Item	100-year ARI Flood		
	Existing Conditions	Option 1	Option 2
Flooded Above Floor Level	63	31	58
Some Inundation on Property	103	108	103
Total Number Subject to Inundation.	161	139	161

Land Use Planning

Flood related zone and overlay delineation option maps have been generated to assist GBCMA in the definition of LSIO, FO and UFZ. The delineation option maps overlay the three FO and UFZ extents previously determined. These maps have been prepared using the hydraulic analysis for existing conditions.

From these delineation option maps, GBCMA has developed the planning maps in accordance with the Victoria Planning Provisions Practice Notes – Applying the Flood Provisions in Planning Scheme (DoI 2000).

The study team recommends the SSC and GBCMA liaise in the preparation and adoption of a planning scheme amendment to enable the draft flood related planning zone and overlays.

Further, the study team recommends GBCMA declares the 100-year ARI flood level for planning purposes under the Water Act (1989).

Flood Warning and Response

Due to the relatively small and steep nature of the Honeysuckle Creek and Long Gully catchment, the lead time for flood warning is less than 6 hours. Under the Bureau of Meteorology definition such a lead time is considered flash flooding and effective flood forecasting and warning is limited.

The study team recommends the SSC and GBCMA liaise to consider feasible flood warning arrangements, given the nature of the contributing catchments.

The study team recommends the SSC and GBCMA develop suitable community flood awareness for the residents of Violet Town.

The study team recommends a full revision of the MEMP Flood Sub-Plan to ensure the incorporation of the flood inundation maps developed by this study.

The study team recommends the siting of an additional gauge board at the Baird Street gauge to extend the gauge to at least 4.5 m.

Recommendations

Recommendation	Priority	Indicative cost (ex GST)
SSC and GBCMA liaise in the preparation and adoption of a planning scheme amendment to enable the draft flood related planning zone and overlays.	**High**	**$2,000**
GBCMA declares the 100-year ARI flood levels for planning and building purposes under the Water Act (1989).	**High**	**$1,000**
SSC liaise with GBCMA to site an additional gauge board at the Baird Street to extend the gauge to at least 4.5 m.	**Medium**	**$1,500**
SCC liaise with GBCMA to prepare a funding bid to State and Australian Governments for the development of a Floodplain Management Plan	**High**	**$2,000**
SSC and GBCMA liaise in the preparation of a Floodplain Management Plan including the following elements: - Preparation of Water Management Scheme or similar: This requires the assessment of mitigation measures, community consultation and assessment of the existing Long Gully levee. - Investigate and develop possible flood warning arrangements for Violet Town including flood monitoring procedures for the Hayes Road and Baird Street gauges. - Revision of MEMP Flood sub-plan - Development of community flood awareness material	**High**	**$75,000**

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1 INTRODUCTION

Water Technology was commissioned by the Goulburn Broken Catchment Management Authority in association with the Strathbogie Shire Council to undertake a flood study of Violet Town. Michael Cawood and Associates undertook an expert review of the technical aspects of the project, with Timcke & McIntosh Surveyors, and Coomes Consulting conducted the field survey components.

The objectives of the Violet Town Flood Study include:

- Involvement of a community reference committee to assist with the understanding of flooding behaviour in Violet Town and its surrounds.
- Furthering the community education process and elevating community awareness of flooding issues.
- Sound and comprehensive hydrological and hydraulic analyses/modelling of Honeysuckle Creek and Long Gully Creek.
- Compilation of flood maps and a range of flood related products to assist in the management of the Honeysuckle Creek and Long Gully Creek floodplain.
- Preparation of a detailed Flood Damage Assessment.
- Production of a Flood Forecasting Correlations between appropriate gauge heights and flooding extents including affected properties and critical access points.
- Preliminary assessment and documentation of structural mitigation options identified in the scoping study using the hydraulic and damage models.
- Development of flood related planning overlays.
- Review of flood warning and response guidelines in light of the study outcomes.

The structure of this report is as follows:

- Section 2 – discusses the main catchment features
- Section 3 – outlines the input data gathered for use in the study
- Section 4 – details the hydrologic analysis
- Section 5 – details the hydraulic model development and calibration
- Section 6 – summarises the outcomes of the flood damage assessment
- Section 7 – outlines the findings of the preliminary mitigation measures assessment
- Section 8 – discusses the preparation of flood inundation for flood response
- Section 9 – details the development of flood mapping for land use planning
- Section 10 – discusses the review of the current flood warning and response arrangements.
- Section 11 – summarises the key study findings and recommendations.
- Appendix A – RORB model data files
- Appendix B – Flood affected property listings

2 STUDY AREA AND CATCHMENT DESCRIPTION

2.1 Overview

Violet Town is located on the foothills of the Strathbogie Ranges, approximately 180 kilometres north of Melbourne between Seymour and Benalla, adjacent to the Hume Highway. Violet Town has a population of approximately 800 and an expected annual growth rate of 1% per annum.

Two watercourses, Honeysuckle Creek and Long Gully Creek flow through Violet Town. Honeysuckle Creek flows through Violet Town before its confluence with Seven Creeks (some 40 kilometres downstream of Violet Town). Honeysuckle Creek to Violet Town has a catchment area of approximately 59.4 km^2. The Honeysuckle Creek catchment varies in elevation from greater than 600 m AHD in the Strathbogie Ranges to approximately only 185 m AHD at Violet Town. A lesser waterway, Long Gully Creek, flows past the south western edge of the township. Long Gully Creek has a catchment area to Violet Town of approximately 11 km^2. Figure 2-1 displays the contributing catchments of Honeysuckle and Long Gully Creeks to Violet Town.

Goulburn Valley Water has recently decommissioned (November 2005) a small water supply reservoir on Honeysuckle Creek upstream of Violet Town. A preliminary investigation into the impact of the decommissioning concluded that appropriate decommissioning of the reservoir would result in negligible impacts on flooding characteristics, both peak flow and total flood volume, at Violet Town (ID&A, 1999). A review of the conclusions reported by ID&A was supported in the flood scoping study (GeoEng, 2002).

A number of significant floods have been experienced at Violet Town including the 1916, 1974, 1993 and 1999 floods. Following community concern relating to the flooding in Violet Town a scoping flood study was commissioned by the Strathbogie Shire Council. The flood scoping study (GeoEng, 2002) determined the nature of flooding and source of all possible relevant flood related information.

This current flood study will build on the information collected from the scoping study, and undertake a risk based analysis to more precisely determine the flood risks in Violet Town.

2.2 Waterway and Floodplain Features

Honeysuckle Creek flows through the town along a well defined channel. It is understood significant straightening of Honeysuckle Creek through Violet Town occurred up until the late 1960's, presumably in an attempt to improve conveyance and reduce flooding.

Long Gully Creek has a small incised channel with an ill defined floodplain. The capacity of Long Gully Creek significantly reduces downstream of High Street. Downstream of the railway crossing a natural channel system no longer exists and flows from Long Gully Creek are incorporated into a small cut drain to divert flows around properties on the outskirts of Violet Town.

The following sections provide a brief discussion of the key natural and artificial features affecting the behaviour of flood flows through Violet Town.

Figure 2-33 shows the location of key waterway and floodplain features.

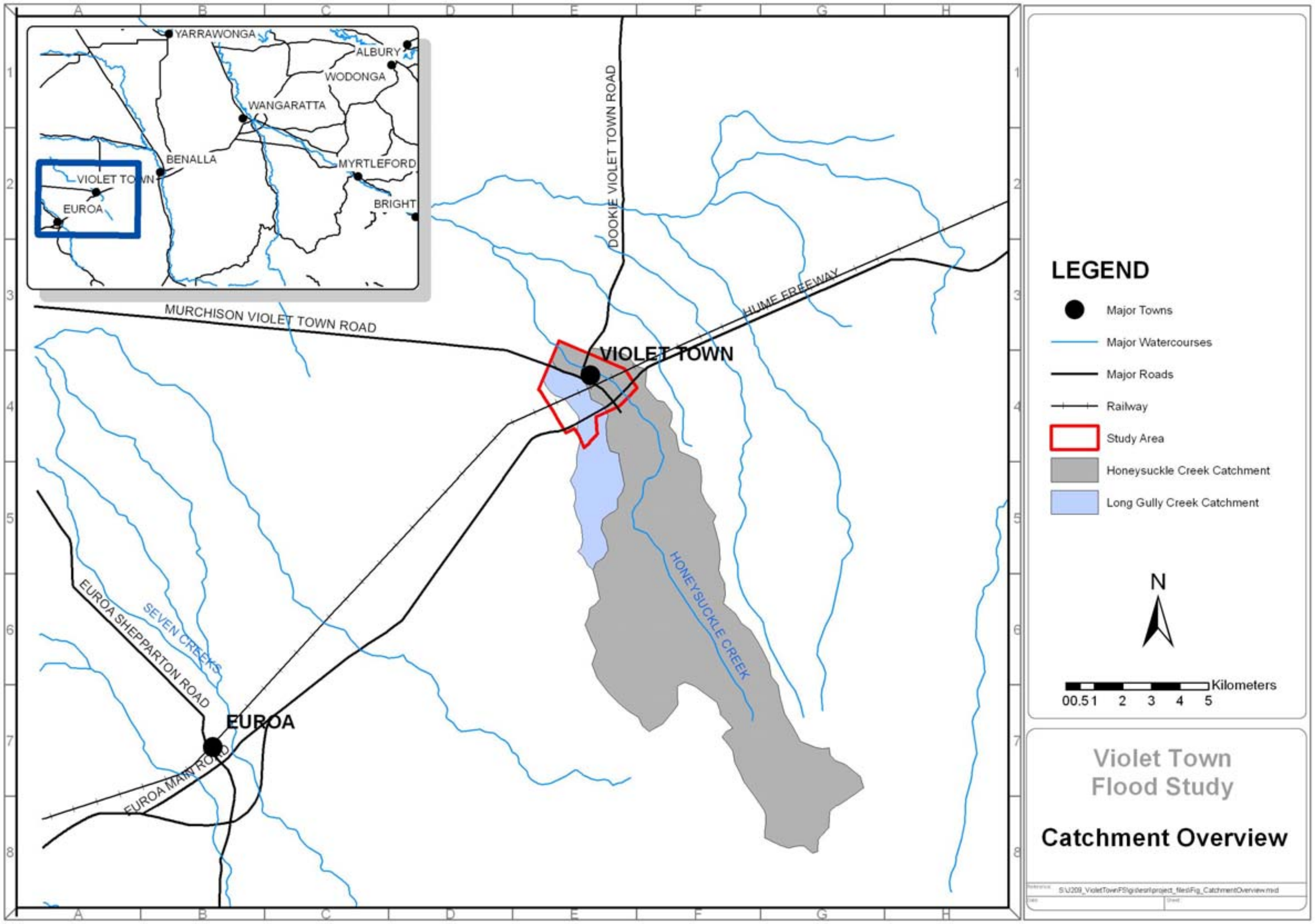

Figure 2-1 Catchment Overview

2.2.1 Hume Freeway

The Hume Freeway was duplicated in the late 1970's/early 1980's. The Hume Freeway crosses both Honeysuckle Creek and Long Gully Creek. The Honeysuckle Creek crossing comprises two separate bridge crossings of the Melbourne and Wodonga-bound on-ramp bound carriageways. The main Long Gully Creek crossing comprises two 3 metre wide by 2.4 metre high box culverts.

A secondary culvert crossing exists approximately 200 metres to the north east of the main Long Gully crossing. These culverts pass flood flows from a small subcatchment of Long Gully Creek upstream of Balmattum Road. Two table drains occur either side of the Hume Freeway, running from the secondary culverts back to the main Long Gully crossing. Presumably these drains were constructed to reduce flows escaping overland and impacting Violet Town. There is evidence in the VicRoads aerial photography taken after the 1993 flood of overland flow emanating from these culverts and impacting Violet Town. The VicRoads aerial photography is displayed in Figure 2-2.

An additional culvert crossing of the Hume Freeway exists through the Benalla side of the Violet Town interchange. These culverts pass flows originating from a small sub catchment adjacent to the Honeysuckle Creek catchment. On the northern side of the Hume Freeway, flows exiting these culverts and flow overland across a slight depression ending near the intersection of Murchison-Violet Town Road and High Street. Flows through these culverts can be seen impacting properties in Violet Town in the VicRoads aerial photography taken after the 1993 flood in Figure 2-2.

The locations of the waterway crossings of the Hume Freeway are indicated in Figure 2-3.

2.2.2 Railway Line

The main north eastern railway line passes through Violet Town, effectively splitting the town in half along a southwest to northeast axis. The associated embankment produces a significant obstruction to the passage of flood flows through the town. This has been illustrated by the development of a long section of the railway embankment compared to the natural surface topography through Violet Town presented in Figure 2-4. Flood flows are forced to pass through a limited number of openings in the embankment causing extensive ponding of floodwaters on the upstream side during large flood events. The waterway openings through the railway embankment are located in Figure 2-3 and are detailed below:

- Honeysuckle Creek Bridge – Large waterway opening, approximately 50 metres wide, with two sets of 3 piers, 10 metres apart.
- Long Gully Creek Bridge - Clear Span opening, approximately 6 metres wide.
- A 1.2 metre diameter pipe located 100 metres northeast of Cowslip Street, which replaced a bridge structure associated with the construction of the standard gauge railway in the early 1960's. A lidded pit with trash racks now controls the entry of flows into the pipe structure.
- A 0.9 metre diameter pipe located 160 metres northeast of the Long Gully Creek culvert. The pipe is in two sections with an entry pit located between the siding and the main line.

2.2.3 Drainage

A number of significant roadside table drains and other drainage channels occur in the vicinity of Violet Town that may influence the behaviour of broad scale flood flows. In particular, a number of drains exist between the southern edge of Violet Town and the Hume

Freeway. These drains appear to have been constructed to reduce nuisance flooding and water logging originating from local runoff and possibly some overland flooding emanating from the two smaller culvert crossings of the Hume Freeway. The small capacity and informal nature of the drains does however to some extent reduce their influence on larger flood flows.

The natural Long Gully Creek channel has been replaced by a cut drain through Violet Town, presumable to divert flood waters around adjacent properties. The small physical dimensions and lack of apparent maintenance would however limit the ability of this channel to convey all but the most minor flows from Long Gully creek.

The location of the major roadside table drains and other drains are indicated in Figure 2-3.

2.2.4 Long Gully Creek Levee

An informal levee exists along Long Gully Creek upstream of Balmattum Road as indicated in Figure 2–3. The levee would appear to have been constructed to prevent flows in Long Gully Creek breaking away across an overland flow path to the north where they can impact Violet Town. Local Long Gully resident Mr Tom Crocker advised that his recollection was that a smaller levee was originally built around the time of the 1916 flood. The existing levee was subsequently built by the council sometime during the wet years of 1955-56. The levee is considered to be in a reasonable condition considering it has been exposed to stock and no apparent maintenance has been undertaken for some time. Headward erosion (process of creek bed deepening) of Long Gully Creek originating from Balmattum Road is threatening to undermine the levee.

Continued deterioration of the levee and its foundations could allow significantly greater flows to breakaway from Long Gully Creek to the neighbouring subcatchment (refer to Figure 2–3) during large floods in the future. The location of the levee is indicated in Figure 2-3.

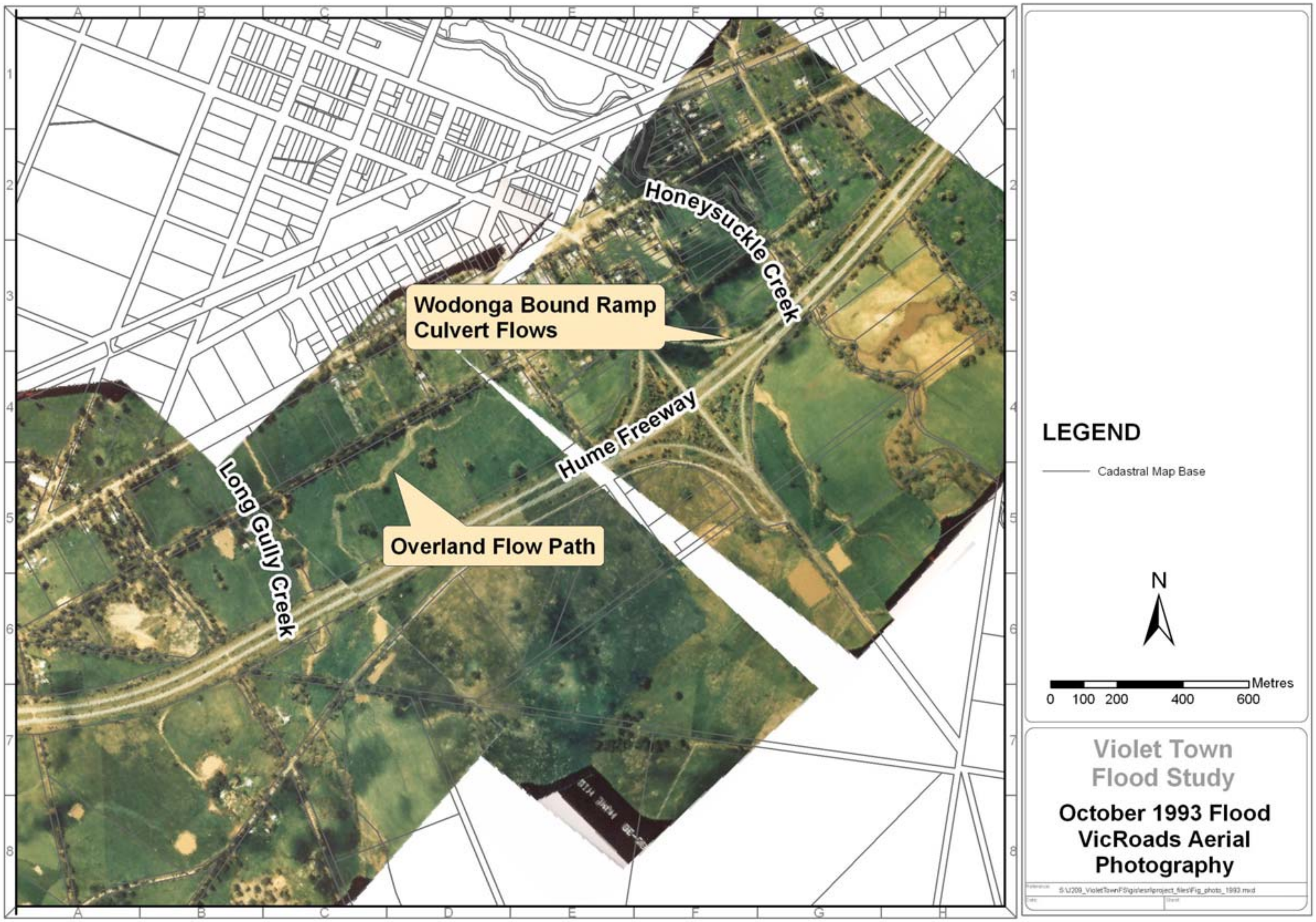

Figure 2-2 October 1993 Flood VicRoads Aerial Photography (Photography taken 6-12 hours after flood peak)

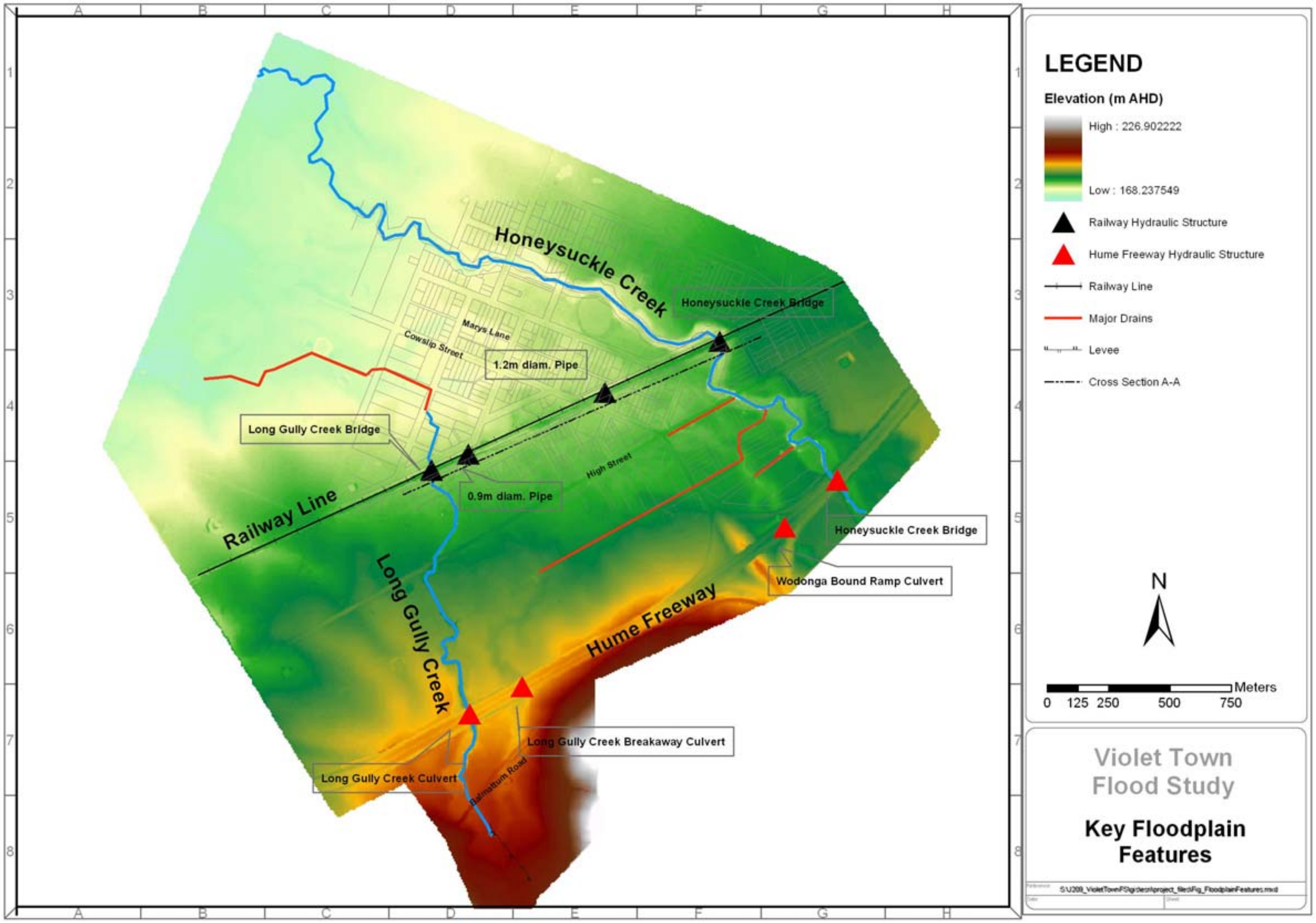

Figure 2-3 Key Waterway and Floodplain Features

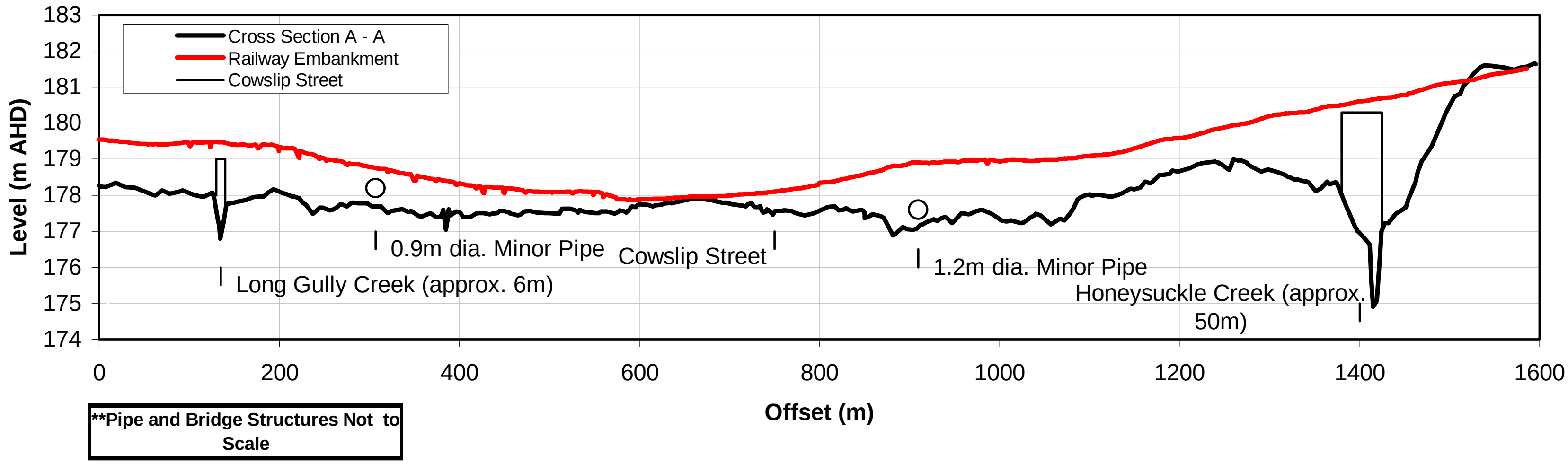

Figure 2-4 Section A-A and Railway Embankment

3 AVAILABLE INFORMATION

3.1 Previous Studies

Previous studies relevant to the flood study include:

- GeoEng 2002, *Violet Town Flood Scoping Study – Final Report,* Report prepared for Strathbogie Shire Council, September 2002.
- SKM 2002, *Shepparton Mooroopna Floodplain Management Study – Stage 1 Technical Report,* Report prepared for Greater Shepparton City Council and Goulburn Broken Catchment Management Authority.
- SKM 1997, *Euroa Floodplain Management Study – Final Report*, Report prepared for Shire of Strathbogie

These resources have been reviewed and drawn upon as necessary to provide background, context and verification of the current study approach and outcomes.

3.2 Hydrologic Data

3.2.1 Streamflow Data

Streamflow gauges within the catchment area are displayed Figure 3-1 and detailed below in Table 3-1.

Table 3-1 Details of Streamflow Gauges

<table>
<tr><th>Station No.</th><th>Station Name</th><th>Period of Record</th></tr>
<tr><td>405294A</td><td>Honeysuckle Ck U/S of Violet Town</td><td>1989 – Present (some gaps)</td></tr>
<tr><td>405247A</td><td>Stony Ck at Tamleugh</td><td>1970 – 1993</td></tr>
<tr><td>NA</td><td>Hayes Road</td><td rowspan="2">Flood level only, Period of data unknown
(No flow data)</td></tr>
<tr><td>NA</td><td>Baird Street</td></tr>
</table>

3.2.2 Rainfall Data

Two pluviographic rainfall station (405294A) lies within or adjacent to the catchment upstream of Violet Town. In addition, a number of daily rainfall gauges exist within or close to the Honeysuckle Creek Catchment

Table 3-2 shows the rainfall stations employed in this study.

Table 3-2 Details of Rainfall Stations

Station No.	Type	Station Name	Period of Record
405294A	Pluviographic	Honeysuckle Ck U/S of Violet Town	1993 – Present (some gaps)
82042	Daily/Pluviographic	Strathbogie	1902 – Present (Daily)
82043	Daily	Strathbogie	1879 – Present
82049	Daily	Violet Town	1883 – Present

3.3 Topographic Data

There have been two major sources of topographic data utilised during the course of the investigation, these being:

- Aerial Photogrammetry
- Field Survey

Following the collection and processing of the topographic information, a detailed Digital Terrain Model (DTM) was developed as the basis for the establishment of a hydraulic model of the study area (Refer to Section 5). The sources of the topographic information are discussed in more detail below.

3.3.1 Aerial Photogrammetry

Low level aerial photogrammetry of Violet Town and the immediate surrounds was undertaken as by QASCO in 2002. The photogrammetry consisted of a 10 metre grid of spot elevations and breaklines defining linear features in the topography.

3.3.2 Field Survey

Additional field survey, primarily of culvert/bridge structure details around Violet Town, was conducted by Timcke & McIntosh surveyors.

Property survey including floor level and building type, was conducted by Coomes Consulting.

Strathbogie Shire Council surveyors levelled the Baird Street gauge to AHD.

Honeysuckle Creek cross-sections were provided by GBCMA.

Some additional stormwater pipe and pit entry details were provided by EarthTech.

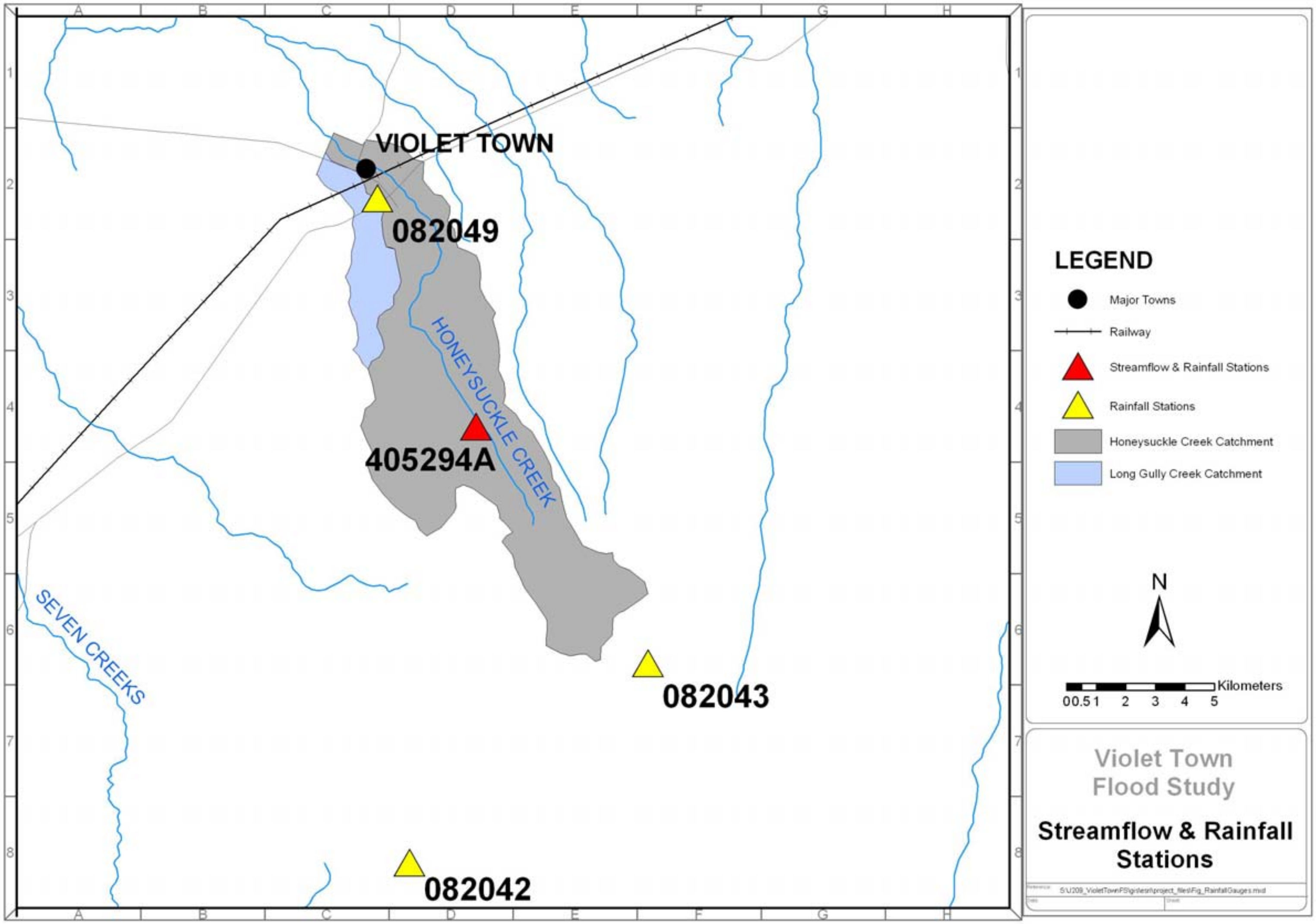

Figure 3-1 Streamflow and Rainfall Stations

4 HYDROLOGIC ANALYSIS

4.1 Approach

Design flood hydrographs were required for the 10, 20, 50, 100 and 500-year ARI flood events and the Probable Maximum Flood (PMF) for Honeysuckle Creek and Long Gully Creek.

The catchment hydrologic model, RORB, was the principal tool employed for the design flood hydrograph estimation. The RORB model is an event based conceptual runoff routing model. RORB routes surface runoff through a network of lumped storages to the catchment outlet.

Development and calibration of the RORB model is discussed in Sections 4.2 and 4.3. The use of RORB model for design flood estimation is outlined in Sections 4.4 and 4.5.

In addition to the RORB model, a range of alternate methodologies for estimating design flows at Violet Town have also been employed. This allowed a comparison with the design flows generated from the RORB model to be made. These comparisons highlighted the degree of uncertainty that exists in defining appropriate design flows at Violet Town. The design flood estimates obtained from the range of alternative flood estimation methodologies are outlined in Section 4.6.

As discussed in Section 2, a significant flood event occurred in 1993 and a large amount of observed flood data in Violet Town is available for this event. However no formal streamflow data for either Honeysuckle or Long Gully Creeks was available for the October 1993 flood. A peak flow estimate for Honeysuckle Creek through the railway bridge is available (GeoEng 2002). This peak flow estimate provided some guidance in the verification of the hydrologic analysis.

The October 1993 was selected as the calibration event for the hydraulic analysis (Refer to Section 5.3). The comparison of the simulated October 1993 flood with the observed flood data as part of hydraulic analysis allowed some further refinement of the October 1993 flow estimates.

Following on from the comparison of the various flood estimation methodologies and hydraulic analysis of the October 1993 flood, the study team in consultation with the Community Reference Committee adopted the October 1993 flow estimates as representative of a 100-year ARI flood at Violet Town. Further discussion on the rationale behind the adoption of the October 1993 flood as representative of a 100-year ARI flood at Violet Town is presented in Section 4.7.

4.2 RORB Model Development

4.2.1 Background

The runoff-routing model RORB, developed by Laurenson, Mein and Nathan (2005) was used to estimate the design flood hydrographs. RORB is a general runoff and streamflow routing program that calculates flood hydrographs from rainfall and other catchment characteristics. The model subtracts losses from rainfall to determine surface runoff which is then routed through a network of storages to produce flood hydrographs at points of interest. RORB is an areally distributed, non-linear model that is applicable to both urban and rural catchments. The model can account for both temporal and spatial distribution of rainfall and losses.

The model is based on catchment geometry and topographic data. RORB has two principal parameters, k_C and m. The parameter m describes the degree of non-linearity of the catchment's response to rainfall, while the parameter k_C describes the storage available within the catchment. The rainfall loss parameters relate to the conversion of rainfall into surface runoff. The RORB model can represent these losses either by the initial loss/continuing loss model, or by the initial loss/volumetric runoff coefficient model. The catchment is subdivided into sub-areas based on topographical features. This catchment sub-division allows for spatial variation of catchment characteristics and rainfall inputs.

4.2.2 Honeysuckle Creek Catchment

A RORB model of the Honeysuckle Creek catchment to downstream of Violet Town was developed by dividing the catchment into a number of sub areas based on the topography and drainage characteristics of the catchment. For design flood estimation purposes all reach types within the catchment were assumed to be natural.

At the Hume Freeway, a small subcatchment of the Honeysuckle Creek catchment passes through a separate set of culverts located through the Wodonga-bound on-ramp. Separate flood hydrographs have therefore been output upstream of these culverts.

Figure 4-1 displays the catchment delineation and sub area division and stream network of the RORB model.

Appendix A contains the RORB model catchment files.

4.2.3 Long Gully Creek Catchment

A RORB model of the Long Gully Creek catchment to downstream of Violet Town was developed by dividing the catchment into a number of sub areas based on the topography and drainage characteristics of the catchment. For design flood estimation purposes all reach types within the catchment were assumed to be natural.

Upstream of Balmattum Road, a small subcatchment of Long Gully Creek catchment passes through two small culverts under Balmattum Road before passing through a separate set of culverts on the Hume Freeway. Separate flood hydrographs have therefore been output upstream of Balmattum Road for this subcatchment.

Figure 4-2 displays the catchment delineation and sub area division and stream network of the RORB model.

Appendix A contains the RORB model catchment files.

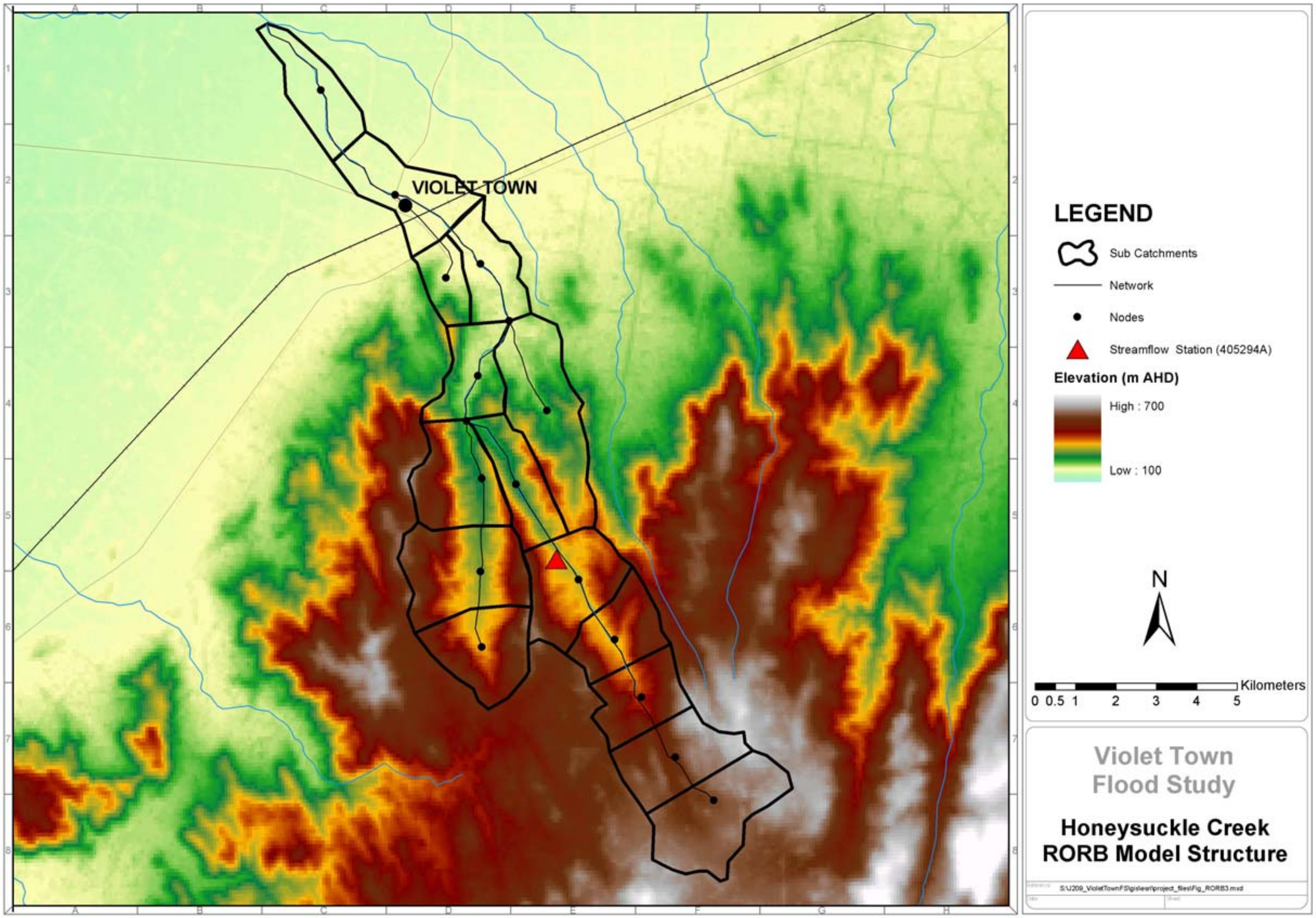

Figure 4-1 Honeysuckle Creek RORB Model Structure

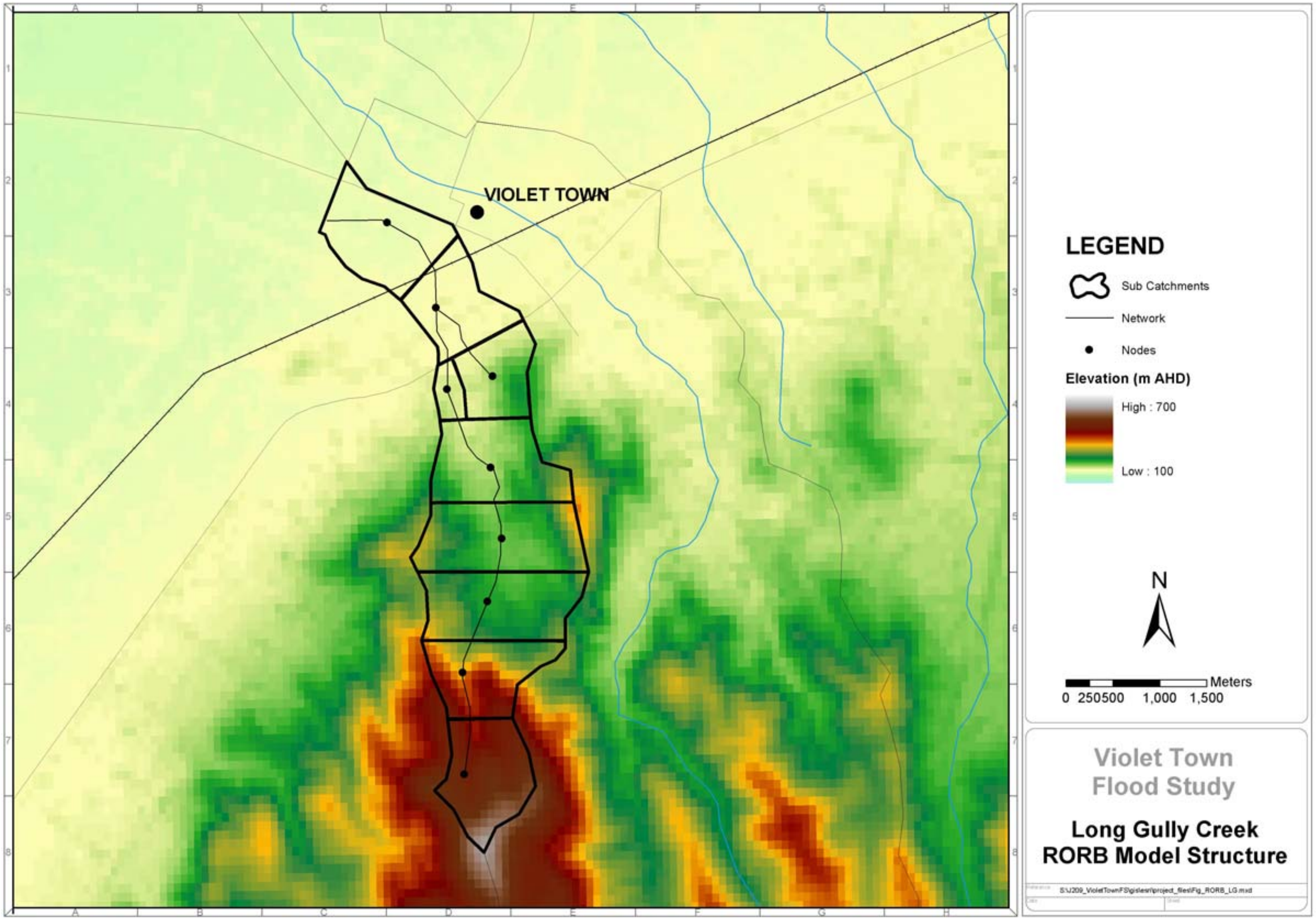

Figure 4-2 Long Gully Creek RORB Model Structure

4.3 RORB Model Calibration

4.3.1 Approach

The RORB model calibration ideally requires the comparison of the modelled flood hydrographs with observed flood hydrographs at streamflow gauge(s) throughout the catchment. One appropriate streamflow gauge exists on the upper catchment of Honeysuckle Creek (405294A), with an approximate catchment area of 25 km^2 to the gauge. A streamflow gauge downstream of Violet Town on Stony Creek does also exist however its catchment area is approximately 6 times larger than the Honeysuckle Creek catchment to Violet Town. Much of the catchment is also topographically dissimilar to the catchment upstream of Violet Town. The parameters derived through the calibration of the RORB model to this gauge are considered unlikely to provide representative parameters for design flood estimates at Violet Town. As a result the RORB model calibration was undertaken to the Honeysuckle Creek gauge (405294A).

For the Long Gully Creek catchment no suitable observed streamflow data is available for the RORB model calibration. As such, the RORB model parameters were estimated using regional estimates.

4.3.2 Honeysuckle Creek RORB Model Calibration Events

RORB model calibration is preferably undertaken with historical floods of a similar magnitude to those being developed for design flood estimation. This is to ensure the calibrated RORB model parameters correctly reproduce the catchment response to rainfall for the range of design flood magnitudes being considered.

The selection of suitable historical flood events for the RORB model calibration is, however, also dependent on the availability of concurrent streamflow and pluviographic rainfall data. As the Honeysuckle Creek streamflow gauge (405294A) only has approximately 16 years of record, a limited number of appropriate historical calibration flood events were available. Unfortunately the record for the October 1993 flood, the most recent large flood experienced in Violet Town, was incomplete and could therefore not be used for calibration purposes.

Following a review of the streamflow and pluviographic records, the three most suitable historical flood events for the RORB model calibration with concurrent pluviographic records were determined and are listed in Table 4-1.

Table 4-1 Honeysuckle Creek RORB Model Calibration Events

Event	Event Start & Finish Date	Honeysuckle Creek U/S Violet Town (405294A)
		Recorded Peak flow (m^3/s)
September 1996	28/09/1996 19:30 – 01/10/1996 23:30	6.8
September 1998	22/09/1998 16:00 – 26/09/1998 13:00	8.5
October 2000	23/10/2000 6:00 – 30/10/2000 00:00	4.8

The flood events in Table 4-1 rank among the highest flood events in the available record. However, missing data for October 1993 compromises the integrity of the streamflow data. The magnitude of the floods used for the calibration is considered relatively small.

Spatial rainfall pattern for RORB model calibration events

Given the relative small size of the Honeysuckle Creek catchment to the streamflow gauge, the adoption of a uniform spatial rainfall pattern based on the Honeysuckle Creek rainfall record (405294A) was considered appropriate for all calibration floods.

Baseflow separation

Examination of the streamflow record at the Honeysuckle Creek gauge showed that only a very minor component of baseflow is present in the record. The component of baseflow in the record is not considered significant compared to the magnitude of the surface flow hydrographs being modelled. The recorded hydrographs have therefore not been modified before comparison with the RORB model surface runoff hydrographs.

4.3.3 Honeysuckle Creek RORB Model Parameter Calibration

There are two RORB model parameters (k_C & m) requiring calibration. The calibration approach adopted by this study was as follows:

- Set m = 0.8. This value is an acceptable value for the degree of non-linearity of catchment response (ARR87).
- For each calibration event the initial loss was determined to result in a reasonable match between the modelled and observed rising limb of the flood hydrograph.
- The runoff co-efficient type and value was determined to provide the closest match between the modelled and observed runoff volume.
- For each calibration event k_C values were trialled to achieve reasonable re-production of the peak flow and general hydrograph shape, with particular attention to the hydrograph recession.

A summary of calibration results are provided in Table 4-2.

Table 4-2 RORB Model Calibration Events- Calibrated Model Parameters

Event	k_C value	Honeysuckle Creek at U/S Violet Town (405294A)			
		Rainfall loss parameters		Peak flow	
		IL* (mm)	RoC**	Observed (m^3/s)	Modelled (m^3/s)
September 1996	19	10	0.38	6.8	5.9
September 1998	26	12	0.31	7.7	7.6
October 2000	35	12	0.34	4.7	5.4

*Initial Loss, **Runoff Coefficient

During the calibration the runoff coefficient loss model was found to achieve a significantly better calibration result than the continuing loss model.

Figure 4-3 to Figure 4-5 display the modelled and observed flood hydrographs and rainfall excess for the RORB model calibration events.

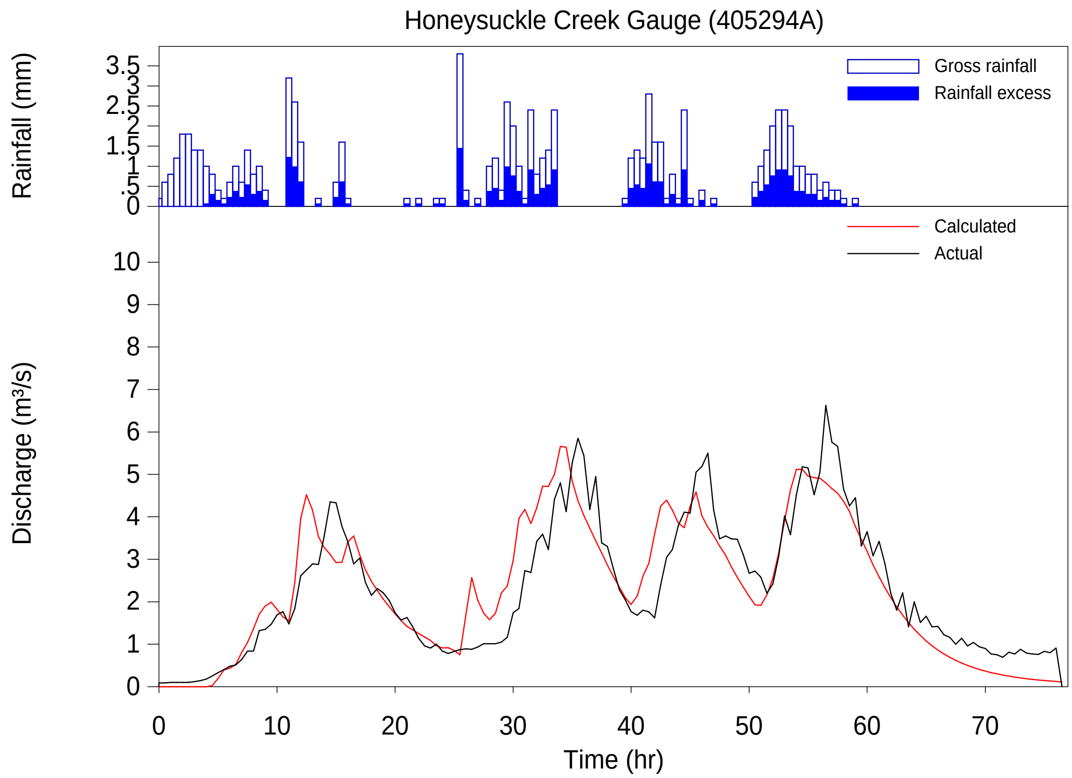

Figure 4-3 RORB Calibration – September 1996

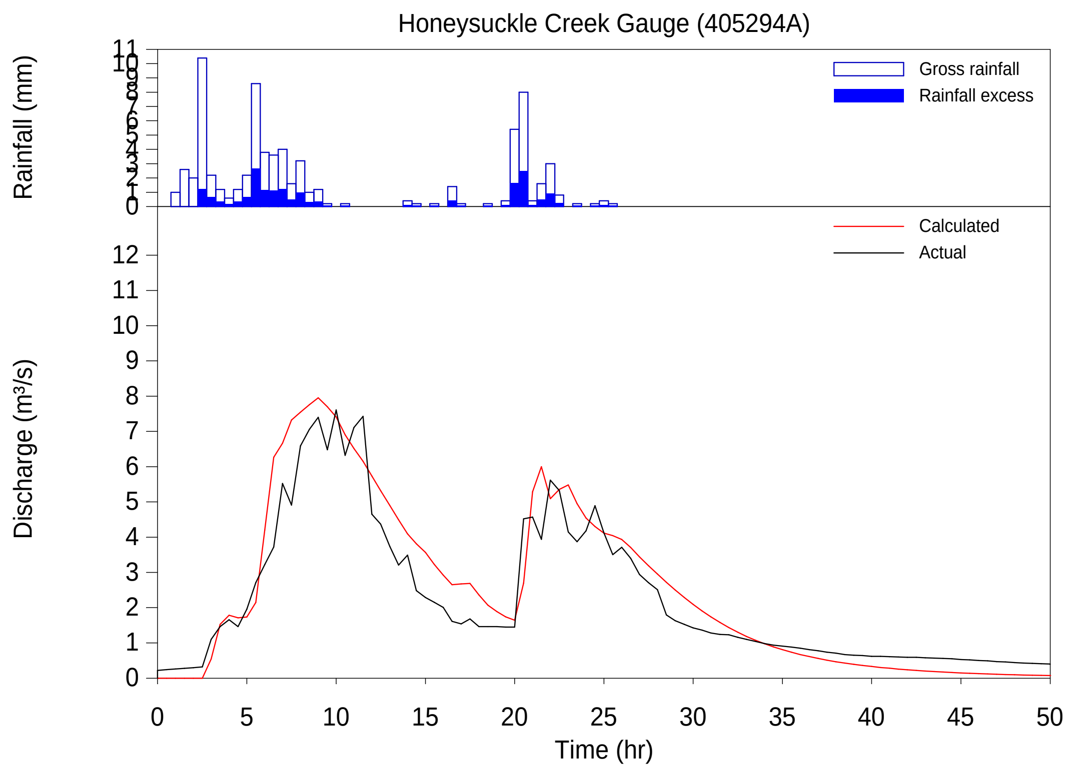

Figure 4-4 RORB Calibration – September 1998

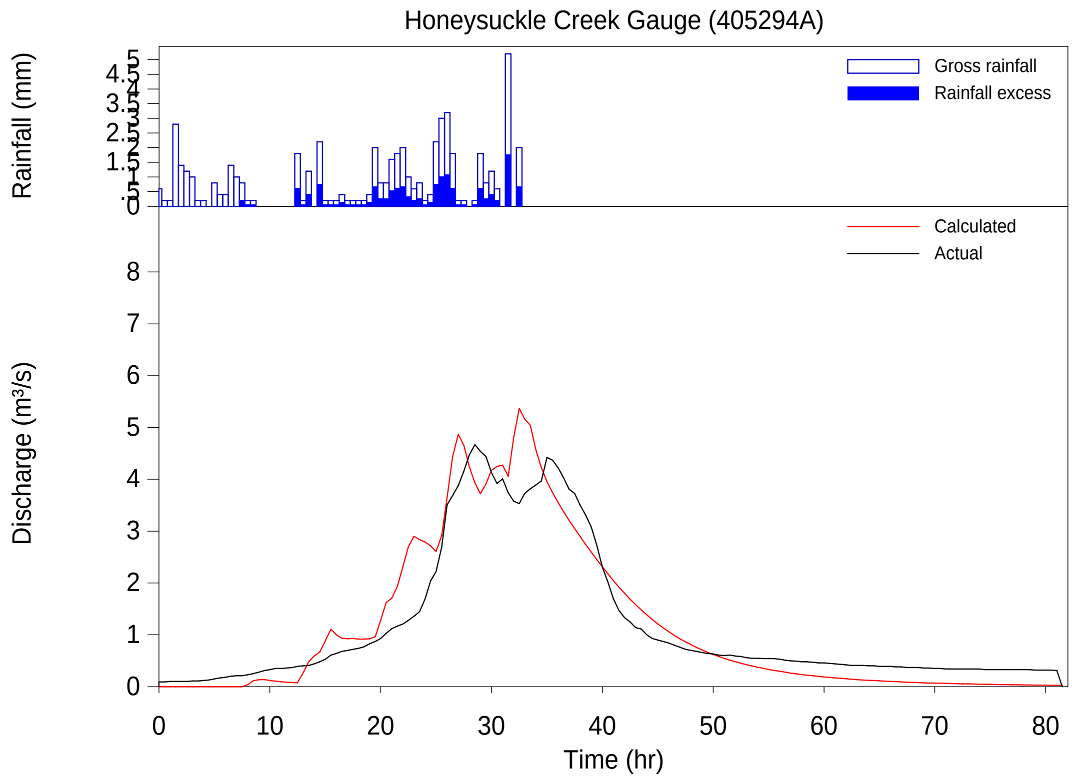

Figure 4-5 RORB Calibration – October 2000

4.3.4 Honeysuckle Creek RORB Model Calibration Discussion

Honeysuckle Creek to the Honeysuckle Creek gauge shows a direct response to rainfall, with the hydrograph shape mirroring the rainfall temporal pattern. Overall, reasonably good fits between the observed and calibrated hydrographs are considered to have been achieved by the RORB model. The modelled peak flows and general hydrograph shape are in good agreement for all three calibration events. A range of kc values, between 19 and 35, were found to provide good representation of peak flow and general hydrograph shape for the calibration events.

It is noted that magnitude of the floods employed for calibration is small compared to the expected magnitude of the design floods. The k_C values determined during the calibration may therefore not be representative of the catchment behaviour during large floods.

4.4 RORB Model Parameter Selection for Design Flood Estimation

4.4.1 Honeysuckle Creek Catchment kc Coefficient

As discussed in Section 4.3.4 only minor flood events were available for calibration and that the calibrated k_C may not be representative of large flood events. To improve the reliability of the k_C values employed in design flood estimation, alternative k_C estimates were evaluated.

A number of regional k_C estimation equations exist which are based on catchment areas or catchment geometries. An additional estimate of k_C for Honeysuckle Creek has been developed by scaling k_C based on the ratio of k_C and the average flow distance from the subcatchment to the outlet (d_{av}), from a calibrated RORB model of Seven Creeks to Euroa developed by Hill et al. (1996). The Seven Creeks catchment to Euroa is adjacent to the

Honeysuckle Creek catchment and both catchments share similarities in topography and geology. The estimation of an appropriate k_C value for Honeysuckle Creek based on the value of k_C determined for Seven Creeks to Euroa is therefore considered reasonable. Using the ratio of distances from centroids (d_{av}) to the catchment outlets, the Honeysuckle Creek k_C was evaluated as follows:

$k_{C\ (Honeysuckle)} = k_{C\ (Euroa)} / d_{av\ (Euroa)}$

$15.5 / 23.8 = k_{C\ (Honeysuckle)} / 15.52$

$k_{C\ (Honeusuckle)} = 10.1$

Table 4-3 displays a comparison between the k_C values determined from the RORB model calibration and those determined from regional estimates for the Honeysuckle Creek catchment.

Table 4-3 Calibrated k_C Values Compared to Regional Estimates for Honeysuckle Creek Catchment

Source	k_C value
RORB Calibration Events	19 (1996) 25 (1998) 35 (2000)
Pearse et al (2000) ($kc = 1.25d_{av}$)	19.4
ARR (BkV) Eqn. 3.21 VIC (MAR>800 mm) (kc = 2.57 A^0.45)	17.1
Scaled Euroa (Hill et al. 1996)	10.1

From Table 4-3 it can be seen that considerable uncertainty in an appropriate value of k_C exists for Honeysuckle Creek. To determine the sensitivity of design flood estimates to the uncertainty of k_C values, two k_C values of 10.1 (Scaled Euroa) and 19.4 (Regional) were selected for further examination as described in Section 4.5.

4.4.2 Long Gully Creek k_C Coefficient

Table 4-3 displays the k_C values determined from regional estimates for the Long Gully Creek catchment and the scaled k_C derived from the Seven Creeks Catchment

Table 4-4 Regional K_C Estimates for Long Gully Creek Catchment

Source	k_C value
Pearse et al (2000) ($k_C = 1.25d_{av}$)	4.83
ARR (BkV) Eqn. 3.21 VIC (MAR>800 mm) (k_C = 2.57 A^0.45)	6.58
Scaled Euroa (Hill et al. 1996)	2.5

4.4.3 Design Loss Values

The selection of design rainfall losses has a significant impact on the magnitude of the design flood estimates. As the magnitude of the floods employed in the calibration of the RORB model are significantly smaller than the magnitude of the design floods required to be estimated, loss values derived from the calibration are not considered applicable for design flood estimation. Recourse was therefore made to determining design loss values based on regional regression relationships. The study team have adopted the methodology developed by Hill et al. (1996). The methodology requires the estimation of the storm initial loss (IL_s) along with the continuing proportional loss (PL) and then the burst initial loss (IL_b). The burst initial loss accounts for the embedded nature of the rainfall bursts within larger storms used to calculate design rainfall in AR&R (1999). The burst initial loss is used for design flood estimation as opposed to the storm initial loss.

Storm Initial Loss (IL_s)

The storm initial loss is estimated using the following equation:

$IL_s = -25.8(BFI) + 33.8$

where: BFI is the base flow index ≈ 0.47 (Hill et al., 1998)(Figure A-1)

$IL_s = 21.7mm$

Proportional Loss (PL)

The proportional loss is estimated using the following equation:

PL = 0.621(BFI) – 0.000175(MAR) + 0.662

where MAR is the mean annual rainfall (mm) ≈ 850

PL = 0.8

RoC = 0.2 (1- 0.8)

The application of the proportional losses calculated with this method were found to produce peak flows which were consistently lower than those obtained from flood frequency analysis of 11 Victorian catchments (Hill et al 1996). A correction factor based on the AEP of the storm is therefore applied to remove the bias. For a 1% AEP, the runoff coefficient (1-PL) is multiplied by a factor of 1.5. For a 2% AEP or greater, the runoff coefficient is multiplied by a factor of 1.8 (Hill et al., 1996). The runoff coefficients (RoC) are displayed in Table 4-5.

Table 4-5 Runoff Coefficients Developed from Hill et al. (1996)

ARI	RoC
10	0.30
20	0.33
50	0.36
100	0.36

Burst Initial Loss (ILb)

The burst initial loss is estimated using the following equation:

$$IL_b = IL_s\,[1-(1/(1+142((\mathit{duration})^{0.5}/MAR))]$$

Where *duration* is the design duration (hrs)

Estimates of the burst initial loss for a range of expected relevant storm durations are displayed in Table 4-6.

Table 4-6 Estimates of Burst Initial Loss for Various Storm Durations

Duration (hr)	ILs (mm)	MAR (mm)	IL_b (mm)
4.5	21.7	850	5.7
6	21.7	850	6.3
9	21.7	850	7.2
12	21.7	850	7.9
18	21.7	850	9.0
24	21.7	850	9.8

Additionally, the loss values determined by Hill et al. (1996) for Euroa have also been employed for design flood estimation. These loss values were based on a calibrated RORB model of Seven Creeks and listed as follows:

IL (Initial Loss) = 23mm

RoC = 0.62

4.4.4 Design Rainfall Depths

Design rainfall depths were calculated for the 10, 20, 50, 100, 200 and 500-year ARI flood events using the intensity frequency duration (IFD) procedures outlined in ARR87. The IFD parameters are provided in Table 4-7.

Table 4-7 Honeysuckle Creek Catchment IFD parameters

IFD Parameter	Value
1 hour duration 2-year ARI	23.5
12 hour duration 2-year ARI	4.5
72 hour duration 2-year ARI	1.4
1 hour duration 50-year ARI	45
12 hour duration 50-year ARI	7.5
72 hour duration 50-year ARI	2.3
Regional skew G	0.22
Geographic factor F2	4.31
Geographic factor F50	15.1
Zone	2

4.4.5 Areal Reduction Factor

The Siriwardena and Weinmann (AR&R, 1999) areal reduction factor was applied for all design events.

4.4.6 Design Temporal Patterns

The AR&R () design filtered temporal patterns for Zone 2 were used in the study for all events.

4.4.7 Design Spatial Patterns

A uniform spatial rainfall pattern (i.e. same rainfall depths applied to the entire catchment) was adopted for all events in this study.

4.5 RORB Model Design Flood Estimates

Design flood hydrographs were determined for the 10, 20, 50, 100, 200 and 500-year ARI flood events for Honeysuckle and Long Gully Creek upstream of the Hume Freeway.

4.5.1 Honeysuckle Creek Upstream of the Hume Freeway

The design flood hydrographs for Honeysuckle Creek upstream of the Hume Freeway were estimated using the parameters developed in Section 4.4. A range of storm durations were modelled to ensure the critical storm duration was determined. The peak flow estimates and critical durations are displayed in Table 4-8 and Table 4-9.

Table 4-8 RORB Model Peak Flow Estimates (Regional k_C and Losses developed from Hill et al. (1996))

ARI	k_C	IL_b	RoC	Duration (hr)	Peak Flow (m^3/s)
10	19.4	7.2	0.29	9	19
20	19.4	7.9	0.33	9	25
50	19.4	7.9	0.36	9	34
100	19.4	7.9	0.36	9	39

Table 4-9 RORB Model Peak Flow Estimates Developed from Scaled k_C and Losses from Seven Creeks Catchment

ARI	k_C	IL_b	RoC	Duration (hr)	Peak Flow (m^3/s)
10	10.1	23	0.62	9	45
20	10.1	23	0.62	6	56
50	10.1	23	0.62	6	74
100	10.1	23	0.62	6	87

4.5.2 Long Gully Creek Upstream of the Hume Freeway

The design flood hydrographs for Long Gully Creek upstream of the Hume Freeway were estimated using the parameters developed in Section 4.4. A range of storm durations were modelled to ensure the critical storm duration was determined. The peak flow estimates and critical durations are displayed in Table 4-10 and Table 4-11.

Table 4-10 RORB Model Peak Flow Estimates (Regional k_C and Losses developed from Hill et al. (1996))

ARI	k_C	IL_b	RoC	Duration (hr)	Peak Flow (m^3/s)
10	4.83	6.3	0.29	6	4
20	4.83	6.3	0.33	6	6
50	4.83	4.9	0.36	3	8
100	4.83	4.9	0.36	3	9

Table 4-11 RORB Model Peak Flow Estimates Developed from Scaled k_C and Losses from Seven Creeks Catchment

ARI	k_C	IL_b	RoC	Duration (hr)	Peak Flow (m^3/s)
10	2.5	23	0.62	3	14
20	2.5	23	0.62	3	17
50	2.5	23	0.62	2	22
100	2.5	23	0.62	2	25

4.6 Alternative Design Flood Estimation

4.6.1 Overview

Due to the absence of appropriate recorded data to develop reliable design flows at Violet Town, a range of design flow estimates have been developed from various hydrological methodologies. The following sections outline the analysis undertaken for the various hydrological methodologies used for estimating the magnitude of the design flows at Violet Town.

4.6.2 Flood Frequency Analysis

The comparison of design peak flows estimated from a RORB model to those obtained through a flood frequency analysis is a common approach to ensure consistency of design flood estimates with observed flood frequency. This approach however requires a suitable streamflow gauge record. Unfortunately, as has already mentioned, the Honeysuckle Creek gauge upstream of Violet Town (405294) has only been in operation since April 1989 and the record does not include the large October 1993 flood event.

Downstream of Violet Town, the streamflow gauge on Stony Creek at Tamleugh (405247) has a record beginning in July 1975, however there are significant gaps in the record and only data for a small number of high flow events. The catchment area to the Stony Creek gauge is also approximately six times the catchment area to Violet Town and contains significant topographic differences to the Honeysuckle Creek catchment upstream of Violet Town. For these reasons, the inference of design flows at Violet Town from the Stony Creek streamflow gauge is not considered likely to provide reliable estimates.

No streamflow gauge exists on Long Gully Creek to allow a flood frequency analysis to be undertaken.

4.6.3 Hydrological Recipes – 'Extending a short flow record'

The methodology as outlined in Hydrological Recipes (CRC-CH, 1996) was applied to develop a relationship between flow and catchment area at Violet Town with the adjoining Seven Creeks catchment to Euroa. The Seven Creeks catchment to Euroa is geographically close to the Honeysuckle Creek catchment and topographically similar, as both are situated in the Strathbogie Ranges. A long period of streamflow record is available at Euroa and the design flow estimates derived from this record for the Shepparton Mooroopna Floodplain Management Study (SKM 2002) are considered reliable.

Table 4-12 displays the ARI flow estimates for Violet Town upstream of the Hume Freeway based on the following parameters:

Catchment Areas

Honeysuckle Creek upstream of Hume Freeway – 59.4 km^2

Long Gully Creek upstream of Hume Freeway – 6.2 km^2

Euroa upstream of Hume Freeway – 251 km^2

Multiplier Function (F)

$F = (Ac/Ag)^{0.7}$

where
Ac = *catchment area of the ungauged catchment* (km^2)
Ag = *catchment area of the gauged catchment* (km^2)

Honeysuckle Creek $Q_y = 0.36 *$ *Euroa* Q_y
Long Gully Creek $Q_y = 0.08 *$ *Euroa* Q_y

Table 4-12 Peak Flow Estimation for Honeysuckle Creek Based on Seven Creeks Flows at Euroa

ARI (yr)	Peak Flow (m^3/s)	
	Euroa	Violet Town U/S Hume Hwy
5	137	49
10	188	68
20	234	84
50	299	107
100	394	142
200	497	179

Table 4-13 Peak Flow Estimation for Long Gully Creek Based on Seven Creeks Flows at Euroa

ARI (yr)	Peak Flow (m^3/s)	
	Euroa	Violet Town U/S Hume Fwy
5	137	11
10	188	15
20	234	19
50	299	24
100	394	32
200	497	40

4.6.4 Rational Method Peak Flow Estimation

The rational method for estimation of peak flows on small to medium rural catchments has been applied to the Honeysuckle Creek and Long Gully Creek catchment as outlined in (ARR). The rational method peak flow estimates to upstream of the Hume Freeway are displayed in Table 4-14 and Table 4-15 for Honeysuckle Creek and Long Gully Creek respectively.

Table 4-14 Rational Method Flow Estimation for Honeysuckle Creek

ARI	Area (km^2)	C_{10}	Tc (hr)	mm/hr	F_y	C_y	Q (m^3/s)
10	59.4	0.14	3.6	14.1	1	0.14	32
20	59.4	0.14	3.6	16.3	1.1	0.15	42
50	59.4	0.14	3.6	19.1	1.2	0.17	53
100	59.4	0.14	3.6	21.3	1.3	0.18	64

Table 4-15 Rational Method Flow Estimation for Long Gully Creek

ARI	Area (km^2)	C_{10}	Tc (hr)	mm/hr	F_y	C_y	Q (m^3/s)
10	6.2	0.14	1.5	39.8	1	0.14	6
20	6.2	0.14	1.5	35.4	1.1	0.15	8
50	6.2	0.14	1.5	29.7	1.2	0.17	10
100	6.2	0.14	1.5	25.6	1.3	0.18	13

4.6.5 Hydrological Recipes – 'Estimating Extreme Flood Discharges'

The methodology as outlined in Hydrological Recipes (CRC-CH, 1996) was applied for estimating the magnitude of the 100-year ARI flood at Violet Town. The method is based on a regression relationship relating catchment area to the magnitude of the 1 in 100 - year floods developed from approximately 100 sites either side of the Great Dividing Range in Victoria.

Rural Catchments:

$$Q_{100} = 4.67A^{0.763}$$

Where
A = catchment area (km^2)

Honeysuckle Creek $Q_{100} = 105\ m^3/s$

Long Gully Creek $Q_{100} = 19\ m^3/s$

4.6.6 October 1993 Flood Estimate

The significant flood event that occurred in October 1993 was provisionally estimated as of the order of a 100-year ARI flood at Violet Town (GeoEng, 2002). Analyses undertaken by the GBCMA and GeoEng (2002) deduced flows in Honeysuckle Creek ranging from 105 to 116 m^3/s. A flow of 39 m^3/s was also estimated for Long Gully Creek.

A large amount of observed flood data in Violet Town is available for the October 1993 flood. Given the magnitude and availability of flood data for this event, the October 1993 was selected as the calibration event for the hydraulic analysis (Refer to Section 5.3). The simulation of the October 1993 flood in the hydraulic model also provided the opportunity to refine the flow estimates previously developed for the October 1993 flood. This required an iterative approach whereby the flow estimates were adjusted based on the results of the hydraulic model compared to the observed flood data in Violet Town for the October 1993 flood.

Initial flow hydrographs for the October 1993 flood were developed by adopting the RORB model parameters developed in Section 4.4 based on the scaled RORB model parameters employed at Euroa for a 100-year ARI flood. Following analysis of the October 1993 flood in the hydraulic model, the initial loss value was subsequently reduced from 23 mm to 10 mm. The adoption of an initial loss value of 10 mm is reasonable considering a 10 -12 mm initial loss was required for the RORB model calibration events. The smaller initial loss for the October 1993 flood is also justified due to the saturated nature of the catchment following a wet September in 1993.

The resulting peak flows adopted for the October 1993 flood were therefore as follows:

Honeysuckle Creek U/S Hume Freeway	112 m^3/s
Wodonga-bound on-ramp culvert	9 m^3/s
Long Gully Creek U/S Hume Freeway	25 m^3/s
Long Gully Creek subcatchment U/S Balmattum Road	1.5 m^3/s

The historical flood hydrographs produced by the RORB model for the October 1993 flood are presented in Figure 4-6.

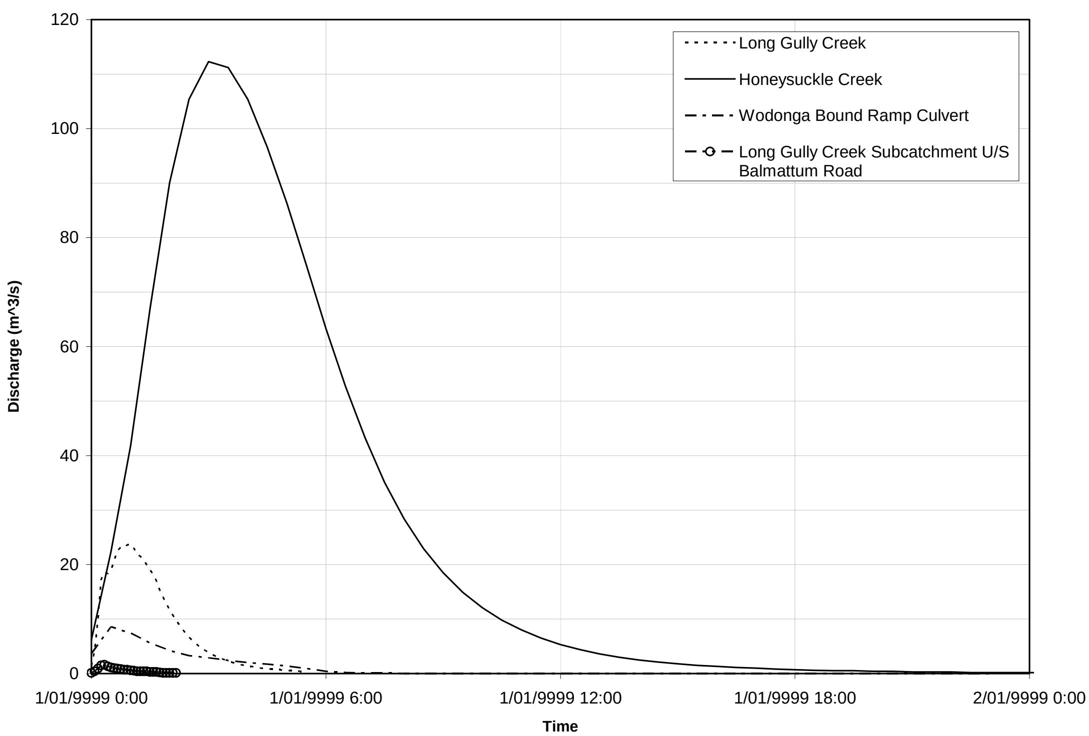

Figure 4-6 Adopted October 1993 Historical Flood Hydrographs

The peak flows developed in this analysis for the October 1993 flood are considered broadly in line with previous estimates developed as part of the flood scoping study (GeoEng, 2002).

Limited flood data is available from which to make informed estimates as to the magnitude of the Long Gully Creek flows during October 1993 flood. The observations of Violet Town residents and SES personnel in Violet Town during the flood indicated that flows from Long Gully Creek combined with heavy local rainfall were causing substantial flooding in Violet Town well before the Honeysuckle Creek flood peak. This is consistent with the expected behaviour of the catchments considering the different relative catchment size of Honeysuckle Creek and Long Gully Creek. With this in mind, the critical storm duration for Long Gully Creek was employed to estimate the magnitude of flows for the October 1993 flood.

It is considered the results of the hydraulic analysis undertaken in Section 5.3 with the adopted flow estimates above for the October 1993 flood produces flooding in general agreement with the limited information available.

4.6.7 Design Flood Estimates Comparisons

The design flood estimates from the various flood estimation methodologies have been summarised in Figure 4-7 and Figure 4-8 for the Honeysuckle Creek and Long Gully Creek respectively. The hydrological analysis undertaken for the Honeysuckle and Long Gully Creek catchments has highlighted the degree of uncertainty that exists in determining design flows for Violet Town.

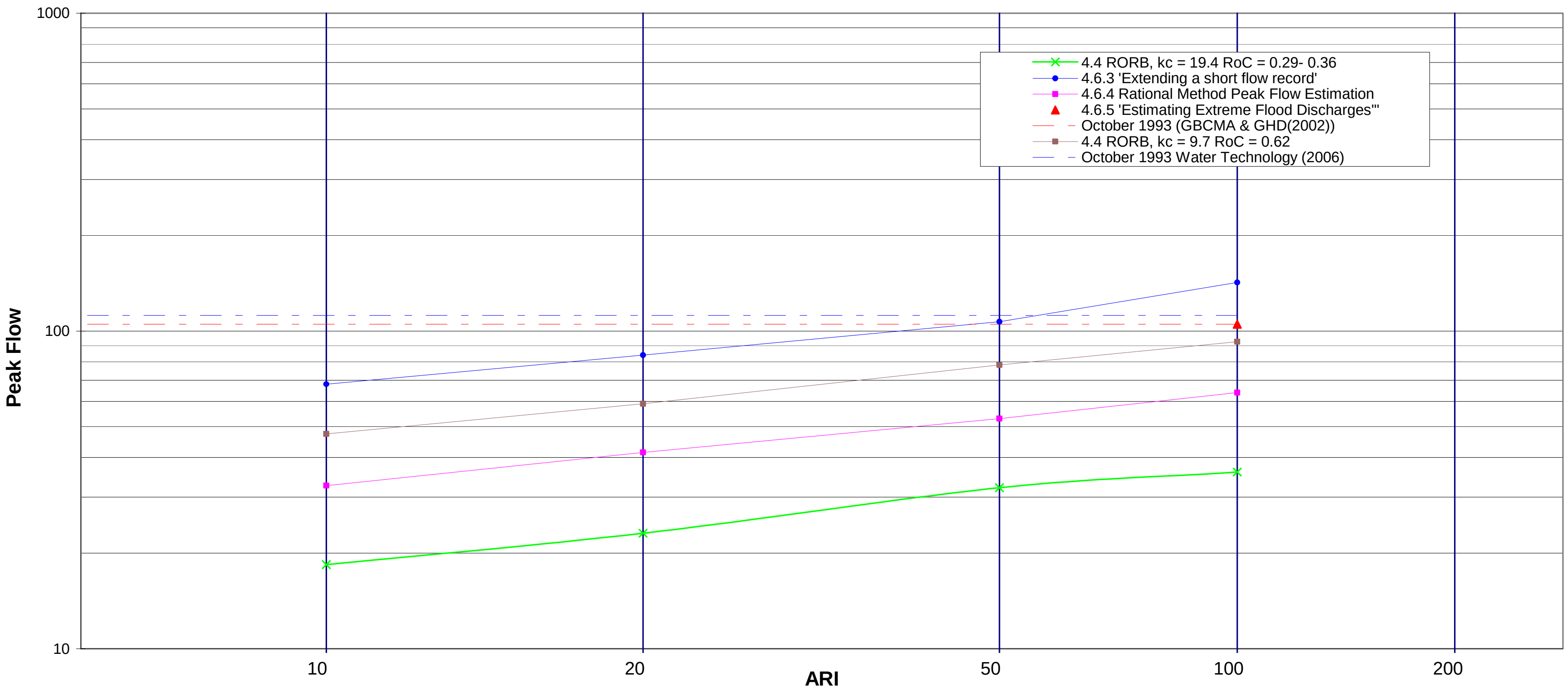

Figure 4-7 Summary of Flood Frequency Estimates for Honeysuckle Creek

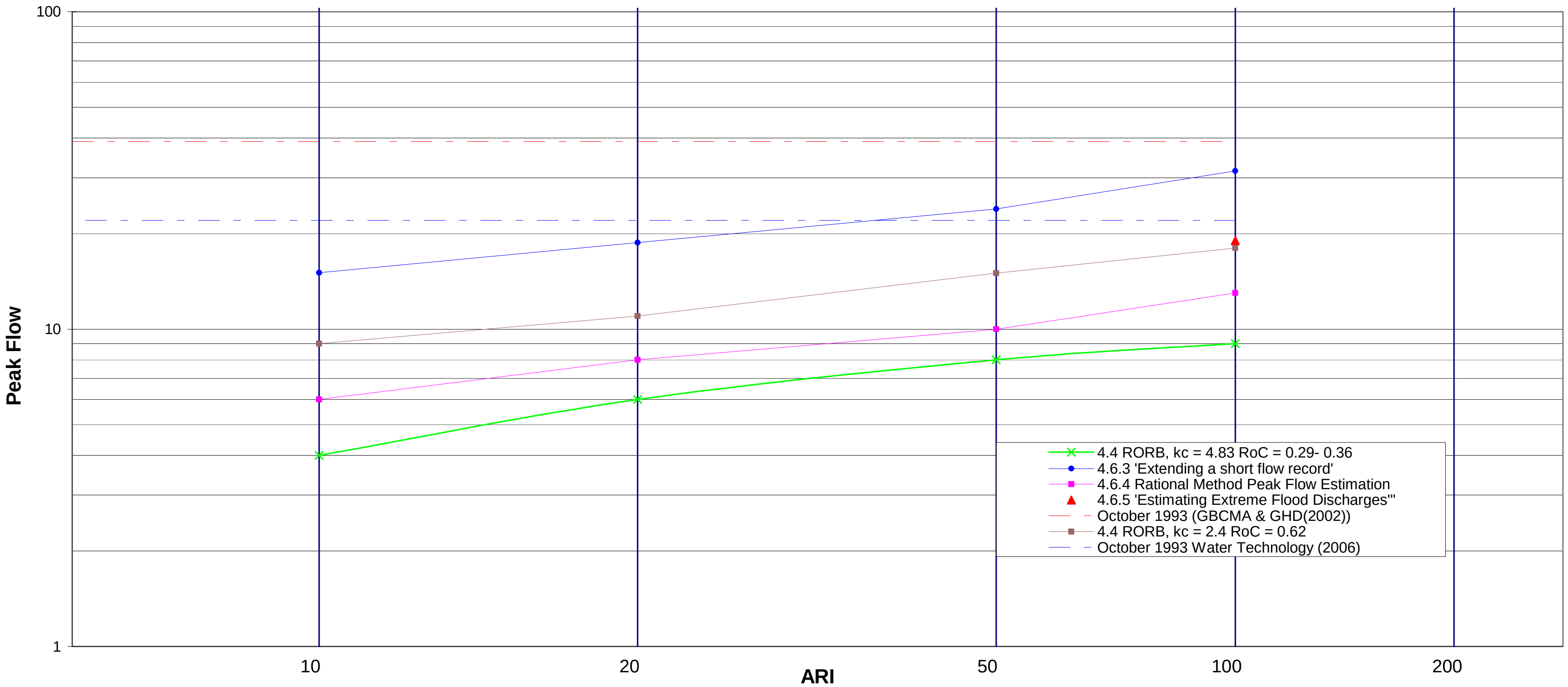

Figure 4-8 Summary of Flood Frequency Estimates for Long Gully Creek

4.7 Adopted Design Flood Estimates

As has been discussed, the provisional estimate of the October 1993 flood was that it was of the order a 100-year ARI flood. Various hydrological methodologies have been employed in order to gain some guidance on the expected magnitudes of the design flows at Violet Town. Based on the hydrological analysis and the analysis of the October 1993 flood in the hydraulic model, the weight of evidence as it were would appear to suggest that the October 1993 flood in Honeysuckle Creek was representative of a 100-year ARI flood. Similarly, the evidence also points to the flooding from Long Gully Creek during the October 1993 flood as being of order a 100-year ARI flood.

In particular it is considered important to note that the adoption of the scaled Euroa RORB model parameters provides some confidence that the parameters adopted for Honeysuckle Creek and Long Gully Creek are broadly representative of the catchment characteristics (topographic relief, geology, vegetation cover) and regional setting of catchments located in the northwestern slopes of the Strathbogie Ranges.

For the reasons outlined above the study team in consultation with the Community Reference Committee have therefore adopted the October 1993 flow estimates developed in this study as representative of a 100-year ARI flood at Violet Town. The adoption of the October 1993 flood as representative of a 100-year ARI flood allows design flood hydrographs to be developed from the RORB model for various other recurrence interval floods. Table 4-16 and Table 4-17 display the adopted RORB model parameters and resulting design peak flows estimates for Honeysuckle Creek and Long Gully Creek respectively.

Table 4-16 Adopted Design Peak Flow Estimates for Honeysuckle Creek

ARI (yrs)	IL (mm)	RoC	k_C	Honeysuckle Creek U/S Hume Freeway		Wodonga-bound on-ramp Culvert	
				Peak Flow (m^3/s)	Duration (hrs)	Peak Flow (m^3/s)	Duration (hrs)
10	10	0.62	10.1	65	6	7	3
20	10	0.62	10.1	79	6	9	3
50	10	0.62	10.1	97	6	11	3
100	10	0.62	10.1	113	6	12	3
200	10	0.62	10.1	129	4.5	14	1
500	10	0.62	10.1	152	4.5	17	1

Table 4-17 Adopted Design Peak Flow Estimates for Long Gully Creek

ARI (yrs)	IL (mm)	RoC	k_C	Long Gully Creek U/S Hume Freeway		SubCatchmet U/S Balmattum Road	
				Peak Flow (m^3/s)	Duration (hrs)	Peak Flow (m^3/s)	Duration (hrs)
10	10	0.62	2.5	14	3	0.8	0.75
20	10	0.62	2.5	17	3	1.0	0.75
50	10	0.62	2.5	22	2	1.4	1
100	10	0.62	2.5	25	2	1.7	1
200	10	0.62	2.5	30	1	1.9	1
500	10	0.62	2.5	36	1	2.3	1

It is considered important to note that due to the significant difference in catchment size between Honeysuckle and Long Gully Creek, coincident 100-year ARI flooding would not necessarily be expected. However, based on the analysis undertaken it would appear that during the October 1993 floods both respective catchments produced flow rates of the order of a 100-year ARI flood. In this respect it is considered that the sum impact of the flooding experienced at Violet Town during the October 1993 flood could possibly be reasoned to have had a recurrence interval somewhat larger than a 100-year ARI flood. This does however provide a degree of conservatism which is considered reasonable given the uncertainty existing in the design flows estimation.

4.8 Probable Maximum Flood Estimation

The Probable Maximum Flood (PMF) has been estimated for the contributing catchment at Violet Town based on a regression equation for PMF's in South Eastern Australia as outlined in Hydrological Recipes (CRC-CH, 1996). Triangular hydrographs were developed based on the methodology outlined to provide boundary conditions for the hydraulic model. The peak flow PMF estimates are displayed below in Table 4-18.

$$Q_{PMF} = 129.1A^{0.616}$$

Where
A = catchment area (km^2)

Table 4-18 PMF Peak Flow Estimates

Catchment	Catchment Area (km^2)	Peak Flow (m^3/s)
Honeysuckle Creek	59.4	1,598
Wodonga-bound on-ramp culvert	2.0	198
Long Gully Creek	6.2	397
Sub-catchment U/S Balmattum Road	0.7	16

5 HYDRAULIC ANALYSIS

5.1 Overview

The hydraulic analysis determined historical and design flood levels and velocities for the study area. In particular, the historical flood levels were used in the model calibration. The design flood levels and velocities were determined for the 10, 20, 50, 100, 200 and 500-year ARI (average recurrence interval) floods and the probable maximum precipitation (PMP) design flood. The design flood levels and velocities were utilised to determine the existing level of flood risk.

The linked one and two dimensional unsteady hydraulic model MIKEFLOOD was the principal tool for the hydraulic analysis. MIKEFLOOD is a state of the art tool for floodplain modelling that has been formed by the dynamic coupling of DHI's well proven MIKE 11 river modelling and MIKE 21 fully two-dimensional modelling systems. The MIKEFLOOD model parameters were determined through calibration of the modelled flood levels with observed flood levels with historical inflow flood hydrographs as an input. Once calibrated, the MIKEFLOOD model was applied to estimate design flood levels with design inflow hydrographs as an input.

This section details the input data, methodology and outputs for the hydraulic analysis. The structure of the section is as follows:

- Hydraulic model development – details the development of the MIKEFLOOD model strucutre (Section 5.2)
- Hydraulic model calibration – details the selection of calibration events and calibration of model paramters (Section 5.3)
- Design flood modelling – summaries the estimation of design flood levels and velocities with the calibrated MIKEFLOOD model (Section 5.4)

5.2 Hydraulic Model Development

5.2.1 Hydraulic Model Software

Hydraulic modelling of the study area has been undertaken utilising the Danish Hydraulic Institute's (DHI) MIKEFLOOD modelling software. MIKEFLOOD is a state of the art tool for floodplain modelling that has been formed by the dynamic coupling of DHI's well proven MIKE 11 river modelling and MIKE 21 fully two-dimensional modelling systems. Through this coupling it is possible to extend the capability of the 2D MIKE 21 model to include:

- A comprehensive range of hydraulic structure (including weirs, culverts, bridges, etc);
- ability to accurately model sub-grid scale channels;
- ability to accurately model dambreak or levee failures.

For the present study, a two-dimensional (2D) MIKE 21 model has been set up to model the overall floodplain flows. A coupled one dimensional (1D) MIKE 11 model has also been utilised to explicitly model waterway bridge and culvert crossings within the study area.

More information on MIKEFLOOD can be found at:

http://www.dhigroup.com/Software/WaterResources/MIKEFLOOD.aspx

5.2.2 Model Structure

The development of a detailed digital terrain model (DTM) and subsequent construction of a hydraulic model of the study area enables the Honeysuckle Creek and Long Gully Creek flood flows to be simulated in greater detail. Flow conditions varying from historical flood events to the simulation of hypothetical "design" events can be modelled to investigate the pattern of flooding behaviour within the study area. These flow conditions can be applied to both the existing topography, and topographies that have been altered to represent changes eg flood mitigation measures or proposed developments.

The basis of the two dimensional model is the topographic grid which is based on the aerial photogrammetry and field survey. A 3 m grid, rotated 45^0 anticlockwise from true north was used for input to the hydraulic model. The grid was rotated to insure computational efficiency, allowing a smaller grid size to be used overall while also aligning the grid parallel to major topographic features such as the railway line and various table drains and channels.

The bridge and culvert crossings within the study area were modelled as MIKE 11 structures and dynamically coupled with the two dimensional model. Head loss through the bridges could therefore be modelled explicitly within the model.

The variation in hydraulic roughness within the study area has been schematised as a hydraulic roughness grid, representing various hydraulic roughness's eg open grassland, roads, thick vegetation. The hydraulic roughness grid was based principally on the aerial orthophoto (QASCO 2002).

5.3 Hydraulic Model Calibration

5.3.1 Approach

The calibration process requires systematically comparing the hydraulic model's representation of flooding in the study area with observed flooding behaviour. This process may incorporate comparisons between gauged stream flows, observed maximum flood levels, areas of inundation as shown in aerial photography and eyewitness recounts of flooding behaviour. Where the model does not adequately represent what was observed, the reason for the discrepancy is identified and inputs into the model are adjusted as required.

The hydraulic model developed by this study is based on current topographic data and flooding behaviour is therefore influenced by the current topography. As such, the ability of the hydraulic model to simulate observed historical flood behaviour is affected by changes to the topography subsequent to the flood event being modelled.

5.3.2 October 1993 calibration

The October 1993 flood event was chosen as the principal calibration flood event. Through the flood scoping study and associated community consultation process (GeoEng, 2002) a number of photos, eyewitness recounts and a total of 54 flood levels were collated from the 1993 flood. This provided a solid basis from which to compare the models flooding behaviour with that observed.

The flow hydrograph estimates developed in Section 4.6.6 for October 1993 were applied to the hydraulic models upstream boundaries. A flow versus height relationship was applied at the models downstream boundary based on a Manning's calculation of the downstream cross section.

Calibration of the model was primarily based on matching the modelled flood levels with those observed throughout Violet Town. This was achieved through a combination of fine tuning of the factors describing head loss through the major bridge and culvert structures, some minor adjustment to the roughness parameters and regions and some revision to the inflow estimates (Refer to Section 4.6.6). Table 5-1 outlines the adopted hydraulic roughness parameters following calibration.

Table 5-1 Hydraulic Roughness Parameters

Floodplain Element	Manning's M	Manning's n (n = 1/M)
General Floodplain roughness (open space, lightly vegetated)	25	0.04
Vegetated areas	16.67	0.06
Thickly Vegetated Areas	14.3	0.07
Clear, paved areas (streets)	66.67	0.015
Urban areas (buildings, backyards)	5	0.20

Figure 5-2 displays the maximum modelled October 1993 flood extent and comparison of the modelled versus observed maximum flood levels. Considering the uncertainty in the historical flood hydrographs, their relative timing, and in the free operation of a number of bridges and culverts (i.e., they may become blocked) during the 1993 flood, it is considered the modelled levels are in good agreement with observed levels for the 1993 flood. It should be noted that care was taken not to adjust various model parameters outside acceptable ranges in order to 'force' an acceptable calibration fit. In this respect it is noted that calibration was readily achieved with standard model parameter values and provides some confidence that the flow estimates for the 1993 flood are reasonable.

By way of quantifying the degree of agreement between the observed maximum flood levels and modelled levels, a comparison of the levels showed that when allowing for the uncertainty attributed to each observed level, 83% of the modelled levels were within 150 mm of the observed levels.

Considering the uncertainty inherent in a number of the model inputs, and the reliability of the recorded peak flood level from personal observations, the calibration exercise has produced a model that is acceptable for this flood study.

The following comparisons, however, on the general flood behaviour during the 1993 flood does provide a useful demonstration of the calibrated hydraulic models ability to reproduce observed flood behaviour in Violet Town:

- The hydraulic model shows floodwaters banking up against Balmattum Road along Long Gully Creek. The intensity of the rainfall within the Long Gully Creek catchment, possibly in combination with outbreaks from Long Gully Creek across the levee (although the hydraulic model doesn't indicate this), resulted in overland flow upstream of Balmattum Road towards the bank of culverts on the Hume Freeway. Downstream of the Hume Freeway these flows follow a poorly defined overland flowpath before being intercepted by a table drain running alongside Murray Street. The VicRoads aerial photography taken following the 1993 flood clearly shows the overland flowpath originating from these Hume Freeway culverts.
- The hydraulic model shows floodwaters passing under the banks of culverts through the Hume Freeway and Wodonga-bound on-ramp. These flood waters flow along a poorly defined overland flow path parallel to Honeysuckle Creek. A number of catch drains have been constructed to intercept these flows and divert them back into

Honeysuckle Creek. The model indicates however that levels in Honeysuckle Creek during the 1993 flood were such that floodwaters backed out of Honeysuckle Creek along these drains, adding to the flows occurring from the bank of culverts upstream. These combined flows could not return to Honeysuckle Creek and flowed towards the intersection of High Street and Cowslip Street. The VicRoads aerial photography taken after the 1993 flood peak shows floodwaters continuing to exit these culverts and impact properties near this road intersection, well after the main Honeysuckle Creek flood peak.

- A maximum flow rate of 87 m^3/s was modelled through the railway bridge over Honeysuckle Creek. This compares well with an estimate of 93 m^3/s developed during the flood scoping study (GeoEng, 2002). There is however a degree of uncertainty as to the accuracy of the flood level used for this calculation.
- Based on the flows derived for Long Gully Creek for the October 1993 flood, the model indicates that flows from Long Gully Creek would have contributed significantly to the total flood volume ponding on the upstream side of the railway embankment. This contrasts with the view that Honeysuckle Creek was the main contributor to flooding within the town during the October 1993 flood (GeoEng, 2002).
- The model shows floodwaters ponding against the railway line embankment. It was reported in the flood scoping study (GeoEng, 2002) that the 1200 mm pipe through the embankment was partly blocked during the flood. The capacity of the culvert was therefore reduced in the model to that of a 600 mm pipe to reflect the reduced capacity. The model predicts floodwaters crossing the railway line over a length of approximately 150 metres, albeit at depths generally less than 200 mm. A number of residents were able to confirm that floodwaters crossed the railway line during the October 1993 flood. A comparison of the crest of the railway line and the observed flood levels on the southern side would also indicate that floodwaters crossed the railway line at some stage during the flood event.
- Downstream of the railway line embankment floodwaters followed local depressions along Mary's Lane and across Cowslip Street towards the corner of Nicholson and Rose Streets. It should be noted that the model predicts floodwaters would have backed up the pipe running along Railway Street to Honeysuckle Creek and begun to overtop the open drain running alongside Railway Street before floodwaters on the opposite side of the railway line embankment began to flow through the 1200 mm pipe. This is considered important to note as this is likely to contribute to flooding downstream of the railway line embankment during high flow events in Honeysuckle Creek.
- Figure 5–2 shows the estimated flood flow distribution through Violet Town as determined from the hydraulic model.
- Consideration should also be provided in the comparison of the modelled verses observed flood behaviour during the October 1993 flood to the impact of the significant local rainfall depths that occurred at Violet Town. The cumulative three day rainfall depth to 9:00 AM on 4 October 1993 at Violet Town (82049) was recorded as 157 mm. Similar total rainfall depths were recorded by local resident of Long Gully Creek, Mr Tom Crocker. In particular, Mr Crocker's observation for 3 October records a total of 115 mm.

While no representative rainfall intensity records are available at Violet Town it is understood that embedded thunderstorms did result in periods of high rainfall intensity that are likely to have contributed significantly to the total rainfall depths experienced at Violet Town. The heavy rainfall at Violet Town experienced during the October 1993 flood is likely to have resulted in a degree of flash flooding in Violet Town that compounded the impact of flooding occurring from Long Gully Creek and Honeysuckle Creek. It is considered that flash flooding may have resulted in localised areas of inundation in Violet Town that were not necessarily a result of mainstream flooding from Honeysuckle or Long Gully Creeks. The hydraulic model has not been simulated with local rainfall inputs and the flooding extents produced therefore represent mainstream flooding from Honeysuckle and Long Gully Creek only.

5.4 Design Flood Modelling

Design flood levels and inundation extent were determined using the calibrated MIKEFLOOD model for the 10, 20, 50, 100, 200 and 500-year ARI and PMF floods. The design inflow hydrographs for Honeysuckle and Long Gully Creeks determined by the hydrologic analysis were used as model inflow boundary conditions.

Table 5-2 displays the peak design flood levels for Honeysuckle Creek at the Baird Street Gauge, just upstream from Baird Street for the design floods

Table 5-2 Baird Street Gauge Design Flood Levels

Design Flood Event ARI (years)	Baird Street Gauge Height	
	(m)	(m AHD)
10	3.86	175.71
20	3.97	175.82
50	4.11	175.96
100	4.18	176.03
200	4.23	176.08
500	4.27	176.12
PMF	5.50	177.35

At the time of the study SSC were in the process of finalising the design of a new footbridge and associated approach ramps across Honeysuckle Creek, just upstream of the lawn bowling club. The design drawings of the footbridge were provided by SSC and the bridge dimensions were incorporated into the hydraulic model description. The design flood modelling was therefore simulated with the footbridge included, which has been incorporated into the flood mapping. Comparison of the 100-year ARI flood results under existing conditions and with the new footbridge included showed that the footbridge would result in an afflux upstream of the footbridge of approximately 200 – 300 mm. The afflux however reduced to zero approximately 350 metres upstream of the footbridge. The afflux results in some minor increase in flood extents locally, immediately upstream of the footbridge however the increased flood extents are contained well within the existing creek reserve and will not impact any properties or roads within Violet Town.

The existing levee on the right bank of Long Gully Creek upstream of Balmattun Road limits the breakout from Long Gully in this reach. Local runoff from the upslope catchment is directed by the levee through culverts under the Hume Freeway to the north of the Long Gully crossing. This flowpath continues in a north west direction towards Murray and Meakin Streets.

A quantitative assessment of the Long Gully levee influence on flood behaviour is warranted. Such quantitative assessment would underpin consideration of management arrangements for the levee.

Figure 5-3 illustrates the flood extents modelled for the various design floods.

An approximate rating for the Baird Street gauge has been extracted from the hydraulic model results and is presented in Table 5-3 and Figure 5-1. It should be noted that this rating only accounts for flows passing the gauge in the immediate vicinity of Honeysuckle Creek. The rating does not account for flows that breakaway from Honeysuckle creek upstream of the railway bridge.

Table 5-3 Baird Street Gauge Rating

Baird Street Gauge Height (m)	Flow (m^3/s)
1.0	4.6
1.2	7.1
1.4	9.5
1.6	12.0
1.8	14.8
2.0	18.2
2.2	21.7
2.4	25.1
2.6	28.6
2.8	32.0
3.0	36.3
3.2	41.7
3.4	47.1
3.6	53.2
3.8	65.8
4.0	75.0
4.2	89.4
4.3	100.6

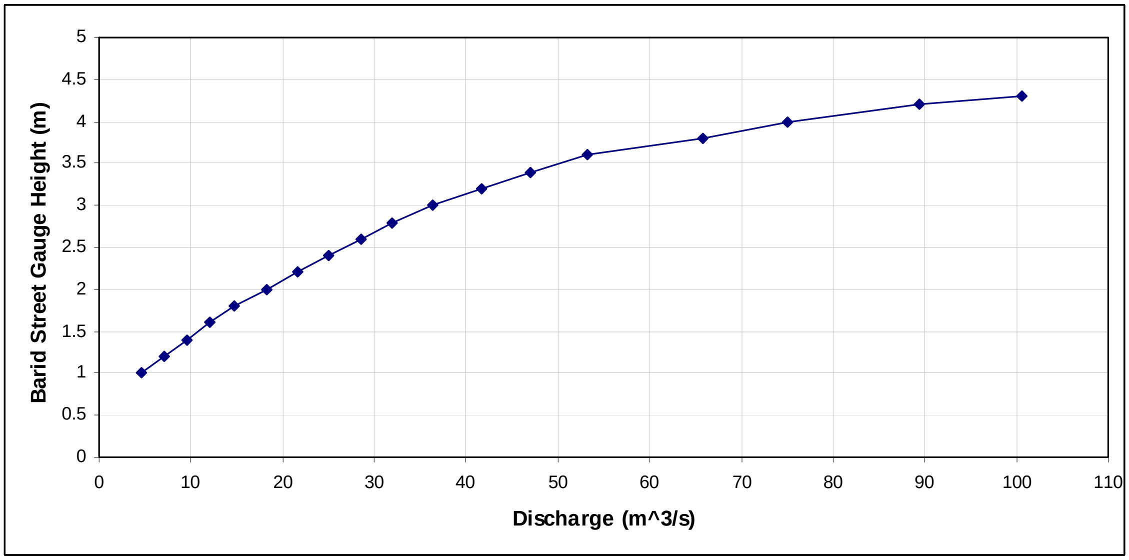

Figure 5-1 Baird Street Gauge Rating Curve

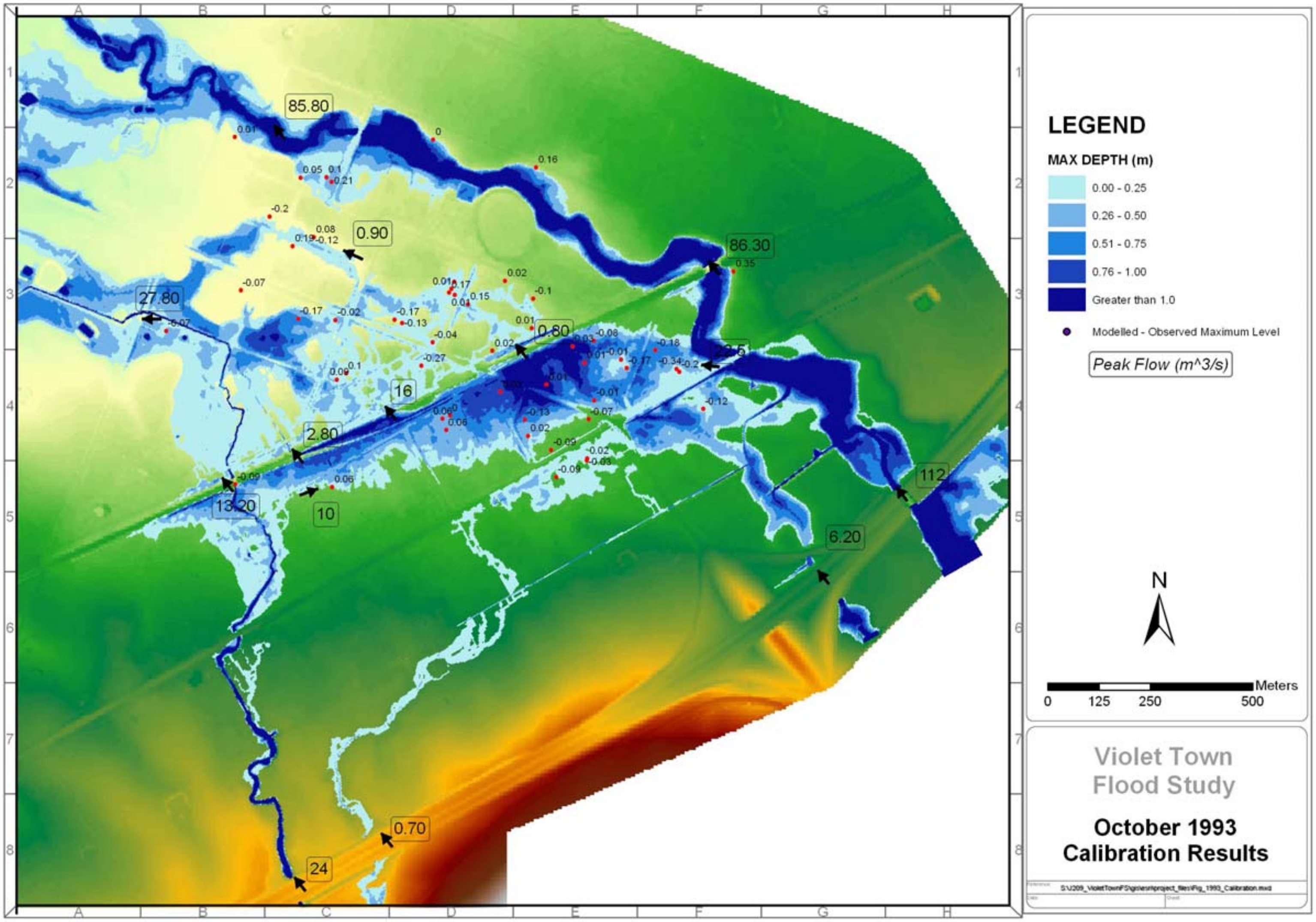

Figure 5-2 October 1993 Calibration Results

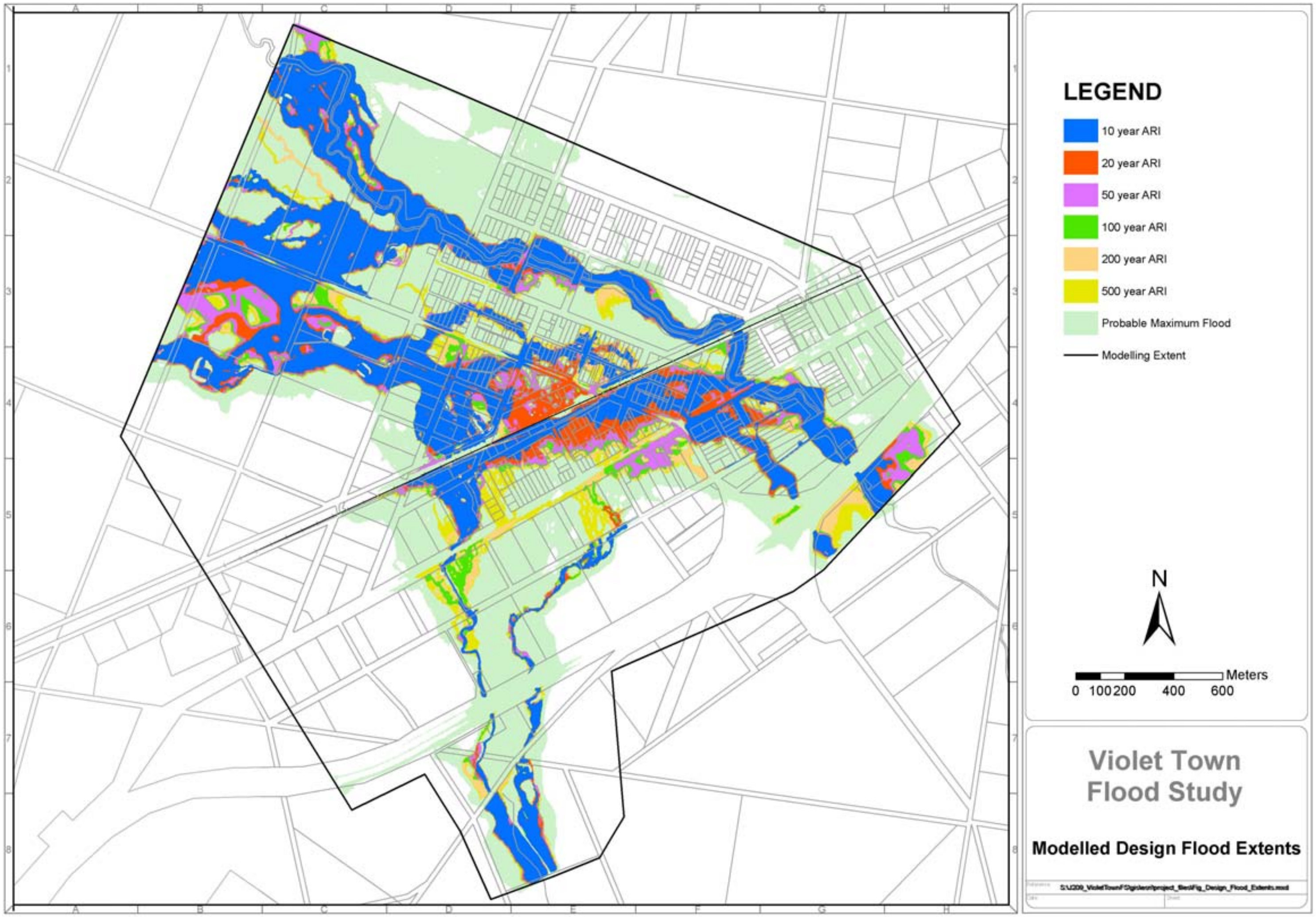

Figure 5-3 Modelled Design Flood Extents

6 FLOOD RISK ASSESSMENT

6.1 Overview

A flood damages assessment has been undertaken for the study area under existing conditions. The flood assessment determined the monetary flood damages for design flood hydrographs as determined by the hydrologic and hydraulic models. The average annual damage (AAD) was also determined as part of the flood damage assessment.

Damages from flooding can be sub-divided into a number of categories. Figure 6-1 shows the various categories commonly used in flood damage assessments.

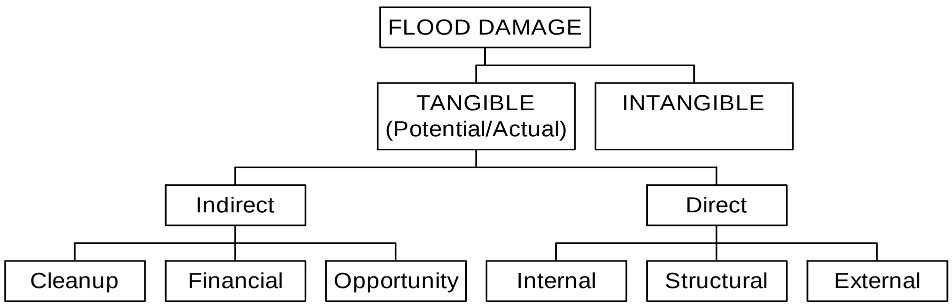

Figure 6-1 Flood Damage Categories

Tangible flood damages are those to which a monetary value can be assigned and include property damages, business losses and recovery costs. Intangible flood damages are those to which a monetary value cannot be assigned and include anxiety, inconvenience and disruption of social activities. Both are a function of flood magnitude. This flood damages assessment focuses on the tangible flood damages. Intangible damages are important but have not been directly accounted for in this flood damage assessment.

Tangible damages can be sub-divided into direct and indirect damages. Direct damages are those financial costs caused by the physical contact of flood waters and include damage to property, roads and infrastructure.

Property damages can be sub-divided into internal and external damages. Internal damages include damage to carpets, furniture and electrical goods. External damages include damages to building structures, vehicles and in rural areas, crops, fencing and machinery.

Tangible direct damages are further defined as either potential or actual damages. Potential damages are the maximum damages that could occur for a given flood event. In determining potential damages, it is assumed that no actions are taken (whether months or hours) prior to or during the flood to reduce damage by, for example, lifting or shifting items to flood free locations, shifting motor vehicles or sandbagging. Actual damages are the expected damages for a given flood event, allowing for some degree of community flood damage control. The actual damage is calculated as a proportion of the potential damage, based on the community's flood preparedness, a function of community awareness and the lead-time of flood warnings.

Indirect damages are those additional financial costs generally incurred after the flood during clean-up and include the cost of temporary accommodation, loss of wages, loss of production for commercial and industrial establishments and the opportunity loss caused by the closure or limited operation of business and public facilities. Indirect damages are often extremely hard to estimate.

The remainder of this section details the input data required and the methodology adopted for this flood damage assessment.

6.2 Available Information

This section outlines the range of information utilised within the flood risk assessment including property and floor level data, infrastructure data and flood data.

6.2.1 Property and Floor Level Data

Property and floor level data were surveyed for 178 properties/buildings within the study area. These properties were identified to lie within the 100-year ARI flood extent or were located immediately adjacent.

The following property data were collected:

- Building location:- property address (Street Number and Street Address) and ground coordinates.
- Building type:- urban and rural residential, commercial, industrial and public
- Property damage or value class:- intended to represent dwellings of respectively poor, normal or excellent value. Reflects value of contents value, construction quality.
- Ground and floor levels: ground and floor level data including location (i.e. coordinates)

A standard medium value class was adopted for all residential and commercial properties in Violet Town for the flood damage assessment.

6.2.2 Infrastructure Data

For this study, as detailed in the report '*Rapid Appraisal Method (RAM) for Floodplain Management*' (NRE, 2000), total damage to infrastructure was based on the length of road infrastructure inundated. NRE (2000) considers this assumption reasonable, as much of the service infrastructure follows the paths of road reserves and the quantity of other infrastructure might be expected to be broadly a function of the length of road. Damage to bridges is also incorporated into the NRE (2000) infrastructure damage cost estimates.

Road were identified using the cadastral information supplied by Strathbogie Shire Council and by inspection of aerial photos.

6.2.3 Flood Data

The hydraulic analysis provides a regular grid of flood elevations and flood depths across the hydraulic model study area. By overlaying the flood elevations and depths onto the property data, a flood level can be assigned to each flood affected building, similarly lengths of road inundated can easily be calculated. The 10, 20, 50, 100, 200 and 500 year ARI design floods were assessed in this study, with a 5 year ARI flood assumed to result in no significant flood damage cost. This is discussed in further detail in Section 6.3.3.

6.3 Approach

The flood damage assessment was based on the RAM (NRE, 2000) and current best practice. The Bureau of Transport Economics report '*Economic Costs of Natural Disasters in Australia'* (BTE, 2001), provides an excellent source of information regarding methodology and cost estimates for flood damage assessments.

The flood damage assessment first estimated costs associated with direct flood damage (e.g. structural building, contents, external property, and infrastructure damage), then considered the costs associated with indirect flood impacts (e.g. emergency services, clean-up costs, alternative accommodation costs).

6.3.1 Direct Flood Damage

Property Damage

For each property in the study area it was first decided if the building was inundated above floor level or below floor level by querying the design flood depths and the floor level from the property survey. Adjusted ANUFLOOD (Smith & Greenway, 1992) stage-damage curves were then applied to each property for above floor flooding and an adjusted stage-damage curve from report '*Floodplain Management in Australia'* (DPIE, 1992), was used for properties with below floor flooding.

The ANUFLOOD stage-damage curves were factored up by 60% to bring them up to a 1999 flood damage cost level as recommended by the RAM (NRE, 2000). The ANUFLOOD stage-damage curves were further adjusted by a Building Price Index (BPI) ratio up to 2004 and by Consumer Price Index (CPI) ratio to June 2005 (BPI was not available for 2005), to bring them all up to a June 2005 flood damage cost level. There are a total of three residential ANUFLOOD stage-damage curves (small, medium and large houses) and fifteen commercial ANUFLOOD stage-damage curves (small, medium and large buildings of value class from one to five).

In this study, properties that contain buildings have been designated either residential medium value or commercial medium value. Essentially, all non-residential properties are designated as commercial, irrespective of their use, so that shops, Council premises and light industry etc. are assigned the same flood-depth to damage curve. The medium value residential damage curves have been adopted for residential properties and the medium value class two commercial damage curves have been adopted for commercial properties. The survey team used to collect this data were experienced in these types of surveys and categorised the majority of the buildings as medium quality. It is recognised that this approach is an approximation, but is considered appropriate given the lack of individual and detailed building size, age, use, value and quality information.

The DPIE stage-damage curve for external damages was factored up using a ratio of the 2004 and 1992 BPI, and a ratio of the June 2005 and 2004 CPI to bring the curve up to a June 2005 flood damage cost level. Note that there is no distinction between residential and commercial external damages. It was found that many of the properties inundated below floor level were only partly inundated. The flood damage cost was reduced by the ratio of the flooded area and the property area.

The stage-damage curves used in this study are displayed in Figure 6-2.

The stage-damage curves were applied to each inundated property and the costs summed to calculate the total direct potential flood damage cost.

The total direct potential flood damage cost is the cost that would be incurred if no mitigation measures are taken prior to or during a flood. In reality communities generally have some degree of warning, and particularly if a community has had previous flood experience, may reduce the effect of the flood significantly. Measures such as evacuation, doorstep sandbagging or the removal of valuable items to a safe level above flood waters have the potential to reduce the flood damage cost. Although some residents in Violet Town . Further, recent drought conditions in Victoria have reduced community awareness of flooding. A potential to actual direct flood damage reduction factor from RAM (NRE, 2000) of 0.8 was adopted. This conservatively assumes that the community has little or no flood experience and that they have less than 12 hours warning time, as shown in Figure 6-3.

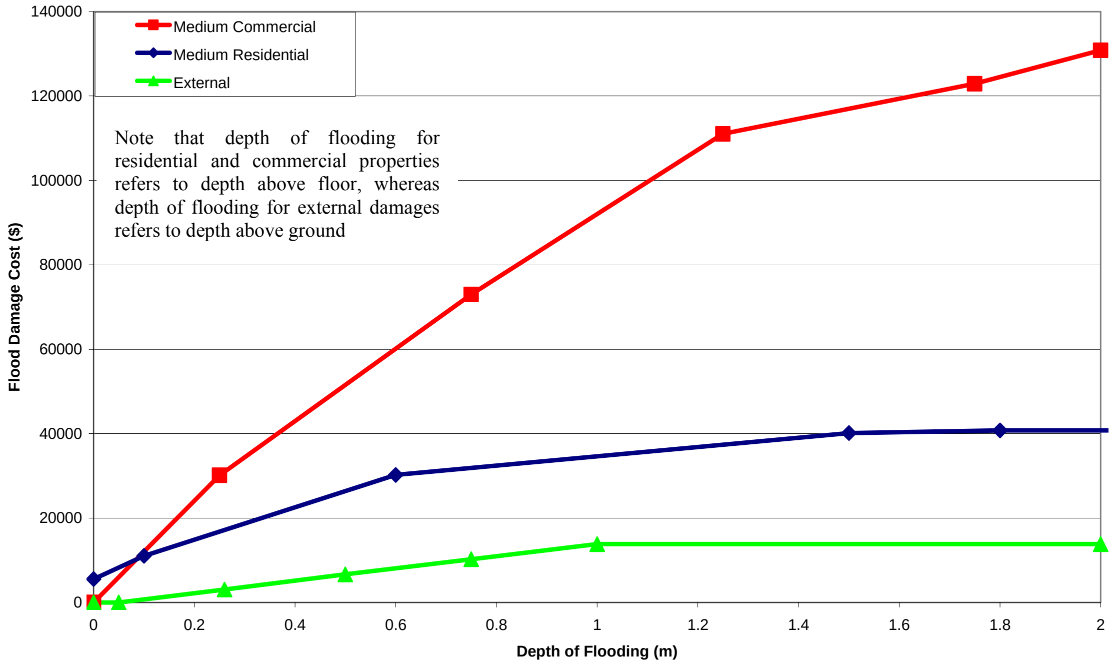

Figure 6-2 Adopted Stage-Damage Curves for Residential, Commercial and External Flooding

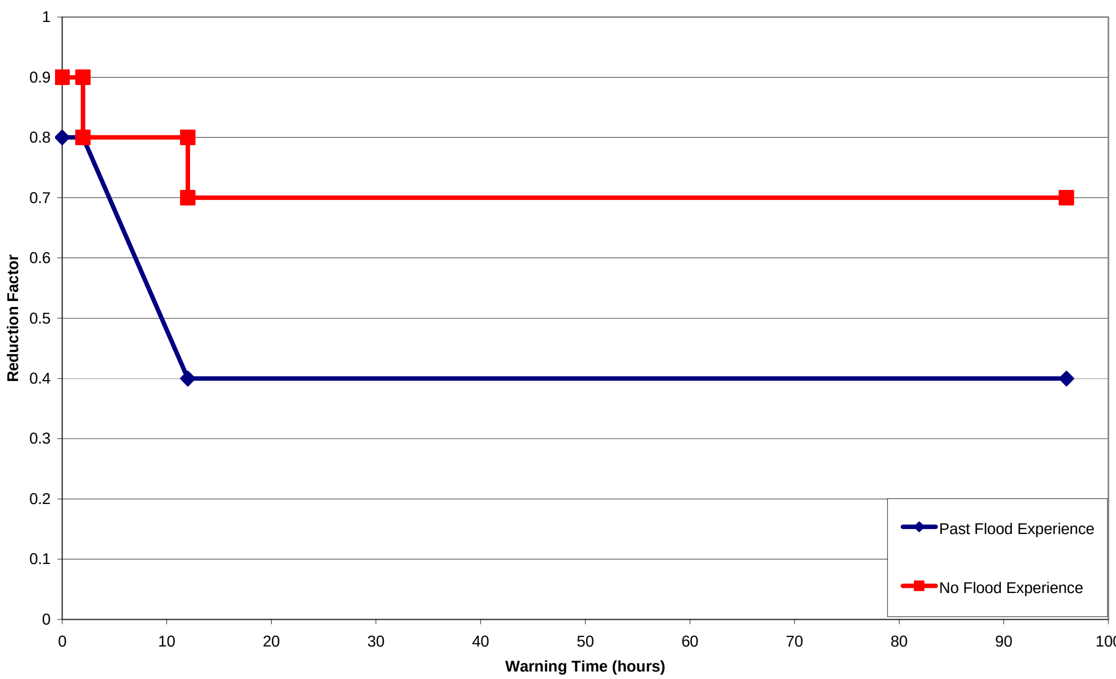

Figure 6-3 Reduction Factor Curves for Potential to Actual Direct Damage Ratio

Infrastructure Damage

Damage to infrastructure includes street and road repairs (including restoration of weakened subgrades), bridge repairs, telephone and telecommunications facilities, electrical connections, water supply and sewerage infrastructure and resulting higher maintenance costs.

For this study, as detailed in the RAM (NRE, 2000), total damage to infrastructure was based on the length of road infrastructure inundated. NRE (2000) considers this assumption reasonable, as much of the service infrastructure follows the paths of road reserves and the quantity of other infrastructure might be expected to be broadly a function of the length of road. Damage to bridges is also incorporated into the NRE (2000) infrastructure damage cost estimates by an approximation of damage to bridges per km of road inundated.

While it is appreciated that using the length of road inundated as the primary measure of total damage to infrastructure is a coarse approximation, it is considered reasonable, as it is the best estimate that we have due to lack of data and as it is only a small portion of the total damage cost.

Roads are subdivided into three categories in NRE (2000) – highway, sealed road and unsealed road. Roads inundated were identified as sealed roads from cadastral information supplied by Strathbogie Shire Council and by inspection of aerial photos.

The length of road inundated for the design flood events was calculated. The RAM (NRE, 2000) estimates of $10,000 per km for initial road repairs, $5,000 per km for road accelerated deterioration and $3,500 per km of road for bridge repairs were adjusted by a Consumer Price Index (CPI) ratio for 1999 to June 2005, to bring them all up to a June 2005 flood damage cost level. The adopted flood damage rates for infrastructure are shown in Table 6-1. The length of inundated road for each design flood event was then multiplied by the adopted flood damage rates.

Table 6-1 Adopted Infrastructure Flood Damage Rates

Infrastructure	Flood Damage Rates (per km of road inundated)
Initial Road Repairs	$12,147
Accelerated Road Deterioration	$6,073
Bridge Repairs and Maintenance	$4,251
Total	$22,471

Estimates adopted from BTE (2001) and adjusted to a June 2005 cost level by a ratio of CPI.

6.3.2 Indirect Flood Damage

Indirect flood damages are damages incurred as a consequence of a flood but are not due to the direct impact of the flood itself (e.g. emergency services, clean-up costs, alternative accommodation, lost business opportunity, etc.). Indirect damages are extremely hard to estimate and are often calculated by assuming they equal 30% of the total actual direct flood damage cost (including damage to properties and infrastructure), as in the RAM (NRE, 2000), however it is recommended that this be revised to best suit population density. BTE (2001) suggests adopting a more rigorous approach, and provide estimates on the cost of post flood clean-up, relocation and emergency response actions. BTE (2001) suggest that post flood residential clean-up may cost approximately $330 for materials and approximately 160 hours in labour (an average weekly wage of $1,008 for May 2005 was adopted from the Bureau of Statistics website). The total commercial clean-up was estimated as $2,400 for inundated properties (BTE, 2001). It was assumed that for external damages (below floor flooding) that the indirect damage cost was equal to one weeks labour. BTE (2001) estimates the cost of residential relocation per property as $53 per house for relocation of household goods and $26 per person per night for alternative accommodation (assuming an average of 2.6 people per household from Bureau of Statistics, and a requirement of seven nights accommodation). BTE (2001) also suggest that volunteer emergency response costs be considered and that estimates of volunteer hours be made. It has been assumed for this study that for the 100, 50 and 20-year ARI design flood events that 50, 40 and 30 volunteers respectively worked for fifteen hours (assuming average weekly wage above). The BTE (2001) cost estimates were based on figures from 1999, they were adjusted by a ratio of CPI for 1999 to June 2005.

To put all these figures into perspective, when applying the above indirect flood damage estimates to each design event it works out that the total indirect flood damage cost is approximately 43% of the total actual direct flood damage cost for the 100-year ARI event and approximately 37% for the 20-year ARI event. This is perhaps higher than the recommended 30% as suggested in the RAM (NRE, 2000). The above indirect flood damage rates are deemed to provide a good estimate of indirect flood damage costs. The BTE (2001) estimates are adopted in this study.

Table 6-2 Adopted Indirect Flood Damage Rates

Indirect Flood Damage Item	Flood Damage Rates
Residential Clean-up Costs	
- Materials	$401 per household (1)
- Labour	$4,032 per household (1,2)
Commercial Clean-up Costs	
- Total	$2,915 per building (1)
Below Floor Flooding Clean-up Costs	
- Total	$1,008 per property (3)
Residential Relocation Costs	
- Relocation of household items	$64 per household (1)
- Alternative accommodation	$575 per household (1,4)
Emergency Response Costs	
- 100-year ARI	$18,902 (5)
- 50-year ARI	$15,122 (5)
- 20-year ARI	$11,341 (5)

1 Estimate adopted from BTE (2001) and adjusted to a June 2005 cost level by a ratio of CPI.

2 Residential labour cost based on 160 hours of labour and an average weekly wage of $1,008.

3 Below floor flooding cost based on one weeks labour and an average weekly wage of $1,008.

4 Alternative accommodation cost assumes an average of 2.6 people per household at $32 per night for 7 nights.

5. Emergency response costs assume that for the 100, 50 and 20 year ARI event that 50, 40 and 30 volunteers respectively worked for 15 hours each at an average weekly wage of $1,008.

6.3.3 Total Flood Damage

The total flood damage cost was calculated as the sum of the direct actual property flood damage cost the direct infrastructure flood damage cost and the indirect flood damage cost.

The Average Annual Damage (AAD) was also calculated. The AAD is a measure of the flood damage per year averaged over an extended period. It is calculated by the area under the flood frequency and total flood damage curve, Figure 6-4 It assumes that no flood damage is incurred at the 5-year ARI flood event, and considers floods up to the 500 year ARI event. The flood damage assessment was conducted for the 10, 20, 50, 100, 200 and 500-year ARI flood events as requested in the project brief.

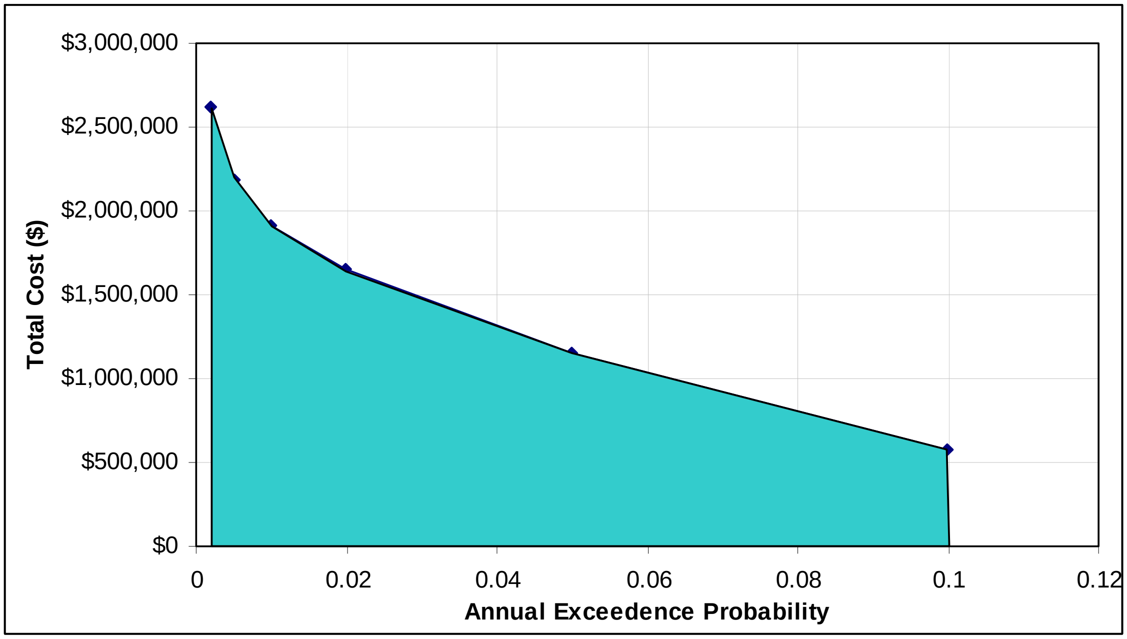

Figure 6-4 Average Annual Damages Curve

6.4 Summary

The results are summarised in Table 6-3. The AAD was calculated to be approximately **$**121,000 per year.

Table 6-3 Flood Damage Assessment Costs for Existing Conditions

Design flood event (ARI (years))	500yr	200yr	100yr	50yr	20yr	10yr
Properties Flooded Above Floor (total)	92	73	63	55	37	14
Properties Flooded Above Floor (residential)	68	53	46	40	27	12
Properties Flooded Above Floor (commercial)	24	20	17	15	10	2
Properties Flooded Below Floor	84	95	99	104	106	104
Total Properties Flooded	**176**	**168**	**162**	**159**	**143**	**118**
Direct Potential External Damage Cost	$411,157	$418,269	$408,597	$400,264	$344,795	$231,537
Direct Potential Residential Damage Cost	$1,221,448	$950,551	$793,370	$645,212	$432,007	$148,996
Direct Potential Commercial Damage Cost	$743,848	$600,440	$498,356	$378,786	$172,364	$40,737
Total Direct Potential Damage Cost	**$2,376,453**	**$1,969,260**	**$1,700,322**	**$1,424,262**	**$949,166**	**$421,270**
Total Actual Damage Cost *(0.8*Potential)*	**$1,901,162**	**$1,575,408**	**$1,360,258**	**$1,139,410**	**$759,333**	**$337,016**
Infrastructure Damage Cost	**$250,674**	**$224,091**	**$218,583**	**$206,922**	**$173,173**	**$132,682**
Indirect Clean Up Cost	$417,796	$343,062	$302,597	$270,526	$194,757	$95,228
Indirect Residential Relocation Cost	$43,462	$33,875	$29,401	$25,566	$17,257	$7,670
Indirect Emergency Response Cost	$7,561	$7,561	$7,561	$7,561	$7,561	$7,561
Total Indirect Cost	**$468,819**	**$384,498**	**$339,559**	**$303,653**	**$219,575**	**$110,458**
Total Cost	**$2,620,656**	**$2,183,997**	**$1,918,400**	**$1,649,985**	**$1,152,081**	**$580,156**

Note: Costs are rounded to the nearest thousand, rounding not carried through the calculations.

The flood scoping study (Geo-Eng 2002) provided the following comments on the flood damage for the 1993 event:

- The 1993 flood affected thirty-three (33) residential and two (2) commercial properties upstream of the railway line
- In all, forty (40) homes were flooded, some to a depth of 1.2m
- Nine (9) businesses were affected including the Catholic Church, Masonic Hall and Bush Nursing Centre.

The magnitude of the 1993 event is similar to the 100-year flood event adopted by this study. The study team assumes that the comments of *forty homes were flooded* and *nine (9) businesses were affected* (Geo-Eng 2002) refers to above floor flooding. Table 6-3 shows 46 residential properties and 17 commercial properties flooded above floor for the 100-year flood event. If the study team's assumption is valid, there is a reasonable agreement between the number of properties flooded in the 1993 and the 100-year flood event.

7 FLOOD MITIGATION MEASURES

7.1 Overview

This section provides a preliminary assessment of the potential mitigation options identified by the flood scoping study and during the course of this study. The assessment has been undertaken through the use of the hydraulic model and subsequent improved understanding of the hydraulic behaviour of floods at Violet Town. The assessment should however not be considered a substitute for the development of a comprehensive floodplain management study for Violet Town.

7.2 Structural Mitigation Measures

Two structural mitigation options were selected for analysis in the hydraulic model based on discussions with the project steering committee. These options were considered likely to provide the greatest reduction in flood risk and consequence at Violet Town. The analysis of these options does not equate to an endorsement of these options but rather provides a basis from which a future comprehensive floodplain management study could be undertaken incorporating community consultation, detailed costing and possibly an additional range of mitigation options available.

7.2.1 Option 1 - Honeysuckle Creek Left Bank Waterway Works

The impact on flooding of a combination of minor and more major works have been investigated on the left bank of Honeysuckle Creek through the use of the hydraulic model. The purpose of these works is to contain flows within the creek and prevent floodwaters breaking out onto the southern floodplain and impacting properties in Violet Town, particularly upstream of the railway line. Figure 7-1 displays the proposed Option 1 works which contain the following elements:

- The construction of a small levee(s) (training walls) to link up with naturally occurring high points on the southern bank of Honeysuckle Creek upstream of the railway line. The levees are designed to prevent flows breaking out to the south during large floods.
- Construction of small uni-directional gated structures on the three small drains that direct flows from the Wodonga-bound on-ramp culvert back into Honeysuckle Creek. The gate structures are proposed to prevent floodwater in Honeysuckle Creek backing out along these drains and impacting properties upstream of the railway line.
- Addition of a uni-directional gate to the culvert running along Railway Street back into Honeysuckle Creek. The gate structure is proposed to prevent floodwaters in Honeysuckle Creek surcharging the pipe and impacting properties in Mary's Lane.

The hydraulic model results for Option 1 have been presented in Figure 7-1. The results have been presented in the form of a difference plot displaying the relative difference in flood levels and extents compared to the existing conditions for a 100-year ARI flood.

The following observations on the impact of the mitigation option are discussed with respect to the hydraulic modelling results:

- The levees and flood gates on the southern bank of Honeysuckle Creek are predicted to result in reductions in flood extents and flood levels upstream of the railway line. Flood levels are predicted to reduce by up to approximately 500 mm locally upstream of the railway line. It should be noted however that flows from the Wodonga-bound on-ramp culvert and Long Gully Creek will still produce flooding upstream of the railway line, but to a reduced magnitude.

- An appreciable reduction in flood extents and flood levels through Violet Town below the railway line are predicted, with maximum flood levels expected to reduce generally by 100 – 300 mm. It should be noted however that flows from the Wodonga-bound on-ramp culvert and Long Gully Creek will still produce flooding through Violet Town downstream of the railway line, but to a reduced magnitude.
- Peak flows through the railway line bridge on Honeysuckle Creek are predicted to increase by approximately 20% to 111 m^3/s. This is predicted to result in increased flood levels along Honeysuckle Creek of generally 100 – 200 mm with some localised increases up to 300mm. The increased flood levels along Honeysuckle Creek are predicted to result in some increases in flood extents along the length of Honeysuckle Creek downstream of the proposed levees. While no additional properties are predicted to be inundated above floor due to the increased flood levels along Honeysuckle Creek, a number of properties near Baird Street that were already vulnerable to flooding under the existing 100-year ARI flood, are likely to be put under increased risk of flooding.

Table 7-1 displays the difference in the property inundation statistics compared to existing conditions.

Table 7-1 Comparison of Non-Vacant Properties Subject to Inundation Statistics for Mitigation Option 1

Item	100yr Mitigation	100yr Existing
Flooded Above Floor (residential)	23	46
Flooded Above Floor (commercial)	8	17
Total Buildings Flooded Above Floor	31	63
Some Inundation on Property	108	99
Total Number Subject to Inundation.	139	162

The mitigation measures modelled for Honeysuckle Creek are predicted to approximately half the number of properties flooded above floor level and provide useful reductions in the total number of properties affected by flooding during a 100-year ARI flood compared to the existing conditions. These comparisons relate only to non-vacant properties, ie, those properties with existing residential or commercial buildings.

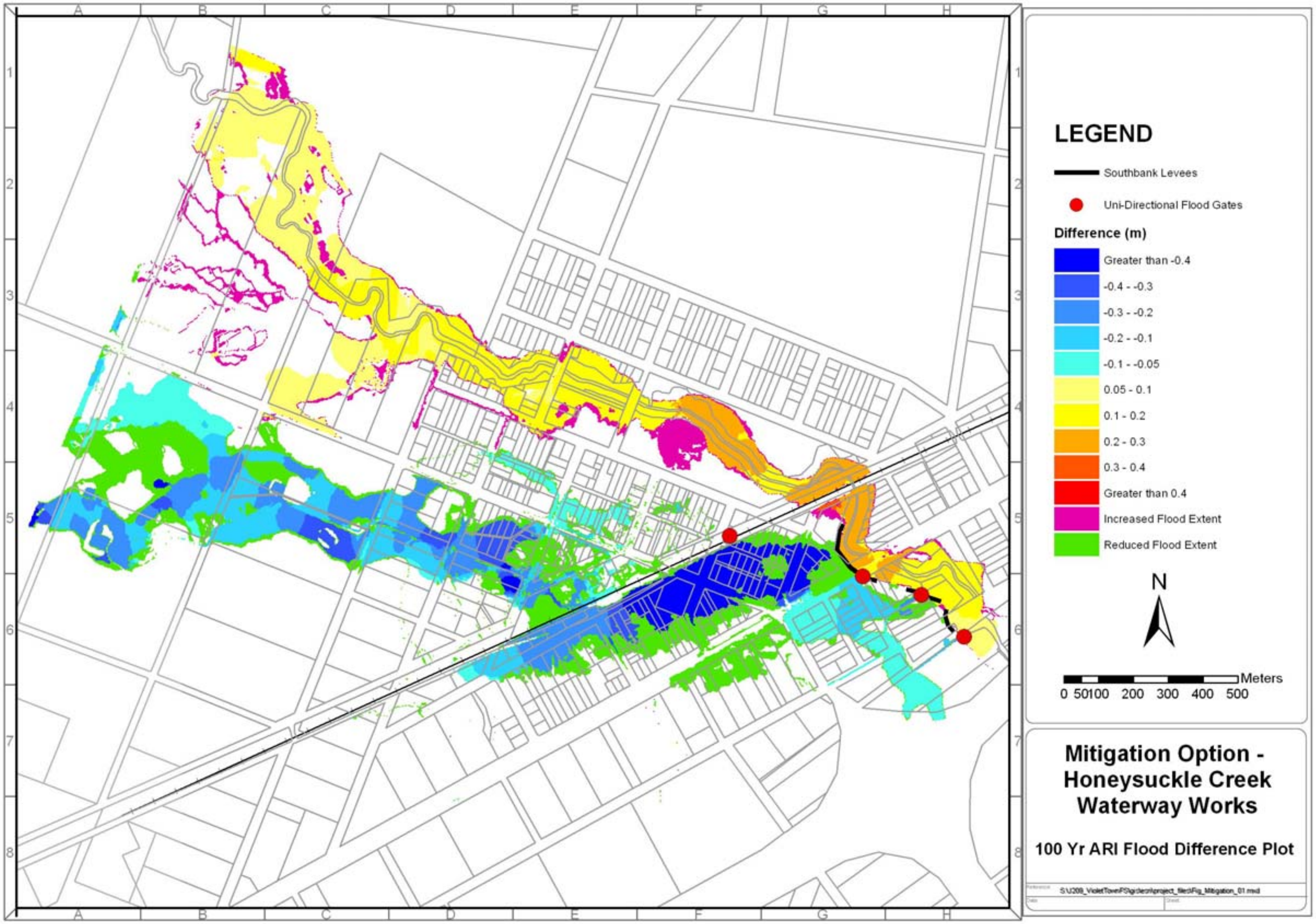

Figure 7-1 Mitigation Option 100-year ARI Flood Level Difference

7.2.2 Option 2 – Long Gully Creek Waterway Works

The impact on flooding of a combination of minor and more major works have been investigated on Long Gully Creek below High Street. The purpose of these works is to contain a greater proportion of flows within the channel and reduce the impact of flows breaking out and impacting properties in Violet Town both above and below the railway line. Figure 7-2 displays the proposed Option 2 works which contain the following elements:

- The enlargement and straightening of the Long Gully Creek channel below High Street to increase its capacity to convey more significant flood flows. Approximately 1200 m of channel has been enlarged in the hydraulic model to provide approximately 13.5 m^2 of cross sectional area with a top width of 9 m and depth of approximately 1.5 to 2.0 m.
- Increasing the cross sectional area available for flows to pass through Long Gully Creek railway culvert by lowering the sill by approximately 1.5 m.
- Lowering the road crest on Lily Street to provide a causeway for flood flows to pass across Lily Street.

The hydraulic model results for this mitigation option have been presented in Figure 7-2. The results have been presented in the form of a difference plot displaying the relative difference in flood levels and extents compared to the existing conditions for a 100-year ARI flood.

The following observations on the impact of the mitigation option are discussed with respect to the hydraulic modelling results:

- Peak flows through the railway line bridge on Long Gully Creek are predicted to increase by approximately 50% to 28.5 m^3/s. This is predicted to result in reduced flooding extents locally upstream of the railway line on Long Gully Creek. Flood levels are also predicted to reduce generally by between 100 to 300 mm upstream of the railway line in the vicinity of Long Gully Creek. It should be noted that flooding upstream of the railway line is still expected due to flows from the Wodonga-bound on-ramp culvert and outbreaks from Honeysuckle Creek
- Modest reductions in flood levels, generally of the order of 100 to 200 mm, and flood extents are predicted by the hydraulic model downstream of the railway line. Also, importantly, the additional capacity created for the Long Gully Creek channel results in no appreciable increase in flood levels or flood extents within the study compared to existing conditions for a 100-year ARI flood.

Table 7-2 displays the difference in the property inundation statistics compared to existing conditions. These comparisons relate only to non-vacant properties, ie, those properties with existing residential or commercial buildings.

Table 7-2 Comparison of Non-Vacant Properties Subject to Inundation Statistics for Mitigation Option 2

Item	100yr Mitigation	100yr Existing
Flooded Above Floor (residential)	43	46
Flooded Above Floor (commercial)	15	17
Flooded Above Floor (total)	58	63
Some Inundation on Property	103	99
Total Number Subject to Inundation.	161	162

The mitigation measures modelled for Long Gully Creek are predicted to result in approximately four less properties flooded above floor level although the same total number of properties is predicted to be affected by flooding during a 100-year ARI flood compared to existing conditions.

7.2.3 Discussion

This study provides a preliminary assessment of two mitigation options. This preliminary assessment provides a broad understanding of the flood level impacts and affected properties of the mitigation options for the 100-year ARI flood event.

On this basis of this preliminary assessment, the study team recommends Option 1 be investigated in more detail to assess the economic cost and benefit of the option. Also this detailed investigation is to assess the risk to properties around Baird Street that are currently not predicted to be flooded in a 100-year ARI flood, but may be under increased risk as a result of Option 1. This recommended detailed investigation is to be included in the preparation of a Violet Town Floodplain Management Plan.

The Community Reference Committee, as part of this Violet Town Flood Study, has identified the following options for further consideration:

- Option 2 as described earlier.
- Reinstatement of the railway bridge that was removed and replaced by the current 1.2 metre diameter pipe culvert during the construction of the standard gauge railway track in the early 1960's.
- Increase flow capacity of other railway culverts.
- Creation of a floodway along Mary's Lane by removal of obstructions.
- Increase waterway capacity of Honeysuckle Creek.
- Provide flow retardation upstream of the Hume Freeway.
- Improved flood warning arrangements.

In addition, the Violet Town Floodplain Management Plan will consider a range of other flood mitigation options suggested by the general community.

It is understood the SSC has commissioned a study to review the capacity of the local drainage infrastructure in Violet Town. Any recommendations from this study to upgrade the local drainage infrastructure should be undertaken in a coordinated manner with any flood mitigation works in Violet Town. Coordination of stormwater and flood mitigation works in Violet Town is likely to improve the economic benefit of these works.

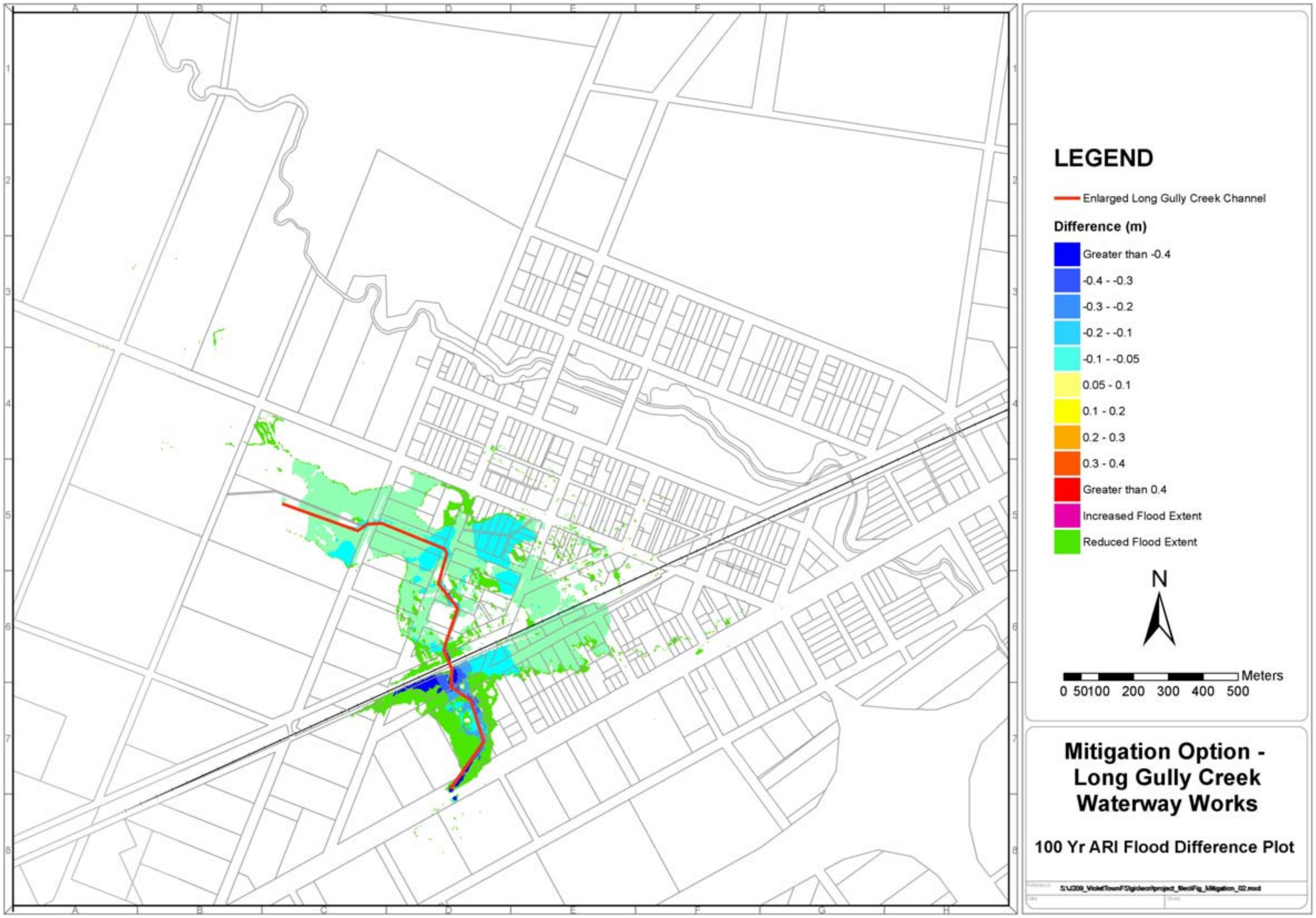

Figure 7-2 Mitigation Option 2 – 100-year ARI Flood Level Difference

7.3 Non-Structural Mitigation Measures

Non-structural measures are management activities aimed at reducing the growth in future damages. Non-structural measures aim to reduce existing flood risk flood by lowering flood damages (consequences) at a given location. Non-structural measures include:

- Catchment management
- Flood awareness, preparedness, warning and response
- Land use planning

Catchment management activities in the upstream catchments can influence the existing catchment runoff characteristics (flood peaks and volumes). The flood volumes and flood peaks are a function of the vegetation cover and land use within a catchment. Land clearing has significantly altered flood response. Further land clearing may lead to increased flood peak and flood volumes resulting from significant rainfall events. Increases in peak flows and flood volumes in turn result a higher flooding likelihood and flood risk. Catchment revegetation, over the longer term may reduce flood volumes. However, in major floods reductions in peak flow would be insignificant.

Flood awareness, preparedness, warning and response aims to reduce the growth in future flood damages by improving community awareness of flooding and emergency services response. Flood awareness within a community reflects the frequency of significant flooding i.e. infrequent insignificant flooding leads to a lower community flood awareness. The most recent significant flooding events occurred in 1993 and 1999. Given relatively infrequent occurrence of significant flooding with associated damages to property, the study team considers the community awareness of floods to be low.

A discussion of flood warning and response arrangements, and community flood awareness is provided in Section 10.

Land use planning aims to reduce the growth in future flood damages by providing appropriate guidelines/controls for land use and development. The Victoria Planning Provisions (VPPs) allow for zoning of land and the application of controls on the type of land use and permitted activities in areas prone to flooding. The VPPs provide for the following zone and two overlays:

- Land Subject to Inundation Overlay (LSIO)
- Floodway Overlay (FO)
- Urban Floodway Zones (UFZ)

The VPPs provide guidelines for the appropriate uses and/or development of land in LSIO, UFZ and FO areas. A more detailed discussion of land-use controls is provided in Section 9.

8 FLOOD INUNDATION MAPPING FOR FLOOD RESPONSE

8.1 Overview

Each design flood, the peak flood elevation at the Baird Street gauge was determined. The flood elevation at the Baird Street gauge was related to the gauge height as shown on the gauge staff boards. Table 8-1 displays the gauge heights at the Baird Street gauge for which flood emergency response maps have been prepared.

Table 8-1 Flood Inundation Emergency Response Maps: Baird Street Gauge Heights for Design Flood Events and Key Historical Events

Baird Street Gauge height[1]	Flood level at Baird Street gauge (m AHD)	Design flood event ARI (years)
3.86	175.71	10
3.97	175.82	20
4.11	175.96	50
4.18	176.03	100
4.23	176.08	200
4.27	176.12	500
5.50	177.35	PMF

1. Baird Street gauge height determined by subtracting the gauge zero elevation in m AHD (171.85 m AHD) from the flood level elevation in m AHD.

The flood response inundation maps have been produced on single A3 and A1 sheets, for each flood event, at 1:6,000. The map base is the cadastre obtained from SSC as current at July 2006. The cadastre is subject to change.

The flood response inundation maps are contained in the accompanying map atlas.

This section details the input data, methodology and outputs for the emergency response inundation mapping. The structure of the section is as follows:

- Flood response inundation map format – outlines the features and formats of the flood inundation maps (Section 8.2)
- Incremental flood inundation map – outlines the features and formats of the incremental flood inundation maps (Section 8.3)
- Flood velocity map – details the preparation of the flood velocity map (Section 8.4)
- Property gauge height correlations – summaries the preparation of the property gauge height correlations estimation (Section 8.5)

8.2 Flood Response Inundation Map Format

8.2.1 Flood extent and flood depth zones

The hydraulic analysis provides a regular grid of flood depth across the hydraulic model study area. As the grid size for the MIKEFLOOD model was 3 m, the flood depths are determined at a 3 m spacing.

The flood extent is defined by the location of the zero flood depth edge. The flood extents were smoothed to reflect the local topography.

Flood depths were classified for mapping employing the following classifications:

- Less than 0.25 m
- 0.25 m to 0.5 m
- 0.5 m to 1.0 m
- Greater than 1.0 m

8.2.2 Flood Elevation Contours

The hydraulic analysis also provides flood elevations to AHD. The flood elevations were contoured at 200 mm intervals. The automatic contouring procedures can create erroneous flood elevation contours which do not reflect the local topographic and hydraulic features. Manual refinement of flood contours was undertaken to remove any erroneous contours.

8.2.3 Flood Affected Properties

A survey was carried out on residential and commercial building floor heights where properties were identified to be within the 100-year ARI flood extent. This information was recorded for 178 properties.

The location of the property foot print polygons indicates the building location. The building's footprint polygons were coloured as follows to indicate the flooding status:

- Below floor flooding:- light grey shading
- Above floor flooding:- red shading

Light grey shading denotes the location of a building not inundated above floor height. It should be noted other areas within the property allotment may however be flooded and access issues should be considered.

8.2.4 Emergency service locations

The locations of the following emergency services were included on the flood response maps:

- Designated Emergency Evacuation Building
- Fire Station
- Police Station

8.3 Incremental flood inundation map

Flood extents from the design flood events were overlayed on a single map. Each design flood extent is coloured differently. The incremental map provides guidance on the gauge height at which access roads are inundated.

8.4 Flood Velocity Map

The hydraulic analysis provides a grid of flow speed and direction (velocity). For the 100-year ARI design event, flow speeds were mapped using the following categories:

- Less than 0.25 m/s
- 0.25 m/s to 0.5 m/s
- 0.5 m/s to 0.75 m/s
- 0.75 m/s to 1.0 m/s
- 1.0 m/s to 1.5 m/s

- Greater than 1.5 m/s

The flow directions were displayed on the map as arrow with the length of the arrow representing the flow speed.

The flow velocity map is contained in the accompanying map atlas.

8.5 Property gauge height correlations

For each flood response map produced, property gauge height correlations have been compiled. The correlations provide peak flow, ARI and gauge height at the Baird Street gauge for each flood response map. The detailed listings provide the following property related data:

- street address,
- building type (i.e. commercial, public or residential),
- ground level
- floor level
- flood elevation, flood depth above ground, flood depth above floor

Appendix B contains the property listings.

9 FLOOD MAPPING FOR LAND USE PLANNING

9.1 Overview

As discussed in Section 7.3, land use planning controls and building regulations provide mechanisms for ensuring appropriate use of land and building construction, given the flooding behaviour. Land use planning controls are aimed at reducing the growth in flood damages over time. The controls balance the likelihood of flooding with the consequences (flood risk).

As part of ongoing municipal reform, the State Government introduced a consistent planning scheme format for application across the State. The Victoria Planning Provisions (VPPs) has been employed by all Victorian municipalities.

Victorian Building Regulations specify that floor levels should be at least 300 mm above a nominated flood level. The nominated flood level is the level of the 100-year ARI flood, or if that has not been determined for a particular area, it is that level nominated by the floodplain management authority usually on the basis of historical flooding. If land is subject to flooding, the municipal council may set conditions that require particular types of construction or particular types of construction materials.

This section details the input data, methodology and outputs for the land use planning flood mapping. The structure of the section is as follows:

- Victoria Planning Provisions – outlines the flood related Victoria Planning Provisions (VPPs) (Section 9.2)
- Flood related planning zones and overlay – details the available flood related planning zone and overlays (Section 9.3)
- Flood related planning zone and overlays delineation – details the delineation of the flood related planning zone and overlays for the study area (Section 9.4)

9.2 Victoria Planning Provisions (VPPs)

The VPPs aim to achieve consistency in the application of planning controls for areas subject to flooding throughout the State. The stated objectives are to protect life, property and community infrastructure from flood hazard, and to preserve flood conveyance capacity, floodplain storage and natural areas of environmental significance.

The VPPs (DoI 2000) provide for two overlays and one zone associated with mainstream flooding as follows:

- Land Subject to Inundation Overlay (LSIO),
- Floodway Overlay (FO),
- Urban Floodway Zone (UFZ).

Details of the above zone and overlays are provided in Section 9.3.

For each of the relevant zone or overlays, the VPPs specify the appropriate types of land uses and developments which are to be regulated through a system of permits. These are intended to achieve consistency throughout the State, but local variations to these guidelines are allowed in planning permit exemptions through a schedule to a flood overlay and/or performance-based criteria through a local floodplain development that has been incorporated into the planning scheme.

9.3 Flood Related Planning Zones and Overlays

9.3.1 Land Subject to Inundation Overlay (LSIO)

The LSIO identifies land liable to inundation by overland flow, in flood storage or in flood fringe areas affected by the 100-year ARI flood.

The permit requirements of LSIO are intended:

- to ensure that development maintains the free passage and temporary storage of floodwaters,
- to minimise flood damage,
- to be compatible with the flood hazard and local drainage conditions,
- not to cause any significant rise in flood level or flow velocity,
- to protect water quality in accordance with relevant State Environment Protection Policies (SEPPs).

In general, emergency facilities (hospitals, schools and police stations etc) must be excluded from this area (refer Clause 15.02). Similarly, developments or land uses which involve the storage or disposal of environmentally hazardous chemicals or wastes, and other dangerous goods should be not located within LSIO.

Permits are required to construct buildings or carry out works including fencing and works which increase the length or height of embankments or roads. Permits are also required to subdivide land.

These controls do not apply to limited categories of buildings or works, such as:

- buildings or works exempted in the schedule incorporated into planning scheme,
- works carried out by the floodplain management authority,
- routine repairs or maintenance to existing buildings or works,
- post and wire, and rural type fencing,
- underground services, and telephone and power lines, provided they do not alter the land surface topography or involve the construction of towers or poles, and provided they are undertaken in accordance with approved plans.

The final extent of the LSIO is discussed in Section 9.4.

9.3.2 Floodway Overlay (FO)

The floodway overlay identifies waterways, main flood paths, drainage depressions and high hazard areas. The identification of floodways can be based on NRE's "Advisory Notes for Delineating Floodways." (NRE 1998). The advisory notes provide three approaches to the delineation of FO, as follows:

- Flood frequency
- Flood hazard
- Flood depth

For **flood frequency**, Appendix A1 of the advisory notes suggest areas which flood frequently and for which the consequences of flooding are moderate or high, should generally be regarded as floodway. The 10-year ARI flood extent was considered an appropriate floodway delineation option for Violet Town.

Flood hazard combines the flood depth and flow speed for a given design flood event. The advisory notes suggest the use of Figure 9-1 for delineating the floodway based on flood hazard. The flood hazard for the 100-year ARI event was considered for this study.

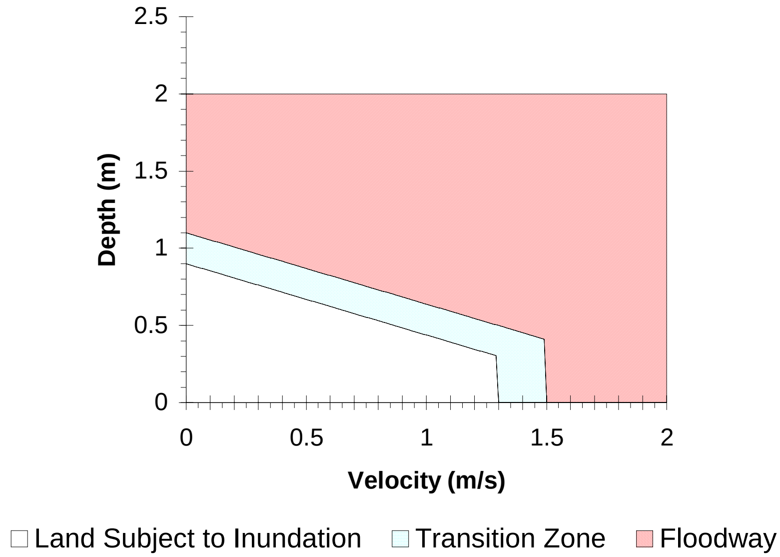

Figure 9-1 Floodway overlay flood hazard criteria

For **flood depth**, regions with a flood depth in the 100-year ARI event greater than 0.5 m were considered as FO based on the flood depth delineation option.

The final extent of the floodway overlay based on the consideration of the three approaches is discussed in Section 9.4.

9.3.3 Urban Floodway Zone (UFZ)

This zone is used to identify waterways, main flood paths, drainage depressions, and high hazard regions within urban areas. Unlike the flood overlays, which provide for additional controls over and above the underlying land use, this zone places restrictions on the use of the land.

The delineation options of the UFZ are determined as for the FO discussed in Section 9.3.2. The final extent of the UFZ, based on the consideration of the three approaches is discussed in Section 9.4.

Within this zone, permits are not required for use of land for agriculture, natural systems, informal outdoor recreation, mineral exploration, or (subject to conditions) mining or stone quarrying.

Permits are required to construct buildings or carry out works including certain fence types and roadworks, except for limited categories of buildings or works. These are identical to those stipulated in the LSIO clauses in the VPPs, except UFZ schedule may only exclude advertising signs.

UFZ and FO have strict controls on subdivisions. Unless a local floodplain development plan specifically provides otherwise, land may only be subdivided to:

- realign lot boundaries,
- excise land to be transferred to the floodplain management authority for public purposes.

9.4 Flood Related Planning Zone and Overlays Delineation

Flood related zone and overlay delineation option maps have been generated to assist GBCMA in the definition of LSIO, FO and UFZ. The delineation option maps overlay the three FO and UFZ extents previously determined and outlined in Section 9.3.2. These maps have been prepared using the hydraulic analysis for existing conditions.

From these delineation option maps, GBCMA has developed the planning maps in accordance with the Victoria Planning Provisions Practice Notes – Applying the Flood Provisions in Planning Scheme (DoI 2000).

Figure 9-2 displays the draft UFZ, LSIO and FO delineations. The 100-year flood level declaration map is included on the accompanying study DVD.

The study team recommends the SSC and GBCMA liaise in the preparation and adoption of a planning scheme amendment to enable the draft flood related planning zone and overlays.

Further, the study team recommends GBCMA declares the 100-year ARI flood level for planning purposes under the Water Act (1989).

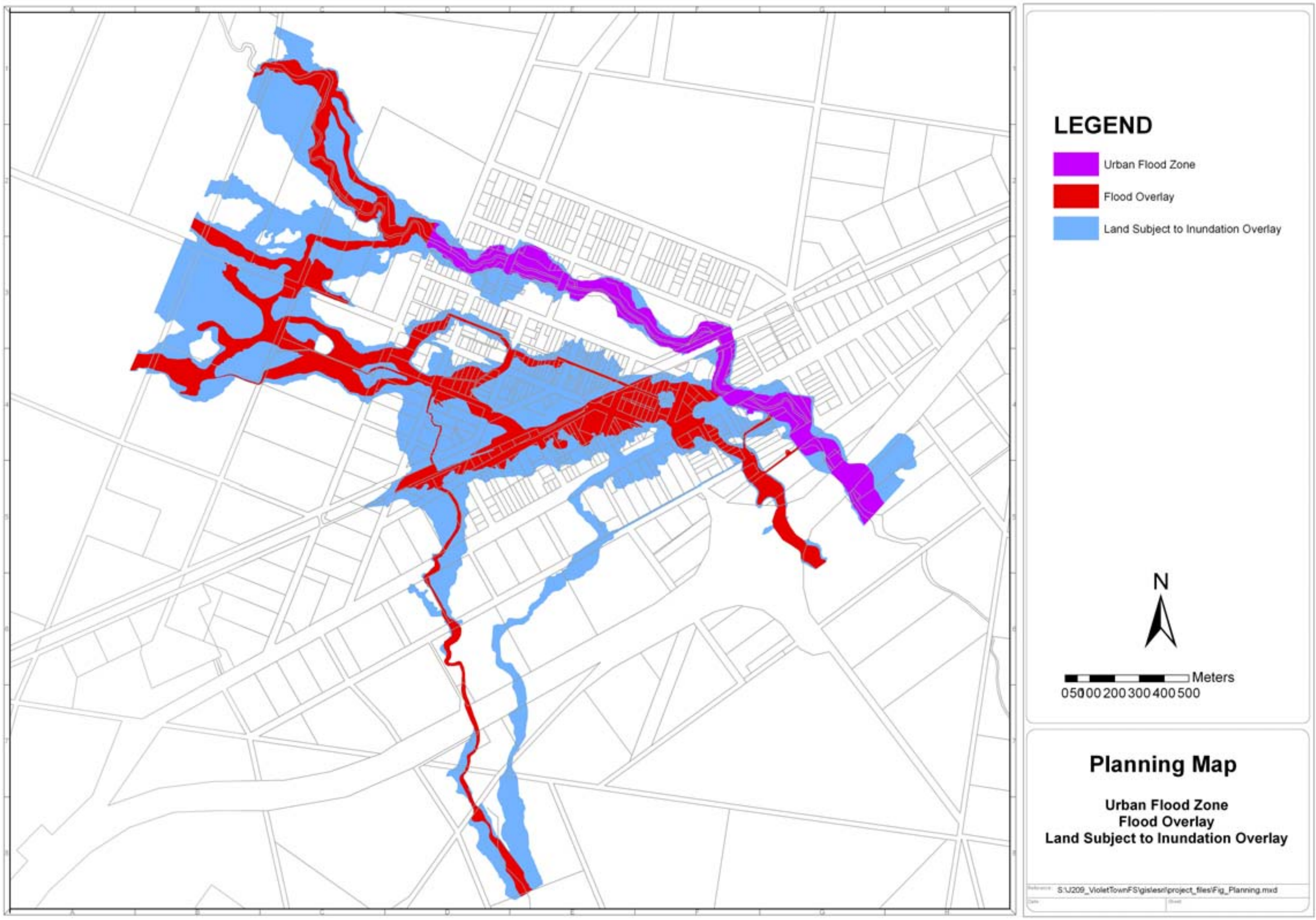

Figure 9-2 Planning Scheme Flood Overlay Delineations

10 FLOOD WARNING AND RESPONSE PROCEDURES REVIEW

10.1 Overview

This section focuses on the review of the existing flood forecasting, warning and response arrangements in operation for Violet Town. The review draws on available on information form the following sources:

- Violet Town Flood scoping study (GeoEng 2002)
- Violet Town Flood Plan (Strathbogie Shire Council – 2004)
- Bureau of Meteorology – Discussions and correspondence (2007)

This section provides preliminary comments on the adequacy of the existing flood warning and responses arrangements. Comments are made on the role of community awareness in flood response. Recommendations for further investigation are provided.

10.2 Flood Forecasting and Warning Components

The existing flood forecasting and warning system comprises three streamflow gauges, one rain gauge and information on recent flood events. Three streamflow gauges are located adjacent to Saw Pit Gully Road (Honeysuckle Creek at Upstream of Violet Town GS405294 ~ 10 km upstream), Hayes Road (~ 5 km upstream), at Baird Street within Violet Town.

The latter two gauges were staff gauges installed as part of a Strathbogie Shire initiative aimed at providing the local community with river level information. The gauges are read by a volunteer observer during high flow events on an as-needs basis and the resulting data/levels are recorded on log sheets by the Shire (Geo Eng 2002). However, through the Community Reference Committee project steering committee, the study team understands that the arrangements for recording of flood levels at both Hayes Road and Baird Street are ad-hoc. The study team recommends that the flood monitoring procedures be formalised as part of the flood warning arrangements. GeoEng (2002) provided the following comment on the status of flood warning:

> *"…because of the short lead time involved, greater responsibility for monitoring rainfall, creek levels and local information should be given to Violet Town residents and that the procedures to be followed for both obtaining relevant information and disseminating it along with possible flood predictions need to be made more robust"*.

The study team understands that there is no flood forecasting models/relationship employed for Violet Town for the Honeysuckle Creek catchment. Further, the study team understands the flood height data collected at the upstream staff gauge (Hayes Road) is not employed to forecast flood heights at the Baird Street gauge in real time.

The study team agrees that the flood warning time is short given the nature of the catchment, likely to be less than 6 to 9 hours. This short lead-time limits the effectiveness of the flood forecasting from the upstream gauges with insufficient warning time to enable appropriate response by the community and/or relevant agencies.

The flood inundation maps, as discussed in Section 8, provide information on flood depths and extents across Violet Town for a range of flood heights at the Baird Street. These flood inundation maps inform the community and relevant agencies of existing flood risk on an individual property basis. The study team considers the utilisation of the flood inundation maps in flood warning and response as essential.

Given the insufficient warning time, the study team considers further investigation into the development of rainfall based flood forecast model, or the determination of flood forecasts based on the Hayes Road gauge is unlikely to yield reliable relationships for use in flood forecasting.

The study team recommends the SSC and GBCMA liaise to consider feasible flood warning arrangements, given the nature of the contributing catchments. The consideration of feasible flood warning arrangements is to involve discussions with Bureau of Meteorology. Procedures for flood monitoring at the Hayes Road and Baird Street gauges are to be included in the development of the flood warning arrangements. The possibility of alarm mechanism linked to possible stream gauge telemetry or web-based environment should be explored. The flood warning arrangements are to be included in the preparation of the Violet Town Floodplain Management Plan.

The flood inundation maps, outlined in Section 8, equate to flood levels at the Baird Street gauge ranging from 3.86 m to 4.27 m. A single gauge board is currently located immediately upstream of the Baird Street on the northern bank. At present, the gauge extends to a height of 3 metres. Given the events (10-year to 500-year) considered by this study results in flood levels up to 4.27 m, the study team recommends the siting of an additional gauge board at the Baird Street gauge to extend the gauge to at least 4.5 m.

10.3 Response components

The study team received a copy of the Violet Town Flood Plan (Strathbogie Shire Council – Township and Rural surrounds 2004) from the Strathbogie Shire Council. This plan has been prepared as part of the Strathbogie Shire Council Municipal Emergency Management Plan.

The study team reviewed the available plan and the following discussion provides comments for consideration by the Shire and GBCMA.

The plan provides general policy framework for flood response in the Strathbogie Shire. However, the plan lacks specific actions and triggers (flood heights) for the flood response in Violet Town. The flood inundation maps, as discussed in Section 8, provide information of flood depth and extents across Violet Town for a range of flood heights at the Baird Street Gauge. These flood maps can provide information to aid in flood response as such road closures, overland flowpaths and affected property locations. The study team recommends the revision of the flood plan to include specific actions and triggers.

The plan outlines the Township Flood warning procedure in Part 2.6. This documented procedure contains limited detail on specific actions required. As discussed in Section 10.2, the flood warning procedure requires revision through discussions between Strathbogie Shire, GBCMA and the Bureau of Meteorology. The study team recommends the relevant flood warning procedure is updating following these discussions.

The study team recommends a full revision of the plan to ensure the incorporation of the flood inundation maps developed by this study. The revision of the flood sub-plan is to be included in the preparation of the Violet Town Floodplain Management Plan.

Improved community awareness of the flood risk can be aid in effective flood response. Using the study outcomes, the study team recommends material aimed at improving community flood awareness is prepared and distributed. The preparation of this material is to be included in the development of the Violet Town Floodplain Management Plan.

11 CONCLUSIONS AND RECOMMENDATIONS

The Violet Town Flood Study has increased the understanding of flood behaviour throughout the study area, leading to the following recommendations.

Existing conditions flood behaviour

The existing levee on the right bank of Long Gully upstream of Balmattun Road limits the breakout from Long Gully in this reach. Local runoff from the upslope catchment is directed by the levee through culverts under the Hume Freeway to the north of the Long Gully crossing. This flowpath continues in a north west direction towards Murray and Meakin Streets.

A quantitative assessment of the Long Gully levee influence on flood behaviour is warranted. Such quantitative assessment would underpin consideration of management arrangements for the levee.

Mitigation options

In partnership with the community, a detailed investigation into a range of flood mitigation options is to be the focus in the preparation of a Violet Town Floodplain Management Plan.

It is understood the SSC has commissioned a study to review the capacity of the local drainage infrastructure in Violet Town. Any recommendations from this study to upgrade the local drainage infrastructure should be undertaken in a coordinated manner with any flood mitigation works in Violet Town. Coordination of stormwater and flood mitigation works in Violet Town is likely to improve the economic benefit of these works.

Land Use Planning

The hydraulic analysis enabled the delineation of revised UFZ, FO and LSIO within the study area.

The study team recommends the SSC and GBCMA liaise in the preparation and adoption of a planning scheme amendment to enable the draft flood related planning zone and overlays.

Further, the study team recommends GBCMA declares the 100-year ARI flood level for planning purposes under the Water Act (1989).

Flood Warning and Response

The study team recommends the SSC and GBCMA liaise to consider feasible flood warning arrangements, given the nature of the contributing catchments. The consideration of feasible flood warning arrangement is to involve discussions with Bureau of Meteorology. The flood warning arrangements are to be included in the preparation of the Violet Town Floodplain Management Plan.

The study team recommends a full revision of the flood sub-plan of the Strathbogie MEMP to ensure the incorporation of the flood inundation maps developed by this study. The revision of the flood sub-plan is to be included in the preparation of a floodplain management plan for Violet Town.

Improved community awareness of the flood risk can aid effective flood response. Using the study outcomes, the study team recommends material aimed at improving community flood awareness is prepared and distributed. The preparation of this material is to be included in the development of the Floodplain Management Plan for Violet Town.

The study team recommends the siting of an additional gauge board at the Baird Street to extend the gauge to at least 4.5 m. The study team recommends that the community be made aware of flooding risk at each specific property given that this information in now readily available.

Table 11-1 lists the study recommendations and indicative costs.

Table 11-1 Study recommendations

Recommendation	Priority	Indicative cost (ex GST)
SSC and GBCMA liaise in the preparation and adoption of a planning scheme amendment to enable the draft flood related planning zone and overlays.	**High**	**$2,000**
GBCMA declares the 100-year ARI flood levels for planning and building purposes under the Water Act (1989).	**High**	**$1,000**
SSC liaise with GBCMA to site an additional gauge board at the Baird Street to extend the gauge to at least 4.5 m.	**Medium**	**$1,500**
SCC liaise with GBCMA to prepare a funding bid to State and Australian Governments for the development of a Floodplain Management Plan	**High**	**$2,000**
SSC and GBCMA liaise in the preparation of a Floodplain Management Plan including the following elements: - Preparation of Water Management Scheme or similar: This requires the assessment of mitigation measures, community consultation and assessment of the Long Gully levee. - Development of flood warning arrangements for Violet Town including flood monitoring procedures for the Hayes Road and Baird Street gauges. - Revision of MEMP Flood sub-plan - Development of community flood awareness material	**High**	**$75,000**

12 REFERENCES

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Institution of Engineers Australia (IEAust, 1999): *Australian Rainfall and Runoff*, Vols 1&2. (Ed: Pilgrim D.H.) Institution of Engineers, Australia.

Laurenson E.M. Mein R. G. and Nathan, R.J., (2005). RORB - *Version 5 Runoff Routing Program User Manual*. Monash University Department of Civil Engineering.

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APPENDIX A RORB MODEL DATA FILES

HoneySuckle Creek

1, channel type flag - all reaches natural
1,1.4,-99, sub-area A (1.4 km)
2,1.8,-99, sub-area B (1.8 km)
2,1.7,-99, sub-area C (1.7 km)
2,1.7,-99, sub-area D (1.7 km)
2,0.8,-99, sub-area E (0.8 km)
7
405294A Honeysuckle Ck U/S Violet Town
5,2.1,-99, route to F
2,2.1,-99, sub-area F (2.1 km)
3, store
1,1.9,-99, sub-area G (1.9 km)
2,2.3,-99, sub-area H (2.3 km)
2,1.5,-99, sub-area I (1.5 km)
4, add h/g's
5,1.2,-99, route to J input
2,1.6,-99, sub-area J (1.6 km)
3, store
2,2.5,-99, sub-area K (2.5 km)
4, add h/g's
5,1.6,-99, route to L input
2,1.5,-99, sub-area L (1.5 km)
7
U/S Hume Honeysuckle
5,1.4,-99, route to N input
3, store
2,1.1,-99 sub-area M (1.08 km)
7
U/S Hume Culvert
5,1.5,-99, route to N input
4, add h/g's
2,3.5,-99, sub-area N (3.5 km)
2,2.3,-99, sub-area O (2.3 lm)
7
Confluence Stony Creek
0, end vector
C Catchment sub areas
6.09,4.72,3.69,3.67,5.15,3.58,4.67,6.42,4.88,3.47,7.28,3.48,2.02,4.84,3.71,-99, areas (sq. km)
0,-99, all areas pervio

Long Gully Creek

1, channel type flag - all reaches natural
1,1.1,-99, sub-area A (1.1 km)

2,0.8,-99, sub-area B (0.8 km)
2,0.7,-99, sub-area C (0.7 km)
2,0.8,-99, sub-area D (0.8 km)
2,1.0,-99, sub-area E (1.0 km)
2,0.25,-99, sub-area F (0.25 km)
7
U/S Hume Highway
5,0.6,-99, route to G input
2,1.1,-99, sub-area G (1.1 km)
2,0.6,-99 sub-area H (0.6 mk)
7
D/S Study Boundary
0, end vector
C Catchment sub areas
0.98,0.87,1.17,1.25,1.09,0.82,0.81,1.09,-99, areas (sq. km)
0,-99, all areas pervio

APPENDIX B PROPERTY GAUGE HEIGHT CORRELATIONS

Violet Town Property Listings

Estimated ARI: 10 Year ARI (10% AEP)
Baird Street Gauge Height: 3.86m (175.71m AHD)

Above Floor Flooded Properties: 14
Below Floor Flooded Properties: 104
Total Flooded Properties: 118

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.50	175.47	0.18	0.13
3	Baird Street	RES	175.02	175.44	175.51	175.48	0.17	0.04
5	Baird Street	RES	175.09	175.23	175.51	175.49	0.36	0.26
15	Cowslip Street	RES	177.17	177.63	177.93	177.83	0.67	0.20
17	Cowslip Street	RES	177.13	177.55	177.93	177.83	0.71	0.28
19	Cowslip Street	RES	176.92	177.82	177.93	177.83	0.92	0.01
32	Cowslip Street	COM	174.71	175.20	175.25	175.23	0.28	0.03
4	Daisy Street	COM	177.87	177.78	178.20	178.11	0.33	0.33
9	Daisy Street	RES	177.19	177.59	177.93	177.84	0.64	0.25
10	Daisy Street	RES	177.33	177.78	177.93	177.84	0.50	0.06
4	Hyacinth Street	RES	175.74	175.99	176.12	176.12	0.38	0.13
12	Primrose Street	RES	176.68	178.27	178.55	178.53	1.61	0.26
23	Primrose Street	RES	177.68	177.87	177.95	177.95	0.27	0.07
1	Rose Street	RES	174.56	174.74	174.80	174.79	0.24	0.05

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	175.77	N/A	0.33	N/A
1	Cowslip Street	RES	177.84	179.08	178.23	178.16	0.38	-0.917
3	Cowslip Street	RES	177.62	178.16	178.16	177.91	0.33	-0.248
6	Cowslip Street	RES	177.61	178.42	177.93	N/A	0.23	N/A
7	Cowslip Street	RES	177.42	178.87	177.94	N/A	0.42	N/A
8	Cowslip Street	RES	177.20	178.04	177.93	177.83	0.63	-0.206
9	Cowslip Street	RES	177.40	178.14	177.93	N/A	0.44	N/A
12	Cowslip Street	COM	177.27	177.87	177.93	177.83	0.60	-0.036
21	Cowslip Street	RES	176.21	177.37	176.44	N/A	0.16	N/A
32A	Cowslip Street	RES	174.34	175.68	175.10	175.06	0.52	-0.621
34	Cowslip Street	RES	174.32	175.27	174.88	174.85	0.53	-0.421
35	Cowslip Street	COM	175.53	176.28	175.86	175.86	0.32	-0.421
36	Cowslip Street	RES	174.32	175.29	174.88	174.85	0.53	-0.441
37-39	Cowslip Street	RES	175.53	176.00	175.73	N/A	0.19	N/A
40	Cowslip Street	RES	174.18	175.80	174.85	N/A	0.71	N/A
43	Cowslip Street	COM	175.29	175.84	175.70	N/A	0.35	N/A
47	Cowslip Street	RES	175.24	175.94	175.66	N/A	0.39	N/A
48	Cowslip Street	COM	173.66	175.04	174.67	N/A	0.58	N/A
51	Cowslip Street	COM	175.24	175.65	175.63	175.60	0.37	-0.047
87	Cowslip Street	RES	174.30	174.63	174.40	N/A	0.11	N/A
2	Crocus Street	RES	177.95	178.64	178.36	178.28	0.31	-0.356
5	Crocus Street	RES	177.45	179.16	178.46	N/A	0.54	N/A
7	Crocus Street	RES	177.87	178.59	178.31	178.27	0.35	-0.32
1	Dahlia Street	RES	177.38	177.86	177.94	177.83	0.46	-0.026
3	Dahlia Street	RES	177.61	178.25	177.93	N/A	0.23	N/A
1	Daisy Street	RES	178.00	178.91	178.26	N/A	0.25	N/A
3	Daisy Street	RES	177.84	178.51	178.20	N/A	0.21	N/A
7	Daisy Street	COM	177.22	178.32	177.94	N/A	0.62	N/A
11	Daisy Street	RES	177.31	178.49	177.93	177.84	0.53	-0.654

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
14	Daisy Street	RES	177.20	177.96	177.93	177.84	0.63	-0.125
172	High Street	RES	178.12	179.25	178.47	N/A	0.20	N/A
176	High Street	RES	178.11	179.35	178.32	N/A	0.21	N/A
179	High Street	RES	178.90	179.66	179.35	179.30	0.41	-0.356
180	High Street	RES	177.71	178.82	178.39	178.21	0.51	-0.61
302	High Street	RES	177.64	179.91	180.58	179.56	2.22	-0.346
12	Hurt Street	RES	174.08	176.25	175.10	N/A	1.02	N/A
14	Hurt Street	RES	174.16	176.00	175.12	N/A	0.92	N/A
16	Hurt Street	RES	174.57	176.05	175.35	N/A	0.52	N/A
18	Hurt Street	RES	175.13	176.17	175.77	175.75	0.62	-0.42
22	Hurt Street	RES	174.75	176.92	175.83	N/A	1.04	N/A
24	Hurt Street	RES	175.35	177.22	175.86	N/A	0.50	N/A
1	Hyacinth Street	RES	176.14	176.30	176.26	176.25	0.14	-0.053
1A	Hyacinth Street	RES	175.99	176.55	176.26	176.27	0.26	-0.277
2	Hyacinth Street	RES	175.91	176.26	176.13	176.12	0.21	-0.144
3	Hyacinth Street	RES	175.78	176.55	176.33	176.30	0.49	-0.254
5	Hyacinth Street	RES	175.97	176.73	176.34	176.29	0.32	-0.436
6	Hyacinth Street	RES	175.68	176.23	176.12	176.12	0.20	-0.114
8	Hyacinth Street	COM	175.62	176.07	175.91	175.88	0.26	-0.189
5	Lily Street	COM	175.54	176.03	175.57	N/A	0.06	N/A
6	Lily Street	RES	175.06	175.71	175.63	175.62	0.56	-0.091
4/8	Lily Street	RES	175.96	176.49	176.00	176.03	0.05	-0.465
9	Lily Street	RES	174.36	175.92	174.86	N/A	0.49	N/A
10	Lily Street	RES	175.80	176.36	176.04	N/A	0.22	N/A
11	Lily Street	RES	174.71	176.46	175.90	N/A	0.15	N/A
11	Lily Street	RES	174.41	176.42	174.88	N/A	0.47	N/A
12	Lily Street	RES	175.74	176.27	176.07	176.04	0.34	-0.228
13	Lily Street	RES	174.61	176.17	175.88	175.87	0.42	-0.304
17	Lily Street	RES	175.06	176.26	176.25	N/A	0.40	N/A
21A	Lily Street	RES	175.61	176.47	176.34	176.26	0.25	-0.211

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
23	Lily Street	RES	176.01	176.92	176.84	176.49	0.34	-0.428
27	Marys Lane	RES	174.49	175.31	174.85	N/A	0.35	N/A
7	McDiarmids Road	COM	172.84	174.62	174.75	174.11	1.55	-0.513
2	Mitchell Street	RES	174.30	175.12	174.99	N/A	0.29	N/A
	Mitchell Street	RES	169.39	174.49	174.46	N/A	3.42	N/A
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.74	N/A	2.87	N/A
4446	Murchison-Violet Town Road	COM	170.91	173.66	173.87	N/A	2.06	N/A
1	Nicholson Street	RES	174.28	175.75	175.80	N/A	0.81	N/A
1	Primrose Street	RES	177.38	178.86	177.93	177.83	0.56	-1.027
2	Primrose Street	RES	177.38	178.60	177.98	177.97	0.60	-0.627
3	Primrose Street	RES	177.72	178.12	177.93	177.86	0.15	-0.263
5	Primrose Street	RES	177.75	178.39	177.93	N/A	0.14	N/A
8	Primrose Street	RES	177.48	178.37	178.48	178.35	0.55	-0.023
9	Primrose Street	RES	177.81	178.25	177.91	N/A	0.10	N/A
11	Primrose Street	COM	177.75	178.09	177.91	N/A	0.15	N/A
13	Primrose Street	RES	177.70	178.07	177.91	177.90	0.22	-0.169
15	Primrose Street	RES	177.75	178.29	0.00	N/A	0.20	N/A
25	Primrose Street	RES	177.65	178.23	177.96	N/A	0.30	N/A
27A	Primrose Street	RES	177.76	178.15	177.96	N/A	0.19	N/A
35-39	Primrose Street	RES	178.38	179.35	179.53	178.91	0.42	-0.44
n/a	Railway Statio n Building	COM	175.81	179.20	177.96	N/A	1.49	N/A
3	Railway Street	RES	176.65	177.13	176.97	176.97	0.17	-0.158
7	Railway Street	COM	176.35	177.00	176.86	176.85	0.29	-0.147
9	Railway Street	RES	176.30	176.67	176.58	N/A	0.18	N/A
3	Rose Street	RES	174.69	175.00	174.80	N/A	0.10	N/A
6	Rose Street	RES	174.21	174.99	174.49	N/A	0.22	N/A
7	Rose Street	RES	174.55	175.35	174.85	N/A	0.30	N/A
8	Rose Street	RES	173.81	174.60	174.31	174.40	0.59	-0.203
10	Rose Street	RES	173.82	174.58	174.31	N/A	0.60	N/A
12	Rose Street	RES	173.92	175.14	174.31	N/A	0.48	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
28	Rose Street	RES	175.37	176.68	176.28	N/A	0.78	N/A
2	Tulip Street	COM	175.48	176.62	177.45	N/A	1.32	N/A
4	Tulip Street	RES	174.67	175.37	175.22	175.10	0.26	-0.268
7	Tulip Street	RES	176.42	176.89	176.93	176.69	0.27	-0.203
8	Tulip Street	RES	174.44	175.35	174.69	N/A	0.25	N/A
10	Tulip Street	RES	174.41	175.30	174.69	N/A	0.22	N/A
12	Tulip Street	RES	174.12	175.08	174.63	N/A	0.34	N/A
13	Tulip Street	RES	176.50	176.59	176.76	N/A	0.09	N/A
15	Tulip Street	RES	176.42	176.74	176.62	N/A	0.09	N/A
14	Tulip Street	RES	173.98	175.29	174.46	N/A	0.44	N/A
17	Tulip Street	RES	176.34	176.53	176.58	N/A	0.11	N/A
18	Tulip Street	RES	174.07	175.22	174.44	N/A	0.35	N/A
23	Tulip Street	RES	176.04	176.52	176.26	176.25	0.21	-0.274
47	Tulip Street	RES	174.62	175.98	174.85	N/A	0.25	N/A
49	Tulip Street	RES	174.52	175.79	174.85	N/A	0.34	N/A

Violet Town Property Listings

Estimated ARI: 20 Year ARI (5% AEP)
Baird Street Gauge Height: 3.97m (175.82m AHD)

Above Floor Flooded Properties: 37
Below Floor Flooded Properties: 106
Total Flooded Properties: 143

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.56	175.54	0.30	0.20
3	Baird Street	RES	175.02	175.44	175.57	175.56	0.24	0.12
5	Baird Street	RES	175.09	175.23	175.57	175.56	0.43	0.33
3	Cowslip Street	RES	177.62	178.16	178.31	178.29	0.66	0.13
8	Cowslip Street	RES	177.20	178.04	178.26	178.26	1.06	0.22
9	Cowslip Street	RES	177.40	178.14	178.27	178.27	0.87	0.13
12	Cowslip Street	COM	177.27	177.87	178.26	178.26	1.02	0.39
15	Cowslip Street	RES	177.17	177.63	178.26	178.26	1.09	0.63
16	Cowslip Street	COM	176.21	176.75	176.81	176.80	0.13	0.05
17	Cowslip Street	RES	177.13	177.55	178.26	178.26	1.14	0.71
19	Cowslip Street	RES	176.92	177.82	178.26	178.26	1.35	0.44
31	Cowslip Street	COM	176.02	176.11	176.21	176.14	0.09	0.03
32	Cowslip Street	COM	174.71	175.20	175.32	175.30	0.36	0.10
33	Cowslip Street	COM	176.21	176.37	176.49	176.49	0.16	0.12
35	Cowslip Street	COM	175.53	176.28	176.36	176.35	0.35	0.07
37-39	Cowslip Street	RES	175.53	176.00	176.03	176.08	0.22	0.08
43	Cowslip Street	COM	175.29	175.84	175.96	175.97	0.38	0.13
51	Cowslip Street	COM	175.24	175.65	175.66	175.66	0.38	0.01
1	Dahlia Street	RES	177.38	177.86	178.26	178.26	0.89	0.40
3	Dahlia Street	RES	177.61	178.25	178.26	178.26	0.65	0.01
4	Daisy Street	COM	177.87	177.78	178.34	178.30	0.51	0.52

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
9	Daisy Street	RES	177.19	177.59	178.27	178.27	1.07	0.67
10	Daisy Street	RES	177.33	177.78	178.27	178.27	0.93	0.49
14	Daisy Street	RES	177.20	177.96	178.26	178.26	1.06	0.30
5	Daphne Street	RES	177.04	177.63	177.97	177.73	0.26	0.10
1	Hyacinth Street	RES	176.14	176.30	176.46	176.41	0.15	0.11
4	Hyacinth Street	RES	175.74	175.99	176.14	176.13	0.39	0.14
10	Lily Street	RES	175.80	176.36	176.72	176.38	0.31	0.02
3	Primrose Street	RES	177.72	178.12	178.25	178.25	0.54	0.13
7	Primrose Street	RES	177.91	178.06	178.24	178.24	0.33	0.18
11	Primrose Street	COM	177.75	178.09	178.23	178.23	0.47	0.13
12	Primrose Street	RES	176.68	178.27	178.58	178.56	1.67	0.28
13	Primrose Street	RES	177.70	178.07	178.23	178.22	0.53	0.15
23	Primrose Street	RES	177.68	177.87	178.21	178.21	0.53	0.34
27A	Primrose Street	RES	177.76	178.15	178.22	178.21	0.45	0.06
1	Rose Street	RES	174.56	174.74	174.83	174.82	0.28	0.08
17	Tulip Street	RES	176.34	176.53	176.59	176.56	0.23	0.03

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	175.99	N/A	0.45	N/A
1	Cowslip Street	RES	177.84	179.08	178.42	178.37	0.59	-0.707
4	Cowslip Street	RES	178.00	178.73	178.27	N/A	0.28	N/A
6	Cowslip Street	RES	177.61	178.42	178.26	178.26	0.65	-0.16
7	Cowslip Street	RES	177.42	178.87	178.27	178.27	0.84	-0.601
20	Cowslip Street	COM	175.87	176.27	176.94	176.07	0.15	-0.205
21	Cowslip Street	RES	176.21	177.37	176.45	N/A	0.17	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2/22	Cowslip Street	COM	175.82	176.08	176.85	176.00	0.18	-0.08
28	Cowslip Street	COM	175.69	175.86	176.33	N/A	0.26	N/A
30	Cowslip Street	COM	175.43	175.92	176.17	175.69	0.22	-0.231
31	Cowslip Street	COM	176.23	176.62	176.55	176.57	0.16	-0.054
32A	Cowslip Street	RES	174.34	175.68	175.15	175.09	0.64	-0.589
34	Cowslip Street	RES	174.32	175.27	175.00	174.97	0.65	-0.298
36	Cowslip Street	RES	174.32	175.29	174.99	174.97	0.65	-0.319
40	Cowslip Street	RES	174.18	175.80	174.97	N/A	0.83	N/A
47	Cowslip Street	RES	175.24	175.94	175.80	175.92	0.43	-0.023
48	Cowslip Street	COM	173.66	175.04	174.87	N/A	0.77	N/A
87	Cowslip Street	RES	174.30	174.63	174.48	N/A	0.06	N/A
2	Crocus Street	RES	177.95	178.64	178.48	178.45	0.50	-0.193
5	Crocus Street	RES	177.45	179.16	178.58	N/A	0.65	N/A
7	Crocus Street	RES	177.87	178.59	178.45	178.44	0.55	-0.151
5	Dahlia Street	RES	178.05	178.57	178.26	178.26	0.21	-0.31
1	Daisy Street	RES	178.00	178.91	178.41	178.41	0.44	-0.496
3	Daisy Street	RES	177.84	178.51	178.40	178.41	0.46	-0.105
7	Daisy Street	COM	177.22	178.32	178.27	178.27	1.05	-0.048
11	Daisy Street	RES	177.31	178.49	178.27	178.27	0.96	-0.225
1	Daphne Street	RES	176.39	177.47	177.21	177.15	0.43	-0.316
3	Daphne Street	RES	176.86	177.49	177.57	177.28	0.26	-0.211
172	High Street	RES	178.12	179.25	178.93	178.80	0.37	-0.453
176	High Street	RES	178.11	179.35	178.98	178.97	0.38	-0.383
179	High Street	RES	178.90	179.66	179.43	179.43	0.51	-0.234
180	High Street	RES	177.71	178.82	178.69	178.43	0.71	-0.393
216	High Street	RES	178.07	178.68	178.26	N/A	0.19	N/A
218	High Street	RES	178.05	178.93	178.25	N/A	0.21	N/A
226	High Street	RES	178.07	178.66	178.25	N/A	0.18	N/A
302	High Street	RES	177.64	179.91	180.65	179.60	2.26	-0.312
12	Hurt Street	RES	174.08	176.25	175.17	N/A	1.09	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
14	Hurt Street	RES	174.16	176.00	175.18	N/A	0.99	N/A
16	Hurt Street	RES	174.57	176.05	175.38	N/A	0.59	N/A
18	Hurt Street	RES	175.13	176.17	175.87	175.87	0.74	-0.303
22	Hurt Street	RES	174.75	176.92	175.92	N/A	1.16	N/A
24	Hurt Street	RES	175.35	177.22	175.95	N/A	0.61	N/A
1A	Hyacinth Street	RES	175.99	176.55	176.39	176.34	0.26	-0.211
2	Hyacinth Street	RES	175.91	176.26	176.14	176.13	0.23	-0.129
3	Hyacinth Street	RES	175.78	176.55	176.35	176.31	0.50	-0.241
5	Hyacinth Street	RES	175.97	176.73	176.35	176.31	0.34	-0.423
6	Hyacinth Street	RES	175.68	176.23	176.13	176.13	0.22	-0.099
8	Hyacinth Street	COM	175.62	176.07	175.94	175.92	0.29	-0.147
5	Lily Street	COM	175.54	176.03	175.59	N/A	0.08	N/A
5A	Lily Street	RES	175.56	176.05	175.59	N/A	0.02	N/A
6	Lily Street	RES	175.06	175.71	175.65	175.64	0.58	-0.068
1/8	Lily Street	RES	175.68	176.53	176.47	176.43	0.26	-0.099
4/8	Lily Street	RES	175.96	176.49	176.47	176.35	0.19	-0.144
9	Lily Street	RES	174.36	175.92	175.67	N/A	0.62	N/A
11	Lily Street	RES	174.71	176.46	176.01	176.00	0.27	-0.459
11	Lily Street	RES	174.41	176.42	175.05	175.97	0.59	-0.45
12	Lily Street	RES	175.74	176.27	176.29	176.19	0.42	-0.085
13	Lily Street	RES	174.61	176.17	176.02	175.99	0.59	-0.183
17	Lily Street	RES	175.06	176.26	176.25	N/A	0.43	N/A
21A	Lily Street	RES	175.61	176.47	176.35	176.28	0.26	-0.192
23	Lily Street	RES	176.01	176.92	176.86	176.53	0.35	-0.394
27	Marys Lane	RES	174.49	175.31	174.87	174.86	0.38	-0.449
7	McDiarmids Road	COM	172.84	174.62	174.84	174.16	1.59	-0.456
2	Mitchell Street	RES	174.30	175.12	175.05	N/A	0.36	N/A
	Mitchell Street	RES	169.39	174.49	174.51	N/A	3.48	N/A
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.78	N/A	2.92	N/A
4446	Murchison-Violet Town Road	COM	170.91	173.66	173.99	N/A	2.20	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
1	Nicholson Street	RES	174.28	175.75	175.86	175.50	0.92	-0.25
1	Primrose Street	RES	177.38	178.86	178.25	178.25	0.98	-0.606
2	Primrose Street	RES	177.38	178.60	178.21	178.21	0.85	-0.387
5	Primrose Street	RES	177.75	178.39	178.25	178.25	0.51	-0.145
8	Primrose Street	RES	177.48	178.37	178.50	178.36	0.74	-0.013
9	Primrose Street	RES	177.81	178.25	178.23	178.23	0.43	-0.022
15	Primrose Street	RES	177.75	178.29	178.21	178.21	0.47	-0.081
19	Primrose Street	RES	177.91	178.22	178.21	178.21	0.46	-0.012
21	Primrose Street	RES	177.75	178.22	178.21	178.21	0.46	-0.012
25	Primrose Street	RES	177.65	178.23	178.21	N/A	0.56	N/A
27	Primrose Street	RES	177.92	178.27	178.21	178.21	0.28	-0.059
29	Primrose Street	RES	178.01	178.54	178.23	178.21	0.21	-0.328
35-39	Primrose Street	RES	178.38	179.35	179.56	178.93	0.45	-0.42
n/a	Railway Statio n Building	COM	175.81	179.20	178.26	178.26	1.80	-0.943
3	Railway Street	RES	176.65	177.13	176.98	176.98	0.17	-0.152
7	Railway Street	COM	176.35	177.00	176.88	176.89	0.31	-0.106
9	Railway Street	RES	176.30	176.67	176.59	N/A	0.19	N/A
3	Rose Street	RES	174.69	175.00	174.85	N/A	0.12	N/A
6	Rose Street	RES	174.21	174.99	174.51	N/A	0.20	N/A
7	Rose Street	RES	174.55	175.35	174.97	174.97	0.41	-0.384
8	Rose Street	RES	173.81	174.60	174.49	N/A	0.54	N/A
10	Rose Street	RES	173.82	174.58	174.48	N/A	0.55	N/A
12	Rose Street	RES	173.92	175.14	174.48	N/A	0.43	N/A
28	Rose Street	RES	175.37	176.68	176.28	N/A	0.78	N/A
2	Tulip Street	COM	175.48	176.62	177.55	N/A	1.43	N/A
4	Tulip Street	RES	174.67	175.37	175.26	175.18	0.32	-0.194
7	Tulip Street	RES	176.42	176.89	176.93	176.70	0.29	-0.187
8	Tulip Street	RES	174.44	175.35	174.76	N/A	0.32	N/A
10	Tulip Street	RES	174.41	175.30	174.75	N/A	0.30	N/A
12	Tulip Street	RES	174.12	175.08	174.68	N/A	0.40	N/A

13	Tulip Street	RES	176.50	176.59	176.73	176.55	0.13	-0.041
14	Tulip Street	RES	173.98	175.29	174.52	N/A	0.51	N/A
15	Tulip Street	RES	176.42	176.74	176.65	176.55	0.13	-0.191
18	Tulip Street	RES	174.07	175.22	174.49	N/A	0.41	N/A
19	Tulip Street	RES	176.39	176.94	176.56	N/A	0.10	N/A
21	Tulip Street	COM	176.33	177.08	176.47	N/A	0.06	N/A
23	Tulip Street	RES	176.04	176.52	176.27	176.25	0.22	-0.267
47	Tulip Street	RES	174.62	175.98	174.89	N/A	0.27	N/A
49	Tulip Street	RES	174.52	175.79	174.88	N/A	0.37	N/A

Violet Town Property Listings

Estimated ARI: 50 Year ARI (2% AEP)

Baird Street Gauge Height: 4.11m (175.96m AHD)

Above Floor Flooded Properties: 55

Below Floor Flooded Properties: 104

Total Flooded Properties: 159

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.64	175.63	0.48	0.29
3	Baird Street	RES	175.02	175.44	175.65	175.64	0.33	0.20
5	Baird Street	RES	175.09	175.23	175.65	175.64	0.51	0.41
3	Cowslip Street	RES	177.62	178.16	178.50	178.48	0.85	0.32
6	Cowslip Street	RES	177.61	178.42	178.45	178.44	0.84	0.02
8	Cowslip Street	RES	177.20	178.04	178.44	178.44	1.24	0.40
9	Cowslip Street	RES	177.40	178.14	178.46	178.45	1.05	0.31
12	Cowslip Street	COM	177.27	177.87	178.44	178.44	1.20	0.57
15	Cowslip Street	RES	177.17	177.63	178.45	178.44	1.27	0.81
16	Cowslip Street	COM	176.21	176.75	176.96	176.91	0.28	0.16
17	Cowslip Street	RES	177.13	177.55	178.44	178.44	1.32	0.89

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
19	Cowslip Street	RES	176.92	177.82	178.44	178.44	1.53	0.62
2/22	Cowslip Street	COM	175.82	176.08	176.94	176.34	0.28	0.26
24	Cowslip Street	COM	175.72	175.95	176.57	176.22	0.29	0.27
28	Cowslip Street	COM	175.69	175.86	176.36	176.01	0.29	0.15
31	Cowslip Street	COM	176.02	176.11	176.23	176.19	0.11	0.08
32	Cowslip Street	COM	174.71	175.20	175.40	175.39	0.45	0.19
33	Cowslip Street	COM	176.21	176.37	176.52	176.53	0.19	0.16
35	Cowslip Street	COM	175.53	176.28	176.37	176.35	0.37	0.07
37-39	Cowslip Street	RES	175.53	176.00	176.07	176.11	0.27	0.11
43	Cowslip Street	COM	175.29	175.84	176.02	176.02	0.42	0.18
47	Cowslip Street	RES	175.24	175.94	175.85	175.96	0.46	0.02
51	Cowslip Street	COM	175.24	175.65	175.70	175.71	0.41	0.06
1	Dahlia Street	RES	177.38	177.86	178.44	178.44	1.06	0.58
3	Dahlia Street	RES	177.61	178.25	178.44	178.44	0.83	0.19
3	Daisy Street	RES	177.84	178.51	178.53	178.53	0.66	0.02
4	Daisy Street	COM	177.87	177.78	178.50	178.49	0.63	0.71
7	Daisy Street	COM	177.22	178.32	178.46	178.46	1.24	0.14
9	Daisy Street	RES	177.19	177.59	178.46	178.46	1.26	0.87
10	Daisy Street	RES	177.33	177.78	178.46	178.46	1.12	0.68
14	Daisy Street	RES	177.20	177.96	178.45	178.45	1.25	0.49
5	Daphne Street	RES	177.04	177.63	178.00	177.80	0.32	0.17
197	High Street	COM	178.89	179.04	179.16	179.16	0.27	0.12
1	Hyacinth Street	RES	176.14	176.30	176.48	176.41	0.15	0.11
4	Hyacinth Street	RES	175.74	175.99	176.14	176.14	0.39	0.14
10	Lily Street	RES	175.80	176.36	176.76	176.42	0.38	0.06
12	Lily Street	RES	175.74	176.27	176.39	176.29	0.53	0.02
3	Primrose Street	RES	177.72	178.12	178.42	178.42	0.70	0.30
5	Primrose Street	RES	177.75	178.39	178.42	178.41	0.67	0.02
7	Primrose Street	RES	177.91	178.06	178.40	178.39	0.48	0.33
8	Primrose Street	RES	177.48	178.37	178.52	178.39	0.85	0.01
9	Primrose Street	RES	177.81	178.25	178.38	178.38	0.57	0.13

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
11	Primrose Street	COM	177.75	178.09	178.38	178.37	0.59	0.28
12	Primrose Street	RES	176.68	178.27	178.61	178.59	1.77	0.31
13	Primrose Street	RES	177.70	178.07	178.37	178.35	0.65	0.28
15	Primrose Street	RES	177.75	178.29	178.34	178.33	0.58	0.04
19	Primrose Street	RES	177.91	178.22	178.33	178.31	0.57	0.09
21	Primrose Street	RES	177.75	178.22	178.33	178.31	0.57	0.09
23	Primrose Street	RES	177.68	177.87	178.33	178.31	0.64	0.44
25	Primrose Street	RES	177.65	178.23	178.32	178.31	0.67	0.08
27	Primrose Street	RES	177.92	178.27	178.32	178.32	0.39	0.05
27A	Primrose Street	RES	177.76	178.15	178.33	178.32	0.55	0.17
1	Rose Street	RES	174.56	174.74	174.86	174.85	0.30	0.11
13	Tulip Street	RES	176.50	176.59	176.73	176.63	0.21	0.04
17	Tulip Street	RES	176.34	176.53	176.59	176.58	0.24	0.05

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	176.11	N/A	0.57	N/A
1	Cowslip Street	RES	177.84	179.08	178.54	178.52	0.74	-0.56
4	Cowslip Street	RES	178.00	178.73	178.45	N/A	0.46	N/A
4A	Cowslip Street	COM	178.27	178.65	178.45	178.44	0.17	-0.209
7	Cowslip Street	RES	177.42	178.87	178.46	178.46	1.03	-0.413
18	Cowslip Street	RES	175.90	176.79	176.34	N/A	0.24	N/A
20	Cowslip Street	COM	175.87	176.27	177.05	176.14	0.23	-0.127
21	Cowslip Street	RES	176.21	177.37	176.45	N/A	0.17	N/A
30	Cowslip Street	COM	175.43	175.92	176.21	175.77	0.29	-0.148
31	Cowslip Street	COM	176.23	176.62	176.57	176.59	0.19	-0.035

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
32A	Cowslip Street	RES	174.34	175.68	175.23	175.19	0.79	-0.49
34	Cowslip Street	RES	174.32	175.27	175.14	175.12	0.80	-0.147
36	Cowslip Street	RES	174.32	175.29	175.15	175.12	0.79	-0.17
40	Cowslip Street	RES	174.18	175.80	175.12	N/A	0.97	N/A
48	Cowslip Street	COM	173.66	175.04	175.05	174.99	0.95	-0.049
48	Cowslip Street	COM	174.48	174.94	175.06	N/A	0.06	N/A
87	Cowslip Street	RES	174.30	174.63	174.48	N/A	0.20	N/A
2	Crocus Street	RES	177.95	178.64	178.62	178.59	0.63	-0.052
5	Crocus Street	RES	177.45	179.16	178.74	N/A	0.76	N/A
7	Crocus Street	RES	177.87	178.59	178.59	178.58	0.68	-0.01
5	Dahlia Street	RES	178.05	178.57	178.44	178.44	0.39	-0.132
1	Daisy Street	RES	178.00	178.91	178.55	178.55	0.58	-0.361
11	Daisy Street	RES	177.31	178.49	178.45	178.45	1.15	-0.037
1	Daphne Street	RES	176.39	177.47	177.59	177.18	0.46	-0.293
2	Daphne Street	RES	176.79	177.54	177.09	N/A	0.07	N/A
3	Daphne Street	RES	176.86	177.49	177.59	177.31	0.29	-0.184
172	High Street	RES	178.12	179.25	179.03	178.88	0.51	-0.37
176	High Street	RES	178.11	179.35	179.05	179.03	0.52	-0.323
179	High Street	RES	178.90	179.66	179.49	179.48	0.55	-0.18
180	High Street	RES	177.71	178.82	178.74	178.57	0.85	-0.254
193	High Street	RES	178.94	179.40	179.40	179.33	0.16	-0.066
203	High Street	RES	178.93	179.15	179.15	179.15	0.23	-0.003
209	High Street	COM	178.90	179.15	179.13	179.11	0.12	-0.037
210	High Street	RES	178.15	178.94	178.45	178.44	0.28	-0.502
216	High Street	RES	178.07	178.68	178.45	N/A	0.37	N/A
218	High Street	RES	178.05	178.93	178.44	N/A	0.38	N/A
221	High Street	RES	178.92	179.10	179.06	N/A	0.12	N/A
226	High Street	RES	178.07	178.66	178.43	178.42	0.35	-0.24
302	High Street	RES	177.64	179.91	180.73	179.64	2.30	-0.271
12	Hurt Street	RES	174.08	176.25	175.25	N/A	1.15	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
14	Hurt Street	RES	174.16	176.00	175.26	N/A	1.06	N/A
16	Hurt Street	RES	174.57	176.05	175.55	N/A	0.66	N/A
18	Hurt Street	RES	175.13	176.17	176.01	176.00	0.88	-0.169
22	Hurt Street	RES	174.75	176.92	176.04	N/A	1.29	N/A
24	Hurt Street	RES	175.35	177.22	176.07	N/A	0.74	N/A
1A	Hyacinth Street	RES	175.99	176.55	176.43	176.36	0.27	-0.195
2	Hyacinth Street	RES	175.91	176.26	176.14	176.13	0.23	-0.126
3	Hyacinth Street	RES	175.78	176.55	176.35	176.32	0.51	-0.235
5	Hyacinth Street	RES	175.97	176.73	176.35	176.31	0.34	-0.417
6	Hyacinth Street	RES	175.68	176.23	176.14	176.14	0.24	-0.095
8	Hyacinth Street	COM	175.62	176.07	175.97	175.94	0.31	-0.134
5	Lily Street	COM	175.54	176.03	175.62	N/A	0.10	N/A
5A	Lily Street	RES	175.56	176.05	175.62	N/A	0.05	N/A
6	Lily Street	RES	175.06	175.71	175.68	175.67	0.61	-0.04
1/8	Lily Street	RES	175.68	176.53	176.52	176.44	0.23	-0.091
4/8	Lily Street	RES	175.96	176.49	176.53	176.41	0.24	-0.076
9	Lily Street	RES	174.36	175.92	175.90	175.88	0.77	-0.044
11	Lily Street	RES	174.71	176.46	176.13	176.13	0.42	-0.328
11	Lily Street	RES	174.41	176.42	176.12	176.12	0.74	-0.303
13	Lily Street	RES	174.61	176.17	176.13	176.10	0.79	-0.066
17	Lily Street	RES	175.06	176.26	176.26	N/A	0.52	N/A
21A	Lily Street	RES	175.61	176.47	176.35	176.29	0.26	-0.184
23	Lily Street	RES	176.01	176.92	176.87	176.54	0.37	-0.376
27	Marys Lane	RES	174.49	175.31	174.90	174.89	0.40	-0.419
7	McDiarmids Road	COM	172.84	174.62	174.92	174.29	1.71	-0.333
2	Mitchell Street	RES	174.30	175.12	175.12	N/A	0.43	N/A
	Mitchell Street	RES	169.39	174.49	174.57	N/A	3.53	N/A
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.83	N/A	2.97	N/A
4446	Murchison-Violet Town Road	COM	170.91	173.66	174.11	N/A	2.33	N/A
1	Nicholson Street	RES	174.28	175.75	175.97	175.72	1.03	-0.03

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
3A	Pink Street	RES	178.18	179.09	178.39	178.39	0.22	-0.702
5	Pink Street	RES	178.25	178.50	178.37	178.37	0.15	-0.126
1	Primrose Street	RES	177.38	178.86	178.43	178.43	1.14	-0.434
2	Primrose Street	RES	177.38	178.60	178.33	178.33	0.96	-0.275
29	Primrose Street	RES	178.01	178.54	178.34	178.32	0.32	-0.216
31	Primrose Street	RES	178.07	178.44	178.35	N/A	0.25	N/A
35-39	Primrose Street	RES	178.38	179.35	179.59	179.03	0.48	-0.316
n/a	Railway Statio n Building	COM	175.81	179.20	178.43	178.43	1.90	-0.768
3	Railway Street	RES	176.65	177.13	176.98	176.98	0.19	-0.15
7	Railway Street	COM	176.35	177.00	176.88	176.90	0.31	-0.104
9	Railway Street	RES	176.30	176.67	177.21	N/A	0.20	N/A
3	Rose Street	RES	174.69	175.00	174.88	N/A	0.15	N/A
6	Rose Street	RES	174.21	174.99	174.54	N/A	0.31	N/A
7	Rose Street	RES	174.55	175.35	175.11	175.11	0.53	-0.243
8	Rose Street	RES	173.81	174.60	174.49	174.48	0.68	-0.117
10	Rose Street	RES	173.82	174.58	174.49	174.48	0.68	-0.097
12	Rose Street	RES	173.92	175.14	174.49	N/A	0.56	N/A
14	Rose Street	RES	174.39	175.52	174.48	N/A	0.09	N/A
28	Rose Street	RES	175.37	176.68	176.31	N/A	0.80	N/A
2	Tulip Street	COM	175.48	176.62	177.62	N/A	1.53	N/A
4	Tulip Street	RES	174.67	175.37	175.35	175.26	0.37	-0.113
6	Tulip Street	RES	174.66	175.60	174.90	N/A	0.21	N/A
7	Tulip Street	RES	176.42	176.89	176.93	176.71	0.29	-0.18
8	Tulip Street	RES	174.44	175.35	174.85	N/A	0.40	N/A
10	Tulip Street	RES	174.41	175.30	174.83	N/A	0.37	N/A
12	Tulip Street	RES	174.12	175.08	174.73	N/A	0.46	N/A
15	Tulip Street	RES	176.42	176.74	176.66	176.63	0.21	-0.114
14	Tulip Street	RES	173.98	175.29	174.57	N/A	0.57	N/A
18	Tulip Street	RES	174.07	175.22	174.56	N/A	0.47	N/A
19	Tulip Street	RES	176.39	176.94	176.58	N/A	0.11	N/A

21	Tulip Street	COM	176.33	177.08	176.48	N/A	0.06	N/A
23	Tulip Street	RES	176.04	176.52	176.27	176.26	0.22	-0.262
47	Tulip Street	RES	174.62	175.98	174.92	N/A	0.30	N/A
49	Tulip Street	RES	174.52	175.79	174.90	N/A	0.40	N/A

Violet Town Property Listings

Estimated ARI: 100 Year ARI (1% AEP)

Baird Street Gauge Height: 4.18m (176.03m AHD)

Above Floor Flooded Properties: 63

Below Floor Flooded Properties: 99

Total Flooded Properties: 162

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.69	175.67	0.52	0.33
3	Baird Street	RES	175.02	175.44	175.70	175.68	0.38	0.24
5	Baird Street	RES	175.09	175.23	175.70	175.68	0.55	0.45
3	Cowslip Street	RES	177.62	178.16	178.60	178.59	0.96	0.43
6	Cowslip Street	RES	177.61	178.42	178.55	178.55	0.94	0.13
8	Cowslip Street	RES	177.20	178.04	178.55	178.54	1.34	0.50
9	Cowslip Street	RES	177.40	178.14	178.57	178.56	1.16	0.42
12	Cowslip Street	COM	177.27	177.87	178.54	178.54	1.30	0.67
15	Cowslip Street	RES	177.17	177.63	178.56	178.55	1.38	0.92
16	Cowslip Street	COM	176.21	176.75	176.98	176.96	0.28	0.21
17	Cowslip Street	RES	177.13	177.55	178.55	178.54	1.42	0.99
19	Cowslip Street	RES	176.92	177.82	178.55	178.54	1.63	0.72
2/22	Cowslip Street	COM	175.82	176.08	177.02	176.56	0.51	0.48
24	Cowslip Street	COM	175.72	175.95	176.68	176.25	0.34	0.30
28	Cowslip Street	COM	175.69	175.86	176.38	176.04	0.28	0.18
31	Cowslip Street	COM	176.02	176.11	176.23	176.19	0.12	0.08
32	Cowslip Street	COM	174.71	175.20	175.45	175.44	0.54	0.24
33	Cowslip Street	COM	176.21	176.37	176.53	176.54	0.20	0.17
35	Cowslip Street	COM	175.53	176.28	176.37	176.36	0.38	0.08
37-39	Cowslip Street	RES	175.53	176.00	176.07	176.11	0.30	0.11
43	Cowslip Street	COM	175.29	175.84	176.04	176.05	0.44	0.21

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
47	Cowslip Street	RES	175.24	175.94	175.93	176.00	0.49	0.06
48	Cowslip Street	COM	173.66	175.04	175.13	175.09	1.05	0.05
48	Cowslip Street	COM	174.48	174.94	175.13	175.13	0.42	0.19
51	Cowslip Street	COM	175.24	175.65	175.76	175.76	0.43	0.11
2	Crocus Street	RES	177.95	178.64	178.72	178.70	0.74	0.06
7	Crocus Street	RES	177.87	178.59	178.70	178.69	0.79	0.10
1	Dahlia Street	RES	177.38	177.86	178.54	178.54	1.17	0.68
3	Dahlia Street	RES	177.61	178.25	178.54	178.54	0.93	0.29
3	Daisy Street	RES	177.84	178.51	178.63	178.63	0.77	0.12
4	Daisy Street	COM	177.87	177.78	178.61	178.59	0.75	0.81
7	Daisy Street	COM	177.22	178.32	178.57	178.58	1.35	0.25
9	Daisy Street	RES	177.19	177.59	178.57	178.56	1.37	0.97
10	Daisy Street	RES	177.33	177.78	178.57	178.57	1.23	0.79
11	Daisy Street	RES	177.31	178.49	178.56	178.56	1.25	0.07
14	Daisy Street	RES	177.20	177.96	178.56	178.56	1.36	0.59
5	Daphne Street	RES	177.04	177.63	178.01	177.82	0.36	0.19
197	High Street	COM	178.89	179.04	179.20	179.20	0.30	0.16
203	High Street	RES	178.93	179.15	179.18	179.18	0.26	0.03
1	Hyacinth Street	RES	176.14	176.30	176.48	176.43	0.16	0.13
4	Hyacinth Street	RES	175.74	175.99	176.14	176.14	0.39	0.15
10	Lily Street	RES	175.80	176.36	176.78	176.45	0.43	0.09
12	Lily Street	RES	175.74	176.27	176.43	176.34	0.59	0.07
1	Nicholson Street	RES	174.28	175.75	176.04	175.76	1.10	0.01
3	Primrose Street	RES	177.72	178.12	178.51	178.51	0.79	0.39
5	Primrose Street	RES	177.75	178.39	178.51	178.50	0.76	0.11
7	Primrose Street	RES	177.91	178.06	178.49	178.48	0.56	0.42
8	Primrose Street	RES	177.48	178.37	178.55	178.43	0.92	0.06
9	Primrose Street	RES	177.81	178.25	178.47	178.46	0.65	0.21
11	Primrose Street	COM	177.75	178.09	178.48	178.45	0.67	0.36
12	Primrose Street	RES	176.68	178.27	178.65	178.61	1.83	0.34

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
13	Primrose Street	RES	177.70	178.07	178.45	178.42	0.72	0.35
15	Primrose Street	RES	177.75	178.29	178.42	178.40	0.65	0.11
19	Primrose Street	RES	177.91	178.22	178.42	178.38	0.63	0.16
21	Primrose Street	RES	177.75	178.22	178.39	178.38	0.63	0.16
23	Primrose Street	RES	177.68	177.87	178.38	178.38	0.70	0.50
25	Primrose Street	RES	177.65	178.23	178.40	178.38	0.73	0.15
27	Primrose Street	RES	177.92	178.27	178.38	178.38	0.45	0.11
27A	Primrose Street	RES	177.76	178.15	178.39	178.38	0.61	0.23
9	Railway Street	RES	176.30	176.67	177.22	176.79	0.20	0.12
1	Rose Street	RES	174.56	174.74	174.88	174.87	0.32	0.13
13	Tulip Street	RES	176.50	176.59	176.73	176.63	0.22	0.04
17	Tulip Street	RES	176.34	176.53	176.60	176.59	0.25	0.06

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	176.17	N/A	0.62	N/A
1	Cowslip Street	RES	177.84	179.08	178.63	178.62	0.84	-0.457
2	Cowslip Street	COM	178.41	178.73	178.54	N/A	0.15	N/A
4	Cowslip Street	RES	178.00	178.73	178.55	178.54	0.57	-0.186
4A	Cowslip Street	COM	178.27	178.65	178.55	178.55	0.27	-0.105
7	Cowslip Street	RES	177.42	178.87	178.57	178.57	1.14	-0.305
18	Cowslip Street	RES	175.90	176.79	176.45	N/A	0.31	N/A
20	Cowslip Street	COM	175.87	176.27	177.09	176.20	0.28	-0.066
21	Cowslip Street	RES	176.21	177.37	176.45	N/A	0.17	N/A
30	Cowslip Street	COM	175.43	175.92	176.22	175.80	0.32	-0.116
31	Cowslip Street	COM	176.23	176.62	176.58	176.60	0.21	-0.022

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
32A	Cowslip Street	RES	174.34	175.68	175.30	175.28	0.89	-0.4
34	Cowslip Street	RES	174.32	175.27	175.24	175.22	0.90	-0.052
36	Cowslip Street	RES	174.32	175.29	175.24	175.21	0.89	-0.076
40	Cowslip Street	RES	174.18	175.80	175.21	175.21	1.06	-0.592
87	Cowslip Street	RES	174.30	174.63	174.49	N/A	0.20	N/A
5	Crocus Street	RES	177.45	179.16	178.83	N/A	0.86	N/A
5	Dahlia Street	RES	178.05	178.57	178.54	178.54	0.49	-0.031
1	Daisy Street	RES	178.00	178.91	178.66	178.65	0.69	-0.256
1	Daphne Street	RES	176.39	177.47	177.60	177.19	0.47	-0.282
2	Daphne Street	RES	176.79	177.54	177.15	177.19	0.09	-0.351
3	Daphne Street	RES	176.86	177.49	177.60	177.32	0.30	-0.172
172	High Street	RES	178.12	179.25	179.06	178.93	0.62	-0.324
176	High Street	RES	178.11	179.35	179.09	179.06	0.63	-0.291
179	High Street	RES	178.90	179.66	179.53	179.52	0.59	-0.138
180	High Street	RES	177.71	178.82	178.78	178.68	0.95	-0.144
193	High Street	RES	178.94	179.40	179.43	179.37	0.31	-0.035
209	High Street	COM	178.90	179.15	179.16	179.14	0.23	-0.009
210	High Street	RES	178.15	178.94	178.54	178.54	0.38	-0.402
216	High Street	RES	178.07	178.68	178.54	N/A	0.46	N/A
218	High Street	RES	178.05	178.93	178.53	N/A	0.48	N/A
220	High Street	RES	178.42	178.99	178.52	N/A	0.10	N/A
221	High Street	RES	178.92	179.10	179.13	N/A	0.23	N/A
226	High Street	RES	178.07	178.66	178.53	178.52	0.44	-0.144
229	High Street	COM	178.77	179.70	180.44	N/A	0.37	N/A
302	High Street	RES	177.64	179.91	180.78	179.67	2.33	-0.243
12	Hurt Street	RES	174.08	176.25	175.33	N/A	1.21	N/A
14	Hurt Street	RES	174.16	176.00	175.35	N/A	1.11	N/A
16	Hurt Street	RES	174.57	176.05	175.57	N/A	0.71	N/A
18	Hurt Street	RES	175.13	176.17	176.07	176.07	0.94	-0.105
22	Hurt Street	RES	174.75	176.92	176.11	N/A	1.35	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
24	Hurt Street	RES	175.35	177.22	176.14	N/A	0.80	N/A
1A	Hyacinth Street	RES	175.99	176.55	176.44	176.37	0.27	-0.183
2	Hyacinth Street	RES	175.91	176.26	176.15	176.14	0.23	-0.122
3	Hyacinth Street	RES	175.78	176.55	176.36	176.32	0.52	-0.229
5	Hyacinth Street	RES	175.97	176.73	176.36	176.32	0.35	-0.411
6	Hyacinth Street	RES	175.68	176.23	176.14	176.14	0.25	-0.09
8	Hyacinth Street	COM	175.62	176.07	175.98	175.94	0.32	-0.128
5	Lily Street	COM	175.54	176.03	175.64	N/A	0.12	N/A
5A	Lily Street	RES	175.56	176.05	175.64	N/A	0.08	N/A
6	Lily Street	RES	175.06	175.71	175.70	175.70	0.63	-0.015
1/8	Lily Street	RES	175.68	176.53	176.54	176.46	0.24	-0.07
4/8	Lily Street	RES	175.96	176.49	176.56	176.43	0.27	-0.06
9	Lily Street	RES	174.36	175.92	175.94	175.91	0.86	-0.008
11	Lily Street	RES	174.71	176.46	176.19	176.19	0.51	-0.272
11	Lily Street	RES	174.41	176.42	176.17	176.17	0.84	-0.251
13	Lily Street	RES	174.61	176.17	176.19	176.16	0.89	-0.006
17	Lily Street	RES	175.06	176.26	176.29	175.86	0.59	-0.4
21A	Lily Street	RES	175.61	176.47	176.36	176.30	0.26	-0.17
23	Lily Street	RES	176.01	176.92	176.94	176.56	0.38	-0.365
27	Marys Lane	RES	174.49	175.31	174.91	174.91	0.42	-0.398
7	McDiarmids Road	COM	172.84	174.62	174.98	174.36	1.80	-0.257
2	Mitchell Street	RES	174.30	175.12	175.17	N/A	0.48	N/A
	Mitchell Street	RES	169.39	174.49	174.61	174.13	3.57	-0.363
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.86	N/A	3.00	N/A
4446	Murchison-Violet Town Road	COM	170.91	173.66	174.17	N/A	2.39	N/A
3A	Pink Street	RES	178.18	179.09	178.49	178.49	0.31	-0.603
5	Pink Street	RES	178.25	178.50	178.46	178.46	0.23	-0.037
1	Primrose Street	RES	177.38	178.86	178.52	178.52	1.24	-0.337
2	Primrose Street	RES	177.38	178.60	178.39	178.39	1.02	-0.211
29	Primrose Street	RES	178.01	178.54	178.40	178.39	0.38	-0.153

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
31	Primrose Street	RES	178.07	178.44	178.40	N/A	0.32	N/A
35-39	Primrose Street	RES	178.38	179.35	179.62	179.05	0.50	-0.302
n/a	Railway Statio n Building	COM	175.81	179.20	178.54	178.53	1.96	-0.67
3	Railway Street	RES	176.65	177.13	176.98	176.98	0.19	-0.149
7	Railway Street	COM	176.35	177.00	176.88	176.90	0.31	-0.103
3	Rose Street	RES	174.69	175.00	174.90	N/A	0.17	N/A
6	Rose Street	RES	174.21	174.99	174.55	N/A	0.32	N/A
7	Rose Street	RES	174.55	175.35	175.20	175.19	0.60	-0.157
8	Rose Street	RES	173.81	174.60	174.50	174.49	0.68	-0.111
10	Rose Street	RES	173.82	174.58	174.50	174.49	0.69	-0.091
12	Rose Street	RES	173.92	175.14	174.51	N/A	0.57	N/A
14	Rose Street	RES	174.39	175.52	174.49	N/A	0.10	N/A
28	Rose Street	RES	175.37	176.68	176.33	N/A	0.81	N/A
2	Tulip Street	COM	175.48	176.62	177.72	N/A	1.61	N/A
4	Tulip Street	RES	174.67	175.37	175.40	175.31	0.42	-0.06
6	Tulip Street	RES	174.66	175.60	174.96	N/A	0.26	N/A
7	Tulip Street	RES	176.42	176.89	176.93	176.72	0.30	-0.167
8	Tulip Street	RES	174.44	175.35	174.91	N/A	0.45	N/A
10	Tulip Street	RES	174.41	175.30	174.88	N/A	0.43	N/A
12	Tulip Street	RES	174.12	175.08	174.77	N/A	0.51	N/A
14	Tulip Street	RES	173.98	175.29	174.62	N/A	0.61	N/A
15	Tulip Street	RES	176.42	176.74	176.67	176.63	0.22	-0.106
18	Tulip Street	RES	174.07	175.22	174.60	N/A	0.51	N/A
19	Tulip Street	RES	176.39	176.94	176.59	N/A	0.11	N/A
21	Tulip Street	COM	176.33	177.08	176.49	N/A	0.07	N/A
23	Tulip Street	RES	176.04	176.52	176.28	176.26	0.23	-0.257
47	Tulip Street	RES	174.62	175.98	174.95	N/A	0.32	N/A
49	Tulip Street	RES	174.52	175.79	174.94	N/A	0.42	N/A

Violet Town Property Listings

Estimated ARI: 200 Year ARI (0.5% AEP)
Baird Street Gauge Height: 4.23m (176.08m AHD)

Above Floor Flooded Properties: 73
Below Floor Flooded Properties: 95
Total Flooded Properties: 168

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.73	175.71	0.54	0.37
3	Baird Street	RES	175.02	175.44	175.74	175.72	0.41	0.28
5	Baird Street	RES	175.09	175.23	175.73	175.72	0.55	0.49
2	Cowslip Street	COM	178.41	178.73	178.79	178.87	0.25	0.14
3	Cowslip Street	RES	177.62	178.16	178.69	178.68	1.05	0.52
6	Cowslip Street	RES	177.61	178.42	178.64	178.64	1.03	0.22
8	Cowslip Street	RES	177.20	178.04	178.63	178.64	1.43	0.60
9	Cowslip Street	RES	177.40	178.14	178.65	178.66	1.26	0.52
12	Cowslip Street	COM	177.27	177.87	178.62	178.62	1.39	0.75
15	Cowslip Street	RES	177.17	177.63	178.65	178.64	1.47	1.01
16	Cowslip Street	COM	176.21	176.75	177.12	176.98	0.29	0.23
17	Cowslip Street	RES	177.13	177.55	178.63	178.64	1.51	1.09
19	Cowslip Street	RES	176.92	177.82	178.63	178.63	1.72	0.81
2/22	Cowslip Street	COM	175.82	176.08	177.02	176.57	0.52	0.49
24	Cowslip Street	COM	175.72	175.95	176.79	176.28	0.36	0.33
28	Cowslip Street	COM	175.69	175.86	176.40	176.05	0.29	0.19
31	Cowslip Street	COM	176.02	176.11	176.26	176.27	0.21	0.16
32	Cowslip Street	COM	174.71	175.20	175.52	175.51	0.62	0.31
33	Cowslip Street	COM	176.21	176.37	176.54	176.56	0.22	0.19
34	Cowslip Street	RES	174.32	175.27	175.35	175.30	0.97	0.03
35	Cowslip Street	COM	175.53	176.28	176.38	176.36	0.45	0.08

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
37-39	Cowslip Street	RES	175.53	176.00	176.09	176.12	0.34	0.12
43	Cowslip Street	COM	175.29	175.84	176.07	176.07	0.52	0.23
47	Cowslip Street	RES	175.24	175.94	176.02	176.03	0.56	0.09
48	Cowslip Street	COM	173.66	175.04	175.17	175.14	1.11	0.10
48	Cowslip Street	COM	174.48	174.94	175.17	175.17	0.24	0.22
51	Cowslip Street	COM	175.24	175.65	175.80	175.80	0.48	0.15
2	Crocus Street	RES	177.95	178.64	178.82	178.79	0.84	0.15
7	Crocus Street	RES	177.87	178.59	178.79	178.79	0.89	0.20
1	Dahlia Street	RES	177.38	177.86	178.63	178.63	1.25	0.77
3	Dahlia Street	RES	177.61	178.25	178.62	178.63	1.02	0.38
5	Dahlia Street	RES	178.05	178.57	178.62	178.63	0.58	0.06
3	Daisy Street	RES	177.84	178.51	178.73	178.72	0.87	0.21
4	Daisy Street	COM	177.87	177.78	178.70	178.69	0.84	0.91
7	Daisy Street	COM	177.22	178.32	178.67	178.67	1.45	0.35
9	Daisy Street	RES	177.19	177.59	178.66	178.66	1.47	1.07
10	Daisy Street	RES	177.33	177.78	178.66	178.66	1.32	0.88
11	Daisy Street	RES	177.31	178.49	178.65	178.66	1.35	0.17
14	Daisy Street	RES	177.20	177.96	178.65	178.65	1.45	0.69
5	Daphne Street	RES	177.04	177.63	178.02	177.83	0.39	0.20
197	High Street	COM	178.89	179.04	179.28	179.23	0.33	0.19
203	High Street	RES	178.93	179.15	179.21	179.21	0.29	0.06
209	High Street	COM	178.90	179.15	179.21	179.19	0.29	0.04
221	High Street	RES	178.92	179.10	179.19	179.19	0.29	0.09
1	Hyacinth Street	RES	176.14	176.30	176.55	176.51	0.23	0.21
4	Hyacinth Street	RES	175.74	175.99	176.19	176.19	0.43	0.19
6	Lily Street	RES	175.06	175.71	175.76	175.75	0.68	0.04
9	Lily Street	RES	174.36	175.92	175.97	175.94	0.94	0.02
10	Lily Street	RES	175.80	176.36	176.80	176.47	0.48	0.11
12	Lily Street	RES	175.74	176.27	176.48	176.39	0.64	0.12
13	Lily Street	RES	174.61	176.17	176.23	176.21	0.96	0.04

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
1	Nicholson Street	RES	174.28	175.75	176.08	175.86	1.16	0.11
5	Pink Street	RES	178.25	178.50	178.53	178.54	0.31	0.04
3	Primrose Street	RES	177.72	178.12	178.59	178.59	0.87	0.47
5	Primrose Street	RES	177.75	178.39	178.58	178.58	0.84	0.19
7	Primrose Street	RES	177.91	178.06	178.57	178.56	0.63	0.50
8	Primrose Street	RES	177.48	178.37	178.56	178.47	0.96	0.10
9	Primrose Street	RES	177.81	178.25	178.54	178.54	0.72	0.29
11	Primrose Street	COM	177.75	178.09	178.55	178.52	0.74	0.43
12	Primrose Street	RES	176.68	178.27	178.67	178.63	1.88	0.36
13	Primrose Street	RES	177.70	178.07	178.52	178.49	0.78	0.42
15	Primrose Street	RES	177.75	178.29	178.48	178.46	0.70	0.17
19	Primrose Street	RES	177.91	178.22	178.48	178.42	0.67	0.20
21	Primrose Street	RES	177.75	178.22	178.45	178.42	0.67	0.20
23	Primrose Street	RES	177.68	177.87	178.45	178.42	0.74	0.55
25	Primrose Street	RES	177.65	178.23	178.44	178.42	0.77	0.19
27	Primrose Street	RES	177.92	178.27	178.43	178.43	0.50	0.16
27A	Primrose Street	RES	177.76	178.15	178.44	178.42	0.66	0.27
7	Railway Street	COM	176.35	177.00	177.02	177.02	0.37	0.02
9	Railway Street	RES	176.30	176.67	177.26	176.83	0.26	0.16
1	Rose Street	RES	174.56	174.74	174.92	174.91	0.37	0.17
13	Tulip Street	RES	176.50	176.59	176.80	176.69	0.26	0.09
17	Tulip Street	RES	176.34	176.53	176.66	176.65	0.31	0.12

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	176.22	N/A	0.67	N/A

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
1	Cowslip Street	RES	177.84	179.08	178.72	178.75	0.93	-0.331
4	Cowslip Street	RES	178.00	178.73	178.63	178.64	0.66	-0.092
4A	Cowslip Street	COM	178.27	178.65	178.65	178.64	0.37	-0.011
7	Cowslip Street	RES	177.42	178.87	178.66	178.66	1.24	-0.211
18	Cowslip Street	RES	175.90	176.79	176.62	176.79	0.35	-0.005
20	Cowslip Street	COM	175.87	176.27	177.10	176.24	0.32	-0.026
21	Cowslip Street	RES	176.21	177.37	177.27	N/A	0.24	N/A
25	Cowslip Street	RES	176.32	177.17	176.48	N/A	0.06	N/A
30	Cowslip Street	COM	175.43	175.92	176.23	175.82	0.34	-0.101
31	Cowslip Street	COM	176.23	176.62	176.60	176.61	0.22	-0.011
32A	Cowslip Street	RES	174.34	175.68	175.37	175.36	0.96	-0.319
36	Cowslip Street	RES	174.32	175.29	175.30	175.29	0.96	-0.004
40	Cowslip Street	RES	174.18	175.80	175.28	175.28	1.12	-0.522
87	Cowslip Street	RES	174.30	174.63	174.50	N/A	0.22	N/A
5	Crocus Street	RES	177.45	179.16	178.90	N/A	0.94	N/A
23	Crocus Street	RES	178.51	179.30	178.67	N/A	0.22	N/A
1	Daisy Street	RES	178.00	178.91	178.75	178.75	0.78	-0.159
1	Daphne Street	RES	176.39	177.47	177.60	177.19	0.48	-0.278
2	Daphne Street	RES	176.79	177.54	177.19	177.20	0.12	-0.336
3	Daphne Street	RES	176.86	177.49	177.60	177.32	0.31	-0.167
172	High Street	RES	178.12	179.25	179.09	178.98	0.71	-0.275
176	High Street	RES	178.11	179.35	179.12	179.09	0.72	-0.258
179	High Street	RES	178.90	179.66	179.60	179.58	0.63	-0.079
180	High Street	RES	177.71	178.82	178.84	178.78	1.05	-0.044
193	High Street	RES	178.94	179.40	179.98	179.39	0.35	-0.006
210	High Street	RES	178.15	178.94	178.65	178.63	0.47	-0.314
216	High Street	RES	178.07	178.68	178.62	178.63	0.55	-0.055
218	High Street	RES	178.05	178.93	178.61	178.62	0.56	-0.311
220	High Street	RES	178.42	178.99	178.60	N/A	0.19	N/A
226	High Street	RES	178.07	178.66	178.60	178.60	0.53	-0.062

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
229	High Street	COM	178.77	179.70	180.48	N/A	0.43	N/A
232	High Street	RES	178.45	179.05	178.58	N/A	0.15	N/A
273	High Street	RES	180.94	181.75	181.09	N/A	0.16	N/A
302	High Street	RES	177.64	179.91	180.82	179.69	2.35	-0.223
12	Hurt Street	RES	174.08	176.25	175.37	N/A	1.25	N/A
14	Hurt Street	RES	174.16	176.00	175.39	N/A	1.16	N/A
16	Hurt Street	RES	174.57	176.05	175.60	N/A	0.75	N/A
18	Hurt Street	RES	175.13	176.17	176.12	176.12	0.99	-0.053
22	Hurt Street	RES	174.75	176.92	176.17	176.16	1.40	-0.756
24	Hurt Street	RES	175.35	177.22	176.19	N/A	0.85	N/A
1A	Hyacinth Street	RES	175.99	176.55	176.50	176.44	0.29	-0.106
2	Hyacinth Street	RES	175.91	176.26	176.19	176.18	0.28	-0.077
3	Hyacinth Street	RES	175.78	176.55	176.43	176.39	0.57	-0.156
5	Hyacinth Street	RES	175.97	176.73	176.43	176.38	0.41	-0.348
6	Hyacinth Street	RES	175.68	176.23	176.19	176.18	0.32	-0.046
8	Hyacinth Street	COM	175.62	176.07	176.04	176.02	0.40	-0.055
5	Lilac Street	RES	179.51	180.25	0.00	N/A	0.10	N/A
5	Lily Street	COM	175.54	176.03	175.68	N/A	0.15	N/A
5A	Lily Street	RES	175.56	176.05	175.69	N/A	0.12	N/A
1/8	Lily Street	RES	175.68	176.53	176.56	176.48	0.26	-0.053
4/8	Lily Street	RES	175.96	176.49	176.58	176.45	0.29	-0.045
11	Lily Street	RES	174.71	176.46	176.24	176.23	0.59	-0.231
11	Lily Street	RES	174.41	176.42	176.21	176.21	0.91	-0.213
17	Lily Street	RES	175.06	176.26	176.31	175.92	0.66	-0.342
21A	Lily Street	RES	175.61	176.47	176.37	176.32	0.26	-0.152
23	Lily Street	RES	176.01	176.92	176.95	176.56	0.38	-0.362
27	Marys Lane	RES	174.49	175.31	174.96	174.96	0.47	-0.346
7	McDiarmids Road	COM	172.84	174.62	175.02	174.42	1.85	-0.202
2	Mitchell Street	RES	174.30	175.12	175.21	N/A	0.52	N/A
	Mitchell Street	RES	169.39	174.49	174.65	174.15	3.60	-0.34

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.89	N/A	3.03	N/A
4446	Murchison-Violet Town Road	COM	170.91	173.66	174.24	N/A	2.44	N/A
3A	Pink Street	RES	178.18	179.09	178.58	178.57	0.39	-0.519
6	Pink Street	RES	178.43	178.70	178.48	N/A	0.06	N/A
1	Primrose Street	RES	177.38	178.86	178.60	178.61	1.32	-0.252
2	Primrose Street	RES	177.38	178.60	178.44	178.43	1.07	-0.167
29	Primrose Street	RES	178.01	178.54	178.46	178.43	0.42	-0.109
31	Primrose Street	RES	178.07	178.44	178.46	N/A	0.36	N/A
35-39	Primrose Street	RES	178.38	179.35	179.63	179.06	0.52	-0.288
n/a	Railway Statio n Building	COM	175.81	179.20	178.62	178.62	2.00	-0.584
3	Railway Street	RES	176.65	177.13	177.02	177.02	0.22	-0.108
3	Rose Street	RES	174.69	175.00	174.95	174.88	0.21	-0.117
6	Rose Street	RES	174.21	174.99	174.59	N/A	0.33	N/A
7	Rose Street	RES	174.55	175.35	175.26	175.26	0.65	-0.092
8	Rose Street	RES	173.81	174.60	174.53	174.50	0.70	-0.096
10	Rose Street	RES	173.82	174.58	174.52	174.50	0.70	-0.076
12	Rose Street	RES	173.92	175.14	174.53	N/A	0.58	N/A
14	Rose Street	RES	174.39	175.52	174.50	N/A	0.11	N/A
28	Rose Street	RES	175.37	176.68	176.33	N/A	0.81	N/A
2	Tulip Street	COM	175.48	176.62	177.78	N/A	1.68	N/A
4	Tulip Street	RES	174.67	175.37	175.48	175.35	0.45	-0.018
6	Tulip Street	RES	174.66	175.60	175.00	N/A	0.31	N/A
7	Tulip Street	RES	176.42	176.89	176.98	176.82	0.39	-0.071
8	Tulip Street	RES	174.44	175.35	174.96	N/A	0.50	N/A
10	Tulip Street	RES	174.41	175.30	174.92	N/A	0.47	N/A
12	Tulip Street	RES	174.12	175.08	174.80	N/A	0.54	N/A
14	Tulip Street	RES	173.98	175.29	174.66	N/A	0.65	N/A
15	Tulip Street	RES	176.42	176.74	176.75	176.69	0.26	-0.055
18	Tulip Street	RES	174.07	175.22	174.64	N/A	0.54	N/A
19	Tulip Street	RES	176.39	176.94	176.64	N/A	0.18	N/A

21	Tulip Street	COM	176.33	177.08	176.56	N/A	0.15	N/A
23	Tulip Street	RES	176.04	176.52	176.47	176.28	0.24	-0.244
47	Tulip Street	RES	174.62	175.98	175.00	N/A	0.38	N/A
49	Tulip Street	RES	174.52	175.79	175.72	N/A	0.46	N/A

Violet Town Property Listings

Estimated ARI: 500 Year ARI (0.2% AEP)

Baird Street Gauge Height: 4.27m (176.12m AHD)

Above Floor Flooded Properties: 92

Below Floor Flooded Properties: 84

Total Flooded Properties: 176

Above Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth above Floor Level (m)
1	Baird Street	RES	174.98	175.34	175.78	175.75	0.57	0.41
3	Baird Street	RES	175.02	175.44	175.78	175.76	0.46	0.32
5	Baird Street	RES	175.09	175.23	175.77	175.76	0.59	0.53
2	Cowslip Street	COM	178.41	178.73	178.92	178.92	0.35	0.19
3	Cowslip Street	RES	177.62	178.16	178.80	178.78	1.16	0.62
4	Cowslip Street	RES	178.00	178.73	178.74	178.74	0.77	0.01
4A	Cowslip Street	COM	178.27	178.65	178.87	178.74	0.47	0.09
6	Cowslip Street	RES	177.61	178.42	178.75	178.74	1.13	0.32
8	Cowslip Street	RES	177.20	178.04	178.74	178.73	1.53	0.69
9	Cowslip Street	RES	177.40	178.14	178.76	178.76	1.36	0.62
12	Cowslip Street	COM	177.27	177.87	178.73	178.72	1.49	0.85
15	Cowslip Street	RES	177.17	177.63	178.76	178.74	1.56	1.11
16	Cowslip Street	COM	176.21	176.75	177.14	177.01	0.33	0.26
17	Cowslip Street	RES	177.13	177.55	178.74	178.73	1.61	1.18
18	Cowslip Street	RES	175.90	176.79	176.96	176.95	0.38	0.16

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
19	Cowslip Street	RES	176.92	177.82	178.73	178.73	1.81	0.91
20	Cowslip Street	COM	175.87	176.27	177.15	176.28	0.35	0.01
2/22	Cowslip Street	COM	175.82	176.08	177.04	176.74	0.68	0.66
24	Cowslip Street	COM	175.72	175.95	176.81	176.31	0.38	0.36
28	Cowslip Street	COM	175.69	175.86	176.43	176.05	0.30	0.19
31	Cowslip Street	COM	176.23	176.62	176.61	176.63	0.24	0.01
31	Cowslip Street	COM	176.02	176.11	176.28	176.28	0.18	0.17
32	Cowslip Street	COM	174.71	175.20	175.62	175.61	0.73	0.41
33	Cowslip Street	COM	176.21	176.37	176.56	176.58	0.23	0.21
34	Cowslip Street	RES	174.32	175.27	175.45	175.42	1.08	0.15
35	Cowslip Street	COM	175.53	176.28	176.40	176.38	0.58	0.10
36	Cowslip Street	RES	174.32	175.29	175.40	175.39	1.06	0.10
37-39	Cowslip Street	RES	175.53	176.00	176.13	176.15	0.48	0.15
43	Cowslip Street	COM	175.29	175.84	176.11	176.11	0.65	0.27
47	Cowslip Street	RES	175.24	175.94	176.07	176.08	0.69	0.14
48	Cowslip Street	COM	173.66	175.04	175.24	175.22	1.20	0.18
48	Cowslip Street	COM	174.48	174.94	175.24	175.23	0.31	0.29
51	Cowslip Street	COM	175.24	175.65	175.89	175.89	0.56	0.24
2	Crocus Street	RES	177.95	178.64	178.92	178.90	0.95	0.26
7	Crocus Street	RES	177.87	178.59	178.91	178.90	1.00	0.31
1	Dahlia Street	RES	177.38	177.86	178.73	178.73	1.35	0.87
3	Dahlia Street	RES	177.61	178.25	178.73	178.72	1.11	0.47
5	Dahlia Street	RES	178.05	178.57	178.73	178.72	0.68	0.15
3	Daisy Street	RES	177.84	178.51	178.84	178.83	0.98	0.32
4	Daisy Street	COM	177.87	177.78	178.81	178.80	0.95	1.02
7	Daisy Street	COM	177.22	178.32	178.79	178.78	1.55	0.46
9	Daisy Street	RES	177.19	177.59	178.77	178.77	1.58	1.18
10	Daisy Street	RES	177.33	177.78	178.77	178.77	1.43	0.99
11	Daisy Street	RES	177.31	178.49	178.77	178.76	1.45	0.27
14	Daisy Street	RES	177.20	177.96	178.76	178.75	1.56	0.79

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5	Daphne Street	RES	177.04	177.63	178.03	177.85	0.42	0.22
180	High Street	RES	177.71	178.82	178.93	178.89	1.16	0.07
193	High Street	RES	178.94	179.40	180.00	179.44	0.41	0.04
197	High Street	COM	178.89	179.04	179.60	179.29	0.39	0.25
203	High Street	RES	178.93	179.15	179.29	179.27	0.35	0.12
209	High Street	COM	178.90	179.15	179.25	179.23	0.32	0.08
216	High Street	RES	178.07	178.68	178.74	178.74	0.64	0.06
221	High Street	RES	178.92	179.10	179.23	179.23	0.32	0.13
226	High Street	RES	178.07	178.66	178.76	178.68	0.62	0.02
1	Hyacinth Street	RES	176.14	176.30	176.62	176.59	0.32	0.28
2	Hyacinth Street	RES	175.91	176.26	176.27	176.27	0.36	0.01
4	Hyacinth Street	RES	175.74	175.99	176.27	176.27	0.50	0.28
6	Hyacinth Street	RES	175.68	176.23	176.27	176.27	0.46	0.04
8	Hyacinth Street	COM	175.62	176.07	176.18	176.15	0.54	0.08
6	Lily Street	RES	175.06	175.71	175.87	175.86	0.77	0.15
9	Lily Street	RES	174.36	175.92	176.00	175.97	1.04	0.05
10	Lily Street	RES	175.80	176.36	176.82	176.50	0.53	0.14
12	Lily Street	RES	175.74	176.27	176.54	176.44	0.69	0.17
13	Lily Street	RES	174.61	176.17	176.29	176.26	1.04	0.09
1	Nicholson Street	RES	174.28	175.75	176.14	175.93	1.23	0.18
5	Pink Street	RES	178.25	178.50	178.62	178.62	0.38	0.12
3	Primrose Street	RES	177.72	178.12	178.68	178.68	0.96	0.56
5	Primrose Street	RES	177.75	178.39	178.68	178.66	0.92	0.27
7	Primrose Street	RES	177.91	178.06	178.66	178.64	0.71	0.58
8	Primrose Street	RES	177.48	178.37	178.60	178.53	1.02	0.16
9	Primrose Street	RES	177.81	178.25	178.63	178.62	0.80	0.37
11	Primrose Street	COM	177.75	178.09	178.64	178.60	0.82	0.51
12	Primrose Street	RES	176.68	178.27	178.70	178.67	1.94	0.39
13	Primrose Street	RES	177.70	178.07	178.60	178.56	0.85	0.49
15	Primrose Street	RES	177.75	178.29	178.56	178.52	0.77	0.23

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19	Primrose Street	RES	177.91	178.22	178.55	178.48	0.73	0.26
21	Primrose Street	RES	177.75	178.22	178.52	178.48	0.73	0.26
23	Primrose Street	RES	177.68	177.87	178.50	178.48	0.80	0.61
25	Primrose Street	RES	177.65	178.23	178.50	178.48	0.83	0.25
27	Primrose Street	RES	177.92	178.27	178.92	178.48	0.55	0.21
27A	Primrose Street	RES	177.76	178.15	178.61	178.48	0.71	0.33
31	Primrose Street	RES	178.07	178.44	179.27	178.58	0.42	0.13
7	Railway Street	COM	176.35	177.00	177.06	177.07	0.47	0.07
9	Railway Street	RES	176.30	176.67	177.28	176.99	0.35	0.32
1	Rose Street	RES	174.56	174.74	175.02	175.01	0.47	0.27
3	Rose Street	RES	174.69	175.00	175.05	175.00	0.31	0.00
8	Rose Street	RES	173.81	174.60	174.75	174.73	0.77	0.13
4	Tulip Street	RES	174.67	175.37	175.52	175.40	0.50	0.03
7	Tulip Street	RES	176.42	176.89	177.01	176.91	0.48	0.02
13	Tulip Street	RES	176.50	176.59	176.87	176.79	0.33	0.20
15	Tulip Street	RES	176.42	176.74	176.81	176.79	0.33	0.05
17	Tulip Street	RES	176.34	176.53	176.74	176.71	0.38	0.18

Below Floor Listing

Street No.	Street Name	Type	Minimum Ground Level in Parcel (m AHD)	Floor Level (m AHD)	Maximum Flood Elevation in Parcel (m AHD)	Maximum Flood Elevation at Building (m AHD)	Maximum Flood Depth in Parcel (m)	Flood Depth below Floor Level (m)
2	Baird Street	COM	175.41	176.50	176.27	176.27	0.70	-0.23
1	Cowslip Street	RES	177.84	179.08	178.83	178.83	1.04	-0.253
7	Cowslip Street	RES	177.42	178.87	178.77	178.76	1.34	-0.107
21	Cowslip Street	RES	176.21	177.37	177.29	177.16	0.36	-0.213
25	Cowslip Street	RES	176.32	177.17	176.63	N/A	0.17	N/A
29	Cowslip Street	RES	176.39	177.45	176.47	N/A	0.08	N/A

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30	Cowslip Street	COM	175.43	175.92	176.24	175.85	0.37	-0.075
32A	Cowslip Street	RES	174.34	175.68	175.49	175.47	1.07	-0.21
40	Cowslip Street	RES	174.18	175.80	175.38	175.38	1.22	-0.422
87	Cowslip Street	RES	174.30	174.63	174.57	174.57	0.28	-0.061
5	Crocus Street	RES	177.45	179.16	178.99	178.94	1.05	-0.223
23	Crocus Street	RES	178.51	179.30	178.83	N/A	0.35	N/A
1	Daisy Street	RES	178.00	178.91	178.86	178.86	0.90	-0.048
1	Daphne Street	RES	176.39	177.47	177.60	177.20	0.50	-0.268
2	Daphne Street	RES	176.79	177.54	177.21	177.23	0.16	-0.313
3	Daphne Street	RES	176.86	177.49	177.60	177.33	0.32	-0.158
19	High Street	RES	180.26	179.50	180.77	N/A	0.15	N/A
40	High Street	RES	178.85	180.27	179.12	N/A	0.17	N/A
172	High Street	RES	178.12	179.25	179.14	179.05	0.83	-0.202
176	High Street	RES	178.11	179.35	179.17	179.14	0.84	-0.213
179	High Street	RES	178.90	179.66	179.68	179.65	0.69	-0.006
210	High Street	RES	178.15	178.94	178.79	178.74	0.57	-0.203
218	High Street	RES	178.05	178.93	178.74	178.74	0.65	-0.191
220	High Street	RES	178.42	178.99	178.74	N/A	0.28	N/A
229	High Street	COM	178.77	179.70	180.48	N/A	0.46	N/A
232	High Street	RES	178.45	179.05	178.68	N/A	0.24	N/A
263	High Street	RES	180.66	182.37	180.81	N/A	0.17	N/A
265	High Street	RES	181.05	181.60	181.20	N/A	0.14	N/A
273	High Street	RES	180.94	181.75	181.25	N/A	0.30	N/A
302	High Street	RES	177.64	179.91	180.85	179.71	2.38	-0.198
12	Hurt Street	RES	174.08	176.25	175.42	N/A	1.30	N/A
14	Hurt Street	RES	174.16	176.00	175.43	N/A	1.20	N/A
16	Hurt Street	RES	174.57	176.05	175.86	N/A	0.80	N/A
18	Hurt Street	RES	175.13	176.17	176.17	176.17	1.04	-0.005
22	Hurt Street	RES	174.75	176.92	176.22	176.21	1.45	-0.708
24	Hurt Street	RES	175.35	177.22	176.24	N/A	0.90	N/A

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1A	Hyacinth Street	RES	175.99	176.55	176.59	176.53	0.37	-0.022
3	Hyacinth Street	RES	175.78	176.55	176.56	176.50	0.66	-0.046
5	Hyacinth Street	RES	175.97	176.73	176.56	176.48	0.52	-0.249
3	Lilac Street	RES	179.78	180.58	180.23	180.13	0.18	-0.455
5	Lilac Street	RES	179.51	180.25	179.95	179.92	0.27	-0.332
5	Lily Street	COM	175.54	176.03	175.76	N/A	0.21	N/A
5A	Lily Street	RES	175.56	176.05	175.77	175.78	0.20	-0.275
1/8	Lily Street	RES	175.68	176.53	176.58	176.50	0.28	-0.033
4/8	Lily Street	RES	175.96	176.49	176.60	176.47	0.33	-0.024
11	Lily Street	RES	174.71	176.46	176.29	176.28	0.69	-0.178
11	Lily Street	RES	174.41	176.42	176.26	176.26	1.02	-0.164
17	Lily Street	RES	175.06	176.26	176.35	175.99	0.74	-0.27
21A	Lily Street	RES	175.61	176.47	176.39	176.36	0.27	-0.114
23	Lily Street	RES	176.01	176.92	176.88	176.57	0.39	-0.355
27	Marys Lane	RES	174.49	175.31	175.08	175.07	0.58	-0.236
7	McDiarmids Road	COM	172.84	174.62	175.09	174.50	1.94	-0.123
2	Mitchell Street	RES	174.30	175.12	175.26	N/A	0.57	N/A
	Mitchell Street	RES	169.39	174.49	174.69	174.16	3.64	-0.334
4437	Murchison-Violet Town Road	RES	170.89	173.63	173.93	173.34	3.06	-0.288
4446	Murchison-Violet Town Road	COM	170.91	173.66	174.35	173.62	2.51	-0.041
3	Pink Street	RES	178.48	179.05	178.61	178.60	0.12	-0.452
3A	Pink Street	RES	178.18	179.09	178.66	178.66	0.48	-0.433
6	Pink Street	RES	178.43	178.70	178.58	N/A	0.15	N/A
1	Primrose Street	RES	177.38	178.86	178.70	178.70	1.41	-0.163
2	Primrose Street	RES	177.38	178.60	178.49	178.49	1.12	-0.11
29	Primrose Street	RES	178.01	178.54	179.05	178.49	0.48	-0.051
35-39	Primrose Street	RES	178.38	179.35	179.74	179.09	0.54	-0.262
n/a	Railway Statio n Building	COM	175.81	179.20	178.71	178.71	2.05	-0.492
3	Railway Street	RES	176.65	177.13	177.06	177.06	0.26	-0.067
6	Rose Street	RES	174.21	174.99	174.72	174.63	0.42	-0.363

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7	Rose Street	RES	174.55	175.35	175.35	175.35	0.73	-0.001
10	Rose Street	RES	173.82	174.58	174.59	174.57	0.77	-0.008
12	Rose Street	RES	173.92	175.14	174.59	N/A	0.65	N/A
14	Rose Street	RES	174.39	175.52	174.86	N/A	0.18	N/A
28	Rose Street	RES	175.37	176.68	176.35	N/A	0.82	N/A
2	Tulip Street	COM	175.48	176.62	177.84	176.42	1.76	-0.197
6	Tulip Street	RES	174.66	175.60	175.05	N/A	0.36	N/A
8	Tulip Street	RES	174.44	175.35	175.02	N/A	0.55	N/A
10	Tulip Street	RES	174.41	175.30	174.98	N/A	0.52	N/A
12	Tulip Street	RES	174.12	175.08	174.85	N/A	0.59	N/A
14	Tulip Street	RES	173.98	175.29	174.70	N/A	0.69	N/A
18	Tulip Street	RES	174.07	175.22	174.69	N/A	0.58	N/A
19	Tulip Street	RES	176.39	176.94	176.70	176.71	0.25	-0.233
21	Tulip Street	COM	176.33	177.08	176.63	N/A	0.23	N/A
23	Tulip Street	RES	176.04	176.52	176.54	176.42	0.28	-0.103
47	Tulip Street	RES	174.62	175.98	175.12	N/A	0.49	N/A
49	Tulip Street	RES	174.52	175.79	175.77	175.77	0.57	-0.022
51	Tulip Street	RES	175.67	175.89	175.77	N/A	0.08	N/A