ARMSTRONG CREEK URBAN GROWTH PLAN
FLOODING AND DRAINAGE STUDY

Technical Report
24 February 2006

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City of Greater Geelong

Armstrong Creek Urban Growth Plan
Flooding and Drainage
Existing Conditions Assessment

Report No. J207/R01 Final 1

February 2006

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1 INTRODUCTION

This report outlines the investigations undertaken for the flooding and drainage component of the Armstrong Creek Urban Growth Plan (UGP). These investigations will aid the City of Greater Geelong (CoGG) in defining the existing flooding behaviour and flooding constraints on future urban development. Figure 1-1 displays the study area for the flooding and drainage investigation. The study area shown was provided to Water Technology by ARUP.

Water Technology undertook these investigations as part of a study team led by David Lock and Associates and ARUP.

The requirements of the flooding and drainage component were defined the Flooding and Drainage Study Brief (Appendix 10). The following outlines the flooding and drainage study tasks:

Task 1 – Digital Terrain Model (DTM)

a) Review of available digital survey data and enhance as necessary to produce a DTM. Specified accuracy 0.15 m.

b) Identify and undertake field survey needed to capture critical structures and features.

Task 2 – Hydrological and hydraulic modelling, and mapping of 1% flood events

a) Development and refinement of rainfall/runoff models for the study area with particular consideration to:

- Flood volume and flood peaks in assessing critical storm and flood events
- Interaction between hydrologic and hydraulic models
- Existing conditions assessment
- Developed conditions with conventional residential development based on WSUD principles
- Hydrologic modelling of urban areas contributing runoff to the study area
- Parameter values for models verified (where possible) and justified in the report

b) Development and refinement of hydraulic models of relevant waterways, drains, culverts and floodplains for the study area with particular consideration to:

- Interaction between hydrologic and hydraulic models
- Use of two dimensional or quasi two dimensional models

c) Utilisation of hydraulic models to produce best estimates of water surface profiles for the critical 1% AEP flood event. Profiles prepared for existing conditions and developed conditions with conventional residential development based on WSUD principles.

d) Generation of flood extent maps for the critical 1% AEP flood events (including flood level contours). Flood extent maps for existing conditions and developed conditions with conventional residential development based on WSUD principles. Maps to be presented on a digital cadastral base.

Task 3 – Assessment of Drainage and Flooding Issues Affecting Development Potential of Nominated Areas

a) Assessment and reporting on the nature and extent of flooding identified in Task 2

b) Identification of unacceptable flooding within the floodplain delineated within Task 2 and possible flood mitigation options for existing conditions and developed conditions with conventional residential development based on WSUD principles.

c) Identification of land within the study area that is considered appropriate for conventional residential development.

d) Identification of land within the study area that is considered appropriate for conventional residential development but due a lack of drainage, or flooding drainage, requires the installation of measures to overcome these constraints. Measures to be described in concept plan or master plan detail.

e) Modelling (hydrological and hydraulic) and mapping (1% AEP flood with developed conditions) for areas identified in subtask d) as benefiting from measures to overcome drainage or flooding constraints

Study tasks addressed by this report:

- Task 1
- Task 2 (part: existing conditions only)
- Task 3 a (all), b(part: existing condition only) and c.

As the nature and extent of the proposed development is yet to be determined, no assessment of flood behaviour under developed conditions has been made to date. CoGG is aware of the reasons underlying the coverage of this report and accepts the outstanding tasks will be addressed in a future report.

The structure of this report is as follows:

- Section 2 Study background – provides study context and background.
- Section 3 Available data – outlines available previous flood related investigations, stream flow and topographic data employed in this study
- Section 4 Existing conditions flood behaviour - discusses the methodology and output from the existing conditions flooding assessment.
- Section 5 Drainage and flooding issues affecting development potential – outlines the land capability/development potential from a flooding and drainage perspective.

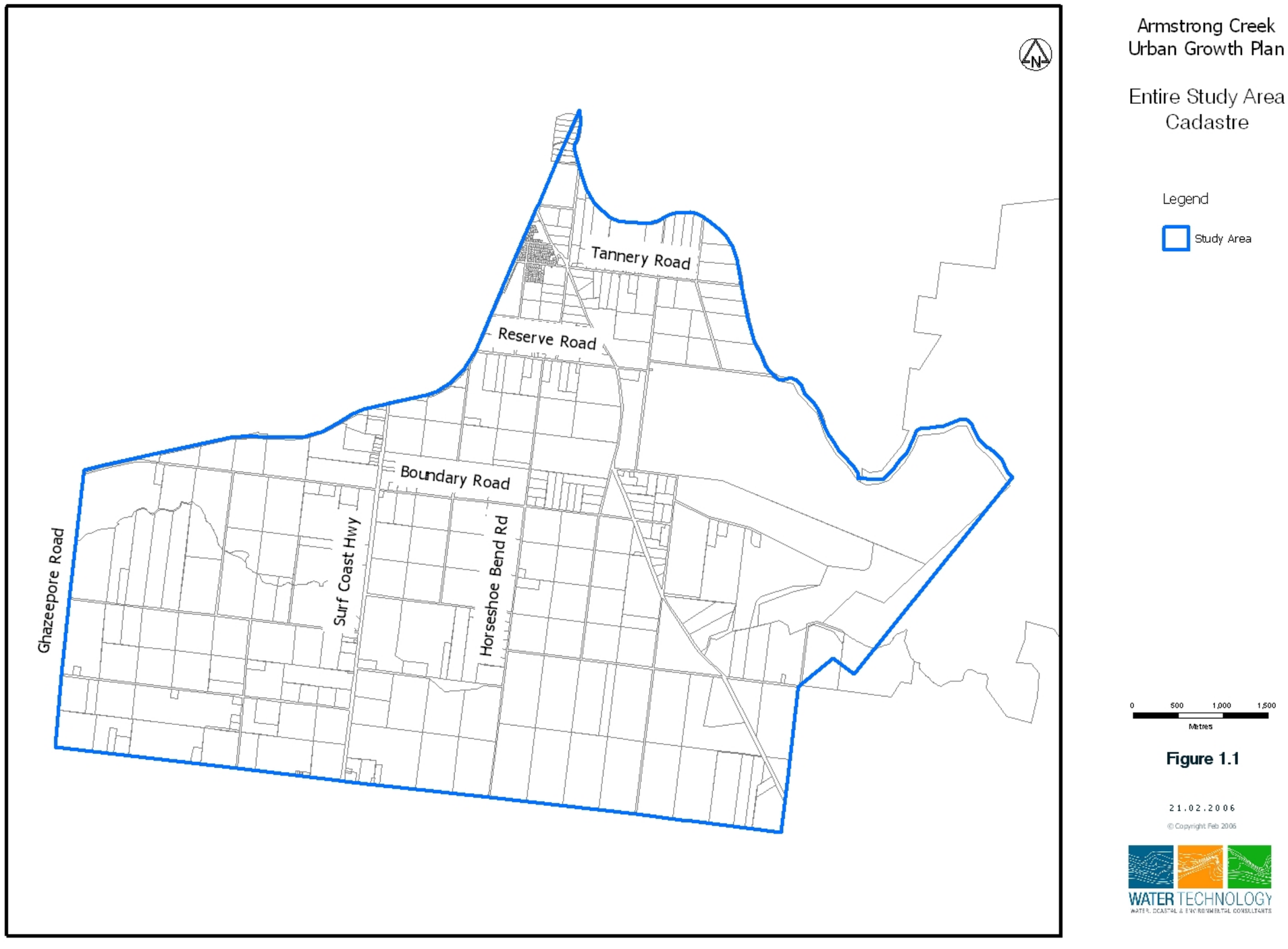

Figure 1-1 Armstrong Creek UGP Study Area (as provided to Water Technology)

2 STUDY BACKGROUND

The study area consists mainly of rural land. The associated drainage is via a number of drainage depressions and larger watercourses. Formal stormwater drainage infrastructure in the study area is limited to a small area of urban development.

Land use planning and drainage management for the study area are the responsibilities of the CoGG. Floodplain management is the responsibility of the Corangamite Catchment Management Authority (CCMA).

The CoGG has divided the study area into a number of drainage catchments. The CoGG catchment boundaries were provided to Water Technology. Figure 2-1 shows the catchment delineation.

The following outlines the nature of the drainage infrastructure in each sub-catchment:

C252 Waurn Ponds Creek

- Large catchment with only a small proportion in study area.
- A proportion in the study area is subject to inundation from the Barwon River

C253 Marshall

- Small catchment with partial urban development.
- Serviced by underground drainage system and retarding basins.

C254 South East Grovedale

- Urban development north of railway (outside study area) serviced by underground drainage system and retarding basin (south of railway).
- Rural land (south of railway) with open watercourses of limited capacity.

C255 Sparrowvale

- Rural land, very flat, with an open constructed drain.
- Private levee encloses low lying land adjacent to the Barwon River and prevents inundation up to a 1 in 10 year flood.
- Local runoff requires pumping over the levee for discharge to the Barwon River.

C256 Sparrowvale North

- Rural land, very flat, with no formal constructed drainage.
- Low lying area inundated by the Barwon River.

C257 Armstrong Creek

- Urban development north of railway (outside study area) serviced by underground drainage system and retarding basin (north of railway).
- Poorly defined watercourses with limited capacity.
- Low lying areas subject to winter waterlogging.

C267 Thompsons Creek – Duneed Creek Branch

- Rural land, several ill defined drainage lines.
- No drainage infrastructure.

As discussed above, underground drainage systems are located in C253 Marshall, C254 South East Grovedale and C257 Armstrong Creek. The last two of which are outside the study area. These underground drainage systems have capacities ranging from the 1 in 5 year to 1 in 10 year flood event.

For C254 South East Grovedale and C257 Armstrong Creek, retarding basins have been constructed at selected outfalls into the study area. These retarding basins have the design intention to reduce peak flow from the upstream urban development areas to rural condition peak flows.

A digital terrain model (DTM) was constructed for the study area. Details of the DTM are discussed in Section 3.3. Using the DTM, the study team analysed the topography and revised the CoGG catchments to better reflect the topography.

The following outlines the key findings from the topographic analysis:

- The catchment boundary between C253 and C254 is not well defined. The topographic analysis reveals overland flow occurs between C254 and C253 adjacent to the corner of Marshalltown Road and Barwon Heads Road. As such, it was not possible to define a catchment boundary along Marshalltown Road. The hydrologic and hydraulic analysis, detailed in Section 4.3, has considered C253 and C254 as a single catchment.
- The catchment boundary between C255 and C256 is not well defined. The topographic analysis reveals overland flow occurs between C255 and C256 adjacent to the corner of Reserve Road and Barwon Heads Road. As such, it was not possible to define a catchment boundary along Reserve Road. The hydrologic and hydraulic analysis, detailed in Section 4.5, has considered C255 and C256 as a single catchment.
- The catchment boundary between C255 and C257 is defined by alignment of the Surf Coast Highway north of Boundary Road. The elevated road formation in this area results in the direction of the overland flow west of the Surf Coast Highway to the south along the western limit of the Surf Coast Highway. Without the Surf Coast Highway, the C255 catchment boundary would extend to the western side of the Surf Coast Highway adjacent to Boundary Road.

Figure 2-1 shows the catchment boundaries used in this study. where revisions have been made, the original boundaries have been shown for comparison.

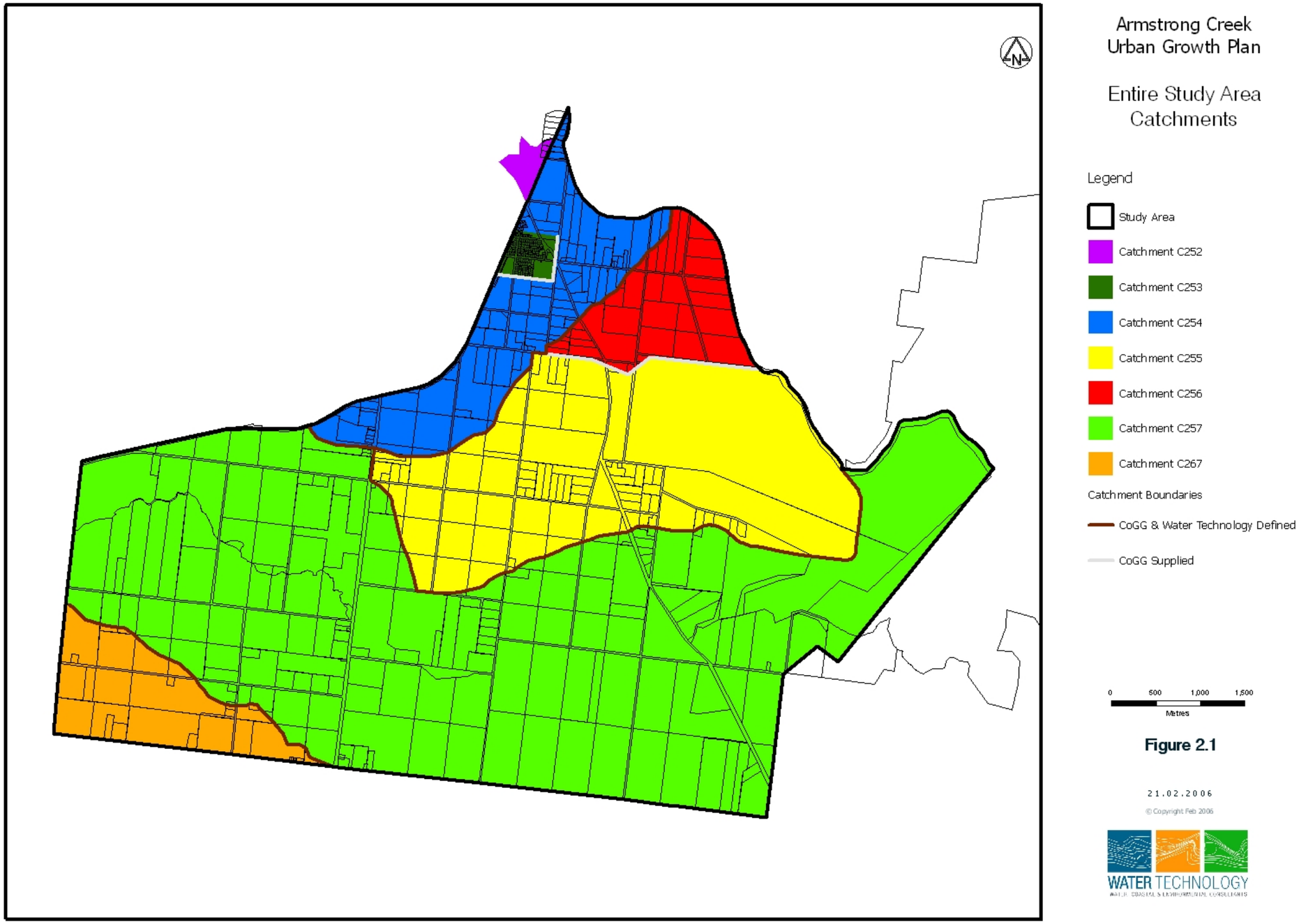

Figure 2-1Armstrong Creek UGP – Drainage catchment

3 AVAILABLE INFORMATION

3.1 Streamflow data

There is no streamflow data available for the catchments in the study area. As such, formal calibration of the hydrologic and hydraulic analyses has not been possible.

3.2 Topographic and structure data

3.2.1 Photogrammetric survey

A photogrammetric survey was received by the study team at the commencement of the study. The photogrammetric survey consists of a regular grid of spot elevation, contours and breaklines to define linear features.

The study team understands QASCO Victoria undertook the photogrammetric survey, and that the accuracy is understood to be +- 150 mm.

3.2.2 Structure arrangements

The details of culverts, bridges and retarding basins were provided by the CoGG. These structures were included, where required, in the hydrologic and hydraulic analyses outlined in Section 4.

Further details of structures were obtained from VicRoads.

3.3 Digital terrain model

A digital terrain model was developed for the study area using the photogrammetric survey. Figure 3-1 shows the extent of the DTM. The shading indicates the natural surface elevation.

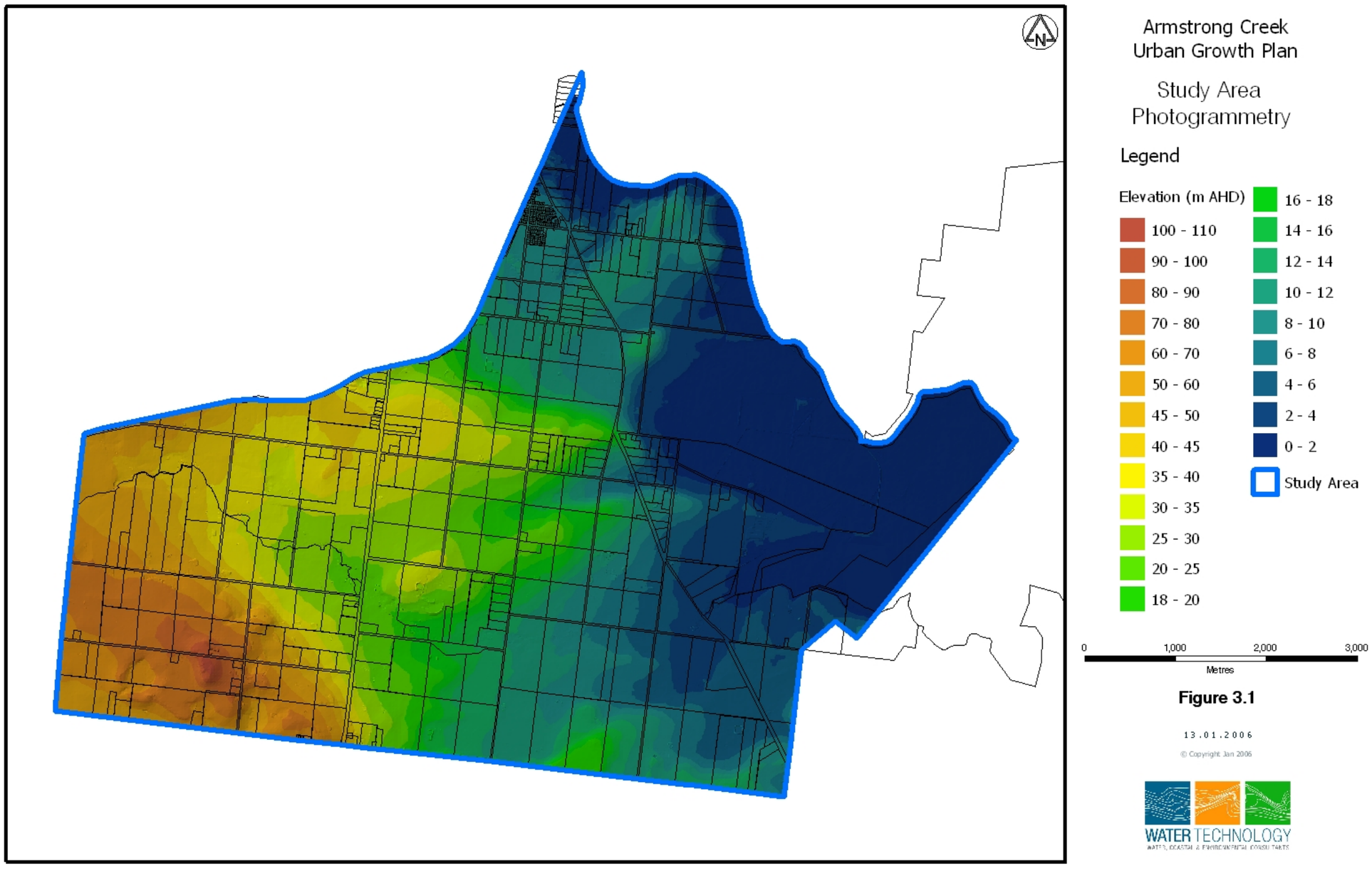

Figure 3-1 Digital Terrain Model

4 EXISTING CONDITIONS FLOOD BEHAVIOUR ASSESSMENT

4.1 Overview

The study brief requires the determination of the 100 year flood extents for waterways within the study area. The determination of flood extent contains the following two components:

- Hydrologic analysis – estimation of flood flows and runoff volumes
- Hydraulic analysis – calculation of flood extents due to the flood flows and volumes determined in the hydrologic analysis

This section details the determination of the 100 year flood extent under existing conditions, and details the input data, methodology and outputs for the hydrologic and hydraulic analysis.

4.2 Methodology

Two approaches have been used for the hydrological and hydraulic modelling of the study area under existing conditions. These two approaches were developed to reflect the different catchment characteristics as follows:

- Enclosed catchments – catchments entirely the study area: Includes C255, C256 and C267
- Catchments with runoff contribution from outside the study: Includes C253, C254 and C257

Sections 4.2.1 and 4.2.2 describe the above two approaches.

4.2.1 Enclosed catchments

The computer package MIKE Flood was applied as a combined hydrological and hydraulic model for the C255, C256 and C267 catchments.

MIKE Flood is a state of the art tool for floodplain modelling that has been formed by the dynamic coupling of Danish Hydraulics Institute's well proven MIKE 11 river modelling and MIKE 21 fully two-dimensional modelling systems. Further MIKE Flood allows the application of net rainfall (rainfall less losses) directly onto the catchment. This direct application of net rainfall enables the consideration of the interaction between the hydrologic and hydraulic analyses.

Design rainfall depths and temporal patterns were obtained from Australian Rainfall and Runoff (IEAust 1999). A uniform design rainfall spatial pattern was applied. To determine net 100 year design rainfalls for input into the MIKE Flood, an initial loss of 10 mm and continuing loss of 2 mm/hour were applied.

The sub-catchment peak flows obtained from the MIKE Flood models were compared to peak flows obtained from the Rational Method. The Rational Method as outlined by VicRoads (1999) was applied with a 10 year runoff co-efficient (C10) of 0.1. The 10 year runoff co-efficient was obtained from Australian Rainfall and Runoff (IEAust 1999).

The MIKE Flood peak flows were refined by the adjustment of the hydraulic roughness parameter (Manning's n) to achieve consistency with the Rational Method peak flows. Due to the extensive available floodplain storage, it is considered that the Rational Method may over-estimate the peak flow. In such instances, similar peak flows from the MIKE Flood model and

Rational Method were not achieved. Further details of the differences between the MIKE Flood model and Rational Method are provided in Sections 4.5 and 4.7.

4.2.2 Catchments with external study area runoff contribution

As discussed in Section 2, the sub-catchments C254 and C257 have catchment areas which extend outside the study area. The hydrological modelling included the application of the runoff routing model RORB to determine the runoff contribution from C254 and C257 at study area limit. The RORB models were developed for the entire catchments of C254 and C257. The RORB parameter kc was determined using a regional prediction formula (Pearse et al 2002). Details of the kc values adopted for C254 and C257 are provided in Section 4.4 and 4.6. The RORB models for C254 and C257 incorporated the existing retarding basins.

Within the study area, a MIKE Flood model was employed as a combined hydrological and hydraulic model. The external runoff contributions from the RORB model were input to the MIKE Flood model as inflows.

Design rainfall depths and temporal patterns were obtained from Australian Rainfall and Runoff (IEAust 1999). A uniform design rainfall spatial pattern was applied. To determine net 100 year design rainfalls for input into the MIKE Flood and RORB models, an initial loss of 10 mm and continuing loss of 2 mm/hour were applied.

Both the MIKE Flood and RORB models were run for a range of design storm durations as to assess the critical durations.

The sub-catchment peak flows obtained from the MIKE Flood models were compared to peak flows obtained from the RORB model for the entire catchment.

The MIKE Flood peak flows were refined by the adjustment of the hydraulic roughness parameter (Manning's n) to achieve consistency with the RORB model peak flows. Further details of the comparison of peak flows are provided in Sections 4.4and 4.6.

4.3 Catchment C252 Waurn Ponds Creek

The proportion of the C252 Waurn Ponds Creek catchment within the study area is subject to flooding from the Barwon River. Given the flooding due to the Barwon River, it was agreed that no assessment of the existing flood conditions was required.

4.4 Catchment C253 Marshall and Catchment C254 South Grovedale

As discussed in Section 2, the catchment boundary between C253 and C254 is not well defined along Marshalltown Road. As such, the hydrologic and hydraulic modelling was undertaken for the combined C253 and C254 catchment. Figure 4-1 shows the combined C253 and C254 catchment.

A RORB model was developed for the entire combined C253 and C254 catchment. The RORB model incorporated the following retarding basins:

- Upstream of Surf Coast Highway to south of the railway line
- Barraware Road
- Balblair Drive

The following parameters were adopted for the RORB model:

- k_c = 3.47 (k_c =1.25*d_{av} Pearse et al 2002. d_{av}: 2.78 km)
- Fraction impervious in urban areas: 0.45

The RORB model yielded a 100 year design peak flow of 12.7 m^3/s with a critical storm duration of 9 hours to the catchment outlet.

Figure 4-1 C253 & C254: Sub-catchments

The MIKE Flood model used the RORB model design flood hydrographs as inflows. Net design rainfalls were applied directly to the MIKE Flood model. The MIKE Flood model employed a 5 m grid. Refinements were made to the hydraulic roughness (Manning's n) until a similar 100 year design peak flow to the RORB model (12.7 m^3/s) was achieved from the MIKE Flood model. Using the hydraulic roughness shown in Figure 4-2, the MIKE Flood model yielded a 100 year design peak flow of 13.6 m^3/s. The study team considers the MIKE Flood model provides a suitable 100 year design peak flow when compared to the RORB model.

The hydraulic roughness shown in Figure 4-2 for the floodplain areas (away from the watercourses) has been assigned a Manning's n value of 0.1. This value of Manning's n is high for the land use and vegetation cover found in these areas. The higher value of Manning's n reflects the increased effective hydraulic roughness due to the shallow flow depths. The flow depths in these areas are less than 50 mm. It is likely that this flow depth is order the of the height of the vegetation in the cleared areas.

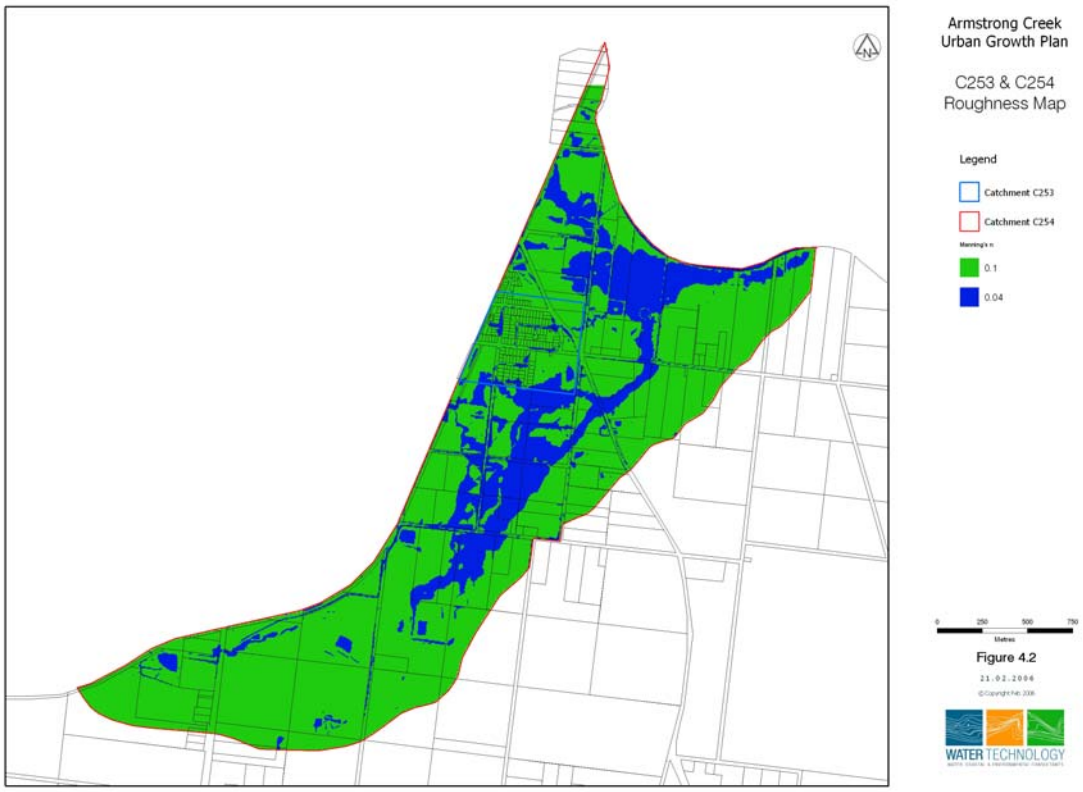

Figure 4-2 C254 South East Grovedale: Roughness

Figure 4-3 shows the 100 year ARI flood extent for C253 and C254 under existing conditions. Also Figure 4-3 displays the flood depth as a shade of blue and water surface elevations as contours.

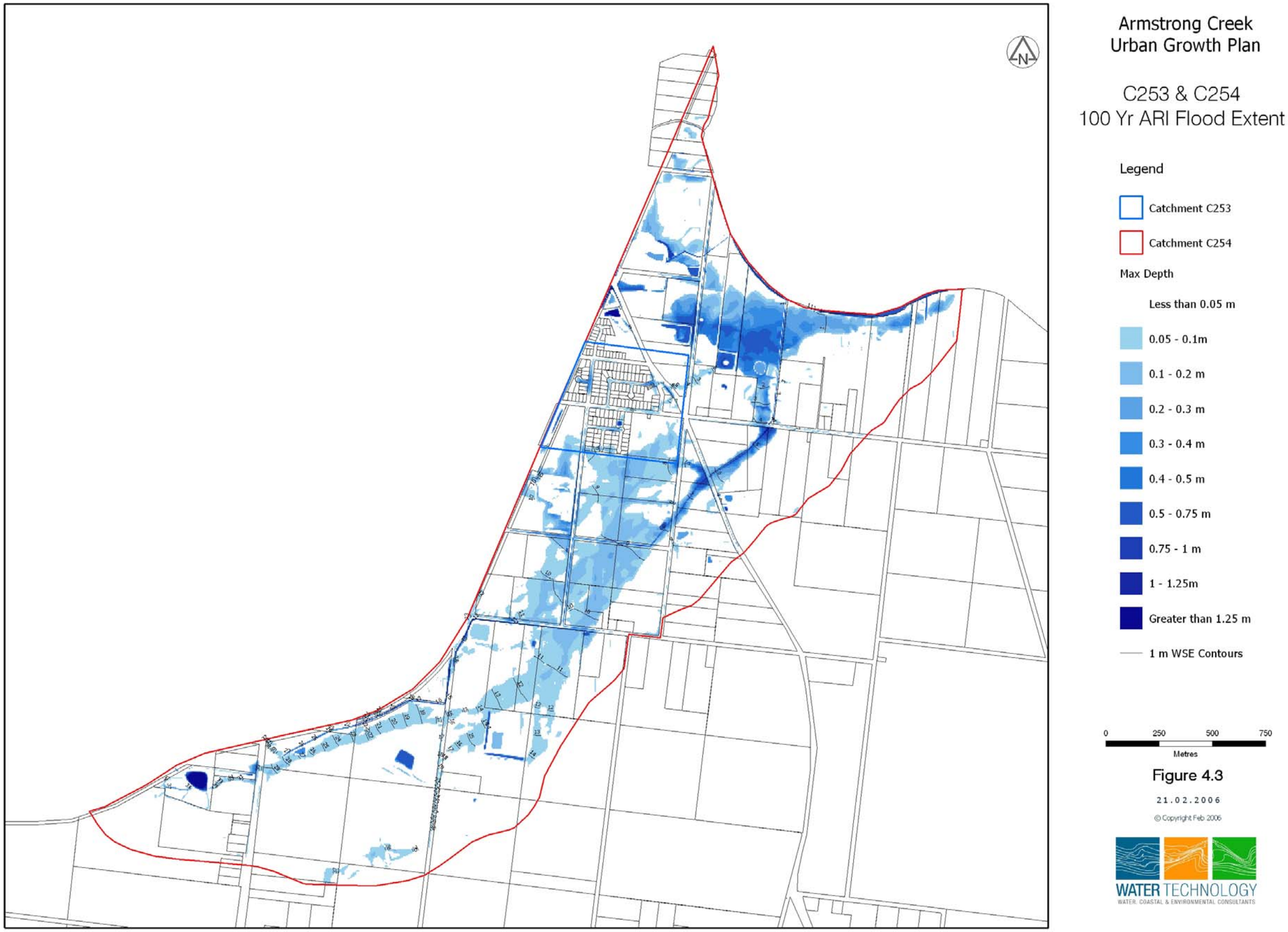

Figure 4-3 C253 & C254 South East Grovedale: 100 year flood extent

4.5 Catchment C255 Sparrowvale and C256 Sparrowvale North

As discussed in Section 2, the catchment boundary between C255 and C256 is not well defined along Reserve Road. As such, the hydrologic and hydraulic modelling was undertaken for the combined C255 and C256 catchment. Delineation of sub-catchments within the combined C255 and C256 catchment is difficult due to the flat nature of land. Figure 4-4 shows the combined C255 and C256 catchment with sub-catchments.

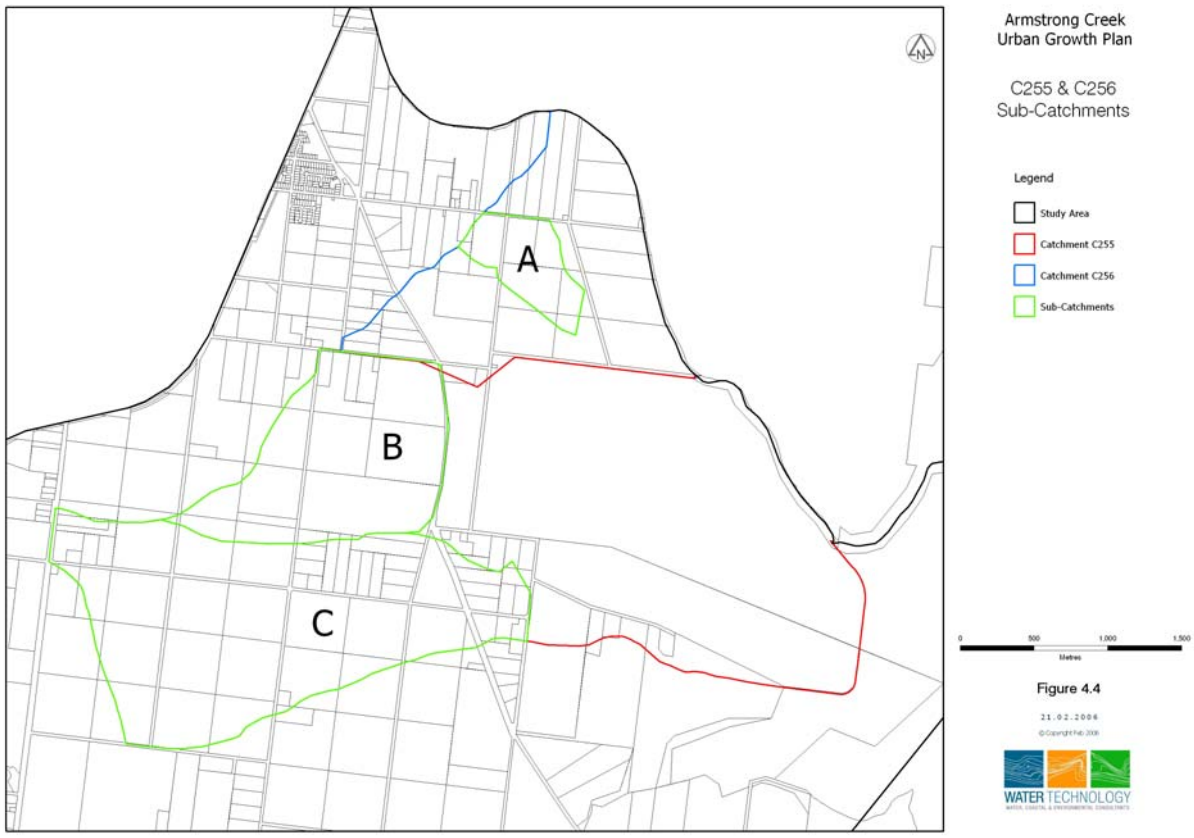

Figure 4-4 C255 & C256: Sub-catchments

The Rational Method was applied to estimate the 100 year design peak for each of the sub-catchments. Table 4-1 displays the Rational Method's parameters and 100 year design peak flows.

Net design rainfalls were applied directly to the MIKE Flood model. The MIKE Flood model employed a 5 m grid. Refinements were made to the hydraulic roughness (Manning's n) until a similar 100 year design peak flow to the Rational Method, where possible, was achieved from the MIKE Flood model. Using the hydraulic roughness shown in Figure 4-5, the MIKE Flood model yielded consistent design 100 year peak flows.

Table 4-1 C255 and C256: 100 year peak flows

Catchment	Area (ha)	T_c (min)	I_{100} (mm/h)	P_{10}	F_a	F_y	Rational Method 100 year design peak flow (m^3/s)	MIKE Flood 100 year design peak flow (m^3/s)
C256 A	37.24	31.33	65.01	0.1	2	1.3	1.8	2.2
C255 B	157.27	54.16	45.19	0.1	2	1.3	5.1	5.8
C255 C	324.53	71.32	37.65	0.1	1.94	1.3	8.6	13.3

Where: T_c –Time of concentration as defined by VicRoads (1999)

I_{100} – Design 100 year design rainfall intensity for storm duration equal to the time of concentration

P_{10} – 10 year runoff co-efficient from Australian Rainfall and Runoff (IEAust 1999)

F_a- Area factor as defined by VicRoads (1999)

F_y – Frequency factor defined by VicRoads (1999)

Table 4-1 shows that the 100 year peak flow estimates obtained from the MIKE Flood model generally higher than those obtained using the Rational Method. C256 A and C255 B display a reasonable level of agreement, within 20 %. An increase in the 10 year runoff co-efficient from 0.1 to 0.12 would result in peak flows from the Rational Method similar to the MIKE Flood estimates. There is considerable uncertainty in the estimation of 10 year runoff co-efficient. Given this uncertainty, it is considered that the use of the higher MIKE Flood peak flows as reasonable and suitable for the purposes of this study.

The MIKE flood model peak flow estimate for C255C is significantly higher than the Rational Method estimate. The catchment for C255C is relatively linear in shape. It is considered that the shape of the catchment results in a shorter overland flow path. This shorter overland flow path results in a higher peak flow.

The hydraulic roughness shown in Figure 4-5 for the floodplain areas (away from the watercourses) has been assigned a Manning's n value of 0.1. This value of Manning's n is high for the land use and vegetation cover found in these areas. The higher value of Manning's n reflects the increased effective hydraulic roughness due to the shallow flow depths. The flow depths in these areas are less than 50 mm. It is likely that this flow depth is of the order of the height of the vegetation in the cleared areas.

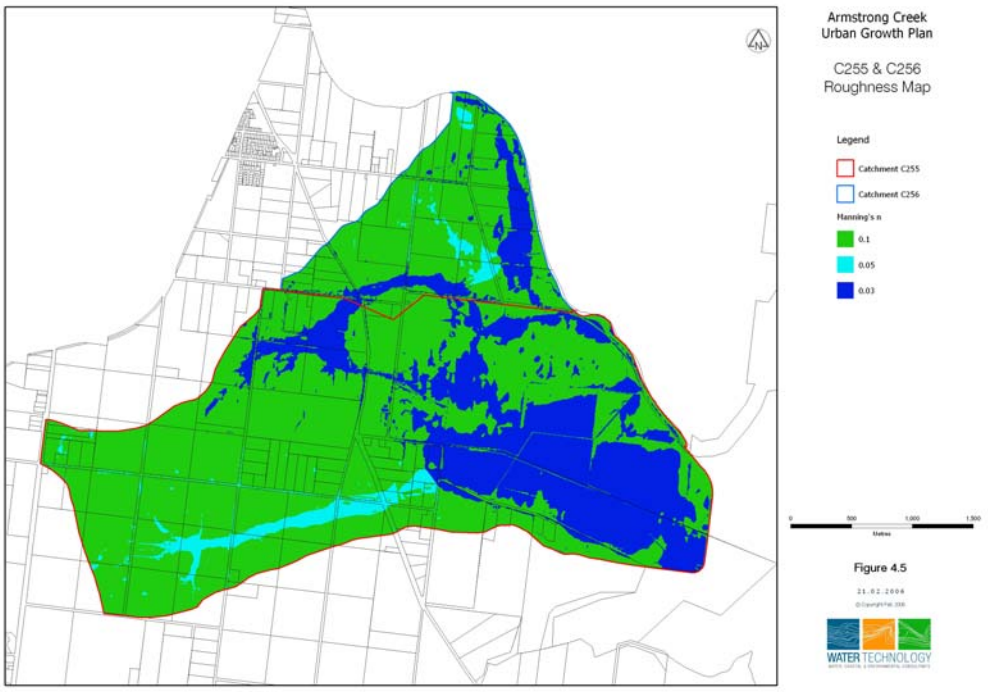

Figure 4-5 C255 & C256 Sparrowvale: Roughness

Figure 4-6 shows the 100 year ARI flood extent for the combined C255 and C256 catchment. Also Figure 4-6 displays the flood depth as a shade of blue and water surface elevations as contours.

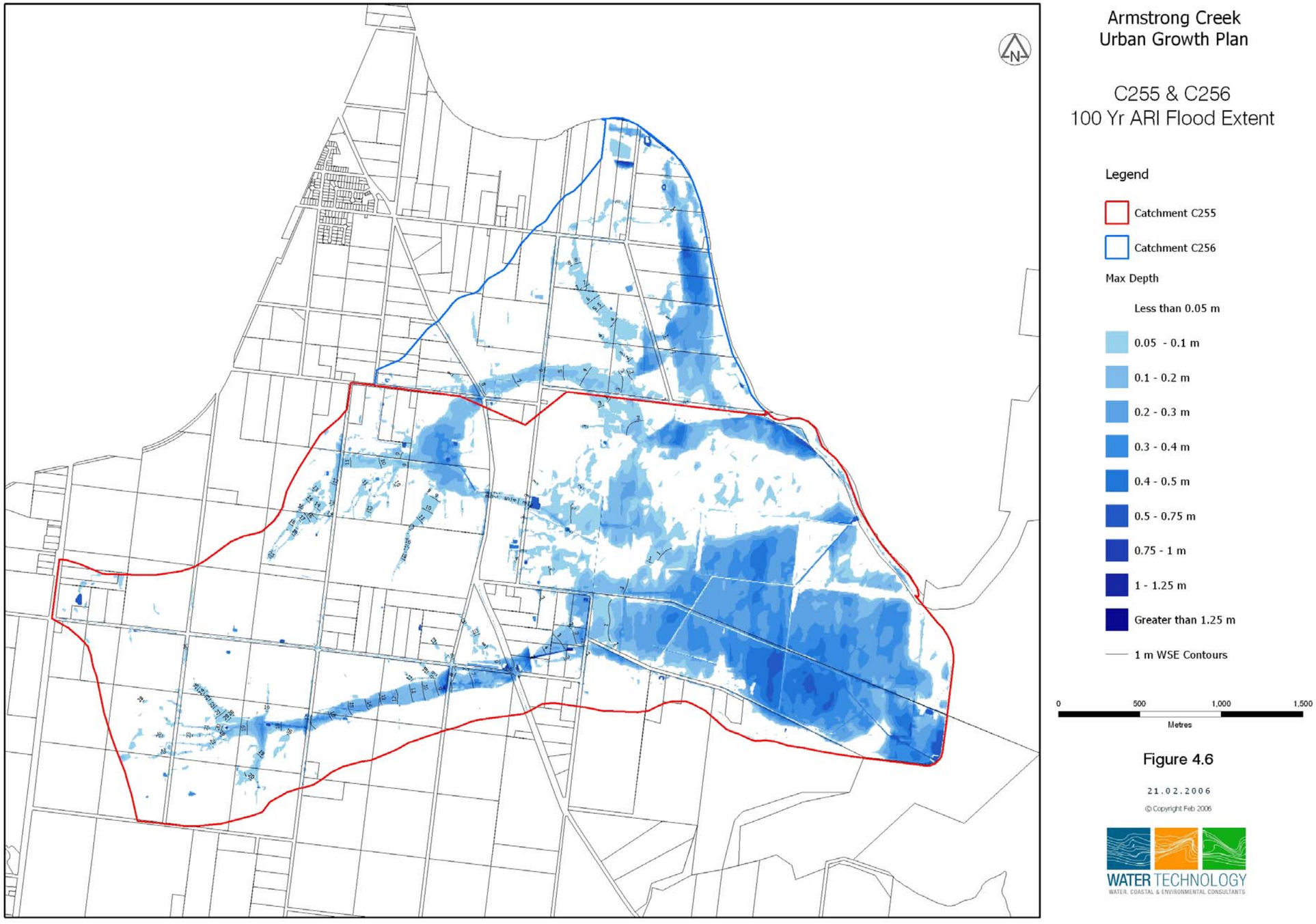

Figure 4-6 C255 & C256 Sparrowvale: 100 year flood extent

4.6 Catchment C257 Armstrong Creek

A RORB model was developed for the entire C257 catchment. Figure 4-7 shows the C257 catchment.

The RORB model incorporated the Hams Road retarding basin.

The following parameters were adopted for the RORB model:

- $k_c = 9.83$ ($k_c = 1.25 * d_{av}$ Pearse et al 2002. d_{av}: 7.78 km)
- Fraction impervious in urban areas: 0.45

The RORB model yielded a 100 year design peak flow of 48 m^3/s with critical storm duration of 12 hours to the catchment outlet. The RORB model 100 year peak flow estimates have revised from the estimate (44 m^3/s) provided in the Draft Technical Report (13/1/06). This revision is due to the change in the fraction impervious for urban area within the C257 catchment. The change in fraction impervious was made to provide the same fraction impervious of the urban areas of C254 and C257.

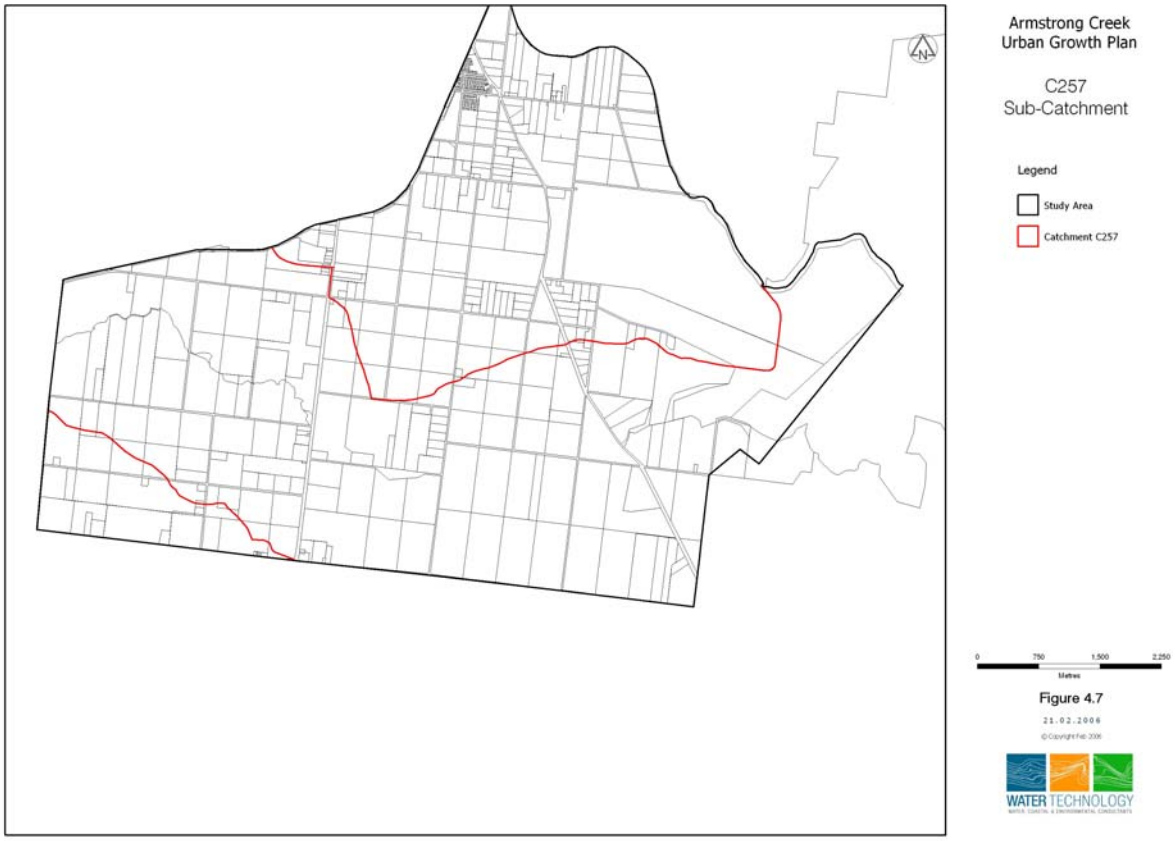

Figure 4-7 C257: Catchment

The MIKE Flood model used the RORB model design flood hydrographs as inflows at the upstream end of the study area. Net design rainfalls were also applied directly to the MIKE Flood model. The MIKE Flood model employed a 5 m grid. Refinements were made to the hydraulic roughness (Manning's n) until a similar 100 year design peak flow to the RORB model (44 m^3/s) was achieved from the MIKE Flood model. Using the hydraulic roughness shown in Figure 4-8, the MIKE Flood model yielded a 100 year design peak flow of 45 m^3/s. This estimate was considered to be a suitable 100 year design peak flow when compared to the RORB model.

The hydraulic analysis revealed overtopping of the Surf Coast Highway by up to 200 mm in the 100 year flood event.

The hydraulic roughness shown in Figure 4-8 for the floodplain areas (away from the watercourses) has been assigned a Manning's n value of 0.1. This value of Manning's n is high for the land use and vegetation cover found in these areas. The higher value of Manning's n reflects the increased effective hydraulic roughness due to the shallow flow depths. The flow depths in these areas are less than 50 mm. It is likely that this flow depth is the order of the height of the vegetation in the cleared areas.

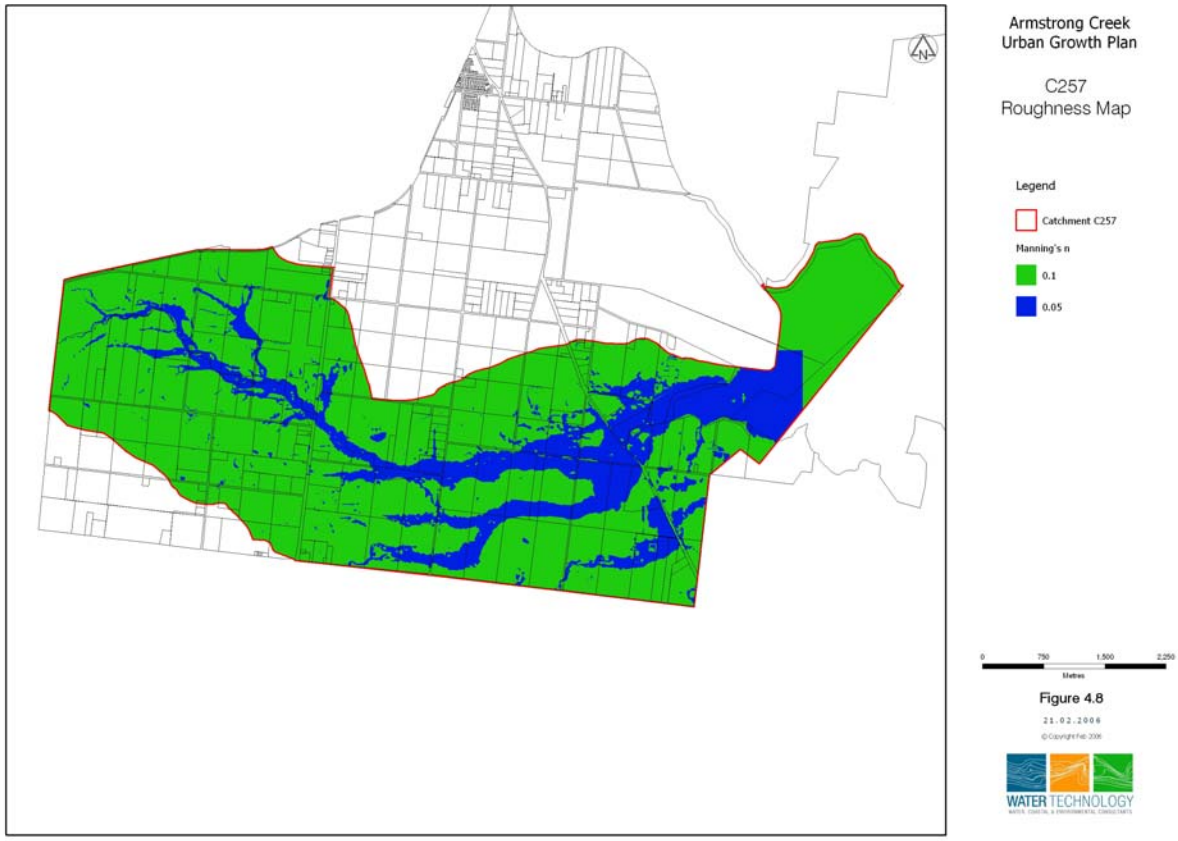

Figure 4-8 C257 Armstrong Creek: Roughness

Figure 4-9 shows the 100 year ARI flood extent for C257 under existing conditions. Also Figure 4-9 displays the flood depth as a shade of blue and water surface elevations as contours.

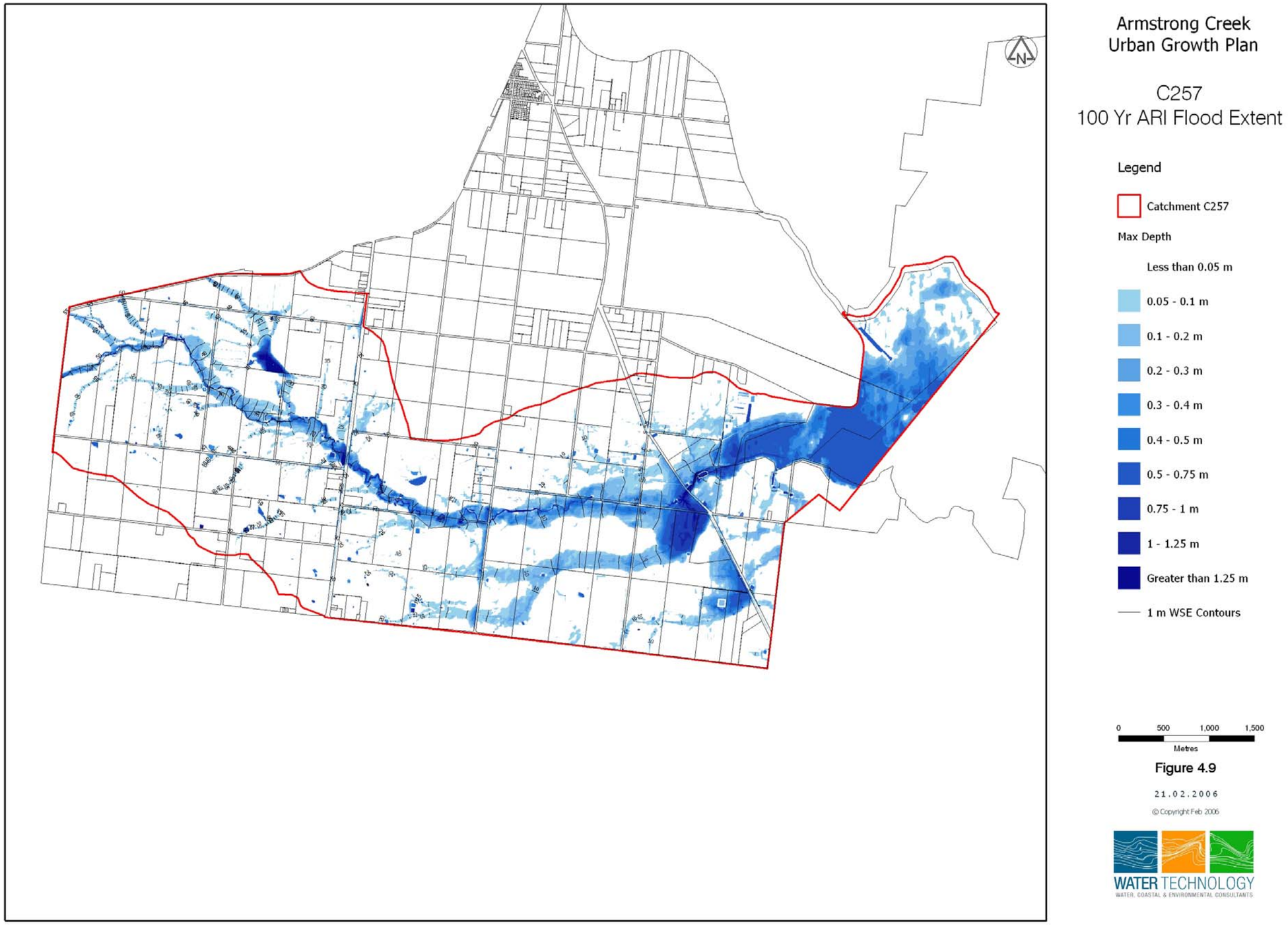

Figure 4-9 C257 Armstrong Creek: 100 year flood extent

4.7 Catchment C267 Thompsons Creek – Duneed Creek Branch

The C267 catchment within the study area forms part of the Thompsons Creek catchment. Within the C267 catchment a number of sub-catchments were delineated. Further analysis of the C267 catchment to the west of Ghazeepore Road was undertaken to allow for the observed flows along Ghazeepore Road north of Mount Duneed Road. Figure 4-10 shows the C267 catchment with sub-catchments and the extension to the west of Ghazeepore Road.

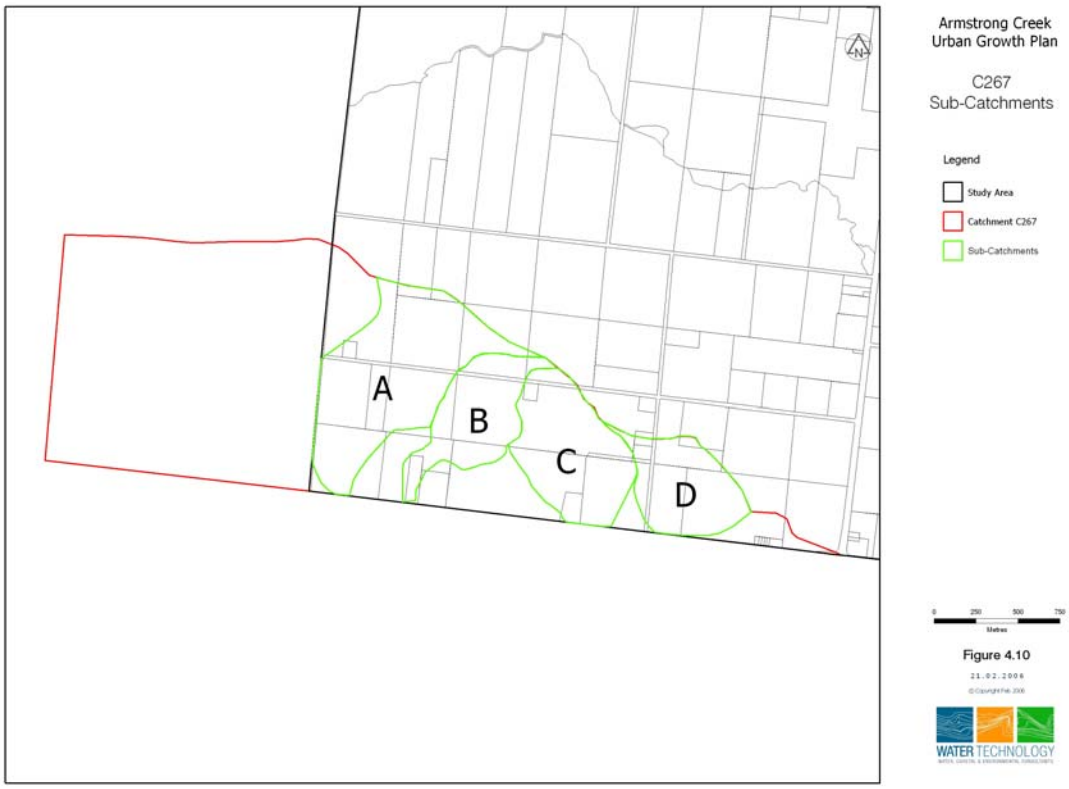

Figure 4-10 C267: Sub-catchments

The Rational Method was applied to estimate the 100 year design peak for each of the sub-catchment. Table 4-2 displays the Rational Method's parameters and 100 year design peak flows.

Net design rainfalls were applied directly to the MIKE Flood model. The MIKE Flood model employed a 5 m grid. Refinements were made to the hydraulic roughness (Manning's n) until a similar 100 year design peak flow, where possible, to the Rational Method was achieved from the MIKE Flood model. Using the hydraulic roughness shown in Figure 4-11, the MIKE Flood model yielded consistent design 100 year peak flows.

Table 4-2 C267: 100 year peak flows

Catchment	Area (ha^2)	T_c (min)	I_{100} (mm/h)	P_{10}	F_a	F_y	Rational Method 100 year design peak flow (m^3/s)	MIKE Flood 100 year design peak flow (m^3/s)
C267 A	74.67	40.81	54.35	0.1	2	1.3	2.9	2.6
C267 B	34.03	30.27	66.59	0.1	2	1.3	1.6	0.7
C267 C	45.57	33.65	61.52	0.1	2	1.3	2.0	3.4
C267 D	31.94	29.55	67.45	0.1	2	1.3	1.6	3.8

The MIKE Flood results in a peak flow for C267 B that is considerably less than that of the Rational Method. It is considered the presence of a farm dam in this sub-catchment significantly attenuates runoff. The farm dam can be seen as a dark blue area in Figure 4-12. The MIKE Flood model accounts for the storage effects of the farm dam. The Rational Method does not account the farm dam's storage effects and in turn yields a larger peak flow. The study team considers as the MIKE Flood model accounts for the farm dam, the resultant peak flow is reasonable and suitable for the purposes of this study.

The MIKE Flood model yields significantly higher peak flows for C267C and C267D than the Rational Method. These sub-catchments are located in the upper part of the C267. As a result, the slope of the terrain is of the order of 1 in 5 to 10. It is considered that this higher slope results in the MIKE Flood model producing larger peak flow estimates. The routing of overland flow in MIKE Flood accounts for the slope of the terrain. The Rational Method no allowance for terrain slope in its' application.

The hydraulic roughness shown in Figure 4-11 for the floodplain areas (away from the watercourses) has been assigned a Manning's n value of 0.1. This value of Manning's n is high for the land use and vegetation cover found in these areas. The higher value of Manning's n reflects the increased effective hydraulic roughness due to the shallow flow depths. The flow depths in these areas are less than 50 mm. It is likely that this flow depth is of the order of the height of the vegetation in the cleared areas.

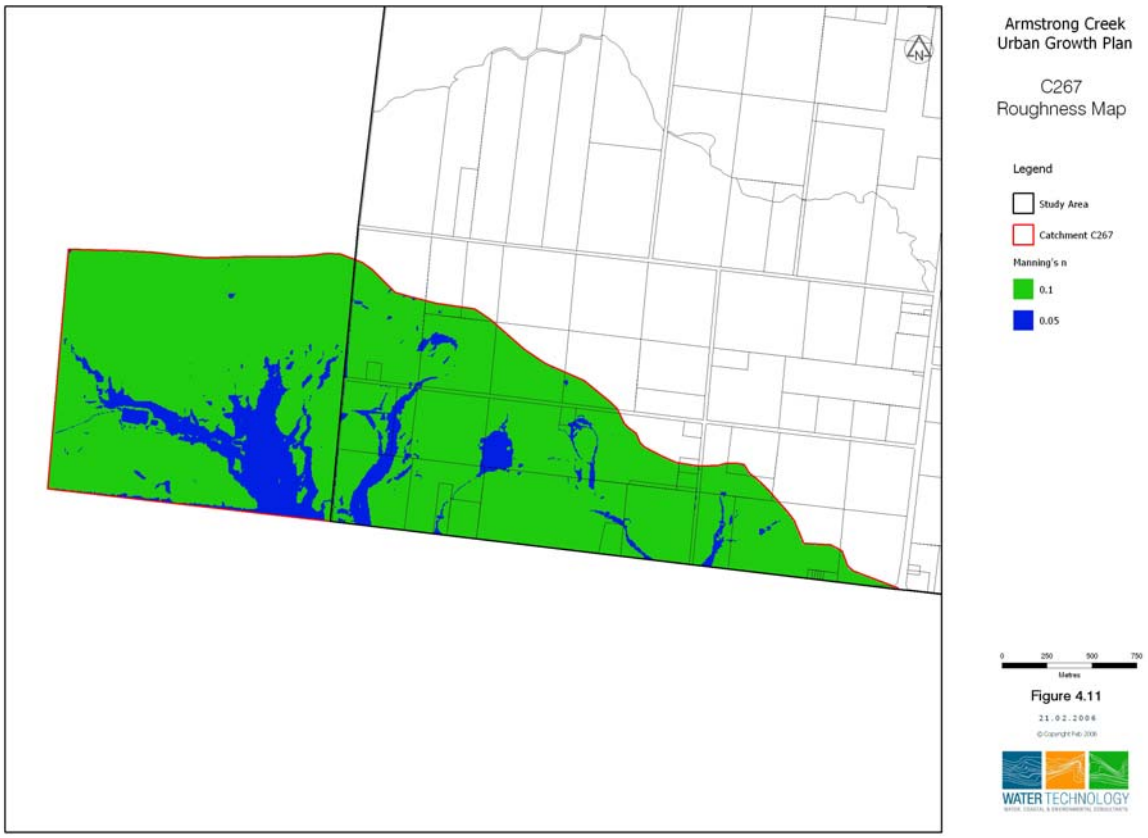

Figure 4-11 C267 Thompons Creek: Roughness

Figure 4-12 shows the 100 year ARI flood extent for the C267 catchment. Also Figure 4-12 displays the flood depth as a shade of blue and water surface elevations as contours.

The hydraulic analysis confirmed the observed overland flow occurring along the Ghazeepore Road to the south.

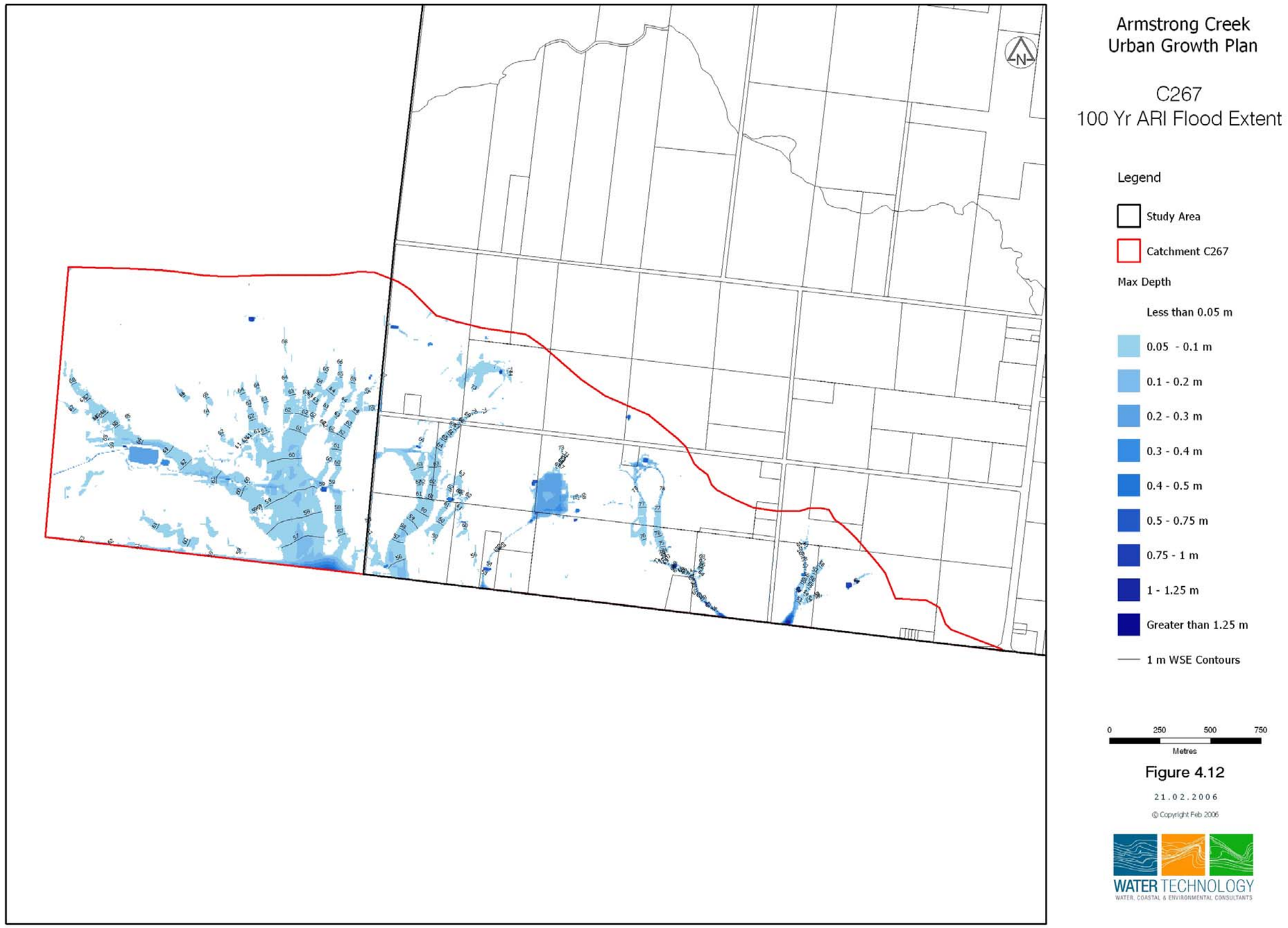

Figure 4-12 C267 Thompsons Creek – Duneed Creek Branch: 100 year flood extent

5 DEVELOPMENT POTENTIAL ASSESSMENT

5.1 Floodplain planning and management framework

This section summarises the key elements in the current floodplain planning framework for the study area. The floodplain planning framework guides the appropriate use and development of flood prone land.

The Victoria Flood Management Strategy (VFMS) (DNRE 1998 a) provides the principal framework for floodplain management in Victoria. The strategy outlines the roles of key agencies at a state, regional and local scale in floodplain management. In particular, the strategy defines the regional and local planning roles within the floodplain management framework.

At a ***state government level***, the VFMS identifies the relevant state legislation, policies and strategies as the underlying foundation for floodplain planning. In particular, state legislation provides statutory authority to regional and local authorities. The state agencies, principally the Department of Sustainability and Environment (DSE), co-ordinate and facilitate floodplain planning practice across the state. The following acts and strategies form the underlying legislative and policy framework for floodplain planning at a state level:

- ***Catchment and Land Protection Act 1994 (CALP)*** – Establishes the Corangamite Catchment Management Authority as the responsible floodplain management authority
- ***Water Act 1989*** – Defines the Corangamite Catchment Management Authority floodplain management functions
- ***Planning and Environment (Planning Schemes) Act 1996*** - Establishes two clear levels of planning policy within the overall state planning framework, State Planning Policy Framework (SPPF) and Local Planning Schemes. Also provides for specific flood management related planning zones and overlays in local planning schemes.
- ***Victoria Flood Management Strategy 1998*** – Establishes effective flood management by providing a consistent, statewide framework for the management of flood related issues. Adopts a risk management approach to floodplain management where the likelihood and consequence of flooding are integral to defining appropriate actions and responses.
- ***Victorian River Health Strategy 2002*** - *P*rovides an overall framework for the management of rivers within Victoria comprising the strategic background, vision for management and river restoration, integrated management framework, specific management issues and management arrangements. Specifies how the various natural resource management agencies in Victoria should work in an integrated way to provide for the maintenance and improvement of river environments. In particular, the strategy identifies ecologically healthy rivers as having:
    - in the river and riparian zone, the majority of plant and animal species are native and the presence of exotic species is not a significant threat to the ecologically integrity of the system
    - natural ecosystem processes are maintained
    - major natural habitat features are represented and are maintained over time
    - native riparian vegetation exists for the majority of the rivers length
    - native fish and other fauna can move and migrate up and down the river
    - linkages between river and floodplain and associated wetlands are able to maintain ecological processes
    - natural linkages with the sea or terminal lakes are maintained
    - associated estuaries and terminal lake systems are productive ecosystems.

- ***Victoria Planning Provisions*** - Define the framework for local government planning schemes. Establishes provisions for the management of flood risk within the planning scheme. Floodplain management is addressed in Clause 15.02 as follows:

  15.02-1 Objective
  To assist the protection of:
  - Life, property and community infrastructure from flood hazard.
  - The natural flood carrying capacity of rivers, streams and floodways.
  - The flood storage function of floodplains and waterways.
  - Floodplain areas of environmental significance.

  15.02-2 General implementation
  Planning controls for areas subject to flooding should be consistent throughout the State. Flood risk must be considered in the preparation of planning schemes and land use planning decisions to avoid intensifying the impacts of flooding through inappropriately located uses and developments.
  Planning authorities should have regard to the following documents when preparing planning schemes for areas affected by flooding:
  - Regional catchment strategies and special area plans approved by the Minister for Environment and Water.
  - State environment protection policies as varied from time to time (Waters of Victoria and specific catchment policies).
  - Any floodplain management manual of policy and practice, or catchment management or floodplain management strategy adopted by the relevant responsible floodplain management authority.
  - Any best practice environmental management guidelines for stormwater adopted by the Environment Protection Authority.

  Land affected by flooding, including floodway areas, as verified by the relevant floodplain management authority, should be shown on planning scheme maps. Land affected by flooding is land inundated by the 1 in 100 year flood event or as determined by the floodplain management authority.

  Emergency facilities (including hospitals, ambulance stations, police stations, fire stations, transport facilities, communications facilities, community shelters and education centres) must be located outside the 1 in 100 year floodplain and, where possible, at levels above the height of the probable maximum flood.

- ***Victoria Planning Provisions: Practice Notes*** Provide guidance to councils, referral authorities and applicants regarding the application of the flood related provisions. A general set of development requirements for appropriate development is provided. However, it noted that the further consideration of local flooding behaviour is required to establish appropriate local development controls. The Department of Infrastructure has prepared the following practice notes:
  - Applying for a planning permit under the flood provisions: A guide for councils, referral authorities and applicants (DoI 2000a)
  - Applying the flood provisions in planning schemes: A guide for councils (DoI 2000b)

At a ***regional scale***, the VFMS identifies the regional catchment strategy and regional floodplain management strategy prepared by Corangamite CMA as the principal regional planning instruments. These regional strategies provide strategic direction and governing philosophies for catchment and floodplain management. The following briefly outlines the key aspects of the regional catchment and floodplain management strategies:

- ***Corangamite CMA Regional Catchment Strategy 2003-2008*** - Provides long-term direction for managing the future of land, water resources, and biodiversity, and the foundation for investment decisions to ensure improved natural resource outcomes. The RCS (CCMA 2003) identifies the key threat arising from flooding as damage to infrastructure (exisiting and proposed):

  The RCS (CCMA 2003) outlines the following actions to address this key flood related threat:
  - By 2008, ensure all new dwellings are protected from flooding and erosion.
  - By 2008, ensure that all new urban developments and high value public assets apply best practice to ensure protection from flooding and erosion.

- Progressively implement the Corangamite Floodplain Management Strategy (2002).
- The number of high value public assets with an appropriate level of protection from flooding and erosion will increase in line with development.
- By 2004, identify key infrastructure areas at risk from flooding, erosion and salinity.

- ***Corangamite CMA Regional Floodplain Management Strategy, 2002***- Provides the strategic direction for future floodplain management. The strategy aims to minimise flood risk and promote sustainable use of the floodplains through community involvement and best management. The objectives of the strategy are as follows:
  - To facilitate sustainable management of floodplain assets
  - To provide development and land use practices to be compatible with the flood risk
  - To gain better understanding of flood risk and to implement measures that reduce the impacts of flooding
  - To more accurately delineate flood prone levels to augment sound land use planning.
  - To provide sound emergency response planning and identify opportunities to minimise the impacts of future flood events.
  - To develop and implement a GIS based information management system

  The CRFMS (2002) emphasises the importance of key Federal, State, Regional and Local authorities in addition to the general community involvement in the floodplain management process.

- ***Corangamite CMA Regional River Health Strategy, 2002***- Provides the strategic direction for regional river health. Vision: Our waterways will be treasured as multi-purpose public assets, managed by the community for the community. They will connect the coast and plains to timbered headwaters, providing opportunities for prosperous farms, resource conservation and recreation. Together, we will reverse the trend of degradation.

  The Regional River Health Strategy contains four key aspects
  - Water quality and quantity
  - Instream habitats
  - Streamside vegetation
  - Physical form.

  Armstrong Creek has been not specifically identified as a priority waterway. However, as a contributing stream to Lake Reedy/Lake Connewarre, Armstrong Creek has a significant environmental value.

At a ***local scale***, the VFMS identifies the municipal strategic statement and the municipal planning scheme prepared by the City of Greater Geelong as the local planning instrument. The following briefly outlines the key flood related aspects of the municipal strategic statement and the municipal planning scheme:

- ***Greater Geelong Planning Scheme*: *State Planning Policy Framework***- defines underlying statewide floodplain management principles and objectives
- ***Greater Geelong Planning Scheme: Municipal Strategic Statement***: concise statement of the key strategic planning, land use and development objectives for the municipality and the strategies and actions for achieving these objectives.

  Clause 21.12 Flood Management outlines the Greater Geelong strategic direction for flooding. This clause identifies the following two objectives:

  - To provide an effective flood management system for flood prone areas within the municipality via:
    - Developing an appropriate Flood Prone Areas Information System.
    - Updatig the flood extent maps of the Barwon River from Fyansford to the Barwon Heads Bridge and of the Moorabool River in Batesford.
    - Programing structural and non-structural flood mitigation measures into Council's current and future Capital Projects Programs.

- Implementing the recommendations of the Geelong Flood Mitigation Strategy.

o To minimise the potential for significant public and private property damage and risks to the safety of the community resulting from flooding via following strategies:
  - Appropriately zone flood prone land.
  - Ensure that land use and development is compatible with flood prone land.

These strategies will be implemented by:
- Considering the impacts of all use and development applications proposed in flood prone areas.
- Applying the Urban Floodway Zone to locations in the urban areas that are high hazard and active floodways and where strict control over land use is required.
- Applying the Floodway Overlay to locations in the urban areas that are high hazard and active floodways.
- Applying the Rural Floodway Overlay to locations in the rural areas that are high hazard and active floodways.
- Applying the Land Subject to Inundation Overlay to locations in both the urban and rural areas that are subject to periodic inundation but which are not high hazard nor active floodplains.
- Applying the Special Building Overlay to land in urban areas that are subject to inundation by surcharge flows from urban drainage systems, such as Barwon Heads and Corio.

- ***Greater Geelong Planning Scheme: Local Planning Policy Framework*** – defines flooding risk through the delineation of Urban Floodway Zone (UFZ) Floodway Overly (FO) and Land subject to Inundation overlay (LSIO). Specifies requirements for development/works within the UFZ, FO and LSIO.

Appendix A displays the current flood related zone and overlays extents as part of the Greater Geelong Planning scheme. Also Appendix A contains the local provisions pertaining the UFZ, FO and LSIO.

5.2 Flooding constraints on land development

This section discusses the flooding constraints on land development. Flooding, for the purposes of this section refer to mainstream flooding. Section 5.3 discusses drainage constraints related to stormwater drainage.

5.2.1 Flood prone land delineation

As highlighted in the VFMS, VPPs and the Greater Geelong Planning Scheme, development in flood prone areas must consider the existing risk of flooding. These considerations include, amongst others, damages and potential hazard to life and property, the natural flood capacity of the floodplain and environmentally significant areas of the floodplain.

The Victorian Planning Provisions and the Greater Geelong Planning Scheme establishes flood related zone and overlays to define flood prone land and associated provisions to set out development requirements. As discussed in Section 5.1, the flood related zone and overlays include:

- Urban Floodway Zone (UFZ)
- Floodway overlay (FO) /Rural Floodway Overlay (RFO)
- Land subject to inundation overlay (LSIO)

The above zone and overlays provide guidance on the flooding constraints to development. Discussion of drainage related constraints is provided in Section 5.3.

Various flood prone land delineations have been undertaken by CCMA, Greater Geelong Planning Scheme and this study. It should be noted that these delineations are based on the existing catchment and floodplain conditions. Any development within the study area may

change flooding behaviour and in turn the flood prone delineation, if appropriate mitigation measures are not undertaken. Further discussion of mitigation measure aimed at maintaining the existing flood behaviour is provided in Section 5.3.

CCMA has identified flood extent and floodway adjacent to the Barwon River and along Armstrong Creek (C257). The floodway and flood extent adjacent to the Barwon River reflects the LSIO and FO contained in the Greater Geelong Planning Scheme. Figure 5-1 shows the CCMA flood extent and floodway.

At present, the UFZ has not been applied in the study area. Further the current FO and LSIO delineation largely shows flooding due to the Barwon River only. No FO/LSIO has been adopted by the Greater Geelong Planning Scheme along other watercourses in the study area. Figure 5-2 shows the existing FO and LSIO within the current Greater Geelong Planning Scheme.

To aid in the identification of flood prone land, not previously identified as FO/LSIO, the hydraulic analysis outcomes were used to determine draft FO and LSIO along watercourses within the study area.

The FO is indented to delineate land subject to higher flood risk. The study team utilised guidelines provided by DNRE (1998b) to investigate possible delineation of FO. The guidelines provide three approaches to the delineation of FO as follows:

- Flood frequency
- Flood depth
- Flood hazard

For **flood frequency**, DNRE (1998b) suggest areas which flood frequently and for which the consequences of flooding are moderate or high, should generally be regarded as floodway. Typically the 10 year ARI flood extent is considered an appropriate floodway delineation option. However, the 10 year flood event was not modelled in this study. The flood frequency approaches was not used to delineate FO for this study.

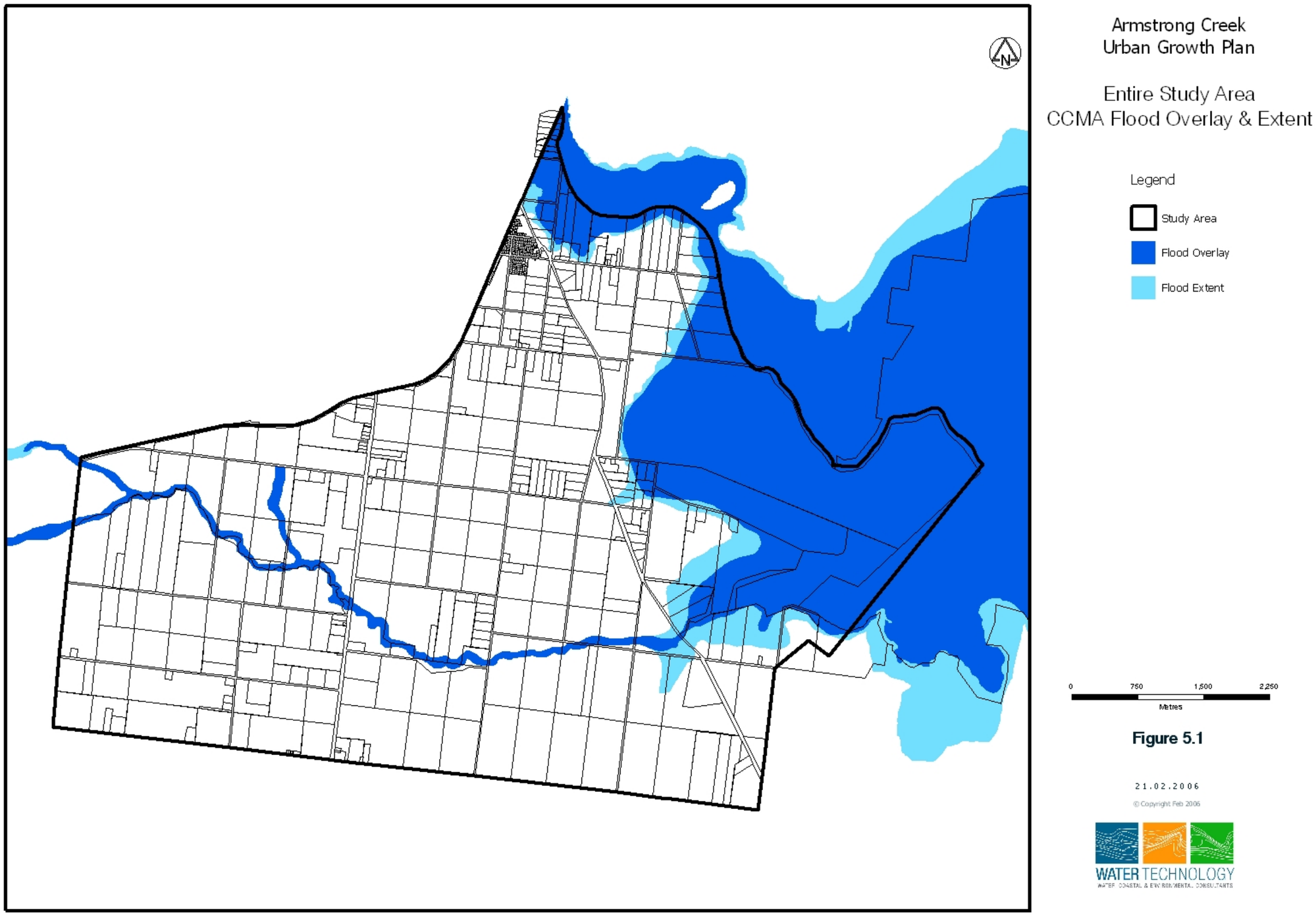

Figure 5-1 CCMA Existing flood related planning overlays

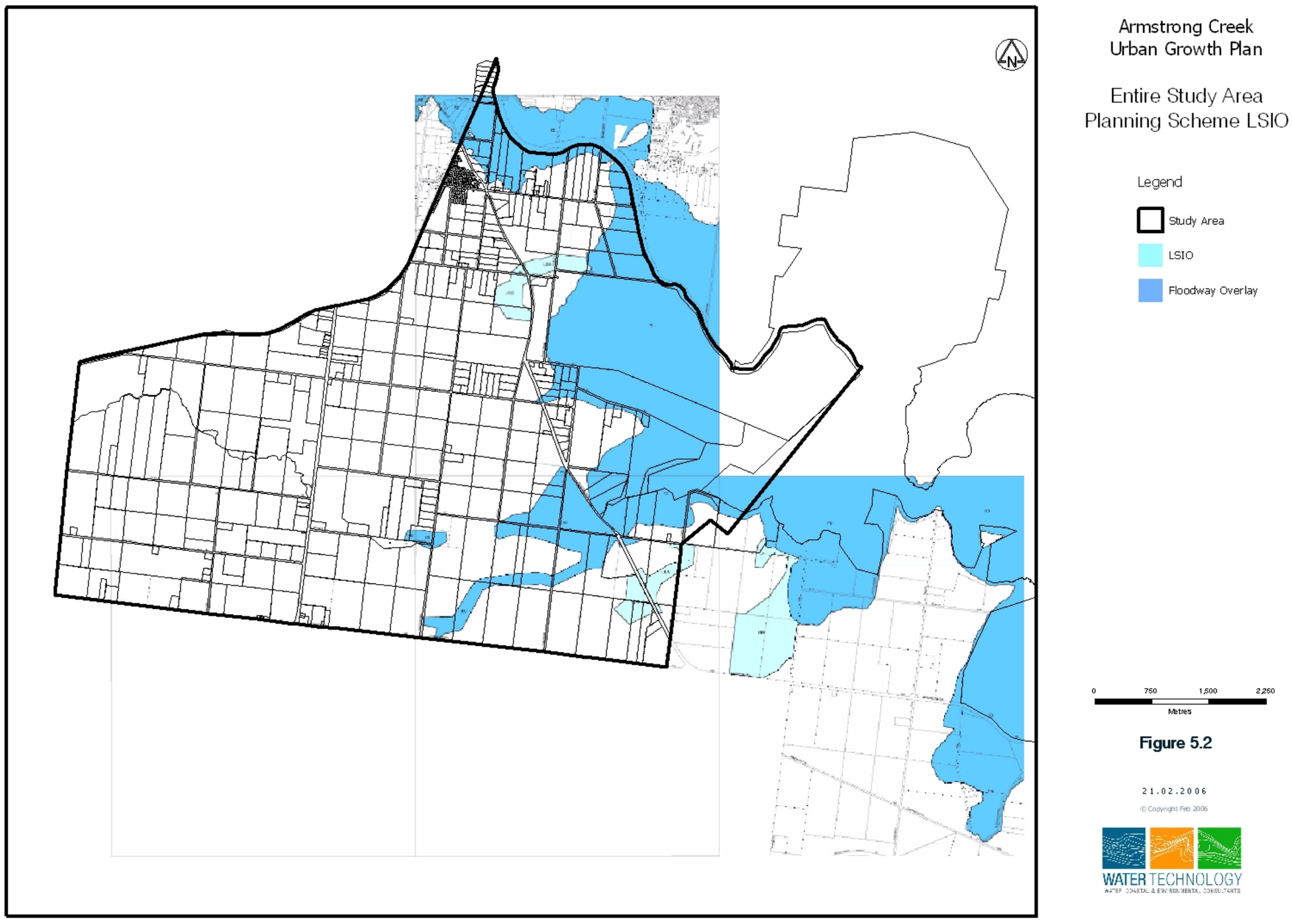

Figure 5-2 Existing Greater Geelong Planning Scheme flood related overlays

Flood hazard combines the flood depth and flow speed for a given design flood event. DNRE (1998b) suggests the use of Figure 5-3 as a guideline for delineating the floodway based on flood hazard. The flood hazard for the 1 in 100 year ARI event was considered for this study. Figure 5-3 displays the flood hazard criteria for floodway delineation.

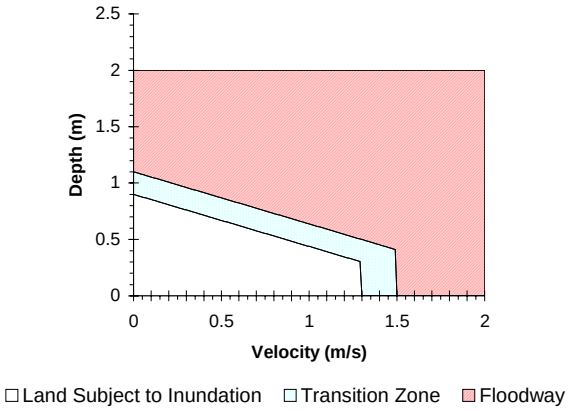

Figure 5-3 Floodway overlay flood hazard criteria

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 LSIO delineation is based on the 100 year ARI flood extent. Due to nature of the hydraulic analysis (net rainfall directly onto a two hydraulic model), the LSIO was delineated as 100 year flood extent where the flood depth is greater than 100 mm.

Figure 5-4 displays the delineation of FO and LSIO for the watercourses in the study area.

5.2.2 Discussion

Various delineations of flood prone land were provided in Figure 5-1, Figure 5-2 and Figure 5-4. These delineations serve as the foundations for the identification of land subject to flooding constraints on development.

It is recommended that the following combination of the various flood prone delineations to define draft FO and LSIO for the application of development controls:

- FO and LSIO shown to the east of Barwon Heads Road in Figure 5-1 and Figure 5-2 (CCMA and Greater Geelong Planning Scheme) are retained for the definition of draft FO and LSIO.
- FO and LSIO shown to the west of Barwon Heads Road in Figure 5-4 (this study) are adopted for the definition of draft FO and LSIO.

The above recommendations reflect the assessment of the reliability of the flood mapping to the east and west of Barwon Heads Road. The study team notes the areas of FO and LSIO shown in Figure 5-1 and Figure 5-2 west of Barwon Heads Road. It is considered that the hydrologic and hydraulic analysis undertaken by this study enables a refinement of these FO and LSIO.

Figure 5-5 shows the proposed draft FO and LSIO for the study area.

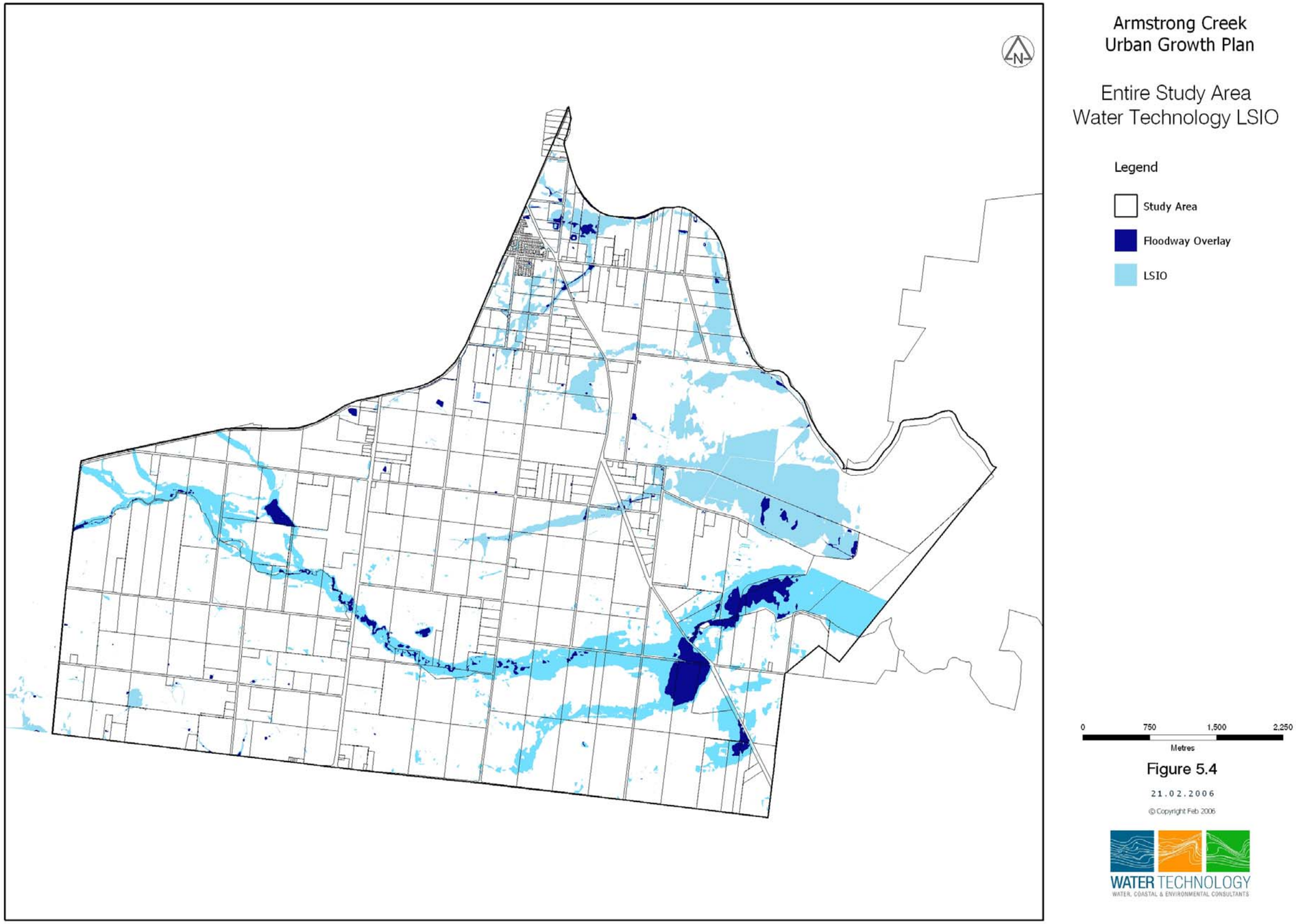

Figure 5-4 FO and LSIO delineation using hydraulic analysis

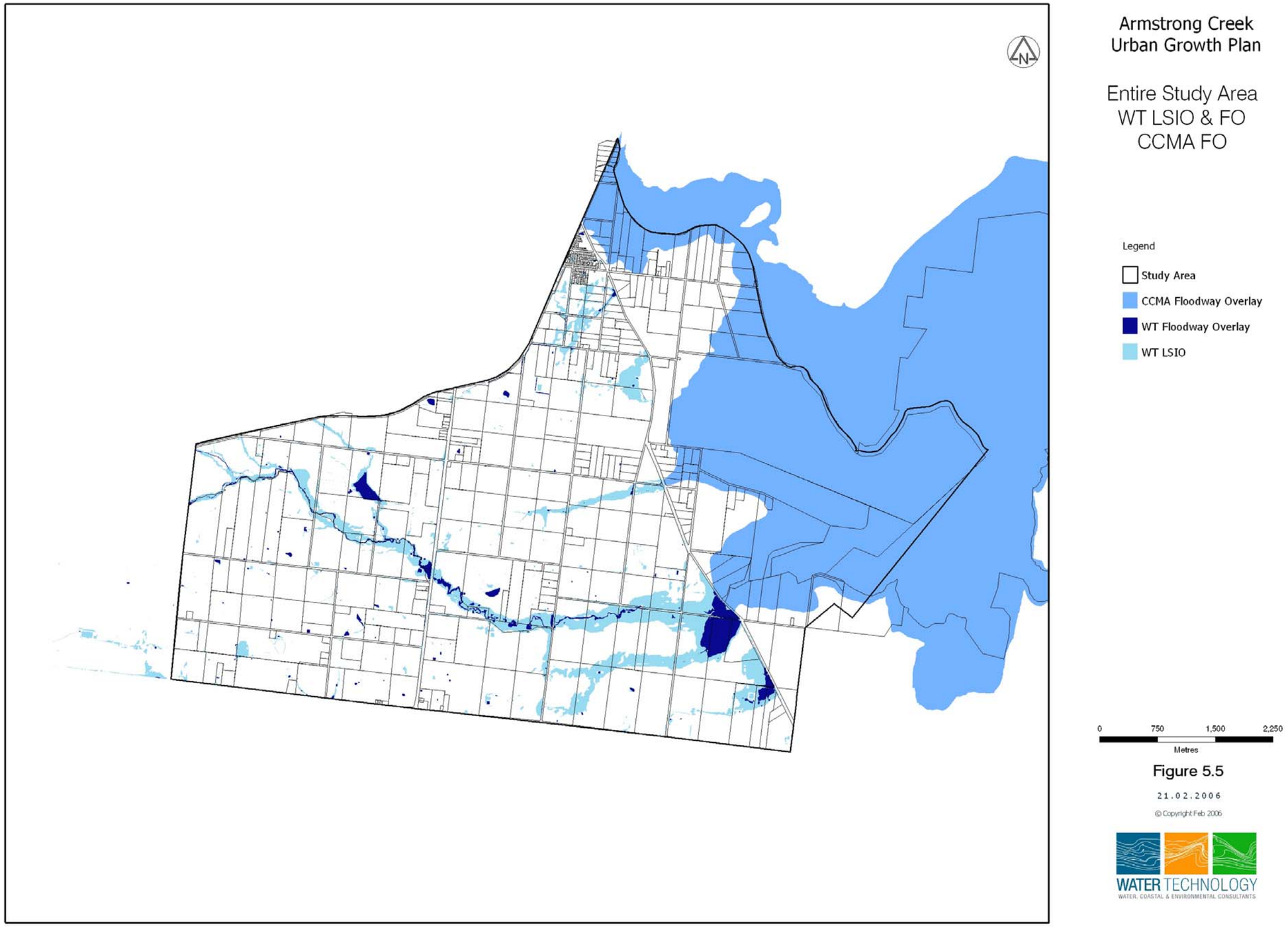

Figure 5-5 Draft FO and LSIO for the study team

Using the references discussed in Section 5.1 a set of draft development guidelines applicable to the draft FO and LSIO have been prepared. Table 5-1 outlines these draft development guidelines.

Table 5-1 Flood related development constraints

Activities	Development constraints/requirements		Source
	FO	LSIO	
Subdivision	No new lots to be created entire within FO	No specific requirement	Greater Geelong Planning Scheme (Clause 44.03)
Dwelling	Floor level at least 300 mm freeboard above 100 year flood level The location, floor level and design of any new building or extension should consider adequate drainage for the site and any adverse hydraulic effects on neighbouring properties.	Floor level at least 300 mm freeboard above 100 year flood level The location, floor level and design of any new building or extension should consider adequate drainage for the site and any adverse hydraulic effects on neighbouring properties.	Building regulations (1994) Planning Practice Notes (DOI 200 a& b)
Commercial buildings	Floor level at least 300 mm freeboard above 100 year flood level The location, floor level and design of any new building or extension should consider adequate drainage for the site and any adverse hydraulic effects on neighbouring properties. Where possible, the building should be aligned to minimise the obstruction to flood flows.	Floor level at least 300 mm freeboard above 100 year flood level The location, floor level and design of any new building or extension should consider adequate drainage for the site and any adverse hydraulic effects on neighbouring properties. Where possible, the building should be aligned to minimise the obstruction to flood flows	Building regulations (1994) Planning Practice Notes (DOI 200 a& b)

DOI (2000 b) notes the 300 mm freeboard requirement is a minimal standard and that higher freeboard (> 300 mm) may be applied. It is considered that the relatively unconfined nature of flooding in the study area enables large increases in flows to occur without significant increases in flood levels. As such, it is considered that the 300 mm freeboard requirement is sufficient.

It should be noted that the current Greater Geelong Planning Scheme (Floodway overlay Clause 44.03) contains development requirements only for subdivision. No other specific development requirements are provided in the current planning scheme.

It is suggested that CoGG and CCMA consider the preparation of specific development requirements for FO and LSIO. It is believed that such development requirements provide will clear understanding for CoGG, CCMA and applicants.

5.3 Drainage constraints on land development

This section discusses the drainage constraints on land development. Drainage, for the purpose of this section refers to stormwater related flooding.

Under the existing conditions formal stormwater drainage infrastructure, within the study area, is limited to C253 Marshall. Future urban development, without appropriate planning, will increase the runoff volume and peak flows in the study area.

Urban Stormwater – Best Practice Environmental Management Guidelines (CSIRO 1999) provides the following objectives and principles:

- Impact minimisation: minimise waterway disturbance caused by the alternation of flow regimes
- Natural drainage system protection: protect channel form and aquatic ecosystems from flow related impacts.
- Integrated stormwater management: adopt an integrated approach to stormwater system management that meets both hydraulic capacity and waterway projection objectives.

To achieve the above objectives and principles, the following techniques (CSIRO 1999) should be applied:

Maintaining natural drainage

- Maintain natural channels and floodplains. Adopt draft FO and LSIO (as in Figure 5-5) appropriate development requirements, as discussed in Section 5.2.2.

Run-off control

- Minimise direct connections between impervious areas and the underground stormwater system
- Minimise the extent of paving: use porous pavements, incorporate shorter driveways, small road widths, and footpaths on only one side of the road
- Grass swales: provide areas of grass swales along verges, to reduce flow velocities
- Roadway design: design roadways and parking area to incorporate detention areas and vegetation
- Public area design: integrate infiltration/detention basins in public areas. Locate local public open space at the base of cul-de-sacs to accommodate local run-off.

Distributed storage/retarding basins

- Small distributed storages: provide small flood storages to limit peak flows for the lot/block scale. Use of household rainfall tanks can be employed to supplement flood storage
- Storage/retarding basin design: Provide storage/outlet to limit 1.5 year and 1000 year peak flow to pre-development conditions.

As the conceptual layout of the proposed development is yet to be completed, no conceptual design of the storage/retarding basin has been completed.

A rough rule of thumb to size required flood storage/retarding basins is 500 m^3 per hectare developed. The study area is approximately 4400 ha. Based on this area, preliminary estimates of the total required flood storage is 2.2 million m^3.

The study brief outlined that drainage may be difficult in areas where the slope is less than 1 in 250. Figure 5-6 shows the areas where the slope is less 1 in 250.

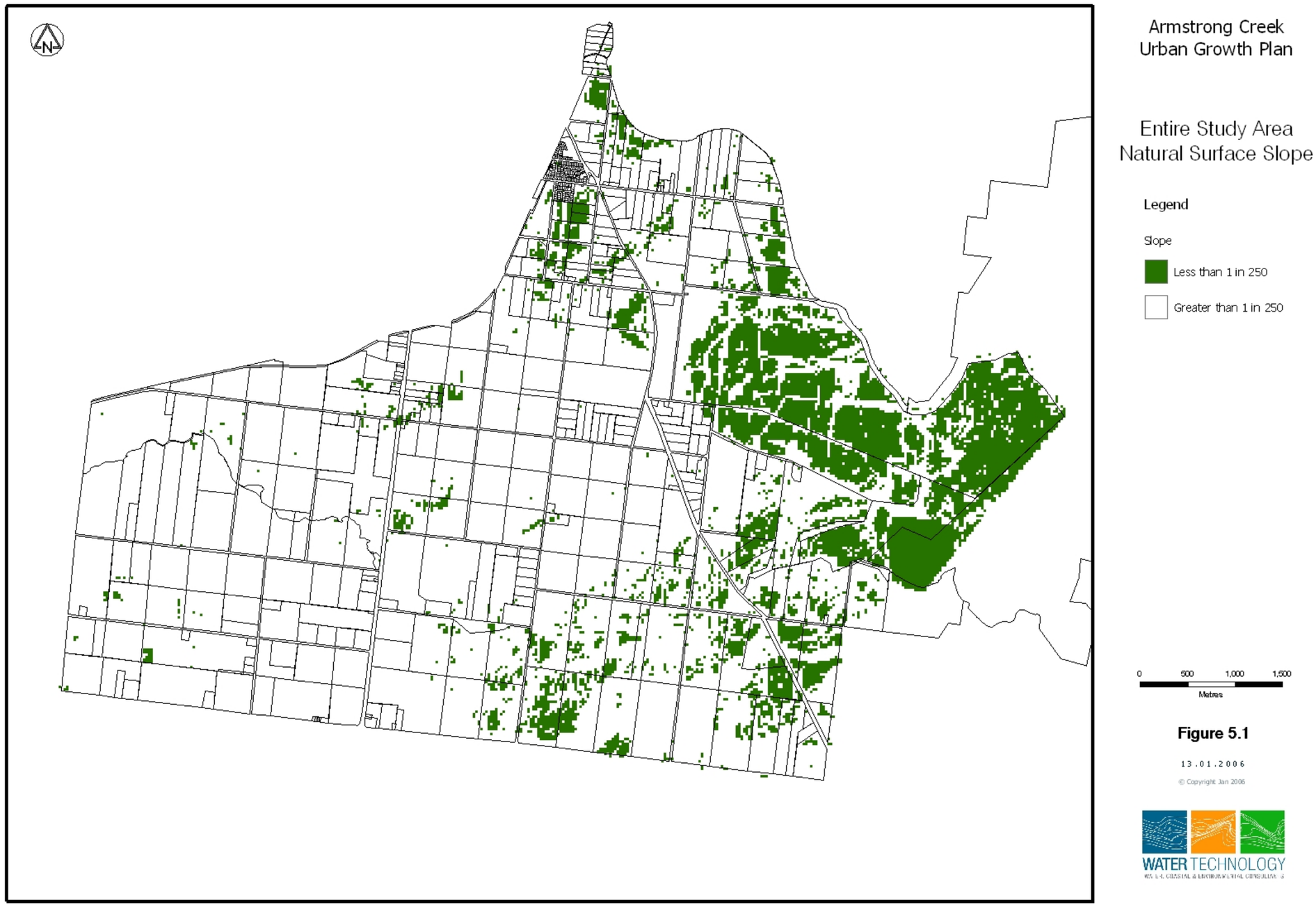

Figure 5-6 Armstrong Creek UGP study area – Natural surface slope

GLOSSARY

Annual Exceedance Probability (AEP)	Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year. A 90% AEP flood has a high probability of occurring or being exceeded; it would occur quite often and would be relatively small. A 1%AEP flood has a low probability of occurrence or being exceeded; it would be fairly rare but it would be relatively large.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datums.
Average Recurrence Interval (ARI)	Refers to the average time interval between a given flood magnitude occurring or being exceeded. A 10 year ARI flood is expected to be exceeded on average once every 10 years. A 100 year ARI flood is expected to be exceeded on average once every 100 years.
Cadastre, cadastral base	Information in map or digital form showing the extent and usage of land, including streets, lot boundaries, water courses etc.
Catchment	The area draining to a site. It always relates to a particular location and may include the catchments of tributary streams as well as the main stream.
Design flood	A significant event to be considered in the design process; various works within the floodplain may have different design events. e.g. some roads may be designed to be overtopped in the 1 in 1 year or 100%AEP flood event.
Discharge	The rate of flow of water measured in terms of volume over time. It is to be distinguished from the speed or velocity of flow, which is a measure of how fast the water is moving rather than how much is moving.
Flash flooding	Flooding which is sudden and often unexpected because it is caused by sudden local heavy rainfall or rainfall in another area. Often defined as flooding which occurs within 6 hours of the rain which causes it.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or overland runoff before entering a watercourse and/or coastal inundation resulting from super elevated sea levels and/or waves overtopping coastline defences.
Flood frequency analysis	A statistical analysis of observed flood magnitudes to determine the probability of a given flood magnitude.
Flood hazard	Potential risk to life and limb caused by flooding. Flood hazard combines the flood depth and velocity.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event, i.e. flood prone land.
Flood storages	Those parts of the floodplain that are important for the temporary storage, of floodwaters during the passage of a flood.
Geographical information systems (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe, in particular, the evaluation of flow parameters such as stage and velocity.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.

Mainstream flooding	Inundation of normally dry land occurring when water overflows the natural or artificial banks of the principal watercourses in a catchment. Mainstream flooding generally excludes watercourses constructed with pipes or artificial channels considered as stormwater channels.
Management plan	A document including, as appropriate, both written and diagrammatic information describing how a particular area of land is to be used and managed to achieve defined objectives. It may also include description and discussion of various issues, special features and values of the area, the specific management measures which are to apply and the means and timing by which the plan will be implemented.
Ortho-photography	Aerial photography which has been adjusted to account for topography. Distance measures on the ortho-photography are true distances on the ground.
Peak flow	The maximum discharge occurring during a flood event.
Probability	A statistical measure of the expected frequency or occurrence of flooding. For a fuller explanation see Average Recurrence Interval.
Risk	Chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. For this study, it is the likelihood of consequences arising from the interaction of floods, communities and the environment.
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Stage	Equivalent to 'water level'. Both are measured with reference to a specified datum.
Stage hydrograph	A graph that shows how the water level changes with time. It must be referenced to a particular location and datum.
Topography	A surface which defines the ground level of a chosen area.

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APPENDIX A GREATER GEELONG PLANNING SCHEME – FLOOD RELATED EXTRACTS

37.03 URBAN FLOODWAY ZONE

19/01/2006
VC37

Shown on the planning scheme map as **UFZ**.

Purpose

To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.

To identify waterways, major floodpaths, drainage depressions and high hazard areas within urban areas which have the greatest risk and frequency of being affected by flooding.

To ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting.

To reflect any declarations under Division 4 of Part 10 of the Water Act, 1989.

To protect water quality and waterways as natural resources in accordance with the provisions of relevant State Environment Protection Policies, and particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

37.03-1 Table of uses

19/01/2006
VC37

Section 1 - Permit not required

USE	CONDITION
Apiculture	Must meet the requirements of the Apiary Code of Practice, May 1997.
Extensive animal husbandry	
Informal outdoor recreation	
Mineral exploration	
Mining	Must meet the requirements of Clause 52.08-2.
Natural systems	
Search for stone	Must not be costeaning or bulk sampling.
Telecommunications facility	Buildings and works must meet the requirements of Clause 52.19

Section 2 - Permit required

USE	CONDITION
Agriculture (other than Apiculture and Extensive animal husbandry)	
Leisure and recreation (other than Informal outdoor recreation, Indoor recreation facility, and Motor racing track)	
Mineral, stone or soil extraction (other than Mineral exploration, Mining, and Search for stone)	
Road	
Utility installation (other than Telecommunications facility)	

Section 3 - Prohibited

USE
Indoor recreation facility
Motor racing track
Any other use not in Section 1 or 2

37.03-2 **Buildings and works**

19/01/2006
VC37

A permit is required to construct a building or construct or carry out works, including a fence and roadworks.

This does not apply to:

- Flood mitigation works carried out by the responsible authority or floodplain management authority.
- The following works in accordance with plans prepared to the satisfaction of the responsible authority:
  - The laying of underground sewerage, water and gas mains, oil pipelines, underground telephone lines and underground power lines provided they do not alter the topography of the land.
  - The erection of telephone or power lines provided they do not involve the construction of towers or poles.
- Post and wire and post and rail fencing.

37.03-3 **Subdivision**

19/01/2006
VC37

A permit is required to subdivide land. A permit may only be granted to subdivide land if the following apply:

- The subdivision does not create any new lots, which are entirely within this zone. This does not apply if the subdivision creates a lot, which by agreement between the owner and the relevant floodplain management authority, is to be transferred to an authority for a public purpose.
- The subdivision is the resubdivision of existing lots and the number of lots is not increased, unless a local floodplain development plan incorporated into this scheme specifically provides otherwise.

37.03-4 **Application requirements**

19/01/2006
VC37

Local floodplain development plan

If a local floodplain development plan has been developed for the area and has been incorporated into this scheme, an application must be consistent with the plan.

Flood risk report

If a local floodplain development plan for the area has not been incorporated into this scheme, an application must be accompanied by a flood risk report to the satisfaction of the responsible authority. The flood risk report must consider the following, where applicable:

- The existing use and development of the land.

- Whether the proposed use or development could be located on flood-free land or land with a lesser flood hazard outside this zone.
- The susceptibility of the development to flooding and flood damage.
- The potential flood risk to life, health and safety associated with the development. Flood risk factors to consider include:
  - The frequency, duration, extent, depth and velocity of flooding of the site and accessway.
  - The flood warning time available.
  - The danger to the occupants of the development, other floodplain residents and emergency personnel if the site or accessway is flooded.
- The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
- The effects of the development on environmental values such as natural habitat, stream stability, erosion, water quality and sites of scientific significance.

37.03-5 **Referral of applications**

19/01/2006
VC37

An application must be referred to the relevant floodplain management authority under Section 55 of the Act unless in the opinion of the responsible authority the proposal satisfies requirements or conditions previously agreed in writing between the responsible authority and the floodplain management authority.

37.03-6 **Decision guidelines**

19/01/2006
VC37

Before deciding on an application, in addition to the decision guidelines in Clause 65, the responsible authority must consider, as appropriate:

- The State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- The local floodplain development plan or flood risk report.
- Any comments of the relevant floodplain management authority.

37.03-7 **Advertising signs**

19/01/2006
VC37

Advertising sign requirements are at Clause 52.05. This zone is in Category 4 unless a schedule to this zone specifies a different category.

Notes: *Refer to the* State Planning Policy Framework *and the* Local Planning Policy Framework, *including the* Municipal Strategic Statement, *for strategies and policies which may affect the use and development of land.*

Check whether an overlay also applies to the land.

Other requirements may also apply. These can be found at Particular Provisions.

44.03 FLOODWAY OVERLAY

19/01/2006
VC37

Shown on the planning scheme map as **FO** or **RFO** with a number (if shown).

Purpose

To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.

To identify waterways, major floodpaths, drainage depressions and high hazard areas which have the greatest risk and frequency of being affected by flooding.

To ensure that any development maintains the free passage and temporary storage of floodwater, minimises flood damage and is compatible with flood hazard, local drainage conditions and the minimisation of soil erosion, sedimentation and silting.

To reflect any declarations under Division 4 of Part 10 of the Water Act, 1989 if a declaration has been made.

To protect water quality and waterways as natural resources in accordance with the provisions of relevant State Environment Protection Policies, and particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

44.03-1 Buildings and works

19/01/2006
VC37

A permit is required to construct a building or to construct or carry out works, including a fence and roadworks.

This does not apply:

- If a schedule to this overlay specifically states that a permit is not required.
- To flood mitigation works carried out by the responsible authority or floodplain management authority.
- To the following works in accordance with plans prepared to the satisfaction of the responsible authority:
  - The laying of underground sewerage, water and gas mains, oil pipelines, underground telephone lines and underground power lines provided they do not alter the topography of the land.
  - The erection of telephone or power lines provided they do not involve the construction of towers or poles.
- To post and wire and post and rail fencing.

44.03-2 Subdivision

19/01/2006
VC37

A permit is required to subdivide land. A permit may only be granted to subdivide land if the following apply:

- The subdivision does not create any new lots, which are entirely within this overlay. This does not apply if the subdivision creates a lot, which by agreement between the owner and the relevant floodplain management authority, is to be transferred to an authority for a public purpose.
- The subdivision is the resubdivision of existing lots and the number of lots is not increased, unless a local floodplain development plan incorporated into this scheme specifically provides otherwise.

44.03-3 **Application requirements**

19/01/2006
VC37

Local floodplain development plan

If a local floodplain development plan has been developed for the area and has been incorporated into this scheme, an application must be consistent with the plan.

Flood risk report

If a local floodplain development plan for the area has not been incorporated into this scheme, an application must be accompanied by a flood risk report to the satisfaction of the responsible authority, which must consider the following, where applicable:

- The State Planning Policy Framework and the Local Planning Policy Framework.
- The existing use and development of the land.
- Whether the proposed use or development could be located on flood-free land or land with a lesser flood hazard outside this overlay.
- The susceptibility of the development to flooding and flood damage.
- The potential flood risk to life, health and safety associated with the development. Flood risk factors to consider include:
  - The frequency, duration, extent, depth and velocity of flooding of the site and accessway.
  - The flood warning time available.
  - The danger to the occupants of the development, other floodplain residents and emergency personnel if the site or accessway is flooded.
- The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
- The effects of the development on environmental values such as natural habitat, stream stability, erosion, water quality and sites of scientific significance.

44.03-4 **Exemption from notice and review**

19/01/2006
VC37

An application under this overlay is exempt from the notice requirements of Section 52(1)(a), (b) and (d), the decision requirements of Section 64(1), (2) and (3) and the review rights of Section 82(1) of the Act.

44.03-5 **Referral of applications**

19/01/2006
VC37

An application must be referred to the relevant floodplain management authority under Section 55 of the Act unless in the opinion of the responsible authority the proposal satisfies requirements or conditions previously agreed in writing between the responsible authority and the floodplain management authority.

44.03-6 **Decision guidelines**

19/01/2006
VC37

Before deciding on an application, in addition to the decision guidelines in Clause 65, the responsible authority must consider, as appropriate:

- The State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- The local floodplain development plan or flood risk report.

- Any comments of the relevant floodplain management authority.

Notes: *Refer to the* State Planning Policy Framework *and the* Local Planning Policy Framework, *including the* Municipal Strategic Statement, *for strategies and policies which may affect the use and development of land.*

Check the requirements of the zone which applies to the land.

Other requirements may also apply. These can be found at Particular Provisions.

44.04 LAND SUBJECT TO INUNDATION OVERLAY

19/01/2006
VC37

Shown on the planning scheme map as **LSIO** with a number (if shown).

Purpose

To implement the State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.

To identify land in a flood storage or flood fringe area affected by the 1 in 100 year flood or any other area determined by the floodplain management authority.

To ensure that development maintains the free passage and temporary storage of floodwaters, minimises flood damage, is compatible with the flood hazard and local drainage conditions and will not cause any significant rise in flood level or flow velocity.

To reflect any declaration under Division 4 of Part 10 of the Water Act, 1989 where a declaration has been made.

To protect water quality in accordance with the provisions of relevant State Environment Protection Policies, particularly in accordance with Clauses 33 and 35 of the State Environment Protection Policy (Waters of Victoria).

44.04-1 Buildings and works

19/01/2006
VC37

A permit is required to construct a building or to construct or carry out works, including a fence and roadworks.

This does not apply:

- If a schedule to this overlay specifically states that a permit is not required.
- To flood mitigation works carried out by the responsible authority or floodplain management authority.
- To the following works in accordance with plans prepared to the satisfaction of the responsible authority:
  - The laying of underground sewerage, water and gas mains, oil pipelines, underground telephone lines and underground power lines provided they do not alter the topography of the land.
  - The erection of telephone or power lines provided they do not involve the construction of towers or poles.
- To post and wire and post and rail fencing.

44.04-2 Subdivision

19/01/2006
VC37

A permit is required to subdivide land.

44.04-3 Application requirements

19/01/2006
VC37

Local floodplain development plan

If a local floodplain development plan has been developed for the area and has been incorporated into this scheme, an application must be consistent with the plan.

44.04-4 **Exemption from notice and review**

19/01/2006
VC37

An application under this overlay is exempt from the notice requirements of Section 52(1)(a), (b) and (d), the decision requirements of Section 64(1), (2) and (3) and the review rights of Section 82(1) of the Act.

44.04-5 **Referral of applications**

19/01/2006
VC37

An application must be referred to the relevant floodplain management authority under Section 55 of the Act unless in the opinion of the responsible authority, the proposal satisfies requirements or conditions previously agreed in writing between the responsible authority and the floodplain management authority.

44.04-6 **Decision guidelines**

19/01/2006
VC37

Before deciding on an application, in addition to the decision guidelines in Clause 65, the responsible authority must consider, as appropriate:

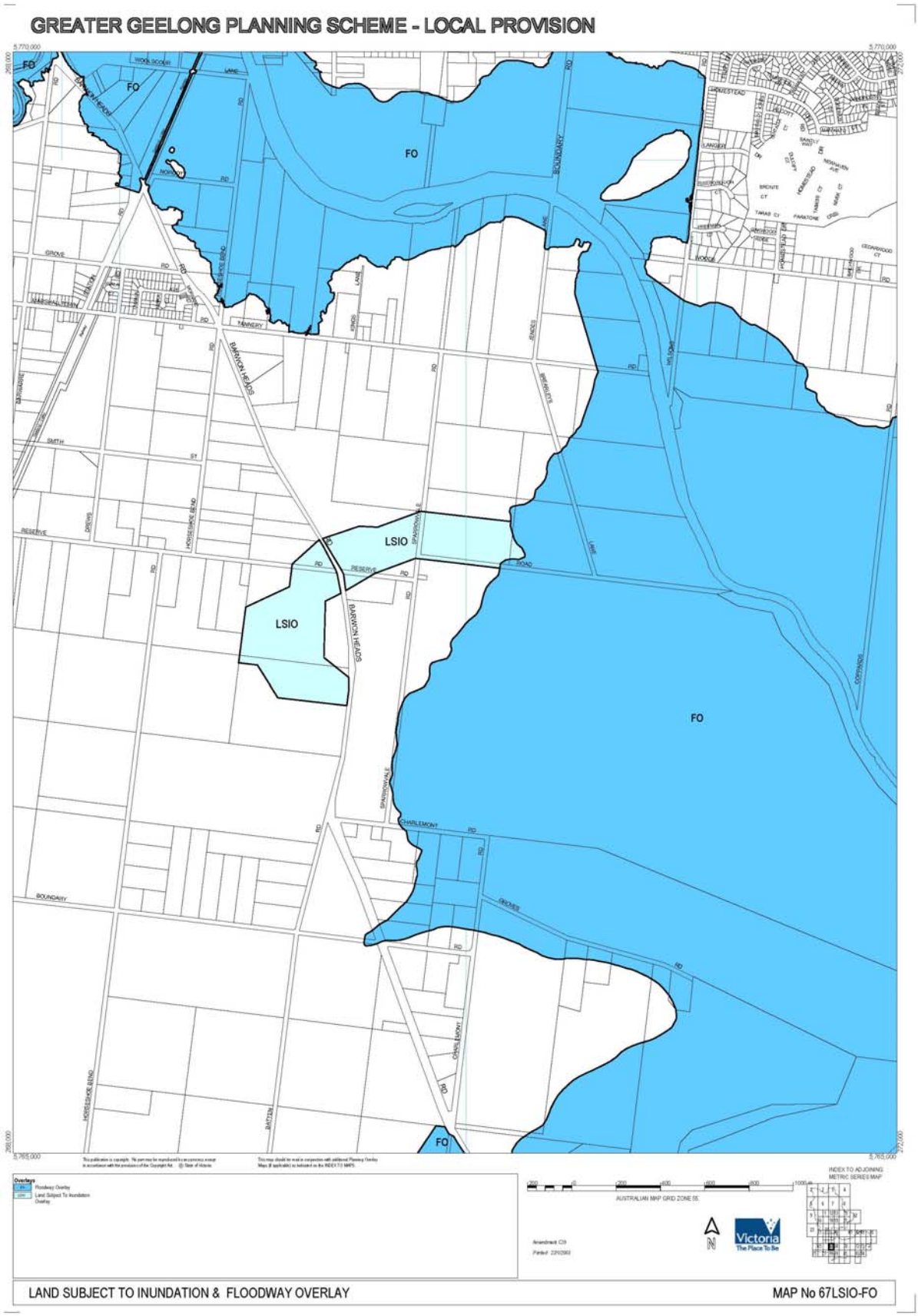
- The State Planning Policy Framework and the Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies.
- Any local floodplain development plan.
- Any comments from the relevant floodplain management authority.
- The existing use and development of the land.
- Whether the proposed use or development could be located on flood-free land or land with a lesser flood hazard outside this overlay.
- The susceptibility of the development to flooding and flood damage.
- The potential flood risk to life, health and safety associated with the development. Flood risk factors to consider include:
  - The frequency, duration, extent, depth and velocity of flooding of the site and accessway.
  - The flood warning time available.
  - The danger to the occupants of the development, other floodplain residents and emergency personnel if the site or accessway is flooded.
- The effect of the development on redirecting or obstructing floodwater, stormwater or drainage water and the effect of the development on reducing flood storage and increasing flood levels and flow velocities.
- The effect of the development on environmental values such as natural habitat, stream stability, erosion, water quality and sites of scientific significance.

Notes: *Refer to the* State Planning Policy Framework *and the* Local Planning Policy Framework, *including the* Municipal Strategic Statement, *for strategies and policies which may affect the use and development of land.*

Check the requirements of the zone which applies to the land.

Other requirements may also apply. These can be found at Particular Provisions.


GREATER GEELONG PLANNING SCHEME - LOCAL PROVISION
FO
FO
FO
FO
LSIO
LSIO
LAND SUBJECT TO INUNDATION & FLOODWAY OVERLAY
MAP No 78LSIO-FO


GREATER GEELONG PLANNING SCHEME - LOCAL PROVISION
FO
LSIO
BARWON HEADS
BOUNDARY
CHARLEMONT
LAND SUBJECT TO INUNDATION & FLOODWAY OVERLAY
MAP No 67LSIO-FO


GREATER GEELONG PLANNING SCHEME - LOCAL PROVISION
5,765,000
WHITES
RD
STEWARTS
FO
RUSSELLS
FEEHANS
MT. DUNEED
WILLIAMS
TORQUAY
LOWER DUNEED
5,760,000
Overlays
Floodway Overlay
AUSTRALIAN MAP GRID ZONE 55
INDEX TO ADJOINING METRIC SERIES MAP
LAND SUBJECT TO INUNDATION & FLOODWAY OVERLAY
MAP No 77LSIO-FO