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FLOOD MODELLING REPORT

Land Adjacent to Albion Park Airport
(Post Development Conditions)

for
Jordan Mealey - Consulting Engineers
February 2007

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FLOOD MODELLING REPORT
Land Adjacent to Albion Park Airport
(Post Proposed Development)

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ABBREVIATIONS

	Abbreviation Description
AEP	Annual Exceedance Probability; The probability of a rainfall or flood event of given magnitude being equalled or exceeded in any one year.
AHD	Australian Height Datum: National reference datum for level
ALS	Air-borne Laser Scanning; aerial survey technique used for definition of ground height
ARI	Average Recurrence Interval; The expected or average interval of time between exceedances of a rainfall or flood event of given magnitude.
AR&R	Australian Rainfall and Runoff; National Code of Practice for Drainage published by Institution of Engineers, Australia, 1987.
EDS	Embedded Design Storm; synthesised design storm involving embedment of an AR&R design burst within a second design burst of much longer duration
FPDM	Floodplain Development Manual; Guidelines for Development in Floodplains published by N.S.W. State Government, 2005.
FSL	Flood Surface Level;
GIS	Geographic Information Systems; A system of software and procedures designed to support management, manipulation, analysis and display of spatially referenced data.
IFD	Intensity-Frequency-Duration; parameters describing rainfall at a particular location.
ISG	Integrated Survey Grid; ISG: The rectangular co-ordinate system designed for integrated surveys in New South Wales. A Transverse Mercator projection with zones 2 degrees wide (Now largely replaced by the MGA).
LEP	Local Environment Plan; plan produced by Council defining areas where different development controls apply (e.g. residential vs industrial)
LGA	Local Government Area; political boundary area under management by a given local council. Council jurisdiction broadly involves provision of services such as planning, recreational facilities, maintenance of local road infrastructure and services such as waste disposal.
MGA	Mapping Grid of Australia; This is a standard 6° Universal Transverse Mercator (UTM) projection and is now used by all states and territories across Australia.
MHI	Maximum Height Indicator; measuring equipment used to record flood levels
PMF	Probable Maximum Flood; Flood calculated to be the maximum physically possible.
PMP	Probable Maximum Precipitation; Rainfall calculated to be the maximum physically possible.
RCP	Reinforced Concrete Pipe;
km	Kilometre; (Distance = 1,000m)
m	Metre; (Basic unit of length)
m2	Square Metre; (Basic unit of area)
ha	Hectare; (Area =10,000 m2)
m3	Cubic Metre; (Basic unit of volume)
m/s	Metres/Second; (Velocity)
m3/s	Cubic Metre per Second; (Flowrate)
s	Second; (basic unit of time)
SCC	Shellharbour City Council; name of the council with jurisdiction over the Shellharbour LGA

TECHNICAL TERMS

Term	Description
Alluvium	Material eroded, transported and deposited by streams.
Antecedent	Pre-existing (conditions e.g. wetness of soils).
Catchment	Area draining into a particular creek system, typically bounded by higher ground around its perimeter.
Critical Flow	Water flowing at a Froude No. of one.
Culvert	An enclosed conduit (typically pipe or box) that conveys stormwater below a road or embankment.
Discharge	The flowrate of water.
Escarpment	A cliff or steep slope, of some extent, generally separating two level or gently sloping areas.
Flood	A relatively high stream flow which overtops the stream banks.
Flood storages	Those parts of the floodplain important for the storage of floodwaters during the passage of a flood.
Floodways	Those areas where a significant volume of water flows during floods. They are often aligned with obvious naturally defined channels and are areas which, if partly blocked, would cause a significant redistribution of flow.
Flood Fringes	Those parts of the floodplain left after floodways and flood storages have been abstracted.
Froude No.	A measure of flow instability. Below a value of one, flow is tranquil and smooth, above one flow tends to be rough and undulating (as in rapids).
Geotechnical	Relating to Engineering and the materials of the earth's crust.
Gradient	Slope or rate of fall of land/pipe/stream.
Headwall	Wall constructed around inlet or outlet of a culvert.
Hydraulic	A term given to the study of water flow, as relates to the evaluation of flow depths, levels and velocities.
Hydrodynamic	The variation in water flow, depth, level and velocity with time
Hydrology	A term given to the study of the rainfall and runoff process.
Hydrograph	A graph of flood flow against time.
Hyetograph	A graph of rainfall intensity against time.
Isohyets	Lines joining points of equal rainfall on a plan.
Manning's n	A measure of channel or pipe roughness.
Orographic	Pertaining to changes in relief, mountains.
Orthophoto	Aerial photograph with contours, boundaries or grids added.
Pluviograph	An instrument which continuously records rain collected
Runoff	Water running off a catchment during a storm.
Scour	Rapid erosion of soil in the banks or bed of a creek, typically occurring in areas of high flow velocities and turbulence.
Siltation	The filling or raising up of the bed of a watercourse or channel by deposited silt.
Stratigraphy	The sequence of deposition of soils/rocks in layers.
Surcharge	Flow unable to enter a culvert or exiting from a pit as a result of inadequate capacity or overload.
Topography	The natural surface features of a region.
Urbanisation	The change in land usage from a natural to developed state.
Watercourse	A small stream or creek.

EXECUTIVE SUMMARY

Macquarie Rivulet is located partly in the Shellharbour City Council local government area and partly in the Wollongong City Council local government area, on the New South Wales coastal plain approximately 100 km to the south of the city of Sydney. It drains an area of approximately 107 km^2 of mixed forest, pasture and urbanised land, discharging into the south-western corner of Lake Illawarra. Flooding in Macquarie Rivulet and its tributaries is adversely affected at some locations by bridges, culverts and intrusions of development onto floodplains. Flooding in the outfall reach of Macquarie Rivulet is in addition affected by the level of flooding in Lake Illawarra.

Flood modelling to quantify flood behaviour in the lower reaches of Macquarie Rivulet was undertaken in two stages. In the first stage, models were constructed reflecting conditions as existing in 1991 and 2005, permitting calibration to the June 1991 flood event and simulation of design flooding under existing conditions Results of this first stage modelling were previously reported by Rienco Consulting in February 2007.

Second stage modelling was undertaken to quantify flood behaviour in Macquarie Rivulet adjacent to Albion Park Airport between the Princes Highway Road Bridge and Albion Park village, for a proposed development adjacent to the airport.. This modelling involved adjustments to the existing hydrodynamic model to reflect the proposed changes and determination of flood levels and hazard levels within and/or adjacent to Lot 6 DP 1100435 and Lot B DP 109816 in a 100 year Average Recurrence Interval (ARI) and "Probable Maximum" design flood. It should be noted that this modelling specifically targeted flood behaviour in this area in these events. It was not intended to and does not purport to provide information on flood behaviour outside the study area.

The proposed development involves a light industrial subdivision on land to the south of the east-west runway and west of the north-south runway of the Albion park Airport. An access road extends out and around the western end of the east-west runway to serve an extension of the light industrial subdivision to the north of the east west runway.The southern most part of the proposed subdivision would be in cut, with material won in the process being used to fill low lying land along the western perimeter of the development. The northern arm of Frazers creek would be realigned to improve its hydraulic performance and skirt an area of proposed filling.

In a 1% AEP flood event, floodwater would be at about RL 6.6m AHD adjacent to the western perimeter of the development, rising to about RL 8.2m AHD in a PMF event. In a 1%AEP flood, all land part of the proposed subdivision would be above flood level. In a PMF event, flood water would inundate the lower (central) portion of the proposed development, south of the east-west runway. At the peak of a PMF event, floodwater would reach 1.1m depth in the sag near the intersection of the western and northern access roads and 0.4m depth in the sag of the eastern access road.. Peak velocities in the inundated area of the site in a PMF event are very low (<0.01m/sec). Peak velocities adjacent to the site in a 1%AEP event are low, being generally less than 0.5m/sec except in the vicinity of the realigned creek below Tongarra Road, where instream velocities reach 1.1m/sec.

Flood impacts are generally not apparent at the 0.5m or m/sec scale used in plots of flood behaviour. Differential plots at an 0.02m (20mm) contour resolution are required to visualise these impacts. Plots at this resolution confirm that the proposed development would generally increase flood levels on the lower floodplain of Macquarie Rivulet (from the Princes Highway up to the line of the east-west runway) by about 33mm in a 1%AEP event and 21mm in a PMF event. Flood levels adjacent to the site and in the vicinity of the north eastern edge of the Albion park village would be increased by about 50mm in a 1%AEP event and 30mm in a PMF event.

1 INTRODUCTION

1.1 REPORT BACKGROUND

A light industrial development is proposed on land in Albion Park adjacent to the Albion Park airport. This proposed development is located on two parcels of land to the immediate west of the north-south runway and to the immediate north and south of the east-west runway. Lot 6 DP 1100435 is located to the immediate south of the east west runway and Lot B DP 109816, to the immediate north.

Since these parcels of land abut the floodplain of Macquarie Rivulet and include land known to have been inundated in past flooding in Macquarie Rivulet, a review of flood behaviour in the vicinity of these sites was commissioned. Jordan Mealey – Consulting Engineers were commissioned to undertake this work and to provide advice to the owners on the best means of accommodating this flooding while meeting the owners vision for the proposed development. Since Rienco Consulting had previously built a hydrologic model of the catchment and hydrodynamic model of the lower reaches of Macquarie Rivulet, they were engaged by Jordan Mealey to undertake the modelling required to support Jordan Mealey's advice on flooding matters to the owners.

The modelling work was to proceed in two stages, initially quantifying flood behaviour under existing conditions and then quantifying flood impacts associated with the development as proposed.

This current report documents the work undertaken in the second modelling stage, quantifying post development flood behaviour in the vicinity of the proposed development site and the impacts of the development proposed on flood behaviour.
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1.2 MODELLING OBJECTIVES

The primary objectives of this modelling stage are then the simulation of flood behaviour in the vicinity of the proposed development site and quantification of the impact of the proposed development on flood behaviour, upstream and downstream of the site.

Tasks involved in meeting these objectives include;

- Construction of a post-development hydrodynamic model using the previously constructed and calibrated hydrodynamic model, amended to reflect changes in topography and surface roughness associated with the proposed development.

- Re-running the post-development model to determine flooding characteristics in terms of flood extents, flood levels, flow depths, flow velocities and provisional hydraulic hazard for the 1% Annual Exceedence Probability (AEP) and Probable Maximum Flood (PMF) events, in the vicinity of the proposed development site.

- Comparison of post-development flood behaviour with existing flood behaviour to quantify the impact of the development as proposed on flood behaviour.

1.3 MODELLING METHODOLOGY

The study methodology adopted to meet the above objectives, included;

- Receipt of documentation describing the layout, levels and landscaping associated with the proposed development
- Conversion of data received into a form suitable for import into the hydrodynamic model
- Re-configuration of the hydrodynamic model to reflect the revised levels and surface roughness proposed within the development area (all else remaining as existing).
- Re-running the hydrodynamic model for the 1%AEP and PMF flood events with all structures clear and policy blocked
- Plotting in a spatial context, the resulting 1% AEP and PMF flood behaviour
- Comparison and plotting of the impact (differences between post-development and existing flood behaviour) in a spatial context for the 1% and PMF flood events

1.4 REPORT QUALIFICATIONS

Information presented in this report has been developed to address the modelling objectives set out above. This report is not and does not purport to be a report on flood behaviour outside of the nominated study area.

This report documents the second (Post Development) stage of a two stage modelling process. It relies on and should be read in conjunction with the first stage (Existing Conditions) report. Refer our earlier report titled “FLOOD MODELLING REPORT - Land Adjacent to Albion Park Airport - (Existing Conditions) prepared for Jordan Mealey - Consulting Engineers (February 2007).

2 THE PROPOSED DEVELOPMENT

2.1 LOCATION

The propose development site is situated on the fringe of the floodplain of Macquarie Rivulet, some 15km to the south of the city of Wollongong. The site is located in the city of Shellharbour, with frontage to Tongarra Road on land to the west of the north-south Albion Park airport runway (refer Figure 2.1 and **Appendix A1**).

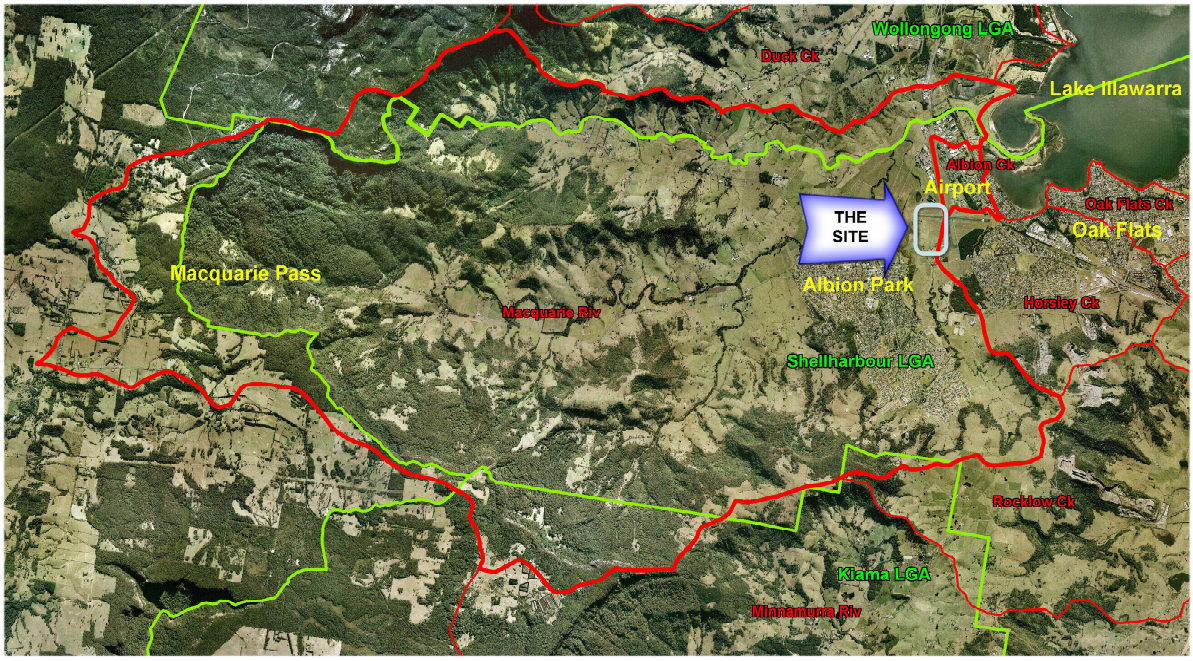

Figure 2.1: Location Plan

2.2 DESCRIPTION

The development is proposed in two parts, the greater part being located to the south of the east-west runway on Lot 6 and the lesser part to the immediate north of the east-west runway on Lot B. Both parts have road access from Tongarra Road with an internal road system connecting the two parts around the western end of the east-west runway. It is proposed to excavate higher ground to the south of Lot 6, to provide fill for lower ground along the western and north-western boundaries of the site. A pronounced u-bend in the eastern arm of Frazers Creek would be infilled in this process, with the creek re-constructed on a more direct realignment to the immediate west of the proposed development The present ill-defined creek alignment along the western boundary of the site would be improved and riparian corridors established. (refer Figure 2.2 and **Appendix A2**)

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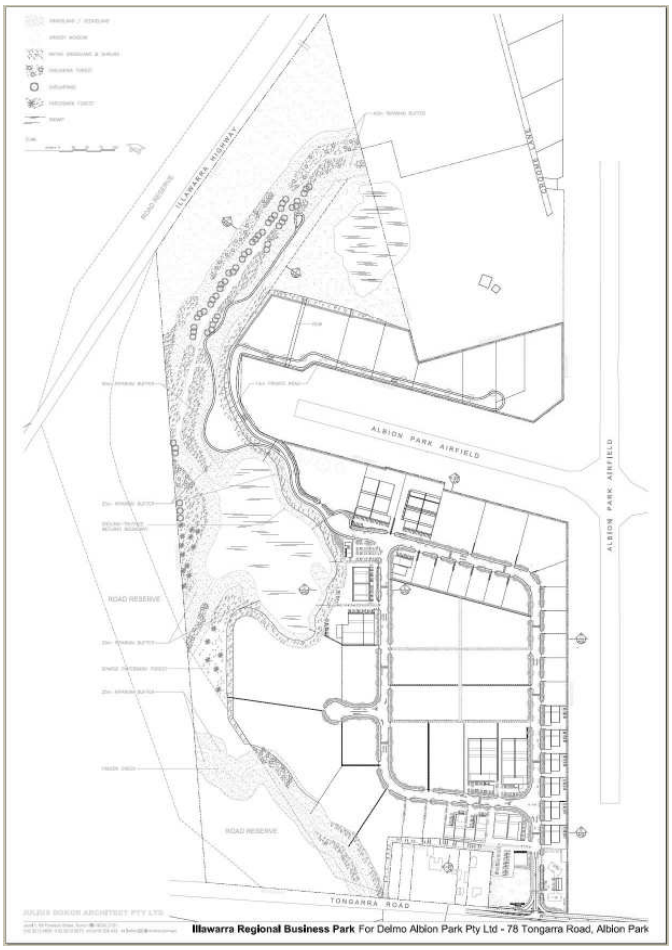

Figure 2.2: Layout Plan

3 MODEL ADJUSTMENTS

3.1 GENERALLY

The configuration of the previously constructed and calibrated hydrodynamic model was adjusted to reflect;

- Topographic changes associated with the proposed earthworks
- Surface roughness changes associated with the proposed development

All other aspects of the model were retained as existing.

3.2 MODEL TOPOGRAPHY

The topography of the proposed development was provided as a 3D (xyz) dataset by the civil engineering consultants for the project, Costin Roe, and input as a new elevation correction

tuflow Zpt-layer to the existing model's Zpt layer. The adjusted model elevation contours are reproduced in Figure 3.2 and **Appendix B1.**

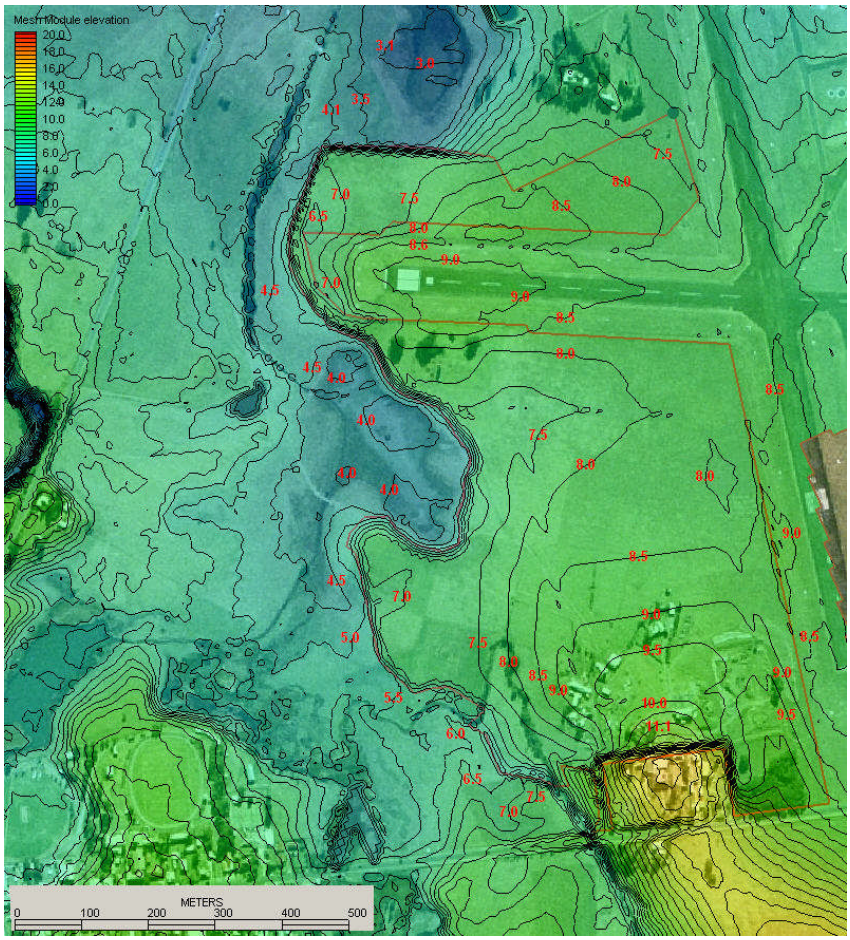

Figure 5.2.3: Model Topography

3.3 MODEL SURFACE ROUGHNESS

Additional material (surface roughness) designations were required to reflect the proposed riparian planting zones, The surface roughness zones added and their roughness values are set out in Table 3.3. As in the existing conditions model, surface roughness varies with depth, being equal to n1 at or below d1m depth and n2 at or above d2m depth. Between d1 and d2 surface roughness is linearly interpolated between the two roughness values.

Table 3.3 Surface Roughness Designations

Material	d1	n1	d2	n2
Native Grassland and shrub nom 0.75 high	0.50	0.150	2.50	0.050
Casuarina-Paperbark cops nom 4m c/c some underbrush to 0.5m	0.50	0.100	2.50	0.075

The distribution of model surface roughness in the vicinity of the post-development site is shown in Figure 3.3 and **Appendix B2.**

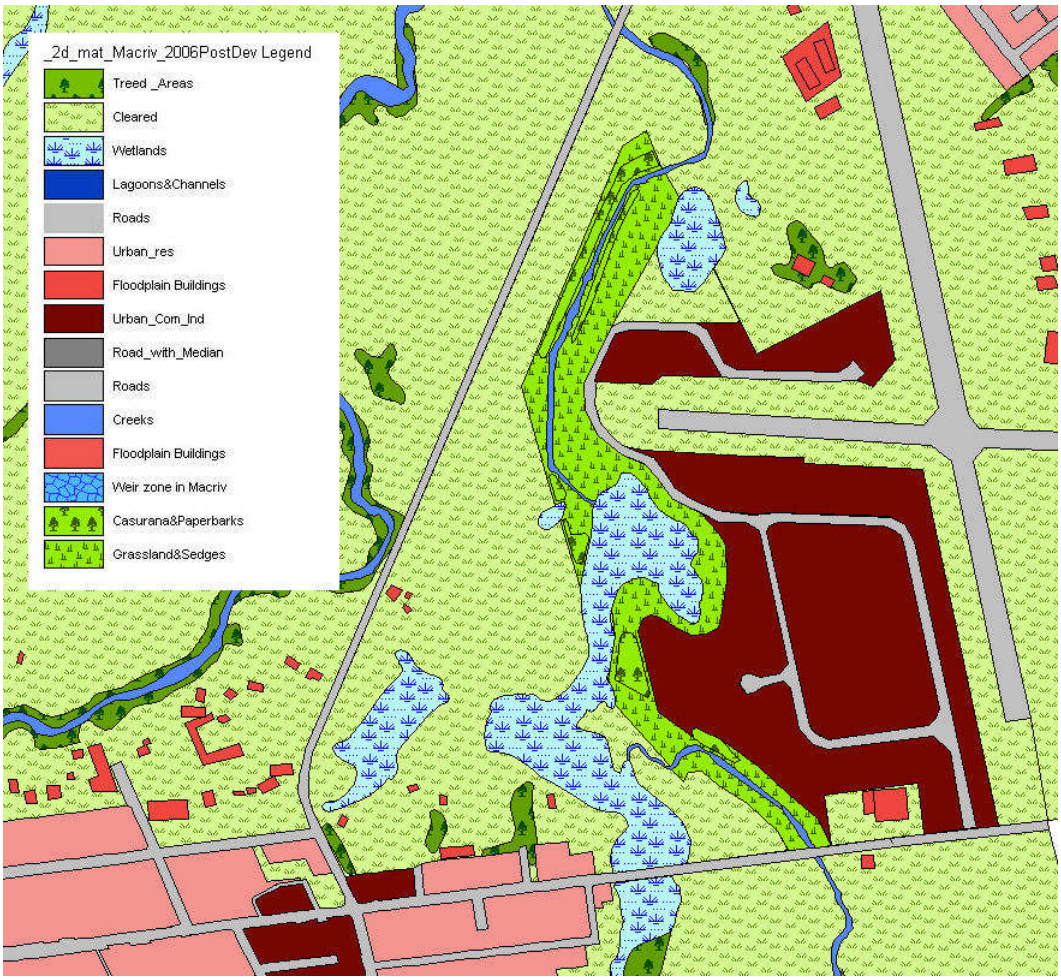

Figure 5.2.2 Model Roughness Zones

4 FLOOD BEHAVIOUR

4.1 GENERALLY

As shown in **Appendix C2**, the northern portion of Lot 6, south of the east-west runway and most of Lot 6 north of the east-west runway would still be inundated in a PMF flood. The northern corner of Lot B would also remain inundated in a PMF flood event.. Both lots remain therefore 'Flood Prone' in part, as defined in the Flood Plain Development Manual (FPDM 2005). As indicated on **Appendix C1**, all of the proposed lots and access roads would be free of flooding in a 1% AEP event.

4.2 FLOOD HYDRAULICS

As is apparent in the graphics describing the distribution of unit flow (VxD) across the study area (**Appendix C7** and **Appendix C8**) flow patterns through the floodplain to the west of the proposed development site are complex, varying in velocity, depth and direction across

the floodplain throughout an event. In general however, flows bordering the proposed development site are relatively low in velocity (refer **Appendix C3a** and **Appendix C4a**) and vary little in elevation along this border (RL 6.6m AHD in 1% AEP event, RL 8.2m AHD in a PMF event). Areas of recirculating flow occur along this border (refer **Appendix C3b** and **Appendix C4b**).north and south of the end of the east-west runway. Some concentration of flow and elevation of velocities locally occurs in Frazers Creek where it is forced to flow out and around the south western corner of the site and around the western end of the east-west runway. In a 1%AEP event the flood surface adjacent to the low point in the runway is at or about the level of the runway. In a PMF event however, the runway would be substantially overtopped (approx 1.7 m deep at the sag), with large quantities of flow leaving Macquarie Rivulet at this location to flow into the headwaters of Albion Creek.

It is of note that this is almost the same description of flood behaviour as presented in the earlier report on existing flood behaviour. To understand the changes in flood behaviour it is necessary to examine flood behaviour on a differential basis at a much higher resolution than that reflected in the above summary. These small differences are explored further in Section 4.4 where flood impacts are discussed.

4.3 FLOOD HAZARD

An assessment of the distribution of provisional hydraulic hazard across the study area is presented in **Appendix C9** (1%AEP) and **Appendix C10** (PMF). These plots reflect the FPDM 2005 provisional hydraulic hazard categories set out in Figure L2 of the manual. The plotted provisional hazard categories are based on the most severe hazard category (based on the consideration of instantaneous velocity and depth), occurring throughout the event.

As shown in **Appendix C9** (1% AEP), the relatively pronounced ground slopes at the edge of the floodplain adjacent to the proposed development sites prevents the development of a zone of low and/or transitional hazard of any significance, land to the west of the development being of high provisional hydraulic hazard close to where it abuts the site. The site itself, being above the level of flooding in a 1% AEP event is not subject to any level of hydraulic hazard from flooding in such an event.

As shown in **Appendix C10** (PMF), a tongue of mostly transitional to low provisional hydraulic hazard floodwater penetrates the northern half of the proposed development to the south of the east-west runway, along the valley created in the surface by the proposed earthworks. Velocities are near zero throughout this zone of inundation and range in depth at the peak from 0.4m where they cross the eastern access road to 1.1m depth where they cross the sag in the western access road. Most of the proposed development north of the east-west runway would be inundated in such an event. Peak flood depth in the development on Lot 6 north of runway would range from zero to about 1.2m, cutting off road access to development on Lot B. Only the northern corner of Lot B would be inundated in such an event, flooding in the area of inundation being shallow in depth and of very low velocity.

Access to and from Tongarra Road is not altered by the proposed development, the intersection between the proposed access road and Tongarra Road remains above the level of PMF flooding.

4.4 FLOOD IMPACTS

To assist with the quantification and understanding of the impact of the proposed development on flooding, plots were constructed at a 0.020m (20mm) contour interval of the

differences between post-development flood levels and velocities and those presently existing. These plots are presented in **Appendices D1 to D4.** It should be noted that this resolution is approaching the numerical resolution of the model at which some spurious differences can be generated. Care is therefore needed in working with results at this level of resolution.

In **Appendix D1**, the impact of the proposed development on flood levels in a 1% AEP flood event is shown. In general this differential plot indicates that flood level on the flood plain downstream of and to the west of the site would be elevated by about 33mm as a consequence of the proposed development. Adjacent to the north-eastern corner of the village of Albion Park and along most of the western boundary of the proposed development, flood water would be elevated by about 50mm. Downstream of Tongarra Road the flood impact would vary from a rise of about 200mm immediately downstream of Tongarra Road, to a reduction of 50mm in the vicinity of the re-aligned channel. Immediately downstream of the realigned channel, the projecting fill of the proposed development creates a sharp increase in flood level (up to 350mm) for a short distance before merging (at a 50mm rise) with the relatively uniform rise of 50mm adjacent to the western boundary of the majority of the proposed development.

In **Appendix D2** the impact of the proposed development on flood levels in a PMF event is shown. Such is the magnitude of a PMF event that the impact of the proposed development on flooding is significantly diminished. With the near level flood pool now extending up to Tongarra Road, flood levels are raised about 22mm across the lower flood plain, rising further to about 30mm in the vicinity of Tongarra Road and the north-eastern corner of Albion Park village.

In **Appendix D3** the impact of the proposed development on flood velocity in a 1% AEP flood event is shown. The most obvious feature of this plot is the general reduction in velocity adjacent to the development's western boundary (in the riparian zone) and the offsetting increase in velocity to the immediate west of this zone. Increased velocities peak at about 0.2m/sec adjacent to the end of the runway and the filled area of Lot 6. Decreased velocities also peak at about -0.2m/sec in the same locations. An increase in velocity locally of about 1m/sec, is evident in the vicinity of the realigned channel.

In **Appendix D4** the impact of the proposed development on flood velocity in a PMF event is shown. The areas of change are similar to those in the 1% AEP event, although the zone to the immediate west of the end of the east-west runway is largely free of velocity change. In general, the inner band of reduced velocities peaks at about 0.5m/sec north of the east-west runway and again opposite the filled projection of Lot 6. The outer band of increased velocities follows a similar pattern

5 ACKNOWLEDGEMENTS

This modelling was undertaken by Rienco Consulting at the request of Jordan Mealey Consulting Engineers to provide background for their review of flood compliance of a proposed development on land adjacent to Albion Park airport.

During compilation of this report valuable assistance and advice was received from officers of Shellharbour City Council, the Department of Natural Resources (Sydney South Coast regional office), David Yates – Surveyors, Manly Hydraulics Laboratory, AAMHatch Consulting, the Bureau of Meteorology, NSW Rural Fire Service and Sydney Water.

The assistance of all parties is gratefully acknowledged.

6 REFERENCES

The following documents are cited in this report.

Rienco Consulting (2007) 'Flood Modelling Report – Land Adjacent to Albion Park Airport – Existing Conditions', for Jordan Mealey Partners, February 2007.

APPENDICES

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D. DEVELOPMENT IMPACTS

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D.2 PMF Flood Level Impact
D.3 1% Flood Velocity Impact
D.4 PMF Flood Velocity Impact