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NSW Department of Planning

Albion Park - Flood Review

February 2008

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Introduction

1.1 Background

This review report was commissioned by the NSW Government Department of Planning and relates to the proposed Illawarra Regional Business Park development by Delmo Albion Park Pty Ltd at 78 Tongarra Road Albion Park (74 hectare), adjacent to the existing Albion Park Airport.

The scope of work for this report is as follows:

- Review available documentation and modelling associated with the flooding of lands within the Business Park site and surrounding area;
- Identify the levels of a 1% AEP and PMF event expected under the current proposal using a precautionary approach;
- Assess how the geomorphic profile of the current proposal will influence flow regimes and sedimentation rates;
- Using the available information, assess the short term and long term stability of the creek banks, riparian corridors, downstream wetlands and adjacent infrastructure, such as roads, bridges, culverts and retention basins, under the current development proposal;
- Make recommendations of the appropriate design of the creeks and riparian corridor in relation to flood risk/ management and long term sustainability of the system.

1.2 Contact Details

The following information is provided in relation to this review report:

Peer Reviewer and Author of Report: Dr Ricky Kwan, GHD Sydney, (02) 9239 7100

Project Director and Internal Reviewer: Dr Rainer Berg, GHD Sydney, (02) 9239 7100

1.3 Available Information

The following documents were provided for review:

1. Flood Modelling Report, Land Adjacent to Albion Park Airport (Existing Conditions), Rienco Consulting for Jordan Mealey Consulting Engineers, for Delmo Pty Ltd, April 2007,
2. Flood Modelling Report, Land Adjacent to Albion Report (Post Development Conditions), Rienco Consulting for Jordan Mealey Consulting Engineers, for Delmo Pty Ltd, February 2007;
3. Report on Flood Impacts of the Proposed Light Industrial Development on Land Adjacent to Albion Park Airport, Jordan Mealey & Partners, for Delmo Pty Ltd, 10 May 2007;
4. Supplementary Report on Flood Impacts of Filling Additional Land Adjacent to Albion Park Airport, Jordan Mealey & Partners, for Delmo Pty Ltd, 23 November 2007;
5. Illawarra Regional Business Park, Study in Support of State Significant Site and Concept Plan Environmental Assessment Report, Volume 1, Julius Bokor Architect Pty Ltd, for Delmo Pty Ltd, July 2007;

6. Illawarra Regional Business Park, Preferred Project Report and Statement of Commitments, Julius Bokor Architect Pty Ltd, for Delmo Pty Ltd, November 2007;
7. Submission on Environmental Assessment Exhibition, Major Project Number 06-0272, Illawarra Regional Business Park – Albion Park, Shellharbour City Council, 5 September 2007, 18 pp;
8. Comments on Proposed Illawarra Regional Business Park, Kate Hopkins, Regional Operations Officer, Department of Environment and Climate Change (undated), 15pp;
9. Comments on Environmental Assessment Exhibition – Illawarra regional Business Park, Department of Water & Energy, 31 August 2007, 2 pp; and
10. Comments Regarding Environmental Assessment Exhibition – Illawarra Regional Business Park, SES Wollongong, 30 August 2007.

Review Comments

2.1 General

We would like to commend Rienco Consulting (2007) for the excellent effort in completing the above flood studies. As flood specialists and engineers, we are fully aware of the huge amount of work required in studies of this nature. We also fully understand the difficulties involved in catchment and flow modelling where the flows are complex and good calibration data is scant.

It is noted that the reports still have a number of typographical errors. Our assumption is that these reports are still in draft form and are yet to be finalised. In some cases, it is not clear whether an apparent discrepancy is due to a typographical error or is an actual finding of the study. In this review, no comment is given to typographical errors unless they impact on the interpretation of the technical findings.

Notwithstanding the good quality of the Rienco reports and soundness of the study methodology adopted, we have a number of issues we need to raise as peer reviewers. This includes potential issues with the discrepancy in design flood levels compared to those from previous studies, limitations in the model calibration, initial loss assumption, lack of sensitivity testing, application of the embedded design storm technique, method of calculation of Probable Maximum Precipitation, cumulative impacts of floodplain development, and aspects of stream morphology. These issues are discussed in the next Section.

It is considered that, on the basis of the information presented, the adoption of a design flood level of 6.6m AHD for the area cannot be fully justified at this stage. One reason is that the previous lowest estimate for the area is about 7.5m AHD (Kinhill 1993). The reasons for the discrepancy are not clear. Discussions with Council also indicated that Council is currently preparing a brief to undertake a flood study and floodplain management study for the area. It would therefore be premature to adopt the 6.6m AHD 1% AEP flood level from the Rienco (2007) reports pending completion of the flood and floodplain management study. In the interim, it is considered that a conservative design flood level in the vicinity of 7.5m AHD would be appropriate.

It is also considered that stream morphological aspects in relation to the proposed works, including potential impacts on bed and bank erosion, have not been adequately addressed in the existing reports. It is recommended that this additional work be undertaken and incorporated as part of the study.

2.2 Detailed Comments

The review comments are provided in Table 1. It is noted that in this table, comments are first provided from an overall technical perspective in relation to the flooding and stream morphology work. This is followed by comments in the order of the page number of the report. It is also noted that as the findings of the other reports hinge on the findings of the initial Rienco report (April 2007), and there a number of issues in relation to this report, only limited comment is provided for these other reports.

Table 1: Detailed Comments

Item	Report Section	Comments
1	Overall – Variation of 1% AEP Design Flood Level with previous studies	The Albion Park Flood Study Report (WRC 1986) reported a 1% AEP flood level at the site of about 9.2m AHD (Report on Flood Impacts, Jordan Mealey & Partners, May 10, 2007, page 6). This was determined from a 1-dimensional flood model. However, Kinhill Engineers (1993) considered that a level of 7.5m AHD was more realistic based on the work of Forbes Rigby & Associates (not dated), which used a 2-dimensional model. Kinhill subsequently adopted a flood level of about 7.5m AHD near the site. The current 1% AEP design flood level of 6.6m AHD given in the Rienco study (April 2007) is therefore about 1m lower than the previous lowest estimate. It is accepted that the results from a 1D model are likely to be less reliable than a 2D model in this case. It is also expected that the use of more recent data, as in Rienco (2007) should provide better results. However, the reasons for the above discrepancies are not entirely clear at this stage. It is accepted that some calibration work was carried out in the Rienco flood model (April 2007) for the June 1991 flood, which does provide a level of confidence in the results. However, it is noted that the calibration was not particularly successful in terms of some of the parameters adopted, the full effects of which are currently not known. In addition, no independent validation of the model was carried out using a different flood or a flood similar to the design flood. As such, the reliability of the results presented in the Rienco flood report (April 2007) is difficult to determine. Until the discrepancies are fully resolved it is suggested that the conservative design flood level of about 7.5m AHD would be appropriate.
2	Overall – Limitations of Calibration and Initial Loss Assumption in Hydrology Modelling	The Rienco flood study (April 2007) adopted the June 1991 historical flood event for calibration of the WBNM and TUFLOW models. The June 1991 event is reported to have a peak discharge of about 513 m^3/s at the Princes Highway gauge site (page 54) and a magnitude of about a 5 to 10 year ARI rainfall event (page 30). By comparison the peak discharge for the 1% AEP event is about 1443 m^3/s (page 63). The June 1991 event is therefore a relatively small flood event and is only about 36% of the 1% AEP event. As they are not of a similar flow range, the 1991 calibration parameters may not be valid when applied to a large event such as the 1% AEP flood. This problem can be accentuated if there are other difficulties during the calibration process. An unrealistically high initial loss of 150mm was specified in the WBNM model in calibrating the June 1991 event (Appendix E2). This is well outside the normal range of values reported in Australian Rainfall and Ruoff (1997) of between 10-35mm for New South Wales and Australia in general. The 150mm initial loss is also markedly different to the 15mm initial loss adopted in the design model (page 63). This suggests that the calibration model for June 1991 may not be fully representative of the catchment conditions in the field. In other words, the unrealistically low initial loss adopted in the calibration may unknowingly mask other errors in the catchment model that are less obvious.

Item	Report Section	Comments
		If this is the case, such errors may also be unknowingly transferred to the model for the design runs.
3	Overall – Verification and Alternative Check in Hydrology Modelling	The calibration results are further limited by the fact that no other historical flood was selected to provide an independent verification check for the model. We understand from the report that no other complete set of data was available. A check of the design flows using an alternative method or model would have been useful in this case.
4	Overall – Sensitivity Testing of Models	Sensitivity testing is often required in projects where there is a lack of data for calibration or verification purposes. This involves varying the catchment parameters and other assumptions to test the sensitivity of the model to those assumptions. A final set of results would then be adopted on the basis of the sensitivity testing. No sensitivity testing was carried out in the Rienco studies. As the project appears to lack good data for calibration and verification, sensitivity testing of the model parameters is considered necessary to provide greater confidence in the results.
5	Overall – Embedded Design Storm Technique	The Rienco studies adopted the Embedded Design Storm (EDS) procedure (April 2007 report, page 57) in modelling the design flows. It is understood that the EDS procedure is basically sound and has been around since the early 1990s. Australian Rainfall and Runoff (1987, 1997) also acknowledges that the design rainfall patterns represent storm bursts rather than complete storms. However, both versions of the AR&R Guidelines do not currently recommend the use of complete storms due to the difficulties associated with the variability of these storms. Embedding a design storm within a larger storm, in any proposed EDS procedure, is expected to have similar difficulties. Issues include the choice of the overall storm to embed the design burst within. At this stage, we understand that the EDS procedure is being considered for inclusion in the next version of AR&R as one of 3 methods of design flood estimation. The design burst method in the existing AR&R would remain as one of the three methods. The form of the EDS procedure that will be recommended in the next version of AR&R is not clear at this stage. It is also doubtful that the new version of AR&R would be ready for release in 2008. On this basis, the use of the EDS procedure stated in the Rienco studies may be pre-mature as the design guidelines for this procedure have not been formulated and decided at this stage. At worst, it may be construed that the Rienco studies have not been carried out in accordance with current industry guidelines. It is therefore recommended to adopt the existing AR&R guidelines for design storm bursts as this method would still be retained in the next version of AR&R.
6	Overall – PMP design method	The Rienco Report (April 2007, page 58) states that as the GSDM Method extends only up to 6 hours (the 36 hour storm was required), it could not be used for the study. It then adopted a PMF embedded design storm derived from a 36 hour, 500 year ARI storm from standard AR&R IFD and temporal pattern data.

Item	Report Section	Comments
		According to Book 6 of AR&R, the GSAM Method (Minty et al 1996) is applicable and should be used for long duration PMF storms between 12 or 24 hours to 120 hours. Estimates for intermediate durations can be obtained by interpolation. Design PMF rainfall estimates can also be obtained from the Bureau of Meteorology. It is not known why the Rienco studies did not follow the recommendations of AR&R for the Estimation of Large to Extreme Floods (Book 6). It is also not known why the 36hr 500 year ARI storm was adopted as the PMF storm, which it clearly isn't. Unless a valid reason exists, the design flow estimates for the PMF event in the Rienco study reports are therefore likely to be incorrect.
7	Overall - Downstream Hydraulic Control	The Rienco report (April 2007, page 35) quotes from the Lake Illawarra Flood Study (Lawson & Treloar 2001) that the 1% AEP lake flood level is 2.3m AHD based on a critical storm duration of 36 hours, while the PMF level is 3.24m AHD. It also states that there is negligible spatial variation in lake flood level across the outlet of Macquarie Rivulet. This is because the lake is controlled largely by the hydraulic constriction at the lake entrance near Windang. In page 61 of the Rienco report (April 2007), in deriving the flood hydrographs, it is assumed that the peak of the storm would not coincide with the peak of the lake water level. A peak lake water level of about 2m AHD was used in the simulation of the 1% AEP storm peak. In general, we agree that in considering the joint probability distribution of concurrent flooding, we should not be overly conservative. In other words it is usually not necessary to assume that the flow series are perfectly correlated and that the peaks would occur simultaneously. However, as Lake Illawarra is largely isolated from the tidal impacts from the ocean (April 2007, page 15) and the Macquarie Rivulet is a major contributing catchment to the Lake (page 4), it is considered that a scenario with the peaks coinciding would be useful to provide an upper limit to the design flood levels. This scenario is not necessarily over conservative as the Lake reached a water level of 1.9m AHD for the June 1991 event (page 29). Consideration should also be given to testing the storm scenarios (as part of a sensitivity testing approach) with lower lake levels to assess the impact on flood velocities as well as flood levels.
8	Overall – Design PMF Discharge	The design PMF discharges presented in the Rienco (April 2007) report appear to be incorrect. In Table 7.2.2 (page 63) the PMF discharges are only about 2 times that of the 1% AEP flood. This is considered to be too low compared to results from most other studies carried out in Australia. In addition it is surprising that both the 1% AEP and PMF peak discharge have the same value of 1443 m^3/s at the Princes Highway Gauge site. This result does not appear to be sensible and may be related to the comments in Item 6.
9	Overall – Design PMF Flood Level	In Table 7.3.3 (page 64, April 2007) both the 1% AEP and PMF flood level at Frazers Creek downstream of Tongarra Road have the same value of 8.5m AHD. This result does not appear to be sensible and may be related to comments in Items 6 and 8 above.

Item	Report Section	Comments
10	Overall – Stream Geomorphology	No analysis has been carried out on the stability of the existing creek system and the likely impacts of the proposed works on stream morphology in any of the reports provided for review. This is considered to be necessary. The large number of meanders in the existing Macquarie Rivulet and Frazers Creek river system, coupled with the existence of remnant channels and ox-bow lakes, suggest several characteristics, including: • That the longitudinal grade of the river system is relatively steep (for rivers). This is often a trigger for morphological changes in a river system. • That the river system has been in a state of change in the past and may continue to undergo morphological changes in the future. It is reassuring that Figure 3.3.1 (page 18 Rienco April 2007 Report) shows that the Macquarie Rivulet has not altered much in shape and form over the past 55 years (1949 to 2004, though the figure is not clear for Frazers Creek). This suggests that the Macquarie Rivulet has been fairly stable up to the dominant channel forming process. However, it is not known if there have been any significant floods (and to what magnitude), during this period. The remnant channels suggest that the spatial variability of the bed material is such that significant changes in channel form may occur if certain thresholds are exceeded in this area. Thus, unless the lateral movement of the creek system has reached a state of stable equilibrium or is hydraulically stabilised, whether artificially or naturally, channel movement may still continue to occur in the future. Evidence of bed degradation (page 12, 3rd paragraph line 8, Rienco April 2007 report), coupled with few exposures of bedrock (page 12, 1st paragraph, line 2) suggests that changes are still occurring in other parts of the river system. It is well documented that creek realignment and floodplain filling can often trigger changes in a river system, including bed and bank erosion, upstream movement of headcuts or knickpoints, and downstream sedimentation problems. On this basis it is considered that an analysis of the stability of the river system is necessary. This would need to take into account the existing and post-development conditions.
11	Overall – Stream Geomorphology	In the Rienco studies, only the 1% and PMF flows have been considered. In terms of stream morphology, it is also important to consider a range of lower flows, including the dominant discharge and bankfull discharge. It is suggested that the assessment of a range of lower flows up to the bankfull flow be included.
12	Overall - Design of Creek and Riparian Corridor System	The design of the creek and riparian corridor would need to demonstrate the application of principles for the design of environmentally sustainable channels. It is recommended that the stability of the design is also addressed from a hydraulic perspective.
13	April 2007 Report, page 21 – vertical accuracy of survey	A vertical accuracy of 0.1m for the ALS survey is quoted. Confirmation is sought as an accuracy of 0.15 to 0.25m is known to be more commonly adopted in studies of this nature.
14	April 2007 Report, page 28,	Section 2.12.3 states that the rating curve in Figure 2.12.3 from WRC

Item	Report Section	Comments
	Rating Curve	(1996) for the Macquarie Rivulet Highway Gauge should provide a reasonable correlation between stage and discharge provided lake levels do not exceed RL 2m. However, the results from this study do not appear to be consistent with the above expectation. The results of the Rienco Study (April 2007) give a discharge of 1443 m^3/s and a flood level of 5.45m near the Gauge (pages 63 and 64). However, based on Figure 2.12.3, a 1% AEP discharge of 1440 m^3/s would correspond to a flood level of about 4.75m AHD, while a flood level of 5.45m would correspond to a discharge of about 2000 m^3/s. This is notwithstanding the fact that the lake level at the time of peak is at 2m AHD (page 61, Figure 7.1.4) and within the range stated on page 28 of the April 2007 Report. This discrepancy would need to be reconciled or explained.
15	April 2007 Report, page 30, second last line	February 1884 event?
16	April 2007 Report, page 43, initial loss and Calibration	The initial loss was "later increased to 150mm for the calibration event to better match the early stage of the recorded hydrographs..." Appendices E1 and E2 suggest that the initial loss specified has in fact led to an underestimation of the predicted flow at the early stages of the recorded hydrographs (for all of 7th June and 1st part of 8th June) leading to the first storm event. In Appendices E1 and E2, the following comments apply to the calibration for June 1991: • The models consistently underestimate the recorded peak flows. • The shape and timing of the hydrographs are reasonable, but much less so for volume. The overall coefficient of determination for calibration of the 6 day storm has not been assessed in the report, but is probably of the order of 80%. • Above the 150-200 m^3/s flow range (and up to about 500 m^3/s), the calibration achieved is reasonable. • Below the 150-200 m^3/s flow range, the calibration achieved is relatively poor. • The performance of the calibration over a much higher flow range (e.g 1% AEP flow of 1443 or 2000 m^3/s) is not known and may differ significantly from that shown.
17	Rienco, April 2007 Report, page 41 ff, Hydrologic Model	In calibrating a 6-day event (or longer) the use of a hydrology model with soil moisture accounting algorithms could probably have yielded a better result. It is apparent that the WBNM model adopted does not have this capability. This may explain the difficulties encountered in achieving the desired calibration fit (e.g Appendix E1) and the need to adopt an unrealistically high initial loss.
18	Rienco, April 2007 Report, page 47	A 10m grid cell and voiding of the 1D Estry link in TUFLOW is noted. This assumption would not define the cross sectional profiles of the channels accurately. However this is not considered to be an issue as the area of interest is mostly a floodplain region with significant

Item	Report Section	Comments
		overbank flows.
19	Rienco, February 2007 Report (Post Development Conditions) – Impact of works	It is agreed that the results in this report show minimal impacts resulting from the proposed works. However, due to the above issues raised in relation to the original modelling (for existing conditions), the final outcome is not clear at this stage. It is also noted that the increase in flood levels resulting from the proposed development (32-60mm), while not significant on its own, may have significant impacts cumulatively. In other words, this development may set a dangerous precedent for other developments, which may lead to significant adverse impacts throughout the floodplain.
20	Rienco, February 2007 Report (Post Development Conditions) and July 2007 Report (Julius Bokor Architect Pty Ltd)	The proposed works and changes to the existing Frazers Creek profile and floodplain have not been clearly shown in these reports. For example, while Figure 6.1 (Julius Bokor Architect report) shows the proposed concept plan, a similar plan showing the existing conditions would be useful Comparisons of the cross sectional profiles of the creek under existing and post-development conditions would also be useful. Page 4 of the Rienco, February Report states that " 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". These details are important but not clearly shown.
21	July 2007 Report (Julius Bokor Architect Pty Ltd), page 96, Section 7.1.4	"The ....new residential developments, have been constructed with floor levels well above the flood levels demonstrated in these studies". The flood planning level adopted in these previous developments is not mentioned. It is not clear from this report whether Council currently has a flood planning level for this area.
22	Report on Flood Impacts (Jordan Mealey & Partners, May 10, 2007, page 7)	Developable areas. It would be useful to provide information on the amount of cut and the amount of fill proposed, and whether additional fill material is imported from elsewhere.
23	Report on Flood Impacts (Jordan Mealey & Partners, May 10, 2007, page 10)	Second paragraph (in bold) quotes Council's Flooding DCP which stipulates that "Flood modelling must include a sensitivity analysis .....". This reviewer concurs with this requirement. No sensitivity testing was carried out in the flood modelling study.
24	Report on Flood Impacts (Jordan Mealey & Partners, May 10, 2007, page 11)	RTA highway. The details of this RTA highway are not clear. It is also apparent that it has not been taken into account in the flood modelling. Potential cumulative impacts of both the RTA work and proposed work for this site add another level of difficulty to the uncertainties in the report results. A modelling scenario with the proposed RTA highway would assist in checking the likely cumulative impacts.
25	Report on Flood Impacts (Jordan Mealey & Partners, May 10, 2007, Appendix A4	Flood free access. Is flood free access provided for the northern corner of the development to the north of the east west runway?

Conclusions

The study approach adopted for the Rienco (2007) studies is considered to be sound. However, a number of issues exist, including apparent discrepancies with previous flood level estimates carried out in the area, limitations in the Rienco model calibration, lack of sensitivity testing, application of the embedded design storm technique, method of calculation of the Probable Maximum Flood, cumulative impacts of floodplain development, and stream morphology. It is recommended that these issues be resolved.

It is understood that Council is currently preparing to undertake a flood and floodplain management study of the area. It is concluded that adoption of a conservative 1% AEP design flood level consistent with the previous lowest estimate of about 7.5m AHD would be appropriate at this stage, pending the outcome of Council's investigations, and resolution of the above issues.

It is concluded that the stream morphological aspects in relation to the proposed realignment works, including potential impacts on bed and bank erosion, have not been adequately addressed. It is recommended that this additional work be undertaken.

GHD Pty Ltd ABN 39 008 488 373

10 Bond Street Sydney NSW 2000

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T: 2 9239 7100 F: 2 9239 7199 E: sydmail@ghd.com.au

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