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Hinchinbrook Creek Link Road - Flood Impact Assessment

Submitted to:
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REPORT

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1.0 INTRODUCTION

The former Hoxton Park Airport (the site) lies adjacent to Hinchinbrook Creek, in the suburb of Hoxton Park. To the west of the site is the M7 motorway, to the south is Cowpasture Road and to the east is Hinchinbrook Creek. Figure A presents a layout of the site together with the location of significant local features. The site is being developed into an industrial development. As part of these works a new road has been proposed that links Cowpasture Road to the new development over Hinchinbrook Creek. A bridge and a series of ten culverts have been proposed for the creek crossing.

This report presents results of hydraulic modelling of proposed changes associated with the Hinchinbrook Creek Link Road at the former Hoxton Park Airport site.

ADW Johnson Pty Ltd (ADW Johnson) engaged Golder Associates Pty Ltd (Golder Associates), in accordance with our proposal, P07626014-001-Rev2 dated 13 May 2010, to modify the TUFLOW hydraulic model of Hinchinbrook and Cabramatta Creek that has been previously used to assess the potential impact of development currently under construction.

2.0 BACKGROUND

The original TUFLOW model of Cabramatta Creek was developed by WBM Oceanics Pty Ltd and then extensively upgraded by SMEC Australia Pty Ltd (SMEC) for detailed design of the M7 Motorway project.

There have been several changes to the TUFLOW model by URS Australia Pty Ltd (URS) and the Cowpasture Road Design Alliance (CRDA) – a joint venture between URS and Roads and Traffic Authority of NSW (RTA) in the vicinity of Hinchinbrook Creek reflecting:

- Flood Impact Assessment of the proposed redevelopment of the Hoxton Park Airport for Hoxton Park Airport Limited (HPAL);
- Flood Impact Assessment of the proposed upgrade to Cowpasture Road for HPAL;
- Hydraulic Design Simulations of the proposed upgrade to Cowpasture Road for CRDA;
- Revised Flood Impact Assessment of the proposed redevelopment of Hoxton Park Airport for Mirvac Projects Pty Ltd (Mirvac).

The most recent flood impact assessment is presented in a report by URS (2010) titled *Report – Hoxton Park Airport – Flooding Investigations* dated 15 April 2010.

Golder Associates understands that Mirvac (from HPAL) holds, by way of license from SMEC, a right to use the TUFLOW model of Cabramatta Creek and that intellectual property rights to changes to the TUFLOW model undertaken by URS and its subconsultants are held by Mirvac.

Golder Associates also understands that the proponent has been granted permission from CRDA (via Roads and Traffic Authority of NSW (RTA)) to use their changes to the TUFLOW model for the purpose of flood impact assessment. Golder Associates understands that CRDA holds, by way of a separate license from SMEC, a right to use the TUFLOW model.

Accordingly, this report documents the changes implemented to the most recent flood impact assessment undertaken by URS and its subconsultants for Mirvac.

3.0 MODEL SETUP

3.1 Model Background

TUFLOW is a two-dimensional (2D) finite difference model that solves the shallow-water flow equations with respect to continuity and momentum. TUFLOW uses one-dimensional (1D) elements, which are dynamically linked to the 2D domain, to represent small-scale hydraulic features such as culverts and open channels.

Topographic features within the model, such as the proposed Hinchinbrook Creek Link Road, are represented via an updated elevation. This model has a cell size of 10 m, therefore elevation data (cell-centre, cell-side, cell-top) is implemented at a 5 m resolution. Hydraulic features within the model such as the proposed bridge and the set of culverts in the eastern embankment are represented by 1D elements.

Hydrologic input into the TUFLOW hydraulic model domain is via inflow hydrographs, which, in this case, are derived from an XP-RAFTS model. These hydrologic inputs were originally received from URS as part of the adopted hydraulic model for this study. Golder Associates understand that no modification has been made to these hydrologic inputs by URS, therefore they should reflect what URS originally received from SMEC.

For context, SMEC's TUFLOW model of Cabramatta Creek was re-calibrated and re-validated against observed flood behaviour (1986 and 1988 flood events), as part of SMEC's works on the Westlink/M7 Motorway project. SMEC then implemented the proposed M7 Motorway on that calibrated model.

Golder Associates modelling approach therefore has been to consider carefully changes in the model that potentially may result in a significant move away from calibration, thereby retaining the robustness of the model for use to determine the impact on modelled flood levels and modelled flood velocities at the former Hoxton Park Airport.

The version of the Mirvac TUFLOW model is Build 2009-07-AE-iDP. An updated version of TUFLOW is now available, 2009-07-AF-iSP, therefore the TUFLOW model was updated to the latest version.

To validate the impact of that change was acceptable, the results of a previous simulation undertaken for Mirvac (URS, 2010) was compared to results of the same simulation using the latest version of TUFLOW. It was found that differences in 2D domain (throughout model) were negligible. Accordingly, Build 2009-07-AF-iSP, was adopted for this study.

3.2 Model Construction

The proposed changes associated with the Hinchinbrook Creek Link Road were implemented within the TUFLOW model. That model incorporates the proposed changes at the former Hoxton Park Airport site itself and proposed earthworks at the entrance to Hinchinbrook Creek Bridge at Cowpasture Road as well as the ground modifications at the entrances to the various culverts under Cowpasture Road. The model also assumes that the development site and the service station on Cowpasture Road are flood-free in the 100 yr event. Further details of that model are provided in URS (2010). It is noted that during the PMF simulations, discussed below, the 'flood-free' assumption was not applied.

For documentation purposes, the base model, from URS, that was updated was *GA_SIM2_10.tcf*.

3.2.1 Updated Existing Conditions

Basin 6

As part of floodplain management in this region, a detention basin, referred to as Basin 6, is to be located on Northern Creek. This creek flows eastward from Middleton Grange, under the M7, through the former Hoxton Park Airport site and into Hinchinbrook Creek. The detention basin was not previously incorporated in the TUFLOW modelling, as there was no link between the basin and the approved development. The TUFLOW model was updated to include this basin.

Changes to the TUFLOW model, to incorporate Basin 6, were implemented via an update to the elevation dataset using Triangular Irregular Network (TIN) files from the 12D civil design package. The 12D TINS were supplied by ADW Johnson (reference *12D-150126-TIN BASIN 6.12da* received 7 July 2010). A minor

amendment to that dataset was the addition of a breakline just south of entrance of Basin 6 to prevent flood waters entering the development site. This was due to the assigned crest level, in 12D, of the access road that runs under the M7. The size and location of the proposed outlet culvert was implemented in TUFLOW based on the data presented in J Wyndham Prince (2010) (Drawing 8240SK20.D). It is noted that the 1050 mm diameter orifice plate referred to in J Wyndham Prince's drawing was not included in the TUFLOW model.

The modelled hydraulic performance of Basin 6, as implemented in TUFLOW, was compared to the analysis presented in J Wyndham Prince (2010). Table 1 presents a summary of the comparison.

Table 1: Comparison of Hydraulic Performance of Basin 6

DESIGN FLOOD EVENT	Maximum Inflow (m^3/s)	Maximum Outflow (m^3/s)
100 y 2 h – TUFLOW	16.9	4.81
100 y 2 h – J Wyndham Prince	16.7	3.99

From Table 1 there is acceptable agreement between the analyses. Accordingly, the current hydrologic model used to provide input into TUFLOW was retained and the hydraulic representation of Basin 6, in TUFLOW as presented above, was adopted for all simulations presented herein.

Bus Depot

New survey was obtained of bus depot site to ensure up-to-date ground elevations were used in that area. The new survey was implemented in TUFLOW using an update to the elevation dataset using TIN files from 12D. The 12D TIN was supplied by ADW Johnson (reference *tin bus depot.12da* received 12 August 2010).

Northern Area

The TUFLOW model was also updated in the area to the north of the former Hoxton Park Airport. Review of the hydraulic properties of 1D elements in that model suggested that cross-sections in that model may now be out-of-date. New ground survey and cross-sections of Hinchinbrook Creek were therefore obtained in that area. During update of the model, the active 2D domain was extended, with Hinchinbrook Creek now represented by combination of 1D elements, presenting the creek itself with the floodplain now represented in 2D, rather than both the creek and floodplain being only in 1D.

The model was updated using a new elevation dataset via 12D TIN files. The 12D TIN was supplied by ADW Johnson (reference *tin_natural_isg.12da* received 19 August 2010). The 12D TIN files were also used to provide detailed information of cross-sections for 1D elements representing the creek

It is noted that there is a relic open channel to the north of the existing airport runway. This channel is a local drainage feature that was constructed during World War II to service the then extended runway. The channel terminates before the boundary of the TUFLOW model. The 12D TIN indicates the ground levels to the north of the start the channel are about 44.9 mAHD. In the 100 y 2 h event, the modelled maximum flood level is 44.6 mAHD; therefore the channel should not be an active flowpath during the 100 y 2 h. For the PMF 2 h event, the modelled flood levels are such that flood waters enter that channel from above.

Following the above modifications, a comparison was undertaken between modelled flood depths of an equivalent previous model and the amendment. It was found, in general, that modelled flood depths decreased by 5 to 10 cm below the northern 2D boundary of the previous model and decreased by 0 to 5 cm adjacent the former Hoxton Park Airport site. It was also found that the change to modelled flood depth was 0 cm at Hinchinbrook Creek bridge on Cowpasture Road and was 0 cm within Basin 18, downstream of Cowpasture Road.

It is therefore concluded that the extension of active 2D domain in the area to the north of the former Hoxton Park Airport has resulted in improved definition of floodplain storage in that location. However, this has not resulted in a significant change in flood behaviour downstream or off-site, that would impact the calibrated state of the model. Accordingly, this extension of the active 2D domain was adopted for all simulations presented herein.

Refinement of Hinchinbrook Creek

1D elements within TUFLOW representing Hinchinbrook Creek were refined in the vicinity of the proposed location of the Hinchinbrook Creek Link Road. Refinement involved splitting the existing 1D element into smaller lengths and updating the relevant hydraulic property tables. This was undertaken so as to allow comparison between the updated existing condition and the proposed condition, which includes the bridge and the culverts. To validate the refinement, the hydraulic property table of the element associated with the proposed bridge was compared to the up-to-date surveyed section and was found to be in reasonable agreement.

3.2.2 Hinchinbrook Creek Link Road and Northern Residential Area

Proposed Bridge and Flood Relief Culverts

Changes to the hydraulic model to incorporate the proposed Hinchinbrook Creek Link Road were then implemented via an update to the elevation dataset using 12D TIN files. The proposed bridge was then implemented using 1D elements and the proposed culverts on the eastern side of the bridge were also implemented using 1D elements. The 12D TIN was supplied by ADW Johnson (reference *tin DESIGN ISG.12da* received 19 July 2010). The layout of the proposed bridge and culverts was based on Drawings *150133-SK-001.C*, *150133-SK-002.B* and *150133-SK-003.C*, dated 11 August 2010 received from ADW Johnson on 11 August 2010. Copies of these drawings are provided in APPENDIX A.

The final configuration of the bridge in TUFLOW consists of six spans. As discussed above, the refined 1D element of Hinchinbrook Creek at the location of the bridge, was substituted from open channel to a bridge structure to allow direct comparison. The bank of 10 culverts were represented in TUFLOW using 1D elements, connected to the 2D domain using Head-Exchange boundary conditions.

Northern Residential Area

An area to the north of the existing airport is proposed to be used for residential purposes during a later stage of this development. The proposed extent of this residential area is indicated in Figure A. The hydraulic model was adjusted by raising the elevations of that residential area such that it was flood-free in the 100 yr event. It is noted that during the PMF simulations, the 'flood-free' assumption was not applied.

3.3 Design Flood Events

There were only two design flood events simulated in TUFLOW:

- 100 y Average Recurrence Interval (ARI), 2 hour duration
- Probable Maximum Flood (PMF), 2 hour duration

The original documentation provided by SMEC to URS, associated with delivery of the model datasets and license to URS, indicated that these were the relevant critical durations with respect to the 100 y ARI and PMF events.

3.4 Model Simulations

Two models were constructed:

- Updated Existing Conditions
- Hinchinbrook Creek Link Road

The TUFLOW control files associated with the results presented herein are provided for documentation purposes:

- GA_BASE3_06.tcf = 100 y 2h ARI design event (Updated Existing Conditions)
- GA_BRG5_12.tcf = 100 y 2h ARI design event (Hinchinbrook Creek Link Road)

- GA_BRG5_17.tcf = PMF 2h ARI design event (Hinchinbrook Creek Link Road)

It is noted that the development site, the service station and the proposed northern residential area were assumed to be 'flood-free' in the 100 yr event. This was achieved by raising the ground elevations by 5 m. The spatial extent of these 'flood-free' assumptions is indicated in model results presented below. In the PMF simulations, the 'flood-free' assumption was not applied.

The modelled impact of the Hinchinbrook Creek Link Road is presented for the 100 y 2h event. The results of simulations of the PMF, however, are intended to be used to provide input into the bridge design process only. Accordingly, 'impact assessment analysis' of the PMF is not provided.

One additional run was also undertaken on the Hinchinbrook Creek Link Road model. The results of that run was used to provide appropriately conservative estimates of modelled flood velocities, for bridge design purposes in the PMF design event. That run was prepared assuming the floodplain and channel roughnesses were 0.020 instead of the nominated calibration values in the original SMEC model.

The result of that simulation is provided in graphical and tabular format. The TUFLOW control files associated with the *Low Manning's n* runs is provided for documentation purposes:

- GA_BRG5_18.tcf = PMF 2 h ARI design event (Hinchinbrook Creek Link Road – Low Manning's n)

4.0 MODEL RESULTS

The TUFLOW models outlined above were executed using the latest version of TUFLOW, Build 2009-07-AF-iSP. Model results are presented in figures for the 100 y 2 h design event and the PMF 2 h design event. Estimates of velocity through 1D elements of the Hinchinbrook Creek Link Road model for the 100 y 2 h and PMF 2 h design events are presented in tabular format.

2D model results are presented in the following figures. These figures include flood impact assessment plots for the 100 y 2 h design event as well as general model output for the 100 y 2 h design event and the PMF 2 h design event. It is noted that model output is only provided for the Hinchinbrook Creek Link Road simulation for the PMF 2 h event.

- Figure 1 to 3 presents the modelled change in maximum flood depth, velocity and provisional flood hazard associated with Hinchinbrook Creek Link Road compared to Updated Existing Conditions for the 100 y 2 h design flood event.
- Figure 4 to 6 presents the modelled maximum flood depth, velocity and provisional flood hazard for 100 y 2 h for Updated Existing Conditions.
- Figure 7 to 9 presents the modelled maximum flood depth, velocity and provisional flood hazard for 100 y 2 h including the Hinchinbrook Creek Link Road.
- Figure 10 to 12 presents the modelled maximum flood depth, velocity* and provisional flood hazard of the PMF 2 h design event.
- Figure 13 presents 2D velocity estimates based on Low Manning's n simulations for the PMF 2 h design event.

* The modelled velocity presented in Figure 11 are from the Low Manning's n simulation for the PMF 2 h design event.

It is noted for all flood impact figures, where there was no change in modelled depth, velocity or provisional hazard class, then no colour was assigned to the particular model cell. As an example, if the change in modelled depth was more than 1 cm to 5 cm then the model cell would be coloured yellow and if the change in modelled depth was less than -1 cm to -5 cm then the model cell would be coloured green, whereas if the change in modelled was less than 1 cm or more than -1 cm then the model cell would be clear.

1D model results of estimated velocity in 1D elements of the Hinchinbrook Creek Link Road model are presented in Table 2.

Table 2: Modelled Maximum Velocity within 1D Elements (m/s) – Low Manning's n Simulation

Element ID	**Modelled Maximum Velocity (m/s)**
	PMF 2 h event
Bridge	4.0
Culverts (Average)	2.0

5.0 CONCLUSION

TUFLOW model simulations were undertaken for the former Hoxton Park Airport development site to consider the impact of the proposed Hinchinbrook Creek Link Road. The Link Road is a component of the former Hoxton Park Airport development site.

As presented above, the 'Updated Existing Condition' model incorporated changes associated with installation of Basin 6, updated survey of the bus depot site, extension of the 2D active domain of the model in the area to the north of the airport as well as refinement of 1D elements in the vicinity of the Hinchinbrook Creek Link Road. This model was then amended to include the proposed Link Road and the proposed northern residential area.

Modelling results, illustrated in Figure 1, indicate that afflux upstream of the Link Road ranges between 10 cm and 40 cm, in general, and that afflux to the east of the residential area ranges between 10 cm and 20 cm, in general. The maximum afflux immediately upstream of the western embankment of the Link Road is 40 cm and is 80 cm immediately upstream of the eastern embankment in the 100 y 2 h design event. The afflux downstream of the Link Road is between 10 cm and 20 cm. The maximum afflux immediately to the east of the proposed residential area is 40 cm in the 100 y 2h design event.

The extent of afflux upstream of the Link Road and to the east of the proposed residential area is relatively localised and resultant flooding levels do not impact on existing residential land to the north of Hoxton Park Airport nor does it impact on the flood-free status of Cowpasture Road. The extent of afflux downstream of the Link Road does not extend to Hinchinbrook Creek Bridge on Cowpasture Road.

Modelling results indicate that the bus depot is flood affected in the 100 y 2 h event. Modelled increase in flood levels at this location, due to the Link Road, is between approximately 20 cm in the 100 y 2 h event. Mitigation works at this location, to alleviate the modelled afflux, may include a minor bund, constructed of suitable material, along the western perimeter of the bus depot.

It is noted that the afflux in the water quality pond at the intersection of M7 Motorway and Cowpasture Road in Figure 1 is due to a local minor difference in ground topography between the two model simulations and should be disregarded.

Model results, illustrated in Figure 2, indicate increased velocities in the vicinity of the bridge and culvert entries of the Link Road of between 0.1 m/s to 0.5 m/s, in general, with a maximum increase of between 0.5 m/s and 1.1 m/s immediately upstream of the eastern set of culverts. Mitigation works at these locations will be required during detailed design of bridge elements.

Velocity estimates at the proposed bridge are presented in Figure 11 and in Table 2 for the PMF 2 h design event. These estimates are based on the hydraulic model, however, all models have a level of uncertainty which is difficult to quantify. It is therefore recommended that an appropriate factor of safety be adopted vis-à-vis velocity estimates during the bridge design.

Similarly, appropriate freeboard should be adopted for establishing the deck level of the bridge and the link/approach roads.

6.0 REFERENCES

URS Australia Pty Ltd, 2010. *Report – Hoxton Park Airport – Flooding Investigations*. Reference No. 43167805/1/3 dated 6 April 2010.

J. Wyndham Prince, 2010. *Basin 6, Hoxton Park – Basin Performance and Channel Options Report*. Reference No. 8240rp1E dated 6 May 2010.

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