4. MODELLING OF HISTORIC FLOODS

4.1 INTRODUCTION

The derivation of design flood levels throughout a study area can be achieved by a number of different approaches. If the study area has been occupied for many decades and there are substantial formal records of water levels and flows available then there are a number of approaches which might be used to directly assess the flood regime (and accompanying flood levels) associated with a range of floods including the 100 year flood.

However most often, as is the case with the Macquarie Park study area, such comprehensive data sets do not exist. This in turn means that numerical models need to be developed so that the 'design' flood levels can be calculated. Ideally such models should be 'calibrated' and 'verified' against historic flood data; that is, the models tested to determine if agreement can be achieved between recorded and simulated water levels during flood events.

To undertake such calibration tasks requires the gathering of as much data as possible regarding documented historic floods. Of particular importance is the quality of the rainfall and water level data that was recorded during each such event, since without comprehensive and accurate data, calibration and verification cannot take place.

4.2 REVIEW OF COUNCIL DATA BASE

The bulk of flood depth information for the study catchments is contained in Council's data base. Most of the information relates to instances of yard flooding however the review found that there was a lack of precision in essentially all of the reported yard flooding flood depths. This conclusion was reached because none of the reported flood depths had 'precise' values (i.e. they have typically been rounded to the nearest 100 millimetres) and nor were their measurement locations defined. With no real degree of confidence able to be placed in the reported depths (or their locations), it follows that is only very limited potential to use the data base information for formal flood calibration purposes.

However the review did conclude that there might be up to three events which potentially had sufficient flood depth information for general flood comparison purposes. Those events were November 1984, December 1989 and 7/8 February 1990.

Of the three dates, it is noted that the study's questionnaire responses provided some additional – but also imprecise – depth information for the 1984 and 1990 events.

December 1989 Event

While Council's data base contains 16 observations of approximate flood depths for this event, none relate to mainstream flooding and only about half of the flood depths are 300mm or less – that is, very shallow inundation. Since any inundation in urban neighbourhoods is often typically quite shallow, and also because (as noted earlier) none of the reported depths relate to specific flood marks, etc., the observations do not constitute 'quality' information for flood modelling purposes.

Additionally, there was also no rainfall recorder operating within the study area.

In discussions with Council, it was considered that there was insufficient information for this event to be used for modelling purposes.

November 1984 Event

This is the only event which has a set of flood depths/flood levels related to mainstream flooding along any of the study area watercourses (and they relate solely to the Shrimptons Creek watercourse). It is also the event which saw substantial flooding through the car park areas of the Macquarie Shopping Centre. There are also a handful of urban neighbourhood flood depth observations almost all of which are almost exclusively within the Shrimptons Creek catchment.

As for the other flood data sets, the neighbourhood depth observations are also of relatively poor quality due to their typical shallowness and absence of information as to location as well as absolute depth.

Given the consistency of data that indicates that this event has been the worst on record and the fact that there was a local rainfall recorder operating at the time, this event has been modelled.

7/8 February 1990

In Council's Data Base there is a total of 58 flood depth observations for 7/8 February 1990 and of those, a total of 29 have depths of 300mm or less. A total of 14 properties reported above floor level flooding and of those, eleven reported depths of less than 50mm.

The study's questionnaire also produced a further three flood depth observations.

As for the other historic flood data sets, the reported depth values are of relatively poor quality given the lack of data about absolute locations and absence of detailed measurements. Additionally, there was also no rainfall recorder operating within the study area.

However given the volume of reported problems, this event has been modelled.

4.3 NOVEMBER 1984 FLOOD

4.3.1 1990 Study Assessment

As noted earlier, the Ryde stormwater study (**Reference 2**) briefly examined November 1984 flooding along Shrimptons Creek catchment between Santa Rosa Park and Waterloo Road. Since there was no river station along the creek, recorded flood discharges were not available for direct calibration of that study's RAFTS hydrologic model. To derive initial flow estimates, an average rainfall depth and temporal pattern (where the latter was taken from that recorded at the West Ryde pumping station) was adopted.

A series of seven post-event debris line photographs which had been taken by Council officers were able to be compared with results obtained from a HEC-2 hydraulic model. Parameter values in both RAFTS and HEC-2 were then adjusted until satisfactory agreement was obtained with the surveyed flood levels.

4.3.2 Council Data Base

Council's data base contains ten overland flow entries for this flood with three including an observation of property flood depth. However since none of the depth observations are related to precise property locations and/or identified flood marks and since also the depths are usually expressed to the nearest 100 millimetres, they do not constitute accurate flood observations. Hence at best the depths only serve to give an indication of a likely local scenario.

4.3.3 Study Questionnaire Responses

Of an additional sixteen depth observations which were extracted from the returned September 2008 questionnaires, most related to neighbourhood overland flow regimes in the Shrimptons Creek catchment. They were also typically 'rounded' values and not based on precise measurements.

4.3.4 Simulation of the 1984 Flood in DRAINS and TUFLOW Models

For these relatively small catchments, the most important rainfall data sets are the temporal rainfall patterns rather than daily rainfall totals. Initial enquiries made through the Bureau of Meteorology web-site indicated that there was a BoM recording rainfall station operating at Marsfield at the time of this storm event. However further enquiries showed that the only BoM Marsfield data related to a daily rainfall station. Nonetheless further research uncovered a conference paper about the 1984 storms which included details of a Marsfield station rainfall pattern recorded by the Macquarie University. Extensive enquiries made with past and present university staff failed to locate the original data series and therefore the pattern presented in the conference paper was digitised (as presented in **Figure 3**).

The University's Marsfield recorder was the only recorder station operating within the overall study area on 8 November and **Table 5** lists those recorder intensities plus data from three other recorders located just beyond the study area boundaries. Comparison of the Marsfield intensities with Council's design rainfall intensities revealed that they were very similar to the 100 year average recurrence interval values.

TABLE 5: MAXIMUM RAINFALL INTENSITIES RECORDED DURING THE EARLY MORNING OF 8 NOVEMBER 1984 (mm/h)

LOCATION	DURATION (HOURS)						
	0.2	0.3	0.5	1	2	3	12
Marsfield	173.1	144.2	95.5	85.0	60.8	43.6	10.8
West Ryde	150.0	118.0	99.0	64.5	41.0	29.0	9.3
Hornsby	130.0	115.0	94.0	59.5	39.8	27.8	8.9
Chatswood	123.0	98.3.0	68.0	51.0	38.0	27.0	7.7

Table 6 lists daily station details for the same period.

TABLE 6: NOVEMBER 1984 DAILY RAINFALL TOTALS TO 9am (mm)

LOCATION	8 NOVEMBER	9 NOVEMBER
Marsfield (066156)	172.0	10.0
Denistone Bowling Club	186.0	10.0
Eastwood Bowling Club (066087)	142.4	11.4
Epping Chester Street (066020)	114.0	27.6
West Ryde Pumping Station (566037)	117.0	8.5

The Marsfield storm pattern was adopted for the Mars Creek and Shrimptons Creek catchments and reduced by 20% for the neighbouring Ryde study area catchments to reflect reduced rainfall totals in those areas. The remaining Lane Cove River sub-catchments were modelled with 65% of the Marsfield pattern to reflect the lower rainfall event totals recorded at Hornsby and Chatswood.

The resultant DRAINS hydrographs were then imported into TUFLOW.

The initial TUFLOW model results along Shrimptons Creek were compared with the flood levels quoted in the 1990 stormwater study (**Reference 2**) and significant differences were found. Upon further investigation – which included a review of the original 'post event' debris line photographs (see **Appendix A1**) – it was found that the historical levels used in the 1990 study were not consistent with the combination of aerial photography-derived ('ALS') surface levels and debris lines in the photographs. Since the ALS levels are known to be accurate, the circa 1990 estimates of flood levels were re-assessed and the findings discussed with Council officers. This process resulted in the discarding of the earlier flood level values.

The historic flood levels were re-calculated using the ALS data. Subsequently, generally good agreement with the initial TUFLOW model results was achieved. Some minor changes made to floodplain roughness parameters were found to improve the fit along Shrimptons Creek and the results are presented in **Table 7**.

Figure 4 presents the resultant November 1984 flood mapping.

The TUFLOW modelling of overland flow regimes was also found to achieve general agreement with the 'approximate' flood depth observations contained in the Council data base and in the returned questionnaires.

(As noted in **Chapter 3**, the DEM and pipe system data sets in the TUFLOW models do not provide a detailed picture of topography, every surface feature and every underground pipe that existed in November 1984. However a review of aerial photographs taken in the mid 1980s showed that in almost all the locations of 1984 flood depth observations, the topography appeared to be very similar to present day conditions. It was therefore concluded that the absence of precise circa 1984 topographical information was unlikely to have significantly impacted on the TUFLOW modelling of that flood event. Furthermore, noting that the majority of the November 1984 flood observations did not provide accurate data – and hence were quite inadequate for the desired purpose of formal flood calibration – there was deemed to be no worthwhile basis for trying to refine the DEM and accompanying floodplain features.)

TABLE 7: SHRIMPTONS CREEK NOVEMBER 1984 FLOOD PHOTO REVIEW

LOCATION	COUNCIL ALBUM PHOTO NO. (See also Appendix A1)	DESCRIPTION	SURVEY DATA	TUFLOW MODEL RESULT	COMMENT
Debris under Fullers Bridge bridge deck	L1	Debris on top of bridge column, say 200-300mm deep.	Top of bridge column, RL 4.3m AHD (from original bridge plan)	5.2 m AHD	Verification not possible since debris cannot lodge on bridge between RL 4.3 and 5.3m AHD
Debris line in lawn area just inside private property (Alma Road frontage)	S6	Width of inundation in private property say between 1 & 2 metres		TUFLOW predicts a 2-3 metre width of inundation at same location	Reasonable fit
Debris on mesh fence at Macquarie Centre frontage to Talavera Road	S5	Height of debris on fence is about one metre.		TUFLOW model calculates a maximum water depth of 1.02 metres at same location	Good fit
Debris line in lawn area, Talavera Road property opposite Macquarie Centre.	S14	Debris line	Cannot locate debris line since property has since been redeveloped	N/A	Calibration not possible
Debris line on creek bank just upstream of Epping Road	S16	Debris line level appears to be similar to adjacent bridge culvert obvert	Culvert obvert (as surveyed) is RL 45.68-45.77m AHD	Water Level of RL 45.89m AHD	Good fit
Debris at Kent Road power pole, northern footpath	S23	Debris is trapped against base of pole, say 300mm deep	Ground level of 50.02m AHD	Water Level of RL 50.44m AHD, therefore depth of approx. 400mm	Considered good fit given lack of clarity in peak water level mark
Debris at Kent Road southern handrail	S24	Debris is caught against handrail post, top of debris say about 700mm above ground level	Ground level of 50.25m AHD	Water Level of RL 50.86m AHD, therefore depth of 610mm	Considered good fit given lack of clarity in peak water level mark
(Indistinct) debris line at upstream face of Lucinda Avenue Footbridge	S26	Hand drawn HWL line in photo appears to be similar to mid depth of footbridge structural beam	As surveyed, underside of beam varies between RL 52.95 & 53.05m AHD.	Water Level of RL 53.29m AHD, which is similar to mid height of beam	Considered good fit given lack of clarity in peak water level mark

LOCATION	COUNCIL ALBUM PHOTO NO. (See also Appendix A1)	DESCRIPTION	SURVEY DATA	TUFLOW MODEL RESULT	COMMENT
Debris trapped against fence at corner of Herring Road and Lucinda Avenue	S29	Hand drawn HWL line in photo indicates that water depth is about 300-400mm deep		TUFLOW model calculates a water depth of 0.3 metres at same location	Considered good fit although there have been local area topographic changes since flood event
Debris trapped against front fence corner of No. 57 Bridge Road	S32	Debris depth say 600-800mm deep at property corner		TUFLOW calculated depth at cadastre corner is 780mm	Considered good fit given lack of clarity in peak water level mark
(Indistinct) water line at upstream side of Bridge Road culvert	S31	Hand drawn HWL line in photo appears to be about 300mm under bridge obvert	As surveyed, culvert obvert is RL 56.55m AHD	Water level of RL 56.38m AHD, therefore just below culvert obvert level.	Model is slightly over-estimating the flood level

4.4 FEBRUARY 1990 FLOOD

4.4.1 1990 Study

The storms experienced on 7 and 8 February 1990 occurred after the completion of the 1990 Ryde stormwater study and therefore were not examined in that document.

4.4.2 Council Data Base

As reported earlier, Council's data base contains 58 observations of property overland flow depths. Unlike for the 1984 flood, there are no observations/measurements of open watercourse flood levels.

As with the 1984 flood data base records, the depth observations in the data base are not related to precise property locations nor identified flood marks and therefore do not constitute accurate flood observations.

4.4.3 Study Questionnaire Responses

Only an additional four depth observations were found within the returned questionnaires and again were not based on specific property locations and/or precise measurements.

4.4.4 Simulation of the 1990 Flood in DRAINS and TUFLOW Models

Table 8 lists SWC intensity data measured at West Ryde Pumping Station together with data recorded at Chatswood while **Table 9** lists daily rainfall totals obtained from the Bureau of Meteorology. **Figure 5** presents the West Ryde temporal pattern.

A comparison of the West Ryde data with Council's design rainfall intensities showed that the storm was between a 1 and 2 year ARI event. Since (a) there was no operating rainfall recorder within the study area, and (b) it is closer to the Ryde study area catchments than Chatswood, the West Ryde data was adopted in the DRAINS models.

TABLE 8: MAXIMUM RAINFALL INTENSITIES RECORDED DURING THE EARLY MORNING OF 7 FEBRUARY 1990 (mm/h)

LOCATION	DURATION (MINUTES)						
	10	20	30	45	60	90	120
West Ryde	78.0	66.0	58.0	45.3	37.5	27.0	21.5
Chatswood	84.0	67.5	68.0	54.7	47.5	34.0	26.8

TABLE 9: FEBRUARY 1990 DAILY RAINFALL TOTALS TO 9am (mm)

LOCATION	7 FEBRUARY	8 FEBRUARY
Marsfield (066156)	135.6	16.0
Lindfield West (066032)	126.6	18.6
Epping Chester Street (066020)	103.0	17.4

The DRAINS flow hydrographs were then imported into the TUFLOW model and **Figure 6** presents the resultant February 1990 flood mapping.

The TUFLOW results were found to achieve general agreement with the 'approximate' flood depth observations contained in the Council data base and in the returned questionnaires.

The DEM and pipe system data sets in the '1990 event' TUFLOW models do not provide a detailed picture of topography, every surface feature and every underground pipe capacity that existed in February 1990. However since none of the February 1990 flood observations provide accurate data – and hence were quite inadequate for the desired purpose of formal flood calibration – there was deemed to be no worthwhile basis for trying to refine the DEM and accompanying floodplain features.