Gosford City Council

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TASCOTT BASIN

FLOODPLAIN MANAGEMENT STUDY

FEBRUARY, 1990

& SEPT. 1992.

WEBB, McKEOWN & ASSOCIATES PTY. LTD.
CONSULTING ENGINEERS

Gosford City Council

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1. INTRODUCTION

In May 1989, Gosford City Council commissioned Webb, McKeown & Associates on behalf of a Steering Committee of interested parties to prepare a Floodplain Management Study of Tascott Basin (Figure 1). The need for a study was demonstrated by the incidence of a serious flood on 6 January 1989, which was the most recent of a number of similar occurrences. This flood caused damage from overtopping of the railway embankment of the Main Northern Railway Line and in addition caused flood damage to a large number of properties upstream of the railway line.

Numerous floods have occurred within the Tascott Basin over the last twenty years resulting in water damage to both residential and commercial properties. Whilst preparing this study a further storm occurred on 5 December, 1989 causing flooding of the area yet again. This flood was not as severe as the storm of January 1989.

It was clear from the history of flooding that culverts through Glenrock Parade, the Main Northern Railway Line and Brisbane Water Drive were of inadequate capacity for even minor floods. This caused water to pond, flooding upstream properties, a large number of which have relatively low floor levels. What was not clear from the history of flooding was what were the precise causes of the flood problem, who was responsible for them and what was the most cost effective way to remedy the problem.

Council therefore convened a Steering Committee consisting of Council, the Roads & Traffic Authority (RTA), State Rail Authority (SRA) and Public Works Department to initiate and guide a Floodplain Management Study to answer the above questions. The Council and SRA contributed towards the costs of the study.

The main objectives of the study were to:

- ensure the safety of the railway line by reducing upstream flood levels,
- minimise damage to Brisbane Water Drive from flooding and scouring and improve road safety and trafficability,
- reduce the frequency of flooding in the residential and commercial area upstream of the railway line by lowering the backwater levels and improving the existing drainage.

2. SITE DESCRIPTION

The study area (Figures 1 and 2) lies within the City of Gosford adjoining Brisbane Water Drive (MR349) and the Main Northern Railway Line. Tascott Basin is some four kilometres south of the Gosford CBD by rail.

The study area is bounded to the west by Brisbane Water National Park and to the east by Brisbane Water. The catchment, of which over 90% lies within the Brisbane Water National Park, has a total area of 187.7 hectares.

Three main watercourses draining the catchment pass through the study area and become a single watercourse at Glenrock Parade. A five cell box culvert is located under Glenrock Parade. Downstream of Glenrock Parade stormwater tends to pond on the western side of the railway line before passing through 2 sets of 2-cell box culverts under the line. The 2 sets of culverts are approximately 160m apart.

Downstream of each set of railway culverts is a short open channel leading to a set of pipe culverts under Brisbane Water Drive. The outlets discharge stormwater directly into Brisbane Water.

Glenrock Parade is a Council maintained road and Brisbane Water Drive is the responsibility of the RTA.

3. DATA COLLECTION

Flood levels from the January 1989 storm were surveyed to obtain an appreciation of the scale of flooding at Tascott as well as for possible use in the calibration of hydrologic and hydraulic models.

An initial survey was carried out to determine the physical details of the culverts under Brisbane Water Drive, the Railway Line and Glenrock Parade together with levels along the centreline of the two roads and the railway line. Cross-sections along the watercourse between Glenrock Parade and Bluefish Crescent were surveyed together with details of the culvert under Bluefish Crescent. A later survey was carried out to determine floor levels of houses and details of the channel and culverts upstream of Bluefish Crescent. Floor levels are shown on Figure 2.

All levels given in this report are in metres to Australian Height Datum.

4. HYDROLOGIC MODELLING

In the absence of any streamflow records, estimates of flood flows were derived by hydrologic modelling using synthetic catchment parameters. A hydrologic model converts rainfall over a catchment into runoff at the catchment outlet. There are a variety of models which can be used, ranging from simple area/discharge relationships to complex non-linear runoff routing computer models. An analysis of methods applicable to NSW is given in Webb & O'Loughlin (1981). Several of these methods were examined in this study to find the most suitable. Since the major portion of the catchment lies within the Brisbane Water National Park, the catchment can be considered largely rural, and the effects of urbanisation on the flows could be disregarded.

As referenced in the Introduction, the January 1989 storm caused serious flooding in Tascott Basin. All relevant flood levels and rainfall data were therefore collected for this storm. However, they were too sparse to enable calibration of the hydrologic models. Default synthetic parameters for the models were accordingly adopted.

Design rainfall intensities and temporal patterns were obtained from Australian Rainfall & Runoff (1987). These data were then input to the hydrological models to determine design flows for a range of recurrence intervals after determination of the critical duration.

The hydrologic model parameters used are listed below:

Catchment Area (ha)	187.7
Probabilistic Rational Method	
Time of Concentration (h)	1.0
Runoff Coefficient (1% flood)	0.86
Cordery-Webb Synthetic Unit Hydrograph Method	
C (h)	0.64
K (h)	1.05
Initial Loss for 1% Flood (mm)	0
Continuing Loss (mm/h)	2.5
RORB Runoff Routing Model	
m	0.8
Kc	1.66
Initial Loss for 1% Flood (mm)	0
Continuing Loss (mm/h)	2.5
Critical Duration (h)	2

Four separate RORB runs were carried out (see RORB layout in Figure 3). The different runs were based on the following criteria:

i) RORB (without basin) - this models the catchment as if there is no special storage upstream of Glenrock Parade.

ii) RORB (with existing flood storage and ponding to RL 2.38m AHD). Currently floodwaters pond on the western side of the railway line to a level of RL 2.38m AHD, which is the low point of the line. Overtopping of the track occurs after this level is reached. RORB can be used to model this by incorporating a special storage in the model.

iii) RORB (with flood storage as it existed prior to development, and ponding to RL 2.38m AHD). This was similar to (ii) above but with a larger flood storage basin, i.e., before filling took place to raise residential lots above RL 1.5m AHD. This was a condition of the subdivision set by the Department of Health in 1967.

iv) RORB (no basin, with concrete lined channels upstream of Glenrock Parade). This run was used to represent the situation if the channel through the subdivision was concrete lined, with no storage west of the railway line, i.e., the stormwater would be contained within the channel.

The results for the various hydrological models are shown in Table 1.

TABLE 1

Upstream of Glenrock Parade (Totally Rural Catchment)

Peak Flows (m3/s)

Design Flood	1%	2%	5%	20%
Probabilistic Rational Method	36.8	30.1	23.3	13.8
Cordery-Webb	27.1	24.1	20.9	15.7
RORB (no special storage & unlined channels)	33.2	29.3	25.3	17.9
RORB (with existing storage)	26.4	22.0	15.6	10.5
RORB (with pre-existing storage)	24.6	19.6	13.2	9.3
RORB (no special storage & concrete channels)	40.9	36.3	31.7	22.8

The RORB (no special storage & unlined channels) and Probabilistic Rational Method results were comparable for the 1%, 2% and 5% floods. The primary objective of this study was to propose a solution for lowering flood levels west of Glenrock Parade such that little or no ponding occurs upstream of the railway line. Thus the RORB (no special storage & unlined channels) flows were adopted for the design of hydraulic structures in the following section.

The results for the adopted RORB model at specific points within the catchment are shown in Table 2. These points can be related to the RORB model layout shown in Figure 3 or to locations shown on Figure 4.

The extreme flood flows were taken as twice the 1% flows.

TABLE 2

Peak Flows (m3/s)

Design Flood	1%	2%	5%	20%
Location:				
Glenrock Parade	33.2	29.3	25.3	17.9
Northern Tributary	7.8	6.9	6.1	4.4
Main Channel west of N Tributary	26.0	22.9	19.4	13.8
Bluefish Crescent	25.5	22.5	19.1	13.6
Sub-Areas A to N	23.1	20.4	17.3	12.3
Sub-Areas I to M	8.8	7.8	6.7	4.7
Sub-Areas A to G	14.2	12.6	10.6	7.5

5. HYDRAULIC MODELLING

Two separate hydraulic models have been employed to assess the capacities of the existing culverts and watercourses. The analyses of the existing and proposed culverts under Glenrock Parade, the Railway Line and Brisbane Water Drive, were carried out using the culvert programs developed by Dr Boyd of the University of Wollongong. The culverts were analysed for both inlet and outlet control conditions. The condition which yielded the lesser capacity was adopted. The adopted capacities are listed in Table 3.

The analyses of the watercourse and culverts upstream of Glenrock Parade were carried out using HEC2, which is a standard step backwater program.

5.1 Existing Culverts - Glenrock Parade to Brisbane Water

The details of the existing culverts are as follows:

Glenrock Parade	5 Box Culverts each 1220mm x 920mm
Railway Line	2 sets of 2 BC's each 1220mm x 920mm
Brisbane Water Drive	2 sets of 2 pipes each 1050mm diameter

The culverts under Glenrock Parade, the Railway line and Brisbane Water Drive have been analysed separately. The parameters used in the analyses assumed no overtopping for the two roads, a freeboard of 300mm for the Railway Line and a starting water level in Brisbane Water of 0.4m AHD. In theory a Brisbane Water level equivalent to Mean Tide level should be used, as this approximates the "most likely" tide level which could be expected to coincide with a runoff event. However, there could be some wave setup or storm surge at the time of a major runoff event, so a slightly higher level was adopted for design purposes.

The capacities of the culverts are listed in Table 3.

TABLE 3

Existing Culvert Details

	Capacity (m3/s)	**Top of Road or Rail Level** (m AHD)	**Headwater Level** (m AHD)
Glenrock Parade	15.0	1.66	1.51
Railway Line	12.7	2.49	2.20
Brisbane Water Drive	4.8	1.35	1.25

The 1% and 5% design profiles under existing conditions are shown on Figure 6. All of the existing culverts, when analysed separately, have capacities less than the 20% (1 in 5 year) flood. Their overall capacity when analysed in combination would be significantly less due to energy losses between culverts.

Hydraulically, the most efficient means of conveying floodwaters from upstream of Glenrock Parade to Brisbane Water would be via a continuous culvert traversing Glenrock Parade, the Railway Line and Brisbane Water Drive.

5.2 Proposed Culverts - Glenrock Parade to Brisbane Water

Two sets of criteria have been adopted for the proposed culverts between Glenrock Parade and Brisbane Water. One set of criteria is to meet Gosford City Council needs and the other to meet SRA needs.

RTA requirements for major culverts have not been considered independently. Due to the closeness of Brisbane Water Drive to the railway culvert outlets, it is recommended that the culverts proposed for the railway line be extended to Brisbane Water.

Council's design criteria for culverts on a minor road would in general be to cater for the 5% flood peak flow with a controlled level of overtopping in a larger storm event, whereas the SRA would require that their culverts be capable of catering for the 2% flood peak flow with a freeboard.

Thus for the 5% flood the following criteria (to meet Council's needs) have been adopted for the proposed culverts:

- downstream water level (Brisbane Water) at RL 0.40m AHD. This level is considered a reasonable assumption for the applicable downstream level during a storm event as discussed earlier,
- maximum upstream water level (at Glenrock Parade) of RL 1.60m AHD (RL 1.60m AHD being the level of the low point on Glenrock Parade),
- downstream invert level to be limited to low water level, i.e., RL - 0.80m AHD,
- culvert upstream invert level set at RL 0.00m AHD.

To satisfy the above conditions it is proposed that the number of box culverts under Glenrock Parade be increased from 5 to 8 and that all 8 be extended to Brisbane Water.

For the 1% flood the following criteria (to meet SRA's needs) has been adopted for the proposed culverts:

- downstream water level (Brisbane Water) at RL 0.40 m AHD,
- maximum water level (immediately upstream of Glenrock Parade) of RL 2.0m AHD approximately. This water level is based on the maximum estimated water level in Brisbane Water likely to occur as a result of a combination of storm surge and wave run-up. This level also allows a limited head difference between the upstream and downstream faces of the railway embankment,
- downstream invert level to be limited to low water level, i.e., RL - 0.80m AHD,
- culvert upstream invert level set at RL 0.00m AHD.

To meet the above criteria the following culvert options are proposed:

Option 1 - Increase number of culverts (1.22m * .92m) under Glenrock Parade from 5 to 8 and extend all 8 to Brisbane Water. Provide the following additional culverts under the Railway Line and Brisbane Water Drive:

3 pipes each 1500mm diameter or
4 pipes each 1350mm diameter or
4 box culverts each 1.22m * 1.22m.
This would limit the water level immediately upstream of Glenrock Parade to RL 1.8m AHD in a 1% storm event

Option 2 - Increase number of culverts (1.22m * .92m) under Glenrock Parade from 5 to 10 and extend all 10 to Brisbane Water. This would limit the water level immediately upstream of Glenrock Parade to RL 1.7m AHD in a 1% storm event

Both options would require the abandonment of the existing northern culverts under the Railway Line and Brisbane Water Drive, as these would not meet the requirements of the proposed culverts on invert levels and size respectively.

The existing southern culverts under the Railway Line and Brisbane Water Drive would be retained to service a small local catchment. These culverts would also receive overflow from the upgraded culverts once Glenrock Parade was overtopped (floods in excess of the 5% flood) leading to potential flooding of Brisbane Water Drive. If this is a concern, a small berm could be constructed to prevent overtopping flows reaching the southern culverts.

5.3 Upstream of Glenrock Parade

A standard step backwater model, HEC2, was established to model the design flood profiles upstream of Glenrock Parade. Data for the existing watercourse were determined from field survey. Cross-sections were taken at regular intervals (Figure 4). There are seven box culverts (1220mm x 770mm) under Bluefish Crescent with inverts at 0.5m AHD. The crest of Bluefish Crescent is at approximately 1.75m AHD.

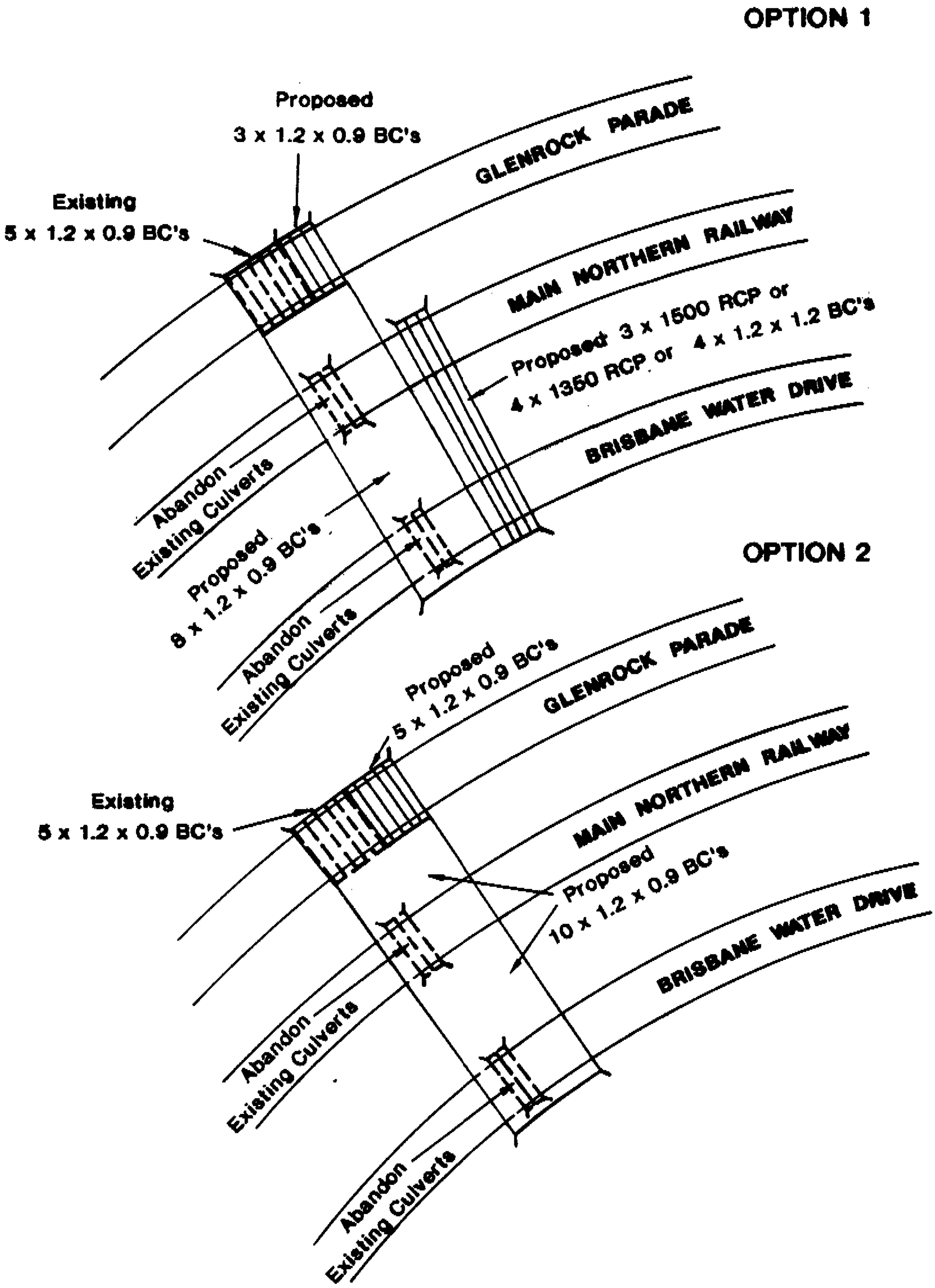
Figure 5 shows flood contours upstream of Glenrock Parade for the 5% and 1% design flood events with the Option 1 culverts in place. Flood profiles, including an extreme flood, are produced on Figure 6.

5.4 Other Considerations

Construction of the culverts proposed under Option 1 will pose a number of difficulties. There is only limited space between the Railway Line and Brisbane Water Drive and the latter has a relatively high traffic volume. Construction will be in water charged ground which will also be saline.

Consideration has been given to the use of bridges rather than culverts. This may be feasible for the Railway Line but would not be possible for Brisbane Water Drive because of its relatively low elevation. A possible tradeoff might be to tolerate more frequent flooding of Brisbane Water Drive, if costs for the proposed structures are greater than can be economically justified.

SKETCH 1


OPTION 1
Proposed
3 x 1.2 x 0.9 BC's
Existing
5 x 1.2 x 0.9 BC's
GLENROCK PARADE
MAIN NORTHERN RAILWAY
Proposed 3 x 1500 RCP or
4 x 1350 RCP or 4 x 1.2 x 1.2 BC's
BRISBANE WATER DRIVE
Abandon
Existing Culverts
Proposed
8 x 1.2 x 0.9 BC's
Abandon
Existing Culverts
OPTION 2
Proposed
5 x 1.2 x 0.9 BC's
GLENROCK PARADE
Existing
5 x 1.2 x 0.9 BC's
MAIN NORTHERN RAILWAY
Proposed
10 x 1.2 x 0.9 BC's
BRISBANE WATER DRIVE
Abandon
Existing Culverts
Abandon
Existing Culverts

6. CONCLUSIONS

6.1 Glenrock Parade to Brisbane Water

Option 1 is recommended for the 1% flood as it would limit flood levels at Glenrock Parade and the Railway Line to RL 1.8m AHD, and would be more economical than Option 2. The recommended option would provide a reasonable margin of freeboard to the railway track (approximately 0.6m), thus eliminating the risk of overtopping in a 1% flood. In addition, the maximum depth of flooding over Glenrock Parade would be of the order of 0.2m in a 1% flood, which would still allow access for most vehicles.

6.2 West of Glenrock Parade

West (upstream) of Glenrock Parade, flood levels would be significantly reduced by the installation of the additional culverts proposed in Option 1. Between Glenrock Parade and Bluefish Crescent, buildings with floor levels less than 2.0m AHD would be liable to inundation in a 1% flood. In the absence of a detailed survey in this area, the number of affected properties is not known. Between Bluefish Crescent and The Broadwater a detailed survey has been carried out, and after completion of the works, all floor levels would be above the 1% flood.

6.3 Possible Flood Mitigation Measures

A detailed assessment of the most suitable flood protection measures for the remaining flood affected properties has not been attempted. One or more of the following options may be suitable:

- installation of a river level indicator/siren to warn residents to lift property prior to a flood occurring. A more sophisticated flood warning system would be ineffective due to the extremely short warning time,
- house raising or flood proofing of goods may be practical,
- a flood awareness campaign may reduce the actual damages and promote more flood compatible use of the area,

- further enlargement of culverts or drainage channels would marginally lower flood levels but would be unlikely to be cost-effective,
- strict enforcement of minimum floor level policy would ensure that future development is flood free,
- a maintenance programme should be implemented to ensure that the hydraulic capacity of the system is maintained.

FIGURES

FIGURE 1

LOCALITY MAP

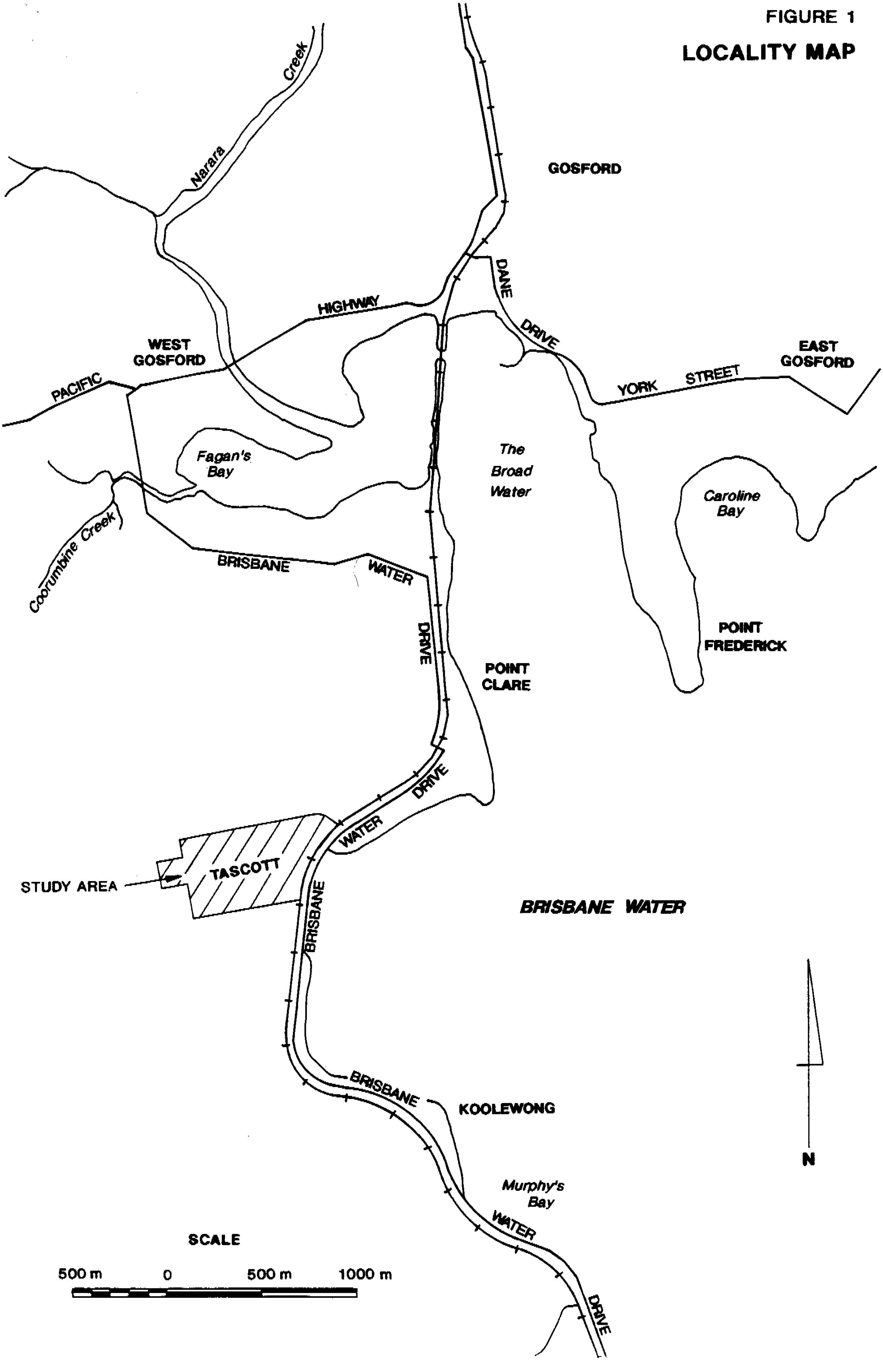


FIGURE 2

STUDY AREA

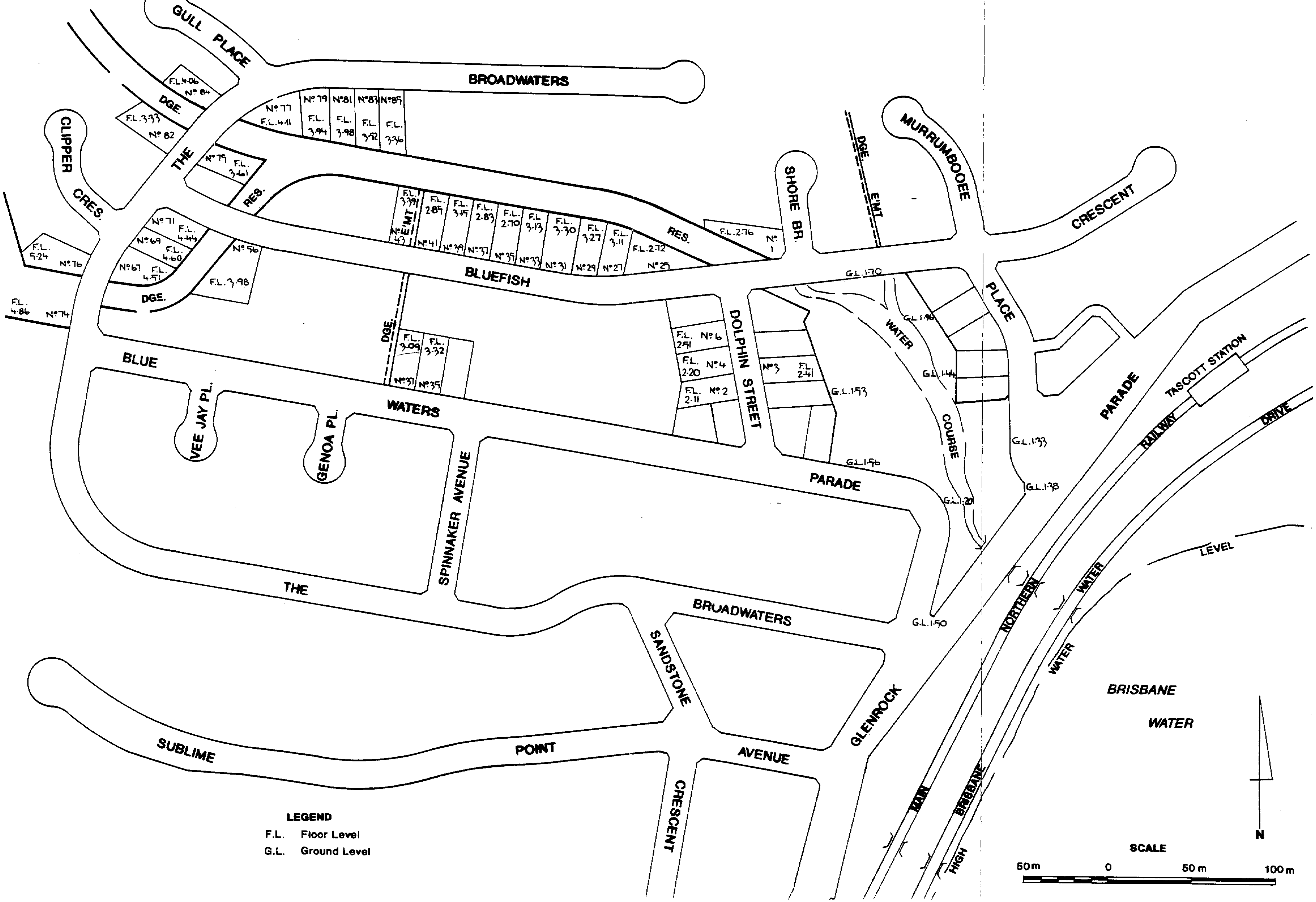


FIGURE 4

HEC2 MODEL LAYOUT

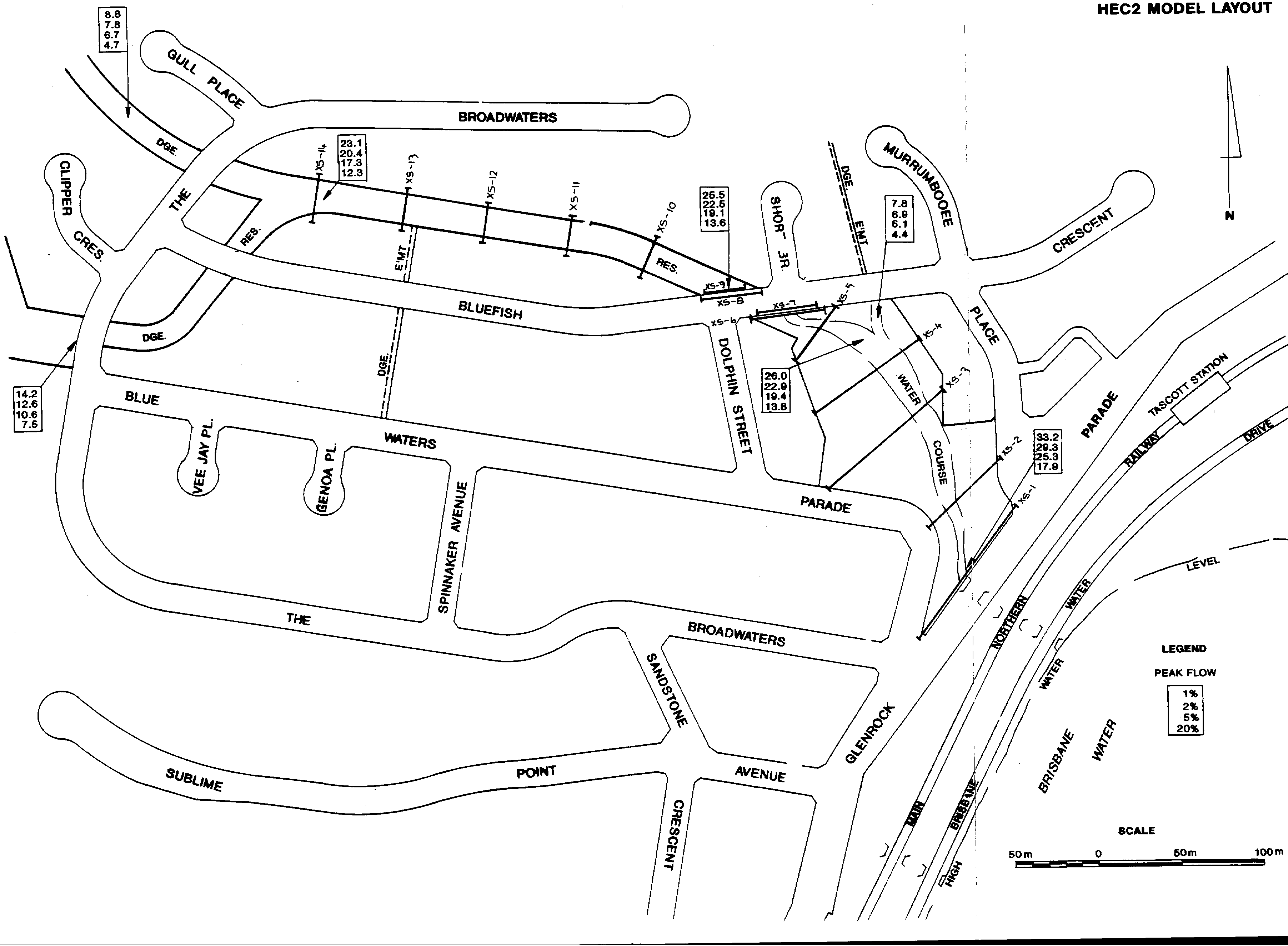


FIGURE 3

RORB MODEL LAYOUT

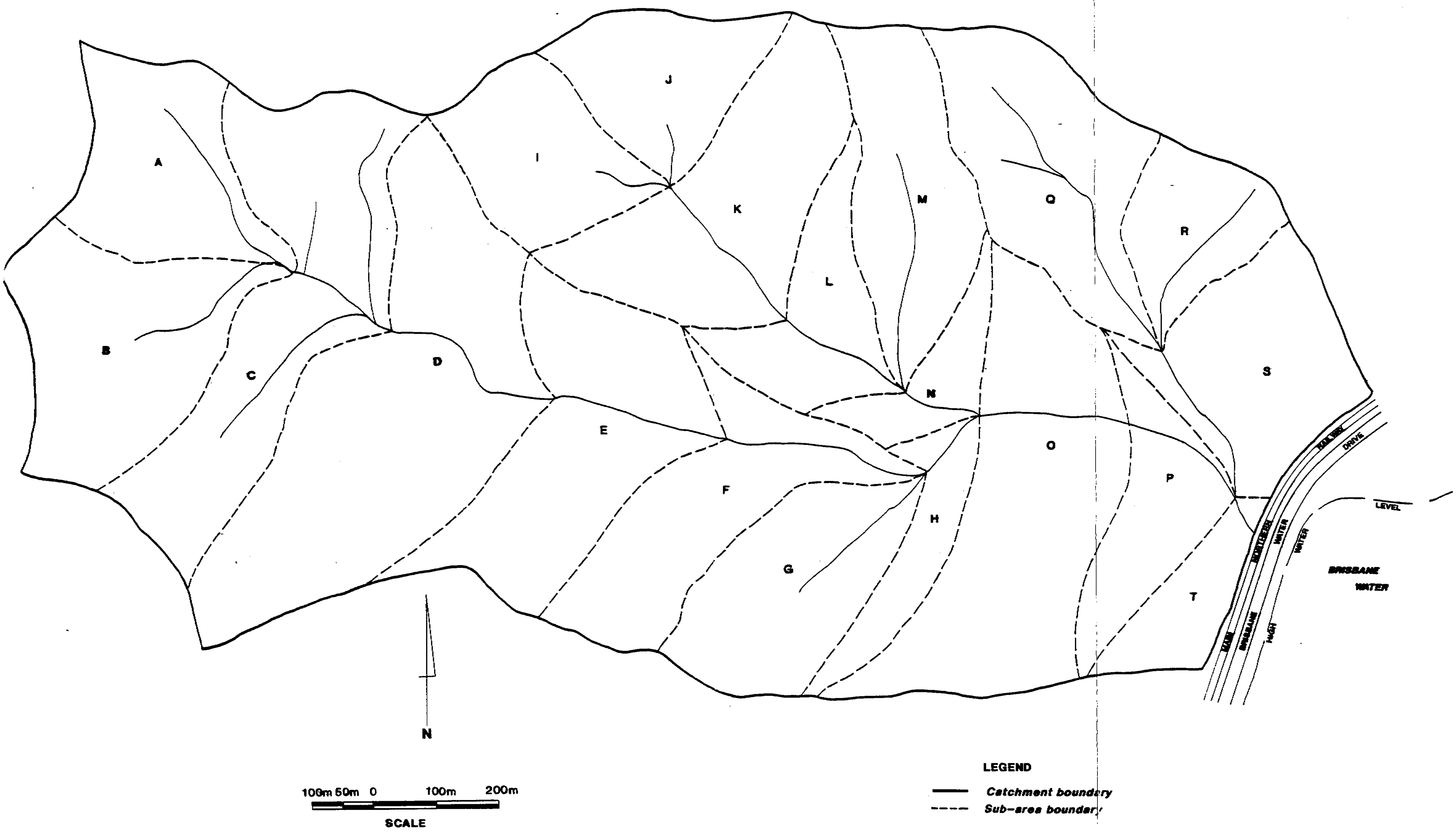
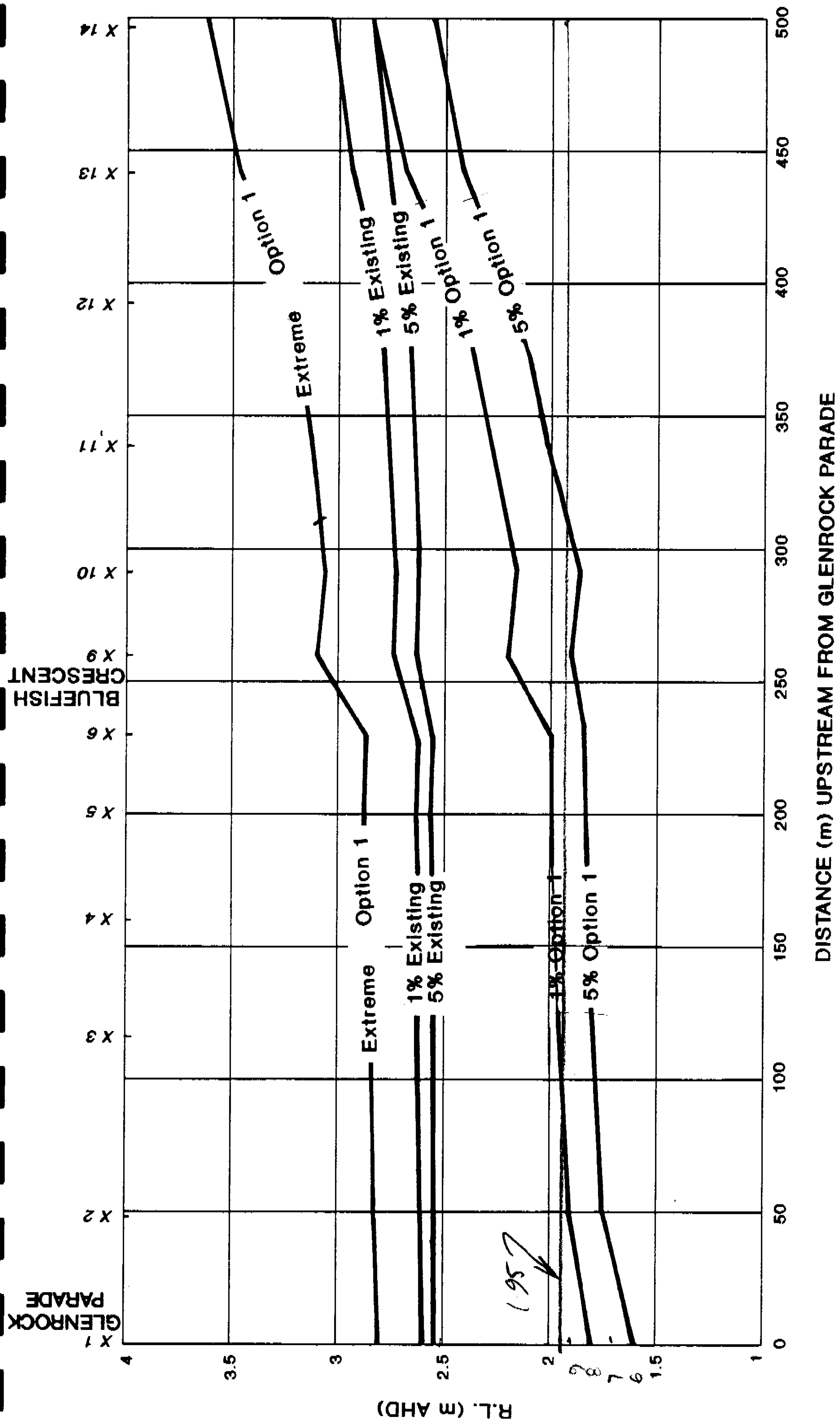


FIGURE 6

DESIGN FLOOD PROFILES



GOSFORD CITY COUNCIL

TASCOTT BASIN
CULVERT INVESTIGATION

SEPTEMBER, 1992

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TASCOTT BASIN
CULVERT INVESTIGATION

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1. INTRODUCTION

Tascott Basin has experienced numerous floods over the past 20 years resulting in damage to both residential and commercial properties. After a serious flood in January 1989, Gosford City Council commissioned Webb, McKeown & Associates to carry out a Floodplain Management Study of the Basin.

This study demonstrated that a series of culverts under Glenrock Parade, the Main Northern Railway Line and Brisbane Water Drive, were inadequate for even minor floods. The principal aims of that study were to determine the precise causes of the flooding problem and find the most cost effective remedies.

The study was published in February 1990 and recommended, inter alia, that the most appropriate mitigation measure would be to provide continuous culverts from upstream of Glenrock Parade to Brisbane Water. They would therefore pass under both of the roads and the railway line.

Subsequent to the release of the study, the State Rail Authority decided independently to provide a bridge under the railway line at Tascott. This decision has effectively nullified the recommendation of the Floodplain Management Study. Gosford City Council commissioned Webb, McKeown & Associates to re-analyse the situation to determine the most suitable culvert combinations under the two roads to complement the SRA bridge.

2. CRITERIA

Council initially provided a list of five criteria to be met in carrying out the investigation:

- culverts under Brisbane Water Drive should cater for the 2% discharge without overtopping the road. The road surface to be at 1.5m AHD,
- any flow over Brisbane Water Drive in the 1% flood should be limited to 0.2m depth (1.7m AHD) and 3m/s,
- culverts under Glenrock Parade to cater for the 2% discharge with no overtopping, with the road low point to be 1.75m AHD,
- any flow over Glenrock Parade in the 1% flood to be limited to 0.2m depth (1.95m AHD) and 3m/s,
- the 1% level at Glenrock Parade should desirably be no more than 1.8m AHD and the economic feasibility of achieving this was to be assessed.

In the evaluation process Webb McKeown was to advise the number and size of culverts required and Council would cost the options.

3. METHODOLOGY

The existing and proposed culverts under the two roads, and the flow over the roads, were analysed using the culvert programs of Dr M Boyd of the University of Wollongong. This methodology was also used in the Floodplain Management Study.

The hydraulic analysis of water levels between Brisbane Water Drive and Glenrock Parade cannot be precise because the final form of the watercourse after construction of the railway bridge is unknown. The hydraulic profile was modelled approximately using Manning's equation and broad assumptions regarding the final channel. Fortunately, the head loss between the waterway structures proved to be minimal compared with the head loss through the railway bridge, which was again determined from the Boyd programs.

The criteria provided by Council are clearly interrelated, and a number of initial calculations were therefore carried out to examine the interrelationship. Achieving the nominated 1% level at Glenrock Parade was found to be the dominant constraint. Once this was met, the other criteria were automatically satisfied.

A final solution was approached interactively, with Webb McKeown providing results to Council, who then refined their requirements and requested further calculations. The next section provides details of the final set of results provided to Council.

4. RESULTS

The final set of results are tabulated below. These are based on a further criteria, determined during the study, that Glenrock Parade be re-constructed as a 70m long causeway at 1.75m AHD and that the Top Water Surface level should not exceed 1.90m AHD.

Other design criteria were derived from the Floodplain Management Study as follows:

- 1% flow - $33.2m^3/s$,
- water level in Brisbane Water - 0.4m AHD.

The head loss between Brisbane Water Drive and Glenrock Parade was estimated to be:

• Brisbane Water Drive to Railway	-	0.02m
• Through Railway	-	0.14m
• Railway to Glenrock Parade	-	0.03m
		0.19m

The head loss was taken to be 0.2m. This was added to the upstream water level at Brisbane Water Drive to obtain the tailwater level at Glenrock Parade.

At both roads it was assumed that the existing culverts would be retained with any new culverts placed alongside. The existing culverts are:

- Brisbane Water Drive - 2 x 1050mm RCP,
- Glenrock Parade - 5 x 1.2 x 0.9m RCBC.

The new culvert sizes to be used were as follows:

- Brisbane Water Drive - 1350mm RCP's,
- Glenrock Parade - 2.1 x 0.9m RCBC's.

Selection of 6, 7 or 8 additional pipes at Brisbane Water Drive in conjunction with 2, 3 or 4 additional box culverts at Glenrock Parade were analysed for the 1% peak flow. The results are tabled below:

BRISBANE WATER DRIVE		GLENROCK PARADE		
No. of New 1350mm RCP's	**U/S Water Level (m AHD)**	**No. of New 2.1 x 0.9m RCBC's**	**U/S Water Level (m AHD)**	**FLOW OVER ROAD (m^3/s)**
6	1.41	2 3 4	1.95 1.93 1.90	11.0 9.1 6.9
7	1.18	2 3 4	1.92 1.87 1.82	8.4 5.0 2.2
8	1.02	2 3 4	1.88 1.81 1.72	5.6 1.8 0

From the above table, the following combinations would appear to satisfy Council's criteria.

Brisbane Water Drive No. of New 1350mm RCP's	Glenrock Parade No. of New 2.1 x 0.9m RCBC's
6	4
7	3
8	2

End of Report