3. ESTABLISHMENT OF COMPUTER MODELS

3.1 HYDROLOGIC MODEL

3.1.1 DRAINS Software

The DRAINS software (**Reference 7**) has principally been used to model the hydrologic regime of the study area. It is a comprehensive hydrologic modelling program for designing and analysing various types of catchments and urban stormwater drainage systems and includes hydraulic modelling capabilities for pipes and overland flowpaths. The software is widely used in Australia and Council itself has used DRAINS for many years.

The DRAINS model version is 2009.06.

While it follows that DRAINS software is suitable for undertaking both hydraulic and hydrologic assessments of urban catchments – and both capabilities have been used in this study – it is important to note that the pipe hydraulic analysis undertaken within the subsequent hydraulic modelling phase (refer **Chapter 4**) provides a more comprehensive picture of both pipe and overland flow rates.

3.1.2 Model Extent

The study area catchment runoff has been assessed by developing a series of three models which respectively model the rainfall/runoff regimes of the Mars Creek, Shrimptons Creek and Industrial/Porters/Lane Cove catchments and also the balance of the Lane Cove River catchment. They include pit-by-pit modelling of every Council stormwater pit – that is, a total of 3,200 pits – throughout the Mars Creek, Shrimptons Creek and Industrial/Porters/Lane Cove catchments.

Together with the 2008 Terrys Creek DRAINS model (**Reference 1**), the combination of the models provides a definition of all flow contributions to the Lane Cove River, see **Figure 2**.

3.1.3 Model Parameters

The DRAINS models were developed using the following data to replicate the 2008 catchment conditions:

(a) stormwater pit and pipe data sourced from Council's stormwater asset database which was updated and supplemented by:

  (i) significant field work undertaken by both the consultant and Council;

  (ii) copies of design plans for works built by Council in various locations; and

  (iii) adoption of 'averaged' pit depths where depths were not provided in Council's database and pit access was not available.

(b) Catchment soil data and rainfall losses as adopted for the neighbouring Terrys Creek study (**Reference 1**), see **Table 2**;

TABLE 2: SOIL DATA AND RAINFALL LOSSES

Soil Type:	ILSAX' Type 3
Antecedent Moisture Content (AMC):	3
Initial Losses:	1mm for paved areas and 5mm for grassed areas.

(c) sub-catchment boundaries which were derived using 2007 ALS-derived digital contour plans provided by Council;

(d) impervious percentages assigned on the basis of values derived from a range of 'typical' land uses/neighbourhoods which were directly measured using digital aerial images provided by Council;

(e) pit loss coefficients, as listed in **Table 3**;

TABLE 3: PIT LOSS COEFFICIENTS

PIT CONFIGURATION	LOSS COEFFICIENT
No angle change through pit	0.5
Angle change (less than 45^o)	1.2
Angle change (more than 45^o)	1.7
Multiple pipe junction pit	2.0
Most upstream pit	3.0

(f) inlet capacities derived on the basis of pit lintel and grate openings (obtained from either Council's database or field inspections). The 'Hornsby' pit inlet capacity relationships embedded in DRAINS were adopted together with the *AR&R* (**Reference 8**) recommendation of 20% blockage of on-grade inlets and 50% blockage of sag inlets; and

(g) a combination of *AR&R* (**Reference 8**) temporal patterns and Council's design rainfall data were utilised.

Since Council does not hold detailed records defining when each of Council's pipe systems were constructed, the only feasible way of developing a workable DRAINS model was to adopt Council's current stormwater asset database information. It therefore follows that the DRAINS pipe model does not necessarily reflect the pipe system networks of earlier years, including the dates of the examined flood events (as described in **Chapter 4**).

For modelling of the two historic events (i.e. November 1984 and February 1990), temporal patterns from local or nearby rainfall recorder stations were used as detailed in **Chapter 4.**

3.2 HYDRAULIC MODEL

3.2.1 TUFLOW Software

The widely used and Australian developed TUFLOW software (**Reference 6**) was chosen as the hydraulic modelling tool for use in the study because of its capability to simulate flood flows along both open watercourses and potentially complicated networks of overland flowpaths such as occurs in the study area.

The technical description of the TUFLOW model and its specific application to the study area is provided in **Appendix C**. The TUFLOW build model is 2008-08-AF- ISP.

The following sections of the report describe the establishment and operation of the TUFLOW model to simulate:

(a) the November 1984 and February 1990 events using DRAINS-derived flows. The simulated flood levels and extents for this event were then compared with the historical information; and

(b) the design 5 year, 20 year, 50 year, 100 year ARI and PMF events.

3.2.2 Model Coverage and Structure

The TUFLOW software has been used to define a combined picture of mainstream and overland flow flooding throughout the study area. The upstream limits in the Mars Creek, Shrimptons Creek, Industrial Creek, Porters Creek and Lane Cove catchments correspond to the most upstream Council stormwater pits while the overall downstream limit is adjacent to the western end of River Avenue, Chatswood West.

The series of TUFLOW models are made up of the following elements:

(a) a two dimensional hydraulic grid with cell width of 3 metres developed from the digital elevation model which is described in the following paragraph (and as shown in **Figures 2** to **6** is covering all of the study area);

(b) a digital elevation model (DEM) which covers the entire hydraulic model area. The DEM has been prepared by the consultant using 2007 ALS data provided by Council and roughnesses (in the form of Mannings 'n' values) have been varied throughout the model footprint to reflect local landuses or vegetation types, see **Table 4**. Building footprints have been digitised and included in the model (and generically assigned a very high roughness coefficient to reflect the potential for floodwaters to inundate them) while the curtilege area coefficient includes allowance for potential impacts associated with a variety of property features including landscaping, fences, etc. Given that there is no comprehensive picture of study area topography for the dates of the examined historic events (see **Chapter 4**) it follows that the adopted TUFLOW DEM cannot replicate the then 'present day' conditions;

(c) networks of study area pits and pipes which exist as a one-dimensional (1D) layer under the DEM and is based on the direct importation of the DRAINS pit and pipe data set. Inlet capacities are derived on the basis of the same pit lintel and grate opening data sets used in DRAINS and the same inlet blockage values used in the DRAINS modelling were adopted; that is, 20% blockage for on-grade inlets and 50% blockage for sag inlets;

(d) details of watercourses plus associated road culverts are defined in a 1D layer within the DEM. But for one exception, the data for these elements was directly extracted from specifically commissioned supplementary field measurements undertaken by registered surveyors. The exception was the bed levels in the Lane Cove River at and downstream of Fullers Bridge which were sourced from NSW Maritime;

(e) inflow hydrographs were directly exported from the DRAINS modelling and imported to the corresponding TUFLOW pits;

(f) an overall downstream boundary regime which was modelled by deriving a 'rating curve' for the Lane Cove River. To ensure this boundary regime did not influence the derivation of flood levels adjacent to River Avenue, the TUFLOW model was extended to the Epping Road bridge. A hydraulic 'uniform flow' approach was adopted to derive the rating curve using NSW Maritime-sourced river bed levels and longitudinal slope data.

TABLE 4: MANNING'S n ROUGHNESSES

Surface Type (Material)	Manning's n
Urban – fences and typical gardens, backyards	0.1
Urban – units and strata titled land	0.025
Roads and paved/concrete areas	0.02
Short grass / bare earth	0.03
Vegetated area	0.05
Vegetated floodplain	0.08
Buildings	20

It is important to note that while the TUFLOW model provides an overall comprehensive picture of flow regimes in both urban neighbourhoods and along watercourses it is unable to model very localised flow regimes. That is, the scale of the model – including its 3 metre grid definition of the topography – means that very localised changes in ground levels (including the impacts of minor obstructions, walls, kerbs and channels, etc.) are unable to be explicitly reflected in the model. Additional more precise modelling would be required if such 'micro' topographical features were to be modelled.

Flood levels along the Lane Cove River itself were derived on the basis of a number of flow contributions which together represent all the catchment flows. These consist of the following:

- importing the DRAINS 'outlet' flows from the 2008 Terrys Creek catchment modelling (**Reference 1**);
- the outflows from each respective 'tributary' TUFLOW model (i.e. Mars Creek, Shrimptons Creek and Industrial/Porters/Lane Cove;

- the DRAINS hydrographs for the balance of the Lane Cove River catchment.

In TUFLOW this has been achieved by a sequence of three separate models whereby the 'upstream' model includes the Mars Creek sub-catchment and the adjacent reach of the Lane Cove River, a 'middle' model which includes the Shrimptons Creek sub-catchment and the adjacent river reach and a 'downstream' model which includes the Industrial, Porters and Lane Cove sub-catchments and Lane Cove River itself.