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RETRO-FITTING TRUNK DRAINAGE IMPROVEMENTS

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Summary

The majority of Sydney's trunk drainage systems have capacities well below the currently accepted design standards. Given the intensive nature of urban development in many areas, the cost of replacing old systems with higher capacity structures of the same type may often be many times the cost of constructing the same systems in green field sites. A lower cost approach is often required.

In addition to the high cost, there are often significant social, technical or legal liability issues which have forced designers to look at alternative methods to system replacement as a means of mitigating flood risk.

The paper briefly discusses various retro-fitting options for trunk drainage systems including pit streamlining, overland flow path construction, detention basin construction, etc. Case studies are discussed where relevant.

1. WHY HAVE DRAINAGE PROBLEMS ARISEN?

1.1 Background

Sydney's urban development has been expanding for over 200 years. The problem of maintaining and improving the capacity of our urban infrastructure is one of enormous size. An important component of this infrastructure is our trunk drainage system which is significantly under capacity.

Sydney has some 20,000km of stormwater drains of which 99% are managed by local councils (**Reference 1**). It is likely that a large portion of the city's underground drainage systems have capacities which can only accept flows originating from storms with average recurrence intervals (ARI) between one and five years, with excess flows being conveyed by surface systems. In may cases however the available surface flow system has little if any capacity.

1.2 Major/Minor Drainage Principles

Current Australian trunk drainage practice has been formulated around the "major/minor" approach as espoused in the 1987 Edition of Australian Rainfall and Runoff (**Reference 2**) and other guides and manuals. The approach is illustrated in **Figures 1** and **2** which have been adapted from **Reference 2**.

The minor system normally comprises the gutter and pipe network capable of carrying runoff from minor storms. The major system comprises the remaining systems which carry the runoff from major storms. The major systems are usually surface systems and may include both planned and unplanned drainage routes.

1.3 System Capacities - New Designs

Current design capacities for stormwater drainage systems vary between Councils and depend on various factors such as:

- type of development, e.g. residential, commercial, industrial;
- rainfall intensities;
- soil infiltration rates;
- intensity of development.

Within Sydney, most local councils have adopted the following design standards:

- major system - 100 year ARI

- minor system - pipe capacity generally between 5 and 50 year ARI, with a majority of Councils now requiring a 20 year ARI capacity for most residential areas. In cases where suitable overland flow paths are not available, pipe systems designed to accept the 100 year ARI storm event are often required.

As part of a growing community awareness of stormwater drainage issues and inundation risks over the last 20 years, design standards have generally increased with time. It is not uncommon to find many Councils which had pipe design standards of 2 or 5 year ARI some 20 years ago, which now have adopted standards such as 20 to 50 year ARI for similar types of developments.

1.4 System Capacities - Actual

Whilst new system design capacities are relatively high, the actual capacities of the large majority of existing systems are well below the current standard.

The experience gained by our firm in completing over 100 major investigations of problem drainage systems over the last eight years has been that actual design capacities are typically 1 to 5 year ARI for pipe systems. Such capacity deficiencies are usually the result of a combination of the following factors:

- original design standards have since been updated;
- original hydrologic design was inadequate in some way, for example:
  - design rainfall intensities may have increased;
  - adopted assumptions concerning development in the catchment were incorrect (e.g. runoff coefficient used was too low);
- original hydraulic design was inadequate in some way, for example:
  - hydraulic pit losses were neglected or under estimated. (Many older designs used a pit loss of $V^2/13$ at every pit and did not take into account the particular hydraulic characteristics of individual pits);
  - hydraulic gradeline analyses were not carried out. Often charts which specified the pipe capacities as a function of the pipe slope were used as the only design tool. Such charts neglected the hydraulic losses at the upstream headwall (or inlet) and at intermediate pits;
- other factors such as:
  - inadequate maintenance of pit inlets and headwall entrances;
  - lack of trash racks and other devices to prevent blockage of pipe and overland flow systems;
  - collapse of pipe systems due to excessive loading;
  - increase in catchment area caused by road or freeway construction work, without adequate consideration of impacts on drainage.

2. SOLUTIONS TO THESE PROBLEMS

2.1 Why Retro-fit?

The simplest method of improving the capacity of an existing system may at first glance involve the complete removal of the existing minor system and its replacement with an identical system of greater capacity. However such an approach may be prohibitively expensive or technically impossible for various reasons including:

- development may have encroached over the system to the extent where construction is impossible without removal of the development. In some cases pipe jacking under the development may be an option, however this is normally very expensive;

- whilst an easement for the pipe system may exist, the easement may be inadequate. It is unusual to find easements larger than 10ft (i.e. 3m) wide in older areas of Sydney. Construction of new pipe systems with diameters larger than say 900mm is often impossible in such easements without using or impacting on land adjacent to the easement;
- social impacts and the costs of restoration of private and public land and structures affected by construction may be excessive;
- the concentration and/or acceleration of flows by piping may marginally increase downstream flood problems and therefore attract liability concerns.

Therefore retro-fitting improvements within an existing system is often the most practical method of increasing system capacity.

2.2 Retro-fit Options

A range of general retro-fit solutions to the capacity problem discussed above are available. These include:

- duplication of the pipe system with a second pipe system;
- construction of detention basins to reduce downstream peak flows;
- establishment or expansion of overland flowpaths;
- construction of trash racks upstream of headwall inlets to prevent blockages;
- streamlining of pits to reduce hydraulic losses;
- provision of additional inlet capacities to pipe systems by raising headwalls or providing larger pit inlets;
- catchment diversion to reduce the catchment area;
- acquisition and removal of development impacted by stormwater inundation.

3. EXAMPLES OF RETRO-FITTING IMPROVEMENTS

It has not been possible in this presentation to the Flood Mitigation Conference to provide case study details to illustrate all of the retro-fit options listed in Section 2.2 above. Four options are briefly discussed below and further details will be explained with the aid of 35mm slides during the presentation.

3.1 Pit Improvements

Figures 3 (a) and **3 (b)** illustrate two separate pits on the same trunk drainage system at Pennant Parade in Carlingford. In both cases, significant reductions in head losses were achieved and pipe capacities improved by approximately 30%. The hydraulic and construction aspects of the projects are described in **References 3** and **4**.

3.2 Overland Flowpath Formalisation

An example of the use of overland flowpaths to improve system performance is shown in **Figure 4**. This site is in Lyndelle Place, one of many examples in the Hornsby Shire where overland flowpath creation has proved to be a practical and cost effective method of alleviating stormwater inundation problems. Further details of the use of this procedure in the Shire can be found in **Reference 5**.

3.3 Additional Inlet Capacity

Figure 5 illustrates the use of additional inlet capacity to improve pipe system capacity at Janet Avenue, Thornleigh. The additional inlet capacity provided by the new pit is in excess of 10 m^3/sec. The pit is a major structure and overland flows are directed to the new pit via the upstream street system.

3.4 Pipe Duplication

Duplication of the an existing pipe system at Fairfield Road, Woodpark is illustrated in **Figure 6**. In this example, excessive inundation of residential development along the existing pipe system was alleviated through the provision of a duplicate pipeline constructed through open space areas adjacent to the existing line. This additional line eliminated above flood level inundation of a number of properties in the 100 year ARI event.

4. REFERENCES

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