Cardno Willing

Engineering the Future

Fairfield City Council

# REVIEW OF PROSPECT CREEK FLOOD LEVELS

## FINAL REPORT

June 2004

FAIRFIELD CITY COUNCIL

# REVIEW OF PROSPECT CREEK FLOOD LEVELS

**FINAL REPORT**
June 2004

Project Nos. 4235 & 4360

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**Cover Images**
Views of the flooding in the Prospect Creek catchment in January 2001.

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# ABBREVIATIONS

| | |
|---|---|
| AAR | Average Annual Retention |
| AEP | Annual Exceedance Probability |
| AHD | Australian Height Datum |
| ARI | Average Recurrence Interval |
| ARR | Australian Rainfall and Runoff (1999 edition) |
| BOM | Bureau of Meteorology |
| FCC | Fairfield City Council |
| GSDM | Generalised Short Duration Method (for estimating short duration PMPs) |
| HEC-RAS | Program for calculating flood profiles |
| OSD | On-Site Detention |
| PMP | Probable Maximum Precipitation |
| SES | NSW State Emergency Service |
| TUFLOW | Unsteady 1-D / 2-D flood routing program |
| XP-SWMM | Unsteady 1-D / quasi 2-D flood routing program |
| XP-RAFTS | Rainfall/runoff program |

# GLOSSARY

The following glossary is drawn from the NSW Floodplain Management Manual (NSW Government, 2001).

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| **annual exceedance probability (AEP)** | the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. For example, if a peak flood discharge of 500 $m^3/s$ has an AEP of 5%, it means that there is a 5% chance (that is one-in-20 chance) of a peak flood discharge of 500 $m^3/s$ or larger occurring in any one year (see average recurrence interval). |
| **Australian Height Datum (AHD)** | a common national surface level datum approximately corresponding to mean sea level. |
| **average recurrence interval (ARI)** | the long-term average number of years between the occurrence of a flood as big as, or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 20 year ARI flood event will occur on average once every 20 years. ARI is another way of expressing the likelihood of occurrence of a flood event. |
| **catchment** | the land area draining through the main stream, as well as tributary streams, to a particular site. It always relates to an area above a specific location. |
| **discharge** | the rate of flow of water measured in terms of volume per unit time, for example, cubic metres per second ($m^3/s$). Discharge is different from the speed or velocity of flow, which is a measure of how fast the water is moving for example, metres per second (m/s). |
| **ecologically sustainable development (ESD)** | using, conserving and enhancing natural resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be maintained or increased. A more detailed definition is included in the Local |

Government Act 1993. The use of sustainability and sustainable in the manual are related to ESD.

**effective warning time** — the time available after receiving advice of an impending flood and before the floodwaters prevent appropriate flood response actions being undertaken. The effective warning time is typically used to move farm equipment, move stock, raise furniture, evacuate people and transport their possessions.

**emergency management** — a range of measures to manage risks to communities and the environment. In the flood context it may include measures to prevent, prepare for, respond to and recover from flooding.

**flash flooding** — flooding which is sudden and unexpected. It is often caused by sudden local or nearby heavy rainfall. Often defined as flooding which peaks within six hours of the causative rain.

**flood** — relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam, and/or local overland flooding associated with major drainage before entering a watercourse, and/or coastal inundation resulting from super-elevated sea levels and/or waves overtopping coastline defences excluding tsunami.

**flood education, awareness and readiness** — **flood education** seeks to provide information to raise awareness of the flood problem so as to enable individuals to understand how to manage themselves and their property in response to flood warnings and in a flood event. It invokes a state of flood readiness.

**flood awareness** is an appreciation of the likely effects of flooding and a knowledge of the relevant flood warning, response and evacuation procedures.

**flood readiness** is an ability to react within the effective warning time.

**flood fringe areas** — the remaining area of flood prone land after floodway and flood storage areas have been defined.

**flood liable land** — is synonymous with flood prone land (ie) land susceptible to flooding by the probable maximum flood (PMF) event. Note that the term flood liable land now covers the whole of the floodplain, not just

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| | that part below the flood planning level, as indicated in the 1986 Floodplain Development Manual (see flood planning area). |
| **flood mitigation standard** | the average recurrence interval of the flood, selected as part of the floodplain risk management process that forms the basis for physical works to modify the impacts of flooding. |
| **floodplain** | area of land which is subject to inundation by floods up to and including the probable maximum flood event, that is, flood prone land. |
| **floodplain risk management options** | the measures that might be feasible for the management of a particular area of the floodplain. Preparation of a floodplain risk management plan requires a detailed evaluation of floodplain risk management options. |
| **floodplain risk management plan** | a management plan developed in accordance with the principles and guidelines in the manual. Usually includes both written and diagrammatic information describing how particular areas of flood prone land are to be used and managed to achieve defined objectives. |
| **flood plan (local)** | A sub-plan of a disaster plan that deals specifically with flooding. They can exist at State, Division and local levels. Local flood plans are prepared under the leadership of the State Emergency Service. |
| **flood planning area** | the area of land below the flood planning level and thus subject to flood related development controls. The concept of flood planning area generally supersedes the "flood liable land" concept in the 1986 Floodplain Development Manual. |
| **flood planning levels (FPL)** | are the combinations of flood levels and freeboards selected for planning purposes, as determined in floodplain risk management studies and incorporated in floodplain risk management plans. The concept of flood planning levels supersedes the "standard flood event" of the first edition of the manual. |
| **flood proofing** | a combination of measures incorporated in the design, construction and alteration of individual buildings or structures subject to flooding, to reduce or eliminate flood damages. |

**flood prone land** is land susceptible to flooding by the probable maximum flood (PMF) event. Flood prone land is synonymous with flood liable land.

**flood risk** potential danger to personal safety and potential damage to property resulting from flooding. The degree of risk varies with circumstances across the full range of floods. Flood risk in the manual is divided into 3 types, existing, future and continuing risks. They are described below.

**existing flood risk:** the risk a community is exposed to as a result of its location on the floodplain.

**future flood risk:** the risk a community may be exposed to as a result of new development on the floodplain.

**continuing flood risk:** the risk a community is exposed to after floodplain risk management measures have been implemented. For a town protected by levees, the continuing flood risk is the consequences of the levees being overtopped. For an area without any floodplain risk management measures, the continuing flood risk is simply the existence of its flood exposure.

**flood storage areas** those parts of the floodplain that are important for the temporary storage of floodwaters during the passage of a flood. The extent and behaviour of flood storage areas may change with flood severity, and loss of flood storage can increase the severity of flood impacts by reducing natural flood attenuation. Hence, it is necessary to investigate a range of flood sizes before defining flood storage areas.

**floodway areas** those areas of the floodplain where a significant discharge of water occurs during floods. They are often aligned with naturally defined channels. Floodways are areas that, even if only partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.

**freeboard** a factor of safety typically used in relation to the setting of floor levels, levee crest levels, etc. It is usually expressed as the difference in height between the adopted flood planning level and the flood used to determine the flood planning level. Freeboard provides a factor of safety to compensate for uncertainties in the estimation of flood levels across the floodplain, such and wave action, localised hydraulic behaviour and impacts that are specific event related, such as levee and embankment settlement, and other effects such as "greenhouse" and climate change. Freeboard is included in the flood planning level.

**habitable room**

in a **residential situation:** a living or working area, such as a lounge room, dining room, rumpus room, kitchen, bedroom or workroom.

in an **industrial or commercial situation:** an area used for offices or to store valuable possessions susceptible to flood damage in the event of a flood.

**hazard**

a source of potential harm or a situation with a potential to cause loss. In relation to the manual the hazard is flooding which has the potential to cause damage to the community. Definitions of high and low hazard categories are provided in Appendix G of the manual.

**hydraulics**

term given to the study of water flow in waterways; in particular, the evaluation of flow parameters such as water level and velocity.

**hydrograph**

a graph which shows how the discharge or stage/flood level at any particular location varies with time during a flood.

**hydrology**

term given to the study of the rainfall and runoff process; in particular, the evaluation of peak flows, flow volumes and the derivation of hydrographs for a range of floods.

**local overland flooding**

inundation by local runoff rather than overbank discharge from a stream, river, estuary, lake or dam.

**local drainage**

are smaller scale problems in urban areas. They are outside the definition of major drainage in this glossary.

**mainstream flooding**

inundation of normally dry land occurring when water overflows the natural or artificial banks of a stream, river, estuary, lake or dam.

**major drainage**

councils have discretion in determining whether urban drainage problems are associated with major or local drainage. For the purposes of the manual major drainage involves:

- the floodplains of original watercourses (which may now be piped, channelised or diverted), or sloping areas where overland flows develop along alternative paths once system capacity is exceeded; and/or
- water depths generally in excess of 0.3m (in the major system design storm as defined in the current version of Australian Rainfall and Runoff). These conditions may result in danger to personal safety and property damage to both premises and vehicles; and/or
- major overland flowpaths through developed areas outside of defined drainage reserves; and/or
- the potential to affect a number of buildings along the major flow path.

**mathematical/computer models**

the mathematical representation of the physical processes involved in runoff generation and stream flow. These models are often run on computers due to the complexity of the mathematical relationships between runoff, stream flow and the distribution of flows across the floodplain.

**merit approach**

the merit approach weighs social, economic, ecological and cultural impacts of land use options for different flood prone areas together with flood damage, hazard and behaviour implications, and environmental protection and well being of the State's rivers and floodplains.

The merit approach operates at two levels. At the strategic level it allows for the consideration of social, economic, ecological, cultural and flooding issues to determine strategies for the management of future flood risk which are formulated into council plans, policy, and EPIs. At a site specific level, it involves consideration of the best way of conditioning development allowable under the floodplain risk management plan, local floodplain risk management policy and EPIs.

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| **minor, moderate and major flooding** | both the State Emergency Service and the Bureau of Meteorology use the following definitions in flood warnings to give a general indication of the types of problems expected with a flood:<br><br>**minor flooding:** causes inconvenience such as closing of minor roads and the submergence of low level bridges. The lower limit of this class of flooding on the reference gauge is the initial flood level at which landholders and townspeople begin to be flooded.<br>**moderate flooding:** low-lying areas are inundated requiring removal of stock and/or evacuation of some houses. Main traffic routes may be covered.<br>**major flooding:** appreciable urban areas are flooded and/or extensive rural areas are flooded. Properties, villages and towns can be isolated. |
| **modification measures** | measures that modify either the flood, the property or the response to flooding. Examples are indicated in Table 2.1 and further discussion is given in Appendix J of the manual. |
| **peak discharge** | the maximum discharge occurring during a flood event. |
| **probable maximum flood (PMF)** | the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation. Generally, it is not physically or economically possible to provide complete protection against this event. The PMF defines the extent of flood prone land, that is, the floodplain. The extent, nature and potential consequences of flooding associated with the PMF event should be addressed in a floodplain risk management study. |
| **probable maximum precipitation (PMP)** | the greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood. |
| **probability** | a statistical measure of the expected chance of flooding (see annual exceedance probability). |

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| **risk** | chance of something happening that will have an impact. It is measured in terms of consequences and likelihood. In the context of the manual it is the likelihood of consequences arising from the interaction of floods, communities and the environment. |
| **runoff** | the amount of rainfall which actually ends up as streamflow, also known as rainfall excess. |
| **stage** | equivalent to “water level”. Both are measured with reference to a specified datum. |
| **stage hydrograph** | a graph that shows how the water level at a particular location changes with time during a flood. It must be referenced to a particular datum. |
| **survey plan** | a plan prepared by a registered surveyor. |
| **water surface profile** | a graph showing the flood stage at any given location along a watercourse at a particular time. |

# EXECUTIVE SUMMARY

In January 2001 the NSW Government released its new Floodplain Management Manual. The manual is directed at providing solutions to existing flooding problems in developed areas, and ensuring that new developments are compatible with the flood hazard and do not create additional flooding problems in other areas. The new manual also details the primary objective of the New South Wales Government's Flood Prone Land Policy, which is to reduce the impacts of flooding on individual owners and occupiers of flood prone land, and to reduce private and public losses caused by flooding. The management of flood prone land is the responsibility of local government. To facilitate this the Government provides funding in support of floodplain management programs.

Fairfield City Council (Council) is responsible for local planning and land management within the Prospect Creek catchment that is located within the Fairfield local government area.

Flood risk management studies and plans were completed in 1990 for the Lower Prospect Creek catchment and in 1993 for Upper Prospect Creek catchment. Council has been progressively implementing strategies recommended in these plans, however, it has been 10 years since the studies were carried out.

Council commissioned a review of flood levels in Prospect Creek as the first stage in its review of the Floodplain Management Plans that it adopted in 1990 and 1993 in accordance with the practices recommended in the 2001 NSW Floodplain Management Manual.

This review will ensure that Council is in compliance with the current NSW Government's Flood Policy and will also provide a basis for sound management of land within the Prospect Creek catchment and its floodplain. This review updates existing information about flood levels and will ensure that Councils flood management policies are consistent with current legislation and best practice in relation to floodplain management.

## THE STUDY AREA

The overall study area is the catchment of Prospect Creek. It comprises the catchments of Prospect Creek and its tributaries between Widemere Road, Wetherill Park and the Georges River at Lansvale. Major proportions of the flood affected areas on both sides of Prospect Creek are urban residential and/or industrial and include parts of Lansvale, Canley Vale, Carramar, Fairfield, Smithfield, Wetherill Park and Greystanes.

## THE NATURE OF FLOODING

Major flooding occurred along Prospect Creek and its tributaries in 1986, 1988, and most recently in January 2001. The floods in 1986 and 1988 caused serious financial hardships to a large number of families and businesses. The 1986 flood caused total damage of approximately $4.8 million. The 1986 and 1988 floods caused strong community pressures for measures to control flooding in the area. The flood mitigation works implemented by council since these floods resulted in substantial reduction in damages in the 2001 flood. The 2001 flood provided valuable data to enable accurate calibration of the new hydraulic model for Prospect Creek.

## HOW THIS STUDY WAS UNDERTAKEN

This study evolved from two companion assessments of Lower and Upper Prospect Creek into a single integrated assessment of the Prospect Creek floodplain.

The review commenced in July 2000 prior to the flood on 30-31 January 2001. This flood provided valuable information about flood behaviour under existing conditions of catchment development including mitigation measures already in place and of creek condition. This flood also influenced directly the scope and direction of the study from February 2001 onwards.

From mid-2001 to mid-2003 the approach to modeling of the Prospect Creek floodplain was a single XP-SWMM floodplain model that was 1-D in upper Prospect Creek and quasi 2-D in lower Prospect Creek. In mid-2003 Council commissioned aerial laser survey of the Fairfield LGA. This provided a valuable new resource of surveyed ground levels across the floodplain at a high density. An initial comparison of typical cross sections in the XP-SWMM 1-D floodplain model with sections extracted from Council's digital aerial survey disclosed differences of up to 1.0 m between the cross sections in the XP-SWMM floodplain model and extracted cross sections. This was of concern because of the ramifications for defining the extent of the floodplain by identifying the extent of inundation in a PMP flood (PMF).

To gain maximum value from the aerial laser survey Council commissioned the creation of a new 2-D floodplain model for the Prospect Creek floodplain extending from the confluence of the Georges River upstream to Widemere Road. The new 2-D floodplain model was calibrated against the observed 2001 flood levels and was then used to estimate to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities.

## HYDROLOGY (FLOOD FLOWS)

The aims of the hydrological analyses were to:

(i) Assemble a detailed overall catchment rainfall/runoff model initially based on the RAFTS models assembled during the previous 1990 and 1993 studies;

(ii) Calibrate and verify the catchment model against available gauged flows in the August 1986, April 1988 and January 2001 floods;

(iii) Estimate flood hydrographs at key locations within the Prospect Creek catchments for the August 1986, April 1988 and January 2001 floods storms based on catchment land uses at the time of each flood. The peak flows were in turn input into the hydraulic model(s) of Prospect Creek to provide estimates of historical flood levels; and

(iv) Estimate flood hydrographs at key locations within the Prospect Creek catchments for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP design storms under existing conditions ie. with the various structural flood mitigation measures completed by Fairfield City Council by 2003. The peak flows were in turn input into the hydraulic models of Prospect Creek to provide estimates of design flood levels.

Complete flow hydrographs are required as input for hydraulic models to represent actual flood behaviour. The model selected was the widely used rainfall-runoff flood routing model, XP-RAFTS.

## Historical Floods

The calibration and verification of the 1993 RAFTS model of the upper Prospect Creek catchment was based on two gauged floods that occurred in August 1986 and April 1988. The aim was to achieve the best agreement with the observed 1988 flood at the Smithfield Road gauging station by adjusting the ARBM loss model parameters. The model was then verified against the gauged hydrograph for the 1986 flood. The same approach was followed for the re-calibration and verification of the new XP-RAFTS model. It was concluded that the agreement achieved for the 1986 flood was good and for the 1988 flood was excellent.

Following the re-calibration of the XP-RAFTS model against the 1988 and 1986 floods a further indirect verification of the model was made using data for the January 2001 flood.

The only gauged hydrograph available for the January 2001 flood was on Orphan School Creek, a tributary of Prospect Creek. All other remaining flood height data comprised peak flood levels as represented by debris marks that were marked several days after the flood and subsequently surveyed and supplemented by a limited number of resident interviews.

It was concluded that the agreement between modelled and observed flows for the January 2001 flood on Orphan School Creek was good.

## Design Floods

Prior to estimating the design flood hydrographs the approach to be adopted for creating the design storms needed to be resolved.

The 1999 revised Book 6 of Australian Rainfall & Runoff (AR&R) recommends that areal reduction factors (ARFs) be applied to point rainfall estimates calculated in accordance with Book 2 of AR&R. For storm durations less than 18 hours, AR&R Book 6 recommends calculating ARFs using a relationship that is a function only of catchment area and storm duration ie. it is not dependent on ARI.

This suggests that conceptually a unique ARF should be calculated at each subcatchment outlet (node) or other location based on the upstream area of a catchment discharging runoff to any given location.

The consequence of this approach would be that peak flows at each location within a catchment would have to be individually calculated at each location using unique ARFs. This approach poses a significant problem when inputting local hydrographs into a hydraulic model for flood routing and flood level estimation purposes ie. it will not achieve flow continuity (similar to the conceptual problems encountered when undertaking hydraulic analysis using Rational formula flows).

To avoid the conceptual problems posed by the above approach two alternative approaches were tested as follows:

(i) Uniform distribution of the ARF (and resulting rainfall) across the overall catchment; or
(ii) Spatial distribution of the ARF based on the spatial distribution of PMPs ie. ellipses of defined areas.

It was concluded from nineteen (19) sensitivity runs that:

(i) An ARF uniformly applied across a catchment is capable of estimating the envelope of peak flows that would be estimated by progressively maximising the PMP spatial rainfall pattern at various locations throughout a catchment;
(ii) The adoption of an ARF based on the overall catchment area has the potential to underestimate peak flows by up to around 5% in comparison with the envelope of peak flows that would be estimated by progressively maximising the PMP spatial rainfall pattern at various locations throughout a catchment;
(iii) For the Prospect Creek catchment the effect of adopting an ARF based on the overall catchment area would be to locally underestimate the peak 100 yr ARI flood level (for a critical 9 hour storm) by up to 0.08 m.

Based on the approach adopted by the Upper Parramatta River Catchment Trust in the mid-1990s and a discussion in Book 6 or AR&R, 1999, consideration was also given to embedding design storm bursts into the observed 2001 storm. This approach was considered because of the calculated similarity of the 2 hour and 9 hour bursts within the 2001 storm to the AR&R design bursts in comparison with the temporal distribution of the 1986 and 1988 storms. It should be noted that the 2 hour design storm is critical in the very upper reaches of Prospect Creek (upstream of Widemere Road) while the 9 hour design storm is critical for the middle and lower reaches of Prospect Creek.

This approach is also considered to give a better representation of the performance of existing and any planned retarding basins ie. the approach accounts for the potential impact of antecedent rainfall and runoff on basin levels and basin storage.

The modelling approach that was adopted was to apply the calculated (overall) ARF to the AR&R design storm burst ( 20 yr ARI, 50 yr ARI and 100 yr ARI) and to then embed this areal storm burst into the 2001 storm ie. the period of time in the 2001 storm that gave the peak bust of the same duration was replaced by the areal AR&R storm burst.

For the 2,000 yr ARI and PMP storms the embedded storm approach was not adopted. Instead the PMP spatial distribution of rainfall was adopted with the spatial pattern centred on the catchment centroid.

Rainfall losses were determined using the ARBM loss model.

The “calibrated” rainfall/runoff model was then run with the various design storms to estimate the hydrographs for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods.

**HYDRAULIC ANALYSES (FLOOD LEVELS)**

1-D Hydraulics

The 1-D hydraulic modelling approach evolved from two companion assessments of Lower and Upper Prospect Creek into a single integrated model of the Prospect Creek floodplain.

The aims of the 1-D hydraulic analyses were to:

(i) Assemble a detailed 1-D floodplain model based on previous floodplain models as appropriate;
(ii) Run the 1-D floodplain model for the 1986, 1988 and 2001 floods to calibrate and verify the model as appropriate;
(iii) Run the calibrated 1-D floodplain model to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities;
(iv) Prepare plots of flood profiles for the 1986, 1988, 2001 floods and the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events;

*Historical Floods*

Models of the 1986 and 1988 floods were created as follows:

- The WILCELL model of lower Prospect Creek and the HEC-RAS model of upper Prospect Creek were uploaded into an overall XP-SWMM floodplain model;
- The previous models were connected through a link representing the Cabramatta-Granville Railway Bridge. This bridge consists of six arches, all arches were assumed to be unblocked and effective and were included in the model;
- Hassall Street and Rosford Street Basins were added to the XP-SWMM model and included the original outlets to the basins;
- Bridges at Vine Street, Fairfield Street, Regents Park-Cabramatta Railway and the Hume Highway were incorporated directly into the XP-SWMM model by creating nodes at the upstream and downstream side of these structures;
- An extra cross section was added into the upper Prospect Creek reach between the existing cross-sections U113.8 and U113.6 because the previous HEC-RAS model inadequately represented the constriction that occurs in Prospect Creek at this location. The geometry of this cross-section was derived from the upstream and downstream cross-sections as well as from aerial photography;
- Inflows for the XP-SWMM model were generated using an overall XP-RAFTS model that represents both the upper and lower Prospect Creek catchments;
- Retarding basins present at the time of the 1986 and 1988 floods were included in the XP-RAFTS model;

- Channel and overbank roughness values were guided by the 1990 and 1993 studies;
- The downstream boundary conditions used in the XP-SWMM model were obtained from the WILCELL model.

The XP-SWMM estimates for the 1986 and 1988 floods were compared with the “calibrated and verified” flood levels from the 1990 and 1993 studies. It was concluded that the XP-SWMM model gave flood estimates were equal or better agreement with the observed levels than the 1990 and 1993 studies.

The model of the 2001 flood was created as follows:

- The configurations of the Hassall Street and Rosford Street basins were changed to reflect the outlet conditions that currently exist;
- Cross-section were extended across the floodplain so extreme flood modeling could occur;
- Changes were made to the 1986 & 1988 floodplain model to represent floodplain management work carried out in Lower Prospect Creek since the early 1990s:-
- The high level floodway that was constructed in the vicinity of Justin St was included in the model from Nodes U126.0 to U124.9;
- The levee on Fairfield High School oval was included in the model. Channel modifications were also undertaken based on survey conducted supplied by Fairfield City Council in 2001;
- Retarding basins constructed in the lower Prospect Creek catchment since the early 1990s were included in the XP-RAFTS model;
- The boundary condition in Chipping Norton Lake (Node LP61) was adjusted to reflect existing conditions;
- Channel and overbank roughness values were determined iteratively to achieve the best fit to observed flood levels; and
- The downstream stage boundary conditions used in the XP-SWMM model was based on stage records at Milperra.

The XP-SWMM model was also run using the 1986 and 1988 storm rainfall to estimate the flood levels that would have occurred today if these storm events recurred under 2001 creek conditions. As expected the predicted flood levels that would have been experienced today if these storm events occurred now are higher than were experience in 1986 and 1988 notwithstanding the mitigation measures that have been completed in the intervening period.

The estimated flood profile for the 2001 flood was compared with the observed flood. It was concluded that the XP-SWMM model flood estimates were in good agreement with the observed levels.

An assessment of the impact or otherwise of the OSD tanks on the 2001 flood levels was undertaken in order to establish the need or otherwise to re-assess design flood levels with OSD tanks in place. It was concluded that the OSD tanks would have had a minor impact on the 2001 flood levels. It was considered that this is most likely due to the OSD tanks overtopping during the storm.

*Design Floods*

The "calibrated" hydraulic model was run to estimate flood discharges, flow velocities and flood profiles for the for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods. Inflow hydrographs were directly input into the hydraulic model in the form of interface files.

Plots of flood profiles were prepared for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events

An assessment of the sensitivity of design flood levels to the adoption of Areal Reduction Factors was undertaken. It was concluded that the design flood levels in upper Prospect Creek were sensitive to the adoption of Areal Reduction Factors and that this sensitivity decreased with distance down Prospect Creek.

An assessment of the impact or otherwise of the OSD tanks on the design flood levels was undertaken in order to establish the need or otherwise to re-assess design flood levels with OSD tanks in place. It was concluded that the OSD tanks would have had a minor impact on the design flood levels. It was considered that this is most likely due to the OSD tanks overtopping in the 9 hour critical duration storm ie. they are not as effective as they would be in shorter duration storms.

## 2-D Hydraulics

The aims of the 2-D hydraulic analyses were to:

(i) Assemble a detailed 2-D floodplain model based on supplied digital aerial survey, additional watercourse cross section surveyed and aerial photographs supplied by Fairfield City Council and previous 2-D floodplain DTMs as appropriate;
(ii) Run the 2-D floodplain model for the 2001 flood to obtain flood level estimates and calibrate the model as appropriate;
(iii) Run the calibrated 2-D floodplain model to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities;
(iv) Prepare final plots of flood contours for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events separately;
(v) Prepare final plots of peak velocity contours for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events separately.

*Historical Floods*

The model of the 2001 flood was created as follows:

- The MapInfo program was used as modeling pre-processor to generate the Digital Terrain Model (DTM) and other layers of spatial information required by the modelling system such as hydraulic roughness zones, road and bridge crossings and levee geometry.
- Recent airborne laser ground level survey data for the Prospect Creek floodplain was supplied by Fairfield City Council and was used to generate the model DTM for TUFLOW.

The model that was assembled extends from Widemere Road down to the confluence of the Prospect Creek and the Georges River;

- The Prospect Creek watercourse and all crossings were modeled using embedded 1-D elements. Fairfield City Council surveyed 131 channel sections located at approximately 80 m intervals. This channel survey extended from the Hume Highway up to the outlet of the Rosford Street Basin;
- Channel and overbank roughness values were determined iteratively to achieve the best fit to observed flood levels; and
- The downstream stage boundary conditions used in the TUFLOW model was based on stage records at Milperra.

The Surface Water Modelling System (SMS) was also used as the post-processor to generate result plots of estimated flood levels, flow velocities, flood level differences and flood hazard maps.

The estimated flood profile for the 2001 flood was compared with the observed flood. It was concluded that the TUFLOW model flood estimates were in good agreement with the observed levels.

An analysis of the differences between the observed and predicted 2001 flood levels for the XP-SWMM and TUFLOW models was undertaken. This comparison disclosed that:

(i) The 1-D and 2-D floodplain models give similar levels of accuracy in predicted flood levels;
(ii) The trend in flood level differences was similar ie. both models gave similar high or low estimates in comparison with the same observed level.

It was also of interest to note that the TUFLOW results were based on an areal distribution of floodplain roughness that differed from the single roughness values adopted for the left and right floodplains in XP-SWMM.

It was concluded that the 2001 flood levels predicted by the TUFLOW model were in as good agreement with the observed levels as was achieved by the XP-SWMM model.

*Design Floods*

Two TUFLOW models were assembled for design floods.

The first was all design floods from 20 yr ARI up to the 2,000 yr ARI storm. The second model was for the PMP storm. The only difference between the two models was the 2-D grid spacing for the floodplains. The first model was based on a 10 m x 10 m grid spacing while the second model was based on a 20 m x 20 m grid. The change in grid spacing was needed to accommodate the increased extent of the floodplain subject to inundation in a PMP storm.

The "calibrated" hydraulic models were run to estimate flood discharges, flow velocities and flood levels for the for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods. Inflow hydrographs were directly input into the hydraulic model in the form of interface files.

Plots of flood contours and velocity fields were prepared for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMP flood.

An analysis of the differences between the XP-SWMM and TUFLOW design flood level estimates was undertaken. It was noted that:

(i) The TUFLOW flood level estimates in the Hassall Street Basin are typically lower than the XP-SWMM flood level estimates;
(ii) The best agreement between the 1-D and 2-D floodplain model results was achieved in the 100 yr ARI flood; and
(iii) The TUFLOW model gave on average higher flood levels than the XP-SWMM model for floods up to the 100 yr ARI flood while in extreme floods it gave on average lower flood levels than the XP-SWMM model. This was attributed to the 2-D model including breakouts from Prospect Creek that were not included in the 1-D floodplain model due to the limited floodplain survey an which to base the 1-D model.

The differences between the 100 yr flood extent as defined by the 2-D results in comparison with previous preliminary manual mapping of the 1-D results included:

(i) A greater identified flood extent in Rosford Basin;
(ii) A breakout from Prospect Creek that inundates Victoria Street;
(iii) More complex inundation in the Granville Street area;
(iv) Less inundation of the Fairfield High School site than previously estimated;
(v) A breakout to the west of The Horsley Drive that overtops the railway line;
(vi) Greater extent of inundation in the Vincent Crescent area;
(vii) Greater extent of inundation in the Ramsay St area (as previously identified in the Carrawood Park investigations).

It was concluded that the flood levels and velocities predicted by the TUFLOW model were suitable for the identification and mapping of interim Flood Risk Management zones based on Fairfield City Council's adopted risk management zone definitions.

**FLOOD RISK**

Flood risk maps have prepared using the results of the 2-D hydraulic modelling of the 100 yr ARI and PMP floods in accordance with Council's adopted flood risk definitions, namely:

*High risk zone*: corresponds to the area of high hazard in the 100 yr ARI flood;

*Medium risk zone*: extends from the High Risk zone, out to the extent of the 100 yr ARI flood; and

*Low risk zone*: extends from the Medium Risk zone out to the extent of the PMF.

The flood risk has been mapped between the Hume Highway and Widemere Road.

## ACCURACY OF THE RESULTS

It is important to recognise that any modelling studies provide only an estimate of the predicted flood levels. Although these estimates are based on the best data available at the time of writing, new data obtained in the future may lead to a revision of the estimates.

The error margin in this study is regarded as moderate due to:

(i) The limited historical rainfall and flood level data;
(ii) Calibration and verification of both hydrological and hydraulic models primarily to the 2001 flood with checking against the 1986 and 1988 only;
(iii) The model parameters are generally typical of values adopted for other flood studies.

The estimated accuracy of the flood levels is ±0.25 m.

## COMMUNITY CONSULTATION

Extensive community consultation has always been a feature of any floodplain planning process and this is the focus of this brief. It is particularly important that all stakeholders and in particular those owners and occupiers who live within the floodplain have input into the development of the Floodplain Risk Management Study and the Floodplain Risk Management Plan.

The new floodplain manual states that the community as a whole should be involved in the formulation and development of these plans. Community consultation is a necessary element of the floodplain risk management process. To conform to the principles of the manual, it is necessary that Council actively involve representatives of the community, particularly owners and occupiers of flood prone land.

Three community consultation workshops were held in November 2002 to inform the owners and occupiers of flood prone land about the implications and consequences of the new State Government Floodplain Management Manual and the current review of the flood study.

# 1 INTRODUCTION

Prospect Creek rises downstream of the Prospect Reservoir and flows into the Georges River, which discharges into Botany Bay. The creek forms the eastern boundary between Fairfield City Council and Holroyd Council with additional parts of the catchment in Bankstown, Blacktown, and Liverpool Councils. The catchment is highly urbanised with a variety of land uses, which include residential, industrial, open space and water bodies. The catchment area is approximately 100 $km^2$.

In 1990 a Floodplain Management Study for Lower Prospect Creek was released. The reach of Prospect Creek that was investigated in detail was downstream of the Cabramatta-Granville Railway Line to the confluence with the Georges River. The study investigated major historical floods in August 1986 and April-May 1988, calculated design flood levels, assessed a range of floodplain management actions and measures and recommended a program of works.

In 1993, a Floodplain Management Study for Upper Prospect Creek was also released. The reach of Prospect Creek that was investigated in detail was downstream of the Rosford Street Basin to the Cabramatta-Granville Railway Line. This study also investigated major historical floods in August 1986 and April-May 1988, calculated design flood levels, assessed a range of floodplain management actions and measures and recommended a program of works.

**THE NEED FOR THE STUDY**

Since 1993 Council has implemented progressively a number of recommended flood mitigation works in upper and lower Prospect Creek. These works have included:

- Hassall Street Retarding Basin modifications;
- Rosford Street Retarding Basin outlet modifications;
- Construction of a high level floodway upstream of Smithfield Road instead of stream clearing;
- Stream Clearing between Little Street and Smithfield Road; at and immediately downstream of Smithfield Road (Kenyons Bridge), upstream of North Fairfield Road and opposite Ace Avenue.
- Orphan School Creek channel improvements;
- Construction of a high level bridge at Vine St with associated channel widening;
- Burns Creek improvements;
- Construction of the Ramsay Avenue deflector levee.

Council has also been actively implementing a program of voluntary purchase or house raising on nominated properties in lower Prospect Creek.

While Council has been progressively implementing strategies recommended in the plan, it has been 10 years since the studies were carried out. Council therefore commissioned this review.

Council commissioned a review of flood levels in Prospect Creek as the first stage in its review of the Floodplain Management Plans that it adopted in 1990 and 1993 as recommended in the 2001 NSW Floodplain Management Manual.

This review will ensure that Council is in compliance with the current NSW Government's Flood Policy. And will also provide a basis for sound management of land within the Prospect Creek catchment and its floodplain. The review will update existing information about flood levels, and ensure that Councils flood management policies are consistent with current legislation and best practice in relation to floodplain management.

**OBJECTIVES**

The primary objective of the study was to define the flood behaviour of Prospect Creek under current conditions. The study was to produce information on flood levels, flood velocities and flows for a full range of flood events under existing catchment and floodplain conditions. The events of interest included the historical floods in 1986, 1988 and 2001 and the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and Probable Maximum Flood (PMF).

This study will form the basis for a subsequent review of the existing Floodplain Management Plans where a detailed assessment of additional flood mitigation measures and floodplain management actions will be undertaken.

**WHAT IS IN THIS STUDY**

This study reviews the available information on historical flooding in Prospect Creek and outlines the flood threat.

Drawing on the available information, hydrological assessments of the flood flows generated by storms that have occurred previously and may occur in the future in the Prospect Creek catchment are described.

In turn estimated historical and "design" flood flows have been converted into flood levels within the study area through hydraulic (flood level) modelling.

The results of this study are presented in the form of tabulated flood levels and flood profiles, flood level contours and flood velocity fields.

Provisional flood risk management zones for the Prospect Creek floodplain from Widemere Road down to the Hume Highway are also presented.

# 2 BACKGROUND

**THE STUDY AREA**

The overall study area is the catchment of Prospect Creek. It comprises the catchments of Prospect Creek and its tributaries between Widemere Road, Wetherill Park and the Georges River at Lansvale. Major proportions of the flood affected areas on both sides of Prospect Creek are urban residential and/or industrial and include parts of Lansvale, Canley Vale, Carramar, Fairfield, Smithfield, Wetherill Park and Greystanes. The Prospect Creek catchment is identified in **Figure 1**.

The overall Prospect Creek catchment area upstream of the Georges River confluence is 98 km2. The headwaters rise at Prospect Reservoir and drain into the Georges River at Chipping Norton. The two principal watercourses are Prospect Creek and Orphan School Creek, which join approximately 1 km downstream of the Granville railway line. Upstream of the confluence, Burns Creek is a major tributary of Prospect Creek and St Elmo's Drain contributes flow to Orphan School Creek. Downstream of the Orphan School Creek confluence the only named tributary to Prospect Creek is Long Creek. In the southern part lower Prospect Creek and upper reaches of Prospect Creek there are only relatively small watercourses, mostly piped, which drain into Prospect Creek.

The catchment topography ranges from undulating land with steep-sided gullies in the northern parts to mangrove flats beside the lower reaches of Prospect Creek. The catchment is highly urbanised and is one of the larger urban catchments in Australia.

**FLOOD HISTORY**

Flood producing storms in and around the catchment have been recorded at all times of the year and show no significant seasonal trend. Historical floods have resulted from major storms over the Sydney region with daily rainfalls of 100 mm to 300 mm. These flood producing rainfalls have sometimes persisted for up to five days, for example in April 1988.

The flood history of the study area is closely related to flooding in the Georges River. Prior to 1986, significant flooding occurred along the Georges River in February 1956, with lesser floods in 1950, 1961, 1963, 1964 and 1978. Some data on these floods is presented in PWD, 1991.

More recent major flooding occurred along Prospect Creek in August 1986 (refer **Plates 1** and **2**), April-May 1988 and most recently in January 2001. The 1986 and 1988 floods caused serious financial losses and hardship to a large number of families and businesses in the study area. The effects of the 1986 flood are documented in Lustig et al, 1988. Analyses of flood damages in the study area are given in Willing & Partners, 1990, 1993. The 1986 and 1988 floods produced strong community pressure for measures to mitigate flooding in Prospect Creek.

**Plate 1  View of Lansvale Peninsula during the August 1986 Flood**

**Plate 2  View of Knight Street, Lansvale during the August 1986 Flood**


**Plate 3   Widemere Road - 30 January 2001**


**Plate 4 Cumberland Highway Crossing (Kenyons Bridge) - 30 January 2001**


**Plate 5 Intersection of Dursley Rd & Railway Parade - 30 January 2001**

On 30-31 January 2001 the most significant flood since 1988 occurred along the upper reaches of Prospect Creek (refer **Plates 3, 4** and **5**). The flooding experienced by a number of landowners in the upper reaches Prospect Creek was unexpected and this led to a review of the estimated flood levels in upper Prospect Creek. This flood provided valuable information about flood behaviour under existing conditions of catchment development including mitigation measures already in place and of creek condition.

## HOW THIS STUDY WAS UNDERTAKEN

This study evolved from two companion assessments of Lower and Upper Prospect Creek into a single integrated assessment of the Prospect Creek floodplain.

The review commenced in July 2000 prior to the flood on 30-31 January 2001. This flood provided valuable information about flood behaviour under existing conditions of catchment development including mitigation measures already in place and of creek condition. This flood also influenced directly the scope and direction of the study from February 2001 onwards.

From mid-2001 to mid-2003 the approach to modeling of the Prospect Creek floodplain was a single XP-SWMM floodplain model that was 1-D in upper Prospect Creek and quasi 2-D in lower Prospect

Creek. In mid-2003 Council commissioned aerial laser survey of the Fairfield LGA. This provided a valuable new resource of surveyed ground levels across the floodplain at a high density.

An initial comparison of typical cross sections in the XP-SWMM 1-D floodplain model with sections extracted from Council's digital aerial survey disclosed differences of up to 1.0 m between the cross sections in the XP-SWMM floodplain model and extracted cross sections. This was of concern because of the ramifications for defining the extent of the floodplain by identifying the extent of inundation in a PMP flood (PMF).

To gain maximum value from the aerial laser survey Council commissioned the creation of a new 2-D floodplain model for the Prospect Creek floodplain extending from the confluence of the Georges River upstream to Widemere Road. The new 2-D floodplain model was calibrated against the observed 2001 flood levels and was then used to estimate to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities.

The various stages of the study that evolved from July 2000 to June 2004 are summarized as follows:

July 2000

In July 2000 Fairfield City Council commissioned an assessment of the effectiveness of the flood mitigation works it had completed in the upper reach of Prospect Creek. The assessment encompassed:

- A review of RAFTS catchment model assembled previously in 1990 and modified in 1993;
- An assessment of the Hassall Street Basin and Rosford Street Basin works;
- A review flood levels in Upper Prospect Creek for 20 yr ARI, 50 yr ARI and 100 yr ARI floods using the HEC-RAS flood profile model;
- An assessment of Waterway Improvement Works;
- An assessment of catchment flooding in PMF and an intermediate Extreme Floods
- Flood Mapping
- Reporting

The 1993 HEC-2 model was uploaded into HEC-RAS and was extended from the outlet of Rosford Street Basin back upstream to Widemere Road. In addition cross sections were extended to include the estimated lateral extent of the PMP flood. The cross sections were extended using available orthophotomaps and additional plans provided by Council both at 2 metre contour intervals.

The HEC-RAS was initially re-run using the peak flows adopted in the 1993 study. This was done to ensure that any differences in estimated flood levels attributable to differences in the models could be allowed for when comparing flood levels before and after implementation of the various floodplain management measures. After “fine-tuning” of model parameters the differences in the 100 yr ARI flood levels previously reported in 1993 and those estimated using the “calibrated” HEC-RAS model were less than 0.03 m at all cross sections.

The calibrated HEC-RAS model was then used to estimate the flood levels for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and the PMP flood (PMF).

### January 2001

On 30-31 January 2001 the most significant flood since 1988 occurred along the upper reaches of Prospect Creek. Rainfall data and flood levels observed during this flood are presented in **Appendix A**.

The flooding experienced by a number of landowners in the upper reaches Prospect Creek was unexpected and this led to a review of the flood levels in upper Prospect Creek estimated using the HEC-RAS floodplain model.

### May 2001

In May 2001 Council commissioned an extension of the assessment of flooding in upper Prospect Creek. The aim of this additional modelling was to undertake hydrological and hydraulic modelling of the flood that occurred on 30-31 January 2001. In view of the availability of new information on Prospect Reservoir and an additional subcatchment to the north of the Sydney Water canal it was envisaged that the hydrological model would need to be updated to provide new estimates of the design flood flows. It was therefore also expected to be necessary to re-run the design floods that had been recently modelled irrespective of any re-calibration of models that may be undertaken to replicate as best possible the January 2001 flood.

This additional modelling encompassed:

- Hydrological modelling of the January 2001 flood
- Hydraulic modelling of the January 2001 flood (using HEC-RAS)
- Map the extent of the January 2001 flood
- Reporting
- Re-runs of Design Models

In May 2001 Fairfield City Council also commissioned a companion assessment to update the lower Prospect Creek hydrological and hydraulic models and to undertake additional modelling of the 2001 flood and design flood events. This assessment encompassed:

Phase 1 – Investigation of January 2001 Flood

- Updating the XP-RAFTS catchment model
- Hydrological modelling of the January 2001 flood
- Establishment of a new XP-SWMM floodplain model
- Hydraulic modelling of the January 2001 flood
- Mapping the extent of the January 2001 flood
- Phase 1 Reporting

Phase 2 – Assessment of Design and Extreme Floods

- Hydrological modelling of Design and Extreme floods
- Hydraulic modelling of Design and Extreme floods
- Mapping the extent of the Design and Extreme Floods
- Phase 2 Reporting

October 2001

The two assessments provided an opportunity to create a single 1-D floodplain model based on the hydraulic models of the upper and lower reaches of Prospect Creek. Consequently a single XP-SWMM floodplain model was assembled extending from the confluence of the Georges River upstream to Widemere Road.

The hydraulic model cross-sections and roughness definitions were also updated to reflect both changes in urbanization since or even before the 1993 study as well as the flood mitigation works that Fairfield City Council and Holroyd Council subsequently implemented.

The XP-SWMM model was "calibrated" against the surveyed debris marks from the 2001 flood and other observations during the January 2001 event. The preliminary results of this study were contained in a draft report entitled Prospect Creek – Analysis of January 2001 Flood dated October 2001.

November 2001

Using the XP-SWMM model calibrated against the 2001 flood, the design flood levels in Prospect Creek were re-estimated. It was found that design flood levels in upper Prospect Creek were higher than the design flood levels estimated in 1993 notwithstanding the completion of recommended modifications to the Hassall Street and Rosford Street basins. These increases were attributed to the re-calibration of the XP-SWMM model to match the January 2001 flood levels and an interpretation of the January 2001 flood levels in comparison with the 1986 and 1988 flood levels, namely that Prospect Creek appears to have become "rougher" over the last 10-12 years.

In order to confirm or otherwise whether this interpretation is correct Council commissioned a further reassessment of creek and floodplain roughness values in the latest XP-SWMM model and other sensitivity runs.

January 2002

In January 2002 a peer review was initiated to investigate the most probable causes for the apparent changes in the estimated 100 yr ARI flood levels taking into account any changes in floodplain topography since the 1990 and 1993 studies, constructed flood mitigation works and the more recent calibration using the 2001 flood data.

It was concluded from a detailed examination of the supplied data and ultimately of the computer models themselves that the primary reason for the differences in estimated 100 yr ARI flood levels is the change in modelling approach between the 1993 and 2001 studies.

It was recommended that Council give consideration to undertaking the following further work to resolve the apparent differences in estimated 100 yr ARI flood levels:

(i) Re-calibrate the XP-RAFTS model for 1986 and 1988 events (when Smithfield Gauge was in operation) for appropriate Muskingum-Cunge channel parameters and modified subcatchment roughness values. This would mean changing reach slopes in the Muskingum-Cunge channel routing data to m/m and lowering subcatchment roughness values (to say 0.025 for pervious areas. and 0.015 for impervious) as appropriate;
(ii) Create an XP-SWMM model of Prospect Creek based on the condition of upper Prospect Creek in 1991-1993 and calibrate the model to the observed 1986 and 1988 flood levels;
(iii) Upload the new calibration parameters into the 2001 XP-RAFTS model and re-run;
(iv) Input the new XP-RAFTS inflows for the 2001 flood into the current XP-SWMM model and re-calibrate against the observed 2001 flood levels/debris marks as appropriate; and
(v) Using the adjusted XP-RAFTS and XP-SWMM models run the 100 yr ARI design storm and compare with the 1993 100 yr ARI flood levels.

This additional modelling was commissioned by Council in March 2002.

February 2003

In November 2002 Holroyd Council provided initial information on On-Site Detention (OSD) tanks installed within the Holroyd LGA and the Prospect Creek catchment. Holroyd Council subsequently updated its records and provided updated information in January 2003.

The OSD information from Holroyd Council changed the initial view of the situation that existed during the January 2001 flood. The updated data suggested that far more OSD had been implemented than first appeared to be the case.

Council commissioned an assessment of the impact or otherwise of the OSD tanks on the 2001 flood levels in order to establish the need or otherwise to re-assess design flood levels with OSD tanks in place.

September 2003

In mid-2003 Council commissioned aerial laser survey of the Fairfield LGA. This provided a valuable new resource of surveyed ground levels across the floodplain at a high density. An initial comparison of typical cross sections in the XP-SWMM floodplain model with sections extracted from Council's digital aerial survey disclosed differences of up to 1.0 m between the cross sections in the XP-SWMM floodplain model and extracted cross sections.

This was of concern because of the ramifications for defining the extent of the floodplain by identifying the extent of inundation in a PMP flood (PMF).

To gain maximum value from the aerial laser survey Council commissioned the creation of a new 2-D floodplain model for the Prospect Creek floodplain extending from the confluence of the Georges River upstream to Widemere Road. The new 2-D floodplain model was calibrated against the observed 2001 flood levels and this model was then used to estimate to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities. The 2-D modelling results were also used to prepare final plots of flood contours for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events separately as well as plots of velocity fields in each design flood.

# 3 AVAILABLE INFORMATION

**PREVIOUS STUDIES**

The following study reports and/or extracts from reports were reviewed:


Cardno Willing (NSW) Pty Ltd (2001) “Fairfield Park Floodway Flood Impact Assessment”, *Final Report*, prepared for Fairfield City Council, September, 13 pp.

Cardno Willing (NSW) Pty Ltd (2002) “Fairfield Park Floodway Flood Impact Assessment”, *Supplementary Report*, prepared for Fairfield City Council, August, 8 pp.

Cardno Willing (NSW) (2004a) “Carrawood Park Deflector Levee Hydraulic Investigations & Concept Plan”, Final Report, March, 22 pp.

Cardno Willing (NSW) (2004b) “Carrawood Park Deflector Levee Hydraulic Investigations & Concept Plan”, Final Supplementary Report, March, 22 pp.

Dalland & Lucas (1990a) "Upper Prospect Creek Flood Study", *Final Report*, (unreleased).

Dalland & Lucas (1990b) "Report on Site Investigation, Survey and Stability Analysis for Prospect Creek Embankment at 26 Bell Crescent, Fairfield", (unreleased).

Lustig, T.L., Handmer, J.W., Smith, D.I., and Greenaway, M.A. (1988) "*The Sydney Floods of August 1986*", 2 Vols,. Canberra, CRES, ANU.

Public Works Department (1991) 'Georges River Flood Study', *PWD Report No. 91066*, December.

SMEC & Sinclair Knight Partners (1985) - "Fairfield Flood Mitigation Study", *Final Report*, for Fairfield City Council, 2 Vols.

Willing & Partners (1990) "Lower Prospect Creek Floodplain Management Study", *Final Report*, 2 Vols, prepared in association with the Centre for Resource & Environmental Studies, May, 35 pp.

Willing & Partners (1993) "Upper Prospect Creek Floodplain Management Study", *Final Report*, 2 Vols, September, 80 pp.

Willing & Partners (NSW) Pty Ltd (2000) “Flood Impact Assessment of Lansvale Factory Units”, *Final Report*, May, 20 pp.

Willing & Partners Pty Ltd (1996) "Carrawood Park Deflector Levee, Carramar", *Preliminary Concept - Options Report*, prepared in association with Clouston, April.

Willing & Partners Pty Ltd (1997) “Vanmeld Pty Ltd and John Anthony Jeans ats Fairfield City Council in the Land and Environment Court NSW No 55080 of 1994”, *Statement of Evidence*, prepared by Dr Brett C. Phillips, June, Willing & Partners Pty Ltd (1998) “Vanmeld Pty Ltd and John Anthony Jeans ats Fairfield City Council in the Land and Environment Court NSW No 55080 of 1994”, *Supplementary Statement of Evidence No. 1*, prepared by Dr Brett C. Phillips, July, 4 pp.

Willing & Partners Pty Ltd (1998) “Vanmeld Pty Ltd and John Anthony Jeans ats Fairfield City Council in the Land and Environment Court NSW No 55080 of 1994”, *Supplementary Statement of Evidence No. 2*, prepared by Dr Brett C. Phillips, November, 4 pp.

Willing & Partners Pty Ltd (1998) “Vanmeld Pty Ltd and John Anthony Jeans ats Fairfield City Council in the Land and Environment Court NSW No 55080 of 1994”, *Supplementary Statement of Evidence No. 3*, prepared by Dr Brett C. Phillips, November, 1 pp.

Each of these reports is summarised in **Appendix A.1**.

**MAPS AND PLANS**

The current study was initially based on the outcomes of the 1990, 1993 and 1997 studies and the information on which those studies were based. Further information was collected during this study to assist the hydrological and hydraulic analyses.

This information is summarized in **Appendix A.2**.

**SURVEY**

Additional survey was provided by Council at different times during the study. This survey included but was not limited to:

- “As constructed” survey for the floodway upstream of Little Street,
- aerial laser survey of the whole city. Relevant information was subsequent imported into MapInfo to create a Digital Elevation Model (DEM) of the Prospect Creek catchment; and
- 131 channel sections located at approximately 80 m intervals. This channel survey extended from the Hume Highway up to the outlet of the Rosford Street Basin.

All levels in this report are expressed in metric units to Australian Height Datum (AHD).

**RAINFALL DATA**

Historical rainfall data used in this study were supplied by several authorities including the Bureau of Meteorology and Sydney Water Corporation. This included rainfall records for the August 1986, April 1988 and January 2001 storms at a number of pluviograph stations.

An analysis of the severity of each historical storm is presented in **Appendix A**. The storm severity was assessed using two criteria, namely, the storm burst rainfall depth (in mm) and the storm burst temporal variation.

As discussed in **Appendix A**, these rainfall bursts were also compared with the design rainfall bursts calculated in accordance with the procedures given in Book 2 of Australian Rainfall and Runoff (IEAust., 1998). Two design rainfall bursts were calculated. The first was the point rainfall bursts of selected durations while the second was the areal rainfall bursts.

It was concluded that the storm burst depths were more severe in the August 1986 and April 1988 storms than the storm burst depths for the January 2001 storm. However, it was found that the 9 hour storm burst temporal pattern in the northern region of the catchment was very similar to the 100 yr ARI design storm burst. It should be noted that the assessed critical duration storm burst for the Prospect Creek catchment downstream of Widemere Road is 9 hours. It is therefore considered that the flooding that was experienced in the upper Prospect Creek in January 2001 was greatly influenced by the storm burst temporal pattern.

Rainfall intensities and temporal patterns for the synthetic design storms were derived in accordance with the procedures given in Book 2 of Australian Rainfall and Runoff (IEAust., 1998).

**OTHER DATA**

Other data included but was not limited to photographs and field notes taken during reconnaissance work to verify ground conditions, creek crossings, and the extent, density and type of vegetation beneath the tree canopy. This information together with the aerial photography was used to assist the estimation of surface roughness for use in the hydraulic model. Particular reference was made to clearing and bush re-generation work undertaken by Fairfield City Council since 1993.

**OBSERVED FLOOD LEVELS**

Where feasible, flood marks were surveyed to provide further information on flood levels during historical floods. The flood marks that were recorded by Council staff and others and subsequently surveyed by Council are summarized in **Appendix A**. These included observed flood levels for the August 1986, April 1988 and January 2001.

A number of photographs of the January 2001 flood were also taken by Council officers and others. These are presented in **Plates A.1** to **A.23**. It should be noted that these photographs were taken at different times of the day and typically do not correspond to the peak of the flood.

# 4 HYDROLOGY (FLOOD FLOWS)

The aims of the hydrological analyses were to:

(i) Assemble a detailed overall catchment rainfall/runoff model initially based on the RAFTS models assembled during the previous 1990 and 1993 studies;
(ii) Calibrate and verify the catchment model against available gauged flows in the August 1986, April 1988 and January 2001 floods;
(iii) Estimate flood hydrographs at key locations within the Prospect Creek catchments for the August 1986, April 1988 and January 2001 floods storms based on catchment land uses at the time of each flood. The peak flows were in turn input into the hydraulic model(s) of Prospect Creek to provide estimates of historical flood levels; and
(iv) Estimate flood hydrographs at key locations within the Prospect Creek catchments for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP design storms under existing conditions ie. with the various structural flood mitigation measures completed by Fairfield City Council by 2003. The peak flows were in turn input into the hydraulic models of Prospect Creek to provide estimates of design flood levels.

Complete flow hydrographs are required as input for hydraulic models to represent actual flood behaviour. The model selected was the widely used rainfall-runoff flood routing model, XP-RAFTS.

The XP-RAFTS model and the modeling approach are described in **Appendix B**.

**HISTORICAL FLOODS**

The calibration and verification of the XP-RAFTS model is described in **Appendix B** and is summarized as follows.

The calibration and verification of the 1993 RAFTS model of the upper Prospect Creek catchment was based on two gauged floods that occurred in August 1986 and April 1988. The aim was to achieve the best agreement with the observed 1988 flood at the Smithfield Road gauging station by adjusting the ARBM loss model parameters. The model was then verified against the gauged hydrograph for the 1986 flood. The same approach was followed for the re-calibration and verification of the new XP-RAFTS model. It was concluded that the agreement achieved for the 1986 flood was good and for the 1988 flood was excellent.

Following the re-calibration of the XP-RAFTS model against the 1988 and 1986 floods a further indirect verification of the model was made using data for the January 2001 flood.

The only gauged hydrograph available for the January 2001 flood was on Orphan School Creek, a tributary of Prospect Creek. All other remaining flood height data comprised peak flood levels as represented by debris marks that were marked several days after the flood and subsequently surveyed and supplemented by a limited number of resident interviews.

It was concluded that the agreement between modelled and observed flows for the January 2001 flood on Orphan School Creek was good.

**DESIGN FLOODS**

The estimation of the design flood hydrographs using the calibrated XP-RAFTS model is described in **Appendix B** and is summarized as follows.

Prior to estimating the design flood hydrographs the approach to be adopted for creating the design storms needed to be resolved.

The 1999 revised Book 6 of Australian Rainfall & Runoff (AR&R) recommends that areal reduction factors (ARFs) be applied to point rainfall estimates calculated in accordance with Book 2 of AR&R. For storm durations less than 18 hours, AR&R Book 6 recommends calculating ARFs using a relationship that is a function only of catchment area and storm duration ie. it is not dependent on ARI. This suggests that conceptually a unique ARF should be calculated at each subcatchment outlet (node) or other location based on the upstream area of a catchment discharging runoff to any given location.

The consequence of this approach would be that peak flows at each location within a catchment would have to be individually calculated at each location using unique ARFs. This approach poses a significant problem when inputting local hydrographs into a hydraulic model for flood routing and flood level estimation purposes ie. it will not achieve flow continuity (similar to the conceptual problems encountered when undertaking hydraulic analysis using Rational formula flows).

To avoid the conceptual problems posed by the above approach two alternative approaches were tested as follows:

(i) Uniform distribution of the ARF (and resulting rainfall) across the overall catchment; or
(ii) Spatial distribution of the ARF based on the spatial distribution of PMPs ie. ellipses of defined areas.

It was concluded from nineteen (19) sensitivity runs that:

(i) An ARF uniformly applied across a catchment is capable of estimating the envelope of peak flows that would be estimated by progressively maximising the PMP spatial rainfall pattern at various locations throughout a catchment;
(ii) The adoption of an ARF based on the overall catchment area has the potential to underestimate peak flows by up to around 5% in comparison with the envelope of peak flows that would be estimated by progressively maximising the PMP spatial rainfall pattern at various locations throughout a catchment;

(iii) For the Prospect Creek catchment the effect of adopting an ARF based on the overall catchment area would be to locally underestimate the peak 100 yr ARI flood level (for a critical 9 hour storm) by up to 0.08 m.

Based on the approach adopted by the Upper Parramatta River Catchment Trust in the mid-1990s and a discussion in Book 6 or AR&R, 1999, consideration was also given to embedding design storm bursts into the observed 2001 storm. This approach was considered because of the calculated similarity of the 2 hour and 9 hour bursts within the 2001 storm to the AR&R design bursts in comparison with the temporal distribution of the 1986 and 1988 storms. It should be noted that the 2 hour design storm is critical in the very upper reaches of Prospect Creek (upstream of Widemere Road) while the 9 hour design storm is critical for the middle and lower reaches of Prospect Creek.

This approach is also considered to give a better representation of the performance of existing and any planned retarding basins ie. the approach accounts for the potential impact of antecedent rainfall and runoff on basin levels and basin storage.

The modelling approach that was adopted was to apply the calculated (overall) ARF to the AR&R design storm burst ( 20 yr ARI, 50 yr ARI and 100 yr ARI) and to then embed this areal storm burst into the 2001 storm ie. the period of time in the 2001 storm that gave the peak bust of the same duration was replaced by the areal AR&R storm burst.

For the 2,000 yr ARI and PMP storms the embedded storm approach was not adopted. Instead the PMP spatial distribution of rainfall was adopted with the spatial pattern centred on the catchment centroid.

Rainfall losses were determined using the ARBM loss model.

The “calibrated” rainfall/runoff model was then run with the various design storms to estimate the hydrographs for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods.

# 5 HYDRAULIC ANALYSES (FLOOD LEVELS)

### 1-D HYDRAULICS

The 1-D hydraulic modelling approach evolved from two companion assessments of Lower and Upper Prospect Creek into a single integrated model of the Prospect Creek floodplain.

The aims of the 1-D hydraulic analyses were to:

(i) Assemble a detailed 1-D floodplain model based on previous floodplain models as appropriate;
(ii) Run the 1-D floodplain model for the 1986, 1988 and 2001 floods to calibrate and verify the model as appropriate;
(iii) Run the calibrated 1-D floodplain model to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities;
(iv) Prepare plots of flood profiles for the 1986, 1988, 2001 floods and the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events;

The creation and calibration of the 1-D floodplain (hydraulic) model(s) is described in **Appendix C** and is summarized as follows.

#### Historical Floods

Models of the 1986 and 1988 floods were created as follows:

- The WILCELL model of lower Prospect Creek and the HEC-RAS model of upper Prospect Creek were uploaded into an overall XP-SWMM floodplain model;
- The previous models were connected through a link representing the Cabramatta-Granville Railway Bridge. This bridge consists of six arches, all arches were assumed to be unblocked and effective and were included in the model;
- Hassall Street and Rosford Street Basins were added to the XP-SWMM model and included the original outlets to the basins;
- Bridges at Vine Street, Fairfield Street, Regents Park-Cabramatta Railway and the Hume Highway were incorporated directly into the XP-SWMM model by creating nodes at the upstream and downstream side of these structures;

- An extra cross section was added into the upper Prospect Creek reach between the existing cross-sections U113.8 and U113.6 because the previous HEC-RAS model inadequately represented the constriction that occurs in Prospect Creek at this location. The geometry of this cross-section was derived from the upstream and downstream cross-sections as well as from aerial photography;
- Inflows for the XP-SWMM model were generated using an overall XP-RAFTS model that represents both the upper and lower Prospect Creek catchments;
- Retarding basins present at the time of the 1986 and 1988 floods were included in the XP-RAFTS model;
- Channel and overbank roughness values were guided by the 1990 and 1993 studies;
- The downstream boundary conditions used in the XP-SWMM model were obtained from the WILCELL model.

The XP-SWMM estimates for the 1986 and 1988 floods were compared with the “calibrated and verified” flood levels from the 1990 and 1993 studies. It was concluded that the XP-SWMM model gave flood estimates were equal or better agreement with the observed levels than the 1990 and 1993 studies.

The model of the 2001 flood was created as follows:

- The configurations of the Hassall Street and Rosford Street basins were changed to reflect the outlet conditions that currently exist;
- Cross-section were extended across the floodplain so extreme flood modeling could occur;
- Changes were made to the 1986 & 1988 floodplain model to represent floodplain management work carried out in Lower Prospect Creek since the early 1990s:-
- The high level floodway that was constructed in the vicinity of Justin St was included in the model from Nodes U126.0 to U124.9;
- The levee on Fairfield High School oval was included in the model. Channel modifications were also undertaken based on survey conducted supplied by Fairfield City Council in 2001;
- Retarding basins constructed in the lower Prospect Creek catchment since the early 1990s were included in the XP-RAFTS model;
- The boundary condition in Chipping Norton Lake (Node LP61) was adjusted to reflect existing conditions;
- Channel and overbank roughness values were determined iteratively to achieve the best fit to observed flood levels; and
- The downstream stage boundary conditions used in the XP-SWMM model was based on stage records at Milperra.

The XP-SWMM model was also run using the 1986 and 1988 storm rainfall to estimate the flood levels that would have occurred today if these storm events recurred under 2001 creek conditions. As expected the predicted flood levels that would have been experienced today if these storm events occurred now are higher than were experience in 1986 and 1988 notwithstanding the mitigation measures that have been completed in the intervening period.

The estimated flood profile for the 2001 flood was compared with the observed flood. It was concluded that the XP-SWMM model flood estimates were in good agreement with the observed levels.

An assessment of the impact or otherwise of the OSD tanks on the 2001 flood levels was undertaken in order to establish the need or otherwise to re-assess design flood levels with OSD tanks in place. It was concluded that the OSD tanks would have had a minor impact on the 2001 flood levels. It was considered that this is most likely due to the OSD tanks overtopping during the storm.

Design Floods

The "calibrated" hydraulic model was run to estimate flood discharges, flow velocities and flood profiles for the for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods. Inflow hydrographs were directly input into the hydraulic model in the form of interface files.

Plots of flood profiles were prepared for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events

An assessment of the sensitivity of design flood levels to the adoption of Areal Reduction Factors was undertaken. It was concluded that the design flood levels in upper Prospect Creek were sensitive to the adoption of Areal Reduction Factors and that this sensitivity decreased with distance down Prospect Creek.

An assessment of the impact or otherwise of the OSD tanks on the design flood levels was undertaken in order to establish the need or otherwise to re-assess design flood levels with OSD tanks in place. It was concluded that the OSD tanks would have had a minor impact on the design flood levels. It was considered that this is most likely due to the OSD tanks overtopping in the 9 hour critical duration storm ie. they are not as effective as they would be in shorter duration storms.

**2-D HYDRAULICS**

The aims of the 2-D hydraulic analyses were to:

(vi) Assemble a detailed 2-D floodplain model based on supplied digital aerial survey, additional watercourse cross section surveyed and aerial photographs supplied by Fairfield City Council and previous 2-D floodplain DTMs as appropriate;
(vii) Run the 2-D floodplain model for the 2001 flood to obtain flood level estimates and calibrate the model as appropriate;
(viii) Run the calibrated 2-D floodplain model to estimate the 20 yr ARI, 50 yr ARI, 100 yr ARI and 2,000 yr ARI and PMF design flood levels and velocities;
(ix) Prepare final plots of flood contours for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events separately;
(x) Prepare final plots of peak velocity contours for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMF events separately.

The creation and calibration of the 1-D floodplain (hydraulic) model(s) is described in **Appendix D** and is summarized as follows.

## Historical Floods

The model of the 2001 flood was created as follows:

- The MapInfo program was used as modeling pre-processor to generate the Digital Terrain Model (DTM) and other layers of spatial information required by the modelling system such as hydraulic roughness zones, road and bridge crossings and levee geometry.
- Recent airborne laser ground level survey data for the Prospect Creek floodplain was supplied by Fairfield City Council and was used to generate the model DTM for TUFLOW. The model that was assembled extends from Widemere Road down to the confluence of the Prospect Creek and the Georges River;
- The Prospect Creek watercourse and all crossings were modeled using embedded 1-D elements. Fairfield City Council surveyed 131 channel sections located at approximately 80 m intervals. This channel survey extended from the Hume Highway up to the outlet of the Rosford Street Basin;
- Channel and overbank roughness values were determined iteratively to achieve the best fit to observed flood levels; and
- The downstream stage boundary conditions used in the TUFLOW model was based on stage records at Milperra.

The Surface Water Modelling System (SMS) was also used as the post-processor to generate result plots of estimated flood levels, flow velocities, flood level differences and flood hazard maps.

The estimated flood profile for the 2001 flood was compared with the observed flood. It was concluded that the TUFLOW model flood estimates were in good agreement with the observed levels.

An analysis of the differences between the observed and predicted 2001 flood levels for the XP-SWMM and TUFLOW models was undertaken. This comparison disclosed that:

(i) The 1-D and 2-D floodplain models give similar levels of accuracy in predicted flood levels;
(ii) The trend in flood level differences was similar ie. both models gave similar high or low estimates in comparison with the same observed level.

It was also of interest to note that the TUFLOW results were based on an areal distribution of floodplain roughness that differed from the single roughness values adopted for the left and right floodplains in XP-SWMM.

It was concluded that the 2001 flood levels predicted by the TUFLOW model were in as good agreement with the observed levels as was achieved by the XP-SWMM model.

## Design Floods

Two TUFLOW models were assembled for design floods.

The first was all design floods from 20 yr ARI up to the 2,000 yr ARI storm. The second model was for the PMP storm. The only difference between the two models was the 2-D grid spacing for the floodplains. The first model was based on a 10 m x 10 m grid spacing while the second model was based on a 20 m x 20 m grid. The change in grid spacing was needed to accommodate the increased extent of the floodplain subject to inundation in a PMP storm.

The "calibrated" hydraulic models were run to estimate flood discharges, flow velocities and flood levels for the for the 20 yr ARI, 50 yr ARI, 100 yr ARI, 2,000 yr ARI and PMP floods. Inflow hydrographs were directly input into the hydraulic model in the form of interface files.

Plots of flood contours and velocity fields were prepared for the 20 yr, 50 yr and 100 yr ARI, 2000 yr ARI and PMP flood.

An analysis of the differences between the XP-SWMM and TUFLOW design flood level estimates was undertaken. It was noted that:

(i) The TUFLOW flood level estimates in the Hassall Street Basin are typically lower than the XP-SWMM flood level estimates;
(ii) The best agreement between the 1-D and 2-D floodplain model results was achieved in the 100 yr ARI flood; and
(iii) The TUFLOW model gave on average higher flood levels than the XP-SWMM model for floods up to the 100 yr ARI flood while in extreme floods it gave on average lower flood levels than the XP-SWMM model. This was attributed to the 2-D model including breakouts from Prospect Creek that were not included in the 1-D floodplain model due to the limited floodplain survey an which to base the 1-D model.

## Discussion

An issue of interest is the magnitude of any changes in the calculated 100 yr ARI flood levels in comparison with the 100 yr ARI flood levels adopted from the 1990 and 1993 studies taking into account any changes in floodplain topography since the 1990 and 1993 studies, constructed flood mitigation works and in particular the flood levels experienced during the January 2001 flood.

Immediately prior to the January 2001 the initial modeling of upper Prospect Creek concluded that:

(i) The increased discharges resulting from further catchment development since 1993 has negated some of the benefits of the flood mitigation program undertaken by Council;
(ii) The 100 Year ARI flood profile has been lowered between the Rosford Street Retarding Basin and Smithfield Road principally due to modifications to the two retarding basins;
(iii) However there have been increases in the estimated 100 Year ARI flood profile generally between Smithfield Road and Crosby Crescent. This was attributed to localized increases in the extent and density of vegetation both in the channel and on the floodplain.

The observed flood levels in the January 2001 flood confirmed the trends in flood levels predicted in these initial findings. In particular it was observed that the 2001 flood profile between the Smithfield Road and the Granville – Cabramatta Railway Line increased from close to 1988 flood levels to comparable to the higher 1986 flood levels (notwithstanding the flood mitigation works implement by Council since 1993).

Subsequent 1-D and 2-D hydraulic models were calibrated to the 2001 flood.

The XP-SWMM model was also run using the 1986 and 1988 storm rainfall to estimate the flood levels that would have occurred today if these storm events recurred under 2001 creek conditions. As expected the predicted flood levels that would have been experienced today if these storm events occurred now are higher than were experience in 1986 and 1988 notwithstanding the mitigation measures that have been completed in the intervening period.

A comparison of the 100 yr ARI flood levels currently adopted by Council and the 100 yr ARI 1-D and 2-D flood levels is given in **Table 1**.

The main differences between current 100 yr ARI flood levels and the proposed flood levels based on the 2-D hydraulic model include:

(i) The 100 yr ARI flood levels between the Rosford Street Basin and Smithfield Road are either similar to current adopted flood levels or are lower;
(ii) The 100 yr ARI flood levels between Smithfield Road and the Granville – Cabramatta Railway Line are generally higher than current adopted flood levels (which reflects the flooding observed in the 2001 flood);
(iii) The 100 yr ARI flood levels between Granville – Cabramatta Railway Line and the confluence of Orphan School Creek and Prospect Creek are substantially lower than current adopted flood levels (which reflects flood mitigation works undertaken by Council);
(iv) The 100 yr ARI flood levels between the confluence of Orphan School Creek and Prospect Creek and the Hume Highway are slightly lower than current adopted flood levels.

The differences between the 100 yr flood extent as defined by the 2-D results (refer Medium Risk zone in **Figure 2**) in comparison with previous preliminary manual mapping of 1-D results included:

(i) A greater identified flood extent in Rosford Basin;
(ii) A breakout from Prospect Creek that inundates Victoria Street;
(iii) More complex inundation in the Granville Street area;
(iv) Less inundation of the Fairfield High School site than previously estimated;
(v) A breakout to the west of The Horsley Drive that overtops the railway line;
(vi) Greater extent of inundation in the Vincent Crescent area;
(vii) Greater extent of inundation in the Ramsay St area (as previously identified in the 2004 Carrawood Park investigations).

It was concluded that the flood levels and velocities predicted by the TUFLOW model were suitable for the identification and mapping of interim Flood Risk Management zones based on Fairfield City Council's adopted risk management zone definitions.

## FLOOD RISK

Flood risk maps have prepared using the results of the 2-D hydraulic modelling of the 100 yr ARI and PMP floods in accordance with Council's adopted flood risk definitions, namely:

*High risk zone*: corresponds to the area of high hazard in the 100 yr ARI flood;

*Medium risk zone*: extends from the High Risk zone, out to the extent of the 100 yr ARI flood; and

*Low risk zone*: extends from the Medium Risk zone out to the extent of the PMF.

The flood risk has been mapped between the Hume Highway and Widemere Road. Flood risk zones are presented in **Figure 2**.

## ACCURACY OF THE RESULTS

It is important to recognise that any modelling studies provide only an estimate of the predicted flood levels. Although these estimates are based on the best data available at the time of writing, new data obtained in the future may lead to a revision of the estimates.

The error margin in this study is regarded as moderate due to:

(iv) The limited historical rainfall and flood level data;
(v) Calibration and verification of both hydrological and hydraulic models primarily to the 2001 flood with checking against the 1986 and 1988 only;
(vi) The model parameters are generally typical of values adopted for other flood studies.

The estimated accuracy of the flood levels is ±0.25 m.

**Table 1**
**Comparison of 100 yr ARI Flood Level Estimates**

| Upper Prospect Ck Location | Chainage | **Current** HEC-RAS Reported 1993 (1) | XP-SWMM 1% AEP (m AHD) (2) | Diff (cm) (2) - (1) | **Proposed** TUFLOW 1%9h (m AHD) (3) | Diff (cm) (3) - (2) | Diff (cm) (3) - (1) |
|---|---|---|---|---|---|---|---|
| u/s Widemere Rd | 16697.0 | | 31.69 | | 31.75 | 6 | |
| | 16673.0 | | 31.48 | | 31.46 | -2 | |
| d/s Widemere Rd | 16657.0 | | 31.31 | | 31.11 | -20 | |
| Hassall St. Basin | 16541.0 | | 31.14 | | 30.95 | -19 | |
| | 16401.0 | | 30.72 | | 30.72 | 0 | |
| | 16251.0 | | 30.71 | | 30.71 | 0 | |
| | 16111.0 | | 30.70 | | 30.71 | 1 | |
| | 15921.0 | | 30.70 | | 30.71 | 1 | |
| | 15761.0 | | 30.69 | | 30.70 | 1 | |
| | 15631.0 | | 30.69 | | 30.70 | 1 | |
| Hassall St. Outlet | 15591.0 | | 30.69 | | | | |
| | 15551.0 | | 30.69 | | 30.67 | -2 | |
| Rosford St. Basin | 15531.0 | | 27.12 | | | | |
| | 15491.0 | | 27.12 | | 27.15 | 3 | |
| | 15471.0 | | 27.11 | | | | |
| | 15461.0 | | 27.12 | | | | |
| | 15231.0 | | 25.68 | | 25.67 | -1 | |
| | 15201.0 | | 25.44 | | | | |
| | 15185.0 | | 25.29 | | 25.29 | 0 | |
| | 15100.0 | | 25.28 | | | | |
| | 14950.0 | | 23.95 | | | | |
| | 14830.0 | | 23.79 | | | | |
| | 14620.0 | | 23.72 | | | | |
| Rosford St. Outlet | 14598.0 | | 23.72 | | 23.81 | 9 | |
| | 14586.0 | | 22.43 | | 22.45 | 2 | |
| d/s Rosford St Basin | 14556.0 | 22.26 | 22.02 | -24 | 22.06 | 4 | **-20** |
| Near Market St. | 14436.0 | 22.00 | 21.88 | -12 | 21.91 | 3 | **-9** |
| d/s Market St. | 14296.0 | 21.85 | 21.83 | -2 | 21.90 | 7 | **5** |
| Behind Edgel | 14218.0 | 21.68 | 21.78 | 10 | 21.73 | -5 | **5** |
| | 14086.0 | 21.54 | 21.40 | -14 | 21.44 | 4 | **-10** |
| Behind Edgel | 14015.0 | 21.46 | 21.27 | -19 | 21.27 | 0 | **-19** |
| | 13905.0 | 21.29 | 21.15 | -14 | 21.03 | -12 | **-26** |
| Industrial Park | 13775.0 | 20.98 | 21.01 | 3 | 21.07 | 6 | **9** |
| Industrial Park | 13685.0 | 20.84 | 20.91 | 7 | 20.85 | -6 | **1** |
| Industrial Park | 13445.0 | 20.49 | 20.30 | -19 | 20.34 | 4 | **-15** |
| u/s Justin St | 13300.0 | 20.26 | 20.11 | -15 | 20.19 | 8 | **-7** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Justin St | 13170.0 | 20.06 | 19.90 | -16 | 20.01 | 11 | **-5** |
| d/s Justin St | 13080.0 | 19.88 | 19.61 | -27 | | | |
| Industrial Park | 12990.0 | 19.74 | 19.26 | -48 | 19.31 | 5 | **-43** |
| u/s Little St | 12930.0 | 19.66 | 19.10 | -56 | 19.27 | 17 | **-39** |
| d/s Little St | 12780.0 | 19.39 | 19.05 | -34 | 19.06 | 1 | **-33** |
| | 12670.0 | 18.90 | 18.61 | -29 | 18.69 | 8 | **-21** |
| | 12580.0 | 18.50 | 18.25 | -25 | | | |
| u/s Kenyons Bridge | 12549.0 | 18.36 | 18.18 | -18 | 18.22 | 4 | **-14** |
| **Kenyons Bridge** | 12530.0 | | 18.15 | | | | |
| d/s Kenyons Bridge | 12511.0 | 18.23 | 18.03 | -20 | 18.09 | 6 | **-14** |
| Adjacent Low St | 12461.0 | 18.08 | 17.96 | -12 | 17.96 | 0 | **-12** |
| Oxford St | 12331.0 | 17.61 | 17.68 | 7 | 17.63 | -5 | **2** |
| | 12126.0 | 17.14 | 17.19 | 5 | 17.36 | 17 | **22** |
| Near Smithfield Park | 11921.0 | 16.85 | 17.04 | 19 | 17.03 | -1 | **18** |
| Adjacent Chisholm St | 11733.0 | 16.71 | 16.85 | 14 | 16.98 | 13 | **27** |
| Near Alt St | 11641.0 | 16.45 | 16.81 | 36 | 16.84 | 3 | **39** |
| | 11571.0 | | | | 16.61 | | |
| Adjacent Solo Cres | 11431.0 | 15.33 | 15.92 | 59 | 15.97 | 5 | **64** |
| | 11333.0 | 15.35 | 15.41 | 6 | 15.48 | 7 | **13** |
| Near Granville St | 11021.0 | 14.96 | 15.34 | 38 | 15.25 | -9 | **29** |
| Near Hemingway Cres | 10881.0 | 14.47 | 14.84 | 37 | 14.74 | -10 | **27** |
| d/s Hemingway Cres | 10756.0 | 14.31 | 14.14 | -17 | 14.13 | -1 | **-18** |
| Near Crosby Cres | 10436.0 | 13.73 | 14.04 | 31 | 14.07 | 3 | **34** |
| d/s Crosby Cres | 10356.0 | 13.45 | 13.89 | 44 | 13.87 | -2 | **42** |
| Bray St | 10216.0 | 13.41 | 13.36 | -5 | 13.40 | 4 | **-1** |
| Loscoe St | 10156.0 | 13.35 | 13.13 | -22 | 13.20 | 7 | **-15** |
| u/s Fairfield Rd | 9866.0 | 12.64 | 12.67 | 3 | 12.67 | 0 | **3** |
| **Fairfield Rd Bridge** | 9853.0 | 12.47 | 12.65 | 18 | | | |
| | 9842.0 | 12.24 | 12.54 | 30 | 12.66 | 12 | **42** |
| d/s Fairfield Rd | 9829.0 | 12.24 | 12.53 | 29 | 12.53 | 0 | **29** |
| | 9689.0 | 11.89 | 12.12 | 23 | 12.15 | 3 | **26** |
| Ace Avenue | 9589.0 | 11.81 | 12.05 | 24 | 12.05 | 0 | **24** |
| d/s Ace Avenue | 9429.0 | 11.66 | 11.64 | -2 | 11.71 | 7 | **5** |
| | 9374.0 | | | | 11.86 | | |
| Whittaker Rd | 9259.0 | 11.34 | 11.53 | 19 | 11.55 | 2 | **21** |
| Behind Fairfield High | 9009.0 | 10.82 | 11.10 | 28 | 11.15 | 5 | **33** |
| d/s Fairfield High | 8859.0 | 10.61 | 11.01 | 40 | 11.01 | 0 | **40** |
| Tip Top Bakery | 8609.0 | 10.15 | 10.56 | 41 | 10.50 | -6 | **35** |
| Bell Cres | 8459.0 | 10.00 | 10.45 | 45 | 10.40 | -5 | **40** |
| | 8289.0 | | 10.16 | | 10.11 | -5 | |
| Horsley Dr. Overpass | 8159.0 | 9.69 | 9.82 | 13 | 9.78 | -4 | **9** |
| u/s Southern Railway | 8089.0 | 9.57 | 9.09 | -48 | 9.09 | 0 | **-48** |

**Table 1 Continued**
**Comparison of 100 yr ARI Flood Level Estimates**

| **Lower Prospect Ck** **Location** | **Chainage** | **WILCELL Reported 1990** (1) | **XP-SWMM** 1% AEP (m AHD) (2) | (2) - (1) | **TUFLOW** 1%9h (m AHD) (3) | Diff (cm) (3) - (2) | (3) - (1) |
|---|---|---|---|---|---|---|---|
| d/s Southern Rwy | 8080.0 | 9.74 | 9.01 | -73 | 8.99 | -2 | **-75** |
| u/s Fairfield Street | 8010.0 | 9.57 | 8.56 | -101 | | | |
| | 7950.0 | | 8.49 | | 8.53 | 4 | |
| | 7935.0 | | 8.48 | | 8.55 | 7 | |
| Patrician Brothers College | 7645.0 | 9.02 | 8.26 | -76 | 8.28 | 2 | **-74** |
| Makepeace Athletic Field | 7365.0 | 8.54 | 7.37 | -117 | 7.32 | -5 | **-122** |
| | 7135.0 | 8.29 | 7.19 | -110 | 7.14 | -5 | **-115** |
| u/s Vine Street Bridge | 6995.0 | | 6.93 | | 6.82 | -11 | |
| d/s Vine Street Bridge | 6985.0 | | 6.82 | | 6.78 | -4 | |
| | 6970.0 | 7.37 | 6.61 | -76 | 6.62 | 1 | **-75** |
| | 6817.5 | | | | | | |
| | 6607.5 | 6.88 | 6.59 | -29 | | | |
| | 6265.0 | 6.75 | 6.58 | -17 | | | |
| Junction of Prospect & Orphan School Cks | 6052.5 | 6.60 | 6.57 | -3 | 6.66 | 9 | **6** |
| u/s Cabramatta Rwy | 5850.0 | 6.55 | 6.56 | 1 | 6.60 | 4 | **5** |
| | 5700.0 | | 6.56 | | 6.49 | -7 | |
| | 5685.0 | | 6.56 | | 6.46 | -10 | |
| d/s Cabramatta Rwy | 5570.0 | 6.54 | 6.56 | 2 | | | |
| | 5340.0 | 6.53 | 6.55 | 2 | 6.44 | -11 | **-9** |
| Cook Avenue | 5137.5 | 6.52 | 6.55 | 3 | 6.44 | -11 | **-8** |
| | 5007.5 | 6.52 | 6.55 | 3 | 6.44 | -11 | **-8** |
| | 4805.0 | 6.51 | 6.55 | 4 | 6.44 | -11 | **-7** |
| | 4510.0 | 6.51 | 6.55 | 4 | 6.44 | -11 | **-7** |
| | 4180.0 | 6.50 | 6.54 | 4 | 6.43 | -11 | **-7** |
| | 4050.0 | | | | | | |
| u/s Hume Highway | 3970.0 | 6.50 | 6.54 | 4 | 6.43 | -11 | -7 |

# 6 CONSULTATION

**AIMS AND OBJECTIVES**

The general aims and objectives of the community consultation were to:

(i) provide a forum for the dissemination of information in regard to flooding issues as a result of the release of the 2001 State Government Floodplain Management Manual;
(ii) identify community concerns and values;
(iii) gather information from the community to facilitate the finalisation of the revised flood study;
(iv) inform the community about the possible action or alternatives and the potential consequences of these;
(v) develop and maintain credibility;
(vi) improve decision making;
(vii) promote ownership by the community of the outcomes of the workshop;
(viii) review the adequacy and effectiveness of previous flood mitigation works; and
(ix) workshop local issues of concern, eg bank stabilisation works, flood proofing and house raising

The objectives of the workshops should also be consistent with the primary objective of the State Government's Flood Policy: "to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible."

**COMMUNITY WORKSHOPS**

Three Community Workshops were held as in November 2002 to inform the community about the progress on the review of flood levels in Prospect Creek and invite community comment as follows:

| Date | Title | Reach of Prospect Creek |
|---|---|---|
| 11 November 2002 | Georges River Workshop | Georges River Confluence to Hume Highway |
| 21 November 2002 | Lower Prospect Creek Workshop | Hume Highway to Georges River Confluence to Granville-Cabramatta Railway Line |
| 27 November 2002 | Upper Prospect Creek Workshop | Georges River Confluence to Granville-Cabramatta Railway Line to Widemere Road |

Each Workshop was:

- Held at Fairfield City Council chambers;
- Led by an external facilitator; and
- Included presentations given by officers of Fairfield City Council, its consultant(s), DIPNR and the NSW SES

The community was invited to make comments and raise queries during the Workshop and/or to make a written submission to Council.

A typical agenda for these Workshops is given in **Appendix E**.

A summary of the queries raised and Council's response for each of the Workshops is also given in **Appendix E**.

# 7 REFERENCES


Cardno Willing (NSW) Pty Ltd (2001) "Fairfield Park Floodway Flood Impact Assessment", *Final Report*, prepared for Fairfield City Council, September, 13 pp.

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FIGURE 1 PROSPECT CREEK CATCHMENT

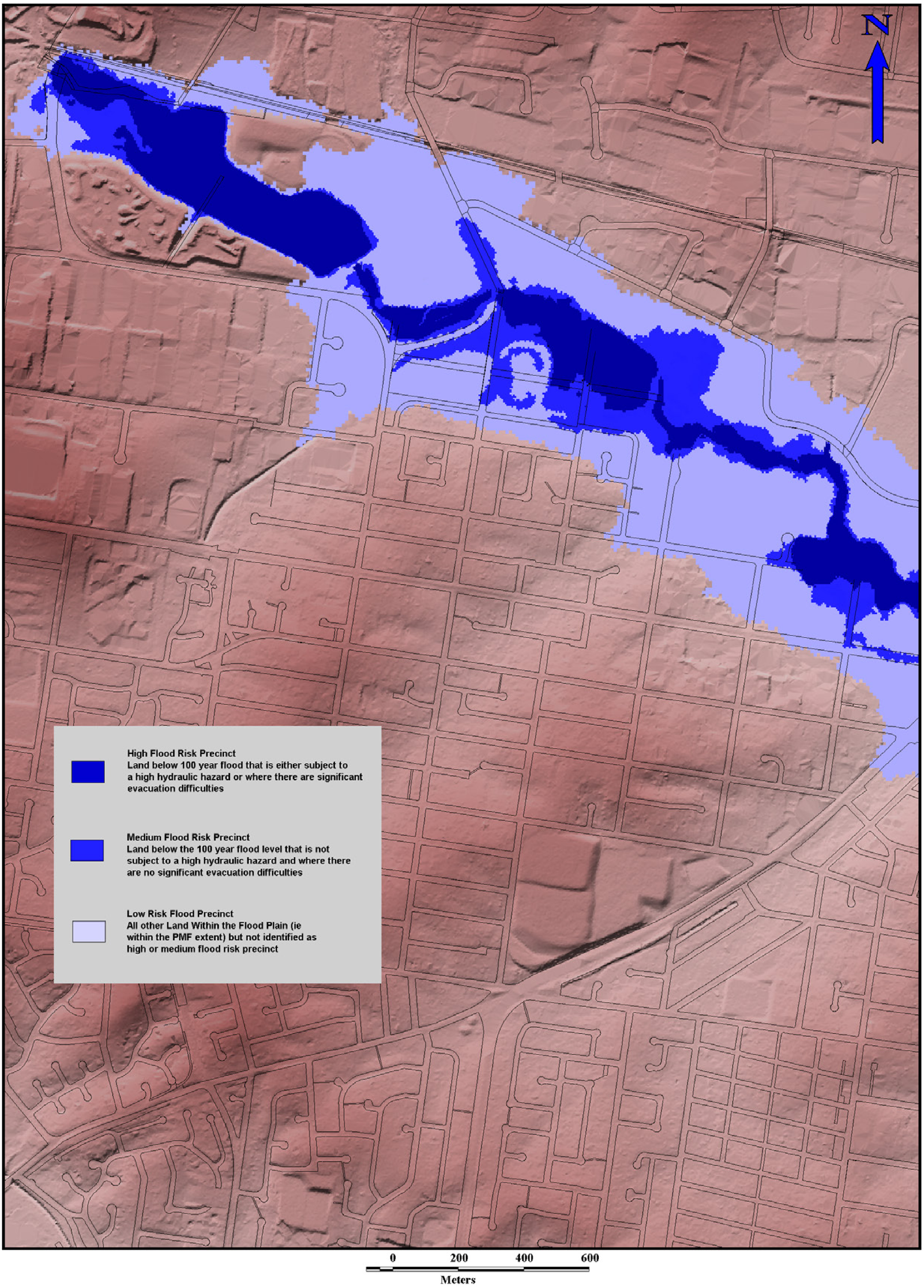


**FIGURE 2A PROSPECT CREEK FLOOD RISK MANAGEMENT ZONES**

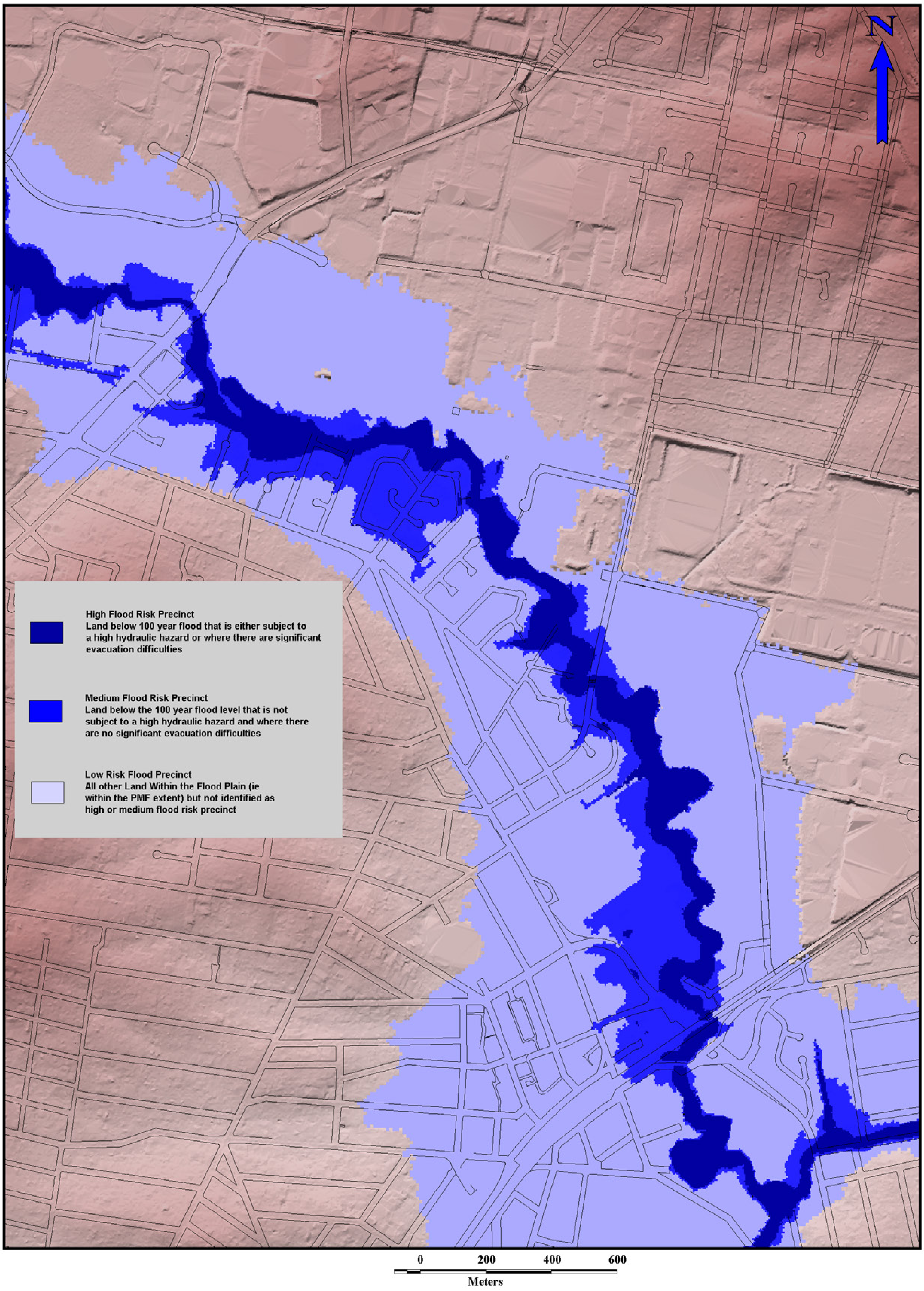


**FIGURE 2B PROSPECT CREEK FLOOD RISK MANAGEMENT ZONES**

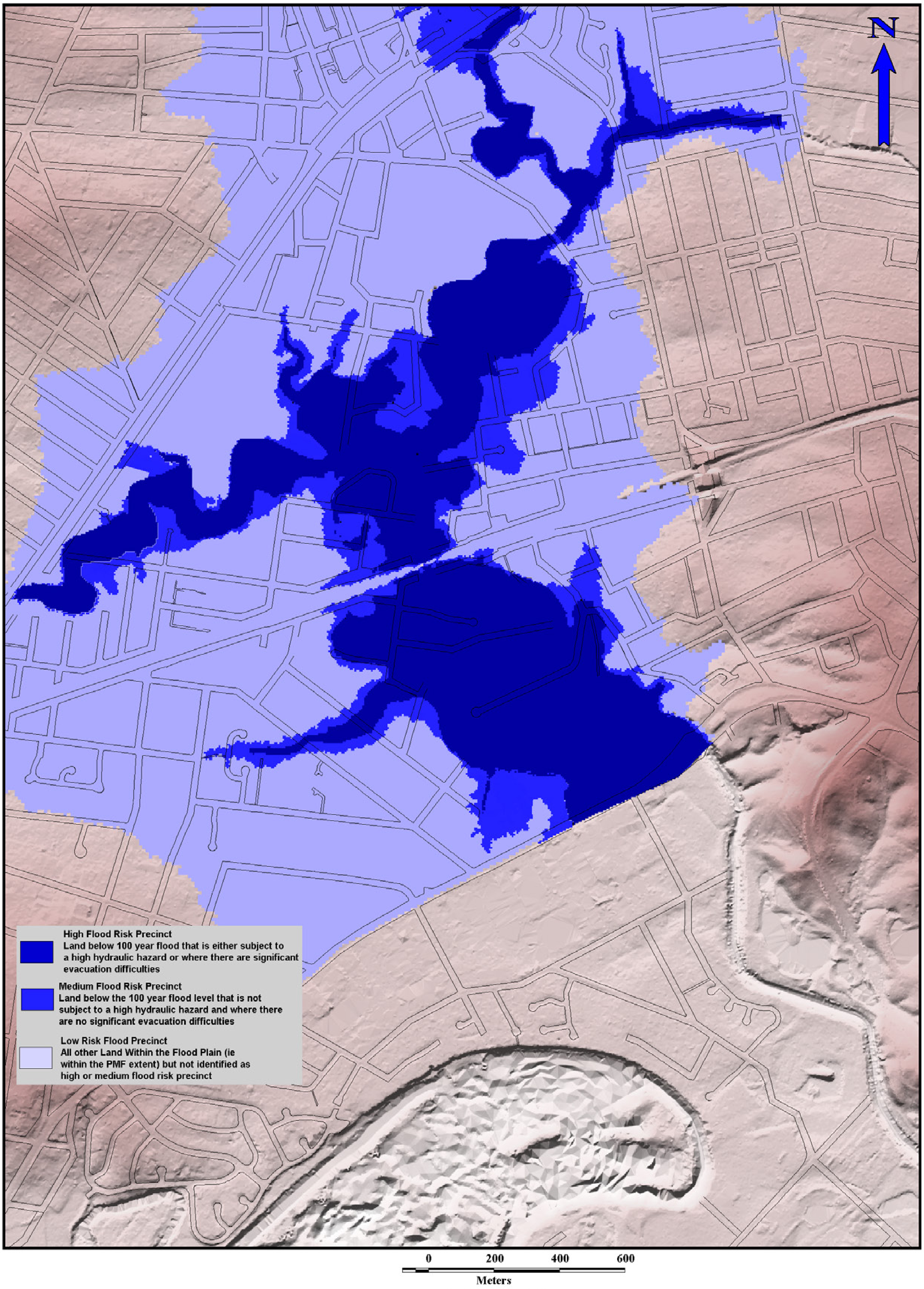


**FIGURE 2C PROSPECT CREEK FLOOD RISK MANAGEMENT ZONES**