Edmondson Park Steering Committee

Edmondson Park Master Planning

Water Cycle Management: Stormwater

Final Report

October 2003

GHD Pty Ltd ABN 39 008 488 373

10 Bond Street Sydney NSW 2000

-

T: 2 9239 7100 F: 2 9239 7199 E: sydmail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1st DRAFT	Rainer Berg	Nicholas Deeks				28/01/2003
2nd DRAFT	Rainer Berg					12/08/2003
3rd DRAFT	Rainer Berg	APP, D Taylor				19/09/2003
Final	Rainer Berg	Nicholas Deeks	[signature]	Grahame Sproats	[signature]	15/10/2003

Contents

Table Index

Appendices

Foreword on Concept Plans

The master planning process is iterative requiring input from a number of disciplines. The concept plans for Edmondson Park constantly evolved throughout the course of the project, as specialist studies informed the urban planning.

The contents of this report was originally based on the March 2003 Concept Plan, which was the latest development footprint proposal at the time of draft compilation. Since then the 15 August 2003 Concept Plan has been developed via a number of intermediate iterations. After a cursory assessment it was decided that the development footprint of the 15 August 2003 Concept Plan did not differ significantly to the March 2003 Concept Plan, in terms of the stormwater master planning on the site. To this end, it was not deemed necessary to re-work the hydrology.

Executive Summary

- This report primarily addresses the stormwater component of the water cycle management for the Master Plan process and identifies constraints and opportunities for the Edmondson Park Composite Site incorporating, flood control, flow control, and water quality control. Water Sensitive Urban Design (WSUD) principles underpin the development of options;
- The Edmondson Park study area (796 hectares) lies within the 2,500 hectare Hoxton Park Release Area. The area is located adjacent to the South Western Freeway, Camden Valley Way, Denham Court to the west and is dissected by Campbelltown Road. The study area excludes the Ingleburn Gardens and Monarch development sites. Three creeks (and their tributaries) dissect the site and drain in a northerly direction, discharging under Camden Valley Way. The southern corner site drains in a southerly direction to Bunbury Curran Creek. It is important to note that hydrological catchment areas are larger than the Edmondson Park release area site, resulting in runoff entering the site at the upstream site boundaries, and discharging through the site;
- Edmondson Park experiences Sydney's sub-tropical climate with rainfall predominantly occurring in late summer and autumn. The site is undulating in relief, varying between flat grades along the major creek lines to steep (10-15%) in the south-western corner;
- Flood hydrographs for the 20, 50, 100-year Average Recurrence Interval (ARI) and the PMF were generated using the RAFTS-XP software. The latest versions of the models compiled for the Cabramatta Creek Floodplain Management Study (CCFMS) and Plan were updated and used;
- The 20, 50, 100-year ARI and the PMF flood extent was calculated using a Mike11 hydraulic model for all creeks and tributaries within the Edmondson Park release area;
- Water Sensitive Urban Design Drainage (WSUD) objectives for Edmondson Park aim to protect and enhance natural water systems, integrate stormwater treatment into the landscapes, protect water quality draining from the development, reduce runoff and peak flows from developments by employing local detention measures, minimise impervious areas and maximise re-use;
- Guiding principles for future drainage management at Edmondson Park in broad terms aim at retention of as much stormwater as possible on site, transport as little stormwater as possible to receiving waters, "lose as much stormwater as possible along the transport chain, and slow the transmission of stormwater to receiving waters as much as possible. Also prevent the transportation of gross and sediment-borne pollutants;
- Stormwater Management Options for Edmondson Park have been proposed and are summarised on Figure 6.1. The strategies developed include:

- Flood Management through provision of five extended detention wet/dry basins, to be located offline where possible, and drainage corridors/easements/bio-engineered channels;
- Flow Attenuation through retarding basins, lakes/ponds, wetlands, rehabilitated creeks, vegetated swales, buffer strips and water re-use schemes;
- Flow Volume Reduction through water re-use, for example rainwater tanks;
- Water Quality Management through wetlands, extended detention wet/dry basins and primary/secondary stormwater treatment processes consisting of amongst others sediment, litter, nutrient and bacteria treatment;

- Scoping level costing of the major drainage elements has been undertaken and is summarised in Table 7.3;

1. Introduction

GHD is a member of a multi disciplinary team of urban planners, water cycle engineers, social planners and economists working interactively to produce the Edmondson Park Master Plan and the supporting documentation.

This report addresses the stormwater management component of the Master Plan process. The Master Plan process consists of specialist technical support in the areas of survey, drainage, utilities infrastructure, transport, land capability/salinity, retail, and social infrastructure.

This report identifies constraints and opportunities on water cycle management and stormwater master planning for the Edmondson Park Composite Site incorporating:

- Flood management;
- Flow management;
- Water quality management; and
- Re-use of stormwater as a resource.

This report identifies issues concerning options and alternatives that may be adopted to deliver sustainable outcomes and maintain economic viability. Water Sensitive Urban Design (WSUD) principles underpin the development of options as presented in this report.

2. Site Description and Derived Constraints

2.1 Region

The Edmondson Park Release Area lies within the 2,500 hectare Hoxton Park Release Aea Corridor within the Liverpool and Campbelltown Local Government Areas. Detailed strategic investigations carried out as part of the Smart Growth planning process have developed the foundation for a sustainable community, of which one of the key aims is to "establish an orderly and coordinated provision of infrastructure, services and amenities." This Smart Growth process is a Liverpool Council initiative that compliments the work of Planning NSW's Sustainability Advisory Council.

This report focuses on the issues, threats and opportunities associated with the planning for sustainable infrastructure development and alternative service provision with respect to stormwater management for the Edmondson Park release area.

2.2 The Study Area

The Edmondson Park Study Area is located adjacent to the South Western Freeway, Camden Valley Way, Denham Court to the west and is dissected by Campbelltown

Road. The southern portion of the site lies within the Campbelltown Local Government Area and the large remaining area is within the Liverpool Local Government Area.

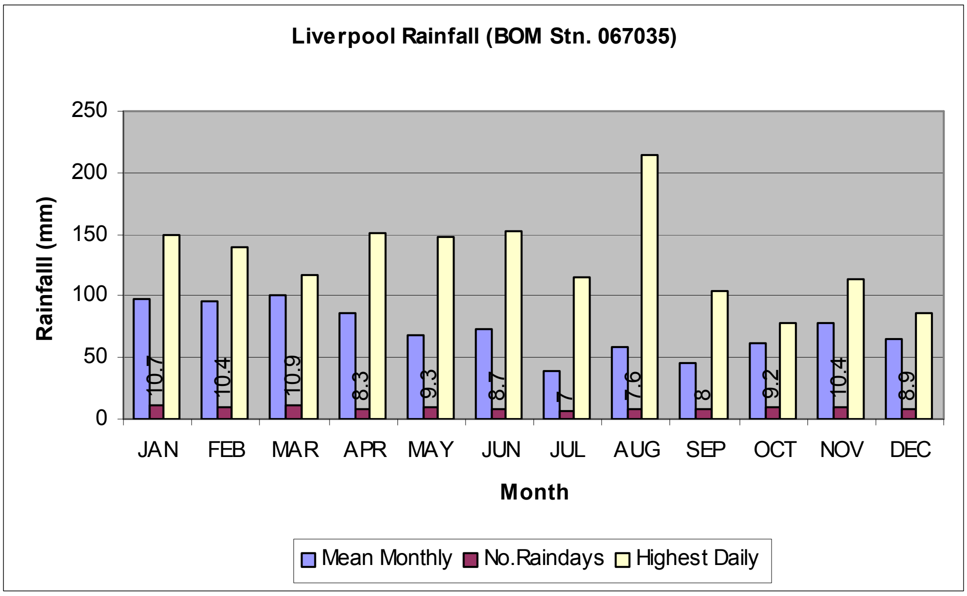
The study area is 796 hectares in size with the Department of Defence landholding equalling 322 hectare and Landcom holding 93 hectare. The remaining 381 ha site is in multiple ownership. The study area excludes the Ingleburn Gardens and Monarch Development sites.

Present land use includes market gardens, the Tree Valley Golf Course, the Ingleburn Defence Site and large lot residential/rural developments.

2.3 Climate

Edmondson Park experiences Sydney's sub-tropical climate with rainfall predominantly occurring in late summer and autumn. Figure 2.1 below shows the mean monthly rainfall, maximum daily rainfall and number of rain days recorded by the Bureau of Meteorology at the Liverpool observation station (BOM Stn 067035), which is considered representative of conditions at Edmondson Park.

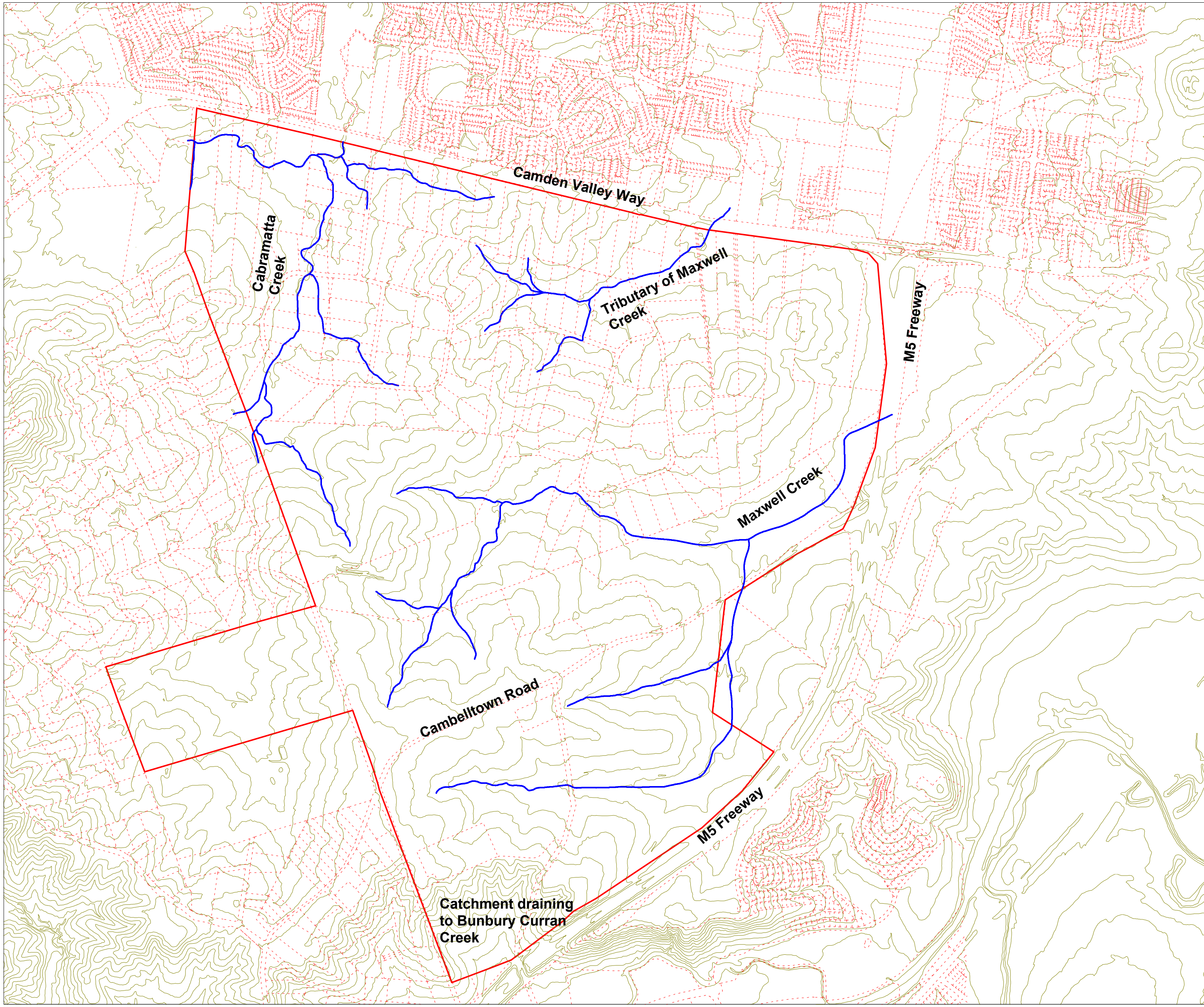
Figure 2.1: Liverpool Rainfall



2.4 Topography

The site is undulating in relief, varying between flat grades along the major creek lines (particularly in the vicinity of Camden Valley way, to steep (10-15%) in the south-western corner, the small sub-catchment draining to the Bunbury Curran Creek. The majority of the site has slopes less than 10%.

The topography is an important consideration when planning off-line detention facilities (facilities should preferably be sited in flatter areas). This is on account of the significant amount of earthworks required, resulting in more expensive facilities.

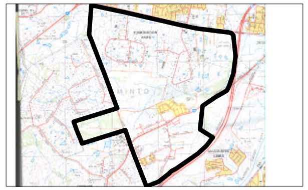


LEGEND/NOTES

- Existing Cadastral
- Creeks
- 4m Contours
- Site Boundary

0.25 0 0.25 0.5
Kilometers

LOCALITY MAP



Horiz. Datum MGA- Zone 56s	**Projection** UTM	
Height Datum	**Metadata Recorded**	
Created	**Checked**	**Approved**
Date	**File Location**	
Revision	**Drawing Number**	

Edmondson Park Master Plan

FIGURE 2.2:
Locality Plan and Creeks

GHD Project Number: 21/11429

2.5 General Drainage and Waterways

Referring to Figure 2.2, three creeks (and their tributaries) dissect the site and discharge in a northerly direction, under Camden Valley Way. The southern corner site drains in a southerly direction to Bunbury Curran Creek. Table 2.1 summarises the catchments, listing catchment areas upstream of the points of discharge, at the downstream site boundary. It is important to note that hydrological catchment areas are larger than the Edmondson Park release area site, resulting in runoff entering the site at the upstream site boundaries, and discharging through the site.

Table 2.1 Main Drainage Creeks Traversing The Site

Catchments	Catchment Area upstream of discharge point* (Ha)
Upper Cabramatta Creek	752
Tributary of Maxwell Creek	144
Upper Maxwell Creek	515
Tributary of Bunbury Curran Creek	34

* Includes catchments outside Edmondson Park site

2.6 Soils and Salinity

Geotechnique undertook the geotechnical investigations for the Edmondson Park Master Plan. Findings, as documented in their Report (Geotechnique, 2003) and relevant to stormwater drainage are:

- Localised salinity hazards may be anticipated across the site, with extensive salinity hazards along the creeks and drainage depressions;
- Saline soils are likely to be encountered in Edmondson Park Release area;
- Dryland salinisation is likely to be the main cause for saline soils and groundwater in the Edmondson Park Release Area
- Recommendations as listed in the report, and proposed for the Edmondson Park site are:
  - Reduce groundwater recharge through appropriate land use and land management practices. This can be achieved by minimising deep infiltration and through flow and maximising vegetation cover, planting of deep-rooted trees and use of salt tolerant plants.
  - Carry out a water balance study to determine possible sources of recharge (rainfall, springs, dams etc) and paths to discharge.
  - Ensure that construction activities do not affect the natural flow of groundwater.

– Select construction materials and techniques suitable for a saline environment. ;

- Both residual and alluvial soils within the Edmondson Park Release Area are dispersive or potentially dispersive and hence, susceptible to erosion;
- Construction materials used in the Edmondson Park Release Area should be suitable for use in a moderately aggressive site in terms of salinity.

2.7 Other Constraints

2.7.1 Vegetation

Ecological Australia undertook an assessment of the state of vegetation on the Edmondson Park site. This assessment, which took into account the varying levels of vegetation significance across the site, formed the basis of discussions and negotiations with the National Parks and Wildlife Services, and the Department of Infrastructure, Planning and Natural Resources. As a result of these negotiations and based on a decision by the NSW Cabinet, agreement has been reached on the extent of conservation on the site. This agreement has enabled the development footprint for the site to be subsequently agreed.

Furthermore, the outcome of the state of vegetation assessment and constraint mapping produced was used to guide the location of water quality and quantity management facilities. Facilities have been located in such a way, to avoid encroaching on ecological communities demarcated as having a 'high' constraint, and mostly avoiding ecological communities demarcated as a 'moderate' constraint.

2.7.2 Heritage

Australian Museum Business Services undertook the archaeological assessment of the site, while HLA Envirosciences undertook the non-indigenous heritage assessment. These studies resulted in the identification and mapping of archaeological and heritage constraints throughout the study area.

2.8 Information from Government Agencies

2.8.1 Liverpool City Council

Liverpool City Council was engaged on a number of occasions to obtain information/data, provide background on flood management in the region, particularly the Cabramatta Floodplain Management Study and Plan, together with the proposed Basin Strategy for the Cabramatta Creek. Apart from the general requirements of WSUD, specific requirements for stormwater management from the Edmondson Park site included:

- A hydrological model must be configured, utilising the latest model updates, and simulation methodologies;

- A hydraulic model must be configured for the Edmondson Park site, capable of simulating a number of Average Recurrence Interval (ARI) flood events for existing, post development and post development with mitigation conditions;
- 'Existing' catchment conditions (baseline) are to be defined at 1989 level. These are similar to 1996 (Epoch 1 defined in the Cabramatta Creek Flood Plain Management Study) conditions in terms of flood peaks;
- Post development discharge at the downstream site boundary must be mitigated to 'existing' conditions. The definition of downstream site boundaries are:
  - Cabramatta Creek: at Camden Valley Way;
  - Tributary of Maxwell Creek: at Camden Valley Way; and
  - Maxwell Creek: at the M5.
- Consideration needs to be given to the PMF and evacuation planning.

2.8.2 Department of Land and Water Conservation

DLWC raised the following key issues:

- The opportunity of combining detention and water quality basins should be explored;
- In terms of overall value, the ranking of creeks is:
  - Cabramatta Creek;
  - Maxwell Creek;
  - Tributary of Maxwell creek.
- Detention and water quality basins between the 100-year and PMF should be explored;
- The value of vegetation connectivity needs to be considered when exploring on/offline basin strategies;

2.8.3 Environment Protection Authority (EPA)

Specific issues raised by the EPA include:

- Integration of all water and wastewater strategies should implemented, namely water demand, stormwater quantity and quality, sewage management and re-use;
- The water quality objectives in the Statement of Intent for the Georges River and Botany Bay System should provide overarching objectives; and
- Strategies for managing stormwater need to be consistent with:
  - The water quality objectives arising out of the Healthy Rivers Commission Inquiry into the Georges River-Botany Bay System;
  - The relevant Stormwater Management Plans prepared by local government;
  - The draft Georges River Regional Environmental Plan.

2.8.4 NSW Fisheries

Specific issues raised by NSW Fisheries include:

- NSW Fisheries favours water sensitive urban design;
- Hard engineering solutions to be avoided.
- Flood mitigation measures, particularly dams, basins, levees, floodgates and channel modifications, must consider fish passage and aquatic habitat issues;
- Approvals are required from NSW Fisheries for amongst others any works within a waterway, potentially including stormwater control devices and removal or movement of snags including vegetation or boulders;
- There should be no net increase in runoff and no reduction in water quality of the receiving waters. Detention ponds and other stormwater treatment devices should be off-line and at-source so they do not interfere with fish passage;.
- There should be no blockages to fish passage, particularly in relation to gross pollutant traps, detention ponds, flood mitigation measures such as levee banks or waterway crossings;
- Avoid ponding of waterways with weir-type structures as ponding encourages exotic species, or include flshways;
- Riparian buffer zones of 50-metre are recommended adjacent to any waterway or wetland;
- Land around creeks should feature the creek;
- The buffer zones adjacent to the waterway should be made up of endemic riparian vegetation, including emergent vegetation, wherever possible, to protect the receiving waters from erosion and runoff, contribute organic matter to the aquatic system (an essential component of the food web for aquatic organisms) and shade the waterway, reducing temperatures and providing shelter;
- Instream vegetation, including trees/snags, macrophytes and algae, should be protected. Macrophytes help to improve water quality by acting as physical filters, stabilising sediments and absorbing nutrients, and they also provide habitats for fish and other aquatic organisms.
- The macrophyte zone should be contiguous with the rest of the riparian zone rather than interrupted by rockwork or a footpath. This allows fauna to move between the zones.
- Even small buffer zones should be encouraged on private land. This should include educating landowners as to the benefits of buffer zones for erosion control and water quality improvement.
- Hard surfaces such as cycle ways and footpaths should be kept to a minimum within the buffer zone and made from permeable materials where practical;
- Development should be staged so that riparian buffer zones are in place and acting to minimise erosion and runoff problems;

- Reclamation or dredging of water land, including the realignment of creeks should be avoided;
- Development within the floodplain should be avoided;
- The potential of acid sulphate soils or other types of contamination, including salinity problems, should be determined prior to any phase of construction and mitigation measures determined; and
- Ground water issues need to be considered, including potential contamination and downstream effects;

3. Hydrological/Hydraulic/Water Quality Analysis

3.1 Hydrological Analysis (Flood Events)

3.1.1 Evolution of Hydrological Models

The hydrology for Cabramatta Creek was originally developed using the XP-RAFTS simulation software for the purposes of the Cabramatta Creek Flood Plain Management Study. Previous to this a RAFTS model (version 2.54) was developed for the Hoxton Park Total Catchment Management Study (1992). Since then the models have been amended and updated for a variety of reasons, the most recent being for the purposes of simulating the effects of the Western Sydney Orbital. This development of models over time has included changes/updates in:

- Sub-catchment discretisation;
- Intensity-Duration-Frequency data for generating storm rainfall events, and utilisation of the accepted Liverpool City Council Intensity Duration Frequency (IDF) curves;
- Modelling methodology, particularly separation of impervious and pervious areas with sub-catchments;
- Calibration parameters; and
- Areal reduction parameters.

For the present study the latest versions of the models were updated to include the Edmondson Park site.

3.1.2 Model Compilation

The latest XP-RAFTS model utilised in the simulations for the Western Sydney Orbital was amended and configured for the Edmondson Park site as follows:

- Sub-catchments within the Edmondson Park site were further discretised, and the delineated catchment boundaries were checked and amended as required;

- The latest simulation methodology, based on the separation of impervious and pervious areas into separate simulation sub-catchments was implemented;
- The latest accepted Liverpool City Council Intensity Duration Frequency (IDF) curves were implemented to generate design rainfall events at the 20, 50, 100-year Average Recurrence Interval (ARI) levels and the PMF; and
- No Areal Reduction Factors were implemented.

It was agreed with Liverpool City Council to utilise the 1989 land use assumptions as provided for the Cabramatta Floodplain Management Study and Plan to determine existing conditions flood peaks. It must be noted that on account of the limited development that has occurred in the catchment upstream of Camden Valley Way, 1989, 1996 and 2001 conditions compare favourably at key locations. Future conditions were assumed to be the 2026 level of development, upstream of the Edmondson Park site, together with the proposed development footprint of the Edmondson Park release area.

3.1.3 Calibration

Calibration for the purpose of this study was achieved by comparing flood peaks at the downstream site boundary, namely at Camden Valley Way and the M5. Comparisons were made between the latest model configured for the Cabramatta Floodplain Management Study and Plan which including the Western City Orbital and the Edmondson Park Master Plan model which included further discretisation of sub-catchments within the Edmondson Park site. Favourable calibration was achieved by increasing the model parameter ‘Bx’ from 1.0 to 1.05. A comparison of 100-year flood peaks is listed in Table 3.1. Referring to Table 3.1, the model referred to as the Edmondson Park Master Plan model has been adopted as the ‘existing conditions’ model for the present study.

Table 3.1 Comparison of simulated 100-year ARI Flood Peaks

Location	Latest Cabramatta Floodplain Management Study and Plan model including WSO (m^3/s)	Edmondson Park Master Plan model (m^3/s) (Existing Conditions Model)
Cabramatta Creek: Upstream site boundary, inflow from southwest	56.3	55.5
Cabramatta Creek: Upstream site boundary, inflow from tributary to the west	22.8	17.2
Cabramatta Creek: Downstream site boundary, outflow at Camden Valley Way	88.6	88.5

Location	Latest Cabramatta Floodplain Management Study and Plan model including WSO (m^3/s)	Edmondson Park Master Plan model (m^3/s) (Existing Conditions Model)
Tributary of Maxwell Creek Downstream site boundary, outflow at Camden Valley Way	15.5	17.8
Upper Maxwell Creek Downstream site boundary, outflow at M5	52.5	52.3

3.1.4 Edmondson Park Master Plan Land Use Assumptions

Definition of the future land-use and layout within the Edmondson Park site is an ongoing process. In order to provide the input required to the overall master planning process, the latest available Concept Plan at the time (March 2003) was used as supplied by Civitas. This Concept Plan, defines the areas of high, medium residential, business, internal road layout, open space and the conservation corridor.

The Concept Plan was intersected with hydrological sub-catchments to determine pervious and impervious areas in each sub catchments. Percentage impervious assumptions for each category, together with the total areas within the Edmondson Park site are listed in Table 3.2 below.

Table 3.2 Land use categories, Total Areas and % Impervious Factors

Category	Total Area (ha)[*1]	Impervious Factor
Residential	315	70%
Business	63	80%
Roads	129	100%
Conservation corridor and open space	289	0%

[*1] as per March 2003 Concept Plan

3.1.5 Simulation

Flood hydrographs for the 20, 50, 100-year Average Recurrence Interval (ARI) and the PMF were generated using the RAFTS-XP software, at key locations throughout the Edmondson Park site. A number of scenarios were simulated as follows:

- Existing conditions;
- Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site; and

- Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site, and provision of mitigation strategies.

In terms of the third scenario, the requirement was that the post development discharge at the downstream site boundary is equal to existing conditions model, for the 20-, 50- and 100-year ARI flood events. Table 3.3 lists flood peaks at the site boundary for a range of ARI's, for existing conditions and for fully developed conditions at key locations. Detailed summaries of flood peaks are given in Appendix A.

3.2 Stormwater Re-use

The analysis of water services to the Edmondson Park site was part of the services brief, being undertaken by URS. The investigation of stormwater as a viable re-use alternative, thus formed part of the URS brief and is not discussed in detail in this report.

As part of WSUD, it is important to encourage stormwater re-use in order to attenuate flows and reduce runoff volume. During smaller events, systems such as rainwater tanks will assist in reducing runoff volumes from developed areas. Theses schemes would thus supplement water supply in a non-potable form, for end uses such as laundry, toilet and irrigation systems. It is important to note, that rainwater tanks will have negligible effect in terms of stormwater management during larger events, providing little or no benefits in terms of flood management.

Table 3.3 Flood Peaks for a range of ARI's at the Edmondson Park site boundaries (as per March 2003 Concept Plan)

Location	20-yr ARI (m^3/s)			50-yr ARI (m^3/s)			100-yr ARI (m^3/s)			PMF (m^3/s)		
	Existing	Developed	Mitigated	Existing	Developed	Mitigated	Existing	Developed	Mitigated	Developed	Developed	Mitigated
Cabramatta Creek: Upstream site boundary, inflow from southwest	39.5	57.1	57.1	47.8	69.5	69.5	55.5	81.1	81.1	352.8	451.4	451.4
Cabramatta Creek: Upstream site boundary, inflow from tributary to the west	12.2	15.9	15.9	14.8	19.3	19.3	17.2	22.6	22.6	116.3	139.1	139.1
Cabramatta Creek: Downstream site boundary, outflow at Camden Valley Way	63.5	82.8	61.3	75.7	101.3	73.3	88.5	117.3	82.8	511.2	669.7	635.5
Tributary of Maxwell Creek Downstream site boundary, outflow at Camden Valley Way	12.5	31.2	14.9	15.4	35.8	16.9	17.8	39.9	18.6	110.7	151.1	140.6
Upper Maxwell Creek Downstream site boundary, outflow at M5	39.5	54.1	41.4	47.7	63.1	49.2	52.3	71.5	55.3	291.6	340.6	338.2
Tributary of Bunbury/Curran Creek Downstream site boundary, outflow at M5	4.7	9.2	3.7	5.7	10.5	4.2	5.6	11.8	4.7	37.5	41.1	40.2

3.3 Hydraulic Analysis (Flood Events)

3.3.1 Evolution of Hydraulic Models

For the Cabramatta Floodplain Management Study and Plan the University of NSW Water Research Laboratory (WRL) developed a RMA-V2 hydraulic model in 1999. This model simulated flood extents for the entire Cabramatta Creek and major tributaries. The upstream limit of the model on the Cabramatta Creek and the Maxwell Creek does not extent sufficiently into the Edmondson Park site for the purposes of the present study. Furthermore this model within the Edmondson Park site was developed using a 20m by 20m grid digital terrain model, developed for the Cabramatta Floodplain Management Study and Plan from photogrammetric analysis.

It must be mentioned that a HEC-RAS model was developed before the RMA-V2 model, however this provided little additional information to the Cabramatta Floodplain Management Study and Plan.

For the Edmondson Park Master Plan it was decide to develop a Mike11 hydraulic model for all creeks and tributaries within the Edmondson Park release area, depicted as "blue" creek lines on the 1 in 25000 scale topographic map (a procedure generally accepted by authorities as defining the creeks within the site). The purpose of the Mike11 modelling was to depict flood extents and assist the Edmondson Park master planning process, by delineation flood extents for:

- Existing conditions;
- Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site; and
- Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site, and provision of mitigation strategies.

3.3.2 Mike11 Model Compilation

A Mike11 hydraulic model for all creeks and tributaries within the Edmondson Park release area, depicted as "blue" creek lines on the 1 in 25 000 scale topographic map (a procedure generally accepted by authorities as defining the creeks within the site) was developed. The model was compiled in the following manner:

- Topography describing the creek channel and floodplains was abstracted from a DTM developed for the Edmondson Park study site by the surveyors on the study team. This provided a DTM for approximately 90% of the site. Areas not covered by the DTM were supplemented from topographical information provided by the Cabramatta Floodplain Management Study and Plan;
- Cross-sections were abstracted at intervals of between approximately 80m to 100m;

- Channel and floodplain roughness was approximated using Manning's n values of between 0.8 and 1.0 for the channel and floodplain, and 0.15 in heavily wooded areas;
- Based on the assumption (based on discussions with the Master Planner) that future road layouts will incorporate river crossings accommodating the 100-year ARI flood event without significant attenuation, no structures were configured in the hydraulic model. In terms of delineating existing conditions, it was assumed that larger floods would overtop existing bridge and culvert crossings; and
- Downstream boundary conditions were chosen as the level of overtopping at Camden Valley Way and the M5 respectively. For the PMF, a estimate of road overtopping was used together with a weir overflow calculation to estimate downstream boundary conditions.

For the purpose of master planning and informing the study, the above methodology was deemed adequate.

3.3.3 Calibration

Calibration of the RMA-V2 model for the Cabramatta Floodplain Management Study and Plan was achieved by comparing simulated flood levels to flood levels observed during two major flood events. This was only possible for the reaches of Cabramatta Creek and Hinchinbrook creek, downstream of the Edmondson Park study where data existed.

In the absence of available observed flood level data within the study area, calibration was achieved by comparing simulated levels to levels reported in the Cabramatta Floodplain Management Study and Plan at key locations.

In the comparisons, it must be noted that the present study relies on survey, which is more accurate than what was available at the time of the Cabramatta Floodplain Management Study and Plan.

Table 3.4 lists comparisons of simulated flood levels at key locations on Cabramatta Creek, tributary of Maxwell Creek and Maxwell Creek with the flood levels reported in the Cabramatta Floodplain Management Study and Plan report.

Table 3.4 Comparisons of Flood Levels at Key Locations

Location	100-year ARI Flood Levels (m)	
	Cabramatta Floodplain Management Study and Plan (RMA-V2)	Edmondson Park (Mike 11)
Downstream of the southern crossing of Jardine Drive over Cabramatta Creek	47.2	47.3
Downstream of the northern crossing of Jardine Drive over Cabramatta Creek	44.7	44.7

3.3.4 Simulation

Flood levels throughout the Edmondson Park site were simulated by routing flood hydrographs for the 20, 50, 100-year ARI and the PMF in Mike11, and delineating flood extents. Simulations were undertaken for a number of scenarios as listed in Table 3.5.

Table 3.5 Summaries of Mike11 Simulations

Scenario	20-yr ARI	50-yr ARI	100-yr ARI	PMF
Existing conditions			✓	
Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site			✓	
Fully developed conditions, that is 2026 development conditions upstream of Edmondson Park together with the proposed development footprint within the Edmondson Park site, and provision of mitigation strategies	✓	✓	✓	✓

3.3.5 Flood Mapping

Flood extent mapping was produced for the scenarios listed in Table 3.5, for each of the creeks traversing the site. Each flood map (refer Appendix B) shows:

- Positions of the cross-sections;
- Location of the flood extent for the a range of scenarios and ARI's;
- Flood level at each cross-section;
- Existing cadastral information for ease of location; and
- Contours information.

It is important to note, that flood extent line shown on the plans are for planning purposes only, and should not be used to stake out positions on the ground. Furthermore, it is important to be mindful of the assumptions used to produce the flood extents.

3.4 Water Quality Analysis

A detailed data analysis and simulation of water quality was outside the scope of this study. Geotechnique, the geotechnical consultants, undertook sampling to assess soil and water body salinities. Their findings are summarised in Section 2.6.

Proposals to address water quality management have been based on qualitative analysis, and procedures outlined in the literature, such as the DLWC Constructed Wetlands Manual.

4. WSUD Stormwater Management

4.1 Objectives

With WSUD, urban planning and design sets out to minimise the hydrological impacts of development on the surrounding environment. To this end the management of stormwater must encompass:

- Flood management;
- Flow management;
- Water quality management; and
- Flow attenuation.

Key planning and design objectives (CRC, 2002) are:

- Protect and enhance natural water systems in urban developments;
- Integrate stormwater treatment into the landscape by incorporating multiple-use corridors, that maximise the visual and recreational amenity of the development;
- Protect water quality draining from the development;
- Reduce runoff and peak flows from developments by employing local detention measures, minimising impervious areas and maximising re-use. Post development runoff peaks to be at pre-development (existing) levels at the downstream site boundary, as stipulated in the Cabramatta Floodplain Management Study and Plan; and
- Add value while minimising drainage infrastructure development costs.

4.2 Guiding principles

Guiding principles for future drainage management at Edmondson Park, in broad terms, should aim at retention of as much stormwater as possible on site, transport as little stormwater as possible to receiving waters, 'lose' as much stormwater as possible along the transport chain, and slow the transmission of stormwater to receiving waters. Additionally, prevent the transportation of gross and sediment-borne pollutants as much as possible. Principles should include:

- Orientation of roads to traverse across contours, providing slopes with grades of 4% or less, to promote the provision of treatment measures into the streetscape;
- Promote cluster lot arrangements around public open space to promote community access to natural and landscaped water features provided for stormwater management;
- Maintain and re-establish vegetation along waterways, and provide public open space along drainage lines to develop multi-use corridors linking public and private areas;

- Preserve and restore (if required) existing valuable elements of the stormwater drainage system (e.g. natural channels, wetlands, riparian vegetation);
- Manage the quality and quantity of stormwater at or near the source, which will involve a significant component of public education and community involvement. Treatment practices such as wetlands to manage water quality should be provided downstream or close to the point of discharge of the upstream catchment. Furthermore detention basins, lakes, and ponds should be located off-line to the creak;
- Provide 'structural' stormwater quantity and quality management practices that provide flood management, flow attenuation, flood volume reduction, and water quality management. Typically detention basins, lakes and ponds, wetlands, rehabilitated waterways and water reuse schemes. Furthermore provide primary stormwater treatment measures, which target litter, gross pollutants and coarse sediments and secondary treatment measures, which target sediment, nutrients and bacteria.

5. Development of Options

5.1 Flood Management

5.1.1 Cabramatta Creek

The Upper Cabramatta Creek draining through the Edmondson Park site receives significant inflow at the upstream site boundary, from a tributary discharging from the southwest and a second tributary to the west (refer Table 3.3), before discharging at Camden Valley Way. Providing numerous dry detention facilities within the Edmondson Park release area, for detaining discharge from the site, is therefore not deemed the most appropriate method to reduce peak flows to existing conditions at Camden Valley Way. To this end, larger detention facilities are proposed to manage both the upstream inflows and runoff from the site. To provide the function for water quality management, it is proposed to configure these facilities as extended detention wet/dry basins, and to locate these as off-channel structures.

Referring to Figure 5.1, four options for extended detention wet/dry basins have been developed, namely:

- Option 1: An extended detention wet/dry basin upstream and adjacent to Camden Valley Way, attenuating runoff from the entire catchment area upstream of this point. This basin would correspond to Basin 12 identified by Liverpool City Council in their Basin Strategy.
- Option 2: An extended detention wet/dry basin at the upstream (southern) site boundary, where Cabramatta Creek discharges into the Edmondson Park release area, upstream of the proposed railway alignment;
- Option 3: An extended detention wet/dry basin on Cabramatta Creek, downstream of the proposed railway alignment (approximately 900 m upstream of Camden Valley Way); and
- Option 4: An extended detention wet/dry basin near the upstream site boundary, directly downstream of the proposed railway alignment;

All four options provide the necessary attenuation to discharge existing conditions flood peaks at Camden Valley Way. Option 3 is the preferred option, as it is:

- Best suited to the precinct and urban planning layout (as indicated by the planners);
- Located near the upstream edge of the site, discharging attenuated flows to Cabramatta Creek;
- Located in flatter topography, preferable for construction;
- Located partly within the conservation corridor;
- Outside and not limited by the proposed railway corridor alignment;
- Not impacting on vegetation designated as ‘high’ or ‘medium’ constraint; and

- Not impacting on any areas demarcated as having archaeological and/or heritage value.

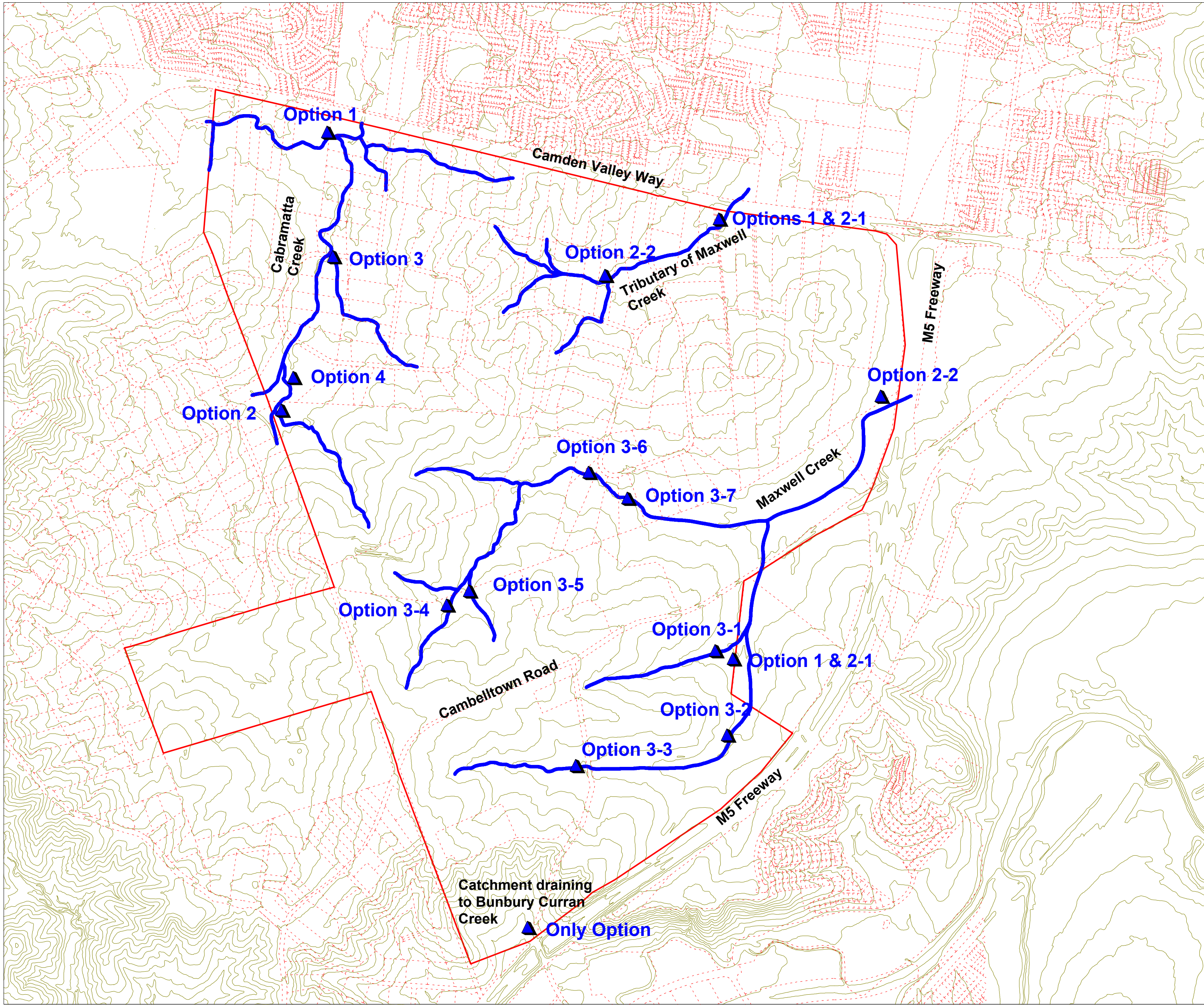
5.1.2 Tributary of Maxwell Creek

Referring to Figure 5.1, in this sub-catchment two options for extended detention wet/dry basins have been developed, namely:

- Option 1: A single extended detention wet/dry basin, upstream and adjacent to Camden Valley Way, attenuating runoff from the entire catchment area upstream of this point. This basin would correspond to Basin 14 identified by Liverpool City Council in their Basin Strategy; and
- Option 2: Two extended detention wet/dry basins on the tributary of Maxwell Creek, one located directly upstream and adjacent to Camden Valley Way, and the other approximately 300 m upstream of Croatia Avenue.

Both options provide the necessary attenuation to discharge existing conditions flood peaks at Camden Valley Way. Option 2 is the preferred option for the following reasons:

- Best suited to the precinct and urban planning layout, not encroaching on lots set aside for potential future use, for example at the intersection of the proposed Transit Way and Camden Valley Way;
- The upstream basin attenuates inflow peaks, discharging lower flood peaks downstream;
- Both basins are located in flatter topography, preferable for construction;
- Not impinging on vegetation designated as ‘high’ constraint, and only partly impinging on vegetation designated as ‘medium’ constraint; and
- Not impacting on any areas demarcated as having archaeological and/or heritage value.

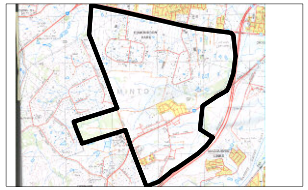


LEGEND/NOTES

Basin Options

0.25 0 0.25 0.5
Kilometers

LOCALITY MAP



COPYRIGHT

Horiz. Datum MGA- Zone 56s		**Projection** UTM	
Height Datum		**Metadata Recorded**	
Created	**Checked**	**Approved**	
Date	**File Location**		
Revision	**Drawing Number**		

Edmondson Park Master Plan

FIGURE 5.1:
Options for Extended Detention Wet/Dry Basin Locations

GHD Project Number: 21/11429

5.1.3 Maxwell Creek

Referring to Figure 5.1, in this sub-catchment, a number of options for extended detention wet/dry basins have been investigated, namely:

- Option 1: An extended detention wet/dry basin at the oval located at the end of Nelson Road within the Ingleburn Village, located on a tributary of Maxwell Creek approximately 500 m upstream of Campbelltown Road;
- Option 2: Two extended detention wet/dry basins, one in a similar position as described above and the other located directly upstream and adjacent to the M5; and
- Option 3: Numerous (up to seven) smaller basin distributed on tributaries discharging to Maxwell Creek.

All options provide the necessary attenuation to discharge existing conditions flood peaks at Camden Valley Way. It must be noted, that there is a significant coverage of vegetation designated as ‘high’ constraint along all the creek lines of Maxwell Creek and numerous archaeological and/or heritage sites, limiting the opportunity of locating many smaller basins. Furthermore the upper reaches of the tributaries tend to be steeper, making construction of offline basins more expensive. Option 1 is the preferred option, as it is:

- Best suited to the general precinct and urban planning layout;
- The basins is located in an area consisting of flatter topography, better suited for off-line basin construction; and;
- Impinging less on vegetation designated as ‘high’ constraint than other locations.

5.1.4 Tributary of Bunbury Curran Creek

Referring to Figure 5.1, for this catchment only one option was considered, namely a detention basin located directly west of the M5 Motorway, approximately at the location where the tributary drains under the M5 Motorway. This option is:

- Best suited to the precinct and urban planning layout;
- Located in flatter part of the catchment, preferable for construction;
- Located entirely within the conservation corridor;
- Not impacting on vegetation designated as ‘high’, ‘medium’ or ‘low’ constraint; and
- Not impacting on any areas demarcated as having archaeological and/or heritage value.

5.2 Flow Attenuation

Apart from the flood attenuation provided by the extended detention wet/dry basins, WSUD flow attenuation strategies should be integrated within the precincts and development layout planning, to provide attenuation to all flows generated within the developed footprint. Proposed opportunities for the Edmondson Park site are further described in Section 6.

5.3 Flow Volume Reduction

Flow volume reduction should be achieved through water re-use where possible. As salinity has been identified as potentially problematic by the geotechnical investigations, infiltration should be avoided on the Edmondson Park site.

Proposed opportunities for the Edmondson Park site are further described in Section 6

5.4 Water Quality Management

Water quality management options should be based on WSUD principles and be integrated into the planning and layout of the precincts. These options should target both primary and secondary pollutants, and treat runoff before discharge to the creeks.

Systems should be located off-channel in order to minimise the impact on the aquatic and riverine environment. Proposed water management options for the Edmondson Park site are discussed further in Section 6 below.

6. Description of Proposed Option

6.1 Flood Management

6.1.1 Extended Detention Wet/Dry Basins

Components

Referring to Figure 6.1, the following extended detention wet/dry basin are proposed:

- Cabramatta Creek: An extended detention wet/dry basin, downstream of the proposed railway alignment (approximately 900 m upstream of Camden Valley Way);
- Tributary of Maxwell Creek: Two extended detention wet/dry basins, one located directly upstream and adjacent to Camden Valley Way, and the other approximately 300 m upstream of Croatia Avenue;
- Tributary of Bunbury Curran Creek: An extended detention wet/dry basins, located directly upstream of the M5; and
- Maxwell Creek: An extended detention wet/dry basin at the oval located at the end of Nelson Road within the Ingleburn Village, located on a tributary of Maxwell Creek approximately 500 m upstream of Campbelltown Road.

Appendix C provides conceptual layout drawings of each extended detention wet/dry basin, listing critical design parameters. Table 6.1 lists critical dimensions.

General Description

It is proposed to provide off-line the extended detention wet/dry basins, which will perform dual functions of flood control and water quality management, by essentially constructing a wetland in the floor of the detention basin. The basins would be located adjacent to the creek, outside areas demarcated as having a ‘high’ ecological community constraint. The basins would be provided with a low flow diversion into the wetland provided by a low submerged weir. A constructed constriction in the creek upstream would divert floods into the basin during larger events.

The incorporated wetland would have alternating zones of shallow and deep water to promote a variety of water quality treatment functions and provide a diverse habitat. Shallow and deep-water zones would be planted with emergent and submerged microphyte species respectively. Each basin would be provided with ‘extended detention storage’ to attenuate storm flow and release it over a period of approximately two days.

Each basin inlet should be provided with a sedimentation forebay, to settle out sediment, reduce base flow velocities and spread flows. Outlets will consist of low and high flow structures, discharging back to the creek.

Drainage corridor to be integrated into open space. Possible drainage easement to be provided, and potential for creek re-habilitation.

Provide Extended Detention Wet/Dry Basin TribMC2, combined detention/water quality/wetland:
V = 19 000m3; A = 1.1ha
Minimum area for water quality treatment 1.4ha

Integrate water quality and flow attenuation strategies into all precincts, eg. GPT's, swales, litter baskets, bufferstrips, landscaping, vegetation, rehabilitated creeks, and integration of other primary and secondary water quality treatment processes

Provide constructed wetland for water quality treatment of minimum area 0.6ha

Potential re-alignment of channel adjacent to Camden Valley Way, with fill of existing creek

Provide Extended Detention Wet/Dry Basin TribMC1, combined detention/water quality/wetland:
V = 34 000m3; A = 1.5ha
Minimum area for water quality treatment 2.1ha

Potential fill areas

Additional fill may be required upstream of this point

Provide constructed wetland for water quality treatment of minimum area 0.2ha

Provide constructed wetland for water quality treatment of minimum area 0.3ha

Potential Landform Adjustment

Provide Extended Detention Wet/Dry Basin CC, combined detention/water quality/wetland:
V = 115 000m3; A = 6.5ha
Minimum area for water quality treatment 1.6ha

Extreme flood management (eg. evacuation planning) to be provided up to PMF, along edges of all creeks.

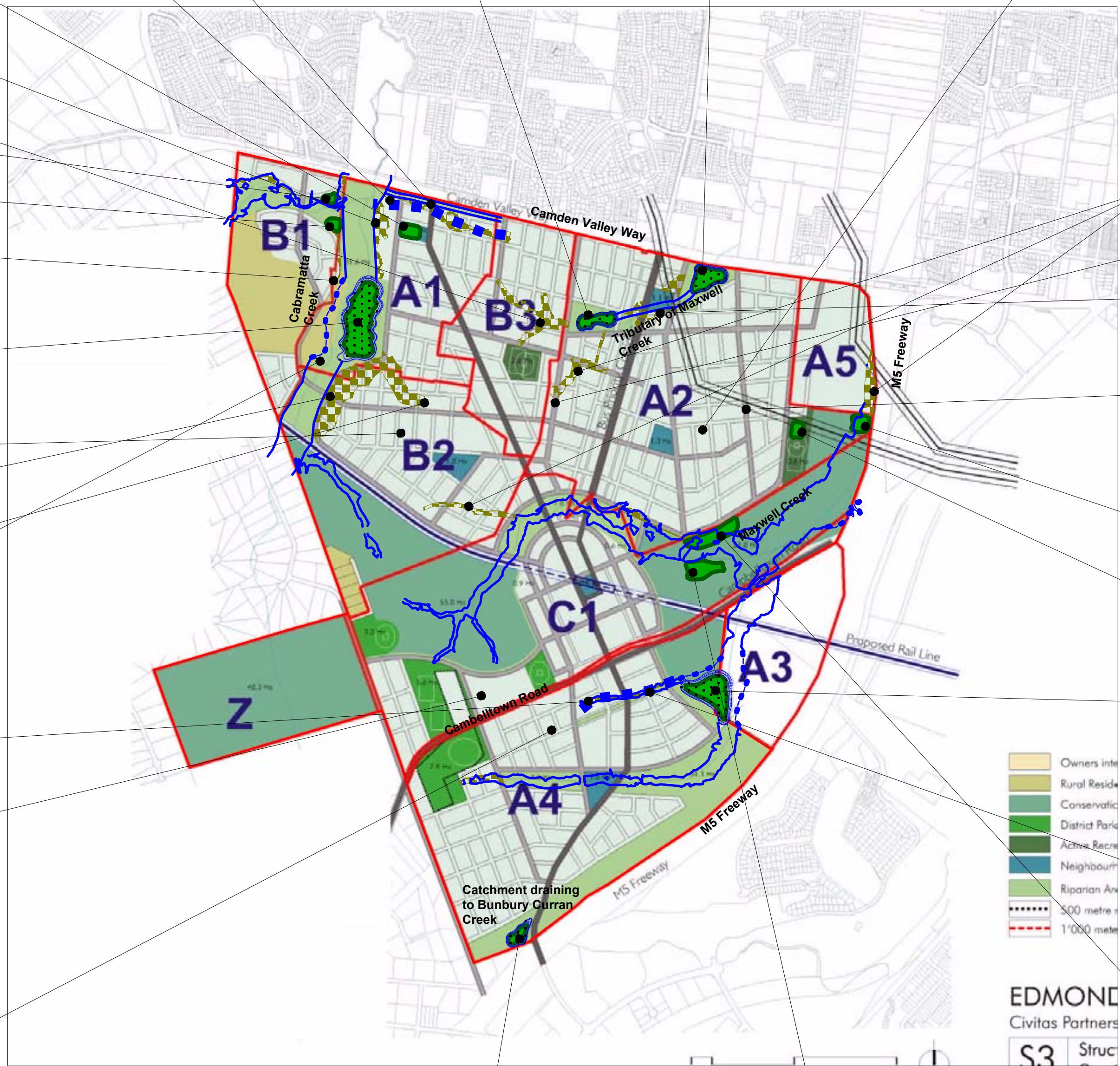
Potential area of fill

Additional fill may be required upstream of this point

Corridor to follow creek centerline more closely

Drainage corridor to be integrated into open space. Possible drainage easement to be provided and potential for creek re-habilitation.

Provide on-site water quality treatment



Potential area of fill

Additional fill may be required upstream of this point

Potential Landform Adjustment

Integrate water re-use into all precincts eg. rainwater tanks

Provide constructed wetland for water quality treatment of approx. 0.6ha

Provide constructed wetland for water quality treatment of approx. 0.4ha

Provide Extended Detention Wet/Dry Basin MC, combined detention/water quality/wetland:
V = 60 000m3; A = 3.2ha
Minimum area for water quality treatment 2.0ha

Potential linear park or bio-engineered channel

Provide constructed wetland for water quality treatment of minimum area 1.5ha

Integrate water quality and flow attenuation strategies into all precincts, eg. GPT's, swales, litter baskets, bufferstrips, landscaping, vegetation, rehabilitated creeks, and integration of other primary and secondary water quality treatment processes

Provide Extended Detention Wet/Dry Basin BC, combined detention/water quality/wetland:
V = 15 000m3; A = 0.9ha
Minimum area for water quality treatment 0.6ha

Provide constructed wetland for water quality treatment of minimum area 1.0ha

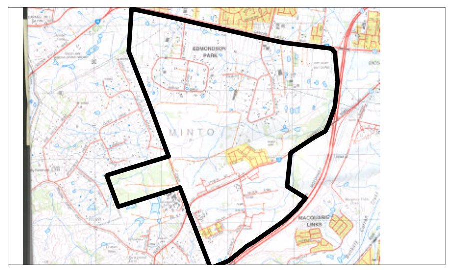
LEGEND/NOTES

Proposals described on this Figure are fully developed in the Report. It is recommended that this figure is read in conjunction with particulary Section 6 of the Water Cycle Management: Stormwater Report

15 August 2003 Structure Plan shown on this figure

- Approx Flood Extent only
- 100-yr ARI Flood Extent
- Detention Basin/Wetlands
- Potential Fill Areas
- Constructed Wetlands

LOCALITY MAP



COPYRIGHT

Horiz. Datum	MGA- Zone 56s	Projection	UTM
Height Datum		Metadata Recorded	
Created	Checked	Approved	
Date	File Location		
Revision	Drawing Number		

Edmondson Park Master Plan

FIGURE 6.1:
Water Cycle Management:
Stormwater Management
Proposed Options

GHD Project Number: 21/11429

Operation

During periods of low flow, a submerged weir diverts runoff to the sediment forebay, through the wetland and back to the creek via the low flow outlet. The location of the low flow outlet would be close to the submerged weir to minimise disturbance to the creek.

Flood flows would be encouraged into the basin via a constriction in the river channel shortly upstream of the basin inlet. A portion of the flood flows would continue in the creek channel, while the remainder would be attenuated within the basin.

Preliminary Design Controls

Table 6.1 Approximate Extended Detention Wet/Dry Basin Dimensions

Location	Name	Storage Volume (m^3)	Top Water Surface Area (ha)*
Cabramatta Creek	CC	115 000	6.5
Tributary of Maxwell Creek	Trib MC2 (upstream)	19 000	1.1
	Trib MC1 (downstream)	34 000	1.5
Upper Maxwell Creek	MC	60 000	3.2
Tributary of Bunbury/Curran Creek	BC	15 000	0.9

*does not allow for additional landscaping around basin edge

6.1.2 Drainage Easements

Referring to Figure 6.1, in a number of locations the upper reaches of tributaries draining to the main creeks are located outside the proposed vegetation corridor. In these cases, it is proposed that these drainage corridors be integrated into the public open space system, potentially being set aside as drainage easements. The creeks draining through the easement would be maintained in their existing status or re-habilitated to enhance their condition if appropriate.

The easements would be required to accommodate the 100-year ARI flood peak.

6.1.3 Linear Parks / Bio-Engineered Channels

Referring to Figure 6.1, a number of potential bio-engineered channels/linear parks are proposed, namely:

- A linear park/bio-engineered channel, adjacent to Camden Valley Way, discharging to the Cabramatta Creek; and
- The linear park / bio-engineered channel, on a tributary of Maxwell Creek starting approximately opposite Ingleburn North Public School downstream of MacDonald Road, and continuing for approximately 800m.

Appendix C provides conceptual layout drawings of each linear park / bio-engineered channel, listing critical design parameters. Table 6.2 lists critical dimensions.

Additional to the abovementioned creek reaches, it is proposed to provide a drainage corridor to the north of the town centre (15 August 2003 Concept Plan), for the northern tributary to Maxwell Creek. In the design of this creek, it will be essential to provide adequate capacity to convey large events up to the 100-year ARI event. This will require careful planning of the drainage corridor, together with management of vegetation, to minimise flow obstruction.

General Description

The two bio-engineered channels would effectively be linear wetlands, providing for flood conveyance and water quality management during times of low-flow. The channels would be designed and landscaped to mimic the form of natural creeks. The channels are proposed to have flat gradients to limit velocity and prevent scouring. To provide these flatter gradients, it is proposed to provide several low drop structures along the route together with rock weir structures and rip-rap lined stilling pools. The channel side slopes would be provided at 1 in 6 grade for safety, aesthetic and erosion considerations.

Landscaping would provide the appearance of natural channels, and trees and shrubs would be provided in a manner not to obstruct the flow path, particularly when conveying larger flood events.

Operation

During periods of low flow, the rock weir structures, flatter grade and small pools will encourage water quality treatment.

Floods, up to the 100-year ARI, event, would be conveyed within the channel profile, with provision of adequate freeboard.

Preliminary Design Controls

Table 6.2 Preliminary Bio-Engineered Channel Dimensions

Location	Total top-width (m)	Base channel invert width (m)	Base channel depth (m)
Adjacent to Camden Valley Way	25	1.5	0.4
On a tributary of Maxwell Creek	25	3.0	0.6

6.1.4 Landform Adjustments

The potential for landform adjustments have been investigated at two locations, namely:

- Cabramatta Creek (adjacent, upstream and downstream of the extended detention wet/dry basin); and
- Tributary of Maxwell Creek (adjacent and downstream of the upstream extended detention wet/dry basin)

The analysis was undertaken in a separate steady-state-analysis using the HECRAS hydraulics software and encroachment widths were iterated until the local increase in flood level exceeded 0.1m. This is based on the assumption documented in the NSW Floodplain Management Manual, that the encroachment on the floodplain would affect flood storage. The manual defines flood storage as *"those areas outside the floodways which, if completely filled with solid material would cause peak flood levels to increase anywhere by more than 0.1m".*

The landscape re-shaping would essentially consist of providing a platform above the 100-year ARI flood level (allowing for freeboard), with in the case of the Tributary to Maxwell Creek, some reshaping of the river channel to provide adequate channel capacity for the 100-year ARI flood. No disturbance to the Cabramatta Creek River channel is proposed. In order to minimise the effect on local flood levels, encroachment should be limited to a minimum of 150m-corridor width in the case of Cabramatta Creek, and 30m width in the case of the tributary to Maxwell Creek which will also require some channel works to provide adequate capacity to convey the 100-year ARI flood.

Typical cross-sections at selected locations are given in Appendix E.

6.1.5 Extreme Flood Management

Extreme flood management, up to the PMF would need to be provided by appropriate evacuation planning, and by provision of escape routes to higher lying areas. These principles would need to be addressed in the precinct layout planning, particularly in considering road layouts.

Furthermore, planning for the corridor between the 100-year ARI and the PMF flood extent should aim to minimise the potential for accelerated flow velocity (for example discharge down roads), areas of excessive depth and the potential for secondary overflow drainage corridors.

6.2 Flow Attenuation

Apart from the flood attenuation provided by retarding basins, lakes/ponds, wetlands, options for flood attenuation would include:

- Bio-engineered creeks, providing pools and riffles.
- Vegetated swales
- Re-habilitated creeks;
- Buffer strips; and
- Water re-use schemes.

These flow attenuation strategies would be integrated within the precincts and development layout planning, to provide attenuation to all flows generated within the developed footprint.

6.3 Flow Volume Reduction

It is proposed that flow volume reduction should be achieved through water re-use, through the provision of storm water harvest systems such as rainwater tanks.

As salinity has been identified as potentially problematic by the geotechnical investigations, infiltration should be avoided on the Edmondson Park site.

6.4 Water Quality Management

It is proposed top provide water quality management through the provision of constructed wetlands throughout the site, treating runoff before discharge to the creeks. These wetlands are to be located either as separate structures, offline to the major creeks or be incorporated into proposed extended detention wet/dry basins. Furthermore it is proposed to locate the basins outside areas demarcated as having a 'high' ecological community constraint. Table 6.3 lists preliminary constructed wetland surface areas, as calculated according to the DLWC Constructed Wetlands Manual, required to treat stormwater runoff from the development, on a water quality catchment basis as shown in Figure 6.2. These wetlands should be located as near to the sub-catchment outlet as possible, treating runoff before this is discharged to the creek.

In addition to the water quality management using the wetlands and extended detention wet/dry basin, it is proposed that the following primary and secondary stormwater treatment processes would be integrated into the precinct planning:

- Typical primary stormwater treatment measures, which target litter, gross pollutants and coarse sediments, such as:
  - Litter baskets and (control) pits - baskets installed within pits to collect rubbish directly entering the stormwater system from road surfaces;
  - Litter (trash) rack—a vertical rack installed across a stormwater conveyance routes (or at the downstream end of a sediment trap;
  - Sediment traps (fore bay)—structure placed within the stormwater system or upstream of other stormwater treatment processes to trap coarse sediment, being either a formal 'tank' or a less formal pond;
  - Gross pollutant trap (GPT)—sediment trap with a litter rack, usually located at the downstream end of the trap;
  - Litter boom—floating device installed in channels and waterways to collect floating litter and oil; and
  - Oil/grit separators (water quality inlets)—generally comprise three underground retention chambers designed to remove coarse sediment and hydrocarbons.
- Typical secondary treatment measures, which target sediment, nutrients and bacteria, such as:

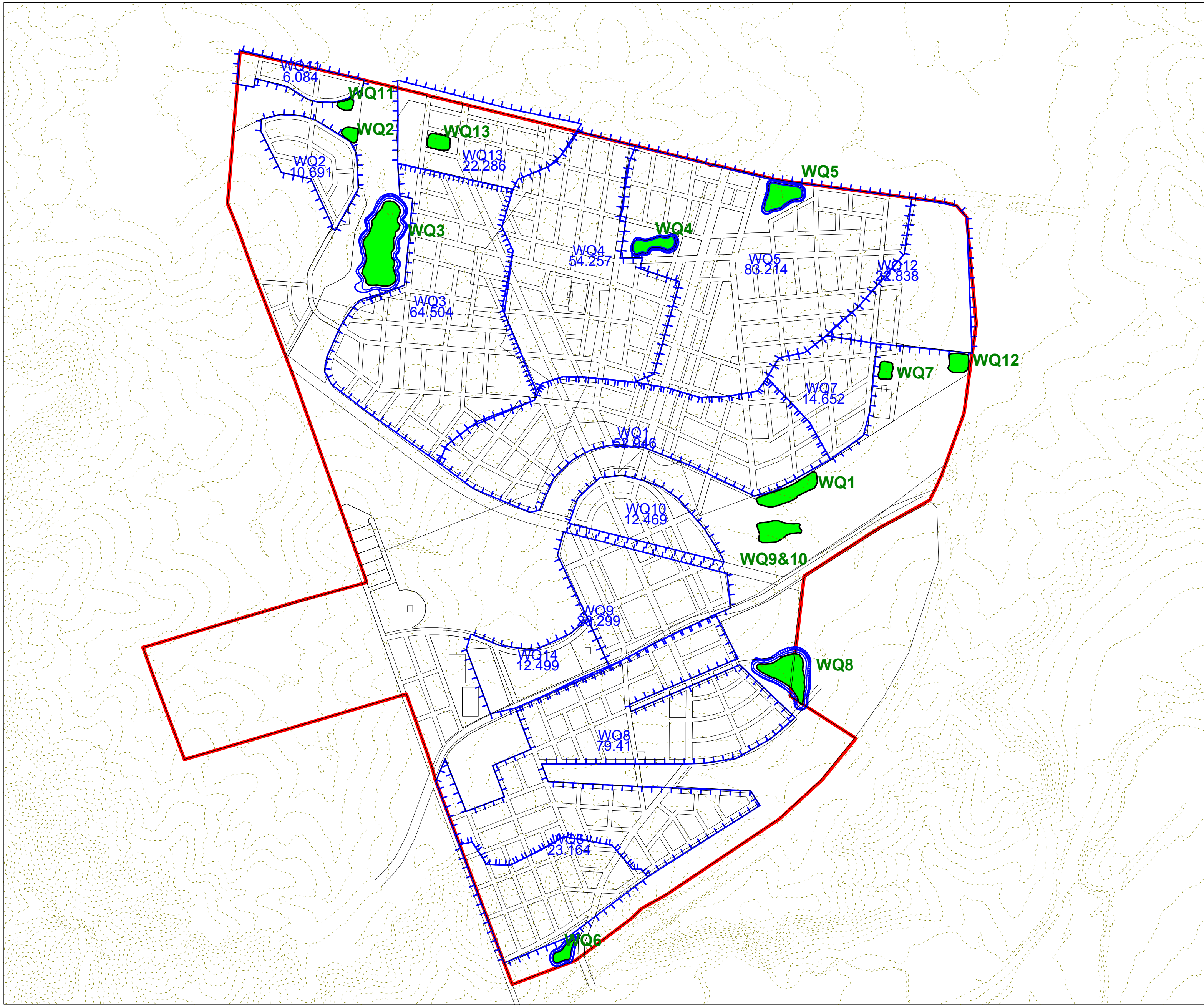
– Filter strips (also known as buffer zones or buffer strips)- grassed or vegetated areas that treat overland flow, often adjacent to watercourses;
– Grass swales—grass-lined channels for conveying runoff from roads and other impervious surfaces; and
– Extended detention zones in basins that store runoff for 1–2 days and drain to an essentially dry condition between storm events;

In addition to the above, it is proposed that landscaping and vegetation be used to further provide water quality management. These strategies would require landscaping to attenuate flows, encourage evaporation and evapotranspiration, and the provision of appropriate vegetation species in precinct buffer strips and open spaces.

Table 6.3 Preliminary Constructed Wetland Surface Areas (Refer Figure 6.2)

Sub-catchment	Approximate Minimum Surface Area (ha)*	Comments
C1	1.5	Provide wetland within conservation area, in location outside 'high constraint' vegetation and flooding area
C2	0.3	Provide wetland within conservation area, in location outside 'high constraint' vegetation and flooding area
C3	1.6	Incorporate into extended detention wet/dry basin CC
C4	1.4	Incorporate into extended detention wet/dry basin MC2 and MC1
C5	2.1	Incorporate into extended detention wet/dry basin MC2 and MC1
C6	0.6	Incorporate into extended detention wet/dry basin BC
C7	0.4	Provide wetland within district park
C8	2.0	Incorporate into extended detention wet/dry basin MC
C9&10	1.0	Provide wetland within conservation area, in location outside 'high constraint' vegetation and flooding area
C11	0.2	Provide wetland within conservation area, in location outside 'high constraint' vegetation and flooding area
C12	0.6	Provide wetland within conservation area, in location outside 'high constraint' vegetation and flooding area
C13	0.6	Provide wetland within district park

*does not allow for additional landscaping around basin edge



LEGEND/NOTES

160903 Structure Plan

Wet/Dry Det Basins

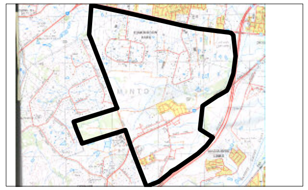
WQ Basins

WQ Basin Catchments

0.25 0 0.25 0.5

Kilometers

LOCALITY MAP



COPYRIGHT

Horiz. Datum MGA- Zone 56s		**Projection** UTM	
Height Datum		**Metadata Recorded**	
Created	**Checked**	**Approved**	
Date	**File Location**		
Revision	**Drawing Number**		

Edmondson Park Master Plan

FIGURE 6.2:
Water Quality Catchments and Basin Locations

GHD Project Number: 21/11429

7. Costing of Options

7.1 General

Costing of the fixed stormwater management elements was undertaken at Scoping Level. Referring to Figure 6.1, the key elements costed are:

- The extended detention wet/dry basin on Cabramatta Creek, approximately 400 m downstream of the upstream site boundary (approximately 900 m upstream of Camden Valley Way);
- The two extended detention wet/dry basins on the tributary of Maxwell Creek, one located directly upstream of Camden Valley Way, and the other approximately 300 m upstream of Croatia Avenue;
- The extended detention wet/dry basin at the oval located at the end of Nelson Road within the Ingleburn Village, located on a tributary of Maxwell Creek approximately 500 m upstream of Campbelltown Road;
- The extended detention wet/dry basin on the tributary of Bunbury Curran Creek, located directly upstream of the M5;
- A linear park/bio-engineered channel, adjacent to Camden Valley Way, discharging to the Cabramatta Creek;
- The linear park/bio-engineered channel, on a tributary of Maxwell Creek starting approximately opposite Ingleburn North Public School downstream of Macdonald Road, and continuing for approximately 800m; and
- The constructed wetlands (WQ 1,2,7, 9&10, 11,12 and 13 – refer to Figure 6.2)

The cost estimates are based on extrapolation of recent similar project pricing, budget quotes for some equipment items, industry unit rates and in-house experience, and are estimated at 2002 base rates. The estimates are based on preliminary concept designs and are not warranted by GHD. Generally, quantities are only as accurate as the concept drawings. A detailed design is recommended should more reliable cost estimate be required.

7.2 Costing Assumptions

7.2.1 General

The following assumptions apply to both the extended detention wet/dry basin and the bio-engineered channels:

- All sites are accessible by motor vehicle;
- All sites are vegetated with medium density bushland;
- All sites have a light topsoil;
- Excavation is in light soil or clay, not rock;
- Spoil is used elsewhere on Edmondson Park site (no disposal fees are applicable);

- All excavations are in uncontaminated soil;
- Constructed basins and channels to have no interaction with groundwater;
- Clay lining seal is 300 mm thick;
- Discount rate is 7% per annum;
- Maintenance and operating costs are given in 2003 dollars;
- Design, supervision, project management and contractor on-costs are assumed as 15% of the project capital cost; and
- Contingencies are assumed at 25%.

Further specific notes regarding costing and design assumptions have been provided in the 'notes' column of each costed item in Appendix D.

7.2.2 Extended Detention Wet/Dry Basins

The following assumptions apply to the extended detention wet/dry basin cost estimates:

- Embankment type to be an earth embankment;
- High flow outlet box culvert dimensions;
- Macrophyte planting density;
- Landscaping of embankments;
- If required, all basins will be fully fenced;
- A gross pollutant trap is provided upstream of each basin;
- Regular ongoing maintenance is limited to mowing, gardening, weeding and litter removal
- Maintenance consists of reporting on the condition of the basin and planting and culling macrophytes every three years; and
- Maintenance consists of draining the basin, removing trapped sediments, revegetating and culling macrophytes, and restoring basin embankments and landscaping every two years.

7.2.3 Linear Parks / Bio-Engineered Channels

The following assumptions apply to the linear parks/bio-engineered channel cost estimates:

- Landscaping of channel floodplain;
- Regular ongoing maintenance is limited to mowing;
- Maintenance consists of reporting on the condition of the channel every three years; and
- Maintenance consists of minor earthworks, rehabilitation, stabilisation and rockworks every two years.

7.3 Costing Summary

Table 7.1 summarises the costing for each of the drainage elements. Detailed breakdown of the costing is given in Appendix D.

Table 7.3 Major Drainage Elements Costing Summary

Location	Cost
Extended Detention Wet/Dry Basin on Cabramatta Creek	$ 2.2 mill
Extended Detention Wet/Dry Basin on Tributary to Maxwell Creek (upstream)	$ 0.7 mill
Extended Detention Wet/Dry Basin on Tributary to Maxwell Creek (downstream)	$ 0.8 mill
Extended Detention Wet/Dry Basin on Maxwell Creek	$ 1.6 mill
Extended Detention Wet/Dry Basin on Bunbury-Curran Creek	$ 0.8 mill
Bioengineered Channel draining to Cabramatta Creek	$ 0.7 mill
Constructed wetlands (refer to Figure 6.2)	
WQ1	$ 0.7 mill
WQ2	$ 0.3 mill
WQ7	$ 0.3 mill
WQ 9&10	$ 0.5 mill
WQ11	$ 0.3 mill
WQ12	$ 0.4 mill
WQ13	$ 0.4 mill

8. Conclusions and Recommendation

GHD, as a member of a multi disciplinary team of urban planners, water cycle engineers, social planners and economists, working interactively to produce the Edmondson Park Master Plan and the supporting documentation, has addressed the stormwater management at the Edmondson Park site. The outcome, documented in this report identifies constraints and opportunities on water cycle management and stormwater master planning incorporating:

- Flood management;
- Flow management;
- Water quality management; and
- Re-use of stormwater as a resource.

Hydrological simulations were undertaken to provide flood hydrographs for the 20, 50, 100-year Average Recurrence Interval (ARI) and the PMF flood events. These were simulated using the Mike11 hydraulic model to calculate flood extent for all creeks and tributaries within the Edmondson Park site area.

Future drainage management at Edmondson Park were based on guiding principles which in broad terms aim at retention of as much stormwater as possible on site, transport as little stormwater as possible to receiving waters, "lose as much stormwater as possible along the transport chain, slow the transmission of stormwater to receiving waters as much as possible, and prevent the transportation of gross and sediment-borne pollutants.

Water Sensitive Urban Design Drainage (WSUD) objectives were incorporated to protect and enhance natural water systems, integrate stormwater treatment into the landscapes, protect water quality draining from the development, reduce runoff and peak flows from developments by employing local detention measures, minimise impervious areas and maximise re-use.

A number of stormwater management options were evaluated and a preferred strategy is recommended, which proposes:

- Flood Management through provision of five extended detention wet/dry basins, to be located offline where possible, and drainage corridors/easements/bio-engineered channels;
- Flow Attenuation through retarding basins, lakes/ponds, wetlands, rehabilitated creeks, vegetated swales, buffer strips and water re-use schemes;
- Flow Volume Reduction through water re-use, for example rainwater tanks; and
- Water Quality Management through wetlands, extended detention wet/dry basins and primary/secondary stormwater treatment processes consisting of amongst others sediment, litter, nutrient and bacteria treatment;

Scoping level costing of the major drainage elements has been undertaken and are presented in Section 7.

It is recommended that future work focus on further developing the stormwater management proposals, particularly with respect to the design and engineering of the extended detention wet dry basins, constructed wetlands and linear parks / bio-engineered channels. This needs to be facilitated by further detailed survey and other detailed supporting studies/investigations (for example geotechnical and hydrological/hydraulic). Furthermore, attention needs to be given to incorporating primary and secondary stormwater treatment processes into the internal precinct planning and maximising stormwater water re-use.

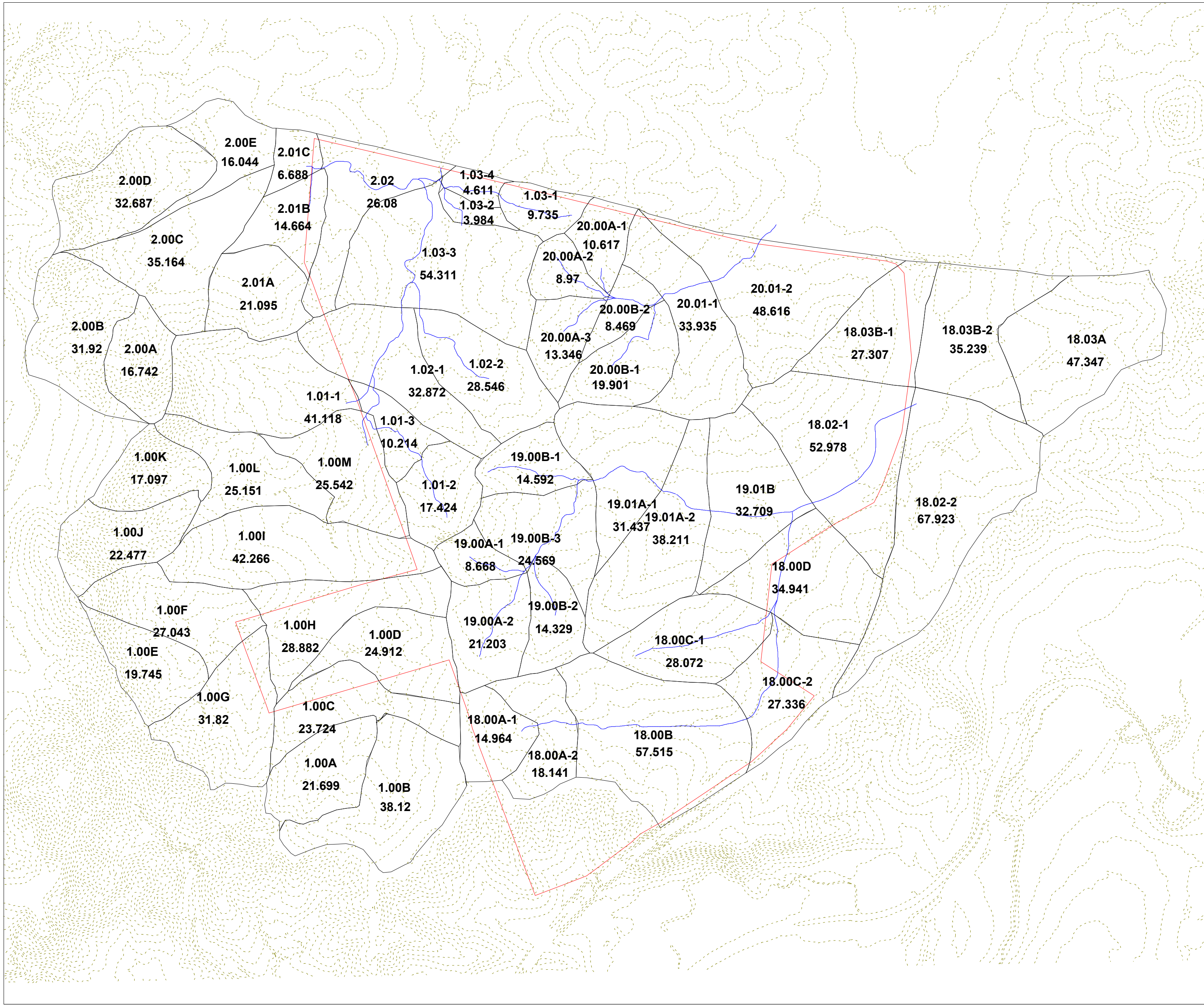
References

- CRC, 2002: Water Sensitive Urban Design – a Stormwater Management Perspective, and Industry Report 02/10;
- Agricultural and Resource Management Council of Australia and New Zealand, 2000: National Water Quality Management Strategy – Australian Guidelines for Urban Stormwater Management;
- NSW EPA, 1997: Managing Urban Stormwater: Treatment Techniques (DRAFT)
- Liverpool City Council, 1999(a) – Cabramatta Creek Floodplain Management Study: Working Paper No.31 Review of Basin Strategy;
- Liverpool City Council, 1999(b) – Cabramatta Creek Floodplain Management Study and Plan: Main Report;
- Liverpool City Council, 1998 – Flood Study Report Epoch 1 Conditions: Working Paper 3;
- Liverpool City Council, 1999(c) – Liverpool District Stormwater Management Plan;
- Knox City Council, 2002: Water Sensitive Urban Design Guidelines for the City of Knox;
- CSIRO Urban Water, 2002: Edmondson Park Feasibility Report;
- Geotechnique, 2003 – Proposed Edmondson Park Release Area – Land Capability Assessment

Appendix A

Hydrology Output

(based on March 2003 Concept Plan)

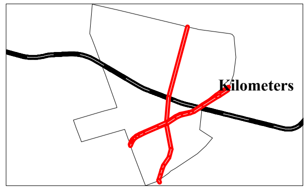


LEGEND/NOTES

Label 1= Name
Label 2= Area (ha)

0.5 0 0.5 1
Kilometers

LOCALITY MAP



Horiz. Datum MGA- Zone 56s	**Projection** UTM	
Height Datum	**Metadata Recorded**	
Created	**Checked**	**Approved**
Date	**File Location**	
Revision	**Drawing Number**	

Edmondson Park Masterplan
RAFTS Sub-catchments

GHD Project Number: 21/11429

Edmondson Park Master Plan: RAFTS Simulation Results (Proj: 21/11429)

20-year ARI

NEW Subcatch Names	Ed Basecase Latest IDF 6 BaseWSO89D-1split1C 100yr 2hr		Ed G5 no Det Basins 9 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr		Ed G5 with Det Basins 12 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr	
	split subcatch, Bx=1.05, latest IDF storms, 2hr duration is worst		NO BASINS !! split subcatch Ed S1(13/03/2003) concept plan, latest IDF data		split subcatch Ed S1 (13/03/2003) concept plan, latest IDF data & final Det Basins	
	Qpeak m3/s		Qpeak m3/s		Qpeak m3/s	
20.00A-1	1.04		3.52		3.52	
20.00A-2	0.91		3.29		3.29	
20.00A-3	1.25		5.00		5.00	
20.00A		3.19		11.81		11.81
20.00B-1	1.78		7.33		7.33	
20.00B-2	4.03		12.92		12.92	
20.00B		5.81		20.25		20.25
20.01-1	8.71		25.48		16.34	
20.01-2		**12.46**		31.22		21.77
20.01-1DS				**31.22**		**14.96**
18.00A-2		5.78		7.63		7.63
18.00B		10.85		16.61		16.61
18.00C-1		3.94		8.14		8.14
18.00C-2		16.46		21.72		21.72
18.00D		19.01		24.07		13.67
19.00A-1	1.21		1.51		1.51	
19.00A-2	2.60		4.57		4.57	
19.00A		3.81		6.07		6.07
19.00B-1	1.72		3.16		3.16	
19.00B-2	1.69		3.20		3.20	
19.00B-3	7.82		12.02		12.02	
19.00B		11.22		18.39		18.39
19.01A-2		15.77		21.20		21.20
19.01B		18.21		24.06		24.06
18.01		37.08		48.14		36.37
18.03B-1		2.07		6.40		6.40
18.02-1	**39.47**		54.11		41.43	
18.02-1DS				**54.11**		**41.43**
18.02-2		44.10		58.22		45.31
18.03A		3.61		7.78		7.78
18.03B-2		48.98		62.91		47.08
1.00A		1.82		2.46		2.46
1.00B		5.20		7.02		7.02
1.00C		7.38		9.73		9.73
1.00D		9.37		12.58		12.58
1.00G		2.98		4.12		4.12
1.00E		2.68		3.59		3.59
1.00F		8.16		10.76		10.76
1.00H		19.64		26.44		26.44
1.00I		22.95		30.79		30.79
1.00J		2.96		3.90		3.90
1.00K		5.43		7.04		7.04
1.00L		30.75		39.50		39.50
1.00M		32.80		42.26		42.26
1.01-2		1.90		5.82		5.82
1.01-1	36.45		49.77		49.77	
1.01-3	3.02		7.28		7.28	
1.01		39.47		57.05		57.05
1.02-1	41.72		52.55		40.21	
1.02-2	2.28		9.29		9.29	
1.02		44.00		61.84		49.49
1.03-4		1.21		3.39		3.39
1.03-2		0.39		1.37		1.37
1.03-3		48.31		62.29		45.51
2.00A		2.18		4.24		4.24
2.00B		5.03		6.86		6.86
2.00C		7.34		9.54		9.54
2.00D		3.42		4.50		4.50
2.00E		11.75		15.23		15.23
2.01A		1.94		2.42		2.42
2.01B		4.06		4.04		4.04
2.01C		12.17		15.94		15.94
2.02		17.75		22.29		22.29
1.04		**63.50**		**82.18**		**61.26**

Edmondson Park Master Plan: RAFTS Simulation Results (Proj: 21/11429)
50-year ARI

NEW Subcatch Names	EXISTING CONDITIONS Ed Basecase Latest IDF 6 BaseWSO89D-1split1C 20yr 2hr split subcatch, Bx=1.05, latest IDF storms, 2hr duration is worst Qpeak m3/s		Ed G5 with Det Basins 10 BaseWSO89D-1split1-EDG5-det2f 20yr 2hr split subcatch Ed G5 rough concept plan, latest IDF data & Final Det Basins Qpeak m3/s		Ed G5 with Det Basins 10 BaseWSO89D-1split1-EDG5-det2f 20yr 2hr split subcatch Ed G5 rough concept plan, latest IDF data & Final Det Basins Qpeak m3/s	
20.00A-1	1.27		3.95		3.95	
20.00A-2	1.12		3.71		3.71	
20.00A-3	1.51		5.56		5.56	
20.00A		3.90		13.22		13.22
20.00B-1	2.20		8.31		8.31	
20.00B-2	4.93		14.58		14.58	
20.00B		7.12		22.89		22.89
20.01-1	10.72		29.15		18.49	
20.01-2		**15.42**		35.81		24.84
20.01-1DS				**35.81**		**16.91**
18.00A-2		6.64		8.92		8.92
18.00B		12.95		18.74		18.74
18.00C-1		4.48		9.22		9.22
18.00C-2		19.51		25.05		25.05
18.00D		22.76		27.82		16.04
19.00A-1	1.47		1.83		1.83	
19.00A-2	3.09		5.15		5.15	
19.00A		4.55		6.98		6.98
19.00B-1	2.07		3.59		3.59	
19.00B-2	2.03		3.64		3.64	
19.00B-3	9.39		13.83		13.83	
19.00B		13.48		21.05		21.05
19.01A-2		18.93		24.40		24.40
19.01B		21.95		27.95		27.95
18.01		44.66		55.75		42.77
18.03B-1		2.58		7.27		7.27
18.02-1	**47.71**		63.16		49.20	
18.02-1DS				**63.16**		**49.20**
18.02-2		53.51		68.54		53.99
18.03A		4.54		8.91		8.91
18.03B-2		59.22		74.56		56.33
1.00A		2.27		2.99		2.99
1.00B		6.42		8.54		8.54
1.00C		9.04		11.88		11.88
1.00D		11.51		15.33		15.33
1.00G		3.61		4.90		4.90
1.00E		3.19		4.30		4.30
1.00F		9.89		12.72		12.72
1.00H		24.07		31.71		31.71
1.00I		28.22		37.08		37.08
1.00J		3.53		4.72		4.72
1.00K		6.47		8.47		8.47
1.00L		37.31		47.59		47.59
1.00M		39.84		50.98		50.98
1.01-2		2.29		6.56		6.56
1.01-1	44.14		61.12		61.12	
1.01-3	3.63		8.34		8.34	
1.01		47.77		69.46		69.46
1.02-1	50.46		64.97		47.56	
1.02-2	2.80		10.45		10.45	
1.02		53.26		75.42		58.01
1.03-4		1.52		3.90		3.90
1.03-2		0.49		1.53		1.53
1.03-3		58.59		76.69		54.91
2.00A		2.60		4.95		4.95
2.00B		6.08		8.29		8.29
2.00C		8.96		11.60		11.60
2.00D		4.22		5.37		5.37
2.00E		14.38		18.30		18.30
2.01A		2.39		2.93		2.93
2.01B		5.01		4.84		4.84
2.01C		14.88		19.26		19.26
2.02		21.76		27.49		27.49
1.04		**75.69**		**101.29**		**73.30**

Edmondson Park Master Plan: RAFTS Simulation Results (Proj: 21/11429)

100-year ARI

NEW Subcatch Names	EXISTING CONDITIONS Ed Basecase Latest IDF 6 BaseWSO89D-1split1C 100yr 2hr split subcatch, Bx=1.05, latest IDF storms, 2hr duration is worst Qpeak m3/s		Ed G5 no Det Basins 9 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr NO BASINS !! split subcatch Ed S1(13/03/2003) concept plan, latest IDF data Qpeak m3/s		Ed G5 with Det Basins 12 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr split subcatch Ed S1 (13/03/2003) concept plan, latest IDF data & final Det Basins Qpeak m3/s	
20.00A-1	1.46		4.45		4.45	
20.00A-2	1.29		4.15		4.15	
20.00A-3	1.78		6.23		6.23	
20.00A		4.53		14.83		14.83
20.00B-1	2.51		9.29		9.29	
20.00B-2	5.70		16.38		16.38	
20.00B		8.21		25.66		25.66
20.01-1	12.42		32.58		20.82	
20.01-2		**17.87**		39.98		27.91
20.01-1DS				**39.98**		**18.61**
18.00A-2		7.76		10.09		10.09
18.00B		15.15		21.13		21.13
18.00C-1		5.06		10.35		10.35
18.00C-2		22.77		28.31		28.31
18.00D		26.20		31.55		17.74
19.00A-1	1.72		2.13		2.13	
19.00A-2	3.53		5.85		5.85	
19.00A		5.25		7.97		7.97
19.00B-1	2.35		4.09		4.09	
19.00B-2	2.31		4.14		4.14	
19.00B-3	10.74		15.77		15.77	
19.00B		15.39		24.00		24.00
19.01A-2		22.06		27.62		27.62
19.01B		25.64		31.69		31.69
18.01		51.59		62.98		48.07
18.03B-1		2.98		8.17		8.17
18.02-1	**52.29**		71.45		55.30	
18.02-1DS				**71.45**		**55.30**
18.02-2		62.00		77.76		60.70
18.03A		5.30		10.04		10.04
18.03B-2		68.52		84.38		63.88
1.00A		2.60		3.44		3.44
1.00B		7.42		9.78		9.78
1.00C		10.45		13.66		13.66
1.00D		13.28		17.63		17.63
1.00G		4.19		5.60		5.60
1.00E		3.64		5.09		5.09
1.00F		11.44		14.85		14.85
1.00H		27.71		36.32		36.32
1.00I		32.55		42.51		42.51
1.00J		4.03		5.56		5.56
1.00K		7.40		9.94		9.94
1.00L		43.30		54.79		54.79
1.00M		46.21		58.84		58.84
1.01-2		2.64		7.35		7.35
1.01-1	51.36		71.57		71.57	
1.01-3	4.14		9.48		9.48	
1.01		55.50		81.05		81.05
1.02-1	58.70		75.89		53.16	
1.02-2	3.25		11.70		11.70	
1.02		61.95		87.59		64.86
1.03-4		1.75		4.40		4.40
1.03-2		0.56		1.71		1.71
1.03-3		68.17		89.01		61.35
2.00A		3.00		5.63		5.63
2.00B		7.07		9.67		9.67
2.00C		10.37		13.59		13.59
2.00D		4.94		6.24		6.24
2.00E		16.64		21.37		21.37
2.01A		2.74		3.38		3.38
2.01B		5.74		5.54		5.54
2.01C		17.24		22.62		22.62
2.02		25.18		32.02		32.02
1.04		**88.53**		**117.14**		**82.81**

Edmondson Park Master Plan: RAFTS Simulation Results (Proj: 21/11429)
PMF

NEW Subcatch Names	Ed Basecase Latest IDF 6 BaseWSO89D-1split1C 100yr 2hr split subcatch, Bx=1.05, latest IDF storms, 2hr duration is worst Qpeak m3/s		Ed G5 no Det Basins 9 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr NO BASINS !! split subcatch Ed S1(13/03/2003) concept plan, latest IDF data Qpeak m3/s		Ed G5 with Det Basins 12 BaseWSO89D-1split1-EDG5-det2g 100yr 2hr split subcatch Ed S1 (13/03/2003) concept plan, latest IDF data & final Det Basins Qpeak m3/s	
20.00A-1	9.62		13.46		13.46	
20.00A-2	8.26		11.47		11.47	
20.00A-3	11.77		17.06		17.06	
20.00A		29.66		41.99		41.99
20.00B-1	17.00		25.40		25.40	
20.00B-2	36.91		52.47		52.47	
20.00B		53.90		77.87		77.87
20.01-1	82.74		116.12		111.18	
20.01-2		**110.75**		151.17		142.08
20.01-1DS				**151.17**		**140.60**
18.00A-2		38.88		38.73		38.73
18.00B		85.80		90.90		90.90
18.00C-1		27.70		33.67		33.67
18.00C-2		119.62		134.30		134.30
18.00D		130.22		163.96		159.32
19.00A-1	9.30		10.31		10.31	
19.00A-2	21.45		25.20		25.20	
19.00A		30.75		35.51		35.51
19.00B-1	14.32		17.03		17.03	
19.00B-2	14.07		16.92		16.92	
19.00B-3	63.18		72.51		72.51	
19.00B		91.57		106.46		106.46
19.01A-2		125.51		132.74		132.74
19.01B		141.44		155.16		155.16
18.01		269.71		311.18		312.88
18.03B-1		21.13		30.24		30.24
18.02-1	**291.58**		340.61		338.23	
18.02-1DS				**340.61**		**338.23**
18.02-2		321.71		366.69		359.27
18.03A		37.35		46.03		46.03
18.03B-2		339.93		373.11		365.37
1.00A		17.79		21.67		21.67
1.00B		50.30		60.44		60.44
1.00C		70.52		84.12		84.12
1.00D		89.46		109.10		109.10
1.00G		27.90		33.66		33.66
1.00E		20.96		24.02		24.02
1.00F		73.69		86.09		86.09
1.00H		187.11		221.65		221.65
1.00I		219.47		262.95		262.95
1.00J		23.64		27.06		27.06
1.00K		43.15		47.90		47.90
1.00L		282.77		332.89		332.89
1.00M		300.10		355.47		355.47
1.01-2		16.86		22.15		22.15
1.01-1	326.93		417.92		417.92	
1.01-3	25.91		33.46		33.46	
1.01		352.84		451.38		451.38
1.02-1	365.71		435.02		421.91	
1.02-2	22.75		35.58		35.58	
1.02		388.46		470.60		457.49
1.03-4		11.90		16.54		16.54
1.03-2		3.79		5.05		5.05
1.03-3		412.80		502.43		473.09
2.00A		17.55		21.05		21.05
2.00B		45.74		51.06		51.06
2.00C		70.95		84.03		84.03
2.00D		31.80		35.83		35.83
2.00E		113.04		133.28		133.28
2.01A		18.65		21.16		21.16
2.01B		38.67		34.60		34.60
2.01C		116.26		139.13		139.13
2.02		165.78		188.03		188.03
1.04		**511.15**		**669.74**		**635.52**

Edmondson Park Master Plan: RAFTS Simulation Results (Proj: 21/11429)
RAFTS Input Data

							Residential					Business						Imperv Area		Imperv Area		PERN				
Name	PREVIOUS Non-split Name	% Inside Ed Pak	Total Area (ha)	Ed Park Area (ha)	PREVIOUS % Imperv WSO2026	PREVIOUS SLOPE	New Area (2a,2c) NOT USED 65%	New Area (1e) MED and LOW Res 70%	Old Area HERITAGE 50%	Old Area (1c) 15%	Rural Area (1d) 30%	Old Area 80%	New Area 80%	School 20%	Road Area 100%	Open Space 0%	check	Inside Ed Park ha	outside Ed Park ha	TOTAL Imp Area ha	Perc Imp %	Forest 0.1	Pasture 0.07	Urban Perv 0.025	Imperv 0.02	PERN
1.00A	1.00A	0	21.7	0.0	9.8	2.500	0%	0%	0%				0%		0%	0%	0%	0.000	2.129	2.129	9.8%		90.2%		9.8%	0.065
1.00B	1.00B	0	38.1	0.0	9.9	3.800	0%	0%	0%				0%		0%	0%	0%	0.000	3.781	3.781	9.9%		90.1%		9.9%	0.065
1.00C	1.00C	25	23.7	6.0	22.0	3.200	0%	0%	0%				0%		0%	25%	25%	0.000	3.906	3.906	16.5%		83.5%		16.5%	0.062
1.00D	1.00D	77	24.9	19.3	17.0	2.900	0%	0%	0%				0%		3%	75%	77%	0.530	0.962	1.491	6.0%		94.0%		6.0%	0.067
1.00E	1.00E	0	19.7	0.0	9.9	8.100	0%	0%	0%				0%		0%	0%	0%	0.000	1.964	1.964	9.9%		90.1%		9.9%	0.065
1.00F	1.00F	4	27.0	1.0	13.5	3.900	0%	0%	0%				0%		0%	4%	4%	0.000	3.511	3.511	13.0%		87.0%		13.0%	0.064
1.00G	1.00G	12	31.8	3.9	9.1	4.400	0%	0%	0%				0%		0%	12%	12%	0.000	2.545	2.545	8.0%		92.0%		8.0%	0.066
1.00H	1.00H	79	28.9	22.7	1.0	2.900	0%	0%	0%				0%		3%	76%	79%	0.657	0.064	0.721	2.5%		97.5%		2.5%	0.069
1.00I	1.00I	4	42.3	1.7	12.2	3.100	0%	1%	0%				0%		2%	1%	4%	0.042	4.958	5.000	11.8%		88.2%		11.8%	0.064
1.00J	1.00J	0	22.5	0.0	10.0	7.800	0%	0%	0%				0%		0%	0%	0%	0.000	2.258	2.258	10.0%		90.0%		10.0%	0.065
1.00K	1.00K	0	17.1	0.0	10.1	7.600	0%	0%	0%				0%		0%	0%	0%	0.000	1.719	1.719	10.1%		89.9%		10.1%	0.065
1.00L	1.00L	0	25.2	0.0	10.0	5.100	0%	0%	0%				0%		0%	0%	0%	0.000	2.506	2.506	10.0%		90.0%		10.0%	0.065
1.00M	1.00M	8	25.5	2.1	14.5	2.800	0%	0%	0%				0%		4%	4%	8%	0.090	3.409	3.499	13.7%		86.3%		13.7%	0.063
1.01-1	1.01	0	41.1	0.0	12.4	3.700	0%	0%	0%				0%		0%	0%	0%	0.000	5.102	5.102	12.4%		87.6%		12.4%	0.064
1.01-2	1.01	100	17.4	17.4	12.4	3.700	0%	61%	0%				0%		21%	18%	100%	11.036	0.004	11.039	63.4%		36.6%		63.4%	0.038
1.01-3	1.01	100	10.2	10.2	12.4	3.700	0%	4%	0%				0%		7%	89%	100%	0.990	0.005	0.995	9.7%		90.3%		9.7%	0.065
1.02-1	1.02	86	32.9	28.2	41.0	2.200	0%	31%	0%				0%		17%	37%	86%	11.046	1.914	12.960	39.4%		60.6%		39.4%	0.050
1.02-2	1.02	100	28.5	28.5	41.0	2.200	0%	88%	0%				0%		6%	7%	100%	19.103	0.000	19.103	66.9%		33.1%		66.9%	0.037
1.03-1	1.03	84	9.7	8.1	58.9	1.500	0%	70%	0%				0%		5%	8%	84%	4.452	0.935	5.387	55.3%		44.7%		55.3%	0.042
1.03-2	1.03	99	4.0	4.0	58.9	1.500	0%	73%	0%				0%		17%	9%	99%	2.692	0.015	2.706	67.9%		32.1%		67.9%	0.036
1.03-3	1.03	100	54.3	54.3	58.9	1.500	0%	52%	0%				0%		18%	30%	100%	29.773	0.000	29.773	54.8%		45.2%		54.8%	0.043
1.03-4	1.03	81	4.6	3.7	58.9	1.500	0%	38%	0%				0%		18%	26%	81%	1.659	0.508	2.167	47.0%		53.0%		47.0%	0.047
18.00A-1	18.00A	72	15.0	10.8	32.5	3.400	0%	7%	24%				0%		12%	29%	72%	3.170	1.343	4.512	30.2%		69.8%		30.2%	0.055
18.00A-2	18.00A	100	18.1	18.1	32.5	3.400	0%	43%	19%				7%		17%	14%	100%	11.200	0.006	11.206	61.8%		38.2%		61.8%	0.039
18.00B	18.00B	98	57.5	56.2	32.6	1.800	0%	21%	0%				25%		23%	29%	98%	32.246	0.415	32.661	56.8%		43.2%		56.8%	0.042
18.00C-1	18.00C	98	28.1	27.4	17.5	1.800	0%	0%	0%				49%		22%	26%	98%	16.839	0.112	16.951	60.4%		39.6%		60.4%	0.040
18.00C-2	18.00C	47	27.3	12.9	17.5	1.800	0%	0%	0%				8%		3%	36%	47%	1.203	2.525	3.727	13.6%		86.4%		13.6%	0.063
18.00D	18.00D	29	34.9	10.2	5.0	1.900	0%	0%	0%				0%		7%	22%	29%	0.727	1.250	1.977	5.7%		94.3%		5.7%	0.067
18.02-1	18.02	81	53.0	42.8	20.9	1.100	0%	28%	0%				0%		11%	43%	81%	12.787	2.126	14.913	28.1%		71.9%		28.1%	0.056
18.02-2	18.02	0	67.9	0.0	20.9	1.100	0%	0%	0%				0%		0%	0%	0%	0.000	14.178	14.178	20.9%		79.1%		20.9%	0.060
18.03A	18.03A	0	47.3	0.0	30.6	2.300	0%	0%	0%				0%		0%	0%	0%	0.000	14.479	14.479	30.6%		69.4%		30.6%	0.055
18.03B-1	18.03B	80	27.3	21.7	76.1	1.900	0%	55%	0%				0%		1%	24%	80%	8.444	4.230	12.674	46.4%		53.6%		46.4%	0.047
18.03B-2	18.03B	0	35.2	0.0	76.1	1.900	0%	0%	0%				0%		0%	0%	0%	0.000	26.805	26.805	76.1%		23.9%		76.1%	0.032
19.00A-1	19.00A	100	8.7	8.7	16.1	3.300	0%	14%	0%				0%		12%	74%	100%	1.906	0.000	1.906	22.0%		78.0%		22.0%	0.059
19.00A-2	19.00A	100	21.2	21.2	16.1	3.300	0%	33%	6%				0%		10%	50%	100%	7.843	0.000	7.843	37.0%		63.0%		37.0%	0.052
19.00B-1	19.00B	100	14.6	14.6	3.9	2.400	0%	25%	0%				0%		21%	54%	100%	5.652	0.000	5.652	38.7%		61.3%		38.7%	0.051
19.00B-2	19.00B	99	14.3	14.2	3.9	2.400	0%	0%	6%				33%		11%	49%	99%	5.746	0.003	5.749	40.1%		59.9%		40.1%	0.050
19.00B-3	19.00B	100	24.6	24.6	3.9	2.400	0%	20%	0%				8%		17%	56%	100%	9.038	0.001	9.038	36.8%		63.2%		36.8%	0.052
19.01A-1	19.01A	100	31.4	31.3	37.7	2.000	0%	46%	0%				11%		26%	17%	100%	20.905	0.042	20.947	66.6%		33.4%		66.6%	0.037
19.01A-2	19.01A	100	38.2	38.2	37.7	2.000	0%	9%	0%				52%		25%	14%	100%	27.727	0.000	27.727	72.6%		27.4%		72.6%	0.034
19.01B	19.01B	100	32.7	32.7	30.4	1.500	0%	35%	0%				3%		14%	48%	100%	13.370	0.002	13.372	40.9%		59.1%		40.9%	0.050
2.00A	2.00A	0	16.7	0.0	34.4	7.800	0%	0%	0%				0%		0%	0%	0%	0.000	5.752	5.752	34.4%		65.6%		34.4%	0.053
2.00B	2.00B	0	31.9	0.0	0.0	4.500	0%	0%	0%				0%		0%	0%	0%	0.000	0.000	0.000	0.0%		100.0%		0.0%	0.070
2.00C	2.00C	0	35.2	0.0	4.0	2.600	0%	0%	0%				0%		0%	0%	0%	0.000	1.411	1.411	4.0%		96.0%		4.0%	0.068
2.00D	2.00D	0	32.7	0.0	2.1	5.900	0%	0%	0%				0%		0%	0%	0%	0.000	0.693	0.693	2.1%		97.9%		2.1%	0.069
2.00E	2.00E	0	16.0	0.0	1.9	1.600	0%	0%	0%				0%		0%	0%	0%	0.000	0.299	0.299	1.9%		98.1%		1.9%	0.069
2.01A	2.01A	0	21.1	0.0	7.5	2.600	0%	0%	0%				0%		0%	0%	0%	0.000	1.577	1.577	7.5%		92.5%		7.5%	0.066
2.01B	2.01B	23	14.7	3.4	26.6	2.700	0%	0%	0%				0%		1%	22%	23%	0.028	3.005	3.034	20.7%		79.3%		20.7%	0.060
2.01C	2.01C	9	6.7	0.6	6.7	3.000	0%	6%	0%				0%		0%	3%	9%	0.027	0.405	0.432	6.5%		93.5%		6.5%	0.067
2.02	2.02	84	26.1	21.9	56.8	2.100	0%	31%	0%				0%		15%	38%	84%	8.086	2.352	10.438	40.0%		60.0%		40.0%	0.050
20.00A-1	20.00A	91	10.6	9.6	57.1	2.600	0%	91%	0%				0%		0%	0%	91%	6.135	0.556	6.691	63.0%		37.0%		63.0%	0.038
20.00A-2	20.00A	100	9.0	8.9	57.1	2.600	0%	91%	0%				0%		9%	0%	100%	6.469	0.022	6.491	72.4%		27.6%		72.4%	0.034
20.00A-3	20.00A	100	13.3	13.3	57.1	2.600	0%	70%	0%				0%		26%	3%	100%	9.976	0.034	10.009	75.0%		25.0%		75.0%	0.033
20.00B-1	20.00B	100	19.9	19.9	57.0	2.700	0%	80%	0%				0%		19%	0%	100%	15.065	0.000	15.065	75.7%		24.3%		75.7%	0.032
20.00B-2	20.00B	100	8.5	8.5	57.0	2.700	0%	61%	0%				0%		21%	18%	100%	5.413	0.006	5.419	64.0%		36.0%		64.0%	0.038
20.01-1	20.01	99	33.9	33.7	57.0	2.700	0%	72%	0%				0%		24%	3%	99%	25.265	0.135	25.400	74.8%		25.2%		74.8%	0.033
20.01-2	20.01	92	48.6	44.7	57.0	2.700	0%	70%	0%				0%		14%	7%	92%	28.312	2.251	30.563	62.9%		37.1%		62.9%	0.039
BC1	20.01	86	33.9	29.0	57.0	2.700	0%	51%	0%				0%		17%	18%	86%	15.296	2.789	18.085	53.3%		46.7%		53.3%	0.043
			1527.6	790.5									Check		32.458 is equal to 32.458	<<OK		380.944	48%	511.943	65%					