EDMONDSON PARK SOUTH

Part 3A Concept Plan

Water Cycle Management Plan




Prepared for:

LANDCOM

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EDMONDSON PARK SOUTH PART 3A CONCEPT PLAN APPLICATION WATER CYCLE MANAGEMENT PLAN

- DOCUMENT CONTROL SHEET -

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1 EXECUTIVE SUMMARY

This report has been prepared by J Wyndham Prince Pty Ltd to accompany a Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act, 1979 (EP&A Act) and a proposal for State significant site listing under Schedule 3 of State Environmental Planning Policy Major Development 2005 (SEPP Major Development) in relation to the former Ingleburn Army Base and certain adjoining lands within the Edmondson Park Precinct of the South West Growth Centre (referred to herein as Edmondson Park South).

The development of Edmondson Park South is subject to the Stormwater Management Master Plan prepared for the overall Edmondson Park Release Area prepared by GHD Pty Ltd (Ref. 1). This Water Cycle Management Plan complements the J Wyndham Prince's (JWP) previous work in 2007 titled "Edmondson Park Water Sensitive Urban Design Strategy" for the Liverpool portion of the Edmondson Park Release Area (Ref. 2 and copy provided in Attachment A).

This report builds on the findings within both the GHD report and the JWP 2007 report to provide the overall Water Cycle Management framework to manage both the water quantity and water quality for Edmondson Park South. The management objectives for this area were identified as:

Environmental – Provision of appropriately designed, functional water quality facilities, salinity management, retention of existing trees, habitat revegetation and ecosystem enhancement; limitation of downstream discharge peaks and velocities; soft bioengineering treatments to reflect natural stream functions; adopt principles of ecologically sustainable design; total catchment management and water sensitive urban design; conform with statutory water quality requirements; maintenance of environmental flows and inundation patterns in creeks and wetlands.

Urban Amenity – Provision of a water cycle management strategy that identifies and controls limits of flood affectation; provision of aesthetic design forms that enhance urban amenity and address proposed adjacent land uses (residential, recreational and transport); views into and out of drainage corridors (security, public safety, amenity); water quality (visual amenity and public health).

Engineering Considerations – Effective management and control of peak discharges, discharge velocities, and flood levels to pre-development and ecologically sustainable levels; industry best practice technical analysis of catchment hydrology and system hydraulic performance, soft sustainable bioengineering treatments, delineation of flood extents and identification of flood risk.

1.1 Proposed Water Cycle Strategy

For the purposes of this report, the site has been divided into three separate localities as indicated on Plate E1 below and on Figure 1, and these localities are summarised as follows:

Locality 1 Development south of Campbelltown Road which lies wholly within the Campbelltown LGA. This portion is the main focus of this report.

Locality 2 Development north of Campbelltown Road and east of the extension of Macdonald Road and east of the TIDC corridor. This locality is wholly within the Liverpool LGA

Locality 3 Development north of Campbelltown Road and west of the proposed extension of Macdonald Road. The proposed TIDC rail corridor forms the northern boundary to Locality 3. This Locality is also wholly within the Liverpool LGA.

The strategy proposed as being most suitable for each of the Edmondson Park South Localities is a series of Water Sensitive Urban Design (WSUD) elements which are summarised for each locality as follows;

1.1.1 Locality 1

Water Quality

A treatment train consisting of:

On Lot Treatments

- Appropriate waterwise landscaping practices (resident education, native gardens, mulch, micro-irrigation).
- Implementation of water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).
- Minimisation of impervious areas.
- Reticulated recycled water.

Street Level Treatments

- Proprietary gross pollutant traps.

Precinct Scale Treatments

- Bio-Retention Raingardens, located within the public reserves and adjacent to the riparian corridors.

Water Quantity

- A regional detention basin within Maxwells Creek which will treat the central portion of Edmondson Park South and is sized to adequately compensate for the adjacent northern areas of the development that bypass detention.
- Within the Bunbury Curran Catchment a detention basin adjacent to the Hume Highway will be required to manage flows from the rural residential portion of the development.

A detailed assessment of the drainage depressions within Locality 1 was undertaken in order to determine their status as riparian corridors under the current guidelines produced by the NSW Office of Water. Two “first order watercourses” were identified on the site and these have been retained in the Concept Plan as riparian corridors having a total width of 45 m. The riparian corridors have been designated as Corridors A and B and these are indicated on Figure 1 and on Plate E1 hereunder.

The open space areas containing Corridor B within the Current LEP are substantially wider. The wider corridor was previously designated in order to provide an offset to

the proposal to retain the existing concrete lined channel in the base of the corridor. It is now proposed that the concrete lined channel is removed and that a natural creek form will be recreated in the corridor. In addition, an Ecological Assessment undertaken on the area in conjunction with this proposal (Ref. 32) found that Corridor B has little ecological value. As a consequence it is not necessary to retain the current LEP's open space allocation in this area and these are to be reduced.

A wider corridor is proposed for Corridor A than the open space currently defined under the current LEP.

1.1.2 Locality 2

This portion of the concept plan will drain to both Cabramatta Creek and Maxwells Creek. It includes the proposed Town Centre and regional park areas and a portion of residential development north of Transport Infrastructure Development Corporate (TIDC) corridor

A detailed Water Cycle Management strategy was previously developed by JWP in 2007 for the Edmondson Park Release Area which falls within the Liverpool LGA. A copy of this investigation is included at Attachment A to this report. This earlier strategy effectively sets the Water Cycle Management Strategy framework for development in the Liverpool LGA portion of the Release Area which includes Locality 2.

There are no changes proposed for open space areas containing riparian corridors in this Locality.

As a consequence no further refinement of the Water Cycle Management Strategy was undertaken to support this Locality.

1.1.3 Locality 3

The previous Water Cycle Management Strategy prepared for the Release Area (refer to Attachment A) also defines the strategy for Locality 3.

However, at the time the Release Area strategy was prepared the proposed strategy for managing water quality did not allow for residential development north of Campbelltown Road (i.e. it was assumed that if development did occur it would be supported by its own water quality management controls). Consequently, we have identified preliminary sizes for two raingardens which will be provided to service this portion of the catchment. The preliminary sizes were determined based on the detailed MUSIC modelling undertaken to support Locality 1.

A detailed flood investigation was undertaken by Webb, McKeown and Associates for the Edmondson Park Release Area on behalf of Landcom in 2007 (Ref. 3, 4 & 5). This study expanded on the analysis previously undertaken by GHD (Ref. 1 and 8) for the Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

The Webb McKeown and Associates report (Ref. 5) did allow for the effects of development within the Maxwells Creek catchment and as a consequence, determined that the proposed basin will "counteract the effects of development on the whole catchment such that peak flows at the M5 Motorway" are reduced. This Water Cycle Management Plan is based on these findings and as a consequence it is not proposed to provide additional detention storage to service locality 2 and 3.

There are no changes proposed for open space areas containing riparian corridors in this Locality.

1.2 Climate Change Considerations

An assessment of the impacts of Climate Change on rainfall intensities and consequently on flood hazard has been undertaken. It has been determined that flood hazard as a result of increased rainfall intensities due to Climate Change implications can be appropriately managed through the detailed design of stormwater conveyance systems (at Construction Certificate stage).

1.3 Summary

The Water Cycle Management strategy proposed for Edmondson Park South is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the release area.

Furthermore, it will ensure that the relevant issues listed in the Director General's requirements relating to the management of the Water Cycle for Edmondson Park South (refer to Table E1 below) are attained. The overall water cycle management concept for the Edmondson Park South Part 3A Application Site is illustrated on Figure 1 which is attached to this report and provided as an inset hereunder.

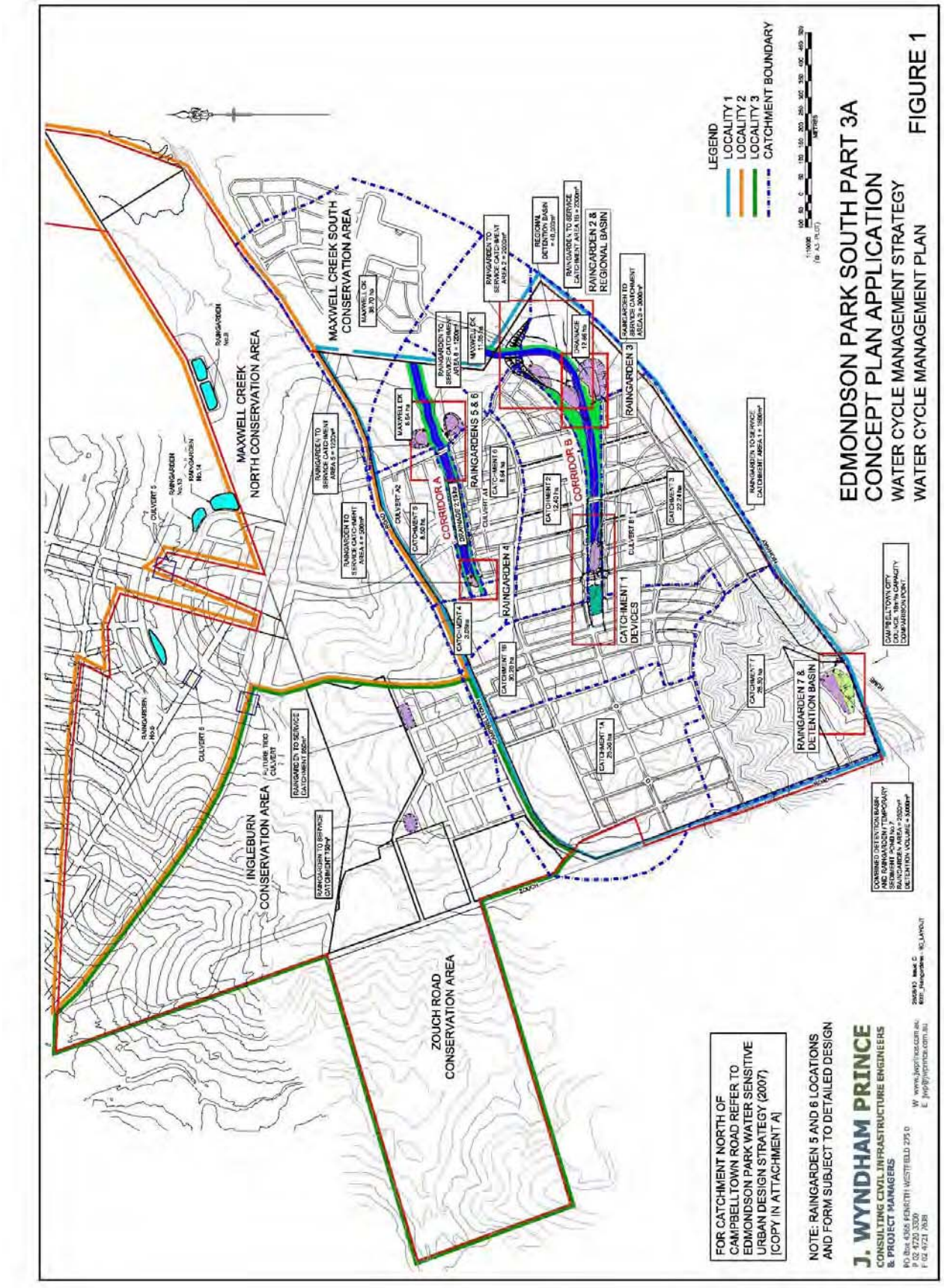

Plate E1: Water Cycle Management Concept Plan (Copy of Figure 1)

Following is a list of the requirements of the NSW Department of Planning's Director General (DGR's) relating to the management of surface water, groundwater quality, riparian corridors, flooding and Ecologically Sustainable Development within Edmondson Park South, as outlined in Section 2 of this report, with the corresponding responses addressed by this report.

Table E.1 RESPONSES TO THE DIRECTOR GENERAL REQUIREMENTS

REQUIREMENT	RESPONSE
➢ **Surface Water, Groundwater Quality and Riparian Corridors**	
(1) Assess any potential impacts of proposed development on hydrology and hydrogeology of the site and adjacent areas in terms of impact on water quality having regard to environmental targets for new urban development set out in Managing urban stormwater: environmental targets – Consultation draft (DECC in association with the Sydney Metropolitan CMA, October 2007). In particular, identify how any potential water quality impacts on wetlands both within and adjoining the site, and the ecological values of the Regional Park, will be avoided, mitigated or managed.	Hydrology and hydrogeology (SEI) assessments were undertaken on the site with regards to water quantity and water quality. Details of the assessments, results and discussions have been outlined in Sections 9, 11, 12. The Water Cycle Management Plan complies with the targets within the listed DGR reference with the results presented in Section 11.4. Suitable management measures to avoid exacerbation of site/soil salinity and to limit additional surface and groundwater interaction are presented in Section 7.8.
(3) Identify drainage and stormwater management infrastructure, including: on site detention of stormwater; water sensitive urban design (WSUD); and drainage infrastructure. Identify the future management and ownership arrangements for stormwater infrastructure, and identify how any requirements of the future owner will be met.	Nominated drainage and stormwater management infrastructure are outlined in Section 7 with descriptions of the individual elements provided within Attachment B. Future management and ownership arrangements are outlined in Section 13.3.
(4) Assess any proposed variation to riparian corridors and associated buffers in accordance with the Riparian Corridor Management Study approach applied to the Growth Centres, and provide justification for any changes. Details of any rehabilitation works for corridors should be provided.	The proposed structure and mechanisms for Riparian corridor management within the site are detailed in Section 8.0 of this report. A justification for proposed changes to the Riparian corridors is presented in Plate 3 and in Section 8.6.
➢ **Flooding**	
(1) Identify any flood risk associated with the site and demonstrate that the proposed development is suitable in terms of flooding and is consistent with the NSW Floodplain Development Manual: the management of flood liable land (2005).	Section 10 of this report discusses the flooding within Edmondson Park South and provides details of the flood investigation undertaken by Webb McKeown & Associates in 2007 (Ref. 4 & 5). Channel sizes within the development have been identified at Section 10.1. The concept plan investigations comply with the FDM guidelines.
➢ **Ecologically Sustainable Development**	
(1) The EA should demonstrate that all aspects of the concept plan satisfy the principles of ESD including compliance with BASIX.	Demonstration of Ecologically Sustainable Development including BASIX compliance is discussed in section 6.7.2 and outlined in Sections 7.1 and 7.2 of this report.
(2) The EA should outline commitments to sustainability including water re-use, waste minimisation, the minimisation of energy use and car dependency.	The report outlines commitments to sustainability including reductions in potable water demand, use of reticulated recycled water and introduction of integrated natural resources that limit the impacts on downstream ecosystems, as outlined in Section 7.1 and 7.2 of this report.

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EDMONDSON PARK SOUTH PART 3A

CONCEPT PLAN

WATER CYCLE MANAGEMENT PLAN

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2 DIRECTOR GENERAL REQUIREMENTS (DGR)

On the 28 July 2010 the Director General of NSW Department of Planning issued a series of requirements (DGR'S) relevant to the Edmondson Park South Concept Plan and Project Applications. A full description of how this report is responding to the individual requirements is summarised in Section 15.

Each of the sub headings below relates to the relevant Key Assessment Requirements as listed in the DGR's.

2.1 Surface Water, Groundwater Quality And Riparian Corridors

(1) Assess any potential impacts of proposed development on hydrology and hydrogeology of the site and adjacent areas in terms of impact on water quality having regard to environmental targets for new urban development set out in Managing urban stormwater: environmental targets – Consultation draft (DECC in association with the Sydney Metropolitan CMA, October 2007). In particular, identify how any potential water quality impacts on wetlands both within and adjoining the site, and the ecological values of the Regional Park, will be avoided, mitigated or managed.

(3) Identify drainage and stormwater management infrastructure, including: on site detention of stormwater; water sensitive urban design (WSUD); and drainage infrastructure. Identify the future management and ownership arrangements for stormwater infrastructure, and identify how any requirements of the future owner will be met.

(4) Assess any proposed variation to riparian corridors and associated buffers in accordance with the Riparian Corridor Management Study approach applied to the Growth Centres, and provide justification for any changes. Details of any rehabilitation works for corridors should be provided.

2.2 Flooding

(1) Identify any flood risk associated with the site and demonstrate that the proposed development is suitable in terms of flooding and is consistent with the NSW Floodplain Development Manual: the management of flood liable land (2005).

2.3 Ecologically Sustainable Development (Esd)

(1) *The Environmental Assessment (EA) should demonstrate that all aspects of the concept plan satisfy the principles of ESD including compliance with BASIX.*

(2) The EA should outline commitments to sustainability including water re-use, waste minimisation, the minimisation of energy use and car dependency.

This report should be read in conjunction with following reports related to the Concept Application:

- Ecological Australia - Concept Plan Report, (Ref 6)
- Golders Associates – Geotechnical, Contamination and UXO – Site Suitability Assessment (Ref 7)

3 INTRODUCTION – PROCESS FRAMEWORK

This report has been prepared by J Wyndham Prince Pty Ltd to accompany a Concept Plan Application under Part 3A of the Environmental Planning & Assessment Act, 1979 (EP&A Act) and a proposal for State Significant Site listing under Schedule 3 of State Environmental Planning Policy Major Development 2005 (SEPP Major Development) in relation to the former Ingleburn Army Base and certain adjoining lands within the Edmondson Park Precinct of the South West Growth Centre (referred to herein as Edmondson Park South).

Landcom is proposing to deliver a new diverse and sustainable urban community at Edmondson Park. Once complete, Edmondson Park will accommodate a mix of land uses, a diversity of housing (approximately 3,200 dwellings), a new town centre incorporating 35,000 – 40,000 m² retail, business and commercial floor space with employment opportunities for 1,000 people, multi-purpose community and education facilities, a new 150 hectare Regional Park, a number of other local parks and environmental conservation areas.

The new urban community at Edmondson Park South will meets the State Government's objectives to increase housing supply, provide community benefits and create jobs. The purpose of the Concept Plan is to secure statutory approval for the overall planning framework for the site and to further resolve a number of remaining site-wide infrastructure delivery and land use planning issues. The Project Application (submitted concurrently with the Concept Plan) for early works, infrastructure and subdivision relating to the initial phases of the development will enable site works to begin in 2010.

The subject site comprises an area of approximately 413.3 hectares and forms part of the larger Edmondson Park Precinct within the South West Growth Centre. It is located to the north-west of the M5 Motorway and lies approximately 40 km to the south west of Sydney CBD. Approximately 260.4 hectares of Edmondson Park is located within the Liverpool LGA and approximately 152.9 hectares is located within the Campbelltown LGA.

The Concept Plan establishes the overall planning framework for the site, including:

- land use type and distribution;
- a mix of housing types and densities (approximately 3,200 dwellings);
- concept location of and approximately 35,000 – 45,000 m^2 of retail / business / commercial floor space within the new Edmondson Park Town Centre;
- identification and location of open space and drainage corridors, environmental conservation lands (to form the new Regional Park), and local active and passive recreation facilities, including levels of embellishment;
- expanded Ingleburn North Primary School and new combined Primary/High School to the north of the site;
- road network layout;
- pedestrian and cycleway network layout;
- pedestrian bridge over the south western railway;
- Campbelltown Road corridor including the establishment of key intersection locations and configuration;
- utilities (including power, telecommunications and gas), infrastructure strategy, potable water strategy, sewer concept plan and water cycle management plan;

- location and dimensions of Bushfire Asset Protection Zones;
- appropriate interpretation of European and Aboriginal heritage located on the site;
- erection of signage and billboards;
- remediation works;
- decommissioning of the existing Sewage Treatment Plant (STP); and
- demolition.

A variety of housing types is proposed to be delivered. The range of densities will enable a range of dwelling types and will include moderate income housing and housing for seniors.

It is proposed to develop the Edmondson Park South site progressively in stages over a 15-20 year period. The Concept Plan will address the staging and delivery of the overall development having regard to the progressive delivery of necessary infrastructure, services and facilities; and market demand.

The Concept Plan is accompanied by a proposal with respect to the future developer contributions framework for the provision of local facilities and services within both the Liverpool and Campbelltown LGAs as well as State Infrastructure.

The residential subdivision Project Application comprises:

- the creation of 206 residential lots, 8 super lots for future subdivision 15 Environmental Living lots and 3 lots for dedication to Campbelltown City Council as Public Reserve in 5 stages*;
- the dedication of roads to Campbelltown City Council;
- On-site works comprising:
    - tree removal;
    - earthworks including excavation, cut and fill;
    - design and construction of physical infrastructure, including roads, stormwater drainage and utility reticulation, traffic management works, establishment of open space areas;
    - retaining walls as determined during detailed design;
    - design and construction of staged stormwater water quantity and quality infrastructure to achieve objectives required by the Water Cycle Management (WCM) strategy for the greater site;
    - demolition of all existing structures;
    - erosion and sediment control to areas of roadworks and bulk earthworks including provision of temporary sedimentation ponds and diversion drains;
    - design and construction of an ornamental pond;
    - landscaping of road reservations;
    - erection of signage and billboards; and;
    - embellishment of open space.
- Off-site works comprising:
    - construction of the sewer lead in from the Sydney Water carrier main at Ash Road;

- upgrade of overhead mains and construction of electrical lead-in feeders from the existing zone substation at Prestons;
- connection to utility services, potable and recycled water, electricity, gas and telecommunications in Campbelltown and Macdonald Roads;
- connection to existing stormwater drainage;
- tree removal;
- earthworks including excavation, cut and fill;
- design and construction of physical infrastructure, including roads, stormwater drainage and utility reticulation, traffic management works, including the connection to the existing Macdonald Road;
- design and construction of staged stormwater water quantity and quality infrastructure to achieve objectives required by the Water Cycle Management (WCM) strategy for the greater site;
- erection of an acoustic wall;
- erection of signage and billboards;
- extension or relocation of existing services including potable and recycled water, gas, telecommunication, power;
- demolition of all existing structures; and;
- proposed new intersection to existing Macdonald Road.

* A number of residue lots will be created in undertaking the Project Application, the number of lots identified in the above description relate to the ultimate number of lots that will be created in the Project Application.

It is intended to seek staged Construction Certificates as necessary to facilitate the efficient delivery of each phase.

This report details the procedures used and presents the results of investigations undertaken in developing a Water Cycle Management Plan that incorporates the principles of Water Sensitive Urban Design (WSUD) to integrate with and support the Edmondson Park South Part 3A Concept Plan Application

The objective of this investigation is to assess the adequacy, in terms of detention and treatment capacity, of the proposed treatment measures to ensure the quantity and quality of stormwater leaving Edmondson Park South meets statutory requirements.

For the purposes of this report, the site has been divided into three separate localities and a description of each locality, and the details of the current investigation undertaken and discussed within this report, are summarised as follows:

3.1 Locality 1 Outline And Investigation Summary

This locality can be defined as the portion of Edmondson Park South of Campbelltown Road which lies wholly within the Campbelltown LGA. Locality 1 is the main focus of this report as there have previously been limited investigations on this portion. Refer to Figure 1 for a definition of the locality boundaries.

The investigation involved the following specific tasks for Locality 1:

- Liaise with Campbelltown City Council, and confirm the statutory requirements and the nominated treatment measures applicable to the site.

- Undertake a hydrologic analysis to determine the peak 5 and 100 year ARI pre development and post development flows at Campbelltown Road;

- Assess the performance of a 45,000 cu.m detention basin located on Maxwells Creek upstream of Campbelltown Road (consistent with the peak flow management strategy proposed for the catchment in 2007 by Webb McKeown). Demonstrate that the basin is adequate to achieve the nominated target discharges and to restrict post development flows at Campbelltown Road to pre development levels;

- For the Bunbury Curran Creek catchments determine the size of the detention storage basins necessary to restrict post development flows at Campbelltown Road to pre development levels and to demonstrate compliance with statutory requirements;

- Undertake a water quality analysis and determine the minimum treatment device areas required to achieve Growth Centres Commission's (GCC) Environmental water quality targets;(Ref. 9)

- Undertake a water quality assessment of the proposed treatment devices to demonstrate compliance and consistency with the objectives of the Stormwater Management Master Plan for the Edmondson Park Release Area prepared by GHD Pty Ltd (Ref. 1).

- Undertake a Stream Erosion Index (SEI) Assessment for the proposal and ensure compliance with the relevant guidelines

- Prepare concept designs for the water quality treatment and detention devices required to achieve the water quality and quantity objectives for the overall developed site;

- Prepare a Water Cycle Management Plan to support the Part 3A Concept Plan Application for development of Edmondson Park South, detailing the investigations, findings, calculations and design details.

3.2 Locality 2 Outline And Investigation Summary

Locality 2 can be defined as the portion of Edmondson Park South, north of Campbelltown Road and east of the extension of Macdonald Road, and east of the TIDC corridor. This locality is wholly within the Liverpool LGA. Refer to Figure 1 for a definition of the locality boundaries.

A detailed Water Cycle Management strategy was previously developed by JWP in 2007 for the Edmondson Park Release Area that falls within the Liverpool LGA. A copy of this investigation is included at Attachment A to this report. This earlier strategy effectively sets the Water Cycle Management Strategy framework for development in the Liverpool LGA portion of the Release Area which includes Locality 2.

As a consequence no further refinement of the Water Cycle Management Strategy was undertaken to support this Locality.

3.3 Locality 3 Outline And Investigation Summary

Locality 3 is defined as the portion of Edmondson Park South, north of Campbelltown Road, west of the proposed extension of Macdonald Road. The proposed TIDC rail corridor forms the northern boundary to Locality 3. This Locality is also wholly within the Liverpool LGA. Refer to Figure 1 for a definition of the locality boundaries.

The previous Water Cycle Management Strategy prepared for the Release Area (refer to Attachment A) also defines the strategy for Locality 3. However, at the time the Release Area strategy was prepared (Attachment A) the proposed strategy for managing water quality did not allow for residential development north of Campbelltown Road (i.e. it was assumed that if development did occur it would be supported by its own water quality management controls). Consequently JWP have identified preliminary sizes for two raingardens which will be provided to service this portion of the catchment. The preliminary sizes were determined based on the detailed MUSIC modelling undertaken to support Locality 1.

A detailed flood investigation was undertaken by Webb, McKeown and Associates for the Edmondson Park Release Area on behalf of Landcom in 2007 (Ref. 3, 4 & 5). This study expanded on the analysis previously undertaken by GHD (Ref. 1 and 8) for the Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

The Webb McKeown and Associates report (Ref. 5) did allow for the effects of development within the Maxwells Creek catchment and as a consequence, determined that the proposed basin will “counteract the effects of development on the whole catchment such that peak flows at the M5 Motorway” are reduced. This Water Cycle Management Plan is based on these findings and as a consequence it is not proposed to provide additional detention storage to service locality 2 and 3.

4 PREVIOUS REPORTS / STUDIES

A number of stormwater management related studies that concern the development site have been undertaken previously. A brief description of these investigations is given below.

- GHD – *Edmondson Park Master Planning, Water Cycle Management: Stormwater – October 2003* (Ref. 1)

  The GHD report was prepared as part of the earlier Master Planning process for Edmondson Park

  The report addressed water cycle management options, identified constraints and opportunities and presented a range of Water Sensitive Urban Design options. Hydrologic and hydraulic (flood mapping) analyses were also undertaken as part of the investigation.

  The recommendations from the report addressing water quantity and quality issues included provision of a number of retarding basins and constructed wetlands.

- GHD – *Edmondson Park Master Planning, Water Cycle Management: Stormwater – Addendum To October 2003 Report – March 2006* (Ref. 8)

  This addendum report was prepared to identify and assess potential impacts on the previous October 2003 report as a result of changes to the Edmondson Park Concept Plan and footprint for Edmondson Park.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 1 – Background and Overview – September 2007* (Ref. 3)

  This report presents the background information for the hydrologic and hydraulic modelling undertaken for Edmondson Park as well as a review of previous studies undertaken on the site.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 4 – Hydrologic/Hydraulic Assessment of Maxwells Creek – September 2007* (Ref. 4)

  The flood investigation undertaken by Webb, McKeown and Associates expanded on the analysis previously undertaken by GHD (Ref. 1 and 8) for the Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 5 – Hydrologic/Hydraulic Assessment of Bunbury Curran Creek – September 2007* (Ref. 5)

  The flood investigation undertaken by Webb, McKeown and Associates expanded on the analysis previously undertaken by GHD (Ref. 1 and 8) for the Bunbury Curran Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

- J. Wyndham Prince - Edmondson Park Water Sensitive Urban Design Strategy – October 2007 (Ref. 2 and Attachment A)

The report investigates the requirements of the Edmondson Park development within the Liverpool City Council local government area and identifies the size and cost of Section 94 components for the Release Area which has been used in the development control plan developed by Liverpool City Council.

5 EXISTING DEVELOPMENT

5.1 The Site

The subject site comprises an area of approximately 413.3 hectares and forms part of the larger Edmondson Park Precinct within the South West Growth Centre (see Plate 1). The Precinct is located to the north-west of the M5 Motorway and lies approximately 40 km to the south west of Sydney CBD. Approximately 260.4 hectares of the site is located within the Liverpool LGA and approximately 152.9 hectares is located within the Campbelltown LGA. Refer to Location Plan at Plate 1.

The Edmondson Park Masterplan (see Plate 2) indicates the proposed development footprint for the concept plan. The main focus of this Water Cycle Management Plan is the area to the south of Campbelltown Road (Locality 1- 201 Ha). This area is located in the Ingleburn locality and lies wholly within the Campbelltown Local Government Area (LGA). The site is bordered by Campbelltown Road to the north, the Hume Highway (South Western Freeway – F5) to the south, the proposed Ingleburn Gardens development to the east, and Zouch Road to the west.

Locality 2 is 87ha catchment that contains a small portion of residential development and the Ingleburn Conservation area.

Locality 3 is 125ha catchment that contains a residential development, commercial/town centre, a proposed school site and the portion of the Maxwell Creek North Conservation area.

Figure 1 shows the three localities within Edmondson Park South for the Concept Plan

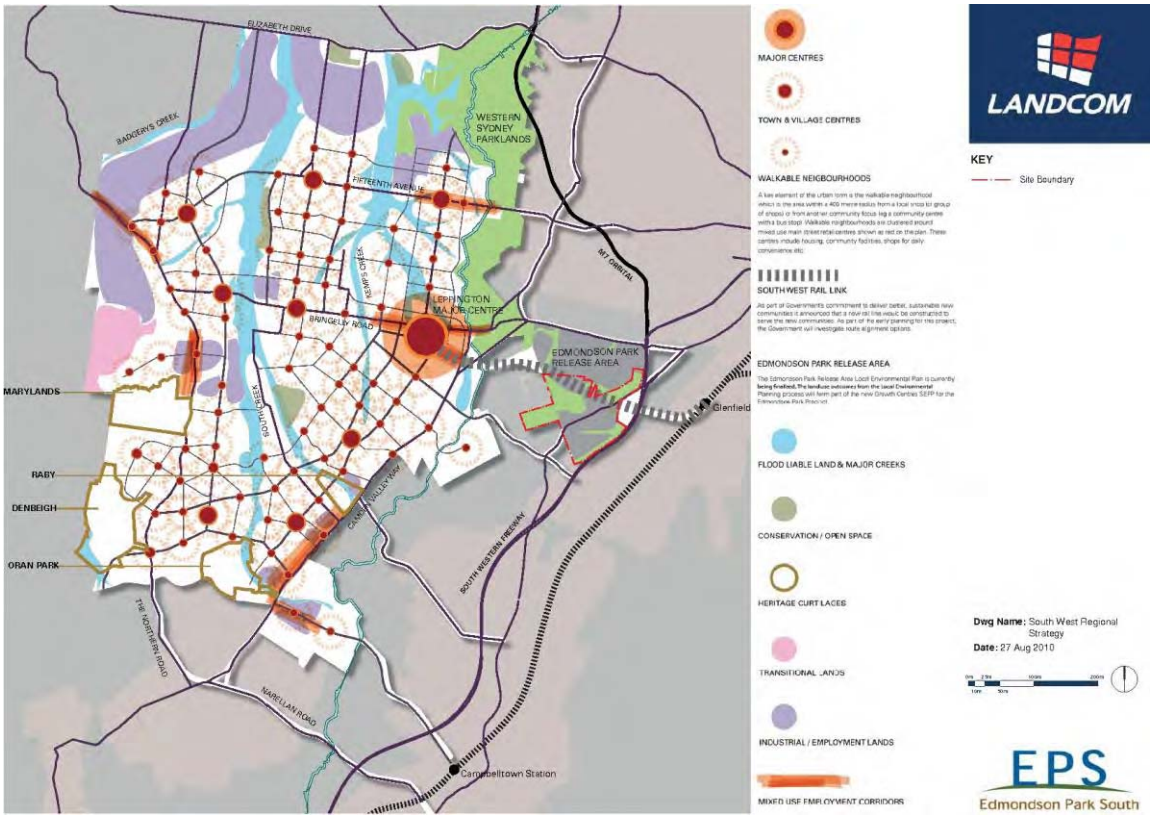

Plate 1: South Western Growth Centre – Structure Plan

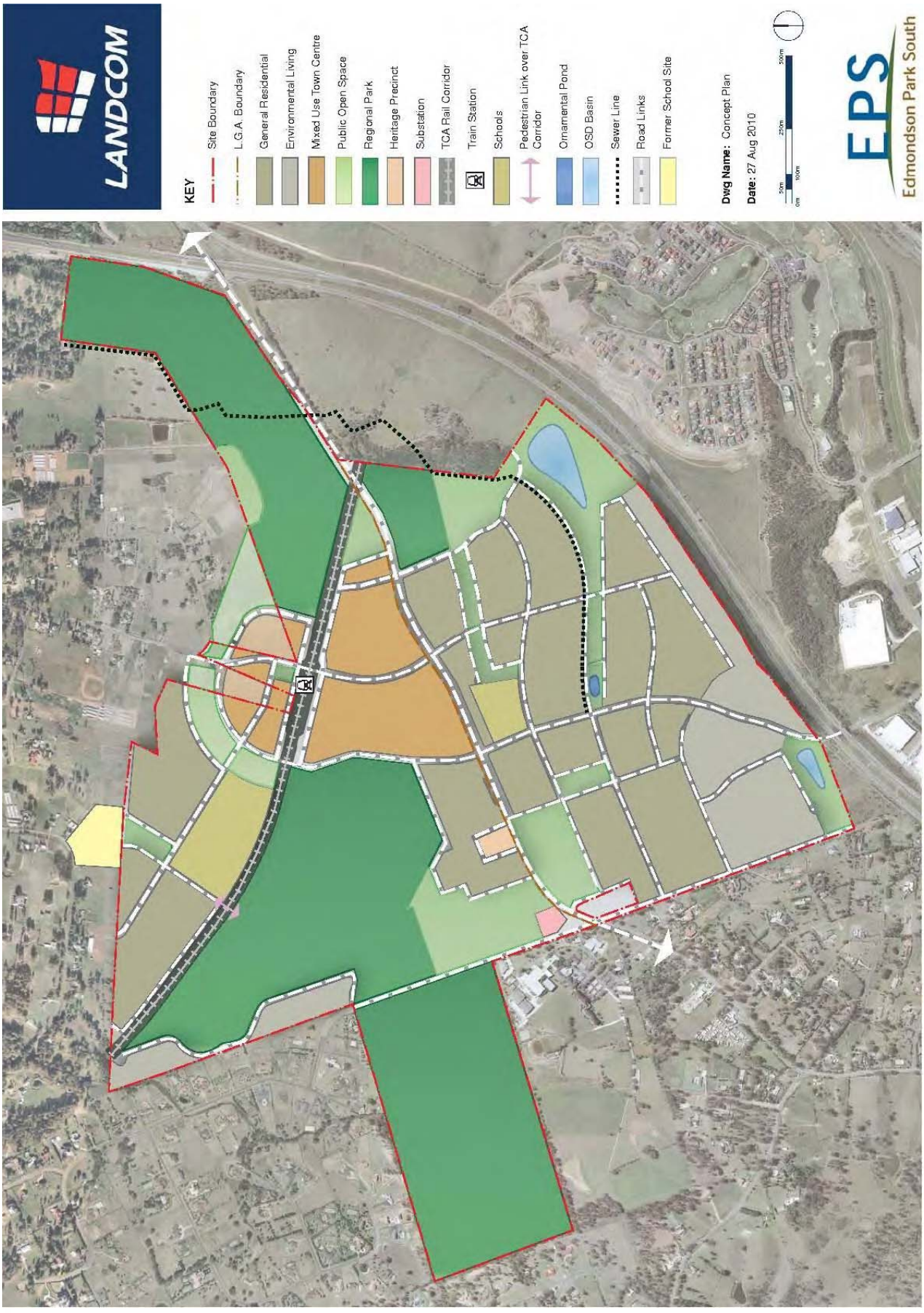

Plate 2: Edmondson Park South - Masterplan

Edmondson Park South consists of undulating grazing land, having generally been cleared and consisting of fenced grass paddocks. Edmondson Park South also includes significant portions of bushland, particularly within and adjacent to the watercourses. An existing primary school and rural residential properties are also located within the site. Edmondson Park South is divided by a ridgeline running generally from west to east along the southern part of the site. The larger northern portion of Edmondson Park South grades to the north forming the headwaters of Maxwells Creek. The southern portion of Edmondson Park South grades southerly, across the Hume Highway at Macdonald Road into Bunbury Curran Creek.

5.2 Existing Drainage Configuration

Edmondson Park South straddles two catchments. The majority of Edmondson Park South (387 ha) drains to the north and is located within the Maxwells Creek catchment (locality 1), the remaining 26 hectares as far as the southern extremities of Edmondson Park South drains to the south-east and is located within the Bunbury Curran Creek catchment. Both creeks drain into and form part of the Georges River catchment. Stormwater within the Maxwells Creek catchment generally drains in a north-easterly direction towards Campbelltown Road. Maxwells Creek drains north along the Hume Highway then discharges into Cabramatta Creek west of the City Centre of Liverpool, Cabramatta Creek drains into the Georges River at Chipping Norton.

Stormwater within the Bunbury Curran Creek catchment drains south-east across the Hume Highway at Macdonald Road. Bunbury Curran Creek drains east across the south-western railway line then directly into the Georges River at Glenfield.

Discharges from the overall catchment upstream of the Hume Highway at Macdonald Road were assessed to determine the impact on the existing drainage infrastructure draining into Bunbury Curran Creek. Campbelltown City Council has advised that the capacity of the existing drainage system downstream of the Hume Highway at Macdonald Road is approximately 18.0 m^3/s (see Figure 1 for comparison location). We have assessed the peak pre-development 100 year ARI discharge to this point and have determined that flows are approximately 24 m^3/s. The existing flows to Bunbury Curran Creek from Edmondson Park South are approximately 6.6 m^3/s. Even if flows are fully detained within Edmondson Park South (which is not possible) the capacity of the existing system would still be exceeded. Therefore it is proposed that discharges from Edmondson Park South are controlled such that post-development discharges do not exceed pre-development levels for the Bunbury Curran Catchment.

There are two culvert crossings servicing Edmondson Park South, one is situated under Campbelltown Rd that drains the Maxwells Creek catchment and the other is located under the Hume Highway at the southern fringe that drains to the Bunbury Curran Creek catchment.

A small portion of the site, along the Maxwells Creek drainage corridor, is affected by flooding from the 100 year ARI and Probable Maximum Flood (PMF) storm events (Ref. 5). The majority of the flood affected areas will form part of the riparian corridors and will not be subject to site filling.

5.3 The Proposed Development

The proposed ‘Edmondson Park” development is expected to yield over 3,200 residential lots, dedicated drainage reserves, open space areas and associated road network with drainage. The proposed development layout is indicated on Plate 2.

The Concept Plan establishes the overall planning framework for the site, including:

- land use type and distribution;
- a mix of housing types and densities (approximately 3,200 dwellings);
- concept location of and approximately 35,000 – 45,000 m2 of retail / business / commercial floor space within the new Edmondson Park Town Centre;
- identification and location of open space and drainage corridors, environmental conservation lands (to form the new Regional Park), and local active and passive recreation facilities, including levels of embellishment;
- expanded Ingleburn North Primary School and new combined Primary/High School to the north of the site;
- road network layout;
- pedestrian and cycleway network layout;
- pedestrian bridge over the south western railway;
- Campbelltown Road corridor including the establishment of key intersection locations and configuration;
- utilities (including power, telecommunications and gas), infrastructure strategy, potable water strategy, sewer concept plan and water cycle management plan;
- location and dimensions of Bushfire Asset Protection Zones;
- appropriate interpretation of European and Aboriginal heritage located on the site;
- erection of signage and billboards;
- remediation works; and
- demolition.

6 DEVELOPMENT GUIDELINES, OPPORTUNITIES AND CONSTRAINTS

6.1 Department Of Environment Climate Change & Water (DECCW) Requirements

6.1.1 Stormwater Quality

The Department of Environment Climate Change & Water (DECCW) has set guidelines for stormwater quality from urban developments in their Managing Urban Stormwater – Environmental Targets (Ref. 9) and Managing Urban Stormwater Council Handbook (Ref. 10). These documents nominate quantitative post construction phase stormwater management objectives for the reduction of various pollutants for a range of new developments. The retention criteria relevant to Edmondson Park South are specified as follows:

Suspended Solids [1]	85% of average annual load for particles 0.5 mm or less
Total Phosphorous [1]	65% retention of average annual load
Total Nitrogen [1]	45% retention of average annual load
Gross Pollutants [1]	90% retention of material greater than 5mm
Fine Particles [2]	50% of average annual load for particles 0.1 mm or less
Litter [2]	Retention of litter greater than 50 mm for flows up to 25% of the 1 year ARI peak flow
Coarse Sediment [2]	Retention of sediment coarser than 0.125mm for flows up to 25% of the 1 year ARI peak flow
Oil and Grease [2]	In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1 year ARI peak flow

1. *Source – Consultation Draft – Managing Urban Stormwater : Environmental Targets*
2. *Source – Managing Urban Stormwater Council Handbook*

DECCW supports the principle of no nett deterioration in water quality and recommends the following;

- Incorporate best management practices to minimise impacts on water quality during construction and long term operation of the development.
- Produce an estimate of the expected pollutant loads from Edmondson Park and identify and describe the likely environmental impact of these loads (changes in water quality).
- Water quality criteria need to be linked with existing Council catchment and stormwater management plans.
- Adequate sediment and nutrient controls should be implemented during and after development of the land in accordance with Council's requirements (Erosion and Sediment Control plans).

6.1.2 Stream Erosion Index

The Department of Environment, Climate Change & Water (DECCW) have recently released draft guidelines (Ref. 9) to facilitate the assessment and mitigation of the impact on watercourse habitat caused by an increase in the frequency of discharges associated with urbanisation of the catchment. This assessment is referred to as the Stream Erosion Index. The stream erosion index assessment is considered to be a more appropriate means of addressing the impacts of urbanisation on the frequency of regular flows to the riparian corridor and downstream environment than by simply reducing peak flows to pre development levels for one particular ARI storm event.

The Stream Erosion Index (SEI) is defined by the DECCW as the post development duration of flows greater than the 'stream forming flow' divided by natural duration of flows greater than the 'stream forming flow'. The 'stream forming flow' is defined as 50% of the 2 year ARI flow rate estimated for the catchment under natural conditions. The DECC guidelines recommend an acceptable stream erosion index range between 3.5 – 5, with an optimum level being closer to 1.0 .

6.1.3 Riparian Corridors

Guidelines on the method for classification of Riparian Widths for watercourses are published by the NSW Office of Water (formerly the Department Of Water & Energy) in a document titled "Guidelines for Controlled Activities – Riparian Corridors (February 2008)". (Ref. 22). A copy of the relevant table is included below.

Types of Watercourses	**CRZ Width**
any first order [1] watercourse and where there is a defined channel where water flows intermittently	10 metres
• any permanently flowing first order watercourse , or • any second order [1] watercourse and where there is a defined channel where water flows intermittently or permanently	20 metres
any third order [1] or greater watercourse and where there is a defined channel where water flows intermittently or permanently. Includes estuaries, wetlands and any parts of rivers influenced by tidal waters.	20-40 metres[2]

[1]as classified under the Strahler System of ordering watercourses and based on current 1:25,000 topographic maps

[2]merit assessment based on riparian functionality of the river, lake or estuary, the site and long-term land use.

The general requirements for the treatment of Riparian Corridors were determined to be:

- Modification of the riparian zone should be minimised. Generally retain as is and implement management strategies for weed removal and revegetation.
- Stormwater quality and quantity treatment from urban areas needs to be generally managed off-line where possible and addressed prior to discharge to core riparian zones.
- Riparian zone restoration/revegetation will be required by DECCW in accordance with their guidelines for preparation of vegetation management plans.

- Remnant riparian vegetation and logs/large woody debris embedded within the creek bed and banks area to be retained where possible to ensure ongoing stability, habitat and health of the stream environment.
- 100 year ARI flow to be kept within the riparian zone.

DECCW recommends that where crossing of the river is required, structures that minimise site disturbance and that maximise the continuity of the natural stream and riparian zone profile should be utilised. The number of crossings should be minimised.

Further details on the riparian corridors assessment undertaken for the site by JWP are presented in Section 8

6.1.4 Floodplain Management

Floodplain management in NSW is governed by the NSW Floodplain Development Manual: the management of flood liable land (2005) (FDM) (Ref. 11). This document sets out the management framework for controlling development within the floodplain.

The "*primary objective of the NSW Government's Flood Prone Land Policy is 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".* The document provides guidance on the development of Floodplain Risk Management plans and indentified Local Government as the agency responsible for management in the floodplain. The Development *manual promotes the use of a "merit approach which balances social, economic, environmental and flood risk parameters to determine whether particular development or use of the floodplain is appropriate and sustainable*."

6.1.5 BASIX

Introduced by the NSW Government, BASIX, the Building Sustainability Index, ensures homes are designed to use less potable water and be responsible for fewer greenhouse gas emissions by setting energy and water reduction targets for houses and units of up to 40% (minmum).

Demand management strategies include: resident education on waterwise practices, triple A rated showerheads, water efficient taps, dual flush toilets, and low water demand gardens (native plantings, mulch, micro irrigation). Research by Sydney Water has indicated that the use of AAA showerheads and dual flush toilets can reduce total domestic water use by 15%. Separate studies by Coombes Consulting Group (2000) (Ref. 12) found that the use of AAA fittings and appliances can reduce total domestic water use by 17.5%.

6.2 Georges River Stormwater Management Plan

The Georges River - Stormwater Management Plan (Ref. 14) prescribes quantitative post construction phase stormwater management objectives for the reduction of various pollutants for a range of new developments. The retention criteria nominated for residential subdivisions are nominated as follows:

Total Suspended Solids	80% retention of average annual load
Total Phosphorus	60% retention of average annual load
Total Nitrogen	35% retention of average annual load

6.3 Campbelltown City Council Stormwater Quality Control Policy

Campbelltown City Council's objectives underlying their stormwater design requirements are:-

- Retention of the natural stormwater system where possible.
- A major/minor approach to stormwater design aimed at controlling flood flows so that severity and frequency of flooding downstream is not increased from undeveloped values.
- In all designs, consideration must be given to the effect of floods greater than the design flood.
- In no circumstances should the design create conditions which would be beyond the capacity of the existing downstream drainage system.
- The stormwater system comprises street gutters, pits, pipelines, overland flow paths, channels, detention basins, gross pollutant control devices and water quality improvement devices and natural watercourses.

The stormwater design requirements of Campbelltown City Council are as follows:-

- The minor drainage system (e.g. Pits, pipes, and swales) shall be designed to convey the peak 5 year ARI flow for urban residential developments.
- The major drainage system (e.g. Pits, pipes, and swales) shall be designed to convey the peak 100 year ARI flow.
- All major structures are to be designed for the peak 100 year ARI storm events without afflux in urban areas.

6.4 Masterplan Objectives

The previous Water Cycle Masterplan for the Edmondson Park Release Area (Ref. 1) aims to ensure that the area is designed, developed and maintained in accordance with the following urban water management objectives.

- To protect and enhance natural water systems in urban developments.
- To integrate stormwater treatment into the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity of the development.
- To protect good quality water draining from the development.
- To reduce runoff and peak flows from development by employing local detention measures, minimising impervious areas and maximising reuse.
- To add value while minimising drainage infrastructure development costs.

6.5 Water Sensitive Urban Design (Wsud)

Water Sensitive Urban Design aims to minimise the hydrological impacts of urban development and maximise the multiple use benefits of a stormwater system that will integrate the solution into the landscape.

Australian Runoff Quality (Ref. 15) identifies the objectives of WSUD to include:

- Reducing potable water demand through water efficient appliances, rainwater and grey water reuse.
- Minimising wastewater generation and treatment of wastewater to a standard suitable for effluent reuse opportunities and/or release to receiving waters.

- Adoption of appropriate waterwise landscaping practices (native gardens, mulching, micro-irrigation).
- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters.
- Preserving the natural hydrological regime of catchments.

Australian Runoff Quality also identifies WSUD as the adoption of the following planning and design approaches that integrate the following opportunities into the built form of cities and towns:

- Detention, rather than rapid conveyance of stormwater.
- Capture and use of stormwater as an alternative source of water to conserve potable water.
- Use of vegetation for filtering purposes.
- Water-efficient landscaping.
- Protection of water-related environmental, recreational and cultural values.
- Localised water harvesting for various uses.
- Localised wastewater treatment systems.

Concept Design guidelines for WSUD from South East Queensland Healthy Waterways Partnership (Ref 15) considers that WSUD seeks to:

- Recognise the resource value and life-sustaining qualities of water in the urban environment by overtly communicating these values and qualities through thoughtful building and landscape design
- Address the fundamental water-cycle transformation caused by traditional forms of urban development by employing principals and practice borrowed from natural environment.
- Re connect people with the natural landscape, in particular to water, and connect the built landscape with locality generated water resources, reducing reliance on imported water resources from outside the urban footprint to sustain urban landscape

6.6 Public Safety Guidelines (Drainage And Flooding)

Council's design standards (Ref. 13) for stormwater drainage design stipulates that all detailed drainage designs shall incorporate an assessment of major system flows to ensure that the major system provides a safe and adequate escape route for stormwater from rare and extreme events. Council's design standard for the major system is the 100 year ARI event.

Roads, pathways, open space reserves and drainage reserves are to generally form the flow path by which major system flows are safely routed through a new subdivision. Major structures are to be designed for the 100 year ARI storm event.

Retarding structures shall be designed to contain a minimum of the 100 year ARI flood event. Additional spillway capacity may be required depending on the ANCOLD (1986) hazard category of the structure.

The above public safety guidelines have been incorporated in the development of the stormwater drainage strategy for Edmondson Park South.

6.7 Stormwater Management Objectives

6.7.1 Overall Objectives

In considering appropriate options for stormwater management the following general objectives were adopted:

Environmental	Provision of appropriately designed, functional water quality facilities and ecosystem enhancement; limitation of downstream discharge peaks and velocities; ecologically sustainable; adopt principles of total catchment management and water sensitive urban design; conform with statutory water quality requirements.
Urban Amenity	Provision of a stormwater management strategy that identifies and controls limits of flood affectation; provision of aesthetic design forms that enhance urban amenity and address proposed adjacent land uses (residential, recreational, environmental and transport); views into and out of drainage corridors; water quality (visual amenity and public health).
Engineering Considerations	Effective management and control of peak discharges, and discharge velocities to pre-development and ecologically sustainable levels; industry best practice technical analysis of catchment hydrology and system hydraulic performance, soft sustainable bioengineering treatments
Economics	Provision of a cost effective, functional stormwater management system that optimises performance, keeps maintenance costs and requirements to an acceptable level, keeps land take to a minimum, provides maximum value for expenditure of public monies and focuses on ecological sustainability.

6.7.2 Specific Development Objectives

In accordance with the principles of Ecologically Sustainable Development (ESD), ensure that the area is designed, developed and maintained in accordance with the following stormwater management objectives.

- Preserve where possible the ecological integrity of the riparian corridors through the proposed development.
- Restrict development to above the 100 year ARI flood level.
- Incorporate water sensitive urban design principles within the development.
- Ensure post-development water quality complies with the requirements of the DECC, GCC Development Code (Ref 17) and the Georges River Stormwater Management Plan.
- Minimise land take for stormwater management measures consistent with the achievement of Council's and the DECCW's technical and environmental objectives.
- Integrate open space with water quality swales (bio-retention) to provide high amenity and maintain the natural character and ecology within the open space corridors.

- Provision of a sustainable aquatic environment that preserves the potential for creating habitat for locally indigenous flora and fauna.
- Minimise Council's maintenance requirements for open space, raingardens and litter control structures.
- Enhance the biodiversity, ecological health and positive water quality benefits within the riparian corridors to provide an integrated natural resource for the incoming residents.

6.8 Consultation

In the development of the Release Area Water Cycle Management Strategy in 2007 (Attachment A) consultation was undertaken with the following agencies:

- Liverpool City Council
- Landcom
- DECCW

As part of the development of the Edmondson Park South Water Cycle Management plan the following agencies were also consulted:

- Campbelltown City Council
- Landcom

The agencies feedback to this consultation process was incorporated in development of the specific objectives for water cycle management for the Release Area.

6.9 Site Geology And Soils

Geotechnical testing and investigation was undertaken on the overall Edmondson Park Development Area by Geotechnique Pty. Ltd. in conjunction with the Masterplan process, which included assessments of samples taken from The Site. The results of the investigation are presented in the report titled "Proposed Future Development – Edmondson Park Release Area – Edmondson Park – Land Capability Assessment" (Ref. 19). In summary it was determined:

- Bedrock at Edmondson Park is anticipated to be Bringelly Shale belonging to the Wianamatta Group of rocks.
- Landscape of the majority of Edmondson Park belongs to the Blacktown (residual) and Luddenham (erosional) Groups, except the drainage depression at the far north western part of Edmondson Park which belongs to the South Creek Group.
- Five types of soils profiles are located on the site:

Fill	Gravelly clay, coal wash, topsoil with some timber, brick and fibro in places, poorly to moderately well compacted.
Topsoil	Clayey silt, silty clay, low plasticity, brown, dry to moist.
Alluvial Soils	Clay, silty clay, gravelly clay, clayey silt, medium to high plasticity, mottled grey, orange-brown, red-brown, moisture content varying from lower to higher than the plastic limit, generally stiff to hard, with clayey gravel and ironstone gravels in places.
Residual Soils	Clay, silty clay, sandy clay, gravelly clay, shaley clay,

generally medium to high plasticity, grey, dark grey, brown, orange, red, moisture content generally lower than plastic limit, with some gravel in places.

Bedrock — Shale, grey, dark grey, extremely to distinctly weathered, extremely low to low strength, indurated in places and sandstone, fine to medium grained, orange, pale brown, extremely weathered, extremely low to low strength.

- The residual and alluvial soils within Edmondson Park are dispersive or potentially dispersive and therefore susceptible to erosion.
- Site condition is non aggressive to mildly aggressive toward concrete structures and mild to moderately aggressive to iron and steel.

Further details on the Site Geology and soils underlying Edmondson Park South can be found in Golders Associate report on the Concept plan (Ref. 7).

6.10 Salinity

Salinity is the accumulation of mineral salts in the soil, groundwater and surface waters. Dry land salinity results when these soluble salts are transported to the surface by rising water table. The groundwater itself can also cause soluble salts to migrate under the ground surface and emerge as saline seepage in low lying areas. Salinity can lead to vegetation loss, weed invasion, soil structure decline and in some cases structural damage to buildings.

A key part of the detailed Geotechnical Investigation, undertaken by Geotechnique (Ref. 19), for the overall Edmondson Park release area was the determination of the extent of both soil and groundwater salinity affecting the site.

6.10.1 Soil Salinity

As a part of the geotechnical investigation of the overall Edmondson Park site, samples were obtained throughout Edmondson Park at varying depths from over seventy test pits to determine soil salinity, including over twenty within Edmondson Park South. The results are summarised as follows:

- Samples recovered from depths of up to 0.3 metres found that the topsoils are generally non-saline.
- Samples recovered from depths of 0.3m to 1.0m found that the soils are generally slightly to moderately saline.
- Samples recovered from depths exceeding 1.0m found that the soils are moderately to highly saline.

From the results of the soil salinity testing it was concluded that:

- Soil salinity increases with depth in both the residual and alluvial profiles.
- Saline soils are likely to be encountered within the Edmondson Park Development area and the environmental, economic and social impacts need to be taken into consideration for the proposed development.

6.10.2 Water Salinity

Over thirty samples were obtained to determine the salinity of water within the overall Edmondson Park site. Sufficient groundwater for testing was encountered in only one of the test pits. The remainder of samples were obtained from dams throughout the Edmondson Park site. The results are summarised as follows:

- A few of the water samples were found to be saline to brackish.
- Twelve of the water samples collected were found to be marginally saline.

From the results of the water salinity testing it was concluded that:

- Surface water collected in dams is likely to be non-saline or marginally saline.
- Groundwater at depths exceeding 2.5m is likely to be saline to brackish.

6.10.3 Salinity Code Of Practice

Land use activities can affect groundwater recharge and discharge, and result in rising water tables and saline groundwater seepage. The key principles recommended by WSROC in their Salinity Code of Practice (Ref. 20) to guide Urban Salinity Management are as follows;

- Identify hazard areas.
- Reduce water inputs to maintain natural water balance and avoid groundwater rises and through flow.
- Maintain good drainage and reduce waterlogging.
- Retain and increase vegetation in strategic areas.
- Implement building controls and / or engineering responses where appropriate.

6.11 Opportunities

In the design of any urban drainage scheme it is desirable to build on the naturally occurring physical and environmental assets of Edmondson Park to maximise the quality of the ultimate living environment. In particular water should be recognised as an important resource that can enhance and bring a focus to areas accessible to the whole community.

For Edmondson Park South, there are major opportunities to:

- Maintain, rehabilitate and enhance permanent riparian corridors.
- Maximise habitat retention along the riparian corridors to provide sustainable aquatic and terrestrial ecosystems.
- Integrate open space areas and riparian corridors.
- Incorporate storage within the water quality elements to maintain environmental (base) flows at pre development levels.

6.12 Constraints

The constraints to be considered in the preparation of a drainage strategy for this site include;

- Water Quality objectives will require allocation of land for water quality control structures
- Stormwater detention is required to reduce post development flows to pre development levels. Appropriate areas will be required to provide necessary detention storage.
- Existing site soil salinity and groundwater salinity constraints.
- Water use activities that can cause unnatural charging of groundwater and create rising watertables (e.g. over-irrigation of public areas, sports fields, private lawns and private gardens).

7 WATER CYCLE MANAGEMENT STRATEGY

The Water Cycle Management Strategy proposed for the development has been prepared with consideration of the statutory requirements and guidelines listed in Section 6 of this report. The strategy focuses on mitigating the impacts of the development on the total water cycle and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices.

7.1 Proposed Water Cycle Management Elements

As discussed in Section 2, for the purposes of this report, the site has been divided into three separate localities (refer to Figure 1). The Water Cycle Management Elements proposed to service each of these three localities are summarised as follows and are also presented on Figure 1.

7.1.1 Locality 1

The primary focus of this investigation includes detailed hydrological and water quality modelling. The Water Cycle Management strategy has been developed as a "treatment train" which will remove various types of pollutants associated with urban development through a number of elements acting in series. Attachment B contains a brief description of the Water Cycle Management elements used in the treatment train and the technical parameters adopted for the Water Quality Modelling (MUSIC) undertaken to confirm the performance of these elements. Detailed modelling results are presented Section 11.

Water Quality

A treatment train consisting of:

On Lot Treatments

- Appropriate waterwise landscaping practices (resident education, native gardens, mulch, micro-irrigation).
- Implementation of water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).
- Minimisation of impervious areas.
- Reticulated recycled water.

Street Level Treatments

- Proprietary gross pollutant traps.

Precinct Scale Treatments

- Bio-Retention Raingardens, located within the public reserves and adjacent to the riparian corridors.

Water Quantity

- A regional detention basin within Maxwells Creek which will treat the central portion of Edmondson Park South and is sized to adequately compensate for the adjacent northern areas of the development that bypass detention.

- Within the Bunbury Curran Catchment a detention basin adjacent to the Hume Highway will be required to manage flows from the rural residential portion of the development.

7.1.2 Locality 2

As discussed under Section 2 of this report, a detailed Water Cycle Management strategy was previously developed by JWP in 2007 for the Edmondson Park Release Area that falls within the Liverpool LGA. A copy of this investigation is included at Attachment A to this report. This earlier strategy effectively sets the Water Cycle Management Strategy framework for development in the Liverpool LGA portion of the Release Area which includes Locality 2.

The area will be serviced by two raingardens (See Figure 2 of JWP 2007 report in Attachment A for detailed locations). A raingarden of 2150m^2 will service an 18.5ha catchment with an additional 5300m^2 raingarden servicing 39.39ha catchment that includes the proposed Town Centre. These raingardens are proposed adjacent to the Maxwell Creek Drainage corridor within the Liverpool Local Government Area. These raingardens are also presented on Figure 1.

7.1.3 Locality 3

The previous Water Cycle Management Strategy prepared for the Release Area (refer to Attachment A) also defines the strategy for Locality 3.

However, at the time the Release Area strategy was prepared the proposed strategy for managing water quality did not allow for residential development north of Campbelltown Road (i.e. it was assumed that if development did occur it would be supported by its own water quality management controls). Consequently, JWP have identified preliminary sizes for two raingardens which will be provided to service this portion of the catchment. The preliminary sizes were determined based on the detailed MUSIC modelling undertaken to support Locality 1.

The two raingardens that are proposed to service this portion of Locality 3 are indicated on Figure 1. The raingardens (with sizes of 750m^2 and 950m^2) will ensure the water quality targets specified by DECCW and Liverpool Council are achieved prior to discharge into the conservation area.

A detailed flood investigation was undertaken by Webb, McKeown and Associates for the Edmondson Park Release Area on behalf of Landcom in 2007 (Ref. 3, 4 & 5). This study expanded on the analysis previously undertaken by GHD (Ref. 1 and 8) for the Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

The Webb McKeown and Associates report (Ref. 5) did allow for the effects of development within the Maxwells Creek catchment and as a consequence, determined that the proposed basin will “counteract the effects of development on the whole catchment such that peak flows at the M5 Motorway” are reduced. This Water

Cycle Management Plan has used these findings and determined that additional detention storage to service locality 2 and 3 was not required.

7.2 Scheme Features & Outcomes

Key features and outcomes of the proposed Water Cycle Management Strategy are summarised as follows:

Social:

- Demand management measures and reticulated recycled water provided to reduce potable water demands.
- Integration of bio-retention raingardens, sand filter and ornamental pond with the overall landscape strategy for the estate to address water quality, offset the impact of development on frequent discharges to the riparian corridors and create an integrated-natural resource for the incoming and wider community.
- Enhanced visual amenity (views out of and through the riparian corridors).
- Flood affectation and public safety issues identified and controlled.
- Provision of aesthetic soft design forms that enhance urban and Environmental amenity.
- Intergenerational equity attained through the provision of a healthy, functioning riparian corridors.

Environmental:

- Limited downstream and in-channel discharge peaks and velocities to avoid scouring, siltation and flora and fauna impacts
- Enhanced ecological health and biodiversity within the downstream riparian corridors.
- Preserve where possible the ecological integrity of the riparian corridors through the proposed development.
- Restrict development to above the 1% AEP flood level.
- Incorporate water sensitive urban design principles within the development.
- Ensure post-development water quality complies with the requirements of the DECC, GCC Development Code (Ref 17) and the Georges River Stormwater Management Plan.
- Minimise land take for stormwater management measures consistent with the achievement of Council's and the DECCW's technical and environmental objectives.
- Integrate open space with water quality swales (bio-retention) to provide high amenity and maintain the natural character and ecology within the open space corridors.
- Provision of a sustainable aquatic environment that preserves the potential for creating habitat for locally indigenous flora and fauna.
- Minimise Council's maintenance requirements for open space, raingardens and litter control structures.
- Provision of gross pollutant traps, bio-retention systems and other treatment devices to achieve water quality capable of sustaining downstream aquatic ecosystems. All devices will incorporate landscaping features which will enhance the visual amenity of the devices and assist in improving the quality of stormwater runoff from the site.
- Peak storm flow attenuation is addressed through provision of constructed detention basins incorporated with bio-retention raingarden devices.

Economic:

- Minimisation of land take consistent with the achievement of environmental and social objectives.
- Proposed water quality improvement measures that keep recurrent maintenance tasks and costs to a minimum.

7.3 Reductions In Potable Water Demand

It is understood that the development will be provided with a reticulated recycled water main in the future. The recycled water main will be utilised in domestic toilets and laundries as well as irrigation of lawns and gardens, significantly reducing the demand on potable water supplies. Therefore rainwater tanks are not intended to be provided for the development.

It is recommended that demand management measures be implemented within all allotments / dwellings to achieve reductions in potable water demand to satisfy the requirements of BASIX.

7.4 Litter And Sediment Control

Local drainage throughout the development would be filtered to remove litter & coarse sediment prior to discharge into the downstream drainage systems, bio-retention raingardens and the riparian corridors. Devices to achieve litter and sediment control come in various forms, such as inlet pit filter inserts, cast in situ and precast gross pollutant traps as well as wet sump and self cleansing units.

It is proposed that the relevant Council approved proprietary gross pollutant trap structures be provided to capture litter, vegetative matter and coarse sediment prior to discharge to the downstream treatment devices. An appropriate unit should be selected such that it intercepts a minimum 70% of the sediment of size 0.15 mm and greater.

It is expected that Edmondson Park South drainage strategy would require 11 devices (at least one prior to discharging into each of the bio-retention raingardens). The approximate locations of the proposed GPT's are shown in Figures 4 - 10.

7.5 Ornamental Pond

A 3000m^2 ornamental pond is proposed to be located at the head of the Maxwells Creek riparian corridor. Refer to Figure 4 for the location and general configuration of the pond.

The Pond is to be configured as an open water body providing an aesthetic feature and improved amenity to the local area. This device would be designed to receive and convey limited flood flows which surcharge from the pipe system in the upstream catchment in a 100 ARI event, and will form part of the flow management arrangement across existing Macdonald Road.

7.6 Bio-Retention "Raingarden" Systems

A number of "Raingardens" have been located within the riparian corridor fringes of Edmondson Park South to facilitate the removal of suspended solids and nutrients from the urban catchment. Figures 4 -10 provided the relative Raingarden sizes and details.

The Raingardens consists of a loam sandy media bed with a surface which is densely vegetated with native sedges and/or grasses. This device would be designed to receive, convey and treat 3 month ARI flows from the upstream catchment. Treatment is attained by

detention of flows, direct filtration and nutrient stripping by bio-films which establish on the surface of the media bed and around the roots of the plants.

7.7 Water Quantity Management

Two Regional detention basins will be incorporated within the development to restrict post development discharges to pre-development levels for the 5 and 100 year ARI storm events. The basins will minimise the impact of the proposed development by reducing storm flows prior to discharge to the bushland and riparian corridors downstream of the site.

These will act as detention systems to limit storm flows up to the 100 year ARI discharging to Maxwells Creek and Bunbury Curran Creek to pre-development levels.

Details of the Water Quantity management elements are provide in Section 9.0 of this report

7.8 Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Campbelltown City Council and the guidelines set out by the NSW Department of Housing (the “Blue Book” Ref. 21).

As the operations of constructed bio-retention raingarden water quality treatment systems are sensitive to the impact of sediment, these devices should not be constructed until a significant portion of the urban release area is developed. Alternatively, a very high level of at source control on individual allotments during the building and site landscaping works, which is regularly inspected by Council officers, would be required.

7.9 Salinity And Groundwater Control Measures

Typical land use practices that should be implemented to avoid salinity impacts and to manage interaction of surface flows with Groundwater systems on Edmondson Park South include:

- Retention and enhancement of vegetation in strategic areas.
- Retention and maintenance of natural riparian corridors.
- Resident and Public Authority education on the need to restrict over-watering of lawns and open space areas to avoid lifting water table levels.
- Encourage residents to grow plants with low water needs (natives); mulch gardens to reduce water use and evaporation; use watering timers with micro irrigation systems.
- Providing sub-surface drainage to ensure that roads and lots do not create impediments to the flow of shallow water tables.
- Ensuring that roof drainage is not connected to on-site recharge pits.
- Ensuring that leakage from water supply services is minimised.
- Maintaining good drainage and reducing waterlogging.
- Avoiding infiltration from water storage bodies, wetlands and bio-retention filters through the incorporation of impermeable barriers or liners.
- Providing polyethylene sheeting underground bearing slabs, effective damp courses and sub-soil drainage.
- Adopt appropriate masonry and concrete construction materials to withstand the effects from saline soils.

- Minimising excavation as much as possible to reduce the disturbance to saline and sodic subsoils.

Groundwater recharge and discharge can both result in rising water tables and saline groundwater seepage. It is anticipated that there will be very little or no impact on groundwater provided the increased runoff from urbanisation is managed on Edmondson Park South to minimise or eliminate the possibility of recharging the groundwater regimes within the site.

It is recommended that erosion control measures should be in place during construction to minimise degradation of soils and minimise the effect of salt input near the proposed waterbody.

All completed areas will be revegetated and re-grassed to minimise salt release as soon as possible following completion. Stockpiling of soils for lengthy periods will be avoided unless stockpiles are re-grassed to minimise the effect of erosion.

7.10 Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish, and monitor plant establishment and health. Some sediment build-up may occur on the surface of the raingardens and may require removal to maintain the high standard of stormwater treatment.

Proper management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. It is strongly recommended that a site-specific Operation and Maintenance (O & M) manual is prepared for the system. The O & M manual will provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual will provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal.
- Management of the raingardens, including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal).
- Management of the ornamental pond including removal of rubbish and plant monitoring as required.

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8 CLASSIFICATION & MANAGEMENT OF RIPARIAN CORRIDORS

8.1 Classification of Corridors Within Locality 1.

In July 2010 JWP undertook an assessment of the existing depressions and creeks within Locality 1 of Edmondson Park South, identified the relevant 'Stream Order' and proposed appropriate Core Riparian Zone (CRZ) and Vegetated Buffer (VB) widths for each watercourse.

A summary of the classification of the various watercourses located within Locality 1 is presented in Table 8.1 on the following page. The table summarises the various factors considered in the determination of the appropriate classification for each stream and provides comment on the justification for any proposed variation in either categorisation or width of the corridor relative to the Current LEP. The table should be read in conjunction with Plate 3 which indicates the title and location of each watercourse. A detailed description of the field investigation and observations for each watercourse assessed is also summarised in Attachment C.

8.2 Adopted Stream Classification Methodology

Under the NSW Office of Waters current guidelines on determining riparian corridor classifications (Ref 24) the definition of a first order watercourse is classified under the Strahler System of ordering watercourses and based on current 1:25,000 topographic maps prepared by the NSW Land and Property Management Authority (LPMA).

These guidelines (Ref.22) supersede the previous Riparian Corridor Management Study (RCMS) Guidelines (Ref.24.) for riparian land which were incorporated into the Growth Centres Development Code (2006) (Ref.18).

The classification of streams in urban fringe areas is only possible following ground truthing to assess the degree of disturbance to the watercourse. Many of the streams located within Locality 1 at Edmondson Park South are in these urban fringe areas within the previous Ingleburn Army Base where there has been a long history of significant disturbance to the sites drainage systems including the introduction of large diameter pipes. The degree of disturbance to watercourses designated as "blue lines" on the 1;25,000 topographic map series was a significant factor in the stream classification process undertaken for Locality 1.

Table 8.1 Summary of Stream Classification

Reach	Catchment (Cumulative Areas) Ha	Shown on 1:25,000	Banks	Bed condition	Flow Regime	Strahler Class.	RCMS Category	Vegetative Condition	Ecological Value	LEP Corridor Widths	Proposed Corridor Widths	Justification for Proposed Variation to previous corridor
A	31.7	Yes	Some evident	Natural	Ephemeral	1	3	Scattered ENV. Modified	Some	30 m and varies	45	Widened to accommodate existing native vegetation
B1	145.5	Yes	Incised Creek & Banks	Natural	Ephemeral	2	2	Some Good Most Modified	Some	>80	>80	No change
B2	113.9	Yes	Incised Creek & Banks	Natural	Ephemeral	1	3	Most Good Some Modified	Some	> 80	>80	No change
B3	89.3	Yes	Concrete Channel	Altered	Ephemeral	1	3	Modified	Little	80	45	Concrete Channel to be removed and restored as a natural channel, Stream has little ecological value.
B4	54	Yes	None evident	Pipe	Ephemeral	1*	-	Highly Modified	Negligible	80	-	Ephemeral stream only , no bed or bank, highly modified, little ecological value
B5	20.7	Yes	None evident	Pipe	Ephemeral	1*	-	Highly Modified	Negligible	-	-	No Change
C	13.7	Yes	None evident	Altered	Ephemeral	1*	-	Highly Modified	Negligible	-	-	No Change
D	5.7	No	None evident	Altered	Ephemeral	-	-	Highly Modified	Negligible	-	-	No Change
E	9.2	No	None evident	Altered	Ephemeral	-	-	Highly Modified	Negligible	-	-	No Change
F	8.3	No	None evident	Altered	Ephemeral	-	-	Highly Modified	Negligible	-	-	No Change

* Strahler Class based on 1:25,000 Topo mapping only - Field classification as a drainage depression - not a watercourse under WMA(2000)

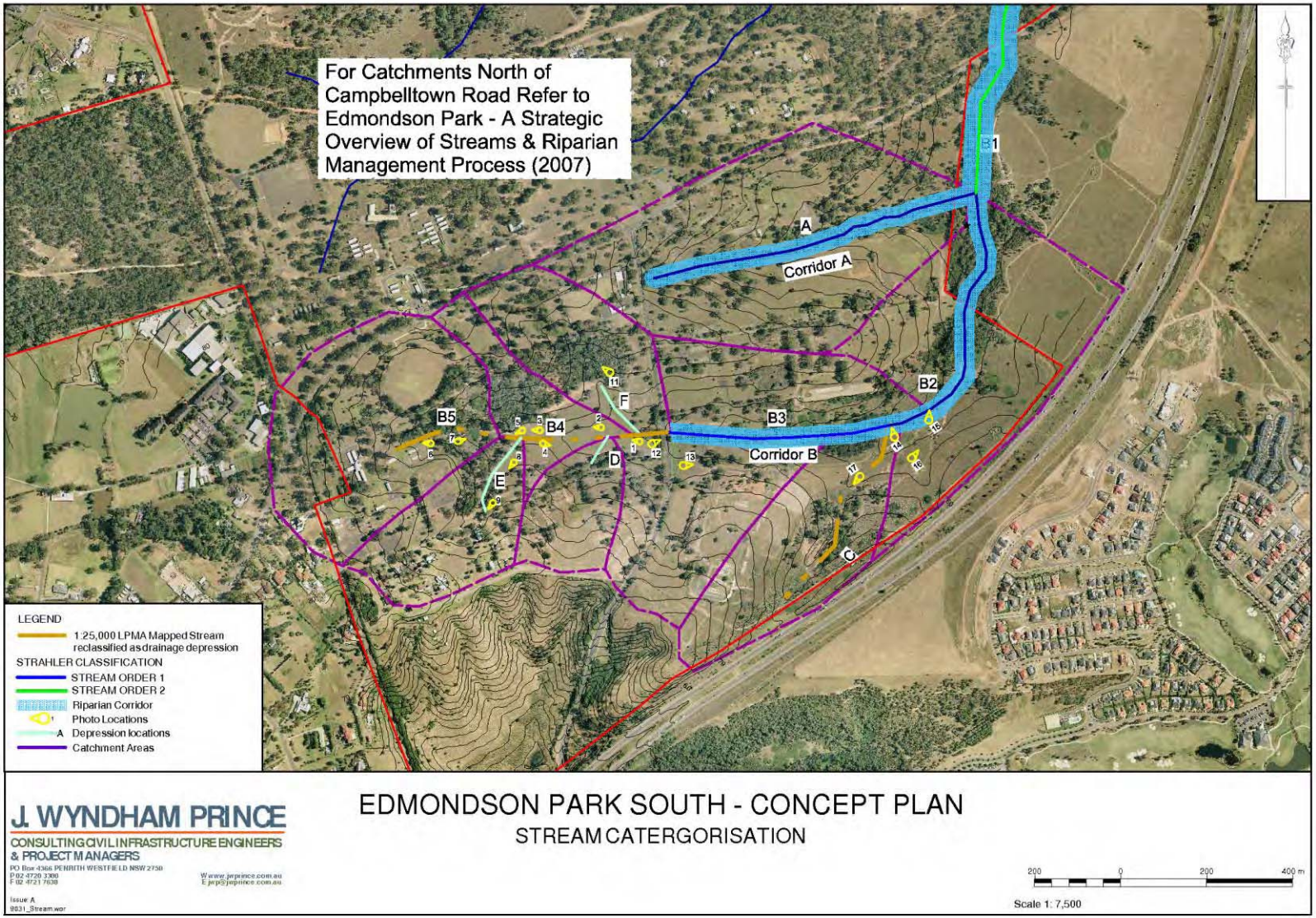

Plate 3 Stream Categorisation

8.3 Rainfall Data

The field observations were undertaken on Friday 23 July 2010. The rainfall data that preceded the field observations was gathered from two rainfall stations near the study area.

The Holsworthy Rain Gauge (Station No. 67117) is located approximately 6.1 km from the intersection of the Maxwells Creek and Macdonald Road. Rainfall records indicated that for the preceding seven days prior to the inspection, a total of 1.8 mm of rain had fallen. Furthermore, the rainfall record for the preceding 22 days (1 July – 22 July 2010), a total of 12.2 mm was recorded.

The Liverpool Rain Gauge (Station 67020) is located approximately 6.8 km from the site. Rainfall records indicated for the preceding 2 days prior to the inspection, a total of 2.4 mm of rain had fallen in this location. Furthermore, the rainfall record for the preceding 22 days (1 July – 22 July 2010), a total of 10.4 mm was recorded.

In summary, prior to the field assessment being undertaken on 23rd July, a reasonable level of preceding rainfall had occurred in the catchment which, in our opinion and given the winter season, was likely to be sufficient to produce visible flow in a watercourse that could be classified as an "intermittent stream". There was no visible streamflow on the site for any of the watercourses assessed.

8.4 Stream Ephemerality Assessment

Watercourses can be classified based on their flow characteristics as follows:

Ephemeral – Stream flows only during and immediately after rain.

Intermittent – Stream flows cease for weeks or months each year.

Perennial – Stream that has continuous flow all year round during years of normal rainfall.

An estimation of the likely catchment response was undertaken for the watercourse designated as B3 on Plate 3 in order to assess its flow classification or degree of ephemerality. The watercourse is located on the headwaters of Maxwells Creek to the west of Macdonald Road. The assessment involved the following process;

- Development of a specific XP-RAFTS hydrologic model of the 54 Ha catchment.
- Configuring the model to account for the likely site soil conditions and to incorporate a long term rainfall record (8.7 years of hourly rain data from the BoM Gauge site at Liverpool).
- Comparison and statistical assessment of the hourly rainfall and flow records derived from the model to assess the catchment response.

An outline of this assessment is presented in Appendix C The results are also presented in Table 8.2 below.

Table 8.2: Stream Ephemerality Assessment – Watercourse B3

Parameter	Results
Years of Hourly Rain Data	8.7 years
Number of Rain Occurrences	5476 hrs (228 days equiv.)
Number of Runoff Occurrences	823 hrs (34.3 days equiv.)
Number of Occurrences of Runoff following a Rain Event	11 times
Median Lag between End of Rainfall and End of Runoff	16 hrs
Minimum Lag between End of Rainfall and End of Runoff	6 hrs
Maximum Lag Time between End of Rainfall and End of Runoff	17 hrs

The modelling results indicate that for the entire duration of about nine years, runoff continued beyond cessation of rainfall on only 11 occasions. Runoff from the 54 ha catchment upstream of Macdonald Road, on the rare occasion that it occurs, usually ceases about 16 hours from the end of the preceding rainfall event.

The hydrological modelling undertaken supports the classification of this drainage depression *as ephemeral only and **not** Intermittent*.

The results of this assessment would also suggest that any other watercourses in this location with a smaller catchment than 54 Ha would also be classified as ephemeral.

8.5 Proposed Riparian Corridors A & B

The riparian corridors A and B proposed within Edmondson Park South Locality 1 (refer to Figure 1) have been determined by JWP to be consistent with a first order watercourse as defined by the latest NSW Office of Water Guidelines on Riparian Corridors (Refer to Section 6.1.3 & Ref.22). It should be noted that this category of minor watercourse (i.e. 1st Order Streams according to the Strahler Method) was previously referred to as a "Category 3" stream in both the RCMS and the Growth Centres Development Code. (Ref. 24 & 18.)

Category 3 streams (i.e. 1st Order Streams) have the following general requirements;

Category 3: Bank Stability and Water Quality

The objectives of a Category 3 Classification include;

- To retain, maintain and restore where possible the natural functions of a stream, including bed and bank stability to protect local water quality.
- To manage the impacts for saline affectation.
- To provide bed and bank stability.
- To protect water quality.
- To protect instream aquatic vegetation.
- To provide core Riparian Zones with a width of 10 metres, measured from the top of bank where evident.

Corridor A and B will be configured as a Category 3 Stream and will have a total riparian corridor width of 45 m which provides for;

- A creek bed and bank width of 5 metres.
- A CRZ of 10 metres from the top of bank on both sides of the watercourse.

- A 10 m wide VB on each side of the watercourse.

These corridors will provide geomorphic form and ecological functions together with terrestrial habitat for the Edmondson Park South development.

8.6 Justification of the Variation to Riparian Corridors Defined by the Current LEP

In conjunction with the Rezoning processes for the Edmondson Park Release Area a detailed assessment was previously undertaken on the watercourses within the site using the previous RCMS methodology (Ref 32). It is understood that this assessment was used as the basis of setting the corridor widths that are defined by the current LEP's covering the site (Campbelltown 2002 and Liverpool 2008).

Corridor Widths

The more recent (August 2010) Ecological Assessment undertaken in support of the Edmondson Park South Part 3A Concept Plan by Ecological Australia (Ref. 32) indicated that at the time of the earlier assessment it was intended to retain the existing concrete lined channel within the southern riparian corridor (indicated as Drainage Depression B on Plate 3). As a consequence the corridors were assigned a "*wider than necessary width*" (Ref. 32) as a measure of compensation for retention of the channel. The current proposal is to remove the channel and restore the depression as a natural channel. The additional channel width is no longer required.

The current Ecological Assessment (Ref. 32) also indicated that the proposed increase in width of the central riparian corridor (Watercourse A on Plate 3), over that defined by the current LEP, "*will enable retention of an additional area of Cumberland Plain Woodland and integration of passive open space elements".*

Stream Ecological Value

The Ecological Assessment (Ref. 32) also assessed the existing ecological conditions of the proposed southern riparian area (indicated as Watercourse B on Plate 3) and concluded *"that there is little ecological value in this stream"* .

It is noted that the corridor does not offer a continuous link between the Regional Parklands and any bushland areas that are to be retained under either the current LEP or the updated Concept Plan.

Corridor lengths

The length of the southern riparian corridor is proposed to be shortened by approximately 400 metres of the previous length defined by the current LEP. This effectively takes the corridor to within 100 metres of Macdonald Road which, as the Major traffic route servicing the area to be retained for some years, is a barrier to connectivity. As outlined above the western extent of the corridor provides no link to open space or retained or regenerated bushland in the current LEP or the proposal.

A raingarden will be located at the head of the corridor (just downstream of Macdonald Road) to ensure that the quality of stormwater flows deriving from the upstream development are suitable for discharge into the riparian corridor. The batters and curtilage area around the raingarden will be revegetated with riparian species. The invert of the basin will be planted with appropriate ground covers and small shrubs from the endemic riparian species palette.

A summary of the proposed adjustments in open space containing riparian corridors in Edmondson Park South relative to the current LEP is presented in Plate 4 below.

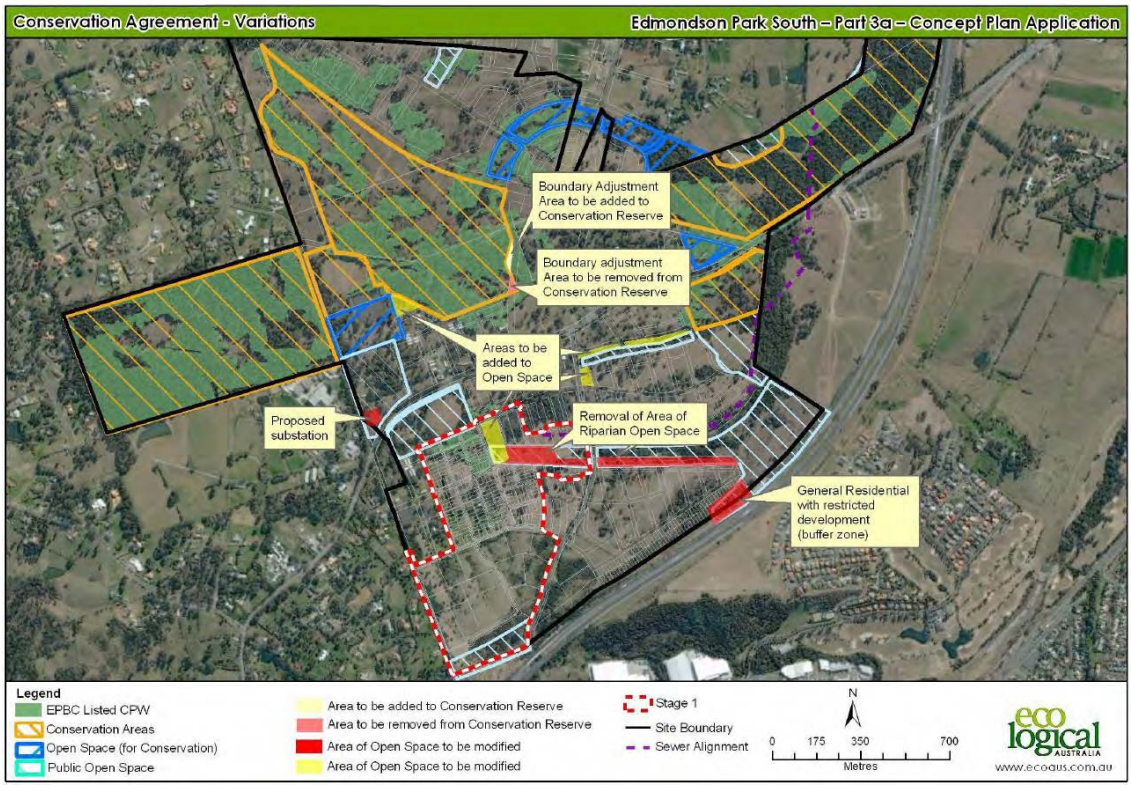

Plate 4 Areas of Open Space to be modified relative to the Current LEP (Source - Ref. 33)

8.7 Management of Riparian Corridors

A range of both structural and vegetative treatments are proposed to rehabilitate the streams to meet the category objectives listed above. The treatments have been proposed based on the following criteria.

- Creation of continuously vegetated corridors for the length of the creek systems.
- Future maintenance practicalities.
- Stabilisation of creek inverts and banks where necessary.
- Use of “natural” type materials only, such as rock, timber and organic fibres in any required structures.
- Stormwater flows will be cleaned and velocities limited before discharge to creek.
- All creek crossing are “fish friendly”

The key elements to the proposal have been categorised into streamworks and vegetative works.

8.8 Stream Works

- Removal of the existing concrete large concrete “vee” drain /channel in the stream invert and restoration in a natural channel form including introduction of stream meanders where possible.
- Re-establishment of a continuous watercourse where this has been lost.
- Stabilisation of existing inverts (drop structures, ramps, sills and headcut management.
- Stabilisation of existing creek banks (bank reshaping, re-vegetation, rock armouring, toe protection, tree undercuts, coir log terracing)
- Filling and trimming of existing dams within the watercourse.
- Construction of fish and fauna friendly culverts.

A defined flow channel will be re-established at locations specified by reforming an invert with grade and in stream geomorphologic features including meander bends, point bars, pools and riffle sections.

Typically this will involve;

- Detail grading of the new invert to longitudinal falls of less than 1%.
- Re-instating a topsoil layer of between 150-200mm thick.
- Installing an edge of coir fibre logs at selected locations, or battering at 3:1 to form banks.
- Providing pinned organic mat or mesh over the entire invert and banks and 5 metres beyond the bank.
- Planting aquatic and sedge species to all disturbed areas

8.9 Culvert Crossings

There is a total of three culvert crossings proposed within Locality 1 of Edmondson Park South. These locations are presented on Figure 1. Generally at all road crossings, the culvert configuration is sized to pass 100 year ARI flows while maintaining appropriate instream flow velocities and is configured to allow for fauna movement. The exception to this is the Basin Outlet / Road Crossing proposed on the Maxwells Creek basin. This structure has been designed to achieve a retardation of the 5 to 100 year ARI events for the post development conditions. The culvert allows environmental flows to continue through and chokes the larger events to provide storage upstream.

All culverts will have a 300mm depth substrate over the culvert base in line with fisheries guidelines.

8.10 Vegetative Works

A range of vegetative treatments are proposed along with the structural streamworks to provide Protection, Revegetation and Regeneration of vegetation within the watercourse and floodplain and an outcome that meets the category objectives.

The key elements include;

- Assisted Bush Regeneration.
- Revegetation
- Protection of existing native vegetation.
- Weed eradication and control.
- Planting and seed specifications for the site.

The selected vegetation will substantially improve the ecological function of the corridor.

8.11 Stormwater Management Devices

A series of water quality and quantity basins are proposed within the proposed open space areas and directly adjacent to the riparian zones. These devices have been sited so they do not impinge upon the minimum core riparian or vegetated buffer widths proposed. Typical details of the location and general configuration of these devices are indicated on Figure 1, and Figures 4-10 of this report. The final basin configurations are subject to future detail design.

The basins will be constructed to;

- Avoid existing vegetation.
- Not prevent environmental flows through the detention structures and substrate.
- Covered with vegetation similar to the adjacent riparian zones.

8.11.1 Raingardens

Raingardens have been proposed as the treatment system, to remove fine sediments and nutrients. They receive stormwater flows via pipes up to the 3 month ARI event. The first flush flows are first passed through a proprietary GPT to remove gross pollutants before entering the raingarden. Flows are retained then cleaned via the media before discharge to the creek. The retention of the 3 Month ARI events helps to control the flow entering the creek to more closely match pre development conditions for the lesser storm events.

The raingardens have generally been located on the outer edge of the 10 m wide buffer zone. The basin surface will be covered with grass and sedges endemic to the region planted as tube stock at densities of 7-8 per m^2. The buffers that form the storage for the raingarden can be planted with groundcovers, shrubs and trees. Trees and tall shrubs should be concentrated to the south of the basins so as to not shadow plants covering the media surface. Refer to Figures 4-10 for typical details and configurations of raingardens.

8.11.2 Detention Basins

A large dry detention basin with a pipe culvert outlet is proposed on Maxwells Creek to the south of Campbelltown Road (Refer to Figure 5). The purpose of the basins is to restrict 5 to 100 year ARI post development flows to pre development levels before leaving the site. The basin has the following features;

- This basin is consistent with the Basin previously proposed in this location by GHD (2003) (Ref.1)
- The basin has been configured to not impede minor flows in the creek system up to the 3 month ARI.
- It has been configured so that it doesn't significantly impede opportunities for terrestrial fauna from migrating up or down the creek system.
- The basins will be planted with ground covers, shrubs and trees endemic to the area in accordance with proposed vegetation.
- Large trees will not be planted on the basin fill embankment.
- A core riparian zone will be maintained around the eastern edge of the basin which will provide opportunity for fully structured riparian vegetation which does not interfere with the basin embankment.

8.12 Riparian Corridors In Localities 2 And 3

For the portions of the Edmondson Park South site north of Campbelltown Road (Localities 2 and 3 on Figure 1), the classification of riparian corridors and the proposed treatment of these corridors was determined in conjunction with the previous planning processes for the Edmondson Park Release Area. Details of these corridors and the proposed Vegetation Management Strategy for this area was prepared by JWP on behalf of the Growth Centres Commission and Liverpool Council in 2007 and this is presented in a report titled "Edmondson Park – A Strategic Overview of Stream and Riparian Management Processes " (2007)(Ref. 25).

9 HYDROLOGIC ANALYSIS

The hydrologic analyses for Locality 1 was undertaken using the rainfall - runoff flood routing model XP-RAFTS (Runoff and Flow Training Simulation with XP Graphical Interface) (Ref. 26 & 27).

9.1 Sub-Catchments (Pre And Post Development)

Sub-catchment areas contributing to this drainage system were established through site investigations and photogrammetric contour survey covering the catchment and consideration of the Masterplan for Edmondson Park. Catchment boundaries for the existing and developed areas contributing to the drainage system are shown on Figures 2 and 3 respectively for the development. Details of the catchments modelled using XP-RAFTS are provided in Attachments D and E.

9.2 Rainfall Data

Design rainfall intensity-frequency-duration (I.F.D.) data for Edmondson Park South was obtained from Appendix B of Campbelltown City Council's (Sustainable City) DCP (Ref.17). A summary of the rainfall intensities adopted in this study is provided in Table 9.1. The critical storm durations were determined using these values for each sub-catchment.

Table 9.1 INGLEBURN RAINFALL INTENSITIES (mm/hr)

Storm Duration (min.)	Rainfall Intensities (mm/hr) Recurrence Interval (ARI)	
	5	100
5	139	226
10	107	174
15	89	146
20	78	127
25	70	114
30	64	104
45	51	83
60	43.2	71
90	33.9	56
120	28.4	47
180	22.0	36.6
270	17.0	28.5
360	14.1	23.9
540	11.0	18.7
720	9.16	15.7
1080	7.14	12.4
1440	5.98	10.5
2880	3.84	6.87

9.3 Pern

The pern (n) values adopted for the catchments in the XP-RAFTS modelling are consistent with the parameters outlined in Councils DCP (Ref. 17) and are listed in Table 9.2.

Table 9.2 XP-RAFTS PERN VALUES

Parameter	Catchment Condition	Value
Pern (n)	Existing Pervious	0.05
	Urban Pervious	0.025
	Urban Impervious	0.015

9.4 Losses

XP-RAFTS modelling was undertaken using a standard initial and continuing loss rate model. The values adopted for XP-RAFTS modelling are consistent with the parameters outlined in Councils DCP (Ref. 17) and are as follows:

- *Pervious catchment*

  Initial Loss 15.0 mm
  Continuing Loss 2.5 mm

- *Impervious Catchment*

  Initial Loss 1.5 mm
  Continuing Loss 0.0 mm

9.5 Calibration

It is normal practice for flood routing models such as XP-RAFTS to be calibrated with historical rainfall and streamflow data for the catchment being investigated in order to produce the most reliable results. Model parameters are adjusted so that the model adequately reproduces observed hydrographs.

As no streamflow records are available for this location, calibration was undertaken by comparing the results obtained from the Probabilistic Rational Method (PRM) for the existing (undeveloped) catchment, and adjusting the XP-RAFTS model to provide similar results.

Table 9.3 SUMMARY OF PEAK 100 yr ARI FLOW RATES OBTAINED FROM THE VARIOUS ESTIMATION METHODS

Number	Catchment Area	Flows (m^3/s)	
		PRM	XP-RAFTS
1.00	33.2	6.69	6.08
1.01	21.4	9.96	9.63
1.02	46	16.16	16.02
1.03	13.4	17.83	18.09
2.00	21.6	4.74	4.44
2.01	10	6.43	6.42
1.05	29	27.80	27.36
3.00	26.2	5.53	6.60

The results presented in Table 9.3 shows that the XP-RAFTS model with appropriate modelling parameters is generally a good match for most rural catchments therefore, no calibration was undertaken for the XP-RAFTS. (BX retained as 1.0)

9.6 Tailwater Effects

The basin outlet operations were checked to confirm whether they were affected by tailwater conditions from regional flooding in the respective watercourses. The storage devices were conservatively designed such that the base of the detention storages were at or above peak

100 year ARI regional flood levels at the respective locations, which is approximately R.L. 51.5 for the Maxwells Creek basin and R.L. 38.0 for the Bunbury Curran Creek basin.

9.7 Post-Development Drainage System

The conveyance of runoff from Edmondson Park South under the urbanised scenario follows the site's natural terrain. The piped drainage system will collect runoff from the lots and roads and discharge the flows into the treatment systems along the fringes of the drainage corridors. Some of the urbanised catchments will bypass the detention system, however they will be compensated for by over detaining of the captured catchments to ensure that the total peak post development discharges from Edmondson Park South at Campbelltown Road are less than the pre-development levels.

The majority of the stormwater flows from Edmondson Park South are discharged into the realigned Maxwells Creek drainage corridor. The remaining southern portion of the development site will consist of rural residential lots and will discharge into a combined water quality/water quantity control device with a storage volume of 5000 m^3.

The post development catchments are shown on Figure 3 and general stormwater management concept layout of the detention basin and bio-retention systems are shown on Figures 4-10.

9.8 Detention Basins Sizing And Configuration

As part of the development of the post development model, basin size and configurations where determined. Table 9.4 provides the detail of the proposed basin arrangements.

Table 9.4 DETENTION BASINS - GENERAL FEATURES AND CONFIGURATIONS

Parameter	Maxwells Creek Basin		Bunbury Curran Creek Basin
	Webb Mckneown (2007) (Ref. 5)	JWP (2010)	
Base Storage Level	-	53.80	38.50
Storage Volume	37000 m^3	45400 m^3	5000 m^3
Top Water Level	-	53.67	40.20
Detention Depth (max)	-	2.17m	1.20 m
Peak 100 ARI Discharge	10 m3/s	9.51 m3/s	6.44 m3/s

9.9 Discharge Estimates

Discharge estimates were derived for the existing and developed catchments for storms with Average Recurrence Intervals (A.R.I.'s) of 5 and 100 years. A range of storm durations from 15 minutes to 12 hours were analysed to determine the critical storm duration for each sub-catchment.

An "Outflows" dummy node was incorporated into the XP-RAFTS model to link and sum all the flows from the sub-catchments so a comparison of the pre-development and post-development flows can be made. This node does not represent a physical location.

The 5 and 100 year A.R.I. peak flows from the catchment for each of these conditions is presented in Tables 9.5 and 9.6. The XP-RAFTS modelling outputs are provided in Attachments D and E.

Table 9.5 SUMMARY OF PEAK DISCHARGES – MAXWELLS CREEK (Node 1.05)

	Pre-development			Post-development			
ARI	Peak Inflow (m^3/s)	Time to Peak (min)	Storm Duration (min)	Peak Inflow (m^3/s)	Time to Peak (min)	Storm Duration (min)	Ratio Post Dev/ Pre Dev
5	13.50	108	270	14.23	37	90	105.4%
100	27.36	67	120	24.98	37	90	91.3%

Table 9.6 SUMMARY OF PEAK DISCHARGES – BUNBURY CURRAN CREEK (Node 7.02d)

	Pre-development			Post-development			
ARI	Peak Inflow (m^3/s)	Time to Peak (min)	Storm Duration (min)	Peak Inflow (m^3/s)	Time to Peak (min)	Storm Duration (min)	Ratio Post Dev/ Pre Dev
5	3.08	90	270	2.96	92	270	96.1%
100	6.60	44	120	6.44	46	120	97.6%

9.10 Basin Performance

The performance of the Maxwells Creek and Bunbury Curran Creek on-line regional basins for the 5 and 100 year ARI storm events under developed conditions are detailed in Tables 9.7 and 9.8, respectively.

Table 9.7 DETENTION BASIN PERFORMANCE – MAXWELLS CREEK BASIN (Node 1.02)

ARI	Max Inflow (m^3/s)	Storm Duration (min)	Time To Peak (min)	Max Outflow (m^3/s)	Storm Duration (min)	Time To Peak (min)	Storage (m^3)	Stage (m)	Depth (m)
5	25.22	25	27	5.62	120	72	21502	53.01	1.51
100	39.51	25	31	9.51	120	72	40873	53.67	2.17

Table 9.8 DETENTION BASIN PERFORMANCE – BUNBURY CURRAN CREEK BASIN (Node 7.00)

ARI	Max Inflow (m^3/s)	Storm Duration (min)	Time To Peak (min)	Max Outflow (m^3/s)	Storm Duration (min)	Time To Peak (min)	Storage (m^3)	Stage (m)	Depth (m)
5	5.32	90	30	2.96	270	92	2250	39.27	0.77
100	11.01	90	30	6.44	120	46	4446	39.63	1.13

9.11 Discussion Of Modelling Results

9.12 Maxwells Creek Catchment

The XP-RAFTS modelling undertaken shows that the on-line regional detention storage provided for the Maxwells Creek catchment draining to Campbelltown Road is larger than the Basin size (37,000 m^3) previously proposed by Webb McKeown & Associates (Ref. 5) and is also adequate to restrict post development peak discharges from the basin to levels that comply with the previous estimates made by Webb McKeown. The Basin is also effective in the management of post development flows from Locality 1 within Edmondson Park South within Maxwells Creek for storm events between the 5 and 100 year ARI for the development as follows:

- A Slight increase of the total 5 year ARI post development peak site discharges to 14.23 m³/s, which is slightly greater than the pre development peak discharge from Locality 1‘ of 13.50 m³/s. However, the inlet arrangement will be optimised during the detailed design phase to ensure that post development flows are reduced to below pre development levels and meet the target objectives specified in the Webb McKeown report...

- Reduction of the total 100 year ARI post development peak site discharges into Maxwells Creek from Locality 1 to 25.07 m³/s, which is less than the pre development peak discharge of 24.98 m³/s.

9.13 Bunbury Curran Creek Catchment

The XP-RAFTS modelling undertaken shows that the detention storage provided for the Bunbury Curran Creek catchment draining to the Hume Highway is adequate to restrict post development peak discharges to pre-development levels within Bunbury Curran Creek for storm events between the 5 and 100 year ARI for the development as follows:.

- Reduction of the total 5 year ARI post development peak site discharges upstream of the Hume Highway into Bunbury Curran Creek to 2.96 m³/s, which is less than the pre development peak discharge from Edmondson Park of 3.08 m³/s.

- Reduction of the total 100 year ARI post development peak site discharges upstream of the Hume Highway into Bunbury Curran Creek to 6.44 m³/s, which is less than the pre development peak discharge from Edmondson Park of 6.60 m³/s.

10 FLOOD MANAGEMENT

Webb McKeown and Associates were engaged by Landcom in 2007 to develop a detailed SOBEK hydraulic model of the Maxwells Creek floodplain. This was summarised in Part 5 of their 2007 study (Ref. 5). The study concluded that the Maxwell Creek drainage corridor downstream of Macdonald Road is affected by flooding from the 100 year ARI and PMF storm events. The majority of these identified flood affected areas will form part of the riparian corridors to be provided in The Edmondson Park South site and as a consequence will not require site filling which may have had an impact upon these identified flood levels.

All development lots are proposed to be outside the 100 year ARI flood and will have a minimum freeboard of 500mmm to comply with the FDM (Ref 11) and Campbelltown and Liverpool City Council requirements.

Throughout the development, 100 year ARI flooding will be managed by a combination of an appropriately designed pipe drainage system and containment of surcharge flows (greater than pipe capacity) within the road reserves. Flows in road reserves will be limited to a V x D product of 0.4 to comply with Campbelltown and Liverpool City Council requirements.

10.1 Channel Capacity

For the two proposed Riparian corridors within Locality 1, channel flow calculations were undertaken based on Manning's equation to demonstrate that the channels can safely convey the predicted flows without affecting adjoining roads or residential allotments. A summary of the key hydraulic parameters are provided in Table 10.1 below.

Table 10.1 LOCALITY 1 - CHANNEL SIZE & HYDRAULIC PERFORMANCE

Channel	100 yr ARI Flow (m3/s)	Channel Width (m)	Channel Depth (m)	Base Width (m)	Batter Slopes	Channel Slope (%)	Roughness (n)	Flow Width (m)	Flow Depth (m)	Freeboard (m)	Channel Velocity (m/s)
Corridor A	14	45	1.39	28.5	6H:1V	0.5	0.125	39	0.89	0.50	0.47
Corridor B	27	45	2.01	22.2	6H:1V	0.5	0.125	39	1.51	0.50	0.61

A typical section of the two proposed riparian corridors within Locality 1 is provided on Figure 11.

For Locality 2 the Channel widths within the Liverpool LGA were previously defined and are presented in a report titled."Edmondson Park – A Strategic Overview of Stream and Riparian Management Processes" which was prepared by JWP in 2007. (Ref. 25)

Locality 3 has no defined channels as the portions of the development discharge into the upper reaches of Maxwells Creek watercourse (Refer to Figure 1).

10.2 Culverts

A number of road crossings of the watercourses within Edmondson Park South are proposed and these will require culverts in the form of pipes or reinforced concrete box units in order to safely convey flows under the road crossings. The location of each of these culverts are indicated on Figure 1.

10.2.1 Locality 1

The Locality 1 culverts have been sized and configured to maintain riparian corridor function in terms of limiting impacts on corridor connectivity and maintaining fish friendly velocities (refer to Section 7.2.2 for further discussion). Each culverts hydraulic

performance has been estimated using industry accepted sizing methods (HY8 and or spreadsheet calculations) and these are summarised in Table 10.2.

Table 10.2 LOCALITY 1 – CULVERT SIZE & HYDRAULIC PERFORMANCE

Culvert No	100 yr ARI Flow (m3/s)	Culvert Type	Culvert Size (No x W x H)	Culvert Length (m)	Culvert Slope (%)	Roughness (n)	Tailwater Depth (m)	Headwater Depth (m)	Channel Afflux (m)	Culvert Velocity (m/s)
A1	5.0	RCBC	3x2400x900	18.0	1.0	0.013	0.71	0.64	0.11	0.98
A2	14.0	RCBC	3x4200x1200	18.0	1.0	0.013	0.89	0.82	0.11	1.18
B1	27.0	RCBC	3x4200x1500	18.0	1.0	0.013	1.51	1.58	0.25	1.76

10.2.2 Locality 2

For Locality 2 the culvert sizes within The Liverpool LGA were previously defined as a bank of 10 x 3.6m x 1.2m box culverts with an additional 2 x 3.6m x1.5m low flow for fauna passage (Ref. 2 & Attachment A)

10.2.3 Locality 3

There are no culverts proposed within Locality 3

10.3 Climate Change Consideration

The International Panel on Climate Change (IPCC) (Ref.35) states that one of the consequences of climate change is that:

> *"there is an increased chance of intense precipitation and flooding due to the greater water-holding capacity of a warmer atmosphere. This has already been observed and is projected to continue because in a warmer world, precipitation tends to be concentrated into more intense events, with longer periods of little precipitation in between. Therefore, intense and heavy downpours would be interspersed with longer relatively dry periods. Another aspect of these projected changes is that wet extremes are projected to become more severe in many areas where mean precipitation is expected to increase, and dry extremes are projected to become more severe in areas where mean precipitation is projected to decrease."*

The FDM (Ref.11) also states that "*the pattern of flood producing storms may intensify as a result of Climate Change Impacts*". To aid in the practical applications of Climate Change considerations, DECCW has produced a guideline titled "Practical Consideration of Climate Change" (Ref. 36). This guideline further supports the FDM by stating that;

> "*climate change impacts on flood producing rainfall events show a trend for larger scale storms (rainfall totals for the 40 year average recurrence interval (ARI) 1 day storm events) tend to increase by 2030 and 2070."*

The guidelines provides a graphical representations (see plate 5) of the *"potential impacts of changes in current design ARIs due to increases in rainfall" e*xpected as a result of Climate Change implications.

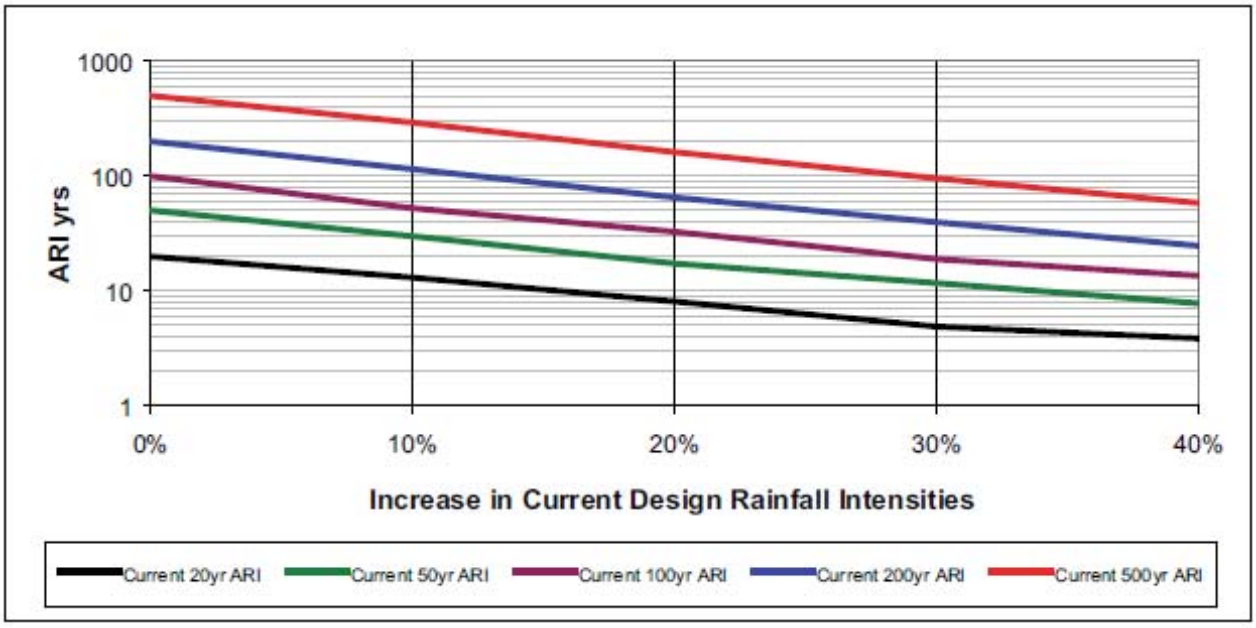

Plate 5 Indicative Change in Design ARI as Rainfall Intensities Increase (Source - Ref. 36)

Furthermore, the guideline recommend that in order to assess Climate Change impacts on a project that a sensitivity analysis is undertaken by considering changes in storm runoff volumes associated with 10%, 20% and 30% increases in rainfall intensities.

This sensitivity assessment was completed as part of post exhibition Water Cycle Management Strategy for the Marsden Park Industrial Precinct (MPIP) within the North West Growth Centres in June this year (Ref. 36). This investigation is relevant to greenfields developments in Western Sydney and forms the basis of guidelines currently being developed by JWP on behalf of the Sydney Metropolitan Catchment Management Authority (SMCMA) which has a title "Impacts of Climate Change on Urban Stormwater Management in Metropolitan Sydney". The guidelines, which are likely to be released in Draft form later this year, encompass the Georges River catchment and are therefore considered to be relevant to Edmondson Park South development.

In the absence of specific guidelines, the MPIP used the following documents as the primary reference sources in the assessment:

1. NSW Climate Change Action Plan: Summary of Climate Change Impacts Sydney Region, October 2008, prepared by the NSW Department of Environment and Climate Change;

2. Practical Consideration of Climate Change – Floodplain Risk Management Guideline, October 2007, prepared by the NSW Department of Environment and Climate Change;

3. Climate Change in the Hawkesbury-Nepean Catchment, 2007, prepared by the Commonwealth Scientific and Industrial Research Organisation, were adopted as the primary reference documents for this assessment; and

4. Climate Change in Australia – Observed Changes and Projections, October 2007, prepared by Australian Government Bureau of Meteorology.

In short the investigation undertaken for the MPIP determined that;

- Rainfall Intensities should be increased by 15% and this generally produces flow increases of up to 25% relative to present conditions.
- The increased flows result in an increased flow depths of up to 0.2 m in naturalised channels which typically reduces standard freeboards from 0.5 m to 0.3 m.
- The size of the basins (storage volume) do not need to be increased due to the impacts of Climate Change however flexible outlet structures which can be adjusted on the basis of anticipated decadal changes to rainfall intensities need to be included. The design of these outlet structures is to be undertaken as part of the more detailed designs required for Development Approval and Construction Certification. The flexible outlet provisions negate any requirement for changes to freeboards for detention basins.

This approach was referred to DECCW for comment and has been confirmed as "a pragmatic approach to considering the impacts of Climate Change on urban drainage systems."

The FDM (Ref.11) also recommends that a 0.5m freeboard provides an appropriate factor of safety for general residential development. The FDM states that;

> *"An appropriate FPL (see Appendix K) for residential development would still generally be the 1% AEP flood event plus 0.5m freeboard. Freeboard could be expected to account for reasonable change in risk over time and therefore selection of a more conservative FPL may not generally be necessary."*

The DECCW's "Draft Flood Risk Management Guides (Ref.37) also indicated that with respect to the freeboard referred to in the FDM that;

> *"This freeboard included a component related to climate change impacts on flood levels in both coastal and non coastal areas and wide variation in sensitivity of estimated design flood flow. The freeboard provides only a relative small allowance to accommodate some of the projected increases in rainfall intensity of flood-producing storm events associated with climate change."*

Therefore, with respect to the Edmondson Park South development the previous assessment undertaken for MPIP confirms that basins size and channel widths that are sized for today's climatic conditions will still be appropriate for a post climate change environment. Consequently, any hazard associated with the flood flows will also be contained within proposed drainage reserves and will not impact on roads and allotments.

JWP considers that this is an appropriate assessment of rainfall intensities and climate change impacts for the Edmondson Park South Development, and that the proposed stormwater conveyance systems will effectively manage post climate change flood hazards for the development.

11 WATER QUALITY ANALYSIS

The water quality analysis for Locality 1 was undertaken using the model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) version 3.01 (Ref. 28). This water quality modelling software was developed by the Cooperative Research Centre (CRC) for Catchment Hydrology, which is based at Monash University and was first released in July 2002. Version 3.01 was released in May 2005.

The model provides a number of features relevant for the development:

- It is able to model the potential nutrient reduction benefits of gross pollutant traps, constructed wetlands, grass swales, bio-retention systems, sedimentation basins, infiltration systems and it incorporates mechanisms to model stormwater re-use as a treatment technique.

- It provides mechanisms to evaluate the attainment of water quality objectives.

The MUSIC modelling was undertaken to demonstrate that the water cycle management system proposed for the development will result in reductions in overall post-development pollutant loads and concentrations being discharged from the proposed development and that these discharges comply with the designated target objectives.

11.1 Catchments

MUSIC models were established for Edmondson Park South's proposed Water Cycle Management components. The general arrangement of these elements is shown in Plate 5.

An overall average fraction impervious of 0.75 was adopted for developed portions of the catchment (new residential lots including half road), the impervious proportion varied according to the expected planning density of the catchments.

All of the treated urbanised areas will discharge to the water quality elements prior to discharging from the site.

The future developments will be treated by devices within Edmondson Park South to achieve the minimum water quality target reductions required by the GCC Development Code. The total area of these catchments is approximately 150 hectares, the general arrangement of the MUSIC model for the treatment trains is shown on Plate 6 and in more detail in Attachment F.

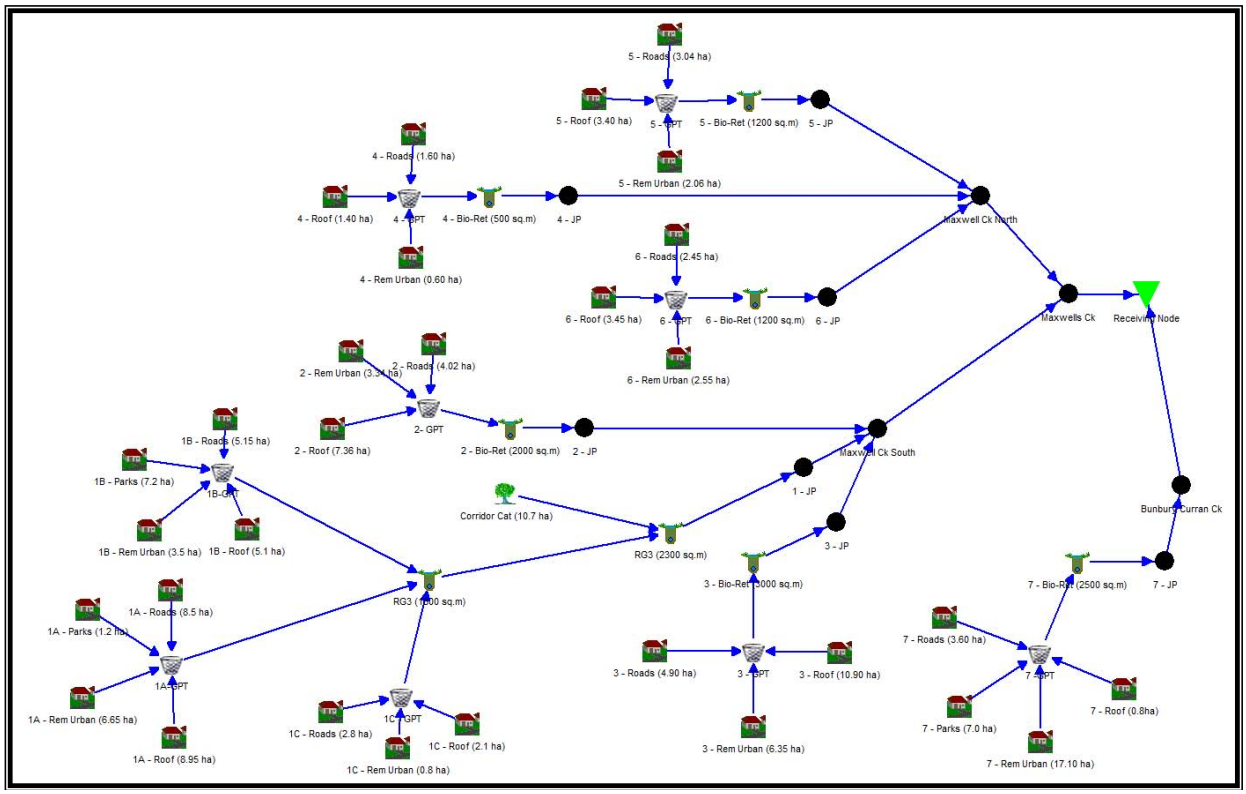

Plate 6: MUSIC Model Layout – Developed Site Conditions (9031MU_08.sqz)

The treated catchments were divided into three sub-catchments representing the proposed developed catchment (Roof, Roads and Remaining Urban). The catchment details are provided in Table 11.1.

Table 11.1 CATCHMENT DETAILS – DEVELOPED SITE CONDITIONS

Catchment	Source	Area (ha)	Fraction Impervious
1A	Roads	8.50	1.0
	Roofs	8.95	1.0
	Remaining Urban	6.65	0.5
	Parks	1.20	0.05
1B	Roads	5.10	1.0
	Roofs	5.15	1.0
	Remaining Urban	3.50	0.4
	Parks	7.20	0.05
1C	Roads	2.8	1.0
	Roofs	2.1	1.0
	Remaining Urban	0.8	0.4
Corridor Cat	Forrest	10.7	0.05
2	Roads	1.0	1.0
	Roofs	1.0	1.0
	Remaining Urban	0.4	0.4
3	Roads	4.90	1.0
	Roofs	10.90	1.0
	Remaining Urban	6.35	0.3
4	Roads	1.60	1.0
	Roofs	1.40	1.0
	Remaining Urban	0.60	0.4
5	Roads	3.04	1.0
	Roofs	3.40	1.0
	Remaining Urban	2.06	0.6
6	Roads	2.45	1.0
	Roofs	3.45	1.0
	Remaining Urban	2.55	0.7
7	Roads	3.60	1.0
	Roofs	0.80	1.0
	Remaining Urban	17.10	0.2
	Parks	7.00	0.05

11.2 Rainfall Data

The MUSIC model is able to utilise rainfall data based on 6 minute, hourly, 6 hourly and daily time steps. A 6 minute time step was used in the analysis which was chosen in accordance with the recommendations for selecting a time step within the MUSIC Users Manual (Ref. 28).

The Bureau of Meteorology provided the 6 minute pluviograph data available at the closest station to Edmondson Park (Station 67035 Liverpool [Whitlam Centre]). The MUSIC modelling was undertaken using the 10 years (1965 - 1974) of 6 Minute data provided for this station. The 10 year (1965 - 1974) period provided a mean annual rainfall of 849mm which is within 3% of the long term average at Campbelltown of 830mm.

The rainfall for the 10 year (1965 - 1974) period analysed is shown on the graph which is provided in Plate 7.

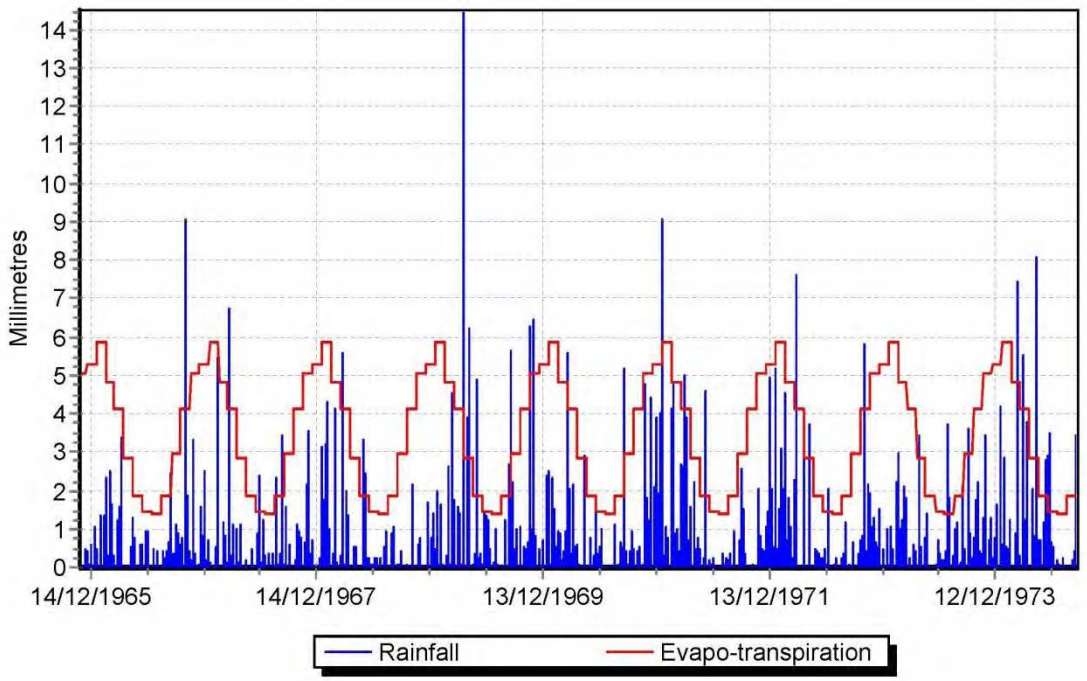

Plate 7: Rainfall & Evapo-Transpiration Data for Liverpool (1965-1974)

11.3 Pollutant Loading Rates And Treatment Train Device Performance

In the absence of site specific data, the soil / groundwater parameters and pollutant loading rates adopted for the natural and urban catchments of the Edmondson Park South site are based on the recommended parameters provided by the Growth Centres Commission for areas within Western Sydney (Ref. 29).

The adopted technical parameters used in this modelling for the individual water quality devices described in section 11.0 are presented in Attachment B.

11.4 Pollutant Load Estimates And Discussion Of Modelling

Total annual pollutant load estimates were derived using MUSIC for the developed site incorporating the proposed water quality treatment system.

The estimated annual pollutant loads and reductions are presented in Table 11.2.

Table 11.2 SUMMARY OF POLLUTANT CONCENTRATION REDUCTIONS

Pollutant	Sources (kg/yr)	Discharges (kg/yr)	Reductions (%)
TSS	99100	9900	90%
TP	188.0	59.5	68%
TN	1460	796	45%
GP	19300	80.0	100%

Table 11.3 COMPARISON OF POLLUTANT REDUCTIONS AND CONCENTRATIONS TO TARGET LEVELS

Pollutant	MUSIC Mean Pollutant Loading Rate - Urban Storm Conditions (mg/l)	MUSIC Mean Discharge Concentration (mg/l)	MUSIC Reduction of Pollutant Loads from Site (9031MU_02.sqz) (%)	Minimum Target Reductions (DECC & Council) (%)	Minimum Target Reductions (Georges River) (%)
TSS	164	1.20	90%	85%	80%
TP	0.23	0.033	68%	65%	60%
TN	1.83	0.69	45%	45%	35%

The performance of the proposed water quality management strategy for Edmondson Park South obtained from the MUSIC model, as summarised in Table 11.3, shows that:

- In order to achieve the objective of an 85% reduction in TSS from the proposed development, the maximum TSS discharge is 14865 kg/yr. The MUSIC modelling predicts that TSS is reduced to 9900 kg/yr. The water quality management strategy therefore achieves the target reductions for TSS.

- In order to achieve the objective of a 65% reduction in TP from the proposed development, the maximum TP discharge is 65.8 kg/yr. The MUSIC modelling predicts that TP is reduced to 59.5kg/yr. The water quality management strategy therefore achieves the target reductions for TP.

- In order to achieve the objective of a 45% reduction in TP from the proposed development, the maximum TN discharge is 803 kg/yr. The MUSIC modelling predicts that TN is reduced to 803 kg/yr. The water quality management strategy therefore achieves the target reductions for TN.

- The proposed water quality management system for Edmondson Park adequately compensates for the catchments bypassing the treatment devices.

The combination of proposed stormwater quality treatment devices will assist the development to meet GCC Development Code and the George's River Stormwater Management Plan water quality objectives for the future development of the Edmondson Park South.

12 STREAM EROSION INDEX

12.1 Introduction

The Stream Erosion Index (SEI) is defined by the DECCW (refer to 6.1.2) as the post development duration of flows greater than the 'stream forming flow' divided by natural duration of flows greater than the 'stream forming flow'. The 'stream forming flow' is defined as 50% of the 2 year ARI flow rate estimated for the catchment under natural conditions. The DECC guidelines recommend an acceptable stream erosion index ranging between 3.5 – 5, with an optimum level being closer to 1.0 .

12.2 Modelling

The pre-development and post-development site MUSIC models described in Section 11, was used to determine the SEI for Maxwells Creek at Campbelltown Road. The general arrangement of the MUSIC models used for the assessment are provided in Attachment G.

A forest node with 0% impervious was adopted to represent the pre-development case. Urban nodes representing the roofs, the roads and parking areas and the remaining urban areas were used to represent the post development scenario, with a total impervious area of approximately 80% (excluding the drainage corridors). Treatment nodes were included to represent the treatment systems (as described in Section 11.0). The adopted parameters for the treatment system nodes are shown in Attachment B

12.3 Stream Forming Flow

The peak 2 year ARI flow for the existing Maxwells Creek catchment at Campbelltown Road (XP-RAFTS node 1.05) was determined to be 10.40 m^3/s using results derived from the XP-RAFTS modelling as outlined in Section 9.8. The stream forming flow was calculated to be 5.20 m^3/s. Just under nine years of six minute rainfall data was used in the simulation. The rainfall data described in Section 11.2 was adopted for the assessment. The SEI results for Stream Forming flow are shown in Table 12.1 and also shown graphically in Plate 8.

Table 12.1 STREAM EROSION INDEX

Development Scenario	Stream Forming Flow (m^3/s)	Number of Times Stream Forming Flow Exceeded	Duration of Stream Forming Flow Exceedence (min)	Stream Erosion Index (Post / Pre)
Pre-Development	5.20	88	528	
Post-Development		201	1206	2.28

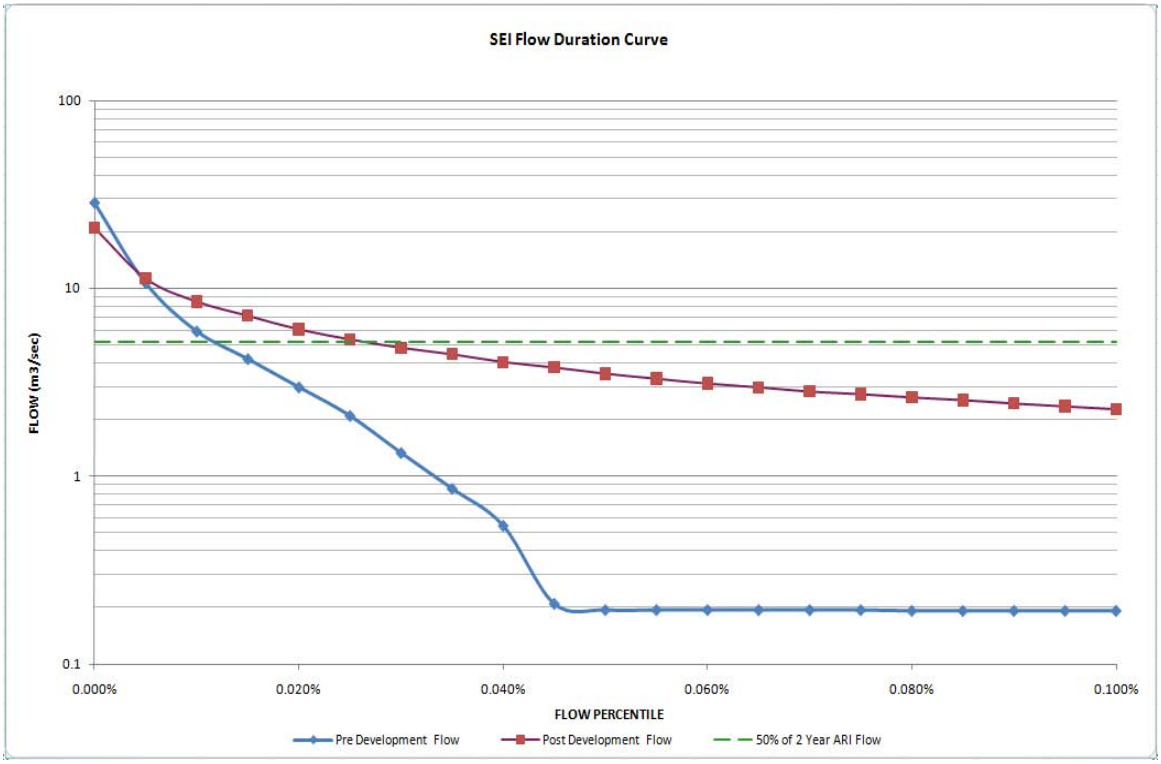

Plate 8: Stream Erosion Index

12.4 Discussion Of Modelling

The SEI assessment indicates that:

- For the pre development case the stream forming flow of 5.20 m³/s is exceeded 88 times (528 minutes) for the 8.8 years of rainfall data assessed.
- Urbanisation of the Maxwells Creek catchments, with water quality treatment and detention storage (modelled as a sedimentation basin) will result in the stream forming flow being exceeded 201 times (1206 minutes) for the 8.8 years of data assessed. This results in a Stream Erosion Index of 2.28, which is below the recommended range of 3.5 – 5.0 as determined by DECCW, and closer to the optimum level of 1.0.
- The results of the modelling show that the provision of WSUD elements and detention basin within the development will assist in minimising the impact of urbanisation on the waterway stability of Maxwells Creek at Campbelltown Road.

13 INDICATIVE CONSTRUCTION AND MAINTENANCE COSTS

13.1 Indicative Construction Costs

Indicative construction costs were determined for the major stormwater elements proposed for the Edmondson Park South development and these are summarised in Table 13.1. The unit rates relating to the construction of the Bio-retention Raingardens and detention basins were determined through extensive experience in the construction of these elements and is consistent within the industry research undertaken by the CRC (Ref. 28).

Table 13.1 INDICATIVE CONSTRUCTION COSTS

	Item	Quantity	Unit	Unit Cost ($/Unit)	Device Cost ($)	Total Cost ($)
Catchment 1	GPT 1a (Max 25ha)	1	ea	110000	110000	
	GPT 1b (Max 25ha)	1	ea	110000	110000	
	Pump return to Pond	1	ea	52000	52000	
	Bio-Retention Raingarden	1800	m^3	250	450000	
	Bio-Retention Raingarden	2300	m^3	250	575000	1,297,000
Catchment 2	GPT 2 (Max 15ha)	1	ea	68000	68000	
	Bio-Retention Raingarden	2000	m^2	250	500000	
	Dentention basin	40000	m^3	20	800000	1,368,000
Catchment 3	GPT 3 (Max 22ha)	1	ea	85000	85000	
	Bio-Retention Raingarden	3000	m^2	250	750000	835,000
Catchment 4	GPT 4 (Max 3ha)	1	ea	26000	26000	
	Bio-Retention Raingarden	500	m^2	250	125000	151,000
Catchment 5	GPT 5 (Max 8.5ha)	1	ea	44000	44000	
	Bio-Retention Raingarden	1200	m^2	250	300000	344,000
Catchment 6	GPT 6 (Max 9ha)	1	ea	44000	44000	
	Bio-Retention Raingarden	1200	m^2	250	300000	344,000
Catchment 7	GPT 7a (Max 20ha)	1	ea	85000	85000	
	GPT 7b (Max 8ha)	1	ea	44000	44000	
	Bio-Retention Raingarden	2500	m^2	250	625000	754,000
Locality 2	GPT L2a (Max 3ha)	1	ea	26000	26000	
	GPT L2b (Max 3ha)	1	ea	26000	26000	
	Bio-Retention Raingarden	750	m^2	250	187500	
	Bio-Retention Raingarden	950	m^2	250	237500	477,000
Riparian Corridors Culverts	Catchment 1 (4.2mx1.5m)	3	ea	7500	22500	
	Catchment 4a (2.4mx0.9m)	3	ea	3500	10500	
	Catchment 4b (4.2mx1.2m)	3	ea	7200	21600	54,600
	Total					5,624,600

N.B: The water quality elements in Locality 3 would be covered be a Section 94 plan for the Liverpool LGA. The Riparian corridors culverts cost include a 25% construction

13.2 Indicative Maintenance Costs

Indicative maintenance costs were determined for the major stormwater elements proposed for the development and are summarised in Table 13.2. Costs were broken down to identify the cost variations for both the establishment period (up to 3 years for construction) and the long term maintenance cost (after the 3 year establishment period).

The unit rate relating to the maintenance of the Bio-retention Raingarden and detention basins were determined through recent experience in the maintenance requirements of these elements

Indicative maintenance requirements for the stormwater management devices are outlined in Section 7.

Table 13.2 INDICATIVE ANNUAL MAINTENANCE COSTS

	Item	Quantity	Unit	Unit Cost ($/Unit)	Estabishment Period (0-3yrs) Frequency (times/year)	Estabishment Period (0-3yrs) Totyal Cost ($/yr))	Long Term Period (>3yrs) Frequency (times/year)	Long Term Period (>3yrs) Totyal Cost ($/yr))
Catchment 1	GPT 1a (Max 25ha)	1	ea	4000	4	16000	2	8000
	GPT 1b (Max 25ha)	1	ea	4000	4	16000	1	4000
	Pump return to Pond	1	ea	4000	4	16000	1	4000
	Bio-Retention Raingarden	1800	m^2	2	2	7200	1	3600
	Bio-Retention Raingarden	2300	m^2	2	2	9200	1	4600
Catchment 2	GPT 2 (Max 15ha)	1	ea	3500	4	14000	2	7000
	Bio-Retention Raingarden	2000	m^2	2	2	8000	1	4000
	Dentention basin	40000		0.5	2	40000	1	20000
Catchment 3	GPT 3 (Max 22ha)	1	ea	4000	4	16000	2	8,000
	Bio-Retention Raingarden	3000	m^2	2	2	12000	1	6,000
Catchment 4	GPT 4 (Max 3ha)	1	ea	2500	4	10000	2	5,000
	Bio-Retention Raingarden	500	m^2	2	2	2000	1	1,000
Catchment 5	GPT 5 (Max 8.5ha)	1	ea	3500	4	14000	2	7,000
	Bio-Retention Raingarden	1200	m^2	2	2	4800	1	2,400
Catchment 6	GPT 6 (Max 9ha)	1	ea	3500	4	14000	2	7,000
	Bio-Retention Raingarden	1200	m^2	2	2	4800	1	2,400
Catchment 7	GPT 7a (Max 20ha)	1	ea	4000	4	16000	2	8,000
	GPT 7b (Max 8ha)	1	ea	3500	4	14000	2	7,000
	Bio-Retention Raingarden	2500	m^2	2	2	10000	1	5,000
Locality 2	GPT L2a (Max 3ha)	1	ea	4000	4	16000	2	8,000
	GPT L2b (Max 3ha)	1	ea	4000	4		2	8,000
	Bio-Retention Raingarden	750	m2	2	2	3000	1	1,500
	Bio-Retention Raingarden	950	m^2	2	2	3800	1	1,900
Locality 3	GPT L3a (Max 20ha)	1	ea	4000	4	16000	2	8,000
	GPT L3a (Max 20ha)	2	ea	4000	4	32000	2	16,000
	Bio-Retention Raingarden	2150	m^2	2	2	8600	1	4,300
	Bio-Retention Raingarden	2500	m^2	2	2	10000	1	5,000
	Bio-Retention Raingarden	2800	m^2	2	2	11200	1	5,600
	Total					244,000		172,300
	Cost per lot	3300 lots				74		52

13.3 Ownership Arrangements

All water quality and quantity devices will be located within public reserves or road ways. It would be envisaged that transfer of ownership of these devices would form part of an agreement between Landcom and Campbelltown City Council at some time in the future when development of Edmondson Park in completed.

14 SUMMARY & CONCLUSION

The Water Cycle Management Plan for Edmondson Park South has been prepared to support the Part 3A Concept Plan Application. The plan has been prepared to conform to the statutory requirements and industry best practice for the Water Cycle Management in this catchment.

The Water Cycle Management Plan consists of a treatment train consisting of an at lot treatment, street level treatment and Precinct Scale treatment measures.

The structural elements proposed for the Edmondson Park development consists of:

- Proprietary GPT units at each stormwater discharge point (11 required).
- Proposed ornamental pond with static water surface area of 3,000 m^2.
- 15 separate proposed raingardens with a combined surface area of 28,450 m^2.
- A proposed regional detention storage basin on Maxwells Creek with a storage volume of approximately 45,000 m^3.
- A proposed regional detention storage basin at the Hume Highway in the Bunbury Curran Creek catchment with a storage volume of 5,000 m^3.

Provision of the proposed detention basins within the development will ensure that peak post development discharges from Edmondson Park South into Maxwells Creek are consistent with the flows management arrangements developed by Webb McKeown and Associates report. For the Bunbury Curran Creek, flows are restricted to below pre development levels.

The Water Cycle Management strategy proposed for Edmondson Park South is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the release area. Furthermore, it will ensure that the relevant issues listed in the Director General's requirements relating to the management of water on the site are attained.

The proposed Water Cycle Management Strategy provides the basis for the detailed design and development of Edmondson Park South to ensure that the objectives for Water Cycle Management on the site are achieved.

15 DGR RESPONSES

Following is a list of the DGR's as outlined in Section 2 with responses addressed in this report and by nominated drawings.

Table 15.1 RESPONSES TO THE DIRECTOR GENERAL REQUIREMENTS

REQUIREMENT	RESPONSE
➢ **Surface Water, Groundwater Quality and Riparian Corridors**	
(1) Assess any potential impacts of proposed development on hydrology and hydrogeology of the site and adjacent areas in terms of impact on water quality having regard to environmental targets for new urban development set out in Managing urban stormwater: environmental targets – Consultation draft (DECC in association with the Sydney Metropolitan CMA, October 2007). In particular, identify how any potential water quality impacts on wetlands both within and adjoining the site, and the ecological values of the Regional Park, will be avoided, mitigated or managed.	Hydrology assessments were undertaken on the site with regards to water quantity and water quality. Details of the assessments, results and discussions have been outlined in Sections 9, 11, 12. The Water Cycle Management Plan complies with the targets within the listed DGR reference with the results presented in Section 11.4. Suitable management measures to avoid exacerbation of site/soil salinity and to limit additional surface and groundwater interaction are presented in Section 7.8.
(3) Identify drainage and stormwater management infrastructure, including: on site detention of stormwater; water sensitive urban design (WSUD); and drainage infrastructure. Identify the future management and ownership arrangements for stormwater infrastructure, and identify how any requirements of the future owner will be met.	Nominated drainage and stormwater management infrastructure are outlined in Section 7 with descriptions of the individual elements provided within Attachment B. Future management and ownership arrangements are outlined in Section 13.3.
(4) Assess any proposed variation to riparian corridors and associated buffers in accordance with the Riparian Corridor Management Study approach applied to the Growth Centres, and provide justification for any changes. Details of any rehabilitation works for corridors should be provided.	The proposed structure and mechanisms for Riparian corridor management within the site are detailed in Section 8.0 of this report. A justification for proposed changes to the Riparian corridors is presented in Plate 3 and in Section 8.6.
➢ **Flooding**	
(1) Identify any flood risk associated with the site and demonstrate that the proposed development is suitable in terms of flooding and is consistent with the NSW Floodplain Development Manual: the management of flood liable land (2005).	Section 10 of this report discusses the flooding within Edmondson Park South and provides details of the flood investigation undertaken by Webb McKeown & Associates in 2007 (Ref. 4 & 5). Channel sizes within the development have been identified at Section 10.1. The concept plan investigations comply with the FDM guidelines
➢ **Ecologically Sustainable Development**	
(1) The EA should demonstrate that all aspects of the concept plan satisfy the principles of ESD including compliance with BASIX.	Demonstration of Ecologically Sustainable Development including BASIX compliance is discussed in section 6.7.2 and outlined in Sections 7.1 and 7.2 of this report.
(2) The EA should outline commitments to sustainability including water re-use, waste minimisation, the minimisation of energy use and car dependency.	The report outlines commitments to sustainability including reductions in potable water demand, use of reticulated recycled water and introduction of integrated natural resources that limit the impacts on downstream ecosystems, as outlined in Section 7.1 and 7.2 of this report.

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Attachment A

Edmondson Park
Water Sensitive Urban Design Strategy

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ATTACHMENT A

Edmondson Park

Water Sensitive Urban Design Strategy

October 2007
Ref 8225rpt1B.doc
Issue B

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GROWTH CENTRES COMMISSION

Liverpool city council
creating our future together

J. WYNDHAM PRINCE PTY LTD
CONSULTING CIVIL ENGINEERS

DOCUMENT CONTROL SHEET

Issue No.	Amendment	Prepared By & Date	Checked By and Date	Approved By and Date
A	Draft	DG (5/10/07)	PM (5/10/07)	PM (5/10/07)
B	Final	DG (22/10/07)	PM (22/10/07)	PM (22/10/07)

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1. INTRODUCTION

The Edmondson Park Precinct consists of 796 hectares of land falling within the Liverpool and Campbelltown local government areas and forms part of the 2,500 hectare Hoxton Park Release Corridor. Previous investigations have been undertaken leading to the precinct being rezoned in March 2006 and a Locality Development Control Plan Template adopted by Liverpool and Campbelltown Councils.

The Minister for Planning recently announced that a Precinct DCP would be prepared for the whole of the Edmondson Park Release Area by the Growth Centres Commission and Liverpool City Council and that the Section 94 Contributions Plan for the Precinct would be amended to reduce the amount of contributions that would apply to the Precinct. The reduction in contributions is to be achieved by narrowing the riparian areas, incorporating some separate open space areas within the creek setbacks and utilising, where possible, on line stormwater detention systems.

This report details the procedures used and presents the results of investigations undertaken by J. Wyndham Prince Pty Ltd in developing a Water Sensitive Urban Design Strategy to integrate with and support the Final Edmondson Park Precinct Development Control Plan. The objective of this investigation is to identify the stormwater issues to be taken into account in the development application, detailed design and development of the Edmondson Park Release Area, to identify appropriate options and locations for the control of the quantity and quality of storm water leaving the site, and to identify the land areas required to implement the recommended options. The outcomes identified by the investigation will then be incorporated into the Section 94 processes and Contributions Plan.

The investigation addresses engineering considerations whilst placing a strong focus on conserving and enhancing the bio- diversity, ecological health and positive water quality benefits within the existing riparian corridors to provide an integrated natural resource for the incoming residents.

The report was commissioned by the Growth Centres Commission and should be read in conjunction with J. Wyndham Prince Plans 8183 SK 01-28.

2. EXECUTIVE SUMMARY

2.1 Project Objective

J. Wyndham Prince Pty Ltd in close consultation with the Growth Centres Commission and Liverpool City Council have prepared a Water Sensitive Urban Design Strategy to integrate with the Master Planning process for the Edmondson Park Development Area. The plan has been prepared to conform with statutory requirements and industry best practice for stormwater management in this catchment. Sufficient detail is provided to integrate with and support the Development Control Planning process for the release area and identify the size and cost of Section 94 components.

The overall water cycle management objectives for the release area were identified as:

Environmental – Provision of appropriately designed, functional water quality facilities, salinity management, retention of existing trees, habitat revegetation and ecosystem enhancement; limitation of downstream discharge peaks and velocities; soft bioengineering treatments to reflect natural stream functions; ecologically sustainable; adopt principles of total catchment management and water sensitive urban design; conform with statutory water quality requirements; maintenance of environmental flows and inundation patterns in creeks and wetlands.

Urban Amenity – Provision of a stormwater management strategy that identifies and controls limits of flood affectation; provision of aesthetic design forms that enhance urban amenity and address proposed adjacent landuses (residential, recreational and transport); views into and out of drainage corridors (security, public safety, amenity); water quality (visual amenity and public health).

Engineering Considerations – Effective management and control of peak discharges, discharge velocities, and flood levels to pre- development and ecologically sustainable levels; industry best practice technical analysis of catchment hydrology and system hydraulic performance, soft sustainable bioengineering treatments.

Economics - provision of a cost effective, functional trunk drainage system that optimises performance, keeps maintenance costs and requirements to an acceptable level, keeps land take to a minimum, provides maximum value for expenditure of public monies and focuses on ecological sustainability.

2.2 Statutory Requirements

In addition to the Growth Centres Commission and Liverpool City Council's requirements for the water cycle master plan, the recommendations contained in the following guidelines have also been addressed in the master planning process.

- Georges River Stormwater Management Plan
- Department of Environment and Climate Change Technical Guidelines

2.3 Methodology

The water cycle master planning process has involved considerable consultation and a number of Workshops have been undertaken to receive input from stakeholders. This consultation has included:

- Liverpool City Council
- Growth Centres Commission
- Jackson Teece
- Department of Water and Energy

The investigation included the following technical tasks:

Hydrology	Review of previous detailed hydrological analyses of the catchments undertaken by others in determining the magnitude of a range of storm flows and evaluation of the performance of proposed detention storage facilities.
Hydraulics	Review of previous hydraulic studies undertaken by others and additional hydraulic analysis of alternate watercourse and retention basin strategies to determine peak flood levels, velocities, flow widths and flood extents.
Water Quality Modelling	Undertake a detailed water quality analysis for the release area to determine existing and post development pollutant loads and evaluate the performance of proposed water quality treatment techniques.
Options/Treatment Techniques	Identify and evaluate a range of suitable treatment techniques to address water quality and water quantity objectives.
Preferred Treatment	Determine size, location, cost, maintenance and performance of preferred treatment techniques.

2.4 Proposed Water Cycle Strategy

A range of structural stormwater management techniques and options were identified as being suitable for managing the discharge of peak flows (water quantity) and pollutants (water quality) for the Edmondson Park Release Area. These are summarised as follows:

Water Quantity: Regional and Local Detention Basins (Wet, Dry, On-Line, Off-Line), Below ground storage tanks (public and private).

Water Quality: Wetlands, Bioretention Raingardens, Infiltration Systems, Vegetated Swales and Sand Filters.

Each of these management techniques were evaluated and compared with consideration of a range of Environmental, Social/Amenity, Economic, Maintenance and Engineering criteria. During the initial phases of the investigation Liverpool Council indicated a strong desire to incorporate dry detention basin systems for water quantity control and bioretention raingardens for water quality control.

The strategy proposed as being most suitable for the Edmondson Park Release Area is a combination of options including:

Water Quality A treatment train consisting of:

On Lot Treatments

- Appropriate waterwise landscaping practices (resident education, native gardens, mulch, micro-irrigation).
- Implementation of water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).
- Minimisation of impervious areas.

Street Level Treatments

- Inlet pit filter inserts or proprietary gross pollutant traps such as CDS units.

Subdivision / Development Treatments

- Bioretention Raingardens located within the public reserves and adjacent to the riparian corridors.

Water Quantity

- On-line detention storage for larger flows (20 and 100 year ARI) located within the riparian corridors and off-line detention storage integrated with the bioretention raingardens for environmental flows (1.5 year ARI) located within proposed public reserves or adjacent to riparian corridors.

A general arrangement plan indicating proposed locations for the water quality and water quantity treatments for the Edmondson Park Release Area is included in Figure 2.

2.5 Conclusion

The stormwater management strategy for the developed site provides a basis for the detailed design and development of the site to ensure that the following objectives for stormwater management and site discharge are achieved:

Environmental Existing stands of vegetation within the trunk drainage corridor retained; existing water bodies with ecological value retained; downstream and in-channel discharge peaks and velocities limited to avoid scouring, siltation and flora and fauna impacts; water quality elements proposed to remove gross pollutants and nutrients from the urban catchments; ecological health and biodiversity within the riparian corridors maintained and enhanced.

Urban Amenity Limits of flood 1% affectation have been defined and future development can conform with requirements for freeboard and public safety; quality passive recreational amenity can be provided for the incoming community.

Engineering Considerations	Peak discharges, peak velocities and flood levels controlled to conform with Council's technical requirements; detention be provided in open space areas to restrict peak discharges to pre-development levels; water quality elements provided to conform with performance and maintenance requirements.
Economics	The stormwater management strategy is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the release area.

Our investigations indicate that there is adequate capacity within the site to achieve the required performance objectives for stormwater management.

3.

PREVIOUS STUDIES

Several previous studies relating to stormwater management and flooding within the site have been prepared and are summarised below.

- GHD – *Edmondson Park Master Planning, Water Cycle Management: Stormwater – October 2003* (Reference 1)

  The GHD report was prepared as part of the earlier Master Planning process for the site. The report addressed water cycle management options, identified constraints and opportunities and presented a range of Water Sensitive Urban Design options. Hydrologic and hydraulic (flood mapping) analyses were also undertaken as part of the investigation.

  The recommendations from the report addressing water quantity and quality issues included provision of a number of retarding basins and constructed wetlands.

- GHD – *Edmondson Park Master Planning, Water Cycle Management: Stormwater – Addendum To October 2003 Report – March 2006* (Reference 2)

  This addendum report was prepared to identify and assess potential impacts on the previous October 2003 report as a result of changes to the Edmondson Park Concept Plan and footprint for the site.

- Ecological Engineering – *Edmondson Park Stormwater Management Review – February 2007* (Reference 3)

  This report was prepared to review and comment on the recommendations presented in the GHD's 2003 and 2006 investigations and update the regional flood and stormwater quality management strategy to accommodate changes in the zoning. The main conclusions of the investigation were:

  - Diversion of stormwater flows from the creeks to regional detention basins was not recommended, rather basins should be located at the end of the stormwater system and treated before discharging to the creeks.
  - Measures should be put in place to restrict peak post development 1.5 year ARI flows to pre development levels.
  - The wetland areas proposed were generally undersized.
  - Bioretention raingardens are suitable alternatives to wetlands.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 1 – Background and Overview – September 2007* (Reference 4)

  This report presents the background information for the hydrologic and hydraulic modelling undertaken for the site as well as a review of previous studies undertaken on the site.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 2 – Hydrologic/Hydraulic Assessment of Cabramatta Creek – September 2007* (Reference 5)

The flood investigation undertaken by Webb, McKeown and Associates expanded on the analysis previously undertaken by GHD (References 1 and 2) for the Cabramatta Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 3 – Hydrologic/Hydraulic Assessment of Tributary to Maxwells Creek – September 2007* (Reference 6)

  The flood investigation undertaken by Webb, McKeown and Associates expanded on the analysis previously undertaken by GHD (References 1 and 2) for the Tributary to Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

- Webb, McKeown and Associates – *Edmondson Park Flood Study, Part 4 – Hydrologic/Hydraulic Assessment of Maxwells Creek – September 2007* (Reference 7)

  The flood investigation undertaken by Webb, McKeown and Associates expanded on the analysis previously undertaken by GHD (References 1 and 2) for the Maxwells Creek catchment to account for variations to land use zonings and realignment of key infrastructure.

4. THE EXISTING ENVIRONMENT

4.1 The Site

The Edmondson Park Development Area, which totals 796 Hectares, is located at Camden Valley Way, Edmondson Park. The development area included in this investigation is bordered by Denham Court to the west, the South Western Motorway to the east, Campbelltown Road to the south and Camden Valley Way to the north. The location of the Edmondson Park Development Area is shown on Plate 1 below and in more detail on Figure 1.

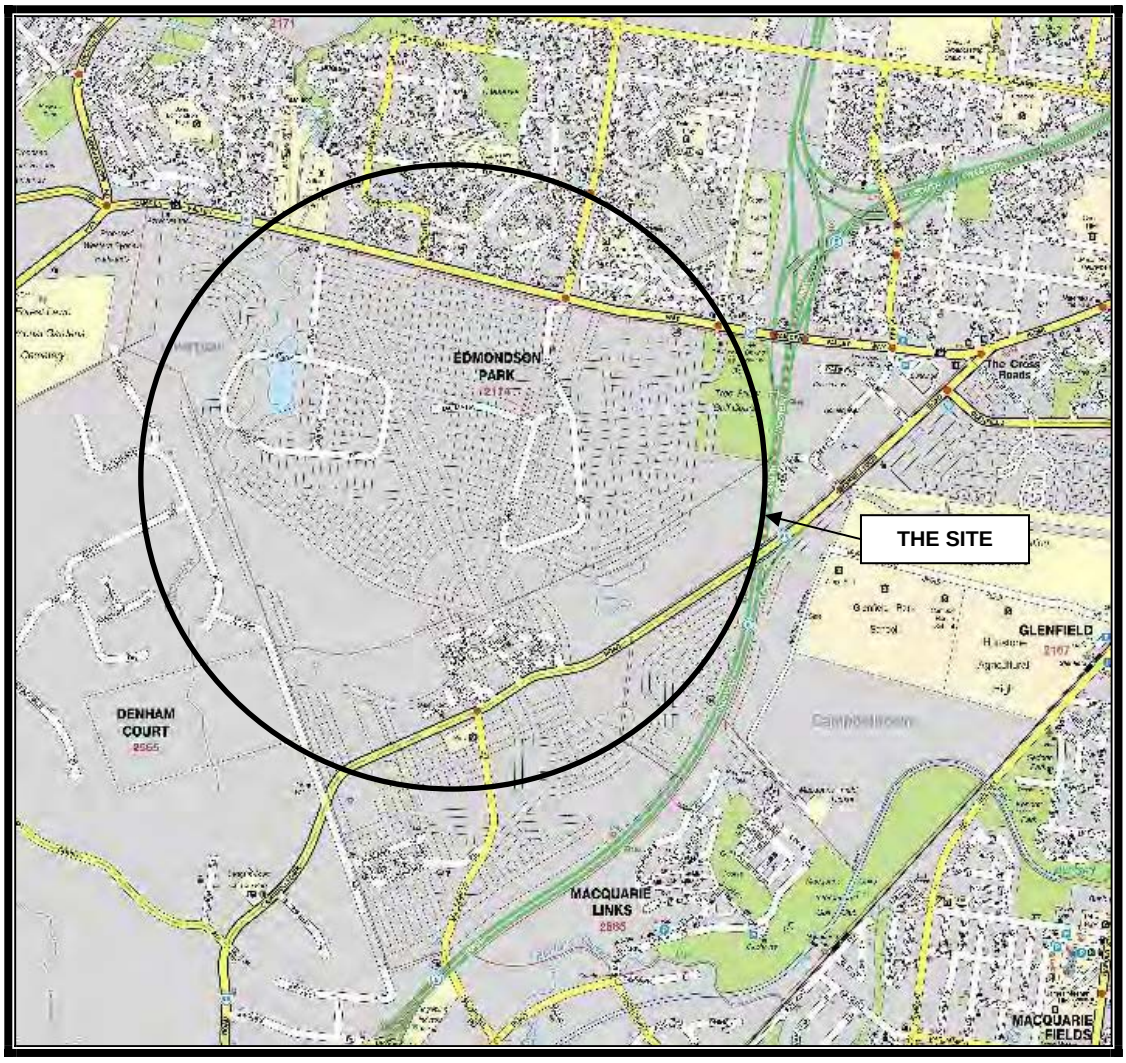


Plate 1 – Location of Edmondson Park Development Area

4.2 Landforms

The site consists of undulating grazing land, having generally been cleared and consisting of fenced grass paddocks. The site also includes significant portions of bushland, particularly within and adjacent to the watercourses as well as the

southern army lands. Homestead cottages are located within the respective rural properties that comprise the site. The site is divided by a ridgeline running generally from south to north. The larger eastern portion of the site grades to the north to Maxwells Creek and its tributary. The western portion of the site grades north to Cabramatta Creek.

The site rises in elevation from approximately RL 37 m at the north eastern extents of the site to a maximum level of RL 84 m at the sites south western corner adjacent to Campbelltown Road.

4.3 Existing Drainage System

The Edmondson Park Site is affected by three main watercourses, Cabramatta Creek, Maxwells Creek and a tributary of Maxwells Creek. Cabramatta Creek drains generally from south to north through the western portion of the site. Maxwells Creek and its tributary drain generally from south-west to north-east through the eastern portions of the site. The Cabramatta Creek watercourse is separated from Maxwells Creek and its tributary by a ridge line which runs from south to north, while a ridge line running east to west separates Maxwells Creek from its tributary. The separate drainage catchments are summarised below and are shown in Figure 2.

Cabramatta Creek	This is the larger of the three main watercourses within the site and is located generally in the western portion. The total catchment area to the site boundary at Camden Valley Way is approximately 752 Ha.
Maxwells Creek	A catchment area of approximately 515 Ha to the site boundary at the M5 Motorway, Maxwells Creek is generally located within the southern and eastern portions of the site.
Northern Tributary to Maxwells Creek	The smaller of the three main watercourses, the tributary has a catchment area of approximately 144 Ha to the site boundary at Camden Valley Way.

5. DEVELOPMENT GUIDELINES, OPPORTUNITIES AND CONSTRAINTS

5.1 Liverpool City Council

Liverpool City Council lists its stormwater drainage design objectives as (Reference 8):

a) To ensure that inundation of private and public buildings located in floodprone areas occurs only on rare occasions and that, in such events, surface flow routes convey floodwaters below the prescribed velocity/depth limits.

b) To provide convenience and safety for pedestrians and traffic in frequent stormwater flows by controlling those flows within prescribed limits.

c) Retain within each catchment as much incident rainfall and runoff as is possible and appropriate for the planned use and the characteristics of the catchment.

d) To ensure all developments do not adversely impact adjoining, downstream or upstream properties. This includes surface flow paths and increasing water levels and velocities.

5.2 Department of Environment and Climate Change

The DECC, formerly the Department of Environment and Conservation (DEC) and Environment Protection Authority (EPA), has set guidelines for stormwater quality from urban developments in their Managing Urban Stormwater Council Handbook (Reference 9) and Interim Recommended Parameters for Stormwater Modelling – North-West and South-West Growth Centres (Reference 10). These documents nominate quantitative post construction phase stormwater management objectives for the reduction of various pollutants for a range of new developments. The retention criteria for the site are nominated as follows:

Total Phosphorous [1]	65% retention of average annual load
Total Nitrogen [1]	45% retention of average annual load
Suspended Solids [1]	85% of average annual load for particles 0.5 mm or less
Gross Pollutants [1]	90% retention of material greater than 5mm
Fine Particles [2]	50% of average annual load for particles 0.1 mm or less
Litter [2]	Retention of litter greater than 50 mm for flows up to 25% of the 1 year ARI peak flow
Coarse Sediment [2]	Retention of sediment coarser than 0.125mm for flows up to 25% of the 1 year ARI peak flow
Oil and Grease [2]	In areas with concentrated hydrocarbon deposition, no visible oils for flows up to 25% of the 1 year ARI peak flow

1. Source – Interim Recommended Parameters for Stormwater Modelling - North-West and South-West Growth Centres
2. Source – Managing Urban Stormwater Council Handbook

The DECC supports the principle of no net deterioration in water quality and recommends the following;

- Incorporate best management practices to minimise impacts on water quality during construction and long term operation of the development.
- Produce an estimate of the expected pollutant loads from the site and identify and describe the likely environmental impact of these loads (changes in water quality).
- Water quality criteria need to be linked with existing Council catchment and stormwater management plans.
- Adequate sediment and nutrient controls should be implemented during and after development of the land in accordance with Council's requirements (Erosion and Sediment Control plans).

5.3 Georges River Stormwater Management Plan

The Georges River Stormwater Management Plan (Reference 11) prescribes quantitative post construction phase stormwater management objectives for the reduction of various pollutants for a range of new developments. The retention criteria nominated for residential subdivisions are nominated as follows:

Total Phosphorus	60% retention of average annual load
Total Nitrogen	35% retention of average annual load
Total Suspended Solids	80% retention of average annual load

5.4 Department of Water and Energy

The Department of Water and Energy (DWE) have had ongoing input to the Masterplanning and DCP process for the Edmondson Park site.

Additional liaison and discussions were held with officers of DWE under this brief to accommodate their requirements with respect to the treatment of the riparian corridors within the site.

Three riparian corridors were identified by DWE as requiring Section 3A permits under the Rivers and Foreshores Improvements Act. These are defined as Cabramatta Creek, Maxwells Creek and the Northern Tributary to Maxwells Creek, which are delineated on Figure 1.

The general requirements for the treatment of Riparian Corridors were determined to be:

- Modification of the riparian zone should be minimised. Generally retain as is and implement management strategies for weed removal and revegetation.
- Stormwater quality and quantity treatment from urban areas needs to be generally managed off-line where possible and addressed prior to discharge to core riparian zones.

- Riparian zone restoration/revegetation will be required by DWE in accordance with their guidelines for preparation of vegetation management plans.

- Remnant riparian vegetation and logs/large woody debris embedded within the creek bed and banks must be retained to ensure ongoing stability, habitat and health of the stream environment.

- 100 year ARI flow to be kept within the riparian zone.

DWE recommends that where crossing of the river is required, structures that minimise site disturbance and that maximise the continuity of the natural stream and riparian zone profile should be utilised. The number of crossings should be minimised.

5.5 Water Sensitive Urban Design

Water Sensitive Urban Design aims to minimise the hydrological impacts of urban development and maximise the multiple use benefits of a stormwater system.

Australian Runoff Quality (Reference 16) identifies the objectives of WSUD to include:

- Reducing potable water demand through water efficient appliances, rainwater and greywater reuse.

- Minimising wastewater generation and treatment of waste water to a standard suitable for effluent reuse opportunities and/or release to receiving waters.

- Treating urban stormwater to meet water quality objectives for reuse and/or discharge to surface waters.

- Preserving the natural hydrological regime of catchments.

Australian Runoff Quality also identifies WSUD as the adoption of the following planning and design approaches that integrate the following opportunities into the built form of cities and towns:

- Detention, rather than rapid conveyance, of stormwater.

- Capture and use of stormwater as an alternative source of water to conserve potable water.

- Use of vegetation for filtering purposes.

- Water-efficient landscaping.

- Protection of water-related environmental, recreational and cultural values.

- Localised water harvesting for various uses.

- Localised wastewater treatment systems.

5.6 Public Safety Guidelines (Drainage and Flooding)

Council's design standards (Reference 8) for stormwater drainage design stipulates that all detailed drainage designs shall incorporate an assessment of major system flows to ensure that the major system provides a safe and adequate escape route for stormwater from rare and extreme events. Council's design standard for the major system is the 100 year ARI event.

Roads, pathways, open space reserves and drainage reserves are to generally form the flow path by which major system flows are safely routed through a new subdivision. Major structures are to be designed for the 100 year ARI storm event.

Retarding structures shall be designed to contain a minimum of the 100 year ARI flood event. Additional spillway capacity may be required depending on the ANCOLD (1986) hazard category of the structure.

The above public safety guidelines have been incorporated in the development of the stormwater drainage strategy for the Edmondson Park site.

5.7 Stormwater Management Objectives

5.7.1 Overall Objectives

The overall site stormwater management objectives were identified as follows;

Environmental	Provision of appropriately designed, functional water quality facilities, limitation of downstream discharge peaks and velocities in the watercourse that bisects the site and maintenance of existing downstream water quality. Maintenance of environmental flows to ecosystems within and downstream of the site.
Urban Amenity	Provision of a stormwater management strategy that identifies and controls limits of flood affectation and provision of aesthetic design forms that enhance amenity.
Engineering Considerations	Effective management and control of peak discharges, discharge velocities, and water quality; industry best practice technical analysis of catchment hydrology and system hydraulic performance.
Economics	Provision of a cost effective, functional site drainage system that optimises performance, provides maximum value for expenditure and keeps on-going maintenance requirements to a minimum.

5.7.2 Specific Development Objectives

In accordance with the principles of Ecologically Sustainable Development (ESD), ensure that the area is designed, developed and maintained in accordance with the following stormwater management objectives.

- Preserve the ecological integrity of the riparian corridors through the proposed development.
- Restrict development to above the 1% AEP flood level.
- Incorporate water sensitive urban design principles within the development.

- Ensure post-development water quality complies with the requirements of the DECC and the Georges River Stormwater Management Plan.

- Minimise land take for stormwater management measures consistent with the achievement of Council's and the DECC's technical and environmental objectives.

- Integrate open space with water quality swales (bio-retention) to provide high amenity and maintain the natural character and ecology within the open space corridors.

- Provision of a sustainable aquatic environment that preserves the potential for creating habitat for locally indigenous flora and fauna.

- Minimise Council's maintenance requirements for open space, litter control structures and nutrient and sediment removal devices.

- Enhance the biodiversity, ecological health and positive water quality benefits within the corridors to provide an integrated natural resource for the incoming residents.

5.8 Consultation

As part of the overall master planning process for the Edmondson Park Release Area, consultation was undertaken to receive input from stakeholders. This consultation has included:

- Liverpool City Council

- Growth Centres Commission

- Landcom

- Department of Water and Energy

Input received from all of these stakeholders through the Project Working Group meetings was used in development of the objectives for stormwater management for the Release Area. A formal site inspection was also conducted with the Department of Water and Energy on 21st September 2007.

5.9 Masterplan Objectives

The Masterplan for the Edmondson Park release area (Reference 13) aims to ensure that the area is designed, developed and maintained in accordance with the following urban water management objectives.

- To protect and enhance natural water systems in urban developments.

- To integrate stormwater treatment into the landscape by incorporating multiple-use corridors that maximise the visual and recreational amenity of the development.

- To protect good quality water draining from the development.

- To reduce runoff and peak flows from development by employing local detention measures, minimising impervious areas and maximising reuse.

- To add value while minimising drainage infrastructure development costs.

5.10 Site Geology and Soils

Geotechnical testing and investigation was undertaken on the Development Area by Geotechnique Pty. Ltd. in conjunction with the Masterplan process. The results of the investigation are presented in the report titled "Proposed Future Development – Edmondson Park Release Area – Edmondson Park – Land Capability Assessment" (Reference 14). In summary it was determined:

- Bedrock at the site is anticipated to be Bringelly Shale belonging to the Wianamatta Group of rocks.

- Landscape of the majority of the site belongs to the Blacktown Group, except the drainage depressions which belong to the South Creek Group.

- Five types of soils profiles are located on the site:

Fill	Gravelly clay, coal wash, topsoil with some timber, brick and fibro in places, poorly to moderately well compacted.
Topsoil	Clayey silt, silty clay, low plasticity, brown, dry to moist.
Alluvial Soils	Clay, silty clay, gravelly clay, clayey silt, medium to high plasticity, mottled grey, orange-brown, red-brown, moisture content varying from lower to higher than the plastic limit, generally stiff to hard, with clayey gravel and ironstone gravels in places.
Residual Soils	Clay, silty clay, sandy clay, gravelly clay, shaley clay, generally medium to high plasticity, grey, dark grey, brown, orange, red, moisture content generally lower than plastic limit, with some gravel in places.
Bedrock	Shale, grey, dark grey, extremely to distinctly weathered, extremely low to low strength, indurated in places and sandstone, fine to medium grained, orange, pale brown, extremely weathered, extremely low to low strength.

- The residual and alluvial soils within the site are dispersive or potentially dispersive and therefore susceptible to erosion.

- Site condition is non aggressive to mildly aggressive toward concrete structures and mild to moderately aggressive to iron and steel.

5.11 Salinity

Salinity is the accumulation of mineral salts in the soil, groundwater and surface waters. Dryland salinity results when soluble salts are transported to the surface by rising water table. The groundwater itself can also cause soluble salts to migrate under the ground surface and emerge as saline seepage in low lying areas. Salinity

can lead to vegetation loss, weed invasion, soil structure decline and in some cases structural damage to buildings.

A key part of the detailed Geotechnical Investigation, undertaken by Geotechnique (Reference 14), for the release area was the determination of the extent of both soil and groundwater salinity affecting the site.

5.11.1 Soil Salinity

At seventy seven of the test pits and boreholes, samples were obtained at varying depths to determine soil salinity. The results are summarised as follows:

- The eighteen samples recovered from depths of up to 0.3 metres found that the soils are generally non-saline. This indicates that the site topsoil is generally non-saline.
- The thirty nine samples recovered from depths of 0.3m to 1.0m found that the soils are generally slightly to moderately saline.
- The twenty samples recovered from depths exceeding 1.0m found that the soils are moderately to highly saline.

From the results of the soil salinity testing it was concluded that:

- Soil salinity increases with depth in both the residual and alluvial profiles.
- Saline soils are likely to be encountered within the Edmondson Park Development area and the environmental, economic and social impacts need to be taken into consideration for the proposed development.

5.11.2 Water Salinity

A total of thirty four samples were obtained to determine the salinity of water within the Edmondson Park site. Sufficient ground water for testing was encountered in only one of the test pits. The remainder of samples were obtained from dams within the site. The results are summarised as follows:

- A total of 4 of the water samples were collected from the site were found to be saline to brackish. One of these was the groundwater test pit sample.
- Twelve of the water samples collected were found to be marginally saline.

From the results of the water salinity testing it was concluded that:

- Surface water collected in dams is likely to be non-saline or marginally saline.
- Groundwater at depths exceeding 2.5m is likely to be saline to brackish.

Land use activities can affect groundwater **recharge** and **discharge** and result in rising water tables and saline groundwater seepage. The key principles recommended by WSROC in their *Salinity Code of Practice* (Reference 15) to guide Urban Salinity Management are as follows;

- Identify hazard areas.

- Reduce water inputs to maintain natural water balance and avoid groundwater rises and through flow.
- Maintain good drainage and reduce waterlogging.
- Retain and increase vegetation in strategic areas.
- Implement building controls and / or engineering responses where appropriate.

Typical land use practices that should be implemented to avoid salinity impacts include:

- Retention and enhancement of vegetation in strategic areas.
- Retention and maintenance of natural riparian corridors.
- Resident and Public Authority education on the need to restrict over-watering of lawns and open space areas to avoid lifting water table levels.
- Encourage residents to grow plants with low water needs (natives); mulch gardens to reduce water use and evaporation; use watering timers with micro irrigation systems.
- Providing sub-surface drainage to ensure that roads and lots do not create impediments to the flow of shallow water tables.
- Ensuring that roof drainage is not connected to on-site recharge pits.
- Ensuring that leakage from water supply services is minimised.
- Maintaining good drainage and reducing waterlogging.
- Avoiding infiltration from water storage bodies, wetlands and bio-retention filters through the incorporation of impermeable liners.
- In sodic soils, providing polyethylene sheeting under ground bearing slabs, effective damp courses and sub-soil drainage.
- Adopt appropriate masonry and concrete construction materials to withstand the effects from saline soils.
- Minimising excavation as much as possible to reduce the disturbance to saline and sodic subsoils.

5.12 Opportunities

In the design of any urban drainage scheme it is desirable to build on the naturally occurring physical and environmental assets of the site to maximise the quality of the ultimate living environment. In particular water should be recognised as an important resource that can enhance and bring a focus to areas accessible to the whole community.

For the Edmondson Park site there are major opportunities to:

- Maintain, rehabilitate and enhance permanent riparian corridors.
- Maximise habitat retention along the riparian corridors to provide sustainable aquatic and terrestrial ecosystems.
- Integrate open space areas and riparian corridors.
- Incorporate storage within the water quality elements to maintain environmental peak flows at pre development levels.
- Potentially incorporate a water reuse scheme to irrigate the proposed playing field.

5.13 Constraints

The constraints to be considered in the preparation of a drainage strategy for this site include;

- Steep site topography may require special treatment to reduce scour and erosion.
- A number of significant stands of trees has been identified on the site.
- Water Quality objectives will require allocation of land for water quality control structures
- Stormwater detention is required to reduce post development flows to pre development levels. Appropriate areas will be required to provide necessary detention storage.
- Existing site soil salinity and groundwater salinity constraints.
- Water use activities that can cause unnatural charging of groundwater and create rising watertables (e.g. over-irrigation of public areas, sports fields, private lawns and private gardens).

6. STORMWATER MANAGEMENT STRATEGY CONCEPT

The stormwater management strategy for th e Edmondson Park development previously proposed by GHD (References 1 and 2) is summarised as follows:

- Flood mana gement thro ugh provision of exten ded detention wet/dry basins, loca ted offline where possible and drainage corridors/easements/bioengineered channels.
- Flow attenu ation throug h retarding basins, lakes/ponds, wetlands, reha bilitated creeks, vegetated swales, buffer strips and water re-use schemes.
- Flow volume reduction through water re-use (e.g. rainwater tanks).
- Water qualit y manage ment through wetlands, extended detention wet/dry basins and primary/secondary stormwater treatment processes such as sediment, litter and nutrient treatment.

The stormwater man agement strategy proposed for t he Edmondson Park site was developed in considerat ion of the statutory requirements and guideline s listed in Se ction 5 of this report.

6.1 Water Quality Management Options

A range of stormwater manageme nt techniqu es and options identif ied as bein g suitable for the management of nutrients and su spended solids discharging from the site are summarised as follows:

6.1.1 Constructed Wetlands

Surface Conventional wetlands.

Sub Surface Gravel filled shallow wetland.

Wetlands are shallow water body systems, densely vegetated with emergent aquatic macrophytes. Wetlands are effective in trapping su spended solids, as well as chemical and biological uptake of pollutants.

6.1.2 Bio-Retention Systems

Bio-Retention systems consist of a f iltration be d with either gravel or sa ndy loam media and an extended dete ntion zone typically from 100-300 mm deep desig ned to det ain and tre at first flu sh flows fro m the upstrea m catchment. They typically take the form of a linear swale and are located within the verge area of a road reserve or extend wit hin the bushland corridors or other open space areas. The surface of the Bio- Retention Swale can be grassed or mass planted with water tolerant specie s. Filtratio n beds of Bio-Retention systems are typically 0.6 metres deep.

6.1.3 Cartridge Filtration Systems

Cartridge filtration syst ems are underground pollution control device s that treats first flush flows. The units cons ists of a vault conta ining a number of cartridges e ach loaded with media that targets specif ic p ollutants. Each cartridge ha s a ma ximum treatable flowrate of approximately 1 litre pe r

second, and the unit can accommodate up to 24 cartridges providing a maximum treatable flowrate of 24 litres per second.

Each of these management techniques were evaluated and compared with consideration of a range of Environmental, Social/Amenity, Economic, Maintenance and Engineering criteria.

6.2 Proposed Stormwater Management Strategy

The stormwater management strategy proposed for the site focuses on minimising the impacts of the development on the total water cycle and maximising the environmental, social and economic benefits achievable by utilising responsible and sustainable stormwater management practices.

To maintain stormwater quality to the required levels, a "treatment train" approach is proposed where various types of pollutants are removed by a number of devices acting in series. The stormwater management strategy consists of the following elements.

WATER QUALITY

On Lot Treatments

Adoption of appropriate waterwise landscaping practices (resident education, native gardens, mulch, micro-irrigation).

Implementation of water efficient fittings and appliances in all dwellings (dual flush toilet, AAA shower heads, water efficient taps and plumbing).

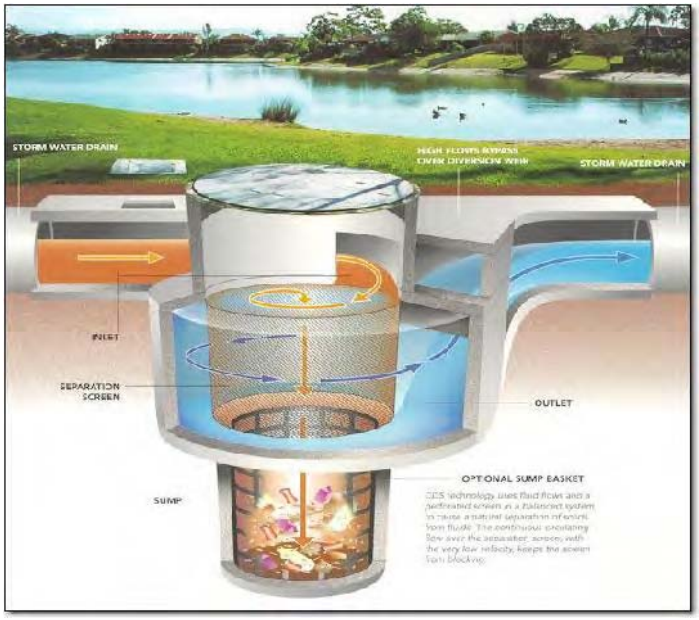
Minimisation of impervious areas.

The provision of a future reticulated recycled watermain to the site, along with implementation of the above water efficient devices, will satisfy the requirements of BASIX.

Street Level Treatments

Inlet Pit Filter Inserts and Gross Pollutant Traps (GPT's)

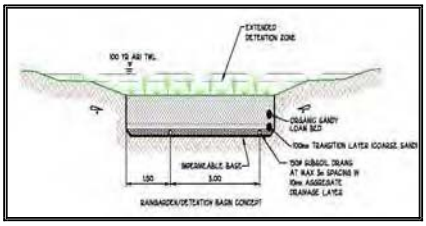
GPT devices are typically provided at the outlet to stormwater pipes. These systems operate as a Primary treatment to remove litter, vegetative matter, free oils and grease and coarse sediments prior to discharge to a downstream (Secondary and Tertiary) treatment devices. They can take the form of trash screens or litter control pits, filter pit inserts and wet sump gross pollutant traps.



Note, it is our view that inlet pit filter inserts have several advantages over end of pipe GPT's, such as providing a dry, at source collection of litter, vegetative matter and sediment as well as allowing for staged construction works without having to provide additional / temporary GPT units. However, it is noted that Liverpool City Council's preference is for proprietary end of pipe GPT's, such as CDS units.

Subdivision / Development Treatment

Bio-retention Raingarden



Bio-retention "Raingardens" are proposed at a number of locations throughout the Edmondson Park development site. The Bio-retention Raingarden will be appropriately sized to achieve the required GCC and Liverpool City Council's nutrient reduction targets. The Bio-retention Raingarden will also function to assist in detaining first flush flows (up to the 1.5 year ARI event) to offset the impact of urban development on bankfull discharges within the riparian corridors.

WATER QUANTITY

Regional Detention Basins

Dry regional detention basins will be incorporated within the riparian corridors at key locations within the development site to restrict peak post development flows to pre development levels for storm events up to and including the 100 year ARI. Outlet control structures will need to be configured to control peak discharges for a range of storm events from 20 year ARI to the 100 year ARI.

Key features of the proposed strategy are as follows:

Social:

- Demand management measures and reticulated recycled water provided to reduce potable water demands.
- Integration of bio-retention raingardens with the overall landscape strategy for the estate to address water quality, offset the impact of development on bankfull discharges within the riparian corridors and create an integrated-natural resource for the incoming and wider community.
- Enhanced visual amenity (views out of and through the riparian corridors).
- Flood affectation and public safety issues identified and controlled.
- Provision of aesthetic soft design forms that enhance urban and Environmental amenity.
- Intergenerational equity attained through the provision of a healthy, functioning riparian corridors.

Environmental:

- Downstream and in-channel discharge peaks and velocities limited to avoid scouring, siltation and flora and fauna impacts
- Enhanced ecological health and biodiversity within the riparian corridors.
- Provision of GPT's and raingardens to achieve water quality capable of sustaining aquatic ecosystems.
- Limitation of magnitude and frequent wetting flows and peak velocities to avoid creek bed/bank erosion and sedimentation.

Economic:

- Minimisation of land take consistent with the achievement of environmental and social objectives.
- Proposed water quality improvement measures that keep recurrent maintenance tasks and costs to a minimum.
- Recycled water main supply to reduce reliance on potable water supplies.

The stormwater management strategy proposed for the Edmondson Park site is functional; delivers the required technical performance; avoids environmental degradation and pressure on downstream ecosystems and infrastructure; and provides for a 'soft' sustainable solution for stormwater management within the estate. The stormwater management concept is illustrated in Figure 2.

6.3 Reductions in Potable Water Demand

Introduced by the NSW Government, BASIX, the Building Sustainability Index, ensures homes are designed to use less potable water and be responsible for fewer greenhouse gas emissions by setting energy and water reduction targets for house and units of up to 40%.

It is understood that the development will be provided with a reticulated recycled water main in the future. The recycled water main will be utilised in domestic toilets and laundries as well as irrigation of lawns and gardens, significantly reducing the demand on potable water supplies. Therefore rainwater tanks are not intended to be provided for the development.

Demand management strategies include: resident education on waterwise practices, triple A rated showerheads, water efficient taps, dual flush toilets, and low water demand gardens (native plantings, mulch, micro irrigation). Research by Sydney Water has indicated that the use of AAA showerheads and dual flush toilets can reduce total domestic water use by 15%. Separate studies by Coombes Consulting Group (2002) (Reference 16) found that the use of AAA fittings and appliances can reduce total domestic water use by 17.5%.

It is therefore recommended that demand management measures be implemented within all allotments / dwellings to achieve initial reductions in potable water demand to satisfy the requirements of BASIX.

6.4 Litter and Sediment Control

Local drainage throughout the development should be filtered prior to discharge into the downstream drainage systems, raingardens and the riparian corridors. Devices to achieve litter and sediment control come in various forms, such as inlet pit filter inserts, cast in situ and precast gross pollutant traps as well as wet sump and self cleansing units.

As discussed in Section 6.2, inlet pit filter inserts have several advantages over end of pipe GPT's, however it is noted that Liverpool City Council's preference is for proprietary end of pipe GPT's, such as CDS units. Therefore it is proposed that Liverpool City Council approved proprietary gross pollutant trap structures, such as CDS units, be provided to capture litter, vegetative matter, coarse sediment prior to discharge to the downstream treatment devices. An appropriate unit should be selected such that it intercepts a minimum 70% of the sediment of size 0.15mm and greater. It is expected that the site drainage strategy would require approximately 14 of these structures (at least one per Raingarden). The approximate locations of the proposed GPT units are indicated on J. Wyndham Prince Plans 8183 SK17-23.

6.5 Bio-Retention "Raingarden" Systems

A number of "Raingardens" have been located within the riparian corridor fringes of the Edmondson Park site to facilitate the removal of suspended solids and nutrients from the urban catchment. Refer to Figure 2 for general Raingarden locations and J. Wyndham Prince Plans 8183 SK01-26 for Raingarden sizes and details.

The Raingardens consists of a sandy loam filled trench. The surface of the Raingarden is to be densely vegetated with native sedges and/or grasses. This device would be designed to receive, convey and treat 1.5 year ARI flows from the

upstream catchment. Treatment is attained by detention of flows, direct filtration and nutrient stripping by bio-films which establish on the surface of the media bed.

The Raingarden will have an extended detention zone of 300 mm depth which will service first flush and base flows from the urban development. An additional 110 cubic metres of storage per catchment hectare provided above the swale will act as a detention system to limit 1.5 year ARI flows discharging to the watercourses to pre-development levels (refer to Section 7.1 and to J. Wyndham Prince Plans 8183 SK01-28 for details).

The size of the Raingardens have been determined using MUSIC modelling (Refer to Section 8). The performance of the devices are detailed in Section 8.5 of this report. The general features and configuration of the system is detailed in Table 6.1 and indicated on Figure 2.

Table 6.1

BIO-RETENTION RAINGARDEN
GENERAL FEATURES AND CONFIGURATION

Storage	
Extended Detention Depth (m)	0.3
Surface Area (typical) (m^2)	1.1 - 1.3% of catchment
Infiltration	
Filter Area (typical) (m^2)	1.1 - 1.3% of catchment
Filter Depth (m)	0.6
Filter Particle Effective Diameter (mm)	0.45
Saturated Hydraulic Conductivity (mm/h)	100
Outlet Properties	
Overflow Weir Width (m)	2

Portions of the raingardens floors should also be utilised as sedimentation control ponds in the interim whilst there is construction in the catchment.

6.6 Water Quantity Management

6.6.1 Environmental Flows (1.5 Year ARI)

Detention storages will be integrated with the raingardens and will be sized to restrict post development discharges for storms up to the 1.5 year ARI design event to pre-development levels.

6.6.2 Infrequent Storm Flows (Up to the 100 Year ARI)

Regional detention basins will be incorporated within the development to restrict post development discharges to pre-development levels for the 20 and 100 year ARI storm events. This will minimise the impact of the proposed development by reducing storm flows prior to discharge to the bushland and riparian corridors downstream of the site.

A discharge control structure will be incorporated within each basin to allow controlled release of stormwater for flows in excess of the 300 mm extended

detention zone. This will act as a detention system to limit storm flows up to the 100 year ARI discharging to Cabramatta Creek, Maxwells Creek and the Maxwells Creek tributary to pre-development levels. The operation of the proposed systems were evaluated by Webb McKeown using the SOBEK hydraulic model (refer to Section 9 for details).

6.7 Location and Size of Treatment Devices

Identification of suitable locations and the preliminary sizing of the water quality and quantity control structures was undertaken as part of this investigation. The general locations of the elements are shown on Figure 2 and predicted sizes of each of these elements are shown on J. Wyndham Prince Plans 8183 SK01-28.

6.8 Channel Treatments

The key channel treatment elements for the Edmondson Park are detailed in the separate Stream Rehabilitation and Vegetation Management report prepared by J. Wyndham Prince Pty Ltd (Reference 17) and are summarised as follows:

- Creation of continuously vegetated corridors for the length of the creek systems.
- Provision of passive recreation areas along the edge in specified areas for Maxwells Creek North and Maxwells Creek.
- Future maintenance practicalities.
- All creek crossing are "fish friendly" in accordance with the Department of Fisheries guidelines.
- Use of "natural" type materials where practical, such as rock, timber and organic fibres in any required structures.
- Stormwater flows will be cleaned and velocities limited before discharge to creek. Any stormwater structures within the riparian zone to be in accordance with the Department of Water & Energy Guidelines.
- Re-establishment of a continuous watercourse where this has been lost.
- Stabilisation of existing inverts.
- Stabilisation of existing creek banks.
- Filling and trimming of existing dams within the watercourse.

6.9 Construction Stage

Erosion and sediment control measures are to be implemented during the construction phase in accordance with the requirements of Liverpool City Council and the guidelines set out by the NSW Department of Housing (the "Blue Book" Reference 18).

The erosion and sediment controls will include the following measures:

- Construction of temporary diversion drains ("Blue Book" Standard Drawing SD 5-8) or provision of staked straw bales (SD 6-6) on the high side of the disturbed areas to direct upstream runoff around the area.

- The use of silt fencing (SD 6-7) on the downstream side of the area of works to retain soil.

- Provision of a stabilised site access (SD 5-7) at appropriate points where construction vehicles will enter and leave the site to reduce the likelihood of vehicles tracking soil materials onto public roads.

- Topsoil stockpile (SD 4-1) located adjacent to the areas of disturbance and to have an earth bank (SD 5-2) on the upslope side to divert runoff around the stockpile with a sediment fence (SD 6-7) located 1 to 2 metres downslope of the stockpile.

- Rock wrapped in geofabric or straw bales will be installed in or around any stormwater drainage inlet.

- Sediment and Erosion Control Basins (Type D or F) integrated with the raingardens and detention basins (Refer to Section 6.10).

As the operation raingarden water quality treatment systems are sensitive to the impact of sedimentation, these controls should generally be maintained until the majority of site building works are complete. Alternatively, a very high level of at source control on individual allotments during the building and site landscaping works, which is regularly inspected by Council officers, would be required.

6.10 Interim Treatment Measures

Sedimentation control ponds are interim devices that should be temporarily located both within permanent detention Basins and as independent devices immediately upstream or within the permanent raingardens. They will be utilised for interim stormwater management throughout the civil and housing construction phases of the development.

Upon 80% completion of housing construction within the catchment, the ponds can be dewatered, desilted, then filled in to form the detention basin floor level, or with filter media to complete the raingarden floor.

6.11 Long Term Management

Regular maintenance of the stormwater quality treatment devices is required to control weeds, remove rubbish, and monitor plant establishment and health. Some sediment build-up may occur on the floor of the raingarden and may require removal to maintain the high standard of stormwater treatment.

Proper management and maintenance of the water quality control systems will ensure long-term, functional stormwater treatment. A site-specific Operation and Maintenance (O & M) manual should be prepared for the system. The O & M manual would provide information on the Best Management Practices (BMP's) for the long-term operation of the treatment devices. The manual should provide site-specific management procedures for:

- Maintenance of the GPT structures including rubbish and sediment removal.
- Management of the raingarden including plant monitoring, replanting guidelines, monitoring and replacement of the filtration media and general maintenance (i.e. weed control, sediment removal).

7. HYDROLOGIC ANALYSIS

Hydrologic analyses for the three watercourse catchments were previously undertaken by Webb McKeown and Associates (References 5-7). A hydrologic model was developed as part of this study using the rainfall - runoff flood routing model XP-RAFTS (Runoff and Flow Training Simulation with XP Graphical Interface) (Reference 19 & 20). The purpose of this model was to develop alternative concept designs for the detention basins previously proposed, which were then input into the hydraulic model to obtain peak flows and flood levels, as further discussed in Section 8. Therefore no alterations to the previous site hydrologic modelling (References 5-7) were made as part of this investigation.

7.1 XP-Rafts Modelling of a Typical 10ha Catchment

Separate modelling was undertaken to analyse the performance of the proposed bio-retention environmental flow detention systems in attenuating frequent storms up to the 1.5 year ARI event using the XP-RAFTS hydrologic model.

7.1.1 Typical Sub-Catchment

The proposed bio-retention systems are to incorporate a detention storage component that will reduce post development discharges to the watercourses for all storms up to and including the 1.5 year ARI design event to pre-development levels (Refer to Section 6.6).

The performance of the detention storage component of the bio-retention systems has been modelled using XP-RAFTS. As each of the combined water quality and quantity control storages is sized approximately proportionate to the catchment it services (1.1% of catchment area), the modelling was undertaken for a nominal 10 hectare sub-catchment which is representative of the typical sub-catchment area found within the development.

Each of the bio-retention swales/detention basins are to service their own sub-catchments independently.

7.2 Calibration

It is normal practice for flood routing models such as XP-RAFTS to be calibrated with historical rainfall and stream flow data for the catchment being investigated in order to produce the most reliable results. The model parameter values are adjusted so that the model adequately reproduces observed hydrographs. Calibration was undertaken of XP-RAFTS models in previous investigations, however calibration was done to larger, less frequent events. The adopted Bx values are therefore unlikely to be applicable for the more frequent environmental flow event. Therefore a Bx factor of 1.0 was adopted for this investigation.

7.2.1 Initial / Continuing Loss Model

XP-RAFTS modelling was undertaken using a standard initial and continuing loss rate model. The values adopted were standard parameters for XP-RAFTS modelling as shown in Table 7.1.

Table 7.1

XP-RAFTS MODEL INITIAL AND CONTINUING LOSSES

Catchment	Initial Loss (mm)	Continuing Loss (mm)
Pervious Catchment	15.0	2.5
Impervious Catchment	1.5	0.0

7.2.2 Model Parameters

The Storage Coefficient Multiplication Factor (Bx) was set to 1.0. The Storage Non-linearity exponent (n) was set at the default value of -0.285. The pern values adopted in the modelling are shown in Table 7.2.

Table 7.2

XP-RAFTS MODEL PARAMETERS

Parameter	Catchment Condition	Value
Pern (n)	Rural Pervious	0.050
	Urban Pervious	0.025
	Urban Impervious	0.015

7.3 Basin Performance

The performance of the typical basin for the 1.5 year ARI st orm event is detailed in Table 7.3.

Table 7.3

DETENTION BASIN PERFORMANCE (Typical 10 Ha. Sub-catchment)

PRE DEVELOPMENT			POST DEVELOPMENT						
Peak Inflow (m^3/s)	Storm Dur. (min)	Time to Peak (min)	Peak Inflow (m^3/s)	Storm Dur. (min)	Time to Peak (min)	Peak Outflow (m^3/s)	Storm Duration (min)	Time to Peak (min)	Storage Used (cu.m)
0.48	720	420	1.85	90	30	0.46	60	45	1099

The storage provided to restrict pea k 1.5 year post development discharges to pre-development levels equates to approximately 110 cu.m/ha. The detention basin proposed to service each of the sub-catchments throughout the development will be sized to provide this same storage rate.

An assessment of each basin is recommended at Development Application stage to optimise the design.

7.4 Discussion of Modelling

The XP-RAFTS modelling showed that the peak post development discharges for the 1.5 year ARI storm event are increased significantly (approximately 385%) following urbanisation of the catchment.

The XP-RAFTS modelling also showed that the incorporation of appropriately sized detention storages incorporated into the proposed bio-retention systems will ensure that post development discharges from the site are reduced to pre- development levels for storms up to and including the 1.5 year ARI design event. This will minimise the impact of the proposed development by reducing the most regular storm flows prior to discharge to the riparian corridors within the Edmondson Park development.

7.5 Stream Erosion Index

The stream erosion index is defined by the Department of Environment and Conservation (Reference 10) as the post development duration of flows greater than the 'stream-forming flow' divided by natural duration of flows greater than the 'stream-forming flow'. The 'stream-forming flow' is defined as 50% of the 2 year ARI flow rate estimated for the catchment under natural conditions. The DEC guidelines recommend a Stream Erosion Index no greater than 3.5 - 5.0.

The XP-RAFTS model described in Section 7.1 was utilised to determine the Stream Erosion Index for a typical 10 hectare catchment of the Edmondson Park site. The Stream Erosion Index was determined to be 2.6, with the provision of a basin to detain 1.5 year ARI flows, which complies with the DEC recommendations. The results are summarised in Table 7.4.

Table 7.4

STREAM EROSION INDEX SUMMARY OF RESULTS

Development Case		Storm Duration									Max. Value	Stream Erosion Index
		30 min	60 min	90 min	120 min	180 min	270 min	360 min	540 min	720 min		
Pre-Development	Peak Flow (m3/s)	0.195	0.461	0.487	0.545	0.510	0.539	0.517	0.536	0.558	0.558	
	50% Threshold Value (m3/s)	0.098	0.231	0.244	0.273	0.255	0.270	0.259	0.268	0.279	0.279	
	Total Threshold Exceedance Time (mins)	0	40	52	62	73	72	70	80	90	90	
Post-Development	Peak Flow (m3/s)	1.967	1.981	2.134	1.968	1.210	1.094	0.815	0.725	0.730	2.134	
Without Basin	Total Threshold Exceedance Time (mins)	28	49	60	78	106	104	94	90	120	120	1.3
Post-Development With	Peak Flow (m3/s)	0.458	0.507	0.484	0.485	0.468	0.459	0.437	0.425	0.417	0.507	
1.5 Yr ARI Basin	Total Threshold Exceedance Time (mins)	78	108	123	144	168	196	184	225	230	230	2.6

LEGEND:

Peak Values

From the results it is noted that the Stream Erosion Index increases with the provision of a basin, i.e. the risk of erosion increases with the inclusion of a basin. However, without provision of a detention basin the peak discharges would increase by approximately 382%. Therefore it is considered that inclusion of the detention basin offers a greater benefit in terms of minimising the environmental risks.

8. WATER QUALITY

The water quality analysis for th is study was undertaken using the model MUSIC (Model for Urban Stormwater Improvement Conceptualisation) version 3.01 (Reference 21). This water quality mod elling softw are was de veloped by the Cooper ative Resea rch Centre (CRC) for Catchment Hydrology which is ba sed at Monas h University and was first relea sed in July 2002. Version 3.01 was released in May 2005.

The model provides a number of features relevant for the development:

- It is able to model the potential nu trient reduct ion benefits of gross p ollutant trap s, constructed wetlands, grass swales, bio-rete ntion syste ms, sedimentation basins, infiltration systems and it incorpora tes mechanisms to model stormwater re-use a s a treatment technique.

- It provides mechanisms to evaluate the attainment of water quality objectives.

The MUSIC modelling was undertaken to provi de an incre ased level o f confiden ce that the water cycle managemen t system proposed for the development will result in redu ctions in overall post –development pollutant loads an d concentrat ions being discharged from the proposed d evelopment and that these disch arges comply with the designat ed target objectives.

8.1 Catchments

A MUSIC model was established for the proposed stormwater management syste m for the Edmondson Park development. The model has bee n divided into three main catchments, representin g the Cabramatta Cre ek, Maxwell s Creek and Northern Tributary to Maxwells Creek catch ments. These catchme nt areas ha ve then been broken down further in to sub-catchments to re present the area contributing to each Raingarden.

The proposed residential development areas have been modelled with a 75% impervious area factor and the commercial developmen t areas wit h a 100% impervious area factor.

A summary of the catch ment areas and Raingarden size s a re shown in Table 8.1 and on Figure 2.

Table 8.1

SUMMARY OF CATCHMENT AND RAINGARDEN DATA FOR THE SITE

	Catchments			Raingardens	
	Type	Area (ha)	Fraction Impervious	ID	Area (m^2)
Cabramatta Creek Catchment	Urban Residential	7.44	0.75	1	683
	Urban Residential	32.69	0.75	2	3776
	Urban Residential	7.80	0.75	3	958
	Urban Residential	63.43	0.75	4	7055
	Urban Residential	29.76	0.75	6	3300
Maxwell Creek Catchment	Urban Residential	18.88	0.75	5	2150
	Commercial	39.69	1.00	13	5300
	Urban Residential	42.45	0.75	9	4890
	Urban Residential	9.52	0.75	10	1000
	Urban Residential	5.91	0.75	11	680
Maxwell Creek Northern Tributary Catchment	Urban Residential	63.93	0.75	7	7000
	Urban Residential	45.60	0.75	8	5240
	Urban Residential	27.80	0.75	12	2970

The general arrangeme nt of the MUSIC model for the trea tment train is shown on Plate 2.

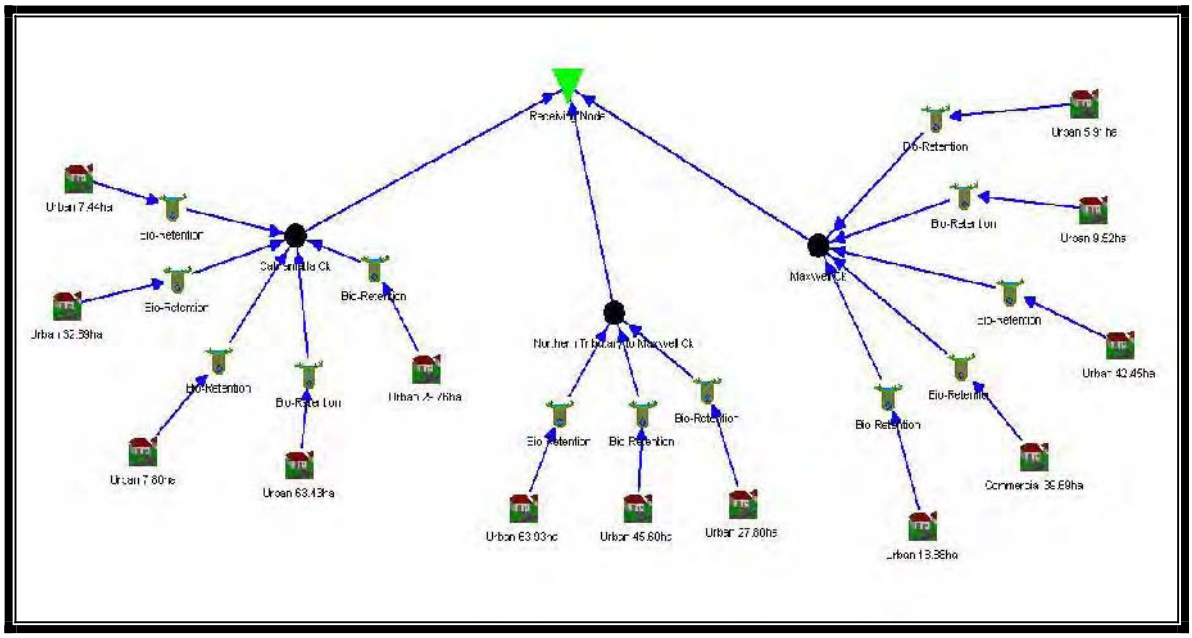


Plate 2: MUSIC Model Layout

8.2 Rainfall Data

The MUSIC model is able to utilise rainfall data based on 6 minute, hourly, 6 hourly and daily time steps. A 6 minute time step was used in the analysis which was chosen in accordance with the recommendations on selecting a time step within the MUSIC Users Manual (Reference 21).

Rainfall records for the Liverpool area were obtained from the Bureau of Meteorology. The nearest rainfall station to the site with a reasonable period of 6 minute rainfall data (to be used in the Water Quality Modelling) was obtained as follows:

Station No	Location	Years of Record	Type of Record
67035	Liverpool (Whitlam Centre)	1965 – 1974	6 minute

A summary of the model rainfall data set and that obtained from the Bureau of Meteorology for the years 1962 – 2001 is shown below in Table 8.2.

Table 8.2

SUMMARY OF RAINFALL DATA FOR THE SITE

Property	MUSIC Model Data Set (1965-1974)	Bureau of Meteorology Data (1962-2001)
Mean Yearly Rainfall (mm)	810	868
Dryest Year In Data Set	503	458
Wettest Year In Data Set	1160	1369
Mean No. Rain Days	112	109
Mean No. Rain Days > 1mm	79	82
Mean No. Rain Days > 10mm	23	24
Mean No. Rain Days > 25mm	7.5	8.4

The rainfall data summarised in Table 8.2 indicates that the data set used in the MUSIC modelling is a reasonable representation of long term statistical data. The rainfall data set incorporated in the modelling includes a dry year (1968 – 503mm), which compares well with the Decile 1 rainfall of 547mm obtained from the Bureau of Meteorology and a wet year (1969 – 1160 mm), which compares well with the Decile 9 rainfall of 1228 obtained from the Bureau of Meteorology.

The rainfall for the period analysed is shown on the graph which is provided in Plate 3.

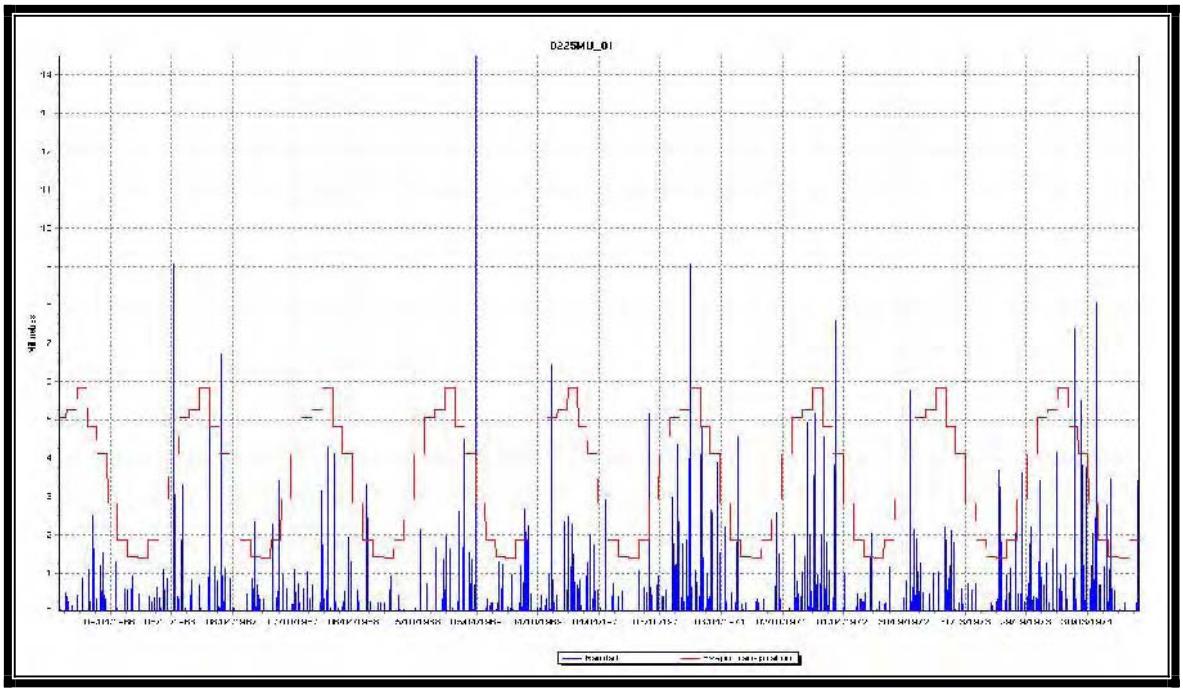


Plate 3: Rainfall For Liverpool (1965-1974)

8.3 Pollutant Loading Rates

In the absence of site specific data, the soil / groundwater parameters and pollutant loading rates adopted for Edmondson Park are based on the recommended parameters provided by the Department of Environment and Climate Change for the Growth Centres Commission Release Areas (Reference 10). The adopted parameters are presented in Tables 8.3 and 8.4.

Table 8.3

ADOPTED SOIL / GROUNDWATER PARAMETERS

	Units	Urban Value
Impervious Area Parameters		
Rainfall threshold	mm/day	1.4
Pervious Area Parameters		
Soil storage capacity	mm	170
Initial storage	% of capacity	30
Field capacity	mm	70
Infiltration capacity coefficient - a		210
Infiltration capacity coefficient - b		4.7
Groundwater Properties		
Initial depth	mm	10
Daily recharge rate	%	50
Daily baseflow rate	%	4
Daily deep seepage rate	%	0

Table 8.4

ADOPTED ANNUAL POLLUTANT LOADING RATES

Pollutant	Base Flow (mg/L)	Storm Flow (mg/L)
TSS	15.9	141
TP	0.141	0.251
TN	1.29	2.00

8.4 Treatment Device Performance

8.4.1 Litter and Sediment Control Structures

As discussed previously in Sections 6.2 and 6.4, the incorporation of inlet pit filter inserts offer some advantages over end of pipe gross pollutant traps, however Liverpool City Council has a preference for proprietary gross pollutant traps, such as CDS units, and these are therefore proposed for end of stormwater pipe treatment. As the sediment and nutrient removal performance of the litter and sediment control structures can vary between devices, they have been conservatively excluded from the modelling.

8.4.2 Bio-retention Raingardens

The expected sediment and nutrient removal performance of the proposed Bio-retention Raingardens was determined using the default equations and parameters provided in the MUSIC model (Reference 21). The water quality reduction mechanisms in MUSIC are based on an exponential decay equation referred to as the k – C* curve (refer to Wong et al. – Reference 22).

The performance parameters used in the MUSIC model are summarised in Table 8.5.

Design Assumptions:

Surface Area The Bio-retention Raingardens provided will have surface areas equal to approximately 1.1% of the catchments they service for residential areas and 1.3% of the catchments they service for commercial areas.

Filter Media It is assumed that the Bio-retention Raingarden provided will utilise organic sandy loam filter media having a media bed depth of 0.6 m, a filter particle effective diameter of 0.45 mm and a saturated hydraulic conductivity of 100 mm/hr.

Sediment Removal It is assumed that trash and gross sediments will be effectively removed prior to entering the Bio-retention Raingarden by the proposed GPT units. In order to reduce the ongoing maintenance requirements for the Raingardens, the GPT should be selected on the basis that it intercepts, as a minimum, 70% of the sediment loads greater than 0.15 mm.

Table 8.5

MUSIC – PERFORMANCE PARAMETERS – RAINGARDEN

Pollutant	k (m/yr)	C* (mg/L)
TSS	8000	20.000
TP	6000	0.130
TN	500	1.400

8.5 Pollutant Load Estimates

Total annual pollutant load estimates were derived using MUSIC for the fully developed site incorporating the proposed water quality treatment system.

The estimated annual pollutant loads, reductions and concentrations for the Edmondson Park development are presented in Table 8.6.

Table 8.6

SUMMARY OF MEAN ANNUAL POLLUTANT LOADS AND REDUCTIONS

Pollutants	Sources	Residual Load at Receiving Node	% Reduction	DECC Target Reductions (% Reduction)	Georges River Target Reductions (% Reduction)
Total Suspended Soilds (kg/Yr)	426000	48300	89%	85	80
Total Phosphorus (kg/Yr)	702.0	196.00	72%	65	60
Total Nitrogen (kg/Yr)	5170.0	2830.0	45%	45	35
Gross Pollutant (kg/Yr)	66200	0.00	100%	-	-

8.6 Discussion of Modelling

The performance of the proposed sub catchment scale water management strategy for Edmondson Park obtained from the MUSIC model is summarised as follows:

- The provision of the proposed water quality management system will ensure that Suspended Solids are reduced by a minimum of 89%, which exceeds the nominated target reduction of 85% recommended in the DECC guidelines (Reference 10) and 80% reduction recommended by the Georges River guidelines (Reference 11).

- The incorporation of the proposed water quality management system for the overall developed site will ensure that post development phosphorus discharges are reduced by a minimum of 72 %. This complies with the objective of 65% retention of the average annual nutrient load nominated in the DECC guidelines (Reference 10) and 60 % retention nominated by the Georges River guidelines (Reference 11).

- The incorporation of the proposed water quality management system for the overall developed site will ensure that post development nitrogen discharges are reduced by a minimum of 45%. This complies with the objective of 45% retention of the average annual nutrient load nominated in the DECC guidelines (Reference 10) and 35 % retention nominated by the Georges River guidelines (Reference 11).

- The nutrient stripping potential of the riparian corridors and their naturally functioning watercourses has not been included in these calculations.

9. HYDRAULIC ANALYSIS

A hydraulic model (SOBEK) was previously developed for the site by Webb McKeown and Associates (References 5-7). As discussed in Section 6.6, alternative detention basin concepts were developed for Cabramatta Creek and the Northern Tributary to Maxwells Creek as part of this investigation and revised surface models input into the SOBEK hydraulic model for reassessment. Additionally, some changes to the previous development conditions, such as flood plain filling, provision of raingardens in the fringe of the corridors and alternate culvert outlet arrangements were also included in the hydraulic model. Through an iterative process, the detention basins were optimised to ensure that the peak post development discharges did not increase over the pre development levels at the downstream site boundary.

Revised 100 year ARI developed scenario flood levels and extents were also determined for the Cabramatta Creek and Northern Tributary to Maxwells Creek watercourses as part of the investigation. The post development 100 year ARI flood extents are shown on J. Wyndham Prince Plans 8183 SK01-28. A summary of the peak discharges determined by the hydraulic analysis undertaken by Webb McKeown in conjunction with this investigation are shown in Table 9.1.

Table 9.1

SUMMARY OF PRE DEVELOPMENT AND POST DEVELOPMENT PEAK FLOWS AT SITE BOUNDARY

Catchment	ARI	Pre-Development (m^3/sec)	Post Development With Basin (m^3/sec)	Approximate Basin Volume Required (m^3)	Basin Volume To Be Provided [2] (m^3)
Cabramatta Creek	20 Year	55.6	53.7	72,000	91,000
	100 Year	81.9	67.5		
Tributary to Maxwells Creek	20 Year	12.9	9.83	48,000	48,000
	100 Year	21.6	12.0		
Maxwells Creek [1]	20 Year	26.0	26.5	32,000	32,000 [3]
	100 Year	35.3	34.9		

Notes: 1. The Maxwells Creek detention basin is located within the Campbelltown City Council LGA portion of the site.
2. As advised by Liverpool Council (19/10/07) to comply with the Cabramatta Creek Floodplain Management Strategy
3. Subject to confirmation by future investigation.

9.1 Discussion of Modelling

The hydraulic modelling shows that the proposed detention basins for the Cabramatta Creek and Maxwells Creek Tributary catchments will reduce post development peak discharges to pre development levels for both the 20 year and 100 year ARI storm events and this will offset the impacts of the proposed site fill within the fringes of the flood plain.

While there may be the potential to further optimise the Cabramatta Creek and Maxwells Creek Tributary basin outlets at development application and detailed design stages and reduce the volume requirements slightly, Liverpool Council require that, in order to comply with the Cabramatta Creek Basin Strategy, the Cabramatta Creek basin volume is to be a minimum of 91,000m^3 and the Maxwells Creek Tributary basin is to be a minimum of 48,000m^3. The outlets should be optimised at development application and detailed design stage to deliver these volumes. The allocated land foot print and proposed surrounding levels will enable the required volumes to be achieved.

The proposed detention basin for the Maxwell Creek catchment will reduce 100 year ARI peak post development flows to pre development levels. The peak 20 year ARI post development flow exceeds the pre development level by 0.5m^3/sec. As discussed in the Webb, McKeown investigation (Reference 7), further optimisation of the outlet would reduce the peak 20 year ARI post development discharge to pre development levels. It is also noted that the proposed Maxwells Creek basin lies within the Campbelltown City Council LGA portion of the site.

9.2 Spillway at Jardine Drive

Jardine Drive has been graded to form a spillway at the Cabramatta Creek crossing at RL 46.52 (the level at which the volume equals 91,000m^3), which is 0.5 metres lower than the adjacent levels, RL 47.02. A preliminary assessment has been undertaken to determine the ability to direct surcharge flows across Jardine Drive in the case of either (or both) the Cabramatta Creek Basin culverts being blocked or during extreme flows (10,000 year ARI).

The 0.5 metre deep spillway was estimated to allow a flow of approximately 54m^3/sec, which, in combination with a 50% blocked outlet, would allow a total of 75m^3/sec (180% of 100 year ARI flows) to discharge from the basin. We estimate this to represent a flow which is slightly less than the 10,000 year ARI flood.

It is beyond the extent of the brief for this investigation to consider appropriate design treatments for the spillway and the downstream embankment. These issues need to be addressed in accordance with the appropriate regulatory requirements during development application and detailed design phases.

10. SUMMARY & CONCLUSION

J. Wyndham Prince Pty Ltd has prepared this Water Sensitive Urban Design Strategy to integrate with the development planning process for the proposed Liverpool City Council portion of the Edmondson Park Release Area. The strategy has been prepared to conform with statutory requirements and industry best practice for stormwater management in this catchment, encompassing The Growth Centres Commission's, Liverpool Council's and the DECC's technical and environmental requirements. Sufficient detail is provided to integrate with and support the development planning process for the release area to identify the size, localities and general configuration of WSUD elements to assist in identification of Section 94 costs.

The preliminary water quality modelling indicates that for the proposed residential development an increase in pollutant loadings will occur if water quality controls are not implemented. DECC guidelines require 45% reduction in annual load of Total Nitrogen, 65% reduction in annual load of Total Phosphorus and 80% retention of the annual load for Total Suspended Solids.

The stormwater management strategy proposed as being most suitable for the Edmondson Park site is a combination of options including:

Litter & Sediment Control — Council approved proprietary gross pollutant traps are to be provided at stormwater discharge points to remove litter, vegetative matter, free oils and grease and sediments prior to discharge to the downstream treatment devices.

Bio-Retention Systems — Bio-retention swales and "Raingardens" will be integrated within targeted open space areas throughout the development and on the edge of riparian corridors to achieve nutrient reductions consistent with the nominated DECC and Georges River targets. The bio-retention systems will be lined to prevent infiltration to groundwater which can exacerbate salinity problems

Detention Storage — Detention storages will be integrated with the bio-retention swales and will be sized to restrict post development discharges for storms up to the 1.5 year ARI design event to pre-development levels. This will minimise the impact of the proposed development by reducing the most regular storm flows prior to discharge to the riparian corridor downstream of the site. This system will complement the regional detention storage basins to be located within the riparian corridors to reduce peak post development storm flows to pre development levels for storms up to and including the 100 year ARI event.

A general arrangement plan indicating proposed locations for the water quality and quantity treatments for the site is shown on Figure 2.

The proposed stormwater management strategy provides a basis for the detailed design and development of the site to ensure that the following objectives for stormwater management and site discharge are achieved:

Environmental

Appropriately designed and functional water quality facilities; salinity effectively managed; existing vegetation retained; habitat revegetation and ecosystem enhancement; maintaining surface hydrology; downstream discharge peaks and velocities limited to avoid scouring, siltation and flora and fauna impacts; soft bioengineering treatments to reflect natural stream functions; ecologically sustainable development; adopt principles of total catchment management and water sensitive urban design; conformance with statutory water quality requirements; maintenance of environmental flows and inundation patterns in creeks and wetlands; water quality elements are proposed to remove gross pollutants, nutrients and suspended solids from the urban catchments; stormwater quality treatments are provided off-line to significantly enhance water quality and aquatic ecosystems.

Urban Amenity

Limits of 1 % and 5% flood affectation within the release area can be defined and future development can conform with Council's requirements for freeboard and public safety; provision of aesthetic design forms that enhance urban amenity and address proposed adjacent landuses (residential, recreational and transport); views into and out of drainage corridors (security, public safety, amenity); water quality (visual amenity and public health); access to proposed bio-retention raingardens is provided; existing aquatic ecosystems are retained and protected and quality passive recreational amenity can be integrated with the concept for the incoming community.

Engineering Considerations

Proposed stormwater quality treatment devices are designed to conform to Council's technical requirements for performance and maintenance; effective management and control of peak discharges, discharge velocities and flood levels to pre-development and ecologically sustainable levels; industry best practice technical analysis of catchment hydrology and system hydraulic performance, soft sustainable bioengineering treatments; litter control structures are proposed in the urban areas to conform to Council's performance and maintenance requirements and enhance downstream water quality.

Economics

The stormwater management concept is functional, cost effective and optimises performance; keeps maintenance costs and requirements to an acceptable level; keeps land take to a minimum; provides maximum value for expenditure of public monies; focuses on ecological sustainability by delivering more than the minimum required technical and environmental performance; avoids environmental degradation and pressure on downstream and adjacent ecosystems; and provides for a 'soft' sustainable solution for management of stormwater at this location.

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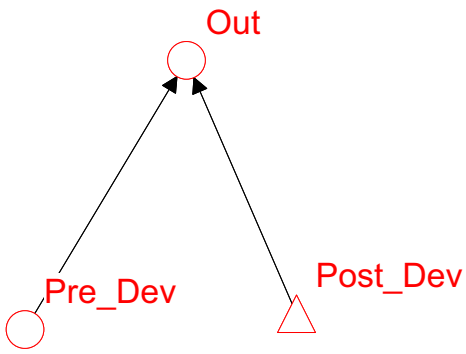
ATTACHMENT A

RAFTS-XP MODELLING RESULTS
EXISTING & DEVELOPED CONDITIONS
1.5 YEAR 60 MINUTE

ATTACHMENT A



EDMONDSON PARK 1.5Yr DETENTION SIZING

8183W\RAFTS-XP\8225ra_04.XP

ATTACHMENT A

8225ra_04(TypCatch1.out
Run started at: 28th September 2007 12:02:46

##
RUNTIME RESULTS
##

Max. no. of links allowed = 2000

Max. no. of routng increments allowed = 25000

Max. no. of rating curve points = 25000

Max. no. of storm temporal points = 25000

Max. no. of channel subreaches = 25

Max link stack level = 25

Input Version number = 650

LINK Pre_Dev 1.000

ESTIMATED VOLUME (CU METRES*10**3) = 1.182
ESTIMATED PEAK FLOW (CUMECS) = 0.31
ESTIMATED TIME TO PEAK (MINS) = 56.00

LINK Post_Dev 2.000

ESTIMATED VOLUME (CU METRES*10**3) = 2.341
ESTIMATED PEAK FLOW (CUMECS) = 1.70
ESTIMATED TIME TO PEAK (MINS) = 25.00

LINK Out 1.001

ESTIMATED VOLUME (CU METRES*10**3) = 3.525
ESTIMATED PEAK FLOW (CUMECS) = 0.77
ESTIMATED TIME TO PEAK (MINS) = 55.00

##
EDMONDSON PARK - Post-Development Catchment

Results for period from 0: 0.0 7/ 4/2002
to 5: 0.0 7/ 4/2002
##

ROUTING INCREMENT (MINS) = 1.00
STORM DURATION (MINS) = 60.
RETURN PERIOD (YRS) = 2.
BX = 1.0000
TOTAL OF FIRST SUB-AREAS (ha) = 12.50
TOTAL OF SECOND SUB-AREAS (ha) = 7.50
TOTAL OF ALL SUB-AREAS (ha) = 20.00

SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area (ha) #1	#2	Slope (%) #1	#2	% Impervious (%) #1	#2	Pern #1	#2	B #1	#2	Link No.
Pre_Dev	10.000	0.000	5.000	0.000	0.000	0.000	.050	0.00	.0643	0.000	1.000
Post_Dev	2.500	7.500	5.000	5.000	5.000	100.0	.025	.015	.0151	.0019	2.000
Out	.00001	0.000	.0010	0.000	0.000	0.000	.025	0.00	.0021	0.000	1.001

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	#2	Cont. Loss #1 (mm/h)	#2	Excess Rain #1 (mm)	#2	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Pre_Dev	28.700	15.00	0.000	2.500	0.000	12.117	0.000	0.3146	56.00	0.000
Post_Dev	28.700	15.00	1.500	2.500	0.000	12.117	27.200	1.701	25.00	0.000
Out	28.700	15.00	0.000	2.500	0.000	12.117	0.000	0.7679	55.00	0.000

ATTACHMENT A

8225ra_04(TypCatch1.out

SUMMARY OF BASIN RESULTS

Link Label	Time to Peak	Peak Inflow (m^3/s)	Time to Peak	Peak Outflow (m^3/s)	Total Inflow (m^3)	Basin Vol. Avail	Basin Vol. Used	Basin Stage Used
Post_Dev	25.00	1.701	45.00	.4630	2340.9	0.0000	1098.8	101.84

SUMMARY OF BASIN OUTLET RESULTS

Link Label	No. of	S/D Factor (m)	Dia (m)	Width (m)	Pipe Length (m)	Pipe Slope (%)
Post_Dev	1.0		.4300	0.000	20.000	0.2000

Run completed at: 28th September 2007 12:02:46

mik open 0