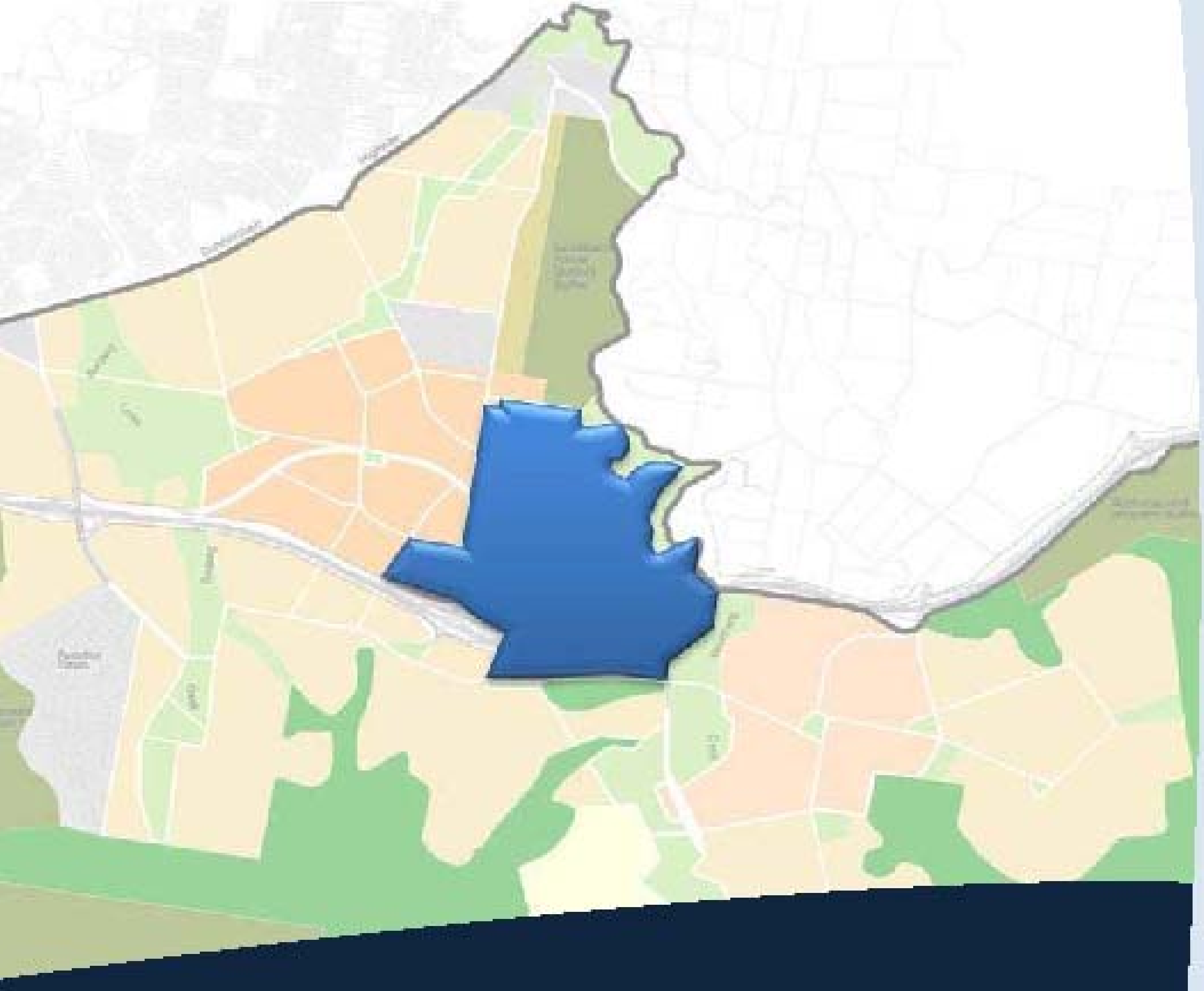

Ripley Valley: Urban Core (UC)

Neighbourhood Master Plan

Conceptual Stormwater Management Plan

CONCEPTUAL STORMWATER MANAGEMENT PLAN

RIPLEY VALLEY URBAN CORE

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REVISION STATUS

MPN Reference No:	5270
Client:	Sekisui House Development Services Pty Ltd
Site Address:	Ripley Road, Ripley Valley
Report Title:	Conceptual Stormwater Management Plan
Synopsis:	This report presents options for Stormwater Management and Treatment which would comply with the objectives of the Ripley Valley Stormwater Plan.

Document Control				
Version	Date	Author	Reviewer	Approved
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BACKGROUND

MPN has been commissioned by Sekisui House Development Services Pty Ltd to prepare a Conceptual Stormwater Management Plan for Sekisui House Landholdings in the Ripley Valley Urban Core. The subject land adjoins other properties which create a number of design constraints with regard to the finished land profile and extent of works which need to be considered in the design phase of the project.

The land is located within the Ipswich City Council local government area. As such, the planning control codes are set by Ipswich City Council and in particular "Planning Scheme Policy 3 General Works 2009" is applicable to the management of stormwater.

A Structure Plan for this project has been approved by the Minister for Planning and is known as "Ripley Valley Master Planned Area Structure Plan" and forms Part 15 of the Ipswich Planning Scheme. Council issued an RFI pursuant to the Neighbourhood Master Plan (NMP) Application lodged by Sekisui House. The previous issue of the CSWMP formed part of the NMP Application.

MPN has held meetings with Council in respect of its requirements for Stormwater Quality and Quantity and to clarify aspects of the RFI. As part of the RFI, it was requested by Council that the CSWMP be amended. MPN has prepared a separate set of responses relevant to the RFI on stormwater which Sekisui House will respond accordingly. MPN has amended this CSWMP pursuant to the RFI. This report presents conceptual solutions to stormwater quality management, conveyance and detention details to demonstrate compliance with Council's performance criteria for best practice stormwater management, and meet the water quality objectives set by Ipswich City Council. The report investigates suitable design principles for the Ripley Valley Urban Core and the implications for various stormwater treatment systems including detention and storage, harvesting and treatment for reuse, bioretention, water bodies and wetlands with respect to best management practices and sustainability.

The options in this report are presented to Sekisui House for consideration of which methodologies should be incorporated into the development to satisfy both the Authorities requirements and the Satoyama Philosophy of Sekisui House.

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1 OVERVIEW TO THE MANAGEMENT OF STORMWATER IN SOUTH EAST QUEENSLAND

1.1 WATER SENSITIVE URBAN DESIGN

At the development scale, WSUD is a planning and design approach that integrates water cycle management into the built form of houses, allotments, streets, suburbs, master-planned communities and structure plan areas. Its aim is to avoid or minimise the effects of development on the natural water cycle and environmental values by:

- Protecting and enhancing the intrinsic values of the natural water cycle by minimising disturbance to natural landforms, wetlands, watercourses and riparian zones
- Protecting the quality of surface and groundwater to maintain and enhance aquatic ecosystems and enable reuse opportunities.
- Reducing downstream flooding and the effects of drainage on aquatic ecosystems by managing stormwater runoff and peak flows.
- Promoting more efficient use of water by reducing the demand for potable water and encouraging use of alternative water supplies.
- Minimising the generation of wastewater and ensuring it is treated to a sufficient standard to enable the effluent to be reused and/or released into receiving waters.
- Controlling soil erosion during the construction and operational phases of development.
- Using stormwater to maximise the visual and recreational amenity of developments (e.g. by using it for landscaping) and to promote an understanding of water in the urban environment.

1.2 COMPLIANCE

The State Government and Local Authorities require the principles of WSUD to be applied to all new developments in SEQ and have introduced legislation to force new developments to comply and have also provided implementation and technical guidelines to assist developments to implement the principles of WSUD.

The required treatment of stormwater to comply with the principles of WSUD can be broken into two categories being stormwater quantity and stormwater quality.

1.2.1 STORMWATER QUANTITY

Generally any new development will increase the impervious area of the development site. This will therefore increase the peak stormwater runoff from the site. It is a requirement of WSUD that the peak stormwater runoff flow from a site post-development does not increase over the pre-development flow. This is to reduce downstream flooding and prevent erosion of downstream gullies and streams.

Some of the devices which can be used to meet the stormwater quantity requirements are listed below:

1.2.1.1 Stormwater Detention Basins

Stormwater Detention Basins control the rate of release of stormwater into downstream properties and waterways. Detention basins provide storage to allow flood waters to be released at a reduced rate downstream, thereby reducing downstream flooding and erosion of creeks and gullies.

Photo 1 - Detention Basin

1.2.1.2 Stormwater Detention Tanks

Stormwater detention tanks operate in a similar way to open basins, but by nature are usually located underground or within a building.

Photo 2 - Underground Detention Tank

1.2.2 STORMWATER QUALITY

Stormwater runoff from any site (developed and undeveloped) will contain pollutants from the site and from airborne deposits. It is required that the pollutants in the stormwater runoff from a developed site be reduced to a defined percentage of the pollutants in the stormwater runoff from the undeveloped site.

The reduction of the pollutants in the stormwater discharging from the site will protect the downstream aquatic ecosystems and prevent silting of downstream waterways. The required pollutant load reduction in the stormwater runoff is listed below:

Pollutant	Pollutant Load Reduction
Gross Pollutants	90%
Total Suspended Solids	80%
Total Phosphorus	60%
Total Nitrogen	45%

1.2.2.1 Stormwater Treatment Devices

There is a menu of stormwater treatment devices which can be incorporated into a development to reduce pollutants (sediment, nitrogen, phosphorus) from the stormwater runoff. Some of the available stormwater treatment devices are listed below:

1.2.2.1.1 Rainwater Tanks

On site rainwater harvesting tanks capture rainfall for reuse for airconditioning cooling towers external cleaning, toilet flushing and irrigation purposes. These tanks will reduce the amount of treated potable water drawn from Council's water mains, but do not reduce stormwater detention requirements as they are a retention device without additional capacity for detention.

Photo 3 - Domestic Rainwater Tank

1.2.2.1.2 Sediment Basins

During the construction of any development, sediment basins, sediment fences and diversion drains are installed to control and minimise the release of sediment from the site into downstream drainage system.

Photo 4 - Sediment Basin

Sediment basins may also be used post construction to treat coarse and fine sediments.

1.2.2.1.3 Swales and Buffer Strips

A swale is a shallow channel lined with vegetation. A buffer strip is a vegetated slope. Treatment is provided by infiltration to the soil and by filtration of sediment during shallow flow through the vegetation.

Photo 5 - Grassed Swale

Photo 6 - Buffer Strip & Swale

1.2.2.1.4 Bioretention Swales

Bioretention swales incorporate a vegetated infiltration trench within the invert of the swale. The infiltration trench enhances removal of pollutants, which are removed biologically as the stormwater percolates into the trench. The treated stormwater is collected by under-drains which are connected to the stormwater system.

Photo 7 -Bioretention Swale

1.2.2.1.5 Bioretention Basins or Garden

A bioretention basin is a vegetated bed of filter material. Captured stormwater runoff drains through the filter media. Pollutants are removed by filtration and biological uptake of nutrients. The soil "filter" must meet the FAWB Specification for SEQ to achieve suitable nutrient uptake whilst not leaching additional nutrients during the establishment phase or upon longer term dry periods. These basins usually have a holding storage capacity of up to 300mm of water depth to allow filtration to occur over a few hours. The plants selected need to be tolerant of this inundation. The treated stormwater is removed by under-drains which are connected to the stormwater system. There are three types of bio-retention devices being pods, gardens and basins, as shown in the following photos.

Photo 8 - Bioretention Pod

Photo 9 - Bioretention Basin/Garden

Photo 10 - Bioretention Basin

The difference between a pod, garden or basin is one of increasing scale – the treatment process is the same in each.

1.2.2.1.6 Constructed Wetlands

Constructed wetlands are shallow, vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater.

Photo 11 - Constructed Wetlands

1.2.2.1.7 Sand Filters

A sand filter is a sand layer designed to filter fine particulates from stormwater before discharging to a downstream drainage system. Council has advised that Sand Filters are not acceptable, but is presented for completeness of potential options available.

Photo 12 - Sand Filter

1.2.2.1.8 Gross Pollutant Traps

In Australia, gross pollutants are defined as anthropogenic litter greater than 5mm in size. Gross Pollutant Traps retain gross organic and man-made litter washed from urban surfaces. They rely on physical screening rather than flow retardation to remove litter.

Photo 13 - Litter Basket type - Gross Pollutant Trap

Photo 14 - Example of a Humeguard (under construction)

Photo 15 - Inside a Humeguard showing trapped Pollutants

Photo 16 - Induct Truck at a Humeguard GPT during waste removal

Various manufacturers produce GPT's which are assembled on-site and are relatively easy to maintain. GPT's can also be purpose built for a site.

1.2.3 STORMWATER TREATMENT TRAIN

Stormwater can carry a wide range of pollutant types and sizes. This range of potential pollutants means no single measure can effectively treat all pollutants carried by stormwater and a combination of stormwater devices is required to reduce pollutants to acceptable levels. The devices are combined to provide a treatment process for the stormwater as it passes each of the devices in turn. Some stormwater devices are better able to remove certain pollutants than others and the removal effectiveness is dependent on their relative location to each other in the treatment train.

A simple stormwater treatment train for a large development is represented diagrammatically below in Figure 1:

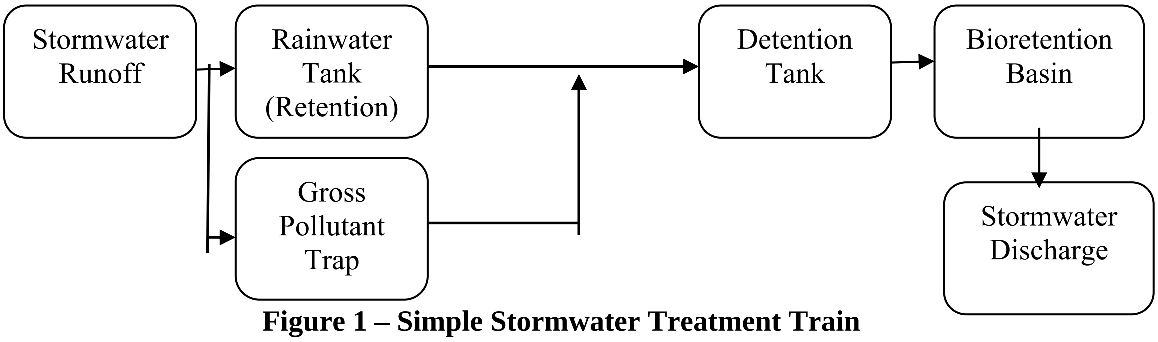


Figure 1 – Simple Stormwater Treatment Train

Whilst this diagram shows the relative sequence of treatment, the flow routing requirement is more complex as only the 1 in 3 month flow (“low flows” in the diagrams) are targeted by the stormwater quality treatment devices as the level of pollutants is significantly diluted in higher flows.

The exception is storage devices such as the rain water tank and detention tank.

The treatment can be either “at source” (on an adjacent to the development) or “end of line” where the discharge from a number of developments is conveyed to the central treatment point just prior to the outlet.

1.2.3.1 “At Source” Treatment

At Source treatment trains are presented in greater detail in the following diagrams, which are representative for a residential site (Figure 2) and a commercial site (Figure 3).

These diagrams need to be considered in terms of the whole development as the "at source" or micro-treatment diagrams. For example they represent how each "house lot" and each "commercial lot" could be treated.

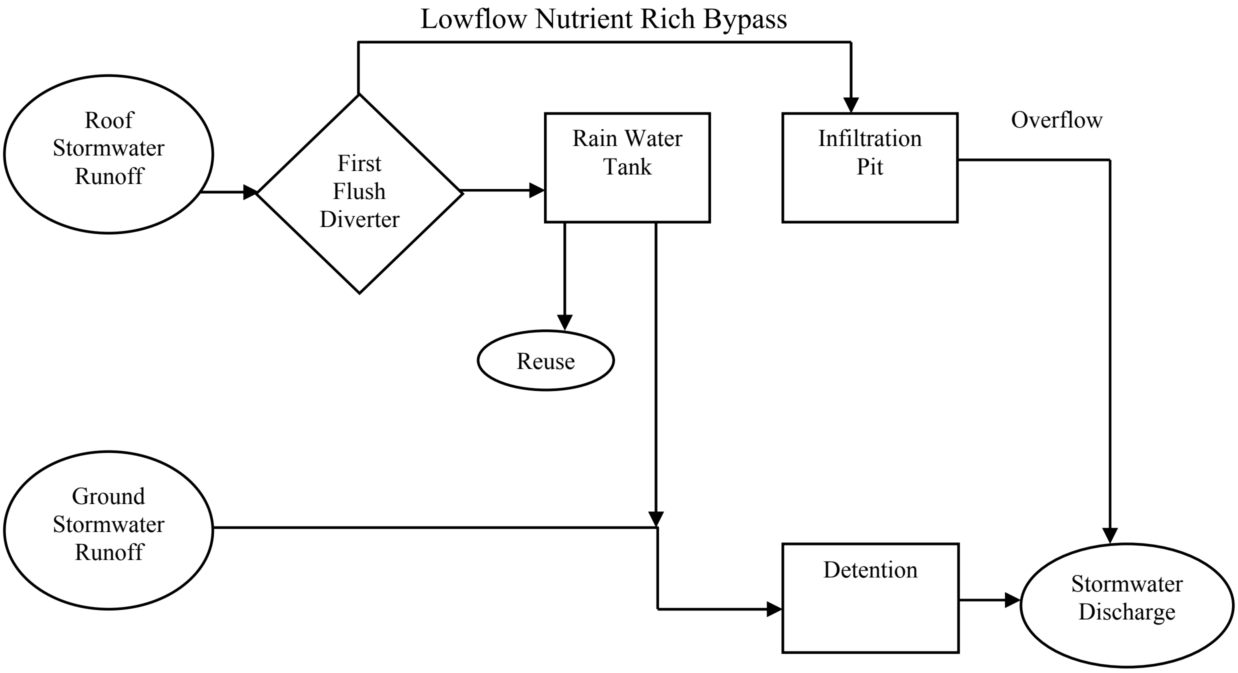


Figure 2
"At Source" single House Site Treatment Flow Chart

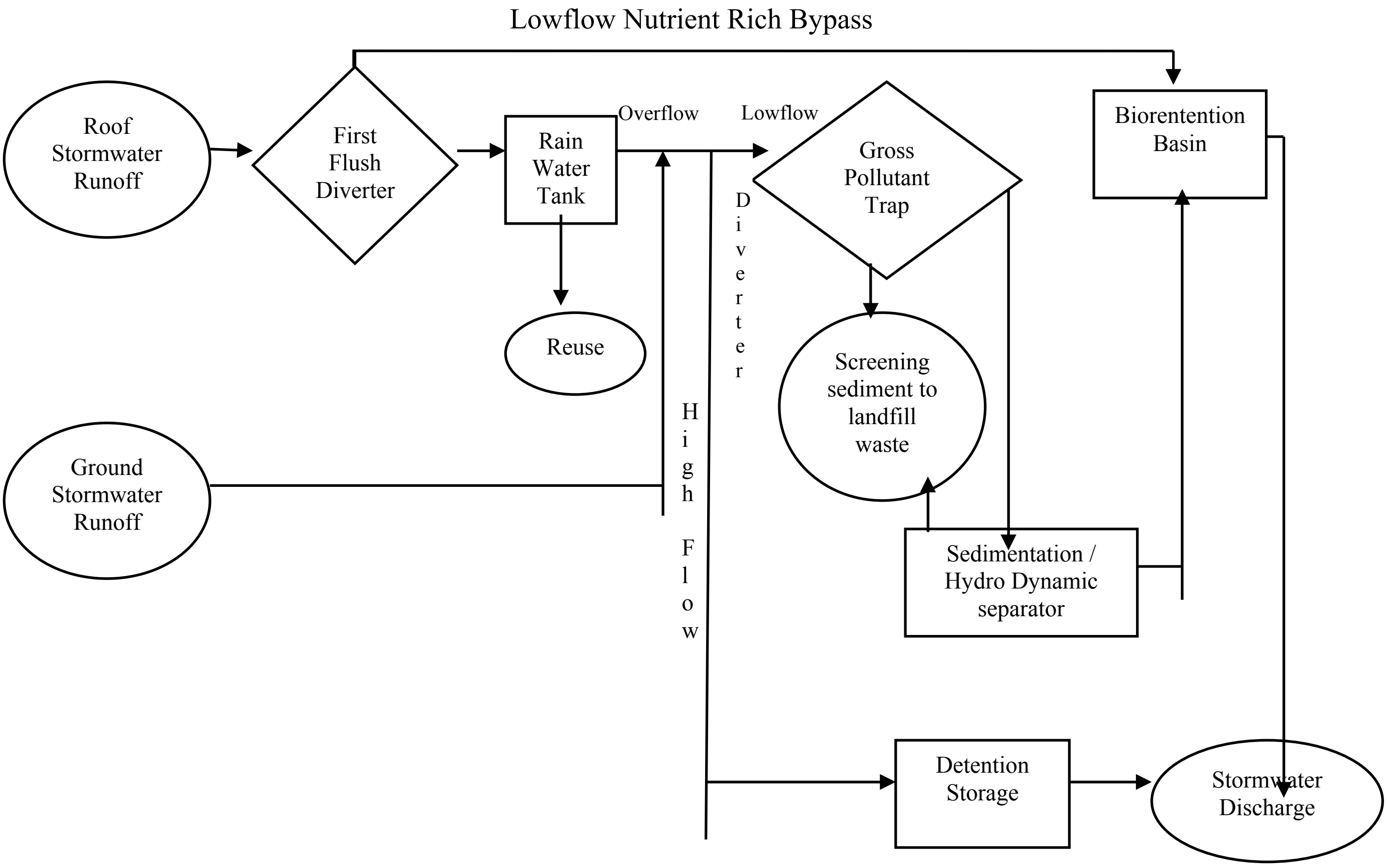


Figure 3
"At Source" single Commercial Site Treatment Flow Chart

It is with these flow charts in mind that a suitable treatment train is designed, based on simulation modelling of standardised pollution flows over a representative 10 to 15 year period to demonstrate compliance with discharge targets. The treatment train may include "at source" scale treatment, "end of line" scale treatments or a combination.

1.2.3.2 "End of Line" Treatment

"End of line" treatment requires consideration of catchment areas and the allocation of land which will enable treatment of the final form of the development.

"End of line" treatment devices could consist of a sediment basin or pond, a gross pollutant trap, and a bioretention device or constructed wetland.

During construction, the protection of these devices is particularly important whilst the treatment devices become established and functional. Otherwise the sediment will bury the plants which provide the treatment environment for the stormwater.

During preliminary design, the locations of these devices will be assessed to balance catchment sizes with the available area within public reserves and waterways to allow treatment. The flow routing necessary for these devices to work effectively will require land shaping and integrated hydraulic structures to separate the 1 in 3 month design flow (for treatment) from the main stormwater flows.

On a "end of line" scale, wetlands become a suitable treatment option as a catchment of at least 10ha is required to sustain a wetland at Ripley. Other options such as bioretention basins, gross pollution traps and swales area also suitable for "end of line" treatment.

In terms of catchments, the relative area required for a "end of line" bioretention basin is 1.25% of the residential catchment contributing and 1.5% of the commercial area contributing. For wetlands, the area required for its location is 5% of the catchment area contributing to it. The advantage of a wetland over a bioretention basin is that the "pond" portion can be used for detention purposes as well to regulate flows. As most detention basins are about 3 to 4% of the catchment area contributing, then a bioretention basin and separate detention basin would also require about 5% of the contributing catchment for their respective locations.

A flow chart for an "end of line" bioretention basin (Figure 4) option and another for a wetland option (Figure 5) are shown below.

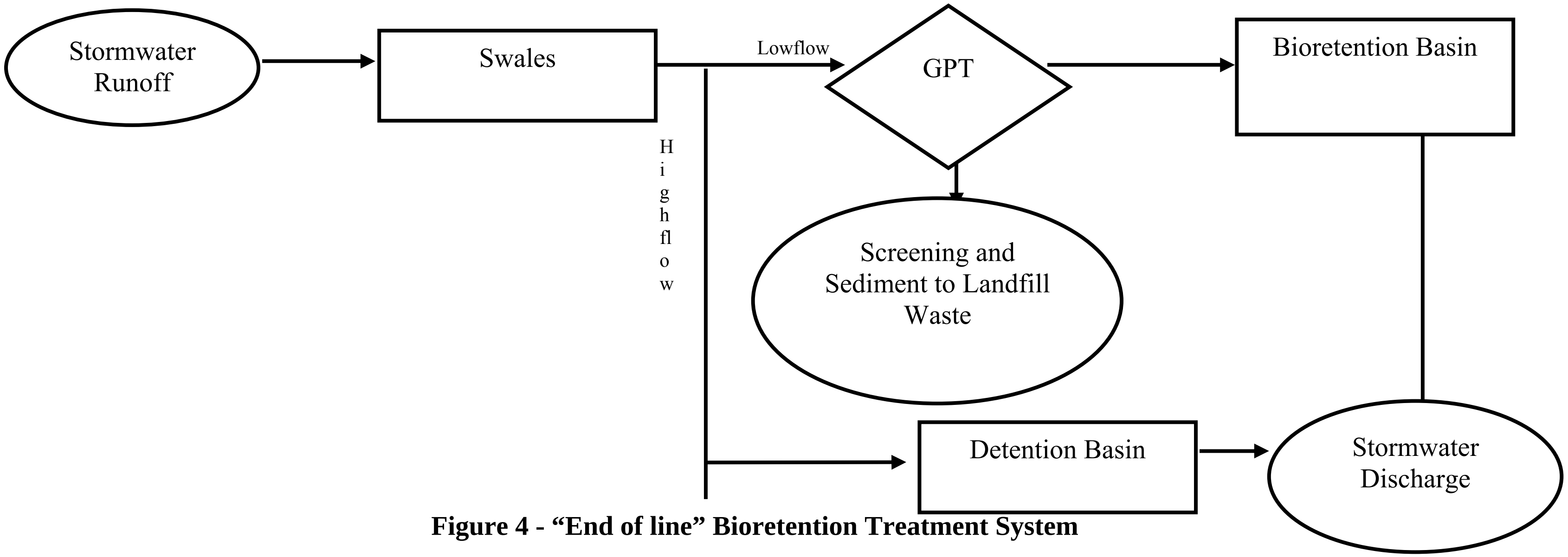


Figure 4 - "End of line" Bioretention Treatment System

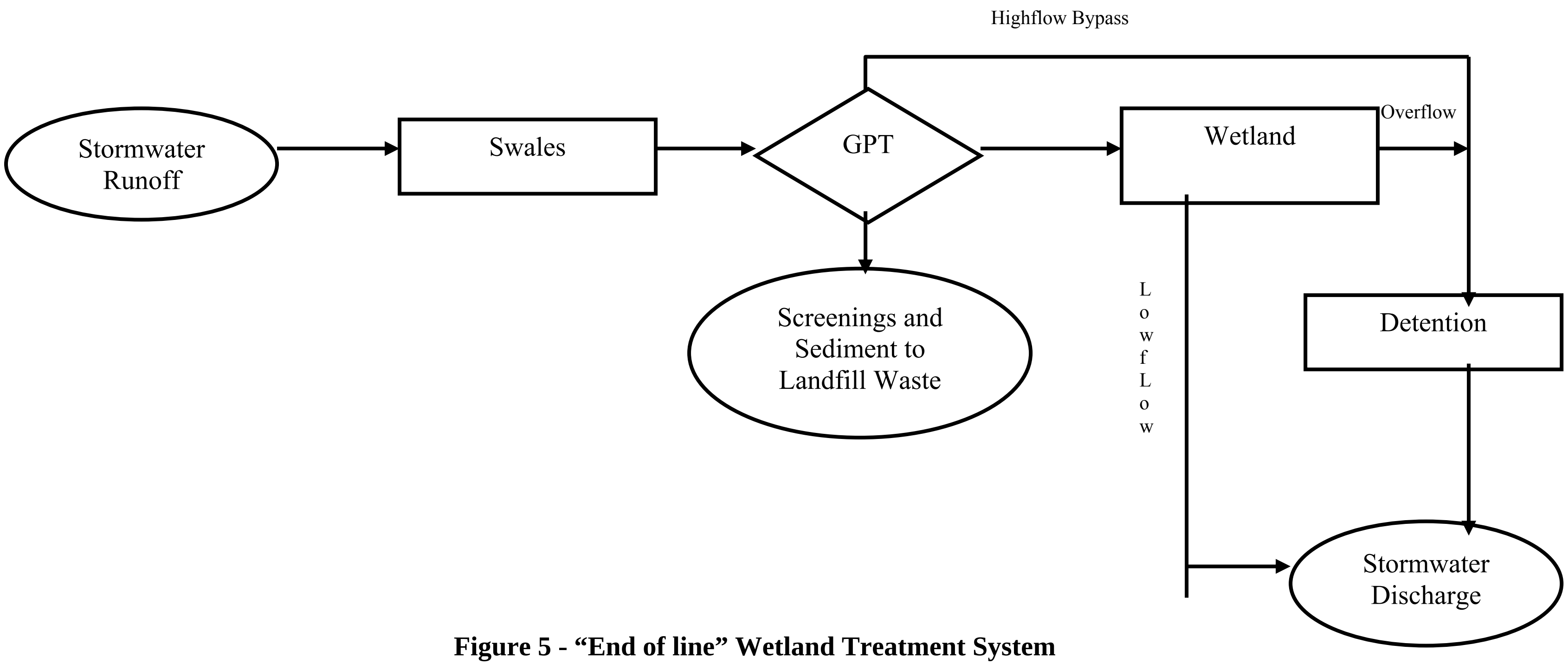


Figure 5 - "End of line" Wetland Treatment System

2 PLANNING AUTHORITIES – JURISDICTION AND STANDARDS

The Ripley Valley Urban Core includes land owned by Sekisui House and is located within the Ipswich City Council local government area. The planning control code applicable is "Part 12 – Assessment Criteria for Development for a Stated Purpose or Of a Stated Type - Division 5 Reconfiguration of a Lot" of the Ipswich Planning Scheme. This part 12 includes traditional neighbourhood land development of the type proposed for Ripley Valley.

The Ripley Valley Structure Plan requires the implementation of WSUD and it is necessary to demonstrate compliance with the new state planning policies for WSUD.

2.1 QUEENSLAND GOVERNMENT – SOUTH EAST QUEENSLAND IMPLEMENTATION GUIDELINES NUMBER 7 (SEQIG7)

The state government has approved a new South East Queensland (SEQ) Regional Plan which is effective from late 2009. The Queensland Department of Infrastructure & Planning (QDIP) has also issued the South East Queensland Regional Plan 2009-2031 Implementation Guideline No. 7 (SEQIG7) which defines the compliance parameters required for development work in respect of WSUD. These overarch the Ipswich Planning Scheme policies and advice from John Rush who is the Manager, Resource and Landscape Planning Specialist and Infrastructure Planning - Planning Group of QDIP is that "demonstrating compliance with the SEQIG7 is taken by QDIP and Department of Environment & Resource Management (DERM) as meeting the requirements of the relevant policies for Urban Water Quality and Stormwater Management Strategies under their jurisdiction".

The Design Objectives for Stormwater Management from the South East Queensland Regional Plan 2009-2031 Implementation Guideline No. 7 (SEQIG7) for water quality and waterway health as referenced therein is:

1. Frequency of Urban Stormwater Flows for In-stream Ecology protection
2. Magnitude and duration of Urban Stormwater Flow for Waterway Stability
3. Loads of Sediment, nutrient and litter in Urban Stormwater for Environmental Protection (Water) Policy compliance

In addition to the above three requirements other aspects of water management which form part of WSUD best management practice are also referenced by the SEQIG7:

1. Control of sediment and erosion
2. Flooding
3. Conservation of potable water
4. Protection and management of riparian corridors
5. Environmentally relevant activities
6. Reuse of grey water

Through the implementation of a suitable Stormwater Management Plan, items 1-7 can be achieved with proper design in consultation with Sekisui House and I.C.C. Consideration may also be given to grey water treatment and storage tanks in accordance with Queensland Development Code (QDC) planning guidelines and, subject to plumbing approval by ICC, used for sanitary flushing, laundry use (cold water only), vehicle washing, and path/wall washdown.

No environmentally relevant activities are proposed within the development and the re-use of grey water is not within the scope of this report.

The conservation of potable water is to be achieved by stormwater harvesting and the provision of a recycled water main. Dual water supplies have been discussed with ICC and it is proposed to install a recycled water main within the commercial districts and within community areas. Council has advised that the grade of water will be A+ quality and thus suitable for "contact" uses such as water features, wash down and cleaning, irrigation etc. If grey water treatment is considered, compliance requirements are specified in the Queensland Wastewater Code (QWC). Grey water use could be considered during the design phase if rainwater harvesting or recycled water supplies are insufficient to meet demand.

Planting of native vegetation to reduce water demand should also be incorporated into the design of the estate.

2.2 IPSWICH CITY COUNCIL PLANNING SCHEME POLICY 3 (ICC PSP3)

ICC PSP3 requires temporary methods of Water Quality Control during construction to comply with Best Management Practice. Advice from Aaron Katt, Senior Engineering Officer is that ICC requires Erosion and Sediment Control Management Plans to comply with the Erosion and Sediment Control Manual recently released by the International Erosion Control Association. This requires the Stormwater Quality Management Strategy to address establishment, maintenance and removal of the temporary treatment measures.

For permanent methods of Water Quality Control, ICC requires the above controls to occur together with compliance with the Water Sensitive Urban Design Technical Design Guidelines (WSUD TDG) prepared by Healthy Waterways.

2.3 RIPLEY VALLEY STRUCTURE PLAN (RVSP)

2.3.1 RIPLEY VISION

Ripley Valley located 5km south-west of Ipswich, will be home to over 120,000 people, housing 10% of South East Queensland's population growth over the next 20 years, providing education, employment and recreation facilities.

The Valley's natural open space will be enhanced to allow the local community to enjoy the area's environmental values, and in the Urban Core Sekisui House will enhance this approach by the incorporation of Satoyama Principles.

2.3.2 ENQUIRY BY DESIGN

The master planning process for the RVSP included an Enquiry by Design (EBD) which involved almost five months of investigation and consultation by the Ripley Valley Master Planning Group (the consultancy team) involving:

- data collection, collation and review;
- plan manipulation and preparation;
- meetings with Council, the Ripley Valley Master Planning Task Force, community groups and land holders;

- establishment of the Ripley Valley Community Reference Group; and
- meetings with State Agencies and Ipswich City Council technical officers.

The EBD process culminated in an intensive seven day workshop from 19 July 2006 to 25 July 2006 where the design team addressed the specific issues of:

- Regional, District & Local Planning Framework;
- Infrastructure, Water Cycle & Servicing;
- Environment & Ecology;
- Open Space & Recreation;
- Housing, Building Types & Architecture;
- Transport & Traffic;
- Community Infrastructure; and
- Employment & Retail.

The outcomes from the EBD were documented in the Ripley Valley Enquiry by Design Report and formed a basis for the Ripley Valley Structure Plan.

2.3.3 IPA PLANNING SCHEME AMENDMENT

Ipswich City Council, together with the Queensland State Government and developers Amex Corporation, Investa, and a consortium under the umbrella of Ripley Valley Holdings, united to develop a Structure Plan for the Ripley Valley. The Ripley Valley Structure Plan together with the Master Planning Framework and Planning Report was the initial step in the process of preparing an amendment to the South East Queensland Regional Plan and subsequently an IPA Planning Scheme amendment for Ipswich to be known as Part 15 of the Ipswich Planning Scheme. At its meeting of 12 December 2007, Ipswich City Council resolved to adopt the Structure Plan - Outline, Regional and Local (Volume 1) and the Master Planning Framework - Planning Report (Volume 2). The Ripley Valley Structure Plan was finally gazetted in September 2009 and governs the basis for development in Ripley Valley.

2.3.4 WATER MANAGEMENT UNDER RVSP

The **Ripley Valley Structure Plan** (RVSP) requires the following outcomes for water management:

"Functional Valley - Specific Outcomes

(a) The Ripley Valley provides an integrated water cycle management solution that protects, maintains and enhances the natural functions and environmental, social and economic values of the area's waterways, wetlands, riparian corridors and floodplains.

(b) An effective, efficient and integrated water cycle management solution ensures that—

(i) there is no worsening of flooding downstream of catchments;

(ii) stormwater discharges are managed to ensure the control of in-stream erosion and bank stability of unlined gullies;

(iii) any proposed filling or channel works is assessed against the current base case model; and

(iv) water is treated as a valuable and finite resource to be managed on a total water cycle basis.

(c) The Structure Plan achieves Integrated Water Cycle management through—

(i) the application of Water Sensitive Urban Design by—

(A) ensuring the treatment of stormwater runoff and protection of stream geomorphology (low flows and high flows) in accordance with best management practices;

(B) the implementation of a subregional approach to the siting of detention basins, in accordance with Figure 15.13 (below);

(C) minimising the impact of development upon flow rates within and downstream of catchments;

(D) siting and constructing water quality treatment devices to maximise bio-retention and bioextended retention.

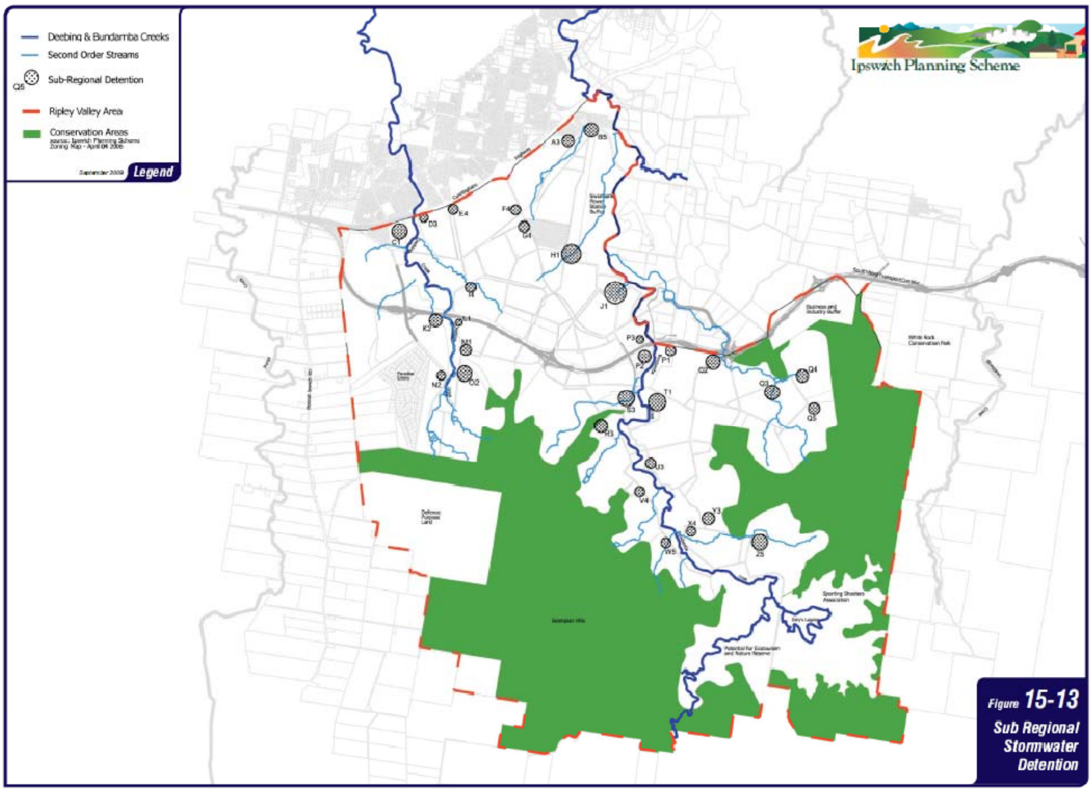


Figure 6:RVSP Figure 15-13.

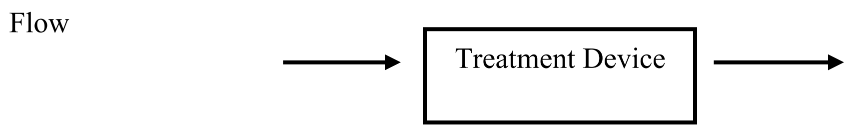
2.3.5 IMPLICATIONS OF RVSP ON THE DEVELOPMENT

It is a requirement of the RVSP to treat the runoff from development areas that discharge to designated second order streams. Further, such treatment shall be in accordance with the Water Sensitive Urban Design Technical Design Guidelines. It is also incumbent within the structure plan that builders comply with Part 25 of the Queensland Development Code for the provision of Rainwater Tanks.

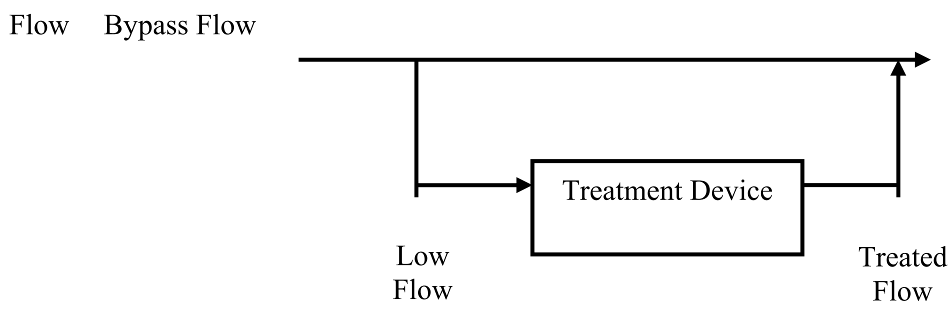
The RVSP seeks to maximise the use of bio-retention and bio-extended retention. Such devices are effective nutrient removers and when used as basins can strip sediment from the stormwater. However, when used "on-line", re-suspension of nutrients and sediment can readily occur and reduce removal performance and increase maintenance costs (the latter especially so during the establishment phase). The preference of I.C.C. therefore is to utilise "off-line" treatment as much as possible.

Diagramatically, the "on-line" and "off-line" locations of a treatment device is represented as follows:

"on-line":



"off-line":



The use of centralised or "end of line" bio-retention basins within detention basins was recommended in the Engineering Masterplan Report. Subsequent liaison with Council's Environmental Division has identified a number of constraints to this type of "on-line" location. These are:

- Depth of inundation of plants in the bio-retention zones is not to exceed 300mm
- Time of inundation of plants in the bio-retention zones is not to exceed a few hours.
- The treated storage volume (3 month flow from the catchment) is not to be mixed with "follow on" flows.

Therefore "off-line" treatment areas are required for bio-retention basins which means that the opportunity to achieve dual purpose use of bio-retention basins within detention basins is not suitable, nor optimal in terms of achieving the long term water quality targets (particularly for storms greater than the 3 month flow events).

Sub-regionally, "off-line" bio-retention basins or bio-swales can be used to pretreat stormwater prior to discharging into the drainage system. In essence the treated volume of water is passed via the subsoil drains from the bio-retention system a few hours after the storm has passed. Flows in excess of the 1 in 3 month storm flow / volume will bypass the entry of the bio-retention and pass directly to the drain drainage channel or gully / pipe system as appropriate to its location.

This is discussed further under Section 4.4

3 DESIGN OUTCOMES

The purpose of a Stormwater Management Plan is to identify the components of a Stormwater Treatment Train that can be constructed as part of the proposed development which will:

- Prevent or minimise adverse social and environmental impacts from stormwater runoff originating from the proposed development.

- Achieve acceptable levels of stormwater runoff quality and quantity by applying water sensitive urban design principals with the development of the site.

As mentioned in the overview (Section 1), legislation has been enabled which requires compliance by the development in terms of stormwater management. The specific requirements for compliance are discussed in Section 2.

The fundamental framework for achieving these requirements, and which ultimately will "shape" the stormwater treatment measures whilst complying with Best Management Practices, is the Ripley Valley Structure Plan, discussed in Section 2.3 of this report.

This report aims to identify Stormwater Quality Best Management Practice options for the development and demonstrate that water quality impacts will be minimised in receiving waters.

4 DESIGN CONCEPTS

4.1 CRITERIA

ICC PSP3 – Part 2 Standards for Design of Stormwater Drainage Works requires that design parameters are to comply with those listed in Part 12 Division 5 of the Ipswich Planning Scheme and Queensland Urban Drainage Manual (QUDM), and the following performance criteria:

- Drainage reserves are to be established over downstream drainage paths or written approval from all the affected property owners is required from the development site to the point of discharge.
- Detention is required where the downstream system does not have adequate capacity to convey the increased discharge.
- The minor drainage system is to be piped throughout the development and accommodate existing and proposed future flows from upstream catchments.
- The stormwater pipes are to be located under the kerbs.
- Overland flow paths are to be provided at all sag points in roads.
- Inter-allotment drainage is required where lots are lower than the roadway or should the runoff cause nuisance e.g. on large lots with high imperviousness, or in highly built up commercial areas.
- Comply with Stormwater Quality Best Management Practices

Water quality objectives for both temporary and permanent methods of water quality control must control the following pollutants:

Water Quality Pollutants	
During Construction	
Litter	Paper, construction packaging, food packaging, cement bags, off-cuts.
Sediment	Unprotected exposed soils and stockpiles during earthworks and building.
Hydrocarbons	Fuel and oil spills, leaks from construction equipment.
Toxic materials	Cement slurry, asphalt prime, solvents, cleaning agents, wash waters (e.g. from tile works).
pH altering substances	Acid sulphate soils, cement slurry and wash waters.

Water Quality Pollutants cont.	
Post Construction	
Nutrients	Nitrogen, Phosphorous, Carbon (leaf litter)
Litter	Anthropogenic litter and sediment
Suspended Solids	Suspended fine and course sediment
Chemicals	Hydro-carbons, heavy metals, surfactants and pathogens

Water quality objectives for both temporary and permanent methods of water quality control must meet the following WQOs:

WQO Target	Reduction
Gross Pollutants	90%
Total Suspended Solids	80%
Total Phosphorous	60%
Total Nitrogen	45%

In addition to these treatment criteria, it is necessary to meet two other criteria of Queensland Department of Infrastructure and Planning (QDIP):

- Frequent Flow Management; and
- Waterway Stability

It will be demonstrated in the following sections that the use of rainwater harvesting tanks achieves the Frequent Flow Management criterion. Further, it will be demonstrated that by satisfying the requirement to not increase peak runoff for all storm events from 1 to 100 year storms, the Waterway Stability criterion is also achieved.
During the detailed design phase a site based stormwater management plan will be prepared that demonstrates compliance with the performance criteria of PSP3 and SEQIG7. This can be achieved by incorporating a selection of treatment devices from the following list:

- Sediment ponds and wetlands which double as a water feature for recreational purposes for sediment and nutrient removal
- Detention devices for sediment removal and to reduce impact of erosion downstream.
- Bio-retention filters with extended detention to reduce sediment and nutrients.
- Buffer strips to reduce sediment.
- Grass swales where suitable to reduce nutrients and facilitate transport of external overland water flows.
- Gross Pollutant Traps to trap floating gross pollutants at the discharge point such as
    - Humes' "Humeguard",
    - Rocla's "Cleansall" or "CDS", and
    - Ecosol's "RSF100" or "RSF1000" series devices.
- Proprietary oil and grease trapping devices such as:
    - Roclas' "First Defence" and "Downstream Defender"
    - Humes' "Humeceptors" and "Hydrofilters"
    - Ecosols' "RSF4000" or
    - SPEL's "Stormceptor".
- Rainwater tanks on each building in accordance with Queensland Development Code (QDC) planning guidelines including rainwater harvesting for toilet flushing, irrigation of landscaped areas and other external uses plus subject to plumbing approval by ICC, use in air conditioning condensers.

Hydrodynamic separators such as the Humeceptor can reduce oil and grease, sediment, suspended solids and non-floating gross pollutants. Where used, a suitable trash rack pit should be used upstream to trap floating debris.

This report presents the conceptual approaches for stormwater management which can achieve these criteria in principle. The selection of the final components and their format is subject to joint consultation by Sekisui House and I.C.C. The performance of the treatment measures selected has been analysed in the program "Model for Urban Stormwater Improvement Conceptualisation" (MUSIC) and this is discussed in section 6.0 titled "Stormwater Quality Management Strategy".

4.2 EXISTING SITE AND CONTEXT

The existing site is located within a 410 Ha area of land fronting Bundamba Creek along its Eastern and Northern boundary, Fischer Road and Wensley Road to the West and extends about 400m South of the newly opened Centenary Highway extension. The site is affected by a number of external catchments to the West and South West and the 1 in 100 year flood line for the site has been extracted from the Bundamba Creek Flood Study prepared for Council in 2008. Drawing 5270-SW1 in Appendix 1 shows the flood line extents, catchments and conveyance flow paths.

The legal point of discharge for the site is Bundamba Creek which is located east of Ipswich, and flows into the Bremer River approximately 3km upstream of the Warrego Highway crossing. Bundamba Creek has a total catchment area of is 110km^2.

The Bundamba Creek catchment (of which Ripley Valley Urban Core forms part) is used mainly for rural purposes with a few rural residences and is currently characterised by large grassed floodplains. Bundamba Creek is located within a densely vegetated meandering channel of about 50 m width and 5 m depth.

Photo 17 – Bundamba Creek Downstream of Centenary Highway Extension

A number of water courses divide the Ripley Urban Core into 3 catchments and the photo below depicts a typical water course within the site.

Photo 18 - Ripley Valley - Undulating Slopes and Landuse Setting showing water course downstream of Ripley Road.

Photo 19 - Ripley Valley – Watercourse upstream of Ripley Road

The topography consists of undulating low hills with a cross slope to the water courses up to 10%. The watercourses slope up to about 8% in the upper reaches and flatten out to about 2% in the lower portions of the site, and enter a flat plain less than 1% prior to discharging into the Bundamba Creek.

The site is not heavily treed and the soils are predominantly dispersive clays. Ground water springs occur in a few low lying areas.

4.3 PROPOSED DEVELOPMENT

The Ripley Valley Urban Core involves the creation of a Peoples Place with construction of residential housing, commercial and retail centres, bulky goods stores, a town centre and community facilities. The physical works will entail lot reconfiguration works, services and infrastructure works, buildings, roads, trunk drainage channels, new services and community facilities, detention basins incorporating water features and landscaping.

The development will incorporate WSUD principles within the design that minimises the demand for water supply and reduces runoff, whilst providing stormwater quality improvement by reducing pollutants and nutrients from entering the waterways, and reducing erosion to protect the aquatic ecosystem.

4.4 PROPOSED SITE DRAINAGE PRINCIPLES

There are three major catchments which drain through the development site as indicated in drawing 5270-SW-1 located in Appendix 1.

1. A northern catchment that includes the proposed first release residential development areas.
2. A central drainage path that bifurcates to the west of Ripley Road and includes a small catchment south of the Centenary Highway.
3. A southern drainage path that runs under and along the Centenary Highway and then passes back to the south of the Centenary Highway near the Ripley Road intersection and west of Bundamba Creek.

Preliminary analysis of the three catchments provide the following calculated results for the existing Terrain Model:

Catchment	Q100 Flow	Time of Concentration
North	$2.9m^3/s$	63mins
Central	$81.6m^3/s$	94mins
South	$26.1m^3/s$	64mins

4.4.1 SEDIMENT BASINS DURING CONSTRUCTION

Sediment basins will be needed during construction for all operations where disturbance of site area greater than 1ha occurs, or where soil testing identifies dispersible soils.

The size of the basins is related directly to the amount of exposed earth.
Inspection of the site reveals evidence of significant erosion upstream and downstream of culverts which indicate dispersible soil characteristics. Even gentle (<3%) grades have scour occurring in table drains, and road shoulders.

The worst case scenario is if all the earthworks operations are completed at once. Upon exposure the site should be grassed to reduce the risk of erosion. Once the grass is established, smaller basins will be required for subsequent operations. In addition, contour banks can be used to act as small sediment basins which will reduce the load on the main basins. Excavation of the whole site initially will require a significant maintenance program over the construction life of the project. The sequencing of construction or staging will affect the size and location of sediment basins.

Development of the project starting from lower parts of the site and working towards the ridges, while beneficial for quantity mitigation, places a higher cost on initial developments to provide for future stages. This method will usually require a permanent sediment basin at the drainage outlets for the construction life of the project. Proprietary GPT’s should be used to control developed areas, and not be placed where future development will cause overload by sediment flow. Alternatively sequential basins can be built within each stage.

Should the program for the development proceed from the ridges to the valley, then conversely smaller basins can be used and less re-establishment of site areas is required.

Construction of sediment basins can be located and configured such that they can be converted to permanent detention basins in the final operating phase.

These alternatives will need to be further considered during the design phase, and are applicable during each phase of the development.

4.4.2 STORMWATER DETENTION

The nature of developments creates increased runoff rates and volumes.

Ipswich City Council Planning Scheme Part 15-3 Ripley Valley requires that the "development shall cause no worsening of flooding downstream of catchments" and that an "end of line" approach should be taken for the siting of detention basins to control and mitigate the impact of development."

The RSVP figure 15-13 is reproduced as Figure 6 in this report and suggests that there are two detention basins to the north of the Centenary Highway and one to the south of Ripley Road/Centenary Highway interchange. This provides two detention bodies for an area of 365ha. Based on site catchment areas, the main detention basin would have a catchment of 320ha which would require an area of 10ha with storage of 1.5m depth. A feature of this size would best be formed by a permanent lake. However, this itself would present significant maintenance issues and does not optimise the topography in the detention locations proposed in the RVSP. Council has advised that it prefers a series of open space areas along the original drainage paths with the intent on providing smaller "cascading" detention basins that better fit the landform and development constraints. The "end of line" stormwater treatment and flood mitigation measures need to be incorporated within these alignments.

Drawing 5270-SW2 in Appendix 1 shows the catchments for the developed site.

Drawing 5270-SW3 in Appendix 1 shows a layout of sequential detention basins and the location of stormwater treatment devices. Individual site based detention for residential lots is not proposed.

The requirement for Waterway Stability will also be achieved by providing the detention to meet flood mitigation constraints with the provision of detention. The detention requirements of PSP3 require that the post-development flow does not exceed the pre-development flows for flood control as per QUDM. More specifically, the 1 in 1 year peak flow post-development will not exceed the pre-existing flow rate (ARI = 1, Duration = 60 minutes) within the ephemeral creeks as part of the QUDM requirements and therefore comply with the Waterway Stability criterion of SEQIG7 and the WSUD TDG.

To demonstrate compliance with Waterway Stability, Healthy Waterways recommend the use of a runoff routing program. MPN has analysed the concept design based on Transect Densities for the Urban Core. The results contained in the table belowdemonstrates compliance as all the flows are less than 47.7 cum/s:

Duration	5	10	20	30	60	Min
Flow	8.95	17.2	26.4	29.4	47.6	Cum/s

4.4.3 PERMANENT STORMWATER TREATMENT DEVICES

To achieve an effective water management system, stormwater drainage should be planned integrally with the stormwater treatment system. This will protect each segment from disturbance by subsequent development construction discharges and can be achieved by planning stages that move linearly along the main discharge valleys.

This does not mean development has to necessarily be sequential, but that the discharge from each stage should be independent of upstream discharges and this is achieved by having stormwater treatment for each stage "off-line" from the main trunk flow paths.

The Ripley Valley structure plan provides that the technical Design Guidelines for WSUD shall be used, which in turn requires primary (coarse sediment and litter) treatment for first-order streams, and tertiary treatment (fine sediment and nutrients) to second order streams. The diversion of the drainage system to "off-line" treatment lends to the application of this directive. Bio-retention swales and basins are tertiary treatment devices and provide the most effective removal of pollutants.

Bio-retention swales are suitable for street scale measures and bio-retention basins are also suitable for allotment scale measures and these measures are suitable to gentle sloped areas (slope <4%).

4.5 QUALITY TREATMENT PHILOSOPHIES

The required Stormwater Treatment Train can be provided by either:

- At source control and treatment
- "End of line" treatment

"At Source" relates to the method whereby the devices which form the treatment train are located on or adjacent to the development which is being treated.

"End of line" treatment is the method whereby the stormwater is collected in its raw form from a number of developments and conveyed to near the catchment outlet where larger devices are installed to collectively treat the discharge.

"At Source" generally is better suited to large scale commercial developments and "end of line" is better suited to freehold residential lots.

The impact of these approaches is one of "scale" in size and location of the treatment devices. Each philosophy is discussed below.

4.5.1 AT SOURCE CONTROL

At source controls differ between residential and commercial projects – largely due to the concessions offered to home owners over commercial developments in the planning requirements. The implications for Ripley is that the treatments in residential areas will be approached in a different manner to the commercial town centre.

4.5.1.1 Residential Lots and Streets

It is possible to treat the quality of stormwater for the individual residential lots using a combination of rainwater storage tanks and localised bio-retention gardens (shown in Figure 7). Detention is not usually provided on a per lot basis.

Roof runoff from individual residences in the minor storm event is conveyed to a first flush separation device. The Queensland Development Code (QDC) requires about 20 litres minimum to be captured in the first flush device. Excess flow enters a harvest tank which for domestic properties is required to be minimum of 5000 litres. Once the harvest tank is full it would overflow to the house drainage system where the overflow meets the first flush flow. Detailed calculations in Appendix 4 show that for Ripley a 6000L tank would be more suitable for a 100 sqm of roof connection to comply with the Frequent Flow Management objective of Healthy Waterways, whilst still meeting QDC requirements.

ICC has advised that regulating a larger tank than specified in QDC would require an amendment to part 12 of the Ipswich Planning Scheme and therefore this option is not supported. However, ICC did advise that the bioretention storage can be included within the calculations for Frequency of Flow Management, provided treatment occurs prior to discharge to the waterway. MPN has prepared calculations to demonstrate that the use of localised bioretention gardens when combined with QDC regulated rainwater 5000L tanks meet the Frequency of Flow Management criteria set by Healthy Waterways. These calculations are also included in Appendix 4.

Under PSP3 the house drainage system would normally connect either to a pipe drainage system (which limits the extent of source control treatment opportunities to remove pollutants and nutrients from the stormwater) or the street kerb. For connections to the street kerb, council would need to be satisfied that capacity exists in the roadway gutter flows such that the connection and flows do not create a flood hazard on the road.

Draining the house drainage to kerb outlets would enable on-street, “off-line”, bioretention gardens to treat the stormwater from the house lots and the roadways. Ground flows from the house lots would spill into the kerb and channel and mix with the road runoff.

Studies by USQ (Ian Brodie, 2005) noted that the runoff from the more frequent storms (generally less than 15 to 20mm) is a major cause of environmental impact to downstream waterways. Urban development leads to a substantial increase in the frequency of these ‘small-to-moderate’ runoff events, which in undeveloped catchments may be absent due to infiltration. The flows and pollution associated with these events can lead to a wide range of impacts, including channel erosion, reduced biodiversity, more variable water temperatures and poor water quality (Walsh et al, 2004). The non coarse particle (NCP) loads generated from urban surfaces in small-to-moderate storms are of particular interest. On a per sqm basis, the road surface generated the highest NCP load in the less than 20mm rainfalls and is thus most likely to be a major contributor to adverse environmental effects. Road drainage is also generally efficient in conveying stormwater directly to waterways which increases the impact potential.

Bio-retention gardens can therefore be located as required within the road reserve and enable the water to be treated at source prior to being discharged into the piped system at the downstream kerb inlet pit. “Off-line” systems typically rely on a standard street gully pit to capture above design flows. Bypass occurs when the extended detention depth within the stormwater garden reaches the kerb invert level.

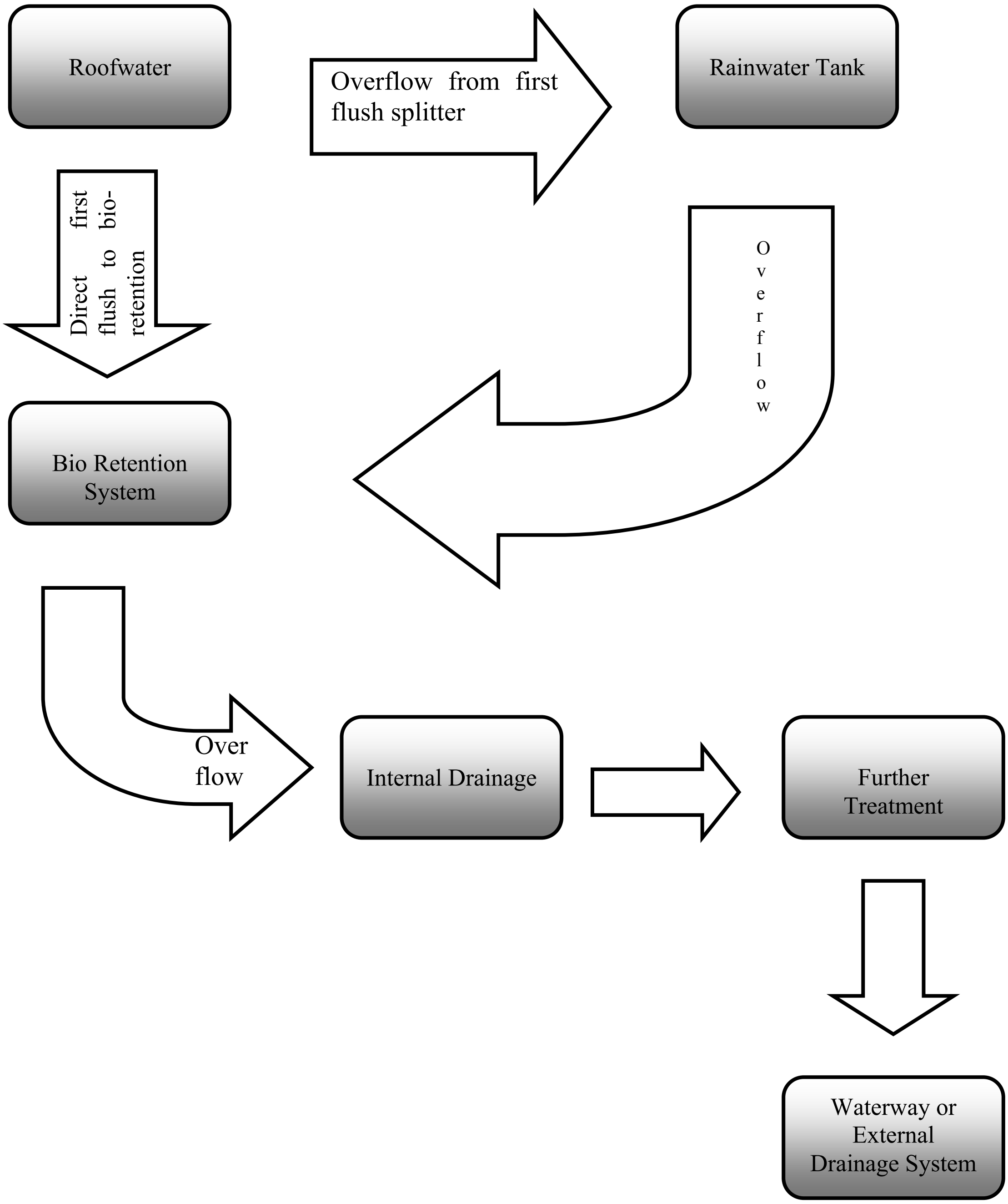


Figure 7 - At Source Residential Flow Chart Stormwater Treatment

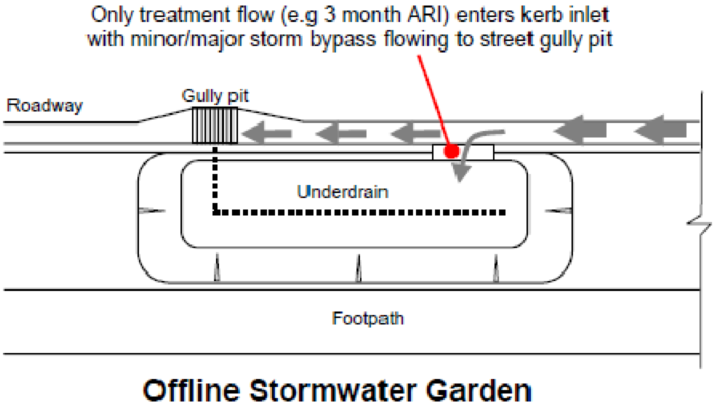


Figure 8 - Stormwater / Bio-retention Garden

The shape of the inlet can also greatly affect the behaviour of both low and high flows.

Desirable attributes of a kerb inlet are provided below.

- Rounded or tapered kerb transitions into the inlet (with sufficiently large radius)
- Depressed kerb invert (of around 50 mm) graded to match kerb invert level at either end of the inlet
- High flow bypass downstream of inlet
- Energy dissipation/ stabilisation at the interface of the inlet with the filter media
- The diversion of flows from the kerb and channel using raised structures (such as small weirs across the flow path) within the kerb and channel should not be used as this poses a potential hazard to bicycles and motor vehicles.

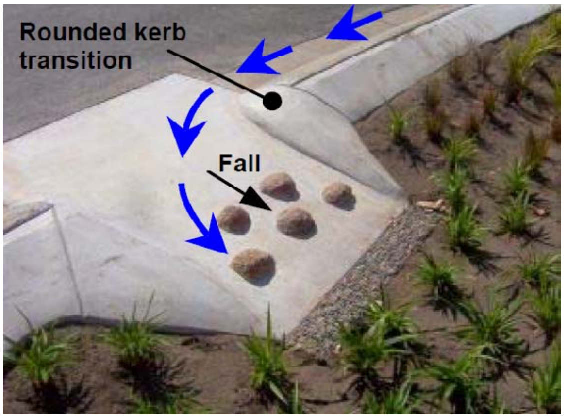


Photo 20 - Bioretention Garden Inlet

Photo 21 - Stormwater Pit downstream of Bio-retention Garden

In most Council areas, the sites are usually treated rather than the roads, with the discharge targets set to compensate. The new legislation is clear on this aspect which states that WSUD is to follow BMP and the new design objectives in SEQIG7 are best achieved with the road corridors being treated.

At a meeting with Gary Ellis, Principal Development Engineer, Ipswich City Council the use of rain gardens (bioretention gardens) was discussed and acknowledged as a suitable treatment device and regarded as WSUD BMP. Drawing 5270-SW-4 shows how rain gardens can be incorporated within residential areas in a conceptual "At Source" train and Figure 9 illustrates an example of a bioretention garden.

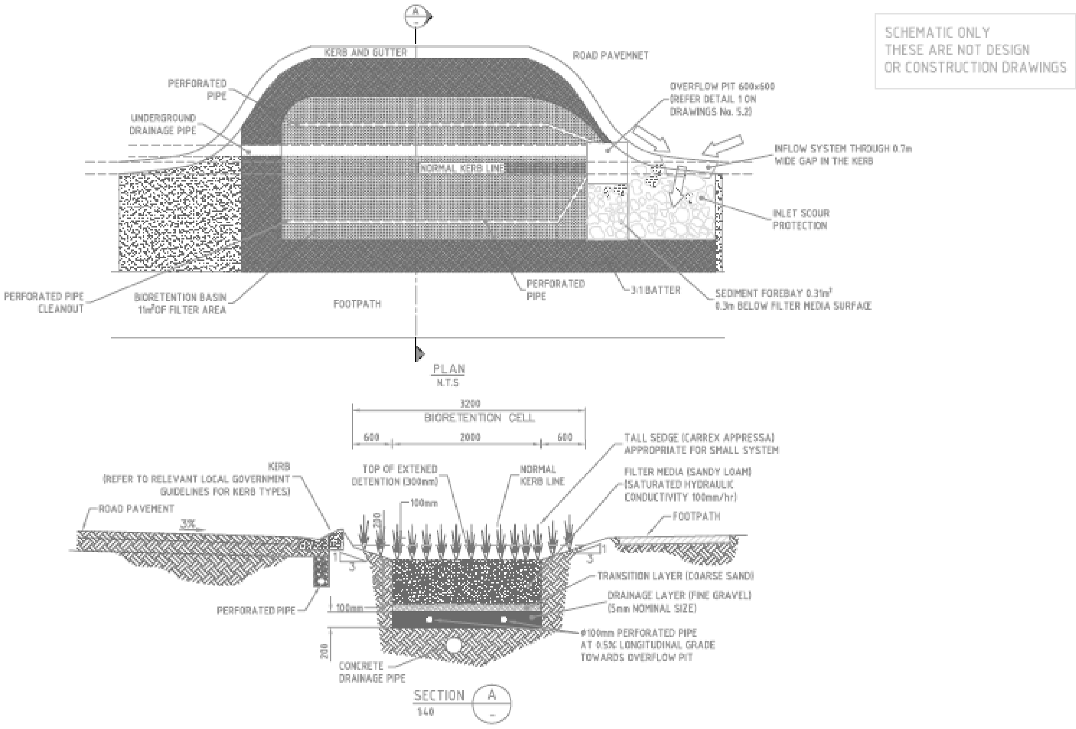


Figure 9 - Stormwater / Bio-retentions Garden Details

For residential areas the following contributing areas were used in the MUSIC modelling:

Roof	=	0.024 ha / Lot @	100% impervious
Landscaping	=	0.018 ha / Lot @	0% impervious
Road	=	0.015 ha / Lot @	80% impervious
Paving	=	0.003 ha / Lot @	100% impervious
		0.064 ha i.e 450 sqm / lot + 150 m² of road / lot	

No allowance for parklands is included in this scenario as modelled as it has been assumed that parklands will have their own treatment or their effluent “polished” in the “end of line” treatment devices.

Analysis in MUSIC shows that the proportions for these types of devices to achieve WQO targets are as follows:

Lots Treated * -	**0.25 ARI Flow l/s for high-flow bypass**	**Detention Area sqm for 300 mm depth**	**Filter Area sqm for 800 mm depth**
2	13.4	10	3.3
4	26.8	24	8
8	53.6	48	12

* This includes road areas fronting the lots.

A single bioretention cell of 48 sqm could treat 8 Lots (450 sqm each) or 12 Lots (300 sqm each).

It is anticipated that a combination of rainwater tanks and bioretention gardens can meet the WQO of SEQIG7 and PSP3. A typical MUSIC model to demonstrate compliance is provided in the Section 7 of this report.

4.5.1.2 Commercial Areas and Streets

4.5.1.2.1 Commercial Lots - Treatment

The Queensland Development Code (QDC) requires commercial development areas to capture a minimum of 1500l of rainwater per pedestal or flushing urinal. The roof area required to be connected is to be a minimum of 50 sq m per pedestal or urinal. For each tank roof connection, a 20 l first flush diversion is also required if the rainwater tank is connected to showers, wash basins, kitchens or hot water services, or a swimming pool. If connected to a swimming pool, additional storage requirements need to be met. For a typical 50,000L swimming pool the minimum tank size is 5000l and the minimum roof catchment required is 50 sqm. Specific details of requirements are included in Appendix B of MP4.3 Alternative Water Sources for Commercial Buildings of QDC.

A separate water storage tank used for the storage of treated, recycled or reclaimed water may also be installed to supplement the rainwater tank storage.

Within the commercial areas it is necessary to provide rainwater tanks for toilet flushing. As a guide, for a typical 1 ha commercial site assuming 80% site coverage by the building and 90% site imperviousness, the number of pedestals/urinals will total about 136 (based on BCA densities for retail/commercial building) and the QDC requires a minimum storage of 1500l per pedestal. Therefore 204kL is the minimum storage required per site ha. As a guide usually 20 -30 days storage is needed to provide a 90% reliable supply and thus the tank storage is between 4800 and 7,200 kl per ha for a 4 storey building of 32,000 m² GFA, but most developments, for commercial reasons, install about 5 days' supply storage.

In addition, air conditioning will require top up water and the air conditioner condenser units will discharge about 20% of their water usage to sewer as part of their normal operating and maintenance schedule.

For commercial areas, the Frequent Flow Management criteria is readily achieved by the provision of rainwater harvest tanks, bioretention basins and if necessary porous pavements to plaza areas and "green" roof tops/podiums to supplement the storage requirements.

Detailed proof of achieving the Frequency of Flow Management requirements in commercial areas will be demonstrated at the detailed design stage and is not appropriate at the NMP level of planning.

For a typical site area of 1ha of commercial development, the Frequency of Flow Management criteria is 15mm retention over the impervious area.

Assuming a site coverage of 50% then the building area would be 5000sqm footprint as a minimum. Allowing 235 sqm / pedestal of GFA, and given that each pedestal requires 1500L of storage which would provided about 12hrs of use based on 6L flush per 3 minutes (equivalent to 32 cum of storage). In addition, the bioretention on site would require 45 cum of extended detention plus incorporate 11 cum within the filter media based on 15% porosity. The airconditioning would require 1.23 L/day/sqm GFA equivalent to 6 cum.

Therefore the total storage provided is:

Toilets	32 cum
A/C	6 cum
Bioretention	<u>56 cum</u>
	<u>94 cum</u> total

The required storage of 15 cum rainfall depth on the impervious faction equates to:

15	x	i%	x	10000/	1000	≤	94	cum
Therefore				Imperviousness		≤	62%	to achieve Frequent Flow Management objectives without additional storage.

From this calculation, it can be seen that the portion of imperviousness of the site must be less than 62% unless additional storage is provided within the development to comply with Frequency of Flow Management criteria.

For commercial areas, the following contributing areas were used in the MUSIC modelling:

Roof	0.8 ha @ 100% impervious
Paving	0.1 ha @ 100% impervious
Landscaping	0.1 ha @ 0% impervious
Road	0.15ha @ 80% impervious
	1.154 ha

Therefore in addition to the tank and reuse, a bioretention basin of 190m² equivalent to 1.65% contributing area is required on the lot in order to meet the water quality objectives and a detention tank of 60m³ for quantity. A diagrammatic Treatment train is shown in Drawing 5270-SW6 in Appendix 1.

In summary, the combined objectives of no increase is peak runoff, stormwater quality improvement, frequent flow management and waterway stability are achieved through to implantation of detention tanks, bioretention gardens, rainwater harvesting systems for reuse of stormwater.

4.5.1.2.2 Stormwater Treatment of Road Reserve & Public Spaces

Within the road reserves, the parking lanes of some commercial areas may become clearway limited in the future and therefore stormwater gardens would not be suitable in those locations. However, reverse cross falling of the road pavement towards the medians would allow for bioretention swales and/or storm gardens to be positioned within the median.

Examples of this treatment method are shown in Photos 22 - 25 and the sighting of the gardens and entry details would be subject to detailed design to ensure flow widths and depths do not create a traffic hazard on the roadway. In such situations, the maximum longitudinal grade must be less than 3% for the device to be effective.

Photo 22 - Median Biofiltration

Photo 23 - Median Biofiltration

Photo 24 - Verge Bio-retention

Photo 25 - Verge Bio-filtration

Photo 26 - Verge Bio-filtration

Management of Waterway Stability can be encompassed in the "end of line" detention basins proposed to be located downstream of the commercial centre if "on site" detention tanks are not utilised. However given the constraints at Ripley (topography, soil types and Riparian Zone proximity), detention tanks are preferred within the Town Centre.

4.5.2 "END OF LINE" TREATMENT

The topography at Ripley can be described as moderate to steeply sloping in the upper portions of the urban core. In the proposed drainage reserves, the slope reduces from undulating to slightly sloped and would lend itself to constructed wetlands as suitable "end of line" or "sub regional" stormwater treatment devices. Where used, these would form part of the tertiary treatment train and parallel bioretention systems in performance but on a larger scale.

At meetings with Council it was suggested that water features would be preferred to counteract the heat sink effect that will occur in the commercial areas. Examples of wetlands and water features that could be incorporated into urban areas are shown in Photos 27 – 30.

Photo 27 - Urban Wetland

Photo 28 - Urban Wetland

Photo 29 - Urban Wetland/Water Feature

Photo 30 - Water Feature

It will need to be determined during the design phase if indeed such features can be sustained given the climatic conditions in Ripley Valley. The urban form of the commercial centre will impact the ultimate layout and viability of such devices.

The advantage of a constructed wetland is that it has aesthetic appeal and can provide some cooling effects in an otherwise warm urban area. The scale of these larger devices requires land which is only slightly sloping or relatively flat. Artificial wetlands have been built within urban areas as indicated by some of the photos 27 - 30 in this report. It is important to differentiate between a water feature or lake and a wetland.

Photo 31 - Built Environment Wetland

The planning legislation states that a lake or water feature is deemed to be a receiving water and is not a treatment device. Evidence justifying this stance by the regulators has been proven correct by experience and in many examples of "failed" urban lakes which were presented at a recent State conference of the Stormwater Industry Association in 2007.

Photo 32 - Wetland

Lakes must only receive treated stormwater with low levels of suspended solids, nitrogen, phosphorus and carbon (organic matter). To avoid stratification, lakes must not exceed 4m depth and should be aligned with the long axis along the prevailing wind direction to provide wind mixing. Lakes must not have convoluted shape which would reduce the ability to optimise wind mixing. Lakes in SEQ require a recirculation system to prevent risk of algal blooms. This requires a parallel wetland to treat the water from the lake. The wetland would be about 25% of the size of the lake in volume. To achieve this typically lakes are 1.5 to 2m deep and the wetland land area required to treat the lake would be 125% of the lake area and 0.3 to 0.5 m deep.

Photo 33 - Wetland

To treat the stormwater using a bioretention basin would require a basin which is about 1.65% of its catchment area, and a pretreatment GPT.

To treat the stormwater using a constructed wetland (prior to discharge to a water feature or lake) would require a pretreatment GPT, and a land area of 1000 sqm for the sediment pond and 5000 sqm for the wetland storage zone. These areas are based on a 11.5ha commercial precinct or town centre module, and equate to 5% of the catchment being treated. In addition, a high flow bypass channel is required around the wetland storage. One of the criteria for a wetland is the ability to maintain a suitable water level for sustainability. This results in a size greater than that required to meet the treatment objectives alone because it is required to limit water level variation to 0.5m below normal water level 20% of the time. Based on the above size ratios, the achieved pollutant reductions for 11.5ha or 87.6% for TSS, 75.5% for TP and 69.4% for TN. (Targets are 80%, 60% and 45% respectively).

Photo 34 - Wetland

Wetland pre-treatment in the form of settlement ponds is a usual prerequisite for wetland performance. Infiltration and evaporation will facilitate compliance with the SEQIG7 design objectives along with Bioretention treatment of outlet flows from the wetland.

In an "end of line" context tertiary treatment of stormwater would include large bioretention basins at an approximate area of 1.25% for residential and 1.65% for commercial areas. If a wetlands option is considered the areas increase to approximately 5% of the contributing catchment as an indicative size for treatment devices for both residential and commercial areas. Drawing 5270-SW3 in Appendix 1 shows possible options for locating bioretention basins. Wetlands would reduce the extend of "dry" green space area for passive recreation and have not been included in the design layout. Sekisui House will need to consider other aspects of the use of bioretention versus wetlands to assess their respective merits, which extend beyond engineering alone, such as aesthetics, amenity and bio-diversity.

5 DUAL WATER SUPPLIES

Whilst not specifically related to Stormwater Management, dual water supplies need to be included in the context of WSUD.

Dual water supplies have been discussed with ICC in commercial areas. The provision of a recycled water main within the residential districts needs to be ratified and may not be warranted. Given the capacity of harvest tanks to meet irrigation needs in residential areas, the cost-benefit of the recycled main will need to be evaluated during the design phase.

6 STORMWATER QUANTITY MANAGEMENT STRATEGY

6.1 LEGAL POINT OF DISCHARGE

The legal point of discharge for parts of the property is Ripley Road and proposed drainage reserves with Bundamba Creek being the final legal point of discharge for the Urban Core.

6.2 SITE HYDROLOGY

The proposed development will result in increased impervious areas which will tend to increase stormwater runoff (peak flow and volume) due to loss of surface storage and reduced infiltration. It is proposed to limit the increase in stormwater runoff from the site to not greater than the existing peak stormwater runoff by provision of on-site stormwater detention. This will be achieved by a combination of Stormwater Quality Improvement Devices (SQID's) and pipe storage, detention basins, ponds and wetlands, below ground detention tanks and stormwater harvest tanks which can have a portion of their total storage set aside for detention. It is worth noting that for the defined flood event (i.e. 1 in 100 year flows) QUDM requires that harvest tanks are to be assumed as full at the start of the storm, but harvest tanks can facilitate reductions in flows for lesser events.

6.3 CATCHMENTS

The site has been divided into 42 sub-catchments covering an area of 385 ha for the purpose of flow modelling. Within the site the sub-catchments are shown in drawings 5270-SW2 and SW5 located in Appendix 1.

6.4 PROPOSED DRAINAGE

A possible decentralised stormwater layout for the development is shown on drawing 5270-SW-3 in Appendix 1.

6.4.1 HYDRAULIC MODELLING METHODOLOGY

MPN has prepared a model of the development catchment which drains into Bundamba Creek. The modelling program used is DRAINS by Watercom Pty. Ltd.

DRAINS uses the *Time-Area Method* of Catchment Analysis which is a form of catchment routing model in which a hyetograph of rainfall is combined with a time-area diagram to produce a flow hydrograph. The procedure effectively divides a catchment into a number of strips of land, and superimposes the individual flows from these sub-areas, allowing for time lags depending on their distance from the outlet. Hydrological routing is the process of converting a hydrograph that passes through some part of a flow system to allow for the changes that occur during its passage. DRAINS incorporates catchment routing in the time-area calculations and non-linear storage routing calculations. This methodology is more accurate than the QUDM Rational Method and caters for volumetric analysis.

6.4.2 CALIBRATION

QUDM requires calibration of all mathematical models to ensure consistency. Recommendations in QUDM are that in the absence of "real event" flow data, that the peak flows for the models must at least be calibrated to the peak flows calculated using the Rational Method. DRAINS incorporates an "extended rational method" which allows peak flows and hydrographs to be developed using runoff coefficients determined from QUDM, and incorporates a "Proportional Loss" method for runoff calculations.

The Intensity Frequency Duration parameters used for the Rational Method Calculations were:

Parameter	Notation	mm/hr
1 hour duration, 2 year ARI intensity read from map 1 for catchment area of interest	${}^{2}i_{1}$	45.20
12 hour duration, 2 year ARI intensity read from map 2 for catchment area of interest	${}^{2}i_{12}$	6.90
72 hour duration, 2 year ARI intensity read from map 3 for catchment area of interest	${}^{2}i_{72}$	1.95
1 hour duration, 50 year ARI intensity read from map 4 for catchment area of interest	${}^{50}i_{1}$	91.00
12 hour duration, 50 year ARI intensity read from map 5 for catchment area of interest	${}^{50}i_{12}$	14.00
12 hour duration, 50 year ARI intensity read from map 6 for catchment area of interest	${}^{50}i_{72}$	3.95
Skewness factors read from map 7 for catchment of interest	G	0.23
6 minute duration geographical factor for 2 year ARI read from map 8 for catchment of interest	F_2	4.39
6 minute duration geographical factor for 50 year ARI read from map 9 for catchment of interest	F_{50}	17.20

The model having been calibrated can then be used with Australian Rainfall and Runoff (ARR) temporal pattern storms to assess the impact of the post-development flows compared to the pre-developed flows. The DRAINS model has been calibrated to the WBNM model flows in Bundamba Creek in previous studies undertaken for ICC by others.

6.4.3 PROCEDURE

The DRAINS model results for the post development case were compared with the flows calculated for the existing case using ARR storm events to assess achievement of flow retardation that does not result in increased runoff. ICC requires flooding to be assessed up to the 1 in 100 year ARI. The storm modelling included the 1 in 1, 1 in 2, 1 in 10, 1 in 20, 1 in 50 and 1 in 100 years average rainfall intensities (ARI) with durations of 5, 10, 20 , 30 , 60 and 120 minutes in DRAINS. Only the *critical storm* events are presented in this report. The detailed data and results used in the DRAINS models for the two scenarios (pre and post development) are included in Appendix 2.

6.4.4 MODEL

Drawing 5270-SW-7 in Appendix 1 shows the 42 subcatchments used to assess stormwater flows in the existing catchment and the impact of the development. Following is the DRAINS network representing these subcatchments and flow routes.

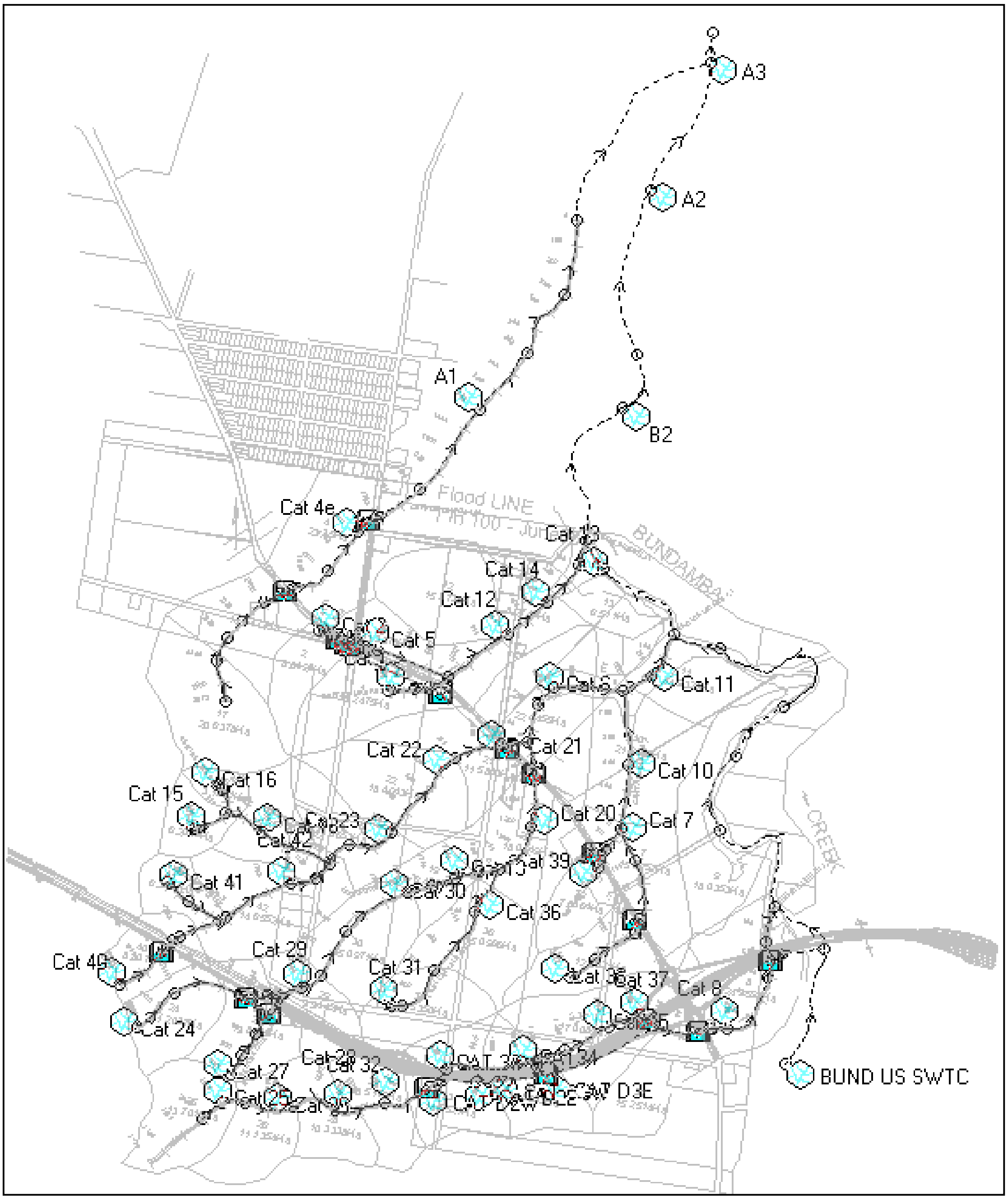


Figure 10 – Drains network for pre-development conditions

Drawing 5270-SW-2 shows the subcatchments used to assess stormwater flows of the developed site.

Following is the DRAINS network model for a proposed development scheme utilising a number of decentralised detention basins showing catchments, basins and culverts with aggregated linkages.

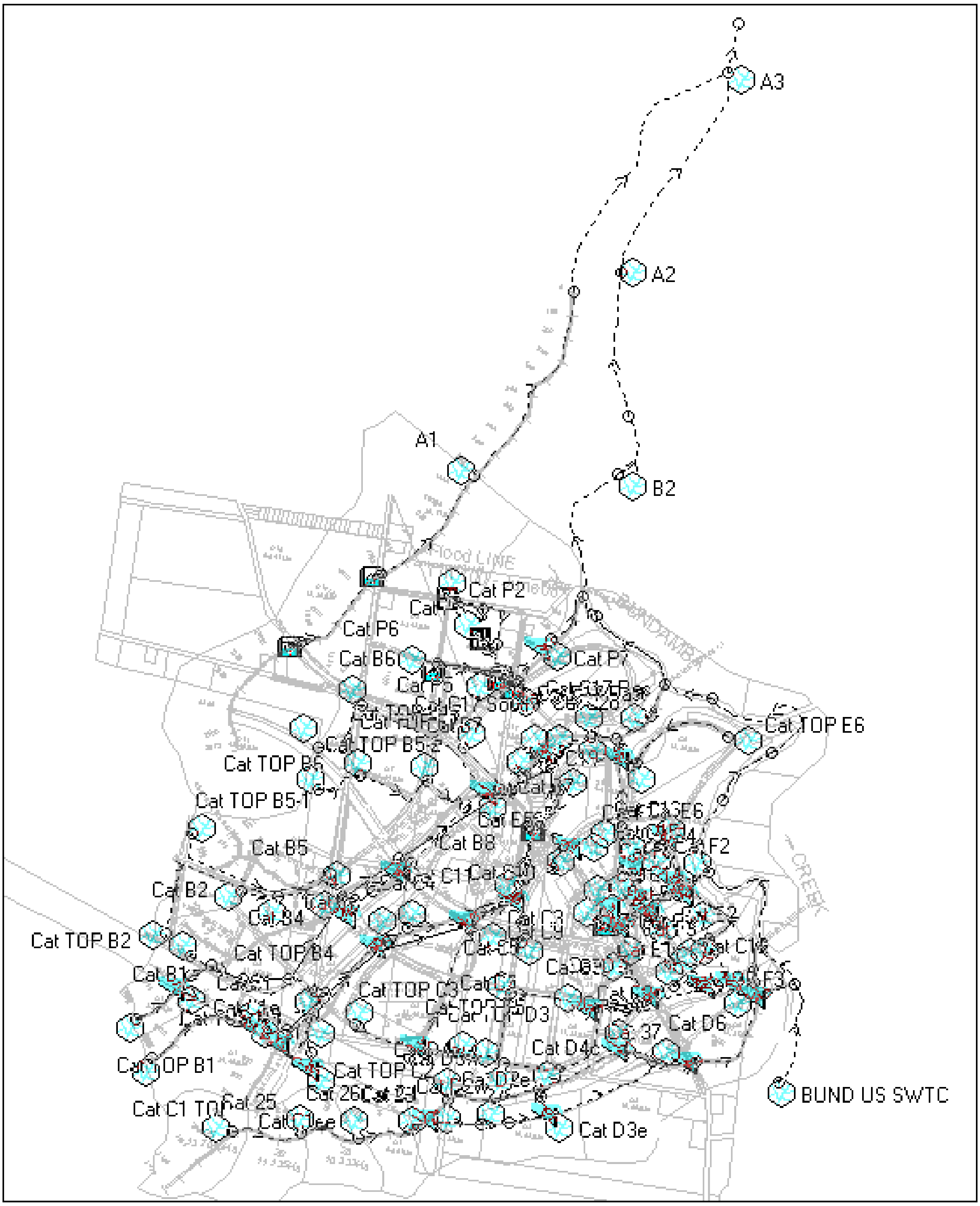


Figure 11 – Drains network details for post-development layout.

6.4.5 ASSESSMENT

The *time of concentration* of the site is 90 minutes for predevelopment and for the post-development scenario it is approximately 75 minutes. Use of detention basins in strategic locations has changed the effective time of concentration for the outlet of the site whilst maintaining post-development flows to less than the predevelopment flows. Assessment of the effectiveness of the detention is based on the all storm events (5, 10, 20, 30, 60, 90 and 120 minutes) for the various ARI storms (1, 2, 10, 20, 50 and 100 years).

6.4.6 DETENTION BASINS

The peak flow calculations show an increase in total site discharge from the existing to the developed scenario without a detention system. A detention system consisting of a number of basins interlinked along the drainage reserve lines will achieve suitable reductions in flow. Flow comparisons for the 1 in 100 year ARI storms are set out below to demonstrate achievement of suitable flood mitigation for properties downstream of the site.

Duration Minutes	Pre Development Flow Cum/s	Post Development Flow Cum/s
5	20.8	20.8
10	30.4	26.8
20	45.4	37.9
30	56.4	46.6
60	74.7	72.1
90	78.7	74.0
120	75.4	68.9

Flood control basins are located on the Layout Plan 5270-SW-3 in Appendix 1, and in summary are:

Basin	Maximum Depth (m)	Volume (m^3)
R1-1	1.6	6040
R1-2	1.7	6625
R1-3	2.4	10980
R1-4	2.9	14380
R2-1	1.8	7225
R2-2	1.8	7225
R2-3	1.0	2890
R3-1	1.3	3450
R4-1	1.2	1560

Detention tanks are proposed within the Town Centre which form part of the “built form”.

Full routing of flows in Bundamba Creek have been incorporated into the modelling to assess impact of the site on creek flows as requested by ICC. The pre and post development flows in Bundamba Creek for ARI1 – 100 and duration 5 – 270 minutes storm events are shown in Appendix 3 and demonstrate that the basins are effective in flood mitigation measures.

7 STORMWATER QUALITY MANAGEMENT STRATEGY

7.1 POTENTIAL POLLUTANTS GENERATED

The pollutants that could be potentially generated as a result of the development use are as follows:

- Litter
- Sediment
- Nutrients (Nitrogen and Phosphorous)
- Hydrocarbons (oil & grease)
- Surfactants
- Heavy metals.
- Pathogens/Faecal Coliforms (bacteria & viruses)

7.1.1 POLLUTANT CONTROL MODEL

The MUSIC computer modelling program developed by the Co-operative Research Centre for Catchment Hydrology was used to predict the performance of the proposed stormwater treatment train.

At this stage the pollutants modelled in MUSIC are Total Suspended Solids (TSS), Total Phosphorus (TP), Total Nitrogen (TN) and Gross Pollutants.

7.1.2 RAINFALL

The rainfall data used in the model was based on the Bureau of Meteorology data from rainfall station 40004 Amberley. The model was run for a 10 year period from 1 January 1990 to 31 December 1999. The modelling time step was 6 minutes.

7.1.3 CATCHMENTS

(a) Residential areas

A typical set of 450 sqm lots was modelled in MUSIC. Assumptions used per lot were:

200 sqm roof of house coverage
40 sqm roof of garage coverage
30 sqm paved areas (driveway)
180 sqm landscaped areas
15 m road frontage
63% pervious road corridor of 150 sqm

(b) Commercial areas

A typical 1 ha site development was modelled in MUSIC. Assumptions used were:
80% building coverage
10% paved areas
10% landscaped areas
100 m road frontage
80% pervious road corridor of 1500 sqm

7.2 POLLUTANT LOAD RELATIONSHIP

The pollutant concentrations used in the MUSIC model have been derived from the Brisbane City Council MUSIC Modelling Guidelines for commercial land uses, with targets and devices modelling as per the WSUD TDG. This approach has been discussed and agreed with ICC Environmental Team Leader, Jane Kilgour.

The event mean concentrations of TSS, TP and TN used in the model for the different land uses are summarised below:

Pollutant Load Generation – Combined Values						
Land use	**Suspended Solids (mg/L)**		**Total Phosphorus (mg/L)**		**Total Nitrogen (mg/L)**	
	Log mean	**Log standard deviation**	**Log mean**	**Log standard deviation**	**Log mean**	**Log standard deviation**
Combined Average Catchment Values						
Residential Stormflow	2.18	0.39	-0.47	0.31	0.26	0.23
Residential Baseflow	1.0	0.34	-0.97	0.31	0.20	0.20
Commercial Stormflow	2.16	0.38	-0.39	0.34	0.37	0.34
Commercial Baseflow	0.78	0.39	-0.60	0.50	0.32	0.30

Pollutant Load Generation – Component Values						
Land use	**Suspended Solids (mg/L)**		**Total Phosphorus (mg/L)**		**Total Nitrogen (mg/L)**	
	Log mean	**Log standard deviation**	**Log mean**	**Log standard deviation**	**Log mean**	**Log standard deviation**
Separated Catchment Component Values - Residential						
Residential Road Stormflow	2.43	0.39	-0.30	0.31	0.26	0.23
Residential Roof Stormflow	1.30	0.39	-0.89	0.31	0.26	0.23
Residential Paving Stormflow	2.18	0.39	-0.47	0.31	0.26	0.23
Residential Landscaping Stormflow	2.18	0.39	-0.47	0.31	0.26	0.23

Separated Catchment Component Values - Commercial						
Commercial Roads Stormflow	2.43	0.38	-0.30	0.34	0.37	0.34
Commercial Roof Stormflow	1.30	0.38	-0.89	0.34	0.37	0.34
Commercial Paving Stormflow	2.43	0.38	-0.30	0.34	0.37	0.34
Commercial Landscaping Stormflow	2.18	0.38	-0.47	0.34	0.37	0.34

7.2.1 WATER QUALITY TARGETS

The water quality objectives of the receiving waters for the development as set out in the following table:

Required Pollution Reduction Target Rates			
Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Visible Gross Pollutants (GP)
80%	60%	45%	90%

7.2.2 TREATMENT TRAIN MODELLING

The MUSIC model networks are set out in the following diagrams.

7.2.2.1 At Source Residential

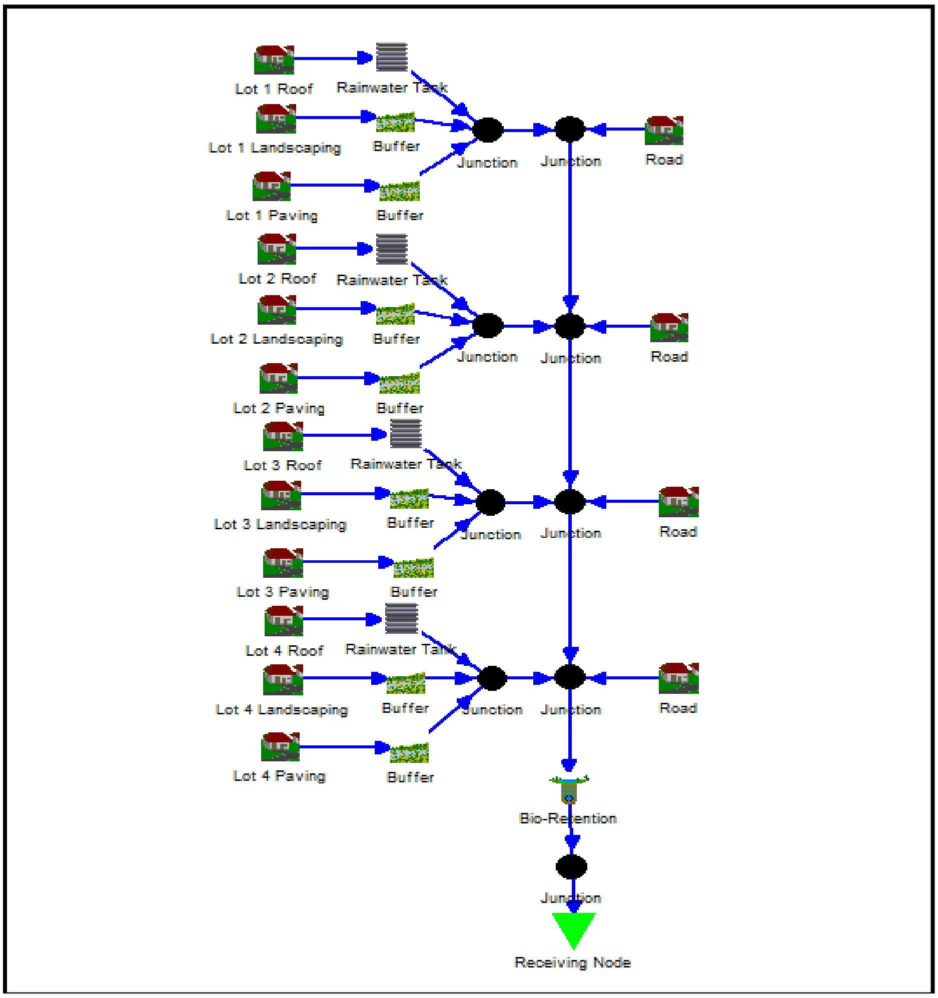


Figure 12 - MUSIC network residential 4 lot module.

The bioretention area required as modelled is about 24-25 sqm per 4 Lots, including public roadways.

7.2.2.2 At Source Commercial

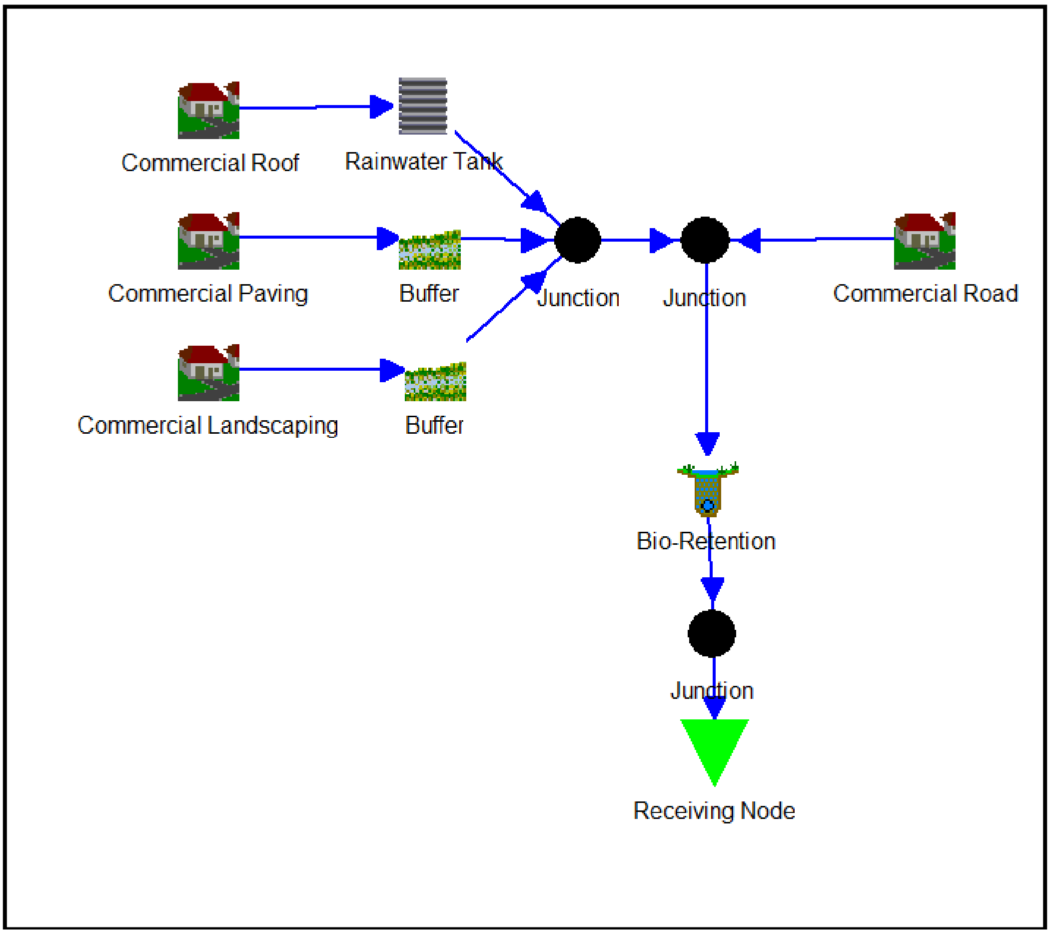


Figure 13 - MUSIC network commercial 1 ha module.

A bioretention area of 165sqm per ha of catchment is required to treat commercial areas (Note this does not include the public roads).

7.2.2.3 "END OF LINE"

A "end of line" wetland was also modelled to assess suitable sizes to achieve the targets based on a 11.5ha module of commercial land.

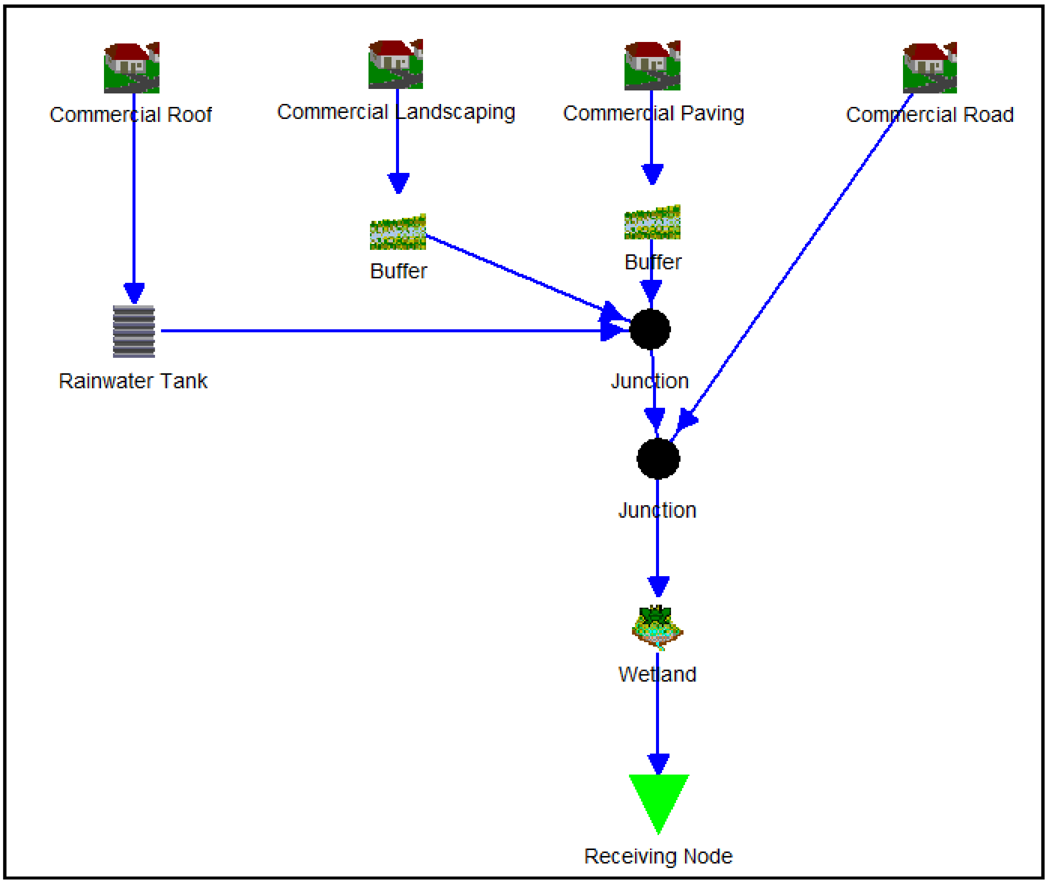


Figure 14 - MUSIC network commercial 11.5 ha module treated by a Wetland.

A Wetland of 1000sqm inlet pond and 5000 sqm storage area is required to achieve the target pollutant reductions and sustainability requirements.

A minimum of 11.5 ha catchment is required to support for a wetland to be sustainable and thus one wetland of the size indicated would treat 10 commercial lots of 1 ha.

7.2.3 RESIDENTIAL TREATMENT TRAIN

7.2.3.1 At Source

To achieve the required reduction in pollutants of the water quality objectives at the source a multi-faceted treatment train is proposed as described below and is illustrated in drawing number 5270-SW-4.

For each lot, a roof water tank with a capacity of 6kL to collect runoff from a minimum area of 200 sqm of the roofs. The rainwater tank will be installed to capture roof water for re-use as required by QDC development policy. First flush diversion devices will be installed to divert the initial 20l runoff from the roof away from the rainwater tank. Rainwater tank overflows will be directed to the road kerb outlet which then will be treated be the bio-retention garden on the street. Overflows from the bio-retention tank will then flow to the kerb and channel immediately downstream. Ground runoff from the lot shall be treated via buffer strips. The modelling by MUSIC for typical 2, 4 and 8 lot modules has demonstrated compliance with the Water Quality Objectives (WQO) and complies with WSUD BMP for utilising point source control and treatment of the runoff. The details of the Bioretention gardens and arrangement of services within the road verges will require further investigation during the design phase.

7.2.3.2 "END OF LINE" (Sub Regional)

Sub-regionally, a bioretention is an alternative treatment option to "at source" treatment. Sub-regional bio-retention basins require a land area of 1.5% of catchment being treated. The location of potential "end of line" bio-retention basins is shown in drawing 5270-SW-7 for treating residential area 1.

7.2.4 COMMERCIAL TREATMENT TRAIN

7.2.4.1 At Source

To achieve the required reduction in pollutants of the water quality objectives at source a multi-faceted treatment train is proposed as described below and is illustrated in drawing number 5270-SW-5.

For a 1 ha commercial area, a roof water tank with a capacity of 204 kl to collect runoff from the roofs is required to meet alternative source requirements of QDC for toilet flushing and air conditioning plant coolant water. The rainwater tank will be installed to capture roof water for re-use as required by QDC development policy. First flush diversion devices will be installed to divert the initial 20l runoff from the roof away from the rainwater tank for each 200 sqm or roof. Rainwater tank overflows will be directed to the site drainage system which will be treated in the bio-retention garden on site. Ground runoff from the lot shall be treated via buffer strips prior to entering into the Bioretention basin. The modelling by MUSIC for typical 1 ha site has demonstrated compliance with the WQO and complies with WSUD BMP for utilising point source control and treatment of the runoff. The details of the Bioretention will require further investigation during the design phase.

Carpark areas on site will be pre-treated by a Hydrodynamic Separator such as a Humeceptor. A Humeceptor will pre-treat all stormwater runoff generated from the roofs and car park areas prior to being discharged to the bio-retention basin and remove hydrocarbons as well. These units are primarily oil and grit separators but as an added benefit it has been demonstrated that significant proportions of other pollutant such as nutrients become attached to fine sediments in the units thereby removing these along with the sediment.

7.2.4.2 "END OF LINE"

Sub-regionally, a constructed wetland is an alternative treatment option and the minimum catchment area required to support a wetland is 10 ha (based on Modelling at Ripley in MUSIC). A land area of about 6000 sqm is required per 11.5ha which is about 5% of the catchment being treated. If bio-retention basins are used instead of wetlands, then only 1.5% of catchment being treated is required. Council has advised its preference for at source treatment. Analysis has shown that only the roads will be treated at end of line devices. The location of potential "end of line" bio-retention basins is shown in drawing 5270-SW-3 in Appendix 1, which are to treat "fringe" roads treated by the onsite bioretention basins in the Town Centre.

7.3 MUSIC RESULTS

The resulting pollutant load removal rates produced by MUSIC can be found below with the corresponding reduction target which was obtained from Ipswich City Council PSP3.

Residential 4 lot Module (refer drawing number 5270-SW-4)

	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants (GP)
Source Load	771 kg/yr	1.90 kg/yr	22.5 kg/yr	188 kg/yr
Residual Load	141 kg/yr	0.72 kg/yr	11.0 kg/yr	Nil
Pollutant Load Reduction	81.7%	61.9%	51.2%	100%
Target Reduction	80%	60%	45%	90%
Target Achieved	Yes	Yes	Yes	Yes

Commercial 1ha Module (refer drawing number 5270-SW-5)

	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants (GP)
Source Load	186.00 kg/yr	0.39 kg/yr	2.39 kg/yr	29.1 kg/yr
Residual Load	33.1 kg/yr	0.12 kg/yr	1.21 kg/yr	Nil
Pollutant Load Reduction	82.2%	69.4%	49.3%	100%
Target Reduction	80%	60%	45%	90%
Target Achieved	Yes	Yes	Yes	Yes

10 Commercial Modules (11.5 ha*) with Wetland Treatment

	Total Suspended Solids (TSS)	Total Phosphorous (TP)	Total Nitrogen (TN)	Gross Pollutants (GP)
Source Load	7860 kg/yr	19.1 kg/yr	222 kg/yr	1880 kg/yr
Residual Load	995 kg/yr	4.73 kg/yr	68.5 kg/yr	Nil
Pollutant Load Reduction	87.3%	75.2%	69.2%	100%
Target Reduction	80%	60%	45%	90%
Target Achieved	Yes	Yes	Yes	Yes

* 8ha Roof, 1ha landscaping, 1ha paving, 1.5ha roads

7.4 POLLUTANT REDUCTION - COMMENTS

7.4.1 LITTER

MUSIC has estimated that the proposed treatment train will remove 100% of gross pollutants from the runoff. Additionally, rubbish bins are to be located within the facility and car park and the car park will be cleaned by sweeping on a regular basis.

7.4.2 SEDIMENT

The Total Suspended Solids removal rate of the treatment train as identified above show the required reduction rate of 80% for TSS is achieved and exceeded. The TSS level is therefore considered acceptable.

7.4.3 NITROGEN AND PHOSPHORUS

The Total Nitrogen and Total Phosphorus removal rates of the treatment train are identified above and the required removal rate of 45% for TN and 60% TP are achieved and exceeded. The TN and TP concentrations are therefore considered acceptable.

7.4.4 HYDROCARBONS

The following applies to commercial carparking areas:

The literature from Humes for their Humeceptor units predicts that they will capture up to 98% of hydrocarbon (free grease and oil) from the stormwater runoff.
Also, hydrocarbons in stormwater runoff become attached to the fine sediment. The removal of the fine sediment should effectively remove most of the hydrocarbons in the runoff. It has been estimated that the proposed treatment train will remove 90% of fine sediment – thereby removing about 88% of hydrocarbons attached to sediment.

7.4.5 SURFACTANTS

Subject of course to water restriction requirements, any washing of cars and equipment will be encouraged on lawn areas only to allow reduction of the levels of surfactants by the soil and mitigating their impact on the creek system.

The type of detergent used can also have an impact. For example, soap made from vegetable oils combines with the calcium present in the soil and the surfactant effect, harmful to aquatic organisms, is neutralized (primary degradation). This is then degraded by microorganisms to carbon dioxide and water (secondary degradation). In the manufacturing process of Sugar Surfactants, constituents are taken from the plant-based raw materials starch, sugar and fat; however, they completely retain their natural structure. It is therefore relatively easy for microorganisms to 100% decompose these surfactants. Soap and Sugar Surfactants are classified as readily biodegradable according to OECD guidelines.

Education is a key management strategy for dealing with the impact of surfactants on the natural water system.

7.4.6 HEAVY METALS

Heavy metals in stormwater runoff generally become attached to the fine sediment. As stated previously it has been estimated that the proposed treatment train will remove 90% of fine sediment. The removal of the fine sediment should effectively remove most of the heavy metals in the runoff.

7.4.7 PATHOGENS / FAECAL COLIFORMS

Any pets associated with the development would generally be domestic dogs, cats and birds. Residents will be encouraged to pick up dog faeces generated while walking their dog and dispose of them in accordance with Council's recommendations. Cats bury their faeces enabling it to be more readily eaten by insects and worms between runoff events, whilst bird waste from domestic birds does not generally enter the water system.

Most home owners generally maintain their yards and the commercial and public grounds will be well maintained. Any remnant Faecal Coliforms will breakdown under the action of ultraviolet light and organisms in the soil.

8 MAINTENANCE

Maintenance of each of the treatment devices will be generally in accordance with the requirements below.

• Swales and Flow Paths:	• Shall be maintained in a clean state and inspected after each rainfall event and at least quarterly. Plant maintenance shall be in accordance with the landscape maintenance specification.
• Stormwater pits and pipes:	• Shall be maintained in a clean state and inspected 6 monthly.
• Bioretention filters:	• Shall be maintained in a clean state and inspected after each rainfall event and at least monthly. Plant maintenance shall be in accordance with the landscape maintenance specification. Any dead plants shall be replaced. As a minimum, annually rake the top 50 mm of soil and remove any contaminants and litter. The filter media is to be tested annually and may require replacement after 10 years or as required subject to horticulturalist advice on plant health and soil condition. The filter media shall comply with FAWB Specification.
• Detention Basins:	• Shall be maintained in a clean state and inspected at least 6 monthly.
• Tank Pumps & Controllers:	• The filter, and associates equipment for the water features shall be inspected and maintained in accordance with the manufacturer's recommendations. Alarm status shall be checked weekly.
• Wetlands	• The objective of the maintenance schedule is to ensure the full potential of the wetland is achieved and to maintain the structural diversity of the wetland whilst ensuring natural surveillance is maintained across the site. Inspect site monthly and remove rubbish. Rubbish to be bagged and removed from the site and disposed of appropriately. Litter level not to exceed a density of more than 15 items of litter (larger than 50mm across) per 1000m². Plants to be inspected 3 monthly and any dead plants replaced.

All debris shall be removed and disposed of in a legal manner. Any erosion to swales shall be repaired immediately. All sediment deposited in the swales shall be disposed of in a legal manner.

9 EROSION AND SEDIMENT CONTROL DURING CONSTRUCTION

A proposed scheme for the control of soil erosion from the site will be detailed in the engineering drawings. In addition, the scheme must be properly maintained and controls put in place to protect the soil on site and the potentially damaging impacts erosion can have both on and off the site. The following table sets out the proposed management strategy during the construction phase:

Objective / Target	To prevent stormwater contamination (of watercourses) and the release of contaminated stormwater and wastewater by ensuring compliance with the Environmental Protection Act 1994 and Environmental Protection (Water) Policy 1997.
Management Strategy	Establish control measures and best practice approaches to prevent stormwater contamination and minimise the risk and adverse effects of erosion and sedimentation.
Tasks /Actions	Obtain a license or approval to operate activities which are classed as environmental relevant activities (i.e. they have the potential to cause environmental harm). Obtain appropriate permits from Ipswich City Council for any of the following activities: • crossing the kerb with heavy vehicles, • working in the road reserve, • connection to a Council drain, • storing of material on the footpath or road, • provision of hoardings and gantries.

<table>
<tr><td>Tasks /Actions
Cont.</td><td>Implement and maintain appropriate control measures to prevent sediment leaden wastewater and other potential pollutants such as oil, paint and wet concrete from entering the stormwater system via stormwater drains and gullies.
The control measures which must be considered to be adopted are:
Limit site access during construction to one entry/ exit location. Install a temporary construction entry/exit sediment trap at this location to minimise mud and sediment from the site being tracked onto public road.
Install and maintain appropriate sediment fences around construction areas.
Diversion of the stormwater around the construction areas to existing or new stormwater drainage systems. Inspection indicates there is no stormwater runoff from adjoining properties which will enter the construction areas and which will require diversion.
Install hay bales and other pollution containment devices around stormwater drains and any other locations where required.
Cover open earth/soil areas with concrete slabs progressively to minimise areas of bare earth/soil.
Any stockpiles of excavated soil and demolition / construction waste must be located where risk of erosion and sediment is minimal.
Implement and maintain appropriate control measures to prevent ponding of stormwater or discharge of stormwater from the site to adjacent properties.
Provision of spill/ pollution control equipment which is readily accessible to clean up spills and leaks.
Inspect spill/pollution control measures are available and maintained in working condition.
Sediment contained by the sediment control devices such as hay bales, sediment fences and containment bunds must be frequently removed.
Implement an inspection schedule for any spill or leaks of any potential polluting areas or activities.</td></tr>
<tr><td>Performance Indicators</td><td>Licenses, approvals, permits and inspection reports.
Sediment or pollution control devices such as hay bales, sediment fences and containment bunds are in place, maintained and effective.
Spill/pollution control equipment is readily accessible at designated locations.
No cumulated sediment contained by the sediment control devices such as hay bales, sediment fences and containment bunds.
No sediment exceeding a depth of 300mm in the pollution control devices (e.g. Silt trap)</td></tr>
<tr><td>Frequency/ Deadline</td><td>Licenses, permits or approvals for each environmentally relevant activity must be obtained prior to commencement of this activity.
Appropriate control measures such as sediment fences, temporary construction entry/exit sediment traps, pollution containment device (e.g. hay bales), stormwater diversions and administrative controls must be installed and established prior to commencement of the earthwork and construction activities.
Pollution control devices such as spill control equipment must be inspected on a regular basis (at least weekly).</td></tr>
</table>

	• Other sediment and pollution control equipment such as containment bunds, hay bales and sediment fences must be inspected on a regular basis (at least daily). • Inspection for any leaks, spills or potential contaminating activity must be performed on a regular basis (at least daily). • Remove cumulated sediment or other contaminants from sediment/ pollution control devices on a regular basis.
Responsible Person or Organisation	Contractor.
Reporting/ Review	Records such as licenses, approvals, permits and inspection reports must be reviewed on a regular basis (e.g. at least monthly) to ensure that legal compliance is met, complaints reviewed and systems are working to prevent contamination. Refer also to the Reporting/Review requirements outlined in the Environmental Management Plan.
Corrective Actions	• Perform clean-up of any spills immediately. • Any mud or sediment which is tracked onto public roads is to be immediately removed up using dry cleanup methods i.e. shovel and broom. • Remove or relocate any stockpiles of waste where there is a reasonable risk of erosion and sedimentation. • Replace or repair sediment or pollution control devices if they are not maintained in good working condition.

10 DEWATERING

Water drawn from the ground during dewatering operations will be pumped to the sedimentation ponds to allow settlement of soil particles and allow treatment by gypsum for any colloidal matter to allow it to settle. The water will be treated for acidity balance before being discharged to the waterways. All discharges of water will be made in accordance with the requirements of DERM.

11 EMERGENCY SPILLS

Fuel spills on the site, although unlikely, are a potential risk which would come from a leaking fuel tank expected to be about 70l from a car or small truck or 200L from a larger vehicle. The leak would find its way into the bio-retention system or if a commercial car park it would be trapped in the Humeceptor (a minimum recommendation from open carpark areas). Should such a spill occur, then the contaminated bio-retention soil media would need to be replaced to prevent the hydrocarbons spreading into the ground water.

12 STORMWATER INFRASTRUCTURE AND EASEMENTS

The overland flow channels carrying stormwater from upstream will be defined in a suitable drainage reserve in favour of Council. All buildings and associated structures will be founded below the invert of the stormwater pipes and culverts in accordance with ICC policy for building adjacent to stormwater services. Any trunk drainage infrastructure on private land will need to be contained within a suitable easement. All structures including retaining walls will be designed by a registered structural engineer.

13 SUMMARY

MPN has assessed the development in accordance with Engineering principles incorporating information provided by the Australian Runoff Quality Guidelines and Water Sensitive Urban Design principles, and prepared this Conceptual Stormwater Management Plan to support the planning of the Ripley Valley Urban Core.

Runoff from the site will be conveyed to the legal point of discharge by a combination of underground pipes culverts and overland flow. No adverse impact to flood levels will be caused by the development.

Options have been examined to provide appropriate treatment trains consisting of a combination Rainwater Tanks/Buffer Strips/Bio-Retention/Humeceptors / Wetlands to treat runoff from the development prior to it leaving the site which will provide an acceptable level of stormwater quality. Grass swales will be used to convey major trunk drainage flows within the proposed drainage reserves.

Detention of stormwater flows will be provided in a combination of on-site detention tanks, local catchment detention basins or a large “end of line” basin. This will ensure that the discharge for all storms up to the l in 100 year event are no greater than pre-development flows.

Based on the assessment, it has been shown that the development will not increase downstream flows and the proposed drainage system and treatment devices achieve pollution and nutrient removals which as a minimum achieve the target removal rates set by ICC and relevant State Planning Policies.

Further, the proposed drainage system meets the criteria for Frequency of Flow Management and Waterway Stability.

This report is based on an assessment of typical land use modules as a mechanism to determine land requirements for various treatment devices, whilst meeting the water quality objectives as required by the Ripley Valley Structure Plan.

These methodologies for treatment will be incorporated into the design of the development.

14 BIBLIOGRAPHY

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10. Water Sensitive Urban Design – Technical Design Guide – June 2006 by Healthy Waterways

15 LIST OF DRAWINGS AND SKETCHES

5270-SW-1	Existing Major Catchments
5270-SW-2	Developed Catchment Plan
5270-SW-3	Stormwater Quality Treatment Plan
5270-SW-4	Typical At Source Treatment for Residential Area
5270-SW-5	Typical At Source Treatment for Commercial Area
5270-SW-6	Existing Catchment Plan
5270-SW-7	Residential Area 1 Treatment Option

16 LIST OF APPENDICES

Appendix 1	Drawings and Sketches
Appendix 2	DRAINS spreadsheets –data and results
Appendix 3	Peak Flows Pre and Post Development
Appendix 4	Domestic Rainwater Tank Calculations
Appendix 5	Commercial Harvest Tank Calculation

17 DEFINITIONS

Best Practice (ARQ 2006)	WSUD calls for a considered, approach to the integration of land and water planning at all levels in the urban development process (i.e. strategic planning, concept planning to detailed design). Fundamental to the philosophy of WSUD is the integrated adoption of appropriate Best Planning Practices (BPPs) and Best Management Practices (BMPs). The performance parameters are usually established by the Local Council and are the minimum target requirements for BPPs. Meanwhile, the BMPs are site specific responses to meeting the objectives required by the BPPs. A BMP refers to the structural and non-structural elements of a design that perform the prevention, collection, treatment, conveyance, storage and reuse functions of a water management scheme. Implementation of a BMP for this project is set out in this SWMP to demonstrate that consideration of the BPPs has been made and upon implementation of its recommendation (via the development process) the development will achieve the specified level of performance required to meet the BPP.
Time of concentration (QUDM 2007)	The *time of concentration* is defined as the travel time for flow from the most remote part of the catchment to the outlet, or the time taken from the start of rainfall until all of the catchment is simultaneously contributing flow to the outlet.
Critical Storm (QUDM 2007)	The concept of *critical storm duration* as opposed to the concept of *time of concentration* used in the *Rational Method* is a term used in computer based runoff routing models for calculating flood hydrographs from rainfall, catchment and channel inputs. The *critical storm duration* for a given catchment may be similar in duration to the *time of concentration*, but the two terms are different and should not be confused. The *critical storm duration* is determined by testing the model for a range of storm durations and is used to assess the performance of the drainage system.
Rational Method (QUDM 2007)	Calculation of the flow at the various inlets and junctions along the drainage line is carried out from the top of the system progressively downstream. The total peak flow at any point is not the sum of the calculated sub-area flows contributing at that point, but is dependent on the *time of concentration* at that point. The actual flow being the product of the sum of the runoff co-efficient, area, values for the contributing sub-catchments, multiplied by appropriate intensity for *time of concentration* at that point. The *Rational Method* should not be used to analyse historical (real) storms.
Time Area Method (QUDM 2007)	DRAINS is a computer-based model which incorporates the routing of the *time-area relationship* developed for the sub-catchments under consideration. DRAINS is suitable for use in urban catchments, but requires calibration with available flow data, or where this is not available it is recommended that the obtained hydrograph be "compared" with the peak discharge derived for the same catchment using the *Rational Method*.

First Order Stream	First Order Stream is a non-branching segment (arm or branch) of a watercourse.
Second Order Stream	Second Order Stream is a branch of a watercourse that only receives first order streams.

18 NOTATION

AHD	Australian Height Datum
ARI	Average Recurrence Interval
ARQ	Australian Runoff Quality (ref: Engineers Australia)
ARR	Australian Rainfall and Runoff (ref: Engineers Australia)
BMP	Best Management Practice
CRC	Co-operative Research Centre for Catchment Hydrology
DERM	Department of Environment & Resource Management (Queensland)
DTMR	Department of Transport and Main Roads (Queensland)
GIS	Geographical Information System
GP	Gross Pollutants
GPT	Gross Pollutant Trap
ICC	Ipswich City Council
IPWEAQ	Institute of Public Works Engineering Australia (Queensland Branch)
IECA	International Erosion Control Association
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
PSP3	Planning Scheme Policy 3 –General Works
QDC	Queensland Development Code (ref: QDIP)
QDIP	Queensland Department of Infrastructure and Planning
QPW	Queensland Plumbing and Wastewater Code
QUDM	Queensland Urban Drainage Manual
RVSP	Ripley Valley Structure Plan – Part 15 of Ipswich Planning Scheme
SEQ	South East Queensland
SEQIG7	South East Queensland Regional Plan 2009-2031 Implementation Guideline No. 7
SQID	Stormwater Quality Improvement Device
TDG	Technical Design Guide
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
WSUD	Water Sensitive Urban Design

APPENDIX 1

Drawings and Sketches

APPENDIX 2

DRAINS spreadsheets –data and results

APPENDIX 3

Bundumba Creek Flow Peaks Pre and Post Development

Flow Cross Section Measurement: Bundamba Creek Just Downstream of Site								
		ARI						
	Duration	**1**	**2**	**5**	**10**	**20**	**50**	**100**
Peak Flow Existing	5	9.4	16.3	26.4	30.1	34.8	46.9	50.0
	10	18.2	27.8	37.0	45.5	50.1	60.0	62.4
	30	32.3	45.2	56.9	61.3	71.1	95.8	126.0
	60	50.0	63.2	90.0	104.0	137.0	196.0	256.0
	120	65.1	84.2	125.0	159.0	199.0	264.0	316.0
	270	83.9	107.0	165.0	199.0	256.0	332.0	411.0
Peak Flow Developed	5	9.0	14.9	24.3	27.8	32.9	44.5	49.7
	10	16.7	25.5	34.3	42.8	49.6	55.7	56.8
	30	28.6	40.9	49.3	52.8	60.0	88.3	116.0
	60	47.0	58.0	81.2	104.0	136.0	204.0	256.0
	120	64.7	81.3	130.0	160.0	203.0	268.0	320.0
	270	80.8	108.0	164.0	200.0	252.0	329.0	387.0

APPENDIX 4

Domestic Rainwater Tank Calculations

A roof eaves gutter is generally sized for a 1 in 20 year event, therefore the house drainage system must cater for a similar flow. Flows from a typical 200 sqm home roof are tabulated below for 5 minute duration storms:

Design Storm Volumes									
ARI year	0.25	0.50	1	2	5	10	20	50	100
Intensity mm/hr	66	99	110	142	182	207	241	286	322
Peak Flow l/s	3.7	5.0	6.1	7.9	10.1	11.5	13.4	15.9	17.9
Volume l	555	750	915	1185	1515	1725	2010	2385 (375 l spilled)	2685 (675 l spilled)

Roof spillage falls to the ground where it mixes with pavement and garden surface flows and enters the roadway or for lots on the low side of the road it enters the inter-allotment drainage system.

For Ripley the expected Average Annual rainfall of 846mm corresponds to a volume which can be captured of 169,200 litres for a 200m^2 roof. A typical house has to have the following connected to the harvest tank in accordance withQDC:

Item	Flow Rate Each (Ref: GCCC)	Qty (assuming 3 EP/house)	Volume/use	Annual Volume
Toilet cisterns	6 l/min	usually 2 off assuming ensuite and main bathroom/WC	6 l @ 4 per EP	26,280
Washing machine cold water taps	9 l/min	1 off	90 l @ 10 min	28,080
External taps	9 l/min	usually 2 off	135 l @ 15 min	14,040
				68,400

Annualised savings from the configuration target 70 kl per year required by QDC which equates to 190 l/day.

On average, 100,800 l of rainwater overflows from the rainwater tank. If the minimum required roof area of 100 sq m is connected then the loss is only 16,200 l with a 5000l storage tank. The overflow from the tank would also be connected to the house drainage system.

Conservatively, assuming the tank is full 50% of the time over a year, then the ability of a house to reuse a portion of the rainfall depth can be calculated as follows:

- Roof Area = 200 sqm
- Driveway Area = 30 sqm
- Rainfall depth to be captured = 15 mm/day (the Frequent Flow Management design objective)
- Rainfall Volume to be reused or treated = 15 mm x 230 sqm =3450 l
- Tank Volume = 5000 l
- Portion of roof connected = 50%
- Connected Roof Area = 100 sqm
- Volume collected from roof = 15 mm/day x 100 sqm = 1500 l
- Less First Flush = 20 l (discharged to downstream treatment)

- Volume collected by Tank = 1500 l – 20 l = 1480 l
- Average available storage = 50% x 5000 l = 2500 l
- Average daily usage = 70,000 l /365 = 190 l
- Available volume after 24 hrs = 2500+190-1480 = 1210 l
- Non-compliant and on average more water (approximately 740 l) would need to pass to the street for subsequent treatment in the street garden 25% of the time.

Option 1 – Rainwater Tank to meet Frequent Flow Management
As an alternative to meet the new Frequent Flow Management design objective in the harvest tank alone, additional tank storage with no increase in roof area connected to the tank would be required.

Assuming 50% of roof connects, and providing a 6000 l tank and 20 l first flush the above figures become:

- Roof Area = 200 sqm
- Driveway Area = 30 sqm
- Rainfall depth to be captured = 15 mm/day (the Frequent Flow Management design objective)
- Rainfall Volume to be reused or treated = 15 mm x 230 sqm =3450 l
- Tank Volume = 6000 l
- Portion of roof connected = 50%
- Connected Roof Area = 100 sqm
- Volume collected from roof = 15 mm/day x 100 sqm = 1500 l
- Less First Flush = 20 l (discharged to downstream treatment)
- Volume collected by Tank = 1500 l – 20 l = 1480 l
- Average available storage = 50% x 6000 l = 3000 l
- Average daily usage = 70,000 l /365 = 190 l
- Available volume after 24 hrs = 3000+190-1480 = 1710 l
- Compliant and on average the tank size of 6000 l for a 100 sqm roof connection would meet the frequent flow design objective.

Accordingly for a typical residential lot a 6000l tank is recommended for harvesting, and to achieve the Frequent Flow Management objective of Healthy Waterways (SEQIG7).

Option 2 – Rainwater Tanks and Bioretention to meet Frequent Flow Management
At a meeting with ICC on 22 March 2010, ICC advised that it would be difficult to amend the Part 12 Planning Legislation to incorporate larger tanks than that specified in the QDC.

Although the QDC regulated 5000 L did not achieve this outcome for Ripley rainfall averages, the provision of bioretention basins in the residential areas provide sufficient storage to supplement that required to achieve the requested frequent flow management objectives of the SEQ Implementation Guidelines No 7.

For commercial areas, the frequent flow management is readily managed by the provision of rainwater harvest tanks, bioretention basins and if necessary porous pavements to plaza areas and “green” roof tops/podiums can be used to supplement the storage requirements.

Detailed proof of achieving the frequency of flow requirements in commercial areas will be demonstrated at the detailed design stage and is not relevant at the NMP level of planning.

For a typical site area of 1ha of commercial development, the Frequency of Flow Management criteria is 15mm retention over the impervious area.

Assuming a plot ratio of 100% then the building area would be 5000sqm footprint as a minimum. Allowing 235 sq / pedestal of GFA, and given that each pedestal requires 1500L of storage which would provided about 12hrs of use based on 6L flush per 3 minutes (equivalent to 32 cum of storage). In addition, the bioretention on site would require 45 cu of extended detention plus incorporate 11 cum within the filter media based on 15% porosity. The airconditioning would require 1.23 L/day/sqm GFA equivalent to 6 cum.

Therefore the total storage provided is:

Toilets	32 cum
A/C	6 cum
Bioretention	56 cum
	94 cum total

The required storage of 15 cum rainfall depth on the impervious faction equates to:

15	x	i%	x	10000/	1000	≤	94	cum
Therefore				Imperviousness		≤	62%	to achieve Frequent Flow Management objectives without additional storage.

APPENDIX 5

Commercial Harvest Tank Calculation

Within the commercial areas it will therefore be necessary to provide rainwater tanks for toilet flushing. As a guide, for a typical 1 ha commercial area assuming 80% site coverage by the building and 90% site imperviousness, the number of pedestals/urinals will total about 136 (based on BCA densities for retail/commercial building and the QDC requires a minimum storage of 1500l per pedestal thus equating to 204kL being minimum required per site ha.

Each pedestal will draw about 6 l/min thus the demand is anticipated to be 816 l/min and the daily drawdown is expected to be 196 kl/day assuming 8hours at 50% average demand.

In addition, air conditioning will require top up water and the air conditioner condenser units will discharge about 20% of their water usage to sewer as part of their normal operating and maintenance schedule. Based on similar centres in South East Queensland, the anticipated water usage for the air conditioning units is about 45-50 kl/year/100 sqm GFA, of which 20% is returned to sewer and the rest is evaporated.

Therefore the estimated air conditioning usage is:

50 kl/year/100sqm GFA x (32000/100) / 365 days/yr x = 43.8kl/day (say 44 kl/day)

Total tank demand (minimum) is 44+196=240 kl/day/ha and the minimum QDC supply tank required is 204 kl which would not be sufficient for the number of toilets anticipated.

As a guide usually 20 -30 days storage is provided and thus the tank storage is between 4800 and 7,200 kl per ha for a 4 storey building of 32,000 m² GFA.