cranbourne east
precinct structure plan

Surface Water Management and WSUD

CEUGP/SR5A

DRAFT ISSUES PAPER

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1 EXECUTIVE SUMMARY

Cranbourne East covers approximately 870 hectares and is in part bounded by:

- Thompsons Road to the north
- Berwick-Cranbourne Road (Clyde Road) to the east
- South Gippsland Highway to the south west

This document is one of a series of specialist reports prepared to inform the strategic planning for the Cranbourne East Precinct Structure Plan. This Issues Paper outlines the Water Sensitive Urban Design (WSUD) opportunities and constraints for the study area and provides information on WSUD elements which may be implemented at the local, precinct and regional scale. Indications are provided on the likely extent of land required to be set aside for the management of surface waters.

A WSUD approach will be adopted for water management at Cranbourne East which encompasses all aspects of integrated urban water cycle management including water supply, sewerage and stormwater management. The principles of WSUD are focused on minimising potable water use and dependence on natural resources, maximising water reuse within the built environment and protecting and enhancing aquatic ecosystem health through improved stormwater quality and flow management,

The WSUD objectives proposed for Cranbourne West are based on identified existing site conditions, environmental values and policies. Site wide strategies have been formulated as a response to the objectives. The proposed water management strategies for the Cranbourne East study area are:

- Incorporate integrated water cycle management into the urban planning process. This includes the use of rain, storm and recycled water in order to reduce the demand on potable mains water.
- Meet best practice objectives for stormwater quality and quantity runoff by incorporating a treatment train of stormwater structural controls.

- Remediate the main drainage system through the site to a healthy ecosystem, including a 30 m riparian/buffer zone either side of the low flow channel.

- Integrate open space areas with conservation corridors, stormwater management controls, and social and community objectives.

In particular, the following opportunities and constraints for water management at Cranbourne East have been identified:

- A dual pipe system using recycled water from the Eastern Treatment Plant will be mandated throughout the subdivisions within the development area for non-potable water demands such as toilet flushing, cold washing machine tap and irrigation (subject to groundwater conditions).

- Rainwater and stormwater harvesting could be employed on site to further reduce demands on potable water. Rainwater can be used in hot water systems and rain and stormwater harvesting can provide an additional water source for irrigation purposes.

- Clause 56 of the Victorian Planning Provisions require best practice water quality treatment in all residential subdivisions. Even though the majority of the study area falls within the Collison Road Drainage Scheme, it is recommended that best practice targets be met within all residential subdivisons within the entire study area thereby endorsing a focus on water quality and quantity controls throughout the development. The regional level treatments identified in this report can ultimately be used for further polishing of the stormwater and for storage for re-use purposes.

- It is proposed to remediate the main drainage channel through the site to a healthy waterway. The waterway will form the main drainage pathway of the site post development and will be remediated to achieve a healthy ecosystem underpinned by good water quality (through adoption of WSUD in individual subdivsions) and geomorphic structure that it compatible with the change in hydrologic conditions for the catchment. It is recommended that a riparian/buffer zone of 30 metres either side of the low flow channel be provided. In addition, this waterway will be linked to the Cranbourne Gardens via a terrestrial environmental corridor.

- Three retarding basins are required within the study area. Preliminary estimates of the site areas required for the basins are provided.

- Information is provided on indicative alignments and widths of reserves required to provide safe conditions for overland flow during major storm events.

Sewerage and potable water supply are beyond the scope of this report; however are to be considered in parallel with issues discussed in this report. Refer to *Hydrogeology Assessment – Groundwater and Salinity* (SKM) and *Services Infrastructure Conditions* (SKM).

2 INTRODUCTION

2.1 Background

The current Cranbourne East Development Plan sets out the planning strategy for rezoning land in Cranbourne East A. The balance of the land within the Urban Growth Boundary, known as Cranbourne East B, is the subject of this Issues Paper. Cranbourne East B is approximately 870 hectares.

2.2 Locality Description

Cranbourne East is in the City of Casey municipality. The City of Casey covers approximately 400 square kilometres and is the largest and fastest growing municipality in Victoria. Figure 1 shows a map of the location of the City of Casey. Figure 2 shows a base plan of the Cranbourne East study area that is the focus of this draft issues paper.

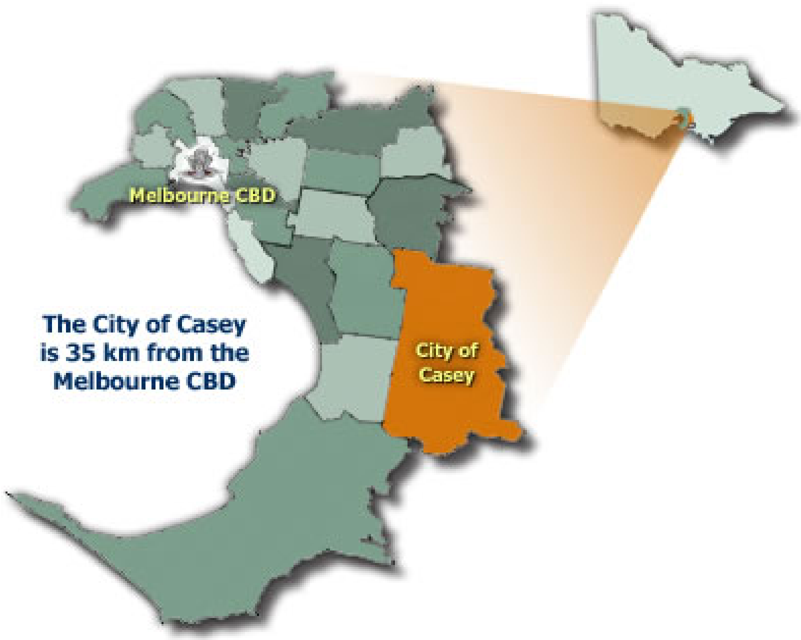

Figure 1 City of Casey

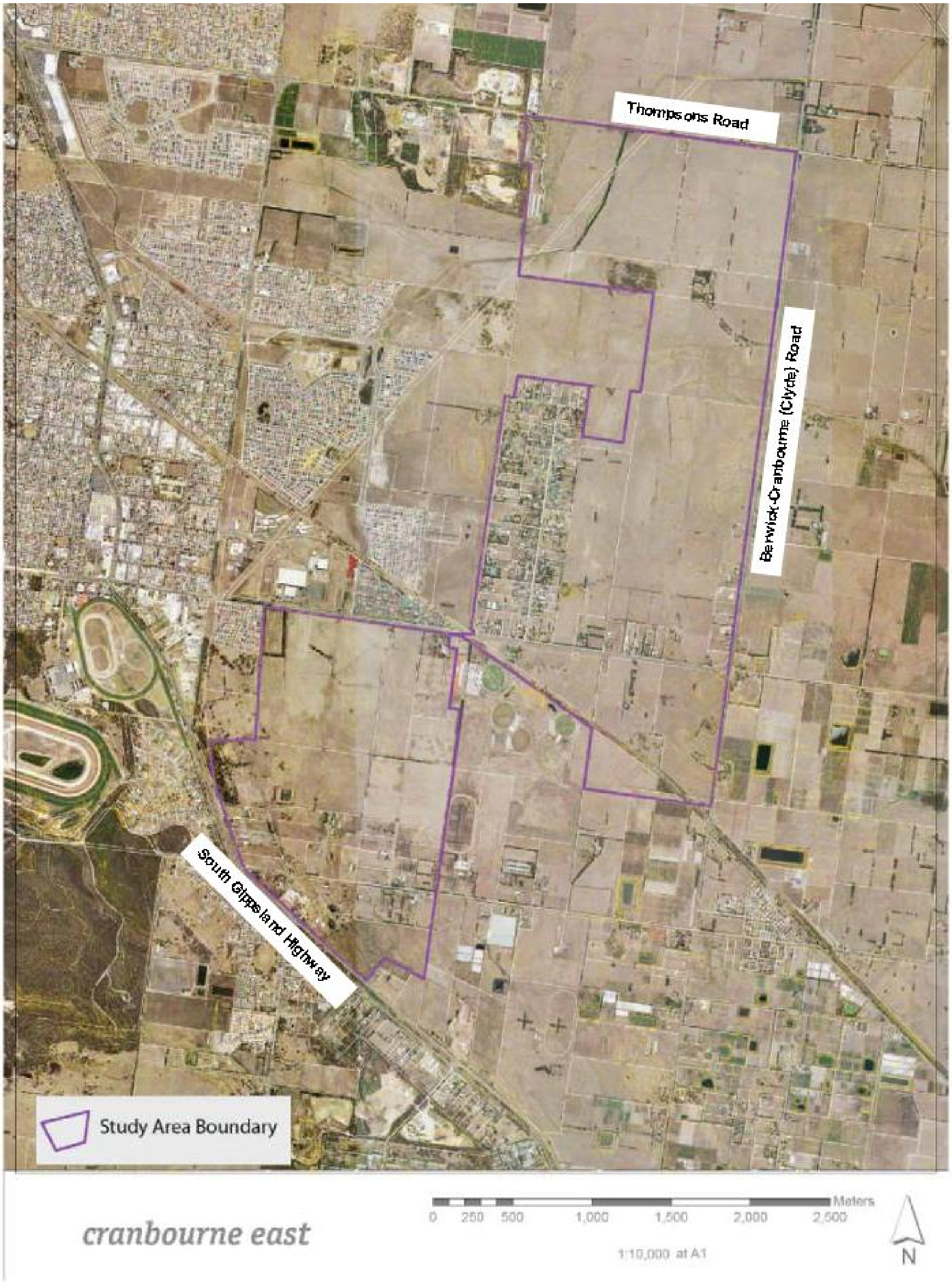

Figure 2 Base Plan of Study Area

2.3 Proposed Land Use

It is expected that the subdivisions within the Cranbourne East Study area will be residential developments. It is uncertain as to whether the area outside the Urban Growth Boundary, south of Thompsons Road, will be made a regional park. For the purposes of this report it is assumed that this area of land will not be developed.

2.4 Purpose of the Issues Paper

It is anticipated that the Cranbourne East study area will provide a future residential growth area with open space networks, a hierarchy of activity centres, transport infrastructure and community facilities.

It is intended that the Cranbourne East development plan will provide an innovative and sustainable social, economic and environmental outcome with input from all key stakeholders that realises Local and State planning policies.

This Draft Issues Paper outlines the Surface Water Management and Water Sensitive Urban Design (WSUD) opportunities and constraints for the site as a whole and provides information on WSUD elements which may be implemented at the local and precinct scale. The sustainable and integrated management of water, through Water Sensitive Urban Design, will form an important component of the Development Plan.

3 CONTEXT AND DRIVERS FOR WATER MANAGEMENT

The water management planning and strategy for Cranbourne East is to be tailored to the existing site conditions in order to provide the most appropriate and sustainable system. Government policy will also be referenced to guide the strategic planning for water management at Cranbourne East. The existing conditions and relevant policies and guidelines are summarised below.

3.1 Existing site conditions

3.1.1 Drainage patterns and flooding

Information on existing drainage patterns and flooding was obtained from a number of sources including the Request for Tender specification, the Collison Road Drainage Scheme and the Collison Estate Water Plans. The following relevant points have been taken from the existing reports:

- The site has a significant low lying section and it is expected that existing drainage lines, flow retardation capacity and water sensitive urban design will be major drivers of open space and land use planning. In addition, the incorporation of separate water supply networks for potable and non-potable uses (i.e. a third pipe system) and a range of water conservation principles should be considered in the preparation of the Development Plan.

- The Collison Road Drainage scheme covers around 700 ha and approximately 465 ha of the Cranbourne East study area falls into this drainage scheme area.

- Collison Estate is a 90 lot low density residential subdivision that sits within the study area. At present there is no piped underground stormwater system. Stormwater runoff is directed to Clyde Creek to the North East of the estate by means of an open channel and roadside swale drains, maintained by the Casey City Council. The area is prone to frequent flooding.

- The existing main drainage line (i.e. the upper reach of Clyde Creek) has been artificially straightened for farming purposes. It appears there is little or no existing vegetation of significance along this reach.

3.1.2 Groundwater, Environmental and Archaeological Assessment

These issues which will interact with surface water management and WSUD are the focus of separate issues papers. The information provided in the other issues papers will be incorporated into the surface water management and WSUD assessment during the planning process.

3.1.3 Rainfall

Climate and rainfall information has been obtained from the Bureau of Meteorology Cranbourne Botanic Gardens meteorological station 086375. Data has been collected at this station since 1990. The annual average rainfall is 865mm. The monthly distribution of median rainfalls (and corresponding 10%tile and 90%tile markers) at Cranbourne Botanic Gardens is shown in Figure 4. The plot shows a fairly uniform monthly distribution of rainfall with the lowest median monthly rainfall of 46 mm (March) and the highest of 97 mm (October). The lowest 10%tile rainfall occurs in the month of February (1.8 mm). The mean annual number of rain days at Cranbourne is 184 days.

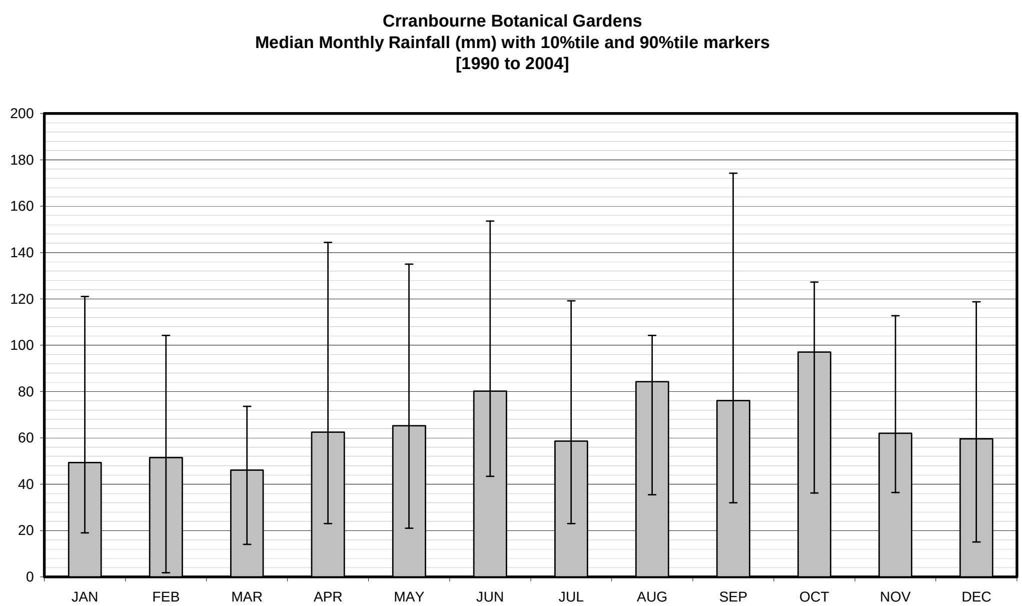

Figure 3 Rainfall

3.2 Guidelines and Legislation

The water management strategy for Cranbourne East; including potable water use, alternative water sources and water quality and quantity management, must meet a range of legislative, government agency, and council requirements for water management. A brief summary is provided below.

3.2.1 State

State legislation and guidelines that influence water management planning at Cranbourne East which should be adhered to include (and are not limited to):

- State Planning Provisions
- The State Environment Protection Policy (Waters of Victoria) and relevant schedules (F6)
- The State Environment Protection Policy (Groundwaters of Victoria)
- Melbourne 2030 Final Report: Casey – Cardinia Committee for Smart Growth
- Sustainable Water Strategy Central Region: Action to 2055
- The White Paper: Securing Our Water Future Together
- A Plan for Melbourne's Growth Areas
- Precinct Structure Planning Guidelines (DSE)

In particular, with regards to stormwater management in greenfield residential developments, the recently revised Clause 56.07-4 of the Victorian Planning Provisions states that water management in residential subdivisions must minimise increases in stormwater runoff and protect the environmental values and physical characteristics of receiving waters. The drainage for the development must be designed to meet current best practice performance for stormwater quality, which is outlined in Urban Stormwater – Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999) as amended.

Regard should be paid to Melbourne 2030's implementation plans which acknowledge the role of sustainable stormwater management in decreasing the effects of urbanisation on the health of Victoria's waters and call for development that will minimise impacts on the environment to create a sustainable path for future growth. The Precinct Planning Guidelines also state that all new urban development should be designed to ensure the health of the downstream waterway does not decline compared to its quality prior to development occurring.

A number of government agencies will need to be consulted during the more detailed Structural and Development Plan stages of strategic planning for recycled water use, rain and stormwater reuse and water quality management at Cranbourne East. These agencies include Melbourne Water, South East Water, the Environment Protection Authority and the Department of Sustainability and Environment.

3.2.2 Local

There are a number of local planning guidelines to be followed which will impact on water management in the area. These include (and are not limited to):

- Casey C21 Strategy: A vision for Our Future (September 2002)
- Municipal Strategic Statement (MSS)
- Casey Image Strategy
- Casey Open Space Strategy
- Cranbourne East Development Plan 2006

Elements of the C21 strategy relevant to water management include retaining existing waterways in new developments with wide green corridors on each side; seeking ways of improving the quality of water and waterways to remediate their ecological functions and natural drainage characteristics and incorporating the principles of best practice in stormwater and effluent management in Casey.

The preferred neighbourhood character and therefore landscaping design, for Cranbourne East is then outlined in the Council Draft Image Strategy and Draft Neighbourhood Character Policy.

There is also the recognition of Clyde Creek as a potential public open space corridor of regional significance, particularly in relation to the connections to Casey Fields and the Cranbourne Botanic Gardens.

4 WSUD OBJECTIVES

In establishing the WSUD objectives and ensuing strategy for the Cranbourne East development area, the regional and local water management values and policies need to be identified. The relevant guidelines and legislation, in addition to inputs such as existing site conditions, assist in setting water management objectives for the area. Water management strategies, using the principles of Water Sensitive Urban Design (WSUD), are then developed in order to meet objectives. A description of WSUD and the proposed water management objectives and strategies are presented below.

4.1 Water Sensitive Urban Design

WSUD evolved from its early association with stormwater management to provide a broader framework for a holistic management of the urban water cycle and its integration into urban design. The conceptual framework linking WSUD to the broader issues of Ecologically Sustainable Development (ESD) is presented in *Australian Runoff Quality: A guide to Water Sensitive Urban Design* (Wong, 2006a). WSUD reflects a new paradigm in the planning and design of urban environments that is 'sensitive' to the issues of water sustainability and environmental protection. It pertains to the synergies within the urban built form (including urban landscapes) and the urban water cycle (as defined by the conventional urban water streams of potable water, wastewater, and stormwater), integrating the holistic management of the urban water cycle into the planning and design of the built form in an urban environment.

WSUD aims to protect water resources in all parts of a catchment through mitigating local impacts of development and, via water conservation, reducing impacts in harvesting catchments. WSUD provides a valuable approach for delivering sustainable urban water management.

The principles of WSUD are focused on minimising potable water use and dependence on natural resources, maximising water reuse within the built environment and protecting and enhancing aquatic ecosystem health through improved stormwater quality and flow management. WSUD can be applied at allotment, local, precinct or regional level. (The provision of sewerage, drainage and potable water services are discussed in a separate draft issues paper).

4.2 Water Management Objectives

The guiding WSUD principles for sustainable water management at Cranbourne East are:

- To reduce potable mains water demand through a combination of demand management initiatives and use of alternative water sources
- To identify and maximise the use of alternative water sources in accordance to a fit-for-purpose approach to use of these water sources
- To minimise the impact of urban stormwater on the receiving aquatic ecosystem through attaining best practice stormwater quality and flow management objectives
- To improve the health of the existing watercourses, and
- Enhance the aesthetic and passive recreational enjoyment of the waterways and surrounding areas

Key initiatives associated with the above guiding principles applicable to a regional strategy are outlined below and discussed in more detail in the following sections of this Issues paper.

- Use an integrated approach to the management of water supply including the use of rain, storm and recycled water in order to reduce the demand on potable mains water
- Meet best practice objectives for stormwater quality and quantity runoff through the adoption of WSUD elements at the regional, precinct and local scale
- Remediate existing drainage systems into healthy ecosystems
- Integrate open space with conservation corridors, stormwater management controls, and social and community objectives.

In addition to the above, demand management initiatives including water efficiency fittings and appliances in household is considered an essential initiative of the WSUD Strategy for Cranbourne East.

5 INTEGRATED WATER CYCLE MANAGEMENT

An integrated urban water cycle management plan will form part of the WSUD strategy for the site. Integrated water cycle management matches available water sources with the most appropriate uses. This is illustrated in Figure 4 and shows the water use hierarchy linking water quality and appropriate use. Water for human consumption requires the highest quality water and hence situated at the 'top'. Toilet water requires the lowest water quality and hence sits at the lowest point. This 'fit-for-purpose' approach is used to match appropriate water sources and water uses. This is a way to reduce the demand on the highest quality potable water.

At Cranbourne East it is proposed to use two alternative water sources to potable mains water. These are recycled water and rain/stormwater harvested at the allotment scale and at a precinct scale. These are discussed in more detail in the next sections.

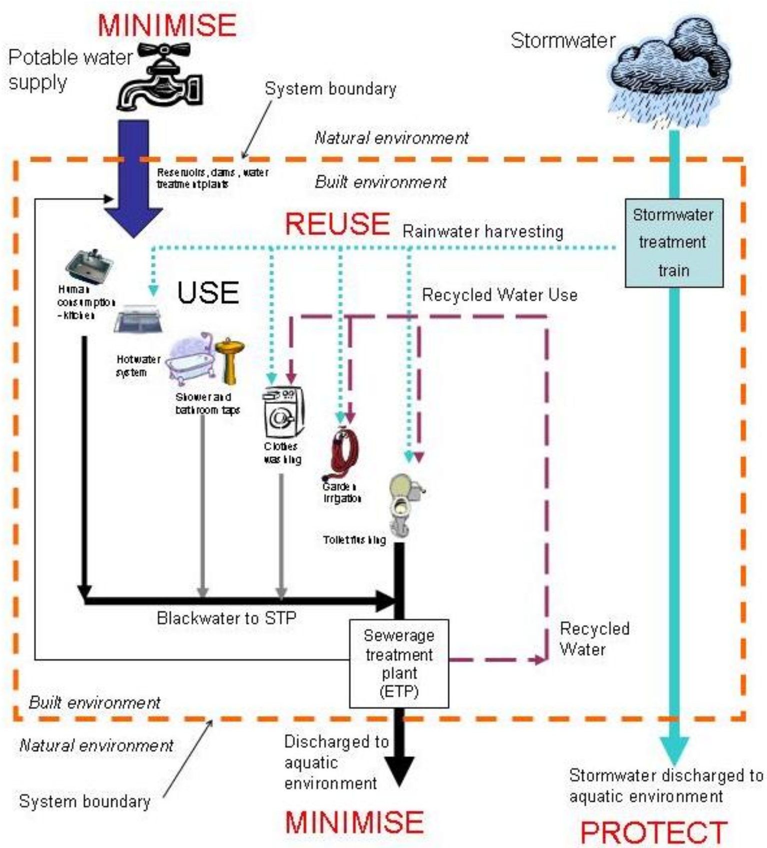

Figure 4 Integrated Water Management Plan for Cranbourne East

5.1 Recycled Water use

South East Water has confirmed that recycled water from the Eastern Treatment Plant will be available for the Cranbourne East area.

Within residential areas connection to the recycled water system will be mandatory. A dual pipe system should be installed and the recycled water would be suitable for:

- Toilet flushing
- Cold washing machine tap
- Private garden irrigation/outdoor use
- Public open space irrigation

Note that the use of recycled water for irrigation purposes needs to be sensitive to the variable hydrogeology in the area and consideration needs to be given to the higher risk to the environment with unregulated domestic use. Use of recycled water for non potable water demands can be expected to reduce demand on mains potable water by up to 60%.

It needs to be confirmed whether or not recycled water will not be available for fire fighting purposes.

5.2 Stormwater reuse

Rainwater can be described as the water that falls on the roofs of buildings. Stormwater runs off other areas within the development such as roads and pavements. The reuse of rain and stormwater addresses both water conservation and stormwater management objectives. Harvesting and reuse of rain and stormwater reduces the demand on potable water resources and reduces the volume of stormwater runoff from a site. As stormwater runoff can pollute and alter the hydrology and hydraulics of receiving waters, a reduction in stormwater volume is desirable. Therefore, in addition to recycled water, options to include rainwater harvesting at individual allotments (e.g., for use in domestic hot water service) and precinct and regional stormwater harvesting should be considered throughout the development.

It is anticipated that recycled water will have higher nutrient and salt levels than rainwater or stormwater and therefore it may be desirable for rainwater to be used for private open space irrigation where management and regulation of irrigation is less structured. With stormwater being treated for reduction in nutrients prior to their storage at precinct and regional storages (e.g. ornamental ponds), a stormwater/recycle water mix may be better suited to application within open spaces to reduce the risk of nutrients and salt reaching the groundwater in the event of over-watering.

Using water from rainwater tanks in the hot water systems within residences, when combined with the dual pipe recycled water system, is expected to reduce total demand for potable mains water by up to 80%.

5.3 Demand Management

It is recommended demand management measures are implemented throughout the development area. Demand management would include water efficient fittings and appliances including plumbing fittings, pressure regulation (at the household – applicability will depend on the type of household appliances), and water efficient garden design including xeriscaping and hydro-zoning. Guidelines and recommendations would be provided to households to effectively promote these initiatives.

The presence and depth of the regional groundwater system is still to be determined. Reducing the likelihood of over-watering is considered more than just an important demand management initiative if the regional groundwater system is shallow to avoid interaction of the groundwater system with the sub-structures of proposed developments in the area.

5.4 Groundwater

A Hydrogeology Assessment (Groundwater and Salinity) is being prepared as a separate issues paper by Sinclair Knight Merz. Information provided in the draft Hydrogeology suggests that there are some areas of the study area may be susceptible to shallow water table conditions. Groundwater salinity is low over most of the study area and areas of slightly higher salinities do not appear to be associated with areas where shallow water tables occur. The majority of the area falls within the Koo Wee Rup Water Supply Protection Area.

5.5 Sewerage and Potable Water Supply

The sewerage and potable water supply systems are the focus of a separate issues paper.

6 STORMWATER QUALITY MANAGEMENT

At Cranbourne East there is the opportunity to incorporate water quality controls into the urban planning process from this preliminary planning stage. These controls can be seamlessly integrated into the urban design throughout the development at all scales. In the first instance, regional water quality facilities should be identified to provide the regional underpinning of stormwater quality management.

6.1 Stormwater Quality Management

Strategies for stormwater quality improvement and flow management have, until recently, been voluntary for the public and private sector despite the statutory status of the performance objectives as outlined in the Victorian Stormwater Committee's Urban Stormwater Best Practice Environmental Management (BPEM) published in 1999. The objectives are summarised in Table 1 below. *Victorian policy, through recent amendments to Clause 56 of the Victorian Planning Provisions, now mandates the implementation of WSUD in all new residential subdivisions*.

Table 1 Victorian best practice performance objectives for urban stormwater – design performance

Pollutant	Current best practice performance objective
Suspended solids (SS)	80% retention of the typical urban annual load
Total phosphorus (TP)	45% retention of the typical urban annual load
Total nitrogen (TN)	45% retention of the typical urban annual load
Litter	70% reduction of typical urban annual load
Flows	Maintain discharges for the 1.5 ARI event at pre-development levels

6.1.1 Clause 56 and Melbourne Water Drainage Schemes

The study area covers four separate surface water catchment areas. A diagram of the study area divided into catchments is provided in .

Parts of the study area fall within two Melbourne Water Drainage Schemes, The Ti Tree Creek Drainage Scheme and The Collison Road Drainage Scheme. The area within the Ti Tree Creek drainage is outside the urban growth boundary and is assumed will become Regional Park. The Collison Road Drainage Scheme is currently under review by Melbourne Water. The scheme covers around 700 ha and approximately 465 ha of the Cranbourne East study area falls into this drainage scheme area. The scheme area is shown in Figure 6.

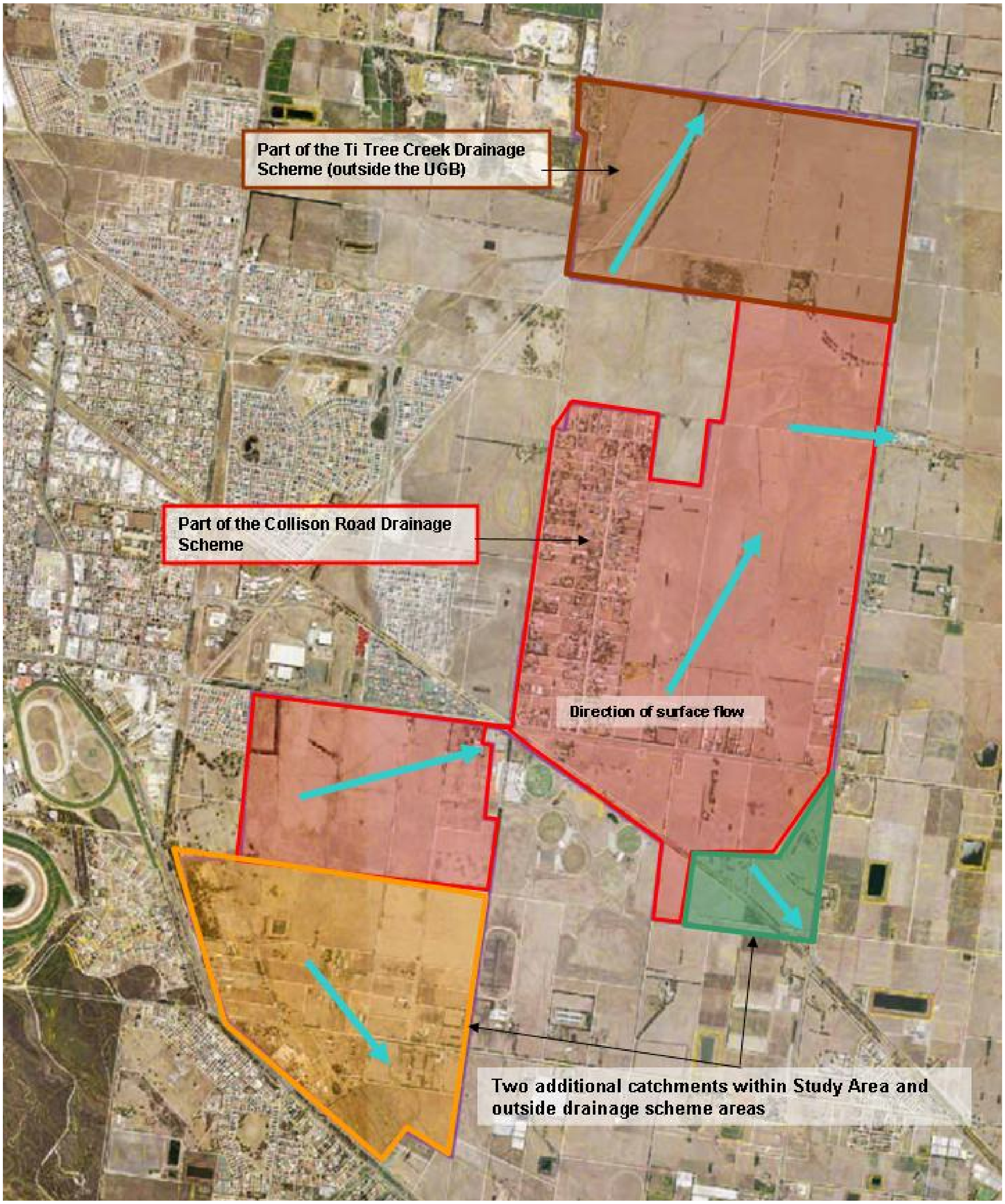

Figure 5 Study Area divided in to surface water catchments

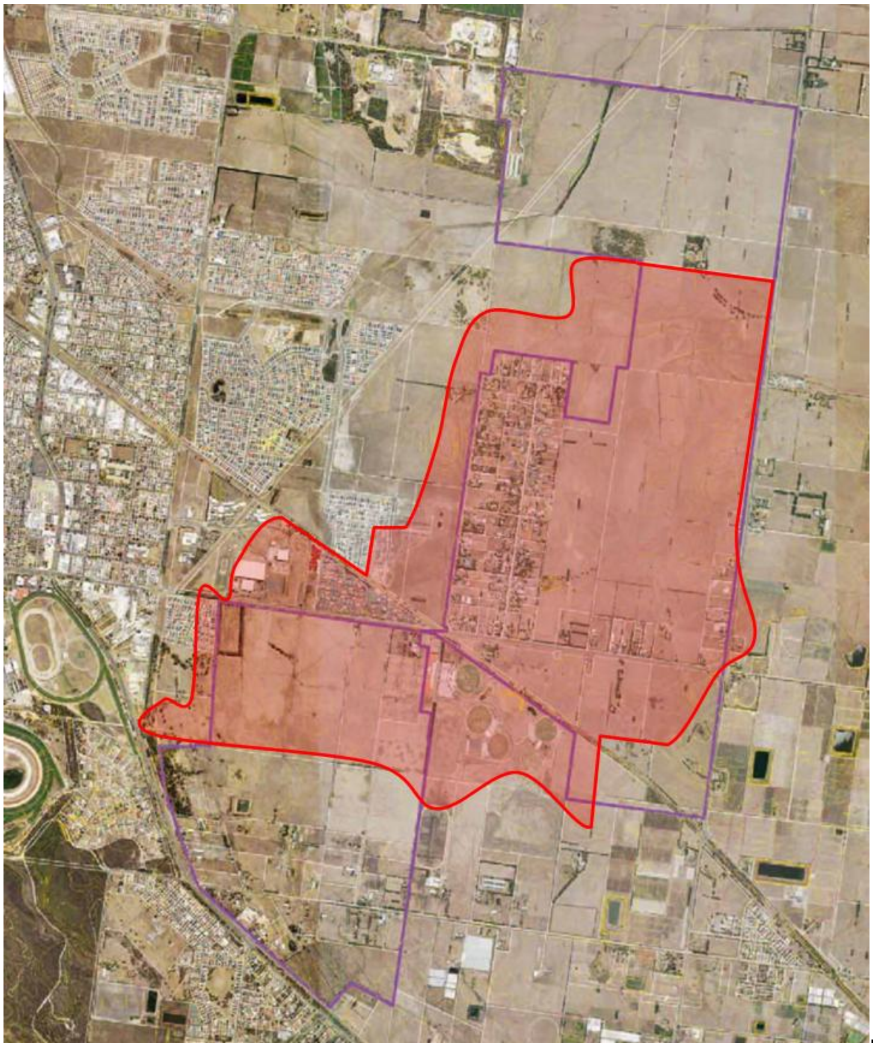

Figure 6 Approximate boundary of Collison Road Drainage Scheme

The provision of a drainage scheme, in the past, would generally plan for achieving best practice in water quality treatment by providing water quality treatment elements at a regional scale (e.g. a regional wetland), thereby negating the need for any sub-divisional scale treatment i.e. Clause 56.04 would not need to apply. However, such an approach will only deliver environmental benefits to downstream aquatic systems outside of the study area.

It is recommended that in all residential subdivisions at Cranbourne East, including those that lie within the scheme area, comply with the objectives of Clause 56.04. As such, WSUD for stormwater quality treatment and flow management should be implemented at the local and precinct scale in all residential subdivision development in order to meet best practice objectives. The reasons for this are two-fold:

- A main waterway remediated to a healthy ecosystem is proposed to run through the entire development area which will act as the main drainage channel for the development. In order to enhance and sustain the ecological integrity of the waterway, stormwater should be treated to best practice at before being discharged to this waterway.
- If water quality management is attained at the subdivisional scale then the regional wetlands can be used for final polishing of stormwater (i.e. stormwater from the site will be treated to better than best practice), and to provide an area of high ecological and habitat value.

The residential subdivisions within the Cranbourne East study area that do no fall within an existing drainage scheme will need to comply with Clause 56.04.

The following sections provide information on WSUD structural elements that can be applied at Cranbourne East.

6.2 Opportunities and Constraints to WSUD Structural Controls

At all scales of WSUD application to water quality and quantity control management, from on lot to regional, there is the opportunity to engage and inform the community on issues of sustainable urban water management and WSUD. For example, aesthetically pleasing precinct scale water features can be passive recreation spaces and in addition raising community awareness about sustainable urban water management. This is an additional positive outcome of the application of WSUD to the urban form.

In some areas the topography is relatively flat which may affect the suitability of some treatment elements, e.g. swales, in certain areas. A more distributed system of controls with a preference for source controls is suitable in flatter terrain.

Groundwater issues will have implications on the extent to which stormwater management by infiltration measures are appropriate and for where lining of other systems may be required. The draft report, *Hydrogeology Assessment – Groundwater and Salinity* (SKM) reports areas of shallow water table within Cranbourne East. It is recommended to avoid land management practices that could promote or create shallow water tables by ensuring that the net groundwater flow does not increase. Ways to manage this may include the possible installation of subsurface drainage; managed use of recycled water for irrigation purposes that is sensitive to the hydrogeology of the area including the use of sensor drip irrigation systems; and the possible extraction and use of groundwater within the development, e.g. for irrigation of public parks or mineral pools. It is likely that infiltration type systems would be unsuitable and wetlands and bioretention systems will need to be lined to prevent infiltration to groundwater. Refer to the SKM report for further information and detail.

The final layout and design of the preferred water quality and quantity measures will be decided upon with consideration to a number of factors including site conditions, urban planning, open space requirements and lifecycle costs. The City of Casey's Works and Operations Department, Melbourne Water and the Environmental Protection Authority (EPA) would be consulted during this process. Best Practice Guidelines would be prepared for various stages of the lifecycle of the WSUD controls including design, construction and operation and maintenance.

6.3 Water Quality Treatment Train

As discussed in the previous section, best practice in stormwater management encompasses treatment elements at various scales which can be combined to provide a strategic framework for integrated stormwater management. A link between the various scales of treatment is displayed diagrammatically in Figure 7.

Local Elements ⟷	***Precinct Elements*** ⟷	***Regional Elements***
▪ allotment density and layout	▪ local street layout & streetscape	▪ major road layout
▪ on site retention (infiltration)	▪ precinct retention (infiltration)	▪ Public Open Space & Multiple Use Corridors
▪ porous pavement	▪ porous pavements	
▪ sand filter	▪ sand filter	
▪ buffer strips	▪ buffer strips	
▪ vegetated swales	▪ vegetated swales	
▪ bioretention system	▪ bioretention system	
▪ rain garden	▪ urban forest	
▪ on-site detention	▪ retarding basins	▪ retarding basins
▪ rainwater tank for stormwater reuse	▪ constructed wetlands & ponds	▪ constructed wetlands & ponds
	▪ stormwater reuse	▪ stormwater reuse

Figure 7 Inter-relationship between local – precinct –regional stormwater management measures

There are four scales of water quality treatment that can be applied at Cranbourne East:

- Local (on lot scale)
- Local (streetscape scale)
- Precinct (subdivision scale)

o Regional (Cranbourne East)

The selection of treatments within the treatment train is best achieved using a holistic approach that focuses on meeting overall water quality and quantity objectives. The final selection and layout of water quality controls will be dependant on integration with other urban design elements, such as infrastructure and road layout, during the urban planning process. Various WSUD options at the different scales are discussed in more detail below.

6.3.1 On lot scale

The function of source controls is primarily to collect and treat stormwater on individual lots and to retain a portion of it for reuse, which will also assist achieving the objective of reducing potable water usage. Options for at-source controls can include rainwater tanks, on-lot bioretention and porous paving. The source controls employed should maximise the potential for on-site detention and reuse of stormwater. It is not within the power of the City of Casey to mandate the provision of water quality and quantity controls within individual lots. The provision of such controls is regulated by the Building Commission.

Rainwater Tanks

Rainwater tanks collect runoff from roof (or other impervious) areas and can provide a supplementary source of non-potable water in urban areas. Rainwater tanks also help to protect urban streams by reducing stormwater runoff volumes, particularly from small storms, and associated pollutants from reaching downstream waterways. Rainwater tanks also serve to retard a flood provided adequate temporary storage is available. Provision of temporary flood storage can reduce peak flow rates of frequent flood events and can contribute substantially to attaining the flow management objective of maintaining discharges from the development for the 1.5 year ARI event to pre-development levels.

Tanks can be incorporated into the building design so they do not impact on the aesthetics of a development. They can be located underground or into fence or wall elements. Collected roof water is suitable for direct use for garden irrigation or toilet flushing with no additional treatment. An assessment would be required to determine the optimum size rainwater tank for each lot, with the primary selection criteria being the percentage reduction in potable water demand that the rainwater tank would provide. Consideration should be given to the mandatory use of rainwater tanks throughout the entire Cranbourne East Development area.

Figure 8 Example rainwater tanks

Bioretention Raingardens

On-lot bioretention (or raingardens) can be located on lots as part of private open space landscaping. Typically the bioretention area required is 1.5% of the impervious catchment area draining to it. Stormwater is treated by filtration through a soil media of selected sandy-loam (replacing the native soil), and subsequently collected by perforated pipes located within the biofiltration pit. The biofiltration pit can receive runoff mainly from ground-level impervious areas on the lot and can also receive overflows from the rainwater tank. They also provide flow retardation.

Bioretention basins in the Cranbourne East area may need to be lined with an impermeable liner to prevent any infiltration into surrounding soils or groundwater. After the stormwater is filtered through the filter media it is collected by underlying perforated pipes before discharging to downstream waters (or collection systems for reuse).

Figure 9 Bioretention systems can be blended into a modern city streetscape or central area

Porous Paving

Driveways and external impervious areas on each lot can be paved with porous pavement to reduce the impervious area on each lot and on the development in general, thereby reducing peak runoff rates and the volume of stormwater discharge, particularly for smaller and more regular storms (only applicable if groundwater recharge is not considered to be a problem in the area). The infiltrated runoff percolates into a sub-base layer of gravel or aggregate which acts as a storage zone. If necessary, the runoff is then intercepted by perforated pipes to a collection pit and conveyed off-site to connect with the street-side underground stormwater system. Some types of modular pavers can planted with grass to provide a greened surface as an alternative to a conventional hard surface.

Porous pavement also provides a pollution-reduction function, by removing fine particle and dissolved pollutants from the stormwater. Gravel driveways may be used as an alternative option to porous pavement where the driveway grade is sufficiently flat.

On Site Detention

The management of stormwater quantity and flooding can be assisted by the provision of on-site detention (OSD). Rainwater tanks with additional storage above its full supply level can often provide the function of an OSD. OSD aims to mitigate stormwater runoff rates and the principal design criterion for on site detention relates to the existing runoff rates during design storms. With the provision of regional flood detention basins for large flood events, OSD within the development would only be required for management of frequent flood events up to the 1.5 year ARI event. The approximate area for on-site detention basins would be approximately 150m^3 per hectare of contributing impervious area.

6.3.2 Streetscape Scale

Stormwater treatment elements in the public domain start at the street-scale applicable in all sub-division types. Options for WSUD elements at the streetscape level include buffer strips, bioretention swales and street trees and are discussed below.

Buffer Strips

Buffer strips are intended to provide discontinuity (i.e. a buffer) between impervious surfaces and the drainage system. Buffer strips are effective in retaining sediments and suspended solids conveyed from impervious areas. A key design consideration of buffer strip is to ensure flows are uniformly distributed at the entry.

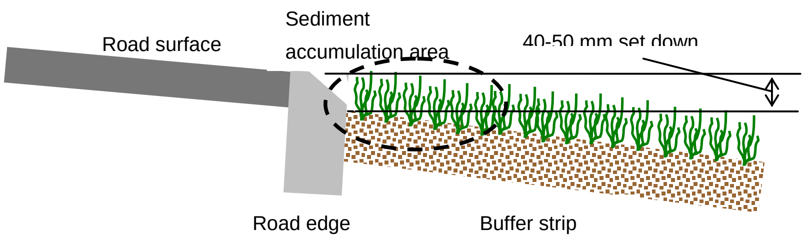

Figure 10 Typical Buffer Strip Arrangement

Swales and Bioretention swales

A swale is a vegetated channel which acts as a drainage channel. A bioretention swale system is a combined vegetated swale with a stormwater filtration system underneath where stormwater is filtered through a prescribed filter medium and is then collected by an underlying perforated pipe for discharge into a stormwater pipe system. Pollutants are removed by deposition and biofiltration processes. Swale bioretention systems provide water quality treatment and a peak flow reduction system.

An important design consideration of swales and bioretention swale system is the provision of above design flow conveyance. Overflow pits would be located along the swale so that in larger storm events, flows in excess of the capacity of these systems would overflow into the pits and discharge directly into the underground piped drainage system.

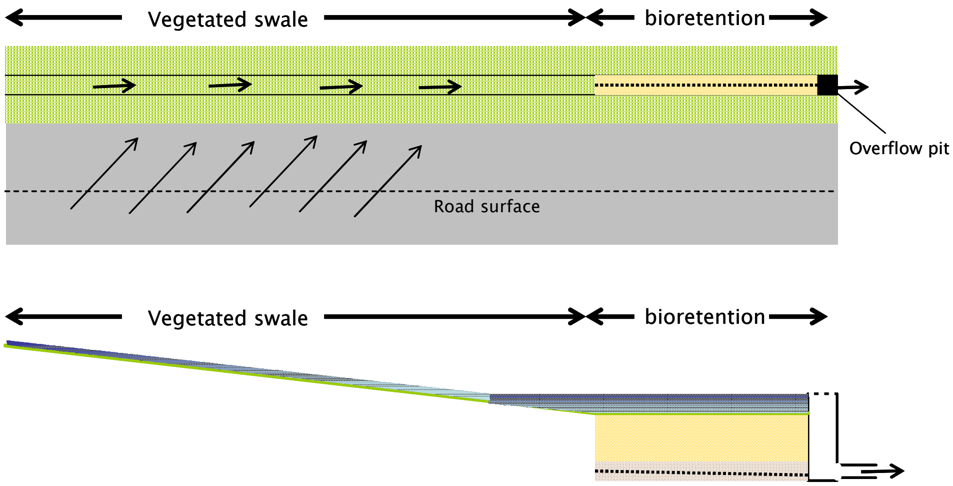

Figure 11 Plan and Longitudinal section of typical roadside bioretention swale

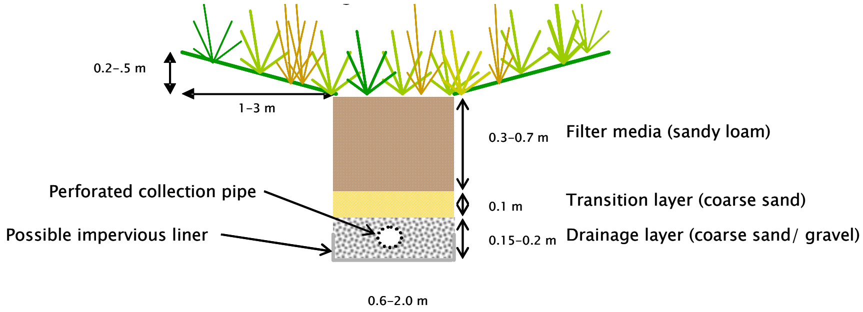

Figure 12 Diagrammatic cross section of bioretention swale

Figure 13 Different arrangements of kerbs with breaks to distribute inflow to bioretention swales

Bioretention street trees

Bioretention street trees are a variation to the conventional bioretention system of stormwater treatment through filtration through soil media. They are well suited to highly urbanised areas with limited space. Street tree pits are designed to incorporate a stormwater treatment function whereby street runoff is diverted to a street tree pit for filtration through the soil media and collected by the underlying perforated pipe. The incorporation of the treatment function requires lowering of the surface of the street tree to below the surface of the adjoining street pavement level to allow stormwater runoff to enter the tree pit

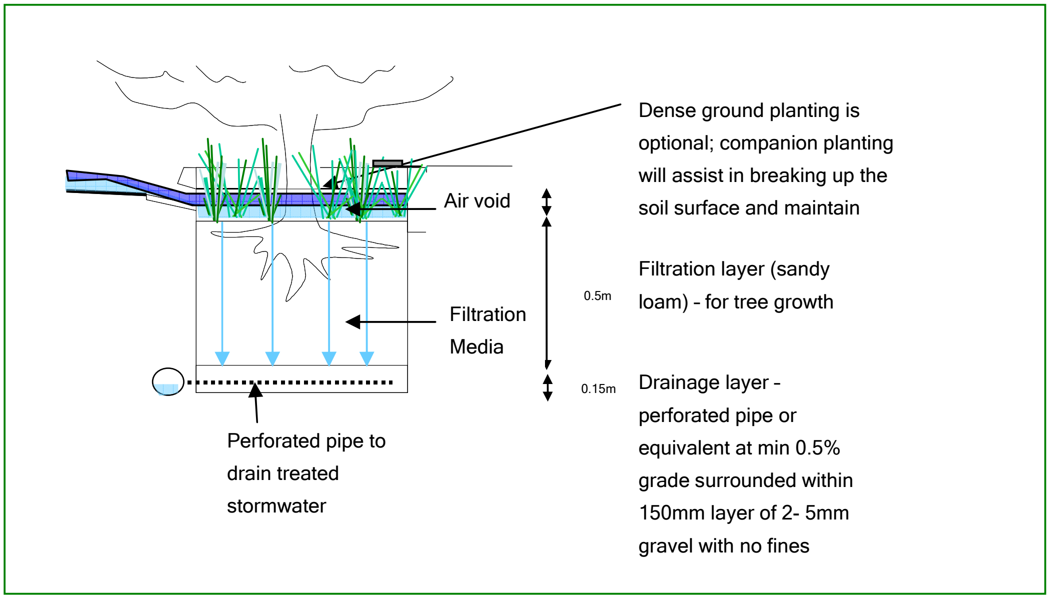

Figure 14 Diagram of bioretention tree – cross section

Figure 15 Examples of bioretention street trees, configured in different landscape finishes

6.3.3 Precinct Scale (Subdivision Scale)

Precinct scale treatments include the provision for both planning controls and management controls. Adopting landuse planning techniques that optimise the opportunities for implementing structural controls should be adopted. Public open space layout, road layouts and streetscaping and lot layouts should be planned to

In line with *Linking People and Spaces* and *C21* the importance of creating open space linkages is stressed. The development of Cranbourne East will need to include a number of local level parks and open spaces. These open space areas should be planned in coordination with the stormwater management systems for the site.

Precinct scale treatments may include ponds, wetlands and bioretention basins. These treatments can be incorporated into community open space areas. The function of this level of treatment is to provide the final treatment of stormwater to ensure that water quality objectives are met at the subdivision level.

It should also be ensured that retardation is required at the precinct scale for the 1.5 year ARI event. This can be provided through a combination of on-lot and precinct scale controls. Generally the storage requirement for 1.5 year ARI flow retardation is 150m^3 of storage per hectare of contributing impervious area.

Wetlands

Constructed wetland systems are shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and pollutant uptake processes to remove pollutants from stormwater. A constructed wetland generally consists of:

- a sedimentation pond which is a relatively deep open water body to remove the coarser sediment in the stormwater runoff; and
- a wetland zone, which is a macrophyte zone, or a permanent or ephemeral shallow water body with vegetation that filters the finer pollutant particles from the water.

A series of connecting wetlands forming the basis for multi-purpose corridors of open space reserves can establish a link between aquatic and terrestrial habitat elements with revegetation of the wetlands reserves and adjoining areas. In addition, wetlands can also have community benefits by providing a focal point for passive recreation or being a central landscape feature.

Figure 16 Wetlands can be a central focus or feature of an urban area

Ponds

Ponds provide fine particle sedimentation and UV disinfection. They can be used as storages for reuse schemes and urban landform features for recreation as well as wildlife habitat. Ponds or lakes can also be used as focal points in developments, with houses or streets having aspect over open water. Ponds should be designed in accordance with Melbourne Water's 'Constructed Shallow Lake Systems' guidelines.

Figure 17 Ponds can be installed at different scales, providing regional water sources for irrigation

6.3.4 Regional Scale (Cranbourne East study area)

The requirement for regional retarding basins within the study area is further discussed in the following section, *Stormwater Quantity Management*.

Water quality treatment elements, e.g. wetlands, should be incorporated into the regional retarding basins for final polishing of the stormwater, to provide an attractive water and central landscape feature for the community, and to provide storage for stormwater water reuse. Wetlands within the retarding basins should be positioned offline. This ensures that the environmental corridor is not interrupted and allows free passage of fauna to downstream of the wetland.

Wetlands can also supplement the treatment of stormwater provided by the lot, street and precinct level controls to ensure that the stormwater management objectives are achieved. Stored water from the wetland can be used for irrigation of public areas. Treated stormwater may be preferable to recycled water for irrigation purposes as it is generally lower in salt and nutrients and therefore less likely to have potential impacts on possible groundwater and salinity issues.

As part of the Collison Road Drainage scheme a wetland of approximately 9.9 ha is proposed within the Clyde Creek retarding basin which will treat flows up to the 1 year ARI flow.

Even though it is proposed to apply the provisions of Clause 56.04 to all subdivisions, even those within the drainage scheme area, it is recommended that this wetland be retained for final polishing of stormwater, to treat any development areas that cannot achieve best practice on site and to provide an area of high ecological and habitat value.

A wetland should also be provided within the proposed retarding basin south of Ballarto Road (Refer to section 7.3.2 for more information). As best practice for water quality would already be achieved within the catchment subdivisions, this wetland again would be provided for that same reasons outlined above. It is estimated that the footprint of this wetland would be about half to two-thirds the footprint of the retarding basin, i.e. 2 - 3 ha.

6.4 Rehabilitation of wetland EVCs

While opportunities exist in the implementation of WSUD elements, such as wetlands, to establish vegetation that is indicative of local Ecological Vegetation Classes (EVCs), it is important that the primary function of the facility remains intact. In other words, while vegetation for a stormwater treatment wetland can include species from local wetland EVCs, the form and function of the individual plant species (and its suitability to water quality treatment functions) will determine whether a species is included in the planting specifications in high proportions. Often the species, proportions and densities of plants in natural wetland EVCs contradict the requirements of vegetation within a stormwater treatment device (which is designed to optimise water quality treatment in a compact space). While all efforts should be made to use locally occurring species within WSUD treatment devices, the proportions and densities are likely to differ from local EVC descriptions.

6.5 Development Construction and Maintenance

The principles of WSUD, including pollution prevention, water conservation and protection of downstream aquatic ecosystems and water resources should also be applied to the construction and maintenance phases of the development.

During construction, pollutant loads (especially sediments) can be up to 100 times that of post development loads. It is important to protect waterways (and treatment measures) from these high loads. A construction management plan should be developed prior to the construction of each stage of the development (e.g. to control erosion). This plan should be designed to address runoff pollutants until approximately 80% of construction is complete, following which the long-term treatment measures will all be installed.

The construction management plan should identify temporary measures to manage expected pollutant loads during construction. A combination of on-site measures (such as silt fences, straw bails and reinforced access tracks) and sediment control ponds can be used. In addition, there may be opportunities to use the proposed long term treatment measures as temporary controls.

7 STORMWATER QUANTITY MANAGEMENT

Stormwater quantity management at Cranbourne East should consider the safe conveyance and management of surface water runoff considering flooding impacts, including upstream and downstream flooding, whilst also considering ecosystem health. This section of the report discusses stormwater conveyance and retarding basin requirements.

7.1 Stormwater Conveyance

In accordance with the approach adopted within Melbourne Water's drainage schemes,it is expected that a piped drainage system with capacity for 5 year ARI peak flows will provide an outfall network for existing properties within the study area. Flows in excess of the piped drainage network must be managed safely overland through a combination of roadways and floodways in accordance with the minor / major drainage system approach described in Australian Rainfall and Runoff. Melbourne water will generally have jurisdiction over drainage assets whose upstream catchment exceeds 50 hectares; and in these cases, there is a preference for these assets to be configured as waterways. The standard of service provided by the underground pipe system may differ from 5 year ARI for internal subdivision drainage in accordance with the City of Casey's polices and standards.

As part of the Collison Road Drainage scheme a 40 m wide vegetated waterway is proposed through the site. As part of this current study, it is proposed to extend and widen this proposed waterway to ensure appropriate environmental values can be established within this waterway and habitat corridor. One of the purposes of the environmental corridor will be to provide an ecological link between the Cranbourne Botanic Gardens and the proposed Regional Park and Clyde Creek floodway. The alignment of this proposed waterway is shown on Figure 18. A discussion on the design of this waterway and environmental corridor, including waterway health, is provided below.

In addition, a number of local minor drainage reserves would be required for overland flow management. It is expected that these reserves would take the form of a vegetated or grassed channel. This is further discussed in Section 7.2.

7.1.1 Main waterway

A main waterway will form the main drainage pathway of the site post-development, designed to convey specific flows, and will also be remediated to achieve a healthy ecosystem underpinned by good water quality (through adoption of WSUD for stormwater quality and quantity management in individual subdivisions as required by Clause 56.04). The design criteria for this waterway will be influenced by hydrology, open space planning requirements, indigenous heritage, impacts on developable area, and flora and fauna considerations.

An alignment of the water way is given in Figure 18 that is considered to best serve the multiple objectives identified during the structure plan investigation. This waterway would run through the proposed Blue Hills Rise development and through Casey Fields. It is acknowledged that the design and approvals process for Blue Hills is well progressed and that its current layout does not include this waterway. For Blue Hills Rise, this waterway alignment involves issues of redesign, land take and conflict between public access and a gated community.

The alternative alignment illustrated in Figure 19 allows the waterway alignment to diverge from a corridor that provides a terrestrial habitat and public access link. This alternative retains the proposed alignment of the waterway through Blue Hills Rise, but offers a potential resolution of the public access problem. Three reasons for retaining the waterway alignment through Blue Hills in this alternative are:

1. It is likely that a route parallel to Berwick Cranbourne Road would not support an open waterway configuration within the space available between Blue Hills Rise and the road. This issue of lack of space appears to be reflected in the developer's wish to contain the entire 100 year ARI peak flow in an underground culvert on this alignment.

2. A waterway (or underground pipeline) route parallel to Berwick Cranbourne Road would prevent grade separation using a rail underpass at Berwick Cranbourne Road.

3. A waterway alignment that is inclusive of the existing wetlands in Casey Fields will not only benefit the ecology of the waterway corridor, but also provides opportunity to improve the sustainability of these wetlands that currently suffer from a deficiency in upstream catchment area.

In both figures, the waterway and the terrestrial corridor are coincident at the western boundary of Casey Fields. Note that the alignment of the terrestrial links shown further west of Casey Fields on Figure 18and Figure 19 are yet to be determined. The terrestrial link has the flexibility to take various alignments and will best be decided during consideration of other issues influencing the urban layout. The final design and alignment of the waterway will be decided upon in consultation with Melbourne Water and other relevant agencies.

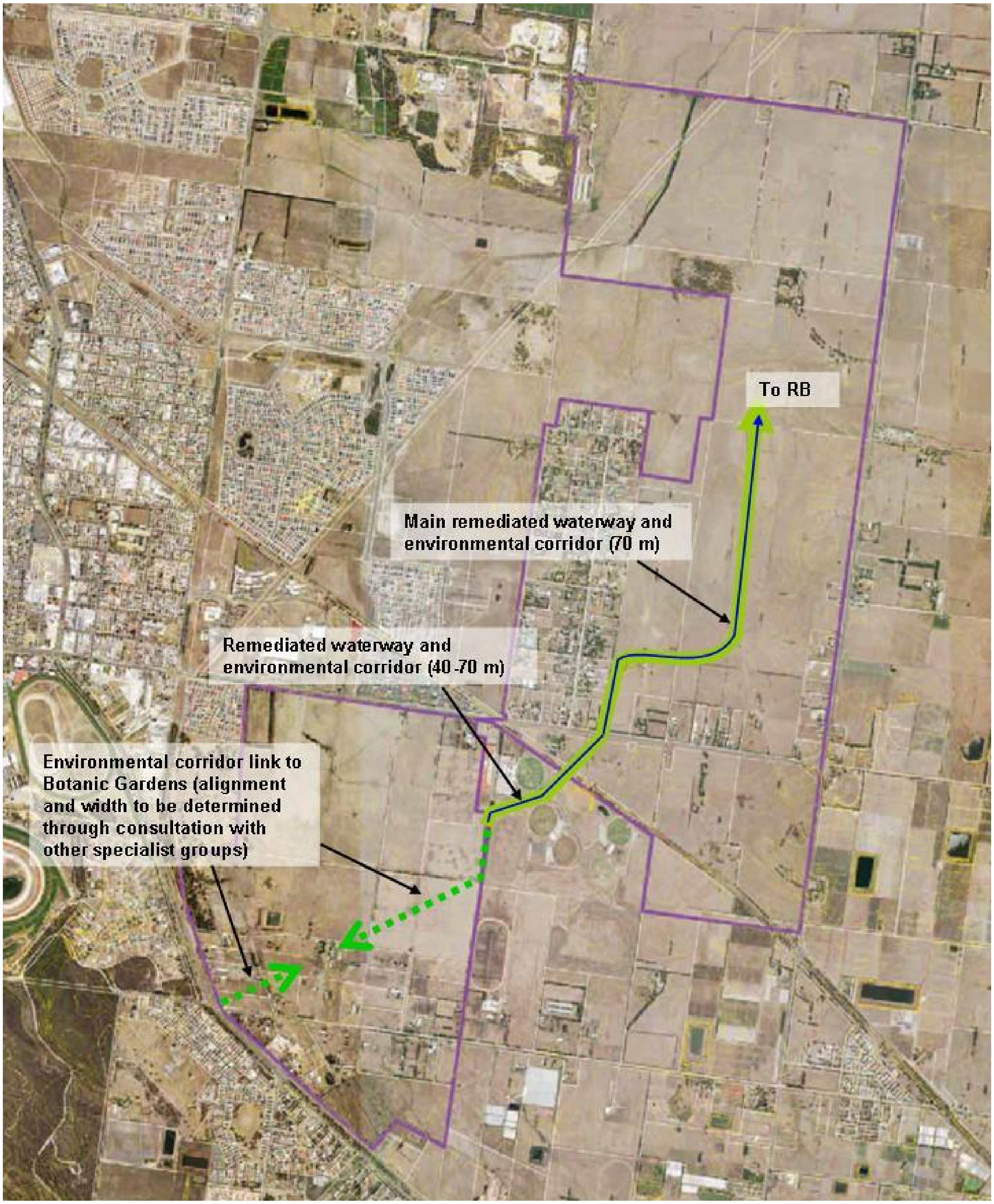

Figure 18 Proposed main waterway (option 1)

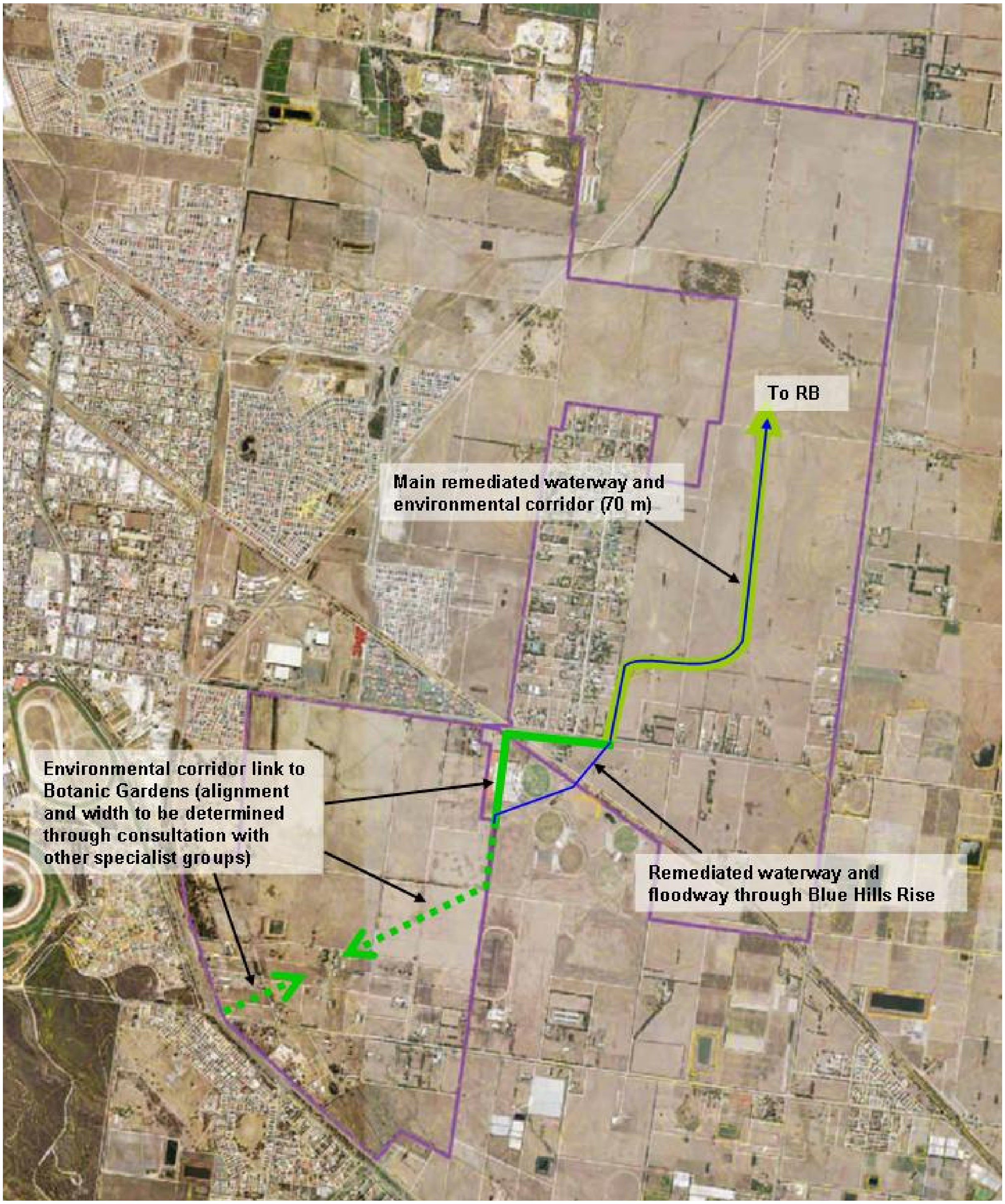

Figure 19 Proposed main waterway (option 2)

7.1.2 Main waterway Health

There are many factors that influence waterway health, and these have been categorised by Breen and Lawrence (2006) into nine key themes as outlined in Table 1 below. These themes are considered as the 'building blocks' of waterway health. However they could be grouped again according to the location of their influence, such as whether they are catchment-based or site specific.

Table 1 Factors influencing waterway health (*adapted from Breen and Lawrence, 2006)*

Biological ▪ Reproduction ▪ Emigration/immigration ▪ Competition ▪ predation	**Geomorphology** ▪ Catchment geology ▪ Position in catchment ▪ Channel characteristics ▪ Macro-habitat	**In-stream habitats** ▪ Particle size of benthos ▪ Organic content of benthos ▪ Large woody debris ▪ vegetation
Hydrology ▪ Frequency, magnitude and duration of runoff events ▪ Predictability of flow ▪ Influence of groundwater	**Hydraulics** ▪ Water velocity ▪ Water depth ▪ Turbulence ▪ Benthic shear stress	**Water Quality** ▪ Suspended particles ▪ Nutrients ▪ Ionic composition and concentration ▪ Dissolved oxygen/BOD ▪ Toxicants
Sediment quality ▪ Particle mineralogy ▪ Carbon content ▪ Redox potential/DO ▪ Toxicant	**Riparian habitat** ▪ Food supply ▪ Habitat supply ▪ Channel form and stability ▪ Micro-climate	**Continuity & barriers** ▪ Proximity to other ecosystems ▪ Barriers to movement

The 'hydrology', 'geomorphology' and 'water quality' themes are of a diffuse nature and are influenced by catchment characteristics, or the state of the catchment. WSUD stormwater management initiatives discussed in the previous section will be directed at ensuring that these elements are appropriately addressed.

The 'biological' theme is a result of the combination of the other factors or themes and determines ecosystem community structure and function. The remaining five themes may be considered site-specific and interacting characteristics that are also influenced by the state of the catchments hydrology and water runoff quality. Guidelines on the design of these five themes include the following:-

- Geomorphic structure and hydraulics - forming cross sections that are adapted to the post-development hydrologic regime associated with suitable bank vegetation, slope (possible pool and riffle sequence. Particular design attention to ensuring maintaining important substratum that serves as habitats to aquatic fauna. The management of erosion potential associated with frequent flood management is an important catchment-wide design criteria (i.e. maintaining peak flows of the 1 in 1.5 year ARI event to pre-development levels)

- In-stream habitats – the provision of suitable substratum, large woody debris and localised zones of low flow velocities are important in providing areas of refuge against high velocities for aquatic fauna. The combination of these measures provides spatial physical diversity as well as a range of food and nutritional resources for aquatic fauna.
- Riparian habitats – provision of an adequate riparian corridor width with appropriate vegetation is essential in promoting stream function and health in a variety of ways. The riparian corridor acts as a transitional zone between the aquatic habitats and the surrounding terrestrial habitat.
- Continuity and barrier – ensuring connection and access to upstream and downstream ecosystems provides ecosystem resilience to localised stressors. Ensuring that physical barriers such as drop structures, pipes and culverts, and weirs are kept to a minimum is recommended in the remediation plan for waterways.

Remediated waterways can be very popular recreation areas in communities (e.g. Dampier Creek, Gardiners Creek, Dandenong Creek etc). Frequently used as linear parks they attract walkers, bike riders, bird watchers as well as providing a natural retreat from urban activities. They also help to promote appreciation of waterways and their ecological values, and can improve property values of surrounding areas. The riparian and grassy woodland zones adjacent to the watercourses will also provide a micro-climate benefit to the surrounding area as vegetation provides shade and cools the air via transpiration and evaporative cooling. Pedestrian pathways within the vegetation canopy can also provide a pleasant and more temperate area for residents to walk.

An important aspect of remediation of the waterway on this site will be the reinstatement of local vegetation communities (Ecological Vegetation Classes – EVCs).The vegetation on site is currently in isolated, highly degraded remnant patches (Golders, Flora and Fauna Draft Issues Paper 2007). Pre European development the locally occurring EVCs were 53, 125, 693 and 48. In general the smaller ‘low flow’ channel will be remediated using species indicative of EVC53 Scrub Swamp which currently has limited presence on site and is degraded. The riparian zone (including the floodway) will be revegetated with species indicative Plains Woodland vegetation communities (EVC 48 and 175). A number of other EVCs that occur just outside the site boundary could also be incorporated into the vegetation specifications of the waterways (EVC 693 and 191).

7.1.3 Main waterway design

The main waterway on this site provides an opportunity to create a good quality habitat corridor with high ecological value and most likely opportunity for future connection to both upstream and downstream habitats. This includes a connection from the Clyde Creek floodway to the Cranbourne Botanic Gardens.

The width of the riparian buffer is determined according to the ecological functional requirements of the waterway. The NSW DNR requirements for riparian buffer corridors are used to guide the functional requirements of waterways on this site. These are based on principles aimed at ensuring specific levels of aquatic ecosystem health and protection are achieved. The categories guide the provision of a riparian width (from the top of bank of the water course) that reflects the functional requirements. It is recommended that the waterway riparian corridor be established as a functional environmental corridor consisting of a 20m riparian zone and 10m buffer on both sides of the waterway.

The waterway will be sized to ensure conveyance of the 1 in 1.5 yr ARI within a formal and meandering 'low flow channel' and conveyance of the 100 yr ARI within a larger floodplain area alongside the low flow channel. An indicative cross section is provided below. It is estimated that the low flow channel will need to be approximately 10 m wide, therefore the total width of the corridor is 70 m

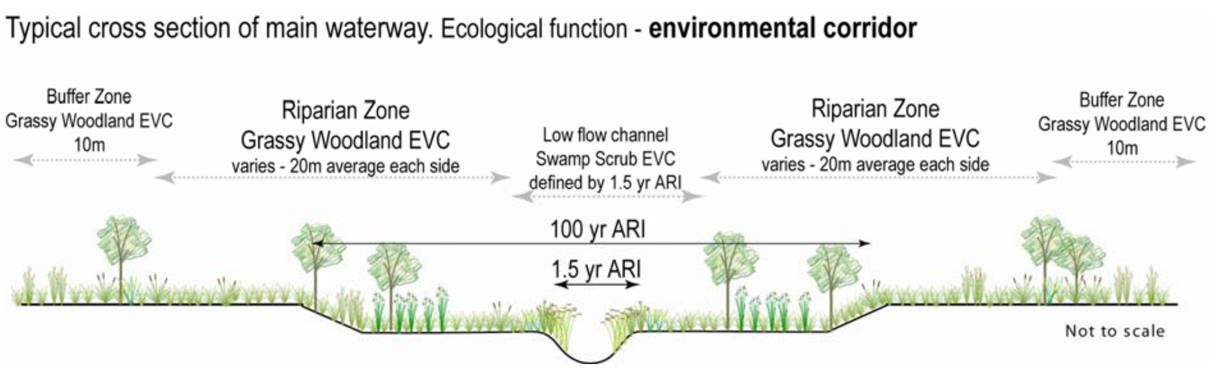

Figure 20 Main Waterway indicative cross section

7.1.4 Varying Riparian Zone Width

It is proposed that main waterway nominated have a core riparian zone width and additional buffer zone width as stated above. On considering the design of the riparian zone and its integration with the urban form, it is proposed to allow the main waterway to meander within the middle third of the corridor. This design has the advantage of maintaining an adequate riparian width for aquatic environment protection while also allowing a more flexible integration with the urban form.

A meander of the channel within the riparian zone results in a riparian width that will vary somewhat along the length of the reach but has an average prescribed width from the edge of the channel. This design provides for a more natural alignment of the low flow channel, increasing the ecological value of the channel, without causing inefficient land-take from a development standpoint. An illustration of this design is shown in Figure 20 below.

The final alignment of the main watercourse will be decided upon considering other influencing factors including indigenous heritage, open space requirements, flora and fauna considerations and urban planning.

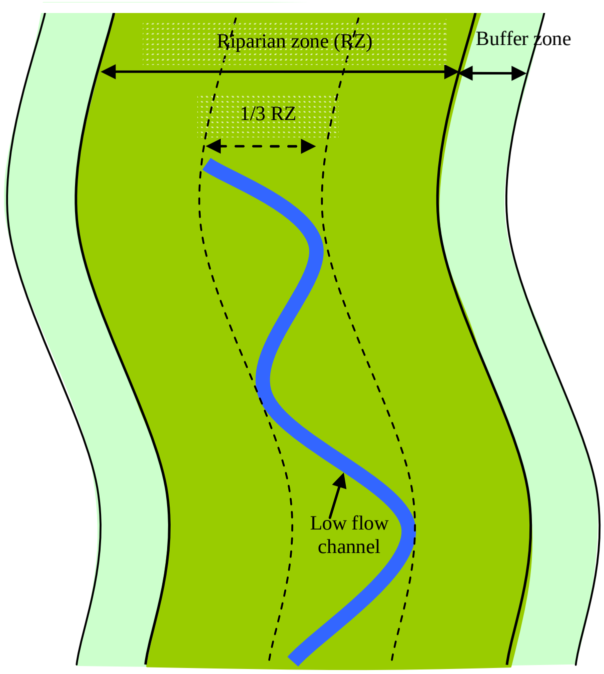

Figure 21. Illustration of meandering channel within the Riparian Zone (RZ)

7.2 Minor drainage reserves

Flood protection for flows greater than the capacity of the piped drainage system (assumed to be the 1 in 5 year ARI capacity) should be provided throughout the development area. Preliminary calculations indicate that when a catchment area is greater than 15 ha an open channel drainage corridor (referred herein as minor waterway corridors) in the form of a vegetated or grassed channel will need to be provided.

Preliminary hydraulic modelling to determine the likely waterway width was undertaken and the indicative locations and approximate widths of these minor drainage corridors to achieve this objective as shown on Figure 22. These are indicative only and will be determined in more detail given the design of each subdivision. The location of the minor drainage corridors should be aligned such that they follow the natural depressions in the terrain as much as possible to avoid excess earthworks.

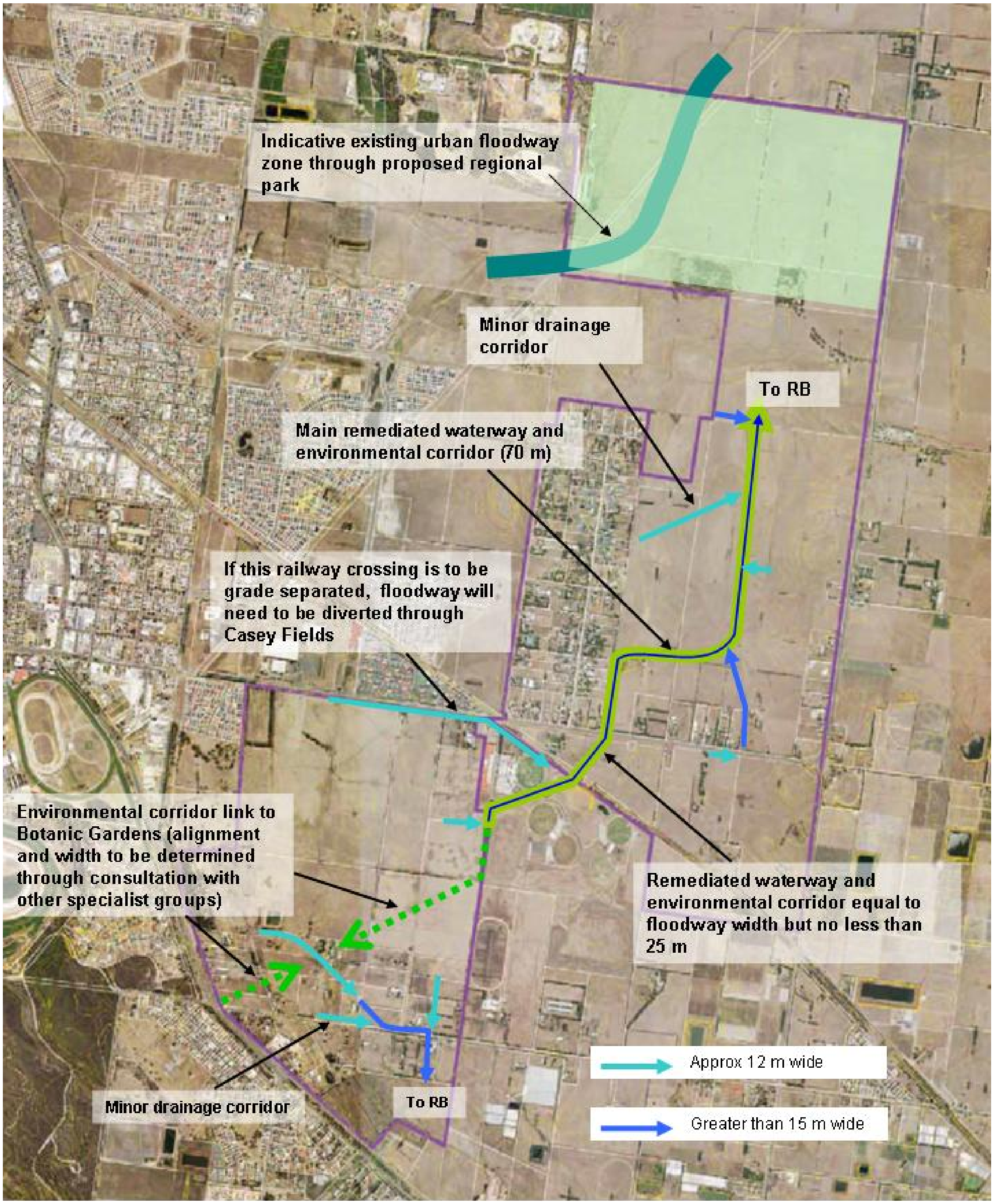

Figure 22 Indicative locations of minor drainage reserves (using option one as main waterway alignment)

Note that the longer of the two minor drainage corridors south of Ballarto Road may be proposed as a remediated waterway. The diagram below demonstrates indicatively how geomorphic design and ecological health requirements could be integrated into the waterway design for this corridor. This option requires further consideration and consultation with local stakeholders and other members of the consulting team.

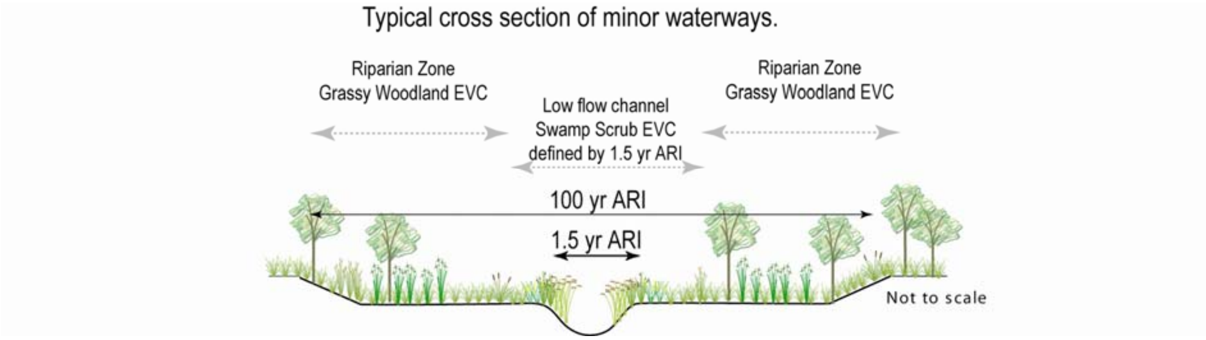

Figure 23 Typical cross section of a minor waterway

7.3 Retarding Basins

Peak flows from the development area should be controlled back to existing rural conditions within the development area land such that the downstream runoff is not increased for a range of events up to the 100 year ARI event. Restricting flows to existing levels reduces the hydraulic impacts on stream beds and downstream channel form. This will be achieved through the use of retarding basins at the downstream boundary at the watercourse locations. This helps to maintain a healthy diverse habitat for wildlife. The land immediately downstream of Cranbourne East is rural and outside the urban growth boundary.

7.3.1 Clyde Creek Retarding Basin

To control flows from the future residential areas back to the existing pre-development flows a retarding basin is required on the upper reach of the Clyde Creek to manage flows from within the Collison Road drainage scheme area.

The Collison Road drainage scheme plans for a 15.5 ha retarding basin. It is assumed that this retarding basin has been designed to manage the 100 year ARI flows and had not considered smaller events, including the 1.5 year ARI event as required by the Best Practice Stormwater Management Guidelines. A site visit indicated that this retarding basin is already under construction. As such there may be little opportunity to re-design the basin to manage flows for events other than the 100 year ARI event. If, however, there is an opportunity to retro-fit the basin this should be investigated. The indicative location of the basin is shown in Figure 24.

7.3.2 RB south of Ballarto Road

There is an area of approximately 155 ha to the south east of the study area that does not lie within the Collison Road drainage scheme area (refer to Figure 6 for a diagram of the Collison Road drainage scheme area). This 155 ha drains in a south westerly direction. A retarding basin is required at the boundary of the study area to control flows for a range of flows (specifically the 1.5 year ARI and the 1 in 10 year ARI events).

It is estimated that a retarding basin floor area of approximately 4 ha would be required with a corresponding site area of around 5 ha. Refer to Figure 24 for a diagram of the proposed retarding basin location.

7.3.3 RB near Clyde Road and railway reserve

There are sections of three properties in the south east corner of the study area that are not within the catchments described above and that drain in a south easterly direction. One of these sections of property would be landlocked if proposed for development and there are suggestions that it should not be included in the growth area. The other two sections of property are north of the railway. Preliminary investigation suggests a retarding basin with floor area 1 hectare would be required for the control of peak flow in accordance with the previously described performance criteria. It is suggested that a site area of approximately 1.5 hectares is required for this purpose.

7.3.4 Area north of the urban growth boundary

For the purposes of this report it is assumed that the area within the study area but outside the urban growth boundary will not be developed and therefore no stormwater management infrastructure is proposed.

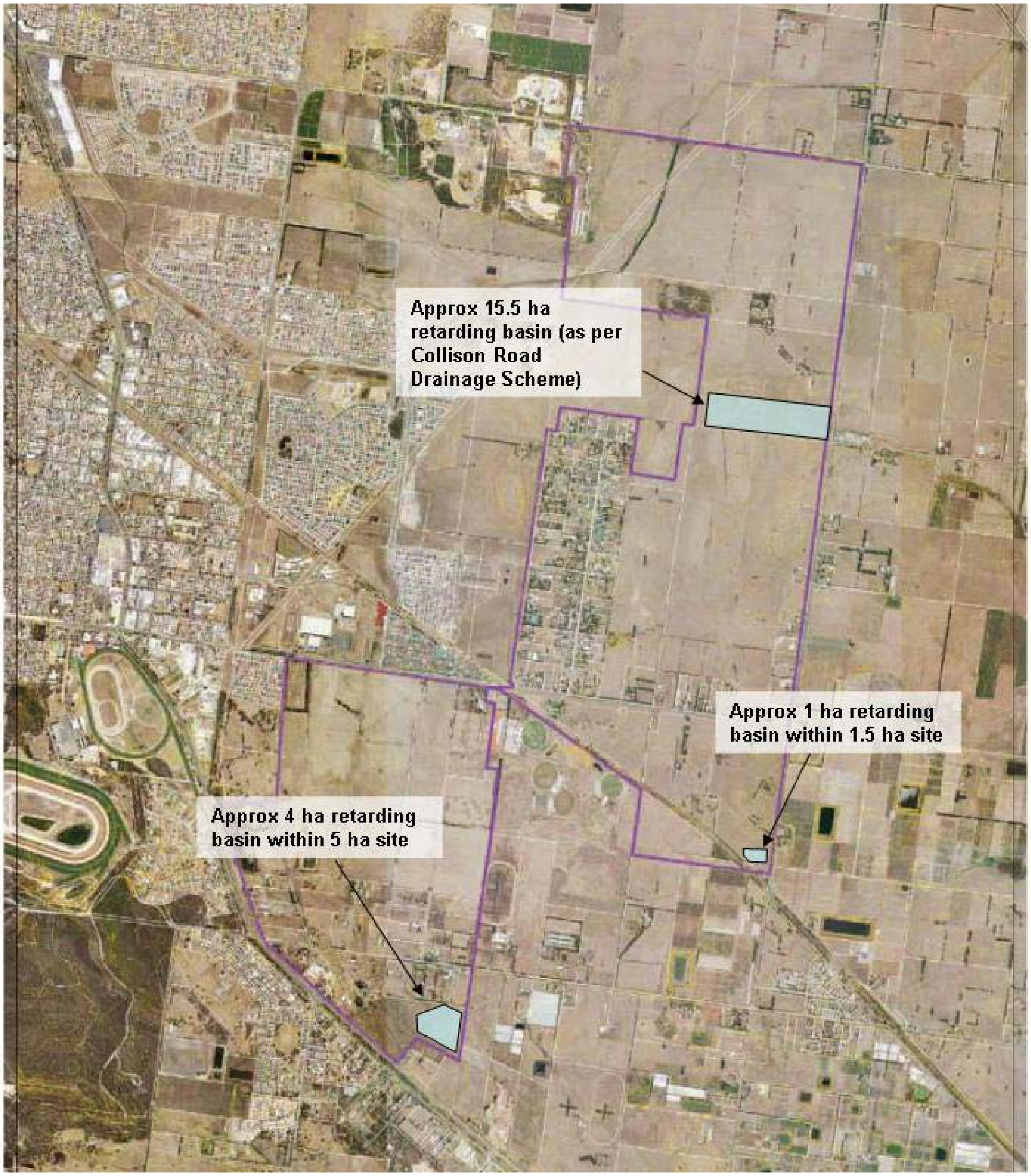

Figure 24 Indicative locations of proposed Retarding Basins

8 RECOMMENDATIONS

Water Sensitive Urban Design aims to protect water resources in all parts of a catchment through mitigating local impacts of development and, via water conservation, reducing impacts in harvesting catchments. The guiding WSUD principles provide a valuable approach for delivering sustainable urban water management in the Cranbourne East Development Area.

The WSUD objectives proposed for Cranbourne East are based on the identified existing site conditions and environmental values and policies. Site wide strategies have then been formulated as a response to the objectives. The proposed water management strategies for the Cranbourne East study area are:

1. Incorporate integrated water cycle management into the urban planning process. This includes the use of rain, storm and recycled water in order to reduce the demand on potable mains water.

    - A dual pipe system using recycled water (Class A) from the Eastern Treatment Plant can be implemented within the development area for non potable water demands including irrigation, toilet flushing and the cold washing machine.

    - Rainwater and stormwater harvesting could be employed on site to further reduce demands on potable water.

        - Rainwater may be used for private open space irrigation at individual allotments.

        - Rainwater can be used in the hot water systems within the development and stormwater harvesting can provide an additional water source for public open space irrigation purposes.

        - With stormwater being treated for reduction in nutrients prior to their storage at precinct and regional storages (e.g. ornamental ponds), a stormwater/recycle water mix may be better suited to application within open spaces.

    - It is recommended demand management measures are implemented as a rule throughout the development area. Guidelines and recommendations should be provided to households to effectively promote these initiatives. Demand management initiatives include the following :-

  - water efficient fittings and appliances
  - water efficient garden design including xeriscaping and hydro-zoning.

2. Meet best practice objectives for stormwater quality and quantity runoff by incorporating stormwater treatment elements throughout the site.
   - o Regional water quality facilities should be identified to provide the regional underpinning of stormwater quality management.
     - Two retarding basins will be required at the downstream edge of the three waterways and the regional water quality facilities could co-locate within these basins
     - There are existing farm/agricultural dams on the site which may be retained for incorporation as water quality treatment facilities and, as an ornamental feature.
   - o Clause 56 of the Victorian Planning Provisions require best practice water quality treatment on all residential subdivisions.
     - It is recommended that even residential subdivisions within the Collison Road Drainage Scheme area meet the requirements of Clause 56 protect the ecological integrity of the main waterway and free up the regional wetlands for final polishing of stormwater (i.e. stormwater from the site will be treated to better than best practice), and to provide an area of high ecological and habitat value.
     - Stormwater quality treatment and flow management controls should be implemented at the local and precinct scale and integrated with urban and landscape design initiatives
   - o Frequent flood detention basins are required at the precinct level for attaining the objective of maintaining the peak 1.5 year ARI discharge to pre-development level. Generally storage volume of approximately 150m3 per hectare of contributing impervious area is required.
3. Re-mediate the natural drainage systems to healthy ecosystems.
   - o A main waterway and environmental corridor is proposed through the development area. This waterway will form the main drainage pathway of the site post-

development and should be remediated to achieve a healthy ecosystem underpinned by good water quality (through adoption of WSUD in individual subdivisions) and geomorphic structure that is compatible with the change in hydrologic conditions in the catchment.

- This main waterway provides an opportunity to create a good quality habitat corridor with high ecological value and opportunity for connection to both upstream and downstream habitats, i.e. between the proposed Regional Park/ Floodway Zone and the Cranbourne Botanic Gardens. It is recommended that the waterway riparian corridor be established as a functional environmental corridor consisting of a 20m riparian zone and 10m buffer on both sides of the waterway. The main waterway should be configured to provide conveyance for runoff from the developed site and therefore, in terms of hydrologic requirements, will contain the 1.5 yr ARI within the low flow channel and the 100 yr ARI within the floodway. This 100 yr ARI floodway will lie within the within the suggested riparian/buffer zones.

4. Integrate open space with conservation corridors, stormwater management controls, and social and community objectives.

Sewerage and potable water supply are beyond the scope of this report; however are to be considered in parallel with issues discussed in this report. There was no information on groundwater conditions available at the time of writing.

9 REFERENCES

Cranbourne North Development Plan Revised Draft for Exhibition 2007

Cranbourne East Development Plan 2006

Collison Estate Background Report 2005

Collison Road Drainage Scheme