9 Appendices

Appendix A Existing policy and legislation framework

Water initiatives for 2050 (South East Water, 2011)

"WIF 2050" adopted themes of sustainable, productive and liveable communities. The aim of the strategy was to optimise the use of all water resources to meet the unique water demand profile of the region. With regard to Council, the strategy specifically mentioned:

- preparing Council for recycled water in dual pipe areas
- guiding for Council to implement WSUD according to priority areas (e.g. UHI mapping, pollution "hot spots", street width)
- facilitate stormwater harvesting and allotment scale WSUD
- review Clause 56.07 to include residential, industrial and commercial development

Better Bays and Waterways (Melbourne Water , 2009)

Better Bays and Waterways is a Water Quality Improvement Plan (WQIP) that aims to address water quality issues in the Port Phillip and Western Port region. Cardinia predominantly drains to Western Port Bay. Westernport's key pollutant is total suspended solids (with other pollutants including nitrogen and phosphorus).
A target to "reduce sediment loads to Western Port by 1000 tonnes per year by 2014 and reduce the nitrogen loads to Western Port by 5 tonnes by 2015" is adopted.
The Bunyip and Lang Lang catchments are key contributors of TSS to Western Port Bay.

Liveability

Alternative water supplies and water efficiency

Cardinia Shire Council

Waterway health and stormwater management

Wastewater management

Melbourne's Water Future (2013)
The Office of Living Victoria released this document in July that reinforced the vision and objectives for Melbourne's water system as:
A smart, resilient water system for a liveable, sustainable and productive Melbourne.

- Support liveable and sustainable communities
- Protect the environmental health of urban waterways and bays
- Provide secure water supplies efficiently
- Protect public health
- Deliver affordable essential water services

Sustainable water use plan (Cardinia Shire, 2011)

The plan focussed on water consumption between 2003/04 and 2008/09 across residential, commercial/industrial and Council facilities . The 2011 review of the SWUP provided targets of a 10% reduction in water use of by 2013/14 (against a 2008/09 baseline) for Council facilities and residential use. The main driver for increased water use was identified as population growth.

Domestic wastewater management plan (Cardinia Shire, 2006-09)

Cardinia Shire is responsible for the approval, supervision of installation and monitoring of domestic wastewater or septic systems . The plan assessed the risk of areas based on risk factors like rainfall, soil type, slope etc.
High risk areas include the Upper Yarra catchments , with the Western Port marine environment an environmental receptor at very high risk .

Cardinia Shire Council Stormwater Management Needs Analysis (with Melbourne Water, 2013)

The "needs analysis" is a self-assessment undertaken with Melbourne Water to understand Cardinia's capacity to deliver best practice stormwater management and water sensitive urban design (WSUD). It identified the following key challenges and opportunities:
1. Improving water quality of Western Port Bay
2. Partnering with Melbourne Water to provide funding, resources and training and helping to engage Councillors and senior executives

Stormwater management plan (Cardinia Shire, 2002)

The aim of this plan was to "improve the environmental management of stormwater within the municipality to meet the community's expectations regarding the health and quality of local receiving waters".
Specifically it identified risk management strategies for priority risks to stormwater quality (like agricultural land use, urban development and septic tanks), recommendations for improvement of Council's management framework and identification of a program to guide Council in implementing the SWMP.

The aim of this legislation and policy review is to set the context for Cardinia Shire's IWM plan by:

- defining the shire's role and responsibilities within the water cycle
- describing the operation and relevance of policies, regulations and guidelines; and
- identifying possible IWM partners with shared goals.

Federal

National Water Initiative (NWI) 2004: The NWI is a blueprint for water reform, with all State governments committing to a range of measures to increase the efficiency of Australia's water use in 2004. The National Water Commission is the independent statutory authority that promotes the objectives of the National Water Initiative (NWI). The ultimate aim of the NMI is to achieve:

- economically efficient water use and related investment to maximise the economic, social and environmental value of Australia's water resources
- improved environmental water outcomes, including the effective and efficient delivery of water to sustain the health of water-dependent ecosystems of waterways and wetlands1.

The NWI encourages water efficiency and the reuse of wastewater and stormwater where cost effective.

Australian guidelines for water recycling (2005-09): produced by the Environment Protection and Heritage Council between 2005 and 2009, the guidelines describe a risk based approach for alternative water supply projects, noting: "it is up to communities as a whole to make decisions on uses of recycled water. The intent of these guidelines is to provide the scientific basis for implementing those decisions in a safe and sustainable manner[2]".

State

Environment Protection Act 1970 (Victoria): the main objective of the act was to develop a legislative framework for the protection of the environment and the establishment of the Environment Protection Authority (EPA). Regarding water, the EPA has moved toward a risk-based approach to identifying adverse impacts on water bodies and the actions to address those risks. This is consistent with the approach within the Guidelines for water recycling (above), and provides the basis for the environmental quality objectives within the Victorian Environment Protection Policy - Waters of Victoria[3].

The EPA also provides guidelines for the appropriate use of alternative water supplies.

The Water Act 1989 (Vic): is the core legislation for the Victorian water industry that provides the framework for the allocation and management of Victoria's water resources. It also defines the functions, rights and obligations of the majority of Victoria's water businesses. The act aims to encourage:

- the equitable and efficient use of water resources; and

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1 http://nwc.gov.au/nwi/objectives (Accessed 13 May 2013)

2 Environment Protection and Heritage Council , Australian Guidelines for Water Recycling: Stormwater harvesting and reuse, July 2009

3 http://www.epa.vic.gov.au/your-environment/water/protecting-victorias-waters/risk-based-approach-protecting-victorias-waters (Accessed 13 may 2013)

- community involvement in the use, conservation or management of water resources.

Under s 51 of the Act, the Minister is responsible for issuing licences for the use of groundwater. However, the Minister has delegated this power to the three rural water authorities who are responsible for administering the Water Act's provisions that relate to groundwater. For Cardinia Shire Council, the relevant groundwater authority is Southern Rural Water.

Planning and Environment Act 1987 (Victoria) – Clause 56 (2006): this act provides for the Minister to prepare standard provisions for planning schemes called the Victoria Planning Provisions (VPP). Clause 56.07 (Integrated water management) of the VPP refers to residential subdivisions and is aimed at improving livability and reducing the stress on traditional water sources by supporting recycled water use and meeting stormwater quality objectives set out in the *Urban stormwater best practice environmental management guidelines* (BPEMG).

Catchment and Land Protection Act 1994 (Victoria): this act applies to the catchment scale and facilitated the establishment of Catchment Management Authorities (CMAs). The aim of CMAs is the protection and restoration of prioritised river systems and reaches (as guided by the Victorian River Health Strategy (VRHS)). Victoria is divided into 10 catchment regions, with Cardinia Shire within the Port Phillip and Westernport CMA.

The Central Region Sustainable Water Strategy (CRSWS): the Central Region incorporates greater Melbourne (including Cardinia Shire). This strategy, released in 2006 (updated in 2007) includes actions and system augmentations to meet the region's water needs for the next 50 years and was prepared in response to the low rainfall experienced across Victoria at that time and to balance the water needs of urban and rural customers and the environment.

Living Melbourne, Living Victoria (2011): the Living Victoria Advisory Council was established to provide recommendations on reform priorities in the water sector to support the Living Melbourne, Living Victoria policy. The policy supports the consideration of water and urban planning together to enhance urban livability and deliver a more resilient and flexible water services system. The objectives of the policy were to:

- establish Victoria as a world leader in liveable cities and integrated water cycle management
- drive generational change in how Melbourne uses rainwater, stormwater and recycled water
- drive integrated projects and developments in Melbourne and regional cities to use stormwater, rainwater and recycled water to provide Victoria's next major water augmentation[4].

This policy statement was followed by the Living Melbourne, Living Victoria, Implementation Plan (2011) that set out the reforms designed to deliver the plan's objectives to:

- support liveable and sustainable communities
- protect the environmental health of urban waterways and bays
- provide secure water supplies efficiently
- protect public health
- deliver affordable essential water services

4 Living Melbourne Living Victoria Roadmap, Ministerial Advisory Council for the Living Melbourne Living Victoria Plan for Water, March 2011

Local

Stormwater Management Plan (2002): The aim of the Stormwater Management Plan (2002) or SWMP, was to "improve the environmental management of stormwater within the municipality to meet the community's expectations regarding the health and quality of local receiving waters"[5].

Specifically the SWMP included:

- risk management strategies that respond to priority risks in the municipality;
- recommendations for improvement of Council's management framework to prevent stormwater degradation before it occurs; and
- identification of a program to guide Council in the implementation of the SWMP.

The SWMP adopted a risk based approach to identify the greatest threats stormwater poses to environmental values.

Table 6. SWMP risk summary

Risk	Description
Agricultural land	The impact of agricultural land use on stormwater quality due to the transport of soil and nutrients during rainfall events
Residential developments	The impact of the South Eastern growth corridor development on vegetation, sediment and litter generation, both during construction and into the future, including the increased imperviousness of the catchment. Lot scale construction was also identified as having relatively poor controls, contributing litter and sediments to the local stormwater system.
Unsealed roads	Sediment transfer
Septic tanks	Poorly maintained or undersized septic systems can see pathogens, contaminants and nutrients entering waterways and the stormwater system, particularly during storm events
Commercial areas	Commercial land uses within the centre of the township of Pakenham was identified as a stormwater hotspot given the impervious catchment and sediment and litter generated
Major roads	Generating and conveying sediment, litter, hydrocarbons and heavy metals
External and upstream flows	Catchments that are not under Cardinia Shire's direct control and particularly those where agricultural activities are being undertaken

The SMP also recommended priority management and implementation initiatives such as Council identify specific milestones, objectives enabling benchmarking, and review of the implementation process.

Sustainable water use plan 2011 (Review): The sustainable water use plan 2011 (SWUP) updated the original 2006 document. The plan focussed on water consumption between 2003-04 and 2008-09 across residential, commercial/industrial and Council facilities and the reasons for any changes.

The 2006 plan set a residential and Council water use reduction target of 15 per cent (no commercial/industrial targets were set). Residential and Council water consumption was

5 Cardinia Shire Council, Stormwater Management Plan, 2002

assessed against a litres per person per day metric to take account of the rapid population growth experienced within Cardinia e.g. there was a 29 per cent increase in properties and 27 per cent increase in population within the municipality between 2003-04 and 2008-09.

The 2011 SWUP review adjusted targets to a 10 per cent reduction in water use of by 2013-14 (against a 2008-09 baseline). This target applied to both Council facilities and residential water consumption and reflected the potential demand reductions identified within the action plan. In summary, the plan identified the following factors that will influence water demand into the future:

Table 7. SWUP (review) Risk Summary

Category	Factors	Comment
Residential	Population growth Property numbers Water restrictions	Water use bounce back: "If water restrictions continue to be lowered over the coming years, the shire may see a significant increase in residential water consumption due to householders being able to irrigate their lawns and gardens".
Commercial/Industrial	Increased economic growth associated with increasing population, increased property numbers and increases in production	An increase in residential populations brings an increase in economic and commercial activity. The employment corridor on the southern side of the Pakenham bypass is anticipated to provide jobs for up to 50,000 people bringing an increase in the number of non-residential sites in Cardinia Shire and water demand.
Council activities	Increased property numbers Increased patrons Upgrades to newer facilities.	Council facilities achieved a water use reduction of 28% in the plan period. Two sectors that dominate water consumption among council operated facilities are Open Space (35%) and Playing Fields (18%). Water restrictions have a significant impact on consumption associated with these facilities.

Water Initiatives for 2050: an Integrated Water Management Strategy for Melbourne's South East (2011): South East Water (SEW) released the draft Water Initiatives for 2050 (WIF2050) in September 2011 working with stakeholders Melbourne Water, Southern Rural Water and a 25-member stakeholder reference group. WIF2050 was developed under the themes of sustainable, productive and liveable communities. The aim of the strategy was to optimise the use of all water resources to meet the unique water demand profile of the region, including residential, agriculture and an established and growing commercial and industrial base.

The future of the strategy is unclear; however, the aims and actions within the plan are generally consistent with the objectives of the Living Melbourne Living Victoria implementation plan.

A range of actions were identified within WIF2050. Some specific actions have been identified below that involve Council action and/or engagement.

Table 8. WIF20520: Action requiring Council involvement

Action	Description
Preparing for recycled water	Embed nominated recycling areas in Council Municipal Strategic Statements and prepare buildings by regulating the requirement for dual pipe plumbing for new buildings
Facilitating stormwater harvesting	Prioritise the stormwater harvesting opportunities identified within the strategy findings.

Action	Description
Greywater	Support the direct diversion of greywater in areas identified in the strategy findings where the risks are assessed to be minimal by promoting relevant information on risk management
Reducing the impact of stormwater through allotment scale WSUD	"Research has shown that if urban runoff is restricted to an average of no more than 15 additional days per year, compared to pre-urbanised conditions, there is a minimal impact on the health of waterways". Undertake a pilot project in a residential greenfield development to demonstrate allotment-scale WSUD within the next 2 years
Improving stormwater quality and liveability through streetscape WSUD	Develop a guide to assist Councils to implement WSUD outlining the relevant criteria such as: • Identification of priority areas based on UHI mapping • Identification of pollution "hot spots" 2006-09where WSUD could assist • Street width and the practicality of implementing streetscape WSUD
Improving rainwater tanks	Encourage the building industry to integrate rainwater tanks within buildings to minimise the aesthetic impact and therefore the liveability in new housing estates.
Existing policy not fulfilling its intent	Review Clause 56.07 within the next 3 years, in conjunction with other regulatory tools such as building standards, to ensure that appropriate Integrated Water Management standards apply to all forms of development including residential, industrial and commercial development.

Better Bays and Waterways: A Water Quality Improvement Plan for Port Phillip Bay and Western Port (EPA and Melbourne Water, 2009) is a Water Quality Improvement Plan that aims to address water quality issues in the Port Phillip and Western Port region. Westernport's key pollutant is identified as total suspended solids (with other pollutants including nitrogen and phosphorus). The target is to "reduce sediment loads to Western Port by 1000 tonnes per year by 2014 and reduce the nitrogen loads to Western Port by 5 tonnes by 2015".

The key risks to waterway health in the Western Port catchment are residential growth, major road construction, agricultural run-off and septic tanks. Actions to reduce impacts including planting along the banks of the waterways, improving habitat, removing barriers that hinder native fish migration and protecting threatened flora and fauna (Melbourne Water, 2007c). The report identifies grazing land in the Cardinia Creek catchment contributes high nutrient and sediment loads to Western Port associated with stock access to waterways (Melbourne Water, 2007b)

Bunyip River: The key challenge for Bunyip River is identified as reducing the amount of sediment entering the river by controlling erosion sites in gullies higher in the catchment, as well as along the river itself (Melbourne Water, 2007c). A key water quality issue is high levels of nutrients, organic matter and sediment associated with dairying in the Tarago River catchment (Melbourne Water, 2007b).

Lang Lang: High nutrient loads from grazing land in the Lang Lang River catchment as well as sediment loads to Western Port associated with stock access to waterways and other dry-land grazing practices (Melbourne Water, 2007b). The Lang Lang catchment is identified as the largest generator of contaminants, contributing 29-40 per cent of the total diffuse loads.

Western port catchment: Urban areas make up around 2 per cent of the Western Port catchment, and yet contribute 14 per cent of diffuse nitrogen loads and 15 per cent of diffuse phosphorus loads. Rural land is a significant source of annual diffuse source loads including 76 per cent of

nitrogen loads, 76 per cent of phosphorus loads and 85 per cent of sediment loads to Western Port.

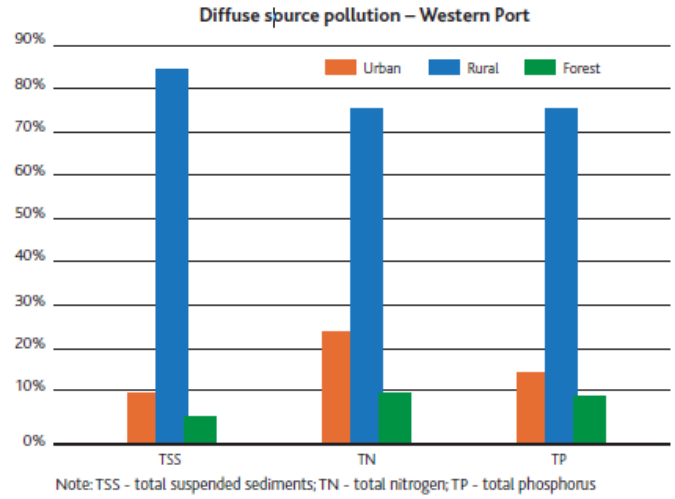


Figure 35. Source of diffuse pollution (Source: better bays and waterways, Melbourne Water and EPA, 2007)

Sediment: The input of fine sediment to Western Port from tributary catchments has been estimated at 62,000 tonnes /year. The dominant source of fine sediment is identified as subsoil from channel and gully erosion of the Bunyip and Lang Lang catchments (Wallbrink et al., 2003a).

Parameter	Urban segments TOTAL	Rural segments TOTAL	Forest segments TOTAL	Non-irrigated pasture cropping	Irrigated pasture cropping, annual & perennial horticulture	Rural roads	Forest	Plantation	Rural township	Rural industrial	Rural greenspace & water
Area (ha)	7378	257 854	70 566	226 771	10 564	9197	53 070	17 496	2715	3000	5607
Area (%)	2%	77%	21%	68%	3%	3%	16%	5%	1%	1%	2%
TN loads (+/- 100%)	14%	76%	10%	52%	6%	7%	7%	3%	4%	5%	2%
TSS loads (+/- 100%)	10%	85%	5%	55%	4%	20%	3%	2%	1%	4%	1%
TP loads (+/- 100%)	15%	76%	9%	45%	4%	14%	6%	3%	5%	7%	1%

Figure 36. Source of TSS, TN and TP within Western Port catchments (Source: better bays and waterways, Melbourne Water and EPA, 2007)

	Area km²	Wet year			Ave year			Dry year		
		t	t/km²	% total	t	t/km²	% total	t	t/km²	% total
Lang Lang	325	10289	31.7	70%	2111	6.5	66%	6410	19.7	68%
Bass	337	174	0.5	1%	73	0.2	2%	76	0.2	1%
Cardinia	181	449	2.5	6%	205	1.1	12%	206	1.1	4%
Watson	55	335	6.1	14%	11	0.2	2%	353	6.4	22%
Bunyip	888	2185	2.5	5%	953	1.1	11%	368	0.4	1%
Other	1562	2762	1.8	4%	1079	0.7	7%	1844	1.2	4%
Total	**3348**	**16193**			**4432**			**9257**		

Note: The uncertainties assigned to catchment contributions vary. For details refer to BMT WBM (2009).

Figure 37. Total suspended solids loads by catchment (Source: BMT WBM, 2009)

	Area km²	Wet year			Ave year			Dry year		
		t	t/km²	% total	t	t/km²	% total	t	t/km²	% total
Lang Lang	325	466.9	1.4	3%	166	0.5	5%	187.1	0.6	2%
Bass	337	117.1	0.3	1%	49.1	0.1	1%	51.3	0.2	1%
Cardinia	181	41.9	0.2	1%	14.2	0.1	1%	12.5	0.1	0%
Watson	55	368.7	6.7	15%	46.1	0.8	9%	231.3	4.2	14%
Bunyip	888	125.9	0.1	0%	46.7	0.1	1%	27.9	0.0	0%
Other	1562	235.2	0.2	0%	104.8	0.1	1%	128	0.1	0%
Total	**3348**	**1356**			**427**			**638**		

Note: The uncertainties assigned to catchment contributions vary, for details refer to BMT WBM (2009).

Figure 38. Total nitrogen loads by catchment (Source: BMT WBM, 2009)

The document identifies urbanisation as impacting waterways and Westernport bay through increased effective imperviousness and "consequent increases in pulse events in waterways". It is therefore important to apply adequate stormwater treatment infrastructure as parts of new developments

Domestic Wastewater Management Plan (2006-2009): The legislation regulating septic tank systems is the Environment Protection Act 1970 (Victoria). Cardinia Shire Council is responsible for the approval, supervision of installation, and monitoring of septic systems up to 5,000 litres of effluent per day or less i.e. domestic systems. Residents are responsible for the maintenance and performance of those systems. The Health Act 1958 (Victoria) is also relevant but requires more general duties including the prevention of disease, prolonging life and promoting public health.

According to Council's website there are approximately 10,000 domestic on-site wastewater treatment systems. The public health risks associated with these systems arise when bacterial contamination associated with human waste contaminates drinking water, waters used for recreational purposes or where there is direct human contact with effluent. They also contribute nitrogen and phosphorous to their catchments. Beyond this, there are social implications of poorly maintained onsite systems including odour.

The strategy did assess risk by area based on the following criteria:

Rainfall
Soil permeability
Slope
Risk of flooding
Depth of water table
Soil thickness
Domestic water catchment
Distance to water course

Table 9. Domestic wastewater risk summary

Area	Risk	Comment
Upper Yarra (Emerald/Avonsleigh, Cockatoo and Gembrook)	Very high	These areas have high rainfall and thin soil profiles. Some systems installed prior to the early 1970's were permitted to discharge to the stormwater system. Since the time that the management plan was written, wastewater infrastructure has been constructed in this area connecting these areas to the metropolitan wastewater network. The rates of connection to that system however were unknown at the time of writing.
Upper Beaconsfield	High	The area features poor soil permeability, thin soils, relatively steep slopes and high rainfall. Areas with high concentrations of unsewered properties also cause amenity and public health impacts.

Bunyip	High	Poor soil permeability, thin soils and high rainfall.
Nar Nar Goon	High	High rainfall and moderate soil thickness. Flat, with roadside drains tending to pond water. When septic tanks leak to these drains it causes public health issues.

Environmental receptor	Risk	Comment
Westernport estuarine, intertidal and immediate marine environment	Very high	The estuarine, intertidal and immediate marine habitat of Westernport Bay is described as an area of very high environmental value with international geological and geomorphological significance (Cardinia Shire Council, 1999). The saltmarsh and mangrove areas are one of the few remaining examples of this type of landscape in southern Australia (Western Port Regional Planning and Co-ordination Committee, 1992). The impact of septic tanks is associated with the nutrient loads conveyed to these receiving waters.
Westernport Bay	Very high	Westernport Bay is an area with very high environmental values with the bay listed under the Ramsar Convention (Cardinia Shire Council, 1999)

Cardinia Shire, City of Casey and Mornington Peninsula shire: Minimisation of the impact of unsealed roads on stormwater quality, September 2004: The data collected indicates that road surface treatments provide minimal benefits to stormwater quality. Neither wet compaction, dry compaction nor an additional surface layer resulted in a reduction in sediment runoff. As a result, efforts should be focused on improved maintenance of roadside drainage structures and the treatment of drainage water prior to discharge. Focusing on the maintenance of roadside drainage structures and the treatment of drainage water prior to discharge will provide maximum benefits for the environment

Analysis of the road runoff found that unsealed roads generate a large proportion of fine sediment particles. Approximately 60per cent of the sediment collected in runoff was very fine silt and a further 30-40per cent was silt.

During large storms a higher proportion of coarse sediment is produced, most probably because the increased volume and velocity of the stormwater has the capacity to pick-up and transport larger road particles.

An unsealed road network may contribute disproportionate amounts of sediment to the catchment. Only some road sections may have the necessary characteristics to potentially impact on water quality of receiving waters. Identifying these areas is an important step in ensuring cost effective sediment control measures that result in the maximum benefits to the environment.

Cardinia Shire Council Stormwater Management Needs Analysis, "A self-assessment tool to identify stormwater partnership opportunities", 2013: The Needs Analysis is a self-assessment undertaken with Melbourne Water to understand Cardinia Shire's capacity to deliver best practice stormwater management and water sensitive urban design (WSUD). The Needs Analysis was undertaken with 38 councils across nine predetermined capacity themes.

Table 10. Cardinia Shire Needs Analysis summary

Nine capacity themes	Community	Commitment	Policy & Planning
	Process Management	Interdepartmental Involvement	Implementation Knowledge & Resources
	Maintenance & Enforcement	Champion	

Key drivers and challenges for council	1. Improving water quality of Westernport Bay 2. Partnering with Melbourne Water to provide funding, resources and training and helping to engage Councilors and senior executives.
Council's capacity (summary of a broader list)	• Council committed to undertaking an IWCM Strategy with stormwater targets • Development of WSUD Guidelines with council specific addenda for internal and external use with the development industry • Coordinated presentation of residential rain gardens at Koo Wee Rup Water Saving Workshop • Key council champions regularly attend South East Council Integrated Water Group • Involvement in Melbourne Water WSUD asset inventory and lifecycle costing programs
Future directions and goals (summary of a broader list)	• Resource designated officer to drive commitment to water quality and WSUD issues • Participation at Melbourne Water education programs to increase general awareness • Include generic media releases or information in Council newsletters or on the website • Engaging Council management to drive overall commitment • Improve awareness of and access to available online resources and training opportunities • Access to a map of locally suitable species for wetlands in order to communicate the information internally, to developers and land owners • Change Planning Scheme to make WSUD mandatory for Commercial & industrial developments • Training for new staff on maintenance and lower cost training solution/greater financial assistance.
Opportunities to partner with Melbourne Water	• Directly engage Councilors and senior executives • Work with Council to develop ideas/ strategies for engaging the community • Support internal workshops or project design meetings with relevant contacts across council • Increase capacity across council through co-contributions to strategic and structural projects that deliver multiple community benefits • Develop an asset register of WSUD assets to aid in monitoring and maintenance • Enable council Parks and Gardens staff to undertake WSUD maintenance training through Clearwater.

Appendix B – MUSIC modelling details

This appendix discusses the assumptions and details for the MUSIC modelling component of the Council's IWMP. The approach outlined in Melbourne Water's MUSIC guidelines has been adopted for the modelling in this project (see Melbourne Water, 2010).

Targets associated with stormwater quality are defined within Best Practice Environmental Management Guidelines (BPEMG) (CSIRO, 2006) as a percentage reduction in loads of typical urban pollutants. These objectives are summarised in Table 11.

Table 11. Stormwater management objectives (CSIRO, 2006)

Pollutant	Receiving water objectives	Best practice stormwater management objective
Total Suspended Solids (TSS)	comply with SEPP (e.g. not exceed the 90th percentile of 80 mg/L)	80% retention of the typical urban annual load
Total Nitrogen (TN)	comply with SEPP (e.g. base flow concentration not to exceed 0.9 mg/L)	45% retention of the typical urban annual load
Total Phosphorus (TP)	comply with SEPP (e.g. base flow concentration not to exceed 0.08 mg/L)	45% retention of the typical urban annual load
Litter or gross pollutants	comply with SEPP (e.g. No litter in waterways)	70% reduction of typical urban annual load

Table 12summarises the MUSIC modelling parameters required for the project.

Table 12. Summary of inputs for MUSIC modelling

Parameter	Description
Rainfall and evaporation	Three stations used to account for the distinct rainfall bands across the shire. Evaporation data for Melbourne will be used for each model as per the MUSIC modelling approach and guidelines.
Time step	A daily time step has been adopted, and is considered suitable for the water and pollutant balance modelling proposed within MUSIC.
Hydrologic routing	No hydrologic routing was employed. Based on discussions with Council staff, this was not deemed necessary for stormwater and pollutant balance modelling.
Soils	The properties of pervious soils specific to Melbourne have been adopted from the MUSIC user manual (Melbourne Water, 2010).
Sub-catchments	The shire had an existing layer with 75 subcatchments, which was considered too fine in scale for this project. A process of reviewing the topography, drainage network, and major tributaries of Dandenong Creek was undertaken to develop a new subcatchment layer. Using local knowledge, Council drainage engineers completed this review and updated the subcatchment layers. These updated subcatchment layers were adopted for this project.

Parameter	Description
Fraction impervious	Spatial data was acquired from Melbourne Water which identified all impervious surfaces as at 2004. This dataset, which was updated to include minor changes in landuse (and included Eastlink), was used to identify the 'effective impervious' fraction. This was achieved by classifying impervious areas that are within a 40 metre buffer from a drainage or waterway. Fraction impervious values for planning zones in Cardinia were taken from the Melbourne Water MUSIC guidelines. The sub-catchment fraction impervious value was the area weighted average of all planning zones within the sub-catchment which were provided in GIS format by Cardinia Shire Council.

Rainfall and evaporation data

Melbourne Water MUSIC Guidelines (Melbourne Water, 2010) provide contours of rainfall bands for the greater metropolitan Melbourne area and suggest representative sites from which pluviograph data can be sourced. There are three distinct rainfall bands within the shire and this has been taken into account for each within the modelling.

Three interrelated MUSIC models were required to reflect the unique rainfall characteristics of each region. The models were structured so that the outputs can be correlated to each other. For example, a shorter rainfall record, between 1974 and 2010, was adopted. Details of the rainfall inputs for each model are summarised in Figure 39.

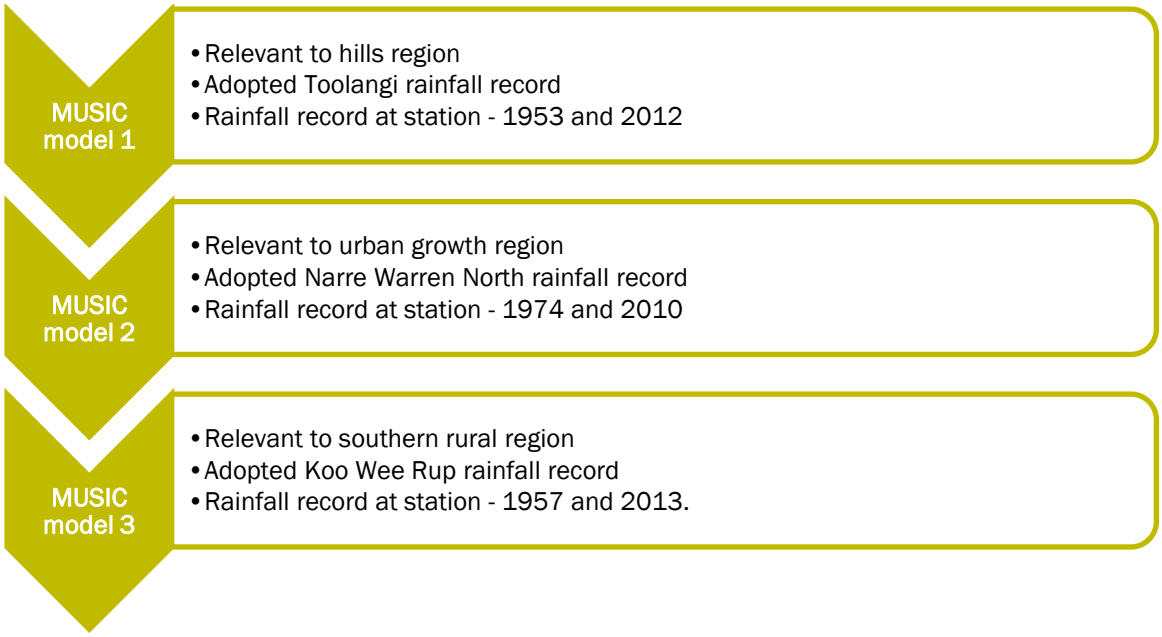


Figure 39. MUSIC model sequence

Sub-catchments

Sub-catchments within the shire were developed using the following data:

- Primary catchments including: Yarra River, Cardinia Creek, Toomuc Creek, Deep Creek, Bunyip River, Yallock Creek, and Lang Lang River (see Figure 40)
- Catchments being the individual stream catchments developed by Melbourne Water
- Rainfall bands to reflect variations in rainfall data, and
- Major points of interest including: water demand, population growth and infrastructure. These areas included Pakenham, Beaconsfield and Officer townships.

A summary of the MUSIC modelling catchment and sub-catchment details is provided in Figure 40 **Error! Reference source not found.**. Layouts of each of these catchments is provided from Figure 39 to Figure 45 (in these figures, forest nodes are represented as green subcatchments, agriculture nodes are brown, and urban nodes are blue).

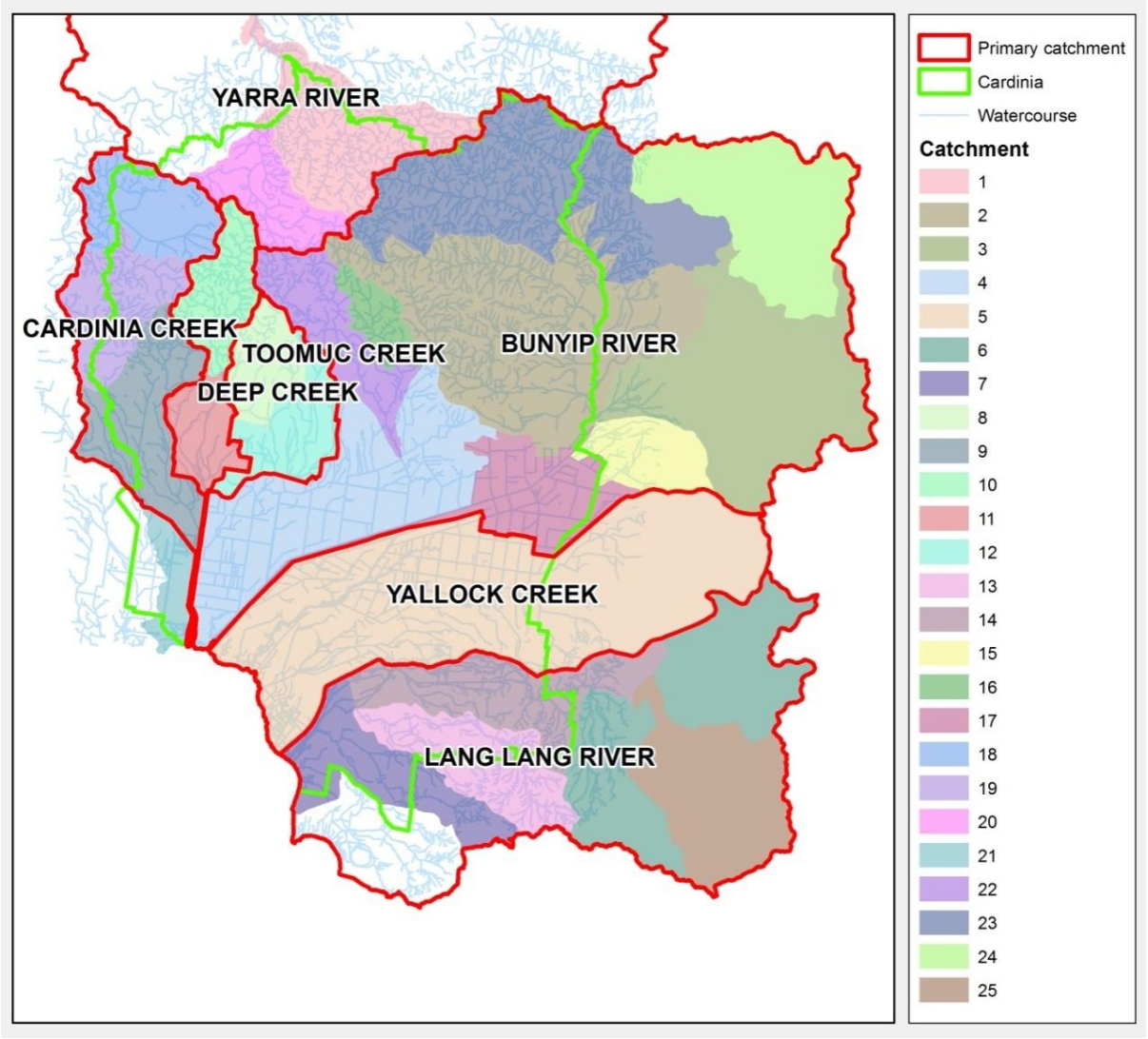


Figure 40. Primary catchment layers

Table 13. MUSIC modelling catchment and sub-catchment details

Catchment	Sub-catchment	Description	Model	Locality of interest	Further details
Bunyip	B-1	Special use zone – Bunyip food bowl area along Bunyip River to Westernport Small urban components Green wedge elsewhere	Agriculture node Urban node	Part of Garfield (one third of the township) Tynong Nar Nar Goon Part of Koo Wee Rup (not the township)	
	B-2	Green wedge	Urban node	None	
	B-3	Small urban component Green wedge elsewhere	Urban node	Maryknoll	
	B-4	Special use zone – Bunyip food bowl area along Bunyip River to Westernport Small urban component Small farm component Green wedge elsewhere	Agriculture node Urban node	Part of Garfield (one third the township) Part of Bunyip (not the township)	
	B-5	Small urban components Small farm zone Green wedge elsewhere	Agriculture node Urban node	Part of Gembrook (not the township) Small part of Maryknoll (not the township) Part of Garfield (one third of the township) Bunyip (the township)	
	B-6	Small farm zone Green wedge elsewhere	Agriculture node Urban node	Part of Gembrook (not the township)	

Catchment	Sub-catchment	Description	Model	Locality of interest	Further details
	B-7	Small urban component Farm zone elsewhere	Agriculture node Urban node	Nothing of interest – upstream of Cardinia (township)	
	B-8	Farm zone Rural development zone	Agriculture node Urban node	Nothing of interest – upstream of Cardinia (township)	
	B-9	Small farm component Small rural development component Green wedge elsewhere	Agriculture node Urban node	None	Reservoir
Cardinia	C-1	Small urban component Green wedge elsewhere	Urban node	Small part of Beaconsfield (part of the township) Part of Officer (not the township) Small part of Pakenham (not the township)	Future development
	C-2	Urban components Green wedge elsewhere	Urban node	Beaconsfield Guys Hill Part of Beaconsfield Upper (the township)	Small future development
	C-3	Small urban components Green wedge elsewhere Reservoir	Urban node	Part of Emerald (part of township areas) Part of Menzies Creek Clematis (township)	Reservoir
Deep	D-1	Urban components Farm component Green wedge elsewhere	Agriculture node Urban node	Part of Pakenham (part of the township) Part of Nar Nar Goon (not the township)	

Catchment	Sub-catchment	Description	Model	Locality of interest	Further details
	D-2	Urban Green wedge elsewhere	Urban node	Part of Pakenham (part of the township)	Some future urban within existing region (negligible)
Lang Lang	L-1	Small urban component Green wedge Farm zone	Urban node Agriculture node	Part of Lang Lang (part of the township)	
	L-2	Green wedge Farm zone	Urban node Agriculture node	Part of Lang Lang (not the township)	
	L-3	Small urban component Green wedge Farm zone	Urban node Agriculture node	Part of Lang Lang (part of the township)	
	L-4	Farm zone	Agriculture node	None	
	L-5	Farm zone	Agriculture node	None	
	L-6	Farm zone	Agriculture node	None	
Toomuc	T-1	Green wedge Urban zone	Urban node	Part of Pakenham (part of the township)	Future development
	T-2	Green wedge	Urban node	Part of Beaconsfield (not the township) Part of Pakenham (not the township)	

Catchment	Sub-catchment	Description	Model	Locality of interest	Further details
Westernport	WP-1	Small special use zone component – Bunyip food bowl Green wedge	Urban node Agriculture node	None	
	WP-2	Small special use zone component – Bunyip food bowl Green wedge	Urban node Agriculture node	None	
		Green wedge Farm zone	Urban node Agriculture node	None	
Yarra	Y-1	Green wedge	Urban node	Part of Cockatoo (not the township) Part of Gembrook (part of the township)	
	Y-2	Urban components Green wedge	Urban node	Part of Gembrook (part of the township) Part of Cockatoo (all township) Part of Emerald (part of the township) Part of Avonsleigh (part of the township)	
	Y-3	Urban components Green wedge	Urban node	Part of Emerald (part of the township)	
Yallock	YK-1	Small urban component Special use zone component – Bunyip food bowl Green wedge Farm zone	Urban node Agriculture node	Part of Koo Wee Rup (township)	

Annual average evaporation and evapotranspiration values across the shire are summarised in Table 14

Table 14. Annual average evaporation and evapotranspiration values across shire (BoM, 2013)

Unit	Range (mm)	Description
Average pan evaporation	1,000 - 1,200	Applies to an indicative amount of water evaporating from bare ground or open water (i.e. design of local infrastructure)
Areal actual evapotranspiration	400 – 600	Applies to a large area of land under existing (mean) rainfall conditions
Areal potential evapotranspiration	1,000 – 1,200	Applies to an area so large that the effects of any upwind boundary transitions are negligible and local variations are integrated to an areal average (i.e. greater than one square kilometre)
Point potential evapotranspiration	1,200 – 1,400	Applies to an area so small that the local evapotranspiration effects do not alter local air mass properties (i.e. small irrigated fields with a never-ending water inflow, surrounded by unirrigated land)

Figure 41. High rainfall band model (relevant to hills region)

Figure 42. Moderate rainfall band model (relevant to urban growth region)

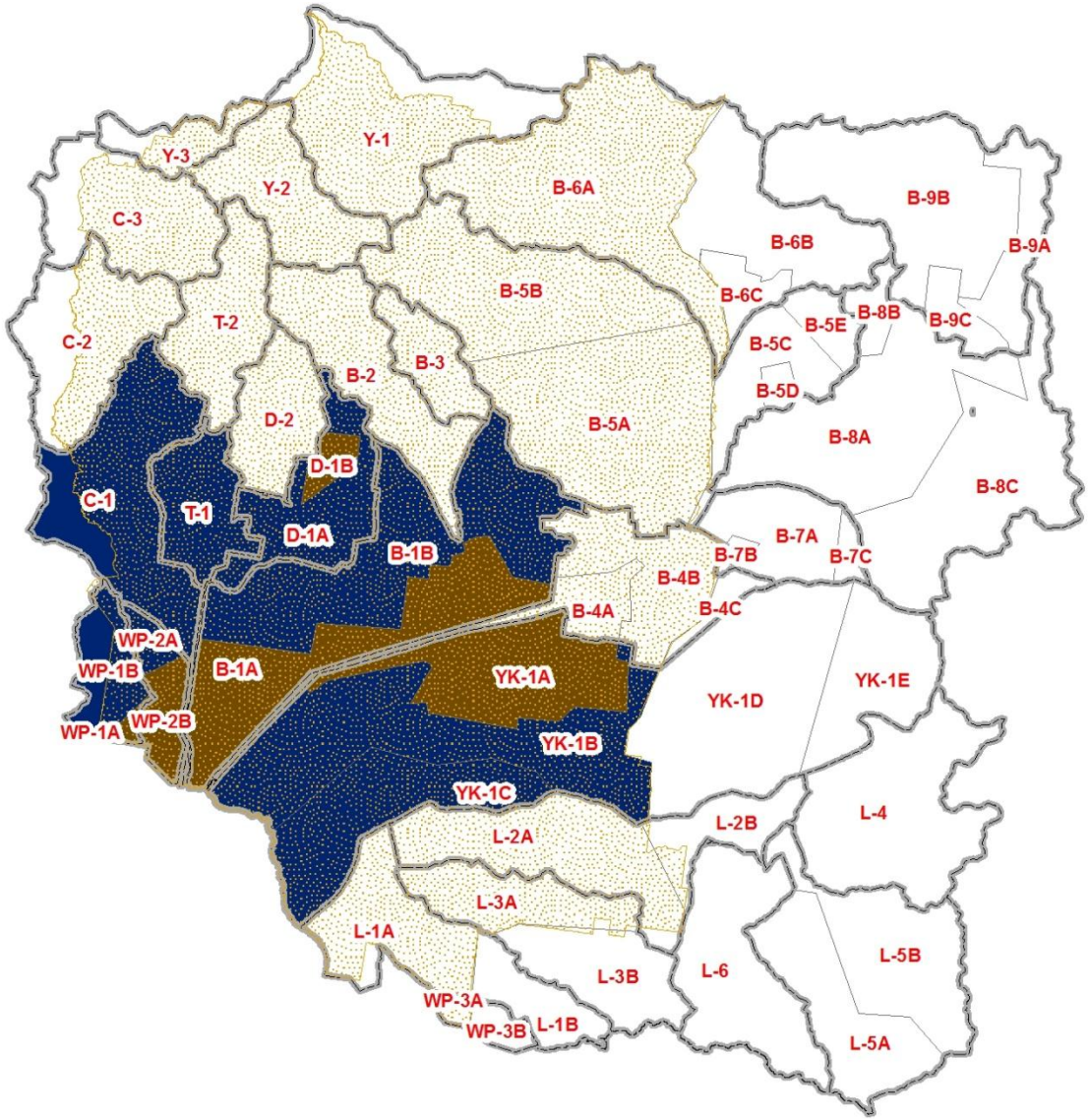


Figure 43. Low rainfall band model (relevant to southern rural area)

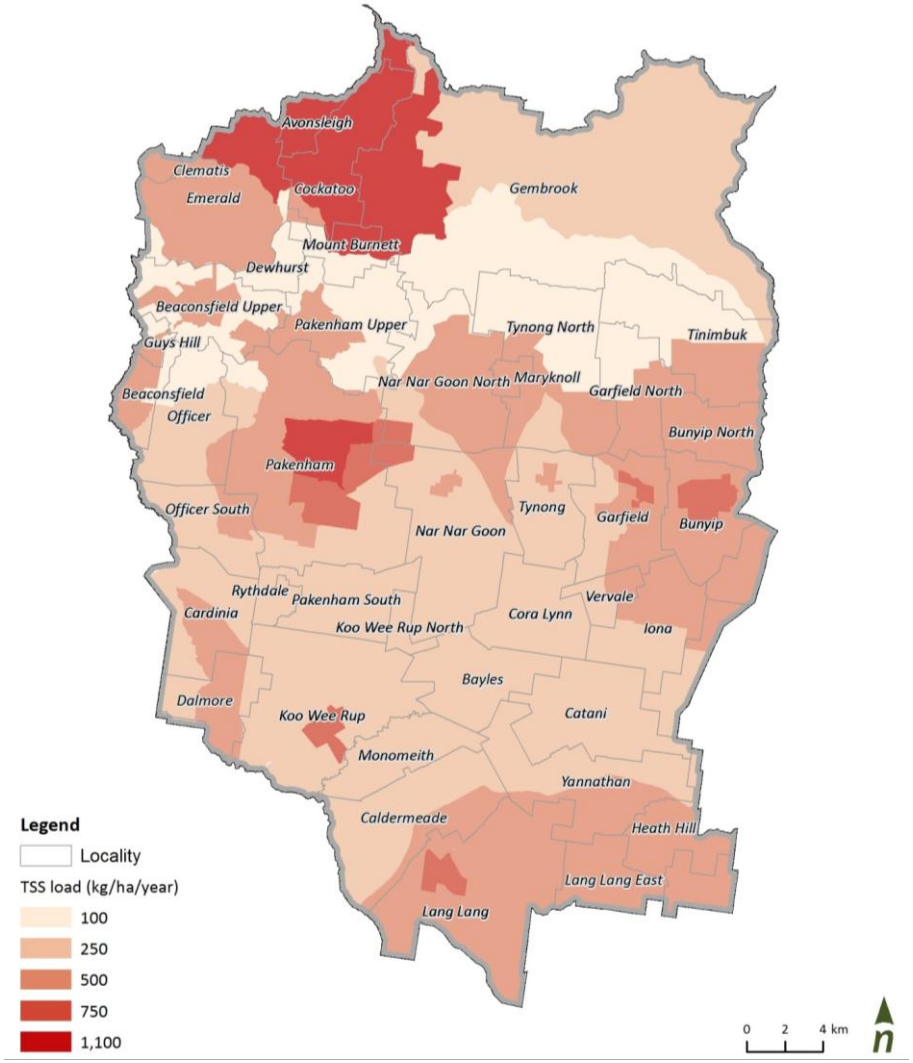


Figure 44. TSS loads modelled by subcatchment, base case scenario

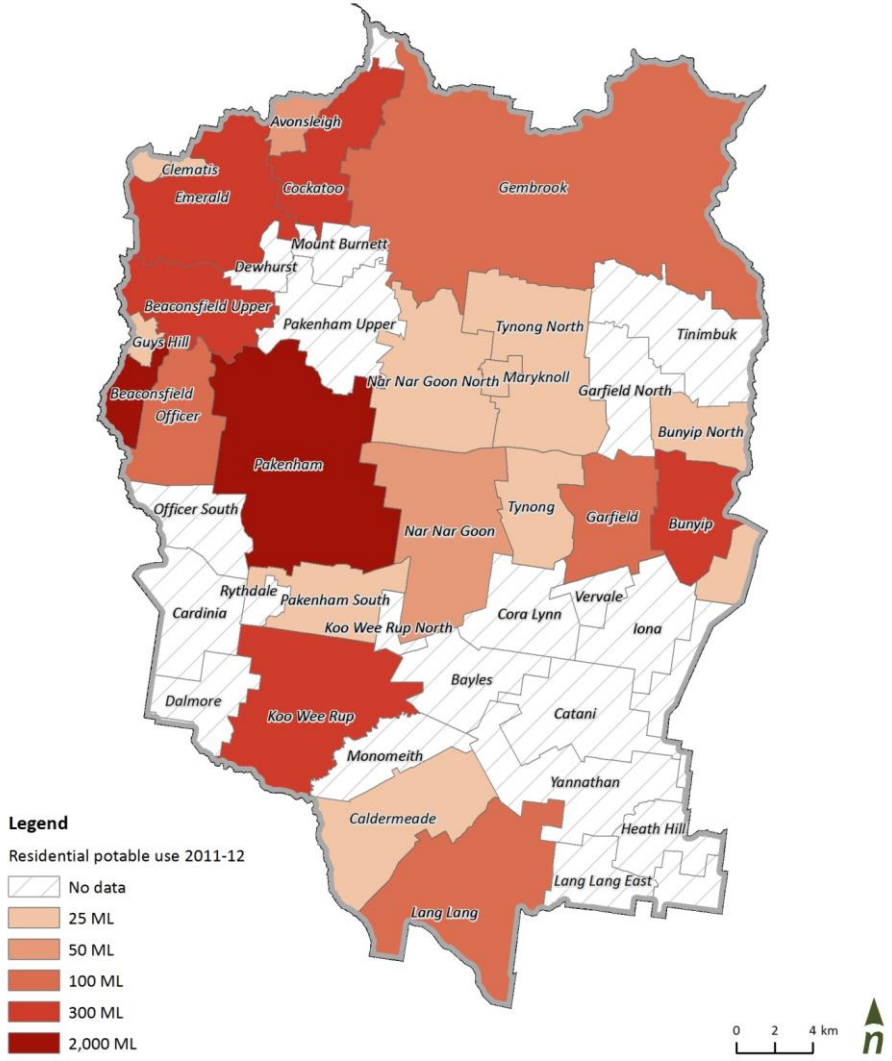


Figure 45. Residential potable water use 2011-12, by suburb

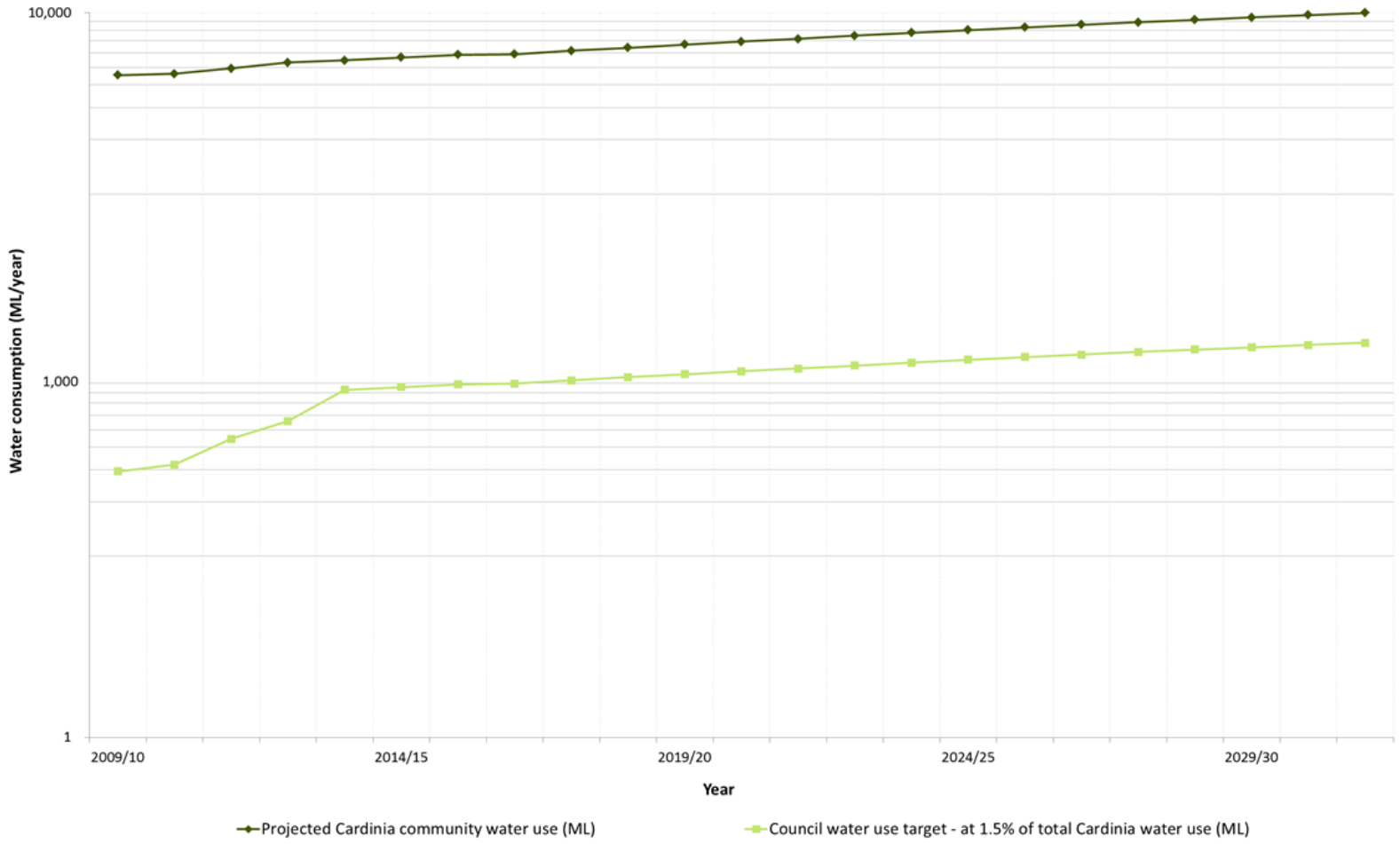


Figure 46. Council water use projections at 1.5 percent of community use

Appendix C: Vision and aspirations

With an understanding of some of the key flows within the shire's Water Cycle and some of the current and likely future influencers behind it, an engagement process was undertaken to develop the vision and aspirations for the shire's water cycle and for the IWMP.

Consultation

Development of the shire's IWMP was supported by a number of internal (Council) and external stakeholders. Communication with these various stakeholders was undertaken collaboratively and primarily within workshops and one-on-one meetings. A summary of the stakeholders involved in the IWMP process is illustrated in Figure 47.

Figure 47. Summary of project stakeholders

Engagement with these stakeholders can be categorised into three types:

- high degree of engagement (day-to-day discussion and feedback) with the shire's Project Manager and team
- workshops with both the shire and external agencies.
- meetings and communications with project stakeholders.

Figure 48 shows the process that was undertaken to develop the vision and aspirations for the shire's IWMP that led to the Targets and Actions that are detailed in Section 5.

Consultation activity	Description
Early engagement with Shire	Inception meeting and ongoing engagement with Council's Environment and Engineering group including regular emails, phone calls, and general feedback.
Workshop 1 (Shire)	Agreed a vision statement and objectives to assist in identifying focus areas for the IWMP. Developed aspirations and highlighted issues and opportunities for each focus area.
Workshop 2 (external agencies)	Reviewed the IWCM actions developed by Council staff. Identified complimentary objectives and programs at external agencies. Nominated agency champions to work with the Shire to develop relevant actions.
Meetings with external agencies	Informal meetings with staff from Metropolitan Planning Authority, Melbourne Water and Office of Living Victoria to discuss various aspects of the project.
Consultation with water retailers	Corresponded with Yarra Valley Water, South East Water and Southern Rural Water via emails and phone calls.
Workshop 3 (Shire)	Developed targets for prioritised issues and opportunities. These were short-listed and voted on during Workshop 3.
Shire review of targets and action plan	Council conducted an internal review of the draft IWMP, aspirations, targets and action plan. Feedback on the IMWP was incorporated into final report and IWMP.
Community consultation	Final daft of Cardinia Shire IWMP was issued to the Shire's broader community for feedback and comment.

Figure 48. Consultation process for the shire's IWMP

Vision

Within the first Workshop it was proposed that the vision and objectives for the Council's IWMP be adapted from the Melbourne's Water Future document (OLV, 2013). This was agreed upon in an attempt to provide consistency across levels of Government while retaining the flexibility to apply the vision and objectives to Cardinia Shire's specific requirements.

Accordingly, the vision statement agreed to within Workshop 1 is for Cardinia Shire to be "a shire that is sustainable, productive and liveable".

The Melbourne's Water Future objectives that will guide the shire toward that overall vision are shown in Figure 49.

Figure 49. Vision and objectives for the Council's IWMP

Workshop 1: the objectives were presented to the group and through discussion adapted as corresponding "focus area" that better reflect Council's role, issues, drivers and language. Following this, aspirations for each focus area were defined by the group. The aspirations were used as guidance for the identification of related issues and opportunities across the shire.

Workshop 2 presented draft objectives to representatives of external agencies including Office of Living Victoria (OLV), Melbourne Water, South East Water (SEW) and the Metropolitan Planning Authority (MPA). The aim of this workshop was to inform these stakeholder agencies of the plan's progress to date and specifically the flavour of the issues and opportunities identified. Further, the potential for Council and stakeholders to collaborate on specific issues or opportunities was flagged.

Workshop 3 focussed on identifying and ranking issues and opportunities. These were broadly defined to capture anything that had the potential to influence the water cycle positively or negatively across policy, trends, community, environment, specific hotspots etc.

shire Workshop 1 – Agenda

Meeting	Workshop 1 – Cardinia Shire's water cycle, issues and opportunities
Meeting held at	Cardinia Cultural Centre, Lakeside Boulevard, Pakenham
Time and date	9.30 – 12.30, 22 August 2013
Project	Cardinia Shire Council IWMP
Invitees	**Council**: Janene Vurlow, Desiree Lovell, Ken White, Martin Teplik, John Holland, Hilary Rutledge, Brett Jackson, Kevin Alexander, Heather Callahan, Cory Bixler, Charles Taveira, Steven Hine, Jim Davine, Steven Pomeroy **Alluvium**: Dan O'Halloran, Rob Catchlove **Apologies:** Stephen Fernee

Time	Item	Responsibility
9.30 – 10.15	**1. Introduction and the shire today** • Why are you here? • Why an IWM plan? • What will we do today? • Cardinia Shire's water cycle: literature, data and modelling results	DOH
10.15 – 10.30	**Break**	
10.30 – 11.20	**2. Vision and objectives: What does the shire with an integrated water cycle look like?**	DOH
	• Office of Living Victoria's objectives? Are these relevant and acceptable for Cardinia? • If not – let's discuss what our objectives should be?	DOH
	Breakout 1: Using these objectives let's discuss the vision for Cardinia **What are the 5 things that will resonate into the future** for Cardinia that define it as a place, a region or a community? Put text and ideas around each objective to "flesh out" what this means for Cardinia and contribute to our vision.	All
11.20 – 11.30	**Break**	
11.30 - 12.30	**3. Issues and opportunities**	DOH
	Breakout 2: With the vision and objectives in mind, break up over maps to brainstorm issues and opportunities across the shire **What actions and projects do we want to take forward?** Be general or specific. Write on the plans!	All
12.30 on	**Final comments and close**	All

Agency workshop 1 – Agenda

Meeting	Agency Workshop 1 – Cardinia integrated water management plan
Meeting held at	Cardinia Cultural Centre, Lakeside Boulevard, Pakenham
Time and date	4 October 2013
Project	Cardinia Shire Council IWM Plan
Invitees	**Council:** Janene Vurlow, Ken White, Desiree Lovell, Hilary Rutledge, Ben Weiner **Agency attendees:** Alan Watts (SEWL), James Westcott (SEWL), Bridget Weatherall (OLV), Jamie Ewert (MW), Gwenda Kullen (GAA) **Alluvium**: Dan O'Halloran

The aim of this meeting was to critically review the IWCM actions that have been developed by Council staff internally, identify complimentary projects and programs at other agencies and identify agency champions that Council can work with to further develop these actions.

Time	Item	Responsibility
10.00 -10.10	**1. Project introduction** Scope and timelines	DOH
10.10 - 10.30	**2. Activities and progress to date** A brief summary of the literature review, data and modelling undertaken to date Brief discussion to follow	DOH
10.30 – 11.30	**3. Objectives, vision and actions** We'll review the outcomes of Council's first internal workshop (summarised within the pdf attached). Note: The actions are categorised by objective and have been derived from the issues and opportunities identified by workshop attendees. We will: • review the actions under each objective • note those actions that relate to agency projects or programs. Are there existing targets or activities that are complimentary to these actions? How can Cardinia work with your agency to realise or progress these actions? • Discussion to follow, focussing on: - Gaps: issues, opportunities and actions that may have been missed - future development of these actions.	DOH
11.30	**Final comments and close**	

shire Workshop 2 - Agenda

Meeting	Workshop 2 – Actions and aspirations
Meeting held at	Cardinia Cultural Centre, Lakeside Boulevard, Pakenham
Date	9.30 – 12.30, 3 December 2013
Project	Cardinia Shire Council IWM Plan
Invitees	**Council:** Janene Vurlow, Desiree Lovell **Alluvium**: Dan O'Halloran, Rob Catchlove, James Fitzgerald

Purpose

This workshop developed targets for prioritised issues and opportunities that were developed within Workshop 1 (within Council) and Workshop 2 (external agencies).

Based on the results of those two workshops we categorised the aspirational statements, issues and opportunities under the following four categories. These correspond to the objectives we adopted within our first workshop.

Waterways and bays

Water efficiency and alternative water sources

Planning and development

Community and public health

Within this workshop we:

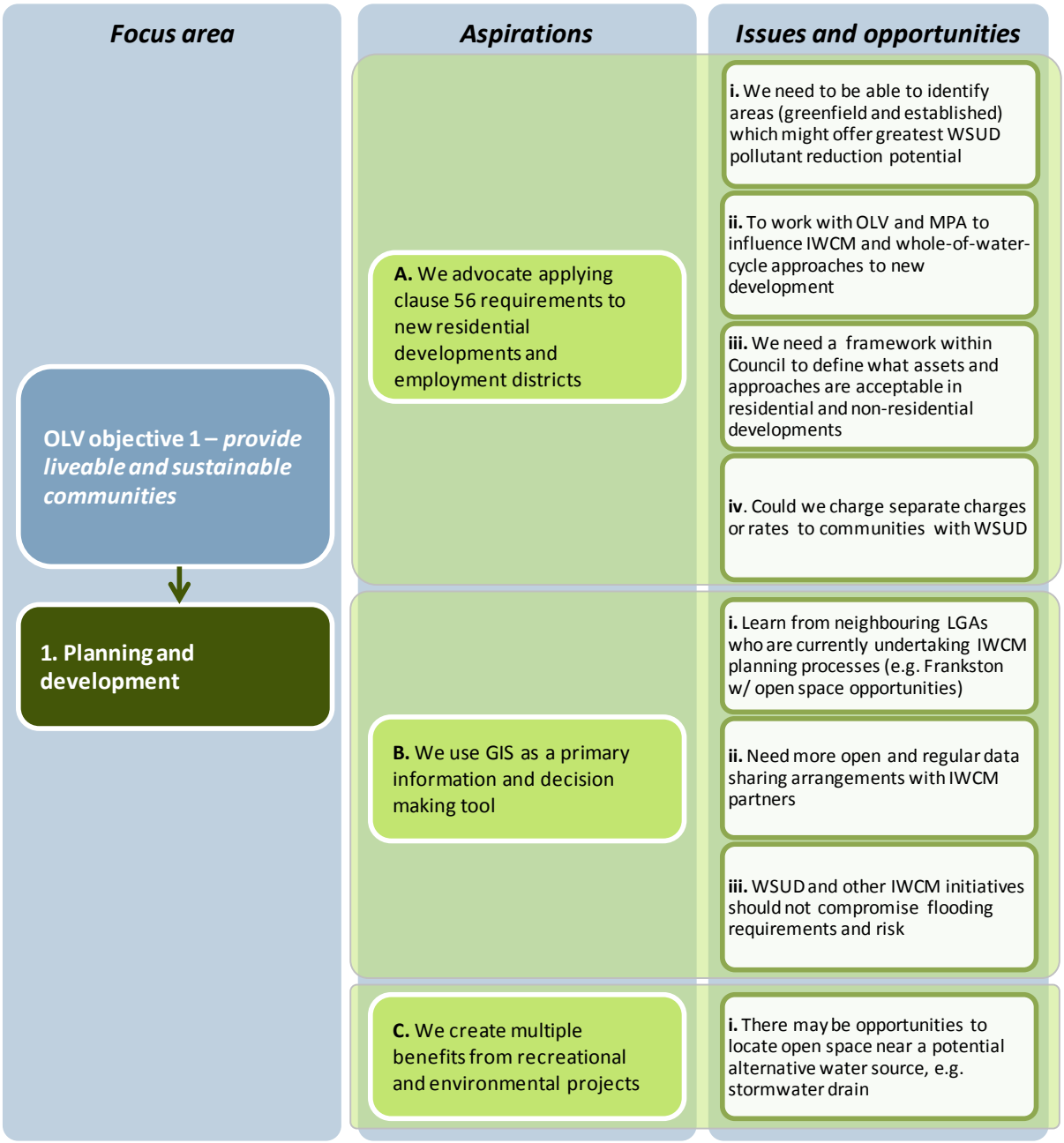
- Critically reviewed the outputs to date and identify gaps (e.g. potable water use reduction)
- Prioritised the issues and opportunities
- Proposed targets for high priority issues and opportunities

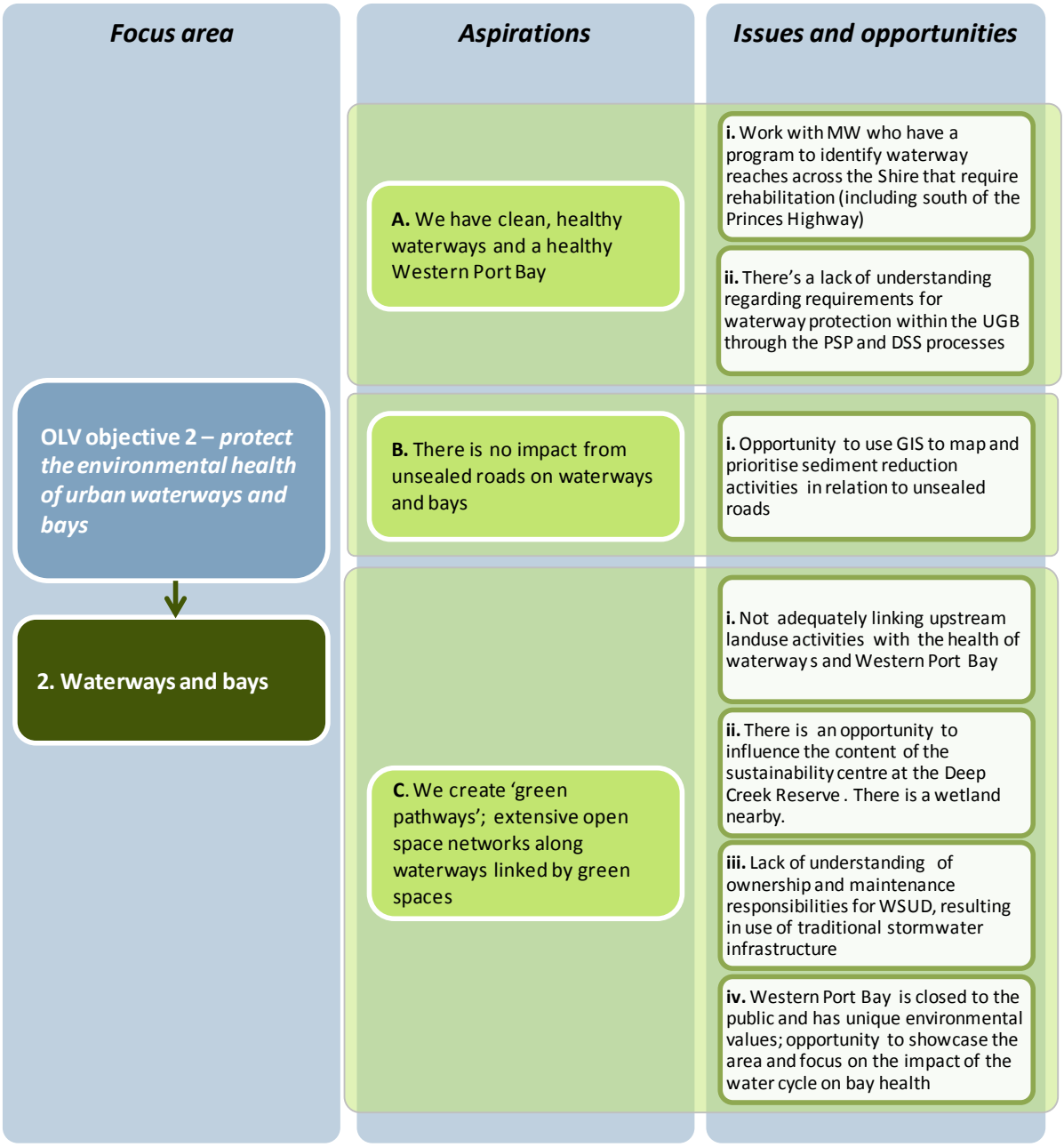
Time	Item	Responsibility
9.30 -9.45	**Introduction** Where are we up to: data, objectives, issues and opportunities What are we aiming to achieve today? What do we mean by a target? What comes after targets? When do we work through the 'Actions and implementation plan'.	DOH
9.45 – 10.15	**Issues and opportunities review** Break into four groups under the headings below: • Waterways and bay • Water efficiency and alternative water sources • Planning and development • Community and public health Review the wording of the issues and opportunities and identify any gaps. Has a key issue or opportunity been missed?	All

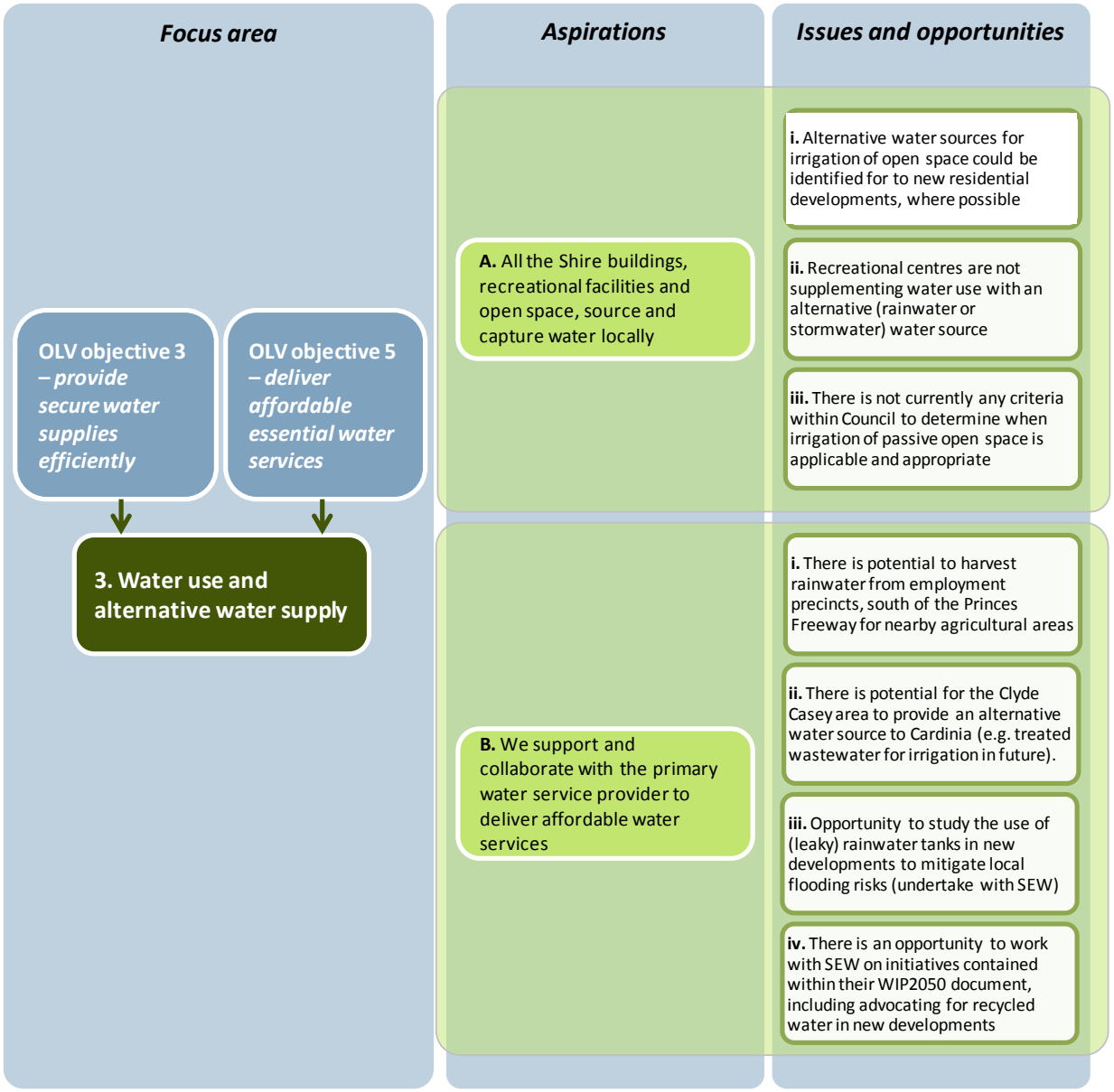
Time	Item	Responsibility
10.15-10.30	**Prioritisation** Each participant will be given 10 dots to place against one or more issues or opportunities to emphasise – in their opinion – the importance of that issues or opportunity to the future of Cardinia.	All
10.30-10.45	**Break**	
10.45 – 11.45	**Targets** Small groups will propose targets for each issue or opportunity. We will tackle these in order of priority. Targets will be expressed to populate the following requirements. Specific: What do we want to accomplish and why? Who would be involved? Where would it take place? Measurable: How much? How many? How will we know when this is accomplished? Attainable: Is this possible? How will it be accomplished? Relevant: Is this worthwhile? Does it 'speak to' the aspiration statement? Time based: This strategy period goes to 2031? Could this be achieved in the first five, or last ten years of the strategy?	All
11.45 – 12:15	**Feedback and next steps** • review the data underlying the target statements proposed within the workshop • refine the target statements and return these to workshop participants for comment, • develop actions to progress toward those targets, focussing on specific case studies.	All

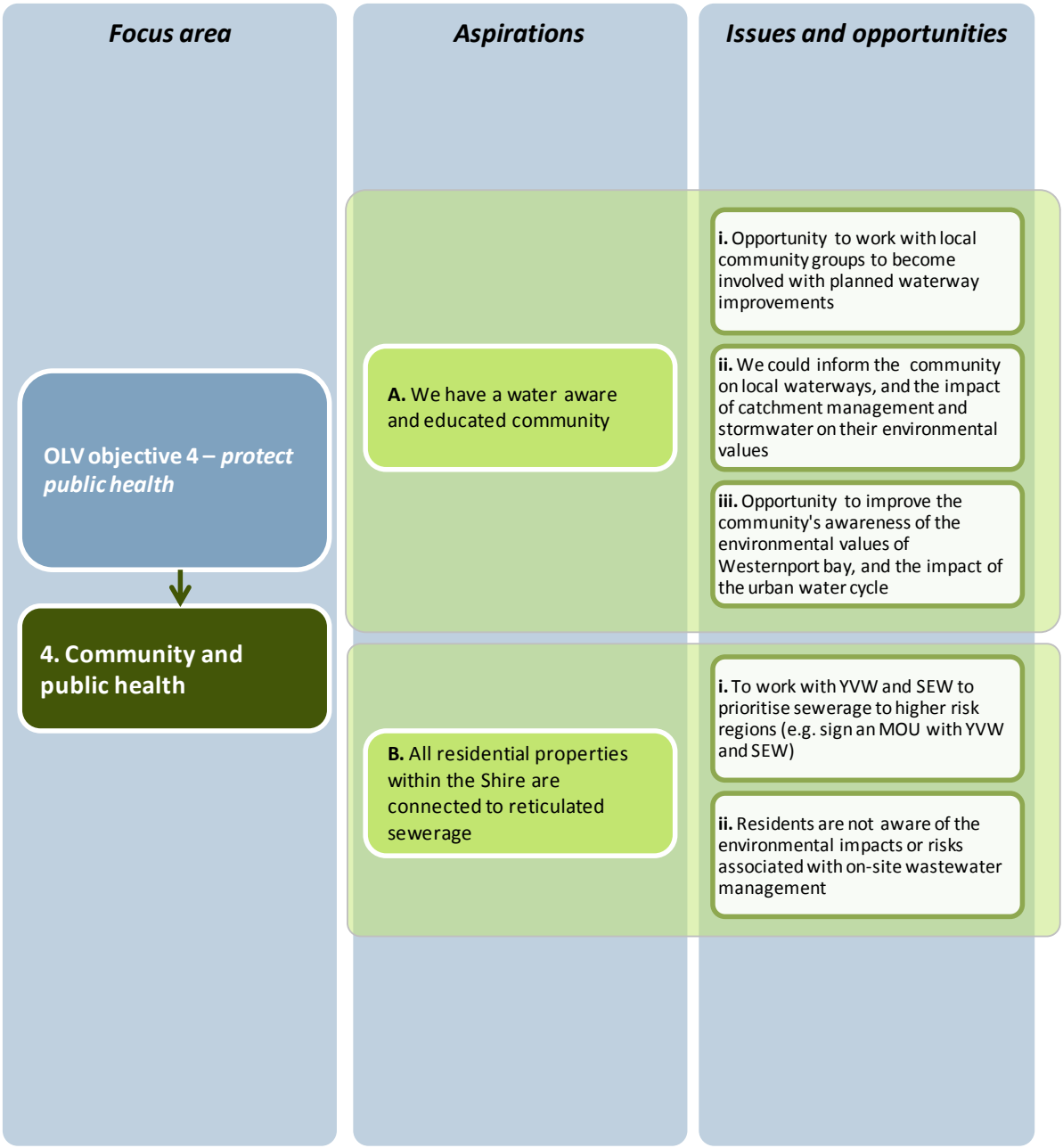
The following tables illustrate Council's aspirations, issues and opportunities under each focus area. Having collated the issues and opportunities offered by Workshop 3 participants, the draft summary was forwarded to agency stakeholders (who were present at Workshop 2) for review. Their comments were incorporated into table 16.

Figure 50. ***Aspirations, issues and opportunities – Objective 1 and 2***




Focus area
Aspirations
Issues and opportunities
OLV objective 2 – protect the environmental health of urban waterways and bays
2. Waterways and bays
A. We have clean, healthy waterways and a healthy Western Port Bay
i. Work with MW who have a program to identify waterway reaches across the Shire that require rehabilitation (including south of the Princes Highway)
ii. There's a lack of understanding regarding requirements for waterway protection within the UGB through the PSP and DSS processes
B. There is no impact from unsealed roads on waterways and bays
i. Opportunity to use GIS to map and prioritise sediment reduction activities in relation to unsealed roads
C. We create 'green pathways'; extensive open space networks along waterways linked by green spaces
i. Not adequately linking upstream landuse activities with the health of waterways and Western Port Bay
ii. There is an opportunity to influence the content of the sustainability centre at the Deep Creek Reserve. There is a wetland nearby.
iii. Lack of understanding of ownership and maintenance responsibilities for WSUD, resulting in use of traditional stormwater infrastructure
iv. Western Port Bay is closed to the public and has unique environmental values; opportunity to showcase the area and focus on the impact of the water cycle on bay health


Focus area
Aspirations
Issues and opportunities
OLV objective 3 – provide secure water supplies efficiently
OLV objective 5 – deliver affordable essential water services
3. Water use and alternative water supply
A. All the Shire buildings, recreational facilities and open space, source and capture water locally
i. Alternative water sources for irrigation of open space could be identified for to new residential developments, where possible
ii. Recreational centres are not supplementing water use with an alternative (rainwater or stormwater) water source
iii. There is not currently any criteria within Council to determine when irrigation of passive open space is applicable and appropriate
B. We support and collaborate with the primary water service provider to deliver affordable water services
i. There is potential to harvest rainwater from employment precincts, south of the Princes Freeway for nearby agricultural areas
ii. There is potential for the Clyde Casey area to provide an alternative water source to Cardinia (e.g. treated wastewater for irrigation in future).
iii. Opportunity to study the use of (leaky) rainwater tanks in new developments to mitigate local flooding risks (undertake with SEW)
iv. There is an opportunity to work with SEW on initiatives contained within their WIP2050 document, including advocating for recycled water in new developments


Focus area
Aspirations
Issues and opportunities
OLV objective 4 – protect public health
4. Community and public health
A. We have a water aware and educated community
i. Opportunity to work with local community groups to become involved with planned waterway improvements
ii. We could inform the community on local waterways, and the impact of catchment management and stormwater on their environmental values
iii. Opportunity to improve the community's awareness of the environmental values of Westernport bay, and the impact of the urban water cycle
B. All residential properties within the Shire are connected to reticulated sewerage
i. To work with YVW and SEW to prioritise sewerage to higher risk regions (e.g. sign an MOU with YVW and SEW)
ii. Residents are not aware of the environmental impacts or risks associated with on-site wastewater management