

Better Bays and Waterways

A Water Quality
Improvement Plan
for Port Phillip Bay
and Western Port

Appendices



Australian Government



Appendix 1: Statement of Reasonable Assurance

Better Bays and Waterways was prepared by obtaining and using the best available information, while accounting for areas of uncertainty.

This statement summarises the degree of confidence associated with implementation of management actions and explains how implementing the measures/actions will result in achievement of water quality targets.

Implementation of management actions

Management actions within the management programs are identified as committed or uncommitted and funded or unfunded. Management actions that are committed and funded have been committed to by the relevant agencies and funding is available to undertake the action. Commitment may be through an organisation's operating plan, or willingness to commit to the action as part of *Better Bays and Waterways*. Funding may already be committed through the relevant organisation, partially funded if a portion of the funding has been committed or not funded if funding is yet to be secured. Where there is no funding or only partial funding, investment must be sought. Implementation of management actions is subject to the availability of funding.

The committed and funded actions within *Better Bays and Waterways* meet the committed targets. A number of key actions have been modelled to provide a higher level of certainty that the proposed interventions will achieve the load reductions necessary to meet the 5-year targets for nitrogen and sediment reductions to Port Phillip Bay and Western Port. Additionally, a number of unquantified, but committed and funded actions greatly increase the certainty that the committed 5-year targets will be exceeded and that these additional actions will contribute significantly towards achieving the long-term targets.

Adaptive Management

Variability is a natural component of ecosystems. Even with the implementation of all committed and funded actions, there are variables that can impact on water quality, particularly in the short-term, in Port Phillip Bay, Western Port and their waterways. The most recent example of this is the 2009 Black Saturday bushfires, though floods and drought both have had similarly significant impacts on water quality both historically and in recent times. Variables such as these may overshadow the benefits of catchment management improvements to water quality in the short to medium term. Being able to adapt to unforeseen events and variables in an adaptive management approach leads to long term benefits in catchment management and practice change.

Other variables such as population growth, climate change and future changes in legislation can also impact on the ability of *Better Bays and Waterways* to effect the planned improvements to water quality. By predicting the impacts of these variables, population growth and climate change have been considered in the development of this plan and are outlined in Chapter 3.

Issues such as these highlight the importance of adaptive management. *Better Bays and Waterways* has adapted during its development to include management actions to mitigate the impacts of unforeseen events such as the 2009 bushfires on water quality. As implementation of the plan continues, the actions outlined in this plan may need to be adapted to ensure the region remains on a trajectory towards improved water quality.

It is necessary to take a long-term view to water quality improvement to ensure that actions undertaken now, using the best available knowledge, will result in the required practice change to facilitate sustained improvements to water quality rather than a short-term fix. Along the way, short-term impacts on water quality can be managed adaptively to ensure we remain on track to meet our long-term goals.

Modelling

To complement the existing monitoring data sets, two key models were developed to assist in analysing the data and extrapolating catchment wide information, such as impacts from pollutant loads. The models, known as Ports E2 and the Receiving Water Quality Model were developed using the best available technologies and were used for both future and hind-casting, so the accuracy of the predictions could be tested. More information on the models is included in Box 3.2 (Chapter 3).

These models have each been peer reviewed, and will benefit from further analysis of their assumptions, limitations and uncertainties. PortsE2 has been calibrated using monitoring data. The lack of significant rainfall events over the past decade has generated an increased level of uncertainty, however both models will continue to be updated and refined as new data becomes available during the rollout of *Better Bays and Waterways*. This will ensure predictions are continuously improved and uncertainties decreased.

There is a level of uncertainty associated with any modelling. The uncertainties associated with the PortsE2 model are shown in Table A1.1 (from BMT WBM, 2009) and are described further in Appendix 2.

Table A1.1: Uncertainties associated with PortsE2 modelling

	Port Phillip Bay uncertainty		Western Port uncertainty	
	TSS	TN	TSS	TN
2004 (Wet year)	+/-78%	+/-46%	+/-71%	+/-42%
2005 (Average year)	+/-44%	+/-31%	+/-81%	+/-60%
2007 (Dry year)	+/-54%	+/-41%	+/-110%	+/-54%

To mitigate this uncertainty, the unquantified committed and funded actions that have not been modelled will further contribute towards meeting the targets.

There is also some uncertainty around the degree and timing of uptake of some interventions, however a conservative assessment of uptake has been assumed to reduce this uncertainty.

Targets

Clause 24 'Regional Target Setting' of the SEPP (Waters of Victoria) recognises that targets need to be established to move towards meeting statutory objectives. The process outlined in Clause 24 was adopted in setting targets in *Better Bays and Waterways*.

Both committed (shorter term) and long-term targets are realistically achievable and are underpinned by the outputs of the models. A few areas of uncertainty in the target setting process are worthy of comment:

- There is a disparity between the level of scientific research on conditions and processes within Port Phillip Bay and Western Port. This plan recommends additional research on Western Port to facilitate future region-specific target setting;
- The uncertainty relating to the Ports E2 model was considered (as described above).
- Continuous monitoring has been limited, with insufficient peak flow events over the past decade. The Ports E2 model was used to predict those loads into Port Phillip Bay and Western Port so that targets could be set.

The target setting approach is explained in Appendix 2 and targets have been set based on the best available science. Melbourne Water and EPA Victoria have a high degree of confidence that the plan's targets will be achieved through the full implementation and delivery of *Better Bays and Waterways*' management programs and their associated actions.

Governance and delivery

Consultation has been a major component of the development of *Better Bays and Waterways*, specifically the management actions. Stakeholders with responsibility for implementing management actions have been consulted and involved in the development of the actions, which are based on the best available science.

Implementation of the plan by these stakeholders and the delivery of actions and management programs will be routinely monitored and annually reported on by an inter-departmental *Better Bays and Waterways* coordinating committee. In accepting responsibility for leading management actions, lead agencies are accountable for committing to delivery subject to available funding.

The appropriate mechanisms have been put in place to provide assurance around the successful delivery of *Better Bays and Waterways*. Future financial support for currently unfunded projects will lead to greater progress towards achieving long term targets, and ultimately, to improved environmental conditions in the Port Phillip and Western Port region.

Appendix 2: Targets background

Port Phillip Bay nitrogen loads target background

Effects of nitrogen on Port Phillip Bay

The CSIRO Port Phillip Bay Environmental Study (Harris *et al.*, 1996) indicated that nitrogen was the limiting nutrient in Port Phillip Bay. It also found that there are two related major points of instability in the Port Phillip Bay system. One relates to phytoplankton in the water column due to the availability of nutrients (particularly nitrogen - see Box A2.1), and the other relates to nutrient processing in the sediments.

The CSIRO study determined that nutrient loads generated by storms require reduction. The key recommendation was to reduce nitrogen loads from catchment sources (rivers, creeks and drains) as nutrients from these sources drive algal blooms in the bay. While continued effort to reduce base loads such as those from the Western Treatment Plant (WTP) was encouraged, and while improved denitrification efficiency at WTP is beneficial, nutrient loads from catchments, especially following storms, were identified in the study to pose a bigger threat to bay environmental health.

The CSIRO study surmised a reduction in the total nitrogen load in the order of 1000 tonnes (from the estimated 1990's load of 7000 tonnes of nitrogen per year) would result in sustained improvements in the water quality in Port Phillip Bay. The critical nitrogen load was modelled to be between double and treble the estimated 1990's load however, the marked non-linear response and significant changes in nutrient load required to recover from anoxia indicated the need to maintain this wide margin of safety. Taking into account this advice, the Port Phillip Bay SEPP required a 1000 tonne reduction in bay nutrient loads compared to the 1996 baseline.

Established targets and strategies

To protect the environmental health of Port Phillip Bay, SEPP (WoV) Schedule F6 established a nitrogen reduction target of 1000 tonnes per year, to be calculated from the baseline established by calculating loads over the period 1991 to 1995 (see Table A2.1).

Subsequently, the Port Phillip Bay EMP was developed to protect the bay and set out how the nitrogen reduction target should be achieved. It required a reduction of 500 tonnes per year (t/y) from WTP nitrogen loads and 500 t/y from catchment nitrogen loads (further specifying that 350 t/y was to come from the Yarra and Maribyrnong catchments and 150 t/y from other catchments) (DNRE, 2002b).

Box A2.1

Nutrient cycling in Port Phillip Bay

Extensive work has been done to analyse the role that sediments play in nutrient cycling in Port Phillip Bay. These studies have identified the types and rates of processes that lead to benthic fluxes. These include exchange of nutrients and the products of respiration (carbon dioxide) and photosynthesis (dissolved oxygen).

*The micro-organisms within Port Phillip Bay have high nutrient demands as plankton biomass and ambient nutrient concentrations in Port Phillip Bay are low. This implies that there is intense recycling of nutrients. Nitrogen does not currently accumulate in the system due to efficient nitrification and denitrification processes (Harris *et al.*, 1996). The supply of ammonia is from organic nitrogen in the sediment, derived mainly from decaying matter. When ammonia levels become elevated, this indicates inefficiency in the denitrification processes within the bay. Compared to similar water bodies, Port Phillip Bay appears to be unusually efficient at denitrification (Harris *et al.*, 1996; Seitzinger *et al.*, 2006).*

*Increasing nutrient loads are expected to lead to a decline in how efficient the denitrification processes are (Murray and Parslow, 1997). Denitrification efficiency is already lower in areas close to major nutrient rich freshwater inputs (such as Hobsons Bay and the Werribee coast) than in the centre of the bay (Berelson *et al.*, 1998). In contrast, decreasing nitrogen loads, such as those from the WTP, should lead to an increase in denitrification efficiency near the inputs. The Port Phillip Bay Environmental Study model indicated that even at current nitrogen loads, a complete loss of denitrification capacity would lead to eutrophic conditions, in turn increasing the risk of algal blooms (Murray and Parslow, 1999). Protection of denitrification efficiency is therefore the key to maintaining water quality in Port Phillip Bay.*

Table A2.1: Nitrogen inputs baseline (EPA Victoria, 2000)

	Western Treatment Plant	Yarra/Maribyrnong Catchment – Upstream Waterways					Yarra and Maribyrnong Estuaries	Koroit Creek	Werribee River	Mordialloc Creek	Paterson River	Other Creeks and Drains	Groundwater	Atmosphere
		Gardiners Creek	Maribyrnong River	Merri Creek	Monnee Ponds Creek	Yarra River								
Annual Load (tonnes N)												537	49	1000
1991-92		78	114	69	91	1249	1867	10	8	483	577			
1992-93		100	306	106	162	1474	2465	9	136	467	742			
1993-94	3368	84	420	107	140	980	2020	39	149	373	588			
1994-95	3181	62	58	72	119	433	935	10	1	459	448			
1995-96	3681													
1996-97	3811													
1997-98	3971													
Precision												Precision cannot be quantitatively estimated but load estimates have high uncertainty		
Mean standard error of annual load estimates	38 (1%)	5 (6%)	4 (2%)	7 (8%)	44 (34%)	40 (4%)	68 (4%)		5 (6%)	36 (8%)	17 (3%)			

The EMP acknowledged the difficulties of balancing nitrogen reduction targets with changing land use and urban expansion.

Progress towards meeting the SEPP/EMP target

Melbourne Water manages WTP – a significant contributor to the baseline nitrogen loads. Nitrogen loads from this source have decreased by more than 500 t/y since upgrade works in 1996 (as outlined in Chapter 3), meeting the EMP target.

Significant areas of the WTP site and the adjacent shoreline are Ramsar-listed wetlands of critical importance to migratory wading birds. Due to the prolonged period of below average rainfall and reduced inflows, the discharge has been reduced by considerably more than the 500 tonnes required and adverse effects are apparent on populations of some bird species in the Ramsar wetlands. Recent studies of bird populations suggest that further reductions in nutrient discharges may be considered a threatening process for the shorebirds and wader species associated with the Ramsar wetlands unless mechanisms can be identified to maintain nutrient delivery to bird habitats irrespective of the overall nitrogen load discharged from the treatment plant.

Melbourne Water, Local government, EPA Victoria and DSE are responsible for managing the catchment reductions.

Since the establishment of the 1996 baseline, catchment works to mitigate nitrogen loads include the construction of numerous wetlands by Melbourne Water to assist in reducing catchment loads from urban areas. Loads models of these initiatives show that these wetlands will, on average, reduce 100 t/y from the Port Phillip Bay catchment by 2010. The majority of these wetlands are situated in the Dandenong catchment due to the location of Melbourne Water-owned land.

In addition to wetland construction, other management actions that have contributed to nitrogen reductions include the containment of bacteriological sources through stormwater diversion to sewer, extensive riparian revegetation along waterways, the installation of litter traps, the installation of rainwater tanks, and the re-use of treated wastewater and stormwater. The contribution of these actions to nitrogen reduction has not been quantified.

Better Bays and Waterways Committed target:

Prevent the addition of at least 40 tonnes per year of nitrogen (equivalent to the overall increase in nitrogen loads due to urban population growth) over five years by reducing diffuse source load contributions by 2014.

About the Committed target

Mitigating the effects of urban growth on diffuse source pollution is a significant challenge. The population of metropolitan Melbourne was projected to increase to between 3.8 and 4.6 million by 2030 (DSE, 2003). Modelling shows this translates into an annual 380 t/y (23%) increase in nitrogen loads to Port Phillip Bay by 2030 (from 1996) if no action is undertaken to address urban growth (as outlined in Chapter 3).

In reality, there are a number of actions already in place to mitigate the effects of urban growth, such as the adoption of Clause 56 of the Victoria Planning Provisions in 2006 that requires Water Sensitive Urban Design (WSUD) for residential subdivisions. These actions will reduce nitrogen loads to the bay. As such a 40 t/y target is required through *Better Bays and Waterways* to prevent an increase in nitrogen loads due to urban population growth.

Appendix 2: Targets background

Meeting the committed target

The committed and funded actions within *Better Bays and Waterways* will meet the committed target of mitigating the forecast 40 t/y contribution due to urban growth. These actions are:

- Rural Land Program (action 7.4);
- Updated best practice environmental management guideline (action 7.9);
- Implement the City of Melbourne's Total Watermark – City as a Catchment policy (action 7.11);
- Establish Victorian stormwater standards for new allotment scale residential and non-residential developments (action 7.15);
- Undertake the Melbourne Water stormwater management programs (action 7.17);
- Review and recognise the environmental benefits of rainwater tanks (action 7.19);
- Encourage uptake of WSUD and investigate opportunities for downpipe disconnection (action 7.20); and
- Urban wetland construction (action 7.21).

Part 2 of *Better Bays and Waterways* outlines the Management Actions and includes the modelled individual actions that contribute to achieving this target as well as a number of unquantified, but committed and funded actions that will result in exceeding the committed target. Given the nature of these unquantified actions, accurate modelling of their effects has not been possible.

The proposed management actions designed to reduce nitrogen inputs to Port Phillip Bay will also result in reductions of other identified pollutants such as phosphorus, sediments and toxicants.

Given that urban growth is exceeding forecasts (DPCD, 2008) the committed target may underestimate the effect of urban growth over the five-year life of the plan, despite the conservative nature of the modelling. In any case, the short-term nature of *Better Bays and Waterways* means that the committed target is not sufficient to ensure the long-term protection of environmental values of Port Phillip Bay. As such, a long-term target accompanies the committed target.

Long Term target:

Protect environmental values by reducing nitrogen by 500 tonnes per year from the 1996 baseline established by EPA Victoria through the gradual reduction of diffuse source load contributions.

About the Long-term target

The long term target is based on the SEPP/EMP target. As a reduction of 500 tonnes per year has been achieved from WTP the remaining target is for 500 tonnes per year to be reduced from catchment sources.

Meeting the long-term target

The catchment modelling undertaken through *Better Bays and Waterways* suggests that the dry conditions over the past twelve years have led to a significant reduction in nitrogen loads.

The model was calibrated with monitored water quality data for key catchments from 2003-2007. The process used the calibrated catchments to inform the model for catchments where monitored load data was not available. As with all models, it is important to know the uncertainty associated with model predictions, and consider these when interpreting the data.

As the method used through *Better Bays and Waterways* differs from that used in establishing the baseline, it is not appropriate to compare the results in Table A2.2 against the baseline estimations from 1996.

An appropriate reassessment of the baseline estimate using current methods will allow us to compare current nitrogen load estimates (Table A2.2) to 1996 estimates. To determine whether we have achieved the 500 t/y reduction target, we will also need to conduct further research into the current denitrification of the system. This will provide information on the effects over the past 12 years of a shifting climate towards drier conditions.

Table A2.2 Total nitrogen loads and uncertainty (BMT WBM, 2009)

Port Phillip Bay	Total Nitrogen (t)	Uncertainty (%)
Dry year (2007)	464	41%
Average year (2005)	1001	31%
Wet year (2004)	1623	46%

In addition to the actions that will meet the 40 t/y committed target, there are a number of funded and committed actions within the plan that are unable to be quantified – these include stock exclusion and riparian revegetation of waterways, natural wetland rehabilitation, and stormwater redirection to sewer. These actions will help ensure that the committed target is exceeded and contribute towards meeting the long-term target. However the quantum of the reduction cannot be modelled with any degree of certainty.

There are also a number of actions included in *Better Bays and Waterways* that will contribute to the long-term target if additional funding is made available – these include expanded stormwater harvesting and increased use of rainwater tanks. Funding and commitment for these actions will further contribute towards protecting, maintaining and improving the region's environmental values.

The key actions proposed to tackle diffuse pollution – WSUD and rural land programs – are approaches that are in early stages of implementation within the region. As the experience and use of these actions grows, the investment required to achieve each tonne of nitrogen reduction will reduce, enabling improved efficiency for the equivalent investment.

Other sources

Other sources of nitrogen to Port Phillip Bay come from atmospheric and groundwater sources.

Atmospheric sources

Modelling from the CSIRO study (1996) indicated that the atmospheric nitrogen contributions across Port Phillip Bay were approximately 1000 t/y (Table A2.1 above). Later modelling (Hearn, 2001; Hurley *et al.*, 2003) estimated a contribution of 100 t/y directly to Port Phillip Bay. The most recent data collection indicates loads of around 630 t/y of nitrogen fall directly onto Port Phillip Bay annually as wet deposition.

Nitrogen loads increases from bushfires are likely to become more common under climate change forecasts. As such they need to be acknowledged as a source in future scenario modelling (Grace, 2009; K Lansdown, 2009).

600 to 1000 tonnes is a significant contribution of nitrogen. Potential management actions to reduce atmospheric contribution include those that reduce contamination from automobile exhaust and industrial sources. These actions are not included within *Better Bays and Waterways* as they form components of broader national programs. Other relevant management actions are those that prevent the delivery of stormwater from pervious surfaces to rivers and bays – these are outlined in Chapter 7.

Groundwater sources

The CSIRO study (Harris *et al.*, 1996) determined that the average groundwater contribution of nitrogen to Port Phillip Bay was 49 t/y, with a maximum estimated load of 82 t/y. Groundwater is a minor nitrogen source that directly inputs to Port Phillip Bay. Groundwater contributes significant base flows to waterways in the region; nitrogen from this source is calculated within the waterway loads. There are several programs underway to reduce pollution entering groundwater systems and any contamination is likely to be historic in nature, difficult to remediate and of limited ecological significance. As a result, *Better Bays and Waterways* does not propose further actions to reduce nitrogen input from groundwater sources.

Prioritising catchments for action

The CSIRO study (Harris *et al.*, 1996) identified the Yarra and Maribyrnong as priority catchments in which nitrogen should be reduced. They were identified as priority catchments because they flow into Hobsons Bay, which is a significantly degraded system and more susceptible to the effects of high nitrogen loads.

In addition, Dandenong, the South East and Werribee were also noted as priority areas due to the high nitrogen loads they contribute (Table A2.3). However, it is inappropriate to use the modelled contributions alone for prioritising between sub-catchments.

Table A2.3: Major catchment total nitrogen diffuse loads to Port Phillip Bay from calibrated PortsE2

	Area km ²	Wet year			Ave year			Dry year		
		t	t/km ²	% total	t	t/km ²	% total	t	t/km ²	% total
Bellarine	681	5.5	0.01	1%	13.3	0.02	3%	4.9	0.01	2%
Werribee	1774	48.4	0.03	2%	112.4	0.06	9%	48.8	0.03	6%
Maribyrnong	1430	15.2	0.01	1%	55.5	0.04	6%	19.4	0.01	3%
Yarra	4050	929.9	0.23	16%	604.2	0.15	22%	209.8	0.05	11%
Dandenong	563	474.8	0.84	59%	157.6	0.28	41%	133.2	0.24	51%
South East	320	82.9	0.26	18%	37.9	0.12	17%	36.2	0.11	25%
Other	1175	66.4	0.06	4%	19.8	0.02	2%	11.5	0.01	2%
Total	9993	1623			1001			464		

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

The uncertainties in the modelled loads vary from catchment to catchment and year to year. Refer to the calibrated loads report for further detail (BMT WBM, 2009).

Years have been assigned as wet, dry and average based on rainfall. However, it is important to note that all the years in the range were within a dry period and that this will affect the loads.

Further priority setting for catchment works will take into account the waterways targets that will be identified through the process outlined in the Waterways targets section later in this appendix.

Western Port sediment loads targets background

Effects of sediment loads on Western Port

As detailed in Chapter 3, sediments can smother plants and animals and also transport nutrients and other chemicals from the catchment into the bay.

Sediments in Western Port come from coastal and catchment sources. Coastal and catchment land use changes have resulted in changes to nutrient, sediment, toxicants and freshwater flows entering Western Port. Catchment sediment loads were extremely high during development of the surrounding area, including the drainage of the Koo Wee Rup area. Coastal sediment loads have increased over the past 40 years (Hancock, *et al.*, 2001).

The extent of seagrass beds is a good measure of the ecological health of Western Port; they provide habitat and food for fish and other marine animals and they help to stabilise the muddy sediments that are a feature of Western Port.

In the mid 1970s the inter-tidal seagrasses of Western Port suffered a significant decline and only limited recovery has occurred since. The exact pathway for seagrass decline is still to be established. Seagrass is sensitive to sediment or water clarity, freshwater inputs and nutrient loads (Morris *et al.*, 2007). Exactly which of these has been the cause of seagrass decline is unknown (EPA, 1997; Blake and Ball, 2001), however the sediment and nutrient loads entering Western Port limits recovery. Sediment is known to carry nitrogen and affects turbidity, and is therefore seen as the priority for action.

Appendix 2: Targets background

The SEPP WoV, Schedule F8 (Waters of Western Port and Catchment) 2001 has a target to increase seagrass cover in the Entrances and North Arm (Rhyll, Upper and Lower North Arm and Entrance) segments by 5% and in the East Arm (Corinella) segment by 10% by 2011.

In addition to catchment sediment sources, shoreline erosion makes a significant contribution to Western Port's sediment loads. The issue of delivery of sediment loads is accompanied by the resuspension of sediments. Suspended particulate matter in the Western Port water column is predominantly resuspended sediment from the bay floor (Wallbrink *et al.*, 2003). This is the key threat to the protection of environmental values in Western Port as it is the key factor limiting the re-establishment of seagrass in the east arm.

The presence of mangroves is critical to the stability of both coasts and mudflats (Sargeant, 1977). Considerable work has been undertaken to stabilise the banks of waterways in the catchment, and more recently mangrove restoration has been undertaken to stabilise the shoreline.

Load estimates

Based on the available data, the pre-European sediment loads entering Western Port are estimated to have been approximately 24 000 t (on average) per year (Hancock *et al.*, 2001). Research from 2003 estimated the input of fine sediment to Western Port from tributary catchments at 62 000 t/y with the dominant source of the fine sediment being subsoil from channel and gully erosion of the Bunyip and Lang Lang catchments (Wallbrink *et al.*, 2003a).

Erosion of topsoil was most significant in the Bass catchment, accounting for 21% of deposited sediments in the Bass River, however the Bass River contributes less than 10% of fine sediments to the southern segment of Western Port (Wallbrink *et al.*, 2003a). Erosion from the clay banks to the north-west of the Lang Lang jetty also appears to be an important local source of fine sediment. It is estimated shoreline erosion has contributed between 1300 and 2800 t of sediment to Western Port annually (Sargeant, 1977; Wallbrink, 2003).

The Ports E2 model (calibrated with monitoring data from 2003-2007) has estimated sediment loads for Western Port (Table A2.4). The results are influenced by the dry condition of the monitoring time series. There are significant uncertainties associated with these estimates.

The estimates of pre-European sediment loads and the Wallbrink *et al.* 2003 Western Port study both used very different methods to estimate sediment loads; methods that were not based on measured suspended sediment concentrations. The results of such different methods cannot be compared to the method used in the development of *Better Bays and Waterways*. The Wallbrink *et al.* methods would have included a considerable amount of fine sediment which still may not be detected by an autosampler (ie. bedload). The method used in *Better Bays and Waterways* to calculate sediment loads is based on monitored data. Monitoring of suspended solids does not measure fine sediments. This method was used to ensure actual data can be used to calculate loads rather than only relying on modelled data.

The total suspended solid (TSS) site mean concentrations (SMCs) for Western Port catchments show higher concentrations in drier years (2006-2007) than in wet or average years (2004-2005). Also, although 2007 was designated a dry year, in actual runoff in the Western Port catchments in 2007 was only marginally less than in 2005 (the 'average' year). Therefore, with a higher SMC for 2007, the total loads will be higher for the dry year than the average year.

It is important to remember that although 2004 is designated a wet year and 2005 is designated an average year, in fact all of the past 12 years have been dry years. The prolonged dry conditions have made it difficult to calculate wet and average year loads. Whilst a longer rainfall record is available that does include wetter years, this would not enable current loads to be calculated as these wetter years would have reflected loads prior to implementation of load reduction measures.

Table A2.4: Total suspended solids loads and uncertainties (BMT WBM, 2009)

Western Port	Total Suspended Solids (t)	Uncertainty (%)
Dry year (2007)	9257	+/-110%
Average year (2005)	4432	+/-81%
Wet year (2004)	16193	+/-42%

Committed target

Reduce the average annual sediment loads to Western Port by 1000 tonnes per year by 2014.

Achieving the 1000 t/y reduction target will provide a 720 t net reduction over predicted urban growth effects over the five years. The PortsE2 model predicts urban growth to increase suspended solid loads to Western Port by 280 t by 2015. However, urban land use is not currently the major source of sediments in Western Port. Road runoff and rural land use contribute significantly higher proportions of suspended solids. The net reduction in suspended solids will improve water quality in Western Port and help protect the environmental values of Western Port and its catchment.

Meeting the committed target

Successful delivery of the committed and funded actions within *Better Bays and Waterways* will meet the committed target of reducing suspended solids by 1000 t/y by 2015. Part 2 of the plan details the modelled load contributions by each management action that can be quantified. These actions are:

- EcoTender (action 7.3);
- Rural Land Program (action 7.4);
- Updated best practice environmental management guideline (action 7.9);
- Establish Victorian stormwater standards for new allotment scale residential and non-residential developments (action 7.15);
- Undertake the Melbourne Water stormwater management programs (action 7.17);
- Review and recognise the environmental benefits of rainwater tanks (action 7.19);
- Encourage uptake of WSUD and investigate opportunities for downpipe disconnection (action 7.20); and
- Urban wetland construction (action 7.21).

The short-term nature of *Better Bays and Waterways* means that the committed target is not sufficient to ensure the long-term protection of environmental values of Western Port. As such, the committed target needs to be accompanied by a long-term catchment and coastal target.

Long-term target

Given the limited understanding of the required sediment load reduction to protect environmental values and the coastal inputs and effects, no quantitative targets have been established. Chapter 8 of *Better Bays and Waterways* includes a recommendation for further investigations in Western Port to assess the issues and recommend appropriate targets.

In addition to the actions that will meet the committed target there are a number of funded and committed actions within the plan that have not been able to be quantified. These include bed and bank stabilisation works, stock exclusion and riparian revegetation of waterways and natural wetland rehabilitation.

These actions will contribute to ensuring that the committed target is exceeded and to further protect the values of Western Port.

There are also a number of actions included in *Better Bays and Waterways* that will contribute to further reducing sediment input to Western Port if additional funding is made available. These include expanding agricultural best management practice, rural wetland development and expanded waterway stabilisation and revegetation. Funding and commitment for these actions will further contribute towards protecting, maintaining and improving the region's environmental values.

Future monitoring will further inform the current load. Funding and commitment for future research will drive the protection and improvement of the region's environmental values.

Prioritising catchments for action

The CSIRO reports on Western Port (Hancock *et al.*, 2001; Wallbrink, 2003; Wallbrink *et al.*, 2003a; 2003b; Hughes *et al.*, 2003) identified the Lang Lang and Bunyip catchments as providing significant loads. The PortsE2 (BMT WBM, 2009) modelling data (Table A2.5) has identified the Lang Lang and Watson catchments as priority catchments for sediment contributions.

Table A2.5: Major catchment total suspended solid loads from calibrated PortsE2 (BMT WBM, 2009)

	Area km ²	Wet year			Ave year			Dry year		
		t	t/km ²	% total	t	t/km ²	% total	t	t/km ²	% 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).

Further priority setting for catchment works will take into account the waterways targets that are described later in this appendix.

Loss of mangroves has increased coastal erosion, and in turn coastal erosion has increased sediment loads. The presence of mangroves is critical to the stability of both coasts and mudflats. Coastal erosion is estimated to be 1300 to 2800 t/y from the Lang Lang cliffs (Sargent in Wallbrink and Hancock, 2003).

The management actions in Chapter 8 aim to improve the condition of Western Port ecosystems (including coastal and marine). They will tackle the effects of sediments entering Western Port and the effects of sediment re-distribution. Monitoring through these programs should provide information on ecosystem improvements, such as those expected in coastal and seagrass communities.

Given the limited understanding of coastal inputs and effects and the potential effects of climate change, no quantitative targets to report on coastal erosion have been established. Chapter 8 includes a recommendation for further research into Western Port to assess the issues and recommend appropriate targets.

Western Port nitrogen load targets background

Effects of nitrogen loads

While the importance of nitrogen to ecosystem function has been well established for Port Phillip Bay, the same connection has not been established for Western Port.

The relationship of nutrient loads to the health of Western Port's seagrass ecosystems is unclear, though the work of Morris *et al.* (2007) found that the nutrient loads affect seagrass condition and concluded that Western Port's seagrass habitat is sensitive to increased nutrients within the water column. Longmore (1997) indicates that Western Port is probably nitrogen limited. Nutrient load targets have been developed for Western Port and have been designed to function alongside the sediment load targets.

A pilot preliminary study (Longmore *et al.*, 1998) established that benthic nitrogen fluxes at three sites in Western Port were similar to or lower than those reported from other Australian bays and estuaries and varied between 23% and 83%. The study recommended further investigations to better understand the spatial variability of denitrification, the significance of seasonal variation and the effect of key ecosystems such as seagrass on denitrification efficiency.

As noted previously, there has been significant loss of seagrass in the north and east arms of Western Port and there has been very little recolonisation, especially in the Corinella (east arm) segment. The cause of the decline in seagrass cover has not been determined, but seagrass is known to be sensitive to poor water quality (and in particular reduced water clarity due to sediment) and changes in salinity, temperature and nutrient concentrations in the water column (Morris *et al.*, 2007).

Total suspended solids and nutrient (nitrogen) concentrations in the water column of the east arm (Corinella segment) regularly exceed SEPP and ANZECC guideline values designed for protecting the ecosystem of Western Port.

Load estimates

The calibrated Ports E2 model has estimated nitrogen loads for Western Port (Table A2.6). With consideration of the uncertainties associated with these estimates and the fact that the data used in the model was drawn from an extended period of dry conditions, these estimates can be used to help understand the current nitrogen loads entering Western Port, the nitrogen processing capacity of sediments and can be used in establishing an appropriate nitrogen load reduction target.

Appendix 2: Targets background

Table A2.6 Total nitrogen loads and uncertainties (BMT WBM, 2009)

Western Port	Total Nitrogen (t)	Uncertainty (%)
Dry year (2007)	638	54%
Average year (2005)	427	60%
Wet year (2004)	1356	42%

Committed target

The PortsE2 model predicts an increase in nitrogen loads to Western Port due to urban growth of 6 t over five years.

The management actions for nitrogen in Western Port are designed to reduce the nitrogen load to Western Port by 11 t over the five years, resulting in a net decrease in nitrogen loads of 5 t over the five years.

The net reduction will assist in improving water quality in Western Port and be beneficial to seagrass condition.

Meeting the committed target

Successful delivery of the committed and funded actions in *Better Bays and Waterways* will meet the committed target of reducing net nitrogen loads to Western Port by a tonne per year or 5 t by 2015.

Part 2 of the plan details the modelled load contributions by each management action.

These actions are:

- EcoTender (action 7.3);
- Rural Land Program (action 7.4);
- Updated best practice environmental management guideline (action 7.9);
- Establish Victorian stormwater standards for new allotment scale residential and non-residential developments (action 7.15);
- Undertake the Melbourne Water stormwater management programs (action 7.17);
- Review and recognise the environmental benefits of rainwater tanks (action 7.19);
- Encourage uptake of WSUD and investigate opportunities for downpipe disconnection (action 7.20); and
- Urban wetland construction (action 7.21).

Better Bays and Waterways is a five-year plan; this means that the committed target is not sufficient to ensure the long-term protection of environmental values of Western Port. As such, the committed target is accompanied by long-term catchment and coastal actions that while not having a specific, quantifiable nitrogen reduction target, will result in reduced nitrogen loads entering or being mobilised in the waters of Western Port.

Long-term target

There is no scientifically established long-term nitrogen reduction target for Western Port. Outcomes from further research on Western Port will establish the nitrogen processing capacity of sediments and potentially a nitrogen load reduction target for Western Port.

In addition to the actions that will meet the committed target there are a number of funded and committed actions within the plan that have not been able to be quantified – these include bed and bank stabilisation works, stock exclusion and riparian revegetation of waterways and natural wetland rehabilitation.

These actions will contribute to ensuring that the committed target is exceeded and further protect the values of Western Port.

In addition there are a number of actions included in *Better Bays and Waterways* that will contribute to further reducing nitrogen into Western Port if additional funding is made available – these include expanding agricultural best management practice, rural wetland development and expanded waterways stabilisation and revegetation. Funding and commitment for these activities will further contribute towards protecting, maintaining and improving the region's environmental values.

Funding and commitment for future research will drive the protection and improvement of the region's environmental values.

Prioritising catchments for action

Table A2.7 presents the diffuse and total nitrogen (TN) generation rates, on a per unit area basis, for each sub-management unit in the Western Port catchment for the representative average, wet and dry years. The figure contrasts the relative nitrogen load contributions of each region to Western Port, and while some smaller catchments may have greater generation rates per square kilometre in some years, the overall loads are greatest from the Lang Lang and Watson sub-catchments. Priority setting for catchment works will take these figures and the waterways targets into account.

Table A2.7 Major catchment total nitrogen loads from calibrated Ports E2 (BMT WBM, 2009)

	Area km ²	Wet year			Ave year			Dry year		
		t	t/km ²	% total	t	t/km ²	% total	t	t/km ²	% 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).

Waterway water quality targets

Target setting for waterways in the region is done through the development of the RRHS. The RRHS considers water quality targets as one component in the development of priorities, targets and management programs for river health. Along with water quality, the RRHS also incorporates requirements for flow, aquatic habitat, riparian vegetation, heritage and recreational outcomes, as well as aquatic species.

Water quality across the Port Phillip and Western Port region is compared to SEPP (WoV), Schedule F7 and F8 objectives. These objectives are set at levels at which beneficial uses are protected. Although water quality in the region as a whole is considered good by world standards, the majority of sites do not meet all objectives.

SEPP (WoV) states that when water quality objectives are unlikely to be met in the life of the policy, regional targets can be set to drive the progressive rehabilitation of environmental quality. To ensure progress towards improved water quality and protected values, interim regional long-term targets, resource condition targets and management action targets may be set.

Through *Better Bays and Waterways*, Melbourne Water initiated the process to develop interim waterway targets. In consultation with EPA Victoria and an expert panel that includes university and research specialists, a method for target development has been recommended. This section presents the recommended method for target development. Once completed, these projects will inform the 20-year waterways vision currently being developed by Melbourne Water and will inform the review of the RRHS.

The process differs significantly for urban and rural waterways as the issues and solutions posed are very different.

Urban waterways water quality targets

As described in Chapter 3, untreated stormwater from impervious surfaces presents the greatest threat to urban waterways through the delivery of pollutants and increased flows. The pollutant loading to waterways, estuaries and bays is directly proportional to the amount of connected imperviousness in a catchment. Therefore, any increase in connected impervious area will increase the loading to the bays.

In urban areas target setting for improved water quality will be undertaken through a combination of a maintenance based approach (to maintain areas currently in good condition) and a risk-based approach (to rectify chronic water quality issues), as well as working across the region to ensure that conditions do not deteriorate as new urban development occurs.

The maintenance based approach is outlined in detail below. It focuses on investing in WSUD in areas that are close to good condition (i.e. areas with relatively low EI) thereby maintaining water quality and urban flows at healthy levels. Significant investment (multi millions) over many decades would be required to implement large scale EI remediation across the region.

Given the need to address areas with chronic water quality issues in the short term, water quality improvements are also targeted at areas with significant water quality issues. These areas will be prioritised and addressed through action 7.31 – targeting hotspot areas (Managing potentially polluting activities).

These two approaches are accompanied by significant investment across the region in building capacity and investment in WSUD across the region (see management program: Managing Effective Imperviousness) and in actions to prevent the delivery of pollutants to the stormwater system (see management program: Managing potentially polluting activities).

Maintenance based approach to target water quality improvements

No monitoring site within the Port Phillip and Western Port region that monitors a catchment with more than 1% EI attained SEPP (WoV) objectives. Catchments with EI values greater than 1% coincide with urbanised areas. For the purpose of establishing targets, this delineation has been used to separate the urban from the rural areas within the region.

The work of Walsh and colleagues (Walsh *et al.*, 2005, Walsh and Kunapo, 2009) demonstrates that if impervious surfaces are allowed to drain to pervious land or to a treatment that retains stormwater for use or loss through evapotranspiration (by vegetation) or infiltration into the ground, then waterways with substantial catchment urbanisation can remain in good ecological health. In eastern Melbourne, waterways with as much as 12% total imperviousness (but near zero EI) attain SEPP (WoV) objectives (Walsh, 2006), and recent work found sites in the Blue Mountains (NSW) with total imperviousness of up to 30% (but near zero EI) that remain in good ecological condition (Walsh, 2008). Such sites are rare, but they present a clear opportunity for new stormwater management methods (Mouritz *et al.*, 2005) that could permit the attainment of SEPP (WoV) objectives for Melbourne's urban streams.

The sudden shift from the good ecological condition of many streams with near zero EI to the poor ecological condition of all sites with more than 1-5% EI presents no obvious, stable, interim resource condition targets (Walsh, 2006), such as those proposed for rural streams (see Rural water quality targets later in this appendix).

The analysis suggests that the only way to achieve substantial improvements in the water quality of urban streams is through the retrofit of targeted sub-catchments and application of WSUD in all new developments to reduce EI. This implies that stormwater retention and treatment methods should be applied universally within a catchment to achieve such a target; only then can underlying water quality issues be addressed further. The method presented assumes that if SEPP (WoV) objectives are to be achieved in urban areas, it is necessary to achieve an EI of near zero. Applying these methods across the region will require long-term programs to:

- ensure all new developments retain their stormwater;
- ensure stormwater drainage renewal and upgrade programs convert existing stormwater drainage to more retentive systems;
- target retrofit projects for streams where demonstrable, short-term improvements are likely; and
- improve stormwater management from roads.

Programs to achieve the first two of these are underway. There is no expenditure program for targeted retrofits except for a pilot project in the Little Stringybark Creek catchment (action 7.7). Vic Roads and local government incorporate WSUD in the upgrade and management (actions 7.22 and 7.23).

The first step to developing such a program is to undertake prioritisation of streams and sub-catchments for targeted retrofit. EI values for all waterways across the region are being developed. The draft method for prioritising streams for targeted retrofit is described in the Yarra case study (see Box A2.2). This analysis will be continued across the region as the EI dataset becomes available.

Appendix 2: Targets background

Box A2.2 The Yarra River catchment case study

Method under consideration

Effective impervious area (EIA) and length of waterway were quantified for each sub-catchment. About 330 sub-catchments were considered in the preliminary analysis. There will be approximately 10,000 in the final EI dataset. A range of methods for prioritising sub-catchments for EI reduction was trialled.

Assumptions:

- Waterways were protected from stormwater effects only if <0.5% of their catchment was covered by conventionally drained impervious surfaces;
- All treated impervious areas used designs that retained and treated stormwater runoff adequately to remove any stormwater effect to the waterway;
- All new greenfield and infill developments used such stormwater retention devices, so that there were no new areas of Directly Connected Impervious (DCI) during the modelling period;
- WSUD projects occur in 1 ha blocks (and rounded the area of EIA to 1 ha in each sub-catchment); and
- Treatment was simulated by removing EIA blocks 1 ha at a time from targeted sub-catchments. The model was run by removing 100 x 1 ha EIA blocks from the dataset in each step, recalculating EI in all sub-catchments, and summing the length of waterway in all sub-catchments with <0.5% DCI. Several strategies for deciding which sub-catchments to treat were trialled (See Walsh and Fletcher, 2007 for more detail).

Results

The prioritisation strategy with the highest rate of increase in stream length with <0.5% EI, was one that removed blocks first from sub-catchments with small areas of DCI, beginning in the headwaters, then from more urbanised catchments, beginning at the most upstream urban areas.

A preliminary analysis on 330 prioritised sub-catchments was undertaken. The list extends to sub-catchments that would require treatment of 14 km² of EIA, with the last listed site requiring treatment of 4 km² of EIA. This is likely to be near the limit of achievable retrofit over a decade. The model predicts that treatment of these sub-catchments would improve approximately 50 km of waterway by reducing their EI to near zero.

In contrast, no other prioritisation strategy modelled resulted in any significant improvement in any waterway reach for the same treatment effort.

Discussion

The list of priority sub-catchments developed using EI prioritisation shares common sub-catchments with the ranking of waterways that have high ecological value identified by Danger and Walsh (2008). Danger and Walsh (2008) identified the upper reaches of each of Dobsons, Olinda, Monbulk, Emerald and Sassafras creeks as supporting multiple urban-sensitive species that are endangered by urban development. The first three, together with Stringybark Creek, were also identified as supporting imperilled, isolated platypus populations that are likely to be threatened, in part, by catchment urbanisation. This work strengthens the argument for making these sub-catchments high priorities for EI reduction.

Further work is required using new data for the Yarra River catchment. Analysis of other areas of Melbourne is also required, once regional EI mapping is complete. Likely priority sub-catchments outside the Yarra region include Jacksons Creek, and the waterways of the Pakenham corridor.

Rural waterways water quality targets

Chapter 3 of *Better Bays and Waterways* describes the threats posed to waterways from poor rural land management. The rural target-setting approach is different to the method explored for the urban due, in part, to the more gradual relationship between water quality and ecological condition in rural waterways. This relationship allows for the identification of interim targets that will assist in identifying the highest priority water quality issues between catchments and will provide milestones towards reaching protection for all environmental values (and SEPP compliance) in the region in the longer term.

In the rural areas the method outlined in SEPP (WoV) for the development of interim targets is the basis for the recommended method. This method mirrors the approach used for the development of SEPP objectives. Through consideration by the expert panel, it was decided that regional targets should be developed for TN, TP and TSS. Interim targets for *E. coli* and heavy

metals were excluded, as levels above SEPP (WoV) triggers will compromise human or ecosystem health respectively.

The method is a three-step process:

1. Delineating sub-regions within the study area

Delineation is based on the segments presented within SEPP (WoV), Schedule F7 and Schedule F8, with refinements made on physiography, land use or water quality.

2. Using existing biological data to determine sites and water quality conditions that are acceptable as targets for each sub-region

Macroinvertebrate and water quality monitoring data is used to determine the current condition of sub-regions across the Port Phillip and Western Port region. Analyses of the data are used to determine levels of macroinvertebrate condition that are appropriate as interim biological targets for sub-regions.

These levels become the regional interim invertebrate target condition. Macroinvertebrate data, threat identification and expert opinion are used to establish the regional targets.

3. Comparing water quality across sites within each sub-region to identify threshold values of ecological significance

The assumed link between macroinvertebrate condition and water quality is that if the macroinvertebrates at a site are in good condition, then the environmental conditions at the site (including water quality, flow and habitat) are not limiting them. Linking in-stream invertebrate data to waterway health is strongly supported as a monitoring approach. This aligns with the approach used to establish water quality objectives for SEPP (WoV) (Newall and Tiller, 2002).

The completion of rural targets will enable future rural initiatives and water quality improvement works to be focused on attaining these interim targets, such as Melbourne Water's Rural Land Program (as described in Chapter 7). The outcomes of this process will be adopted into Melbourne Water's 20-year vision, and will inform the next RRHS.

Melbourne Water will continue to review its monitoring network to ensure it can further understand local limitations and refine targets.

Meeting waterway quality targets

The committed and funded actions in *Better Bays and Waterways* will have a positive effect on water quality the region. In addition to the nitrogen and sediment loads, the actions contribute to reductions in phosphorus, toxicants, pathogens, litter and detrimental urban flows. Given the dispersed nature of the actions in most cases, the effect of the actions cannot be attributed to a specific waterway.

Flow targets

Environmental flow is one of the major factors affecting river health. Not a pollutant, but a measure of waterway health, environmental flow can affect the concentrations of pollutants and the preservation of ecological habitats.

In many streams and estuaries reduced flows or changed flow patterns are of concern. In urban catchments the significant increase in flow volume and frequency of runoff is as damaging to creek environments as pollution.

Environmental flows

Melbourne Water is investigating the environmental flow requirements of priority waterways in the Port Phillip and Western Port region to improve the Environmental Water Reserve (EWR) across the area.

The FLOWS method is used in this region and across Victoria on priority and flow-stressed freshwater reaches to determine environmental flow needs. The FLOWS method was developed as the preferred way of assessing the environmental water requirements of rivers and streams across the state (DNRE, 2002c). The method includes identifying ecological and geomorphologic values, and uses these as the basis for establishing objectives. The FLOWS method uses an expert panel approach, with a significant level of community and stakeholder participation to establish agreed environmental objectives for a particular waterway. The agreed objectives state preferred ecological goals for water assets/processes, such as 'improve', 'maintain' or 'restore' asset condition.

The FLOWS method recognises the importance of a flow regime that identifies the critical flow components needed to achieve ecological objectives. These include protecting:

- low flows for provision of habitat;
- natural flow variation;
- freshening flows to provide crucial biological triggers; and
- high flows to engage wetlands and floodplains (DNRE, 2002c).

Several objectives and targets have been developed for the Port Phillip and Western Port region, and are detailed in Table A2.9.

The Central Region Sustainable Water Strategy (SWS) (DSE, 2006) outlined the Victorian Government's commitment to increasing the EWR of rivers across the region to ensure sustainability. Table A2.8 outlines these commitments for the rivers within the Port Phillip and Western Port region.

Table A2.8: The increase in environmental water reserve committed to by the government to be achieved by 2015 for rivers in the Port Phillip and Western Port region (from the Central Region SWS)

River	Current (2006) EWR (ML)	Addition to EWR (ML) by 2015*	EWR to meet environmental needs (current + additional) (ML)
Yarra	577 000	20 000	597 000
Werribee	59 000	6 000	65 000
Maribyrnong	95 000	3 000	98 000
Bunyip/Tarago	112 000	3 000	115 000

* The environmental water reserve entitlements have been deferred by the Victorian government due to the current water shortage until water restrictions within the region return to Stage 1 or less.

Other commitments of the Central Region SWS relevant to improved water quality through environmental flows are:

- Undertake further work to document the volume and use of small catchment dams, understanding their effects and ways of mitigating these effects. Within the Port Phillip and Western Port region, the Maribyrnong is a priority catchment. This work will be completed in consultation with affected communities;
- Operating and harvesting rules will be reviewed to store and release environmental water in a pattern that better meets the needs of the environment; and
- Enhance environmental flows in the Werribee and Maribyrnong rivers by 2015. The benefits of the increased environmental flows will be monitored and assessed to determine whether water quality has improved and whether further enhancements are required.

In addition, flow targets for the Port Phillip and Western Port region have been set in the RRHS (Melbourne Water, 2007c). The RRHS divides the region into 63 units based on riverine reaches and for management purposes. Table A2.9 identifies units where improvement works will be targeted and flow condition improved over the lifespan of the RRHS. The conditions of the remaining management units (not listed in Table A2.9) are to be, at the least, maintained for the life the RRHS. When the RRHS is reviewed, there is potential for commitment to be made for improvements to additional waterways. Both the RRHS and the Central Region SWS were published in 2007. *Better Bays and Waterways* does not propose any additional environmental flow targets to those listed in Tables A2.8 and A2.9.

Appendix 2: Targets background

Table A2.9: Flow targets for management units in the Port Phillip and Western Port region (from RRHS)

Management unit	Management unit status	Current condition (2005)	Target condition (2015)
Deep Creek Upper	Low	Poor	Moderate
Emu Creek	High	Poor	Moderate
Maribymong River	High	Poor	Moderate
Diamond Creek (rural)	High	Good	Excellent
Olinda Creek	Very High	Moderate	Excellent
Plenty River (rural and lower)	Very High	Very poor	Poor
Plenty River (source)	Very High	Moderate	Good
Woori Yallock	Very High	Moderate	Good

Urban flow target

In addition to environmental flow targets, which are focused on the provision of additional flows to provide required environmental conditions, there are urban flow targets, focused on reducing damaging flows through urbanisation.

Increased flows due to urbanisation are a significant threat to the health of urban waterways. The Best Practice Environmental Management Guidelines sets the flow target to maintain flows at pre-urbanisation levels.

Flow best management objectives will be reviewed through the Stormwater Best Practice Environmental Management Guidelines review (action 7.9).

Estuarine flow targets

The SKM (2007b) report established preliminary estuarine environmental flow objectives for the Yarra, Maribyrnong, Werribee, Little River, Bunyip, Bass and Lang Lang estuaries (see Chapter 5). However, estuarine flow objectives and targets were not developed.

It is important to recognise that the patterns of freshwater flows into estuaries are almost impossible to manipulate. The primary mechanism for delivering estuarine environmental flows is through the provision of flows to the upstream reaches of rivers. Water supply reservoirs are usually located many kilometres upstream and cannot release the flow volumes necessary to recreate natural freshwater flows into estuaries. In addition, EI needs to be managed in modified, urban areas to reduce the damaging effect of high flow frequency and volume.

Overall, the conclusion was that the ecological effects of changes in flows are not well understood, even in well-monitored systems. Therefore, the available data did not provide a sound basis to set targets that would protect the values of the estuaries (SKM, 2007b). The need to develop targets is described further in the Environmental Flows Additional Investment Opportunities section of Chapter 7.

The report noted that the lack of data is an issue not just for Victoria but also on a national scale. The need to conduct further research into estuarine flows and estuarine systems in general is evident, and will be addressed through the development of an estuary strategy (and discussed further in Chapter 9).

The principles and objectives presented in the report will soon be superseded with the development of an estuarine FLOWs module for the consistent consideration of estuary flow requirements. To be consistent with the FLOWs method for environmental flow determinations for freshwater reaches, the estuarine flow objectives will be expressed in terms of ecological assets or processes that should be maintained, rehabilitated or restored. Once the module is developed, it will be trialled for specific estuaries. The need to set objectives and targets can only be explored following this analysis. As the need to establish objectives and targets is yet to be determined, no further action is outlined within *Better Bays and Waterways*.

Use of modelling to establish water quality targets

Two models developed for *Better Bays and Waterways* provide an assessment of current pollutant loads into the bays and aided the development of targets. The models are the PortsE2 catchment model and the Receiving Waters hydrodynamic model. Following is an overview of the limitations of the models, which have been considered in the use of the modelling results.

PortsE2 model limitations and uncertainty

PortsE2 is based on the E2 modelling framework from the eWater Cooperative Research Centre. Whilst the PortsE2 model is the best modelling tool available for the region there are a number of issues (inherent in such models) that limit the certainty of the outputs.

The PortsE2 project provided two key reports. The Melbourne Water (2009) report is based on the initial model, the BMT WBM (2009) report is based on the calibrated model.

These two reports have contributed to different aspects of *Better Bays and Waterways*. The following outlines the uncertainties associated with the model uses in the three key areas the modelling data has been utilised.

Land use contributions

The relative catchment inputs of nitrogen and sediment loads are from the initial model. The model calculations for land use contributions are informed by the scientific literature for different land uses.

The uncertainties assigned to the catchment contributions are +80/-100% for flow, nitrogen, phosphorus and sediment loads. The estimate of uncertainties is based on considered opinion. The model design is believed to provide a conservative (over) estimation of pollutant loads.

The results are suitable for reporting on relative load contributions from catchments, and for the comparison of scenarios. Given the uncertainties it is inappropriate to use this modelling alone for prioritising between sub-catchments.

Land use contributions have not been recalculated with the calibrated model as the calibration approach was not able to provide additional certainty about contributions. There are a number of factors contributing to uncertainty.

The two key factors are:

- PortsE2 used the best available data from scientific literature to inform the model on the generation of pollutants from different land types and uses. The data used is international data, as there is a lack of validated local data across all land uses and land types for this region. PortsE2 will be updated as this information becomes available.
- PortsE2 was not able to model a number of known pollutant processes that occur in-stream due to a lack of knowledge about these processes. These processes include in-stream pathogen decay, sediment settlement (both in-stream and on floodplains) and in-stream nutrient processing. Due to the exclusion of these processes the model assumes the complete transport of pollutants from the source to the bays. This results in the model providing a conservative (over) estimation of pollutant loads.

Forecasting future loads

The future loads forecasting utilised in the target setting for *Better Bays and Waterways* is based on the initial PortsE2 model. In addition to the issues outlined above, the uncertainty associated with forecasting future loads is compounded by the uncertainty in urban growth predictions.

The urban growth forecasts used for modelling were taken from Melbourne 2030, Planning for sustainable growth (DSE, 2002). As outlined in Chapter 3, recent studies have indicated that growth is occurring more rapidly than anticipated within the 2030 forecasts. In December 2008, the Victorian Government released updated population growth projections that indicated that Melbourne was likely to reach a population of 5 million by 2026, 10 years earlier than previous projections (DPCD, 2008). A review of the urban growth boundaries was announced in December 2008, which will change the effects of population growth on diffuse source pollution. For future forecasting, *Better Bays and Waterways* recommends the use of a range of urban growth projections.

Estimating total loads

To reduce the uncertainty in the PortsE2 modelling, the model was calibrated to inform the model with monitored pollutant load data from 2003 - 2007. Given the impact of pollutant concentration generated through wet weather events (as opposed to base flow concentration), the calibration required significant wet weather sampling.

The calibration project used load monitoring data to calibrate 14 key catchments across the Port Phillip and Western Port region. The calibrated data was used to inform the model for catchments where monitored loads data was not available, thus providing a platform to estimate loads across the entire region.

Receiving Water model limitations and uncertainty

All models are limited by the amount and quality of the data used to create them. The Receiving Water model is a temperature and salinity stratified, three-dimensional model of Port Phillip Bay, Western Port and the surrounding areas of Bass Strait.

The Receiving Water model was created using a 3DD Suite[©], a commercially available package of marine modelling modules. The Model 3DD (hydrodynamics), pol3DD (dispersal) and 3DDLIFE (primary production) were the key models used, each supported by data analysis, boundary generation and graphical tools. Details of the model can be found on the ASR Pty Ltd website (www.asrltd.co.nz/downloads_model.htm).

The model contains grid linkages to 45 unique catchment model point sources and 18 km of diffuse shoreline flow, accounting for the flow rate, salinity, total suspended solids, total nitrogen, total phosphorus, *E. coli*, toxicants and litter at a daily resolution.

The Receiving Water model has the following limitations:

Data that is interpolated over the cells within the model are limited by changing cloud cover in the satellite imagery. As the model is based on full ocean/atmospheric heat balance, equations 'nudging' is used to minimise the divergence across cells. Thus variables that change spatially are not precisely known throughout the model grid and small errors in solar input and cooling terms that depend on measured variables that vary spatially may result in significant drift in the predicted water temperature over the long term (Harrison *et al.*, 2007).

Good time series data is available for Port Phillip Bay and has been used in calibrating the model. However, in Western Port the hydrodynamic data is limited and better field measurements in the embayment are needed for the model to be rigorously calibrated. The predictions for Western Port from the model are comparable to previous predictions of net circulation for the spring neap cycle. To achieve a higher level of resolution, comparable to that available for Port Phillip Bay, additional monitoring data from Western Port is needed to fill this data gap.

The model has been calibrated against measurements and shown to effectively reproduce key elements of the bay's systems. However, as knowledge of key processes increases, the model will be refined to account for the growth in knowledge. This is particularly the situation for primary productivity and sediment processes in Port Phillip Bay and sediment transport in Western Port, where more accurate bathymetry and hydrodynamic data is required to achieve the desired level of accuracy.

Appendix 3: SEPP Objectives relevant to Port Phillip Bay and Western Port

Figure A3.1 SEPP (WoV) segments

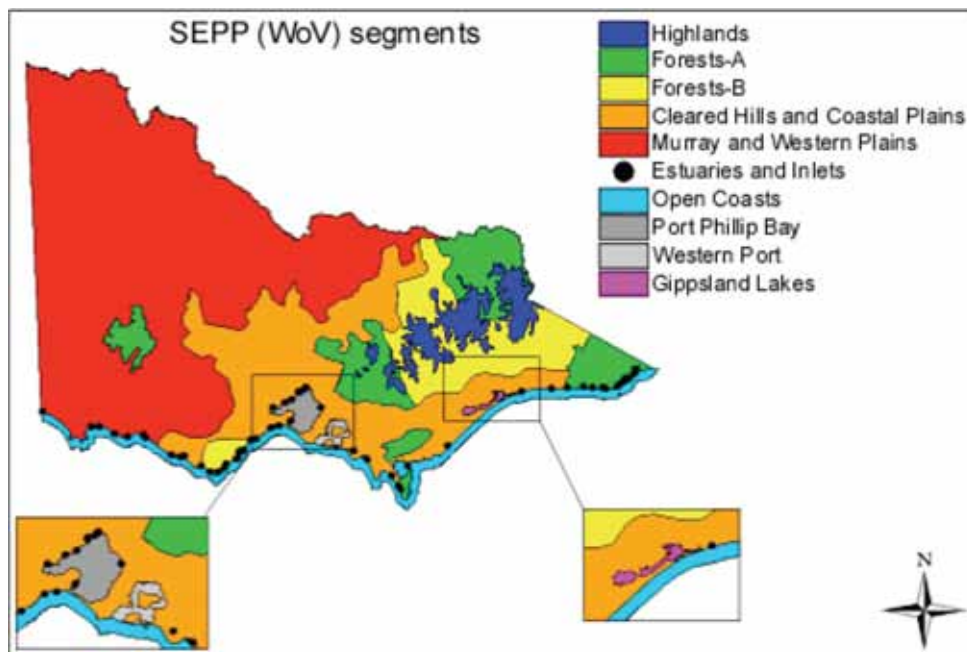


Figure A3.2 Port Phillip Bay and Western Port SEPP segments

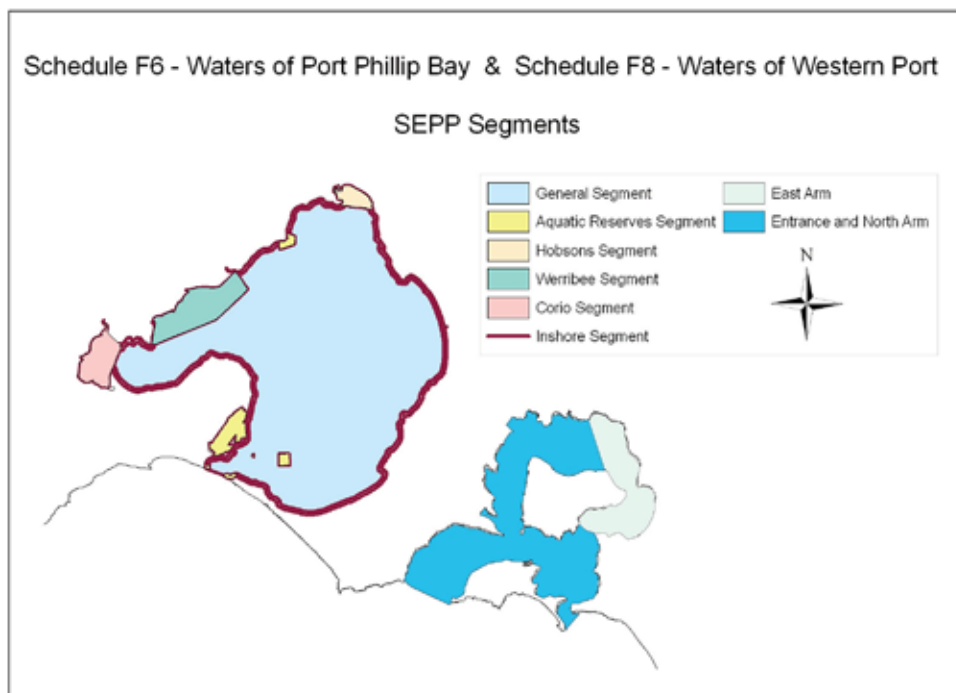


Table A3.1 Inland SEPP water quality objectives

SEPP segment applied	SEPP objective – DO 25%ile (%sat)	SEPP objective – DO Max (%sat)	SEPP objective – DO Min (mg/L)	SEPP objective – DO Min (%sat)	SEPP objective – EC 75%ile (uS/cm)	SEPP objective – EC Max # (uS/cm)	SEPP objective – EC# 90%ile (uS/cm)	SEPP objective – pH range WoV (units)	SEPP objective – pH range (units)
WoV Forests A 4	90	110	-	-	100	-	-	6.4 / 7.7	-
WoV Cleared Hills 1	85	110	-	-	1500	-	-	6.5 / 8.3	-
WoV Cleared Hills 2	85	110	-	-	500	-	-	6.4 / 7.7	-
WoV Cleared Hills 3	85	110	-	-	500	-	-	6.5 / 8.3	-
Yarra Parks and Forests	-	-	8	85	-	333	-	6.5 / 8.5	-
Yarra Rural Eastern A	-	-	6	80	-	333	-	-	6 / 8.5
Yarra Rural Eastern B	-	-	6	80	-	833	-	-	6 / 8.5
Yarra Rural Western	-	-	6	60	-	2500	-	-	6 / 8.5
Yarra Urban A	-	-	6	60	-	833	-	-	6 / 8.5
Yarra Urban B	-	-	6	60	-	1666	-	-	6 / 8.5
Yarra Urban C	-	-	6	60	-	833	-	-	6 / 8.5
Yarra Urban D	-	-	6	60	-	833	-	-	6 / 8.5
Yarra Upper Estuary	-	-	6	60	-	-	-	-	6.5 / 8.5
Yarra Port	-	-	6	60	-	-	-	-	6.5 / 8.5
Westernport Northern Hills	-	-	-	85	-	333	-	-	6.5 / 9
Westernport Peninsula	-	-	-	80	-	833	-	-	6.5 / 9
Westernport South Eastern	-	-	-	80	-	833	-	-	6.5 / 9
Westernport Lowlands Phillip Island	-	-	-	80	-	833	-	-	6.5 / 9

	SEPP objective – Turb 75%ile (NTU)	SEPP objective – Turb 50%ile (NTU)	SEPP objective – Turb 90%ile (NTU)	SEPP objective – SS 50%ile (mg/L)	SEPP objective – SS 75%ile (mg/L)	SEPP objective – SS 90%ile (mg/L)	SEPP objective – TP 75%ile (mg/L)	SEPP objective – TP max (mg/L)	SEPP objective – TN 75%ile (mg/L)	SEPP objective – TN max (mg/L)
WoV Forests A 4	5	-	-	-	-	-	0.025	-	0.5	-
WoV Cleared Hills 1	10	-	-	-	-	-	0.045	-	0.6	-
WoV Cleared Hills 2	10	-	-	-	-	-	0.045	-	0.6	-
WoV Cleared Hills 3	10	-	-	-	-	-	0.025	-	0.6	-
Yarra Parks and Forests	-	5	10	5	-	10	-	0.03	-	0.2
Yarra Rural Eastern A	-	15	30	20	-	40	-	0.05	-	0.6
Yarra Rural Eastern B	-	15	30	20	-	40	-	0.05	-	0.6
Yarra Rural Western	-	25	80	25	-	90	-	0.05	-	0.6
Yarra Urban A	-	-	-	-	-	-	-	0.08	-	0.9
Yarra Urban B	-	25	80	25	-	90	-	0.1	-	1
Yarra Urban C	-	20	50	25	-	60	-	-	-	-
Yarra Urban D	-	30	80	50	-	90	-	-	-	-
Yarra Upper Estuary	-	30	80	50	-	90	-	-	-	-
Yarra Port	-	20	50	25	-	60	-	-	-	-
Westernport Northern Hills	25	5	-	5	10	-	-	0.03	-	0.2
Westernport Peninsula	25	15	-	20	30	-	-	0.05	-	0.6
Westernport South Eastern	25	15	-	20	30	-	-	0.05	-	0.6
Westernport Lowlands Phillip Island	-	15	-	20	30	-	-	0.05	-	0.6

Appendix 3: SEPP Objectives relevant to Port Phillip Bay and Western Port

	SEPP objective – As (mg/L)	SEPP objective – Cd (mg/L)	SEPP objective – Cu (mg/L)	SEPP objective – Pb (mg/L)	SEPP objective – Ni (mg/L)	SEPP objective – Zn (mg/L)
WoV Forests A 4	0.001	0.00006	0.001	0.001	0.008	0.0024
WoV Cleared Hills 1	0.024	0.0002	0.0014	0.0034	0.011	0.008
WoV Cleared Hills 2	0.024	0.0002	0.0014	0.0034	0.011	0.008
WoV Cleared Hills 3	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Parks and Forests	0.001	0.00006	0.001	0.001	0.008	0.0024
Yarra Rural Eastern A	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Rural Eastern B	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Rural Western	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Urban A	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Urban B	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Urban C	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Urban D	0.024	0.0002	0.0014	0.0034	0.011	0.008
Yarra Upper Estuary	0.094	0.0004	0.0018	0.0056	0.013	0.015
Yarra Port	0.094	0.0004	0.0018	0.0056	0.013	0.015
Westernport Northern Hills	0.001	0.00006	0.001	0.001	0.008	0.0024
Westernport Peninsula	0.024	0.0002	0.0014	0.0034	0.011	0.008
Westernport South Eastern	0.024	0.0002	0.0014	0.0034	0.011	0.008
Westernport Lowlands Phillip Island	0.024	0.0002	0.0014	0.0034	0.011	0.008

Table A3.2 SEPP sediment water quality objectives

Sediments	Cadmium		Chromium		Copper		Lead		Zinc		ANZECC objective – Tributyltin (mg Sn/kg dry wt)		ANZECC objective – Silver (mg/L)		ANZECC objective – Total PCBs (mg Sn/kg dry wt)		ANZECC objective – Total PAHs (mg Sn/kg dry wt)	
	Urban	Other	Urban	Other	Urban	Other	Urban	Other	Urban	Other	ISQG Low	ISQG High	ISQG Low	ISQG High	ISQG Low	ISQG High		
WoV, Yarra and Westernport defer to ANZECC	10	1.5	370	80	270	65	220	50	410	200	0.005	0.07	0.001	0.0037	0.23	4	45	

Table A3.3 SEPP estuary water quality objectives

SEPP segment applied	SEPP objective – TP 75%ile (mg/L)	SEPP objective – DIP 75%ile (mg/L)	SEPP objective – TN 75%ile (mg/L)	SEPP objective – DIN 75%ile (mg/L)	SEPP objective – Chla 75%ile (mg/L)	SEPP objective – DO Min (%sat)	SEPP objective – DO Max (%sat)	SEPP objective – DO Min (mg/l)	SEPP objective – PAR 25%ile (m)
Estuaries SEPP (WoV), Yarra (excluding Upper Estuary) and Westernport	30	5	300	30	4	80	110		R25
Yarra Upper Estuary (also on previous spreadsheet)	-	-	-	-	-	60	-	6	-

SEPP segment applied	SEPP objective – SS 75%ile (mg/l)	SEPP objective – SS 50%ile (mg/l)	SEPP objective – SS 90%ile (mg/l)	SEPP objective – Turb 75%ile (NTU)	SEPP objective – Turb 50%ile (NTU)	SEPP objective – Turb 90%ile (NTU)	SEPP objective – pH range (NTU)	SEPP objective – pH Max Var (NTU)	SEPP objective – E.coli mean (org/100ml)
Estuaries SEPP (WoV), Yarra (excluding Upper Estuary) and Westernport	R75	-	-	R75	-	-	-	-	-
Yarra Upper Estuary (also on previous spreadsheet)	-	50	90	-	30	80	6.5 - 8.5	0.5	200

Table A3.4 SEPP marine water quality objectives

Marine segments	SEPP objective – DO surf (%sat)	SEPP objective – DO bott (%sat)	SEPP objective – pH range (units)	SEPP objective – pH var (units)	SEPP objective – Secchi depth (m)	SEPP objective – Secchi depth med (m)	SEPP objective – Secchi depth 25%ile (m)	SEPP objective – PAR 90%ile (m)	SEPP objective – Salinity (% var)
Port Phillip Bay Aquatic Reserves	90	90	7.5 - 8.5	0.5	N	-	-	N	N
Port Phillip Bay Corio	90	90	7.5 - 8.5	0.5	3	-	-	0.45	5
Port Phillip Bay Hobsons	90	90	7.5 - 8.5	0.5	2	-	-	0.5	5
Port Phillip Bay Werribee	90	90	7.5 - 8.5	0.5	3	-	-	0.45	5
Port Phillip Bay Inshore	90	90	7.5 - 8.5	0.5	3	-	-	0.45	5
Port Phillip Bay General	90	90	7.5 - 8.5	0.5	4	-	-	0.35	5
Westernport Entrance North Arm	>90	-	7.5 - 8.5	-	-	2.4	1.4	-	1
Westernport East Arm	>90	-	7.5 - 8.5	-	-	0.7	0.4	-	1

	SEPP objective – Chla med (ug/L)	SEPP objective – Chla 90%ile (ug/L)	SEPP objective – Chla 75%ile (ug/L)	SEPP objective – E.coli 42 day Mean (orgs/100 ml)	SEPP objective – E.coli 42 day 80%ile (orgs/100 ml)	SEPP objective – Tox fish (ug/L) ANZECC
Port Phillip Bay Aquatic Reserves	N	N	-	N	N	No detectable concentration
Port Phillip Bay Corio	1.5	2.5	-	200	400	TC ANZECC threshold of taste
Port Phillip Bay Hobsons	2.5	4	-	200	400	TC ANZECC threshold of taste
Port Phillip Bay Werribee	2.5	4	-	1000	-	TC ANZECC threshold of taste
Port Phillip Bay Inshore	1.5	2.5	-	14 / 200	400	TC ANZECC threshold of taste
Port Phillip Bay General	1	2	-	14	-	TC ANZECC threshold of taste
Westernport Entrance North Arm	1.6	-	2.5	14 / 200	-	
Westernport East Arm	2.1	-	5	200	-	

	SEPP objective – Turb 75%ile (NTU)	SEPP objective – SS med (mg/L)	SEPP objective – SS 75%ile (mg/L)	SEPP objective – DIN 75ile (ug/L)	SEPP objective – DIP 75ile (ug/L)	SEPP objective – nutrient loads
Port Phillip Bay Aquatic Reserves	-	-	-	-	-	Reduce annual load of nitrogen discharged from the catchment to the Bay by 1000 tonne by 2006.
Port Phillip Bay Corio	-	-	-	-	-	
Port Phillip Bay Hobsons	-	-	-	-	-	
Port Phillip Bay Werribee	-	-	-	-	-	
Port Phillip Bay Inshore	-	-	-	-	-	
Port Phillip Bay General	-	-	-	-	-	
Westernport Entrance North Arm	-	9	19	15	8	
Westernport East Arm	10	30	90	43	10	

Toxicants	SEPP objective – As (mg/L)	ANZECC objective – Cd (mg/L)	ANZECC objective – Cu (mg/L)	ANZECC objective – Pb (mg/L)	ANZECC objective – Ni (mg/L)	SEPP objective – Zn (mg/L)	ANZECC objective – Hg (mg/L)	SEPP objective – Cr (mg/L)	ANZECC objective – Tributyltin (mg/L)	ANZECC objective – Cobalt (mg/L)	ANZECC Objective – Silver (mg/L)
Port Phillip Bay Aquatic Reserves	N-	0.0007	0.0003	0.0022	0.007	N (0.007)	0.0001	0.00014 (ANZECC)	0.0000004	0.000005	0.0008
Port Phillip Bay Corio	<0.003	0.014	0.003	0.0066	0.2	<0.005	0.0007	<0.005	0.00002	0.014	0.0018
Port Phillip Bay Hobsons	<0.003	0.014	0.003	0.0066	0.2	<0.010	0.0007	<0.005	0.00002	0.014	0.0018
Port Phillip Bay Werribee	<0.003	0.014	0.003	0.0066	0.2	<0.005	0.0007	<0.005	0.00002	0.014	0.0018
Port Phillip Bay Inshore	<0.003	0.0055	0.0013	0.0044	0.07	<0.005	0.0004	<0.005	0.000006	0.001	0.0014
Port Phillip Bay General	<0.003	<0.00015	0.0013	0.0044	0.07	<0.005	0.0004	<0.005	0.000006	0.001	0.0014
Schedule F8 specific toxicant objectives											
	As (mg/L)								ANZECC objectives		
Westernport Entrance North Arm	<0.003	<0.00005	<0.001	<0.001	<0.001	<0.002	<0.000005	0.0044	0.0000004	0.000005	0.0008
Westernport East Arm	<0.005	<0.00005	<0.002	<0.002	<0.003	<0.005	<0.00001	0.020	0.000006	0.001	0.0014

Appendix 4: The Framework for Marine and Estuarine Water Quality Protection

Australia's Marine and Estuarine Environment

All catchments in Australia, with the exception of the Lake Eyre Basin, ultimately discharge to estuarine or marine ecosystems. This, along with the fact that:

- a quarter of Australia's population lives within three kilometres of the sea, and
- two thirds reside in our coastal towns and cities;

means that significant sections of coastline have been affected by urban, industrial and agricultural development, and recreational activity.

The health of marine and estuarine ecosystems is inextricably linked to the catchments with which they interact. Consequently, many land-based activities can have a significant effect on our coastal environments. It is estimated that some 80 percent of water quality impairment in Australia is caused by broadscale landuse activities (SoMER 1995). The two major problems facing our marine and estuarine ecosystems are increasing nutrient and sediment loads.

Pollutants affecting Australia's coastal waters

The main pollutants, listed in approximate order of significance, that affect marine and estuarine water quality in Australia are:

- Nutrients;
- Sediments;
- Acid sulfate soils;
- Organochlorines;
- Heavy metals;
- Oil and hydrocarbons; and
- Pathogens.

Nutrients

Agricultural and urban runoff, wastewater treatment plants and septic tanks, are the major sources of nutrients to Australia's rivers, estuaries and coastal waters.

Elevated loads of nutrients – nitrogen and phosphorus – can result in algal blooms, which in turn may adversely impact coastal waters by preventing light reaching benthic plants, and by producing toxins detrimental to animal and human health. Further, the death and decay of algal blooms can reduce the amount of dissolved oxygen available to aquatic life, sometimes causing extensive fish kills.



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Sediments

The discharge of sediments to coastal waters is significantly increased through land clearing, poor cultivation practices and urban development. Soil erosion is considered the major common contributing factor.

Excessive sediment loads have many undesirable effects on receiving waters, such as siltation and smothering of aquatic ecosystems, turbidity, and reduced light penetration causing changes to primary production.

In many instances, sediments may also transport significant loads of nutrients, heavy metals and organochlorines, as these materials are commonly attached to sediment particles.

Of the total yield of suspended sediment from six north Queensland catchments it is estimated 26% is attributable to natural processes, 66% to grazing practices and 8% to cropping.

Source: State of the Environment Queensland 1999

Acid Sulfate Soils

Acid sulfate soils (ASS) are found in lowlying coastal areas and contain high concentrations of sulfide minerals (mainly iron pyrite, FeS₂).

ASS are relatively harmless in their undisturbed (submerged) state but may generate large quantities of sulfuric acid when exposed to the atmosphere through excavation, dredging or lowering of the water table. In addition, iron and aluminium metals may become soluble under acid conditions (Al³⁺, Fe²⁺ and Fe³⁺) and

enter rivers and estuaries where they may have detrimental effects on aquatic organisms. Major fish and crustacean kills, outbreaks of red-spot disease in fish and increased incidence of disease-carrying acid tolerant mosquitoes have been linked to the disturbance of these soils.

Organochlorines

These are synthetic compounds developed for agricultural and industrial use and are often found in urban and agricultural run-off. Whilst these compounds are usually not detectable or only present in extremely low concentrations in seawater, they can bioaccumulate to toxic levels.

Pesticides such as diuron and dieldrin are present in marine sediments of the Great Barrier Reef, and significant levels of residues have been found in the Reef's dugongs and dolphins.

Little is known about the levels of organochlorines in Australia's marine environment although it is thought that pesticides such as DDT are widely present in marine life around Australia. There is little information available about the effect of organochlorines in Australia's coastal waters, however, these compounds are suspected of causing kidney damage in Arctic birds and mammals.

Heavy metals

Heavy metals enter marine and estuarine ecosystems through the discharge of industrial waste, treated sewage, stormwater run-off, mining operations and other diffuse sources (such as from vehicles). The most common heavy metal pollutants are arsenic, cadmium, chromium, copper, nickel, lead and mercury.

Heavy metals persist in the environment and so tend to accumulate in soils, sediments and living organisms. Organisms accumulate heavy metals in their tissues and this contamination is concentrated in organisms higher up the food chain ('bioaccumulation'). Heavy metal contamination can affect marine biota, fisheries and other aquacultural operations and human consumers of seafood.

"Economists have estimated the value of goods and services provided by the ocean in regulating atmospheric gases, nutrient cycling, biological control, food production, raw materials and recreation at US\$21 500 billion annually"

Source: Pollution from the land: the threat to our seas.



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Oil and hydrocarbons

Oil and hydrocarbon pollution of coastal waterways is largely linked to industrial and stormwater discharges. Many of the compounds in crude oil and other petroleum products have been known to smother organisms, lower fertility and cause disease in aquatic organisms.

Pathogens

Pathogens such as faecal coliforms and enterococci enter the marine environment through the discharge of sewage via ocean outfalls and from stormwater system overflows to rivers and streams. These pathogens pose threats to human health through gastro-enteritis, hepatitis and other diseases.

Unacceptable faecal discharges to coastal waters may arise from aging sewage and stormwater infrastructure, combined system overflows after heavy rains or inadequate wastewater treatment. Human health may therefore be at risk from direct contact with contaminated waters (e.g. swimming) or from consumption of contaminated seafood (e.g. oysters).

United Nations Global Programme of Action

Land-based sources of marine pollution are recognised internationally as a major environmental issue. The international community, through the United Nations Environment Programme, has initiated action to address this issue, specifically through the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (the GPA).

In response to the widespread pollution of the marine environment, 108 governments (including Australia) and the European Commission have declared their commitment to protecting and preserving the marine environment from the adverse environmental impacts of land-based activities. As a result, the GPA was adopted in 1995.

The 20th Session of the United Nations Environment Program Governing Council resolved (in 1999) to undertake the First Intergovernmental Review (IGR) of the GPA, which was held in Montreal, Canada from 26 to 30 November 2001.

The IGR meeting reviewed progress on implementation of the GPA at the global, regional and national levels. Australia's national report was coordinated by Environment Australia, in collaboration with State and Territory governments. This report considered national coordination of efforts to address land-based sources of marine pollution, including the application of the following National policies and programs.

Appendix 4: The Framework for Marine and Estuarine Water Quality Protection

National Policies and Programs

Australia meets its obligations under the GPA through implementation of the policies, principles and industry guidelines of the National Water Quality Management Strategy and the following actions and programs:

National Water Quality Management Strategy

The National Water Quality Management Strategy (NWQMS) was introduced by the Commonwealth, State and Territory Governments in 1992 as a response to growing community concern about the condition of the nation's water bodies and the need to manage them in an ecologically sustainable way.

In 1994 the NWQMS was included in the Council of Australian Governments (COAG) Water Reform Framework. The NWQMS is comprised of 21 guideline papers, the most significant and recent paper to be released being the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000), which outlines a framework for water resource protection and management. The Commonwealth will now be seeking to implement this framework through its policy and funding programs.

The Framework for Marine and Estuarine Water Quality Protection

The Framework for Marine and Estuarine Water Quality Protection was developed as a nationally consistent approach to protecting the marine environment from the effects of land based pollution, therefore contributing to meeting Australia's obligations under the GPA. Identification and achievement of reductions in pollutant loads and establishment of end of river targets are central components of the Framework and the development of coastal water quality improvement plans.

The Framework builds upon the Council of Australian Government's Water Reform Framework, including key elements of the NWQMS as it applies to coastal waters and wetlands and the National Principles for the Provision of Water for Ecosystems.

The Framework is based upon the identification and protection of the environmental values of water (as detailed under the NWQMS). Water quality improvement plans developed using the Framework will identify management actions that would protect these values.

Key features of the Framework include identification of:

- the environmental values of the coastal water; the catchment that discharges to that coastal water;
- the water quality issues (e.g. algal blooms, sedimentation, high coliform concentrations causing beach closures) and subsequent water quality objectives;
- the total maximum load of pollutant/s to be achieved to attain and maintain the water quality objectives;
- the allocation of the total maximum load of pollutant/s to diffuse and point sources of pollution;
- the river flow objectives to protect identified environmental values, having regard for matters such as natural low flows, flow variability, floodplain
- inundation, interactions with water quality and the maintenance of estuarine processes and habitats;
- management measures, timelines and costs in implementing the plan; and

- the grounds for a "reasonable assurance" from jurisdictions to provide security for investments to achieve the specified pollutant load reduction and environmental flow targets.

Priority coastal areas will be targeted for planning and subsequent funding. In the absence of an accredited water quality protection plan, interim water quality targets and pollution reduction strategies may be established to guide Commonwealth funding during plan development.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000) should be consulted in the application of this Framework. Terms used in the Framework, such as environmental value, water quality objective and monitoring and reporting have the same meaning as those in the NWQMS documents.

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Photographs

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Appendix 5: Statutory and institutional arrangements

Relevant Legislation, Policies and Institutional Arrangements

International

International conventions play a major role in protection of waterways and catchments. Conventions become binding on Australia when signed and ratified by the Australian Government. The Australian Government is signatory to several international agreements that aim to protect and manage waterways and wetlands directly or indirectly as habitats for migratory species. The key convention relating to *Better Bays and Waterways* is the 'Convention on Wetlands of International Importance especially as Waterfowl Habitat' known as the 'Ramsar Convention' which was signed at Ramsar, Iran in 1971 and came into force in 1975. Several areas in the Port Phillip and Western Port region are listed under Ramsar.

The protection and management of Ramsar listed sites in Australia is generally conducted through State and Territory legislation but Federal legislation also plays an important role through the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

Three other international treaties are important agreements for the protection of migratory species and their habitats, including wetlands:

- The China-Australia Migratory Bird Agreement (CAMBA);
- The Japan-Australia Migratory Bird Agreement (JAMBA); and
- The Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention).

Both CAMBA and JAMBA seek to protect migratory birds and their environment. The parties to these conventions agreed to preserve migratory birds and enhance their environment.

Another important convention is the Convention of Biological Diversity, signed at the 1992 Rio Earth Summit, which is dedicated to promoting sustainable development and includes provisions which could promote waterways conservation. Article 8 of the convention obliges Contracting Parties to establish and manage a system of protected areas to conserve biodiversity, rehabilitate and restore degraded ecosystems and promote the recovery of threatened species and conserve biodiversity both within and outside protected areas.

Australia's primary method of implementing the above instruments and obligations is through the EPBC Act.

National

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The most relevant national legislation for the Port Phillip and Western Port region is the EPBC Act. The EPBC Act is the key statute for implementing Australia's commitments to international conventions. There are two main mechanisms employed by the Act to achieve its objectives. These are systems of development ("action") assessments and approvals; and for the management of protected areas and the identification, protection and recovery of threatened biodiversity.

'Matters of national environmental significance' and for protection under the EPBC Act include Ramsar wetlands, listed migratory species, threatened species and ecological communities, Commonwealth marine areas and National Heritage Places. Any development that is likely to have a significant impact on a 'matter of national environmental significance' will be subject to an environmental assessment and approval regime. The Act is administered by the Department of Environment Water Heritage and the Arts. Under agreement with the Victorian Government, the Victorian environment effects and approval processes have been accredited as satisfying the Commonwealth development assessment processes. The Commonwealth however still retains its decision making role under the EPBC Act.

For more information on the EPBC Act see www.environment.gov.au.

National Policies and Programs

National policies are instrumental in setting the context and coordinating Commonwealth and State regulation of waterways and catchments, although they are not legally binding. National programs have an influence on sustainable management through financial assistance. Key national policies and programs impacting on the Port Phillip and Western Port region are the National Water Quality Management Strategy, the Framework for Marine and Estuarine Water Quality Protection, the National Water Initiative and the National Heritage Trust/Caring for Our Country. Each of these is briefly outlined below (for more information on national policies and programs see www.environment.gov.au).

National Water Quality Management Strategy (NWQMS)

The NWQMS has been a joint development (since 1992) between the Australian Government and state and territory governments to promote the sustainable management of the nation's water resources. The objective of the strategy is to achieve sustainable use of the nation's water resources by protecting and enhancing their quality while maintaining economic and social development. The establishment of local environmental values and water quality objectives by the community and government is the mechanism for setting the desired condition of waterways that overall management should seek to achieve and maintain.

The Australian and New Zealand Guidelines for Fresh and Marine Water Quality were jointly produced under the NWQMS by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

National Environment Protection Council (NEPC) Act and Environment Protection and Heritage Council (EPHC)

The National Environment Protection Act was passed in 1994 and resulted in the NEPC being formed. NEPC comprises of environment ministers from the Australian Government and each state and territory. Its formation was an outcome of the Intergovernmental Agreement on The Environment reached at a special Premiers Conference in 1990 and it came into effect in 1992. The purpose of NEPC is to ensure that:

- Australians enjoy the benefit of equivalent protection from air, water or soil pollution and from noise wherever they live; and
- business decisions are not distorted and markets are not fragmented by variations in major environment protection initiatives between member governments.

NEPC was incorporated in the Environmental Protection and Heritage Council (EPHC) in June 2001. However, under the NEPC Act it retains its distinct status within the EPHC.

The EPHC was formed through the amalgamation of the NEPC, the environment protection components of ANZECC and the heritage ministers meeting.

The NEPC has the authority to make National Environment Protection Measures (NEPMs) that outline national objectives for protecting or managing particular aspects of the environment. NEPMs may be a combination of goals, guidelines, standards or protocols, analogous to SEPPs in Victoria. Any NEPMs made by NEPC must be implemented by each jurisdiction. In Victoria this is through SEPPs or waste management policies.

NEPMs relevant to *Better Bays and Waterways* are the NEPM Assessment of Site Contamination and the NEPM National Pollutant Inventory. The Site Contamination NEPM guides the assessment of contaminated and potentially contaminated land. This NEPM allows risk to be assessed and then appropriate action can be taken to ensure beneficial uses are protected.

The National Pollutant Inventory NEPM is designed to help in the reduction of the potential impacts of the emission of substances to the environment. It provides a mechanism for the collection of information on the emission of selected pollutants to the environment. Results from this data gathering are made available to the public.

There is no NEPM dealing specifically with water quality however the development of the ANZECC guidelines for Water Quality and other national programs on water issues outlined below provide an extensive framework for a uniform approach by the states and territories.

(For further information on NEPC and EPHC see www.environment.gov.au)

Framework for Marine and Estuarine Water Quality Protection

The Framework for Marine and Estuarine Water Quality Protection was developed as a nationally consistent approach to protecting the marine environment from the effects of land based pollution. The Framework is based on identification of environmental values and objectives (as described under the NWQMS). Water Quality Improvement Plans developed consistent with the Framework will identify management actions that will be effective in achieving these objectives and protection of these environmental values.

In Victoria these environmental values (beneficial uses) and associated water quality objectives for particular waterbodies are prescribed in SEPPs, which also describe the management framework and programs for achievement of these objectives and thus protection of the beneficial uses.

National Water Initiative (NWI)

The NWI (2004) is a collaboration between the Australian Government and state and territory governments and builds upon the shared commitment to water reform established by the Council of Australian Governments. The NWI acknowledges "The continuing national imperative to increase the productivity and efficiency of Australia's water use; the need to service rural and urban communities; and ensuring the health of river and groundwater systems, including establishing clear pathways to return all systems to environmentally sustainable levels of extraction".

Development of performance indicators and implementation of the NWI is the responsibility of the Natural Resource Management Ministerial Council. The National Water Commission is the lead Australian Government agency for the NWI (www.nwc.gov.au).

Natural Heritage Trust/ Caring for Our Country

The Natural Heritage Trust was set up in 1997 to help restore and conserve Australia's environment and natural resources. The Trust provided funding for environmental activities including national, regional and local investment.

Caring for Our Country commenced on 1 July 2008 and replaces the Natural Heritage Trust.

The goal of Caring for Our Country is to have an environment that is healthy, better-protected, well-managed, resilient and that provides essential ecosystem services in a changing climate.

The program focuses on six national priority areas, a national reserve system; biodiversity and natural icons; coastal environments and critical aquatic habitats; sustainable farm practices; natural resource management in remote and northern Australia; and community skills, knowledge and engagement (www.nrm.gov.au).

Appendix 5: Statutory and institutional arrangements

National Cooperative Approach To Integrated Coastal Zone Management Framework and Implementation Plan

The Cooperative Approach to Integrated Coastal Zone Management Framework and Implementation Plan was released by the Commonwealth Government in 2006. The purpose of the framework was to achieve a national cooperative approach for integrated coastal management. Although each State and Territory generally has legislation and policies to address coastal issues, these lack consistency. The framework aims to address these inconsistencies between the States and Territories.

A more consistent framework will allow states and territories to improve cooperation of cross border issues. This framework also allows standardised data monitoring, collection and information sharing. The standardised approach allows objective assessments of areas or projects for investment from the Commonwealth Government. The implementation of the framework directly relates to Caring for Our Country and Nation Action Plan funding. The development of *Better Bays and Waterways* has broadly followed this framework.

For more information please go to (<http://www.environment.gov.au/coasts/publications/framework/pubs/framework.pdf>)

State

In Victoria there is a comprehensive range of legislation, statutory and non-statutory policies, strategies and plans that can be used to achieve desired water quality objectives. These are administered by various departments, agencies and local government. The ones of major relevance to the implementation of *Better Bays and Waterways* are outlined below.

Catchment and Land Protection (CaLP) Act 1994

The CaLP Act provides a framework for the integrated management and protection of catchments, establishes processes to encourage and support community participation in the management of land and water resources and provides for a system of controls on noxious weeds and pest animals. The Act also establishes the Victorian Catchment Management Council and ten Catchment Management Authorities (CMAs).

The CMAs are statutory bodies with legislated objectives, powers and functions. The major function of CMAs is the preparation and implementation of Regional Catchment Strategies. These strategies identify the regional environmental, social and economic values of surface waters and after consideration of environmental, social and economic needs, set appropriate goals, priorities and environmental targets for catchment and coastal environments.

Most of the catchment considered in *Better Bays and Waterways* is contained in the area managed by the Port Phillip and Westernport CMA. A small part of Corangamite CMA's catchment (the Bellarine peninsula) drains to Port Phillip Bay and is addressed within *Better Bays and Waterways*. The legislation CaLP Act 1994 is administered by the Department of Sustainability and Environment (DSE).

Water Act 1989

This Act establishes rights and obligations in relation to water resources, provides mechanisms for the allocation of water resources, governs the statutory powers and functions of all water authorities outside the metropolitan area and provides for integrated management of the water resource for environmental and consumer protection. This legislation is administered by DSE.

CMAs are provided with regional water, floodplain, drainage and environmental water reserve management powers under the Water Act 1989, except in the case of the Port Phillip and Western Port catchment where these powers have been delegated to Melbourne Water.

However, an agreement made in 1927 between the then Melbourne and Metropolitan Board of Works (predecessor to Melbourne Water) and local councils in metropolitan Melbourne, assigned responsibility for drainage for areas less than 60 hectares to the relevant local council.

Melbourne Water Corporation Act 1992

This Act provides for the corporatisation of the Melbourne and Metropolitan Board of Works (Melbourne and Metropolitan Board of Works Act 1958) by establishing the Melbourne Water Corporation. The Act establishes objectives for the Corporation, defines the relationship between the Corporation, the Minister and Parliament, sets out the role of the Corporation's Board of Directors and makes provision for monitoring the Corporation's performance.

Water Industry Act 1994

This Act provides for the regulation of the water industry, particularly detailing requirements for licensing water, sewerage, drainage, sewage treatment or water headwork activities. This Act is administered by DSE.

In the Melbourne metropolitan area three state owned companies, known as Water Retailers, were established under the Corporations Act (2001.) These retailers are holders of water and sewerage licenses issued under the Water Industry Act (1994). The Water Retailers are City West Water Ltd, South East Water Ltd and Yarra Valley Water Ltd.

The Water Retailers provide retail water supply and sewerage services to customers in the Melbourne metropolitan area. Melbourne Water provides bulk water and bulk sewerage services in the Melbourne metropolitan area (as well as managing rivers and creeks and major drainage systems in the Port Phillip and Western Port region, see Water Act 1989). See also www.ourwater.vic.gov.au for further information on water industry arrangements.

Under Section 41 of the Water Industry Act 1994, a Statement of Obligations has been issued to Melbourne Water (amended June 2008) which imposes obligations in relation to the performance of its functions and exercise of its powers.

Relevant to *Better Bays and Waterways* is section 7 of the Statement which requires Melbourne Water to develop a Waterways Water Plan for the purposes of enabling the Essential Services Commission to determine prices for metropolitan drainage and diversion services for a 5 year period commencing July 2008. This plan was submitted to the Commission on 19 December 2007 and is now in operation.

In addition, Section 23 of the Statement requires that Melbourne Water develop and implement an Operating Charter. This sets out Melbourne Water's responsibilities, goals and programs to be delivered for the waterway and drainage services (for more information see www.melbournewater.com.au).

A key program is the Yarra River Action Plan. Water quality in the Yarra River has improved markedly since the 1970s and its health compares favourably with similar rivers around the world. However, additional improvements are still needed to meet water quality objectives. These relate to recreation (to ensure the river is safe for water sports, and fishing) and general river health (to increase the numbers of native fish, plants and platypus).

For more information on the Yarra River Action Plan see:

http://www.melbournewater.com.au/content/library/publications/reports/rivers_and_creeks_reports/Yarra_River_Action_Plan.pdf

Environment Protection Act 1970

This Act establishes the Environment Protection Authority (EPA) and its powers, duties and functions. It is Victoria's primary environment protection legislation. It is based on environment protection principles set out in the Act, that broadly relate to ecologically sustainable development and pollution prevention. Protection of the environment to the desired extent is achieved through the setting of objectives in statutory policies and establishing programs to meet these objectives using the policies and various statutory procedures, approvals, licences, regulations and notices available under the Act.

Premises which are considered to pose a significant threat to the environment are 'scheduled' by regulations. Occupiers are required to hold an EPA licence and seek prior approval from EPA Victoria before undertaking new and/or altered activities. EPA licences can specify operating parameters, resource efficiency requirements, waste discharge limits and monitoring/reporting requirements.

Other premises not 'scheduled' by the regulations are still required to comply with legislative provisions preventing pollution and also with relevant SEPPs. Most of these premises are categorised as small-medium enterprises (SMEs) and are dealt with by EPA Victoria on an 'as needs' basis. This is done primarily if they are considered to have caused or be likely to cause point source pollution, rather than pollution from diffuse run-off issues.

SEPPs are subordinate legislation made under the Act. They are administered by EPA Victoria and cover the air, land, groundwater, noise and water environments.

The SEPP (Waters of Victoria) sets a statutory framework for the protection of the uses and values of Victoria's fresh and marine water environments. As required by the Environment Protection Act 1970, the SEPP includes:

- The uses and values of the water environment that the community and government want to protect – these are known as beneficial uses;
- The objectives and indicators which describe the environmental quality required to protect beneficial uses;
- Guidance to CMAs, coastal boards, water authorities, communities, businesses and local and state government agencies to protect and rehabilitate water environments to a level where environmental objectives are met and beneficial uses are protected – this is known as the attainment program.

The implementation of the SEPP (Waters of Victoria) helps to ensure that catchments, rivers and coasts are managed in an integrated manner so that actions in the catchment do not have a detrimental impact on the quality of fresh and marine water environments.

Specific schedules to SEPP (Waters of Victoria) such as Schedule F6 (Waters of the Port Phillip Bay), Schedule F7 (Waters of the Yarra Catchment) and Schedule F8 (Waters of Western Port and Catchment) are relevant to *Better Bays and Waterways* and contain detailed requirements for those catchments.

Whilst EPA Victoria is responsible for ensuring the overall implementation of the SEPP (Waters of Victoria) and its schedules, implementation is the shared responsibility of state government agencies, local government, catchment and coastal management organisations, water authorities, government owned companies, water retailers, industries and communities. The SEPP (Waters of Victoria) attainment program (Clauses 12 to 58) identifies key responsibilities, provides guidance and specifies requirements for waste and wastewater management; water management and catchment management (for further information see www.epa.vic.gov.au).

Essential Services Commission Act 2001

This Act establishes the Essential Services Commission (ESC). A major function of the Commission is to determine the charges that utility providers can impose on their customers. This includes charges made by water authorities/companies such as Melbourne Water, Yarra Valley Water, City West Water and South-East Water.

Under the Essential Services Act, Water authorities are obligated to undertake the development of water plans. These water plans operate on a 5-year cycle and must include detail of the capital and operational costs of the water authority for the next planning cycle. The ESC assesses the proposed price structure put forward by the water authority to recover the cost against the capital and operational programs proposed. The ESC determines if the activities proposed are part of the water authority's charter; whether they are a legal requirement of the authority's business; and whether the public will receive the services that are required from the authority. The ESC then considers the proposed price tariffs of the water authority and determines an allowable pricing structure (effective for the next 5-year planning cycle).

To ensure the environmental obligations of water authorities/companies are considered in the ESC process, EPA Victoria produced an Information Bulletin "Principals to Establish Environmental Obligations for the Water Businesses for the 2008-2013 pricing determination". This document is in addition to any EPA discharge licences held by water authorities and sets out the broad requirements and environmental obligations EPA Victoria expects these businesses to meet during the forthcoming planning cycle.

Appendix 5: Statutory and institutional arrangements

The Water Plan's association with Local Government:

Domestic Wastewater Management:

The "Principles to Establish Environmental Obligations for Water Businesses for the 2008-2013 pricing determination" references other work funded by the State Government, in particular the Domestic Wastewater Management Plans (DWMP) (funded by DSE). These plans are aimed at addressing domestic wastewater management issues faced by local government. Local government are responsible for domestic wastewater management outside the declared sewer districts of water authorities. These plans identify the areas with the highest need for sewerage, as non-reticulated domestic wastewater management options are not sustainable for the current developments. Areas highlighted by a DWMP are considered by water authorities for the introduction of reticulated sewerage during the formulation of their ESC water plans, including associated cost projections and proposed tariff increases. This connection between water authorities and local government at a municipal level is aimed at ensuring integrated wastewater management across communities and addressing historical wastewater management issues that are impacting on our environment.

Planning for Future Development:

In addition to the DWMPs, water authorities are expected to consult with local councils on plans for urban development. This ensures appropriate future wastewater management is undertaken and development growth is managed to reduce environmental impacts.

Appropriate planning through the ESC process sets levels of expenditure to ensure that our waterways and hence the Port Phillip and Western Port region receive adequate protection from both point source and diffuse wastewater pollution.

Planning and Environment Act 1987

This Act establishes Victoria's state planning framework and provides the powers for local government to act as a planning and responsible authority. The Act is administered by the Department of Planning and Community Development.

A planning authority may be a local council or the State Government. They prepare land-use planning schemes and sets appropriate controls. A responsible authority is usually the local council and administers the planning scheme. This involves:

- considering proposals to use or develop land and giving notices and issuing permits in accordance with the planning scheme;
- making sure that the land is not used or developed in conflict with the scheme's requirements; and
- issuing planning certificates about the scheme.

The Planning and Environment Act 1987 provides for the preparation of a set of standard provisions for planning schemes called the Victoria Planning Provisions (VPP).

The VPP is a state-wide reference for constructing standard planning schemes. It provides the framework, standard provisions and State planning policy. It also references a number of documents that are common to all planning schemes.

Planning schemes set out policies and provisions for the use, development and protection of land. Each municipality in Victoria is covered by a planning scheme.

The planning authority (usually the local council) must provide the local planning policy content (including a Municipal Strategic Statement (MSS) and local planning policies) and the appropriate zones and overlays from the VPP for inclusion in their planning scheme.

Both the Planning and Environment Act and the VPP contain requirements that water quality issues must be considered in planning decisions.

The Act requires a planning authority when preparing a planning scheme or a planning scheme amendment to 'take into account any significant effects which it considers the scheme or amendment might have on the environment' (section 12). The Act also requires a responsible authority to consider 'any significant effects which the responsible authority considers the use or development may have on the environment' (section 60) before deciding on a planning permit application.

In the VPP Clause 15 of the State Planning Policy Framework section specifically relates to protection of catchments, waterways and the marine environment and requires that decisions by planning and responsible authorities must be consistent with relevant SEPPs (Waters of Victoria and specific catchment policies). In addition they should have regard to regional catchment strategies where relevant.

Clause 18.09 of the State Planning Policy Framework requires provision of water supply, sewerage and drainage services to meet community needs and protect the environment. It also identifies the need to ensure water quality is protected and sewerage is provided either at the time of subdivision or at an allotment scale where each lot is capable of adequately treating and retaining domestic wastewater within its boundary.

Generally subdivision applications have to be referred to the relevant water, drainage or sewerage authority. For the Port Phillip and Western Port region this gives Melbourne Water the opportunity to comment on issues such as water sensitive urban design (WSUD).

Clause 56 of the VPP was revised in 2006 to require new subdivisions to meet stormwater targets within each subdivision. Melbourne Water is working with councils in the Port Phillip and Western Port region to implement the integrated water management provisions in Clause 56 in a coordinated manner (see VPP Clause 56 Practice Note, October 2006 www.dse.vic.gov.au/planning).

However the VPP do not contain similar requirements for industrial and commercial subdivisions. In addition, such requirements are not in place for allotment scale developments, irrespective of proposed use.

Building Act 1993

The Building Act 1993 provides for the regulation of plumbing and building standards in Victoria. This includes technical and administrative matters. Construction provisions are concerned with the building that occurs on an allotment and focuses on the physical characteristics associated with health, safety and amenity.

The provisions of the Building Act address ongoing building safety and maintenance, providing a holistic approach to the management of the built environment.

While the technical focus of the Building Act is on the allotment, it allows for the consideration of issues outside the allotment that effect the function of the building. This includes water supply for fire fighting purposes and accessibility for people with disabilities.

To achieve the objectives of the Act, there is the provision to make regulations, that address both technical and administrative matters. The two key regulations are the Building Regulations 2005 and Plumbing Regulations 1998. The administration of these regulations is undertaken by discrete building and plumbing commissions.

A report prepared for DSE in 2005 entitled "Review of Victoria Planning Provisions, Building and Plumbing Regulations" reviews and recommends better alignment of these pieces of legislation with sustainable urban water management.

The Port Phillip Bay Environmental Management Plan (EMP)

The Port Phillip Bay environmental study in 1996 resulted in a revision of the SEPP Schedule for Port Phillip Bay. The revised schedule recognised the need to develop an EMP and outline the overarching framework for management of the bay. The EMP's purpose is to facilitate, in a structured way, coordination of planning and resource management activities to target key desired environmental outcomes for the bay. It is important to note that the EMP is not intended to override existing programs for environmental management of the bay, but provides better coordination between these activities and also aims to address key gaps.

The EMP is broadly based on the principles set out in the International Standards (ISO 14001). This includes:

- policy setting, including bay objectives;
- key environmental risks to the bay; and
- objectives and targets for mitigating key risks;

Key environmental management objectives include:

- conservation of biodiversity;
- provide recreation and tourism opportunities;
- secure production and sustainable use of wild fisheries;
- provide for aquaculture, protect cultural heritage;
- provide for shipping and boating; and
- provide for industrial purposes.

A number of risks were also identified for the bay including:

- deterioration of water quality (increased nutrient loading and changes to nutrient cycling, toxicant inputs, increased suspended solids, presence of pathogens);
- exotic marine pests;
- presence of litter;
- physical disturbance of habitats; and
- harvesting activities.

The first two were identified as the key risks for the bay.

The EMP is the point of coordination for environmental activities around the bay. This involves activities from each level of government. It should be considered when developing planning and management actions. The EMP and critical programs to achieve targets are periodically monitored, reviewed and evaluated by DSE. For more information please visit (<http://www.ccb.vic.gov.au/>).

Coastal Management Act 1995

This Act provides for the development of a Victorian Coastal Strategy and Strategic Planning for the management of the Victorian coast. It also establishes the Victorian Coastal Council and three regional coastal boards. The Act is administered by DSE.

A Victorian Coastal Strategy was released in December 2008. It provides a comprehensive integrated framework for the management of Victorian coasts. The Act directs the strategy to provide long-term planning for Victoria's coastal areas over the next 100 years and beyond. The plan will be reviewed after 5 years.

The purpose of the strategy is to provide:

- a vision for the planning, management, and use of coastal, estuarine and marine environments;
- the governments' policy commitment for coastal, estuarine and marine environments;
- a framework for the development and implementation of other specific strategies and plans such as Coastal Action Plans, management plans and planning schemes; and
- a guide for exercising discretion by decision-makers, where appropriate.

Actions from the VCS (2008) should be considered alongside those described in *Better Bays and Waterways* to ensure comprehensive and integrated management actions are implemented.

A copy of the plan is available from the Coastal Management Council of Victoria at <http://www.vcc.vic.gov.au>.

Waste Management Policy Ships Ballast Water 2004

This policy protects the Victorian marine waters from the introduction of marine pests transported through domestic ballast water from other Australian ports. Responsibility for international ballast falls to the Commonwealth Government and its agency the Australian Quarantine Inspection Service (AQIS).

Guidance on managing domestic ballast water is outlined in the Protocol for Environmental Management, Domestic Ballast Water Management in Victorian State Waters, EPA Victoria.

The waste management policy is supported by the Environment Protection (Ship's Ballast Water) Regulations 2006. These regulations allow EPA Victoria to charge a fee to ships entering Victorian Ports and cover the cost of administering the Ballast Water Program.

Pollution of Waters by Oils & Noxious Substances Act 1986

This act prevents pollution of marine waters and implements the 'Marpol Convention', the International Convention for the Prevention of Pollution from Ships 1973. The legislation is administered by EPA Victoria and Marine Safety Victoria.

Fisheries Act 1995

This Act repeals the 1968 Fisheries Act and provides an updated management framework for fisheries. Management plans are created in accordance with the Act specifying policies and strategies for management of a specific fishery. The Act also provides for the management, development and promotion of an ecologically sustainable and viable aquaculture industry. EPA Victoria does not licence in-situ marine aquaculture operations but these are required to monitor and manage their impact on the environment under fishery reserve management plans. The legislation is administered by the Department of Primary Industry.

Appendix 5: Statutory and institutional arrangements

Our Water Our Future

In 2004 the Victorian Government developed a long-term plan for water – Our Water Our Future.

Our Water Our Future sets out 110 initiatives for water conservation aimed at every sector of the community, seeking to provide water to sustain growth over the next 50 years.

Its 110 actions aim to:

- repair rivers and groundwater systems – the natural source of all our fresh water – by giving them legal water rights and conducting restoration works;
- price water to encourage people to use it more wisely;
- permanently save water in our towns and cities, through common sense water saving and recycling measures;
- secure water for farms through pioneering water allocation and trading systems; and
- manage the water allocation to find the right balance between its economic, environmental and social values

This significant policy has assisted in achieving better coordination between state agencies and local government in sustainable water management over the past four years. For further information see www.ourwater.vic.gov.au

Local Government

Local councils are established under the Local Government Act 1989.

Clause 17 of SEPP (Waters of Victoria) identifies the range of local council responsibilities in relation to protection of water quality.

Councils are provided with powers under the Planning and Environment Act 1987 to act both as a planning authority and a responsible authority. Councils are therefore in a key position to require provision of measures to protect water quality through their planning schemes and their administration and enforcement. State government, through the VPP, provides the overall direction and emphasis to local government regarding planning measures to protect water quality.

In recent years, councils together with state agencies, have been active in improving urban stormwater quality through a range of programs such as the Victorian Stormwater Action Program, preparation of Stormwater Management Plans and the introduction of WSUD into new developments.

Under the 1927 agreement with Melbourne Water, local councils are responsible for drainage issues in areas under 60ha. Given the longstanding nature of this agreement there are coordination and support mechanisms in place to assist local government. From a catchment-wide perspective however, the priority given to the implementation of WSUD and protection of water quality varies significantly between councils.

Local government are also involved in programs to improve on-site domestic wastewater management to prevent the transport of nutrients, pathogens and other pollutants to waterways and bays. SEPP (Waters of Victoria) clauses 32 to 35 discuss on-site domestic wastewater management and sewerage issues.

Stormwater runoff from roads also affects water quality. Road managers including VicRoads and councils need to maintain and manage roads to minimise erosion and sediment and pollutant transport, particularly along urban, unsealed and forestry roads (SEPP (Waters of Victoria) Clause 57).

In addition to exercising powers under local by-laws, council officers may also have powers under the Environment Protection Act 1970, as litter officers for example, or more generally, if appointed as Authorised Officers under the Local Government Act 1989. There are advantages in having delegated powers under state environmental legislation to allow for a more consistent approach across local government when enforcing environmental matters. This requires the development and implementation of appropriate training and guidance programs (see EPA Victoria and Melbourne Water 2007).

Analysis of Statutory and Institutional Gaps

The Purpose of Analysis

An analysis of the Statutory and Institutional Arrangements was undertaken by EPA Victoria to ensure that all programs and actions described in *Better Bays and Waterways* could be allocated to lead agencies and implemented effectively.

Method of Analysis and Tables of Results

To analyse the statutory and institutional arrangements, two processes were run concurrently.

The first process involved consultation with key agencies. A number of questions were asked of these stakeholders to gain the following information:

- What stakeholders see as their main statutory obligations
- What interactions do they have with other organizations
- Where did they see gaps in the statutory and institutional arrangements; and
- How the gaps they perceive in these arrangements could be filled.

Table A5.1 shows the results of this consultation.

The second process involved reviewing all proposed programs in *Better Bays and Waterways*. The review assessed whether there was an appropriate and capable lead agency for program delivery and secondly whether the lead agency had the statutory and institutional capacity to complete the program assigned to it.

Table A5.2 shows the results of this analysis.

Table A5.1 Key Agency/Stakeholder Consultation on Statutory and Institutional Arrangements

Stakeholder	Major Responsibilities in Relation to Better Bays and Waterways	Statutory and Institutional Potential Gaps	Other stakeholders who identified similar gaps	Recommended Strategy to Address Gap
<p>Department of Sustainability and Environment.</p> <p>(Please note that DSE and the Department of Planning and Communities (DPCD) separated in August 2007. EPA has consulted DSE and intends on consulting DPCD through the use of this document.)</p>	<p>Responsible for bulk water entitlements and management of water resources, stormwater management and inclusion of Clause 56 for integrated water cycle</p> <p>Advises the Government on statewide policy issues including land use and catchment planning, urban policy and river health policy and planning</p> <p>Establishes statewide policy on river health and manages government investment in river and bay health</p> <p>Administers key relevant legislation (including the Land Act, Crown Land (Reserves) Act, National Parks Act and Coastal Management Act) and manages the sea bed and therefore the water above the sea bed as unreserved coastal crown land.</p> <p>Management and review of the Port Phillip Bay Environmental Management Plan (EMP).</p>	<p>There is no equivalent to Clause 56.07-4 for non residential subdivision</p> <p>Some councils not motivated to apply WSUD because it has no impact on their Municipality</p> <p>Need for clarity amongst agencies and Council's about roles in stormwater management</p> <p>Lack of a state-wide policy context for stormwater management</p> <p>Lack definition ownership and entitlements to stormwater.</p> <p>Clause 56.07-4 does not adequately address infill development whereby allotments are built prior to subdivision</p>	<p>Clause 56: Melbourne Water, local government</p> <p>Stormwater ownership and management: Local government</p>	<p>VPPs be amended so that stormwater management requirements are applicable to industrial/commercial premises</p> <p>Establish stormwater management standards for allotment scale development across all land types</p> <p>Development of a updated stormwater strategy</p> <p>DSE to determine the rights around ownership and use of storm water in consultation with local government.</p> <p>Clarification of roles and responsibilities by referring to this document when project planning and setting up governance arrangements for programs</p>
Melbourne Water	<p>Responsible for surface water licensing in the Yarra and lower Maribyrnong rivers</p> <p>Managing the Environmental Water Reserve for surface and groundwater in Port Phillip and Western Port</p> <p>Waterways Manager in Port Phillip and Western Port</p> <p>Bulk Water and Bulk Sewerage Services</p> <p>Responsible for drainage above the 60 hectares of drainage catchment.</p> <p>Responsible for developing the Regional River Health Strategy</p>	<p>Definition around the role of councils in water and diffuse pollution management. Particularly in the area of storm water and waterways.</p> <p>Capacity within state and local government to carry out enforcement of polluting activities.</p> <p>Need additional clarity from DSE re: Stormwater Strategy</p> <p>Better clarity around statutory arrangements for diffuse source pollution</p> <p>Different agencies have responsibilities for different aspects of the water cycle – surface water, groundwater, stormwater</p> <p>The current referral system to Melbourne Water does not address allotment scale and infill development WSUD.</p> <p>Uniformity in approaching catchment issues between different council's varies substantially.</p> <p>Water Act only assigns responsibility to Local Councils for drainage, when stormwater harvesting and reuse is an emerging issue with no legislative recognition</p>	<p>stormwater issues: DSE, LG</p> <p>clarification of roles and responsibilities: DPI, LG</p> <p>enforcement capability: LG</p>	<p>That DSE clarify the direction for stormwater management</p> <p>Work on making council's roles clearer on stormwater and diffuse pollution issues including enforcement</p> <p>Water Act should have provisions that recognise harvesting and use of stormwater</p> <p>Work on revising VPP's to address infill and allotment scale subdivisions.</p> <p>Councils formally sign up to targets for pollution reductions to waterways</p> <p>Need an integrated catchment management approach to water cycle management</p>
Environment Protection Authority	<p>Setting of targets for the bays using SEPPs and Schedules for Port Phillip and Western Port bays</p> <p>Have carriage of a significant amount of legislation in the Environment Protection Act, and Pollution of waters by Oil and Noxious Substances (POWBONS)</p> <p>Enforcement of general pollution provisions of the Environment Protection Act</p>	<p>Use of reclaimed water in waterways as environmental flow</p> <p>Clarity of roles and responsibilities in relation to SMEs</p> <p>Roles and responsibilities of agencies in the Port Phillip and Western Port Bays and catchments</p> <p>Consistent and easily understood water quality reporting</p>	<p>reclaimed water as environmental flow: DSE</p> <p>clarity of roles: LG, Melbourne Water and DPI</p> <p>consistent and easily understood water quality reporting: PPWCMA, LG</p>	<p>Discussion Paper and future direction on reuse to waterways</p> <p>Articulation of lead agencies and support agencies for BBW WQIP programs to help define roles within the Port Phillip and Western Port Bays and Catchments</p>

Appendix 5: Statutory and institutional arrangements

Stakeholder	Major Responsibilities in Relation to Better Bays and Waterways	Statutory and Institutional Potential Gaps	Other stakeholders who identified similar gaps	Recommended Strategy to Address Gap
Port Phillip and Westernport CMA	<p>Lead agency that coordinates the Regional Catchment Strategy (RCS)</p> <p>Also develops Native Vegetation Plan, Pest Plant and Animal Plan and Landcare Plan</p> <p>Unlike other CMAs the PPWCMA do not develop the Regional River Health Strategy, this is done by Melbourne Water</p>	<p>Most significant gap identified was the consistency of monitoring and reporting for the bays</p>	<p>simple consistent monitoring and reporting: EPA and LG</p>	<p>Adoption of the CMAs report card for Port Phillip and Western Port Bays</p>
Local Government (In attendance, Mornington Peninsula, Port Phillip and Kingston Council's, Municipal Association of Victoria and Association of Bayside Municipalities)	<p>Local Government (LG) has legislative responsibilities that are predominantly sourced from Acts more strongly associated with other agencies e.g. Septic tank responsibilities from the Environment Protection Act</p> <p>Stormwater and domestic Wastewater management were significant</p> <p>Are a planning Authority and a Responsible Authority under the Planning Legislation</p> <p>Influence by CALP Act, PPWCMA's Regional Catchment Strategies and Victorian Coastal Strategies many of these issues may be reflected in the Municipal Strategic Statement.</p> <p>Melbourne 2030 and how this will impact on population growth and infrastructure.</p>	<p>Definition and clarity around the roles for stakeholders involved in the catchments</p> <p>Stormwater no clarity around ownership and use rights</p> <p>Stormwater no clarity of who is responsible quality.</p> <p>That the standards for the management of pollution and various catchment issues vary between Council's</p> <p>The need for areas to be retrofitted to manage use of stormwater and to cope with climate change, current arrangements do not help this</p> <p>More consideration of upstream stormwater from other Council's</p> <p>The difference between good and poor performing Council's</p> <p>That the planning provisions only apply in areas of new development, many issues relate to existing developments.</p> <p>EPA under resourced to do the job on all point source emissions</p> <p>Current monitoring is not strategic, not generally understood by the public and fragmented in the information gained.</p> <p>Local government considers that additional expectations are being given to them without adequate resources to cover costs</p>	<p>issues around stormwater: DSE</p> <p>Monitoring: PPWCMA, EPA and Melbourne Water</p>	<p>Roles need to be further clarified between different stakeholders</p> <p>Stormwater rights and ownership and responsibility need to be clarified.</p> <p>Must be clear guidance around management of stormwater set to ensure all Council's meet a minimum level of management.</p> <p>Stormwater management guidance needs to set out mechanisms to require retrofitting of current stormwater systems that do not meet minimum standards</p> <p>Guidance and minimum standards should even difference out between poor and well performing Councils.</p> <p>Planning provisions may need some amendment that allows retrospective stormwater issues to be addressed.</p> <p>EPA needs addition resources or alternatively needs to have more powers delegated to local government.</p> <p>Monitoring needs to be rationalized and streamlined to ensure all monitoring programs are co-ordinated, target and reports results to the community in a simple format.</p> <p>Waterwatch should be better incorporated into the monitoring program.</p> <p>Involve local government when requiring them to make additional inputs or commitments</p>
Department of Primary Industries	<p>DPI has legislative responsibility for implementation of the Fisheries Act 1995. Sustainable management of fisheries and development of the aquaculture sector (including management, research and compliance).</p> <p>DPI has institutional responsibilities in the catchment including: providing expertise to natural resource managers, assisting to deliver farm program for Melbourne Water, DPI can be a referral Authority under the Water Act.</p> <p>Are involved in some animal welfare actives that could impact on water quality</p>	<p>The main gaps identified were the clarity of roles and responsibilities between agencies.</p>	<p>Roles and responsibilities: Melbourne Water, LG, EPA</p>	<p>That more clarity is provided around the roles and responsibilities of the following major players within the Port Phillip and Western Port catchments:</p> <ul style="list-style-type: none"> • Melbourne Water • EPA Victoria • DSE • DPCD • Parks Vic • Forests Vic • Local Government
Stakeholder Advisory Group	<p>Provision of community and stakeholder advice to EPA Victoria and Melbourne Water on <i>Better Bays and Waterways</i> development</p>	<p>Natural Resource Management in Port Phillip and Western Port bays is fragmented because of the organisational division between the Port Phillip and Westernport CMA and catchment functions of Melbourne Water</p>		<p>The Stakeholder Advisory Group recommended merging the Port Phillip and Westernport CMA with Melbourne Water's catchment divisions (environmental flows, waterway management and community engagement) to achieve improved strategic management of these catchments. This would result in improved organisational critical mass.</p>

Table A5.2 Analysis of programs proposed in *Better Bays and Waterways* and the statutory and institutional arrangements to assist delivery

Program Proposed	Lead Agency	Are Statutory Arrangements Adequate to Deliver Programs	Are Institutional Arrangements Adequate to Deliver on Programs	Gaps Identified	Strategy to Assist delivery
Managing Rural Diffuse Pollution	Melbourne Water with support from DSE, DPI, CMAs, EPA and LG	Yes	Yes, but there is a need for better coordination	Perceived lack of direct regulation on some rural activities impacting on water quality	<i>Better Bays and Waterways</i> will help further clarify and coordinate programs by various agencies
Managing Diffuse Urban Pollution	Responsibility predominantly falls to Melbourne Water and LGs some support from DSE and EPA will be required	Generally yes	Partially	<p>Ownership and rights to stormwater</p> <p>An updated Stormwater Strategy</p> <p>Ad hoc implementation between Councils of stormwater and diffuse urban pollution issues</p> <p>Insufficient support of council for standard procedures and enforcement options</p> <p>Current VPPs do not require WSUD for commercial/industrial premises and for infill and allotment scale developments</p> <p>Councils not all formally committed to pollution reduction targets in waterways</p>	<p>DSE to clarify ownership and use rights around stormwater.</p> <p>Overall framework for stormwater management to address current ad hoc implementation</p> <p>Education of council officers regarding powers. Need to investigate the potential to delegate powers to councils from EPA.</p> <p>VPPs amended to require WSUD for these type of developments</p> <p>Melbourne Water to engage councils to sign up for pollution reduction targets for waterways</p> <p>Identify how EPA, Melbourne Water and LG can integrate their approach on SMEs such as developing guidelines, delegating EPA powers to LG, and training and support.</p>
Managing Litter	LGA and EPA	Yes	Yes	Inadequately defined stakeholder roles. In that there a number of stakeholders without one clear strategic direction on litter management throughout Victoria. These stakeholders include EPA, LGs, Sustainability Victoria and Victorian Litter Action Alliance.	There is a need to better articulate stakeholder roles around litter in the context of a statewide strategic direction on litter management into the future
Managing Point Source	Predominantly EPA with some assistance from Melbourne Water and LG	Yes	Partial	Lack of clarity regarding action SMEs.	Need to clearly articulate roles and determine how EPA, Melbourne Water and LG can work better together on SMEs. This could include development of certain guidelines, delegation of EPA powers to LG, training and support to LG etc.
Managing impacts of bushfires	Multiple (predominantly Melbourne Water actions in <i>Better Bays and Waterways</i>)	Yes	Yes	Recent addition to plan – not consulted on as part of the S&I project	Recent addition to plan – not consulted on as part of the S&I project
Environmental Flows	DSE (Bulk entitlement and Sustainable Water Strategy) and Melbourne Water (Waterways Manager)	Yes, except potential use of reclaimed water to supplement environmental flows	Yes	Use of reclaimed water to supplement environmental flows is currently enabled under SEPP, but there is no guidance on how to meet the required objectives.	Guidance for use of reclaimed water in streams currently being addressed by DSE and EPA, through the Central Region Sustainable Water Strategy and Reuse to Waterways Project.
Marine Influences	Yes	Yes	Yes	None	None
In stream Monitoring	Melbourne Water and DHS with support from EPA and DSE	Yes	Yes, but could be improved	Better coordination in monitoring programs	Monitoring programs should be with buy in from all agencies involved in monitoring in Port Phillip Bay and Western Port. It has been suggested that <i>Better Bays and Waterways</i> adopt the report card put forward by PPWCMA
In Bay monitoring	EPA and DSE	Yes	Yes	None	None

Appendix 5: Statutory and institutional arrangements

Program Proposed	Lead Agency	Are Statutory Arrangements Adequate to Deliver Programs	Are Institutional Arrangements Adequate to Deliver on Programs	Gaps Identified	Strategy to Assist delivery
Community Engagement	All agencies involved in <i>Better Bays and Waterways</i>	Not Statutory	Partial	Adoption of coordinated community engagement strategy between all agencies	There is a need to develop community engagement strategies for each of the proposed programs in <i>Better Bays and Waterways</i> . Community Engagement should be considered as part of the governance for each program.
Research and Investigations	Melbourne Water and in the case of Groundwater and surface water exchange jointly between Melbourne Water and DSE	Yes	Yes	None	None
Governance	All agencies	Yes	Yes	Lack of understanding of organisational roles	<i>Better Bays and Waterways</i> provides guidance on lead agencies for proposed programs and whether statutory and institutional arrangements need amending to assist in the delivery of the plan.
Reporting – Implementation report, and report card	All agencies with a role in <i>Better Bays and Waterways</i>	Yes	Partial	Uniformity of reporting and in simple to understand format	Adoption of the draft reporting framework and report card provided by PPWCMA.

Conclusions

The above analysis shows that the current statutory and institutional arrangements provide a substantial basis for implementation of *Better Bays and Waterways* programs. Whilst some statutory changes are proposed these are under active consideration by the responsible agencies, therefore no significant changes in direction are needed. Agencies whose programs include these statutory tools should consult with the responsible agency on progress, to assist them in planning and implementation of their programs.

No substantive gaps were identified in institutional arrangements but strengthening of institutional capacity and better coordination between agencies is proposed to improve delivery of some programs. Agencies should take these proposed strategies into account during the planning and implementation of programs.

Appendix 6: Detailed assessment of current condition for waterways

Waterway water quality monitoring

Water quality in rivers and creeks across the region are assessed against objectives of SEPP (WoV), including Schedules F6, F7 and F8 (State of Victoria 1997, 1999, 2001). These are the environmental quality objectives required to protect identified values and uses for various river segments. If environmental quality objectives are not met this can indicate deterioration in water quality that may affect values and uses associated with the waterway.

Prior to July 2007, water quality in the Port Phillip and Western Port region was routinely monitored at 72 sites, which included sites. The number was increased to over 100 sites following a review of the monitoring network in 2007. The monitoring network now provide a more comprehensive coverage of the entire Port Phillip and Western Port region, including the expanded catchment areas that Melbourne Water now manages. It will take several years to accumulate the required water quality data to allow a valid assessment of compliance with SEPP at these new sites. Therefore, water quality resented in this report is based on data from the 72 sites that were in operation before 2007.

Variables monitored include suspended solids, turbidity, nutrient concentrations (nitrogen and phosphorus), dissolved oxygen concentration, pH, temperature, salinity, heavy metals concentrations and bacterial contamination.

A summary of attainment with SEPP water quality objectives using water quality data for the five-year period 2001-2005 is presented in the following tables. Important regional observations include:

- Compliance of water quality with SEPP criteria across the whole region tends to be poor for nutrients and dissolved oxygen and generally good for pH and salinity.
- Compliance of metal concentrations and turbidity with SEPP criteria is variable and depends on location.
- Conditions are suitable for primary and secondary recreation contact during low flows at some locations in the Yarra River, but not during higher flows and across most other catchments.

Werribee catchment

An assessment of water quality data at seven sites across the Werribee catchment was undertaken for the period 2001-2005 (Table A6.1) to assess attainment of SEPP objectives (SKM, 2007a). SEPP objectives for chromium, copper and zinc were rarely met. Objectives for electrical conductivity, turbidity, nitrogen, *E. coli* and lead were also rarely or occasionally met. Sites frequently met objectives for dissolved oxygen, pH and arsenic. More detail on the results of the assessment can be found in the SKM 2007a report and Table A6.2.

Table A6.1: Percentage of monitoring sites (2001-2005) rarely, occasionally and frequently meeting SEPP objectives for selected water quality variables in the Werribee catchment (Source: SKM 2007a)

Variable	Werribee compliance		
	Rare (0-20% compliance, 0-1 out of 5 years)	Occasional (40-60% compliance, 2-3 out of 5 years)	Frequent (80-100% compliance, 4-5 out of 5 years)
DO	0%	0%	100%
EC	71%	29%	0%
pH	14%	14%	71%
Turbidity	67%	33%	0%
Phosphorus	57%	29%	14%
Nitrogen	71%	29%	0%
<i>E. coli</i>	67%	33%	0%
Arsenic	0%	0%	100%
Cadmium	25%	25%	50%
Chromium	100%	0%	0%
Copper	100%	0%	0%
Lead	75%	25%	0%
Nickel	25%	25%	50%
Zinc	100%	0%	0%

Table A6.2: Detailed description of water quality issues in the Werribee catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>Forest harvesting is restricted to the upper catchment (within the catchments of the Lerderderg River, Parwan Creek and Korweinguboorra Creek); there is a potential for poor water quality due to deforestation, but major effects have not been recorded. Significant deforestation will increase surface runoff, thus increasing sediment transport.</p>
<p>Rural/agricultural</p> <p>Bed and bank erosion poses a threat to a number of waterways - Goodmans Creek (within Lerderderg River catchment), Middle Werribee River and the Parwan Creek (has major erosion issues).</p> <p>Irrigated pasture is a comparatively small source of pollutants in the Werribee catchment, but intensive horticulture in areas around Werribee (including market gardens) and Bacchus Marsh is a potential threat to downstream values. There are anecdotal reports of discharges (nutrients, sediments) from market gardens in Werribee South directly into Port Phillip Bay via a pipe or open channel (Wyndham CC, pers. comm.).</p> <p>Stock access to waterways is a source of nutrient, faecal indicator and sediment pollution through much of the Upper Werribee River, Middle Werribee River, and Little River. Upland Kororoit Creek has high levels of phosphorus and nitrogen from grazing fertilisers. Stock access threatens water quality upstream of Pykes Creek Reservoir, an important regional water supply.</p> <p>There are high nutrient and sediment loads from non-irrigated pasture in the Werribee River catchment.</p> <p>Very high salinity levels within Kororoit Creek and the Little River are considered natural but are being added to by human induced dryland salinity.</p> <p>There are some septic tank inputs throughout the catchment. The biggest problems are in the Werribee River catchment upstream of Werribee Reservoir.</p>
<p>Urban</p> <p>Despite relatively small areas of urbanisation in the Werribee catchment, new urban development is a major source of pollution, particularly sediment and turbidity. Key sources include expansion at Werribee, Little River, Hoppers Crossing, and the Laverton Creek sub-catchment. The Skeleton Creek sub-catchment is currently 15% urbanised and has low DO, the result of organic inputs from urban sources.</p> <p>Significant sources of litter originate within the Kororoit Creek catchment and Laverton sub-catchment, and localised sources around Werribee and Hoppers Crossing.</p> <p>Kororoit Creek is affected by industrial land use (both runoff and some discharges). In particular, sampling of the creek at Altona shows high levels of heavy metals. Part of this is attributed to past discharges, but present industrial and general urban runoff is believed to be a significant source. Metals are also recorded at elevated levels in Skeleton Creek near Laverton and Kororoit Creek at Altona (this site had the highest metal concentrations recorded in any of the 35 Streamwatch sites during 1996) and Melton East.</p> <p>Industrial discharges are known to contribute high nitrogen loads to Stony Creek.</p> <p>The large contributions of contaminants from industrial sources are to be expected from the heavily industrialised North Shore area of Geelong (SKM, 2007).</p> <p><i>E. coli</i> levels are high in Cherry Lake, although this is believed to be at least partly contributed to by birds within the lake.</p> <p>Soil acidification (68% of the catchment is considered to be strongly acidic) will contribute to the mobilisation of heavy metals within waterway sediments.</p>

Appendix 6: Detailed assessment of current condition for waterways

Maribyrnong catchment

An assessment of water quality data at ten sites (five urban and five rural) across the Maribyrnong catchment was undertaken for the period 2001-2005 (Table A6.3) to assess attainment of SEPP objectives (SKM, 2007a). This assessment found that SEPP objectives for pH, arsenic and cadmium were frequently met but objectives for nitrogen, phosphorus, chromium, copper, lead, and zinc were rarely met.

Table A6.3: Percentage of monitoring sites (2001-2005) rarely, occasionally and frequently meeting SEPP objectives for selected water quality variables (Source: SKM 2007a) in the Maribyrnong catchment

Variable	Maribyrnong compliance		
	Rare (0-20% compliance, 0-1 out of 5 years)	Occasional (40-60% compliance, 2-3 out of 5 years)	Frequent (80-100% compliance, 4-5 out of 5 years)
DO	0%	50%	50%
EC	56%	0%	44%
pH	0%	11%	89%
Turbidity	0%	100%	0%
Phosphorus	67%	33%	0%
Nitrogen	78%	11%	11%
<i>E. coli</i>	20%	20%	60%
Arsenic	0%	25%	75%
Cadmium	0%	25%	75%
Chromium	100%	0%	0%
Copper	100%	0%	0%
Lead	75%	25%	0%
Nickel	25%	25%	50%
Zinc	100%	0%	0%

Monitoring at rural sites found that half of the sites rarely attained the nitrogen objective and two sites rarely attained the phosphorus objective. The urban monitoring found that there is significant room to improve water quality in the urban parts of the catchment. More detail is available in the SKM (2007a) report and table A6.4.

The water quality in the catchment poses significant risks to the social and environmental values of the catchment. Threats to the recreational and social values of the catchment include sediment, nutrient, toxicant (i.e. heavy metals) and litter loads.

Table A6.4: Detailed description of water quality issues in the Maribyrnong catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>Forest practices can result in sediment mobilisation and thus contribute to TSS loads. However, relatively, forestry has little impact in this catchment.</p>
<p>Rural/agricultural</p> <p>With grazing being the main land use, stock access to stream banks is a major contributor to sediment and turbidity, and nutrient loads. Runoff from broadacre grazing also brings nutrients and sediment (these areas are particularly vulnerable after a prolonged dry period where the soil can be prone to erosion). Despite this, the Maribyrnong River has relatively low levels of sediment. Turbidity can be more of a problem, and is the only variable which often does not comply with SEPP guidelines.</p> <p>Rural land use also contributes some BOD, most likely as a result of direct stock access to streams. This is particularly the case in the Deep Creek and Emu Creek sub-catchments.</p> <p>The other key rural input is nutrient runoff from broadacre cropping areas (although it is a small overall contributor to loads). Much of the nutrients are in particulate form, attached to sediment that is being eroded from the catchment.</p> <p>There are some market gardens near Keilor, which contribute nutrients to the Maribyrnong.</p>
<p>Urban</p> <p>Urban development is one of the key threats to water quality in the Maribyrnong catchment. Particular concern relates to developments around Taylors Lakes, Caroline Springs, and Deer Park. High levels of turbidity and suspended solids are observed wherever new urban development or roadworks occur.</p> <p>Pollution spills and discharges from industrial areas are another key source of pollutants to the Maribyrnong. Examples include the Melbourne Airport and surrounding industrial complex (affecting Steele Creek and Arundel Creek). Industrial discharges, including unlicensed discharges, have contributed to very poor water quality in Stony Creek.</p> <p>Discharge from the Sunbury STP contributes nutrients to Jacksons Creek however recent upgrades have significantly reduced discharges to the creek. Closure of the Keilor STP (1998) reduced nutrient levels in the mid Maribyrnong.</p> <p>Some metals and toxicants are present, both within the water column and within sediments. These are likely to result from industrial discharges (and general urban runoff). While levels are quite low relative to the intensity of industrial land use, there are some known sources/problems. For example, chromium concentrations in the Maribyrnong River at Canning Ford are very high. In some places, metal concentrations have increased (due to increased urban land use; e.g. Lower Maribyrnong River), while in others they have decreased (due to cessation of industrial discharges). Currently, urban stormwater is the main source of heavy metal and PAH pollution, particularly from areas of industrial estates. Metals loads are also generally high in Steeles Creek downstream of Melbourne Airport (despite decreases in copper and nickel, Steele Creek has very high concentrations of nickel, as well as lead, chromium and zinc), originating from Airport West, via Clydesdale stormwater drain.</p> <p>General urban runoff contributes high nutrient loads to Deep and Jacksons creeks. Urban runoff is also likely to be contributing to the low DO levels at Deep Creek.</p> <p>Heavy metal concentrations in sediments of the streams of Maribyrnong usually exceed the Australian sediment quality guidelines.</p>

Appendix 6: Detailed assessment of current condition for waterways

Yarra catchment

An assessment of water quality data at 36 sites across the Yarra catchment (17 rural and 19 urban) was undertaken for the period 2001-2005 (Table A6.5) to assess attainment of SEPP objectives (SKM, 2007a). This assessment found that SEPP objectives for phosphorus, nitrogen, chromium, copper, lead and zinc were rarely attained, with no more than one site meeting any objective at least four years out of five. The objective for dissolved oxygen was also rarely met, with 85% of sites only meeting the objective once in every five years. Conversely, SEPP objectives for pH, arsenic, cadmium, and to a lesser extent nickel, were frequently met.

In tributaries generally had a lower attainment with water quality objectives than the main river (SKM, 2007a). Attainment with water quality objectives was generally poorer in urban reaches compared to rural reaches.

The *E. coli* objective for primary contact recreation (e.g. swimming) was met at most rural sites, except sometimes after rain but not at most urban sites. Objectives for non-contact recreational activities, such as fishing, kayaking and boating, were generally always met at most rural and urban sites, except following heavy rain (Melbourne Water, 2007c). Further details of Yarra catchment water quality can be found in table A6.6 and A6.7

Table A6.5 Percentage of monitoring sites (2001-2005) rarely, occasionally and frequently meeting SEPP objectives for selected water quality variables (Source: SKM 2007a) in the Yarra catchment

Variable	Yarra compliance		
	Rare (0-20% compliance, 0-1 out of 5 years)	Occasional (40-60% compliance, 2-3 out of 5 years)	Frequent (80-100% compliance, 4-5 out of 5 years)
DO	85%	3%	12%
EC	48%	27%	24%
pH	0%	0%	100%
Turbidity	15%	39%	45%
Phosphorus	80%	20%	0%
Nitrogen	97%	0%	3%
<i>E. coli</i>	50%	24%	26%
Arsenic	3%	3%	94%
Cadmium	3%	21%	76%
Chromium	100%	0%	0%
Copper	100%	0%	0%
Lead	79%	21%	0%
Nickel	6%	34%	59%
Zinc	100%	0%	0%

Table A6.6: Detailed description of water quality issues in the Upper and Middle Yarra catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>The only identified source of water pollution from within the forested upper, mountainous areas is poor water quality emanating from forested areas of Steels and Pauls Creeks. Timber harvesting operations in the Little Yarra River have been known to cause some sediment transport problems, with access roads a significant source of sediment.</p>
<p>Rural/agricultural</p> <p>The most widespread source of water quality degradation within rural areas comes from stock access (inadequate stream frontage protection and riparian vegetation), causing sediment mobilisation, nutrient and faecal contamination, and sediment runoff from cropping and grazing land. Areas affected include the rural parts of the Upper Yarra River, Little Yarra River (with overstocking in some areas) and Hoddles Creek, Woori Yallock Creek (which also has intensive cropping), Watts River (where significant bed and bank erosion is present), Watsons, Steels, Dixons and Pauls creeks, Stringybark Creek, Merri Creek and Olinda Creek. In some small intermittent northern tributaries of the Yarra (e.g. upstream Darebin Creek, Merri Creek), stock access combines with low flows to create high concentrations of nutrients, sediment, and low oxygen levels. In Pauls Creek, combination of dairy farming, and movement of cattle along the bed and banks, causes substantial nutrient and sediment loads.</p> <p>Surprisingly high levels of copper in the Upper Yarra catchment (e.g. Millgrove, Healesville, Launching Place) suggest significant sources from agricultural chemical inputs (as well as possibly from reticulated water supply pipes).</p> <p>Pesticide and other agricultural chemicals have been detected in Stringybark Creek, Cockatoo Creek and Emerald Creek. Examples include Dieldrin. Pesticide inputs from Woori Yallock Creek catchment are also considered a problem. Sources of biocides (fungicides, insecticides, etc.) present a risk to the Mid-Yarra, particularly the Sugarloaf Reservoir. Primary sources are the intensive horticulture and flower-growing areas, as well as areas of grape production.</p> <p>Unsealed roads contribute sediment through much of the rural/urban interface areas, such as in the Plenty River. The Melba Highway and nearby tracks are also contributors of sediment to Dixon Creek.</p> <p>Leaf drop from reaches with high densities of willows are contributing to low DO levels.</p> <p>Septic tanks are an identified source of nutrients, faecal coliforms and total organic carbon (TOC) in the Woori Yallock and Little Yarra River catchments. There is also some evidence of septic tank inputs at Hoddles Creek, downstream of Launching Place. In the Middle Yarra, upstream of Warrandyte (e.g. Stringybark Creek, Wandin Yallock Creek, Sassafra Creek, New Chum Creek), septic tanks, combined with stock access, are the main sources of <i>E. coli</i>. Microbial levels in the river are derived from local catchments rather than being imported from upstream of Warrandyte. There is a clear pattern of rapidly waning influence of herbivore faecal inputs downstream of Warrandyte, and an increasing presence of human faecal indicators downstream of Heidelberg.</p> <p>Fertiliser inputs to agricultural land are a significant input; examples include Plenty River, and most of the Upper Yarra tributaries (Woori Yallock, Hoddles, Little Yarra). A significant source of sediment to the Yarra in rural areas is in-stream mobilisation, particularly from Little Yarra and Woori Yallock Creek (in urban areas, stormwater runoff contributions are greater).</p>
<p>Urban</p> <p>Urban stormwater is the largest single contributor of pollution within the urban area. A significant proportion of the micro-organisms found in urban stormwater originate from human sources. Sewer cross connections and leaks lead to deposition of microbes in the stormwater system during dry weather which then provides a source of micro-organisms for future wet weather events. Whilst some hotspots have been identified, the sources of stormwater pollution are widespread. Key affected reaches include Stringybark Creek, Olinda Creek, Merri Creek, Moonee Ponds Creek, the Middle Yarra and its tributaries, such as Darebin Creek and Gardiners Creek (including Scotchmans and Damper Creeks). Urban stormwater problems are associated not only with direct pollutant inputs, but also with channel erosion due to increased flows, mobilising and transporting sediment (e.g. erosion in Olinda Creek, downstream of Lilydale). Bell St Main Drain is a particular source of pollutants to Darebin Creek. A good illustration of the impact of urban development on water quality is the effect of the Diamond Creek and Eltham townships on Diamond Creek, resulting in increased turbidity, nutrients, BOD and <i>E. coli</i>. Stormwater drains were identified as the main source of pollution to Darebin Creek, particularly for nutrients.</p> <p>Diversions of industrial discharges and STPs have reduced nutrient and turbidity levels in the Yarra River. For example, the Plenty River, downstream of Whittlesea, was degraded by high levels of nitrogen and phosphorus, discharged from the Whittlesea STP, which has now ceased discharge to the river and is recycling 100% of its wastewater.</p> <p>Heavy metal concentrations are increasing. For example, zinc, mercury and chromium have all shown increases. Urban stormwater is the main source, including runoff from roads (including vehicles, road surface degradation).</p> <p>Principal sources of copper include leaching from water supply pipes, and industrial sites, while roofs are a principal source of zinc. Gardiners Creek is an identified hotspot for metals (as is Merri Creek at Barry Road), with high levels of copper, lead and zinc, both in the water column and in sediment.</p> <p>Heavy metal concentrations were monitored in the base flow (dry weather flow) of 15 urban drains in Merri and Darebin Creeks, as well as in the sediment of the two creeks. It was found that the main sources of heavy metals in the creeks are diffuse (non-point) discharges from small to medium sized industries (due to poor practices). Zinc and copper were common pollutants, with the all drains having very poor compliance to Australian water quality guidelines, particularly in industrial catchments. Persistent elevated concentrations of chromium occurred in Heidelberg West and of nickel in Lillimur drain.</p> <p>Litter is an ongoing problem in urban areas of the Yarra catchment. Hotspots include Gardiners Creek, Darebin Creek, Prahran Main Drain and Kew Main Drain.</p> <p>Unsewered areas in the Middle and Upper Yarra and its tributaries are a known source of nutrients (particularly nitrogen) and faecal coliforms, although urban stormwater runoff was a greater contributor of phosphorus and sediment in the Dandenong Ranges (e.g. Olinda, Kallista, Monbulk and Sassafra) than septic tank density. Within the Woori Yallock Creek, there are significant known septic tank problems, leading to elevated levels of phosphorus, nitrogen and <i>E. coli</i>. Contributions from areas with faulty septs (e.g. Mullum Mullum) are a source of nutrients.</p> <p>Major inputs of pollutants, including faecal material, come from the Mullum Mullum Creek, Darebin and Gardiners Creek catchments. They also have high levels of toxicants and frequent pollutant spills. Merri Creek and Moonee Ponds Creeks are also a known source of toxicants and heavy metals. On the Yarra River main stem, <i>E. coli</i> levels increase substantially downstream of Warrandyte. Similarly, turbidity and nutrient levels begin to increase at this point, as stormwater inputs begin to become substantial.</p> <p>Both the northern and southern tributaries of the urban reach of the Yarra are broadly affected by stormwater pollution, consequently being significant sources of nutrients, faecal coliforms, toxicants, heavy metals, and sediment. In general, the southern tributaries have higher pollutant generation rates, but the northern tributaries have been more affected by occasional events such as sewer spills.</p> <p>Olinda and Brushy Creeks are major sources of nutrients and high BOD, both receiving discharges from STPs. Urban stormwater is also considered a major source of pollutants to Brushy Creek.</p> <p>In the Plenty River sub-catchment, the Mernda Drain is clearly a major source of pollutants, with phosphorus concentrations up to 500 times SEPP guidelines, nitrogen 20 times, and the presence of both raw sewage and waste domestic water. As a result, DO levels downstream are severely diminished.</p> <p>Mullum Mullum Creek is a major source of pollutants to the Yarra River, contributing high levels of litter, nutrients, copper, zinc, as well as sediment and turbidity. As well as catchment sources, channel erosion contributes sediment.</p> <p>Within urban areas of the Yarra, dry leaves and vegetative matter can make up around 20% of TSS loads, and around 10% of nutrient loads. Loads from sewage are very high and include high amounts of copper (from pipes). However, treated effluent makes up less than 10% of phosphorus and nitrogen across the Yarra catchment; overflows make up even smaller amounts (less than 5%).</p>

Appendix 6: Detailed assessment of current condition for waterways

Table A6.7: Detailed description of water quality issues in the Lower Yarra catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>There are no forested areas within the Lower Yarra catchment.</p>
<p>Rural/agricultural</p> <p>There are no significant agricultural sources within the Lower Yarra catchment.</p>
<p>Urban</p> <p>The tributary drains to the Lower Yarra have generally poorer water quality than the river itself, particularly for nutrients. One exception is turbidity, which is higher in the river than in the tributary drains (partly because turbidity in the Yarra is a function of the channel soil properties, whilst the tributary drains are constructed conduits).</p> <p>Stormwater is a major source of pollution, with elevated levels of turbidity, suspended solids and metals during wet weather conditions. The Lower Yarra contains major areas of commercial development, which are likely to have some illegal discharges, as well as being a major source of litter.</p> <p>Harper Street Main drain is a major source of pollution, with the highest levels of phosphorus, nitrogen (particularly ammonia), <i>E. coli</i> (up to 68000 org/100 mL) and Enterococci, suggesting inputs from sewage or illegal stormwater connection. Ammonia concentrations are considered toxic to fish.</p> <p>The Alexander Parade Relief Drain contributes substantial concentrations of NOx.</p> <p>Palmer St. Main Drain recorded TKN readings of up to 9.6 mg/L, suggesting sewage inputs. The drain also has high metal concentrations.</p> <p>Monitoring has shown that TP concentrations in the Lower Yarra tributary drains are higher during low flow, suggesting illegal inputs, such as from sewage, or illegal industrial, commercial or domestic connections to the stormwater system.</p> <p>Within Gardiners Creek, Murrumbeena Main Drain is identified as a major source of nutrients (particularly ammonia), BOD (and thus low-oxygen water) and <i>E. coli</i>; testing identifies that human faecal contamination from sewage is a problem in Hedgeley Dene Drain. Similar patterns are observed in Merri Creek, with elevated levels of phosphorus; stormwater drains are considered the main source, with wastewater flows into these stormwater drains likely. Other key contributors include Back Creek (nutrients, BOD, TOC and <i>E. coli</i>), Hedgeley Dene Main Drain, Murrumbeena Main Drain and Scotchmans Creek. Similarly, Hawthorn Main Drain is a significant source of human faecal contamination.</p> <p>Merri Creek is rated as having the poorest water quality of any major tributary in the Yarra catchment. The biggest single source is Melville Main Drain (draining Coburg and Brunswick): nutrient concentrations downstream of it are double those upstream. There are some pollutant spills from industrial premises upstream. Metals within this catchment exceed guidelines, both in the water column and in sediment. Human faecal inputs are an identified problem.</p> <p>Prahran Main Drain and Canberra Main Drain both have high recorded levels of TOC, due either to vegetation inputs (from leaf drop by deciduous trees, conveyed through the efficient stormwater system) or sewage. Given the high levels of human faecal contamination in Prahran Main Drain, it is clear that there are substantial sewage inputs.</p> <p>Substantial investigation of sources of faecal contamination has taken place in the Lower Yarra, showing that downstream of Dights Falls, human faecal matter can contribute a major part of the faecal load, with herbivore inputs also substantial.</p> <p>High levels of surfactants have been detected at the Gipps Street Main Drain and the Alexander Parade Main Drain.</p> <p>Heavy metal levels are quite high in several parts of the catchment. Arsenic and cadmium is elevated at Canberra Road Main Drain, whilst copper has been high at Yarra River (Johnston St Bridge) and Prahran Main Drain. Chromium is elevated within the Yarra River, although the source is not clear. Lead wash-off from roads was in 2002/3 still a problem in both the Yarra and its tributary drains. With the now total phase-out of leaded petrol, ongoing monitoring will be needed to determine if this is still the case (and thus to identify sources). Zinc levels are low within the river itself, but high in the tributary drains, probably reflecting roofs as a key source (although industrial areas are also likely to be a major source). Sediment concentrations of many heavy metals in the Lower Yarra are elevated and have a high probability of being toxic to aquatic life.</p> <p>There are elevated PCB levels in the Yarra River sediments near Herring Island and accumulations of metals and other toxins in sediments. EPA Victoria recently announced that eating fish from the Yarra River should be restricted to once a week (and not at all for children and women of child-bearing age), to avoid any adverse health effects from toxins accumulated in fish.</p> <p>Note: Assessment conducted by McGuckin (McGuckin, 2003) is based on relatively limited data, and thus should be interpreted with caution.</p>

Dandenong catchment

Monitoring of water quality in the Dandenong Catchment began in the 1980s, and has continued at a range of sites periodically since then. An assessment of water quality data at 13 sites across the Dandenong catchment was undertaken for the period 2001-2005 (Table A6.8) to assess attainment of SEPP objectives (SKM, 2007a). This assessment found that SEPP objectives for chromium, copper, nitrogen, phosphorus and zinc were rarely met. Attainment of objectives for electrical conductivity, lead and turbidity was also poor. Objectives for dissolved oxygen, arsenic and nickel were frequently met. Attainment of objectives was relatively uniform across urban and rural sites. Detailed water quality information for the Dandenong catchment can be found in Table A6.9.

Table A6.8: Percentage of monitoring sites (2001-2005) rarely, occasionally and frequently meeting SEPP objectives for selected water quality variables (Source: SKM 2007a) in the Dandenong catchment

Variable	Dandenong compliance		
	Rare (0-20% compliance, 0-1 out of 5 years)	Occasional (40-60% compliance, 2-3 out of 5 years)	Frequent (80-100% compliance, 4-5 out of 5 years)
DO	8%	0%	92%
EC	92%	0%	8%
pH	25%	25%	50%
Turbidity	83%	8%	8%
Phosphorus	100%	0%	0%
Nitrogen	100%	0%	0%
<i>E. coli</i>	69%	8%	23%
Arsenic	17%	0%	83%
Cadmium	17%	42%	42%
Chromium	100%	0%	0%
Copper	100%	0%	0%
Lead	92%	8%	0%
Nickel	8%	25%	67%
Zinc	100%	0%	0%

Table A6.9: Detailed description of water quality issues in the Dandenong catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>Forested areas are not known to be contributing major pollution problems.</p>
<p>Rural/agricultural</p> <p>Horticulture contributes high levels of nitrogen, phosphorus and TSS to the Upper Dandenong Creek, Boggy and Kananook creeks.</p> <p>Grazing, piggeries and manure-based horticulture are believed to be contributing to <i>E. coli</i> levels in the Upper Dandenong Creek catchment and Eumemmerring Creek. In particular, market gardens within the Eumemmerring Creek catchment are considered to be a major source of nutrients.</p>
<p>Urban</p> <p>Urban land use and industrial discharge result in highly elevated nutrient levels in Patterson River and Lower Eumemmerring Creek (particularly phosphorus). Industrial zones are located in the South Eastern Growth Corridor and also Kilsyth, Bayswater, Ferntree Gully, and areas such as Clayton and Springvale. Urban runoff from Narre Warren North, and particularly unsewered areas, contributes to high nutrient concentrations near Lysterfield Lake.</p> <p>Phosphorus concentrations are high in the Upper Dandenong catchment, due to stormwater inputs. Bungalook Creek at Montrose is a hotspot for both nitrogen and phosphorus inputs, with evidence of septic inputs. There are quite a few pockets of unsewered properties in the upper tributaries, such as Blind Creek and Bungalook Creek.</p> <p>Elevated nutrient concentrations in Lower Eumemmerring Creek are of particular concern, with major contributions of phosphorus and nitrogen. While some of this is from agricultural inputs, there are also substantial diffuse sources from urban stormwater, as a result of industry and intense residential development (particularly upstream of Hallam Main Drain).</p> <p>Urban areas in the Upper Dandenong Creek catchment have low DO concentrations. For example, Bungalook Creek at Montrose is believed to be subject to sewer leakage. Faecal contamination is also detected at Heatherton Road Drain.</p> <p>Urbanisation is resulting in high levels of TSS and turbidity, both through runoff from impervious surfaces and flow-induced stream erosion.</p> <p>STPs were causing elevated nitrogen, phosphorus and turbidity in Upper Dandenong Creek (however, this was decommissioned in 1996), Lower Dandenong Creek and Patterson River. Turbidity was ranked as poor at all sites on Dandenong and Eumemmerring Creeks in the 1996 Streamwatch evaluation.</p> <p>There are elevated levels of <i>E. coli</i> in Dandenong Creek, Patterson River and Lower Eumemmerring Creek. Levels are reasonably high in the upper catchment, due to urban inputs. Urban sources include unsewered townships and STPs. Industrial areas are also known to be contributing <i>E. coli</i> to beaches along the Port Phillip coastline.</p> <p>Elevated levels of copper, lead and zinc in sediments within Kananook Creek come from industrial sources. Patterson River and Mordialloc Creek are believed to contribute 35-75% of the catchment's metal loads into Port Phillip Bay. Metal concentrations are generally low in the upper tributaries of Dandenong Creek, but increase with the level of stormwater inputs from urban areas. Zinc levels were highest of all metals, in the upper tributaries. Copper levels are also high in the upper tributaries, due to a combination of industrial discharges, but also possibly from septic (water pipes).</p> <p>Dandenong catchment has a very high density of landfills, with many rated as having a high hazard rating (and some rated as extreme).</p> <p>A study of upland small streams in the Dandenong Ranges (in both the Dandenong and Yarra catchments) showed that loads of phosphorus and TSS were a result of directly connected impervious areas. Nitrogen loads were due to septic tank density.</p> <p>Expert interviews (e.g. Rooney, Pettigrove, Coleman, Argent) suggested that Lower Dandenong Creek and Mordialloc Creek are two of the worst contributors to water quality pollution within the catchment.</p>

Appendix 6: Detailed assessment of current condition for waterways

Western Port catchment

An assessment of water quality data at 21 sites across the Western Port catchment was undertaken for the period 2001-2005 (Table A6.10) to assess attainment of SEPP objectives (SKM, 2007a). This assessment found that SEPP objectives for chromium, copper, nitrogen, lead and zinc were rarely met. Attainment of objectives for phosphorus and dissolved oxygen was also poor, with only one site frequently meeting objectives and all others rarely meeting objectives. Attainment of electrical conductivity and *E. coli* objectives was also low. Detailed information on the water quality of the Western Port catchment can be found in Table A6.11

Table A6.10: Percentage of monitoring sites (2001-2005) rarely, occasionally and frequently meeting SEPP objectives for selected water quality variables (Source: SKM 2007a) in the Western Port catchment

Variable	Western Port compliance		
	Rare (0-20% compliance, 0-1 out of 5 years)	Occasional (40-60% compliance, 2-3 out of 5 years)	Frequent (80-100% compliance, 4-5 out of 5 years)
DO	95%	0%	5%
EC	71%	19%	10%
pH	14%	67%	19%
Turbidity	45%	40%	15%
Phosphorus	95%	0%	5%
Nitrogen	100%	0%	0%
<i>E. coli</i>	65%	25%	10%
Arsenic	35%	10%	55%
Cadmium	45%	5%	50%
Chromium	100%	0%	0%
Copper	100%	0%	0%
Lead	100%	0%	0%
Nickel	15%	30%	55%
Zinc	100%	0%	0%

Table A6.11: Detailed description of water quality issues in the Western Port catchment (after Fletcher and Deletic, 2006)

Source
<p>Forest</p> <p>There are no identified major pollutant sources from forested areas in the Western Port catchment.</p>
<p>Rural/agricultural</p> <p>The Bass River has moderate water quality (with some areas in good condition), but very poor in the lower reaches. Erosion is contributing sediment loads to Western Port. High sediment loads are also coming from the Lang Lang River. Of particular concern are the agricultural drains of the former Koo Wee Rup Swamp, which deliver high levels of sediment, and efficiently transport pollutants from agricultural land use. Similar problems exist in the catchment of the Dalmore Outfalls, which are considered a risk to the health of Western Port. High sediment loads have also been recorded in the Lower Bunyip (very erosion prone), Bass and Lang Lang rivers, and Cardinia Creek (e.g. Deep Creek at Ballarto Road and Yallock Outfall at South Gippsland Hwy.)</p> <p>Of the waterway sources of sediment to Western Port, subsoil erosion from gullies and channel banks is the primary source of fine (<4µm) sediment, but with surface erosion being the greatest case in the Bass River catchment (accounting for 21% of deposited sediment). Direct stock access is a widespread problem throughout the catchment, and is accentuating erosion and sediment mobilisation.</p> <p>Water quality is moderate in the Tarago River – primarily because of the effects of agricultural land use on the Tarago River East Branch, including some dairying. High groundwater nutrient levels contribute to high base flow nutrient concentrations in the Bunyip and Tarago catchments.</p> <p>Unsealed roads are known to be a source of sediment into waterways within the catchment, both in rural and urban areas, although the recent tracer studies suggests it makes up only 2% of inputs to the North Bay, despite earlier reports stating that it was a substantial source. It is likely that at certain places, roads do provide a substantial localised source of sediment.</p> <p>Poor agricultural practices (direct access to streams, over-use of fertilisers) are contributing sediment, nutrient and faecal loads to rural areas within the Western Port catchment, and the artificial drainage of these areas has increased the efficiency of pollution transport to receiving waters. For example, the median concentration of TN in the Lang Lang River at South Gippsland Hwy is 2.33 mg/L, and concentrations in the Poowong area have been shown to exceed SEPP guidelines by 29 times (due to surface erosion, dairy effluent, and septic tanks). Intensive dairy contributes organic pollution in the Lang Lang and Bass Rivers.</p> <p>Watsons Creek (Mornington Peninsula) has high levels of nutrients (particularly N), resulting in part from market gardens (and growing urban influences).</p> <p>Increases in the amount of intensive horticulture (primarily viticulture) within the Mornington Peninsula area (South East Mornington Peninsula Waterways) represents an increasing threat to nutrient and sediment loads.</p> <p>Water quality in the Yallock Outfall is very poor, with elevated turbidity, TSS, N and P. High levels of nutrients appear to be coming from the agricultural drains that contribute to these natural waterways, along with the Drouin South STP. Market gardens and poorly functioning septic tanks are also likely contributors. Particular sources include Number Four Drain, Scanlons Drain, Number Seven Drain and Murray Road Drain.</p>
<p>Urban</p> <p>Urban stormwater is a known pollution source in the catchment. In particular, small townships such as Koo Wee Rup, Bayles, and Drouin South all contribute to very poor water quality in the Lower Bunyip River. Urban development poses a potential source of pollution, particularly in the areas around Pakenham, Cranbourne, Upper Beaconsfield and Nar Nar Goon. Similarly, urban development within the Mornington Peninsula, Cardinia, Toomuc, Deep and Ararat Creek catchments is an increasing source of nutrients, sediments and toxicants. Urban development on Phillip Island is a source of sediment.</p> <p>Low density urban (rural-residential) land use within the North-Eastern Peninsula (Watsons, Olivers, Kings and Warringine creeks); stormwater is a critical and emerging source of pollution in these catchments.</p> <p><i>E. coli</i> levels of as high as 300 000 organisms/100 mL have been recorded around Somers/Balnarring during summer periods.</p> <p>Septic tanks, in low-density urban areas, are known to be a source of nutrients and faecal indicators to surface waters, and contribute to groundwater nutrient levels (which contributes to elevated base flow concentrations of nutrients). This is a particular problem in the sandy soil areas, including Nepean Peninsula, Flinders, Shoreham, Point Leo, Somers, Warneet, Cannon Creek, Tyabb, Blind Bight and Tooradin.</p> <p>Watsons Creek (Mornington Peninsula) has high levels of nutrients (particularly N), resulting in part from local industrial wastewater and pesticides.</p> <p>There are a large number of poorly constructed landfill sites within the catchment. These generally do not have liners, and were constructed on old extraction sites, often with direct connections to groundwater. Many were built in gullies or across waterways, accentuating the risk. Many of these are located right near the coast, whilst several are located on Mornington Peninsula. Pollutant seepage from the old Mornington Shire and Cranbourne tips appear to be a source of oxygen-demand and other toxicants.</p> <p>Urban development and construction of major roads have been ranked as major sources of pollutant threat within the catchment. It also appears that urban development is leading to some increasing trends in pollution in recent years.</p> <p>There are several STPs having a significant effect. Koo Wee Rup STP contributes to the Yallock Creek, while Drouin STP discharges high nitrogen (particularly ammonia) and phosphorus levels into King Parrot Creek. The STPs also cause elevated turbidity levels. Under very wet conditions, Longwarry STP may discharge. Pakenham STP (due to close in 2008) has major nutrient inputs.</p> <p>Industrial sources are centred on Hastings (major metal and petrochemical industry), and are likely to be affecting Olivers and Watsons Creeks. Industrial zones around Pakenham are growing, as are those around Drouin and the Mornington Peninsula. Industrial land use within unsewered areas (e.g. Tooradin, Rye and Sorrento) are of particular concern. Industrial discharges are also present in the Bayswater area.</p> <p>Recent monitoring has revealed that Cardinia and Toomuc creeks have reasonable water quality upstream of Princes Highway, but this degrades to poor, downstream of the Princes Highway. Gum Scrub and Deep creeks have poor water quality, with high levels of TSS, turbidity and nutrients. DO is also low at times.</p>

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