Melbourne Water

Greenvale Reservoir Catchment: Drinking Water Quality Risk Management Plan

SUMMARY REPORT:

MAINTAINING AND IMPROVING THE PROTECTION OF GREENVALE RESERVOIR

- 6th March 2008

Melbourne Water

Contents

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Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
1	12/12/07	D Deere	M Van Donkelaar		
2	16/12/07	D Deere	M Van Donkelaar		
3	3/3/08	D Deere	M Van Donkelaar		
4	6/3/08	N Crosbie, G Lattouf	Rob Considine	6/3/08	

Distribution of copies

Revision	Copy no	Quantity	Issued to
1	NA	electronic	M Van Donkelaar, R Considine Melbourne Water
2	NA	electronic	M Van Donkelaar, R Considine Melbourne Water
3	NA	electronic	M Van Donkelaar, R Considine Melbourne Water
4	NA	electronic	Stakeholders

Printed:	06 March 2008
Last saved:	06/03/2008 16:04
File name:	Greenvale Reservoir Risk Management Plan V3.doc
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Name of organisation:	Melbourne Water
Name of project:	Greenvale Reservoir: Drinking Water Quality Risk Management Plan
Name of document:	Summary report: maintaining and improving the protection of Greenvale Reservoir
Document version:	V4

Executive Summary

Melbourne enjoys safe and acceptable drinking water due to a risk management approach involving multiple barrier protection and appropriate treatment. Planning for drinking water quality requires consideration of strategic improvement drivers and challenges for the water supply system to be sustainable.

Development, and urban development in particular, are not compatible with good source water protection. Although most of Melbourne's water supply catchments are well-protected from the detrimental effects of development, its inner open storage reservoirs are increasingly becoming surrounded by encroaching urban development. Greenvale Reservoir in particular is now surrounded by the urban growth corridor for north western Melbourne.

This report summarises the risk assessment and risk management planning undertaken as part of conforming to the requirements for Water Storage Managers in Victoria under the *Safe Drinking Water Act 2003* (SDWA) and *Safe Drinking Water Regulations 2005* (SDWR). The document sets out the nature of hazardous substances that might contaminate the Greenvale raw water storage reservoir were urban development to expand unchecked within its catchment. The document then sets out the preventative measures required to control hazards to reduce risks to within tolerable levels, defined as being at, or below, current levels of risk.

The document summarises the work undertaken by a representative group of stakeholders, including officers of the Department of Human Services, the Melbourne water businesses, Hume City Council, developers and various technical services providers. Their involvement has been captured through a series of workshops and the review of written material circulated to all parties. A consensus building approach was used throughout the process that relates specifically to Greenvale Reservoir, and that may have implications for other sites.

The following key issues emerged:

- Urban development is an established source of contaminants that are significantly hazardous to health and drinking water quality. Such development cannot take place in drinking water catchments unless highly reliable protection is implemented;
- The net effect of any development in a water supply catchment needs to be to maintain, or reduce, the level of risk – risks should not be allowed to incrementally increase;
- All parties, including regulators, government agencies and developers, agreed on a balanced outcome for drinking water quality risk management in the Greenvale Reservoir catchment that was considered to represent a net reduction in water quality risk whilst allowing development to proceed;
- The appropriate parties will play key roles in managing particular risks – e.g. Melbourne Water (the Greenvale water storage manager, as defined under the Safe Drinking Water Act 2003) will manage dam structures such as bund walls and Yarra Valley Water (the sewerage license holder, as is defined in the Water Industry Act 1994) will manage sewerage systems and recycled water assets; and
- Verification activities form a key part of the risk management plan and ongoing verification is required to demonstrate ongoing compliance.

1. System Description and Context

1.1. Stakeholders

The following are the key stakeholders that are considered to have an active role in giving effect to this Risk Management Plan (RMP):

- The Greenvale water storage manager for overall coordination of the RMP and its stakeholders, and for management of the reservoir, bund walls, catch drains and reservoir water quality testing and to assess the impact of development on Greenvale Reservoir against water quality risk management obligations such as the *Safe Drinking Water Act 2003*;
- The sewerage license holder for supply of sewerage services, recycled water supply and for treated water quality testing and to notify the Greenvale water storage manager if there is any possibility of sewage or recycled water contamination of the Greenvale Reservoir;
- Department of Human Services for oversight of the drinking water quality risk management plans of the water utilities;
- Hume City Council for oversight of development in the Greenvale catchment and to assist in any emergency response if required;
- The Aitken Hill Conference and Events Venue to manage their facility so as to protect the Greenvale Reservoir and to notify the Greenvale water storage manager if they become aware of any possibility of contamination;
- Developers, such as Peet Ltd, to maintain their developments within criteria that assure the protection of Greenvale Reservoir water quality and to notify the Greenvale water storage manager if they become aware of any possibility of contamination; and
- Response agencies, such as the Emergency Services and VicRoads, to notify the Greenvale water storage manager in the event of suspected or actual contamination incidents.

1.2. Biophysical system and context

The Greenvale Reservoir is located near Craigieburn in the north west of greater Melbourne (Figure 1-1). In the north west of the catchment is the 69 Ha Aitken Hill Conference and Events Venue (AHCEV), on Dunhelen Lane, servicing up to 350 delegates with 124 residential rooms housing up to 248 guests (Figure 1-2). A sewered urban residential development is in the north east of the catchment and includes residential properties (Figure 1-2). AHCEV has an on-site sewage treatment and recycling system and captures treated sewage and stormwater in lagoons on site for irrigation, and which drains to the north west of the reservoir (Figure 1-3). It is proposed to add a vehicle demonstration track and day spa to the AHCEV, noting that these additions are subject to precinct structure planning and subsequent planning scheme amendment processes (Figure 1-4). In the north east of the catchment, Peet Ltd, that developed Greenvale Rise, intend to develop Greenvale Lakes (Figure 1-5). A new E14 highway is to be built within the catchment along with a number of other developments (Figure 1-5 and Figure 1-6). The remainder of the catchment is largely low-grade grazing land, with the reservoir protected by a 1/100 AEP catch drain managed by the Greenvale water storage manager.

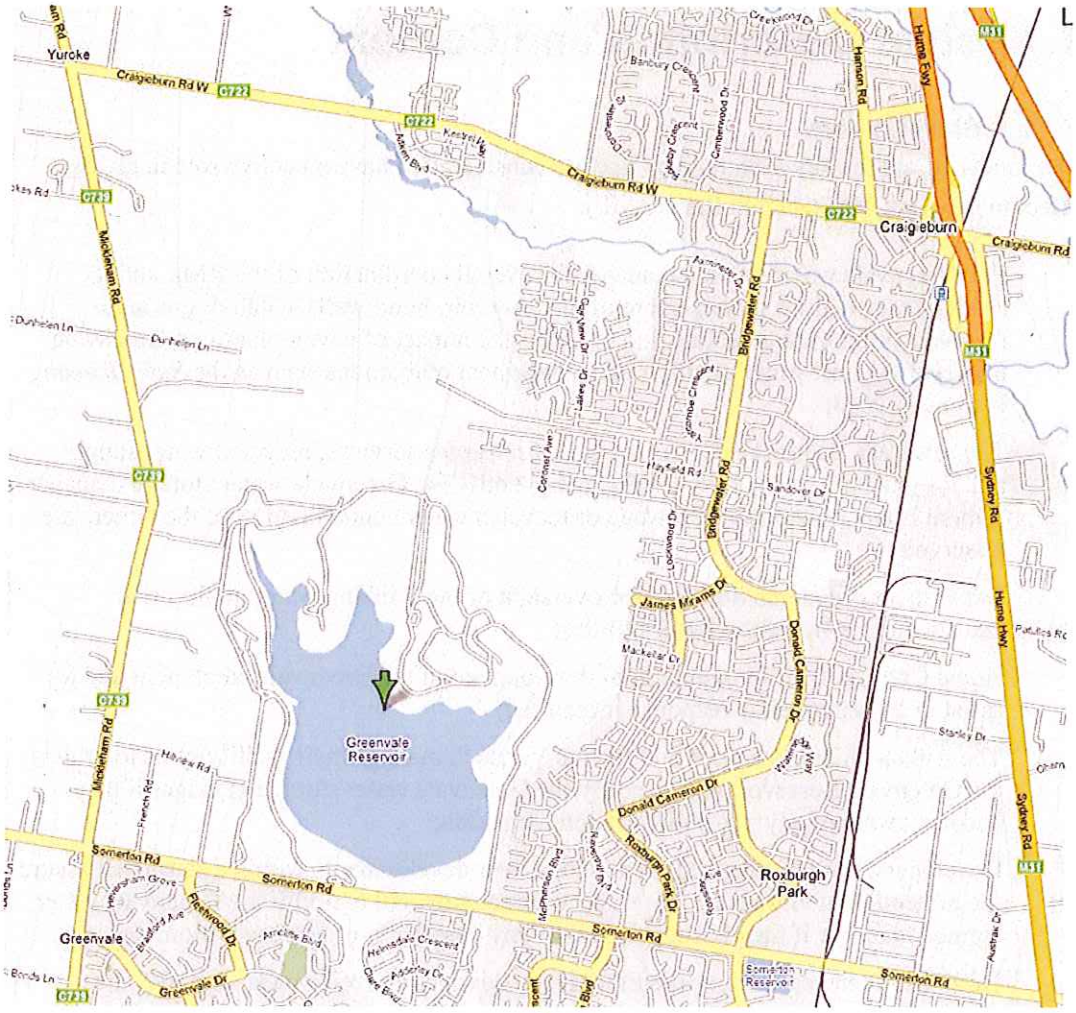
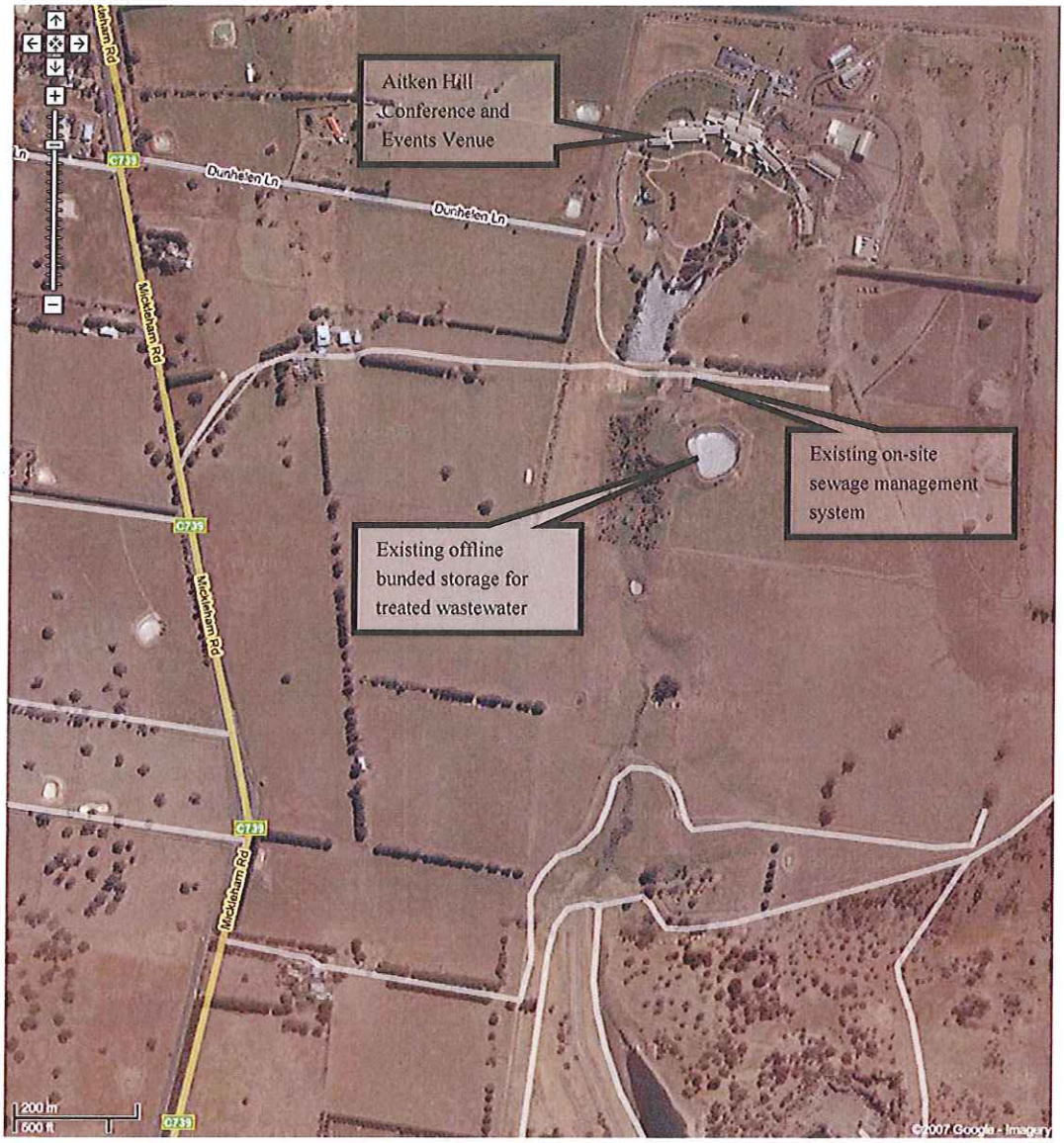
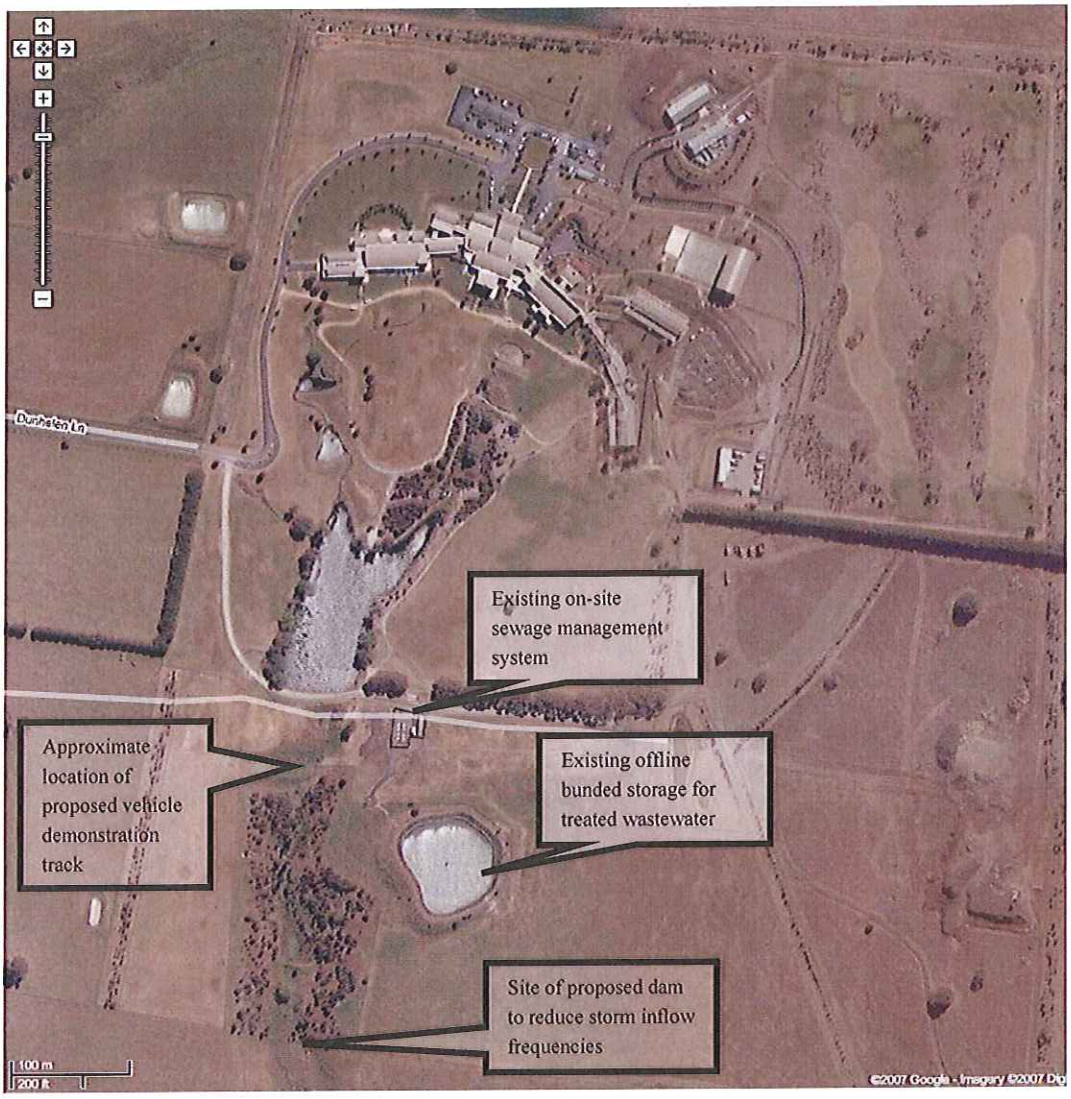


Figure 1-1. Location of the Greenvale Reservoir (image © Google maps 2007)

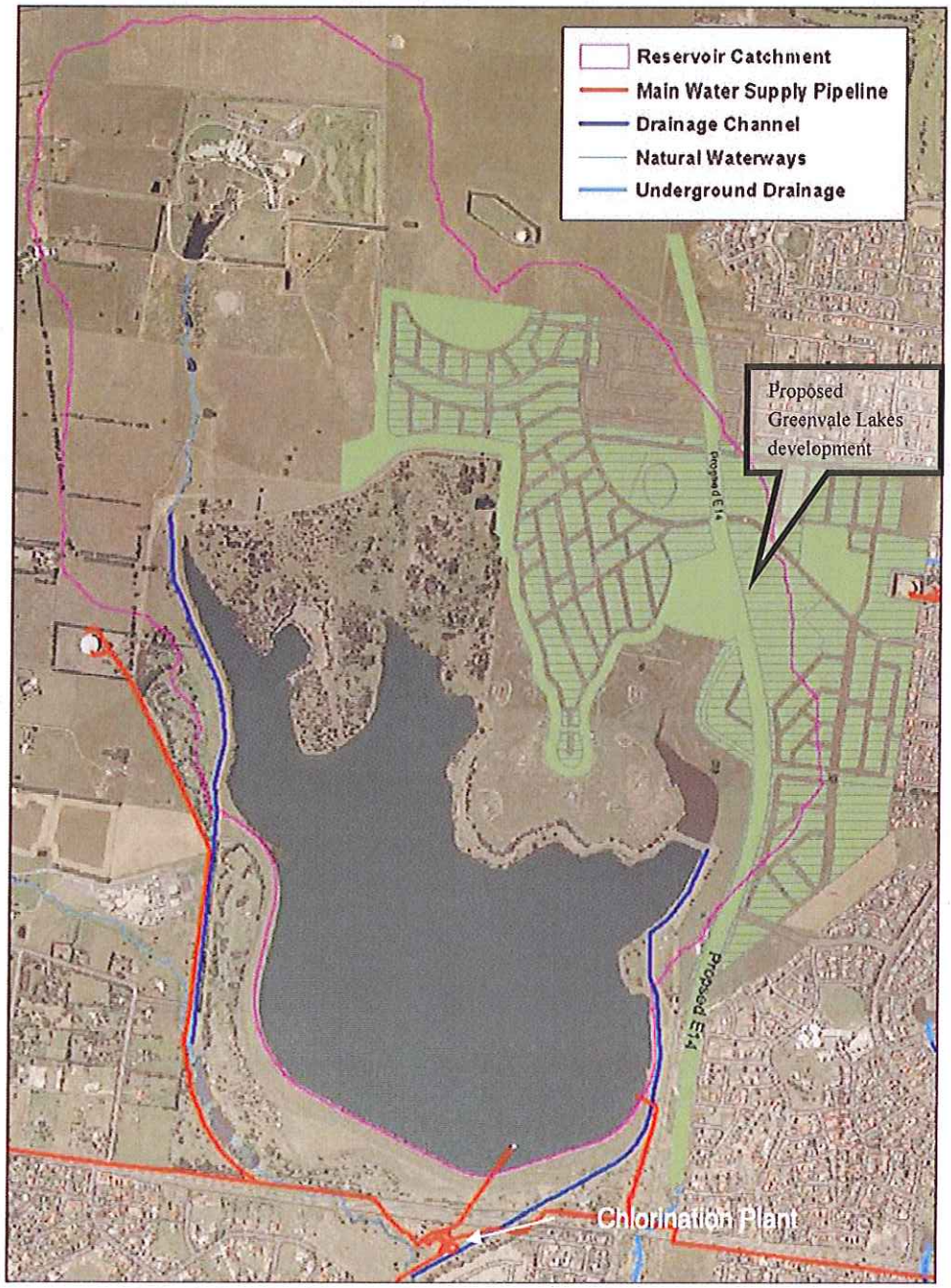
- **Figure 1-2. Satellite image of the Greenvale Reservoir (image © Google maps 2007)**



- **Figure 1-3. Satellite image of AHCEV draining to the reservoir north west arm (image © Google maps 2007)**



- **Figure 1-4. Satellite image of AHCEV showing the areas to be developed (image © Google maps 2007)**



- Figure 1-5. Illustration of the proposed Greenvale Lakes Development

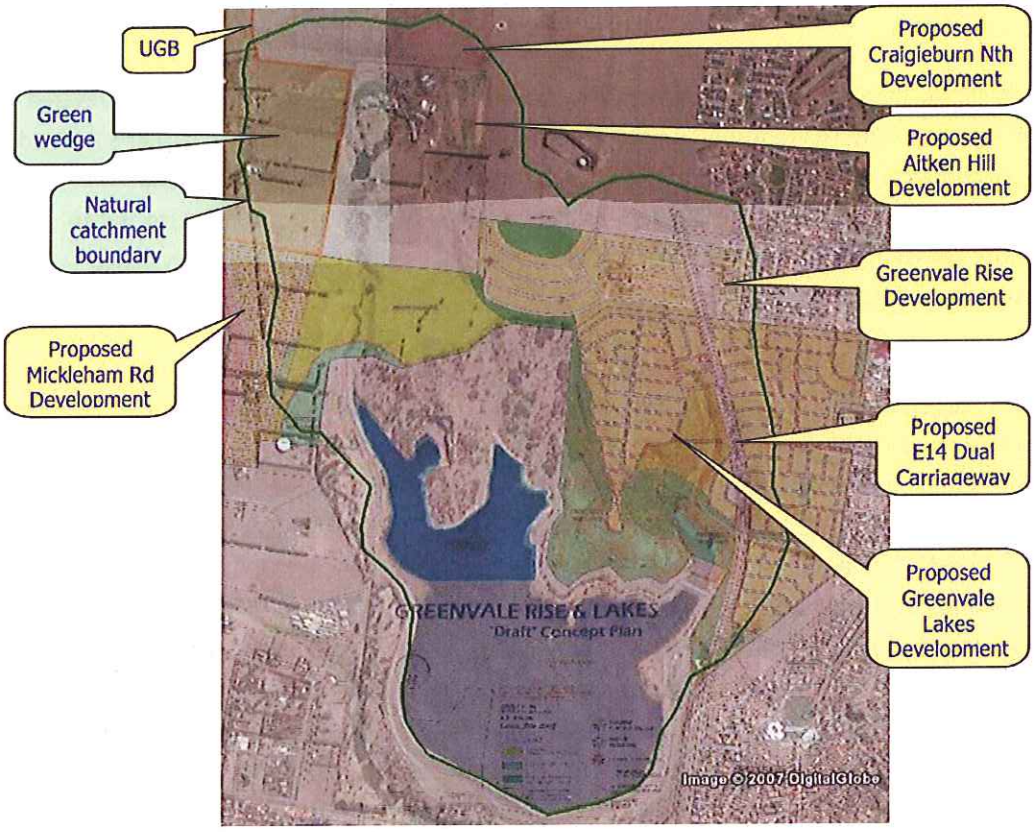


Figure 1-6. Image of the Greenvale Reservoir catchment illustrating the existing and proposed developments in the area (image © Melbourne Water 2007). UGB = Urban Growth Boundary.

1.3. Historical context

The Greenvale water storage manager has identified that the Greenvale Reservoir was constructed in the early 1970s to provide more reliable water supplies for Melbourne's north and west. The reservoir was designed to be supplied with water harvested from Melbourne's forested catchments, so there is limited downstream treatment (chlorination only) before direct supply to customers. The catchment was largely undeveloped arid farming land (apart from a largely unused Department of Defence site). The catchment was protected from development by a pre-1998 planning scheme coupled with provisions under the *Melbourne Metropolitan Board of Works Act*. A concrete/earthen drainage system was constructed to be capable of withstanding storms with an Annual Exeedance Probability (AEP) less than 1:100. Therefore, there is no intentional water harvesting from the catchment.

In the early 1990s, a significant conference centre was constructed in the catchment (AHCEV). Records of the planning permit decision for the conference centre indicate the drainage system around the reservoir was considered relevant to granting the permit. The

conference centre remains unsewered, and currently stores and irrigates treated sewage from a lagoon on-site.

In 1998, the planning scheme applicable to the Greenvale Reservoir catchment was revised and land was noted as farming/commonwealth land. In the late 1990s, one farmer sold land to a developer, Peet Ltd. The Greenvale water storage manager initially opposed development of the land for urban use, primarily on the basis of risks to drinking water quality caused by overland flow of stormwater, as well as sewerage emergency relief structures and pump stations.

Planning Panels Victoria subsequently recommended against development to protect Greenvale Reservoir. A new Overlay was created (DPO11) which incorporates the Greenvale water storage manager's conditions for development. The development was subsequently revised (called Greenvale Rise) to address the Greenvale water storage manager's concerns and Council, Peet Ltd. and the Greenvale water storage manager then entered an agreement on title (S173) to a revised development (smaller, gravity sewer, 1:1,000,000 AEP bund) following a risk assessment in 2002. The Greenvale water storage manager also notified the Department of Sustainability and Environment that the development principles identified for Greenvale Rise were applicable to the entire Greenvale catchment. Economic, Social and Environmental Values were specifically associated with the specifically mentioned Greenvale Reservoir in Melbourne 2030 (Department of Infrastructure, 2002, Department of Sustainability and Environment, 2005).

Today, the current Greenvale catchment:

- Contains a mix of urban residential, farming, tourist accommodation, public and unzoned land;
- Is within the Urban Growth Boundary (UGB) and growth corridor;
- The majority would normally be expected to be urbanised by 2030; and
- The Greenvale water storage manager is not currently a consent authority but is notified of new subdivisions and is likely to refer development proposals to water quality specialists within the Greenvale water storage manager.

It is known to the Greenvale water storage manager that landholders, Council and various state government departments hold development aspirations for much of the land in the Greenvale Reservoir catchment. The development potential of the catchment rests on whether the relevant water authorities and regulators can be satisfied that development can proceed and avoid an escalation of risks to drinking water quality.

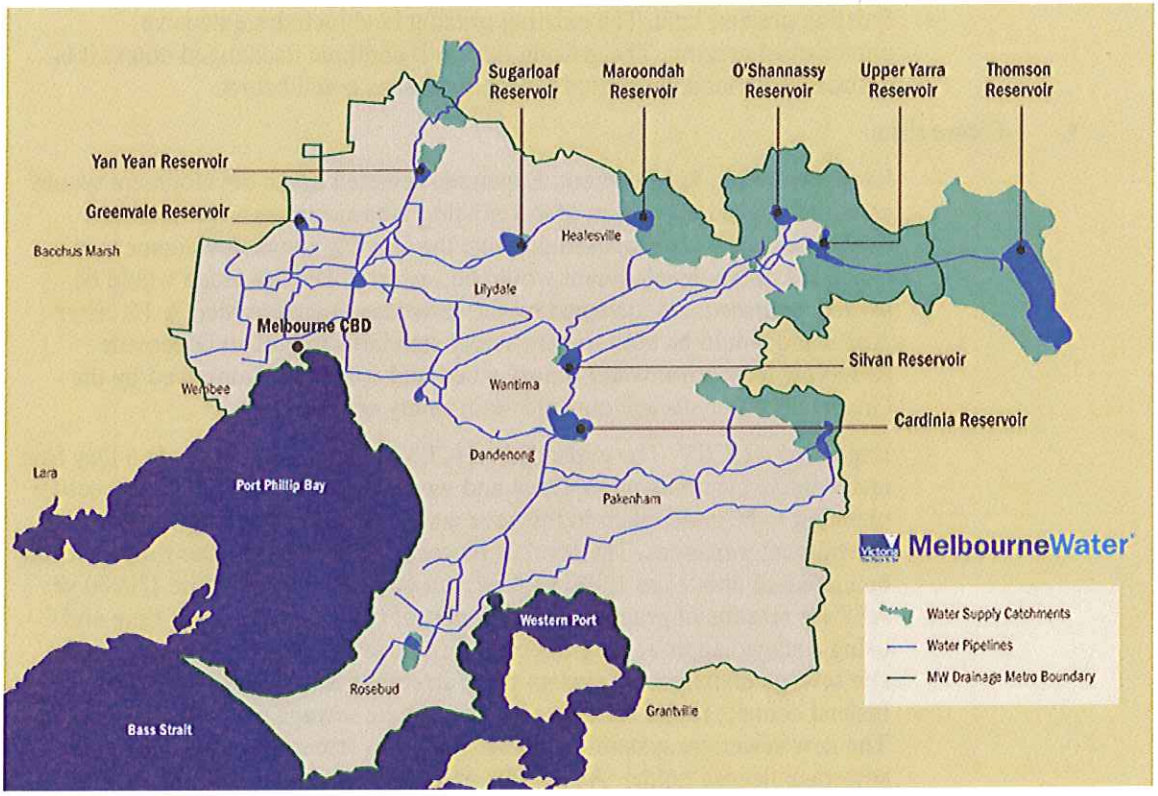
The Greenvale water storage manager has developed this RMP to:

- Coordinate the management of the likely cumulative impacts of development to achieve net beneficial outcomes;
- Avoid piecemeal decision making;
- Improve certainty for the Greenvale water storage manager (regarding risk increment over time) as well as planning authorities and landholders; and

- Enable consistent and transparent application of the the Greenvale water storage manager Public Health/Risk Management policies to complex issues.

1.4. Formal and regulatory context

The Greenvale water storage manager has an extensive set of reservoirs and catchments and would be expected to adopt a consistent approach to protecting these assets (Figure 1-7). Under the Victoria *Safe Drinking Water Act 2003* (SDWA) and *Safe Drinking Water Regulation 2005* (SDWR) the Greenvale water storage manager is required to complete a Risk Management Plan (RMP) as a Water Storage Manager. In outline, the RMP must set out the possible sources of risk of drinking water contamination, identify how to adequately control those risks and verify that controls are implemented in practice.



- **Figure 1-7. Melbourne Water context**

To meet the SDWR requirements, a workshop was held to provide an open forum for discussing the nature of the system, considering both the current system and future proposals. The workshop involved developers, regulators and water utilities who constituted the Risk Assessment Team (as shown in Section A.2).

Both current existing developments, and future developments, were considered in the workshops and included the following:

- Current risks:

- Existing urban development. The existing sewered urban development includes urban residential lots, some of which are currently being constructed. Any stormwater runoff would be diverted and kept out of Greenvale Reservoir in storm events that didn't overwhelm the 1/100 yr annual exeedance probability (AEP) catch drain, but could potentially influence the reservoir in the event of very large storms.
- Existing Aitken Hill Conference and Events Venue (AHCEV). AHCEV sits in a Farming Zone (FZ1). At the time of writing, there is a planning scheme amendment request with Council to rezone the land as a Special Use Zone. The site currently includes an on-site sewage management system and a stormwater drainage system. Any stormwater runoff would be diverted and kept out of Greenvale Reservoir in storm events that didn't overwhelm the 1/100 yr AEP catch drain, but could potentially influence the reservoir in the event of very large storms. The centre includes accommodation, conference and car parking facilities.
- Existing grazing land. The existing grazing land includes extensive unimproved grazing. The grazing land will continue unchanged unless it is replaced with land developed for other uses, as noted below.

- Future risks:
  - Expanded urban development. Expanded sewered urban development would essentially be an expansion of the existing urban areas to cover a more extensive area. It is proposed that like the existing urban development, the expanded urban development would be sewered. The sewerage would be owned, overseen and managed by the sewerage license holder. A 1/1 m•yr AEP bund would be built to dam safety standards to protect Greenvale Reservoir from stormwater runoff. The bund would be maintained by the Greenvale water storage manager dam safety engineers.
  - Expanded AHCEV. The expanded AHCEV is proposed to include a Day Spa and Vehicle Demonstration Track and would be subject to precinct structure planning to be undertaken in this area and subsequent planning scheme amendment processes. The level of protection from stormwater runoff would be increased above the 1/100 yr AEP, but probably not up to the 1/1000 yr AEP for reasons of practicability. As part of the expansion, over time and using a staged approach, a preferred option would be to close down the on-site sewage management system that currently treats recycled water and instead connect to the sewerage system to take sewage out of the catchment. The new sewerage system would be owned, overseen and managed by the sewerage license holder. As a trade off for the loss of the current on-site sewage treatment and irrigation system, that has a current recycled water class probably equivalent to B or C (EPA Victoria), a new recycled water supply would be provided from the sewerage license holder system. Initially the recycled water might be at Class B and then after a time Class A. Class A recycled water was considered to represent a lowered risk relative to the current situation since currently irrigation water was probably not at Class A. Class B would represent an approximately equivalent risk to the current situation. During the risk assessment, it was assumed that the site was sewered and that Class A recycled water was being used for irrigation – the longer-term future scenario. If the site were not sewered and on-site sewage treatment were to continue, the risk assessment would need to be repeated.

There may appear to be an anomaly between the runoff protection proposed for the urban residential development (1/1 m•yr AEP) and the AHCEV (between 1/100 and 1/1000 yr

AEP). However, it is important to note that the AHCEV is a special case since it is a single major institutional entity that will be subjected to institutional risk management. Polluting activities are likely to be more readily controlled and more easily audited and managed. In that sense, AHCEV contrasts with the urban residential situation where extensive polluting activities are more likely to occur and more difficult to control, such as overuse of biocides, fertilizers and other sources of contaminated urban runoff. There is no guarantee that the AHCEV site will in practice be well-managed in the long-term, but it is somewhat simpler to provide oversight of this one entity than numerous smaller ones. Verification activities by the Greenvale water storage manager can help monitor these controls at the AHCEV. Should the AHCEV site be converted to a medium or high-density residential or industrial development similar to the urban residential land considered in other parts of the Greenvale catchment, the 1/1 m•yr AEP control requirements would logically apply.

At the time of writing, the timing of the staged implementation of recycled water of particular classes at AHCEV, and the funding and governance arrangements, have yet to be clarified. Furthermore, the timing and funding arrangements for any AHCEV connection to sewer have yet to be clarified. These issues are discussed further in Appendix B.

2. Risk Assessment

2.1. Approach

To conform with SDWA and SDWR, significant risks must be identified. In this process, risks were assessed at a workshop using a blind-voting peer jury system according to the type of likelihood and consequence risk ranking described in the handbook supporting *AS/NZS 4360:2004 Risk Management*. The approach is identical to that used by the sewerage license holder for its water quality and recycled water risk assessment projects. One change made was that the scoring metrics were varied from those normally used by the sewerage license holder and a tailored set of scoring metrics was applied (as shown in A.1). A multi-discipline Risk Assessment Team (as shown in A.1) with expertise in public health, water quality risk assessment, water microbiology, chemistry, limnology, dam safety and sanitary and water engineering completed the assessment using an electronic voting system. Each participant was able to freely discuss their understanding of the risks and once all participants were ready to do so, each person pressed a voting button to electronically score the risks.

Two participants could not remain for the whole day resulting in two of the remaining participants getting two votes each – the workshop facilitator (Dan Deere) and the Department of Human Services representative (Julie Eichner) filled in and operated the voting systems to provide the extra votes. Other than that, each person present had one vote throughout the workshop. Each risk category was assessed up to four times to reflect different situations. Specifically, the following scenarios were considered when assessing risks:

- Current situation (current risks): risks as they currently stand at Greenvale Reservoir, that is, protected by a 1/100 year annual exeedance probability (AEP) catch drain;
- Following development with no special preventive measures (maximum risk): risks if the currently proposed developments go ahead and the preventive measures remain as a 1/100 yr AEP catch drain and only conventional stormwater and sewerage systems are implemented;
- Following development with best practice preventive measures (residual risk): preventive measures to include a 1/1 m•yr AEP bund maintained to dam safety standards by the Greenvale water storage manager for stormwater retention with a fully sewered development with sewerage maintained by the sewerage license holder, and subject to audit during installation and ongoing verification of preventive measures [not considering the proposed expanded AHCEV development]; and
- As per the above bullet point but also considering the proposed expanded AHCEV development controlled to a best practicable level of somewhere between 1/100 and 1/1000 AEP stormwater bund and including becoming fully sewered with sewerage assets maintained by the sewerage license holder, Class A recycled water supplied by the sewerage license holder, and being subject to audit during installation and ongoing verification of preventive measures.

The risk of bund failure was not scored because it was considered so unlikely, i.e. no more likely than failure of the Greenvale Dam itself. Such an event would be a major disaster and outside the scope of a conventional drinking water risk assessment process. Responses to major disasters are handled at the regional level by state and local agencies.

2.2. Results of risk assessment

The raw results of the risk assessment, as generated during the workshop, are given in Appendix C. A simplified rolled up synthesis of these risks is given in Table 1. Each risk category (from 1 to 17) was scored either three of four times. If the risk was considered to differ when the presence of an expanded AHCEV was taken into account, then the risk was scored four times. If the risk was considered not to differ when the presence of an expanded AHCEV was taken into account, then the risk was scored only three times.

The risk scoring system was not foolproof. From time to time risks scores appeared anomalous with one or more persons appearing to score at the wrong end of the scale. For example, on some occasions all but one person scored five and the remaining person scored 1, suggesting an error in scoring. Nonetheless, the computer system summarised results to produce average scores that help to smooth out these effects. The process provides a useful means of gathering an anonymous consensus from the group. On the other hand, small differences in risk score may not reflect true differences in risk perception but might arise by chance. Therefore, risk scores were considered to be significant from one another only if the final risk scores differed by greater than one unit, on the scale from one to 25. The value of one unit was chosen as a significant value for two reasons. Firstly, a difference of one risk score unit could only have arisen by error if more than two erroneous risk scores were entered and so was unlikely to be a result of erroneous scoring. Secondly, one unit represents approximately a 5% difference within the dynamic range of the scoring system. Risks that increased by ≥ 1 unit from the baseline are shown in bold in Appendix C.

In synthesising and summarising these results, several important conclusions emerge. If expanded development were to take place and only be controlled to the extent that development had been controlled in the past (maximum risk), it was considered that there would be increased risk to Greenvale Reservoir water quality. Ten out of the 17 risk categories were scored significantly (≥ 1 unit) higher for the expanded development without special preventive measures than the existing situation. If expanded development were to take place but be controlled with the proposed enhanced mitigation measures (residual risk), it was considered that there would be equivalent or reduced risks than at present. None of the 17 risk categories were scored significantly (≥ 1 unit) higher than the existing situation for the expanded development with the special preventive measures. Importantly, the preventive measures relating to the future expanded developments would also capture and enhance the protection of the reservoir from some of the existing developments – hence in some cases risks to the reservoir were considered to be reduced following the increased development. Finally, for the special case of the expanded AHCEV, one of the 17 risk categories was scored significantly (≥ 1 unit) higher for the expanded development than the existing situation. The risk scored significantly higher was that from Category 15 relating to increased organic runoff. The presence of a vehicle demonstration track could potentially lead to organic matter being discharged into the reservoir, e.g. from petroleum hydrocarbons. Special preventive measures for this type of contamination event are understood to be proposed if the development is to go ahead.

3. Risk Management Plan

To conform with SDWA and SDWR significant risks must be adequately controlled. Most of the risks identified would be mitigated by a relatively small number of broad preventive control measures. Therefore, rather than set out a risk-by-risk control approach, this RMP sets out controls for the broad categories of risk. The result is a 'rolled up' summary of 'synthesised' controls that should prove relatively simple to communicate and monitor. The RMP is summarised in Table 1. A number of important risk management principles are encapsulated in the RMP.

Risks are allocated to those best placed to manage them. During construction, for example, it is simpler for the developer to install sewerage and recycled water reticulation systems and stormwater controls. Therefore, installation of preventive measures is allocated to developers. Similarly, once installed, and the developer moves on, the institutional entities with special skills and authority to manage the sewerage, recycled water and dams move in to provide long-term maintenance of the assets. The Greenvale water storage manager is especially equipped to maintain dams and bund systems, whilst the sewerage license holder is especially equipped to manage and maintain sewerage systems and recycled water quality and reticulation. Furthermore, the sewerage license holder will take on responsibility for water recycling rather than leaving it to on-site entities. the sewerage license holder is especially equipped and skilled to undertake such services.

Risks are best managed by those that wear the adverse consequences should risks become impacts. An important benefit of the recommended strategy for control of risks in this situation is that the major preventive measures (sewers, catch drains and bunds) will be managed directly by those that will wear the consequences should the preventive controls fail. The sewerage license holder and the Greenvale water storage manager will directly wear major consequences should their water supply become contaminated. Therefore, these water utilities have an ongoing vested interest in maintaining the controls that protect water quality making it more likely that they can be relied upon to do so.

In general, identifiable institutions are better placed to manage risks than diffuse groups of individuals. For example, thousands of urban residents and small developments are unlikely to take individual accountability for their potentially polluting actions. If a pollution event were to arise, it would not be possible to hold any individual, or group of individuals to account. It is hard, if not impossible to check the controls that are in place at the household level. On the other hand, large, identifiable institutions have systems in place to manage a whole range of risks, including those to the environment. Such institutions can be directly held accountable for any failure to control risks and can be readily audited if required. As a result, the rigour of control for the diffuse source residential development is set at a higher standard (1/1 million•yr AEP containment) than that for the identifiable, intuitionally controlled point source AHCEV (1/100 to 1/1000 AEP best practicable containment).

Provided the recommended risk management measures are installed, implemented, and maintained correctly, the level of risk to water quality should reduce over time representing a win-win outcome for the developers and the water suppliers.

Table 1. Rolled up synthesised summary of risks denoting the preventive measures required to control hazards and reduce risks to tolerable levels

Potential source of contamination	Hazardous event	Hazard(s)	Preventive measure(s) required to control hazards to reduce risks to at or below current and tolerable levels	Planning response for preventative measure(s)	Responsibility for management of preventive measure(s)
Unchecked increase in land use intensity.	Significant decline in runoff water quality over the long term.	Microbial Physical Chemical	The Greenvale water storage manager will be informed of significant development activities within the Greenvale catchment by being a statutory referral authority (as per Section 56 of the Planning and Environment Act, 1987).	Precinct structure plan 1 to enable an ESO for the whole catchment, making the Greenvale water storage manager† a statutory referral authority (as per Section 56 of the Planning and Environment Act 1987).	
Increased urban development (e.g. Greenvale Lakes)	Major storm leading to contamination of Greenvale reservoir from stormwater runoff.	Viral, bacterial and protozoan pathogens Organic matter Hazardous household waste Nutrients	<u>Bunds</u> Bunding to be around the entire outer extent of site. The lower section of E14 shall be in cut or partly in cut. Bunds to be designed, by a suitably qualified engineer, as dam walls (compliant with current ANCOLD guidelines) capable of withstanding force greater than the 1000000 year ARI water depth. Bunds to be protected by 1.5m wide concrete path; landscaping to deter access to the reservoir catchment. Bund fencing to meet requirements of Greenvale water storage manager†. Bunds to be maintained under Greenvale water storage manager† system. Educational signage to be constructed highlighting the function of bunds. Allowance to be made for all stormwater runoff input (for example, including Highlands development north of Greenvale Rise) when setting the required height of bunds. A bund must be a minimum of 600mm high and the top of a bund must also have a minimum of 600mm freeboard to the flood level associated with the 1000000 year ARI storm event. A bund must be designed and constructed such that any overtopping of the bund will not result in sub sequential undermining or breaching that will affect the short term or long term structural stability of the bund. It is essential that bunds be visible entities that can be easily identified and inspected by the Greenvale water storage manager†. Bunds must be located in public ownership ensuring the Greenvale water storage manager† has rights and access to the bund, or be located in a Greenvale water storage manager† reserve.	Preventative measures, described at left, to be incorporated as conditions in an agreement between the Greenvale water storage manager†, the land holder and the responsible authority; and/or planning controls.	

Potential source of contamination	Hazardous event	Hazard(s)	Preventive measure(s) required to control hazards to reduce risks to at or below current and tolerable levels	Planning response for preventative measure(s)	Responsibility for management of preventive measure(s)
			Sewer reticulation: all joints and pits to be sealed, and a number of additional construction control mechanisms to be included as conditions by the relevant sewerage license holder pursuant to the Water Industry Act 1994 Covenant on land along ridge of land shaping preventing excavation. No recreational and/or community ponds, wetlands, retarding basins, or artificial lakes with connection to the storm water system to be built.	Preventative measures, described at left, to be incorporated as conditions in an agreement between the Greenvale water storage manager†, the land holder and the responsible authority; and/or planning controls.	
Expanded Aitken Hill Convention and Events Venue	Contaminated stormwater runoff	Pathogens Organic matter Nutrients	An obligation to connect the property to reticulated sewerage services as soon as they become available at the property boundary; An obligation to decommission the on-site sewerage treatment plant as soon as a connection to a sewerage license holder sewerage service becomes available at the property boundary; An obligation to restrict surface run-off flowing off-site to a probability of 1:100; An obligation to control irrigation to prevent excess wetting which would exacerbate run-off when it rains and to prevent direct recycled water run-off into the dam; and If recycled water is used on site, an obligation to use Class A quality recycled water.	Preventative measures, described at left, to be incorporated as conditions in an agreement between the Greenvale water storage manager†, the land holder and the responsible authority; and/or planning controls.	
All sites	Major disaster, e.g. fire or air crash into dam or surrounding area	Various possible contaminants	Activate emergency response procedures and PERFORM		Greenvale water storage manager†
	Failure of disinfection system	Viral and bacterial pathogens (not some protozoan pathogens)	On-line monitored, reliable and maintained chlorine dosing systems backed up by protective responses to any chlorinator outages		Greenvale water storage manager†
	Contaminated stormwater runoff	Hazardous agricultural waste	Contaminated spill clean-up response		Greenvale water storage manager†

† The Greenvale water storage manager is defined under the Safe Drinking Water Act 2003, and at the time of writing, is Melbourne Water Corporation. The relevant sewerage license holder is defined in the Water Industry Act 1994, and at the time of writing, is Yarra Valley Water.

4. Verification

In order to conform with the SDWA and SDWR it is important that ongoing verification take place to demonstrate that risks are adequately controlled. Verification includes activities aimed at confirming the quality of water supplied as well as activities aimed at confirming the adequacy of preventive measures.

Preventive measures whose status cannot be verified are helpful, but cannot be relied upon to control risks and are only considered to be supporting. Only verifiable preventive measures can be relied upon. The collective effect of the verifiable control measure combinations must be sufficient to control hazards so as to reduce them to tolerable levels. Since all of the preventive measures identified were considered to be essential to reduce risks to tolerable levels, all must be made verifiable.

Some forms of verification serve as final confirmation of the total system. For example, drinking water quality testing serves as verification of the quality of water as supplied, which in turn represents the effect of all the processes that contribute to its quality. Importantly, verification of drinking water quality is only able to confirm that preventive measures were effective in the past, it cannot provide early warning of contamination. By definition, if contamination is detected during verification testing it is too late to protect consumers from that water because of the time lag between sampling and the reporting of, and response to, test results.

Other forms of verification serve to check that the RMP is being conformed with in practice with particular attention being paid to the proper operation of preventive measures. These verification actions include physical checking of assets and systems as well as auditing of the activities of persons and of process performance. Such verification is useful since failure to undertake actions relating to preventive measures can be detected early, hopefully early enough to take corrective action before water becomes contaminated. For example, if checks reveal that catch drains are not being maintained, rectification of the situation can take place, hopefully before catch drains actually block up and fail.

Table 2 sets out the proposed verification activities that are required to support and complete the RMP for the Greenvale Reservoir catchment if the proposed developments discussed in this document are to go ahead.

Table 2. Rolled up summary of verification activities

Activity group	Subordinate activities	Responsibility†	Frequency
Water testing	Raw water routine monitoring and analysis of results to look for trends and maintain an awareness of reservoir condition	Greenvale water storage manager	Weekly to monthly
	Raw water event monitoring to provide warning of contamination following major storm, such as 1/5 yr AEP, or other hazardous events	Greenvale water storage manager	Following events
	Routine drinking water quality monitoring to provide evidence of good treatment and system performance	Sewerage license holder	Daily to weekly in the distribution system
Utility auditing	Auditing of the actions of Greenvale water storage manager† against the SDWA and SDWR, to include within the scope this RMP and the management of the catch drain, chlorination plant and bund wall	Department of Human Services	Annually
	Auditing of the actions of the sewerage license holder as a sewage manager against its ISO 14001 Environmental Management System, to include within the scope this RMP and the management of the sewerage systems and recycled water systems	Sewerage license holder	Annually
Sanitary Inspection	External audit of stakeholders through physical and desktop inspection of the catchment and its preventive measures, including both at the institutional and field level, to check conformity with this RMP	Greenvale water storage manager (AHCEV, developers and Hume City Council to cooperate)	Triennially

† The Greenvale water storage manager is defined under the Safe Drinking Water Act 2003. The sewerage license holder is defined in the Water Industry Act 1994

5. Conclusion

This RMP sets out a consensus position for the management of drinking water quality risks in the Greenvale Reservoir catchment that evaluates the developments proposed in the foreseeable future.

The urban developments, as proposed, can expand into the Greenvale Reservoir catchment provided the preventive measures proposed to be in place in this RMP are properly designed, installed and maintained (Table 1), and provided ongoing verification, assessment and maintenance is institutionalised to provide for ongoing control of risks (Table 2).

Conversely, the urban developments, as proposed, cannot expand into the Greenvale Reservoir catchment if the preventive measures are not in place, or are not properly designed, installed and maintained, or if ongoing verification, assessment and maintenance is not institutionalised to provide for ongoing control of risks.

Appendix A Workshop record

A.1 15th November 2007

Agenda for Risk Assessment Workshop for Risk Management Plan for the Greenvale Reservoir Catchment

Details

Purpose: To undertake a peer judgement risk assessment for the Greenvale Reservoir Catchment to inform the development of a Risk Management Plan for the catchment.

Date: Thursday 15th November 2007.

Location: 1) Greenvale Reservoir meet at Greenvale Reservoir Park under the Melbourne Water Cairn. Melway reference B4.

2) Yarra Valley Water, Room B1, Lucknow St, Mitcham.

Time: 8:45 am at Greenvale site, 12:00 pm at YVW site, close 5:00 pm

Participants

Melbourne Water: Robert Considine (RC) [convenor], Marissa Van Donkelaar, Raffaela Crupi, Paul Pretto, Katherine Miller (tentative) Yarra Valley Water: Natalie Portlock, Simon Pearcehiggins, Asoka Jayaratne [AJ], Paul Curtis (tentative)	Hume City Council: Aaron Chiles (AC) (observer) DHS: David Sheehan apology, Julie Eichner present Ecos: Nick O'Connor (NO) [info capture] Water Futures: Dan Deere (DD) [facilitator]

Agenda

Time	Item
8:45 am	Arrive at site for site tour [RC]
12:15 pm	Lunch at Yarra Valley Water [AJ]
1:00 pm	Welcome and introductions [RC]
1:10 pm	Overview of the current and future situation in the catchment [DD, RC]
1:20 pm	Overview of risks arising from developments in catchments and quantitative risk assessment findings [NO]
1:30-4:45 pm Break ~3 pm	Risk assessment, judge each, one-by-one, up to 5' each [DD, AJ]: Likelihood? Consequence? Additional risks?
4:45 pm	Summary of outcomes and discussion of next steps [DD, RC]
5:00 pm	Close

Handouts to be provided on the day

- Risk Assessment Scoring Matrix to be used
- Copies of site plan(s) showing the physical context

- List of 'top 50' default risks to be scored [*participants will be given the opportunity to propose additional risks, the 'default' risks are those that are commonly found in drinking water risk management plans*]

Likelihood definition
1 = Less than once every 1000 years
2 = Once every 1000 years to < once every 100 years
3 = Once every 100 years to < once every five years
4 = Once every five years to < once per month
5 = Once per month or more frequently

Consequence definition	Could cause e.g.:
1 = no impact or not detectable	Increase in turbidity from 2 to 3 NTU
2 = impact on operations	Switching to an alternative supply, increasing chlorine dose or implementing incident response protocol, but no impact on customer
3 = detectable customer complaint	Change in reporting figures, such as a spike in dirty water or T&O complaint rates
4 = undetectable impact on public health	Slight increase in background disease due to increased disinfection by-products or trace increases in pathogens
5 = detectable impact on public health	Outbreak of waterborne disease

Term	Working definition
Development	The developments currently proposed for the catchment, including Peet Ltd and others
No special controls	1/100 yr AEP bund, conventional stormwater and sewer
Best practice controls	1/1 m•yr AEP bund maintained to dam safety standards for S/W, fully sewered development, all with checks and audits

Assess current & future risks & consider controls required to reduce risks below current levels.

Category 1: Aircraft crashing into dam releasing fuel

1 Current situation: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers

2 Following development with no special controls: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers

3 Following development with best practice controls: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers

Category 2: Truck spilling aesthetically problematic contaminants into dam

4 Current situation: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers

5 Following development with no special controls: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers

6 Following development with best practice controls: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers

Category 3: Truck spilling health-hazardous contaminants into dam

7 Current situation: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers

8 Following development with no special controls: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers

9 Following development with best practice controls: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers

Category 4: Airshed contamination reaching health-hazardous levels in dam

10 Current situation: air shed contamination is hazardous to health of water consumers

11 Following development with no special controls: air shed contamination is hazardous to health of water consumers

12 Following development with best practice controls: air shed contamination is hazardous to health of water consumers

Category 5: Malicious contamination of dam causing public concern due to fear and/or aesthetic impact

13 Current situation: malicious hoax or aesthetic hazard contaminates dam leading to public concern

14 Following development with no special controls: malicious hoax or aesthetic hazard contaminates dam leading to public concern

15 Following development with best practice controls: malicious hoax or aesthetic hazard contaminates dam leading to public concers

Category 6: Malicious contamination of dam causing health impact

16 Current situation: malicious dumping of toxic or infectious hazard contaminates dam leading to public health impact

17 Following development with no special controls: malicious dumping of toxic or infectious hazard contaminates dam leading to public health impact

18 Following development with best practice controls: malicious dumping of toxic or infectious hazard contaminates dam leading to public concers

Category 7: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom and taste and odour problems

19 Current situation: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer

20 Following development with no special controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer

21 Following development with best practice controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer

Category 8: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom and cyanotoxin problems

22 Current situation: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values

23 Following development with no special controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values

24 Following development with best practice controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values

Category 9: Pathogen contamination from runoff in dam leading to increased background disease rates

25 Current situation: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY

26 Following development with no special controls: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY

27 Following development with best practice controls: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY

Category 10: Pathogen contamination from runoff in dam leading to increased disease rates detectable as outbreak

28 Current situation: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak

29 Following development with no special controls: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak

30 Following development with best practice controls: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak

Category 11: Disinfection outage during dry periods leading to pathogen contamination detectable as outbreak

31 Current situation: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak

32 Following development with no special controls: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak

33 Following development with best practice controls: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak

Category 12: Disinfection outage during wet period leading to pathogen contamination detectable as outbreak

34 Current situation: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak

35 Following development with no special controls: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak

36 Following development with best practice controls: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak

Category 13: Chemical contamination from runoff in dam leading to T&O or colour complaint detectable by consumer

37 Current situation: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer

38 Following development with no special controls: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer

39 Following development with best practice controls: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer

Category 14: Chemical contamination from runoff in dam leading to increased background disease rates

40 Current situation: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY

41 Following development with no special controls: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY

42 Following development with best practice controls: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY

Category 15: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY

43 Current situation: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY

44 Following development with no special controls: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY

45 Following development with best practice controls: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY

Category 15: Chemical contamination from runoff in dam leading to increased disease rates detectable as poisoning incident

46 Current situation: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident

47 Following development with no special controls: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident

48 Following development with best practice controls: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident

A.2 26th October 2007

Agenda for Stakeholder Perspectives Workshop for Risk Management Plan for the Greenvale Catchment

Details

Purpose:	To provide an opportunity for key stakeholders of the Greenvale Reservoir Catchment to present and discuss their perspectives on risks and opportunities
Date:	Friday 26th October 2007
Location:	Melbourne Water, Meeting Room 4.1, 100 Wellington Parade
Time:	10:30 am to 2:30 pm

Participants

Landholders	Water businesses
Peet Ltd: Brenton Downing Pask: Dean Pask/Karl Rogers George Adams: Philippa Rech	Melbourne Water: Robert Considine; Paul Pretto, Raffaela Crupi Yarra Valley Water: Paul Curtis, Nicola Portlock (sewer), Asoka Jayartne, Simon PearceHiggins (water)
Planning & Regulatory Authorities	**Facilitators**
Hume City Council: Aaron Chiles DHS: Julie Eichner Growth Areas Authority: Karoline Dinevski (Mia Davison in attendance)	Dan Deere & Nick O'Connor and John Glossop (observer)

Agenda

Time	Item	Who
10.30	Welcome, introductions and rules for the day	Rob
10.40	Greenvale catchment risk assessment & planning: Objectives, Process, Outcomes, Timeframes & Commitments	Rob
11	Context: Safe Drinking Water Act 2003; Regs 2005 and the need for a Risk Management Plan (RMP)	Dan
11.20	Measurement of risks to drinking water quality	Dan
11.40	Overview of risks arising from development in water catchments	Nick
12	Stakeholder perspectives, one-by-one, 20 to 30' each What is your role? What are your interests in Greenvale catchment? What risks/opportunities are important to you? How would you like to be involved in the RMP?	All parties
12:15	Lunch (45 mins)	
2:15	Summary of approach and discussion of next steps	Dan
2:30	Close	

Handouts to be provided on the day

1. The preferred Melbourne Water culture
2. The process to be used to develop the RMP

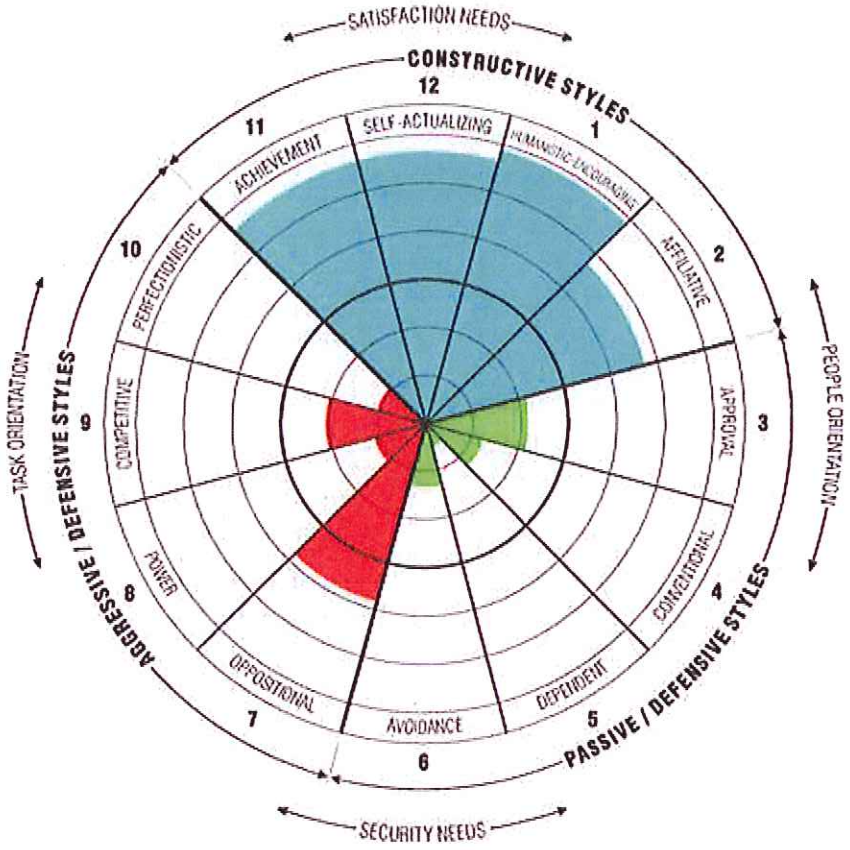
3. Extracts from legislation showing the need for a RMP and what it entails
4. Melbourne water supply system map
5. Greenvale Reservoir catchment showing the physical context

Melbourne Water

August 2005

Leadership Team

Preferred Culture Circumplex; N = 9



What does this mean for the Risk Management Plan:

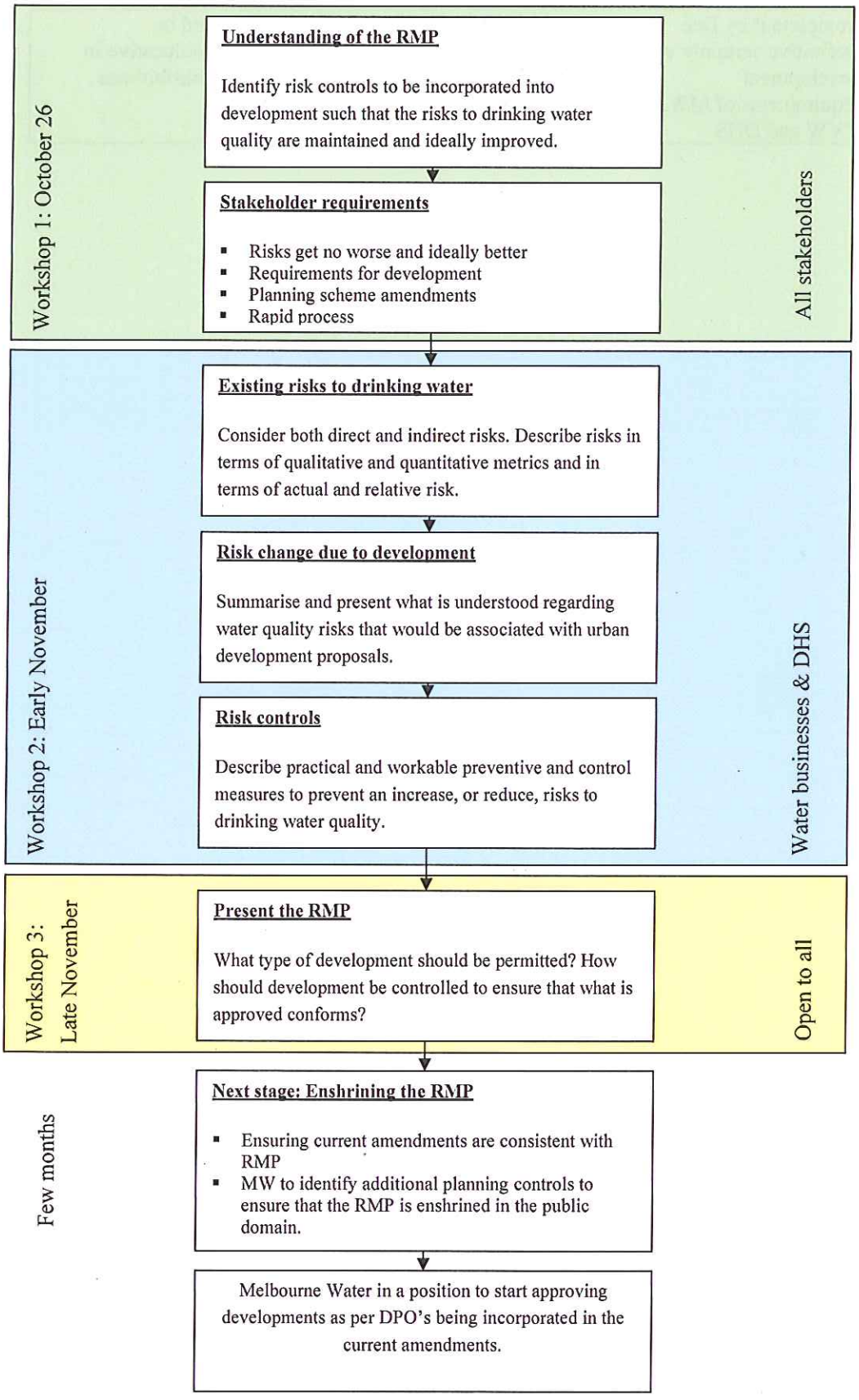
- All stakeholders should appreciate that Melbourne Water is conscious of how behaviour impacts on you (and vice versa)
- There are preferred styles that we need all stakeholders will embrace

Achievement	Self-Actualizing	Humanistic encouraging
Focus on the outcome	*Think independently*	*Be constructive not defensive*
▪ Commit to the RMP process	▪ Consider all policy implications	▪ Be open to influence with each other

Handout 1 Melbourne Water preferred culture.

▪ Complete it by Dec ▪ Definitive certainty wrt development requirements of MW, YVW and DHS	▪ Acknowledge self-interests ▪ Don't prejudice the outcome	▪ Try and be helpful/educative in your contributions

Handout 2 The process to develop the catchment risk management plan to protect drinking water quality in Greenvale Reservoir



Handout 3 Extracts from the *Victorian Safe Drinking Water Regulations* relevant to the development of a risk management plan.

Relevant sections are noted with ★.

PART 2—MANAGEMENT OF RISKS TO WATER SUPPLY

6. Risk management plan

(1) For the purposes of section 9(1)(e) of the Act, a risk management plan must contain the following matters—

(a) the names and contact details of, and the positions held by, the persons responsible for managing hazards and risks to the quality of the water identified in the risk management plan; and

★ (b) details of the activities undertaken, and measures taken, to manage hazards and risks to the quality of the water identified in the risk management plan, including the method by which the effectiveness of these activities and measures is verified; and

★ (c) details of the features of the system of supply designed to assist in the management of risks to the quality of the water identified in the risk management plan, including the method by which the effectiveness of these features is verified; and

(d) in the case of a water supplier, details of the procedures for consultation with water storage managers and other water suppliers for the purpose of achieving agreement on the hazards and risks to quality of the water supplied—

(i) to the water supplier by water storage managers or other water suppliers; and

(ii) by the water supplier to other water suppliers; and

(e) details of procedures and management systems for—

(i) ensuring that the amount and purity of chemicals added to drinking water does not adversely affect the quality of that water or pose a risk to human health; and

(ii) controlling any residue or chemical by-products imparted to drinking water as a result of the addition of chemicals to water supplied for drinking purposes; and

★ (f) details of emergency management arrangements and procedures for dealing with an incident, event or emergency that may adversely affect the quality or safety of drinking water, or result in water being supplied that poses a risk to human health, including—

(i) the names and contact details of, and the positions held by, the persons responsible for dealing with such an incident, event or emergency; and

(ii) methods for communicating or disseminating information to the public in relation to any such incident, event or emergency.

★ (2) For the purposes of section 9(2) of the Act, a risk management plan must address the following risks—

(a) the risk to human health that arises from the presence in water of—

(i) pathogenic micro-organisms; and

(ii) inorganic chemicals, including inorganic disinfection by-products; and

Handout 3 Extracts from the *Victorian Safe Drinking Water Regulations* relevant to the development of a risk management plan.

Relevant sections are noted with ★.

(iii) organic chemicals, including pesticides, pesticide residues and organic disinfection by-products; and

(iv) radiological parameters; and

(v) algal toxins; and

(b) the risks arising from an incident or event that may cause the organisms, substances and matters referred to in paragraph (a) to enter or be present in the system of supply of the water supplier or the water supplied by the water storage manager (as the case requires); and

(c) the risk of transfer of the organisms, substances and matters referred to in paragraph (a) in water being supplied by the water supplier or water storage manager (as the case requires).

★ **7. Risk management plan audits**

For the purposes of section 10(2) of the Act, the specified documents are—

(a) the risk management plan; and

(b) any document or operating manual, procedure or protocol created pursuant to the risk management plan or containing material relating to the content of the risk management plan; and

(c) any training and competency manual relating to the responsibilities of the staff of the water supplier or water storage manager (as the case requires) to manage and deal with—

(i) risks identified in the risk management plan; and

(ii) emergencies, incidents or events that may adversely affect the quality of—

(A) in the case of a water supplier, drinking water;

(B) in the case of a water storage manager, the water supplied or to be supplied.

8. Audit certificate

For the purposes of section 12(2) of the Act, a risk management plan audit certificate must be in the form of Schedule 1.

9. Approval of risk management plan auditors

(1) For the purposes of section 13(2) of the Act, the auditor approval criteria are that the applicant for approval—

(a) holds an accreditation by an institution which, in the opinion of the Secretary, makes the applicant suitable for approval as a risk management plan auditor; or

(b) demonstrates to the Secretary that he or she has the experience, qualifications and skills necessary to independently conduct audits of risk management plans.

(2) In addition, the applicant for approval must provide to the Secretary a written declaration that he or she has no conflict of interest that would impinge on their ability to objectively conduct an audit of a risk management plan.

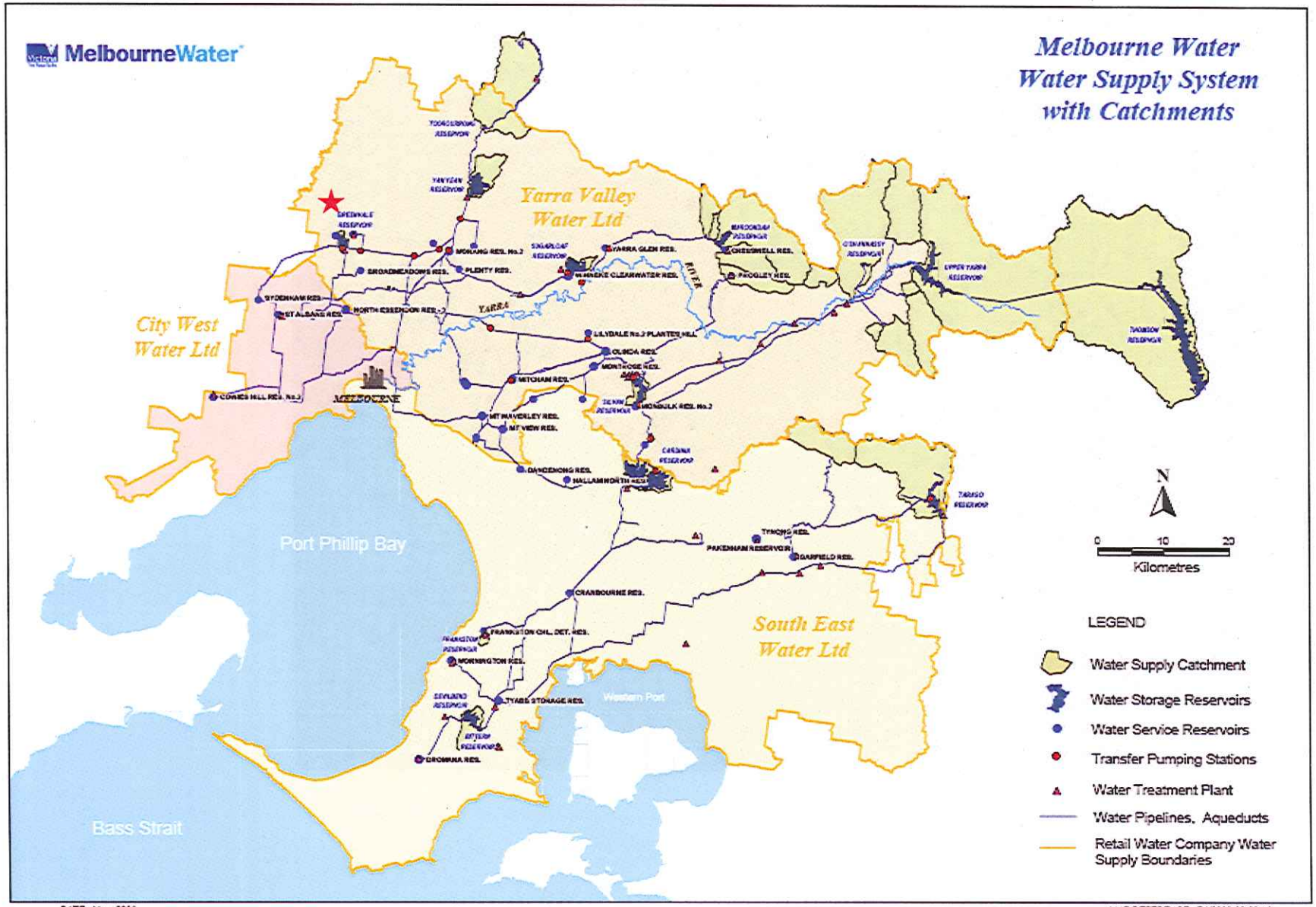
PART 3—DRINKING WATER QUALITY STANDARDS

10. Drinking water quality standards

For the purposes of section 17 of the Act, the quality standards specified for drinking water supplied within a water sampling locality are—

(a) if the drinking water contains a parameter specified in column 1 of the Table in Schedule 2 that the parameter not exceed the standard set out in column 3 of that Table opposite that parameter;

★ (b) if the drinking water contains an algal toxin, or any other pathogen, or any substance or chemical not specified in column 1 of the Table in Schedule 2, that the water not contain that toxin, pathogen, substance or chemical, whether alone or in combination with another toxin, pathogen, substance or chemical, in such amounts that may pose a risk to human health.


MelbourneWater
Melbourne Water
Water Supply System
with Catchments
Yarra Valley
Water Ltd
City West
Water Ltd
South East
Water Ltd
Port Phillip Bay
Bass Strait
Western Port
YARRA
MELBOURNE
N
0
10
20
Kilometres
LEGEND
Water Supply Catchment
Water Storage Reservoirs
Water Service Reservoirs
Transfer Pumping Stations
Water Treatment Plant
Water Pipelines, Aqueducts
Retail Water Company Water
Supply Boundaries
DATE : May, 2006
MAP REFERENCE : FW0000-00-02 A3

Melbourne Water

Appendix B Stakeholder Perspectives

In this section of the report, a summary of additional comments and suggestions from stakeholders is presented. The comments given are paraphrased summaries of stakeholder consultation feedback and are recorded here to provide a record for consideration by the Greenvale water storage manager.

The Greenvale water storage manager responses are given in italics.

- Changes may occur over time and oversight agencies, such as the Department of Human Services, needs to act to oversee the activities of others. For example, consideration should be given to keeping a watching brief on the situation and adapting to changes in development, such as if the AHCEV were broken up into more complex management arrangements, or increases in development densities were to arise over time. Furthermore, there needs to be consideration given to how risks would be managed in the event of changes in institutional arrangements, such as a change in the water utility structure. It may also be necessary to give further consideration to managing incremental risks and how these can be managed from a land use and development perspective.

To avoid water utility changes impacting upon the Risk Management Plan, the water utility is referred to as the "Greenvale water storage manager" (as defined under the Safe Drinking Water Act 2003.). The relevant sewerage license holder is defined in the Water Industry Act 1994, and at the time of writing, is Yarra Valley Water.

The Risk Management Plan recommends that the Greenvale water storage manager be informed of significant development activities within the Greenvale catchment by being made a statutory referral authority (as per Section 56 of the Planning and Environment Act, 1987).

- In addition to thinking about how to mitigate risks from future development, Melbourne Water should consider how to deal with mitigating existing risks. For example, the catch drain could be upsized to provide protection to a larger storm event size than the current 1/100 yr AEP. Doing so could reduce all risks, from both existing and proposed development.

The 1:100 yr AEP catch drain is an appropriate level of protection against perceived risk for the non-urbanised catchment land. The 1,000,000 AEP bund is designed to protect against the higher level risk associated with urban development within the catchment.

- In relation to drainage, further review is recommended for the Greenvale Lakes Drainage Strategy to ensure alignment with the RMP. Issues for consideration include subcritical/supercritical flows, velocities, scour protection, requirements for bund protection (e.g. cycle path), fencing for access and vehicle control, freeboard requirements and clarification of "compaction to dam specification standard" / "maintained to dam specification standard" issues.

Review of the Drainage Strategy will be undertaken as further information is provided, as development proceeds.

- Requiring sewering of the AHCEV has cost implications and these need to be considered against benefits. It is envisaged the future connection of the AHCEV to sewer will run via either Peet Ltd's Mickelham Rd or Greenvale Lakes developments. Melbourne Water, Yarra Valley Water and Peet Ltd will need to discuss this aspect. There may be some issues in relation to who bears costs for the AHCEV sewer connection. For example, it has been suggested that as part of their broader development, Peet Ltd would finance the sewer extension to the AHCEV. It could be considered that since the Peet Ltd development is potentially increasing the water quality risks in the catchment, their funding of additional water quality protection works is part of the trade off that offsets these risks.

In the production of this Risk Management Plan, the Greenvale water storage manager has not engaged stakeholders in issues of cost sharing.

- There may be some difficulties in supplying recycled water to the AHCEV in the short term. At present, the recycled water used on site is probably not of higher quality than a utility-supplied Class B (EPA Victoria) effluent. Therefore, in the short term, providing Class B effluent for irrigation would represent no increase in risk. In the longer term, a move to Class A effluent is recommended. At the time of writing it is not clear who would necessarily initiate the agreement to supply recycled water to the AHCEV. There may be no obligation on Yarra Valley Water to supply the recycled water unless specifically requested to do so by a customer, and at cost to the customer. It is not certain that AHCEV would make such a request or provide the required funding.

The Risk Management Plan recommends the use of Class A recycled water on site.

- Timing of the finalisation of the RMP and other submissions relating to development needs to be recognised as important to allow progress of zoning and other development control considerations.

The Greenvale water storage manager will act with due expediency to ensure that the RMP is not delayed.

- This document could be used to set guidelines for future developments with DPO11 potentially being applied to the whole catchment. Alternatively Melbourne Water could be made a drinking water quality issue referral authority across the whole catchment.

The Risk Management Plan recommends that the Greenvale water storage manager be informed of significant development activities within the Greenvale catchment by being made a statutory referral authority (as per Section 56 of the Planning and Environment Act, 1987).

- There may be some benefit in having the bunds on land that is owned and managed by Melbourne Water. Furthermore, access arrangements need to be considered, e.g. arrangements should the bund be publicly accessible.

The Risk Management Plan recommends that the Greenvale water storage manager maintain authority over the Greenvale catchment-related issues irrespective of land title.

- Responsibility for preventive measures shouldn't necessarily rest with developers and alternative approaches are possible in some cases.

The Risk Management Plan enshrines public responsibility for the preventative measures by the incorporation of planning controls and through the water storage manager and the sewerage licence holder.

Melbourne Water

Appendix C Raw Results from Risk Assessment Workshop.

Melbourne Water

- **Raw results from risk assessment workshop. Emboldened results represent situations where the future risk score was significantly (≥ 1 scoring unit) greater than the current situation risk score.**

	Assess current & future risks & consider preventive measures required to reduce risks below current levels.	Likelihood	Severity	Risk Score
	Category 1: Aircraft crashing into dam releasing fuel			
1	Current situation: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers	1.9	2.9	5.51
2	Following development with no special controls: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers	1.9	2.9	5.51
3	Following development with best practice controls: aircraft crashes into dam releasing levels of fuel into water so as to be detectable to water consumers	1.9	2.9	5.51
	Category 2: Truck spilling aesthetically problematic contaminants into dam			
4	Current situation: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers	2.4	3.1	7.44
5	Following development with no special controls: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers	3.3	2.9	**9.57**
6	Following development with best practice controls: truck tips load into dam releasing levels of hazardous substance into water so as to be aesthetically detectable to water consumers	1.8	2.8	5.04
6a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.2	3	6.6
	Category 3: Truck spilling health-hazardous contaminants into dam			
7	Current situation: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers	2.2	4.5	9.9
8	Following development with no special controls: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers	2.6	4.3	**11.18**
9	Following development with best practice controls: truck tips load into dam releasing levels of hazardous substance into water so as to be hazardous to health of water consumers	1.4	4.1	5.74

	Assess current & future risks & consider preventive measures required to reduce risks below current levels.	Likelihood	Severity	Risk Score
9a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.3	3.9	8.97
	Category 4: Airshed contamination reaching health-hazardous levels in dam			
10	Current situation: air shed contamination is hazardous to health of water consumers	2.1	3.7	7.77
11	Following development with no special controls: air shed contamination is hazardous to health of water consumers	2.2	3.7	8.14
12	Following development with best practice controls: air shed contamination is hazardous to health of water consumers	1.9	3.7	7.03
	Category 5: Malicious contamination of dam causing public concern due to fear and/or aesthetic impact			
13	Current situation: malicious hoax or aesthetic hazard contaminates dam leading to public concern	2.4	3	7.2
14	Following development with no special controls: malicious hoax or aesthetic hazard contaminates dam leading to public concern	2.5	3	7.5
15	Following development with best practice controls: malicious hoax or aesthetic hazard contaminates dam leading to public concers	2.3	3	6.9
	Category 6: Malicious contamination of dam causing health impact			
16	Current situation: malicious dumping of toxic or infectious hazard contaminates dam leading to public health impact	1.9	4.1	7.79
17	Following development with no special controls: malicious dumping of toxic or infectious hazard contaminates dam leading to public health impact	2	4.2	8.4
18	Following development with best practice controls: malicious dumping of toxic or infectious hazard contaminates dam leading to public concers	1.8	4.1	7.38
	Category 7: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom and taste and odour problems			
19	Current situation: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer	2	2.9	5.8

Assess current & future risks & consider preventive measures required to reduce risks below current levels.		Likelihood	Severity	Risk Score
20	Following development with no special controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer	2.9	3.1	**8.99**
21	Following development with best practice controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with aesthetic impacts due to taste and odour detectable by consumer	1.3	2.8	3.64
21a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.3	2.8	6.44
	Category 8: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom and cyanotoxin problems			
22	Current situation: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values	2.1	2.7	5.67
23	Following development with no special controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values	2.9	2.5	**7.25**
24	Following development with best practice controls: Excessive nutrient build-up from runoff in dam leading to blue-green algae bloom with health impacts due to cyanotoxin hazardous to consumer, above guideline values	1.5	2.4	3.6
24a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.1	2.5	5.25
	Category 9: Pathogen contamination from runoff in dam leading to increased background disease rates			
25	Current situation: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY	2.4	3.8	9.12
26	Following development with no special controls: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY	3.3	4	**13.2**

Assess current & future risks & consider preventive measures required to reduce risks below current levels.		Likelihood	Severity	Risk Score
27	Following development with best practice controls: Pathogen contamination from runoff in dam leading to high pathogen levels with increased background disease rates, above 1 µDALY	1.6	3.7	5.92
27a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.1	4	8.4
	Category 10: Pathogen contamination from runoff in dam leading to increased disease rates detectable as outbreak			
28	Current situation: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak	2	4.7	9.4
29	Following development with no special controls: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak	2.8	5	**14**
30	Following development with best practice controls: Pathogen contamination from runoff in dam leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.3	4.3	5.59
30a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	1.8	4.7	8.46
	Category 11: Disinfection outage during dry periods leading to pathogen contamination detectable as outbreak			
31	Current situation: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.8	4.7	8.46
32	Following development with no special controls: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.7	4.7	7.99
33	Following development with best practice controls: Disinfection outage during dry periods leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.5	4.3	6.45
	Category 12: Disinfection outage during wet period leading to pathogen contamination detectable as outbreak			

Assess current & future risks & consider preventive measures required to reduce risks below current levels.		Likelihood	Severity	Risk Score
34	Current situation: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.8	4.9	8.82
35	Following development with no special controls: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak	2.7	5	**13.5**
36	Following development with best practice controls: Disinfection outage during major storm event > 1/100 yr AEP leading to extreme pathogen levels with increased disease rates detectable as outbreak	1.3	4.7	6.11
36a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2	4.7	9.4
	Category 13: Chemical contamination from runoff in dam leading to T&O or colour complaint detectable by consumer			
37	Current situation: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer	2.2	2.9	6.38
38	Following development with no special controls: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer	2.9	3	**8.7**
39	Following development with best practice controls: Chemical contamination from runoff in dam leading to high chemical levels with T&O or colour complaint detectable by consumer	1.6	2.9	4.64
39a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.4	2.9	6.96
	Category 14: Chemical contamination from runoff in dam leading to increased background disease rates			
40	Current situation: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY	1.8	3.7	6.66
41	Following development with no special controls: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY	2.9	4	**11.6**

Assess current & future risks & consider preventive measures required to reduce risks below current levels.		Likelihood	Severity	Risk Score
42	Following development with best practice controls: Chemical contamination from runoff in dam leading to high chemical levels with increased background disease rates, above 1 µDALY	1.7	3.2	5.44
42a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.1	3.6	7.56
	Category 15: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY			
43	Current situation: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY	1.6	3.4	5.44
44	Following development with no special controls: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY	1.3	3.4	4.42
45	Following development with best practice controls: Organic contamination from runoff in dam leading to increased disinfection by-products with increased background disease rates, above 1 µDALY	1.5	3.3	4.95
45a	As per the above table cell and with the expanded AHCEV, with sewer replacing on-site sewage management system, with stormwater controls between 1/100 and 1/1000 AEP	2.3	3.7	**8.51**
	Category 16: Chemical contamination from runoff in dam leading to increased disease rates detectable as poisoning incident			
46	Current situation: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident	1.3	4.7	6.11
47	Following development with no special controls: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident	1.8	5	**9**
48	Following development with best practice controls: Chemical contamination from runoff in dam leading to extreme chemical levels with increased disease rates detectable as poisoning incident	1.3	5	6.5

	Assess current & future risks & consider preventive measures required to reduce risks below current levels.	Likelihood	Severity	Risk Score
	Category 17: Grassfire in the catchment followed by a rain event			
49	Current situation: Grassfire followed by major storm with runoff to dam leading to extreme turbidity and operational problems.	2.8	2.8	7.84
50	Following development with no special controls: Grassfire followed by major storm with runoff to dam leading to extreme turbidity and operational problems.	2.5	2.4	6
51	Following development with best practice controls: Grassfire followed by major storm with runoff to dam leading to extreme turbidity and operational problems.	1.8	2.4	4.32

Melbourne Water