Impacts of timber harvesting on water quality in state forests supplying water to Melbourne

SUMMARY REPORT

- Final
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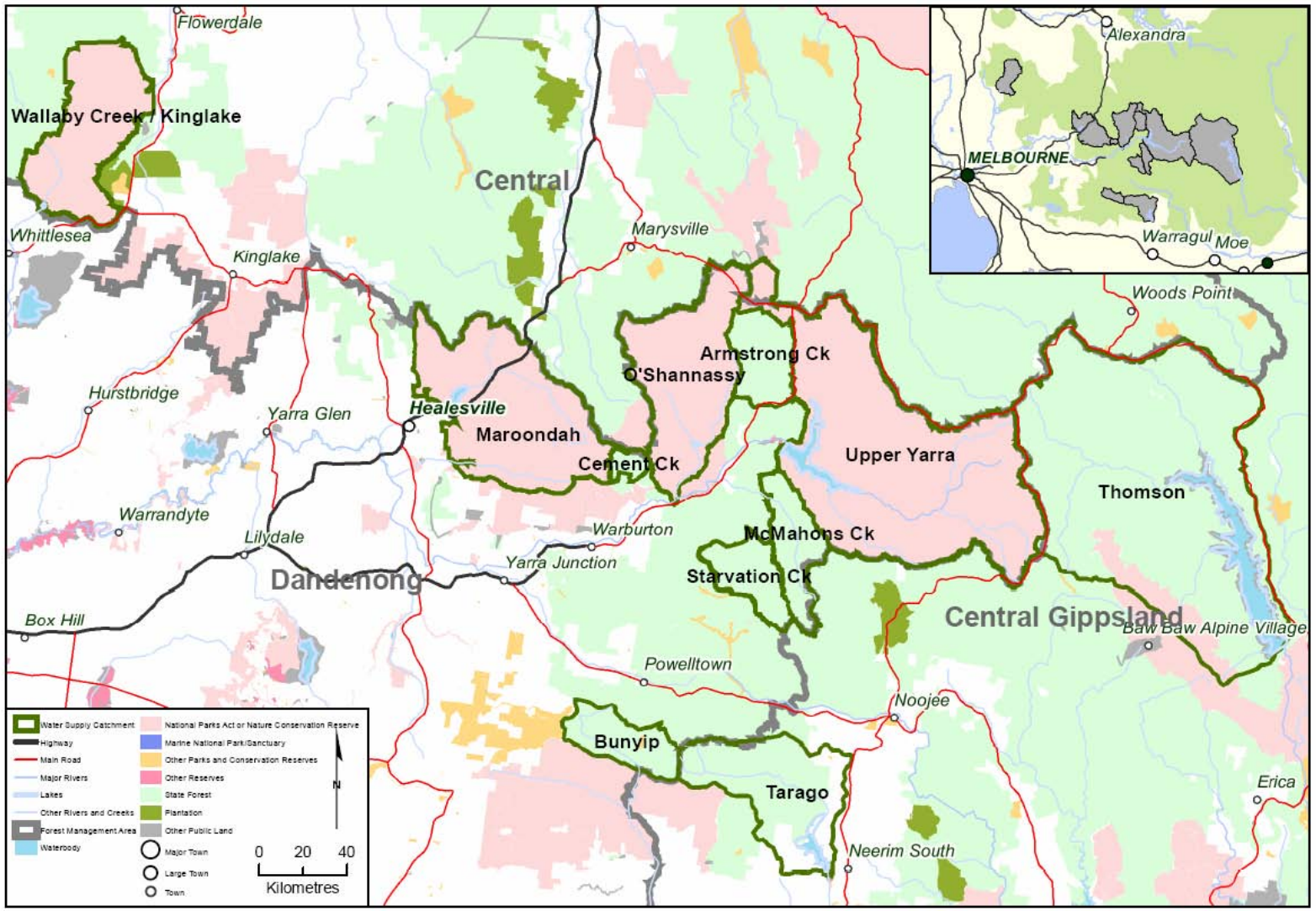
1. Introduction

Melbourne's drinking water is sourced primarily from the Yarra River catchment and Thomson River, located approximately 80 km east of Melbourne. The Tarago Bunyip System currently supplies West Gippsland and will supply Melbourne in 2011 following the construction of a water filtration plant (Yurisich and Rhodes, 1998). These catchments are covered by ash-type forest, principally Mountain Ash (*Eucalyptus regnans*), Alpine Ash (*E. delegatensis*) and Shining Gum (*E. nitens*) and drier mixed species eucalypt forest (NRE, 1998). Timber harvesting activities are undertaken in some of these water supply catchments, specifically those of the Thomson and Tarago Reservoirs and the Bunyip, Armstrong, Starvation, McMahons and Cement Creek catchments (Figure 1.1) and has been identified as a potential risk to instream water quality. Other designated water supply catchments where timber harvesting does not occur are the Upper Yarra, O'Shannassy, Maroondah and Wallaby Creek catchments.

This summary report provides an overview of a more detailed literature review (SKM 2006) of the impacts of timber harvesting on instream water quality with particular reference to the potential impacts of timber harvesting on instream water quality in Melbourne Water's water supply catchment. It also incorporates a summary review of audits specific to timber production in the Dandenong and Central Gippsland Forest Management Areas, which cover the principle water supply catchments described above (SKM and Landuse Hydrology 2006).



- **Figure 1.1 Designated water supply catchment areas (supplied by DSE)**

2. Melbourne's water supply

Melbourne's water supply system is operated by Melbourne Water and can be characterised in terms of a headworks, seasonal transfer system and regional distribution system (Yurisich and Rhodes, 1998). The principal function of the headworks system is to harvest streamflow from the catchment areas. The headworks comprise the catchments, weirs, pumping stations and storage reservoirs such as Thomson, Upper Yarra, Maroondah, O'Shannassy and Tarago. The seasonal transfer system primarily transports water from the headworks to the seasonal balancing storages closer to Melbourne and includes Cardinia, Greenvale, Silvan and Yan Yean Reservoirs. Silvan Reservoir for example, receives water harvested from the upper Yarra tributaries and Coranderrk Creek, and transfers from O'Shannassy Reservoir and Upper Yarra Reservoir (SKM, 2002). Water from Silvan Reservoir is then transferred to the other balancing storages throughout the metropolitan area and then to the reticulation system.

Melbourne Water manages the storage reservoirs and is responsible for the harvesting, treatment and transfer of water to the three Melbourne retail water companies – City West Water, South East Water and Yarra Valley Water. Melbourne Water has a HACCP (Hazard Analysis Critical Control Point) risk management plan to identify and manage risks to drinking water that is consistent with the National Health and Medical Research Council and Natural Resource Management Ministerial Council guidelines (Abby Farmer, Melbourne Water Corporation, *pers. com*.). The plan is based on the multiple barrier principle with protection of source water quality being the foundation of the plan. Melbourne's drinking water supply is largely unfiltered, with the only treatment being disinfection prior to the delivery to customer taps. Hence, Melbourne Water's risk management plan has identified timber harvesting in source catchments as a potential hazard to the quality of source water, particularly with respect to sediment input and turbidity.

The quality of drinking water is important as it determines whether it is safe for humans to drink and to use for domestic purposes, such as cooking, washing up, bathing and showering (CRC for Water Quality and Treatment, unknown). According to the *Australian Drinking Water Guidelines* (NHMRC/NRMMC, 2004), "ideally drinking water should be clear, colourless, and well aerated, with no unpalatable taste or odour, and it should contain no suspended matter, harmful chemical substances, or pathogenic micro-organisms". Catchment management is an important barrier and is critical to the provision of safe drinking water, highlighted by the Australian Drinking Water Guidelines, which state: "the most effective barrier is protection of source waters to the maximum degree practical".

To meet these requirements and ensure that water is of the highest quality and requires little treatment, Melbourne Water has established a number of catchment protection measures:

- Public access to water supply catchments and reservoirs is restricted to minimise the risk of human borne disease and chemical contaminants from entering the water supply system.
- Bushfire risks are managed to ensure that the water source is protected from soot and ash.
- Timber harvesting activities in water supply catchments are managed through the *Code of Forest Practices for Timber Production* (Revision no. 2) (the Code) (NRE, 1996). The Code sets the minimum standards for water quality protection and guidelines to protect water yield from catchments used for water supply. In addition, EPA Victoria is commissioned by the Victorian Government to engage an independent environmental auditor to assess compliance on public land with the Code.

Water quality is commonly assessed in terms of physico-chemical indices such as temperature, suspended sediment concentration, dissolved solids, nutrients and bacteria. These indices have traditionally been used to determine water quality for end uses such as domestic consumption. Unless source water is of very high quality, it undergoes various water treatment processes that remove any chemicals, organic substances or organisms that could be harmful to human health and/or contribute to taste and/or odour problems. The quality of source water determines the specific water treatment processes required in order to meet Australian Drinking Water Guidelines and this source water is itself dependent on the quality of water entering reservoirs from the catchment and on processes that occur within reservoirs.

Timber harvesting is one of the activities that can impact on the quality of instream water entering reservoirs and this review specifically considers the potential impacts of timber harvesting on instream water quality only. It is beyond the scope of this review to consider the impacts of reservoir dynamics on water quality and hence the ultimate quality of water that enters treatment plants and the potable water supply system. Suffice to say that reservoir dynamics such as retention times, mixing patterns and sediment/water column interface processes can have impacts on reservoir water quality, effectively altering the water quality characteristics of inflowing water with consequent impacts on water treatment requirements.

3. Instream water quality impacts of timber harvesting

3.1 Overview of instream water quality impacts of timber harvesting

The impacts of forest harvesting practices on instream water quality have been studied extensively over the last 30 years. Research has largely focussed on two approaches. The first approach typically involves the measurement of instream water quality variables at the catchment outlet, usually using a paired-catchment design with monitoring before and after the period of major disturbance. The second approach typically involves quantifying erosion rates on specific land elements such as roads, tracks and General Harvesting Areas (GHA) and using these data to construct sediment budgets and scaling approaches to assess changes in catchment water quality due to forest harvest disturbances.

3.1.1 Sediment

With respect to studies of forestry impacts on stream water quality in Australia and overseas, most studies conclude that unsealed forest roads are the major source of sediment in managed forests through the detachment, abrasion and crushing of the road surface materials, increasing the availability of fine, easily transported material. Roads are also commonly regarded as the dominant pathway for runoff and sediment delivery to streams. Road usage is a critical factor in explaining sediment production rates on roads, but is dependent on the specific characteristics of the road such as the type and erodibility of surface material applied to the road (ie. gravelled versus ungravelled), slope, location of drains and weather. Therefore any combination of these factors makes it difficult to predict the impact of forest roads at a specific location. For example, forest roads that carry high traffic volumes can degrade road surfaces, but to compensate they tend to be constructed to a higher engineering standard (e.g. better surfacing, lower slope).

While not as significant as roads, GHAs can also represent a source of sediment to waterways, but the impacts are very site specific depending upon the interaction between factors such as slope, runoff and physical characteristics (eg degree of disturbance, vegetation cover, soil type and distance from waterways).

3.1.2 Nutrients

The main factors affecting potential for nutrient transport to waterways is the form in which nutrients are stored and the overall distribution of nutrients within the soil profile. In forest ecosystems, which are highly dependent upon litter fall processes, most available nutrients are concentrated on the soil surface in association with organic matter. Leaching of nutrients from this organic material into the solution pathway and direct transport of nutrients bound to sediment are the two pathways for the export of nutrients from forest areas to waterways. Forest operations can

influence both pathways, but in particular the second pathway where sediment production and export becomes a significant factor.

Export of nutrients can increase following logging because of decreased nutrient uptake by vegetation and increased discharge as a consequence of increased water exported from the catchment. Where prescribed and regeneration burns are also conducted there can be a consequent increase in nutrient concentration in waterways due to the direct precipitation of ash into the stream and via overland flow that has been in contact with ash.

Despite the potential for increased nutrient export to streams, the overall nutrient loads to waterways as a result of harvesting activities is considered low when compared to the nutrient load from the total catchment. In addition, any elevated concentration is relatively short lived because once regeneration commences nutrient uptake by vegetation also becomes re-established with a consequent decrease in potential for nutrients to be exported.

Overall nutrient concentrations in streams draining forested catchments, including those subject to timber harvesting, are considerably lower than those reported for other land uses and particularly agriculture.

3.1.3 Mitigation measure

Best Management Practices in forestry operations play a significant role in the reduction of adverse effects on water quality in forested catchments. Forest buffer strips are an effective measure in reducing the volume of surface runoff and the quantity of sediment/nutrients delivered to a stream. Following the completion of harvesting activities, discontinuation of the use of track and forest roads can also significantly reduce sediment production and subsequent transport to water ways. Sediment yields decrease rapidly after road use is discontinued and as GHAs are allowed regenerate.

3.2 Specific impacts of timber harvesting on Melbourne's water supply catchments

With respect to Melbourne's water supply catchments, a number of studies have examined the impacts of timber harvesting and roading on instream water quality in the Coranderrk (Langford and O'Shaughnessy, 1977), Maroondah (Langford and O'Shaughnessy, 1980; Haydon *et al*. 1991) and Armstrong Creek (Wu *et al*. 1994). This work was undertaken over a twenty year period from the late 1950s to the late 1970s. Notably, this research is consistent with the general findings from the literature that unsealed forest roads are the major source of sediment in managed forests.

3.3 Overview of compliance with Code of Forest Practices in the Dandenong and Central Gippsland Forest Management Areas

The EPA Victoria is commissioned by the Victorian Government to engage an independent environmental auditor to assess compliance on public land with the *Code of Forest Practices for Timber Production* (NRE 1996). The literature review of timber harvesting impacts on instream water quality shows that roads in managed forests are the leading contributor of sediment to streams, so compliance with roading conditions is essential if water quality impacts are to be minimised.

A review of six audits published since 1997/98 assessing compliance with the Code for the Dandenong and Central Gippsland Forest Management Areas (FMAs) indicates that compliance was generally above the state average but that there were also a number of non-compliances (SKM and Landuse Hydrology, 2006). In the Dandenong FMA compliance was above the state average for the focus areas of streamside buffer protection, filter strip protection, log landings and dumps, snig tracks and boundary tracks, and above the state average for roads. In the Central Gippsland FMA, compliance was above the state average for the focus areas of log landings and dumps and boundary tracks, about the state average for snig tracks and roading, and below the state average for streamside buffer protection and filter strip protection.

The 2004/05 audit examined compliance with roading conditions, and noted that many temporary roads were non-compliant because of inadequate drainage, poor location, poor design, wet weather use and inadequate closures. Permanent roads were found to be more compliant. The audit recommended that temporary roads be better located and designed and as a result new Management Procedures that address these matters were implemented by DSE in October 2005. Previous audits have also identified non-compliance with prescribed ripping depths on landings, with the width of streamside buffers and filter strips and with drainage conditions on roads.

Most instances of non-compliance were considered to have resulted in a negligible, minor or occasionally moderate environmental impact, with no more than localised potential short-term impacts on the quality of stream water. Exceptions were in the Central Gippsland FMA where four major impact non-compliances occurred as a result of soil erosion on three log landings and erosion associated with a poorly designed and located road, and four moderate impact non-compliances were generated by inadequate road drainage. These compliance shortfalls may have had short or medium-term localised impacts on water quality. Nevertheless the very limited extent, and transient nature, of these non-compliances were unlikely to have had any quantifiable effect on the quality of water in receiving waterways or on that delivered to Melbourne's water storages. The 2004/05 audit concluded that the identified areas of Code non-compliance did not represent a risk to beneficial uses of the forest.

None of the audits comment on the adequacy, or otherwise, of Code conditions specifically formulated to protect catchment values and preserve water quality, as the audit method employed does not specifically generate a record of occasions when undesirable outcomes have occurred despite a complete compliance with Code requirements. It is therefore not possible to conclude from these audits whether current Code conditions prescribed for, say, soil and water protection during harvesting operations, is adequate. Furthermore, no judgment can be made on whether an unacceptable risk to water quality was generated by any non-compliance with conditions, or of the potential impacts on water quality in streams inflowing to Melbourne's water supply reservoirs.

3.4 Specific impacts on Melbourne's water supply

Although the impacts of timber harvesting on instream water quality has been well-researched, the link between the effects of timber harvesting on instream water quality and potable water quality are more difficult to quantify. To our knowledge, no studies have been undertaken to determine the specific relationship between timber harvesting and potable water quality with Melbourne's water supply systems. For Melbourne's supply system this is only an issue where water from the forested catchments is delivered into the distribution systems with minimal treatment. One study has examined the relationship between the inflow water to Silvan Reservoir and outflow water to downstream treatment plants (Cinque *et al*. 2005). The authors show that turbidity at the reservoir outlets is dominated by the turbidity of inflowing water and conclude that internal reservoir dynamics and short-circuiting means that the reservoir cannot be relied upon for providing detention times of sufficient duration to allow settling of sediment present in inflowing water. Although it should be noted that the Silvan Reservoir is a small reservoir with a capacity of 40,000 ML, unlike the Thompson Reservoir with a capacity of 1,068,000 ML and where residence times are likely to be much longer due to the larger size.

Other factors that may influence water quality between the time that instream water is harvested and drinking water is delivered to Melbourne's retail water companies include the location of harvesting areas in relation to offtake weirs, timing of timber and water harvesting and reservoir capacity and settling times. It is beyond the scope of the current project to explore these factors in anymore detail.

4. Conclusions

Based on the review of timber harvesting impacts on water quality the following conclusions can be made:

- Unsealed forest roads are the major sources of sediment in managed forests, particularly where channelised flow pathways form at drainage outlets.
- Road usage is a critical factor in explaining the rate of sediment production on these roads.
- Sediment and nutrient yields from forested (managed and un-managed) catchments are considerably lower than those from other land uses, particularly agriculture.
- Sediment production rates on roads and tracks decline within the time frame of 2 to 5 years after logging ceases to levels comparable to lightly disturbed General Harvesting Areas
- Instream impacts as a result of increased sediment and nutrient input may occur but observed impacts are short-lived and transient with no long-term effect.
- Best management practices such as vegetated buffer strips, dispersed sediment flow paths, appropriate road surface treatment and maintenance and retention of vegetation on GHAs that provide roughness and slow overland flow are effective at minimising sediment and nutrient inputs to waterways.

With respect to the assessment of compliance with the *Code of Forest Practices for Timber Production*:

- Several instances of non-compliance with Code prescriptions have occurred in the Dandenong and Central Gippsland Forest Management Areas.
- Most instances of non-compliance were considered to have resulted in a negligible, minor or occasionally moderate environmental impact, with no more than localised potential short-term impacts on the quality of stream water.
- No judgment can be made on whether an unacceptable risk to water quality was generated by any non-compliance, or of the potential impacts on water quality in streams inflowing to Melbourne's water supply reservoirs.

With specific regard to Melbourne's water supply catchments, the studies have been undertaken have drawn conclusions consistent with literature outcomes; that unsealed roads are the greatest sediment source to waterways. No studies have been undertaken to determine the specific relationship between timber harvesting and potable water quality within Melbourne's water supply system.

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