# The importance of estimating stock and domestic water use in the context of a water constrained future – Lessons from the Woori Yallock catchment, Victoria

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*Managing competing needs in water resource planning will become increasingly important due to the impacts of climate change on water availability (DSE 2008). A holistic management approach is required to ensure sustainable and equitable allocation between consumptive and environmental water needs (IPCC 2007). While consumptive licences are currently metered in Victoria, there is little data about stock and domestic (D&S) usage and its associated impact on streamflow. This project aimed to estimate the use of D&S water in the Woori Yallock catchment from waterways, groundwater and dams. The project gathered data that will improve the confidence of hydrological modelling underpinning stream flow management planning in and around Melbourne.*

## 1. INTRODUCTION

Melbourne Water manages the licensing of surface water diversions from rivers, creeks and dams in the Yarra River, Lower Maribyrnong River and Western tributary catchments around Melbourne, Victoria. This water is used for a variety of agricultural, industrial, commercial and domestic purposes and is managed according to the licensing requirements of the *Water Act 1989 (Vic)*. The Woori Yallock catchment, within the Yarra catchment, has been declared a Water Supply Protection Area (WSPA). This declaration enables Stream Flow Management Plans (SFMP) to be produced for the area to allocate available water amongst consumptive and environmental needs, through specifying the future management of surface water licences.

Section 8 of the *Water Act 1989 (Vic)* provides 'private rights' for landholders to access water in waterways and groundwater for use for D&S purposes. These uses are not metered, licensed, registered or quantified in any way and include water for:

- Household purposes and watering a kitchen garden for household use
- Watering cattle or other stock and animals kept as pets
- Watering an area around the house for fire prevention purposes

The current levels of D&S use are not well documented and there is a need to better understand the quantum, source and timing of D&S water use in proportion to diversion licenses. The appointed SFMP Consultative Committee requested that further work be undertaken to determine the use of D&S water in the Woori Yallock catchment from waterways, groundwater and dams. This will enable more informed decision making by catchment managers and licensing authorities, such as Melbourne Water, in relation to environmental flow requirements at a catchment and sub-catchment scale in the context of climate change.

It is important to understand all the demands on water resources due to a reduction in future average rainfall and runoff in unregulated catchments (DSE 2008). The purpose of this project was to determine the use of D&S water in the Woori Yallock catchment from waterways, groundwater and dams. The data gathered during this project will inform the resource allocation modelling (REALM) that is used to inform streamflow planning and management. This will improve the confidence in the hydrological model underpinning stream flow management planning in and around Melbourne.

## 2. METHODOLOGY

The modelling approach involved three main stages (Figure 1). A high-level catchment scale framework allowed a first order estimate of D&S demand and supply from waterways, groundwater and dams from readily available information (ABS 2010; Ceena 1983; DPI 2010; DSE 2002; DSE 2010a; DSE 2010b; DGC and SKM 2009; Lowe et al. 2009; SKM 2005; SKM 2009a; SKM 2009b; The Public Land Consultancy 2008). The second stage assessed demand and supply at a parcel and sub-catchment level using analysis of Geographic Information System (GIS) data and aerial imagery. This built a demand and supply profile from the property level up. Stage three involved a landholder survey to validate stages one and two, and provided qualitative usage characteristics. A purposive sample (De Vaus 2002) of thirty properties was taken from each of the seven REALM model sub-catchments within the Woori Yallock catchment. The response rate was 55%, which is moderately high for a survey of this type.

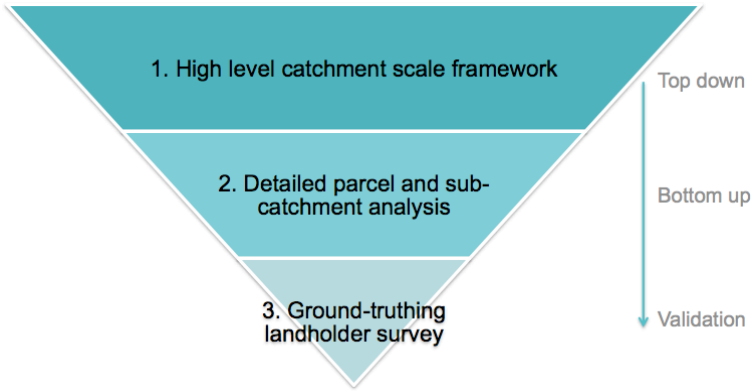


*Figure 1: Method for assessing D&S water use*

The formulas for calculating D&S demand and supply are outlined in Table 1 below.

*Table 1: Formulas for calculating D&S demand and supply*

| **Demand** | **Formula** | |
|---|---|---|
| Stock | *Stock demand (mega litres (ML)/year) = area of catchment (ha) × area of land grazed (%) × realistic carrying capacity (DSE/ha) × annual stock water consumption (kL/DSE/ha) ÷ 1,000* | *(1)* |
| Domestic | *Domestic demand (ML/year) = number of properties with a domestic D&S demand (>4,000 sq. m and not connected to town water supply) (No.) × proportion of properties with a house (%) × usage per house (ML/house/year)* | *(2)* |
| Curtilage | *Curtilage (ML/year) = number of properties with a domestic D&S demand (>0.4 hectares and not connected to town water supply) (No.) × proportion of properties with a house (%) × curtilage per house (ML/house/year)* | *(3)* |
| Dam losses | *Dam losses (ML/year) = volume of total number of catchment dams (ML) − volume of licensed and registered dams (ML) = volume of D&S dams (ML) ÷ average depth of dam × Class A pan evaporation × pan factor* | *(4)* |
| **Supply** | | |
| Dams | *Dam supply (ML/year) = volume of total number of catchment dams (ML) − volume of licensed and registered dams (ML) = volume of D&S dams (ML) × dam demand factor (%)* | *(5)* |
| Bores | *Bore supply (ML/year) = number of D&S bores (unlicensed <30 years old with use code 1: DS, DM or ST) (No.) × activation rate (%) = active bores (No.) × usage rate (ML/bore)* | *(6)* |
| Waterways | *Waterways supply (ML/year) = area of land with riparian access (ha) ÷ area of total catchment (ha) = proportion of catchment with riparian access (%)*<br>• *Potential waterway supply for stock, freehold (ML/year) = stock demand (ML/year) × proportion of catchment with riparian access (%) × proportion of riparian land that is freehold (%)* | *(7)* |

| | | |
|---|---|---|
| | • *+ Potential waterway supply for stock, Crown frontage (ML/year) = stock demand (ML/year) × proportion of catchment with riparian access (%) × proportion of riparian land that is Crown frontage (%) × proportion of properties with Crown frontage (%)*<br>• *+ Potential waterway supply for domestic, freehold (ML) = domestic demand (ML/year) × proportion of catchment with riparian access (%) × proportion of riparian land that is freehold (%)* | |

## 3. WOORI YALLOCK CATCHMENT LAND USE PROFILE

To provide context to D&S water use in the Woori Yallock catchment it is important to understand the predominant land uses. Figure 2 shows the Woori Yallock catchment and the seven REALM model sub-catchments.

Approximately 80% of the catchment has been cleared, with this cleared area now used for urban and rural-residential developments, intensive horticulture and grazing (Melbourne Water 2011).

The upper regions of the catchment are a mix of forest, intensive horticulture (flowers and nursery, orchard fruit, berries, viticulture, and vegetables), and urban developments. The lower, northern reaches have predominantly been cleared for grazing and horticulture. Key land use characteristics include:

- About 40% of the whole catchment is available for grazing. Grazing intensity is highest in the centre of the catchment running north south through sub-catchment A, western parts of B and C, E and eastern area of G (Figure 2).
- Irrigation is clustered in the north west of the Woori Yallock catchment in sub-catchment E, F and the western area of G, as well as the southern parts of sub-catchment A and B.
- D&S houses, on properties greater than 0.4 hectares and not connected to town supply, are spread across the entire catchment but with higher concentrations in the west near the urban areas and smaller lot horticultural land uses. This governs domestic D&S demand.

The landholder survey found that most (70.4%) landholders use their property for grazing, with the majority (62.8%) grazing cattle. Over a quarter (30.2%) identified their land use as a lifestyle property. The proportion of the property that was grazed varies greatly. The full grazing capacity of properties is rarely utilised, with few (11.4%) landholders using 100% of the capacity of their land.

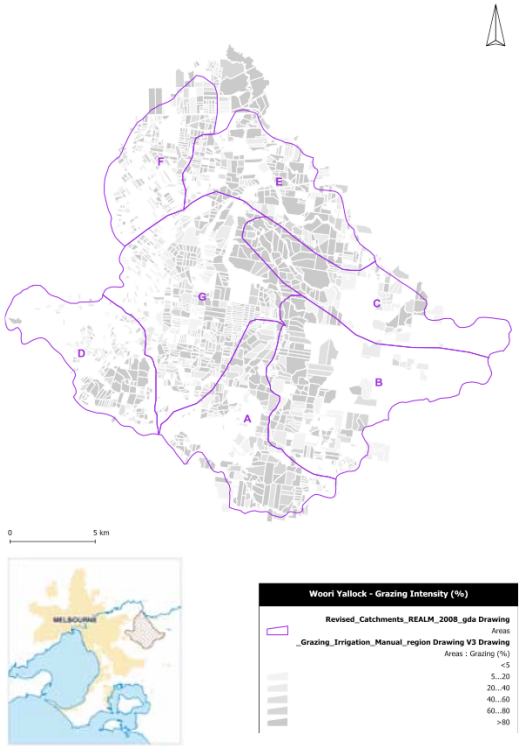


*Figure 2: Grazing intensity in the Woori Yallock catchment*

# 4. KEY FINDINGS

## 4.1. High-level approach

The high-level approach presents evidence to provide resource managers with an additional understanding of the current and possible D&S use:

- Upper limit of demand that the D&S users could reasonably take given the land use and available sources of supply. This provides an upper ceiling, or maximum development scenario, for future potential demands within the catchment if all properties were to exercise their full D&S right and graze to maximum carrying capacity.
- Lower limit estimate that represents a projection on probable levels of demand given assumptions about the level of activity and types of demand.

An estimate of the D&S water use at a catchment level from the high-level approach is provided in Table 2 below. This includes both the upper and lower limits based on a sensitivity analysis of the key variables.

*Table 2: Summary of D&S water use in the Woori Yallock catchment*

| | **Upper limit (ML/y)** | Percentage of D&S Use | Proportion total licensed allocation | **Lower limit (ML/y)** | Percentage of D&S Use | Proportion total licensed allocation |
|---|---|---|---|---|---|---|
| **Demand** | | | | | | |
| Stock | 366 | 10% | 4% | 250 | 12% | 3% |
| Domestic | 341 | 9% | 4% | 282 | 13% | 3% |
| Curtilage | 999 | 26% | 10% | 200 | 9% | 2% |
| Dam losses* | 2,090 | 55% | 22% | 1,394 | 66% | 15% |
| **Total** | **1,706** | 100% | **18%** | **732** | 100% | **8%** |
| **Supply** | | | | | | |
| Dams | 1,110 | 60% | 12% | 178 | 21% | 2% |
| Bores | 594 | 32% | 6% | 509 | 61% | 5% |
| Waterways | 156 | 8% | 2% | 144 | 17% | 2% |
| **Total** | **1,859** | 100% | **19%** | **831** | 100% | **9%** |

* Dam losses are not included in the total demand or proportion total licensed allocation consistent with current policy for diversion licenses.

The findings suggest that:

- Maximum D&S demand in the Woori Yallock catchment could be as high as 1,700 ML per year. This is equivalent to about 20% of the total volume of licensed diversions.
- However, in practice demand could be as low as 730 ML per year, which would be 8% of total licensed diversions;
- Dam losses are by far the largest of the component of D&S demand. Losses exceed the sum of estimated stock, domestic and curtilage combined. Note that loss figures are not included in the reported total demand, consistent with current policy for diversion licenses.

## 4.2. Demand

A summary of the D&S water demand by sub-catchment is outlined in Table 3 below. D&S water demand consists of stock, domestic, curtilage and dam losses. D&S demand is likely to be 1,150 ML per year, which is 12 per cent of total licensed volume. This analysis refines the high-level approach

figures presented in Section 4.1 above. The findings show:

- D&S demand is highest in the Woori Yallock and Stoney Creeks (270 ML/year) and Emerald and Sassafras Creeks (250 ML/year) sub-catchments.
- Domestic demand is the highest D&S use by volume (578 ML/year) representing 21 per cent of total demand, after dam losses via evaporation and seepage (58%). However, note the discussion below that over 50% of houses have no access to a D&S supply and rely on rainwater tanks so the demand on standard D&S supplies may be less than these figures suggest.

*Table 3: Summary of D&S water demand by sub-catchment*

| Sub-catchment | Sub-catchment name | Stock (ML/year) | Domestic (ML/year) | Curtilage (ML/year) | Dam losses (ML/year)* | Total (ML/year)* | Percentage D&S Use | Proportion sub-catchment licensed volume |
|---|---|---|---|---|---|---|---|---|
| A | Cockatoo Creek | 46 | 66 | 33 | 194 | **145** | 12% | 11% |
| B | Shepherd Creek | 41 | 45 | 23 | 138 | **109** | 9% | 8% |
| C | McCrae Creek | 35 | 22 | 11 | 143 | **68** | 8% | 13% |
| D | Emerald and Sassafras Creeks | 20 | 153 | 77 | 54 | **250** | 11% | 14% |
| E | Sheep Station Creek | 49 | 73 | 37 | 295 | **159** | 16% | 15% |
| F | Wandin Yallock Creek | 25 | 70 | 35 | 132 | **129** | 9% | 12% |
| G | Woori Yallock and Stoney Creeks | 66 | 136 | 68 | 594 | **270** | 31% | 11% |
| H | Area north of sub-catchment F | 17 | 14 | 7 | 42 | **37** | 3% | N/A |
| **Total*** | | **300** | **578** | **289** | **1,593** | **1,167** | **-** | - |
| Percentage D&S Use | | 11% | 21% | 10% | 58% | - | **100%** | - |
| Proportion total licensed allocation | | 3% | 6% | 3% | 17% | - | - | **12%** |

* Dam losses are not included in the total demand or proportion total licensed allocation consistent with current policy for diversion licenses.

The results of the detailed per property estimation fall neatly midway between the upper and lower bounds of the outcomes of high-level model (Table 4). This suggests that the two approaches are broadly consistent and the results therefore likely to be a robust estimation.

*Table 4: Comparison of demand estimation*

| **Stage** | **1** | **2 & 3** | **1** |
|---|---|---|---|
| | **Upper** | **Detailed** | **Lower** |
| Stock (ML/year) | 366 | 300 | 250 |
| Domestic (ML/year) | 341 | 578 | 282 |
| Curtilage (ML/year) | 999 | 289 | 200 |
| Dam losses (ML/year)* | 2,090 | 1,593 | 1,394 |
| **Total (ML/year)** | **1,706** | **1,167** | **732** |

The detailed estimation for domestic demand may be higher than the upper and lower high-level estimate as it accounts for D&S houses more accurately. This figure reflects the peri-urban and highly developed nature of the Woori Yallock catchment.

## 4.3. Analysis of water sources

D&S demand can be supplied from any combination of three sources:

- Farm dams
- Groundwater bores
- Waterways via direct access or pumping and off stream watering.

These are additional rather than exclusive rights, so a single property may make use of a combination of all of these sources, as shown in Figure 3 below.

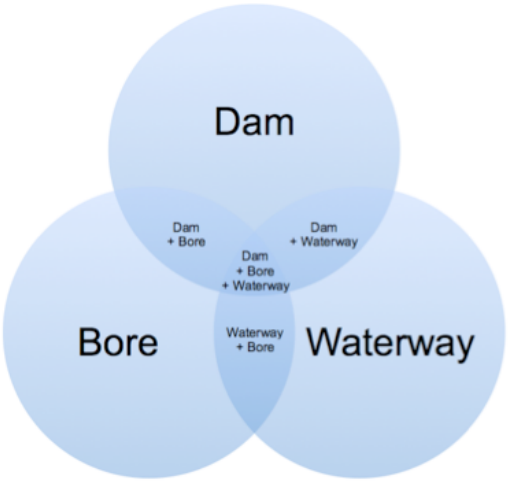


*Figure 3: D&S supply options on a property*

Using the property scale data assembled for this project it has been possible to analyse the sources used for the components of D&S water demand in the Woori Yallock catchment and in the REALM sub-catchments. This provides greater insights into usage patterns and impacts.

Analysis of sources of stock water demonstrated that:

- Most stock water is supplied from either dams or waterways.
- 37% of properties have access to both a dam and a waterway for stock watering.
- Very little stock water is supplied from bores.

About 14% of stock demand has no defined D&S source. This demand occurs on properties that do not have a supply option from a dam, bore or waterway. These properties could either be run together with contiguous parcels that do contain a source, or they might rely on rainwater tanks or town water.

Analysis of sources of domestic water showed:

- Half of the 'D&S houses' are located on parcels of land that have no access to any of the three D&S supply sources (i.e. 'Other'). This could be because they are adjacent to parcels that share a common source of domestic water, or, more likely, the supply for many of these houses is sourced from rainwater tanks. This trend is particularly strong in the heavily urbanised sub-catchment D.
- Dams and waterways supply most of the balance. Bores contribute very little domestic water.

The survey confirmed this analysis as it found that the main water source for household use is rainwater (84.1%) followed by dams (72.7%). The least common water sources of landholders surveyed were bores (9.1%) and waterway via direct stock access (6.8%).

## 4.4. Alternative sources of water

The landholder survey sought feedback on the range of alternative sources of water supply available to landholders including private rainwater tanks and reticulated town supply from Yarra Valley Water. The survey found that, if available, these are the most common supplementing sources for D&S water.

The landholder survey found that rainwater tanks are the primary source of water for household (63.6%) and garden (58.5%) use. Over one third (36.1%) of the landholders rely on rainwater to supply all their household and garden use. This is primarily (88.9%) due to availability and the properties not being connected to town supply.

## 4.5. Timing and prioritisation of use

Timing and prioritisation of use is important as this governs when and from what source D&S water is being used. It will help greater understanding of the risks of high demand patterns at times of low flows.

The landholder survey found that:

- Rainwater tanks, bores and town supply are predominantly used year-round to supply water for household and garden purposes. Dams and waterways are mainly used in summer (December to February) for domestic use, although this use is minimal (15.9% and 6.8% of survey respondents respectively).
- Most households relied on rainwater tanks as their primary source of domestic supply rather than external sources of supply.
- It was difficult to determine seasonality of use for stock purposes. The majority of sources were used year-round, which is consistent with stock watering requirements.
- Stocking levels were generally well below standard commercial rates. This meant that demand for stock watering was below the projected levels.
- Very few landholders made use of direct rights of access to the river for D&S use.
- The preferred source used as a back-up for D&S purposes is dams (40.0%) followed by rainwater tanks (25.0%) and town supply, if available (25.0%).

As a result, the overall levels of demand were generally below the estimated lower bound figures from the modelling. This outcome reflected the characteristics of the catchment with its high percentage of small-scale life-style properties and few large commercial enterprises. It also reflected the fact that irrigated horticulture is the dominant farming enterprise sector which relies on Section 51 diversion licences rather than Section 8 Private Rights under the *Water Act 1989 (Vic)*.

# 5. CONCLUSION

It is important to quantify and understand D&S water use in unregulated catchments in the context of a water constrained future. This will improve REALM modelling and water resource management. The key findings in relation to D&S water use in the Woori Yallock catchment from this study are:

- The three level approach adopted was a robust methodology that provided alternative sources of evidence to allow cross validation of the estimated demand.
- Average D&S demand estimated by the detailed assessment is likely to be around 1,100 ML per year, which is 12 per cent of total licensed volume. This falls mid way between the upper and lower limits from the high-level model (1,700 ML and 730ML respectively).
- The survey was valuable in cross-checking the level and seasonality of demand. This confirmed that D&S usage was likely to be towards the lower end of the likely spectrum of demand.
- Dam losses are by far the largest usage related to D&S demand. Dam losses from D&S dams could be as high as 1,600 ML per year, one-and-a-half times the estimated combined use from stock watering, domestic use and curtilage supply. These dam losses are not included in the total demand or proportion total licensed allocation consistent with current policy for diversion licenses.
- Most D&S demand is supplied from dams and waterways, with very little being supplied from bores. This is particularly true of stock watering where 77% of demand comes from these two sources. The survey suggested that, in practice, most stock watering is likely to come from dams rather than waterways.
- Up to half of all relevant houses in the catchment have no access to a D&S supply and therefore rely on rainwater tanks. Alternatively, there may be more extensive access to town water sources than identified, and further work would be required to confirm this.

The data will be used to update the REALM model, which is used as part of surface water management. In addition, Melbourne Water is undertaking other projects in the catchment to better

understand water use, for example installing smart meters on extraction licences. By combining with the knowledge of D&S usage this will contribute to more equitable water sharing arrangements in response to climate change.

The methodology is transferable to other catchments, which was one of the original aims of the project. Melbourne Water is rolling out the methodology across other catchments in the Port Phillip and Westernport catchment to compare D&S usage and assist in future understanding and management.

## 6. ACKNOWLEDGMENTS

This work was conducted in collaboration with Melbourne Water Environmental Flows Team with funding from the Victorian Department of Sustainability and Environment.

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