An Assessment of Water Resources and Recharge in the Hindmarsh River, Inman River and Currency Creek Catchments

by
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Statement of Originality

This work contains no material which has been accepted for the award of any other degree or diploma in any University or other institution and, to the best of my knowledge, contains no material previously published or written by another person, except for where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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Executive Summary

The Mount Lofty Ranges lie to the east of Adelaide and contain a significant groundwater resource of low salinity. There are three catchments in the Southern Mount Lofty Ranges where minimal information exists on the sustainable groundwater yield - Hindmarsh River, Inman River and Currency Creek. Effective water allocation in this area requires information on the extent of the water resource and the relationship between surface and groundwater. As this resource is coming under increasing pressure for development it is important to develop appropriate land and water management strategies in order to ensure that future development is sustainable.

The hydrogeology of all three study catchments is directly related to the underlying geological formations which determine both the quantity and quality of groundwater in the area: Cape Jervis Beds, Kanmantoo Formation, Quaternary and Tertiary Limestone. Except for the clearly defined confined Tertiary Limestone aquifer in the Hindmarsh Tiers valley, there does not appear to be any apparent delineation of aquifers in the other formations. The Cape Jervis Bed formations are a mixture of erratic sand and clay layers and wells are completed in both. The "aquifers" in the Cape Jervis Bed formation appear to be small, local and not interconnected. The Kanmantoo Group is tapped by many bores throughout each of the study catchments and water quality and well yields appear to be highly variable and most likely dependent on the fracture zones in which the bore is completed.

There are 84 operational bores in the Hindmarsh River Catchment, 47 of which are listed as irrigation bores. In the Inman River Catchment 70 bores are listed as operational with 45 bores listed as being used for irrigation. In the Currency Creek Catchment, there are 61 bores listed as being operational and 25 irrigation bores. These bores are tapped into different geological formations which impact the quality and quantity of water they can provide.

The Hindmarsh Tiers Basin in the Hindmarsh River Catchment has a well established observation bore network with 25 years of record on water levels. Most of these observation bores are showing a decreasing water level trend over the years which is most likely due to decreasing rainfall and increasing irrigation in the area. The potentiometric surface at the lower southeastern end of the catchment appears to have decreased by 10 metres in the last 25 years.

Salinity in the groundwater varies depending on the geological formation the bore is completed in. In the Hindmarsh River Catchment, the lowest salinity concentrations are evident in the Tertiary Limestone formation and the Kanmantoo Group and Cape Jervis Bed formation appear to have about the same salinity concentrations (Cape Jervis Beds are slightly higher). In the Inman River Catchment, the highest salinity concentrations were found in the Cape Jervis Beds and the average concentrations were almost double those in the Hindmarsh River Catchment. In the Currency Creek Catchment, the

salinity concentrations of bores completed into the Cape Jervis Beds and the Kanmantoo Group had similar average salinity concentrations which were a bit lower than bores in the Hindmarsh River Catchment.

Land use in all three catchments was fairly similar with grazing being the predominant land use followed by dairy. Urban developments accounted for 2% of the land use in the Hindmarsh River and Inman River Catchments which is associated with Victor Harbour. The Currency Creek Catchment has had more land use changes in the past 6 years as the area for growing vines has doubled. Hindmarsh River and Inman River have similar amounts of native vegetation (12%) and Currency Creek has about half (5%).

Water balances were calculated for each of the catchments using direct and indirect estimations of the water balance components: rainfall, runoff, evapotranspiration and farm dam volumes. The highest rainfall was estimated for Inman River followed by Hindmarsh River and Currency Creek Catchments. These results are consistent with the weather coming from the southwest in this area. Analysis of the rainfall data indicates that since the last above average rainfall event in 1992/1993, rainfall has been below average. It is estimated that the Inman River and the Hindmarsh River have similar natural runoff volumes followed by Currency Creek. However, the volume of water reaching the lower ends of these catchments is reduced by diversions into farm dams and irrigation use. The highest water loss through evapotranspiration is in the Inman River Catchment, followed by the Hindmarsh and Currency Creek. Inman River Catchment has the highest estimated volume of water in farm dams followed by Currency Creek and then Hindmarsh River Catchments.

Groundwater recharge was estimated for each of the study catchments by three different methods producing three different results: water balance, chloride and groundwater balance methods. In the water balance method recharge was estimated to be:

- 17,152 ML for the Hindmarsh River Catchment;
- 24, 581 ML for the Inman River Catchment; and
- 6,347 ML for the Currency Creek Catchment.

The recharge estimates from the chloride method were lower by one order of magnitude and were discarded as a salt balance indicated that there is a net export of salt out of these catchments. This implies that the chloride concentrations in these catchments are not in a steady state and this method of calculating recharge is invalid.

The groundwater balance method recharge values were much lower than those estimated through the water balance method:

- 9,736 ML for the Hindmarsh River Catchment;
- 9,114 ML for the Inman River Catchment; and
- 2,721 ML for the Currency Creek Catchment.

This method is dependent on the groundwater use and baseflow and in the Inman River Catchment it was determined that there was very low usage of groundwater which in turn has resulted in a low estimate for recharge for Inman River Catchments. Therefore, the most reasonable estimate of recharge is most likely the water balance recharge results.

Water use was estimated in each of the study catchments through theoretical estimations and a field survey and estimations of domestic and stock use. The results of the field survey estimated irrigation volumes that were considerably less than the theoretical estimations. The results of the field survey should not be considered to be precise, as the rates of use provided by the irrigators were approximations only. Irrigation use in the Hindmarsh Valley Catchment appears to have increased over the years, as indicated by a two-fold increase in the irrigation use in the Hindmarsh Tiers Basin. In the Inman Valley Catchment, there does not appear to be much irrigation which is mainly due to the quality of the groundwater and surface water in the area. In the Currency Creek Catchment, there is no historical irrigation data for comparison but it is assumed that there is increasing irrigation in this catchment due to the development of vines and olive orchards. The following irrigation volumes were estimated through the field survey:

- 4,854 ML in the Hindmarsh River Catchment;
- 156 ML in the Inman River Catchment; and
- 909 ML in the Currency Creek Catchment.

The following results are for the total water use in each catchment. The higher end of each range is based on theoretical estimations only and, as seen, these numbers appear to be much higher than the estimations based on the field survey. The largest water use was in the Hindmarsh River Catchment where the total water use ranged from 5,087 to 10,382 ML per year. This catchment also had the highest groundwater use with the volumes ranging from 5,464 to 8,784 ML per year. The next highest water use was seen in the Currency Creek Catchment with the total water use ranging from 1,095 to 8,795 ML per year and the groundwater use ranging from 634 to 3,986 ML per year. The smallest water use was apparent in the Inman River Catchment with total water use ranging from 432 to 10,164 ML per year and groundwater use from 109 to 534 ML per year. The largest use of groundwater is in the Hindmarsh River Catchment followed by Currency Creek. Inman River Catchment only uses a small amount of groundwater. Caution should be taken in the accuracy of all these estimations and if more accurate data is made available, these numbers should be revised.

It has been proposed that the sustainable yield for groundwater should not exceed 75% of the estimated recharge. In the Hindmarsh River Catchment, the current level of groundwater use is most likely around 50% of the recharge for the catchment. There is intensive groundwater irrigation in the Hindmarsh Tiers Basin which has more than doubled in the last 25 years. Although the groundwater use in this catchment is below the adopted 75% of recharge, the groundwater usage should be carefully monitored on a regular basis to ensure that the reduction of water levels in the Tertiary Limestone aquifer are not being impacted further from groundwater extraction. The total water use for this catchment is slightly higher and could be up to 60% of the annual recharge.

In the Inman River Catchment, the groundwater use is very low and well below any level of concern with respect to groundwater sustainability. There is not a lot of irrigation currently occurring in this catchment due in part to the high salinity levels found in both the groundwater and surface water in the summer. There is more concern in this catchment with the surface water resource and care should be taken to ensure that dams and water diversions are constructed and managed in such a way to protect the rights of the downstream users and to ensure that there are adequate environmental flows to protect catchment ecosystems.

In the Currency Creek Catchment, the estimated groundwater use is below the estimated 50% of recharge but the total water use is approximately 50% of the annual recharge. The low groundwater use has been estimated from the results of the field survey where it was found that surface water and groundwater were used in almost equal portions for irrigation. In addition, like the Inman River Catchment, the quality of the groundwater in parts of Currency Creek deters its use for irrigation, stock and domestic use. The level of development in the Currency Creek Catchment is in more of a dynamic state than the other two catchments and future developments should be closely monitored with respect to their impacts on the existing water resources to ensure their sustainability.

Recent changes in the *Water Resources Act* have placed the burden of water management on local governments and Catchment Water Management Boards. In areas that are not proclaimed waterways, this burden is more pronounced as water management is an invasive issue and in some cases beyond the control and resources of local governments. This presents a challenge to all those involved and it is hoped that this study will in some way assist in the future management of the important water resources in the Hindmarsh River, Inman River and Currency Creek Catchments.