CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

The calculated water ratio (measured as the volume of water used per volume of beer produced) per section at the South African Breweries Rosslyn plant is shown in Table 7.1. (Note that the ratio for cellars and packaging relates to the volume of water introduced in the respective sections, and not to the total amount of water entering each section.)

Table 7.1 Summary of the calculated water ratios for each section at the Rosslyn plant.

Section	Water ratio (hl/hl)
Brewhouse	1,39
Cellars	0,93
Packaging	1,55
Overall (including general water)	4,98

The following sections address possible options to reduce the overall water usage at the plant.

7.2 CONCLUSIONS AND RECOMMENDATIONS OVER EACH SECTION AT THE ROSSLYN BREWERY

The minimisation of the water used within the brewery would ultimately result in lower effluent volumes and therefore lower effluent costs. However, since the effluent tariff is dependent on the volume and the chemical oxygen demand (COD) value, a reduction in effluent volumes could result in a more concentrated effluent. To reduce the effluent costs of the brewery to the greatest extent, the COD content of the effluent stream needs to be reduced in conjunction with the minimisation of the influent water volumes.

7.2.1 Brewhouse

Reuse of liquor from the lauter tun

A schematic representation of a portion of the brewhouse, with a recommended alteration to the system, is shown in Figure 7.1. The wastewater from the lauter tun (stream d) represents a large proportion of the water used in the brewhouse section. Once the cutoff volume to the underback (stream c) is reached, the liquor remaining in the lauter tun (stream d containing, *inter alia*, a small percentage of extractable sugars and unwanted elements), is discharged to the drains.

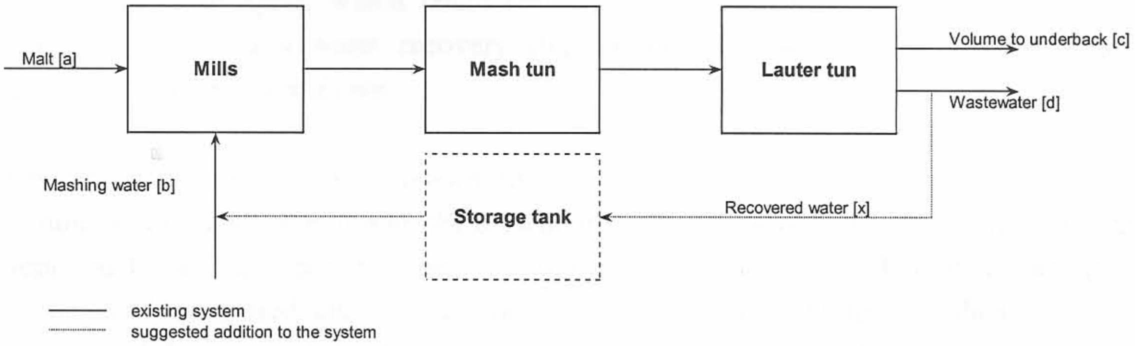

Figure 7.1 The existing system within the brewhouse at the Rosslyn plant and the recommended alteration to the system to recover liquor from the lauter tun.

The mass balance over the lauter tun in Chapter 3 reveals that approximately 39% of the process water entering the lauter tun is discharged to the drains as a part of stream d in Figure 7.1 (34 144 hl of process water per week is discharged to the drains of a total 87 424 hl of process water entering the lauter tun per week). Recovering a portion of this wastewater stream to the mills should be considered to reduce the amount of water required during milling and mashing. Laboratory tests should be conducted to determine the quality of this wastewater at different stages of the disposal to the drains, and its reuse capabilities as mash liquor in the following brew. These analyses may indicate the deterioration in the quality of the wastewater as a function of the time of disposal to the drains and a recoverable volume of water determined. This recovered water could be stored in a tank and transferred to the mash tun during milling of the next brew.

Rinse water

Approximately 29% of the wastewater from the brewhouse is due to the rinsing of vessels after the transfer of mash, mash liquor or wort to the following vessel. The solids concentration of the wastewater emanating from a rinse will decrease over time during the rinsing operation, that is, the quality of the water will improve. The water from the rinsing processes could be diverted to a separate storage vessel once the quality of the rinsing water is acceptable (for further use, to be determined from plant trials). This water could then be used as the first, or initial, rinse water of vessels during the next brewing cycle, resulting in a reduction in the volumes of water used for rinsing in the brewhouse. However, the cost associated with such a system, and the process viability of the recommendation, should be investigated.

Cleaning water
Approximately 21% of the wastewater from the brewhouse is due to the CIP cleaning of the vessels. The brewhouse at the Rosslyn plant does not have a water recovery system within their CIP cycle, which could result in substantial water savings. The process viability of adding a water recovery step to the CIP cycle should be investigated, similarly to rinse water above.

Control of the flowrates in the brewhouse
A number of the streams within the brewhouse at the Rosslyn plant are not measured and supplied by a single pump station, as explained in Chapter 3. This could affect the volumes of water used and also have quality implications on the final product. The areas of required flow control should be identified and flow meters installed. This will result in better control of the process and a better understanding of the water volumes used within the brewhouse.

Evaporation
5 024 hl of water is evaporated from the wort kettles with the steam containing small amounts of volatile compounds. Condensing the steam and removing volatile compounds through the use of, for example, activated carbon filters, the resultant water may be used for other purposes, like rinse and/or CIP water.

7.2.2 Cellars

Cooling water
240 hl of water per week is utilised for cooling the centrifuge during the racking process and is discharged directly to the drains. However, if this water is collected, it could be reused as cooling or cleaning water.

Water used during filtration
3 500 hl of water per week is used during backwashing of the filters. Prior to the transfer of beer to the filters, the filters are also precoated with filter aids and an average of 3 514 hl of water per week is used during this process and discharged to the drains. Depending

on the quality of the precoat water, it could be recovered and used as backwash water during the backwashing cycle.

Transfer water

Water utilised to transfer product between vessels forms approximately 16 % of the total water introduced into the cellars section. The transfer function is controlled in most cases by a timing system and optimisation of these times needs to be undertaken. Sections of plant where transfer water can be recovered and stored in separate vessels for reuse should be identified. Depending on the quality of recovered water, it may be utilised for other purposes, possibly washdown of the cellars section.

Cleaning water

The cellars section at the Rosslyn brewery has two CIP stations, each equipped with a water recovery system. These stations are capable of cleaning more than one vessel or pipeline system simultaneously. However, since each CIP station is equipped with only one vessel to store recovered water, recovery of the final rinse in a CIP cycle does not necessarily occur. (The CIP cycles of all the vessels and lines are not all the same and no schedule is in place when cleaning more than one vessel at the same time. The timing of the CIP programme needs to be investigated and optimised. Should the system and changeover between solutions be correctly optimised, substantial water savings within the cellars section are expected.

7.2.3 Packaging

Bottle washer rinsing water

59 850 hl of water is used, on average, by the three bottle washers per week. The bottle washer ultimately ensures that bottles returned from trade are cleaned before reuse. However, new bottles are also entered into the system and cleaned in the bottle washer, despite the fact that they are theoretically clean. The viability of either introducing these new bottles later on the line, or diverting them past the bottle washer (only to be rinsed before filling, as on the can and nonreturnable bottle lines) should be investigated. This will reduce the number of bottles being cleaned by the bottle washers, and the subsequent water used in the process.

In addition, the 59 850 hl of potable water used for rinsing is discharged to the drains. This water could rather be utilised in the crate washers where the quality of water used plays a lesser role, as the crates do not come into contact with the beer product.

Vacuum pump water
Similarly to the centrifuge cooling water in the cellars section, the 930 hl of water used per week by the vacuum pump is discharged to the drains and should rather be collected and reused, since very little deterioration in the water quality occurs.

After filling rinsing water
After the bottles are filled with beer they are rinsed with 4 062 hl of water (per week by the three lines) and this water discharged to the drains. However, this water could be reused for this rinsing cycle since the percentage of impurities in the water is normally not very high. The quality of this water should be checked regularly and once the quality deteriorates below a certain level, it can be discharged to the drains.

Can and nonreturnable bottle lines rinsing water
Before filling the cans and nonreturnable bottles with beer, they are rinsed with water which is discharged to the drains. 3 825 hl of water per week is used to rinse these containers. The quality of the discharged water is good and should either be recycled to the bottle or crate washers, or used as washdown water within the packaging hall.

Pasteuriser on the can line
The pasteuriser on the can line uses an average of 14 700 hl potable water in its final zone, which is discharged to the drains. As discussed in Chapter 5, this practice has been adopted to ensure that the cans are clean before packing into trays. However, the water used within the final zone should rather be recycled to the cooling towers and the cans rinsed with potable water on exiting the pasteuriser.

7.2.4 General water

Activated carbon filters
The effluent generated during backwashing and regeneration of the activated carbon filters is of sufficient quality to be used for other purposes in the brewery. These may include, *inter alia*, washdown of floors or equipment and toilet facilities.

Washdown water
The use of high pressure hoses should be managed and a culture change instilled to stop cleaners from unnecessarily using hoses in each section. Since volumes of water associated with the washdown of equipment and floors are not controlled or reported, management is unaware of the impact of this use on the volumes of water utilised and

volumes of effluent generated. Since the brewery floors and equipment should be clean and tidy, washdown is essential. However, the quality of the water used does not need to be of drinking water standard and recovered water, as suggested in Section 7.2, can therefore be used.

Other uses

Water brews are conducted before the start-up of production and the water leaving the vessels and lines is of sufficient quality to be utilised as, *inter alia*, rinse or washdown water.

As discussed in Section 6.2.2, water from the chilled liquor tanks is discharged to the drains when a temperature deviation occurs. This water should be transferred to a storage facility and utilised for other purposes including, *inter alia*, rinse or washdown.

A high volume of water is utilised as a coolant by the ammonia condensers each week. This water does not come into physical contact with the ammonia and is of a relatively high quality. It is recommended to investigate the development of a system where the water vapour is recaptured, condensed and reused within the cycle.

7.3 THE DEVELOPMENT OF AN INTEGRATED WATER RECOVERY SYSTEM

As seen thus far, each section within the brewery has the potential to optimise its water usage. However, the installation of many small storage facilities with associated piping will have high cost implications. Therefore an integrated approach to water minimisation should be taken. In conclusion, it is recommended that all opportunities to minimise water usage in a section should be identified and a centralised water collection point be developed where water with the potential to be reused can be stored. This will involve developing a water network within the brewery collecting water from the areas where the major losses occur. The quality of this water should be analysed and its use for washdown or other purposes investigated.