Nile Brewery Ltd.

UN Cleaner Production Assesment
Water and Waste Water

Job No. 18884-001-003

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1 Summary

United Nations Environmental Programme have asked Danbrew to conduct an assesment of Nile Brewery Ltd. in order to identify the potential of saving water and to verify the Cleaner Production methods are appropriate remedies to achieve this potential.

The assessment is part of the ABREW project with the aim of identifying the total potential of water consumption and waste water reductions in the African Brewing Sector. The outcome of the project will be a well documented strategy for implementation and thereby potential funding.

The purpose of Cleaner Production is to continuously reduce consumption and discharge during production. One of the main ideas is that high consumption production facilities can reduce usage by 20 to 50% without investing in new equipment. Instead of new equipment an effort for training and re-engineering the processes is suggested as a remedy.

The report covering assessment of Nile Brewery Ltd. has three parts; Pre-assessment, In-plant assessment and Feasibility Studies.

The Pre-assessment is based on data sent to Danbrew by Nile Brewery Ltd. The data have been computed and the results have been verified by the brewery on the first day of the in-plant assessment. The Pre-assesment shows that Uganda Breweries Ltd. is a medium water consuming brewery with a water / beer ratio of 7.2. Low consuming breweries have a ratio of 5. However, there is uncertainty around the water usage due to other meter readings indicate a water ratio of 7.8. Brewhouse accounts for most of the excess consumption, but also Packaging, Utilities and Domestic, Office, Canteen & Garden have the potential for reducing water consumption and discharge. During the last 20 months there has been a trend of excess water usages in all function except Packaging.

The 2 day “In-plant” assessment revealed a brewery with efficient processes but with areas of poor water housekeeping. Especially the many leaks and overflows leave room for improvement of water usages that does not require major investments.

Brewhouse is the major water consumer at Nile Brewery Ltd. compared to the benchmarks. The assessment revealed that some of the problems were related to measuring problems that both create uncertainty towards the overall water consumption and also uncertainty of the water usage in Brewhouse and Beer Processing. The measurement problems make water management difficult. The assessment also showed that there was no automated CIP system at Nile Brewery Ltd. which causes large water and caustic usage.

The beer losses in Beer Processing appeared to be very high. A good solution to this is yeast recovery which can be installed at a little extra cost together with the yeast dryer that already is planned. Potentially this could save 180,000 hl/year of water a year including 22,500 hl of green beer.

Water saving in the Packaging department is dependant on services, investment in new equipment as well as extended maintenance. The equipment is hard pressed to

meet sales requirements which in turn allows little down time for maintenance, a vicious circle.

In low consuming breweries the Warehouse, Domestic, Office, Canteen & Garden only account for 0.05 of the beer / water ratio. In Nile Brewery Ltd. t is 0.2. A way to reduce the water consumption would be to reuse more of the waste water once treated, for gardens and toilets, etc.

The in-plant assessment of the management systems showed that their attention is paid to water saving due to standards set by the SAB Miller Group. This has also been the driver for the brewery achieving ISO 14001 certified status.

Nile Brewery Ltd. monitors the water usages together with other Key Performing Indicators (KPI) on billboards around the brewery. The responsibility for this KPI and the water consumption is placed on the Utility Manager who works hand in hand with other departments. A further effort in this area could be to break the target down into departments making these managers also responsible.

The feasibility study for investments in new equipment covers a semi automated CIP plant and a new vacuum pump, since those are the obvious suggestions that require major investments.

An investment in a semi automated CIP plant will be 550 M UGX and the water saving is can not be calculated from the available information, but can be up to 800.000 hl/year. The feasibility study shows that the investment is quit feasible in a financial perspective.

A new vacuum pump cannot be financed by the saving in water. Alternatively it is suggested to recirculate the cooling water using existing cooling facilities and equipment. The water saving potential is 80,000 hl/year.

The conclusion of the assessment of Nile Brewery Ltd. is that there is potential water saving of more than 2.7 million hl/year or 45% and there is equivalent potential of waste reduction.

The UN assumption of 32 hl water per hl beer at African Breweries cannot be confirmed. The comprehensive metering at the brewery that Danbrew have confirmed shows a water ratio of 7.8 (7.2).

Since Nile Brewery Ltd is medium water consuming the Cleaner Production assumptions for high and low consuming breweries does not apply directly. For Nile Brewery Ltd. the approach would first be to focus the action in the two less expensive areas of Cleaner Production; Training and Engineering. It this sense Nile Brewery Ltd. falls in the category of High water consuming breweries.

The recommendation is to focus on the management follow-up, the measurement and training of people, which is expected to provide savings from fewer leaks, overflows and unnecessary water usage.

2 Introduction

This assessment of the water consumption and the waste water discharge at Nile Brewery Ltd. is part of a UNEP project covering the Water consumption in African breweries. The project is named Abrew and is funded through the UN. Danbrew was commissioned to conduct the assesment.

2.1 Objectives

The objective of the Abrew project is to

- identify the potential for water savings in the African brewery sector and suggest solutions.
- develop a UN project for external funding for implementing water conservation measures in the brewing sector and subsequently in the entire beverage sector in Africa.

The objective of the assessments is to test the preliminary assumptions of the Abrew project such as

- African breweries have a water usage of 32 hl water per 1 hl beer.
- Cleaner Production methods are assumed to generate savings of 20 to 50%.

These two assumptions together with the assumption that African breweries can contribute with 171 million m^3 of water saving.

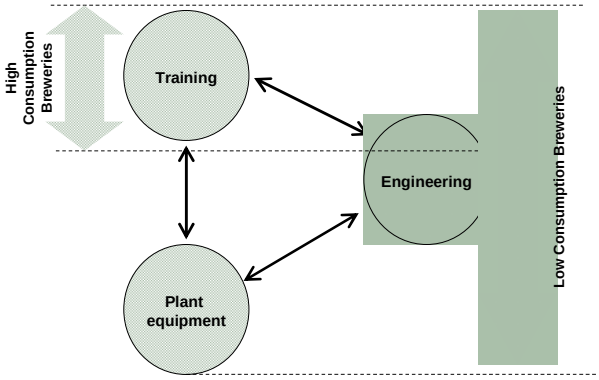
The objective of the assesment is also to test the Cleaner Production (CP) approach for the African Brewery sector. This is done by using an Audit tool developed by Danbrew for CP assessments of water consumption. The results of the test will be incorporated in the audit tool.

2.2 Methodology

The methodology of the assesment is derived from the CP manual from UNEP: Environmental Management in the Brewing Industry (Technical Report N° 33).

The purpose of CP is to continuously reduce consumption and emissions from production processes, products and services. The preferred CP option is reduction of waste at source[1].

Upgrading a brewery in order to implement CP, requires action in three areas that are interrelated as illustrated below. Action in one area without taking complementary action in the other two areas may greatly reduce its effectiveness[2].

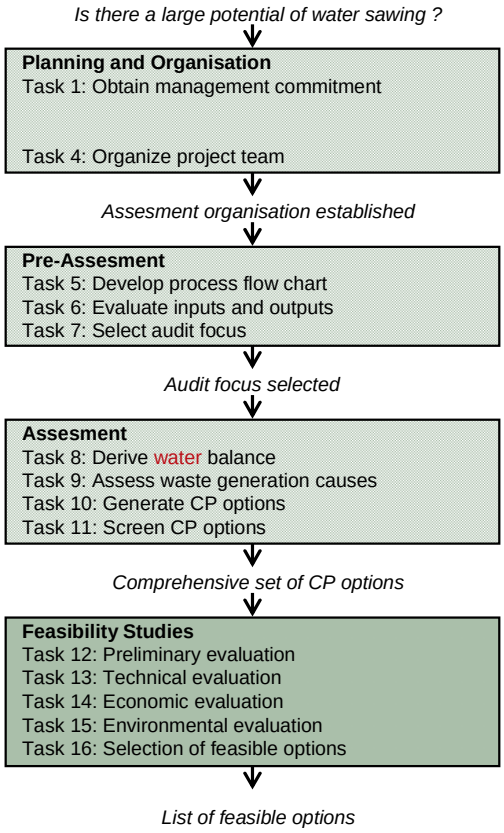


High Consumption Breweries can immediately achieve substantial reduction by addressing management issues and small changes in ancillary operations and process systems.

Low Consumption Breweries need to begin focusing on all three functional groups in detail.

The process of a CP-assessment is described in Technical Report N° 33[3]. Normally the process would be initiated by the brewery, but in this situation the process is initiated by UNEP with a reduced objective compared to normal CP. Therefore the process is reduced to the following:

[1] Technical Report N° 33, p. 39
[2] Technical Report N° 33, p. 40
[3] Technical Report N° 33, Annex 5 p. 101



Compared to the normal CP-assesment approach the implementation & continuation phase is not included, neither are the tasks of identifying barriers and solutions (task 2) and set up of plant wide CP goals (task 3).

Only the assessment phase has been conducted on site at the brewery. All other phases have been done at the premises of Danbrew. The pre assesment has been done on the basis of a questionnaire and a water audit tool. The purpose of the questionnaire is

1. to get a basic impression of the brewery

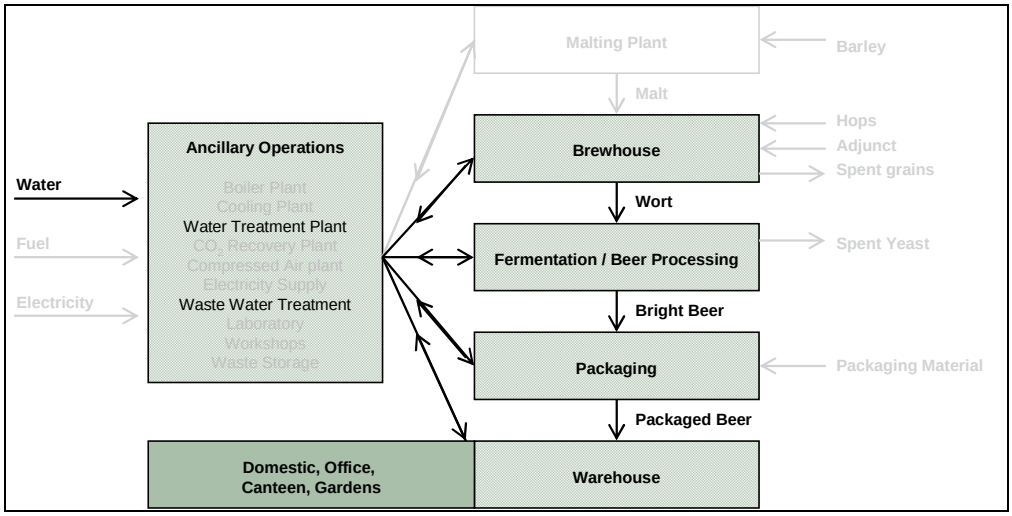
2. to provide material balance data for the water audit tool

The Assesment has been done by doing a tour of the brewery following the water flow (water flow tour) and by interviewing relevant people at the brewery. The water audit tool is more thoroughly described in the section below.

2.3 Water Audit Tool

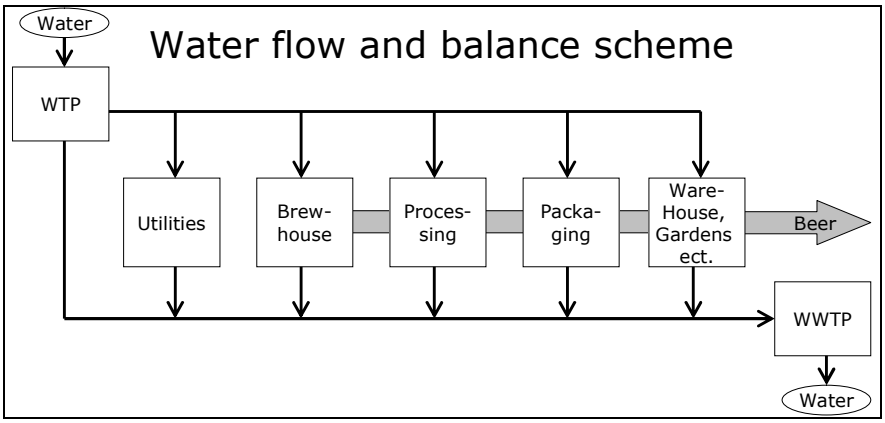
The purpose of the Water Audit Tool is to provide a guide line for the water balances in each part of the process. This requires a process overview, measurements for the relevant parameters and benchmarks. With this information potential water saving can be calculated for each part of the process in order to focus the effort on saving water. But the tool also intends to support the decision process of implementing water saving initiatives by calculating the value of the water saving.

The brewing process is described generically in the Technical Report[4]. The generic process also includes other inputs than water and it includes the malting process. For the purpose of an Audit with focus on water usage the holistic process from the Technical Report needs to be simplified. This is illustrated below in the schematic layout of a brewery. The functions of Domestic, Office, Canteen and Gardens have been added to the model as an entity together with the Warehouse.



A further simplification of the water flow is illustrated below and is the platform of the Water Audit Tool, which is used in the water CP-assesment of the brewery.

[4] Technical Report N° 33, p. 19



For each of the functions in the process a water balance can be made that defines

1. Input of water
2. Output of beer
3. Output of beer loss
4. Output of waste water
5. Quality of waste water (kg. COD/HL) (only total)

The actual readings can be compared to benchmarks and potential saving can be calculated as the difference between the actual and the benchmark. The focus area of the in-plant assesment should be where the largest potential saving exists.

In order to motivate a water saving effort the water savings are theoretically converted into amounts. This is done from two perspectives; The input / output perspective and the Beer loss perspective.

The input/output perspective is based on the assumption that efforts to reduce water consumption at the brewery will also result in saving of other consumptions and in lees output of waste water. A major input to the brewery is energy that is used to circulate the water around and both to cool and to heat the water. The water audit tool calculates the potential saving on energy by a simple extrapolation between the low and high consuming benchmarks. This approach is used on malt and adjunct, energy, fuel and waste water, and the price of all these input and output are therefore part of the data collection. It could be argued that workforce should also be included as well as the cost of the equipment, but the aim is to keep the model as simple as possible and secondly to stay in line with the input/output definitions of the UN Technical Report No 33.

The beer loss perspective is relevant in the sense that beer loss is also loss of water and that the value of beer is high since it is the product of all the inputs to the process.

Both perspectives are based on the assumption that a reduction in water usages will result in reductions according to benchmarks in other fields of the process. This is a very rough assumption, but experience with Lean manufacturing shows that such rough simplifications work. Lean manufacturing is also based on an assumption that focusing on waste and continuous improvement will reduce cost.

2.4 Evaluation of the tool used at the pre-assessment.

Originally the tool was built using Microsoft Visio with Excel objects incorporated, but during the pre-assessment it became evident that this solution was not sufficient. This was due to both IT problems with the Excel and Visio links. But also the fact that the solution could not handle larger time series.

The development of water usage during the last two years has proved to be important and therefore the tool has now been developed using Excel with the ability to analyse the data of up to two years.

It also became clear during the assessment that the metering in most breweries is not consistent. The reason for this is that metering of water is not normally being prioritised during e.g. installation of new equipment. Therefore meters are sometimes not in the right places which make it difficult to calculate the water balance. One day during the visit at the brewery should be allocated to go though the data and the results from the pre-assessment to have them verified.

The tool is designed for monthly recording of data instead of the most common standard at breweries of weekly recording. This reduces the data in the model significantly, but makes it difficult to us as a tool for ongoing management follow up at the brewery.

3 Pre-assessment

The pre-assessment of Nile Brewery Ltd. (NBL) took place in the period from November 2006 when the questionnaire was submitted until the first day of the visit at the site January 17, 2007.

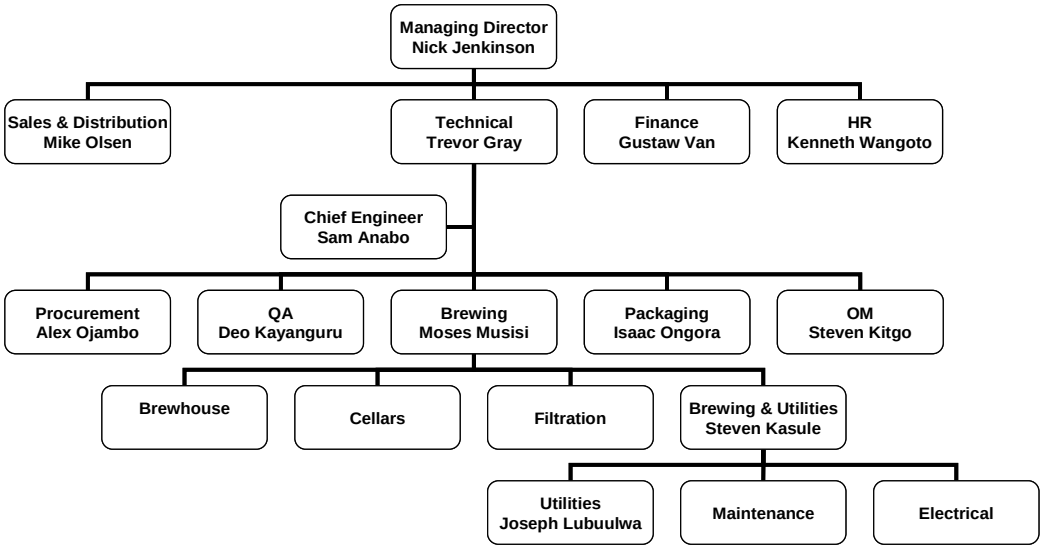
The purpose of the pre-assessment is to analyse the water balance of the brewery and from that derive the focus areas that needs to be addressed during the in-plant assessment.

Data has been provided for a 20month period. Data is not complete and has therefore been extrapolated by Danbrew.

3.1 Organisation

NBL is owned by SAB Miller. NBL is situated in Jinja and SAB has HQ in South Africa.

The management contact person for the project was the Technical Director Trevor Gray. The appointed operational contact person was the Utility Manager Joseph Lubuulwa. The organisation of NBL is as shown below.

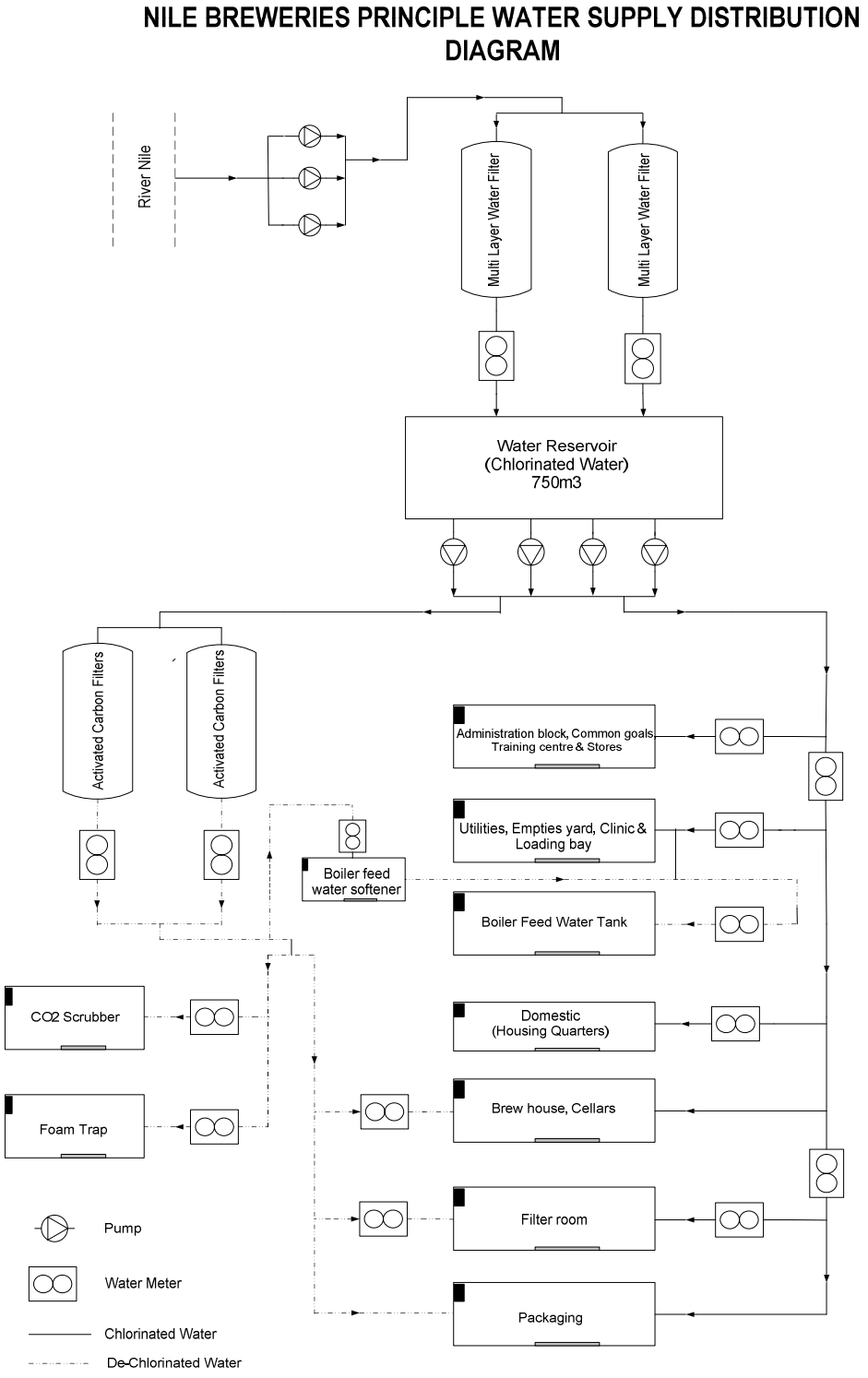


3.2 Production information

The brewery has an annual production in 2006 of 745,000 hl. of beer with a peak month production of 11.6%. The brewery produces 5 brands; Club Pilsner (15%), Nile Special (28%), Eagle Extra 43%, Eagle Ordinary (4%) og Chairmans Extra Strong Brew (10%). The main part of production is filled in 500 ml returnable glass bottles. Kegs exist but are used very little.

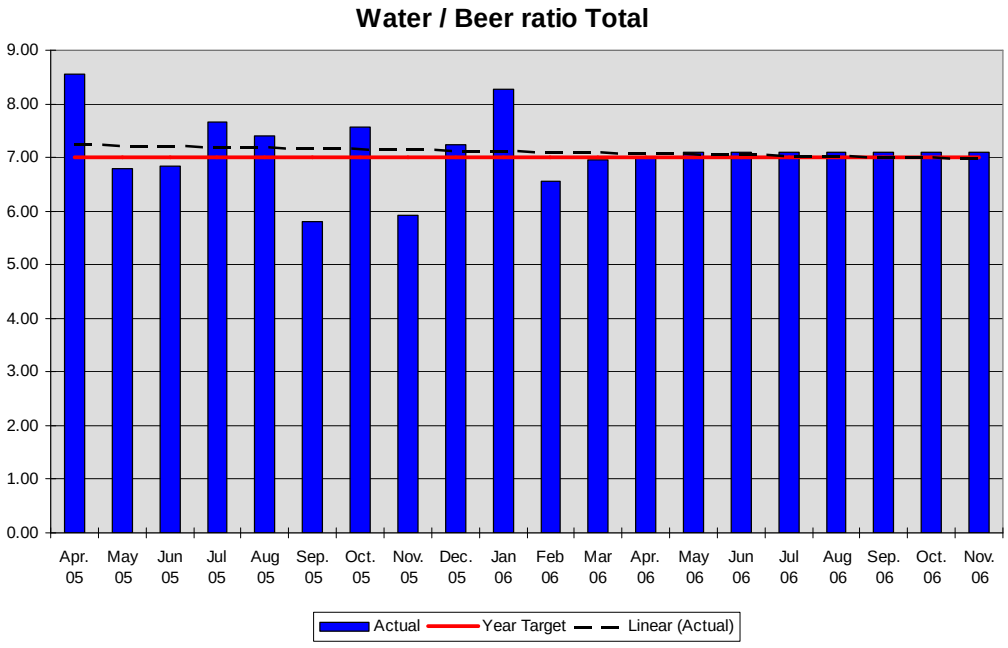
The brewery has 7 working days with 3 shifts of 8 hours except for packaging where there is 5 working days a week. The brewery is working close to maximum utilisation. In packaging there is one line with a capacity of 36,000 bph. The line works with an efficiency of 71%.

3.3 Water flow diagram provided by NBL



3.4 Overall water intake

The water intake to the brewery has been slightly decreasing during the last 20 months with an average volume consumption in 2005 of 7.4 hl water per hl beer to an average in 2006 of 7.2. This development is illustrated in the graph below. The red line in the graph is the target set by Technical Director. The history of the company shows a more significant development from a ration of 15.4 in 2003 and 9.4 in 2004.



3.5 Water balance

The 2006 water balance of NBL is illustrated below. The water balance shows that there exists potential savings in 4 out of 5 functions of the brewery.

Calculating the water balance has revealed discrepancies between the overall water intake meter readings and the sum of the water intake meter readings for each function. The sum of the functional meter is approx. 250,000 hl higher that the overall water intake meter reading. Some of the meters can have been out of order for a period and readings can have been miscalculated due to the complexity:

The positions of the meters are illustrated in section 3.3, and it is evident that meters are not optimally placed, which creates an unnecessary complexity to the assessment of water usages.

In some of following schemes the discrepancy has not been adjusted, so the sum of the functional water ratio is 7.81 while the actual reading on overall water intake meter gives a ratio of 7.16.

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
Beer sold	**1**	**1**	**-**	762,220	762,220	**-**
Water intake in HL						
Utilities	0.72	0.25	0.47	547,436	190,555	356,881
Brewhouse	3.07	1.25	1.82	2,336,789	952,775	1,384,014
Beer Processing	0.76	1.45	0.00	578,043	1,105,219	0
Packaging	3.07	2.00	1.07	2,343,332	1,524,440	818,892
Warehouse ect.	0.19	0.05	0.14	145,670	38,111	107,559
Total water intake	**7.81**	**5.00**	**3.50**	**5,951,270**	**3,811,099**	**2,667,347**
Waste water						
Wastewater in HL	6.36	3.5	2.86	4,847,736	2,667,769	2,179,966
COD kh	0.99	1.00	0.00	756,247	762,220	0
BOD kg	0.66	0.80	0.00	504,165	609,776	0
Beer losses in hl						
Brewhouse	0.0130	0.0100	0.00	9,909	7,622	2,287
Processing	0.0520	0.0250	0.03	39,635	19,055	20,580
Packaging	0.0180	0.0150	0.00	13,720	11,433	2,287
Warehouse	0.0000	0.0005	0.00	0	381	0
Total beer loss	**0.083**	**0.051**	**0.033**	**63,264**	**38,492**	**25,153**

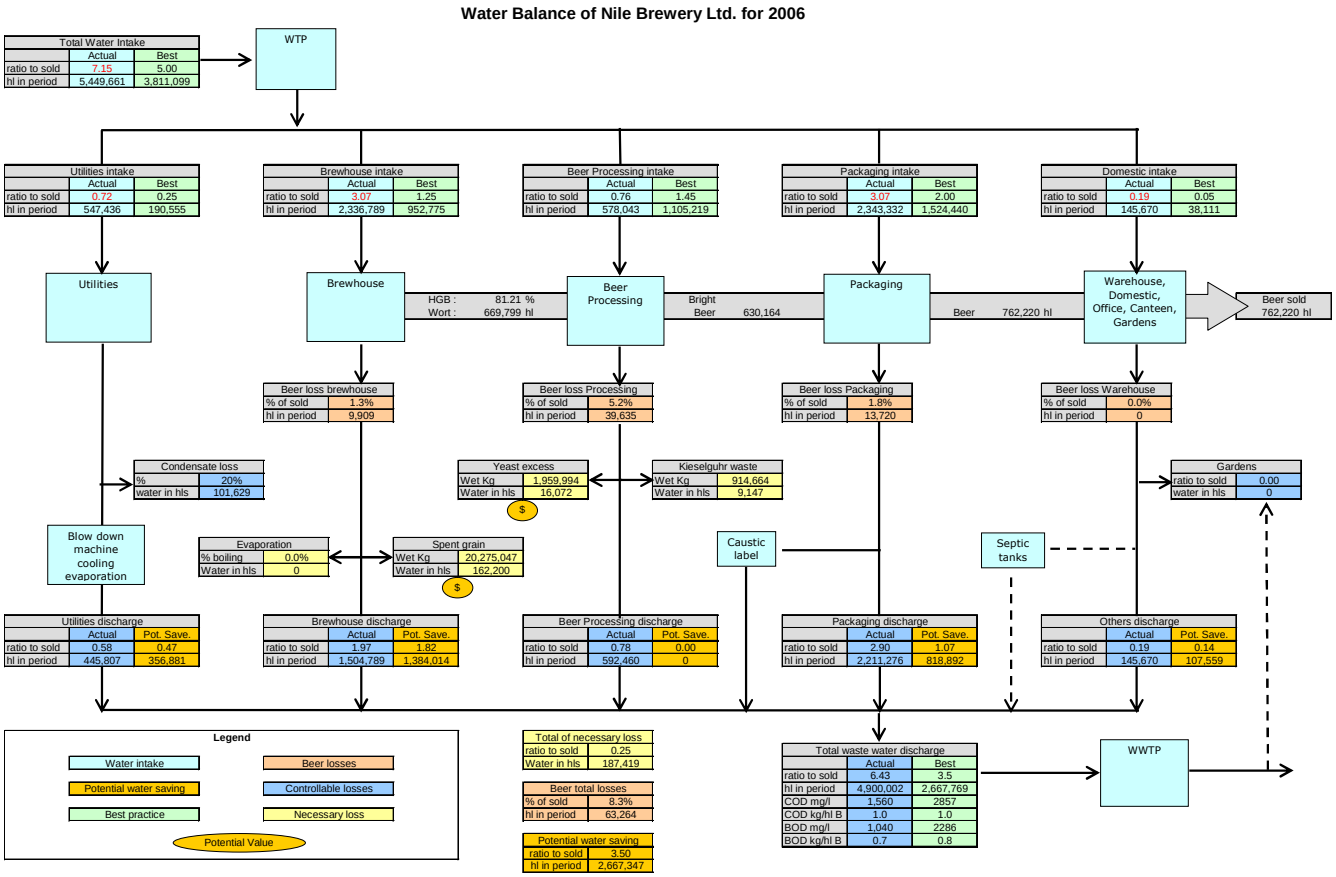
The most significant saving is within Brewhouse where the water intake is equivalent to a water/beer ratio of 3.1 where a low consumption brewery is doing 1.3. The potential saving is calculated to 1.3 million hl./year

Secondly, Packaging seem to have potential savings of 0.8 million hl if the water ratio is brought down from 3.1 to 2.0.

Thirdly, there is a potential at Utilities where the ratio is 0.7 compared to low consumption ration of 0.3. The potential saving is 0.4 million hl./year.

The fourth area is Warehouse, Domestic, Gardens, Office and Canteen with a potential saving 0.1 million hl. due to a present ratio of 0.2 compared to low consumption ratio of 0.1.

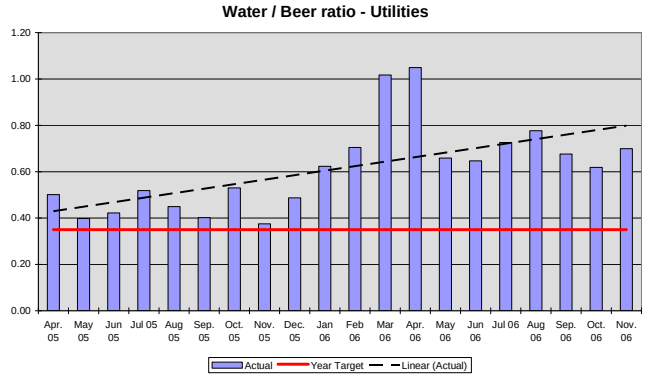
The complete flow of the water as well as Beer is illustrated in the model below:

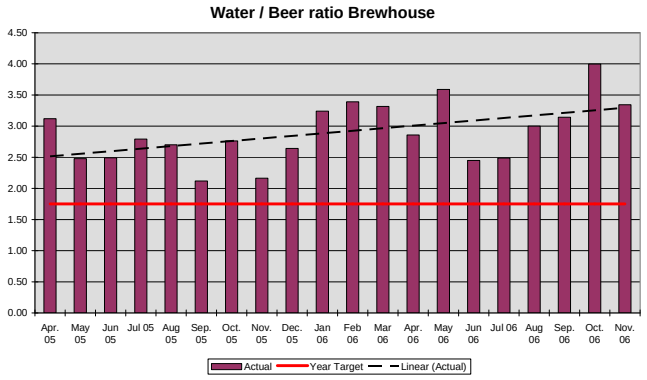


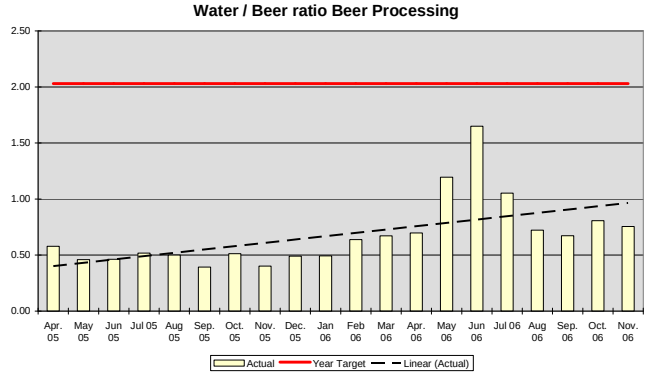
3.6 Water intake development per function

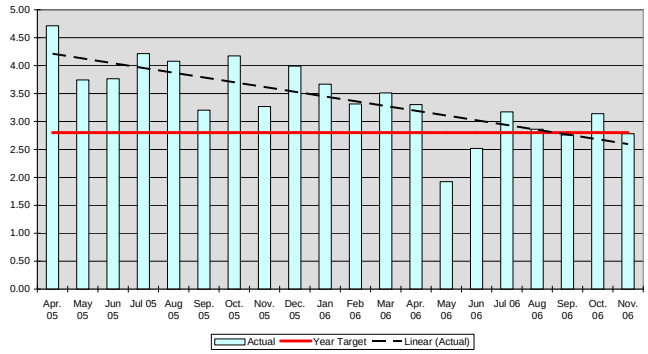
The trend analysis from section 3.4 shows a small overall improvement during the last 20 months. The driver of the improvement is Packaging as shown below. All functions except Packaging are actually consuming more water during the period.

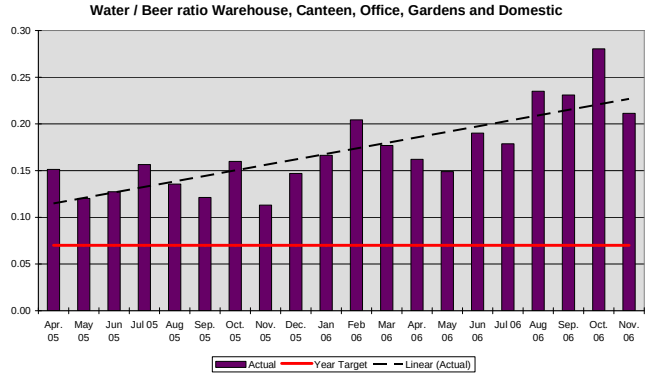
In this perspective the brewery is on a wrong path.











3.7 Water usages in a financial perspective

Saving water will normally result in savings in the cost of acquiring water. Since NBL pays a flat fee for the right to extract water from the Nile River there are no direct variable costs associated with the water intake, neither is there any variable cost associated with the waste water disposal discharged back in to the river (just a flat fee).

If we on the other hand assume that water saving is related to the intake of other materials as well as the amount of waste products and by-products, the financial implication can be estimated from this by extrapolating between high and low consumption benchmarks using the water consumption as the indicator. The result of such extrapolation might be as follows:

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
Extrapulated effect on other input/outputs						
Malt / adjuct in kg	15.71	15.00	0.71	11,972,727	11,433,297	539,429
Energy in MJ	197.18	150.00	47.18	150,294,939	114,332,974	35,961,965
Electricity in kWh	12.36	10.00	2.36	9,420,296	7,622,198	1,798,098
Spent grain	15.47	15.00	0.47	11,792,917	11,433,297	359,620
Excees yeast	3.00	3.00	0.00	2,286,659	2,286,659	0

Given the following unit prices

Cost of Malt/Adjunct per kg	967.50	UGX
Cost of Energy per MJ	18.69	UGX
Cost of electricity per kWh	123.00	UGX

the financial effect of such extrapolation would be yearly savings of 1.4 billion UGX as shown below:

	UGX			UGX		
Financial effect on inputs						
Cost of Water	0.00	0.00	0.00	0	0	0
Cost of Malt / adjuct	15,197.21	14,512.50	-684.71	11,583,613,211	11,061,715,195	521,898,017
Cost of Energy	3,685.01	2,803.28	-881.74	2,808,790,655	2,136,714,588	672,076,067
Cost of Electricity	1,520.16	1,230.00	-290.16	1,158,696,468	937,530,383	221,166,085
Total inputs	**20,402.38**	**18,545.78**	**-1856.60**	**15,551,100,335**	**14,135,960,166**	**1,415,140,168**
Financial effects on outputs						
Cost of Waste Water	0.00	0.00	0.00	0	0	0
Value of spent grains	154.72	150.00	-4.72	117,929,170	114,332,974	-3,596,196
Value of excess yeast	0.00	0.00	0.00	0	0	0
Total outputs	**154.72**	**150.00**	**-4.72**	**117,929,170**	**114,332,974**	**-3,596,196**
Financial total	**20,557.10**	**18,695.78**	**-1861.32**	**15,669,029,505**	**14,250,293,140**	**1,411,543,972**

Another perspective of the savings would be to look at the cost implication from beer losses and assume that an effort to reduce water usage will affect the beer loss. The financial effect would then also be around 1.4 billion UGX as shown below:

	Per HL of Beer Sold			Total of the brewery		
	Actual	Low Consumption Brewery	Savings potential	Actual	Low Consumption Brewery	Savings potential
	UGX			UGX		
Beer loss						
Cold Wort	409	315	94	312,069,120	240,053,169	72,015,951
Bright Beer	2,700	1,298	1,402	2,058,098,840	989,470,596	1,068,628,244
Packaged Beer	2,520	2,100	420	1,920,793,956	1,600,661,630	320,132,326
Beer loss total	**5,630**	**3,713**	**1,916**	**4,290,961,916**	**2,830,185,395**	**1,460,776,521**

The savings in both the beer loss perspective and the input/output perspective give a clear indication of the financial potential of savings.

This is of course based on the assumption that the effort of reducing water usage will affect the usages of other materials and wastes equivalently. An in-plant assessment of the potential should provide a better indication.

3.8 Audit focus for the in-plant assessment

The focus of the in-plant assessment of NBL is:

	Actual ratio Peak / non peak	Low Consumption Ratio	Potential savings
Major loss at Brewhouse	3.10	1.25	1.4 million hl/year 0.7 billion UGX
Medium loss at Packaging	3.07	2.00	0.8 million hl/year 0.4 billion UGX
Medium loss at Utilities	0.72	0.25	0.4 hl/year 0.2 billion UGX
Medium loss at Warehouse, Gardens, Canteen, Office & Domestic	0.19	0.05	0.2 hl/year 0.1 billion UGX

In order to target the focus areas the following people should be interviewed:

- Deo Kayanguru, QA Manager
- Alex Ojambo, Procurement Manager
- Isaac Ongora, Packaging Manager
- Joseph Lubuulwa, Utilities Manager
- Moses Musisi, Brewing Manager (and his direct subordinates)

4 In-plant assessment

The in-plan assessment of Nile Brewery Ltd. (NBL) has taken place in the period from January 18 until January 19, 2007.

The purpose of in-plant assessment is to identify the causes of high water consumption and discus possible solutions with the people involved in the following functions in the process:

- Brewhouse
- Beer Processing
- Utilities
- Warehouse / Domestic

Beer losses are higher than perhaps they should be. This loss is especially in the Brewhouse and in the Cellars.

The In-plant assessment is based on a tour of the brewery following the flow of the water from the water treatment plant to waste water outlet. The focus areas will be subject for a more thorough investigation and interviews with key persons. Furthermore, the ISO 14000 plan has been a valuable source.

4.1 Water Tour

The brewery is fairly well maintained and is being kept clean and tidy but with several water leaks and overflows in all functions of the brewery.

Almost all equipment in the brewery has an age less than 15 years, and therefore the leaks cannot be due to old equipment.

The brewery is highly utilised and is presently undergoing expansions in most functions.

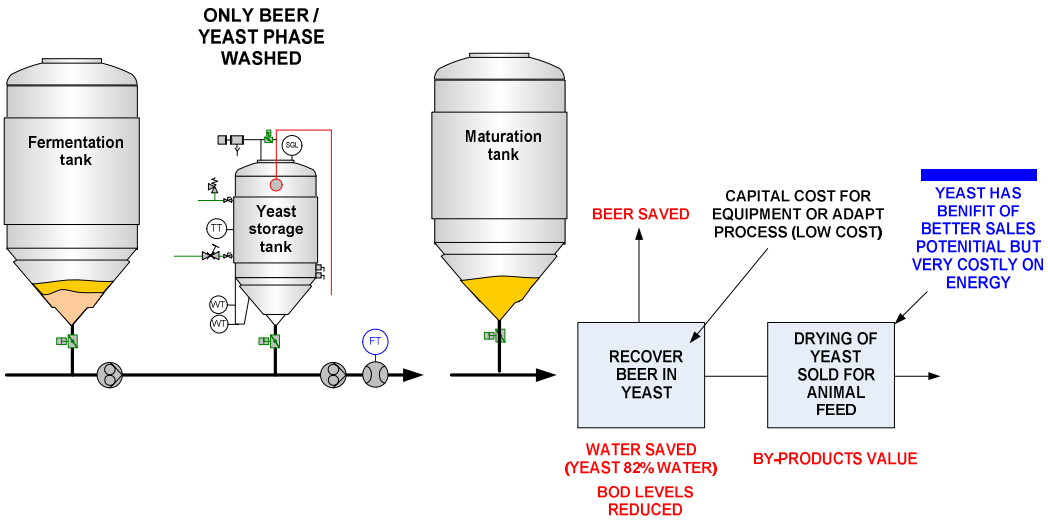
4.2 Brewhouse (and Beer Processing)

The pre-assessment showed that the Brewhouse was using 2.4 million hl water a year at a water/ beer ratio of 3.1. This gives a potential water saving of 1.4 million hl.

The assessment showed that Brewhouse and Beer Processing cannot be separated without ambiguity. Therefore the following includes issues from both Brewhouse and Beer Processing.

The first finding during the assessment was that NBL does not dispose of the yeast appropriately. This also causes high BOD levels (which will be an added burden for a future effluent plant) and result in high beer losses:

One way of saving could be excess yeast recovery following the principle illustrated below:



There is a potential of recovering 2% of lost beer. This is equivalent to water saving of 180,000 hl/year.

In contrast to the more common yeast recovery method of ceramic cross flow this suggestion involves less investment, but there is a risk of affecting the beer quality. Breweries using this method have differing results. The brewery is already planning to invest in a yeast dryer which will include a tank for yeast. Therefore, the above process could be implemented almost without any investment.

The second finding showed that there is a high beer loss during transfer to filtration. To reduce this it is suggested to use a small dilution factor before the high gravity brewing dilution point, i.e. chasing with deaerated water.

The third finding showed that the cleaning procedures are open ended as NBL does not have an automated CIP plant. High water loss in the Cellars could well be due to the current CIP procedures, that also causes a high usage and loss of caustics. The picture below from the brewery shows an example of hot caustic water outlet to the drains.

4.3 Packaging

The pre-assessment showed that the Brewhouse was using 2.3 million hl of water a year at a water/ beer ratio of 3.07. This gives a potential water saving of 0.8 million hl.

The vacuum pump in Packaging is using large quantities of water for cooling the pump. It is estimated that the pump uses 10 hl/h or approx. 80,000 hl. year. There are two solutions to this - both involving new equipment. The vacuum pump can be replaced with a non-water using vacuum pump or the water from the water pump can be cooled down again and reused. Such solutions would require a cooling tower.

4.4 The Warehouse, Domestics, Office, Canteen and Gardens

The water usage in Warehouse Domestics, Office, Canteen and Gardens is 0.1 million hl. at a ratio of 0.2. This is a considerable excess compared to low consuming breweries where the ratio is 0.05.

The in-plant assessment did not give any reasons for the high usage other than there where large areas of the gardens that would need watering during dry periods and the water from the Waste Water Treatment Plant could be used for this. This solution could also apply for the toilets, even though there was no indication of the toilets being the cause of the high usage.

4.5 Management and Training

In different places around the brewery the management presented the past weeks' results on billboards. The example below is a billboard with all indicators that determined the SAB Miller contest of "brewery of the year". The small diagram in the top left corner is the water usage.

The billboard clearly demonstrates the management's attention to water usages at the brewery, and the driver is the incentives given from HQ of SAB Miller who determined the indicators.

The Utility Manager is responsible for the water usages and the water/beer ratio is set to be less the 6 for year 2007. This aim is set by the Technical Director, but it has not been broken down into each of the functional areas of the brewery and neither has the responsibility.

The effect of making aims on a functional level should receive considerable attention regarding unnecessary water usage, but this does not seem to be the case at NBL judging from the following examples.

Pipes dripping constantly – go unnoticed but over long periods are responsible for huge volumes of water

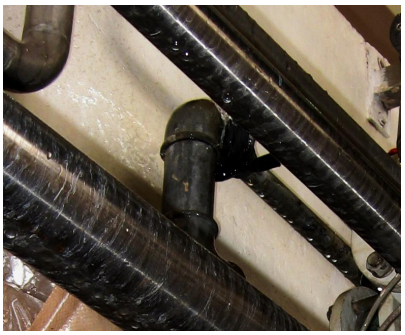
In-plant assessment



Unattended overflow

More than 4 water hoses were discovered running during the water tour. 100 m3/week

Many leakages in this fairly well maintained brewery indicates that it takes long time from a leak appears until it is repaired.



Even though the brewery is in good condition a number of minor improvements could help to save water, eg. use of hoses for cleaning with smaller diameter and/or with pistols. The lack of such simple solution indicates a potential for more efficient management focus on water consumption. Compared to the high water usage of a brewery this might be a minor issue, but it is important for the management to visually demonstrate their efforts to save water and especially avoid obvious and unattended failures of saving water.

4.6 List of CP-options

Training and engineering:

- The responsibility of water usages should be given to those persons who are responsible for the process where the water is being used.
- Direct metering of the different functions will reduce complexity and thereby ease management
- CP-training for all employees in production.
- Watering the gardens with water from Waste Water Treatment Plant
- Pistols for water hoses
- Incorporate deaerated water to reduce beer losses
- Yeast recovery

Major investments in equipment:

- CIP irrigation system
- New vacuum pump or irrigation system

The investment in equipment is considered as a barrier of gaining water savings at NBL and therefore a feasibility study of the investments would be recommended.

5 Feasibility Study

In this chapter the feasibility for the water improving investments is calculated and evaluated in economic, technical and environmental terms.

The investments that is subject for the calculation are:

- Semi automated CIP plant
- Vacuum pump

The other CP options are not subject to feasibility studies since the investments related to them is either very small or only related to the time spent for management and training.

In the calculation below the cost of water is calculated as the cost of pumping energy and the materials and maintenance for the water treatment plant. The cost of water is therefore assumed to be 44 UGX / hl.

5.1 Semi automated CIP plant

Losses of water and caustic can be reduced considerably by installing a semi automated CIP plant. Such investment will avoid ensure excess usage of both water and caustic in the cleaning process and is used by many low consuming breweries.

The cost of a semi automated CIP plant with the required capacity as the existing is 250,000 EUR FOB cost or 550 M UGX.

The water usage of a semi automatic CIP plant is estimated 5-10 hl. per tank cleaned depending on what programme one uses. The automated CIP plant is seen as the major remedy for water savings at the Brewhouse and the brewing process in NBL. The result could potentially bring the annual water usages down from 2.9 M hl to 2.1 M hl with at saving of 0.8 M hl.

The financial impact from operations of a semi automated CIP plant is difficult to estimate since it depends on how the company chooses to operate the plant, but based on cost relating to the potential water saving, the energy saving for heating the water and for deduced use of cleaning materials such as caustics the cost can be estimated.

The water savings is 35 M UGX, based on the assumptions above. The savings in energy is calculated using the theoretical extrapolation method described in chapter 3 which gives a potential saving of 199 M UGX. The expected saving on cleaning materials is 70% based on benchmark figures is equivalent to approximately 1,370 M UGX a year. The sum of these savings from a semi automated CIP plant is 1,600 M UGX with means that such investment has a payback of 3 month. In a financial perspective the investment is feasible.

From an environmental perspective the benefits of operating with a semi automated CIP plant are evident, since:

- No change in contamination of process wastes.
- No cross media effects.
- Significant reduction in toxicity, degradability or tractability since the use of caustic soda and other cleaning chemicals will be reduced with 375 tons/year.
- 0.8 M hl of water saved per year

5.2 Vacuum Pump

The loss of water from the vacuum pump can be reduced significantly either by replacing the pump with a no-water-consuming pump or by installing a water cooling facility for the vacuum pump.

Current experience has shown problems running with no-water-consuming pump, but advances will make them more practical.

Generally with already installed pumps a circulation system with an existing tower etc. is envisaged.

The total cost of a new Vacuum Pump with the same capacity as the existing is approximately 25.000 EUR or 55 M UGX. The cost of installing a water cooling depends very much on the existing opportunities at the brewery but it should not exceed 10 billion UGX.

The water consumption of the present vacuum pump is approx. 80.000 hl/year and considering the present cost of water this has a value of 3,5 M UGX. With a payback of 16 years (without considering cost of capital) water saving will not a drive a more effective solution, unless the brewery can use existing facilities and equipment (which is likely).

In an environmental perspective the feasibility of operating with a new pasteurizer is evident, since:

- Reduced contamination of process wastes.
- No cross media effects.
- Reduced toxicity, degradability or tractability
- 80.000 hl of water saved per year
- Minor saving in electricity