APPLICATION OF PINCH TECHNOLOGY IN AN INTEGRATED PULP AND PAPER MILL

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Abstract

The objective of this investigation was to utilise water pinch analysis as a tool for the optimisation of fresh water use in an integrated pulp and paper mill. The investigation was carried out at Mondi Paper in Merebank, south of Durban.

The pulp and paper manufacturing process is a large consumer of fresh water and minimising the amount of fresh water used in the processes is beneficial from both a cost and environmental point of view. There are examples of mills which have "closed" their water systems to the extent that fresh water make up is minimal and most of the water is recycled and reused in a closed loop. These examples provide guidance on the basis of proven methods for reducing water consumption in the pulp and paper industry and can be used as a reference for mills wishing to reduce water consumption by making use of tried and tested methods. This investigation sought to provide an alternative method to identifying potential savings in fresh water consumption by making use of water pinch analysis.

This was done at Mondi Paper by analysing individual parts of the mill and then a larger section of the mill which included both pulp and paper production. Flowrates of water streams and fibre content in those streams were obtained from plant data, where available, and this data was used to produce a mass balance using the Linnhoff-March software, Water Tracker. The balance produced using Water Tracker provided the missing flow and fibre content data and this data was used as the input for the Linnhoff-March software, Water Pinch, to perform the water pinch analysis.

The results achieved when analysing the individual parts of the mill did not demonstrate potential for significant savings in fresh water consumption, however the analysis of the integrated section of the mill identified a potential reduction in fresh water. It was found that the application of a single contaminant analysis to the larger section of the mill identified a possible reduction in the fresh water requirement of 8.1% and a reduction in effluent generated of 5.4%. This is a savings of R1 548 593 per annum based on 2003 costs of fresh water and effluent disposal.

This analysis was conducted using the most simplified representation possible to produce meaningful results in order to evaluate the effectiveness of water pinch analysis in optimising the fresh water consumption in an integrated pulp and paper mill. It is demonstrated that water pinch analysis is potentially a useful tool in determining the minimum fresh water requirement of a site.

Preface

I, Gladys Naylor, declare that unless indicated, this dissertation is my own work and that it has not been submitted, in whole or part, for a degree at another University or Institution.

………………………………………..
Gladys Naylor
September 2003

As Gladys Naylor's supervisor I have approved this dissertation for submission

………………………………………..
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Glossary

Term	Definition
Additives	Materials added to paper or to the papermaking furnish to modify or improve certain paper properties or to facilitate the papermaking process. This classification encompasses all materials that enter the system except for fibre and water. Common additives are fillers, dyes, biocides, defoamers, and retention aids.
Bleached Kraft	Refer to Kraft Pulping
Broke	Paper after forming section of paper machine which is not suitable for its end use. When produced, broke can be wet or dry, coated or uncoated, on-machine or off-machine, calender broke, winder broke, coater broke, or trim. Machine trim, while generally identical to the main sheet at that point is continuously produced, is usually referred to as trim if it is continuously produced, to differentiate it from other broke, which is only sporadically produced.
Cationic Demand	Cationic demand is a quantitative measure of the available anionic charge of furnish components (e.g. fibre carboxyl groups, recycled starches, polyphosphates, anionic sizing materials, residual lignins and miscellaneous anionic contaminants) that can be neutralised by reaction with a cationic polymer. Cationic demand is defined as the amount required to reach zero charge per given amount of stock. It can be expressed in several different ways, such as percent cationic polymer on fibre weight, milliequivalent charge per litre of stock or kg cationic polymer per ton of ovendry stock. There is no standard procedure for determining the cationic demand of a furnish. Variations in the procedure occur in the cationic polymer titrants, pH conditions, polymer:fibre contact times, and endpoint detection method. These can all influence the amount of cationic polymer necessary to adjust the furnish to zero charge. In any form, it is a useful parameter for assessing the cationic requirements of a furnish, and the measurement is widely used in troubleshooting paper machine problems and optimising paper machine performance.
Chemical Pulp	Pulp obtained from wood (or other plant raw material) principally by chemical means. The two major types of chemical pulp are kraft (sulphate) pulp and

	sulphite pulp.
Closed Water System	A term used to describe a mill in which the only fresh water added is to make up for losses through evaporation and moisture which leaves in the product.
Cloudy Filtrate	Water which contains a relatively high fibre content compared to clear filtrate. Cloudy filtrate is produced early in the filtration cycle by a disc filter. Cloudy filtrate from a disc filter is generally much leaner than paper machine white water.
Dryer Fabric	The machine clothing that conveys and/or holds the sheet to the dryer cylinder and removes moisture by the evaporative process. It is usually an open mesh structure made from polyester and fibres and filaments that resist hydrolysis.
Fines	Very short pulp fibres or fibre fragments and ray cells. These may pass through the fabric of a paper machine during sheet formation.
Forming Fabric	An endless belt woven of plastic for use on the forming section of the paper machine. The fineness of the fabric is approximated by the mesh count. The weave configurations of forming fabrics are constantly being expanded to fit the various drainage and sheet requirements in the industry.
Freeness	The rate at which water drains from a stock suspension through a wire mesh screen or a perforated plate. When measured by the Canadian Standard Freeness (CSF) test, the CSF freeness is reported as the volume (in millilitres) of water flowing through the side orifice of the tester under test method conditions.
Furnish	The mixture of various materials that are blended in the stock suspension from which paper is made. The chief constituents are the fibrous material (pulp), sizing materials, wet-strength or other additives, fillers and dyes.
Groundwood Pulp (GWD)	A mechanical pulp produced by pressing debarked logs sideways against a rotating pulpstone in the presence of water and reducing the wood to a mass of relatively short fibres and fines.
Integrated Mill	A mill which produces both pulp and paper. A non-integrated mill would produce only pulp or only paper.
Kraft Pulping	The alkaline pulping process that uses a combination of sodium hydroxide and

	sodium sulphide. It is derived from the German word meaning "strong", a fitting term since kraft pulp is the strongest chemical pulp. An alternative term is sulphate pulping.
Long Fibre	Softwood chemical pulp.
Mill Closure	A closed mill would be a mill with no water effluent eminating from it. Degrees of closure in a paper mill are defined by the amount of fresh water used per ton of paper produced.
Neutral Sulphite SemiChemical (NSSC) Pulping	This pulping process utilises sodium sulphite cooking liquor which is buffered with sodium carbonate to neutralise the organic acids liberated from wood during cooking.
Paper Machine Fabrics	Paper machine fabrics refer to dryer fabrics, forming fabrics and press fabrics. Refer to descriptions of individual fabrics.
Pitch	In the paper industry, pitch is largely a mixture of fatty and resin acids and unsaponifiable organic substances that can be extracted from the wood, mechanical pulp and chemical pulp by means of organic solvents, such as alcohol and ether. Pitch is associated mainly with ray cells of the wood and under certain conditions it accumulates on the paper machine fabric or on the press felt in the press section and causes trouble in the papermaking operation.
Press Fabric	A woven fabric made chiefly from polyester and used in the press section to provide void volume in the nip. The press fabric is run inside, or under the felt, e.g. between the felt and the roll.
Retention	The process of retaining soluble and insoluble stock components (chemicals, fillers, cellulose fines) in the forming paper web on the paper machine.
Retention program	A combination of chemicals added to retain the soluble and insoluble stock components in the forming paper web on the paper machine
Saveall	A device that recovers and thickens fibres and other suspended solids from low consistency broke, trim or white water, and thickens it to the point that it can be conveniently reintroduced into the stock preparation system. Many types of savealls are used commercially, including disc filters, vacuum drum filters, deckers, dissolved air flotation clarifiers, and sidehill screens.

Short Circulation	The white water recirculation loop immediately adjacent to the forming section. This white water is called rich white water due to the high fibre content.
Shives	Intact fibre bundle or fibrous mass having a contrasting colour to the pulp fibres and having dimensions greater than some arbitrarily set minimum.
Sizing	(1) A property of paper resulting from an alteration of fibre surface characteristics. In internal sizing, the entire furnish is uniformly treated before the paper is formed to increase its resistance to the penetration of polar liquids. The surface sizing relates to treating the finished sheet, on one or both sides, to increase such properties as water resistance, abrasion resistance, abrasiveness, creasability, finish, smoothness, surface bonding strength and printability. (2) The addition of materials to a papermaking furnish or the application of materials to the surface of paper to provide resistance to liquid penetration and, in the case of surface sizing, to effect one or more of the properties listed in (1).
Stickies	Suspended particulate contaminants, usually of low specific gravity, in the finished pulp. These contaminants originate with the adhesive and coating residues, ink residuals, tars, latexes, and hot melt materials. If not removed during processing, the stickies can cause sheets of paper to stick together.
Stock	Pulp that has been refined, treated with sizing, colour, filler etc. and which after dilution is ready to be formed into a sheet of paper.
Supercalendered	A finish obtained by passing paper between the rolls of a supercalender under pressure. Supercalenders are usually composed of alternate chilled cast iron and fibrous or polymeric rolls. The resulting finish will vary, depending on the raw material used in the paper and the pressure exerted upon it. Supercalendered finish is also know as supercalendering.
Tear Index	The numerical value found by dividing the value of the tearing resistance in milliNewtons (mN) by the basis weight in grams per square meter.
Tearing Resistance	In milliNewtons (mN). Obtained by multiplying the mass to tear a single sheet in grams by 9.807
Thermomechanical Pulp (TMP)	A mechanical pulp produced from wood chips, where the wood particles are softened by pre-heating in a pressurised vessel at temperatures not exceeding

	the glass transition point of the lignin, before a pressurised primary refining stage.
White Water	All waters of a paper mill which have been separated from the stock or pulp suspension, either on the paper machine or accessory equipment such as thickeners, washers and savealls, and also from pulp grinders. It carries a certain amount of fibre and may contain varying amounts of fillers, dyes, etc.

Chapter 1

Introduction

This investigation entails the application of water pinch analysis at an integrated pulp and paper mill. The aim of the investigation is to assess the tool of water pinch analysis in identifying and quantifying potential savings in fresh water consumption in an industry which is typically a large user of water. Internationally the pulp and paper industry is under pressure to reduce its impact on the environment and improve the efficiency of production. There are a number of drivers for the pulp and paper industry to adopt cleaner production mechanisms in order to improve the environmental performance and this investigation looks at the application of water pinch technology as one of the tools available to the industry to achieve a reduction in water consumption.

1.1 Water Use in South Africa

Water is a resource for all life on earth and without water the growth and economic development of South Africa is not possible. It is vital that this scarce resource is well managed to meet the needs of a growing population as well as the demands of increased industrialisation. As a developing nation, South Africa is striving to provide a safe and reliable drinking water supply to the growing and increasingly urbanised population and it is becoming more evident that new approaches to the problem of water supply and consumption will be needed (Lesan 1999).

South Africa is a relatively dry country, with irregular rainfall across the country and from year to year. The average annual rainfall is 500mm compared with the global average of 800mm. Water scarcity is further aggravated by the fact that 60% of the river flow arises from only 20% of the land area. In addition, South Africa has limited groundwater supplies (Schreiner 1998).

The total natural runoff in South Africa is estimated at 55 billion m^3 per year, of which only 33 billion m^3 is utilisable (DWAF 2000). It is estimated that water use will increase from a current level of 18 billion m^3 (1996 estimate, DWAF 2000) to 30 billion m^3 per year in 2030. From this is it apparent that an action plan is urgently needed to ensure wise supply and use of water. The first step in such a process should be to ensure more efficient use of the current water supply.

The use of water for agriculture in South Africa accounts for 60% of the total water use in the country. Domestic and general urban use of water constitutes about 11% of the total and approximately 8% is used by mining and larger industries (DWAF 2002).

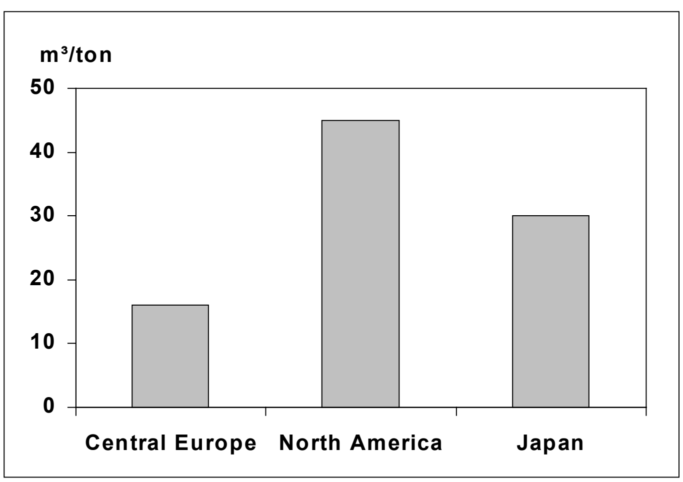
1.2 Water Use in the Pulp and Paper Industry

Pulping and papermaking is undeniably a very water intensive industry with a *gross* consumption well in excess of 100 m³ per ton of paper for even the most efficient operation (Webb 1992). Fortunately, the industry has always relied on some degree of water recycling as a means of recovering fibre that has escaped being retained in the paper the first time round. In this way, the consumption of *fresh* water (a better index of environmental impact than gross water consumption) has been progressively reduced by pulp and paper mills. This can be illustrated with trends from various countries.

The benchmark in the field of water consumption in pulp and paper manufacturers is *specific water consumption* which represents the amount of fresh water used to produce a ton of product. In the USA figures from the largest pulp and paper producers indicate that the water use of 53.5 m³/ton across the whole industry achieved in the early 1990s represented a 27% reduction since 1975 and a 70% reduction since 1959 (Miner 1991). In Europe there have been comparable reductions in water consumption. The UK paper industry has experienced a rather uneven trend with large reductions up to about 1980, about 80 m³/ton in the late 1960s to 60 m³/ton in the mid 1970s to 40 m³/ton in 1980, but a much smaller reduction since then to about 35 m³/ton in the late 1980s (Webb 1988). In the Netherlands the water consumption was similar to the UK in 1970, but declined to a very low 8.5 m³/ton across 18 mill by the mid 1980s.

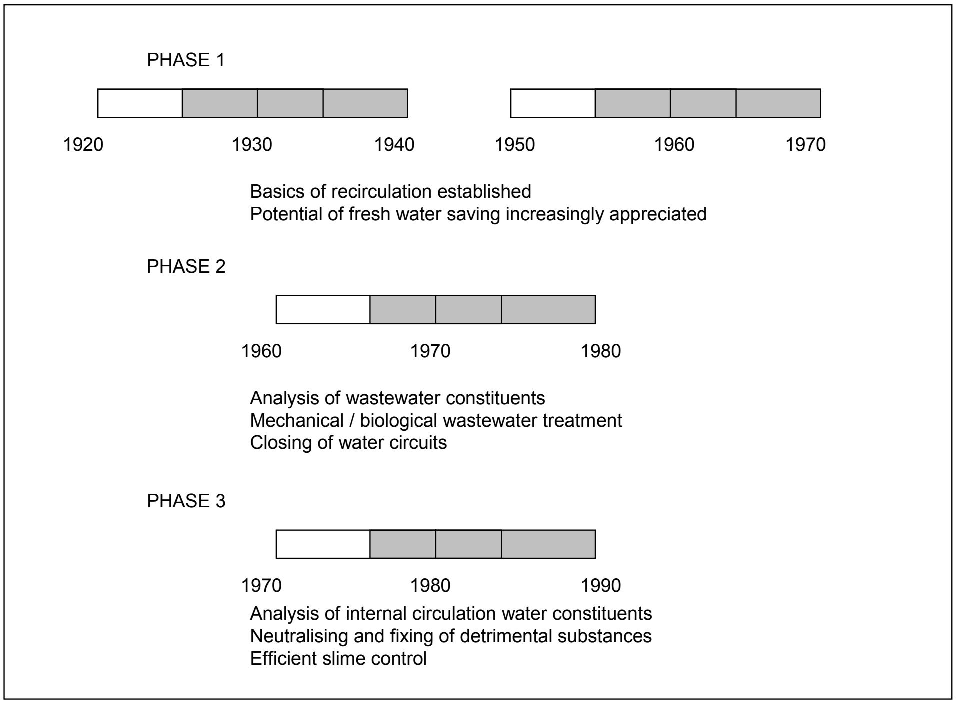
There are still considerable regional differences regarding the progress made in reduction of water consumption. A comparison of the average consumption values in important areas of paper manufacture in 1998, Figure 1.1, shows a relatively low value for central Europe whereas North America still has a fairly high water consumption (Auhorn, 1999).

Figure 1.1 Fresh water use shows substantial regional differences



Concepts and developments in the field of water reduction began as long ago as the 1930s and were further developed in the 35 years between 1955 and 1990. Historical progress in water management is divided into three phases by Zippel (1990), Figure 1.2

Figure 1.2 Three historical phases of progress in water management



In Phase 1 the more technical possibilities of wastewater recycling and fresh water saving were the main interest of research and practice. The main goals were reduction of fresh water consumption and stock losses. However, the initially dominating economic aspect gave way quite rapidly in the fifties to ecological requirements.

Legal ecological requirements initiated in Phase 2 meant the focus was on the constituents of the process water which polluted the receiving waters, in particular, with the biological and chemical oxygen demands. The paper industry's efforts were to a large extent directed in parallel towards the installation of water treatment plants or towards solving the emission problems by completely closing the water circuit systems. It was in this period that the terms *environment, recycling, disposal, constituents, pollutants* probably became part of routine vocabulary in the pulp and papermaking industry.

The restriction of fresh water consumption led to serious problems in the production processes in Phase 3 due to enrichment of organic substances in the recirculation water. The increasing use of recovered paper intensified the difficulties. Thus the third phase was characterised by basic investigation work at research institutions and in the chemical industry with these priorities

- Determination of essential constituents of circuit water

- Reduction of their disturbing effects by chemical aids and circuit optimisation.

1.2.1 Fresh Water Consumption for Different Grades of Paper

The earliest data on fresh water consumption of paper machines compiled by Brecht (1933) is shown in Table 1.1 along with data provided by Zippel (2001).

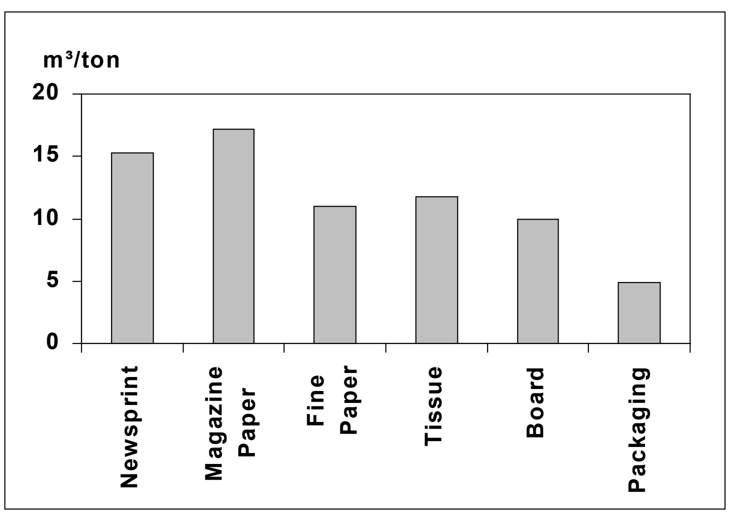
Table 1.1 Specific Fresh Water Consumption

Paper Grade	Specific Fresh Water Consumption m^3/ton
Newsprint (including groundwood mill)[1.]	180-200
Newsprint (without groundwood mill)[2.]	2-130
Printing and writing medium[2.]	45-500
Writing paper fine and medium[2.]	60-600
Fine paper[1.]	200-300
Wrapping paper (from virgin fibre)[1.]	100-150
Various papers[2.]	3-330

1. Zippel (2001
2. Brecht (1933)

In a later study of paper mills across Germany, Zippel (2001) evaluated the amount of fresh water consumed for the production of different paper grades, Figure 1.3. The overall average of all plants investigated is about 11.3 m^3/ton representing a significant reduction in fresh water consumption from the figures shown in Table 1.1.

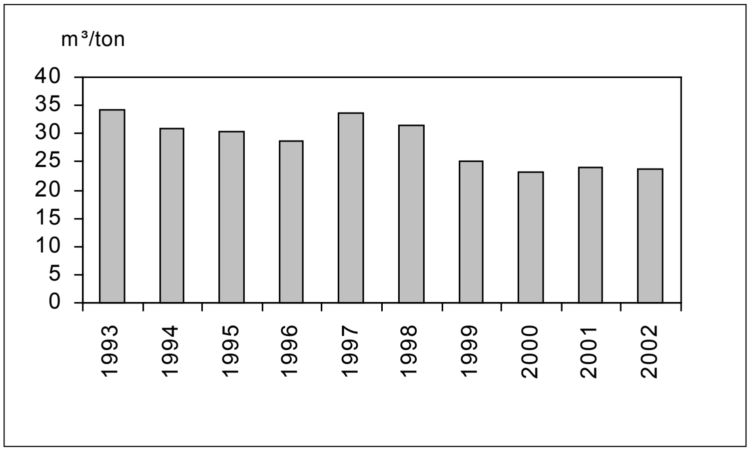
Figure 1.3 Specific fresh water consumption, averages for six paper grades



1.3 Water Use at Mondi Paper

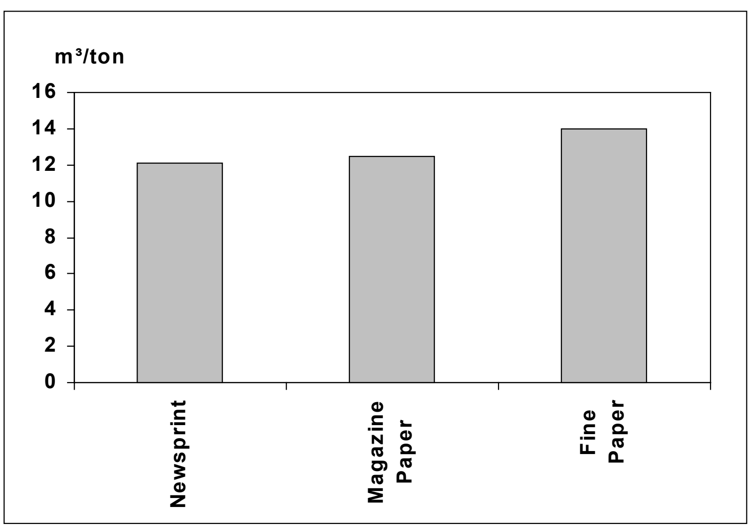
The consumption of fresh water at Mondi Paper has been reduced over the years to a current level of just over 24 m^3/ton, Figure 1.4.

Figure 1.4 Specific Water Consumption at Mondi Paper



The specific water consumption shown in Figure 1.4 is for the integrated mill including the production of pulp. The specific water consumption for each of the paper grades made at the mill is shown in Figure 1.5, this does not include water consumed in the production of pulp.

Figure 1.5 Specific water consumption for the paper grades produced at Mondi Paper



1.4 Environmental Protection and Cleaner Production

The Cleaner Production concept embodies a preventative approach to dealing with pollution instead of dealing with the problem at the end-of-the-pipe stage. Cleaner Production is defined by the United Nations Environment Programme (UNEP) as (UNEP, 2002)

The continuous application of an integrated preventative environmental strategy to processes, products and services to increase the overall efficiency, and reduce risks to humans an the environment.

For production processes: Cleaner production results from one or a combination of conserving raw materials, water and energy; eliminating toxic and dangerous raw materials; and reducing the quantity and toxicity of all emissions and wastes at source during the production process.

Over the past decade, environmental protection in the forest industry has become increasingly integrated into general management of the mill (Hynninen, 1998).

Environmental Protection is a much wider concept than nature conservation. The driving forces behind environmental protection has always been the desire to secure man's well-being, which is expressed in the Brundtland definition of sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

1.4.1 Drivers for Cleaner Production (Hynninen, 1998)

There are a wide array of factors that might motivate individual mill's to close up their water system, with environmental factors arguably being the most important.

1.4.1.1 Legislation

Certain principles guide South Africa's environmental policy and perhaps the most significant of these is the principle of sustainable development. In addition to this a number of other principles form the basis for environmental legislation:

- Principle of prevention: The principle of prevention refers to environmental hazards whose likelihood of occurrence is known with some degree of probability. This means that requesting certain protective measures in advance can prevent hazards from arising at all. The design of this principle is to help protect the environment at as early a stage as possible and to encourage prevention rather than reacting to hazards after they have occurred.

- Precautionary principle: The precautionary principle requires precautions to be taken to prevent hazards from arising from human activity. It goes further than the principle of preventive action in that it required that action be taken before it can be assumed that some accident or consequence may arise.

- Source principle: If an activity causes damage to the environment, the damage must be tackled as quickly as possible at source. This principle is based on the belief that it is more expedient to tackle environmental hazards at source than the direct activity at the affected area. Combating pollution at source applies directly to waste management and cleaner production, which deals with the source rather than the end result of a process.

- Polluter pays principle: This principle states that the party whose activity causes the hazard should bear the cost of reducing and preventing environmental hazards. It is based on the concept that no-one has the right to pollute the environment at others' expense.

Internationally there are regulations which are based on similar principles such as the Integrated Pollution Prevention and Control (IPPC) Directive which is aimed at not merely reducing emissions throughout the EU but also promoting the use of cleaner production. The IPPC Directive states that permit conditions applied to industrial manufacturing plants must be based on the use of Best Available Techniques (BAT).

1.4.1.2 Environmental Management Systems

Companies introduce environmental management systems such as ISO 14001 on a voluntary basis, however for the company to attain ISO 14001 certification an external accredited verifier must review and validate the company's environmental policy, objectives, programs, performance and audits. Subscribing to the principles of an environmental management system such as ISO 14001 requires a commitment on the part of the company to continuous improvement, which in turn requires the company to integrate cleaner production into its operations.

1.4.1.3 Environmental Labels

The purpose of environmental labels is to provide consumers with more information about the environmental impacts of products and to steer product manufacture and consumption towards more environmentally friendly solutions. These labels are awarded only to those products that can be shown to impose smaller loads on the environment than other products intended for the same purpose.

1.4.1.4 Economic factors

Improved efficiencies generated by implementing cleaner production have the potential to reduce manufacturing costs. The motivation for investigating potential reductions in raw material consumption and waste generation by employing cleaner production technologies is therefore not only related to the environmental benefits associated with these activities.

1.4.2 Achieving Cleaner Production

The pulp and paper industry is under regulatory pressure internationally to reduce the volume and toxicity of its wastewater. Many new mills are installing closed water systems and some existing mills are using pinch analysis in their engineered retrofits, Tripathi (1996). A systematic methodology for analysing the ways to reduce the amount of wastewater and consequently reduce the fresh water usage is called Mass Exchange Integration. Determining which water streams to recycle is the best way to achieve reduction.

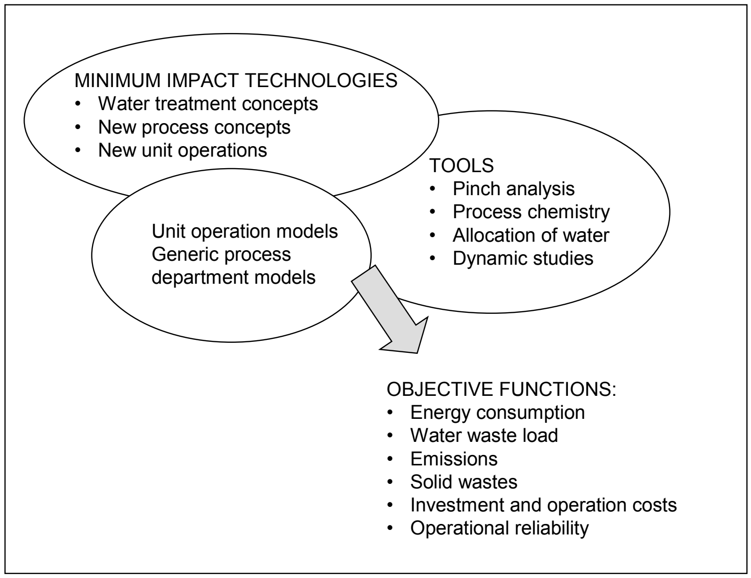
Cripps (2000) notes that the manufacture of pulp and paper is both highly energy intensive and a major user of water. A culture of investment in capacity is progressively being replaced by one of investment in efficiency, both in response to regulatory pressure and as the long-term benefits of resource conservation and environmental protection come to be reflected in economics.

On the other hand the industry is privileged to have potentially renewable raw materials and energy supply. It has a vital contribution to make towards sustainable generation of wealth and achieving this depends on using resources efficiently. Technology that enables the industry to do so brings a two-fold benefit:

- Substantial cost savings – operating costs and energy/water/effluent infrastructure costs
- Market advantage of demonstrated environmental responsibility

In the pulp and paper industry, the traditional use of the term *integrated plant* implies that pulp and paper-making take place on the same site. This must be distinguished from *process integration* as described in Chapter 4 which refers to a systematic approach resulting in efficient process design with integrated use of energy and water between process operations on the site. El-Hawagi (1997) defined process integration as a *holistic approach to process design, retrofitting, and operation which emphasises the unity of a process*. Edelmann (1999) presents a process engineering “toolbox” for use in the development of closed water cycles in the pulp and paper manufacturing process, Figure 1.6, which includes pinch analysis as one of the tools used to achieve cleaner production.

Figure 1.6 Process engineering toolbox for closed water cycles



1.5 Water Pinch Analysis

One of the areas falling under Process Integration is Pinch Analysis. Water Pinch Analysis developed from the original Thermal Pinch Analysis concept using the analogies between heat and mass-transfer. The design objectives in water-using networks is to minimise the water consumption by maximising the reuse of water. Further reductions in water can be obtained by introducing processes for partial treatment of the wastewater known as regeneration, allowing further reuse or recycling of water. The approach developed for the design of water systems is based on the work of El-Hawagi and Manousiouthakis (1990) for mass exchange systems, which in turn was based on analogies with the design of heat exchanger networks. Various water using processes are combined to give a composite curve for the entire system, allowing targets to be set for minimum water supply. Extension of the methods of energy integration to water integration is in principle quite straightforward (Smith, 1999). However, this approach runs into problems when dealing with multiple contaminants rather than a single contaminant. The introduction of flow rate constraints, cost optimisation and forbidden matches leads to a problem not easily solved using the graphical approach. However, it is possible to formulate the problem using mathematical programming to obtain an approach that allows for all of the complexities of water system design to be included (Wang and Smith, 1994). Mutliple contaminants, multiple water sources, flowrate constraints, forbidden matches, water costs, effluent treatment costs and piping costs can all be included in the problem.

1.6 Objective of the Investigation

The objective of this investigation was to evaluate the potential use of water pinch analysis as a tool to identify potential reduction in water consumption in an integrated pulp and paper mill.

This project is a component of a larger project entitled The Further Application of Pinch Analysis for Water and Effluent Management (WRC Project No. 1158) funded by the Water Research Commission of South Africa (WRC). The objective of this project included the application of Water Pinch Analysis to various industrial sites and an assessment of its applicability to the various situations encountered. The project included investigations in the pulp and paper sector at the Mondi Paper Merebank mill, Sappi Ngodwana Mill as well as the Sappi Mandini mill. Investigations were also conducted at other industries such as the Sasol Polymers chlor-alkali complex at Umbogintwini and at AECI Bioproducts also at Umbogintwini.

Chapter 2

Mondi Paper

The plant where this investigation was conducted is an integrated pulp and papermaking mill. The mill consists of three pulp plants, namely a groundwood pulp plant, thermo-mechanical pulp plant and a recycled fibre pulp plant. In addition, there are five paper machines producing supercalendered magazine paper, uncoated woodfree paper, newsprint and telephone directory paper. A coating machine produces carbonless coated paper making use of a lightweight uncoated woodfree paper as the base. The paper produced is wound into reels or cut into sheets before being distributed to customers.

Mondi Paper is an integrated pulp and paper mill, producing three types of pulp, supercalendered magazine paper, uncoated woodfree paper, newsprint, telephone directory and carbonless coated paper. The three types of pulp produced at Mondi Paper are:

- Thermomechanical pulp
- Groundwood pulp
- Recycled fibre pulp

The groundwood and thermomechanical pulps are produced by mechanically separating the fibres from other wood constituents, by means of log grinding in the groundwood process and chip refining in the thermomechanical process.

The fibre sources used in the production of the pulp and paper are:

- Logs and chips - Pine
- Recycled paper - newspapers and magazines
- Chemical pulp - hardwood pulp produced from Eucalyptus wood and softwood pulp produced from Pine

There are five paper machines at Mondi Paper producing the following paper grades:

Paper Machine 1	Supercalendered magazine paper
Paper Machines 2 and 3	Uncoated woodfree paper
Paper Machines 4 and 5	Newsprint and telephone directory

Some of the uncoated woodfree paper produced at the mill is coated with microcapsules, on a separate coating machine, to produce carbonless coated paper.

The steam requirements of the mill are supplied by the power plant which comprises two coal fired boilers, two stand-by oil boilers and two stand-by gas boilers. The coal boilers supply the steam required to produce the pulp and dry the paper.

The paper produced is wound into various size reels to meet customers' requirements or cut into sheets and sold as flat sheets.

2.1 Pulp Mill

The pulp mill consists of the woodyard as well as the three pulping plants, namely the thermo-mechanical pulping plant, the groundwood pulping plant and the recycled fibre pulping plant.

2.1.1 Woodyard

The wood used in the thermomechanical and groundwood pulping processes arrives at Mondi in the form of logs and chips. The logs are transported to the mill via rail trucks as well as road trucks. The production of pulp requires approximately 1600 tons of logs per day.

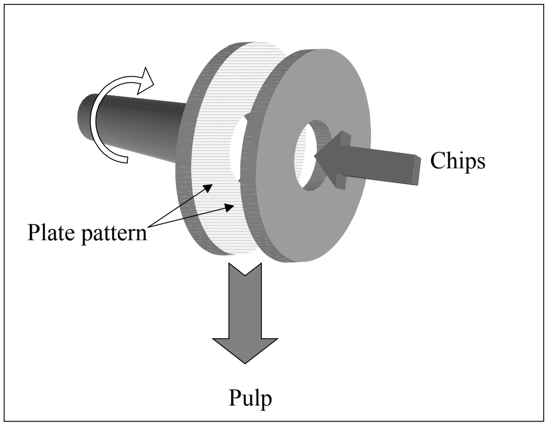
The logs are debarked in a dry drum debarker and then fed to the sawdecks to be cut into smaller logs for the groundwood pulping process or fed to the chipper to be chipped for the thermo-mechanical pulping process.

2.1.2 Thermo-mechanical Pulping

Thermo-mechanical pulping produces pulp with high tearing resistance for newsprint and telephone directory paper. The process involves steaming wood chips under pressure for a short period of time prior to and during refining. The steaming, which happens in the digester, softens the chips and the result is a greater percentage of long fibres in the pulp produced and fewer shives. The heating and first stage refining are carried out under pressure, while the second stage refining is carried out at atmospheric pressure.

The refiner consists of two revolving discs driven in opposite directions by two electric motors. The chips are fed in between the discs at the centre of the discs and the centrifugal force forces the chips along the discs and over the edges. Consistency control of the stock is very important as it plays a large part in the retention time of the stock between the plates.

Figure 2.1 Principle of refining



After refining, the stock is screened and cleaned and finally thickened, before being fed to the paper machines. The purpose of screening and cleaning is to remove unseparated fibre bundles, shives, and other undesirable components (e.g. dirt particles) from the pulp stream. The objective of thickening is to remove water containing impurities dissolved during pulping and to raise the consistency of the stock before it is pumped to the paper machines.

2.1.3 Groundwood Pulping

In the stone groundwood process, pulp is produced by pressing logs against an abrasive rotating stone surface. The logs are oriented parallel to the axis of the stone so that the grinding action removes intact fibres.

Previously, the mechanism of grinding was viewed simply as the biting and tearing action of protruding grits on the stone fiberising the wood. Although this mechanism does apply, research has shown that the dominant action is the high frequency compression and decompression at the interface as the grits contact the wood (Smook, 1997). This serves to loosen the fibres by fatigue and failure. The heat generated by the friction of stone against wood and wood against wood softens the lignin binding the fibres and assists in separating fibres from the wood mass.

Temperature control by showering is an important aspect of the grinding operation since virtually all the grinding energy is dissipated as heat in the grinding zone. Too much cooling water will impede the softening action, while insufficient cooling water will allow the wood to become charred.

2.1.4 Recycled Fibre Pulping

The raw material for this process is newspapers and magazines. The recycled fibre process removes contaminants, including ink, from the waste paper and produces clean fibre for papermaking.

Ink is separated from the fibres by chemical and mechanical action and removed from the stock by flotation. Other contaminants are removed by sorting, screening and cleaning. The process comprises of the following stages:

2.1.4.1 Waste Paper Repulping

Bales of waste paper are slushed in a high consistency batch pulper at about 14%. Set amounts of water and chemicals are added at the start of the repulping cycle. A combination of chemical and mechanical action separates the fibres and loosens the ink particles from the fibres.

After repulping the stock is diluted to 4-5% consistency and dumped through a coarse screen, where the largest contaminants are removed. Accepted stock is pumped to a tank where chemical reaction continues. Water for repulping is heated to $50^{o}C$ with direct steam injection. The chemicals added to the pulper are: caustic soda, sodium stearate, sodium silicate and hydrogen peroxide.

2.1.4.2 High Density Cleaning and Screening

After the pulper the process becomes continuous. Contaminants with a high density are removed in the high density cleaners and other large contaminants are removed in the coarse screens. The consistency of the stock is controlled to approximately 3% by the addition of cloudy filtrate.

2.1.4.3 Flotation

Once the larger contaminants have been removed from the stock, it is fed to the flotation cell. Here the ink is removed from the process using air bubbles and calcium ions. Calcium soaps form in the hard water conditions. These act as collectors for the ink particles by attaching to the ink particles and also attaching to the air bubbles. The air bubbles carry the ink to the surface and are removed by overflows. Stock in the flotation feed tank is diluted to 1.2% by the addition of cloudy filtrate dilution water. The pH of the stock flowing to the flotation cell is controlled to a preset value, normally 8.5, by the addition of sulphuric acid. The pH is adjusted to this level to prevent precipitation of calcium salts in the flotation cells. Calcium chloride solution is added to give the required amount of water hardness.

2.1.4.4 Cleaning for Removal of Lightweight Rejects

After the flotation cell, the next sections of the plant are designed to remove the smaller contaminants by centrifugal cleaning and fine screening. Stock is first pumped through rotary, horizontal hydrocyclones, which efficiently remove the light weight contaminants, those with specific gravity of less than one.

2.1.4.5 Cleaning for Removal of Heavy Rejects

Fine sand, grit and heavy clay particles with specific gravity of greater than one are removed by a four stage, cascade cleaner plant.

2.1.4.6 Screening with Pressure Screens

Final cleaning of the stock is achieved by pressure screens. A three stage cascade arrangement is used. These screens have slotted baskets with a slot width of 0.25mm and remove any fibre clumps which are still held together.

2.1.4.7 Thickening and Washing

In this section of the plant the chemicals from the deinking process are removed from the stock by thickening it to remove the alkaline, deinking process water. Accepted stock from the fine screens is thickened to about 10% consistency and then diluted to approximately 5% consistency with cleaner water. The stock is then thickened to approximately 30% in a wire pulp press to prevent water from being carried over from the pulp mill to the paper machines. The pH is adjusted to the level used on the paper machines. This is so that extra stickies which precipitate at low pH can be dispersed in the disperser. A displacement washing section of the press uses paper machine water to replace up to 30% of the process water.

2.1.4.8 Dispersion

Other chemical contaminants and remaining ink particles are made less troublesome by dispersing them evenly throughout the stock. Stock from the wire pulp press is heated to soften stickies such as hot melt adhesives and other similar contaminants. The disperser also removes any ink particles still attached to the fibres and breaks them up into smaller particles so that they are less noticeable. The dispersing section consists of a heating screw and a disperser. The stock is pushed through the screw and heated by direct injection of steam. The temperature is normally controlled to about 90^{o}C to melt the stickies and adhesives. After the disperser the stock is diluted to 10-12% consistency using water from the paper machines.

2.2 Paper Mill

The paper mill consists of the stock preparation plant, the additives plant and the five paper machines.

2.2.1 Additives Plant

“Additives” is the term used to describe a wide range of chemicals and other substances used in the manufacture of paper. The additives plant is where these substances are mixed and stored before they are dosed to the paper machines.

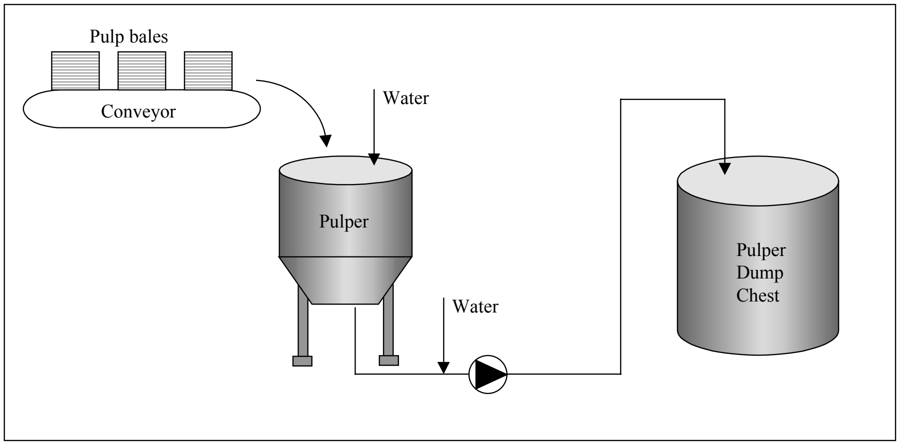
2.2.2 Stock Preparation Plant

The chemical pulp purchased primarily for the production of uncoated woodfree grades, as well as for strength properties in the other paper grades, is delivered to Mondi Paper in bales of dry pulp. Water and dry pulp bales are fed into a pulper vat and a rotor disintegrates the bales to form the fibre slurry. The objectives of slushing are to disintegrate:

- the bales into a pumpable slurry by releasing fibre bonds created in the pulp dewatering and drying processes
- the fibre slurry so that there are no visible fibre flakes or bundles
- the fibre slurry so that fibres are separated, wetted, and flexible before entering the refining stage.

The stock preparation plant has nine vertical pulpers, with the rotor located at the bottom of the pulper vats. The pulp bales are fed onto conveyors, which feed the bales into the pulper vats. The operation of the pulpers is batchwise and at 5%-6% consistency. The fibre slurry is diluted to 4%-5% during discharging. Figure 2.2 shows the slushing sequence.

Figure 2.2 Slushing of baled pulp



The pulper vat is filled with a given amount of water and a given amount of pulp. The bales are dropped into the pulper, which has been filled with water. Water temperature and pH influence the pulper operation. An increase in the water temperature reduces slushing time and energy requirement. When increasing the temperature from 20^{o}C to 40^{o}C, the effect is remarkable, approximately 50% reduction in the slushing energy, but increasing the temperature from 40^{o}C to 60^{o}C has only a minor influence on the slushing time (Paulapuro 2000). A low pH in the water means more difficult water penetration into the fibres and higher energy requirements in pulping.

2.2.3 Paper Machines

The production conditions and parameters on the five paper machines are quite different according to the different paper grades produced. Process conditions have to be stable to ensure the required product quality and a high production efficiency. Variation in any of the following can cause problems on the paper machines:

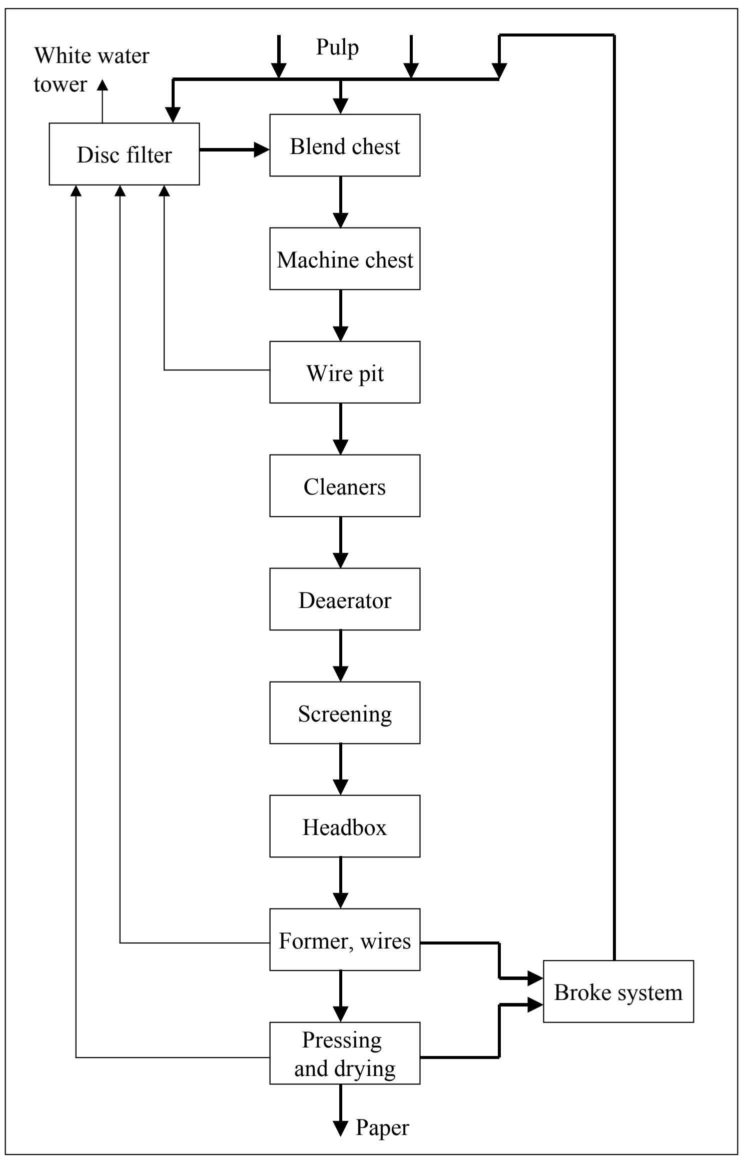
- Flow rate
- Pressure
- Temperature
- Flow conditions and turbulence
- Consistency
- Furnish composition and inorganic solids content
- Specific surface of fibres, content of fines, freeness
- Charge content, cationic demand, pH
- Content and distribution of chemicals and additives
- Undesired substances and contaminants, including air

The properties of the different paper grades produced on the paper machines are determined by the properties of the stock components used. The stock is a blend of the different components in order to achieve the desired paper properties in the most economical way. Table 2.1 shows the composition of the paper grades.

Table 2.1 Fibre Composition of paper grades

Supercalender Magazine Paper Machine 1	**Uncoated Woodfree Paper Machine 2 and 3**	**Newsprint and Telephone Directory Paper Machines 4 and 5**
Groundwood pulp 75%	Chemical short fibre 60%	Thermomechanical pulp 70%
Chemical long fibre 25%	Chemical long fibre 15%	Recycled fibre 25%
		Chemical long fibre 5% (maximum)

Figure 2.3 Block diagram of a paper machine



Chapter 3

Literature Review – Water use in Pulp and Paper Mills

Water is used as a transport medium in the pulp and papermaking processes. During these processes contaminants build up in the water streams and these contaminants impact on the pulp and papermaking processes and therefore restrict the amount of water that can be recycled and reused without treatment and regeneration. The consequences of reducing the amount of freshwater make up into the process is examined as well as means of characterising filtrate or effluent streams within a process.

Water is used as transport and processing medium in the pulp and paper industry. Water is essential in developing hydrogen bonds between fibres, which gives paper its strength. Water is also used as dilution for chemicals, coolant in process equipment, sealant in vacuum pumps and as cleaning fluid of equipment surfaces. Fresh water is introduced to the process mainly through paper machine wire and press section showers and is then led counter-currently to various washing and diluting duties in the pulp production plant. The role of the showers on the paper machines is to lubricate and to keep the fabrics used to support the paper web clean. Shower water is heated (50^{o}C) in the paper machine heat recovery system. In modern mills the water consumption is 5-10m^3/ton paper (Edelmann 1999).

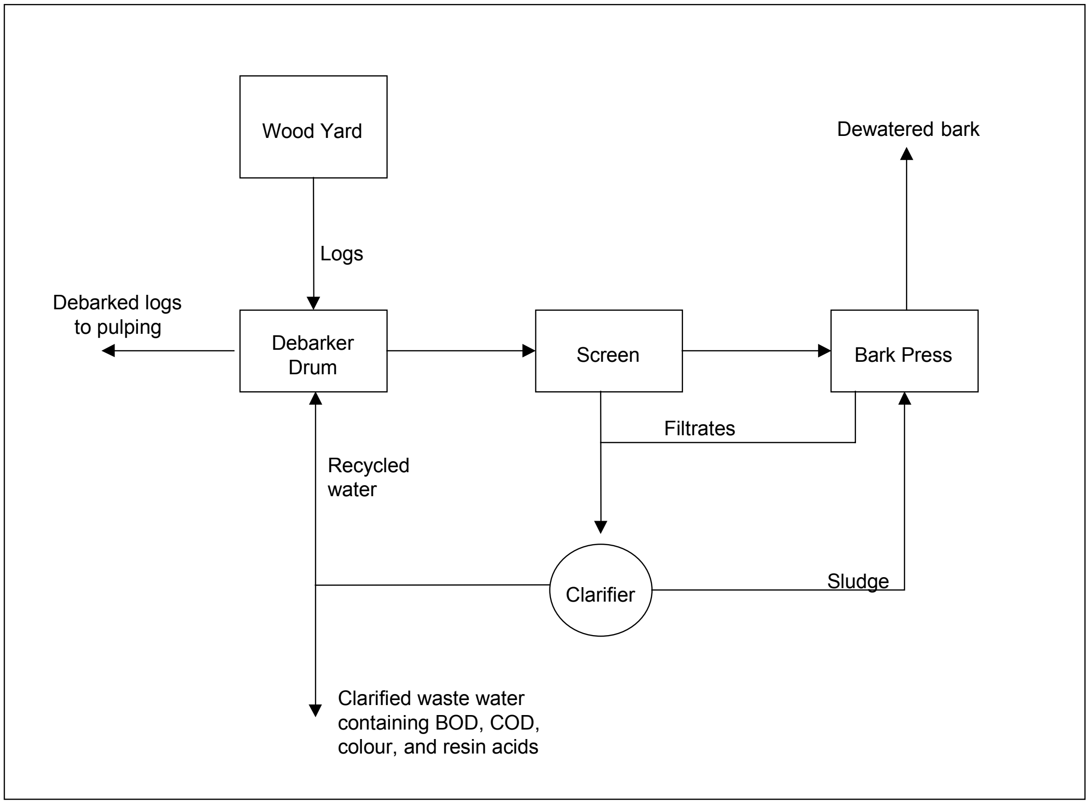
3.1 Water use in pulping (Webb, 1992)

Webb (1992) discusses various uses of water in the pulping process, specifically mechanical pulping, which differs significantly from chemical pulping. In conventional mechanical pulping, dissolved organics extracted from the wood are partitioned between the pulp passing forward to the paper machine and the wastewater streams leaving the pulp mill. Sundholm (2000) reports that when wood is processed into mechanical pulp by conventional grinding or refining, 2-5% of the wood material is dissolved, or dispersed as colloidal particles, into the process water. Most of the material staying with the fibre which is sent from the pulp mill to the paper machine will be released in the paper machine wastewater unless the paper machine water system is very closed. By contrast, at chemical pulping plants with recovery systems for the chemicals, most of the organics dissolved during pulping are retained in the black liquor for incineration.

3.1.1 Debarking

Debarking has remained unchanged for many years. Debarking drums are operated in either "wet" or "dry" modes with the latter generating much lower wastewater losses than the former. Even in the "wet" process (Figure 3.1), the load of dissolved organics in the wastewater can be reduced substantially by maximising recirculation of clarified water.

Figure 3.1 Typical wet debarking process



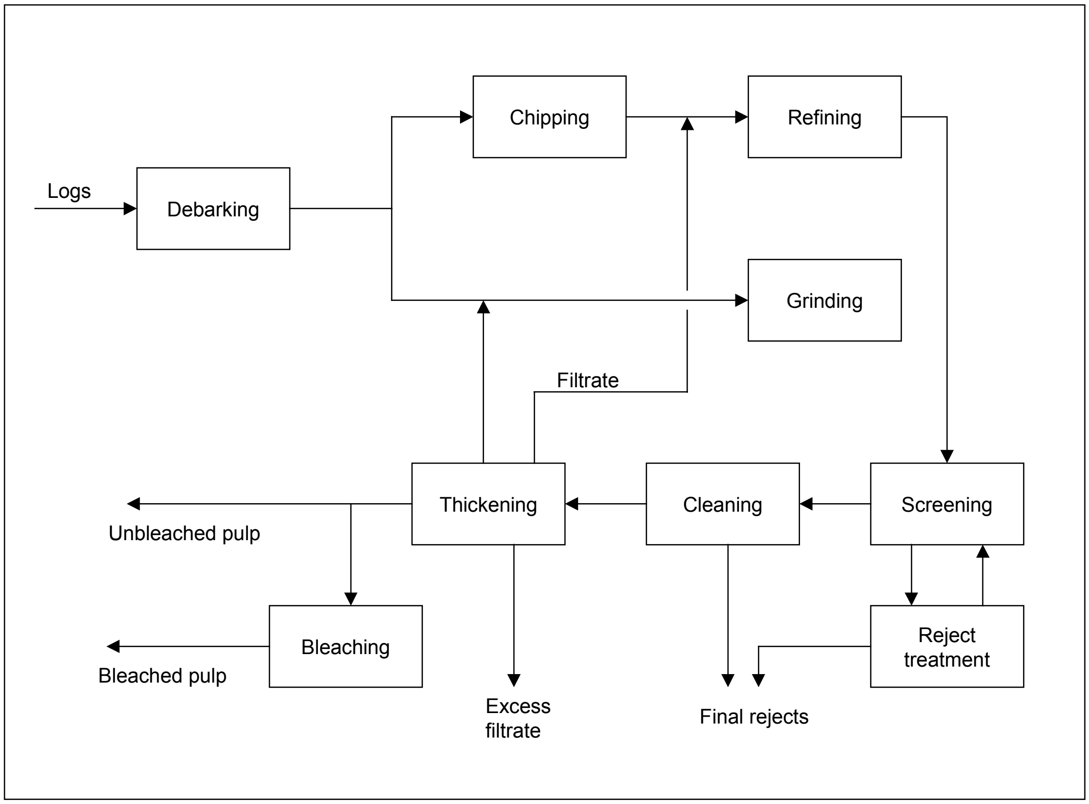
3.1.2 Mechanical pulping

Refer to Figure 3.2 for a simplified diagram of mechanical pulping circuits. The circuits are kept fairly closed in order to maintain high process temperatures from the energy dissipated in grinding / refining with excess white water from the paper machine used for make-up. The release of dissolved organics during mechanical pulping depends on a combination of factors (e.g. process temperature and chip steaming time for thermo-mechanical pulping processes) which are controlled to maximise pulp quality rather than to minimise wastewater losses.

The distribution of dissolved organics between the outputs from the mechanical pulping process depend on the amount of fresh water entering the system, the dryness of the dewatered, cleaned pulp and the rejects flow.

The use of genuine washing of mechanical pulps has been proposed as a means of reducing the carry-over of dissolved organics to the paper machine in view of their adverse effect on wet end chemistry and retention. In a thermo-mechanical pulping system, washing is best practiced between the two refining stages as most of the organics are dissolved in the first refiner.

Figure 3.2 Simplified mechanical pulping processes



3.2 Water use in papermaking

Water forms an essential part of the papermaking process, but it acts as a carrier rather than a significant component of the final product. Webb (1992) explains the important role of water in papermaking in controlling losses for those raw materials which are not well retained in the formation wire e.g. solubles. The cascading of used water from the cleaner paper mill system to the pulp mill is a way of closing up the system and of keeping the paper machine free from the effects of materials building up.

3.2.1 Deinking (Webb, 1992)

Deinking is principally a cleaning process, whereas pulping of wood is both a defibering and cleaning / separation process. The particulate contaminants are all removed by mechanical treatment processes such as flotation, dispersion / washing and screening assisted by the addition of chemicals. The soluble components of waste paper (largely starches) are removed fortuitously and the distribution of solubles between the deinked pulp and the wastewater is determined by the amount and the way that water is used.

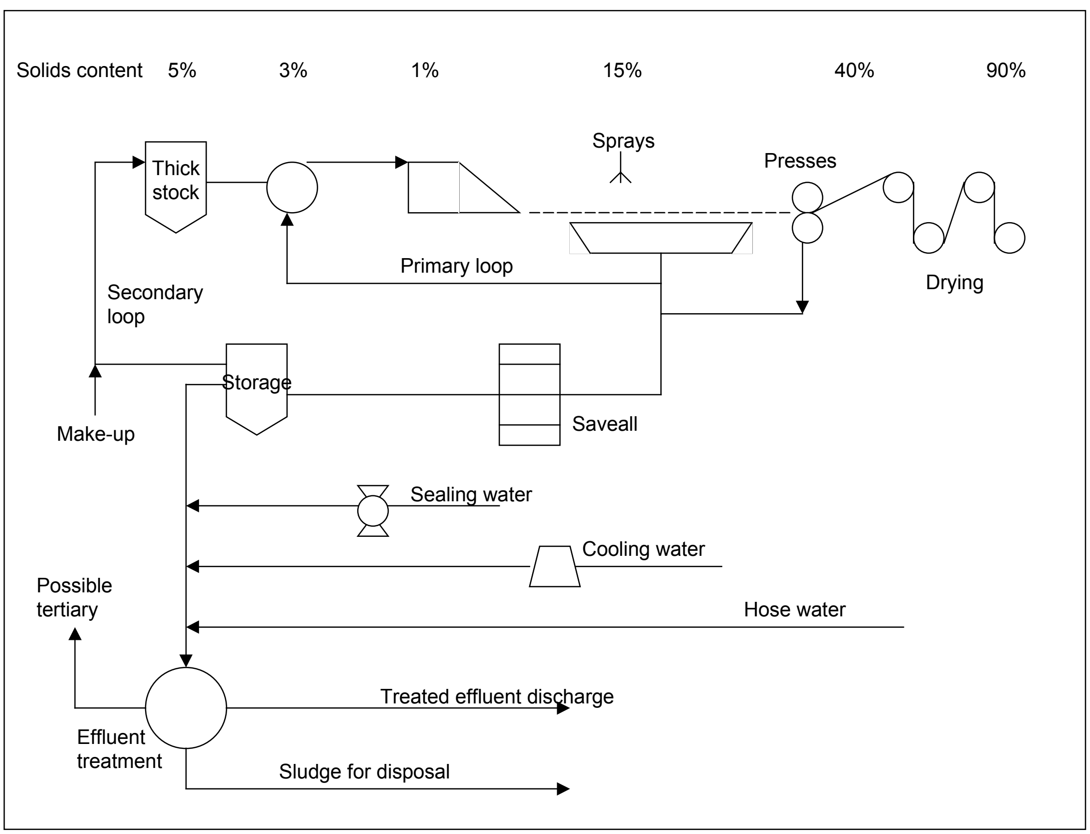
Water recirculation within deinking systems is usually high, but is sometimes constrained by the different chemistries in different parts of the plant, e.g. the alkaline flotation loop followed by the acid washing loop. The loops are separated by thickening the stock at the end of the flotation system and re-using the alkaline filtrate in that loop. The overall loss from the deinking circuit should be restricted to the reject lines from the various cleaning / screening stages (and should be less than 10m³/ton deinked pulp).

3.2.2 Papermaking

The use of water in papermaking can be classified into three main areas, largely determined by the quality of the water required and the level of pre-treatment provided: boiler water of very high quality, cooling water of relatively low quality and process water of intermediate quality (Webb, 1992).

The three principal water recirculation loops in papermaking are summarised in Figure 3.3, which illustrates the main uses of water for transportation, cleaning and sealing.

Figure 3.3 Main uses of water in the paper process (Webb, 1992)



Venter (1986) lists the classes of water used on the paper machine in order of decreasing contamination as follows:

- Tray water
- Suction box and couch water
- Wire pit water
- Wet felt cleaning water
- Vacuum pump sealing water
- Cooling water and gland water

On the paper machine the showers are a significant user of fresh water. Watters (2001) lists vendor specified requirements for shower flows for the same application: filtered white water versus fresh water.

Table 3.1 Vendor specified requirements for shower flows for the same application: filtered white water versus fresh water (100 mesh screen, 100ppm) on the paper machine

Shower service	White Water Flow Litres per minute	Fresh Water Flow Litres per minute
Uhle Box Lube	136	53
Uhle Box Lube	136	53
Uhle Box Lube	136	53
Doctor Lube	121	30
Doctor Lube	121	30
Doctor Lube	121	30
Doctor Lube	102	26
Doctor Lube	91	23
Doctor Lube	91	60
Doctor Lube	91	60
Total Shower Flow	1 146	418

3.3 Mill Closure

The shortage of water resources in South Africa has been one of the driving forces for industry to make the most effective use of water and to recycle as much water as possible for re-use within the process. Experience has shown that effort expended on water conservation and effluent control must be directed at process changes allowing greater internal recycling and inter-process re-use, rather than at external or end-of-pipe treatment systems. The ultimate goal would be a mill in which the only water leaving the system would be through evaporation and the water contained in the final product.

There are several incentives for process recycling and some of these are given by Venter (1986):

- Improved economy
- Smaller volume of effluent per unit production
- Reduction of external treatment costs
- Reduction of discharge of pollutants to receiving water
- Potential fibre savings
- Energy savings

Regardless of the degree of recycling done, the closing of paper mill water systems is impossible as long as the wood and/or the pulp enters the system with a water content higher than that of the paper entering the dryers. For a non-integrated mill, the raw materials usually enter in an air-dry form and the paper leaves in an air-dry form. The water is used in the process and removed at the paper machine, with approximately 97% removed at the wire, 2% at the press section and 1% at the dryer section (Venter 1986). Edelmann (1999) estimates that losses from the dryer section and machine room ventilation amount to $2m^3$/ton paper.

Targets set by the industry (Edelmann 1999) regarding the reduction of water consumption:

- Paper quality and process operability should not be impaired
- Water treatment concepts should not lead to increased consumption of chemicals
- System closure should lead to a cleaner process and better process management
- Environmental impacts on water, air and soil should be reduced
- Solutions should not impair the competitiveness of the mill

Closing the mill's water systems and reducing water consumption is a process that happens step by step. Large changes are not likely to take place because of the complexity of water chemistry. The role of water in papermaking is a complex one and many conditions must be satisfied before adopting closed water cycle concepts, starting with paper quality and ending in overall environmental effects and competitiveness of the paper industry. The changes made in certain areas of the plant may impact on the whole mill, and, in addition to heat and mass balances, electricity consumption of the processes should also be considered. Several aspects of process engineering have to be taken in to account (Edelmann 1999), like contaminant generation, behaviour of contaminants, separation of contaminants, interaction of papermaking chemicals with process and with contaminants, energy efficiency of the concepts, waste streams, operational reliability and control methods.

Venter (1986) and Berard (2000) list some objections to recycling process water:

- Reduced production;
- Reduced product quality;
- Difficult sizing;

- Difficult production of coloured grades unless cationic dyes are used or the colour is destroyed;
- Increase in ionic concentrations and concentration of dissolved organic substances;
- Difficulties with wire and felt cleaning, causing increased wear, formation of slime, objectionable odour, temperature increases and increased corrosion;
- Scaling from calcium and carbonates (possible sulphate as well);
- Foam from conductivity and dissolved colloidal substances.

A totally closed white water system would cause problems in the areas of sizing, brightness reversion and first pass retention. Adverse effects associated with the build-up of dissolved organic and inorganic substances, e.g. small amounts of dissolved organic material, can decrease the effectiveness of cationic retention aids. These dissolved materials can be hemi-celluloses, fatty and resin acids or lignosulphonic acids. Their presence in the papermaking system causes a higher cationic demand, thereby increasing the amount of cationic retention aid required to achieve optimum flocculation.

3.3.1 Contamination of process water (Edelmann, 1999)

Recycling of process water is restricted by water soluble materials released from fibre and other raw materials. In mechanical pulping lignin, lignans, lipophilic extractives, carbohydrates, resin and fatty acids are dissolved or dispersed into process water.

The dissolution of wood components depends on the quality of raw material, temperature, pH, residence time, turbulence of mixing and consistency. For example, at boiling water conditions the amount of material dissolved is three times the amount dissolved at room temperature, measured as COD. In thermomechancial pulp production 20kg/ton pulp is dissolved, measured as total organic carbon (TOC). Approximately 40kg/ton pulp of dissolved and colloidal material is produced in the thermomechanical pulping process. Bleached softwood sulphate cellulose releases much less organic material, 0.6 – 0.9 kg/ton pulp, compared to mechanical pulps.

The concentration of dissolved and colloidal substances in the short circulation of the paper machine depends on their retention on the machine and on the intake of fresh water. The short circulation comprises of the forming section, silo, headbox and the deculator. Introduction of fresh water to the short circulation of the paper machine helps to keep the process clean, however, acceptable printing paper quality and runnability can be achieved at the contamination level of 150 – 300 mg/L (COD), depending on the machine and on the paper grade.

The extent to which the different substances accumulate in circulation waters with increased recycling is not well known. Based on laboratory work, higher concentrations impair paper quality and increase biochemical activity in the process water. As a result, harmful deposits may form and in anaerobic conditions unpleasant smell and acidic corrosive compounds compounds are formed. It is estimated that the reduction of water consumption to one third would increase the COD value by a factor of four. Most of the organic material is released from wood in mechanical pulping and in bleaching. The carrying over of these contaminants to the paper machine is decreased by separating the pulping water from the paper machine water.

In addition to releases from fibre itself, a significant amount of dissolved solids originates from the chemicals used in the process. Furthermore, harmful contaminants enter the water circulation through the broke system. These contaminants can be especially problematic when coated grades are produced

On the paper machines, fillers, pigments and coating chemicals are the dominating chemicals used.

Uses of chemicals and/or additives in the papermaking process:

- To improve opacity and brightness of the paper;
- To improve printing properties of the paper;
- To colour the paper;
- To improve retention of fibres and fillers in dewatering;
- To control pH of pulp;
- To control electrical charge of pulp;
- To complex metal ions;
- To reduce foaming;
- To disperse colloidal material;
- To prevent slime formation or bacterial growth.

Paper mills have been able to increase recycling of process water by adapting saveall filtering techniques in the short circulation. Approximately half of the fresh water needed in the wire section showers can be replaced by clear or superclear filtrates from the saveall. A further increase could be achieved through more efficient solids removal and extraction of dissolved material.

The circulation water of a thermomechanical pulping process, with a capacity of 200 ton/day, may contain 2000 mg/L organic and 1500 mg/L inorganic dissolved material; representing a typical contaminant flow in the range of 330-420 kg/h (oven dry) at the solid content of 0.35-0.4%. In addition to dissolved material, circulation water also contains fibre, 100-200 mg/L. Recovering this fibre is important, not only for the operation of water treatment equipment but also for economical reasons.

3.3.2 Effect of contaminants on the paper machine

Closing up a pulp and paper mill's white water system without attending to the potential consequences may result in reduced production and quality. To date, white water closure has occurred predominantly in uncoated linerboard and corrugated medium grade mills operating with acid to neutral papermaking conditions. The importance of water quality, materials management and deposition control is elevated at printing and writing grade mills since quality and production in these grades are usually more sensitive to deposition and microbiological growth (Gudlauski 1996).

Webb (1992) summarises the consequences of closing water systems on the paper machine.

Table 3.2 Consequences of closing water systems on the paper machine

Causative factor	Benefit	Drawback
Lower fresh water and effluent flow	Reduced water supply and treatment costs. Reduced size of effluent treatment units.	Non-compliance with discharge standard. Slower equilibrium.
Increased water temperature	Better drainage Less slime? Less energy needed in water removal	More slime? Tackier deposits Sizing problems Reduced vacuum pump capacity
Increased dissolved solids concentration	Higher retention of solubles	Lower retention Increased corrosion Increased scaling Increased slime Increased foaming Odour problems
Increased fines concentration	Reduced sludge disposal costs	Lower drainage Impaired product quality Felt / shower plugging

Whether substances come in with wood, process water, or recovered paper, papermakers should work to eliminate them from the overall paper cycle (Webb 1997). There is a wide range of substances present in papermaking that can cause problems.

These substances are loosely defines by Webb (1997) as "substances that impair the runnability of the papermaking process and/or the quality of the product".

3.3.2.1 Deposition and corrosion

The tendency for deposition from most materials is increased on closing up as a result of increased concentrations and temperatures. Certain deposits, e.g. pitch and stickies, also become more mobile due to the effect of temperature on surface characteristics and they may penetrate further down the system, e.g. into the press section (Webb 1992).

3.3.2.2 Retention

As paper mills close up, the opportunity to purge the system of fines and contaminants is greatly diminished. Wire retention may deteriorate due to the colloid protection effect from the build up of dissolved organics such as starches. Increased fines concentrations may also lead to worse formation of the sheet. The effectiveness of retention aids may be adversely affected by this build up of fines.

Barnett (1996) lists the total ions that build up in a closed system and interfere with high molecular weight retention aids:

Cationic:
Sodium (Na)
Aluminium (Al)
Calcium (Ca)
Magnesium (Mg)
Various heavy metals

Anionic:
Chloride (Cl)
Sulphate (SO_4)
Phosphate (PO_4)

Other cationic materials such as starch, wet-strength resins, size, and certain dyes can also contribute significantly to polymer interference.

3.3.2.3 Microbiological build-up

Increased white water closure changes the environment and growth conditions for micro-organisms in the papermaking process. Changes such as increased temperature, lower dissolved oxygen content, longer residence time and increased total solids, create conditions for increased incubation and for different inoculation points of micro-organisms that result in quality, runnability and safety issues. Microbiological growth can manifest itself as either slime deposition, formation of volatile gases, or spoilage-producing acids that affect the bonding of organic compounds leading to degradation of additives and wood fibre.

The quality of the paper produced is also affected by sheet defects from microbiological deposition and reduction in sheet from fibre spoilage.

Runnability of the paper machine is affected by some of the following: (Gudlauski 1996)

- Breaks due to microbiological deposits
- Downtime to wash up or boil out deposits
- Reduced production capacity due to screen plugging
- Downtime for repairs due to deposit corrosion

Paper breaks and the corresponding downtime are the most common runnability problems. Safety becomes and issue when anaerobic bacteria produce toxic or explosive gases, such as hydrogen sulphide (H_2S), hydrogen (H_2) and methane (CH_4) in stock or water chests. Slime deposition can make catwalks and machine surfaces slippery, causing lost time accidents.

3.3.2.4 Dissolved and suspended solids

An increase in dissolved solids will have cumulative effects. It leads to poor shower water quality and eventual plugging of paper machine fabrics. Deposits slough off the machine and shower surfaces and result in defects and breaks. Suspended solids cycle-up will cause an increase in deposition and might cause problems as subtle as a gradual loss of vacuum on the paper machine, or as obvious as filled felts that no longer remove enough water from the sheet (Dexter 1996).

A higher level of solids puts a greater load on the retention program. If fewer fines are retained, they gather at sites on the machine providing initial deposition and eventual microbiological growth. This can lead to under-deposit corrosion. As bacteria metabolise, they secrete exopolysaccharides (slime) and acidic by-products (Gudlauski 1996). These acids attach metal surfaces, resulting in pitting, etching and promotion of stress fracture corrosion. The best known anaerobes are the sulfate reducing bacteria (Dexter 1996).

Higher solids also increase the demand for microbiological inhibiting products such as biocides and oxidizers. Treatment costs increase and deposition control is more difficult.

It is generally understood that disproportionate amounts of system additives associate with fines. As such, their build-up in a closed system can lead to problems. As the fines increase, the system can begin to foam more readily due to fines' stabilising effect on foam and the cycle-up of additives. The surface foam increases the potential for entrained air to accumulate. Entrained air in the system can cause pump cavitation and drainage problems, which can impede production. Increased fines can lead to a weaker sheet (Barnett 1996) with related strength and quality production losses. Increased surface foam can also cause deposition.

3.3.3 Effect of contaminants on the paper properties

Zhang (2000) examined the separate effects of the dissolved and colloidal fractions in the white water on the paper properties.

A 0.22µm membrane filter was used to separate colloidal particles from the dissolved substances in newsprint mill white water.

Analysis of the size of the colloidal particles in this white water indicated that the majority of the particles were in the 250 to 1000nm range with very few particles less than 220nm in size. Thus it was possible to separate the colloidal organics from the dissolved fraction by filtration through a 0.22µm membrane filter.

The colloidal fraction consisted mainly of lignin with smaller amounts of resin and fatty acids and esters.

The presence of the colloidal fraction in the white water had a marked effect on sheet porosity, moisture absorption and brightness. Brightness was not affected by dissolved components. This was likely the result of absorption of light by lignin, which is the main component of the colloidal fraction.

Reductions in paper strength were mainly caused by the dissolved substances. Thus the study showed that colloidal substances were primarily responsible for impairment of paper surface and optical properties, and dissolved substances for impairment of strength properties.

3.3.4 Detrimental substances from the pulping process

The term "detrimental substances" has been around for some time, but it begs the question – detrimental to what? All problematic substances interfere with the process or product in some way, but detrimental substances do so through their physico-chemical interaction with chemical additives (Webb 1997). This interaction is usually brought about by the charged groups present within the interfering substance. These charges are usually negative and this has led to the common terminology "anionic trash" (Webb 1997). One of the best known effects from the presence of anionic interferences is the consumption of cationic retention aids and the consequent decline in fines retention on the paper machine. Bräuer *et al* (1999a) define anionic trash as "the total amount of anionic oligomers and polymers and nonionic hydrocolloids". Examples of the different organic and inorganic nature of these substances as well as the different origins are shown in Table 3.3.

Table 3.3 Examples of the chemical nature and origin of detrimental substances

Chemical	Origin
Sodium silicate	Peroxide bleaching, deinking
Hemicellulose Fatty acids Resin	Wood
Lignin derivatives	Cooking processes with chemical pulp and chemi-thermomechanical pulp production
Humic acids	Fresh water
Polyphosphates Polyacrylates	Filler dispersion aids
Organic acids	Resin dispersion aids
Carboxyl methyl cellulose (CMC)	Broke dispersion of coated paper
Starch	Recycled paper, broke
Salts	pH changes, residual peroxide destruction (neutralisation)
Sulphites	Cooking, dithionite bleaching
Acids	PH changes
Soaps	Deinking

These materials are either partially adsorbed or not adsorbed onto the fibres, and they are not necessarily removed from the system with the final product. Instead they accumulate in the water loops to a concentration which depends on their degree of adsorption onto the fibres, fines and fillers in the paper machine furnish. The problem becomes more severe if the water loops in the different process steps are closed to a large extent.

Organic substances, such as lignin derivatives, lignosulfonates or hemicelluloses are dissolved in the refining, grinding and in bleaching stages. Inorganic substances are introduced with bleaching chemicals.

Chemicals added on the paper machine also impact on the bleaching process in the pulp mill. Bräuer *et al* (1999a) give an overview of the papermaking chemicals which impact on bleaching.

Table 3.4 Papermaking chemicals which impact on bleaching

Description	Used for
Alum (anionic)	Retention agent; pitch control
Cationic poly-alkyl-amine	Control of detrimental substances and pitch
Cationic quaternary poly-hydroxyl-alkylen-polyamine (PAA)	Control of detrimental substances
Modified cationic poly-ethylene-imine (PEI)	Fixation agent; reduction of anionic trash; cleaning of filtrates
Modified inorganic pigment; cationic bentonite	Retention and dewatering agent
Cationic polyacrylamide (PAM)	Retention and dewatering agent
Magnesium-aluminum-silicate (Talcum)	Pitch control; control of hydrophobic substances

Some of the chemicals used in the paper machine recirculate with the paper machine filtrate and enter the pulp mill. There they may interact with the bleaching chemicals used in peroxide bleaching and have either positive or negative effects on the efficiency of the bleaching reaction. In experiments conducted by Bräuer *et al* (1999a) samples of pulp were treated with various paper machine chemicals and showed an average of 0.8% lower ISO brightness than the control sample.

Potential anionic trash is released during peroxide bleaching. Although the silicate has some influence on the cationic demand and may interact with cationic papermaking chemicals, polygalacturonic acids, which are released from the pulp during peroxide bleaching, account for the major part of anionic trash in bleached mechanical pulps. Bräuer *et al* (1999a) show in a laboratory study that about 2.0-10.0 kg/ton of anionic trash are relased during peroxide bleaching. While the bleaching reaction accounts for approximately 80-90% of the detrimental substances in the experimental work by

Bräuer *et al* (1999a), the sodium silicate, which may interact with some cationic polymers at the machine, accounts for the remaining 10-20%.

3.3.5 Characterising a filtrate or effluent stream

Numerous measuring methods for detrimental substances are suggested in the literature but the following three methods are the most widely used (Bräuer *et al* 1999b):

- Cationic demand (mg/L of defined titration chemical)
- Chemical oxygen demand (mg O_2/L)
- Conductivity

Others, like turbidity, ζ-potential or streaming-current detection are either too complicated, less accurate or simply cannot be related to the real problems in the mill. According to Bräuer *et al* (1999b) to characterise a filtrate or effluent stream, the COD measurement is no longer sufficient. This has led many mills to also measure the cationic demand.

Conductivity characterises the salt content of the pulp suspension and thus can give some information about the degree of closure of a filtrate system. If the conductivity stays below a certain, relatively high limit, its influence on the paper production is surprisingly low. Therefore Bräuer *et al* (1999a) conclude that conductivity alone is not an adequate measure for detrimental substances.

Bräuer *et al* (1999b) conclude that an overall judgement of the filtrate quality in the different loops and on the paper machine is possible by measuring COD, cationic demand, turbidity and dissolved solids. In addition they state that the behaviour of cationic demand and turbidity is similar to COD.

Chapter 4

Literature Review – Water Pinch Analysis

Pinch Analysis was initially developed for the optimisation of heat exchanger networks. Water Pinch Analysis has evolved from the simple design of heat exchanger networks into a general methodology for the design of integrated systems and has been applied to many industrial cases. A description of the development of Water Pinch Analysis is given in this chapter. The importance of data in process integration methodologies is reviewed and the sourcing and reconciliation of data is discussed. The conceptual approaches to modelling water using networks are reviewed, including a review of the graphical approaches which illustrate the concept of water pinch analysis. Mathematical programming techniques using algorithms to determine the design of water-using systems at minimum cost of operation both for new designs and retrofit of existing processes are also included in this chapter as well as a description of mathematical programming software available for use in Water Pinch analysis. Finally a section on the application of Water Pinch analysis in the pulp and paper industry is included.

4.1 The Development of Water Pinch Analysis (Brouckaert 2000)

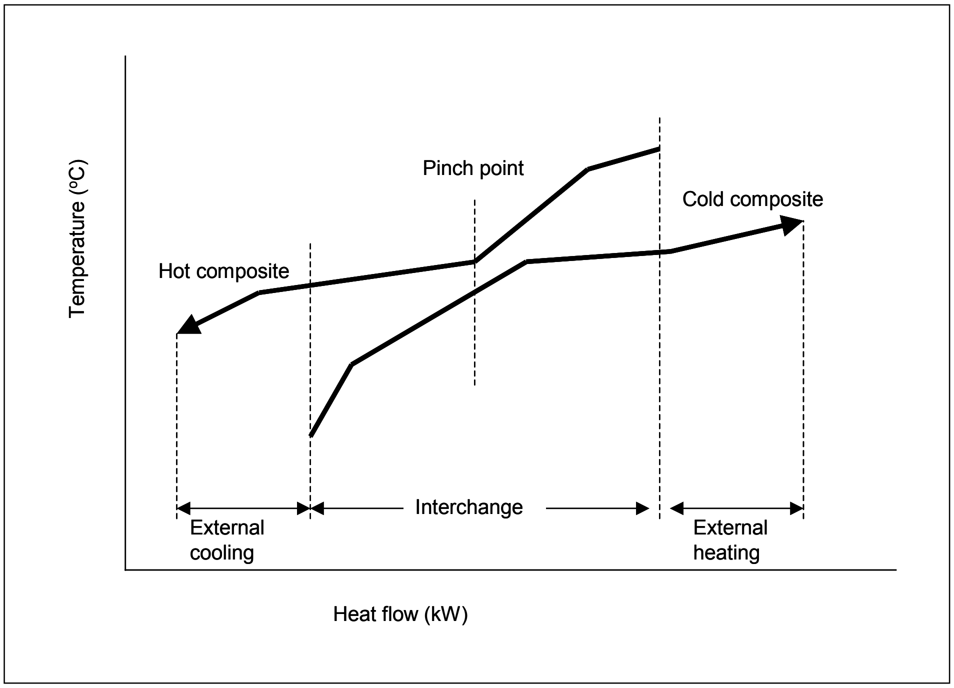
In order to implement cleaner production designs as well as improve the eco-efficiency of existing processes a method is required to investigate the implications of various options. Process integration is an approach which emphasises the unity of a process (El-Hawagi, 1997). It provides a basis for analysing and developing a design at an early stage of its development by providing global insights of the process to the designer, coupled with methodical targeting and design procedures. This allows for the design of eco-efficient processes where the pollution is minimised and does not rely on end-of-pipe solutions to minimise the pollution.

This has led to the development of process synthesis which has been defined as *the discrete decision making activities of conjecturing which of the many available component parts one should use, and how they should be interconnected to structure the optimal solution to a design* (Westerberg 1987).

Process synthesis methodologies systematically guide the designer in the screening of the various process options in order to identify the optimum design. It also allows the assessment of the design possibilities before detailed design is initiated.

The first application of these design techniques involved the conservation of energy through the optimisation of heat exchanger networks. This led to the development of Pinch Analysis as applied to energy conservation. Linnhoff *et al.* (1994) used a graphical approach in which a heat exchange system is represented by a plot of temperature as a function of enthalpy. A hot composite curve is made up of the streams which require cooling and a cold composite curve is made up of the streams which require heating.

Figure 4.1 Composite curves in thermal pinch analysis



The point at which these curves come in the closest contact is the point at which there is a minimum heat transfer driving force, known as the pinch point. This point is used to determine the minimum process requirement and the optimal network design.

Pinch analysis was initially developed for the optimisation of heat exchanger networks following the methodology proposed by Linnhoff and Flower (1978). In this paper the problem of synthesizing optimal heat exchanger networks was approached in two stages. In the first stage the heat exchange opportunities were assessed within temperature intervals. The problem was divided into several sub networks from which the overall heat exchange network was generated. The second stage involved an approach in which a chosen minimum temperature approach (ΔT_{min}) between the hot and the cold streams based on practical implications. A zero ΔT_{min} set an ideal uppermost bound in energy recovery.

The role of ΔT_{min} and the effect of the pinch point in the design of energy recovery networks was further demonstrated by Linnhoff, Mason and Wardle (1979) where this methodology was applied to practical problems. This paper describes the optimum use of utilities, the determination of the minimum number of process units, the effect of stream splitting and cyclic networks, practical problem constraints as well as data modification.

Linnhoff and Hindmarsh (1983) described the design method based on the location of the pinch point. This method entails splitting the problem into two regions, above the pinch and below the pinch.

Analogies between heat conservation and wastewater minimisation have been used to extend the pinch concept to wastewater minimisation. Takama *et al.* (1980) developed a superstructure of all possible re-use and regeneration opportunities in a petroleum refinery situation. The superstructure was optimised and the uneconomical features of the design removed. The regeneration of wastewater was also considered in this work.

This work addressed both single and multi-contaminant cases as well as the identification of regeneration opportunities. Procedures were presented for the design of networks, which allow the minimum target to be achieved. In their methodology different minimum concentration differences can be allowed throughout the network, together with constraints. A composite curve was constructed similar to the temperature enthalpy curves introduced in thermal pinch analysis. This composite curve was then matched to a composite curve through the origin. This minimum water supply line touches the composite curve at a minimum of two points i.e. the origin and one other. The point other than the origin is known as the pinch point. Two methods were presented to achieve this minimum flow rate design. The first is referred to as the maximum driving force method, which uses concentration differences between the various streams to target the minimum flow rate. The second method is referred to as the minimum number of water sources method and uses load intervals. In each interval only enough water is used to maintain network feasibility, the remainder is bypassed and used later. Wang and Smith (1994) also considered the case where more than one contaminant is present and extended their methodology to deal with this situation. They also considered the implications of regeneration of wastewater.

In a later paper Wang and Smith (1995a) discussed single and multiple operations with fixed flow rate and processes with multiple sources of water of varying quality. Water loss in processes is also taken into account. New design rules allow novel water flow schemes to be developed based on local recycling and splitting of operations.

Kiperstock and Sharratt (1995) showed that the usual method of incorporating environmental constraints into a mathematical model as a fixed set of upper limits to concentration for each discharge is not always the best solution. Better solutions can be obtained by allowing the final discharges to vary in composition, while maintaining a fixed total load.

Dhole *et al.* (1996) introduced an approach slightly different to that of Wang and Smith. This method, known as the Two Composite Method, was designed to overcome the problem encountered in real life application of the Wang and Smith methodology. Beuhner and Rossiter (1996) further expanded this methodology. They used *purity* on the vertical axis and water flow on the horizontal axis. The input streams of all the water using processes are plotted in a demand composite curve in order to define the water demand for the entire plant. The output streams are plotted in the same way in order to construct the source composite for the entire plant. The composite curves form a pinch point that represents a bottleneck in the reuse of water. The design of the minimum water network is then achieved by the mixing of wastewater of varying qualities in order to relieve the bottleneck in reuse opportunities that is created by the pinch point.

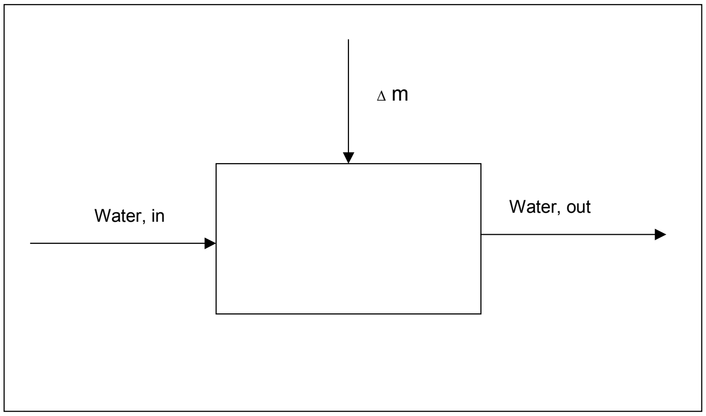
El-Halwagi and Hamad (1996) introduced the concept of synthesising *waste-interception networks* (WINs) and incorporated them into a mass-integration framework for the global allocation of pollutants. This provides a selective inception and rerouting of undesirable species at the heart of the process instead of dealing with the pollutants in the final waste streams. It also provides a unified framework for simultaneously tackling gaseous and liquid streams. This process involves tracking the pollutant through the process and then determining the optimal interception policies and is done by developing a path diagram as a means of characterising the global flow of the pollutant through the process. The path diagram is then integrated with the interception techniques using mass exchange pinch diagrams. This WIN synthesis strategy is formulated as a mixed integer linear programming problem whose solution yields the optimal interception locations, loads and separating agents.

Olesen and Polley (1997) reviewed the procedures introduced by Wang and Smith concerning single contaminants. They introduced a new network designing procedure in which they classify operations into distinct types, each of which has distinct design implications. This method is based on the use of a load table, which tabulates the distribution of duties in the region of the pinch and the minimum water needs for each operation. They considered the case of simple re-use, water draws and regenerated water re-use.

El-Hawagi (1997) details some new and interesting techniques developed to handle problems encountered in real life situations as well as previously developed ideas such as reacting networks (El-Hawagi, 1992) and the combination of thermal and water pinch technology.

A case study presented by Doyle and Smith (1997) consisted of *fixed-mass-load operations*, this mathematical programming approach can be applied to operations with more complex contaminant loading models.

Figure 4.2 A fixed-mass-load operation



Alva-Argaez *et al*. (1998) extended the work of Doyle and Smith and incorporated effluent treatment plants in the proposed mathematical programming model. The proposed model includes mass balance constraints, demand and capacity constraints, environmental constraints on waste discharge, design equations for pipes and treatment operation performance constraints.

4.2 Data

The subject of data extraction and its importance to the final solution achieved by the application of process integration methodologies is dealt with by Linnhoff and Akinradewo (1999). While the context is energy integration based, several aspects are transferable to water-use networks, particularly the consequences of including features of the existing process network as constraints in solving process integration problems. The authors point out that data extraction should be carried out by an engineer with some expert knowledge of a process integration technique to prevent the use of data that has been inappropriately extracted for a process integration study. Koolen *et al*. (1999) weigh up the vulnerability of integrated chemical complexes to chains of events, leading to total stoppages, against the benefits gained from integration and optimisation. Although this paper is written from the perspective of energy integration, the discussion is directly applicable to water-use networks.

Jodicke *et al*. (2000) indicated that in process integration projects, a significant amount of time is required to obtain the desired data such as maximum inlet and outlet concentrations. A mixed integer non-linear programming method was presented for establishing the viability of projects with minimum data requirements. The model uses information that is easily accessible and reduces the effort required to produce optimal solutions.

A hierarchical system for classifying operational sub-units of a processing plant was proposed by Serageldin (1995) in order to effectively track materials. The method is designed to help companies identify sections of their processes that are most problematic in terms of emissions.

In addition to sourcing the data it is essential to ensure that the data is representative for the plant. Meyer *et al*. (1993) described a general method for data reconciliation applied to material balances for steady-state chemical processes. Sets of rules were proposed that facilitated classification of measurements and mass balance equations. The purpose of doing this is to reduce the number of variables that required optimisation. The numerical method proposed determines the best fit of the variables, using redundant equations as constraints. Most data reconciliation techniques rely on a similar technique of fitting data by using a sum of least squares regression method.

The optimal solutions determined when using the minimum amount of available data may prove to be infeasible due to unforeseen circumstances which only become clear once the project has been evaluated.

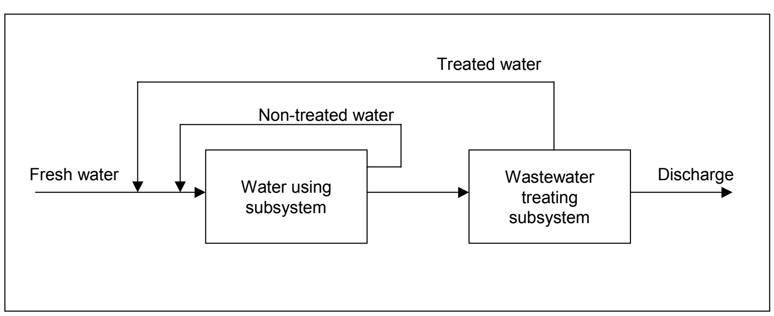
4.3 Modelling the Water-Using Network

Graphical analysis tools have been used to gain insight into the nature of water-using networks. In most of these methods the elements of the overall system are addressed separately. For example Wang and Smith (1994a and b) used a graphical approach to design the water-using subsystem and the treatment network for the wastewater streams is determined as a second step. Kuo and Smith (1998) and Hallale and Fraser (2000a and b) used graphical insights to address the design of the overall system. Graphical methods are however generally limited for use in systems that have multiple contaminants and flow rate constraints which make them difficult to solve. The graphical approach targets the fresh water flow rate and therefore does not allow for incorporation of additional variables such as piping and discharge costs.

4.3.1 Characterising the Water-Using Network

Takama (1980) classified water use into four general categories. Fresh water is required by operations that discharge wastewater, which is treated and discharged or regenerated for reuse and recycle.

Figure 4.3 Industrial water use system



Alva-Argaez *et al*. (1998) characterised the four basic elements of an industrial water-using system as follows:

i) *Freshwater sources*, each with a maximum available flow rate, concentration of key pollutants and cost per unit used.

ii) Water and wastewater *treatment* plants, each with a maximum flow capacity, and efficiency for the removal of the key pollutants and possible water losses.

iii) *Water-using operations* each with a flow demand and quality requirements.

iv) A *wastewater discharge point* where some environmental regulations must be met, in terms of maximum concentration of key contaminants, or maximum contaminant loads.

4.4 Graphical Approaches to Pinch Analysis

Analogies between heat and mass transfer have been used to extend the concept of pinch analysis to encompass waste minimisation and pollution prevention. Techniques have been developed in order to design optimal mass exchanger networks (MEN). These minimum flow rate networks minimise the amount of fresh water consumed and wastewater produced.

The method developed for heat exchanger networks by Linnhoff and Hindmarsh (1983) was adapted by El-Halwagi and Manousiouthakis (1989). This work focussed on the mass exchange of a single contaminant between a set of rich process streams and a set of lean process streams. A minimum allowable concentration difference was defined which applied throughout the whole mass exchange network. The concept of a mass exchange network synthesis was introduced whereby the rich and lean streams were matched.

El-Halwagi (1990 a, b) automated this approach and modified it to include regeneration. A procedure was developed which allowed the simultaneous synthesis of primary mass exchanger networks and their associated regenerative networks. The regenerative network was aimed at regenerating any recyclable lean streams. The proposed procedure deals with the problem in two stages. The first stage involves the solving of a mass-integer non-linear programming in order to minimise the cost of mass separating and generating agents. This linear programming problem was formulated using thermodynamic constraints. The solution allows the location of all the pinch points as well as the optimal flow rates of the lean and regenerative streams. The second stage of the procedure allows the number of units in both networks to be minimised by solving a mixed integer linear program. El-Halwagi *et al*. (1992) applied this approach to phenol treatment in petroleum refinery wastewater.

Wang and Smith (1994a) presented an approach in which targets are set that maximise water reuse. They present fours general approaches to waste minimisation:

i) Process changes: this involves reducing the inherent demand of a process for water.

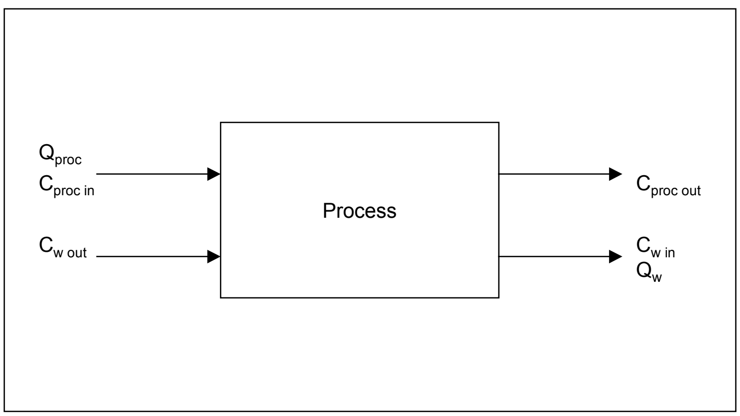
ii) Re-use: wastewater can in some cases be reused directly in other operations, provided the level of contamination introduced in the previous operation does not interfere with the process. It may require blending of wastewaters or the blending of wastewater with fresh water.

iii) Regeneration Reuse: wastewater can be regenerated by partial treatment to remove contaminants which would prevent its reuse, and then reused in other operations. It may not be reused in the operation that generated the waste in the first place, as this recycling will eventually lead to build up within the process. The regenerated water may be blended with other wastewater or with fresh water.

iv) Regeneration Recycling: wastewater can be regenerated to remove contaminants that have built up, that is then recycled back to the process that generated the waste originally.

The water-using process in which a single contaminant is removed from a process stream using water (Figure 4.4) was initially considered by Wang and Smith.

Figure 4.4 The water-using process considered by Wang and Smith



A contaminant is removed from a process stream by contact with water. In this process the water becomes contaminated. Different water flow rates and contaminant levels can solve the same problem. In order to maximise the possibility of water reuse from other operations Wang and Smith specify water with the highest possible inlet concentration, then by specifying the maximum possible outlet concentration, the minimum water flow is defined. This case is known as the limiting case, any water supply below this (and hence water flow rate above) will satisfy the process requirement. These maximum inlet and outlet concentrations might be fixed by:

i) minimum mass transfer driving force;

ii) maximum solubility;

iii) corrosion limitations;

iv) fouling, etc.

The limiting water profile is used in the analysis because this approach can be applied to operations very different in nature and use of the limiting case allows all the processes to be treated on a uniform basis.

Wang and Smith produce a table of limiting process water data. This is done by:

i) Specifying the mass load of contaminant (m) to be removed from the process stream.

$$m = Q_{proc} (C_{proc\ in} - C_{proc\ out}) \qquad (4.1)$$

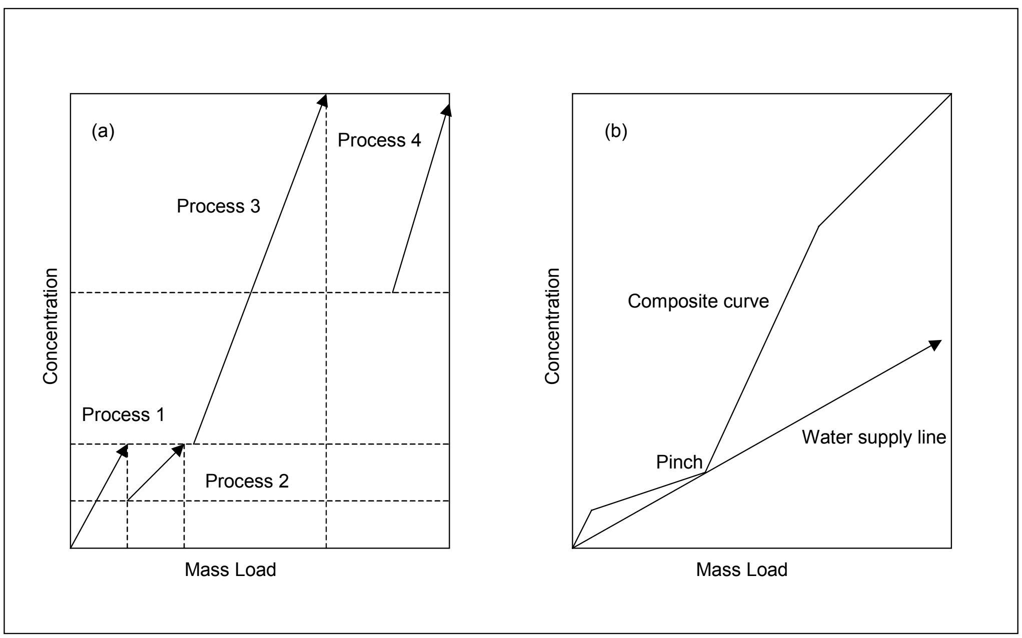
ii) Specifying the maximum allowable contaminant concentration ($C_{w\ in\ max}$) in the feed water or in the outlet ($C_{w\ out\ max}$) to determine by process or equipment limitations such as precipitation or corrosion potential.

iii) Calculating the maximum wash water flow for each process.

$$Q_w = m \,/\, (C_{w\ out\ max} - C_{w\ in\ max}) \qquad (4.2)$$

This is repeated for each process and the results tabulated. The limiting water data are then plotted as *limiting profiles* and these profiles used to construct a *limiting composite curve* (Figure 4.5 (a) and (b)). Combining the operations between concentration intervals generates the composite curve.

Figure 4.5 (a) and (b) Composite curves for determining minimum fresh water requirements



The composite curve shows the critical sections of the plant. The sections at or close to the pinch point require close attention in order to minimise the water flow rate. This composite curve is then matched to a water supply line. The inlet contaminant concentration of the water supply line is assumed to be zero and therefore passes through the origin.

Any line through the origin below the composite curve represents a water supply flow rate that will satisfy the system. The minimum water supply line representing the minimum water flow rate, is the line that just touches the composite curve. Each point where the supply line touches the composite curve represents a pinch in the design. The inverse of the gradient of this water supply line specified the target for the minimum water flow rate.

Having specified the minimum water flow rate, Wang and Smith then present two methods for the network design. The first method maximises the concentration driving forces in the resulting design and takes full advantage of the concentration difference between the limiting composite curve and the water supply line. The composite curve is divided into vertical mass load intervals at each point where the gradient changes. Wang and Smith then use the grid diagram for network design, a concept initially developed by Linnhoff and Flower (1998). This method produces a design which meets the minimum water flow rate, however it is more complex than necessary. Independent loops were identified in the design which were then broken to produce a less complex design.

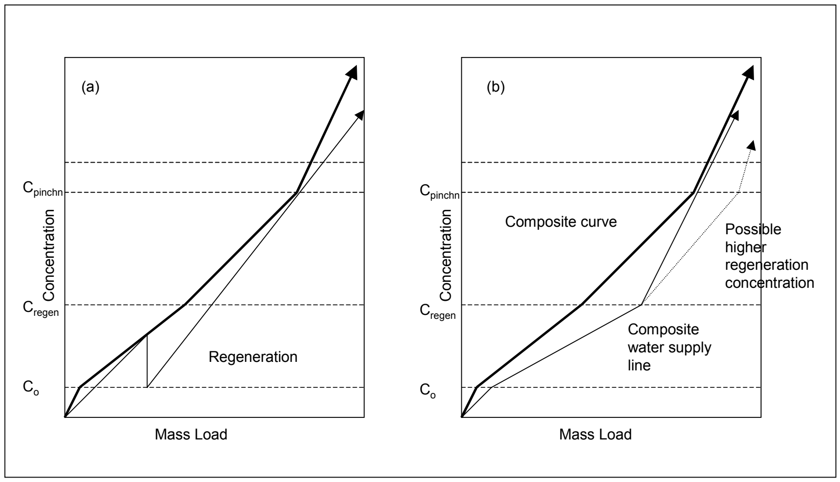
The second method introduced by Wang and Smith ensures the minimum number of water sources are used. This method involves following the concentration intervals instead of the mass load intervals. In each match the minimum amount of water required by the process is used and the unused water is bypassed to be mixed in later. The design procedure then follows that of the first method producing a water-use network and simplifying it by breaking loops. This method produces a design with a single water source that achieves the minimum flow rate target.

4.4.1 Regeneration Reuse

Wang and Smith consider first the placement of regeneration processes for a single contaminant when reuse but not recycling is allowed. Figure 4.6 shows a limiting composite curve with a water supply line matched against it. The water supply line also shows a regeneration process. The limiting composite curve determines C_{Regen}, the maximum water concentration before the regeneration process. After the regeneration process the level of contaminant is reduced to C_o. The mass transfer is completed with regenerated water.

The placement of the regeneration process, Figure 4.6 (a) brings a reduction in flow rate and to determine whether this flow rate is minimised the water supply composite is constructed, Figure 4.6 (b). The composite water supply line in Figure 4.6 (b) just touches the limiting composite curve, which suggests that the water flow rate with regeneration is minimised. However, the dotted line shows what would have happened if the water had been allowed to reach a higher concentration before entering the regeneration process. The gap between the water composite curve and this dotted line indicates that the water flow is not minimised. Using the same limiting composite curve, and allowing the water to reach pinch concentration, C_{pinch}, produces the minimum water flow rate. Thus, by allowing the water to reach C_{pinch} before regeneration allows the designer to achieve both the minimum water flow rate and the minimum concentration reduction in the regeneration process.

Figure 4.6 Placement of a water regeneration process in relation to the composite curves.

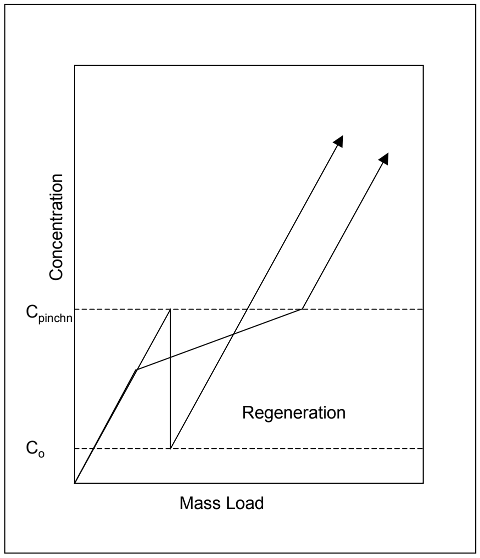


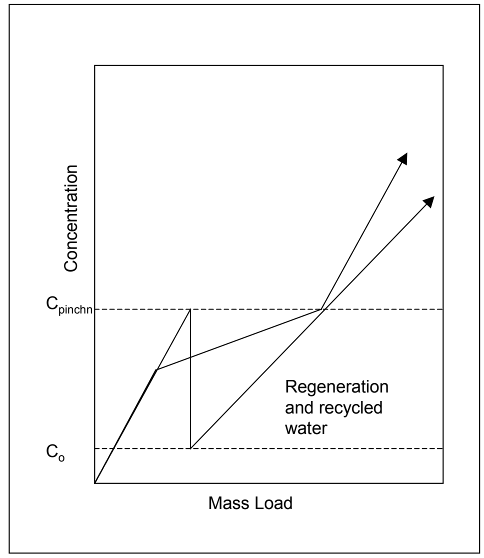
4.4.2 Regeneration Recycling

If recycling is allowed, it is possible to reduce the supply flow rate below that for reuse only. Figure 4.7 shows the situation where regeneration is not sufficient to satisfy the problem. If the flow rate is allowed to reach Cpinch and regenerated there is insufficient water to satisfy the problem. The flow rates needs to be increased after regeneration by recycling. The slope of the curve in Figure 4.8 shows the total flow rate of regenerated plus recycled water.

Figure 4.7 Slope of composite curve below C_o sets the minimum water flow rate

Figure 4.8 Water supply does not satisfy the problem and an increase in flow rate is required implying recycling is necessary



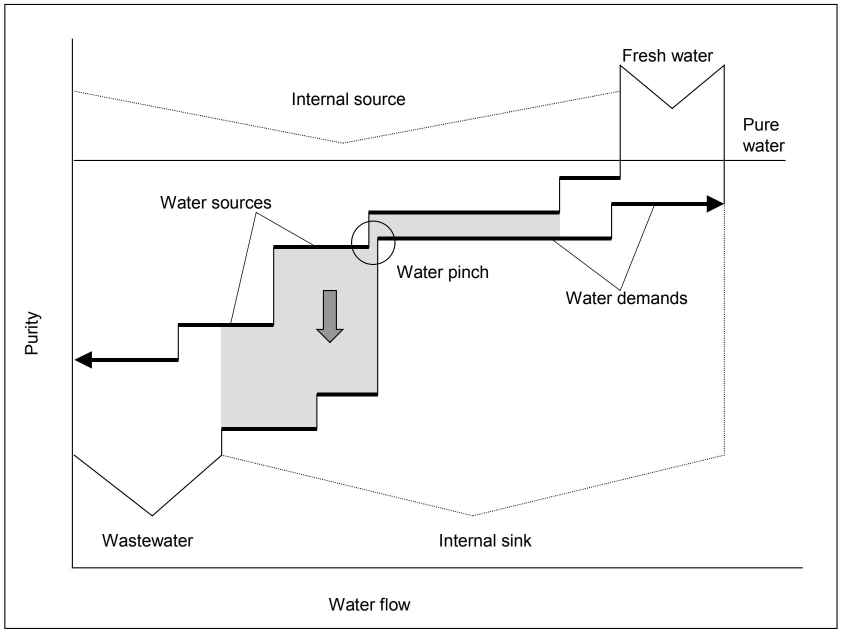


4.4.3 Two Composite Plots

Buehner and Rossiter (1996) present a plot using purity as the vertical axis and water flow rate as the horizontal axis. Each water using process has input and output water streams. There can be several input and output water streams at different purities for a single operation. The input streams of all the water using processes are combined in a demand composite curve in order to define the water demand for the entire plant. The output water streams for all the operations are combined to construct the source composite curve for the entire plant. This is an elaboration of the method suggested by Dhole *et al*. (1996).

This approach is illustrated in Figure 4.9, the overlap between the source and demand composites, the shaded area, indicates the scope for reuse. The pinch point limits the available overlap. Minimum fresh water demand and wastewater generation without wastewater mixing are also identified in Figure 4.9.

Figure 4.9 Demand and source composite



4.5 Mathematical Programming

The graphical approaches outlined so far provide valuable insights to water optimisation problems, however these methods become increasingly difficult to apply when multiple contaminants or special process constraints are involved. The graphical approaches are also unable to deal with optimisation of objective functions which include factors other than water use, in particular economic factors. El-Hawagi and Manousiouthakis (1990) defined a linear programme used to calculate the minimum utility cost and the limiting pinch points. In a second stage they used a mixed-integer linear program (MILP) to optimise the matches of streams on each side of the pinch. Wang and Smith (1994a) published a general algorithm for targeting wastewater for multiple contaminants.

El-Hawagi (1995) introduced mathematical programming techniques using algorithms to determine the design of water-using systems at a minimum cost of operation and installation both for new designs and retrofit of existing processes.

Mathematical programming has been used by Takama *et al*., (1980) and Rossiter and Nath (1995) for mass-transfer networks. The formulation of these programmes corresponds to the water pinch approach which was set out by Doyle and Smith (1997) and extended by Alva-Argaez *et al*. (1998). The Water Pinch software from Linnhoff-March is also largely based on this approach.

The state of the art mathematical programming, as applied to the automated design integration and operation of chemical processes was reviewed by Grossman *et al* (1999).

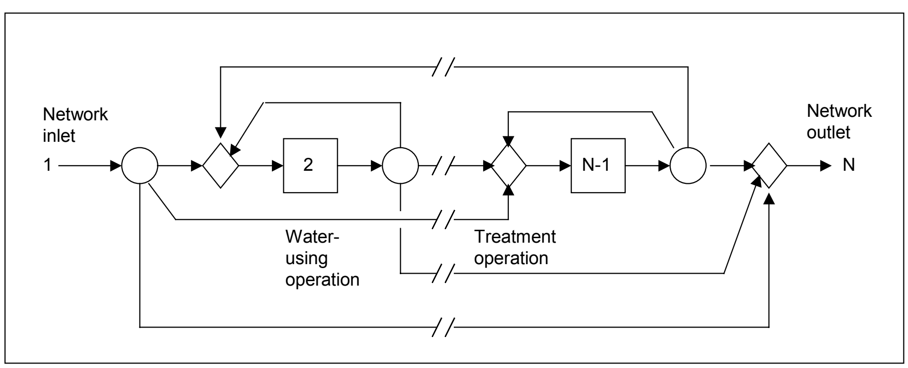
4.5.1 Mathematical Programming Techniques

Depending on the nature of the constraints and the types of variables involved in the optimisation problem, different algorithms are required to solve the different optimisation problems which arise. *Linear programming* (LP) problems contain only continuous variables and the constraints and objective function are all linear (Gianadda 2002). Algorithms that contain continuous real variables (e.g. flow rate, pressure, temperature) as well as integer variables (e.g. 0,1,2…) is called a *mixed integer program* (MIP). Depending on the linearity characteristics of the algorithm, MIPs can be further classified into *mixed-integer linear programs* (MILPs) and *mixed-integer non-linear programs* (MINLPs). A useful class of integer variables is the 0/1, or *binary* variables, which are most often used to model logical events and decisions. A 0/1 variable may be designated to assume the value of 1 when an event occurs (e.g. a unit operation is used) and 0 when that event does not occur.

Doyle and Smith (1997) pointed out that non-linear programs suffered from the difficulties finding the global optimum to a problem rather than a local optimum, particularly for problems involving many variables. Linear programs, on the other hand can handle large problems, and global convergence is readily obtained.

Takama *et al*. (1980) used mathematical programming to address the problem of optimal water allocation in a refinery. A *superstructure* of all water-using and treatment operations was set up and an optimisation was carried out to reduce the system structure by removing irrelevant and uneconomical connections. The result is the structure which represents the optimal water allocation strategy.

Figure 4.10 Superstructure of all possible inter-operational connections.



The superstructure consists of a total of N nodes, which consist of all the water sources, discharge points as well as the water-using and treatment operations. The problem is stated as a dual optimisation problem. The first requirement is to optimise the allocation of water to the subsystems, i.e. determine the optimal structure. The second stage assumes a fixed structure, determined from the first stage, and optimises the design of the individual subsystems. The process is repeated with a new design parameter for each subsystem. In this paper, the authors only address the structural optimisation. The objective function is defined as a function of return on investment, operating cost of the wastewater treatment system and fresh water costs. Linear mass loading and removal terms are specified for each subsystem. A solution method is presented that uses a penalty function to deal with constraint violations. The penalty function is added to the objective function.

Doyle and Smith (1997) consider that a water-using network is not simply a special case of a mass-exchange network, because operations such as cooling towers, steam systems and hosing operations cannot be considered as mass-exchangers. The basic model used is similar to Wang and Smith's fixed-load model (see Figure 4.2), except that:

i) an alternate option is considered, where the mass load is allowed to vary in order to fix the outlet concentration of contaminant;

ii) water gain or loss is allowed, to model operations such as a cooling tower or evaporator.

The concepts of limiting flows and concentrations and the relationship between them via mass balances, are the same as in Wang and Smith (1994a).

To automate the procedure for finding the optimal set of connections between units, they also used a superstructure for the network, which allowed in principle, all possible connections. The solution procedure specified used a combination of linear and non-linear models to determine the minimum cost of water utilisation. A fixed outlet water stream concentration is assumed, which allows the process mass load to vary. The solution to the linear model is used as the starting estimate for the non-linear model that ensures a fixed mass load. The mass load is fixed by specifying a non-linear constraint. The inter-operational flow rates, flow rates from fresh water sources and outlet concentrations from processes are the variables. The flow rates are constrained by a limiting flow rate which corresponds to the flow demand of processes when the inlet concentration is at its maximum limit. Cost factors are included, allowing for a cost per unit flow used. A non-linear objective function is specified, which may be simplified to a linear function is only the cost of fresh water is taken into account.

Alva-Argaez *et al*. (1998) extended this work by noting that once a set of flow rates have been obtained from the linear programming solution, which assumes that the outlet concentrations are at their limiting values, the corresponding set of concentrations can be calculated to determine where the assumptions are in error. If the calculated concentrations are below the limits, the errors are of no consequence. Where the concentrations exceed the limits, the errors can be added into the objective function to be minimised. Running the linear-programming model again will tend to drive the errors to zero. This provides the basis for a method which uses a series of linear-programming optimisations which converge to the non-linear programming solution, taking advantage of the particular mathematical structure of water pinch problems.

Binary variables were introduced corresponding to each possible connection in the network. A value of 1 indicates that the connection exists. The formulation allows automatic control of features such as the elimination of streams which fall below a specified flow rate or the maximum number of connections allowed in a network. The addition of binary variables move the optimisation into the class of mixed integer programming.

4.5.2 Mathematical Programming Software

Modelling systems such as GAMS (General Algebraic Modelling System) can be used to formulate and solve major types of mathematical programming problems. The model needs to be expressed in algebraic form and GAMS interfaces with cods to solve the various types of problems. This modelling system can be run on most desktop personal computers, making its use and application widely available.

The solution of LP problems relies largely on the simplex algorithm. MILP methods rely on simplex LP-based branch and bound methods that consist of tree enumeration in which LP sub-problems are solved at each node, and eliminated based on bounding properties, Grossman *et al*. (1999).

The solution of NLP problems relies on the reduced gradient method and for convex problem NLP methods can guarantee global optimality. For non-convex problems, global optimality cannot be guaranteed.

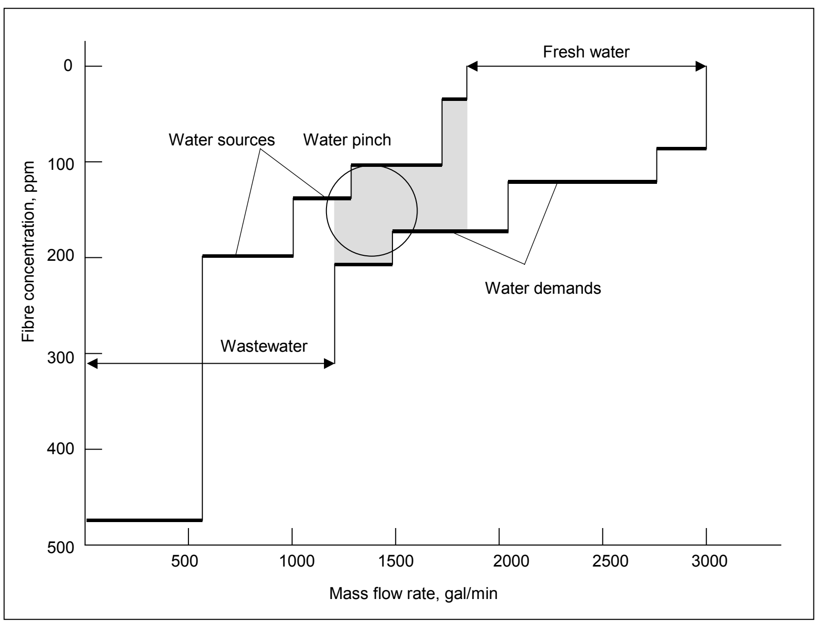
Water Target is a suite consisting of two parts. WaterTracker is a tool for performing water and contaminant balances for a site. It shows a graphical presentation of the water network. The second part of the suite, WaterPinch, uses algorithms to identify and optimise the best water reuse, regeneration and effluent treatment opportunities Linnhoff-March (1999). GAMS provides the optimisation algorithms in WaterTracker.

4.6 Pinch Analysis Application in the Pulp and Paper Industry

Noel (1995) did a thermal energy conservation study at the Donohue Clermont newsprint mill using pinch analysis as the tool. A composite curve was developed to determine the minimum heating required by the entire mill. This example illustrates the savings potential when the whole plant is considered and the systematic method for identifying energy savings projects using pinch technology.
Karlsson (1999) uses Total Site Integration (TSI) to calculate the energy usage and balance for a paper mill site and constructs hot and cold composite curves to determine the effect of new drying technologies on paper mill energy consumption.

Tripathi (1996) describes how pinch analysis is used for minimising the wastewater in a pulp and paper mill. The practice of taking effluent from all parts of the plant to a single treatment plant for treating and recycling is demonstrated to be an inefficient process. Internal recycles identified using pinch analysis are identified. In this example the water consumption in a paper machine is considered and the water streams are combined to from a demand-composite curve, Figure 4.11

Figure 4.11 Two composite plot of water sources and demands in a paper machine.



Total suspended solids were used as the measure of purity in this example and constraints were used to allow for other process requirements which dictated a minimum purity of water, for example showers on the paper machine. The savings achieved in this example had a return on investment of less than two years, based on a reduction in fresh water usage, pumping costs, and reduced heating costs.

Pinch analysis has been applied successfully to the pulp and paper industry for improving thermal efficiency (Ashton *et al*., Calloway *et al*., Cripps *et al*. 1993, 1996, 1997 and Folkestad *et al*.) and Kuofos and Retsina (2001) present a table summarising steam savings from pinch applications, Table 4.1.

Table 4.1 Practical steam savings identified by pinch analysis

Mill Type	$/ton
Bleached Kraft / NSSC	2.61
Bleached Kraft / TMP and Other	4.5
Bleached Kraft market pulp	4.95
Non-integrated Papermaking	1.17
Kraft / NSSC / OCC	2.61
Sulfite or Semisulfite	3.96

Koufos and Retsina (2001) describe the steps required in the application of water pinch methodology as follows:

1. Flowsheet: Develop a simple flowsheet model of the water system, showing where water is used and where waste water is generated i.e. determine the water *sources* and *sinks.*
2. Contaminant Data: Select key contaminants e.g. COD, salts, suspended solids. A *key contaminant* is defined as *any property that prevents the direct reuse of the wastewater stream*, this might include temperature and/or acidity. Choose design concentrations which are the maximum allowable for the sinks and the minimum practical for the sources. This is done with input from the process technology experts in the relevant process.
3. Software implementation: Create a simulation model of the flowsheet. Perform multidimensional water pinch analysis to determine the optimum matches between the sources and sinks.
4. Review Design: Examine the resulting network design and identify the pinches for the selected contaminants. It is usually necessary at this point to assess the design and determine which additional contaminants should be considered; which matches should be forbidden, and which matches should be forced (if any). This procedure may also include process modifications and *regeneration* options that would result in lower targets.

A de-inking plant is used in this example and a 20% reduction in fresh water consumption is identified however the authors note that some “non-logical” connections appear in the solution which requires further refining. The example demonstrates “proof of concept”.

4.7 Conclusions

This chapter has reviewed the concepts and literature on the field of water pinch analysis. Subsequent chapters will draw on these concepts as water pinch analysis is applied to the specific example of an integrated pulp and paper mill. The approach which is used in this study uses mathematical programming, however the conceptual understanding of water pinch analysis based on the literature review presented in this chapter is important, particularly with reference to water using operations, contaminants and the interpretation of the results of the study.

Chapter 5

Development of a of Water Pinch Model for Mondi Paper

In order to perform a Water Pinch analysis on a site which is as complicated as the Merebank mill, the operation was divided into manageable sections. A flow sheet model of the sections was then developed and a water and contaminant balance, accurate to within 10% of the metered amounts of the larger streams, was developed. Once a sufficiently accurate water and contaminant balance was achieved, the streams which were not variable and therefore did not form part of the water pinch analysis (e.g. product streams) were not considered further. In order to perform a water pinch analysis a relationship between streams into and out of the unit operations which make up the sections was required. In this study the balance produced using the Water Tracker software was used to determine these relationships. Once the streams which did not form part of the water pinch analysis had been removed and the water pinch model of the plant had been developed, this model was tested by "forcing" the streams to represent the actual plant situation as closely as possible by introducing flow constraints into the model. The next step involved removing the feasible bounds and allowing the model to re-route streams in order to achieve a minimum fresh water consumption.

5.1 Water Pinch Modelling Framework

As described in Section 4.6, the application of water pinch methodology requires firstly the development of a flowsheet model of the water system showing where water is used and where wastewater is generated.

The development of a water pinch model, using the Linnhoff-March model framework, that represents the process accurately involves the specification of a water-using system comprising of various *nodes* which represents the water use in the actual plant. The nodes which make up the water-using system are classified as follows:

i) Sources: inlets to the water using system. Sources that have a fixed flowrate are called *process sources*. Sources that have variable flowrates are called *utility sources*.

ii) Sinks: outlets from the water-using system. Sinks that have fixed demands are called *process sinks*. Sinks that have variable demands are called *utility sinks*.

iii) Operations: unit operations that use water and affect the mass flow of contaminant. The water-using operations are divided into two types:

   a. Water-using subsystem: typically operations that have fixed water demands and supplies. Operations within the water-using subsystem typically add contaminant mass to the water stream via mass transfer from a process stream.

b. Wastewater treatment system: typically operations that treat or regenerate wastewater arising from the water-using subsystem. Operations within the wastewater treating system typically remove contaminant mass from the water streams.

Nodes that have both an inlet and an outlet are called unit operations. *Process unit operations* have fixed inlet and outlet flowrates, however a flow balance is not necessarily maintained across a process unit operation. A maximum of five inlets and outlets may be specified for an individual process unit operation. *Utility unit operations* have a variable inlet flow rate, which may be split into a maximum of two dependent outlet flows. The flow balance across a utility unit operation is necessary.

iv) Streams: connections between nodes that represent material flow from one node to another.

Sources and sinks form the boundary of the water-using system. Other water-using operations may exist outside this boundary, but are not considered as part of the analysis.

In the Linnhoff-March Water Pinch software all sources, sinks and unit operations are divided into two categories:

- Utility: A source, sink or unit operation whose water flowrates can be changed during the water pinch analysis. For each utility you can provide minimum and maximum flow limits together with two cost terms; fixed cost and variable cost; for example the supply of city water to a site.
- Process. A source, sink or unit operation whose water flowrates must be fixed during the water pinch analysis; for example the supply of water to showers on a paper machine.

In order to develop a model of the plant or section of the plant which can be optimised using the Water Pinch software, the functional units of the plant need to be represented by models. The models available in the Water Pinch software are described below.

5.1.1 Unit Operations Available in the Water Pinch Software

A unit operation in the Water Pinch software represents a piece of equipment or a processing unit that acts both a sink and a source for water. In other words, a unit operation takes water in and sends water out. In addition, a unit operation will normally change the contaminant load of the water flowing through it in some way. There are two types of generic unit operations available in the Water Pinch software namely a process unit operation and a utility unit operation.

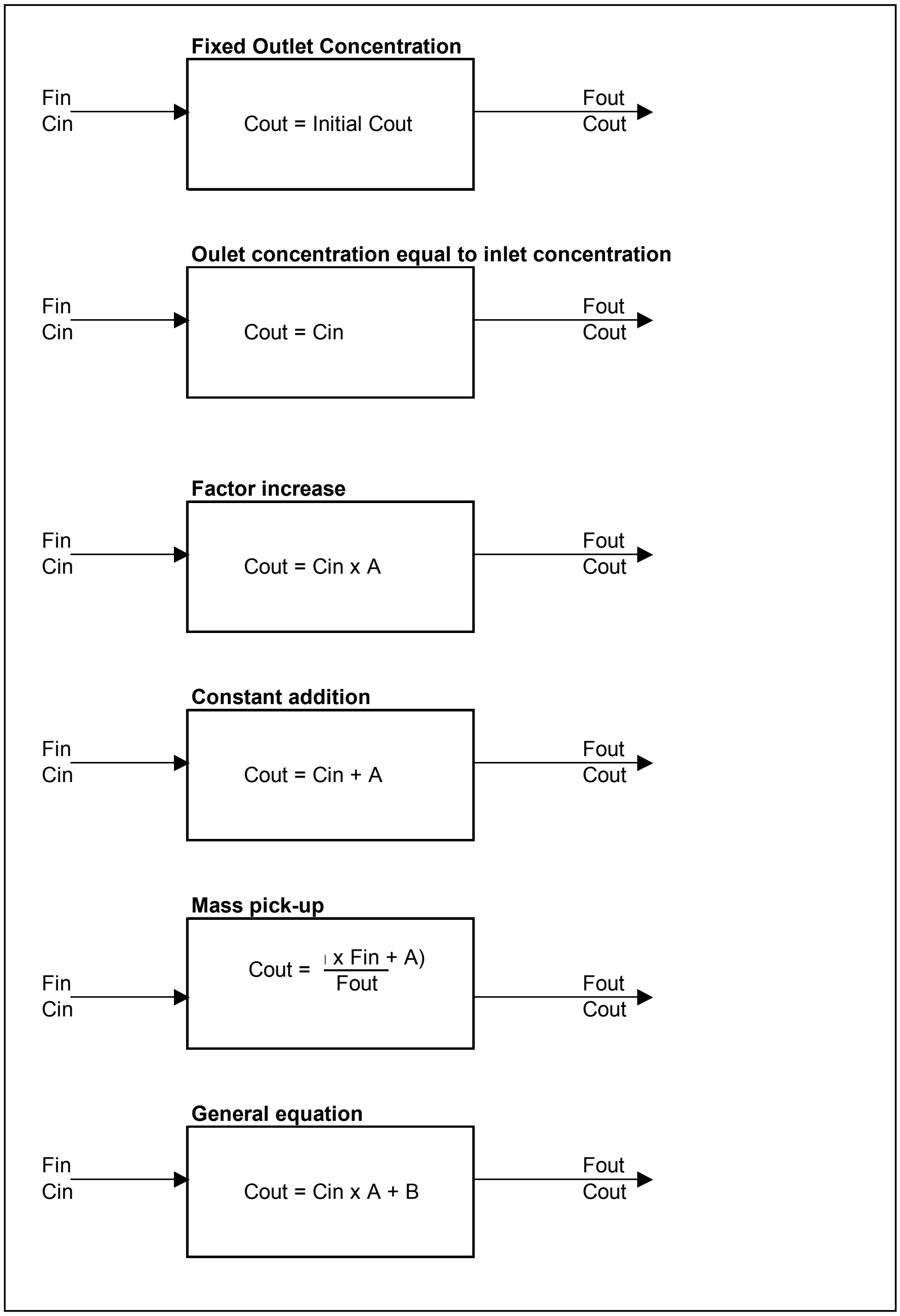
The water flows entering and leaving the process unit operation are always fixed at a particular flow. The process unit can have between one and five sinks and between one and five sources. The total flow of water entering the sinks does not have to equal the total flow leaving the sources sink the process unit operation does not represent the water balance of the plant, but merely the water streams which can be varied in the analysis. The contaminant concentrations of the sources can be linked to the sink concentrations mathematically so that the outlet concentrations can be a function of the inlet concentrations.

The water flows entering and leaving a utility unit operation are variable between an upper and lower limit specified by the user. In addition, the total flow of water entering a unit operation is always equal to the flow leaving it. A utility unit operation always has one sink and either one or two sources. The contaminant concentration of the sources can be linked to the sink concentrations mathematically so that the outlet concentrations are a function of the inlet concentrations. The choices available are as follows:

- Fixed outlet concentration – the outlet concentration will be fixed at the value specified and will have no relationship to any inlet concentration
- Outlet concentration equal to inlet concentration – The outlet concentration will always be the same as the inlet concentration. This type of relationship can be used if a contaminant simply passes through as unit operation.
- Factor increase – The outlet concentration will be proportional to the inlet concentration.
- Constant addition - The outlet concentration will be equal to the inlet concentration plus a constant
- Mass pick-up – A constant mass load of contaminant will be transferred to the water in the unit operation
- General Equation – Any of the above relationships can be modelled with this equation

These unit operations are represented in Figure 5.1

Figure 5.1 User Defined Unit operations



Fin = inlet flow

Cin = inlet concentration

Fout = outlet flow

Cout = outlet concentration

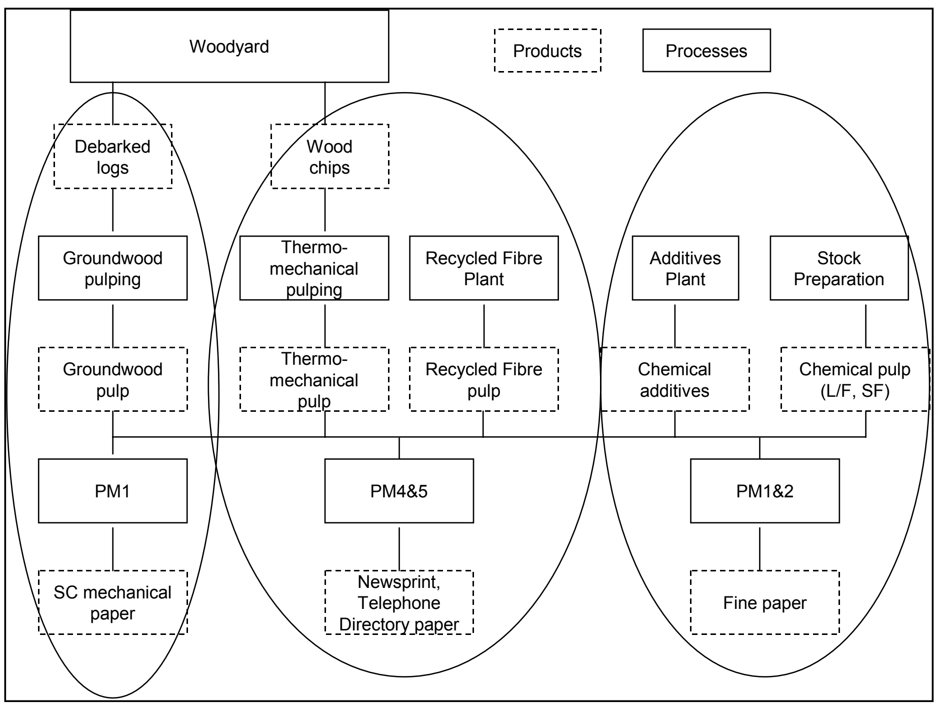
A, B = constant

The WaterTarget software provides a number of standard unit operations to represent some common equipment. The equations and relationships between the inlet and outlet streams are automatically set up in these standard unit operations. These unit operations include the following: generic treater, reverse osmosis, backwash filter, precipitator, dissolved air flotation, air stripper, steam stripper, ion exchange. Alternatively a generic unit operation is availably where the user is able to specify the relationship between the inlet and outlet streams.

5.2 Division of the Mill into Sections

The Merebank mill can be divided into three main sections based on the paper grades produced.

Figure 5.2 Division of the Mill into Sections



The paper machine number one, producing supercalendered magazine paper, along with the groundwood pulp mill forms the first section. The second section of the mill consists of paper machines numbers two and three which produce fine paper, the additives plant and the stock preparation plant. The third section of the mill consists of the two newsprint paper machines, machines numbers four and five, as well as the woodyard, the thermo-mechanical pulp mill and the recycled fibre plant. The utility plants which service the production plant include are the power plant and the waterworks. These utility sections have not been included in this study.

5.3 Choice of Key Contaminant

The contaminants in the pulp and papermaking process which limit the recycling and reuse of water within the process are discussed in detail in Chapter 3. In order to perform a pinch analysis at the Merebank mill it was necessary to select key contaminants which would limit the recycling and reuse of water streams. The key contaminants which could be considered are as follows:

i) Dissolved solids
ii) Suspended solids
iii) COD

In order to perform this water pinch analysis with the information available, the assumption was made that in the Merebank mill fibre is the main contaminant in the streams which form part of the analysis. Data on dissolved solids, COD and temperature of all the streams was not readily available. Suspended solids was therefore selected as the key contaminant that would prevent recycling and reuse of streams in this analysis and dissolved solids and COD were not included as contaminants.

There were areas in the process where other contaminants were the limiting factor for example: if suspended solids (fibre) is the only contaminant limiting the use of water in all areas in the plant, clean cold water could be used in the showers in the headbox of the paper machine. In reality this is not the case, since the water used in the headbox needs to be hot water. In this study, flow constraints were used to prevent streams from being used in certain areas where suspended solids was not the only factor limiting the use of water as in the example above.

5.4 Data

The Merebank mill was built in 1969 and consisted of only one paper machine. The mill has grown over the years to its current size, now comprising of five paper machines and three pulp mills. Water consumption has become increasingly important over the years, however when the mill was constructed, water consumption was not a primary concern and as a result there are very few water meters throughout the mill. The availability of water flow rate data is limited. Similarly, contaminant data is limited and in order to evaluate contaminant concentration in the various streams throughout the mill a large number of tests would be required. The approach taken in this study was to use the data readily available to determine a water balance accurate to within 10% of the measured major flow rates.

The fresh water flows which are measured are:

i) Total flow to the Newsprint Circuit

ii) Total flow to the Recycled Fibre Plant
iii) Total flow to the Thermo-mechanical Pulp Mill
iv) Cold fresh water to Paper Machine No. 4

These streams make up the larger fresh water flows in the Newsprint circuit and a year's data was averaged for use in the water balances.

The amount of fibre in the various streams which formed part of the water and fibre balances was based on average operating conditions. The data used in the balances was based on measured consistencies averaged over a period of a year as well as target consistencies in certain streams. An average dryness of the paper produced was used to calculate the evaporation from the paper machine.

The flow rate of shower water on the paper machines was based on the specification from the nozzle suppliers and the number of showers in use during the study.

The reject rates from cleaners and screens was based on design reject rates.

Chemical additives flow rates were based on one year's consumption data.

Where data was missing information provided by experienced engineers in the plant was used, with appropriate uncertainty factors in the Water Tracker software, for example in the Thermo-mechanical pulp mill no data is available for the amount of plug wiper water or sealing water used and the estimates of experiences plant engineers was used as approximations in the model. The Water Tracker software allows the user to enter a "trust category" which represents the reliability of the estimate. Where estimated data was used, the trust category was larger, for example a trust category of 25% was used for data that was estimated by plant engineers and data which came from flow measurements taken over the period of one year had a much lower trusts category of 2%. 2% was used for measured flows to allow for accuracy of flow meters.

Another type of data which was used in the mass balances was plant data – for example, pressure readings from pumps were recorded and the corresponding flow rates, from the pump curves, were used to estimate the flows for certain streams. This type of information was used where there were no flow measurements available, however the "trust category" for these streams was also high (25%).

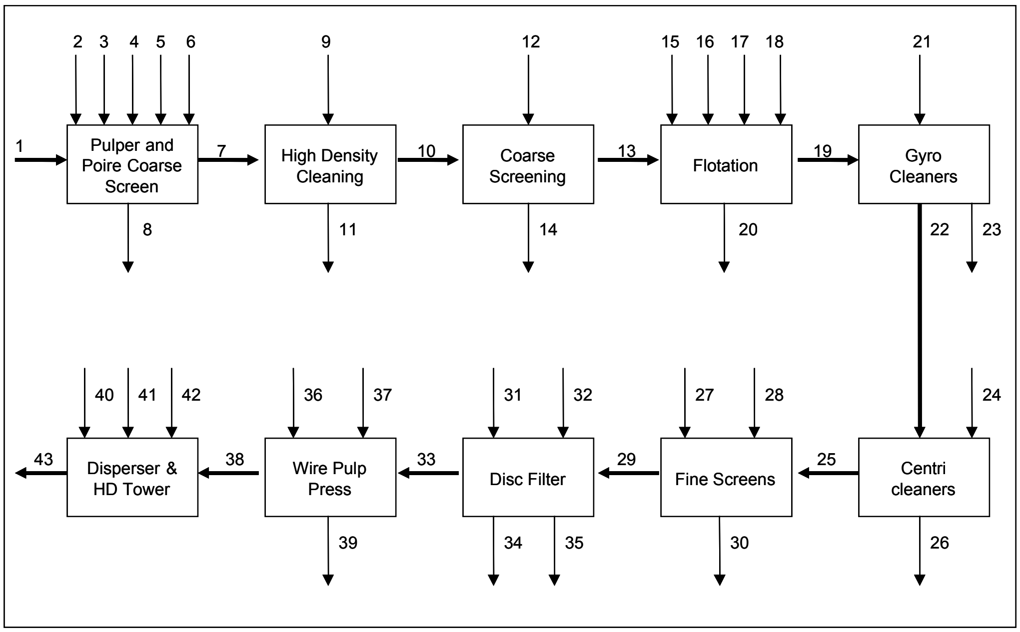
5.5 Water Balances

Water balances for each of the sections were performed using the Linnhoff March Water Tracker software. Water Tracker performs the water and contaminant balance simultaneously.

5.5.1 Recycled Fibre Plant

The Recycled Fibre Plant was divided into functional units and each unit / block analysed. Figure 5.3 shows the breakdown of this section of the plant.

Figure 5.3 Recycled Fibre Plant Functional Units



Note: the bold arrows indicate process streams.

Description of Streams:

1	Waste Paper	2	Sodium Silicate	3	Hydrogen Peroxide	4	Caustic Soda
5	Cloudy Filtrate	6	Steam	7	Pulp	8	Rejects
9	Cloudy Filtrate	10	Pulp	11	Rejects	12	Cloudy Filtrate
13	Pulp	14	Rejects	15	Cloudy Filtrate	16	Soap
17	Calcium Chloride	18	Sulphuric Acid	19	Pulp	20	Ink Sludge
21	Clear Filtrate	22	Pulp	23	Rejects	24	Clear Filtrate
25	Pulp	26	Rejects	27	Clear Filtrate	28	Cloudy Filtrate
29	Pulp	30	Rejects	31	Clear Filtrate	32	Tempered Water
33	Pulp	34	Cloudy Filtrate	35	Clear Filtrate	36	Paper Machine White Water
37	Sulphuric Acid	38	Pulp	39	Cloudy Filtrate	40	Paper Machine White Water

41 Steam 42 Hydrosulphite 43 Pulp

The function of each of these units is described in Table 5.1.

Table 5.1 Function of each process unit in the Recycled Fibre Plant

Pulper and Poire Screen	Waste paper repulping and coarse screening to remove largest contaminants
High density cleaning	Removal of high density contaminants from pulp
Coarse screening	Removal of remaining large contaminants
Flotation	Removal of ink
Gyro cleaners	Removal of smaller, lightweight contaminants (specific gravity <1)
Centri cleaners	Removal of fine sand, grit and heavy clay particles with specific gravity > 1
Fine screens	Removal of fibre clumps
Disc filter	Thickening pulp
Wire pulp press	Pulp is thickened from 5% to 30% consistency to remove alkaline, deinking process water
Disperser and HD tower	Pulp is heated to soften stickies, hot melt adhesives and other similar contaminants. These contaminants are then dispersed evenly throughout the stock. Any ink particles still attached to the fibres are broken up into smaller particles so that they are less noticeable.

A mass and water balance was performed over these functional units. Refer to Appendix B for the detailed balance. The water flow rates were based on design conditions for the recycled fibre plant as well as the total flow rate of fresh water to this plant, which is metered. The fibre content of the streams is based on design conditions and on-line consistency measurements in the plant as described in section 5.4.

The data available was entered into the Linnhoff-March WaterTracker software and an uncertainty range was specified for all the data entered.

The next step in the Water Pinch analysis entails characterising the various streams in the Recycled Fibre Plant. It is necessary to represent the quality of these streams by means of contaminants.

The variables which could be used to characterise the streams in a water pinch analysis are listed in Table 5.2.

Table 5.2 Variables which could be used to characterise the streams in the Recycled Fibre Plant

Stream		Contaminants
1	Waste paper	90% Fibre
2	Sodium Silicate	Na_2SiO_3 ppm (wt)
3	Hydrogen Peroxide	H_2O_2 ppm (wt)
4	Caustic Soda	NaOH ppm (wt)
5	Cloudy Filtrate	Fibre – 0.06% fibre
6	Steam	Temperature
7	Pulp	Fibre
8	Rejects from Poire screen	Particle size (> 6mm)
9	Cloudy Filtrate	Fibre – 0.06%
10	Pulp	Fibre
11	Rejects from HD cleaners	Density and size of solids
12	Cloudy Filtrate	Fibre – 0.06%
13	Pulp	Fibre
14	Rejects from coarse screens	Fibre, Particles (size >1.6mm)
15	Cloudy Filtrate	Fibre – 0.06%
16	Soap	ppm (wt)
17	Calcium chloride	$CaCl_2$ ppm (wt)
18	Sulphuric Acid	H_2SO_4 ppm (wt)
19	Pulp	Fibre
20	Ink sludge	Ink concentration
21	Clear filtrate	Fibre
22	Pulp	Fibre
23	Rejects from Gyro cleaners	Fibre, Particles (Density, specific gravity <1 and size of solids)
24	Clear filtrate	Fibre
25	Pulp	Fibre
26	Rejects from centri cleaners	Fibre, Particles (Density, specific gravity >1 and size of solids)
27	Clear filtrate	Fibre
28	Cloudy Filtrate	Fibre – 0.06%
29	Pulp	Fibre
30	Rejects from Fine screens	Fibre, Particles (Size of solids <0.25mm)
31	Clear filtrate	Fibre
32	Tempered water	Fibre – 0%

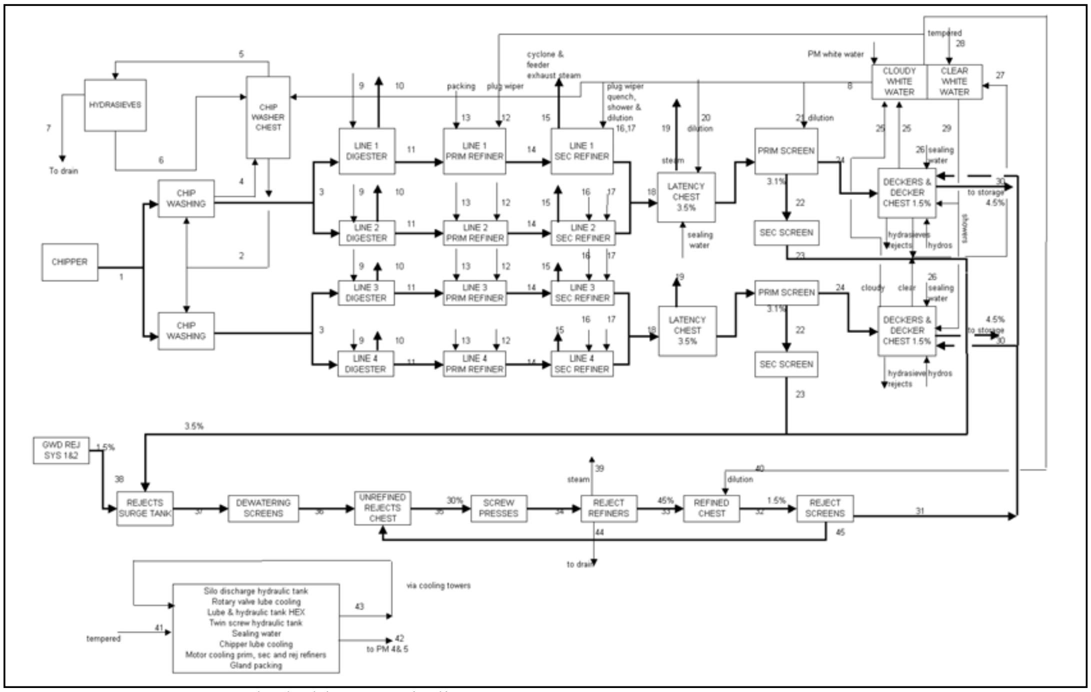
Stream		Contaminants
33	Pulp	Fibre
34	Cloudy filtrate	Fibre – 0.06%
35	Clear filtrate	Fibre
36	PM white water	Fibre
37	Sulphuric acid	H_2SO_4 ppm (wt)
38	Pulp	Fibre
39	Cloudy filtrate	Fibre – 0.06%
40	PM white water	Fibre
41	Steam	Fibre (0%), temperature
42	Hydrosulphite	$Na_2S_2O_3$ ppm (wt)
43	Pulp	Fibre

Table 5.2 shows that the main contaminant in the process is fibre. The chemical additives, (streams numbers 2, 3, 4, 16, 17, 18, 37, and 42), steam (streams numbers 6 and 41) and pulp streams (streams numbers 1, 7, 10, 13, 19, 22, 25, 29, 33, 38 and 43), are not included in the water pinch analysis since they are a part of the process and will not be changed.

5.5.2 Thermo-mechanical Plant

The thermo-mechanical pulping pulping process is represented in Figure 5.4 below. The diagram shows the functional units of this section of the plant.

Figure 5.4 Thermo-mechanical Pulp Mill functional units



Note: the bold arrows indicate process streams.

Description of Streams:

1	Chips	2	Chip wash water	3	Pulp	4	Chip wash water
5	Chip wash water	6	Chip wash water	7	Rejects	8	Cloudy white water
9	Sodium Hydrosulphite	10	Steam	11	Pulp	12	Cloudy white water
13	Fresh water	14	Pulp	15	Steam	16	Fresh water
17	Fresh water	18	Pulp	19	Steam	20	Cloudy white water
21	Cloudy white water	22	Pulp	23	Pulp	24	Pulp
25	Cloudy white water	26	Fresh water	27	Clear white water	28	Fresh water
29	Clear white water	30	Pulp	31	Pulp	32	Pulp
33	Pulp	34	Pulp	35	Pulp	36	Pulp
37	Pulp	38	Pulp	39	Steam	40	Cloudy white water
41	Fresh water	42	Cooling water	43	Cooling water	44	Rejects
45	Rejects						

The function of each of these units is described in Table 5.3.

Table 5.3 Function of each process unit in the Thermo-mechanical Pulp Mill

Chipper	Processes logs into chips
Chip washer	Washes chips to remove dirt (e.g. sand)
Hydrasieves	Cleans chip wash water
Digesters	Softening lignin in chips
Primary Refiners	Separating wood fibres
Secondary Refiners	Separating wood fibres
Latency Chest	"Unwinding" fibres in hot water
Primary Screens	Removing unrefined fibre
Secondary Screens	Removing unrefined fibre
Deckers	Removes water from the fibre before paper machines
Rejects System (Dewatering screens, Screw presses, Reject refiners, Reject screens)	Processes fibre which was rejected from the initial refining process

A mass and water balance was then performed over these functional units. Refer to Appendix C for the detailed balance. Once again the balance was based on the design conditions for the plant and the metered flow of fresh water to this section of the plant. The fibre content of the streams was obtained from on-line consistency measurements in the plant as well as the information gathered from experienced mill personnel.

The variables which could be used to characterise the streams in a water pinch analysis of the thermo-mechanical pulp plant are listed in Table 5.4.

Table 5.4 Variables which could be used to characterise the streams in the Thermo-mechanical Pulp Mill

Stream		Contaminants
1	Chips	Fibre
2	Chip wash water	Fibre
3	Pulp	Fibre
4	Chip wash water	Fibre
5	Chip wash water	Fibre
6	Chip wash water	Fibre
7	Rejects	Fibre
8	Cloudy white water	Fibre

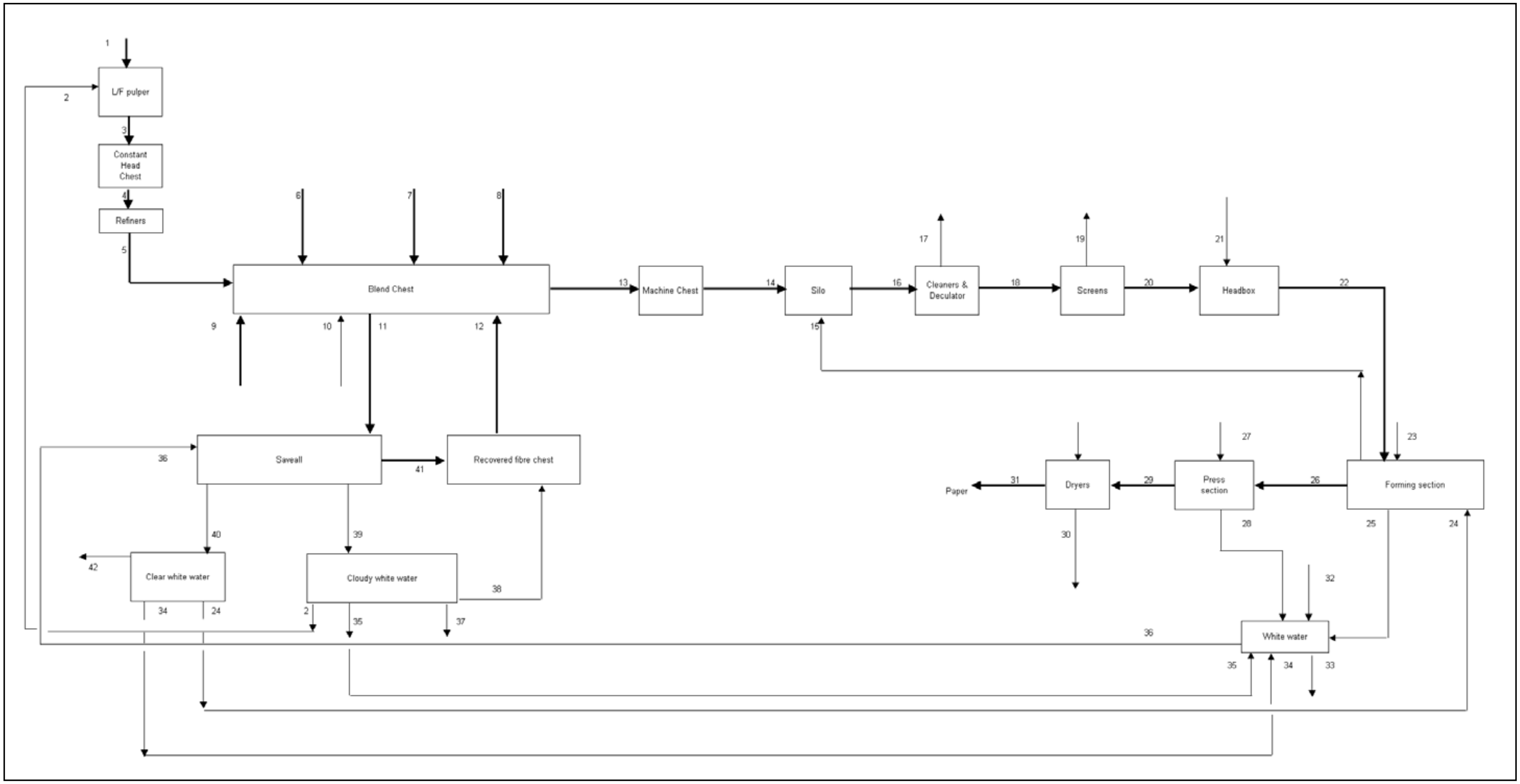
Stream		Contaminants
9	Sodium Hydrosulphite	$Na_2S_2O_3$ ppm (wt)
10	Steam	Fibre (0%), temperature
11	Pulp	Fibre
12	Cloudy white water	Fibre
13	Fresh water	Fibre (0%)
14	Pulp	Fibre
15	Steam	Fibre (0%)
16	Fresh water	Fibre (0%)
17	Fresh water	Fibre (0%)
18	Pulp	Fibre
19	Steam	Fibre (0%), temperature
20	Cloudy white water	Fibre
21	Cloudy white water	Fibre
22	Pulp	Fibre
23	Pulp	Fibre
24	Pulp	Fibre
25	Cloudy white water	Fibre
26	Fresh water	Fibre (0%), temperature
27	Clear white water	Fibre
28	Fresh water	Fibre (0%)
29	Clear white water	Fibre
30	Pulp	Fibre
31	Pulp	Fibre
32	Pulp	Fibre
33	Pulp	Fibre
34	Pulp	Fibre
35	Pulp	Fibre
36	Pulp	Fibre
37	Pulp	Fibre
38	Pulp	Fibre
39	Steam	Fibre (0%), temperature
40	Cloudy white water	Fibre
41	Fresh water	Fibre (0%)
42	Cooling water	Fibre, temperature
43	Cooling water	Fibre, temperature
44	Rejects	Fibre
45	Rejects	Fibre

The streams which were not included in the pinch analysis because they need to remain unchanged are the pulp streams (streams numbers 1, 2, 3, 11, 14, 18, 22, 23, 24, 30, 31, 32, 33, 34, 35, 36, 37, and 38), steam (streams numbers 10, 15, 19, and 39) and chemical additives (stream number 9). Once again it can be seen that the main contaminant in the remaining streams which are variable is fibre.

5.5.3 Paper Machines

The functional units of the paper machines are represented in Figure5.5.

Figure 5.5 Paper Machine functional units



Note: the bold arrows indicate process streams

Description of Streams:

1	Long fibre	2	Cloudy white water	3	Pulp	4	Pulp
5	Pulp	6	Recycled fibre pulp	7	Groundwood pulp	8	Thermo-mechanical pulp
9	Broke	10	Polymer	11	Pulp	12	Pulp
13	Pulp	14	Pulp	15	White water	16	Pulp
17	Cleaner rejects	18	Pulp	19	Screen rejects	20	Pulp
21	Polymer	22	Pulp	23	Fresh water	24	Clear white water
25	White water	26	Paper	27	Fresh water	28	White water
29	Paper	30	Evaporation	31	Paper	32	Sealing water
33	White water	34	Clear white water	35	Cloudy white water	36	White water
37	Cloudy white water	38	Cloudy white water	39	Cloudy white water	40	Clear white water
41	Pulp	42	Pulp	43	Steam		

The function of the main units is described in Table 5.5.

Table 5.5 Function of each process unit in the Paper Machine

Long Fibre Pulper	Disperses the baled chemical long fiber pulp in water to form a slurry
Refiners	"Develop" pulp fibres for the papermaking process
Headbox	Discharges a uniform jet of papermaking stock onto the moving forming section
Forming section	Forms the fibres into a matted web while the water is drained by suction forces
Press section	The sheet is pressed between a series of roll presses where additional water is removed
Drying section	Most of the remaining water is evaporated when the sheet comes into contact with steam heated cylinders in the drying section

A mass and water balance was then performed over these functional units. Refer to Appendix D for the detailed balance.

The variables which could be used to characterise the streams in a water pinch analysis of the paper machine are listed in Table 5.6.

Table 5.6 Variables which could be used to characterise the streams in the Paper Machine

Stream		Contaminants
1	Long fibre	Fibre
2	Cloudy white water	Fibre
3	Pulp	Fibre
4	Pulp	Fibre
5	Pulp	Fibre
6	Recycled fibre pulp	Fibre
7	Groundwood pulp	Fibre
8	Thermo-mechanical pulp	Fibre
9	Broke	Fibre
10	Polymer	ppm (wt)
11	Pulp	Fibre
12	Pulp	Fibre
13	Pulp	Fibre
14	Pulp	Fibre
15	White water	Fibre
16	Pulp	Fibre
17	Cleaner rejects	Fibre
18	Pulp	Fibre
19	Screen rejects	Fibre
20	Pulp	Fibre
21	Polymer	ppm (wt)
22	Pulp	Fibre
23	Fresh water	Fibre (0%)
24	Clear white water	Fibre
25	White water	Fibre
26	Paper	Fibre
27	Fresh water	Fibre (0%)
28	White water	Fibre
29	Paper	Fibre
30	Evaporation	
31	Paper	Fibre
32	Sealing water	Fibre
33	White water	Fibre

Stream		Contaminants
34	Clear white water	Fibre
35	Cloudy white water	
36	White water	Fibre
37	Cloudy white water	Fibre
38	Cloudy white water	Fibre
39	Cloudy white water	Fibre
40	Clear white water	Fibre
41	Pulp	Fibre
42	Pulp	Fibre
43	Steam	Fibre (0%), temperature

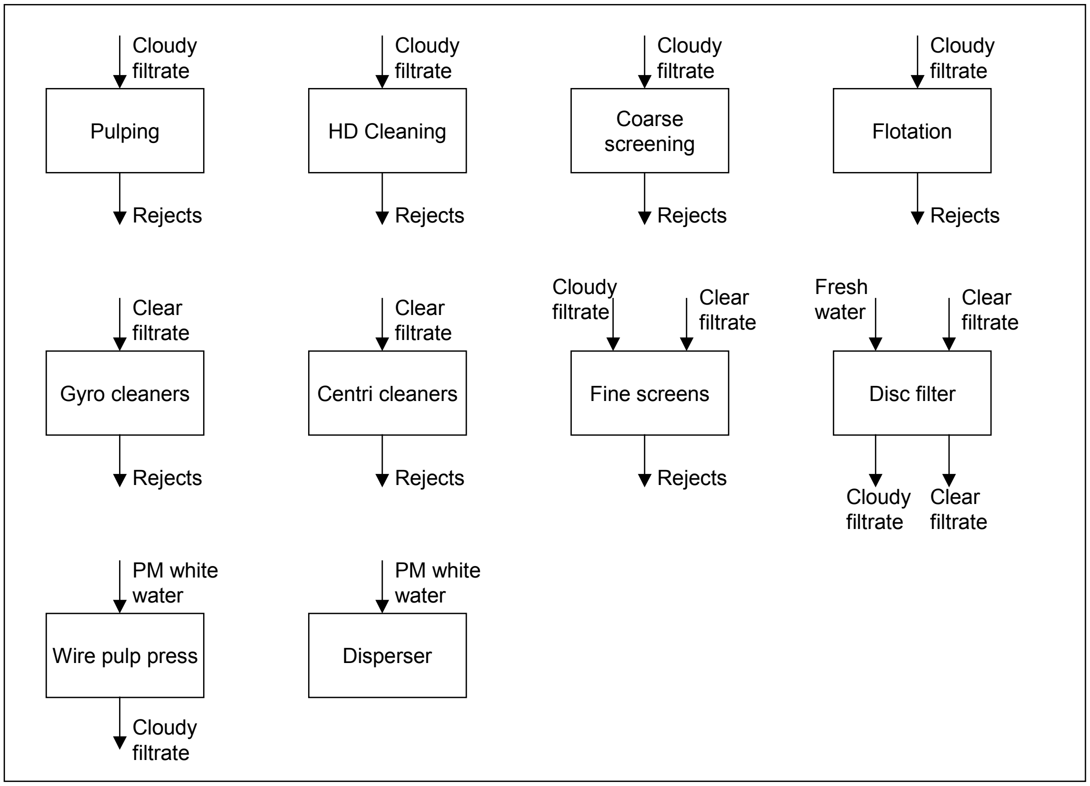
The streams which were not included in the pinch analysis because they need to remain unchanged are the pulp and paper streams (streams numbers 1, 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 16, 18, 20, 22, 26, 29, 31, 41 and 42), steam (stream number 43) and chemical additives which have not been shown in Figure 5.4. The polymer stream is included since it is diluted using water the quality of which may vary. Once again it can be seen that the main contaminant in the remaining streams which are variable is fibre.

5.6 Water Pinch Models of the Individual Sections of the Plant

The individual sections of the plant as described in sections 5.2.1, 5.2.2 and 5.2.3 were analysed separately to determine the minimum fresh water consumption in each of these sections of the plant. The following sections, section 5.4.1, 5.4.2 and 5.4.3, describe the methodology used to perform the analysis.

5.6.1 Recycled Fibre Plant

Figure 5.6 Representation of the Recycled Fibre Plant for the water pinch analysis



The utility sources in the recycled fibre plant are defined as follows:

Cloudy filtrate	Clear filtrate
Paper machine white water	Fresh water

The utility sinks are defined as:

Effluent

The process unit operations are:

Pulping	High density cleaning
Coarse screening	Flotation
Gyro-cleaning	Centri-cleaning
Fine screening	Filtering
Pressing	

The source flowrates and fibre content of each source is given in Table 5.7

Table 5.7 Utility source flowrates and fibre content in the Recycled Fibre Plant

Source	Flowrate [t/h]	Fibre Content [ppm]
Cloudy filtrate	Variable	1 000
Clear filtrate	Variable	600
Paper machine white water	Variable	100
Fresh water	Variable	0

Table 5.8 Utility sink flowrate and fibre content in the Recycled Fibre Plant

Source	Flowrate [t/h]	Fibre Content [ppm]
Effluent	Variable	No maximum

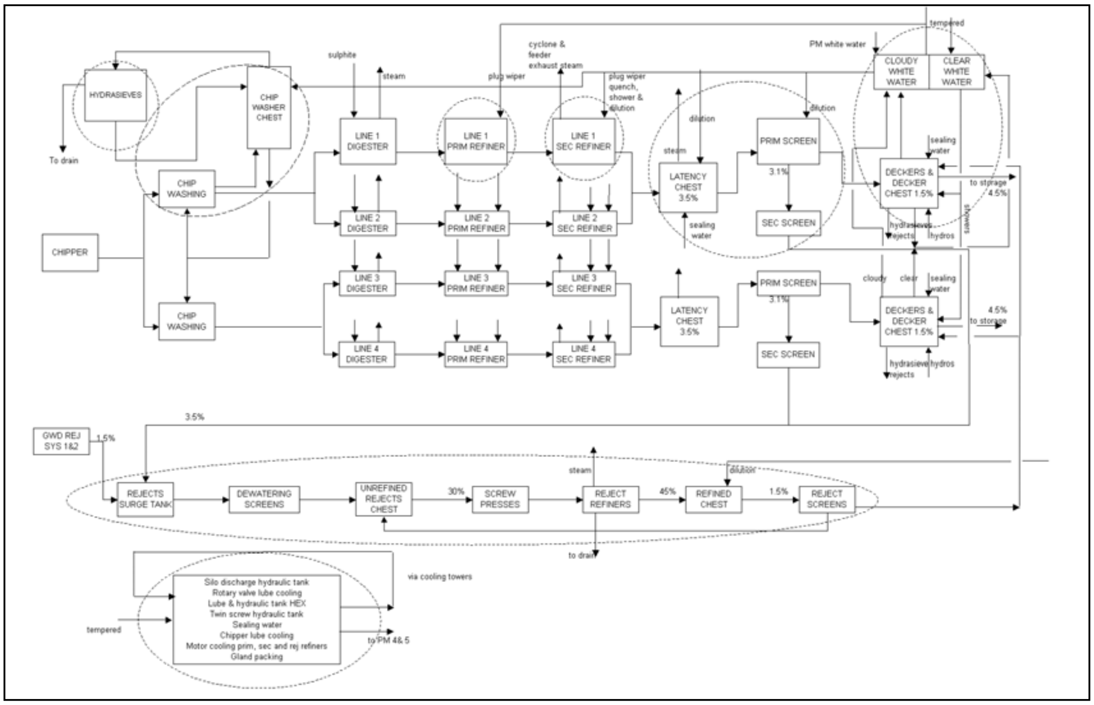
Table 5.9 Maximum fibre constraints for process sinks in the Recycled Fibre Plant

Operation	Stream	Flow [t/h]	Maximum Fibre [ppm]
Recycled FibrePlant Pulping	Cloudy filtrate	288	1800
Recycled Fibre Plant High Density Cleaning	Cloudy filtrate	87	1800
Recycled Fibre Plant Coarse Screening	Cloudy filtrate	3.7	1800
Recycled Fibre Plant Flotation	Cloudy filtrate	251.7	1800
Recycled Fibre Plant Gyrocleaners	Clear filtrate	96.72	1000
Recycled Fibre Plant Centricleaners	Clear filtrate	224.35	1000
Recycled Fibre Plant Fine screens	Clear filtrate	50.7	1000
	Cloudy filtrate	0	1800
Recycled Fibre Plant Disc filter	Clear filtrate	103.7	1000
Recycled Fibre Plant Wire pulp press	Paper machine white water	43.2	600
Recycled Fibre Plant Disperser	Paper machine white water	125.6	600

5.6.2 Thermo-mechanical Pulp Mill

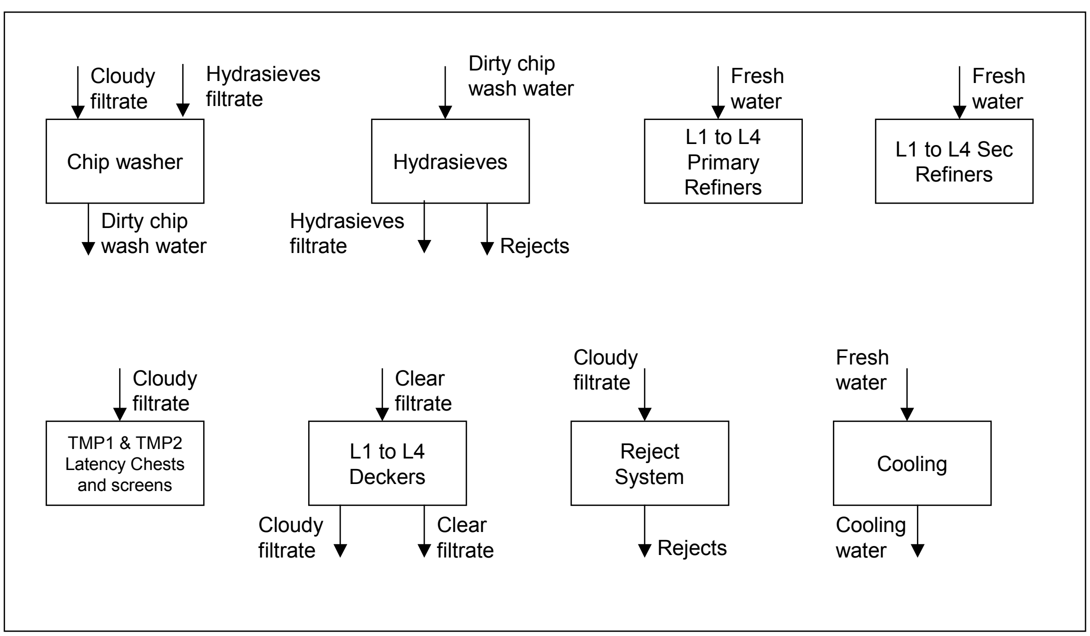
The thermo-mechanical pulp mill can be broken down into functional units for the pinch analysis as shown in Figure 5.7 below.

Figure 5.7 Grouping of equipment in the Thermo-mechanical pulp mill



The dotted lines indicate the plant equipment that can be grouped together for the water pinch analysis. This results in the simplified model shown in Figure 5.8.

Figure 5.8 Representation of the Thermo-mechanical pulp mill for the water pinch analysis



The utility sources in the thermo-mechanical pulp mill are:

Cloudy filtrate
Clear filtrate
Paper machine white water
Fresh water

The utility sink is:

Effluent

The process unit operations are:

Chip washer
Hydrasieves
Reject System
Cooling
Line 1 to Line 4 Deckers
Sealing water

The process sinks are:

Line 1 to Line 4 Primary refiners
Line 1 to Line 4 Secondary refiners
TMP1 and TMP2 Latency and screens

Table 5.10 Utility source flowrate and fibre content in the Thermo-mechanical pulp mill

Source	Flowrate [t/h]	Fibre Content [ppm]
Cloudy filtrate	Variable	1 000
Clear filtrate	Variable	600
Paper machine white water	Variable	100
Fresh water	Variable	0

Table 5.11 Utility sink flowrate and fibre content in the Thermo-mechanical pulp mill

Source	Flowrate [t/h]	Fibre Content [ppm]
Effluent	Variable	No maximum

Table 5.12 Maximum fibre constraints for process sinks

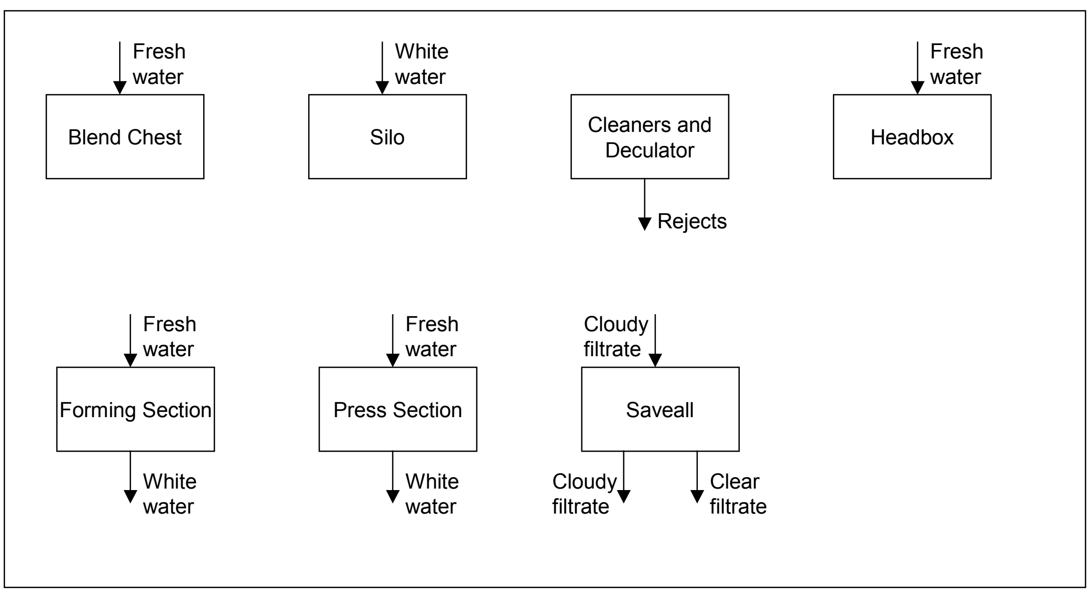
Operation	Stream	Flow [t/h]	Maximum Fibre [ppm]
Chip washer	Cloudy filtrate	22.27	3000
	Hydrasieves filtrate	376.15	3000
Hydrasieves	Dirty chip wash water	395.7	4000
Line 1 Primary Refiner	Fresh water	0.01	0

Line 2 Primary Refiner	Fresh water	0.01	0
Line 3 Primary Refiner	Fresh water	0.01	0
Line 4 Primary Refiner	Fresh water	0.01	0
Line 1 Secondary Refiner	Fresh water	126.35	0
Line 2 Secondary Refiner	Fresh water	126.35	0
Line 3 Secondary Refiner	Fresh water	126.35	0
Line 4 Secondary Refiner	Fresh water	126.35	0
TMP1 Latency and screens	Cloudy filtrate	398.65	1000
TMP1 Latency and screens	Cloudy filtrate	398.65	1000
Line 1 Decker	Clear filtrate	120	1000
Line 2 Decker	Clear filtrate	120	1000
Line 3 Decker	Clear filtrate	120	1000
Line 4 Decker	Clear filtrate	120	1000
Reject system	Cloudy filtrate	277.20	2000
Cooling	Fresh water	20	0

5.6.3 Paper Machines

The water pinch analysis of the paper machines was not performed due to the limited opportunity for re-routing streams on the paper machines without installing some form of treatment equipment.

Figure 5.9 Representation of a paper machine for the water pinch analysis

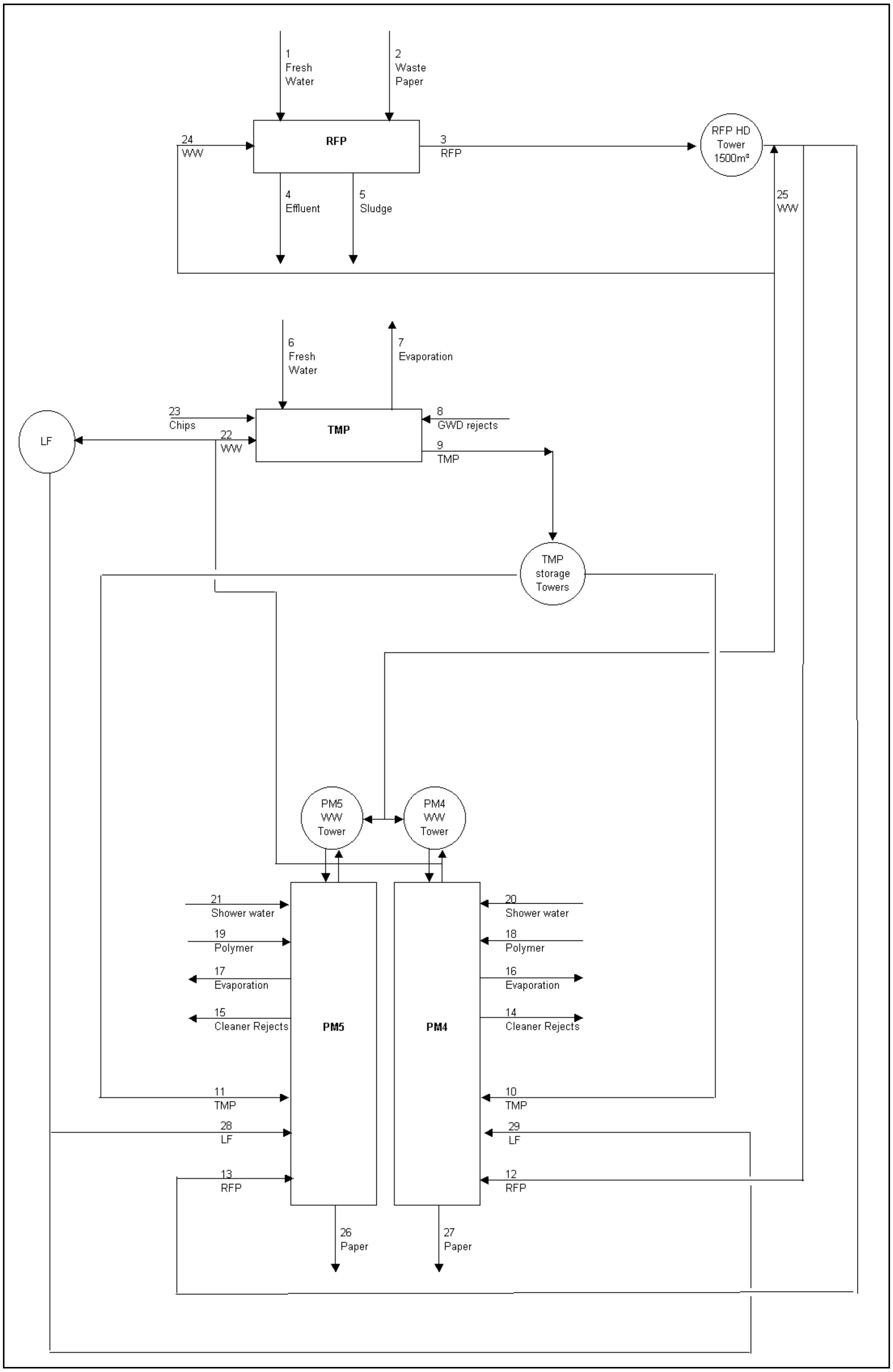


The flows and concentrations of the streams in the paper machine models are included in Tables 5.13, 5.14 and 5.15 in Section 5.6.

5.7 Water Pinch analysis of the Newsprint Circuit

The Newsprint circuit, as described earlier, is made up of the recycled fibre plant, the thermo-mechanical pulp mill and the paper machines.

Figure 5.10 Newsprint Circuit

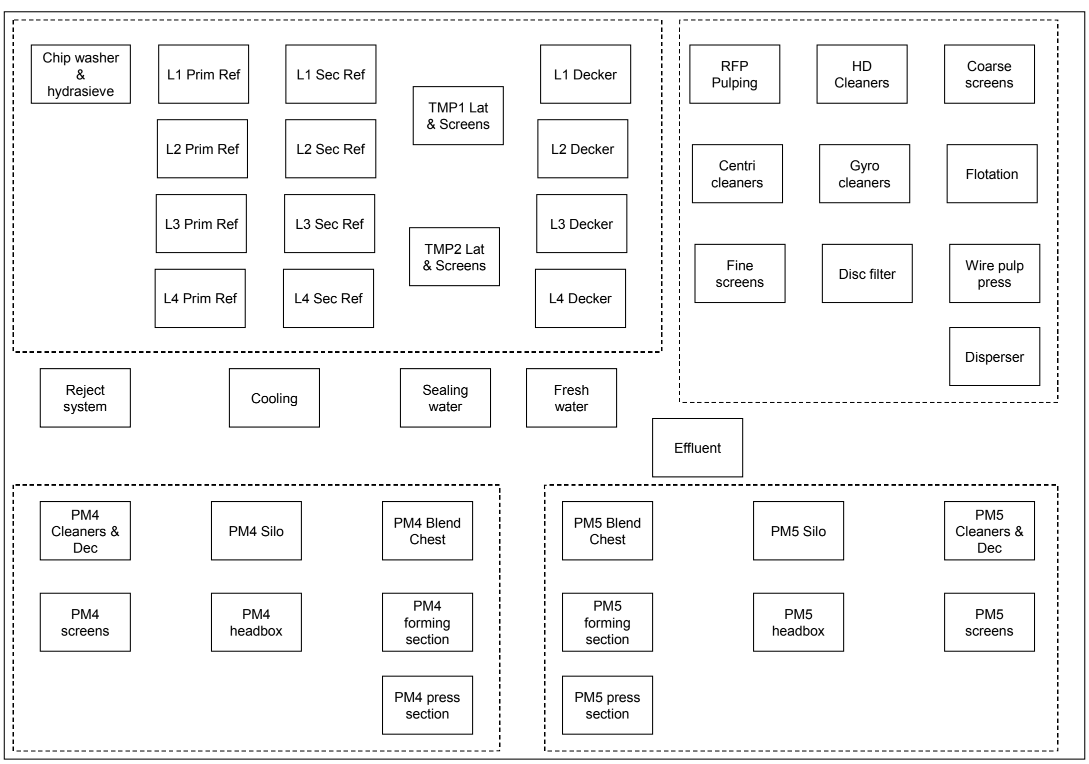

1
Fresh
Water
2
Waste
Paper
24
WW
RFP
3
RFP
RFP HD
Tower
1500m³
4
Effluent
5
Sludge
25
WW
6
Fresh
Water
7
Evaporation
23
Chips
LF
22
WW
TMP
8
GWD rejects
9
TMP
TMP
storage
Towers
PM5
WW
Tower
PM4
WW
Tower
21
Shower water
19
Polymer
17
Evaporation
15
Cleaner Rejects
PM5
PM4
20
Shower water
18
Polymer
16
Evaporation
14
Cleaner Rejects
11
TMP
28
LF
13
RFP
10
TMP
29
LF
12
RFP
26
Paper
27
Paper

Description of Streams:

1	Fresh water	2	Waste Paper	3	Recycled Fibre Pulp	4	Effluent
5	Sludge	6	Fresh water	7	Evaporation	8	Groundwood rejects
9	Thermo-mechanical pulp	10	Thermo-mechanical pulp	11	Thermo-mechanical pulp	12	Recycled Fibre Pulp
13	Recycled Fibre Pulp	14	Cleaner rejects	15	Cleaner rejects	16	Evaporation
17	Evaporation	18	Polymer	19	Polymer	20	Shower water
21	Shower water	22	White water	23	Chips	24	White water
25	White water	26	Paper	27	Paper	28	Long Fibre
29	Long Fibre						

Figure 5.10 above represents the newsprint circuit without showing the details of the individual plants. In order to identify opportunities for re-routing streams and minimising fresh water consumption it is necessary to include the details of each of the sections of the newsprint circuit and the model used for the water pinch analysis is shown in Figure 5.11 with the dotted line indicating the various sections which have been combined to form the newsprint circuit.

Figure 5.11 Simplified Newsprint Circuit for the water pinch analysis



The utility sources and sinks for the newsprint circuit are:

Utility source: Fresh water

Utility sink: Effluent

The process unit operations are:

Chip washer	Hydrasieves
Reject system	Cooling
Line 1 Decker	Line 2 Decker
Line 3 Decker	Line 4 Decker
Sealing water	RFP Pulping
RFP High density cleaning	RFP Coarse screening
RFP Flotation	RFP Gyro-cleaning
RFP Centri-cleaning	RFP Fine screening
RFP Filtering	RFP Pressing
PM4 blend chest	PM4 Forming section
PM4 Press section	PM4 Saveall
PM5 blend chest	PM5 Forming section
PM5 Press section	PM5 saveall

The process sources are:

PM4 Cleaners and deculator	PM4 Screens
PM5 Cleaners and deculator	PM4 Screens

The process sinks are:

RFP Disperser	TMP Lines 1 to 4 Primary refiners
TMP Lines 1 to 2 Secondary refiners	TMP1 and TMP2 Latency and screens
PM4 Silo	PM4 Headbox
PM5 Silo	PM5 Headbox

The relationship between the inlet and the outlet streams in the unit operations was determined using the results from the water balance performed using the Water Tracker software and a mass pickup equation with the constant A determined by the relationship between the inlet and outlet stream in the water balance.

The process unit operations with the relationships between inlet and outlet streams are included in Appendix L.

The source and sink flowrates and fibre content for the newsprint circuit are shown in Tables 5.13 5.14 and 5.15.

Table 5.13 Utility source flowrate and fibre content in the Newsprint circuit

Source	Flowrate [t/h]	Fibre Content [ppm]
Fresh water	Variable	0

Table 5.14 Utility sink flowrate and fibre content in the Newsprint circuit

Source	Flowrate [t/h]	Fibre Content [ppm]
Effluent	Variable	No maximum

Table 5.15 Maximum fibre constraints for process sinks

Operation	Stream	Flow [t/h]	Maximum Fibre [ppm]
Recycled FibrePlant Pulping	Cloudy filtrate	288	1800
Recycled Fibre Plant High Density Cleaning	Cloudy filtrate	87	1800
Recycled Fibre Plant Coarse Screening	Cloudy filtrate	3.7	1800
Recycled Fibre Plant Flotation	Cloudy filtrate	251.7	1800
Recycled Fibre Plant Gyrocleaners	Clear filtrate	96.72	1000
Recycled Fibre Plant Centricleaners	Clear filtrate	224.35	1000
Recycled Fibre Plant Fine screens	Clear filtrate	50.7	1000
	Cloudy filtrate	0	1800
Recycled Fibre Plant Disc filter	Clear filtrate	103.7	1000
Recycled Fibre Plant Wire pulp press	Paper machine white water	43.2	600
Recycled Fibre Plant Disperser	Paper machine white water	125.6	600
Chip washer	Cloudy filtrate	22.27	3000
	Hydrasieves filtrate	376.15	3000
Hydrasieves	Dirty chip wash water	395.7	4000
Line 1 Primary Refiner	Fresh water	0.01	0
Line 2 Primary Refiner	Fresh water	0.01	0

Operation	Stream	Flow [t/h]	Maximum Fibre [ppm]
Line 3 Primary Refiner	Fresh water	0.01	0
Line 4 Primary Refiner	Fresh water	0.01	0
Line 1 Secondary Refiner	Fresh water	126.35	0
Line 2 Secondary Refiner	Fresh water	126.35	0
Line 3 Secondary Refiner	Fresh water	126.35	0
Line 4 Secondary Refiner	Fresh water	126.35	0
TMP1 Latency and screens	Cloudy filtrate	398.65	1000
TMP1 Latency and screens	Cloudy filtrate	398.65	1000
Line 1 Decker	Clear filtrate	120	1000
Line 2 Decker	Clear filtrate	120	1000
Line 3 Decker	Clear filtrate	120	1000
Line 4 Decker	Clear filtrate	120	1000
Reject system	Cloudy filtrate	277.20	2000
Cooling	Fresh water	20	0
Sealing	Fresh water	19	50
PM4 Blend Chest	Fresh water	4.5	0
PM4 Silo	Cloudy white water	2181	3600
PM4 Headbox	Fresh water	20	0
PM4 Forming section	Fresh water	21	0
	Clear white water	122	300
PM4 Press section	Fresh water	88	0
PM4 Saveall	Cloudy white water	1428	700
PM5 Blend Chest	Fresh water	4.5	0
PM5 Silo	Cloudy white water	2179	3600
PM5 Headbox	Fresh water	20	0
PM5 Forming section	Fresh water	21	0
	Clear white water	166	300
PM5 Press section	Fresh water	88	0
PM5 Saveall	Cloudy white water	1428	700

5.7.1 Flow Constraints

Flow constraints have been used to model plant constraints by the following means:

- Water streams are prevented from flowing from the pulp mill to the paper machines to avoid carryover of harmful contaminants, other than fibre, from the pulp mill to the paper machines which may affect paper quality or upset production on the paper machines as discussed in Chapter 3.

- Zero flow rates have been set to prevent certain flows from being directed to nodes where process constraints preclude such connections. For example the fibre content in cooling water would not prevent it from being used in the paper machine showers, however the temperature is not suitable for use in this application. In this case the flow from the cooling water to the paper machine showers is set to zero to prevent the model from making that connection.

Chapter 6

Results

Section 6.1 considers the results from the optimisation of the subsections in isolation from each other. Section 6.2 considers the strategy required for the integration of the subsystems and the results obtained from this integration.

6.1 Individual Sections

As described in Chapter 5, the mill was divided into sections and water pinch analysis was performed in each of the sections individually. The results of the analysis on the Recycled Fibre Plant and the Thermo-mechanical Pulp Plant are presented in sections 6.1.1 and 6.1.2 below. Based on the results of the analysis in these two sections, the paper machines were not analysed in isolation, section 6.1.3.

6.1.1 Recycled Fibre Plant

The water pinch analysis of the recycled fibre plant in isolation was unable to identify a significant reduction in fresh water consumption. The minimum fresh water consumption determined by the water pinch analysis was 45t/h while in reality the process consumes 44t/h, based on a production of 150 adt/day. The routing of the streams within the water pinch solution differed from the actual plant configuration, however this is not uncommon since multiple optimal solutions often occur for simple objective functions, known as degenerate solutions. It is possible for the flows to be split in different ways between various units and still give rise to the same optimum objective function value. The difference in the amount of fresh water consumption determined by the water pinch model and the actual plant consumption can be attributed to the accuracy of the data available for producing this model.

The routing of the streams as determined by the water pinch model is shown in Appendix I, Table I.1. The resultant source and sink conditions are shown in Appendix I, Tables I.2 and I.3 respectively.

6.1.2 Thermo-mechanical Pulp Plant

The water pinch analysis of the thermo-mechanical pulp plant in isolation was unable to identify a significant reduction in fresh water consumption. The minimum fresh water consumption determined by the water pinch analysis was 182t/h while in reality the process consumes 185t/h, based on a production of 150 adt/day per line. As was the case in the water pinch analysis of the recycled fibre plant, the routing of the streams within the water pinch solution differed from the actual plant configuration. This solution is once again an example of a degenerate solution, as was the case in the recycled fibre plant, where difference routings of the streams gave rise to the same objective function value. The difference between the actual consumption of fresh water in the thermo-mechanical pulp mill and the modelled minimum fresh water consumption is simply a reflection of the accuracy of the data used to develop the model and does not represent an opportunity for fresh water saving.

The routing of the streams as determined by the water pinch model is shown in Appendix J, Table J.1. The resultant source and sink conditions are shown in Appendix I, Tables J.2 and J.3 respectively.

6.1.3 Paper Machines

Due to the limited scope for re-using existing water streams on the paper machines without removing fibre content, as well as the limited potential for fresh water savings in the recycled fibre mill and the thermo-mechanical pulp mill when considered in isolation, a water pinch analysis of the paper machines in isolation was not carried out. It was decided to consider the newsprint circuit as a whole, where there is more scope for re-routing existing water streams in order to minimise fresh water consumption.

6.2 Newsprint Circuit

The newsprint circuit, which is a combination of the recycled fibre plant, the thermo-mechanical pulp mill and the two newsprint paper machines provides greater opportunity for optimising the amount of fresh water consumed by re-routing existing water streams between the individual sections of the circuit.

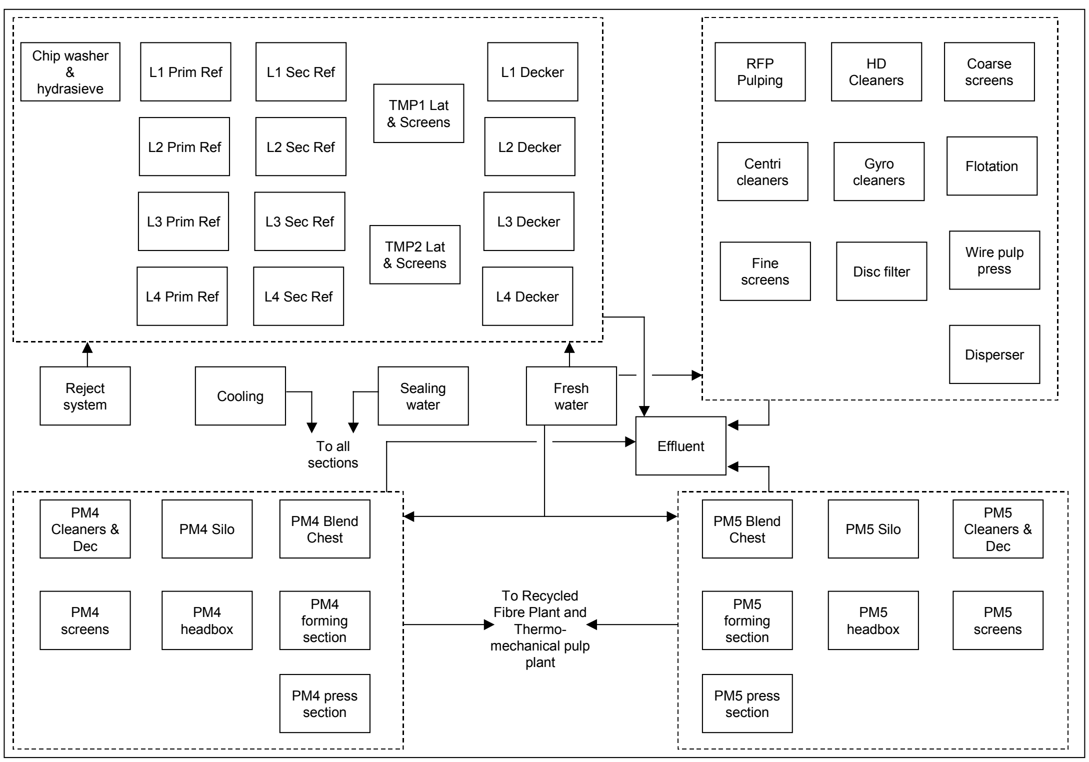
The model of the plant developed for optimisation does not replicate the complexity of the existing plant, but is a simplified representation of the actual process. It comprises only those factors which are likely to limit water re-use (Wang and Smith, 1995) which in this case is fibre content in the water streams. The models used to represent the various process options are simplified models which are used to approximate the behaviour of the actual operations in the plant. An example of this is the treatment of tanks in the simplified model. In the plant water streams from a number of different process operations are collected in a tank and then pumped to various other process operations. In the simplified model of the plant these water streams are not collected in a single point and then redistributed, the model simply makes allowance for connections from all the processes which generate water to all the processes where the water is pumped to from the tank in the actual plant. The resulting representation of the plant is verified by ensuring that the fibre content in the stream flowing to a process, which is made up of mixture of streams from various sources, is close enough to the existing data available from the plant. Figures 5.6, 5.8 and 5.9 show the simplified models of the individual sections making up the newsprint circuit, while Figure 5.11 shows the newsprint circuit.

6.2.1 Model Representing Current Situation

In order to ensure that the model developed to represent the newsprint circuit is an accurate representation of the plant, the water pinch model was “forced” to represent reality by placing bounds on the model to constrain the connectivity of all the streams to conform to the current situation in the plant. The flows and fibre content of the streams were evaluated to ensure that the model represented the existing situation accurately enough to use it for the optimisation.

Figure 6.1 shows the flow of water streams between the individual sections of the newsprint circuit currently.

Figure 6.1 Flow of water streams between sections of the current newsprint circuit



The stream flow rates of all the streams in the model representing the existing situation in the plant is set out in Appendix E.

6.2.2 Model Representing Optimised Situation

The model representing the current situation was used as the base to develop the optimised model. This was achieved by removing all the constraints which could feasibly be removed and allowing the Water Pinch software to optimise the amount of fresh water consumed. Constraints preventing water streams from being sent from the pulp mill to the paper machine were not removed since the single contaminant of fibre used in this study did not address the issue of dissolved solids build up and carry over of contaminants from the pulp mill to the paper machine which are known to be detrimental to the paper quality. Appendix K shows the flow constraints for the model representing the existing plant and the shaded blocks in Table K1 indicate the constraints which were removed in for the optimisation.

The two most significant groups of constraints which were removed were the clear and cloudy filtrates from the disc filters in the Thermo-mechanical pulp plant and Recycled Fibre Plant. The constraints preventing the flow of these filtrates between these two sections of the newsprint circuit were removed.

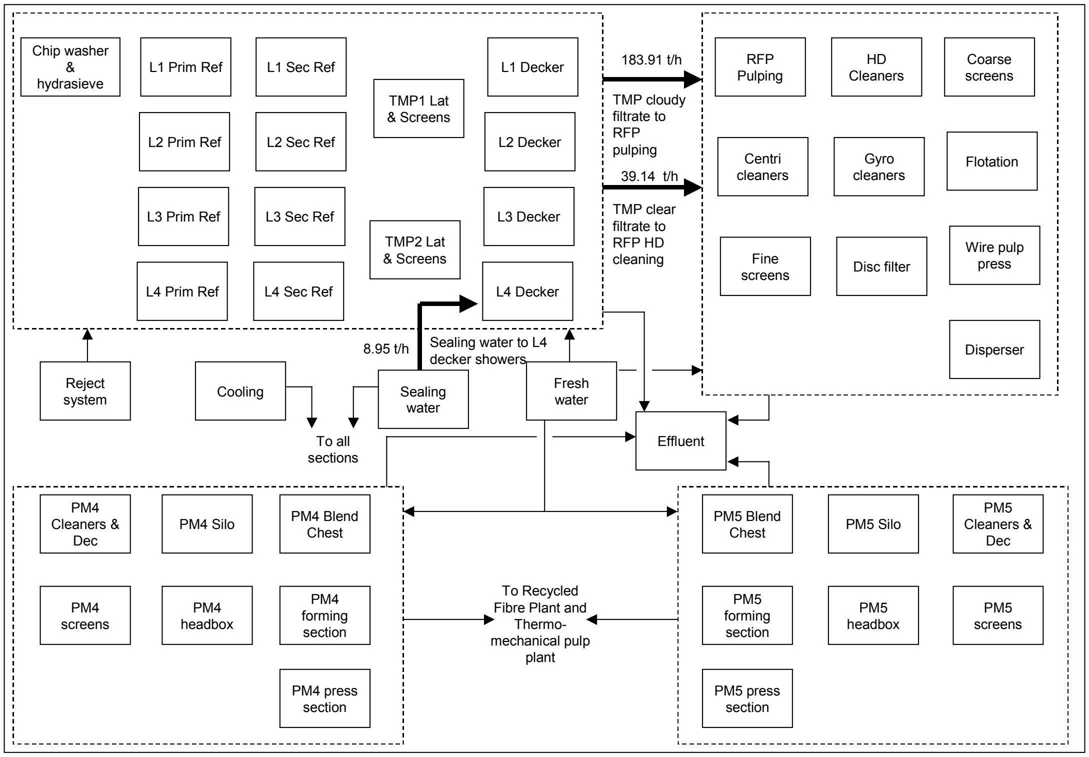
The resultant model produced thirty two new connections, however only three of these new connections were responsible for the reduced the fresh water consumption. The fresh water consumption was reduced by 8.1% to 51.54 t/h in the optimised model.

The new connections were as follows:

- Cloudy filtrate from the thermo-mechanical pulp mill to the recycled fibre plant pulping process
- Clear filtrate from the thermo-mechanical pulp mill to the recycled fibre plant high density cleaning process
- Sealing water which currently goes to drain was directed to one of the deckers in the thermo-mechanical pulp mill for use as shower water.

These new connections are indicated in bold lines in Figure 6.2

Figure 6.2 Flow of water streams between sections of the newsprint circuit in the optimised model



The new connections made in the optimised model were evaluated by performing a sensitivity analysis on the model of the existing plant in order to determine the largest sensitivity coefficients for the flow constraints. The was done in the following way:

$F_{current}$ = Flow rates of streams in representing current situation in the mill

F_{opt} = Flow rates generated by the optimised model

F_{diff} = Difference between current flow rate and optimised flow rate

i) For each stream the current flow rate was subtracted from the flow rate generated by the optimised model.

$F_{opt} - F_{current} = F_{diff}$

ii) The flow rate representing the difference between the optimised flow and the current flow was multiplied with the sensitivity coefficient for the flow constraints.

iii) The values obtained were ranked to give a priority for the new connections.

The top three new connections identified in this manner corresponded to the three streams which were responsible for fresh water savings in the optimised model.

Chapter 7

Conclusions and Recommendations

From this investigation of the application of water pinch analysis in an integrated pulp and paper mill, the following can be concluded:

i) Scope for optimisation and water savings within individual sections of the mill was insignificant. There are a number of reasons for this namely:

- Only utility water was considered in this analysis
- There has been a considerable amount of effort already put into reducing water consumption at the mill over a number of years.
- Water is already recycled and re-used within the process to some extent

ii) By application of single contaminant analysis to a larger section of the mill it is possible to reduce the fresh water requirement by 51.54 t/h (8.1%).

iii) The effluent generated is consequently reduced by the same amount, 51.54 t/h (5.4%).

iv) These reductions translate into a savings of R1 548 593/annum. The savings was calculated by the objective function which included fresh water costs and effluent costs, but did not include engineering costs or piping costs. In addition, the objective function did not take geographical costs into account, the distance between the sections in the plant was not included in the analysis.

v) There are operability constraints which prevent these savings from being achieved since they involve the transfer of water from two batch process which are not always in operation at the same time. The thermo-mechanical pulp plant is operated at full capacity during periods when the electricity charges are the lowest which is during the night. The recycled fibre plant is operated according the paper machines' demand for recycled fibre. As a result there are times when the thermo-mechanical plant is in operation and the recycled fibre plant is not in operation or vice versa. The transfer of water between these two sections of the plant is therefore not ideal. In the current plant situation a "take or pay" agreement is in place with a external supplier of water to the mill. The mill uses treated sewage water for all the process requirements and in terms of the agreement with the water supplier the mill pays for a minimum amount of water per day, whether this amount of water is used or not. Currently the mill consumption of water is slightly below the "take or pay" minimum specification. There is thus currently no commercial incentive to introduce measures to reduce the amount of reclaimed sewage used in the process.

vi) Thirty two new connections were generated in the optimised model, however, only three of these were required to achieve the savings in fresh water consumption. These three streams were also identified using a novel approach to implementing water pinch analysis which involved the evaluation of sensitivity coefficients of the flow constraints in combination with the magnitude of the streams involved. The top three new connections identified in this manner corresponded to the three streams which were responsible for the fresh water savings in the optimised model generated by the water pinch analysis.

The following recommendations can be made:

- Operability issues need to be investigated further, since the use of fibre as the only contaminant does not address the potential build-up of other harmful substances, for example dissolved and colloidal substances.
- This study has not considered the use of treatment options to reduce the fibre content in the existing streams and thereby reduce the fresh water consumption further. Removal of fibre from streams will allow further re-use and recycling within the process and thus a further reduction in the amount of fresh water required.

Concluding remarks on water pinch analysis applied in the pulp and paper industry:

- A significant amount of the water used in the pulping and papermaking process is not utility water, but is integral to the process. The scope for identifying savings in utility water consumption is therefore limited.
- In an integrated pulp and paper mill the water streams are usually already counter current, i.e. water from the paper machines is used in the pulp mills and within the pulp mills and paper machines water is recirculated and reused to a large extent already. The potential for identifying savings in water consumption by re-routing water streams is therefore limited.
- Water pinch analysis does not account for the temperature of the water streams. Temperature is a significant factor in the pulping and papermaking process and needs to be accounted for in the water management on the site.
- Interactions between contaminants, other than fibre, as they build up is difficult to predict and the effect on the product, in this case paper, is also to a large extent unknown for a particular mill.

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Appendix A

Newsprint Circuit Water Balance from Water Tracker

Table A.1 Newsprint Circuit water balance flowrates from Water Tracker

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
Chip washer			
	Chips -> chip washer	48	
	Hydrasieves -> chip washer	376.15	
	JNC- cloudy ww to chip washer -> chip washer	22.27	
	Chip washer -> hydrasieves		395.7
	Chip washer -> chip washer jnc		50.72
Hydrasieves			
	Chip washer -> hydrasieves	395.7	
	Hydrasieves -> chip washer		376.15
	Hydrasieves -> Hydrasieve rejects		19.55
Line 1 Digester			
	Chip washer jnc -> Line 1 Digester	12.68	
	Feed steam jnc -> Line 1 Digester	2	
	Sodium sulphite jnc -> Line 1 Digester	0.28	
	Line 1 Digester -> rotary valve exhaust steam jnc		0.08
	Line 1 Digester -> digester vent steam jnc		0.18
	Line 1 Digester -> Line 1 Prim Refiner		14.7
Line 2 Digester			
	Chip washer jnc -> Line 2 Digester	12.68	
	Feed steam jnc -> Line 2 Digester	2	
	Sodium sulphite jnc -> Line 2 Digester	0.28	
	Line 2 Digester -> rotary valve exhaust steam jnc		0.08
	Line 2 Digester -> digester vent steam jnc		0.18
	Line 2 Digester -> Line 2 Prim Refiner		14.7
Line 1 Primary Refiner			
	Line 1 Digester -> Line 1 Prim Refiner	14.7	
	TMP1 cloudy ww2 -> Line 1 Prim Refiner	0.01	
	Line 1 Prim Refiner -> Line 1 Sec Refiner		12.76

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	Line 1 Prim Refiner -> prim ref back flow steam jnc		1.95
Line 2 Primary Refiner			
	Line 2 Digester -> Line 2 Prim Refiner	14.7	
	TMP1 cloudy ww2 -> Line 2 Prim Refiner	0.01	
	Line 2 Prim Refiner -> Line 2 Sec Refiner		12.76
	Line 2 Prim Refiner -> prim ref back flow steam jnc		1.95
Line 1 Secondary Refiner			
	Line 1 Prim Refiner -> Line 1 Sec Refiner	12.76	
	TMP1 cloudy ww2 -> Line 1 Sec Refiner	126.35	
	Line 1 Sec Refiner -> sec refiner jnc		129.64
	Line 1 Sec Refiner -> sec refiner exhaust steam jnc		7.03
	Line 1 Sec Refiner -> sec refiner losses jnc		2.44
Line 2 Secondary Refiner			
	Line 2 Prim Refiner -> Line 2 Sec Refiner	12.76	
	TMP1 cloudy ww2 -> Line 2 Sec Refiner	126.35	
	Line 2 Sec Refiner -> sec refiner jnc		129.64
	Line 2 Sec Refiner -> sec refiner exhaust steam jnc		7.03
	Line 2 Sec Refiner -> sec refiner losses jnc		2.44
TMP1 Latency & screens			
	Secondary refiner jnc -> TMP1 Latency & screens	259.28	
	TMP1 cloudy ww1 -> TMP1 Latency & screens	398.65	
	TMP1 Latency & screens -> JNC-TMP1 latency to deckers		594
	TMP1 Latency & screens -> JNC-latency steam		5
	TMP1 Latency & screens -> JNC-latency to rej sys		58.93
Line 1 Decker			
	JNC-TMP1 latency to deckers -> Line 1 Decker	297	
	JNC-Reject system -> Line 1 Decker	93.85	
	JNC-TMP1 clear ww to deckers -> Line 1 Decker	120	
	JNC-Hydros -> Line 1 Decker	0.11	
	Line 1 Decker -> JNC-TMP1 pulp to storage		117.3
	Line 1 Decker -> JNC-TMP1 cloudy		320.66
	Line 1 Decker -> JNC-TMP1 clear		73
Reject System			
	GWD rejects -> Reject System	26.7	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	Cloudy ww2 -> Reject System	277.2	
	JNC-latency to rej sys -> Reject System	117.86	
	Reject System -> Rejects from pressure screen		46.36
	Reject System -> JNC-Rej sys		375.4
Cooling			
	Fresh water jnc -> Cooling	20	
	Cooling tower -> [Blowdown]	540	
	[Make-up] -> cooling tower		540.54
	Cooling -> PM ww jnc		19.46
Fresh water jnc			
	Fresh water -> fresh water jnc	747.18	
	Fresh water jnc -> Cooling		20
	Fresh water jnc -> JNC-tempered to clear ww		40
	Fresh water jnc -> Sealing water		19
	Fresh water jnc -> RFP Temp jnc		0
	Fresh water jnc -> fresh water to PMs jnc		668.18
Chip washer jnc			
	Chip washer -> chip washer jnc	50.72	
	Chip washer jnc -> Line 1 Digester		12.68
	Chip washer jnc -> Line 2 Digester		12.68
	Chip washer jnc -> Line 3 Digester		12.68
	Chip washer jnc -> Line 4 Digester		12.68
Rotary valve exhaust steam jnc			
	Line 1 Digester -> rotary valve exhaust steam jnc	0.08	
	Line 2 Digester -> rotary valve exhaust steam jnc	0.08	
	Line 3 Digester -> rotary valve exhaust steam jnc	0.08	
	Line 4 Digester -> rotary valve exhaust steam jnc	0.08	
	Rotary valve exhaust steam jnc -> Rotary valve exhaust steam		0.32
Digester vent steam jnc			
	Line 1 Digester -> digester vent steam jnc	0.18	
	Line 2 Digester -> digester vent steam jnc	0.18	
	Line 3 Digester -> digester vent steam jnc	0.18	
	Line 4 Digester -> digester vent steam jnc	0.18	
	Digester vent steam jnc -> Digester vent steam		0.72

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
Feed steam jnc			
	Steam -> feed steam jnc	15.5	
	Feed steam jnc -> Line 1 Digester		2
	Feed steam jnc -> Line 2 Digester		2
	Feed steam jnc -> Line 3 Digester		2
	Feed steam jnc -> Line 4 Digester		2
	Feed steam jnc -> RFP disperser		7.5
Sodium sulphite jnc			
	Sodium sulphite -> sodium sulphite jnc	1.12	
	Sodium sulphite jnc -> Line 1 Digester		0.28
	Sodium sulphite jnc -> Line 2 Digester		0.28
	Sodium sulphite jnc -> Line 4 Digester		0.28
	Sodium sulphite jnc -> Line 3 Digester		0.28
Secondary refiner jnc			
	Line 1 Sec Refiner -> sec refiner jnc	129.64	
	Line 2 Sec Refiner -> sec refiner jnc	129.64	
	Secondary refiner jnc -> TMP1 Latency & screens		259.28
Primary ref back flow steam jnc			
	Line 2 Prim Refiner -> prim ref back flow steam jnc	1.95	
	Line 1 Prim Refiner -> prim ref back flow steam jnc	1.95	
	Line 3 Prim Refiner -> prim ref back flow steam jnc	1.95	
	Line 4 Prim Refiner -> prim ref back flow steam jnc	1.95	
	Primary ref back flow steam jnc -> back flow steam		7.8
Secondary refiner exhaust steam jnc			
	Line 1 Sec Refiner -> sec refiner exhaust steam jnc	7.03	
	Line 2 Sec Refiner -> sec refiner exhaust steam jnc	7.03	
	Line 3 Sec Refiner -> sec refiner exhaust steam jnc	7.03	
	Line 4 Sec Refiner -> sec refiner exhaust steam jnc	7.03	
	Secondary refiner exhaust steam jnc -> Cyclone and feader exhaust steam		28.12
TMP1 cloudy ww2			
	TMP1 cloudy ww1 -> TMP1 cloudy ww2	252.72	
	TMP1 cloudy ww2 -> Line 1 Sec Refiner		126.35
	TMP1 cloudy ww2 -> Line 1 Prim Refiner		0.01
	TMP1 cloudy ww2 -> Line 2 Prim Refiner		0.01

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	TMP1 cloudy ww2 -> Line 2 Sec Refiner		126.35
Secondary refiner losses jnc			
	Line 1 Sec Refiner -> sec refiner losses jnc	2.44	
	Line 2 Sec Refiner -> sec refiner losses jnc	2.44	
	Line 3 Sec Refiner -> sec refiner losses jnc	2.44	
	Line 4 Sec Refiner -> sec refiner losses jnc	2.44	
	Secondary refiner losses jnc -> Losses		9.76
Line 3 Digester			
	Sodium sulphite jnc -> Line 3 Digester	0.28	
	Feed steam jnc -> Line 3 Digester	2	
	Chip washer jnc -> Line 3 Digester	12.68	
	Line 3 Digester -> Line 3 Prim Refiner		14.7
	Line 3 Digester -> rotary valve exhaust steam jnc		0.08
	Line 3 Digester -> digester vent steam jnc		0.18
Line 4 Digester			
	Sodium sulphite jnc -> Line 4 Digester	0.28	
	Feed steam jnc -> Line 4 Digester	2	
	Chip washer jnc -> Line 4 Digester	12.68	
	Line 4 Digester -> Line 4 Prim Refiner		14.7
	Line 4 Digester -> rotary valve exhaust steam jnc		0.08
	Line 4 Digester -> digester vent steam jnc		0.18
Line 3 Primary Refiner			
	Line 3 Digester -> Line 3 Prim Refiner	14.7	
	TMP2 cloudy ww2 -> Line 3 Prim Refiner	0.01	
	Line 3 Prim Refiner -> Line 3 Sec Refiner		12.76
	Line 3 Prim Refiner -> prim ref back flow steam jnc		1.95
Line 4 Primary Refiner			
	Line 4 Digester -> Line 4 Prim Refiner	14.7	
	TMP2 cloudy ww2 -> Line 4 Prim Refiner	0.01	
	Line 4 Prim Refiner -> Line 4 Sec Refiner		12.76
	Line 4 Prim Refiner -> prim ref back flow steam jnc		1.95
Line 3 Secondary Refiner			
	Line 3 Prim Refiner -> Line 3 Sec Refiner	12.76	
	TMP2 cloudy ww2 -> Line 3 Sec Refiner	126.35	
	Line 3 Sec Refiner -> JNC-TMP2 sec ref to latency		129.64

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	Line 3 Sec Refiner -> sec refiner exhaust steam jnc		7.03
	Line 3 Sec Refiner -> sec refiner losses jnc		2.44
Line 4 Secondary Refiner			
	Line 4 Prim Refiner -> Line 4 Sec Refiner	12.76	
	TMP2 cloudy ww2 -> Line 4 Sec Refiner	126.35	
	Line 4 Sec Refiner -> JNC-TMP2 sec ref to latency		129.64
	Line 4 Sec Refiner -> sec refiner exhaust steam jnc		7.03
	Line 4 Sec Refiner -> sec refiner losses jnc		2.44
Line 3 Decker			
	JNC-TMP2 latency to deckers -> Line 3 Decker	297	
	JNC-Rej sys -> Line 3 Decker	93.85	
	JNC-TMP2 clear ww1 -> Line 3 Decker	120	
	JNC-Hydros -> Line 3 Decker	0.11	
	Line 3 Decker -> JNC-TMP2 pulp to storage		117.3
	Line 3 Decker -> JNC-TMP2 cloudy ww3		320.66
	Line 3 Decker -> JNC-TMP2 clear ww2		73
Line 4 Decker			
	JNC-TMP2 latency to deckers -> Line 4 Decker	297	
	JNC-Rej sys -> Line 4 Decker	93.85	
	JNC-TMP2 clear ww1 -> Line 4 Decker	120	
	JNC-Hydros -> Line 4 Decker	0.11	
	Line 4 Decker -> JNC-TMP2 pulp to storage		117.3
	Line 4 Decker -> JNC-TMP2 cloudy ww3		320.66
	Line 4 Decker -> JNC-TMP2 clear ww2		73
JNC-pulp to storage			
	JNC-TMP2 pulp to storage -> JNC-pulp to storage	234.6	
	JNC-TMP1 pulp to storage -> JNC-pulp to storage	234.6	
	JNC-pulp to storage -> pulp jnc		469.2
JNC-TMP2 pulp to storage			
	Line 4 Decker -> JNC-TMP2 pulp to storage	117.3	
	Line 3 Decker -> JNC-TMP2 pulp to storage	117.3	
	JNC-TMP2 pulp to storage -> JNC-pulp to storage		234.6
JNC-TMP2 latency to deckers			
	TMP2 Latency & screens -> JNC-TMP2 latency to deckers	594	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	JNC-TMP2 latency to deckers -> Line 3 Decker		297
	JNC-TMP2 latency to deckers -> Line 4 Decker		297
JNC-TMP2 sec ref to latency			
	Line 3 Sec Refiner -> JNC-TMP2 sec ref to latency	129.64	
	Line 4 Sec Refiner -> JNC-TMP2 sec ref to latency	129.64	
	JNC-TMP2 sec ref to latency -> TMP2 Latency & screens		259.28
PM ww to pulp mill jnc			
	PM ww jnc -> PM ww to pulp mill jnc	753.54	
	PM ww to pulp mill jnc -> PM ww to RFP jnc		295.47
	PM ww to pulp mill jnc -> JNC-TMP1 clear ww chest		236
	PM ww to pulp mill jnc -> JNC-TMP2 clear ww chest		222.07
Line 2 Decker			
	JNC-TMP1 latency to deckers -> Line 2 Decker	297	
	JNC-Reject system -> Line 2 Decker	93.85	
	JNC-TMP1 clear ww to deckers -> Line 2 Decker	120	
	JNC-Hydros -> Line 2 Decker	0.11	
	Line 2 Decker -> JNC-TMP1 pulp to storage		117.3
	Line 2 Decker -> JNC-TMP1 clear		73
	Line 2 Decker -> JNC-TMP1 cloudy		320.66
JNC-TMP1 pulp to storage			
	Line 1 Decker -> JNC-TMP1 pulp to storage	117.3	
	Line 2 Decker -> JNC-TMP1 pulp to storage	117.3	
	JNC-TMP1 pulp to storage -> JNC-pulp to storage		234.6
JNC-Rej sys			
	Reject System -> JNC-Rej sys	375.4	
	JNC-Rej sys -> JNC-Reject system		187.7
	JNC-Rej sys -> Line 3 Decker		93.85
	JNC-Rej sys -> Line 4 Decker		93.85
JNC-tempered to clear ww			
	Fresh water jnc -> JNC-tempered to clear ww	40	
	JNC-tempered to clear ww -> JNC-TMP1 clear ww chest		20
	JNC-tempered to clear ww -> JNC-TMP2 clear ww chest		20
JNC-TMP1 latency to deckers			
	TMP1 Latency & screens -> JNC-TMP1 latency to	594	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	deckers		
	JNC-TMP1 latency to deckers -> Line 1 Decker		297
	JNC-TMP1 latency to deckers -> Line 2 Decker		297
JNC-Reject system			
	JNC-Rej sys -> JNC-Reject system	187.7	
	JNC-Reject system -> Line 1 Decker		93.85
	JNC-Reject system -> Line 2 Decker		93.85
JNC-TMP1 cloudy			
	Line 1 Decker -> JNC-TMP1 cloudy	320.66	
	Line 2 Decker -> JNC-TMP1 cloudy	320.66	
	JNC-TMP1 cloudy -> JNC-TMP1 cloudy ww chest		641.32
JNC-TMP1 clear			
	Line 1 Decker -> JNC-TMP1 clear	73	
	Line 2 Decker -> JNC-TMP1 clear	73	
	JNC-TMP1 clear -> JNC-TMP1 clear ww chest		146
JNC-TMP1 clear ww to deckers			
	JNC-TMP1 clear ww chest -> JNC-TMP1 clear ww to deckers	406.75	
	JNC-TMP1 clear ww to deckers -> Line 1 Decker		120
	JNC-TMP1 clear ww to deckers -> Line 2 Decker		120
	JNC-TMP1 clear ww to deckers -> JNC-TMP1 cloudy ww chest		166.75
JNC-TMP2 cloudy ww3			
	Line 3 Decker -> JNC-TMP2 cloudy ww3	320.66	
	Line 4 Decker -> JNC-TMP2 cloudy ww3	320.66	
	JNC-TMP2 cloudy ww3 -> JNC-TMP2 cloudy ww chest		641.32
JNC-TMP2 clear ww2			
	Line 4 Decker -> JNC-TMP2 clear ww2	73	
	Line 3 Decker -> JNC-TMP2 clear ww2	73	
	JNC-TMP2 clear ww2 -> JNC-TMP2 clear ww chest		146
JNC-TMP2 clear ww1			
	JNC-TMP2 clear ww chest -> JNC-TMP2 clear ww1	392.82	
	JNC-TMP2 clear ww1 -> Line 3 Decker		120
	JNC-TMP2 clear ww1 -> Line 4 Decker		120
	JNC-TMP2 clear ww1 -> JNC-TMP2 cloudy ww chest		152.82

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
Cloudy ww2			
	TMP1 cloudy ww1 -> cloudy ww2	138.6	
	TMP2 cloudy ww1 -> cloudy ww2	138.6	
	Cloudy ww2 -> Reject System		277.2
TMP2 cloudy ww2			
	TMP2 cloudy ww1 -> TMP2 cloudy ww2	252.72	
	TMP2 cloudy ww2 -> Line 4 Prim Refiner		0.01
	TMP2 cloudy ww2 -> Line 4 Sec Refiner		126.35
	TMP2 cloudy ww2 -> Line 3 Sec Refiner		126.35
	TMP2 cloudy ww2 -> Line 3 Prim Refiner		0.01
TMP2 cloudy ww1			
	JNC-TMP2 cloudy ww chest -> TMP2 cloudy ww1	794.14	
	TMP2 cloudy ww1 -> TMP2 cloudy ww2		252.72
	TMP2 cloudy ww1 -> TMP2 Latency & screens		398.65
	TMP2 cloudy ww1 -> cloudy ww1		4.17
	TMP2 cloudy ww1 -> cloudy ww2		138.6
TMP2 Latency & screens			
	JNC-TMP2 sec ref to latency -> TMP2 Latency & screens	259.28	
	TMP2 cloudy ww1 -> TMP2 Latency & screens	398.65	
	TMP2 Latency & screens -> JNC-TMP2 latency to deckers		594
	TMP2 Latency & screens -> JNC-latency steam		5
	TMP2 Latency & screens -> JNC-latency to rej sys		58.93
JNC-latency steam			
	TMP1 Latency & screens -> JNC-latency steam	5	
	TMP2 Latency & screens -> JNC-latency steam	5	
	JNC-latency steam -> Latency steam		10
TMP1 cloudy ww1			
	JNC-TMP1 cloudy ww chest -> TMP1 cloudy ww1	808.07	
	TMP1 cloudy ww1 -> TMP1 cloudy ww2		252.72
	TMP1 cloudy ww1 -> TMP1 Latency & screens		398.65
	TMP1 cloudy ww1 -> cloudy ww2		138.6
	TMP1 cloudy ww1 -> cloudy ww1		18.1
JNC- cloudy ww to chip washer			

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	TMP1 cloudy ww1 -> cloudy ww1	18.1	
	TMP2 cloudy ww1 -> cloudy ww1	4.17	
	JNC- cloudy ww to chip washer -> chip washer		22.27
JNC-latency to rej sys			
	TMP1 Latency & screens -> JNC-latency to rej sys	58.93	
	TMP2 Latency & screens -> JNC-latency to rej sys	58.93	
	JNC-latency to rej sys -> Reject System		117.86
JNC-Hydros			
	Hydros -> JNC-Hydros	0.44	
	JNC-Hydros -> Line 1 Decker		0.11
	JNC-Hydros -> Line 2 Decker		0.11
	JNC-Hydros -> Line 4 Decker		0.11
	JNC-Hydros -> Line 3 Decker		0.11
Sealing water			
	Fresh water jnc -> Sealing water	19	
	Sealing water -> JNC-sealing water to clear ww		9.5
	Sealing water -> sealing water to drain		9.5
JNC-sealing water to clear ww			
	Sealing water -> JNC-sealing water to clear ww	9.5	
	JNC-sealing water to clear ww -> JNC-TMP1 clear ww chest		4.75
	JNC-sealing water to clear ww -> JNC-TMP2 clear ww chest		4.75
Cooling tower			
	[Make-up] -> cooling tower	540.54	
	Cooling tower -> [Losses]		0.54
	Cooling tower -> [Evapor.]		0
	Cooling tower -> [Blowdown]		540
RFP Pulping			
	RFP waste paper -> RFP Pulping	9.64	
	RFP cloudy filtrate jnc2 -> RFP Pulping	288	
	RFP Pulping -> RFP-HD cleaning		160.7
	RFP Pulping -> RFP rej jnc1		136.94
RFP-HD cleaning			
	RFP Pulping -> RFP-HD cleaning	160.7	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	RFP cloudy filtrate jnc2 -> RFP-HD cleaning	87	
	RFP-HD cleaning -> RFP coarse screens		238.4
	RFP-HD cleaning -> RFP rej jnc1		9.3
RFP coarse screens			
	RFP-HD cleaning -> RFP coarse screens	238.4	
	RFP cloudy filtrate jnc2 -> RFP coarse screens	3.7	
	RFP coarse screens -> RFP flotation		239.2
	RFP coarse screens -> RFP rej jnc1		2.9
RFP flotation			
	RFP coarse screens -> RFP flotation	239.2	
	RFP cloudy filtrate jnc2 -> RFP flotation	251.7	
	RFP flotation chemicals -> RFP flotation	52.21	
	RFP flotation -> RFP gyro cleaners		512.26
	RFP flotation -> RFP rejects jnc2		30.85
RFP gyro cleaners			
	RFP flotation -> RFP gyro cleaners	512.26	
	RFP clear ww jnc -> RFP gyro cleaners	96.72	
	RFP gyro cleaners -> RFP centri cleaners		603.58
	RFP gyro cleaners -> RFP rejects jnc2		5.4
RFP centri cleaners			
	RFP gyro cleaners -> RFP centri cleaners	603.58	
	RFP clear ww jnc -> RFP centri cleaners	224.35	
	RFP centri cleaners -> RFP fine screens		820
	RFP centri cleaners -> RFP rejects jnc2		7.93
RFP fine screens			
	RFP centri cleaners -> RFP fine screens	820	
	RFP clear ww jnc -> RFP fine screens	50.7	
	RFP cloudy ww jnc -> RFP fine screens	0	
	RFP fine screens -> RFP disc filter		852.8
	RFP fine screens -> RFP rejects jnc2		17.9
RFP disc filter			
	RFP fine screens -> RFP disc filter	852.8	
	RFP Temp jnc -> RFP disc filter	0	
	RFP clear ww jnc -> RFP disc filter	103.7	
	RFP disc filter -> RFP wire pulp press		124.4

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	RFP disc filter -> RFP clear ww jnc		582.4
	RFP disc filter -> RFP cloudy ww jnc		249.7
RFP wire pulp press			
	RFP disc filter -> RFP wire pulp press	124.4	
	PM ww to RFP jnc -> RFP wire pulp press	43.2	
	RFP wire pulp press -> RFP disperser		20.5
	RFP wire pulp press -> RFP cloudy ww jnc		147.1
RFP disperser			
	RFP wire pulp press -> RFP disperser	20.5	
	PM ww to RFP jnc -> RFP disperser	125.6	
	feed steam jnc -> RFP disperser	7.5	
	RFP disperser -> pulp jnc		153.6
Pulp jnc			
	RFP disperser -> pulp jnc	153.6	
	JNC-pulp to storage -> pulp jnc	469.2	
	Pulp jnc -> PM5 Blend chest		311.4
	Pulp jnc -> PM4 Blend chest		311.4
RFP rej jnc3			
	RFP rejects jnc2 -> RFP rej jnc3	62.08	
	RFP rej jnc1 -> RFP rej jnc3	149.14	
	RFP rej jnc3 -> RPF rejects		211.22
RFP rejects jnc2			
	RFP fine screens -> RFP rejects jnc2	17.9	
	RFP centri cleaners -> RFP rejects jnc2	7.93	
	RFP flotation -> RFP rejects jnc2	30.85	
	RFP gyro cleaners -> RFP rejects jnc2	5.4	
	RFP rejects jnc2 -> RFP rej jnc3		62.08
RFP clear ww jnc			
	RFP Temp jnc -> RFP clear ww jnc	0	
	RFP disc filter -> RFP clear ww jnc	582.4	
	RFP clear ww jnc -> RFP fine screens		50.7
	RFP clear ww jnc -> RFP centri cleaners		224.35
	RFP clear ww jnc -> RFP gyro cleaners		96.72
	RFP clear ww jnc -> RFP disc filter		103.7
	RFP clear ww jnc -> RFP cloudy ww jnc		106.93

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
RFP cloudy ww jnc			
	PM ww to RFP jnc -> RFP cloudy ww jnc	126.67	
	RFP disc filter -> RFP cloudy ww jnc	249.7	
	RFP wire pulp press -> RFP cloudy ww jnc	147.1	
	RFP clear ww jnc -> RFP cloudy ww jnc	106.93	
	RFP cloudy ww jnc -> RFP fine screens		0
	RFP cloudy ww jnc -> RFP cloudy filtrate jnc2		630.4
RFP Temp jnc			
	Fresh water jnc -> RFP Temp jnc	0	
	RFP Temp jnc -> RFP clear ww jnc		0
	RFP Temp jnc -> RFP disc filter		0
PM ww to RFP jnc			
	PM ww to pulp mill jnc -> PM ww to RFP jnc	295.47	
	PM ww to RFP jnc -> RFP cloudy ww jnc		126.67
	PM ww to RFP jnc -> RFP wire pulp press		43.2
	PM ww to RFP jnc -> RFP disperser		125.6
RFP cloudy filtrate jnc2			
	RFP cloudy ww jnc -> RFP cloudy filtrate jnc2	630.4	
	RFP cloudy filtrate jnc2 -> RFP flotation		251.7
	RFP cloudy filtrate jnc2 -> RFP coarse screens		3.7
	RFP cloudy filtrate jnc2 -> RFP-HD cleaning		87
	RFP cloudy filtrate jnc2 -> RFP Pulping		288
RFP rej jnc1			
	RFP-HD cleaning -> RFP rej jnc1	9.3	
	RFP coarse screens -> RFP rej jnc1	2.9	
	RFP Pulping -> RFP rej jnc1	136.94	
	RFP rej jnc1 -> RFP rej jnc3		149.14
PM4 Blend chest			
	Fresh water to PM4 jnc -> PM4 Blend chest	4.5	
	Pulp jnc -> PM4 Blend chest	311.4	
	LF jnc -> PM4 Blend chest	16	
	JNC-broke to PM's -> PM4 Blend chest	96.01	
	PM4 Blend chest -> JNC-PM4 Blend to silo		243.78
	PM4 Blend chest -> PM4 saveall		184.13
PM4 silo			

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	JNC-PM4 Blend to silo -> PM4 silo	400.96	
	PM4 forming section -> PM4 silo	2181.15	
	PM4 silo -> PM4 cleaners & deculator		2582.11
PM4 cleaners & deculator			
	PM4 silo -> PM4 cleaners & deculator	2582.11	
	PM4 cleaners & deculator -> PM4 screens		2453
	PM4 cleaners & deculator -> PM4 ww to drain jnc		129.11
PM4 screens			
	PM4 cleaners & deculator -> PM4 screens	2453	
	PM4 screens -> PM4 headbox		2330.35
	PM4 screens -> PM4 ww to drain jnc		122.65
PM4 headbox			
	PM4 screens -> PM4 headbox	2330.35	
	fresh water to PM4 jnc -> PM4 headbox	20	
	PM4 headbox -> PM4 forming section		2350.35
PM4 forming section			
	PM4 headbox -> PM4 forming section	2350.35	
	fresh water to PM4 jnc -> PM4 forming section	21	
	JNC-PM4 clear chest -> PM4 forming section	122	
	PM4 forming section -> PM4 press section		62.2
	PM4 forming section -> PM4 ww jnc2		250
	PM4 forming section -> PM4 silo		2181.15
PM4 press section			
	PM4 forming section -> PM4 press section	62.2	
	fresh water to PM4 jnc -> PM4 press section	88	
	PM4 press section -> PM4 dryers		31.1
	PM4 press section -> PM4 ww jnc2		119.1
PM4 dryers			
	PM4 press section -> PM4 dryers	31.1	
	PM4 dryers -> dryer steam evap jnc		17.6
	PM4 dryers -> final paper jnc		13.5
Dryer steam evap jnc			
	PM4 dryers -> dryer steam evap jnc	17.6	
	PM5 dryers -> dryer steam evap jnc	17.6	
	Dryer steam evap jnc -> evaporation		35.2

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
Final paper jnc			
	PM4 dryers -> final paper jnc	13.5	
	PM5 dryers -> final paper jnc	13.5	
	Final paper jnc -> Paper		27
PM5 dryers			
	PM5 press section -> PM5 dryers	31.1	
	PM5 dryers -> dryer steam evap jnc		17.6
	PM5 dryers -> final paper jnc		13.5
PM5 press section			
	PM5 forming section -> PM5 press section	62.2	
	Fresh water to PM5 jnc -> PM5 press section	88	
	PM5 press section -> PM5 dryers		31.1
	PM5 press section -> PM5 ww jnc2		119.1
PM5 forming section			
	PM5 headbox -> PM5 forming section	2354.49	
	Fresh water to PM5 jnc -> PM5 forming section	21	
	JNC-PM5 clear chest -> PM5 forming section	166.01	
	PM5 forming section -> PM5 press section		62.2
	PM5 forming section -> PM5 ww jnc2		300
	PM5 forming section -> PM5 silo		2179.3
PM5 headbox			
	PM5 screens -> PM5 headbox	2334.49	
	Fresh water to PM5 jnc -> PM5 headbox	20	
	PM5 headbox -> PM5 forming section		2354.49
PM5 screens			
	PM5 cleaners & deculator -> PM5 screens	2457.36	
	PM5 screens -> PM5 headbox		2334.49
	PM5 screens -> PM rej to drain jnc		122.87
PM5 cleaners & deculator			
	PM5 silo -> PM5 cleaners & deculator	2586.69	
	PM5 cleaners & deculator -> PM5 screens		2457.36
	PM5 cleaners & deculator -> PM rej to drain jnc		129.33
PM5 silo			
	JNC-PM5 blend chest to silo -> PM5 silo	407.39	
	PM5 forming section -> PM5 silo	2179.3	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	PM5 silo -> PM5 cleaners & deculator		2586.69
PM5 Blend chest			
	Fresh water to PM5 jnc -> PM5 Blend chest	4.5	
	Pulp jnc -> PM5 Blend chest	311.4	
	LF jnc -> PM5 Blend chest	16	
	JNC-broke to PM's -> PM5 Blend chest	96.01	
	PM5 Blend chest -> PM5 saveall		180.52
	PM5 Blend chest -> JNC-PM5 blend chest to silo		247.39
PM ww jnc			
	PM ww jnc1 -> PM ww jnc	363.66	
	Cooling -> PM ww jnc	19.46	
	Fresh water to PMs jnc -> PM ww jnc	401.18	
	PM ww jnc -> PM rej to drain jnc		0
	PM ww jnc -> PM ww to pulp mill jnc		753.54
	PM ww jnc -> LF jnc		30.76
PM5 ww jnc2			
	PM5 press section -> PM5 ww jnc2	119.1	
	PM5 forming section -> PM5 ww jnc2	300	
	PM5 ww jnc2 -> PM ww jnc1		419.1
PM4 ww jnc2			
	PM4 forming section -> PM4 ww jnc2	250	
	PM4 press section -> PM4 ww jnc2	119.1	
	PM4 ww jnc2 -> PM ww jnc1		369.1
PM ww jnc1			
	Fresh water to PMs jnc -> PM ww jnc1	0	
	PM5 ww jnc2 -> PM ww jnc1	419.1	
	PM4 ww jnc2 -> PM ww jnc1	369.1	
	PM ww jnc1 -> PM ww jnc		363.66
	PM ww jnc1 -> PM4 ww jnc1		187.05
	PM ww jnc1 -> PM5 ww jnc1		237.49
PM4 ww jnc1			
	JNC-PM4 cloudy chest -> PM4 ww jnc1	1140.95	
	JNC-PM4 clear chest -> PM4 ww jnc1	100	
	PM ww jnc1 -> PM4 ww jnc1	187.05	
	PM4 ww jnc1 -> PM4 saveall		1428

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
PM5 ww jnc1			
	JNC-PM5 clear chest -> PM5 ww jnc1	129.99	
	JNC-PM5 cloudy chest -> PM5 ww jnc1	1060.52	
	PM ww jnc1 -> PM5 ww jnc1	237.49	
	PM5 ww jnc1 -> PM5 saveall		1428
PM rej to drain jnc			
	PM5 cleaners & deculator -> PM rej to drain jnc	129.33	
	PM5 screens -> PM rej to drain jnc	122.87	
	PM ww jnc -> PM rej to drain jnc	0	
	PM4 ww to drain jnc -> PM rej to drain jnc	251.76	
	PM rej to drain jnc -> Drain		503.96
PM4 ww to drain jnc			
	PM4 screens -> PM4 ww to drain jnc	122.65	
	PM4 cleaners & deculator -> PM4 ww to drain jnc	129.11	
	PM4 ww to drain jnc -> PM rej to drain jnc		251.76
Fresh water to PMs jnc			
	Fresh water jnc -> fresh water to PMs jnc	668.18	
	Fresh water to PMs jnc -> fresh water to PM4 jnc		133.5
	Fresh water to PMs jnc -> fresh water to PM5 jnc		133.5
	Fresh water to PMs jnc -> PM ww jnc1		0
	Fresh water to PMs jnc -> PM ww jnc		401.18
Fresh water to PM4 jnc			
	Fresh water to PMs jnc -> fresh water to PM4 jnc	133.5	
	Fresh water to PM4 jnc -> PM4 headbox		20
	Fresh water to PM4 jnc -> PM4 Blend chest		4.5
	Fresh water to PM4 jnc -> PM4 forming section		21
	Fresh water to PM4 jnc -> PM4 press section		88
Fresh water to PM5 jnc			
	Fresh water to PMs jnc -> fresh water to PM5 jnc	133.5	
	Fresh water to PM5 jnc -> PM5 Blend chest		4.5
	Fresh water to PM5 jnc -> PM5 headbox		20
	Fresh water to PM5 jnc -> PM5 forming section		21
	Fresh water to PM5 jnc -> PM5 press section		88
LF jnc			
	LF to PMs -> LF jnc	1.24	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	PM ww jnc -> LF jnc	30.76	
	LF jnc -> PM5 Blend chest		16
	LF jnc -> PM4 Blend chest		16
JNC-broke to PM's			
	Broke to PM's -> JNC-broke to PM's	8.02	
	JNC-PM5 cloudy chest -> JNC-broke to PM's	92	
	JNC-PM4 cloudy chest -> JNC-broke to PM's	92	
	JNC-broke to PM's -> PM5 Blend chest		96.01
	JNC-broke to PM's -> PM4 Blend chest		96.01
JNC-PM5 recovered fibre chest			
	PM5 saveall -> JNC-PM5 recovered fibre chest	128	
	JNC-PM5 cloudy chest -> JNC-PM5 recovered fibre chest	32	
	JNC-PM5 recovered fibre chest -> JNC-PM5 blend chest to silo		160
PM5 saveall			
	PM5 Blend chest -> PM5 saveall	180.52	
	PM5 ww jnc1 -> PM5 saveall	1428	
	PM5 saveall -> JNC-PM5 recovered fibre chest		128
	PM5 saveall -> JNC-PM5 cloudy chest		1184.52
	PM5 saveall -> JNC-PM5 clear chest		296
JNC-PM5 clear chest			
	PM5 saveall -> JNC-PM5 clear chest	296	
	JNC-PM5 clear chest -> PM5 forming section		166.01
	JNC-PM5 clear chest -> PM5 ww jnc1		129.99
JNC-PM5 cloudy chest			
	PM5 saveall -> JNC-PM5 cloudy chest	1184.52	
	JNC-PM5 cloudy chest -> PM5 ww jnc1		1060.52
	JNC-PM5 cloudy chest -> JNC-PM5 recovered fibre chest		32
	JNC-PM5 cloudy chest -> JNC-broke to PM's		92
JNC-PM5 blend chest to silo			
	PM5 Blend chest -> JNC-PM5 blend chest to silo	247.39	
	JNC-PM5 recovered fibre chest -> JNC-PM5 blend chest to silo	160	
	JNC-PM5 blend chest to silo -> PM5 silo		407.39

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
JNC-PM4 Blend to silo			
	PM4 Blend chest -> JNC-PM4 Blend to silo	243.78	
	JNC-PM4 recovered fibre chest -> JNC-PM4 Blend to silo	157.18	
	JNC-PM4 Blend to silo -> PM4 silo		400.96
PM4 saveall			
	PM4 Blend chest -> PM4 saveall	184.13	
	PM4 ww jnc1 -> PM4 saveall	1428	
	PM4 saveall -> JNC-PM4 recovered fibre chest		128
	PM4 saveall -> JNC-PM4 cloudy chest		1262.13
	PM4 saveall -> JNC-PM4 clear chest		222
JNC-PM4 recovered fibre chest			
	PM4 saveall -> JNC-PM4 recovered fibre chest	128	
	JNC-PM4 cloudy chest -> JNC-PM4 recovered fibre chest	29.18	
	JNC-PM4 recovered fibre chest -> JNC-PM4 Blend to silo		157.18
JNC-PM4 cloudy chest			
	PM4 saveall -> JNC-PM4 cloudy chest	1262.13	
	JNC-PM4 cloudy chest -> JNC-broke to PM's		92
	JNC-PM4 cloudy chest -> PM4 ww jnc1		1140.95
	JNC-PM4 cloudy chest -> JNC-PM4 recovered fibre chest		29.18
JNC-PM4 clear chest			
	PM4 saveall -> JNC-PM4 clear chest	222	
	JNC-PM4 clear chest -> PM4 forming section		122
	JNC-PM4 clear chest -> PM4 ww jnc1		100
JNC-TMP1 cloudy ww chest			
	JNC-TMP1 clear ww to deckers -> JNC-TMP1 cloudy ww chest	166.75	
	JNC-TMP1 cloudy -> JNC-TMP1 cloudy ww chest	641.32	
	JNC-TMP1 cloudy ww chest -> TMP1 cloudy ww1		808.07
JNC-TMP1 clear ww chest			
	JNC-TMP1 clear -> JNC-TMP1 clear ww chest	146	
	JNC-tempered to clear ww -> JNC-TMP1 clear ww chest	20	
	JNC-sealing water to clear ww -> JNC-TMP1 clear ww	4.75	

Node Name	Streams In/Out	Flow IN [t/h]	Flow OUT [t/h]
	chest		
	PM ww to pulp mill jnc -> JNC-TMP1 clear ww chest	236	
	JNC-TMP1 clear ww chest -> JNC-TMP1 clear ww to deckers		406.75
JNC-TMP2 clear ww chest			
	PM ww to pulp mill jnc -> JNC-TMP2 clear ww chest	222.07	
	JNC-sealing water to clear ww -> JNC-TMP2 clear ww chest	4.75	
	JNC-tempered to clear ww -> JNC-TMP2 clear ww chest	20	
	JNC-TMP2 clear ww2 -> JNC-TMP2 clear ww chest	146	
	JNC-TMP2 clear ww chest -> JNC-TMP2 clear ww1		392.82
JNC-TMP2 cloudy ww chest			
	JNC-TMP2 cloudy ww3 -> JNC-TMP2 cloudy ww chest	641.32	
	JNC-TMP2 clear ww1 -> JNC-TMP2 cloudy ww chest	152.82	
	JNC-TMP2 cloudy ww chest -> TMP2 cloudy ww1		794.14

Table A.2 Newsprint Circuit water balance fibre content from Water Tracker

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
Chip washer			
	Chips -> chip washer	398606.21	
	Hydrasieves -> chip washer	1370.07	
	JNC- cloudy ww to chip washer -> chip washer	1526.8	
	Chip washer -> hydrasieves		1500
	Chip washer -> chip washer jnc		376327.9
Hydrasieves			
	Chip washer -> hydrasieves	1500	
	Hydrasieves -> chip washer		1370.07
	Hydrasieves -> Hydrasieve rejects		4000
Line 1 Digester			
	Chip washer jnc -> Line 1 Digester	376327.9	
	Feed steam jnc -> Line 1 Digester	0	
	Sodium sulphite jnc -> Line 1 Digester	0	
	Line 1 Digester -> rotary valve exhaust steam jnc		0
	Line 1 Digester -> digester vent steam jnc		1
	Line 1 Digester -> Line 1 Prim Refiner		324641.25
Line 2 Digester			
	Chip washer jnc -> Line 2 Digester	376327.9	
	Feed steam jnc -> Line 2 Digester	0	
	Sodium sulphite jnc -> Line 2 Digester	0	
	Line 2 Digester -> rotary valve exhaust steam jnc		0
	Line 2 Digester -> digester vent steam jnc		1
	Line 2 Digester -> Line 2 Prim Refiner		324641.25
Line 1 Prim Refiner			
	Line 1 Digester -> Line 1 Prim Refiner	324641.25	
	TMP1 cloudy ww2 -> Line 1 Prim Refiner	1567.95	
	Line 1 Prim Refiner -> Line 1 Sec Refiner		374000.16
	Line 1 Prim Refiner -> prim ref back flow steam jnc		0

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
Line 2 Prim Refiner			
	Line 2 Digester -> Line 2 Prim Refiner	324641.25	
	TMP1 cloudy ww2 -> Line 2 Prim Refiner	1567.95	
	Line 2 Prim Refiner -> Line 2 Sec Refiner		374000.16
	Line 2 Prim Refiner -> prim ref back flow steam jnc		0
Line 1 Sec Refiner			
	Line 1 Prim Refiner -> Line 1 Sec Refiner	374000.16	
	TMP1 cloudy ww2 -> Line 1 Sec Refiner	1567.95	
	Line 1 Sec Refiner -> sec refiner jnc		35700
	Line 1 Sec Refiner -> sec refiner exhaust steam jnc		0
	Line 1 Sec Refiner -> sec refiner losses jnc		140247.66
Line 2 Sec Refiner			
	Line 2 Prim Refiner -> Line 2 Sec Refiner	374000.16	
	TMP1 cloudy ww2 -> Line 2 Sec Refiner	1567.95	
	Line 2 Sec Refiner -> sec refiner jnc		35700
	Line 2 Sec Refiner -> sec refiner exhaust steam jnc		0
	Line 2 Sec Refiner -> sec refiner losses jnc		140247.66
TMP1 Latency & screens			
	Secondary refiner jnc -> TMP1 Latency & screens	35700	
	TMP1 cloudy ww1 -> TMP1 Latency & screens	1567.95	
	TMP1 Latency & screens -> JNC-TMP1 latency to deckers		12000
	TMP1 Latency & screens -> JNC-latency steam		0
	TMP1 Latency & screens -> JNC-latency to rej sys		46722.53
Line 1 Decker			
	JNC-TMP1 latency to deckers -> Line 1 Decker	12000	
	JNC-Reject system -> Line 1 Decker	17000	

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	JNC-TMP1 clear ww to deckers -> Line 1 Decker	563.73	
	JNC-Hydros -> Line 1 Decker	0	
	Line 1 Decker -> JNC-TMP1 pulp to storage		39200
	Line 1 Decker -> JNC-TMP1 cloudy		1733.73
	Line 1 Decker -> JNC-TMP1 clear		1000
Reject System			
	GWD rejects -> Reject System	20000	
	Cloudy ww2 -> Reject System	1458.16	
	JNC-latency to rej sys -> Reject System	46186.97	
	Reject System -> Rejects from pressure screen		0
	Reject System -> JNC-Rej sys		17000
Cooling			
	Fresh water jnc -> Cooling	0	
	Cooling tower -> [Blowdown]	0	
	[Make-up] -> cooling tower		0
	Cooling -> PM ww jnc		0
Fresh water jnc			
	Fresh water -> fresh water jnc	0	
	Fresh water jnc -> Cooling		0
	Fresh water jnc -> JNC-tempered to clear ww		0
	Fresh water jnc -> Sealing water		0
	Fresh water jnc -> RFP Temp jnc		0
	Fresh water jnc -> fresh water to PMs jnc		0
Chip washer jnc			
	Chip washer -> chip washer jnc	376327.9	
	Chip washer jnc -> Line 1 Digester		376327.9
	Chip washer jnc -> Line 2 Digester		376327.9
	Chip washer jnc -> Line 3 Digester		376327.9
	Chip washer jnc -> Line 4 Digester		376327.9
Rotary valve exhaust steam jnc			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Line 1 Digester -> rotary valve exhaust steam jnc	0	
	Line 2 Digester -> rotary valve exhaust steam jnc	0	
	Line 3 Digester -> rotary valve exhaust steam jnc	0	
	Line 4 Digester -> rotary valve exhaust steam jnc	0	
	Rotary valve exhaust steam jnc -> Rotary valve exhaust steam		0
Digester vent steam jnc			
	Line 1 Digester -> digester vent steam jnc	1	
	Line 2 Digester -> digester vent steam jnc	1	
	Line 3 Digester -> digester vent steam jnc	0	
	Line 4 Digester -> digester vent steam jnc	0	
	Digester vent steam jnc -> Digester vent steam		0.5
Feed steam jnc			
	Steam -> feed steam jnc	0	
	Feed steam jnc -> Line 1 Digester		0
	Feed steam jnc -> Line 2 Digester		0
	Feed steam jnc -> Line 3 Digester		0
	Feed steam jnc -> Line 4 Digester		0
	Feed steam jnc -> RFP disperser		0
Sodium sulphite jnc			
	Sodium sulphite -> sodium sulphite jnc	0	
	Sodium sulphite jnc -> Line 1 Digester		0
	Sodium sulphite jnc -> Line 2 Digester		0
	Sodium sulphite jnc -> Line 4 Digester		0
	Sodium sulphite jnc -> Line 3 Digester		0
Sec refiner jnc			
	Line 1 Sec Refiner -> sec refiner jnc	35700	
	Line 2 Sec Refiner -> sec refiner jnc	35700	
	Sec refiner jnc -> TMP1 Latency & screens		35700
Primary ref back flow steam jnc			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Line 2 Prim Refiner -> prim ref back flow steam jnc	0	
	Line 1 Prim Refiner -> prim ref back flow steam jnc	0	
	Line 3 Prim Refiner -> prim ref back flow steam jnc	0	
	Line 4 Prim Refiner -> prim ref back flow steam jnc	0	
	Primary ref back flow steam jnc -> back flow steam		0
Secondary refiner exhaust steam jnc			
	Line 1 Sec Refiner -> sec refiner exhaust steam jnc	0	
	Line 2 Sec Refiner -> sec refiner exhaust steam jnc	0	
	Line 3 Sec Refiner -> sec refiner exhaust steam jnc	0	
	Line 4 Sec Refiner -> sec refiner exhaust steam jnc	0	
	Secondary refiner exhaust steam jnc -> Cyclone and feader exhaust steam		0
TMP1 cloudy ww2			
	TMP1 cloudy ww1 -> TMP1 cloudy ww2	1567.95	
	TMP1 cloudy ww2 -> Line 1 Sec Refiner		1567.95
	TMP1 cloudy ww2 -> Line 1 Prim Refiner		1567.95
	TMP1 cloudy ww2 -> Line 2 Prim Refiner		1567.95
	TMP1 cloudy ww2 -> Line 2 Sec Refiner		1567.95
Secondary refiner losses jnc			
	Line 1 Sec Refiner -> sec refiner losses jnc	140247.66	
	Line 2 Sec Refiner -> sec refiner losses jnc	140247.66	
	Line 3 Sec Refiner -> sec refiner losses jnc	128877.06	
	Line 4 Sec Refiner -> sec refiner losses jnc	118873.07	
	Secondary refiner losses jnc -> Losses		132061.36
Line 3 Digester			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Sodium sulphite jnc -> Line 3 Digester	0	
	Feed steam jnc -> Line 3 Digester	0	
	Chip washer jnc -> Line 3 Digester	376327.9	
	Line 3 Digester -> Line 3 Prim Refiner		324641.26
	Line 3 Digester -> rotary valve exhaust steam jnc		0
	Line 3 Digester -> digester vent steam jnc		0
Line 4 Digester			
	Sodium sulphite jnc -> Line 4 Digester	0	
	Feed steam jnc -> Line 4 Digester	0	
	Chip washer jnc -> Line 4 Digester	376327.9	
	Line 4 Digester -> Line 4 Prim Refiner		324641.26
	Line 4 Digester -> rotary valve exhaust steam jnc		0
	Line 4 Digester -> digester vent steam jnc		0
Line 3 Prim Refiner			
	Line 3 Digester -> Line 3 Prim Refiner	324641.26	
	TMP2 cloudy ww2 -> Line 3 Prim Refiner	1348.38	
	Line 3 Prim Refiner -> Line 3 Sec Refiner		374000
	Line 3 Prim Refiner -> prim ref back flow steam jnc		0
Line 4 Prim Refiner			
	Line 4 Digester -> Line 4 Prim Refiner	324641.26	
	TMP2 cloudy ww2 -> Line 4 Prim Refiner	1348.38	
	Line 4 Prim Refiner -> Line 4 Sec Refiner		374000
	Line 4 Prim Refiner -> prim ref back flow steam jnc		0
Line 3 Sec Refiner			
	Line 3 Prim Refiner -> Line 3 Sec Refiner	374000	
	TMP2 cloudy ww2 -> Line 3 Sec Refiner	1348.38	
	Line 3 Sec Refiner -> JNC-TMP2 sec ref to latency		35700
	Line 3 Sec Refiner -> sec refiner exhaust steam jnc		0
	Line 3 Sec Refiner -> sec refiner losses jnc		128877.06

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
Line 4 Sec Refiner			
	Line 4 Prim Refiner -> Line 4 Sec Refiner	374000	
	TMP2 cloudy ww2 -> Line 4 Sec Refiner	1348.38	
	Line 4 Sec Refiner -> JNC-TMP2 sec ref to latency		35888.29
	Line 4 Sec Refiner -> sec refiner exhaust steam jnc		0
	Line 4 Sec Refiner -> sec refiner losses jnc		118873.07
Line 3 Decker			
	JNC-TMP2 latency to deckers -> Line 3 Decker	12000	
	JNC-Rej sys -> Line 3 Decker	17000	
	JNC-TMP2 clear ww1 -> Line 3 Decker	717.65	
	JNC-Hydros -> Line 3 Decker	0	
	Line 3 Decker -> JNC-TMP2 pulp to storage		40000
	Line 3 Decker -> JNC-TMP2 cloudy ww3		1498.68
	Line 3 Decker -> JNC-TMP2 clear ww2		1000
Line 4 Decker			
	JNC-TMP2 latency to deckers -> Line 4 Decker	12000	
	JNC-Rej sys -> Line 4 Decker	17000	
	JNC-TMP2 clear ww1 -> Line 4 Decker	717.65	
	JNC-Hydros -> Line 4 Decker	0	
	Line 4 Decker -> JNC-TMP2 pulp to storage		40000
	Line 4 Decker -> JNC-TMP2 cloudy ww3		1498.68
	Line 4 Decker -> JNC-TMP2 clear ww2		1000
JNC-pulp to storage			
	JNC-TMP2 pulp to storage -> JNC-pulp to storage	40000	
	JNC-TMP1 pulp to storage -> JNC-pulp to storage	39200	
	JNC-pulp to storage -> pulp jnc		39600
JNC-TMP2 pulp to storage			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Line 4 Decker -> JNC-TMP2 pulp to storage	40000	
	Line 3 Decker -> JNC-TMP2 pulp to storage	40000	
	JNC-TMP2 pulp to storage -> JNC-pulp to storage		40000
JNC-TMP2 latency to deckers			
	TMP2 Latency & screens -> JNC-TMP2 latency to deckers	12000	
	JNC-TMP2 latency to deckers -> Line 3 Decker		12000
	JNC-TMP2 latency to deckers -> Line 4 Decker		12000
JNC-TMP2 sec ref to latency			
	Line 3 Sec Refiner -> JNC-TMP2 sec ref to latency	35700	
	Line 4 Sec Refiner -> JNC-TMP2 sec ref to latency	35888.29	
	JNC-TMP2 sec ref to latency -> TMP2 Latency & screens		35794.14
PM ww to pulp mill jnc			
	PM ww jnc -> PM ww to pulp mill jnc	612	
	PM ww to pulp mill jnc -> PM ww to RFP jnc		612
	PM ww to pulp mill jnc -> JNC-TMP1 clear ww chest		612
	PM ww to pulp mill jnc -> JNC-TMP2 clear ww chest		612
Line 2 Decker			
	JNC-TMP1 latency to deckers -> Line 2 Decker	12000	
	JNC-Reject system -> Line 2 Decker	17000	
	JNC-TMP1 clear ww to deckers -> Line 2 Decker	563.73	
	JNC-Hydros -> Line 2 Decker	0	

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Line 2 Decker -> JNC-TMP1 pulp to storage		39200
	Line 2 Decker -> JNC-TMP1 clear		162.55
	Line 2 Decker -> JNC-TMP1 cloudy		1924.38
JNC-TMP1 pulp to storage			
	Line 1 Decker -> JNC-TMP1 pulp to storage	39200	
	Line 2 Decker -> JNC-TMP1 pulp to storage	39200	
	JNC-TMP1 pulp to storage -> JNC-pulp to storage		39200
JNC-Rej sys			
	Reject System -> JNC-Rej sys	17000	
	JNC-Rej sys -> JNC-Reject system		17000
	JNC-Rej sys -> Line 3 Decker		17000
	JNC-Rej sys -> Line 4 Decker		17000
JNC-tempered to clear ww			
	Fresh water jnc -> JNC-tempered to clear ww	0	
	JNC-tempered to clear ww -> JNC-TMP1 clear ww chest		0
	JNC-tempered to clear ww -> JNC-TMP2 clear ww chest		0
JNC-TMP1 latency to deckers			
	TMP1 Latency & screens -> JNC-TMP1 latency to deckers	12000	
	JNC-TMP1 latency to deckers -> Line 1 Decker		12000
	JNC-TMP1 latency to deckers -> Line 2 Decker		12000
JNC-Reject system			
	JNC-Rej sys -> JNC-Reject system	17000	
	JNC-Reject system -> Line 1 Decker		17000
	JNC-Reject system -> Line 2 Decker		17000
JNC-TMP1 cloudy			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Line 1 Decker -> JNC-TMP1 cloudy	1733.73	
	Line 2 Decker -> JNC-TMP1 cloudy	1924.38	
	JNC-TMP1 cloudy -> JNC-TMP1 cloudy ww chest		1829.06
JNC-TMP1 clear			
	Line 1 Decker -> JNC-TMP1 clear	1000	
	Line 2 Decker -> JNC-TMP1 clear	162.55	
	JNC-TMP1 clear -> JNC-TMP1 clear ww chest		581.28
JNC-TMP1 clear ww to deckers			
	JNC-TMP1 clear ww chest -> JNC-TMP1 clear ww to deckers	563.73	
	JNC-TMP1 clear ww to deckers -> Line 1 Decker		563.73
	JNC-TMP1 clear ww to deckers -> Line 2 Decker		563.73
	JNC-TMP1 clear ww to deckers -> JNC-TMP1 cloudy ww chest		563.73
JNC-TMP2 cloudy ww3			
	Line 3 Decker -> JNC-TMP2 cloudy ww3	1498.68	
	Line 4 Decker -> JNC-TMP2 cloudy ww3	1498.68	
	JNC-TMP2 cloudy ww3 -> JNC-TMP2 cloudy ww chest		1498.68
JNC-TMP2 clear ww2			
	Line 4 Decker -> JNC-TMP2 clear ww2	1000	
	Line 3 Decker -> JNC-TMP2 clear ww2	1000	
	JNC-TMP2 clear ww2 -> JNC-TMP2 clear ww chest		1000
JNC-TMP2 clear ww1			
	JNC-TMP2 clear ww chest -> JNC-TMP2 clear ww1	717.65	
	JNC-TMP2 clear ww1 -> Line 3 Decker		717.65
	JNC-TMP2 clear ww1 -> Line 4 Decker		717.65
	JNC-TMP2 clear ww1 -> JNC-TMP2 cloudy ww chest		717.65

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
Cloudy ww2			
	TMP1 cloudy ww1 -> cloudy ww2	1567.95	
	TMP2 cloudy ww1 -> cloudy ww2	1348.38	
	Cloudy ww2 -> Reject System		1458.16
TMP2 cloudy ww2			
	TMP2 cloudy ww1 -> TMP2 cloudy ww2	1348.38	
	TMP2 cloudy ww2 -> Line 4 Prim Refiner		1348.38
	TMP2 cloudy ww2 -> Line 4 Sec Refiner		1348.38
	TMP2 cloudy ww2 -> Line 3 Sec Refiner		1348.38
	TMP2 cloudy ww2 -> Line 3 Prim Refiner		1348.38
TMP2 cloudy ww1			
	JNC-TMP2 cloudy ww chest -> TMP2 cloudy ww1	1348.38	
	TMP2 cloudy ww1 -> TMP2 cloudy ww2		1348.38
	TMP2 cloudy ww1 -> TMP2 Latency & screens		1348.38
	TMP2 cloudy ww1 -> cloudy ww1		1348.38
	TMP2 cloudy ww1 -> cloudy ww2		1348.38
TMP2 Latency & screens			
	JNC-TMP2 sec ref to latency -> TMP2 Latency & screens	35794.14	
	TMP2 cloudy ww1 -> TMP2 Latency & screens	1348.38	
	TMP2 Latency & screens -> JNC-TMP2 latency to deckers		12000
	TMP2 Latency & screens -> JNC-latency steam		0
	TMP2 Latency & screens -> JNC-latency to rej sys		45651.42
JNC-latency steam			
	TMP1 Latency & screens -> JNC-latency steam	0	
	TMP2 Latency & screens -> JNC-latency steam	0	
	JNC-latency steam -> Latency steam		0

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
TMP1 cloudy ww1			
	JNC-TMP1 cloudy ww chest -> TMP1 cloudy ww1	1567.95	
	TMP1 cloudy ww1 -> TMP1 cloudy ww2		1567.95
	TMP1 cloudy ww1 -> TMP1 Latency & screens		1567.95
	TMP1 cloudy ww1 -> cloudy ww2		1567.95
	TMP1 cloudy ww1 -> cloudy ww1		1567.95
JNC- cloudy ww to chip washer			
	TMP1 cloudy ww1 -> cloudy ww1	1567.95	
	TMP2 cloudy ww1 -> cloudy ww1	1348.38	
	JNC- cloudy ww to chip washer -> chip washer		1526.8
JNC-latency to rej sys			
	TMP1 Latency & screens -> JNC-latency to rej sys	46722.53	
	TMP2 Latency & screens -> JNC-latency to rej sys	45651.42	
	JNC-latency to rej sys -> Reject System		46186.97
JNC-Hydros			
	Hydros -> JNC-Hydros	0	
	JNC-Hydros -> Line 1 Decker		0
	JNC-Hydros -> Line 2 Decker		0
	JNC-Hydros -> Line 4 Decker		0
	JNC-Hydros -> Line 3 Decker		0
Sealing water			
	Fresh water jnc -> Sealing water	0	
	Sealing water -> JNC-sealing water to clear ww		0
	Sealing water -> sealing water to drain		0
JNC-sealing water to clear ww			
	Sealing water -> JNC-sealing water to clear ww	0	
	JNC-sealing water to clear ww -> JNC-TMP1 clear ww chest		0

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	JNC-sealing water to clear ww -> JNC-TMP2 clear ww chest		0
Cooling tower			
	[Make-up] -> cooling tower	0	
	Cooling tower -> [Losses]		0
	Cooling tower -> [Evapor.]		0
	Cooling tower -> [Blowdown]		0
RFP Pulping			
	RFP waste paper -> RFP Pulping	900000	
	RFP cloudy filtrate jnc2 -> RFP Pulping	1010.41	
	RFP Pulping -> RFP-HD cleaning		50000
	RFP Pulping -> RFP rej jnc1		6805.88
RFP-HD cleaning			
	RFP Pulping -> RFP-HD cleaning	50000	
	RFP cloudy filtrate jnc2 -> RFP-HD cleaning	1010.41	
	RFP-HD cleaning -> RFP coarse screens		30000
	RFP-HD cleaning -> RFP rej jnc1		104398.43
RFP coarse screens			
	RFP-HD cleaning -> RFP coarse screens	30000	
	RFP cloudy filtrate jnc2 -> RFP coarse screens	1010.41	
	RFP coarse screens -> RFP flotation		28126
	RFP coarse screens -> RFP rej jnc1		147585.97
RFP flotation			
	RFP coarse screens -> RFP flotation	28126	
	RFP cloudy filtrate jnc2 -> RFP flotation	1010.41	
	RFP flotation chemicals -> RFP flotation	0	
	RFP flotation -> RFP gyro cleaners		13133.44
	RFP flotation -> RFP rejects jnc2		8243.77
RFP gyro cleaners			
	RFP flotation -> RFP gyro cleaners	13133.44	
	RFP clear ww jnc -> RFP gyro cleaners	0	
	RFP gyro cleaners -> RFP centri cleaners		11000
	RFP gyro cleaners -> RFP rejects jnc2		16362.63

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
RFP centri cleaners			
	RFP gyro cleaners -> RFP centri cleaners	11000	
	RFP clear ww jnc -> RFP centri cleaners	0	
	RFP centri cleaners -> RFP fine screens		8000
	RFP centri cleaners -> RFP rejects jnc2		10010.09
RFP fine screens			
	RFP centri cleaners -> RFP fine screens	8000	
	RFP clear ww jnc -> RFP fine screens	0	
	RFP cloudy ww jnc -> RFP fine screens	0	
	RFP fine screens -> RFP disc filter		7692.31
	RFP fine screens -> RFP rejects jnc2		0
RFP disc filter			
	RFP fine screens -> RFP disc filter	7692.31	
	RFP Temp jnc -> RFP disc filter	0	
	RFP clear ww jnc -> RFP disc filter	0	
	RFP disc filter -> RFP wire pulp press		50372.61
	RFP disc filter -> RFP clear ww jnc		0
	RFP disc filter -> RFP cloudy ww jnc		1176
RFP wire pulp press			
	RFP disc filter -> RFP wire pulp press	50372.61	
	PM ww to RFP jnc -> RFP wire pulp press	612	
	RFP wire pulp press -> RFP disperser		294000
	RFP wire pulp press -> RFP cloudy ww jnc		1806.87
RFP disperser			
	RFP wire pulp press -> RFP disperser	294000	
	PM ww to RFP jnc -> RFP disperser	612	
	Feed steam jnc -> RFP disperser	0	
	RFP disperser -> pulp jnc		39738.72
Pulp jnc			
	RFP disperser -> pulp jnc	39738.72	
	JNC-pulp to storage -> pulp jnc	39600	
	Pulp jnc -> PM5 Blend chest		39634.21
	Pulp jnc -> PM4 Blend chest		39634.21
RFP rej jnc3			

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	RFP rejects jnc2 -> RFP rej jnc3	6798.62	
	RFP rej jnc1 -> RFP rej jnc3	15628.95	
	RFP rej jnc3 -> RPF rejects		13033.62
RFP rejects jnc2			
	RFP fine screens -> RFP rejects jnc2	0	
	RFP centri cleaners -> RFP rejects jnc2	10010.09	
	RFP flotation -> RFP rejects jnc2	8243.77	
	RFP gyro cleaners -> RFP rejects jnc2	16362.63	
	RFP rejects jnc2 -> RFP rej jnc3		6798.62
RFP clear ww jnc			
	RFP Temp jnc -> RFP clear ww jnc	0	
	RFP disc filter -> RFP clear ww jnc	0	
	RFP clear ww jnc -> RFP fine screens		0
	RFP clear ww jnc -> RFP centri cleaners		0
	RFP clear ww jnc -> RFP gyro cleaners		0
	RFP clear ww jnc -> RFP disc filter		0
	RFP clear ww jnc -> RFP cloudy ww jnc		0
RFP cloudy ww jnc			
	PM ww to RFP jnc -> RFP cloudy ww jnc	612	
	RFP disc filter -> RFP cloudy ww jnc	1176	
	RFP wire pulp press -> RFP cloudy ww jnc	1806.87	
	RFP clear ww jnc -> RFP cloudy ww jnc	0	
	RFP cloudy ww jnc -> RFP fine screens		0
	RFP cloudy ww jnc -> RFP cloudy filtrate jnc2		1010.41
RFP Temp jnc			
	Fresh water jnc -> RFP Temp jnc	0	
	RFP Temp jnc -> RFP clear ww jnc		0
	RFP Temp jnc -> RFP disc filter		0
PM ww to RFP jnc			
	PM ww to pulp mill jnc -> PM ww to RFP jnc	612	
	PM ww to RFP jnc -> RFP cloudy ww jnc		612
	PM ww to RFP jnc -> RFP wire pulp press		612

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	PM ww to RFP jnc -> RFP disperser		612
RFP cloudy filtrate jnc2			
	RFP cloudy ww jnc -> RFP cloudy filtrate jnc2	1010.41	
	RFP cloudy filtrate jnc2 -> RFP flotation		1010.41
	RFP cloudy filtrate jnc2 -> RFP coarse screens		1010.41
	RFP cloudy filtrate jnc2 -> RFP-HD cleaning		1010.41
	RFP cloudy filtrate jnc2 -> RFP Pulping		1010.41
RFP rej jnc1			
	RFP-HD cleaning -> RFP rej jnc1	104398.43	
	RFP coarse screens -> RFP rej jnc1	147585.97	
	RFP Pulping -> RFP rej jnc1	6805.88	
	RFP rej jnc1 -> RFP rej jnc3		15628.95
PM4 Blend chest			
	Fresh water to PM4 jnc -> PM4 Blend chest	0	
	Pulp jnc -> PM4 Blend chest	39634.21	
	LF jnc -> PM4 Blend chest	38000	
	JNC-broke to PM's -> PM4 Blend chest	39200	
	PM4 Blend chest -> JNC-PM4 Blend to silo		40000
	PM4 Blend chest -> PM4 saveall		37812.88
PM4 silo			
	JNC-PM4 Blend to silo -> PM4 silo	42071.44	
	PM4 forming section -> PM4 silo	3533.89	
	PM4 silo -> PM4 cleaners & deculator		9518.09
PM4 cleaners & deculator			
	PM4 silo -> PM4 cleaners & deculator	9518.09	
	PM4 cleaners & deculator -> PM4 screens		9000
	PM4 cleaners & deculator -> PM4 ww to drain jnc		19361.73
PM4 screens			
	PM4 cleaners & deculator -> PM4 screens	9000	
	PM4 screens -> PM4 headbox		8895.7
	PM4 screens -> PM4 ww to drain jnc		10981.76

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
PM4 headbox			
	PM4 screens -> PM4 headbox	8895.7	
	Fresh water to PM4 jnc -> PM4 headbox	0	
	PM4 headbox -> PM4 forming section		8820
PM4 forming section			
	PM4 headbox -> PM4 forming section	8820	
	Fresh water to PM4 jnc -> PM4 forming section	0	
	JNC-PM4 clear chest -> PM4 forming section	300	
	PM4 forming section -> PM4 press section		200000
	PM4 forming section -> PM4 ww jnc2		2475
	PM4 forming section -> PM4 silo		3533.89
PM4 press section			
	PM4 forming section -> PM4 press section	200000	
	Fresh water to PM4 jnc -> PM4 press section	0	
	PM4 press section -> PM4 dryers		400000
	PM4 press section -> PM4 ww jnc2		0
PM4 dryers			
	PM4 press section -> PM4 dryers	400000	
	PM4 dryers -> dryer steam evap jnc		0
	PM4 dryers -> final paper jnc		921481.48
Dryer steam evap jnc			
	PM4 dryers -> dryer steam evap jnc	0	
	PM5 dryers -> dryer steam evap jnc	0	
	Dryer steam evap jnc -> evaporation		0
Final paper jnc			
	PM4 dryers -> final paper jnc	921481.48	
	PM5 dryers -> final paper jnc	921481.48	
	Final paper jnc -> Paper		921481.48
PM5 dryers			
	PM5 press section -> PM5 dryers	400000	
	PM5 dryers -> dryer steam evap jnc		0
	PM5 dryers -> final paper jnc		921481.48

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
PM5 press section			
	PM5 forming section -> PM5 press section	200000	
	Fresh water to PM5 jnc -> PM5 press section	0	
	PM5 press section -> PM5 dryers		400000
	PM5 press section -> PM5 ww jnc2		0
PM5 forming section			
	PM5 headbox -> PM5 forming section	8820	
	Fresh water to PM5 jnc -> PM5 forming section	0	
	JNC-PM5 clear chest -> PM5 forming section	300	
	PM5 forming section -> PM5 press section		200000
	PM5 forming section -> PM5 ww jnc2		1405.29
	PM5 forming section -> PM5 silo		3650.16
PM5 headbox			
	PM5 screens -> PM5 headbox	8895.56	
	Fresh water to PM5 jnc -> PM5 headbox	0	
	PM5 headbox -> PM5 forming section		8820
PM5 screens			
	PM5 cleaners & deculator -> PM5 screens	9000	
	PM5 screens -> PM5 headbox		8895.56
	PM5 screens -> PM rej to drain jnc		10984.31
PM5 cleaners & deculator			
	PM5 silo -> PM5 cleaners & deculator	9617.29	
	PM5 cleaners & deculator -> PM5 screens		9000
	PM5 cleaners & deculator -> PM rej to drain jnc		21345.77
PM5 silo			
	JNC-PM5 blend chest to silo -> PM5 silo	41537.95	
	PM5 forming section -> PM5 silo	3650.16	
	PM5 silo -> PM5 cleaners & deculator		9617.29
PM5 Blend chest			
	Fresh water to PM5 jnc -> PM5 Blend chest	0	
	Pulp jnc -> PM5 Blend chest	39634.21	

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	LF jnc -> PM5 Blend chest	38000	
	JNC-broke to PM's -> PM5 Blend chest	39200	
	PM5 Blend chest -> PM5 saveall		37769.14
	PM5 Blend chest -> JNC-PM5 blend chest to silo		40000
PM ww jnc			
	PM ww jnc1 -> PM ww jnc	1319.89	
	Cooling -> PM ww jnc	0	
	Fresh water to PMs jnc -> PM ww jnc	0	
	PM ww jnc -> PM rej to drain jnc		0
	PM ww jnc -> PM ww to pulp mill jnc		612
	PM ww jnc -> LF jnc		612
PM5 ww jnc2			
	PM5 press section -> PM5 ww jnc2	0	
	PM5 forming section -> PM5 ww jnc2	1405.29	
	PM5 ww jnc2 -> PM ww jnc1		1005.93
PM4 ww jnc2			
	PM4 forming section -> PM4 ww jnc2	2475	
	PM4 press section -> PM4 ww jnc2	0	
	PM4 ww jnc2 -> PM ww jnc1		1676.37
PM ww jnc1			
	Fresh water to PMs jnc -> PM ww jnc1	0	
	PM5 ww jnc2 -> PM ww jnc1	1005.93	
	PM4 ww jnc2 -> PM ww jnc1	1676.37	
	PM ww jnc1 -> PM ww jnc		1319.89
	PM ww jnc1 -> PM4 ww jnc1		1319.89
	PM ww jnc1 -> PM5 ww jnc1		1319.89
PM4 ww jnc1			
	JNC-PM4 cloudy chest -> PM4 ww jnc1	600	
	JNC-PM4 clear chest -> PM4 ww jnc1	300	
	PM ww jnc1 -> PM4 ww jnc1	1319.89	
	PM4 ww jnc1 -> PM4 saveall		673.29
PM5 ww jnc1			
	JNC-PM5 clear chest -> PM5 ww jnc1	300	

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	JNC-PM5 cloudy chest -> PM5 ww jnc1	600	
	PM ww jnc1 -> PM5 ww jnc1	1319.89	
	PM5 ww jnc1 -> PM5 saveall		692.42
PM rej to drain jnc			
	PM5 cleaners & deculator -> PM rej to drain jnc	21345.77	
	PM5 screens -> PM rej to drain jnc	10984.31	
	PM ww jnc -> PM rej to drain jnc	0	
	PM4 ww to drain jnc -> PM rej to drain jnc	15279.18	
	PM rej to drain jnc -> Drain		15788.98
PM4 ww to drain jnc			
	PM4 screens -> PM4 ww to drain jnc	10981.76	
	PM4 cleaners & deculator -> PM4 ww to drain jnc	19361.73	
	PM4 ww to drain jnc -> PM rej to drain jnc		15279.18
Fresh water to PMs jnc			
	Fresh water jnc -> fresh water to PMs jnc	0	
	Fresh water to PMs jnc -> fresh water to PM4 jnc		0
	Fresh water to PMs jnc -> fresh water to PM5 jnc		0
	Fresh water to PMs jnc -> PM ww jnc1		0
	Fresh water to PMs jnc -> PM ww jnc		0
Fresh water to PM4 jnc			
	Fresh water to PMs jnc -> fresh water to PM4 jnc	0	
	Fresh water to PM4 jnc -> PM4 headbox		0
	Fresh water to PM4 jnc -> PM4 Blend chest		0
	Fresh water to PM4 jnc -> PM4 forming section		0
	Fresh water to PM4 jnc -> PM4 press section		0
Fresh water to PM5 jnc			
	Fresh water to PMs jnc -> fresh water to PM5 jnc	0	

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	Fresh water to PM5 jnc -> PM5 Blend chest		0
	Fresh water to PM5 jnc -> PM5 headbox		0
	Fresh water to PM5 jnc -> PM5 forming section		0
	Fresh water to PM5 jnc -> PM5 press section		0
LF jnc			
	LF to PMs -> LF jnc	965463.61	
	PM ww jnc -> LF jnc	612	
	LF jnc -> PM5 Blend chest		38000
	LF jnc -> PM4 Blend chest		38000
JNC-broke to PM's			
	Broke to PM's -> JNC-broke to PM's	924786.03	
	JNC-PM5 cloudy chest -> JNC-broke to PM's	600	
	JNC-PM4 cloudy chest -> JNC-broke to PM's	600	
	JNC-broke to PM's -> PM5 Blend chest		39200
	JNC-broke to PM's -> PM4 Blend chest		39200
JNC-PM5 recovered fibre chest			
	PM5 saveall -> JNC-PM5 recovered fibre chest	54744.89	
	JNC-PM5 cloudy chest -> JNC-PM5 recovered fibre chest	600	
	JNC-PM5 recovered fibre chest -> JNC-PM5 blend chest to silo		43915.91
PM5 saveall			
	PM5 Blend chest -> PM5 saveall	37769.14	
	PM5 ww jnc1 -> PM5 saveall	692.42	
	PM5 saveall -> JNC-PM5 recovered fibre chest		54744.89
	PM5 saveall -> JNC-PM5 cloudy chest		600
	PM5 saveall -> JNC-PM5 clear chest		300
JNC-PM5 clear chest			
	PM5 saveall -> JNC-PM5 clear chest	300	

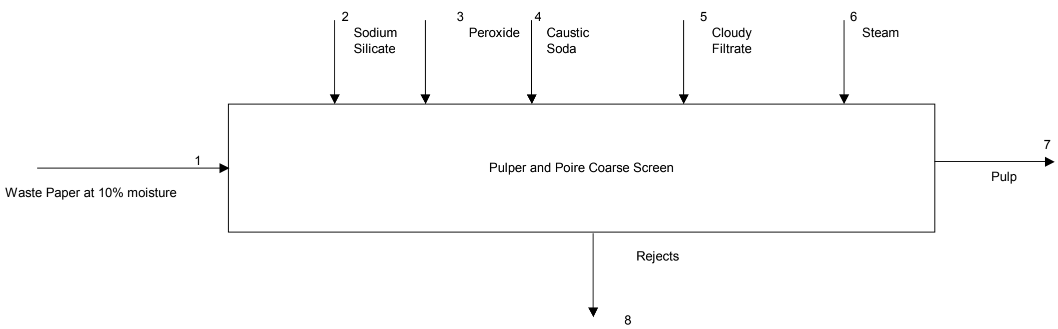
Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	JNC-PM5 clear chest -> PM5 forming section		300
	JNC-PM5 clear chest -> PM5 ww jnc1		300
JNC-PM5 cloudy chest			
	PM5 saveall -> JNC-PM5 cloudy chest	600	
	JNC-PM5 cloudy chest -> PM5 ww jnc1		600
	JNC-PM5 cloudy chest -> JNC-PM5 recovered fibre chest		600
	JNC-PM5 cloudy chest -> JNC-broke to PM's		600
JNC-PM5 blend chest to silo			
	PM5 Blend chest -> JNC-PM5 blend chest to silo	40000	
	JNC-PM5 recovered fibre chest -> JNC-PM5 blend chest to silo	43915.91	
	JNC-PM5 blend chest to silo -> PM5 silo		41537.95
JNC-PM4 Blend to silo			
	PM4 Blend chest -> JNC-PM4 Blend to silo	40000	
	JNC-PM4 recovered fibre chest -> JNC-PM4 Blend to silo	45284.24	
	JNC-PM4 Blend to silo -> PM4 silo		42071.44
PM4 saveall			
	PM4 Blend chest -> PM4 saveall	37812.88	
	PM4 ww jnc1 -> PM4 saveall	673.29	
	PM4 saveall -> JNC-PM4 recovered fibre chest		55469.34
	PM4 saveall -> JNC-PM4 cloudy chest		600
	PM4 saveall -> JNC-PM4 clear chest		300
JNC-PM4 recovered fibre chest			
	PM4 saveall -> JNC-PM4 recovered fibre chest	55469.34	
	JNC-PM4 cloudy chest -> JNC-PM4 recovered fibre chest	600	
	JNC-PM4 recovered fibre chest -> JNC-PM4 Blend to silo		45284.24

Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
JNC-PM4 cloudy chest			
	PM4 saveall -> JNC-PM4 cloudy chest	600	
	JNC-PM4 cloudy chest -> JNC-broke to PM's		600
	JNC-PM4 cloudy chest -> PM4 ww jnc1		600
	JNC-PM4 cloudy chest -> JNC-PM4 recovered fibre chest		600
JNC-PM4 clear chest			
	PM4 saveall -> JNC-PM4 clear chest	300	
	JNC-PM4 clear chest -> PM4 forming section		300
	JNC-PM4 clear chest -> PM4 ww jnc1		300
JNC-TMP1 cloudy ww chest			
	JNC-TMP1 clear ww to deckers -> JNC-TMP1 cloudy ww chest	563.73	
	JNC-TMP1 cloudy -> JNC-TMP1 cloudy ww chest	1829.06	
	JNC-TMP1 cloudy ww chest -> TMP1 cloudy ww1		1567.95
JNC-TMP1 clear ww chest			
	JNC-TMP1 clear -> JNC-TMP1 clear ww chest	581.28	
	JNC-tempered to clear ww -> JNC-TMP1 clear ww chest	0	
	JNC-sealing water to clear ww -> JNC-TMP1 clear ww chest	0	
	PM ww to pulp mill jnc -> JNC-TMP1 clear ww chest	612	
	JNC-TMP1 clear ww chest -> JNC-TMP1 clear ww to deckers		563.73
JNC-TMP2 clear ww chest			
	PM ww to pulp mill jnc -> JNC-TMP2 clear ww chest	612	
	JNC-sealing water to clear ww -> JNC-TMP2 clear ww chest	0	

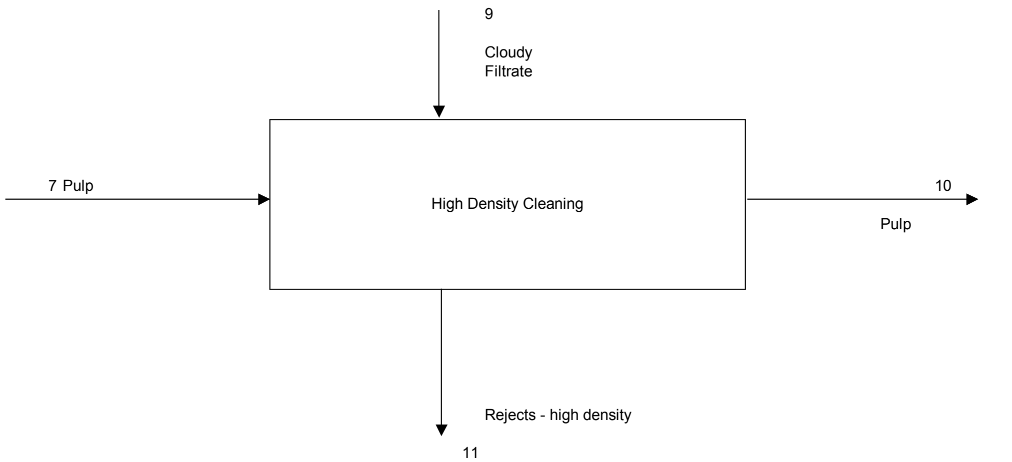
Node Name	Streams In/Out	Concentration. IN [ppm]	Concentration OUT [ppm]
	JNC-tempered to clear ww -> JNC-TMP2 clear ww chest	0	
	JNC-TMP2 clear ww2 -> JNC-TMP2 clear ww chest	1000	
	JNC-TMP2 clear ww chest -> JNC-TMP2 clear ww1		717.65
JNC-TMP2 cloudy ww chest			
	JNC-TMP2 cloudy ww3 -> JNC-TMP2 cloudy ww chest	1498.68	
	JNC-TMP2 clear ww1 -> JNC-TMP2 cloudy ww chest	717.65	
	JNC-TMP2 cloudy ww chest -> TMP2 cloudy ww1		1348.38

Appendix B

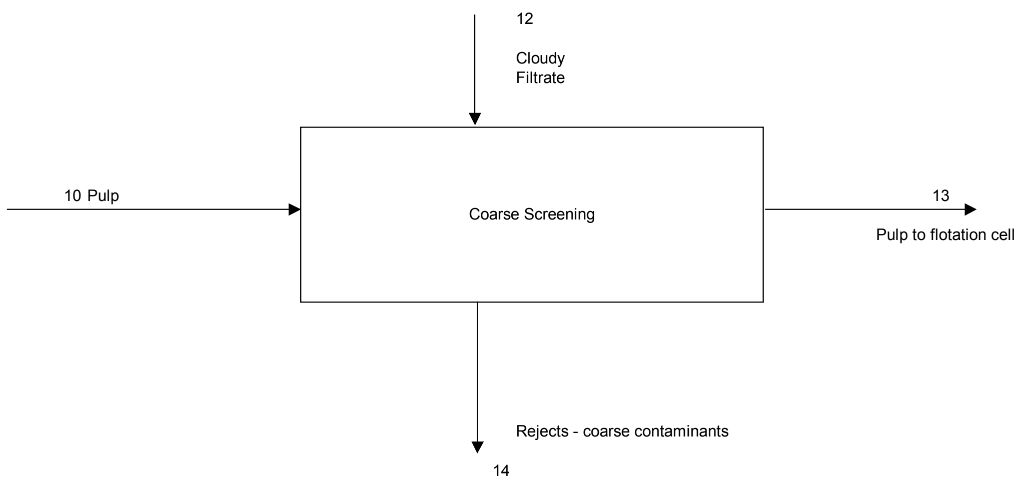
Recycled Fibre Plant Water Balance



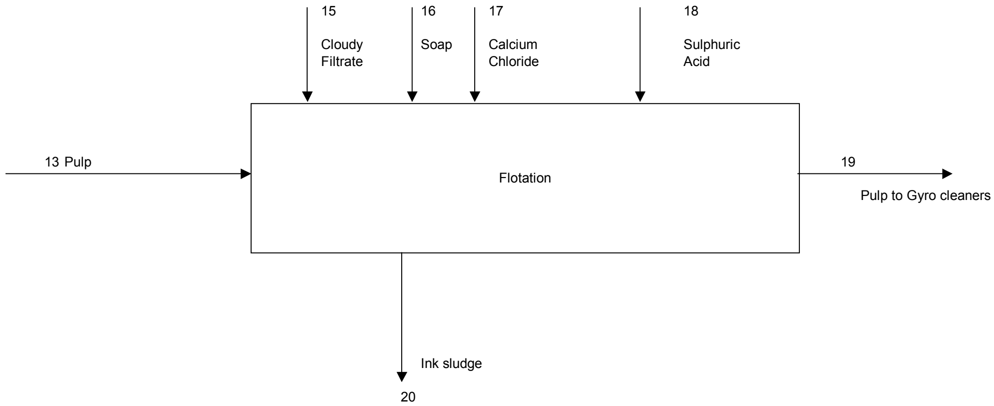
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
1	Waste Paper	9.64		90	8.64		0.96	
2	Sodium Silicate	0.17		50	0.09		0.09	
3	Peroxide	0.17		50	0.08		0.08	
4	Caustic Soda	0.23		25	0.06		0.17	
5	Cloudy Filtrate	288.00		0.06	0.17		287.83	
6	Steam							
7	Pulp		160.70	5		8.04		152.67
8	Rejects		137.47	0.73		1.01		136.47



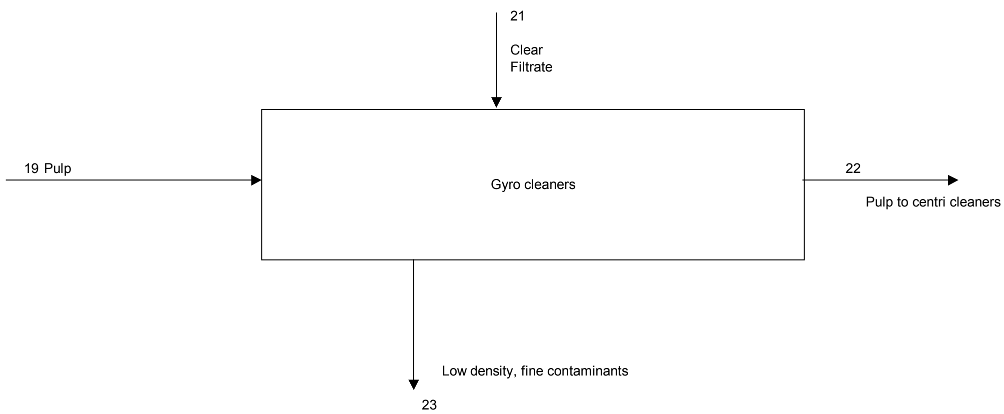
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h		t/h	
7	Pulp	160.70		5	8.04		152.67	
9	Cloudy Filtrate	87.01		0.06	0.05		86.96	
10	Pulp to coarse screens		238.38	3		7.15		231.23
11	Rejects		9.34	10		0.93		8.40



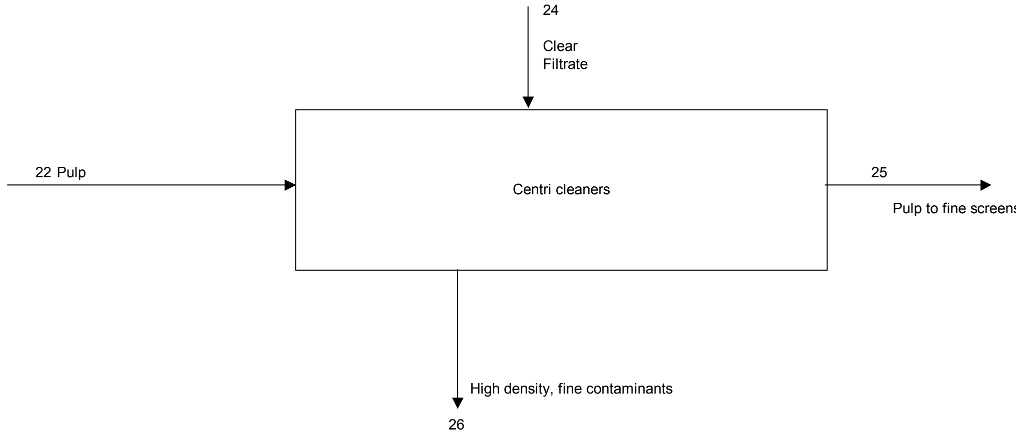
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h		t/h	
10	Pulp	238.38		3	7.15		231.23	
12	Cloudy Filtrate	3.69		0.06	0		3.69	
13	Pulp to flotation		239.21	2.87		6.87		232.34
14	Rejects		2.86	10		0.29		2.57



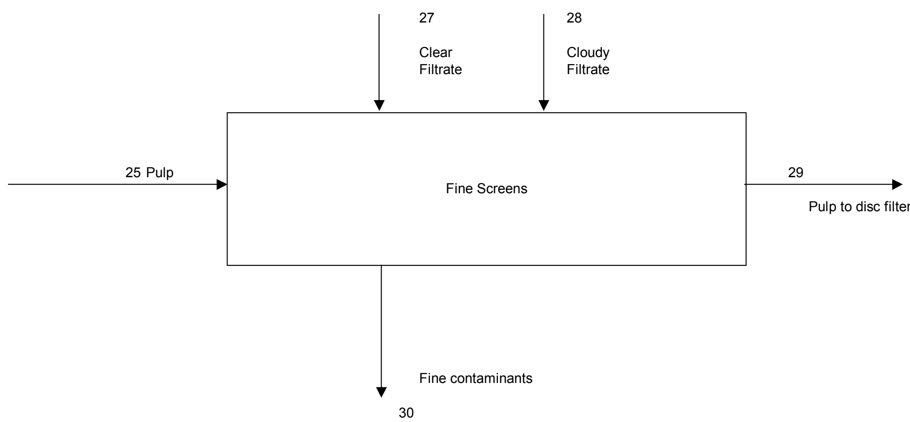
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
13	Pulp	239.21		2.87	6.87		232.34	
15	Cloudy Filtrate	251.73		0.06	0.15		251.58	
16	Soap	0.44		5	0.02		0.42	
17	Calcium Chloride	0.07		32	0.02		0.05	
18	Sulphuric Acid	51.70		8	0		51.70	
19	Pulp to Gyros		512.26	1.3		6.66		505.60
20	Ink Sludge		30.89	1.3		0.40		30.49



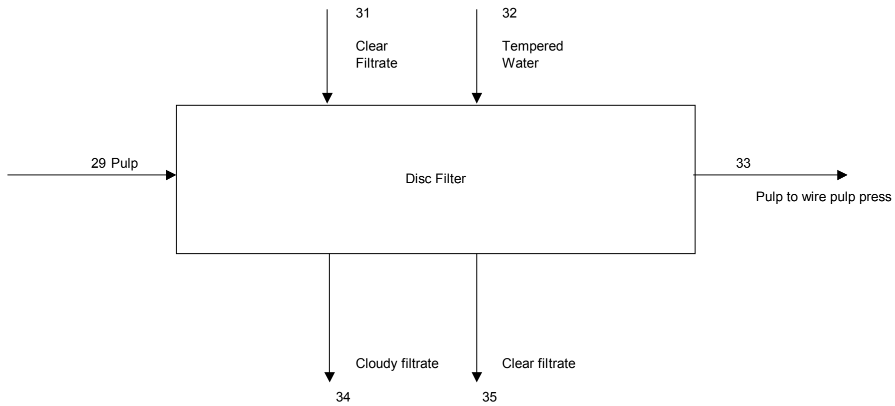
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
19	Pulp	512.26		1.3	6.66		505.60	
21	Clear Filtrate	96.72		0	0		96.72	
22	Pulp to centri cleaners		603.58	1.1		6.64		596.94
23	Rejects - low density, fine cont		5.40	0.37		0.02		5.38



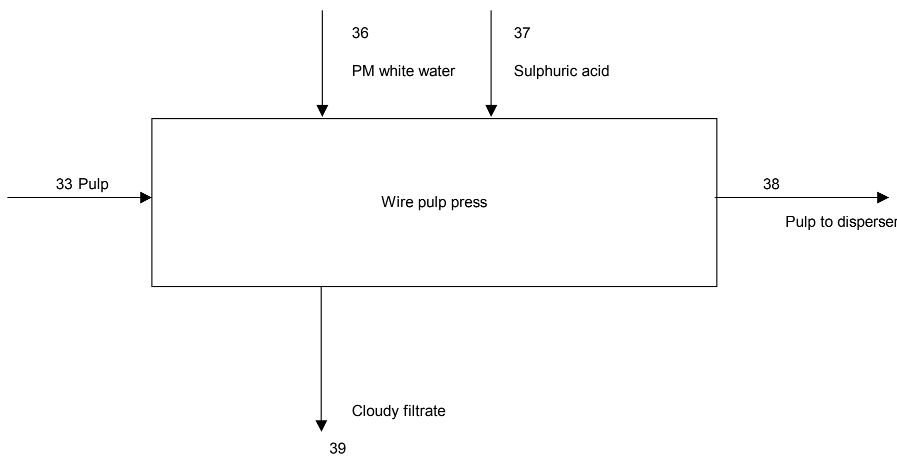
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
22	Pulp	603.58		1.1	6.64		596.94	
24	Clear Filtrate	224.35		0			224.35	
25	Pulp to fine screens		819.96	0.8		6.56		813.40
26	Rejects -high density, fine cont		7.97	1		0.08		7.89



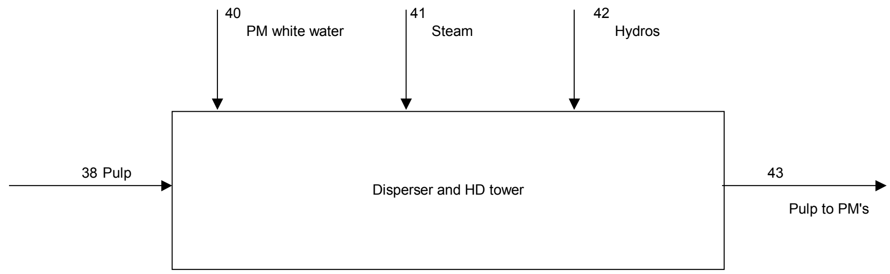
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT		t/h	t/h	t/h	t/h
25	Pulp	819.96		0.8	6.56		813.40	
27	Clear Filtrate	50.69		0	0		50.69	
29	Pulp to disc filter		852.76	0.76		6.48		846.28
30	Fine contaminants		17.89	0.44		0.08		17.81



Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT		t/h	t/h	t/h	t/h
29	Pulp	852.8		0.76	6.48		846.3	
31	Clear Filtrate	103.6952		0.005	0.01		103.69	
32	Tempered water	0.05		0			0.05	
33	Pulp to wire pulp press		124.4	5		6.22		118.2
34	Cloudy filtrate		249.71	0.07		0.17		249.5
35	Clear filtrate		582.38	0.02		0.12		582.3



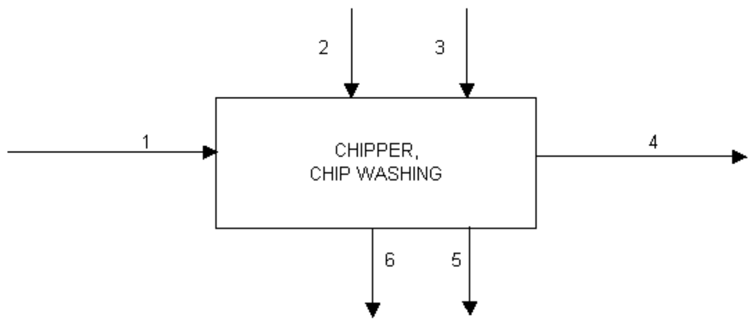
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT		t/h	t/h	t/h	t/h
33	Pulp	124.4		5	6.22		118.2	
36	PM white water	43.2		0.01	0.0		43.2	
38	Pulp to disperser		20.5	30		6.16		14.4
39	Cloudy filtrate		147.11	0.05		0.07		147.0



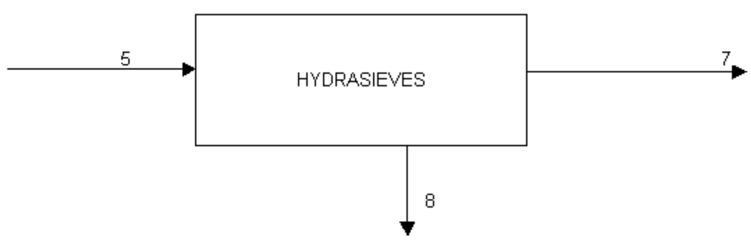
Stream No.	Description	Total Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
38	Pulp	20.5		30	6.16		14.4	
40	PM white water	125.64		0			125.64	
41	Steam	7.5		0			7.5	
42	Hydros	0.35		10	0.04		0.32	
43	Pulp to PM's		153.99	4		6.16		147.83

Appendix C

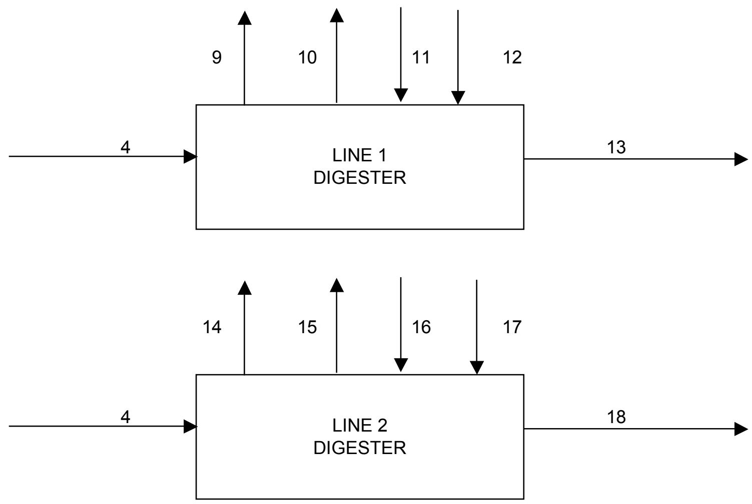
Thermo-mechanical Pulp Plant Water Balance



Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
1	Chips	33.06		40	13.23		19.84	
2	Chip wash water	259.06					259.06	
3	Make up water	16.13					16.13	
4	Chips		35.57	37		13.16		22.41
5	Chip wash water to hydrasieves		272.52					272.52
6	Chip losses		0.18	37		0.07		0.11



Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
5	chip wash water	273						
7	accepts to chip washer tank		259					
8	rejects to drain		13					

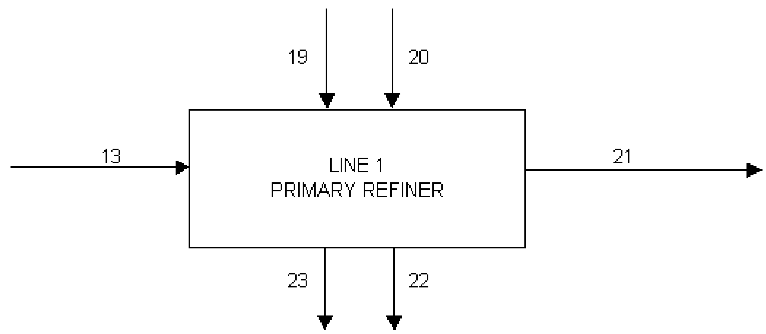


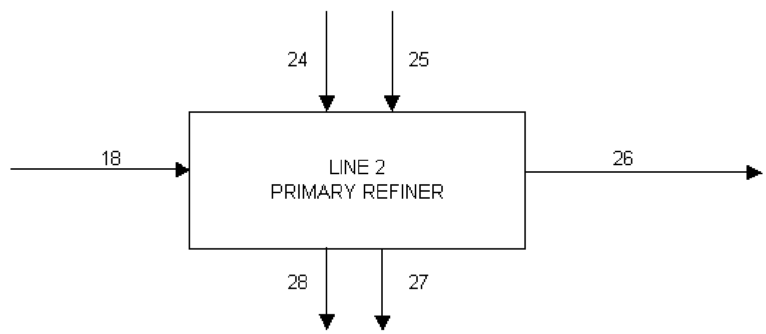
Line 1

Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
4	chips	17.78		37	6.58		11.20	
9	rotary valve exhaust steam		0.11					0.11
10	digester vent steam		0.24					0.24
11	sodium sulphite	0.39		10			0.39	
12	steam (start-up)	2.00					2.00	
13	chips to refiner		20.25	32.5		6.58		13.67
		20	21				14	14

Line 2

Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
4	chips	17.78		37	6.58		11.20	
14	rotary valve exhaust steam		0.11					0.11
15	digester vent steam		0.24					0.24
16	sodium sulphite	0.39		10			0.39	
17	steam (start-up)	2.00					2.00	
18	chips to refiner		20.25	32.5		6.58		13.67
		20	21				14	14



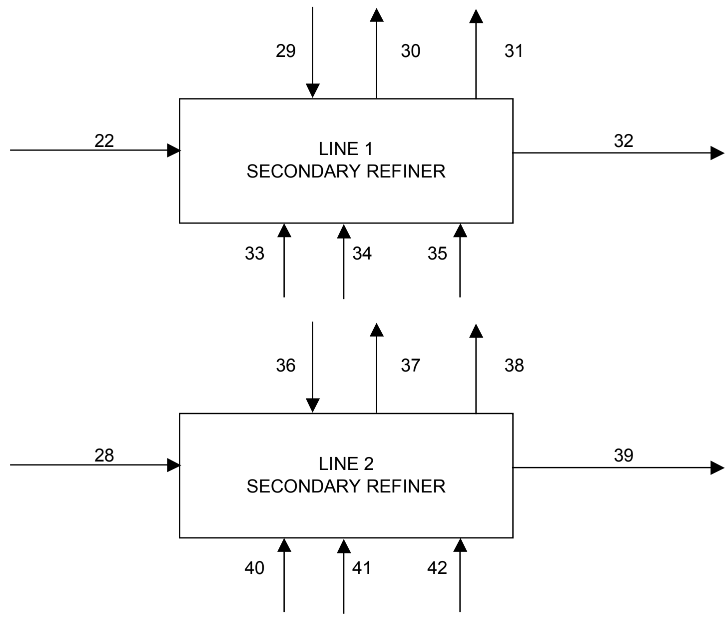


Line 1

Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
13	chips from digester	20		32.5	6.58		13.67	
19	packing	0.60					0.60	
20	plug wiper water							
21	pulp to secondary refiner		17.59	37.4		6.58		11.01
22	back flow steam		2.69					2.69
23	gland water to drain		0.30					0.30
		20.85	20.59		6.58	6.58	14.27	14.01

Line 2

Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
18	chips from digester	20		32.5	6.58		13.67	
24	packing	0.60					0.60	
25	plug wiper water							
26	pulp to secondary refiner		17.59	37.4		6.58		11.01
27	back flow steam		2.69					2.69
28	gland water to drain		0.30					0.30
		20.85	20.59		6.58	6.58	14.27	14.01

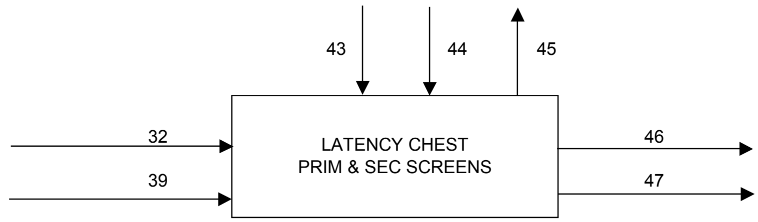


Line 1

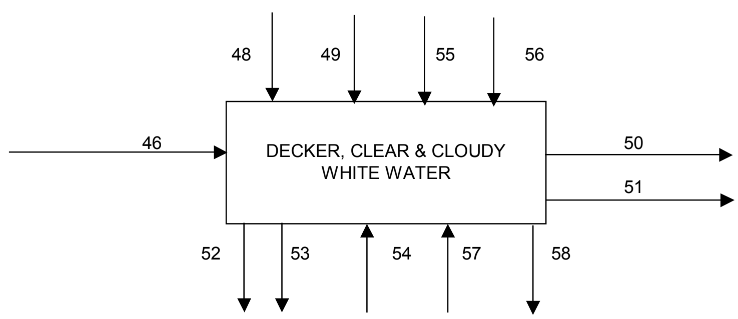
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
21	pulp from primary refiner	17.6		37.4	6.58		11.01	
29	quench water	8.50					8.50	
30	cyclone exhaust steam		9.68					9.68
31	plug wiper water						0.00	
32	shower water	28.80					28.80	
33	sec dilution water	136.73					136.73	
34	pulp to latency chest		178.57	3.5		6.25		172.32
35	Losses		3.36	0.10		0.33		3.03
		191.62	191.62		6.58	6.58	185.04	185.04

Line 2

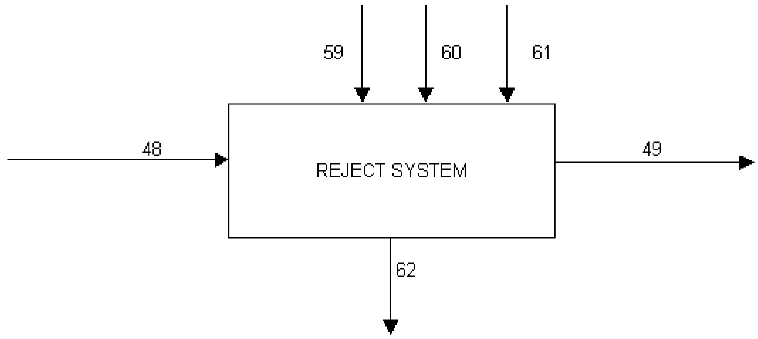
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
26	pulp from primary refiner	17.6		37.4	6.58		11.01	
36	quench water	8.50					8.50	
37	cyclone exhaust steam		9.68					9.68
38	plug wiper water						0.00	
39	shower water	28.80					28.80	
40	sec dilution water	136.73					136.73	
41	pulp to latency chest		178.57	3.5		6.25		172.32
42	Losses		3.36	0.10		0.33		3.03
		191.62	191.62		6.58	6.58	185.04	185.04



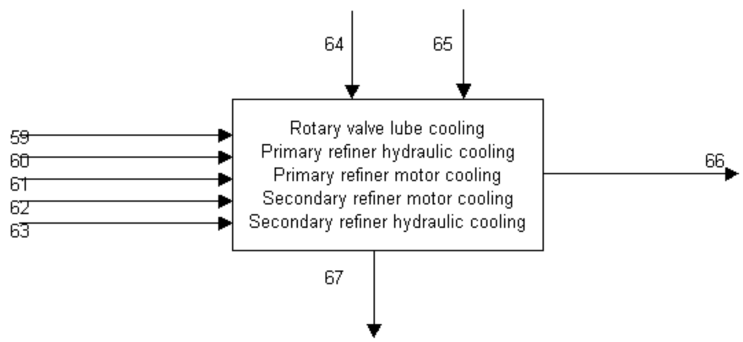
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
32	pulp from line 1 sec refiner	179		3.5	6.25		172.32	
39	pulp from line 2 sec refiner	179		3.5	6.25		172.32	
43	polymer	1.00					1.00	
44	screen dilution	548.25		0.01	0.04		548.21	
45	steam		6.91					6.91
46	pulp to deckers		818.32	1.2		9.82		808.50
47	sec screen rejects to rej system		81.16	3.35		2.72		78.44



Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
46	pulp from prim screens	818		1.2	9.82		808.50	
48	pulp from rej screens	258.58		1.2	3.10		255.48	
49	shower water	240.00					240.00	
50	clear ww		199.90					199.90
51	cloudy ww		799.62					799.62
52	pulp to storage tower		323.07	4.0		12.92		310.15
53	losses from clear ww screens		6.00	0.2		0.01		5.80
54	hydros	0.20					0.20	
55	sealing water to mech seals on pr	3.96					3.96	
56	sealing water to pumps	6.00					6.00	
57	sealing water to agitators	8.64					8.64	
58	sealing water to drain		7.31					7.31



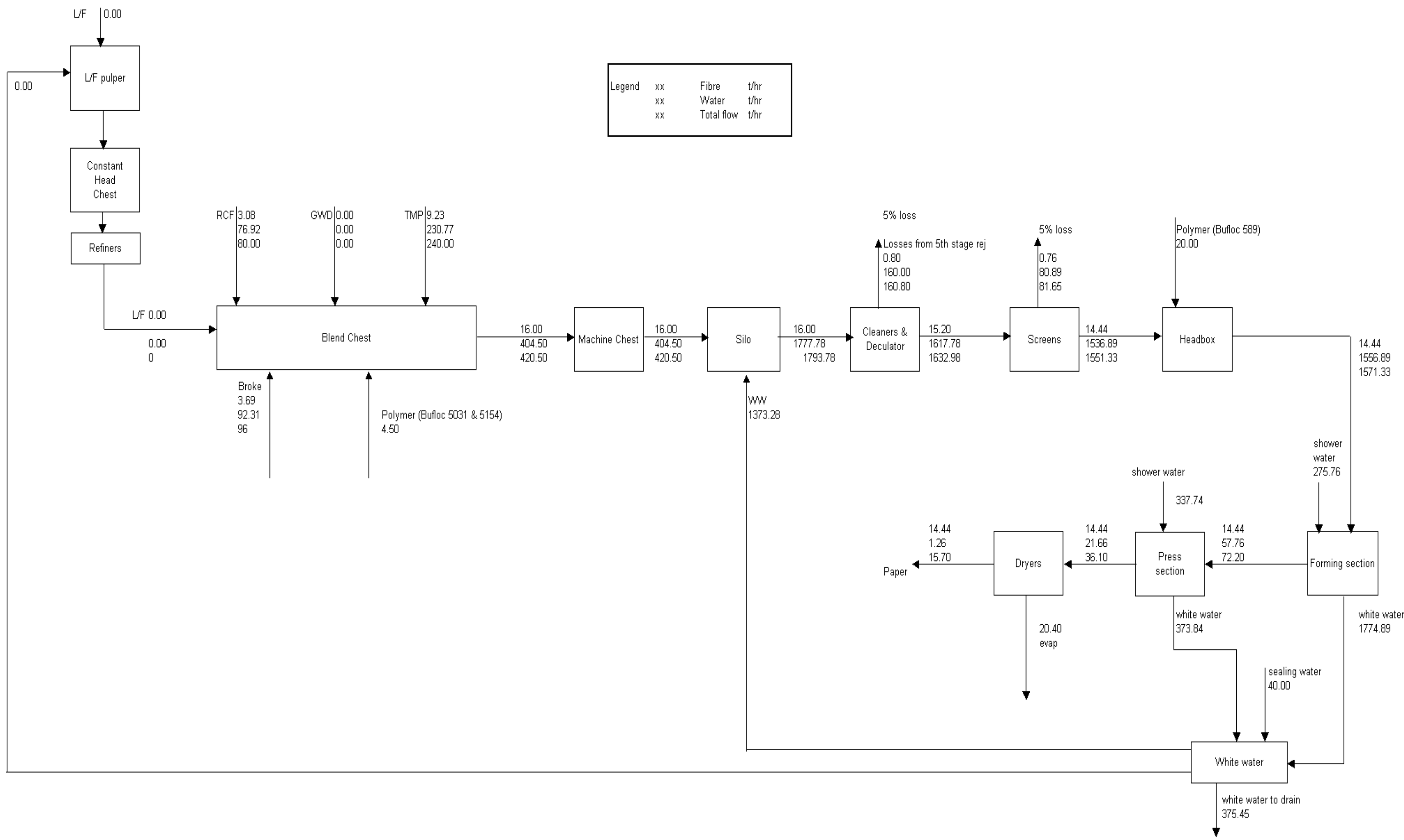
Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
48	sec screen rejects	162		3.35	5.44		156.88	
59	cloudy ww for ref disc flushing	0.48					0.48	
60	dilution into refined chest	191					191.28	
61	GWD systems 1&2	36.76		2	0.74		36.03	
49	pulp to deckers		517.16	1.2		6.21		510.95
62	rejects from pressure screen		25.50	0.62		0.16		25.34



Stream No.	Description	Flow		Consistency	Fibre IN	Fibre OUT	Water IN	Water OUT
		IN	OUT	%	t/h	t/h	t/h	t/h
59	Rotary valve lube cooling	5.76					5.76	
60	Primary refiner hydraulic cooling	27.36					27.36	
61	Prim refiner motor cooling	172.80					172.80	
62	Sec refiner motor cooling	172.80					172.80	
63	Sec refiner hydraulic cooling	27.36					27.36	
64	Chipper lube cooling							
65	Reject refiner motor cooling	172.80					172.80	
66	to cooling towers							
67	to PM4 and PM5							

Appendix D

Paper Machine Water Balance


L/F 0.00
L/F pulper
0.00
Constant Head Chest
Refiners
L/F 0.00
0.00
0
Legend xx Fibre t/hr
xx Water t/hr
xx Total flow t/hr
RCF 3.08
76.92
80.00
GWD 0.00
0.00
0.00
TMP 9.23
230.77
240.00
Blend Chest
Broke
3.69
92.31
96
Polymer (Bufloc 5031 & 5154)
4.50
16.00
404.50
420.50
Machine Chest
16.00
404.50
420.50
Silo
WW
1373.28
16.00
1777.78
1793.78
5% loss
Losses from 5th stage rej
0.80
160.00
160.80
Cleaners & Deculator
15.20
1617.78
1632.98
5% loss
0.76
80.89
81.65
Screens
14.44
1536.89
1551.33
Polymer (Bufloc 589)
20.00
Headbox
14.44
1556.89
1571.33
shower water
275.76
Forming section
white water
1774.89
shower water
337.74
14.44
57.76
72.20
Press section
white water
373.84
14.44
21.66
36.10
Dryers
20.40
evap
14.44
1.26
15.70
Paper
sealing water
40.00
White water
white water to drain
375.45

Appendix E

Newsprint Circuit Existing Flows and Optimised Flows

Table E.1 Newsprint Circuit existing flows and optimised flows

Current condition			Optimised condition		
Source	Sink	Flow	Source	Sink	Flow
Chip Washer	Chip washer	376.15	Chip Washer	Chip Washer	376.15
Chip Washer	Effluent	19.55	Chip Washer	Effluent	19.55
Cooling	Cooling	540	Cooling	Cooling	540
Cooling	Process Water	19.46	Cooling	Cooling	19.46
Fresh Water	Cooling	20	Fresh Water	Cooling	0.54
Fresh Water	Line1 Decker	120	Fresh Water	Line1 Decker	37.32
			Fresh Water	Line2 Decker	72.79
Fresh Water	Line3 Decker	120	Fresh Water	Line3 Decker	18.17
Fresh Water	Line4 Decker	120	Fresh Water	Line4 Decker	101.55
Fresh Water	Line1 Secondary Refiner	13.82			
Fresh Water	Line3 Secondary Refiner	10.17			
			Fresh Water	Line4 Secondary Refiner	1.23
Fresh Water	PM4 Blend Chest	4.5	Fresh Water	PM4 Blend Chest	4.5
Fresh Water	PM4 Forming Section (1)	21	Fresh Water	PM4 Forming Section (1)	21
Fresh Water	PM4 Forming Section (2)	2.09	Fresh Water	PM4 Forming Section (2)	1.28
Fresh Water	PM4 Headbox	20	Fresh Water	PM4 Headbox	20
Fresh Water	PM4 Press Section	88	Fresh Water	PM4 Press Section	88
Fresh Water	PM5 Blend Chest	4.5	Fresh Water	PM5 Blend Chest	4.5
Fresh Water	PM5 Forming Section	21	Fresh Water	PM5 Forming Section	21
Fresh Water	PM5 Headbox	20	Fresh Water	PM5 Headbox	20
Fresh Water	PM5 Press Section	88	Fresh Water	PM5 Press Section	88

Fresh Water	Sealing Water	19	Fresh Water	Sealing Water	19
			Fresh Water	Disperser	48.62
			Fresh Water	Wire Pulp Pres	17.24
Hydrasieves (1)	Effluent	0.71	Hydrasieves (1)	Effluent	8.98
Hydrasieves (1)	Hydrasieves	375.44	Hydrasieves (1)	Hydrasieves	367.17
Hydrasieves (2)	Chip Washer	13.76			
Hydrasieves (2)	Effluent	5.79	Hydrasieves (2)	Effluent	19.55
Line1 Decker (1)	Chip Washer	8.51			
Line1 Decker (1)	Line1 Secondary Refiner	35.63	Line1 Decker (1)	Line1 Secondary Refiner	64.53
Line1 Decker (1)	Line2 Secondary Refiner	122.51			
Line1 Decker (1)	TMP1 Latency & Screens	227	Line1 Decker (1)	TMP1 Latency & Screens	256
Line1 Decker (2)	Line1 Secondary Refiner	31.16	Line1 Decker (2)	Line1 Secondary Refiner	9.05
Line1 Decker (2)	Line2 Secondary Refiner	41.84	Line1 Decker (2)	Line2 Secondary Refiner	9.32
			Line1 Decker (2)	TMP1 Latency & Screens	54.62
			Line2 Decker (1)	Line1 Secondary Refiner	36.63
Line2 Decker (1)	Line2 Secondary Refiner	3.84	Line2 Decker (1)	Line2 Secondary Refiner	36.37
Line2 Decker (1)	TMP1 Latency & Screens	69.15			
Line2 Decker (2)	Line1 Secondary Refiner	76.9	Line2 Decker (2)	Line1 Secondary Refiner	16.14
			Line2 Decker (2)	Line2 Secondary Refiner	80.67
Line2 Decker (2)	Reject System	212.9	Line2 Decker (2)	Reject System	181
Line2 Decker (2)	TMP1 Latency & Screens	30.86			

			Line2 Decker (2)	RFP Coarse Screens	3.7
			Line2 Decker (2)	RFP High Density Cleaning	39.14
			Line3 Decker (1)	Chip Washer	13.1
Line3 Decker (1)	Effluent	158.54	Line3 Decker (1)	Effluent	18.33
Line3 Decker (1)	Line4 Secondary Refiner	80.67			
Line3 Decker (1)	Reject System	64.3			
Line3 Decker (1)	TMP2 Latency & Screens	17.14	Line3 Decker (1)	TMP2 Latency & Screens	96.73
			Line3 Decker (1)	Reject System	8.51
			Line3 Decker (1)	RFP Pulping	183.91
Line3 Decker (2)	Line3 Secondary Refiner	3.75			
Line3 Decker (2)	TMP2 Latency & Screens	69.25	Line3 Decker (2)	TMP2 Latency & Screens	73.00
Line4 Decker (1)	Line3 Secondary Refiner	81.38	Line4 Decker (1)	Line3 Secondary Refiner	80.95
			Line4 Decker (1)	Line4 Secondary Refiner	80.73
Line4 Decker (1)	TMP2 Latency & Screens	239.28	Line4 Decker (1)	TMP2 Latency & Screens	158.97
Line4 Decker (2)	Line3 Secondary Refiner	45.68	Line4 Decker (2)	Line3 Secondary Refiner	28.71
Line4 Decker (2)	Line4 Secondary Refiner	27.31	Line4 Decker (2)	Line4 Secondary Refiner	44.29
PM4 Cleaners & Deculator	Effluent	129.11	PM4 Cleaners & Deculator	Effluent	129.11
PM4 Forming Section (1)	PM4 Saveall (2)	29.27	PM4 Forming Section (1)	PM4 Saveall (2)	30.32
PM4 Forming Section (1)	PM4 Silo (1)	20.26	PM4 Forming Section (1)	PM4 Silo (1)	52.57
			PM4 Forming	PM5 Silo (1)	28.53

			Section (1)		
PM4 Forming Section (1)	PM5 Saveall (2)	16.56	PM4 Forming Section (1)	PM5 Saveall (2)	15.51
PM4 Forming Section (1)	RFP flotation	17.41			
PM4 Forming Section (1)	RFP Coarse Screens	0.32			
PM4 Forming Section (1)	RFP Pulping	157.67	PM4 Forming Section (1)	RFP Pulping	1.52
PM4 Forming Section (1)	RFP HD Cleaning	8.51	PM4 Forming Section (1)	RFP HD Cleaning	
			PM4 Forming Section (1)	Reject System	44.33
			PM4 Forming Section (1)	Effluent	76.15
PM4 Forming Section (2)	PM4 Silo (1)	1979.07	PM4 Forming Section (2)	PM4 Silo (1)	2128.58
PM4 Forming Section (2)	PM5 Silo (1)	202.08			
			PM4 Forming Section (2)	Chip Washer	9.17
PM4 Press Section	PM5 Saveall (2)	10.59			
PM4 Press Section	RFP Disc Filter (2)	9.35			
PM4 Press Section	RFP Disperser (1)	55.4			
PM4 Press Section	RFP Fine Screens (1)	3.2			
PM4 Press Section	FRP Gyro Cleaners	24.43			
PM4 Press Section	RFP Wire Pulp Press	16.12			
			PM4 Press Section	TMP1 Latency & Screens	88.03
			PM4 Press Section	TMP2 Latency & Screens	31.07
PM4 Saveall (1)	PM4 Saveall (2)	1219.75	PM4 Saveall (1)	PM4 Saveall (2)	1262.13

PM4 Saveall (1)	PM5 Saveall (2)	42.38			
PM4 Saveall (2)	Line1 Decker	55.79			
			PM4 Saveall (2)	Line3 Decker	101.83
PM4 Saveall (2)	PM4 Forming Sec (2)	119.91	PM4 Saveall (2)	PM4 Forming Sec (2)	120.16
PM4 Saveall (2)	TMP1 Latency & Screens	46.30			
PM4 Screens (1)	Effluent	122.65	PM4 Screens (1)	Effluent	122.65
PM5 Cleaners & Deculator (1)	Effluent	129.33	PM5 Cleaners & Deculator (1)	Effluent	129.33
PM5 Forming Section (1)	PM4 Saveall (2)	126.05	PM5 Forming Section (1)	PM4 Saveall (2)	100.23
PM5 Forming Section (1)	PM5 Saveall (2)	173.95	PM5 Forming Section (1)	PM5 Saveall (2)	199.77
PM5 Forming Section (2)	Hydrasieves	20.26	PM5 Forming Section (2)	Hydrasieves	28.53
PM5 Forming Section (2)	PM5 Silo (1)	1977.22	PM5 Forming Section (2)	PM5 Silo (1)	2150.77
PM5 Forming Section (2)	PM4 Silo (1)	181.82			
			PM5 Press Section	Line3 Secondary Refiner (1)	16.69
PM5 Press Section	PM4 Saveall (2)	52.93	PM5 Press Section	PM4 Saveall (2)	20.07
			PM5 Press Section	PM5 Saveall (2)	43.45
PM5 Press Section	RFP Wire Pulp Press	2.47			
PM5 Press Section	TMP1 Latency & Screens	9.6			
PM5 Press Section	TMP2 Latency & Screens	53.52	PM5 Press Section	TMP2 Latency & Screens	38.89
			PM5 Saveall (1)	PM4 Saveall (2)	15.25

PM5 Saveall (1)	PM5 Saveall (2)	1184.52	PM5 Saveall (1)	PM5 Saveall (2)	1169.27
			PM5 Saveall (2)	Line1 Decker	82.68
PM5 Saveall (2)	Line2 Decker	120	PM5 Saveall (2)	Line2 Decker	47.21
PM5 Saveall (2)	PM5 Forming Secondary (2)	166.01	PM5 Saveall (2)	PM5 Forming Secondary (2)	166.01
PM5 Saveall (2)	TMP1 Latency & Screens	9.99			
PM5 Screens (1)	Effluent	122.87	PM5 Screens (1)	Effluent	122.87
Reject System	Effluent	46.36	Reject System	Effluent	46.36
RFP Centri Cleaners	Effluent	7.93	RFP Centri Cleaners	Effluent	7.93
RFP Coarse Screens	Effluent	2.90	RFP Coarse Screens	Effluent	2.90
RFP Disc Filter (1)	RFP Centri Cleaners	224.35	RFP Disc Filter (1)	RFP Centri Cleaners	224.34
RFP Disc Filter (1)	RFP Disc Filter (2)	81.64	RFP Disc Filter (1)	RFP Disc Filter (2)	103.70
RFP Disc Filter (1)	RFP Disperser	65.25	RFP Disc Filter (1)	RFP Disperser	76.98
RFP Disc Filter (1)	RFP Fine Screens	43.62	RFP Disc Filter (1)	RFP Fine Screens	50.56
			RFP Disc Filter (1)	RFP Flotation	4.17
RFP Disc Filter (1)	RFP Gyro Cleaners	41.65	RFP Disc Filter (1)	RFP Gyro Cleaners	96.61
RFP Disc Filter (1)	RFP Pulping	101.29			
RFP Disc Filter (2)	RFP Flotation	114.61	RFP Disc Filter (2)	RFP Flotation	147.13
RFP Disc Filter (2)	RFP Pulping	11.28	RFP Disc Filter (2)	RFP Pulping	102.57
RFP Disc Filter (2)	RFP Coarse Screens	3.23			
RFP Disc Filter (2)	RFP Disc Filter (2)	12.71			

RFP Disc Filter (2)	RFP Gyro Cleaners	29.38			
RFP Disc Filter (2)	RFP High Density Cleaning	78.49			
RFP Fines Screens	Effluent	17.9	RFP Fines Screens	Effluent	17.9
RFP Flotation	Effluent	30.85	RFP Flotation	Effluent	30.85
RFP Gyro Cleaners	Effluent	5.4	RFP Gyro Cleaners	Effluent	5.4
RFP Pulping	Effluent	136.94	RFP Pulping	Effluent	136.94
RFP Wire Pulp Press	RFP Disperser	4.94			
RFP Wire Pulp Press	RFP Fine Screens	3.88			
RFP Wire Pulp Press	RFP Flotation	119.68	RFP Wire Pulp Press	RFP Flotation	100.39
RFP Wire Pulp Press	RFP Gyro Cleaners	1.27			
RFP Wire Pulp Press	RFP Pulping	17.17			
			RFP Wire Pulp Press	RFP High Density Cleaning	46.71
RFP High Density Cleaning	Effluent	9.3	RFP High Density Cleaning	Effluent	9.3
Sealing Water	Effluent	9.5			
			Sealing Water	Line4 Decker	8.95
			Sealing Water	PM4 Forming Section	0.55
			Sealing Water	Line4 Decker	9.5
Sealing Water	Line3 Secondary Refiner	3.75			
Sealing Water	TMP1 Latency & Screens	5.75			

Appendix F

Data for Water Pinch Model of Existing Newsprint Circuit

Table F.1 Newsprint Circuit Source Conditions

Name	Flow [t/h]	Fibre content [ppm]
Chip washer out	395.7	1587
Hydrasieves out 1	376.15	2946
Hydrasieves out 2	19.55	4000
Line 1 Decker out 1	320.66	1524
Line 1 Decker out 2	73	900
Reject System out	46.36	3355
Cooling out 1	540	0
Cooling out 2	19.46	0
Line 3 Decker out 1	320.66	1524
Line 3 Decker out 2	73	900
Line 4 Decker out 1	320.66	1524
Line 4 Decker out 2	73	900
Line 2 Decker out 1	73	900
Line 2 Decker out 2	320.66	1524
Sealing water out 1	9.5	0
Sealing water out 2	9.5	0
RFP Pulping out	136.94	8490
RFP-HD cleaning out	9.3	111882
RFP coarse screens out	2.9	148607
RFP flotation out	30.85	14761
RFP gyro cleaners out	5.4	3967
RFP centri cleaners out	7.93	10044
RFP fine screens out	17.9	4000
RFP disc filter out 1	582.4	942
RFP disc filter out 2	249.7	1568
RFP wire pulp press out	147.1	1801
PM4 cleaners & deculator out 1	129.11	19362
PM4 screens out 1	122.65	10982
PM4 forming section out 1	250	2329

Name	Flow [t/h]	Fibre content [ppm]
PM4 forming section out 2	2181.15	3517
PM4 press section out	119.1	50
PM5 press section out	119.1	50
PM5 forming section out 1	300	1239
PM5 forming section out 2	2179.3	3627
PM5 screens out 1	122.87	10984
PM5 cleaners & deculator out 1	129.33	21346
PM5 saveall out 1	1184.52	525
PM5 saveall out 2	296	312
PM4 saveall out 1	1262.13	547
PM4 saveall out 2	222	307
Fresh water	619.48	0

Table F.2 Newsprint Circuit Sink Conditions

Name	Flow [t/h]	Fibre content [ppm]
Chip washer in 1	376.15	15861
Chip washer in 2	22.27	3000
Hydrasieves in	395.7	3000
Line 1 Prim Refiner in 1	0.01	1000
Line 2 Prim Refiner in 1	0.01	1000
Line 1 Sec Refiner in 1	126.35	1000
Line 2 Sec Refiner in 1	126.35	1000
TMP1 Latency & screens in 1	398.65	1000
Line 1 Decker in	120	0
Reject System in	277.2	1524
Cooling in 1	20	0
Cooling in 2	540	0
Line 3 Prim Refiner in 1	0.01	1000
Line 4 Prim Refiner in 1	0.01	1000
Line 3 Sec Refiner in 1	126.35	1000
Line 4 Sec Refiner in 1	126.35	1000
Line 3 Decker in	120	0
Line 4 Decker in	120	0
Line 2 Decker in	120	0
TMP2 Latency & screens in 1	398.65	1000

Name	Flow [t/h]	Fibre content [ppm]
Sealing water in	19	0
RFP Pulping in	288	1800
RFP-HD cleaning in	87	1800
RFP coarse screens in	3.7	1800
RFP flotation in	251.7	1800
RFP gyro cleaners in	96.72	1000
RFP centri cleaners in	224.35	1000
RFP fine screens in 1	50.7	1000
RFP fine screens in 2	0	0
RFP disc filter in 1	0	0
RFP disc filter in 2	103.7	679
RFP wire pulp press in	43.2	600
RFP disperser in 1	125.6	612
PM4 Blend chest in	4.5	0
PM4 silo in 1	2181.15	3517
PM4 headbox in 1	20	0
PM4 forming section in 1	21	0
PM4 forming section in 2	122	0
PM4 press section in	88	0
PM5 press section in	88	0
PM5 forming section in 1	21	0
PM5 forming section in 2	166.01	0
PM5 headbox in 1	20	0
PM5 silo in 1	2179.3	3624
PM5 Blend chest in	4.5	0
PM5 saveall in 1	0	0
PM5 saveall in 2	1428	629
PM4 saveall in 1	0	0
PM4 saveall in 2	1428	626
Effluent	938.82	12405

Appendix G

Newsprint Circuit Flowrate Data Specifications in Water Tracker

Table G.1 (a) Newsprint Circuit flowrate specifications in Water Tracker

	From	To	Calc.'d	Flow rate
1	Fresh water	fresh water jnc	747.18	865
2	Fresh water jnc	Cooling	20	20
3	Chips	chip washer	48	48
4	Chip washer	hydrasieves	395.7	395.7
5	Hydrasieves	chip washer	376.15	376.15
6	Chip washer	chip washer jnc	50.72	57.86
7	Chip washer jnc	Line 1 Digester	12.68	11.52
8	Chip washer jnc	Line 2 Digester	12.68	11.52
9	Hydrasieves	Hydrasieve rejects	19.55	0
10	Line 1 Digester	rotary valve exhaust steam jnc	0.08	0.08
11	Line 2 Digester	rotary valve exhaust steam jnc	0.08	0.08
12	Rotary valve exhaust steam jnc	Rotary valve exhaust steam	0.32	0
13	Line 1 Digester	digester vent steam jnc	0.18	0.18
14	Line 2 Digester	digester vent steam jnc	0.18	0.18
15	Digester vent steam jnc	Digester vent steam	0.72	0
16	Steam	feed steam jnc	15.5	0
17	Feed steam jnc	Line 1 Digester	2	0
18	Feed steam jnc	Line 2 Digester	2	2
19	Sodium sulphite	sodium sulphite jnc	1.12	0
20	Sodium sulphite jnc	Line 1 Digester	0.28	0.28
21	Sodium sulphite jnc	Line 2 Digester	0.28	0.28
22	Line 2 Digester	Line 2 Prim Refiner	14.7	14.7
23	Line 1 Digester	Line 1 Prim Refiner	14.7	14.7
24	Line 1 Prim Refiner	Line 1 Sec Refiner	12.76	12.76
25	Line 2 Prim Refiner	Line 2 Sec Refiner	12.76	12.76
26	Line 1 Sec Refiner	sec refiner jnc	129.64	129.64
27	Line 2 Sec Refiner	sec refiner jnc	129.64	129.64
28	Sec refiner jnc	TMP1 Latency & screens	259.28	0
29	Line 2 Prim Refiner	prim ref back flow steam jnc	1.95	1.95

	From	To	Calc.'d	Flow rate
30	Line 1 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
31	Prim ref back flow steam jnc	back flow steam	7.8	0
32	Line 1 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
33	Line 2 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
34	Sec refiner exhaust steam jnc	Cyclone and feader exhaust steam	28.12	0
35	TMP1 cloudy ww2	Line 1 Sec Refiner	126.35	126.35
36	TMP1 cloudy ww2	Line 1 Prim Refiner	0.01	10.44
37	GWD rejects	Reject System	26.7	26.7
38	Reject System	Rejects from pressure screen	46.36	25.5
39	Line 1 Sec Refiner	sec refiner losses jnc	2.44	0
40	Line 2 Sec Refiner	sec refiner losses jnc	2.44	0
41	Sec refiner losses jnc	Losses	9.76	0
42	Line 3 Digester	Line 3 Prim Refiner	14.7	14.7
43	Line 3 Prim Refiner	Line 3 Sec Refiner	12.76	12.76
44	Line 4 Decker	JNC-TMP2 pulp to storage	117.3	117.3
45	JNC-TMP2 pulp to storage	JNC-pulp to storage	234.6	0
46	Line 3 Decker	JNC-TMP2 pulp to storage	117.3	117.3
47	Line 3 Sec Refiner	JNC-TMP2 sec ref to latency	129.64	129.64
48	Line 4 Sec Refiner	JNC-TMP2 sec ref to latency	129.64	129.64
49	JNC-TMP2 latency to deckers	Line 3 Decker	297	297
50	JNC-TMP2 latency to deckers	Line 4 Decker	297	369.17
51	Line 4 Digester	Line 4 Prim Refiner	14.7	14.7
52	Line 4 Prim Refiner	Line 4 Sec Refiner	12.76	12.76
53	Line 3 Digester	rotary valve exhaust steam jnc	0.08	0.08
54	Line 4 Digester	rotary valve exhaust steam jnc	0.08	0.08
55	Sodium sulphite jnc	Line 4 Digester	0.28	0.28
56	Sodium sulphite jnc	Line 3 Digester	0.28	0.28
57	Line 3 Digester	digester vent steam jnc	0.18	0.18
58	Line 4 Digester	digester vent steam jnc	0.18	0.18
59	Feed steam jnc	Line 3 Digester	2	0
60	Feed steam jnc	Line 4 Digester	2	0
61	Line 3 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
62	Line 4 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
63	Line 3 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
64	Line 4 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
65	Line 3 Sec Refiner	sec refiner losses jnc	2.44	0

	From	To	Calc.'d	Flow rate
66	Line 4 Sec Refiner	sec refiner losses jnc	2.44	0
67	Line 1 Decker	JNC-TMP1 pulp to storage	117.3	117.3
68	Line 2 Decker	JNC-TMP1 pulp to storage	117.3	117.3
69	Fresh water jnc	JNC-tempered to clear ww	40	0
70	JNC-TMP1 pulp to storage	JNC-pulp to storage	234.6	0
71	TMP1 Latency & screens	JNC-TMP1 latency to deckers	594	594
72	JNC-TMP1 latency to deckers	Line 1 Decker	297	409.16
73	JNC-TMP1 latency to deckers	Line 2 Decker	297	409.16
74	JNC-Rej sys	JNC-Reject system	187.7	187.7
75	JNC-Reject system	Line 1 Decker	93.85	93.9
76	JNC-Reject system	Line 2 Decker	93.85	129.29
77	JNC-Rej sys	Line 3 Decker	93.85	93.9
78	JNC-Rej sys	Line 4 Decker	93.85	0
79	Line 1 Decker	JNC-TMP1 cloudy	320.66	0
80	Line 1 Decker	JNC-TMP1 clear	73	73
81	Line 2 Decker	JNC-TMP1 clear	73	73
82	Line 2 Decker	JNC-TMP1 cloudy	320.66	65
83	JNC-TMP1 clear ww to deckers	Line 1 Decker	120	120
84	JNC-TMP1 clear ww to deckers	Line 2 Decker	120	120
85	Line 3 Decker	JNC-TMP2 cloudy ww3	320.66	0
86	Line 4 Decker	JNC-TMP2 cloudy ww3	320.66	0
87	Line 4 Decker	JNC-TMP2 clear ww2	73	73
88	Line 3 Decker	JNC-TMP2 clear ww2	73	73
89	JNC-TMP2 clear ww1	Line 3 Decker	120	120
90	JNC-TMP2 clear ww1	Line 4 Decker	120	120
91	Cloudy ww2	Reject System	277.2	191.5
92	TMP2 cloudy ww2	Line 4 Prim Refiner	0.01	0
93	TMP2 cloudy ww2	Line 4 Sec Refiner	126.35	126.35
94	TMP2 cloudy ww2	Line 3 Sec Refiner	126.35	126.35
95	TMP2 cloudy ww2	Line 3 Prim Refiner	0.01	0
96	TMP2 cloudy ww1	TMP2 cloudy ww2	252.72	0
97	JNC-TMP2 sec ref to latency	TMP2 Latency & screens	259.28	0
98	TMP2 Latency & screens	JNC-TMP2 latency to deckers	594	594
99	TMP2 cloudy ww1	TMP2 Latency & screens	398.65	398
100	TMP1 Latency & screens	JNC-latency steam	5	5
101	TMP2 Latency & screens	JNC-latency steam	5	5

	From	To	Calc.'d	Flow rate
102	JNC-latency steam	Latency steam	10	0
103	TMP1 cloudy ww1	TMP1 cloudy ww2	252.72	0
104	TMP1 cloudy ww1	TMP1 Latency & screens	398.65	398
105	TMP1 cloudy ww2	Line 2 Prim Refiner	0.01	10.44
106	TMP1 cloudy ww2	Line 2 Sec Refiner	126.35	126.35
107	TMP1 cloudy ww1	cloudy ww2	138.6	138.6
108	TMP1 cloudy ww1	JNC- cloudy ww to chip washer	18.1	18.1
109	JNC- cloudy ww to chip washer	chip washer	22.27	32.26
110	TMP2 cloudy ww1	JNC- cloudy ww to chip washer	4.17	0
111	TMP2 cloudy ww1	cloudy ww2	138.6	138.6
112	Chip washer jnc	Line 3 Digester	12.68	11.52
113	Chip washer jnc	Line 4 Digester	12.68	11.52
114	TMP1 Latency & screens	JNC-latency to rej sys	58.93	58.93
115	JNC-latency to rej sys	Reject System	117.86	162
116	Reject System	JNC-Rej sys	375.4	375
117	TMP2 Latency & screens	JNC-latency to rej sys	58.93	58.93
118	JNC-Hydros	Line 1 Decker	0.11	0.11
119	JNC-Hydros	Line 2 Decker	0.11	0.1
120	JNC-Hydros	Line 4 Decker	0.11	0.11
121	JNC-Hydros	Line 3 Decker	0.11	0.11
122	Hydros	JNC-Hydros	0.44	0.44
123	Fresh water jnc	Sealing water	19	18.6
124	Sealing water	JNC-sealing water to clear ww	9.5	0
125	Sealing water	sealing water to drain	9.5	7.31
126	Cooling tower	[Losses]	0.54	0
127	Cooling tower	[Evapor.]	0	0
128	Cooling	cooling tower	540.54	0
129	Cooling tower	Cooling	540	540
130	RFP waste paper	RFP Pulping	9.64	9.64
131	RFP Pulping	RFP-HD cleaning	160.7	160.7
132	RFP-HD cleaning	RFP coarse screens	238.4	238.4
133	RFP coarse screens	RFP flotation	239.2	239.2
134	RFP flotation	RFP gyro cleaners	512.26	512.26
135	RFP gyro cleaners	RFP centri cleaners	603.58	603.58
136	RFP centri cleaners	RFP fine screens	820	820
137	RFP fine screens	RFP disc filter	852.8	852.76

	From	To	Calc.'d	Flow rate
138	RFP disc filter	RFP wire pulp press	124.4	124.4
139	RFP wire pulp press	RFP disperser	20.5	24
140	RFP disperser	pulp jnc	153.6	154
141	RFP fine screens	RFP rejects jnc2	17.9	17.9
142	RFP rejects jnc2	RFP rej jnc3	62.08	0
143	RFP rej jnc3	RPF rejects	211.22	0
144	RFP centri cleaners	RFP rejects jnc2	7.93	8
145	RFP flotation	RFP rejects jnc2	30.85	30.89
146	Fresh water jnc	RFP Temp jnc	0	0
147	RFP Temp jnc	RFP clear ww jnc	0	0
148	RFP clear ww jnc	RFP fine screens	50.7	50.7
149	RFP clear ww jnc	RFP centri cleaners	224.35	224.35
150	RFP clear ww jnc	RFP gyro cleaners	96.72	96.72
151	RFP disc filter	RFP clear ww jnc	582.4	582.4
152	PM ww to RFP jnc	RFP cloudy ww jnc	126.67	231
153	PM ww to RFP jnc	RFP wire pulp press	43.2	43.2
154	PM ww to RFP jnc	RFP disperser	125.6	125.6
155	PM ww to pulp mill jnc	PM ww to RFP jnc	295.47	412
156	RFP disc filter	RFP cloudy ww jnc	249.7	249.7
157	RFP cloudy ww jnc	RFP fine screens	0	0
158	RFP cloudy ww jnc	RFP cloudy filtrate jnc2	630.4	726
159	RFP cloudy filtrate jnc2	RFP flotation	251.7	251.7
160	RFP cloudy filtrate jnc2	RFP coarse screens	3.7	4.26
161	RFP cloudy filtrate jnc2	RFP-HD cleaning	87	87
162	RFP cloudy filtrate jnc2	RFP Pulping	288	288
163	RFP-HD cleaning	RFP rej jnc1	9.3	10.7
164	RFP coarse screens	RFP rej jnc1	2.9	2.9
165	RFP Pulping	RFP rej jnc1	136.94	158.29
166	RFP rej jnc1	RFP rej jnc3	149.14	0
167	RFP gyro cleaners	RFP rejects jnc2	5.4	5.4
168	RFP Temp jnc	RFP disc filter	0	0.05
169	PM4 dryers	dryer steam evap jnc	17.6	20.4
170	Dryer steam evap jnc	evaporation	35.2	0
171	PM4 dryers	final paper jnc	13.5	13.5
172	Final paper jnc	Paper	27	0
173	PM5 dryers	dryer steam evap jnc	17.6	20.4

	From	To	Calc.'d	Flow rate
174	PM5 dryers	final paper jnc	13.5	13.5
175	PM4 silo	PM4 cleaners & deculator	2582.11	2694
176	PM4 cleaners & deculator	PM4 screens	2453	2453
177	PM4 screens	PM4 headbox	2330.35	2330.2
178	PM4 headbox	PM4 forming section	2350.35	2350.2
179	PM4 forming section	PM4 press section	62.2	62.2
180	PM4 press section	PM4 dryers	31.1	31.1
181	PM5 silo	PM5 cleaners & deculator	2586.69	2694.4
182	PM5 cleaners & deculator	PM5 screens	2457.36	2430
183	PM5 screens	PM5 headbox	2334.49	2308.5
184	PM5 headbox	PM5 forming section	2354.49	2350.2
185	PM5 forming section	PM5 press section	62.2	62.2
186	PM5 press section	PM5 dryers	31.1	31.1
187	PM5 press section	PM5 ww jnc2	119.1	78
188	PM5 forming section	PM5 ww jnc2	300	0
189	PM4 forming section	PM4 ww jnc2	250	0
190	PM4 press section	PM4 ww jnc2	119.1	78
191	PM5 cleaners & deculator	PM rej to drain jnc	129.33	241.5
192	PM5 screens	PM rej to drain jnc	122.87	0
193	PM ww jnc	PM rej to drain jnc	0	0
194	PM rej to drain jnc	Drain	503.96	0
195	PM4 screens	PM4 ww to drain jnc	122.65	0
196	PM4 cleaners & deculator	PM4 ww to drain jnc	129.11	241.5
197	PM4 ww to drain jnc	PM rej to drain jnc	251.76	242.45
198	Fresh water jnc	fresh water to PMs jnc	668.18	0
199	Fresh water to PMs jnc	fresh water to PM4 jnc	133.5	184.5
200	Fresh water to PM4 jnc	PM4 headbox	20	20
201	Fresh water to PM4 jnc	PM4 Blend chest	4.5	4.5
202	Fresh water to PMs jnc	fresh water to PM5 jnc	133.5	160
203	Fresh water to PM5 jnc	PM5 Blend chest	4.5	4.5
204	Fresh water to PM5 jnc	PM5 headbox	20	20
205	PM ww jnc1	PM ww jnc	363.66	0
206	JNC-pulp to storage	pulp jnc	469.2	0
207	PM ww jnc	PM ww to pulp mill jnc	753.54	1500
208	Pulp jnc	PM5 Blend chest	311.4	0
209	Pulp jnc	PM4 Blend chest	311.4	0

	From	To	Calc.'d	Flow rate
210	LF jnc	PM5 Blend chest	16	16
211	LF jnc	PM4 Blend chest	16	16
212	LF to PMs	LF jnc	1.24	1.24
213	Cooling	PM ww jnc	19.46	20
214	Fresh water to PM5 jnc	PM5 forming section	21	21
215	Fresh water to PM5 jnc	PM5 press section	88	88
216	Fresh water to PM4 jnc	PM4 forming section	21	21
217	Fresh water to PM4 jnc	PM4 press section	88	88
218	Feed steam jnc	RFP disperser	7.5	7.5
219	RFP flotation chemicals	RFP flotation	52.21	52.21
220	RFP clear ww jnc	RFP disc filter	103.7	103.7
221	RFP wire pulp press	RFP cloudy ww jnc	147.1	147.1
222	PM ww jnc	LF jnc	30.76	32.8
223	Broke to PM's	JNC-broke to PM's	8.02	8.02
224	JNC-broke to PM's	PM5 Blend chest	96.01	96
225	JNC-broke to PM's	PM4 Blend chest	96.01	0
226	PM5 Blend chest	PM5 saveall	180.52	180.52
227	PM5 saveall	JNC-PM5 recovered fibre chest	128	128
228	PM5 Blend chest	JNC-PM5 blend chest to silo	247.39	240
229	JNC-PM5 recovered fibre chest	JNC-PM5 blend chest to silo	160	160
230	JNC-PM5 blend chest to silo	PM5 silo	407.39	400
231	PM5 saveall	JNC-PM5 cloudy chest	1184.52	1184
232	PM5 saveall	JNC-PM5 clear chest	296	296
233	PM5 ww jnc1	PM5 saveall	1428	1428
234	JNC-PM5 clear chest	PM5 forming section	166.01	205
235	JNC-PM5 clear chest	PM5 ww jnc1	129.99	0
236	JNC-PM5 cloudy chest	PM5 ww jnc1	1060.52	0
237	JNC-PM5 cloudy chest	JNC-PM5 recovered fibre chest	32	0
238	JNC-PM5 cloudy chest	JNC-broke to PM's	92	92
239	PM4 Blend chest	JNC-PM4 Blend to silo	243.78	240
240	JNC-PM4 Blend to silo	PM4 silo	400.96	400
241	PM4 saveall	JNC-PM4 recovered fibre chest	128	128
242	JNC-PM4 recovered fibre chest	JNC-PM4 Blend to silo	157.18	160
243	PM4 saveall	JNC-PM4 cloudy chest	1262.13	1184
244	JNC-PM4 cloudy chest	JNC-broke to PM's	92	92
245	JNC-PM4 cloudy chest	PM4 ww jnc1	1140.95	0

	From	To	Calc.'d	Flow rate
246	PM4 saveall	JNC-PM4 clear chest	222	296
247	JNC-PM4 clear chest	PM4 forming section	122	205.2
248	JNC-PM4 clear chest	PM4 ww jnc1	100	0
249	PM4 Blend chest	PM4 saveall	184.13	180.52
250	PM4 forming section	PM4 silo	2181.15	2294
251	PM5 forming section	PM5 silo	2179.3	2294
252	PM4 ww jnc1	PM4 saveall	1428	1428
253	Fresh water to PMs jnc	PM ww jnc1	0	0
254	Fresh water to PMs jnc	PM ww jnc	401.18	0
255	RFP clear ww jnc	RFP cloudy ww jnc	106.93	0
256	JNC-PM4 cloudy chest	JNC-PM4 recovered fibre chest	29.18	0
257	JNC-TMP1 cloudy ww chest	TMP1 cloudy ww1	808.07	0
258	JNC-TMP1 clear ww to deckers	JNC-TMP1 cloudy ww chest	166.75	0
259	JNC-TMP1 cloudy	JNC-TMP1 cloudy ww chest	641.32	0
260	JNC-TMP1 clear	JNC-TMP1 clear ww chest	146	0
261	JNC-TMP1 clear ww chest	JNC-TMP1 clear ww to deckers	406.75	0
262	JNC-tempered to clear ww	JNC-TMP1 clear ww chest	20	0
263	JNC-sealing water to clear ww	JNC-TMP1 clear ww chest	4.75	0
264	PM ww to pulp mill jnc	JNC-TMP1 clear ww chest	236	300
265	JNC-TMP2 cloudy ww3	JNC-TMP2 cloudy ww chest	641.32	0
266	JNC-TMP2 cloudy ww chest	TMP2 cloudy ww1	794.14	0
267	JNC-TMP2 clear ww1	JNC-TMP2 cloudy ww chest	152.82	0
268	PM ww to pulp mill jnc	JNC-TMP2 clear ww chest	222.07	300
269	JNC-sealing water to clear ww	JNC-TMP2 clear ww chest	4.75	0
270	JNC-tempered to clear ww	JNC-TMP2 clear ww chest	20	0
271	JNC-TMP2 clear ww2	JNC-TMP2 clear ww chest	146	0
272	JNC-TMP2 clear ww chest	JNC-TMP2 clear ww1	392.82	0
273	PM ww jnc1	PM4 ww jnc1	187.05	0
274	PM ww jnc1	PM5 ww jnc1	237.49	0
275	PM5 ww jnc2	PM ww jnc1	419.1	0
276	PM4 ww jnc2	PM ww jnc1	369.1	0

Table G.1 (b) Newsprint Circuit flowrate specifications in Water Tracker

	Use?	Trust	Minimum	Maximum	Linked To	Use?
1						
2	Yes	+/- 5.0%	19	21		
3	Yes	+/- 2.0%	47.04	48.96		
4	Yes	+/- 2.0%	387.79	403.61	None	
5	Yes	+/- 2.0%	368.63	383.67	chip washer -> hydrasieves	
6	Yes	+/- 5.0%	54.97	60.75	None	
7						
8						
9					None	
10	Yes	+/- 2.0%	0.08	0.08	None	
11	Yes	+/- 2.0%	0.08	0.08	None	
12						
13	Yes	+/- 2.0%	0.18	0.18	None	
14	Yes	+/- 2.0%	0.18	0.18	None	
15						
16						
17						
18						
19						
20	Yes	+/- 2.0%	0.27	0.29		
21	Yes	+/- 2.0%	0.27	0.29		
22	Yes	+/- 2.0%	14.41	14.99	None	
23	Yes	+/- 2.0%	14.41	14.99	None	
24	Yes	+/- 5.0%	12.12	13.4	None	
25	Yes	+/- 5.0%	12.12	13.4	None	
26	Yes	+/- 2.0%	127.05	132.23	None	
27	Yes	+/- 2.0%	127.05	132.23	None	
28						
29	Yes	+/- 2.0%	1.91	1.99	None	
30	Yes	+/- 2.0%	1.91	1.99	None	
31						
32	Yes	+/- 2.0%	6.89	7.17	None	
33	Yes	+/- 2.0%	6.89	7.17	None	
34						
35	Yes	+/- 5.0%	120.03	132.67		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
36						
37	Yes	+/- 2.0%	26.17	27.23		
38					None	
39					None	
40					None	
41						
42	Yes	+/- 2.0%	14.41	14.99	None	
43	Yes	+/- 2.0%	12.5	13.02	None	
44	Yes	+/- 2.0%	114.95	119.65	None	
45						
46	Yes	+/- 2.0%	114.95	119.65	None	
47	Yes	+/- 2.0%	127.05	132.23	None	
48	Yes	+/- 2.0%	127.05	132.23	None	
49	Yes	+/- 2.0%	291.06	302.94		
50						
51	Yes	+/- 2.0%	14.41	14.99	None	
52	Yes	+/- 2.0%	12.5	13.02	None	
53	Yes	+/- 2.0%	0.08	0.08	None	
54	Yes	+/- 2.0%	0.08	0.08	None	
55	Yes	+/- 2.0%	0.27	0.29		
56	Yes	+/- 2.0%	0.27	0.29		
57	Yes	+/- 2.0%	0.18	0.18	None	
58	Yes	+/- 2.0%	0.18	0.18	None	
59						
60						
61	Yes	+/- 2.0%	1.91	1.99	None	
62	Yes	+/- 2.0%	1.91	1.99	None	
63	Yes	+/- 2.0%	6.89	7.17	None	
64	Yes	+/- 2.0%	6.89	7.17	None	
65					None	
66					None	
67	Yes	+/- 2.0%	114.95	119.65	None	
68	Yes	+/- 2.0%	114.95	119.65	None	
69						
70						
71	Yes	+/- 2.0%	582.12	605.88	None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
72						
73						
74	Yes	+/- 2.0%	183.95	191.45		
75	Yes	+/- 2.0%	92.02	95.78		
76						
77	Yes	+/- 2.0%	92.02	95.78		
78						
79					None	
80	Yes	+/- 5.0%	69.35	76.65	None	
81	Yes	+/- 2.0%	71.54	74.46	None	
82					None	
83	Yes	+/- 25.0%	90	150		
84	Yes	+/- 25.0%	90	150		
85					None	
86					None	
87	Yes	+/- 2.0%	71.54	74.46	None	
88	Yes	+/- 2.0%	71.54	74.46	None	
89	Yes	+/- 25.0%	90	150		
90	Yes	+/- 25.0%	90	150		
91						
92						
93	Yes	+/- 2.0%	123.82	128.88		
94	Yes	+/- 2.0%	123.82	128.88		
95						
96						
97						
98	Yes	+/- 2.0%	582.12	605.88	None	
99	Yes	+/- 2.0%	390.04	405.96		
100	Yes	+/- 2.0%	4.9	5.1	None	
101	Yes	+/- 2.0%	4.9	5.1	None	
102						
103						
104	Yes	+/- 5.0%	378.1	417.9		
105						
106	Yes	+/- 5.0%	120.03	132.67		
107	Yes	+/- 2.0%	135.83	141.37		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
108	Yes	+/- 2.0%	17.74	18.46		
109						
110						
111	Yes	+/- 2.0%	135.83	141.37		
112						
113						
114	Yes	+/- 2.0%	57.75	60.11	None	
115						
116	Yes	+/- 2.0%	367.5	382.5	None	
117	Yes	+/- 2.0%	57.75	60.11	None	
118	Yes	+/- 2.0%	0.11	0.11		
119						
120	Yes	+/- 2.0%	0.11	0.11		
121	Yes	+/- 2.0%	0.11	0.11		
122	Yes	+/- 2.0%	0.43	0.45		
123	Yes	+/- 5.0%	17.67	19.53		
124					None	
125					fresh water jnc -> Sealing water	Yes
126						
127						
128					None	
129	Yes	+/- 25.0%	405	675		
130	Yes	+/- 2.0%	9.45	9.83		
131	Yes	+/- 2.0%	157.49	163.91	None	
132	Yes	+/- 2.0%	233.63	243.17	None	
133	Yes	+/- 2.0%	234.42	243.98	None	
134	Yes	+/- 2.0%	502.01	522.51	None	
135	Yes	+/- 2.0%	591.51	615.65	None	
136	Yes	+/- 2.0%	803.6	836.4	None	
137	Yes	+/- 2.0%	835.7	869.82	None	
138	Yes	+/- 2.0%	121.91	126.89	None	
139					None	
140	Yes	+/- 2.0%	150.92	157.08	None	
141	Yes	+/- 2.0%	17.54	18.26	None	
142						

	Use?	Trust	Minimum	Maximum	Linked To	Use?
143						
144					None	
145					None	
146						
147						
148	Yes	+/- 2.0%	49.69	51.71		
149	Yes	+/- 2.0%	219.86	228.84		
150	Yes	+/- 2.0%	94.79	98.65		
151	Yes	+/- 2.0%	570.75	594.05	None	
152						
153	Yes	+/- 2.0%	42.34	44.06		
154	Yes	+/- 2.0%	123.09	128.11		
155						
156	Yes	+/- 5.0%	237.22	262.19	None	
157						
158						
159	Yes	+/- 2.0%	246.67	256.73		
160						
161	Yes	+/- 2.0%	85.26	88.74		
162	Yes	+/- 2.0%	282.24	293.76		
163					None	
164	Yes	+/- 2.0%	2.84	2.96	None	
165					None	
166						
167					None	
168						
169					None	
170						
171	Yes	+/- 2.0%	13.23	13.77	None	
172						
173					None	
174	Yes	+/- 2.0%	13.23	13.77	None	
175					None	
176	Yes	+/- 2.0%	2403.94	2502.06	None	
177	Yes	+/- 2.0%	2283.6	2376.8	None	
178					None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
179	Yes	+/- 2.0%	60.96	63.44	None	
180	Yes	+/- 2.0%	30.48	31.72	None	
181					None	
182	Yes	+/- 2.0%	2381.4	2478.6	None	
183	Yes	+/- 2.0%	2262.33	2354.67	None	
184					None	
185	Yes	+/- 2.0%	60.96	63.44	None	
186	Yes	+/- 2.0%	30.48	31.72	None	
187					None	
188					None	
189					None	
190					None	
191					PM5 silo -> PM5 cleaners & deculator	Yes
192					PM5 cleaners & deculator -> PM5 screens	Yes
193						
194						
195					PM4 cleaners & deculator -> PM4 screens	Yes
196					PM4 silo -> PM4 cleaners & deculator	Yes
197						
198						
199						
200	Yes	+/- 2.0%	19.6	20.4		
201	Yes	+/- 2.0%	4.41	4.59		
202						
203	Yes	+/- 2.0%	4.41	4.59		
204	Yes	+/- 2.0%	19.6	20.4		
205						
206						
207						
208						
209						
210	Yes	+/- 2.0%	15.68	16.32		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
211	Yes	+/- 2.0%	15.68	16.32		
212	Yes	+/- 2.0%	1.22	1.26		
213	Yes	+/- 25.0%	15	25	fresh water jnc -> Cooling	
214	Yes	+/- 5.0%	19.95	22.05		
215	Yes	+/- 5.0%	83.6	92.4		
216	Yes	+/- 5.0%	19.95	22.05		
217	Yes	+/- 5.0%	83.6	92.4		
218	Yes	+/- 2.0%	7.35	7.65		
219	Yes	+/- 2.0%	51.17	53.25		
220	Yes	+/- 2.0%	101.63	105.77		
221	Yes	+/- 2.0%	144.16	150.04	None	
222						
223	Yes	+/- 2.0%	7.86	8.18		
224	Yes	+/- 2.0%	94.08	97.92		
225						
226	Yes	+/- 2.0%	176.91	184.13	None	
227	Yes	+/- 2.0%	125.44	130.56	None	
228					None	
229	Yes	+/- 2.0%	156.8	163.2		
230	Yes	+/- 2.0%	392	408		
231					None	
232	Yes	+/- 25.0%	222	370	None	
233	Yes	+/- 5.0%	1356.6	1499.4		
234	Yes	+/- 25.0%	153.75	256.25		
235						
236						
237						
238	Yes	+/- 2.0%	90.16	93.84		
239					None	
240	Yes	+/- 2.0%	392	408		
241	Yes	+/- 2.0%	125.44	130.56	None	
242	Yes	+/- 2.0%	156.8	163.2		
243					None	
244	Yes	+/- 2.0%	90.16	93.84		
245						
246	Yes	+/- 25.0%	222	370	None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
247						
248						
249	Yes	+/- 2.0%	176.91	184.13	None	
250	Yes	+/- 5.0%	2179.3	2408.7	None	
251	Yes	+/- 5.0%	2179.3	2408.7	None	
252	Yes	+/- 5.0%	1356.6	1499.4		

Table G.1 (c) Newsprint Circuit flowrate specifications in Water Tracker

	Value	Split Frac.	Phys.Max.	Use?
1			600	
2			+inf	
3			50	Yes
4	0		+inf	
5	0.95		550	
6	0		72.6	
7		0.25	+inf	
8		0.25	+inf	
9	0		14	
10	0		+inf	
11	0		+inf	
12			0.5	Yes
13	0		+inf	
14	0		+inf	
15			1	Yes
16			16	Yes
17		0.129	+inf	
18		0.129	+inf	
19			2	Yes
20		0.25	+inf	
21		0.25	+inf	
22	0		+inf	
23	0		+inf	
24	0		13.5	Yes
25	0		13.5	Yes
26	0		133	Yes

	Value	Split Frac.	Phys.Max.	Use?
27	0		133	Yes
28			+inf	
29	0		+inf	
30	0		+inf	
31			12	Yes
32	0		+inf	
33	0		+inf	
34			48	Yes
35			133	Yes
36			+inf	
37			40	Yes
38	0		32	
39	0		+inf	
40	0		+inf	
41			12	
42	0		+inf	
43	0		+inf	
44	0		+inf	
45			+inf	
46	0		+inf	
47	0		+inf	
48	0		+inf	
49		0.5	+inf	
50			+inf	
51	0		+inf	
52	0		+inf	
53	0		+inf	
54	0		+inf	
55		0.25	+inf	
56			+inf	
57	0		+inf	
58	0		+inf	
59		0.129	+inf	
60		0.129	+inf	
61	0		+inf	
62	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
63	0		+inf	
64	0		+inf	
65	0		+inf	
66	0		+inf	
67	0		+inf	
68	0		+inf	
69			40	Yes
70			+inf	
71	0		900	
72		0.5	+inf	
73			+inf	
74		0.5	+inf	
75		0.5	+inf	
76			+inf	
77		0.25	+inf	
78			+inf	
79	0		1000	Yes
80	0		77	Yes
81	0		300	
82	0		1000	Yes
83			170	Yes
84			+inf	
85	0		1000	Yes
86	0		1000	Yes
87	0		300	
88	0		300	
89			+inf	
90			+inf	
91			+inf	
92			+inf	
93			130	Yes
94			+inf	
95			+inf	
96			+inf	
97			+inf	
98	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
99			+inf	
100	0		+inf	
101	0		+inf	
102			15	Yes
103			+inf	
104			+inf	
105			+inf	
106			+inf	
107			142	Yes
108			+inf	
109			35	Yes
110			+inf	
111			+inf	
112		0.25	+inf	
113			+inf	
114	0		+inf	
115			+inf	
116	0		+inf	
117	0		+inf	
118		0.25	+inf	
119			+inf	
120		0.25	+inf	
121		0.25	+inf	
122			+inf	
123			20	Yes
124	0		+inf	
125	0.5		10	Yes
126		0.001	+inf	
127		0	+inf	
128	0		560	Yes
129			+inf	
130			+inf	
131	0		+inf	
132	0		+inf	
133	0		+inf	
134	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
135	0		+inf	
136	0		840	Yes
137	0		+inf	
138	0		127	Yes
139	0		28	Yes
140	0		+inf	
141	0		20	Yes
142			+inf	
143			+inf	
144	0		8	Yes
145	0		32	Yes
146			+inf	
147			+inf	
148			60	Yes
149			230	Yes
150			+inf	
151	0		255	
152			+inf	
153			+inf	
154			+inf	
155			+inf	
156	0		265	Yes
157			10	Yes
158			+inf	
159			260	Yes
160			+inf	
161			+inf	
162			340	Yes
163	0		11	Yes
164	0		+inf	
165	0		150	Yes
166			+inf	
167	0		5.6	Yes
168			1	Yes
169	0		+inf	
170			+inf	

	Value	Split Frac.	Phys.Max.	Use?
171	0		+inf	
172			+inf	
173	0		+inf	
174	0		+inf	
175	0		+inf	
176	0		+inf	
177	0		+inf	
178	0		+inf	
179	0		+inf	
180	0		+inf	
181	0		+inf	
182	0		+inf	
183	0		+inf	
184	0		+inf	
185	0		+inf	
186	0		+inf	
187	0		+inf	
188	0		300	Yes
189	0		250	Yes
190	0		150	Yes
191	0.05		+inf	
192	0.05		+inf	
193			+inf	
194			+inf	
195	0.05		+inf	
196	0.05		+inf	
197			+inf	
198			+inf	
199			+inf	
200			+inf	
201			+inf	
202			+inf	
203			+inf	
204			22	Yes
205			+inf	
206			800	Yes

	Value	Split Frac.	Phys.Max.	Use?
207			400	
208		0.5	+inf	
209			+inf	
210		0.5	6.6	
211			6.6	
212			1.4	Yes
213	1		40	Yes
214			80	Yes
215			95	Yes
216			+inf	
217			93	
218			+inf	
219			55	
220			+inf	
221	0		+inf	
222			+inf	
223			12	
224		0.5	+inf	
225			+inf	
226	0		+inf	
227	0		+inf	
228	0		+inf	
229			+inf	
230			+inf	
231	0		+inf	
232	0		+inf	
233			+inf	
234			220	
235			+inf	
236			+inf	
237			+inf	
238			+inf	
239	0		+inf	
240			+inf	
241	0		+inf	
242			+inf	

	Value	Split Frac.	Phys.Max.	Use?
243	0		+inf	
244			+inf	
245			+inf	
246	0		+inf	
247			250	Yes
248			100	Yes
249	0		+inf	
250	0		2500	Yes
251	0		2500	Yes
252			+inf	
253			10	
254			70	
255			+inf	
256			+inf	
257			+inf	
258			500	
259			+inf	
260			+inf	
261			+inf	
262			+inf	
263			+inf	
264			+inf	
265			+inf	
266			+inf	
267			500	
268			315	
269		0.5	+inf	
270		0.5	47	Yes
271			+inf	
272			+inf	
273			+inf	
274			+inf	
275			+inf	
276			+inf	

Appendix H

Newsprint Circuit Fibre Content Data Specifications in Water Tracker

Table H.1 (a) Newsprint Circuit fibre content data specifications in Water Tracker

	From	To	Calc.'d	Flow rate
1	Fresh water	fresh water jnc	747.18	865
2	Fresh water jnc	Cooling	20	20
3	Chips	chip washer	48	48
4	Chip washer	hydrasieves	395.7	395.7
5	Hydrasieves	chip washer	376.15	376.15
6	Chip washer	chip washer jnc	50.72	57.86
7	Chip washer jnc	Line 1 Digester	12.68	11.52
8	Chip washer jnc	Line 2 Digester	12.68	11.52
9	Hydrasieves	Hydrasieve rejects	19.55	0
10	Line 1 Digester	rotary valve exhaust steam jnc	0.08	0.08
11	Line 2 Digester	rotary valve exhaust steam jnc	0.08	0.08
12	Rotary valve exhaust steam jnc	Rotary valve exhaust steam	0.32	0
13	Line 1 Digester	digester vent steam jnc	0.18	0.18
14	Line 2 Digester	digester vent steam jnc	0.18	0.18
15	Digester vent steam jnc	Digester vent steam	0.72	0
16	Steam	feed steam jnc	15.5	0
17	Feed steam jnc	Line 1 Digester	2	0
18	Feed steam jnc	Line 2 Digester	2	2
19	Sodium sulphite	sodium sulphite jnc	1.12	0
20	Sodium sulphite jnc	Line 1 Digester	0.28	0.28
21	Sodium sulphite jnc	Line 2 Digester	0.28	0.28
22	Line 2 Digester	Line 2 Prim Refiner	14.7	14.7
23	Line 1 Digester	Line 1 Prim Refiner	14.7	14.7
24	Line 1 Prim Refiner	Line 1 Sec Refiner	12.76	12.76
25	Line 2 Prim Refiner	Line 2 Sec Refiner	12.76	12.76
26	Line 1 Sec Refiner	sec refiner jnc	129.64	129.64
27	Line 2 Sec Refiner	sec refiner jnc	129.64	129.64
28	Sec refiner jnc	TMP1 Latency & screens	259.28	0
29	Line 2 Prim Refiner	prim ref back flow steam jnc	1.95	1.95

	From	To	Calc.'d	Flow rate
30	Line 1 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
31	Prim ref back flow steam jnc	back flow steam	7.8	0
32	Line 1 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
33	Line 2 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
34	Sec refiner exhaust steam jnc	Cyclone and feader exhaust steam	28.12	0
35	TMP1 cloudy ww2	Line 1 Sec Refiner	126.35	126.35
36	TMP1 cloudy ww2	Line 1 Prim Refiner	0.01	10.44
37	GWD rejects	Reject System	26.7	26.7
38	Reject System	Rejects from pressure screen	46.36	25.5
39	Line 1 Sec Refiner	sec refiner losses jnc	2.44	0
40	Line 2 Sec Refiner	sec refiner losses jnc	2.44	0
41	Sec refiner losses jnc	Losses	9.76	0
42	Line 3 Digester	Line 3 Prim Refiner	14.7	14.7
43	Line 3 Prim Refiner	Line 3 Sec Refiner	12.76	12.76
44	Line 4 Decker	JNC-TMP2 pulp to storage	117.3	117.3
45	JNC-TMP2 pulp to storage	JNC-pulp to storage	234.6	0
46	Line 3 Decker	JNC-TMP2 pulp to storage	117.3	117.3
47	Line 3 Sec Refiner	JNC-TMP2 sec ref to latency	129.64	129.64
48	Line 4 Sec Refiner	JNC-TMP2 sec ref to latency	129.64	129.64
49	JNC-TMP2 latency to deckers	Line 3 Decker	297	297
50	JNC-TMP2 latency to deckers	Line 4 Decker	297	369.17
51	Line 4 Digester	Line 4 Prim Refiner	14.7	14.7
52	Line 4 Prim Refiner	Line 4 Sec Refiner	12.76	12.76
53	Line 3 Digester	rotary valve exhaust steam jnc	0.08	0.08
54	Line 4 Digester	rotary valve exhaust steam jnc	0.08	0.08
55	Sodium sulphite jnc	Line 4 Digester	0.28	0.28
56	Sodium sulphite jnc	Line 3 Digester	0.28	0.28
57	Line 3 Digester	digester vent steam jnc	0.18	0.18
58	Line 4 Digester	digester vent steam jnc	0.18	0.18
59	Feed steam jnc	Line 3 Digester	2	0
60	Feed steam jnc	Line 4 Digester	2	0
61	Line 3 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
62	Line 4 Prim Refiner	prim ref back flow steam jnc	1.95	1.95
63	Line 3 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
64	Line 4 Sec Refiner	sec refiner exhaust steam jnc	7.03	7.03
65	Line 3 Sec Refiner	sec refiner losses jnc	2.44	0

	From	To	Calc.'d	Flow rate
66	Line 4 Sec Refiner	sec refiner losses jnc	2.44	0
67	Line 1 Decker	JNC-TMP1 pulp to storage	117.3	117.3
68	Line 2 Decker	JNC-TMP1 pulp to storage	117.3	117.3
69	Fresh water jnc	JNC-tempered to clear ww	40	0
70	JNC-TMP1 pulp to storage	JNC-pulp to storage	234.6	0
71	TMP1 Latency & screens	JNC-TMP1 latency to deckers	594	594
72	JNC-TMP1 latency to deckers	Line 1 Decker	297	409.16
73	JNC-TMP1 latency to deckers	Line 2 Decker	297	409.16
74	JNC-Rej sys	JNC-Reject system	187.7	187.7
75	JNC-Reject system	Line 1 Decker	93.85	93.9
76	JNC-Reject system	Line 2 Decker	93.85	129.29
77	JNC-Rej sys	Line 3 Decker	93.85	93.9
78	JNC-Rej sys	Line 4 Decker	93.85	0
79	Line 1 Decker	JNC-TMP1 cloudy	320.66	0
80	Line 1 Decker	JNC-TMP1 clear	73	73
81	Line 2 Decker	JNC-TMP1 clear	73	73
82	Line 2 Decker	JNC-TMP1 cloudy	320.66	65
83	JNC-TMP1 clear ww to deckers	Line 1 Decker	120	120
84	JNC-TMP1 clear ww to deckers	Line 2 Decker	120	120
85	Line 3 Decker	JNC-TMP2 cloudy ww3	320.66	0
86	Line 4 Decker	JNC-TMP2 cloudy ww3	320.66	0
87	Line 4 Decker	JNC-TMP2 clear ww2	73	73
88	Line 3 Decker	JNC-TMP2 clear ww2	73	73
89	JNC-TMP2 clear ww1	Line 3 Decker	120	120
90	JNC-TMP2 clear ww1	Line 4 Decker	120	120
91	Cloudy ww2	Reject System	277.2	191.5
92	TMP2 cloudy ww2	Line 4 Prim Refiner	0.01	0
93	TMP2 cloudy ww2	Line 4 Sec Refiner	126.35	126.35
94	TMP2 cloudy ww2	Line 3 Sec Refiner	126.35	126.35
95	TMP2 cloudy ww2	Line 3 Prim Refiner	0.01	0
96	TMP2 cloudy ww1	TMP2 cloudy ww2	252.72	0
97	JNC-TMP2 sec ref to latency	TMP2 Latency & screens	259.28	0
98	TMP2 Latency & screens	JNC-TMP2 latency to deckers	594	594
99	TMP2 cloudy ww1	TMP2 Latency & screens	398.65	398
100	TMP1 Latency & screens	JNC-latency steam	5	5
101	TMP2 Latency & screens	JNC-latency steam	5	5

	From	To	Calc.'d	Flow rate
102	JNC-latency steam	Latency steam	10	0
103	TMP1 cloudy ww1	TMP1 cloudy ww2	252.72	0
104	TMP1 cloudy ww1	TMP1 Latency & screens	398.65	398
105	TMP1 cloudy ww2	Line 2 Prim Refiner	0.01	10.44
106	TMP1 cloudy ww2	Line 2 Sec Refiner	126.35	126.35
107	TMP1 cloudy ww1	cloudy ww2	138.6	138.6
108	TMP1 cloudy ww1	JNC- cloudy ww to chip washer	18.1	18.1
109	JNC- cloudy ww to chip washer	chip washer	22.27	32.26
110	TMP2 cloudy ww1	JNC- cloudy ww to chip washer	4.17	0
111	TMP2 cloudy ww1	cloudy ww2	138.6	138.6
112	Chip washer jnc	Line 3 Digester	12.68	11.52
113	Chip washer jnc	Line 4 Digester	12.68	11.52
114	TMP1 Latency & screens	JNC-latency to rej sys	58.93	58.93
115	JNC-latency to rej sys	Reject System	117.86	162
116	Reject System	JNC-Rej sys	375.4	375
117	TMP2 Latency & screens	JNC-latency to rej sys	58.93	58.93
118	JNC-Hydros	Line 1 Decker	0.11	0.11
119	JNC-Hydros	Line 2 Decker	0.11	0.1
120	JNC-Hydros	Line 4 Decker	0.11	0.11
121	JNC-Hydros	Line 3 Decker	0.11	0.11
122	Hydros	JNC-Hydros	0.44	0.44
123	Fresh water jnc	Sealing water	19	18.6
124	Sealing water	JNC-sealing water to clear ww	9.5	0
125	Sealing water	sealing water to drain	9.5	7.31
126	Cooling tower	[Losses]	0.54	0
127	Cooling tower	[Evapor.]	0	0
128	Cooling	cooling tower	540.54	0
129	Cooling tower	Cooling	540	540
130	RFP waste paper	RFP Pulping	9.64	9.64
131	RFP Pulping	RFP-HD cleaning	160.7	160.7
132	RFP-HD cleaning	RFP coarse screens	238.4	238.4
133	RFP coarse screens	RFP flotation	239.2	239.2
134	RFP flotation	RFP gyro cleaners	512.26	512.26
135	RFP gyro cleaners	RFP centri cleaners	603.58	603.58
136	RFP centri cleaners	RFP fine screens	820	820
137	RFP fine screens	RFP disc filter	852.8	852.76

	From	To	Calc.'d	Flow rate
138	RFP disc filter	RFP wire pulp press	124.4	124.4
139	RFP wire pulp press	RFP disperser	20.5	24
140	RFP disperser	pulp jnc	153.6	154
141	RFP fine screens	RFP rejects jnc2	17.9	17.9
142	RFP rejects jnc2	RFP rej jnc3	62.08	0
143	RFP rej jnc3	RPF rejects	211.22	0
144	RFP centri cleaners	RFP rejects jnc2	7.93	8
145	RFP flotation	RFP rejects jnc2	30.85	30.89
146	Fresh water jnc	RFP Temp jnc	0	0
147	RFP Temp jnc	RFP clear ww jnc	0	0
148	RFP clear ww jnc	RFP fine screens	50.7	50.7
149	RFP clear ww jnc	RFP centri cleaners	224.35	224.35
150	RFP clear ww jnc	RFP gyro cleaners	96.72	96.72
151	RFP disc filter	RFP clear ww jnc	582.4	582.4
152	PM ww to RFP jnc	RFP cloudy ww jnc	126.67	231
153	PM ww to RFP jnc	RFP wire pulp press	43.2	43.2
154	PM ww to RFP jnc	RFP disperser	125.6	125.6
155	PM ww to pulp mill jnc	PM ww to RFP jnc	295.47	412
156	RFP disc filter	RFP cloudy ww jnc	249.7	249.7
157	RFP cloudy ww jnc	RFP fine screens	0	0
158	RFP cloudy ww jnc	RFP cloudy filtrate jnc2	630.4	726
159	RFP cloudy filtrate jnc2	RFP flotation	251.7	251.7
160	RFP cloudy filtrate jnc2	RFP coarse screens	3.7	4.26
161	RFP cloudy filtrate jnc2	RFP-HD cleaning	87	87
162	RFP cloudy filtrate jnc2	RFP Pulping	288	288
163	RFP-HD cleaning	RFP rej jnc1	9.3	10.7
164	RFP coarse screens	RFP rej jnc1	2.9	2.9
165	RFP Pulping	RFP rej jnc1	136.94	158.29
166	RFP rej jnc1	RFP rej jnc3	149.14	0
167	RFP gyro cleaners	RFP rejects jnc2	5.4	5.4
168	RFP Temp jnc	RFP disc filter	0	0.05
169	PM4 dryers	dryer steam evap jnc	17.6	20.4
170	Dryer steam evap jnc	evaporation	35.2	0
171	PM4 dryers	final paper jnc	13.5	13.5
172	Final paper jnc	Paper	27	0
173	PM5 dryers	dryer steam evap jnc	17.6	20.4

	From	To	Calc.'d	Flow rate
174	PM5 dryers	final paper jnc	13.5	13.5
175	PM4 silo	PM4 cleaners & deculator	2582.11	2694
176	PM4 cleaners & deculator	PM4 screens	2453	2453
177	PM4 screens	PM4 headbox	2330.35	2330.2
178	PM4 headbox	PM4 forming section	2350.35	2350.2
179	PM4 forming section	PM4 press section	62.2	62.2
180	PM4 press section	PM4 dryers	31.1	31.1
181	PM5 silo	PM5 cleaners & deculator	2586.69	2694.4
182	PM5 cleaners & deculator	PM5 screens	2457.36	2430
183	PM5 screens	PM5 headbox	2334.49	2308.5
184	PM5 headbox	PM5 forming section	2354.49	2350.2
185	PM5 forming section	PM5 press section	62.2	62.2
186	PM5 press section	PM5 dryers	31.1	31.1
187	PM5 press section	PM5 ww jnc2	119.1	78
188	PM5 forming section	PM5 ww jnc2	300	0
189	PM4 forming section	PM4 ww jnc2	250	0
190	PM4 press section	PM4 ww jnc2	119.1	78
191	PM5 cleaners & deculator	PM rej to drain jnc	129.33	241.5
192	PM5 screens	PM rej to drain jnc	122.87	0
193	PM ww jnc	PM rej to drain jnc	0	0
194	PM rej to drain jnc	Drain	503.96	0
195	PM4 screens	PM4 ww to drain jnc	122.65	0
196	PM4 cleaners & deculator	PM4 ww to drain jnc	129.11	241.5
197	PM4 ww to drain jnc	PM rej to drain jnc	251.76	242.45
198	Fresh water jnc	fresh water to PMs jnc	668.18	0
199	Fresh water to PMs jnc	fresh water to PM4 jnc	133.5	184.5
200	Fresh water to PM4 jnc	PM4 headbox	20	20
201	Fresh water to PM4 jnc	PM4 Blend chest	4.5	4.5
202	Fresh water to PMs jnc	fresh water to PM5 jnc	133.5	160
203	Fresh water to PM5 jnc	PM5 Blend chest	4.5	4.5
204	Fresh water to PM5 jnc	PM5 headbox	20	20
205	PM ww jnc1	PM ww jnc	363.66	0
206	JNC-pulp to storage	pulp jnc	469.2	0
207	PM ww jnc	PM ww to pulp mill jnc	753.54	1500
208	Pulp jnc	PM5 Blend chest	311.4	0
209	Pulp jnc	PM4 Blend chest	311.4	0

	From	To	Calc.'d	Flow rate
210	LF jnc	PM5 Blend chest	16	16
211	LF jnc	PM4 Blend chest	16	16
212	LF to PMs	LF jnc	1.24	1.24
213	Cooling	PM ww jnc	19.46	20
214	Fresh water to PM5 jnc	PM5 forming section	21	21
215	Fresh water to PM5 jnc	PM5 press section	88	88
216	Fresh water to PM4 jnc	PM4 forming section	21	21
217	Fresh water to PM4 jnc	PM4 press section	88	88
218	Feed steam jnc	RFP disperser	7.5	7.5
219	RFP flotation chemicals	RFP flotation	52.21	52.21
220	RFP clear ww jnc	RFP disc filter	103.7	103.7
221	RFP wire pulp press	RFP cloudy ww jnc	147.1	147.1
222	PM ww jnc	LF jnc	30.76	32.8
223	Broke to PM's	JNC-broke to PM's	8.02	8.02
224	JNC-broke to PM's	PM5 Blend chest	96.01	96
225	JNC-broke to PM's	PM4 Blend chest	96.01	0
226	PM5 Blend chest	PM5 saveall	180.52	180.52
227	PM5 saveall	JNC-PM5 recovered fibre chest	128	128
228	PM5 Blend chest	JNC-PM5 blend chest to silo	247.39	240
229	JNC-PM5 recovered fibre chest	JNC-PM5 blend chest to silo	160	160
230	JNC-PM5 blend chest to silo	PM5 silo	407.39	400
231	PM5 saveall	JNC-PM5 cloudy chest	1184.52	1184
232	PM5 saveall	JNC-PM5 clear chest	296	296
233	PM5 ww jnc1	PM5 saveall	1428	1428
234	JNC-PM5 clear chest	PM5 forming section	166.01	205
235	JNC-PM5 clear chest	PM5 ww jnc1	129.99	0
236	JNC-PM5 cloudy chest	PM5 ww jnc1	1060.52	0
237	JNC-PM5 cloudy chest	JNC-PM5 recovered fibre chest	32	0
238	JNC-PM5 cloudy chest	JNC-broke to PM's	92	92
239	PM4 Blend chest	JNC-PM4 Blend to silo	243.78	240
240	JNC-PM4 Blend to silo	PM4 silo	400.96	400
241	PM4 saveall	JNC-PM4 recovered fibre chest	128	128
242	JNC-PM4 recovered fibre chest	JNC-PM4 Blend to silo	157.18	160
243	PM4 saveall	JNC-PM4 cloudy chest	1262.13	1184
244	JNC-PM4 cloudy chest	JNC-broke to PM's	92	92
245	JNC-PM4 cloudy chest	PM4 ww jnc1	1140.95	0

	From	To	Calc.'d	Flow rate
246	PM4 saveall	JNC-PM4 clear chest	222	296
247	JNC-PM4 clear chest	PM4 forming section	122	205.2
248	JNC-PM4 clear chest	PM4 ww jnc1	100	0
249	PM4 Blend chest	PM4 saveall	184.13	180.52
250	PM4 forming section	PM4 silo	2181.15	2294
251	PM5 forming section	PM5 silo	2179.3	2294
252	PM4 ww jnc1	PM4 saveall	1428	1428
253	Fresh water to PMs jnc	PM ww jnc1	0	0
254	Fresh water to PMs jnc	PM ww jnc	401.18	0
255	RFP clear ww jnc	RFP cloudy ww jnc	106.93	0
256	JNC-PM4 cloudy chest	JNC-PM4 recovered fibre chest	29.18	0
257	JNC-TMP1 cloudy ww chest	TMP1 cloudy ww1	808.07	0
258	JNC-TMP1 clear ww to deckers	JNC-TMP1 cloudy ww chest	166.75	0
259	JNC-TMP1 cloudy	JNC-TMP1 cloudy ww chest	641.32	0
260	JNC-TMP1 clear	JNC-TMP1 clear ww chest	146	0
261	JNC-TMP1 clear ww chest	JNC-TMP1 clear ww to deckers	406.75	0
262	JNC-tempered to clear ww	JNC-TMP1 clear ww chest	20	0
263	JNC-sealing water to clear ww	JNC-TMP1 clear ww chest	4.75	0
264	PM ww to pulp mill jnc	JNC-TMP1 clear ww chest	236	300
265	JNC-TMP2 cloudy ww3	JNC-TMP2 cloudy ww chest	641.32	0
266	JNC-TMP2 cloudy ww chest	TMP2 cloudy ww1	794.14	0
267	JNC-TMP2 clear ww1	JNC-TMP2 cloudy ww chest	152.82	0
268	PM ww to pulp mill jnc	JNC-TMP2 clear ww chest	222.07	300
269	JNC-sealing water to clear ww	JNC-TMP2 clear ww chest	4.75	0
270	JNC-tempered to clear ww	JNC-TMP2 clear ww chest	20	0
271	JNC-TMP2 clear ww2	JNC-TMP2 clear ww chest	146	0
272	JNC-TMP2 clear ww chest	JNC-TMP2 clear ww1	392.82	0
273	PM ww jnc1	PM4 ww jnc1	187.05	0
274	PM ww jnc1	PM5 ww jnc1	237.49	0
275	PM5 ww jnc2	PM ww jnc1	419.1	0
276	PM4 ww jnc2	PM ww jnc1	369.1	0

Table H.1 (b) Newsprint Circuit fibre content data specifications in Water Tracker

	Use?	Trust	Minimum	Maximum	Linked To	Use?
1						
2	Yes	+/- 5.0%	19	21		
3	Yes	+/- 2.0%	47.04	48.96		
4	Yes	+/- 2.0%	387.79	403.61	None	
5	Yes	+/- 2.0%	368.63	383.67	chip washer -> hydrasieves	
6	Yes	+/- 5.0%	54.97	60.75	None	
7						
8						
9					None	
10	Yes	+/- 2.0%	0.08	0.08	None	
11	Yes	+/- 2.0%	0.08	0.08	None	
12						
13	Yes	+/- 2.0%	0.18	0.18	None	
14	Yes	+/- 2.0%	0.18	0.18	None	
15						
16						
17						
18						
19						
20	Yes	+/- 2.0%	0.27	0.29		
21	Yes	+/- 2.0%	0.27	0.29		
22	Yes	+/- 2.0%	14.41	14.99	None	
23	Yes	+/- 2.0%	14.41	14.99	None	
24	Yes	+/- 5.0%	12.12	13.4	None	
25	Yes	+/- 5.0%	12.12	13.4	None	
26	Yes	+/- 2.0%	127.05	132.23	None	
27	Yes	+/- 2.0%	127.05	132.23	None	
28						
29	Yes	+/- 2.0%	1.91	1.99	None	
30	Yes	+/- 2.0%	1.91	1.99	None	
31						
32	Yes	+/- 2.0%	6.89	7.17	None	
33	Yes	+/- 2.0%	6.89	7.17	None	
34						
35	Yes	+/- 5.0%	120.03	132.67		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
36						
37	Yes	+/- 2.0%	26.17	27.23		
38					None	
39					None	
40					None	
41						
42	Yes	+/- 2.0%	14.41	14.99	None	
43	Yes	+/- 2.0%	12.5	13.02	None	
44	Yes	+/- 2.0%	114.95	119.65	None	
45						
46	Yes	+/- 2.0%	114.95	119.65	None	
47	Yes	+/- 2.0%	127.05	132.23	None	
48	Yes	+/- 2.0%	127.05	132.23	None	
49	Yes	+/- 2.0%	291.06	302.94		
50						
51	Yes	+/- 2.0%	14.41	14.99	None	
52	Yes	+/- 2.0%	12.5	13.02	None	
53	Yes	+/- 2.0%	0.08	0.08	None	
54	Yes	+/- 2.0%	0.08	0.08	None	
55	Yes	+/- 2.0%	0.27	0.29		
56	Yes	+/- 2.0%	0.27	0.29		
57	Yes	+/- 2.0%	0.18	0.18	None	
58	Yes	+/- 2.0%	0.18	0.18	None	
59						
60						
61	Yes	+/- 2.0%	1.91	1.99	None	
62	Yes	+/- 2.0%	1.91	1.99	None	
63	Yes	+/- 2.0%	6.89	7.17	None	
64	Yes	+/- 2.0%	6.89	7.17	None	
65					None	
66					None	
67	Yes	+/- 2.0%	114.95	119.65	None	
68	Yes	+/- 2.0%	114.95	119.65	None	
69						
70						
71	Yes	+/- 2.0%	582.12	605.88	None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
72						
73						
74	Yes	+/- 2.0%	183.95	191.45		
75	Yes	+/- 2.0%	92.02	95.78		
76						
77	Yes	+/- 2.0%	92.02	95.78		
78						
79					None	
80	Yes	+/- 5.0%	69.35	76.65	None	
81	Yes	+/- 2.0%	71.54	74.46	None	
82					None	
83	Yes	+/- 25.0%	90	150		
84	Yes	+/- 25.0%	90	150		
85					None	
86					None	
87	Yes	+/- 2.0%	71.54	74.46	None	
88	Yes	+/- 2.0%	71.54	74.46	None	
89	Yes	+/- 25.0%	90	150		
90	Yes	+/- 25.0%	90	150		
91						
92						
93	Yes	+/- 2.0%	123.82	128.88		
94	Yes	+/- 2.0%	123.82	128.88		
95						
96						
97						
98	Yes	+/- 2.0%	582.12	605.88	None	
99	Yes	+/- 2.0%	390.04	405.96		
100	Yes	+/- 2.0%	4.9	5.1	None	
101	Yes	+/- 2.0%	4.9	5.1	None	
102						
103						
104	Yes	+/- 5.0%	378.1	417.9		
105						
106	Yes	+/- 5.0%	120.03	132.67		
107	Yes	+/- 2.0%	135.83	141.37		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
108	Yes	+/- 2.0%	17.74	18.46		
109						
110						
111	Yes	+/- 2.0%	135.83	141.37		
112						
113						
114	Yes	+/- 2.0%	57.75	60.11	None	
115						
116	Yes	+/- 2.0%	367.5	382.5	None	
117	Yes	+/- 2.0%	57.75	60.11	None	
118	Yes	+/- 2.0%	0.11	0.11		
119						
120	Yes	+/- 2.0%	0.11	0.11		
121	Yes	+/- 2.0%	0.11	0.11		
122	Yes	+/- 2.0%	0.43	0.45		
123	Yes	+/- 5.0%	17.67	19.53		
124					None	
125					fresh water jnc -> Sealing water	Yes
126						
127						
128					None	
129	Yes	+/- 25.0%	405	675		
130	Yes	+/- 2.0%	9.45	9.83		
131	Yes	+/- 2.0%	157.49	163.91	None	
132	Yes	+/- 2.0%	233.63	243.17	None	
133	Yes	+/- 2.0%	234.42	243.98	None	
134	Yes	+/- 2.0%	502.01	522.51	None	
135	Yes	+/- 2.0%	591.51	615.65	None	
136	Yes	+/- 2.0%	803.6	836.4	None	
137	Yes	+/- 2.0%	835.7	869.82	None	
138	Yes	+/- 2.0%	121.91	126.89	None	
139					None	
140	Yes	+/- 2.0%	150.92	157.08	None	
141	Yes	+/- 2.0%	17.54	18.26	None	
142						

	Use?	Trust	Minimum	Maximum	Linked To	Use?
143						
144					None	
145					None	
146						
147						
148	Yes	+/- 2.0%	49.69	51.71		
149	Yes	+/- 2.0%	219.86	228.84		
150	Yes	+/- 2.0%	94.79	98.65		
151	Yes	+/- 2.0%	570.75	594.05	None	
152						
153	Yes	+/- 2.0%	42.34	44.06		
154	Yes	+/- 2.0%	123.09	128.11		
155						
156	Yes	+/- 5.0%	237.22	262.19	None	
157						
158						
159	Yes	+/- 2.0%	246.67	256.73		
160						
161	Yes	+/- 2.0%	85.26	88.74		
162	Yes	+/- 2.0%	282.24	293.76		
163					None	
164	Yes	+/- 2.0%	2.84	2.96	None	
165					None	
166						
167					None	
168						
169					None	
170						
171	Yes	+/- 2.0%	13.23	13.77	None	
172						
173					None	
174	Yes	+/- 2.0%	13.23	13.77	None	
175					None	
176	Yes	+/- 2.0%	2403.94	2502.06	None	
177	Yes	+/- 2.0%	2283.6	2376.8	None	
178					None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
179	Yes	+/- 2.0%	60.96	63.44	None	
180	Yes	+/- 2.0%	30.48	31.72	None	
181					None	
182	Yes	+/- 2.0%	2381.4	2478.6	None	
183	Yes	+/- 2.0%	2262.33	2354.67	None	
184					None	
185	Yes	+/- 2.0%	60.96	63.44	None	
186	Yes	+/- 2.0%	30.48	31.72	None	
187					None	
188					None	
189					None	
190					None	
191					PM5 silo -> PM5 cleaners & deculator	Yes
192					PM5 cleaners & deculator -> PM5 screens	Yes
193						
194						
195					PM4 cleaners & deculator -> PM4 screens	Yes
196					PM4 silo -> PM4 cleaners & deculator	Yes
197						
198						
199						
200	Yes	+/- 2.0%	19.6	20.4		
201	Yes	+/- 2.0%	4.41	4.59		
202						
203	Yes	+/- 2.0%	4.41	4.59		
204	Yes	+/- 2.0%	19.6	20.4		
205						
206						
207						
208						
209						
210	Yes	+/- 2.0%	15.68	16.32		

	Use?	Trust	Minimum	Maximum	Linked To	Use?
211	Yes	+/- 2.0%	15.68	16.32		
212	Yes	+/- 2.0%	1.22	1.26		
213	Yes	+/- 25.0%	15	25	fresh water jnc -> Cooling	
214	Yes	+/- 5.0%	19.95	22.05		
215	Yes	+/- 5.0%	83.6	92.4		
216	Yes	+/- 5.0%	19.95	22.05		
217	Yes	+/- 5.0%	83.6	92.4		
218	Yes	+/- 2.0%	7.35	7.65		
219	Yes	+/- 2.0%	51.17	53.25		
220	Yes	+/- 2.0%	101.63	105.77		
221	Yes	+/- 2.0%	144.16	150.04	None	
222						
223	Yes	+/- 2.0%	7.86	8.18		
224	Yes	+/- 2.0%	94.08	97.92		
225						
226	Yes	+/- 2.0%	176.91	184.13	None	
227	Yes	+/- 2.0%	125.44	130.56	None	
228					None	
229	Yes	+/- 2.0%	156.8	163.2		
230	Yes	+/- 2.0%	392	408		
231					None	
232	Yes	+/- 25.0%	222	370	None	
233	Yes	+/- 5.0%	1356.6	1499.4		
234	Yes	+/- 25.0%	153.75	256.25		
235						
236						
237						
238	Yes	+/- 2.0%	90.16	93.84		
239					None	
240	Yes	+/- 2.0%	392	408		
241	Yes	+/- 2.0%	125.44	130.56	None	
242	Yes	+/- 2.0%	156.8	163.2		
243					None	
244	Yes	+/- 2.0%	90.16	93.84		
245						
246	Yes	+/- 25.0%	222	370	None	

	Use?	Trust	Minimum	Maximum	Linked To	Use?
247						
248						
249	Yes	+/- 2.0%	176.91	184.13	None	
250	Yes	+/- 5.0%	2179.3	2408.7	None	
251	Yes	+/- 5.0%	2179.3	2408.7	None	
252	Yes	+/- 5.0%	1356.6	1499.4		

Table H.1 (c) Newsprint Circuit fibre content data specifications in Water Tracker

	Value	Split Frac.	Phys.Max.	Use?
1			600	
2			+inf	
3			50	Yes
4	0		+inf	
5	0.95		550	
6	0		72.6	
7		0.25	+inf	
8		0.25	+inf	
9	0		14	
10	0		+inf	
11	0		+inf	
12			0.5	Yes
13	0		+inf	
14	0		+inf	
15			1	Yes
16			16	Yes
17		0.129	+inf	
18		0.129	+inf	
19			2	Yes
20		0.25	+inf	
21		0.25	+inf	
22	0		+inf	
23	0		+inf	
24	0		13.5	Yes
25	0		13.5	Yes
26	0		133	Yes

	Value	Split Frac.	Phys.Max.	Use?
27	0		133	Yes
28			+inf	
29	0		+inf	
30	0		+inf	
31			12	Yes
32	0		+inf	
33	0		+inf	
34			48	Yes
35			133	Yes
36			+inf	
37			40	Yes
38	0		32	
39	0		+inf	
40	0		+inf	
41			12	
42	0		+inf	
43	0		+inf	
44	0		+inf	
45			+inf	
46	0		+inf	
47	0		+inf	
48	0		+inf	
49		0.5	+inf	
50			+inf	
51	0		+inf	
52	0		+inf	
53	0		+inf	
54	0		+inf	
55		0.25	+inf	
56			+inf	
57	0		+inf	
58	0		+inf	
59		0.129	+inf	
60		0.129	+inf	
61	0		+inf	
62	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
63	0		+inf	
64	0		+inf	
65	0		+inf	
66	0		+inf	
67	0		+inf	
68	0		+inf	
69			40	Yes
70			+inf	
71	0		900	
72		0.5	+inf	
73			+inf	
74		0.5	+inf	
75		0.5	+inf	
76			+inf	
77		0.25	+inf	
78			+inf	
79	0		1000	Yes
80	0		77	Yes
81	0		300	
82	0		1000	Yes
83			170	Yes
84			+inf	
85	0		1000	Yes
86	0		1000	Yes
87	0		300	
88	0		300	
89			+inf	
90			+inf	
91			+inf	
92			+inf	
93			130	Yes
94			+inf	
95			+inf	
96			+inf	
97			+inf	
98	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
99			+inf	
100	0		+inf	
101	0		+inf	
102			15	Yes
103			+inf	
104			+inf	
105			+inf	
106			+inf	
107			142	Yes
108			+inf	
109			35	Yes
110			+inf	
111			+inf	
112		0.25	+inf	
113			+inf	
114	0		+inf	
115			+inf	
116	0		+inf	
117	0		+inf	
118		0.25	+inf	
119			+inf	
120		0.25	+inf	
121		0.25	+inf	
122			+inf	
123			20	Yes
124	0		+inf	
125	0.5		10	Yes
126		0.001	+inf	
127		0	+inf	
128	0		560	Yes
129			+inf	
130			+inf	
131	0		+inf	
132	0		+inf	
133	0		+inf	
134	0		+inf	

	Value	Split Frac.	Phys.Max.	Use?
135	0		+inf	
136	0		840	Yes
137	0		+inf	
138	0		127	Yes
139	0		28	Yes
140	0		+inf	
141	0		20	Yes
142			+inf	
143			+inf	
144	0		8	Yes
145	0		32	Yes
146			+inf	
147			+inf	
148			60	Yes
149			230	Yes
150			+inf	
151	0		255	
152			+inf	
153			+inf	
154			+inf	
155			+inf	
156	0		265	Yes
157			10	Yes
158			+inf	
159			260	Yes
160			+inf	
161			+inf	
162			340	Yes
163	0		11	Yes
164	0		+inf	
165	0		150	Yes
166			+inf	
167	0		5.6	Yes
168			1	Yes
169	0		+inf	
170			+inf	

	Value	Split Frac.	Phys.Max.	Use?
171	0		+inf	
172			+inf	
173	0		+inf	
174	0		+inf	
175	0		+inf	
176	0		+inf	
177	0		+inf	
178	0		+inf	
179	0		+inf	
180	0		+inf	
181	0		+inf	
182	0		+inf	
183	0		+inf	
184	0		+inf	
185	0		+inf	
186	0		+inf	
187	0		+inf	
188	0		300	Yes
189	0		250	Yes
190	0		150	Yes
191	0.05		+inf	
192	0.05		+inf	
193			+inf	
194			+inf	
195	0.05		+inf	
196	0.05		+inf	
197			+inf	
198			+inf	
199			+inf	
200			+inf	
201			+inf	
202			+inf	
203			+inf	
204			22	Yes
205			+inf	
206			800	Yes

	Value	Split Frac.	Phys.Max.	Use?
207			400	
208		0.5	+inf	
209			+inf	
210		0.5	6.6	
211			6.6	
212			1.4	Yes
213	1		40	Yes
214			80	Yes
215			95	Yes
216			+inf	
217			93	
218			+inf	
219			55	
220			+inf	
221	0		+inf	
222			+inf	
223			12	
224		0.5	+inf	
225			+inf	
226	0		+inf	
227	0		+inf	
228	0		+inf	
229			+inf	
230			+inf	
231	0		+inf	
232	0		+inf	
233			+inf	
234			220	
235			+inf	
236			+inf	
237			+inf	
238			+inf	
239	0		+inf	
240			+inf	
241	0		+inf	
242			+inf	

	Value	Split Frac.	Phys.Max.	Use?
243	0		+inf	
244			+inf	
245			+inf	
246	0		+inf	
247			250	Yes
248			100	Yes
249	0		+inf	
250	0		2500	Yes
251	0		2500	Yes
252			+inf	
253			10	
254			70	
255			+inf	
256			+inf	
257			+inf	
258			500	
259			+inf	
260			+inf	
261			+inf	
262			+inf	
263			+inf	
264			+inf	
265			+inf	
266			+inf	
267			500	
268			315	
269		0.5	+inf	
270		0.5	47	Yes
271			+inf	
272			+inf	
273			+inf	
274			+inf	
275			+inf	
276			+inf	

Appendix I

Water Pinch Results from the Recycled Fibre Plant

Table I.1 Routing of streams from Water Pinch Model of the Recycled Fibre Plant

From...	...to	Flow [t/h]
From Process...	...to Process	
Disc filter out 1	Flotation in	290.2
Disc filter out 1	Centri-clean in	258.6
From Utility...	...to Process	
Cloudy out 1	disc filter in 1	119.5
Clear out 1	HD Cleaning in	55.35
Clear out 1	Gyroclean in	111.5
Clear out 1	fine screens in 1	58.43
Fresh water	HD Cleaning in	44.89
PM white water out 1	Pulping in	333.58
PM white water out 1	Coarse Scr in	4.26
PM white water out 1	wire pulp press in	43.2
PM white water out 1	Disperser in 1	145.98
From Process...	...to Utility	
Pulping out	Rej-1 in 1	158.29
HD Cleaning out	Rej-1 in 1	10.69
Coarse Scr out	Rej-1 in 1	3.3
Flotation out	cloudy-disc in 1	35.61
Gyroclean out	Rej-1 in 1	6.22
Centri-clean out	Rej-1 in 1	9.18
Fine screens out	Rej-1 in 1	20.62
Disc filter out 1	clear-disc in 1	122.55
Disc filter out 2	Rej-1 in 1	22.33
Disc filter out 2	cloudy-disc in 1	265.57
Wire pulp press out	cloudy-disc in 1	162.98
From Utility...	...to Utility	
PM white water out 1	cloudy-disc in 1	284.54

Table I.2 Source conditions from Water Pinch Model of the Recycled Fibre Plant

Name	Flow [t/h]	Fibre [ppm]
Process		
Pulping out	158.29	7300
HD Cleaning out	10.69	100000
Coarse Screens out	3.3	100000
Flotation out	35.61	4889.64
Gyroclean out	6.22	3786
Centri-clean out	9.18	10000
Fine screens out	20.62	4400
Disc filter out 1	671.35	200
Disc filter out 2	287.9	700
Wire pulp press out	162.98	500
Utility		
Cloudy out 1	119.5	600
Clear out 1	225.31	1086.55
Fresh water	44.94	0
PM white water out 1	811.59	100

Table I.3 Sink conditions from Water Pinch Model of the Recycled Fibre Plant

Name	Flow [t/h]	Fibre [ppm]
Process		
Pulping in	333.58	100
HD Cleaning in	100.24	600
Coarse Screens in	4.26	100
Flotation in	290.2	200
Gyroclean in	111.5	1086.55
Centri-clean in	258.6	200
Fine screens in 1	58.43	1086.55
Fine screens in 2	0.06	600
Disc filter in 1	119.5	600
Disc filter in 2	0.05	0
Wire pulp press in	43.2	100
Disperser in 1	145.98	100
Utility		
Rej-1 in 1	230.63	11935.41

Name	Flow [t/h]	Fibre [ppm]
Cloudy-disc in 1	748.7	627.71
Clear-disc in 1	122.55	200

Appendix J

Water Pinch Results from the Thermo-mechanical Pulp Plant

Table J.1 Routing of streams from Water Pinch Model of the Thermo-mechanical Pulp Plant

From...	...to	Flow [t/hr]
From Process...	...to Process	
Chip washer out	chip washer in 1	464.06
Chip washer out	TMP1 cloudy ww chest in 1	70.71
Chip washer out	TMP1 cloudy ww chest in 2	5.44
Chip washer out	TMP2 Latency & screens in 1	4.83
Hydrasieves out 1	Reject System in	165.27
Hydrasieves out 1	TMP1 cloudy ww chest in 1	352.52
Hydrasieves out 2	chip washer in 1	27.19
Line 1 Decker out 1	chip washer in 1	26.54
Line 1 Decker out 1	chip washer in 2	32.25
Line 1 Decker out 1	Line 1 Sec Refiner in 1	98.25
Line 1 Decker out 1	Line 2 Sec Refiner in 1	116.31
Line 1 Decker out 2	Reject System in	38.17
Line 1 Decker out 2	TMP1 cloudy ww chest in 2	148.22
Reject System out	Cooling in 2	25.5
Cooling out 1	Line 3 Decker in	20
Cooling out 2	Cooling in 1	40
Cooling out 2	Cooling in 2	41
Cooling out 2	Line 4 Decker in	64.63
Cooling out 2	TMP2 clear ww chest in 4	3.96
Cooling out 2	Line 2 Decker in	2.79
Cooling out 2	TMP1 clear ww chest in 1	14.75
Cooling out 2	cooling tower in	392.87
Line 3 Decker out 1	TMP1 cloudy ww chest in 2	273.38
Line 3 Decker out 2	Line 1 Decker in	72.96
Line 3 Decker out 2	TMP1 clear ww chest in 2	113.43
Line 4 Decker out 1	Reject System in	179.46
Line 4 Decker out 1	TMP1 cloudy ww chest in 2	93.91

From...	...to	Flow [t/hr]
Line 4 Decker out 2	hydrasieves in	101
Line 4 Decker out 2	TMP2 clear ww chest in 2	58.81
Line 4 Decker out 2	TMP1 clear ww chest in 2	13.39
Line 4 Decker out 2	TMP1 clear ww chest in 4	4.75
Line 4 Decker out 2	TMP2 Latency & screens in 1	8.44
TMP2 clear ww chest out	TMP2 clear ww chest in 1	289.13
TMP2 clear ww chest out	TMP2 clear ww chest in 2	262.84
TMP2 clear ww chest out	TMP1 clear ww chest in 2	171.77
TMP2 cloudy ww chest out	TMP2 cloudy ww chest in 2	558.22
TMP2 cloudy ww chest out	TMP1 clear ww chest in 2	11.33
TMP2 cloudy ww chest out	TMP2 Latency & screens in 1	535.42
Line 2 Decker out 1	TMP1 cloudy ww chest in 1	123.52
Line 2 Decker out 1	TMP1 clear ww chest in 2	62.87
Line 2 Decker out 2	TMP1 Latency & screens in 1	182.04
Line 2 Decker out 2	Line 3 Sec Refiner in 1	91.33
TMP1 cloudy ww chest out	hydrasieves in	444.04
TMP1 cloudy ww chest out	Line 4 Sec Refiner in 1	174.03
TMP1 cloudy ww chest out	TMP2 cloudy ww chest in 1	449.6
TMP1 clear ww chest out	Line 1 Sec Refiner in 1	76.79
TMP1 clear ww chest out	Line 2 Sec Refiner in 1	18.53
TMP1 clear ww chest out	TMP1 Latency & screens in 1	327.97
TMP1 clear ww chest out	Line 1 Decker in	9.79
TMP1 clear ww chest out	Line 3 Sec Refiner in 1	82.7
TMP1 clear ww chest out	TMP2 cloudy ww chest in 1	97.15
TMP1 clear ww chest out	TMP1 clear ww chest in 3	73.55
Sealing water out 1	Line 3 Decker in	9.5
Sealing water out 2	Line 3 Decker in	9.5
Cooling tower out	Cooling in 2	473.5
Cooling tower out	Line 3 Decker in	37.7
Cooling tower out	TMP2 clear ww chest in 2	9.8
Cooling tower out	Sealing water in	19
From Utility...	...to Process	
Fresh water	TMP2 clear ww chest in 3	14.75
Fresh water	cooling tower in	167.13
PM white water out 1	Line 2 Sec Refiner in 1	40.2

From...	...to	Flow [t/hr]
PM white water out 1	Line 3 Decker in	6.06
PM white water out 1	Line 4 Decker in	18.13
PM white water out 1	TMP2 clear ww chest in 1	83.65
PM white water out 1	Line 2 Decker in	79.97
PM white water out 1	TMP1 clear ww chest in 3	220.64

Table J.2 Source conditions from Water Pinch Model of the Thermo-mechanical Pulp Plant

Name	Flow [t/h]	Fibre [ppm]
Process		
Chip washer out	545.04	3000
Hydrasieves out 1	517.79	1325.25
Hydrasieves out 2	27.25	3140.09
Line 1 Decker out 1	273.38	1890.76
Line 1 Decker out 2	186.39	953.02
Reject System out	25.5	2000
Cooling out 1	20	0
Cooling out 2	560	0
Line 3 Decker out 1	273.38	1691.77
Line 3 Decker out 2	186.39	661.17
Line 4 Decker out 1	273.38	1718.26
Line 4 Decker out 2	186.39	700.01
TMP2 clear ww chest out	723.74	600
TMP2 cloudy ww chest out	1104.97	1500
Line 2 Decker out 1	186.39	899.07
Line 2 Decker out 2	273.38	1952.74
TMP1 cloudy ww chest out	1067.7	1500
TMP1 clear ww chest out	686.46	1000
Sealing water out 1	9.5	0
Sealing water out 2	9.5	0
Coling tower out	540	0
Utility		
Fresh water	181.88	0
PM white water out 1	450	600

Table J.3 Sink conditions from Water Pinch Model of the Thermo-mechanical Pulp Plant

Name	Flow [t/h]	Fibre [ppm]
Process		
chip washer in 1	517.79	2950.5
chip washer in 2	32.25	1890.76
hydrasieves in	545.04	1351.75
Line 1 Prim Refiner in 1	0	1500
Line 2 Prim Refiner in 1	0	1500
Line 1 Sec Refiner in 1	175.04	1500
Line 2 Sec Refiner in 1	175.04	1500
TMP1 Latency & screens in 1	510.01	1340.07
Line 1 Decker in	82.76	701.26
Reject System in	382.96	1472.63
Cooling in 1	40	0
Cooling in 2	540	0
Line 3 Prim Refiner in 1	0.03	1500
Line 4 Prim Refiner in 1	0.03	1500
Line 3 Sec Refiner in 1	174.03	1500
Line 4 Sec Refiner in 1	174.03	1500
Line 3 Decker in	82.76	905.21
Line 4 Decker in	82.76	921.14
TMP2 clear ww chest in 1	372.78	600
TMP2 clear ww chest in 2	331.45	600
TMP2 clear ww chest in 3	14.75	100
TMP2 clear ww chest in 4	4.75	100
TMP2 cloudy ww chest in 1	546.75	1411.16
TMP2 cloudy ww chest in 2	558.22	1500
Line 2 Decker in	82.76	579.75
TMP1 cloudy ww chest in 1	546.75	1445.56
TMP1 cloudy ww chest in 2	520.95	1500
TMP1 clear ww chest in 1	14.75	100
TMP1 clear ww chest in 2	372.78	700
TMP1 clear ww chest in 3	294.18	700
TMP1 clear ww chest in 4	4.75	700
TMP2 Latency & screens in 1	549.25	1500
Sealing water in	19	0

Name	Flow [t/h]	Fibre [ppm]
Cooling tower in	560	0

Appendix K

Flow Constraints for Water Pinch Model of Newsprint Circuit

Table K.1(a) Flow Constraints for Water Pinch Model of Newsprint Circuit

	P1 chip washer in 1	P2 chip washer in 2	P3 hydrasieves in	P4 Line 1 Prim Refiner in 1	P5 Line 2 Prim Refiner in 1
P1 chip washer out		flow = 0		flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0		flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0		flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0		flow = 0		
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0		
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0		
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0		
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P1 chip washer in 1	P2 chip washer in 2	P3 hydrasieves in	P4 Line 1 Prim Refiner in 1	P5 Line 2 Prim Refiner in 1
1					
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2		flow = 0			
P41 PM4 saveall out 1					
P42 PM4 saveall out 2					
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(b) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P6 Line 1 Sec Refiner in 1	P7 Line 2 Sec Refiner in 1	P8 TMP1 Latency & screens in 1	P9 Line 1 Decker in	P10 Reject System in
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1				flow = 0	
P5 Line 1 Decker out 2					
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	

	P6 Line 1 Sec Refiner in 1	P7 Line 2 Sec Refiner in 1	P8 TMP1 Latency & screens in 1	P9 Line 1 Decker in	P10 Reject System in
P13 Line 2 Decker out 1					
P14 Line 2 Decker out 2				flow = 0	
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2					
P41 PM4 saveall out 1					
P42 PM4 saveall out 2					
U1 Fresh water			flow = 0		

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(c) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P11 Cooling in 1	P12 Cooling in 2	P13 Line 3 Prim Refiner in 1	P14 Line 4 Prim Refiner in 1	P15 Line 3 Sec Refiner in 1
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0		flow = 0	flow = 0	flow = 0
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0			flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0			
P11 Line 4 Decker out 1	flow = 0	flow = 0			
P12 Line 4 Decker out 2	flow = 0	flow = 0			
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out	flow = 0	flow = 0			
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1	flow = 0	flow = 0			
P31 PM4 forming section out 2	flow = 0	flow = 0			
P32 PM4 press section out	flow = 0	flow = 0			
P33 PM5 press section out	flow = 0	flow = 0			
P34 PM5 forming section out 1	flow = 0	flow = 0			

	P11 Cooling in 1	P12 Cooling in 2	P13 Line 3 Prim Refiner in 1	P14 Line 4 Prim Refiner in 1	P15 Line 3 Sec Refiner in 1
P35 PM5 forming section out 2	flow = 0	flow = 0			
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out	flow = 0	flow = 0			
P39 PM5 saveall out 1	flow = 0	flow = 0			
P40 PM5 saveall out 2	flow = 0	flow = 0			
P41 PM4 saveall out 1	flow = 0	flow = 0			
P42 PM4 saveall out 2	flow = 0	flow = 0			
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(d) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P16 Line 4 Sec Refiner in 1	P17 Line 3 Decker in	P18 Line 4 Decker in	P19 Line 2 Decker in	P20 TMP2 Latency & screens in 1
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0		flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2					
P9 Line 3 Decker out 1				flow = 0	
P10 Line 3 Decker out 2					
P11 Line 4 Decker out 1				flow = 0	
P12 Line 4 Decker out 2					flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0		flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P16 Line 4 Sec Refiner in 1	P17 Line 3 Decker in	P18 Line 4 Decker in	P19 Line 2 Decker in	P20 TMP2 Latency & screens in 1
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2					
P41 PM4 saveall out 1					
P42 PM4 saveall out 2					
U1 Fresh water					flow = 0

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(e) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P21 Sealing water in	P22 RFP Pulping in	P23 RFP-HD cleaning in	P24 RFP coarse screens in	P25 RFP flotation in
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P21 Sealing water in	P22 RFP Pulping in	P23 RFP-HD cleaning in	P24 RFP coarse screens in	P25 RFP flotation in
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2	flow = 0				
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2	flow = 0				
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0				
P25 RFP disc filter out 2	flow = 0				
P26 RFP wire pulp press out	flow = 0				
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1	flow = 0				
P31 PM4 forming section out 2	flow = 0				
P32 PM4 press section out	flow = 0				
P33 PM5 press section out	flow = 0				
P34 PM5 forming section out 1	flow = 0				
P35 PM5 forming section out 2	flow = 0			flow = 0	
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P21 Sealing water in	P22 RFP Pulping in	P23 RFP-HD cleaning in	P24 RFP coarse screens in	P25 RFP flotation in
P38 PM5 Blend chest out	flow = 0				
P39 PM5 saveall out 1	flow = 0				
P40 PM5 saveall out 2	flow = 0				
P41 PM4 saveall out 1	flow = 0				
P42 PM4 saveall out 2	flow = 0				
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(f) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P26 RFP gyro cleaners in	P27 RFP centri cleaners in	P28 RFP fine screens in 1	P29 RFP fine screens in 2	P30 RFP disc filter in 1
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P26 RFP gyro cleaners in	P27 RFP centri cleaners in	P28 RFP fine screens in 1	P29 RFP fine screens in 2	P30 RFP disc filter in 1
P24 RFP disc filter out 1					
P25 RFP disc filter out 2			flow = 0		
P26 RFP wire pulp press out					
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2					
P41 PM4 saveall out 1					
P42 PM4 saveall out 2					
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(g) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P31 RFP disc filter in 2	P32 RFP wire pulp press in	P33 RFP disperser in 1	P34 PM4 Blend chest in	P35 PM4 silo in 1
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P31 RFP disc filter in 2	P32 RFP wire pulp press in	P33 RFP disperser in 1	P34 PM4 Blend chest in	P35 PM4 silo in 1
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1				flow = 0	flow = 0
P25 RFP disc filter out 2				flow = 0	flow = 0
P26 RFP wire pulp press out				flow = 0	flow = 0
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2					
P41 PM4 saveall out 1					

	P31 RFP disc filter in 2	P32 RFP wire pulp press in	P33 RFP disperser in 1	P34 PM4 Blend chest in	P35 PM4 silo in 1
P42 PM4 saveall out 2					
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(h) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P36 PM4 headbox in 1	P37 PM4 forming section in 1	P38 PM4 forming section in 2	P39 PM4 press section in	P40 PM5 press section in
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2		flow = 0			
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2			flow = 0		
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out					

	P36 PM4 headbox in 1	P37 PM4 forming section in 1	P38 PM4 forming section in 2	P39 PM4 press section in	P40 PM5 press section in
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1	flow = 0	flow = 0	flow = 0		
P31 PM4 forming section out 2	flow = 0	flow = 0	flow = 0		
P32 PM4 press section out	flow = 0	flow = 0	flow = 0		
P33 PM5 press section out	flow = 0	flow = 0	flow = 0		
P34 PM5 forming section out 1	flow = 0	flow = 0	flow = 0		
P35 PM5 forming section out 2	flow = 0	flow = 0	flow = 0		
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out	flow = 0	flow = 0	flow = 0		
P39 PM5 saveall out 1	flow = 0	flow = 0	flow = 0		
P40 PM5 saveall out 2	flow = 0	flow = 0	flow = 0		
P41 PM4 saveall out 1	flow = 0	flow = 0	flow = 0		
P42 PM4 saveall out 2	flow = 0	flow = 0			
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(i) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P41 PM5 forming section in 1	P42 PM5 forming section in 2	P43 PM5 headbox in 1	P44 PM5 silo in 1	P45 PM5 Blend chest in
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P8 Cooling out 2	flow = 0				flow = 0
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0

	P41 PM5 forming section in 1	P42 PM5 forming section in 2	P43 PM5 headbox in 1	P44 PM5 silo in 1	P45 PM5 Blend chest in
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P30 PM4 forming section out 1	flow = 0	flow = 0	flow = 0		
P31 PM4 forming section out 2	flow = 0	flow = 0	flow = 0		
P32 PM4 press section out	flow = 0	flow = 0	flow = 0		
P33 PM5 press section out	flow = 0	flow = 0	flow = 0		
P34 PM5 forming section out 1	flow = 0	flow = 0	flow = 0		
P35 PM5 forming section out 2	flow = 0	flow = 0	flow = 0		
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	flow = 0
P38 PM5 Blend chest out	flow = 0	flow = 0	flow = 0		
P39 PM5 saveall out 1	flow = 0	flow = 0	flow = 0		
P40 PM5 saveall out 2	flow = 0		flow = 0		
P41 PM4 saveall out 1	flow = 0	flow = 0	flow = 0		
P42 PM4 saveall out 2	flow = 0	flow = 0	flow = 0		
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Table K.1(j) Flow Constraints for Water Pinch Model of existing Newsprint Circuit

	P46 PM5 saveall in 1	P47 PM5 saveall in 2	P48 PM4 saveall in 1	P49 PM4 saveall in 2	U1 Effluent
P1 chip washer out	flow = 0	flow = 0	flow = 0	flow = 0	
P2 hydrasieves out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P3 hydrasieves out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P4 Line 1 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P5 Line 1 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P6 Reject System out	flow = 0	flow = 0	flow = 0	flow = 0	
P7 Cooling out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P8 Cooling out 2					
P9 Line 3 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P10 Line 3 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P11 Line 4 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P12 Line 4 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P13 Line 2 Decker out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P14 Line 2 Decker out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P15 Sealing water out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P16 Sealing water out 2					
P17 RFP Pulping out	flow = 0	flow = 0	flow = 0	flow = 0	
P18 RFP-HD cleaning out	flow = 0	flow = 0	flow = 0	flow = 0	
P19 RFP coarse screens out	flow = 0	flow = 0	flow = 0	flow = 0	
P20 RFP flotation out	flow = 0	flow = 0	flow = 0	flow = 0	
P21 RFP gyro cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	
P22 RFP centri cleaners out	flow = 0	flow = 0	flow = 0	flow = 0	
P23 RFP fine screens out	flow = 0	flow = 0	flow = 0	flow = 0	
P24 RFP disc filter out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P25 RFP disc filter out 2	flow = 0	flow = 0	flow = 0	flow = 0	
P26 RFP wire pulp press out	flow = 0	flow = 0	flow = 0	flow = 0	
P27 PM4 Blend chest out					
P28 PM4 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P29 PM4 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P30 PM4 forming section out 1					
P31 PM4 forming section out 2					
P32 PM4 press section out					
P33 PM5 press section out					
P34 PM5 forming section out 1					
P35 PM5 forming section out 2					

	P46 PM5 saveall in 1	P47 PM5 saveall in 2	P48 PM4 saveall in 1	P49 PM4 saveall in 2	U1 Effluent
P36 PM5 screens out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P37 PM5 cleaners & deculator out 1	flow = 0	flow = 0	flow = 0	flow = 0	
P38 PM5 Blend chest out					
P39 PM5 saveall out 1					
P40 PM5 saveall out 2					
P41 PM4 saveall out 1					
P42 PM4 saveall out 2					
U1 Fresh water					

Note: Shaded blocks indicate bounds removed in optimised model

Appendix L

Unit Operations in the Newsprint Circuit

Figure L.1 Chip washer

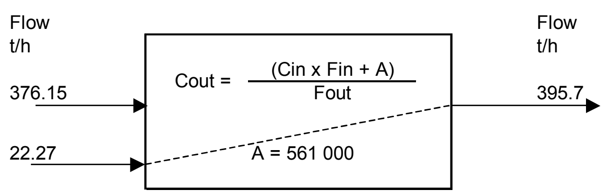


Figure L.2 Hydrasieves

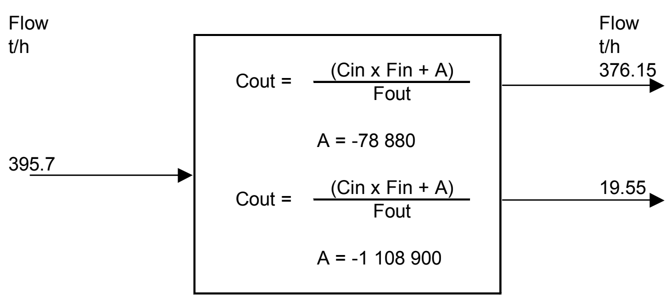


Figure L.3 Lines 1 to 4 Deckers

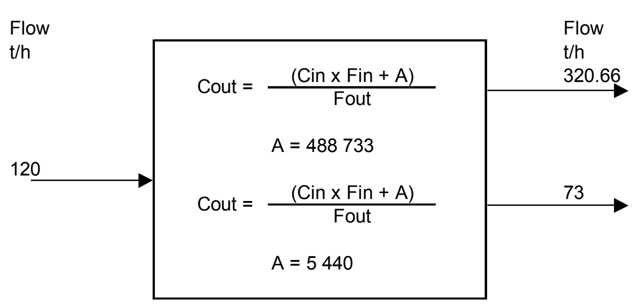


Figure L.4 Reject system

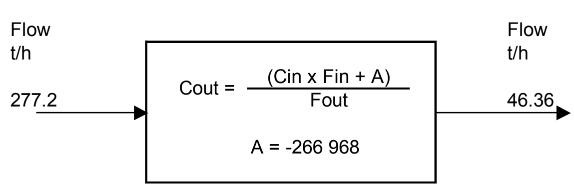


Figure L.5 Cooling

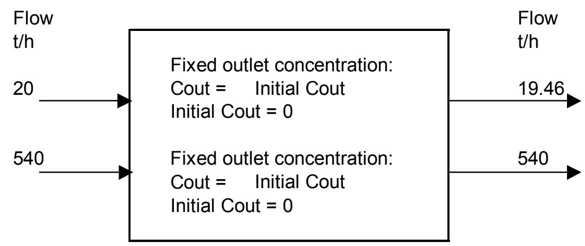


Figure L.6 Sealing water

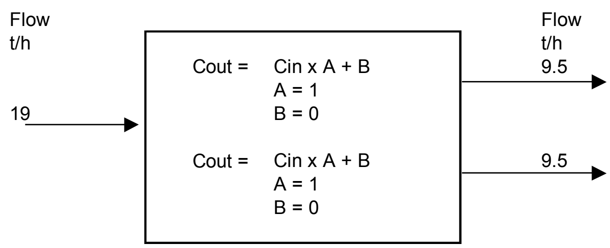


Figure L.7 Recycled Fibre Plant Pulping

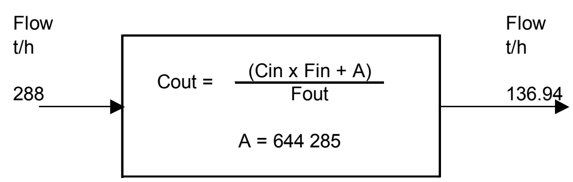


Figure L.8 Recycled Fibre Plant High Density Cleaning

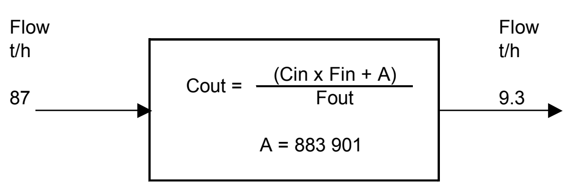


Figure L.9 Recycled Fibre Plant Coarse screens

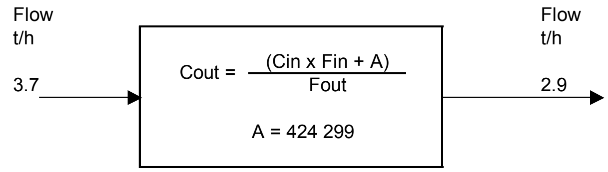


Figure L.10 Recycled Fibre Plant Flotation

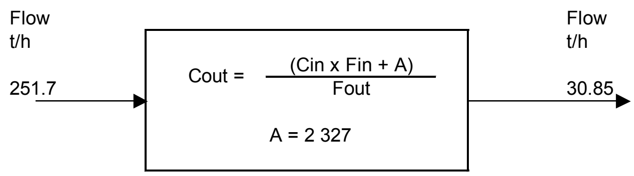


Figure L.11 Recycled Fibre Plant Gyrocleaners

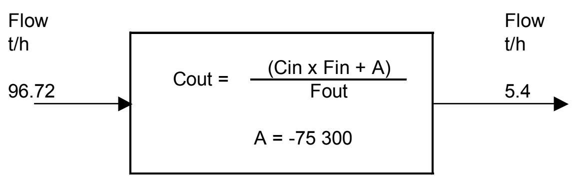


Figure L.12 Recycled Fibre Plant Centricleaners

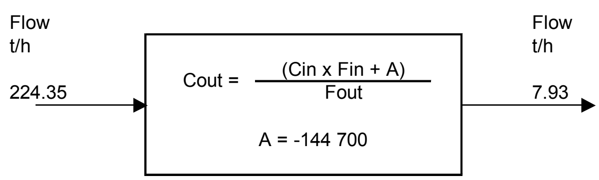


Figure L.13 Recycled Fibre Plant Fine screens

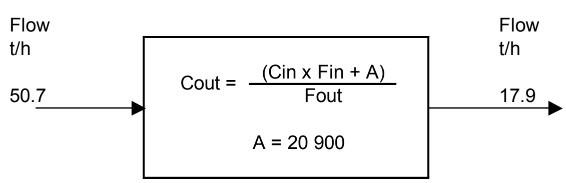


Figure L.14 Recycled Fibre Plant Disc Filter

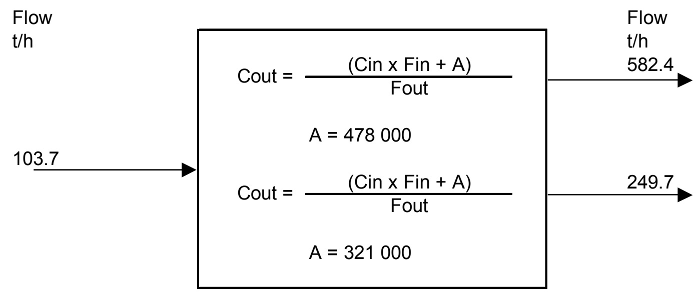


Figure L.15 Recycled Fibre Plant Wire pulp press

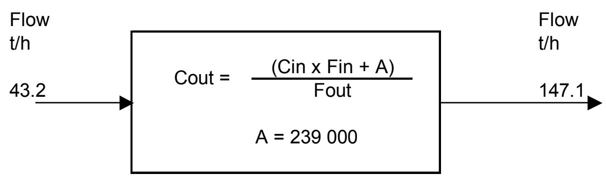


Figure L.16 PM4 Forming Section

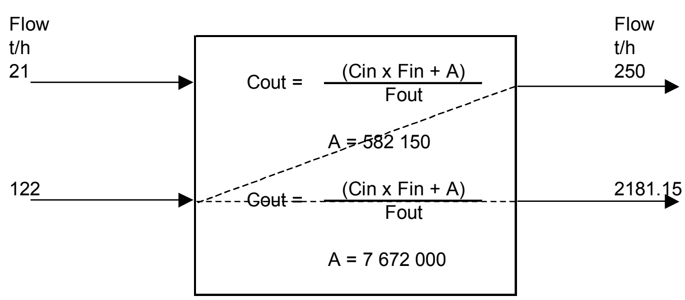


Figure L.17 PM4 Press Section

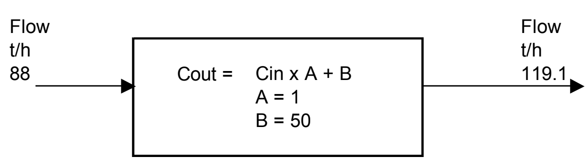


Figure L.18 PM4 Saveall

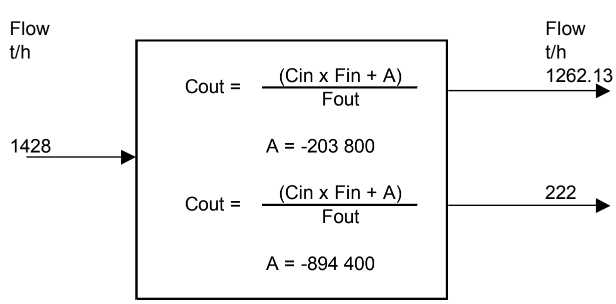


Figure L.19 PM5 Forming Section

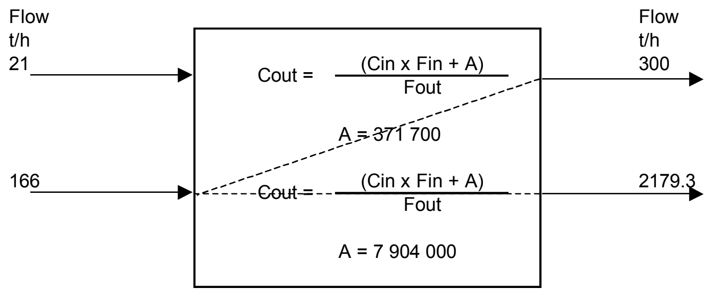


Figure L.20 PM5 Press Section

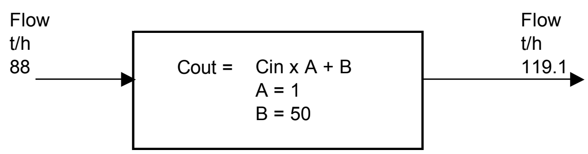


Figure L.21 PM5 Saveall