ISCOR
Flat steel

ISCOR VANDERBIJLPARK STEEL
ENVIRONMENTAL MASTER PLAN
SPECIALIST REPORT

INDUSTRIAL WATER

BY
RICHARD PAXTON & ASSOCIATES

SERIES IV
DOCUMENT IVS/SR/030
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STRICTLY CONFIDENTIAL
ISCOR VANDERBIJLPARK STEEL PROCESS WATERS MASTER PLAN REPORT
Part 1 of 2

November 2002
RPA Report No: LA1075

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CONTENTS

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1. INTRODUCTION

Members of the R. Paxton and Associates Ltd team (RPA) were originally contracted by Ockie Fourie Toxicologists (OFT) on behalf of Iscor Vanderbijlpark Steel (IVDBS) to provide a critique of the proposed OETP (Organic Effluent Treatment Plant) and the CETP (a modified Chemical Effluent Treatment Plant) during early 2000.

The OETP was perceived (circa 2000) as one of the major components of the necessary water management infrastructure for the IVDBS site. In assessing its performance requirements, an overall water management strategy was evolved some years previously. This strategy was updated and adapted to suit the ever changing requirements of the site and the ever tightening expectations of the Department of Water Affairs and Forestry (DWAF) and other interested and affected parties. The strategy had the specific aim of achieving a zero dry weather effluent flow from the site (ZED). This strategy means that as water becomes too contaminated for it to be usable anywhere on site, it has to be treated and recovered for re-use, with the solid treatment residues suitably rendered harmless or disposed of appropriately. The strategy took the view that, ideally, the recovered water should equal or exceed the highest quality water used at the site; as this would yield the greatest flexibility for re-use.

The circa 2000 Overall Strategy for water and waste management set out to achieve the following:

- Achieve zero dry weather flow to the Rietkuil Spruit
  - by processing, treating and returning all plant discharges,
  - by routing most/all of the coke oven area storm water in this OETP treatment plant
  - by routing dump leachates into OETP treatment; and
  - by routing toe seepage – e.g. Du Preez Dam into OETP treatment.

- OETP was the major cost item identified within the overall process water strategy of 2000.
  - It was to process organically contaminated waters using biological treatment.
  - followed by removal of salts (using membrane and evaporator technologies) to enable the water to be recovered as a high quality resource for re-use.

- CETP was to be rebuilt and re-arranged
  - originally to enable metal recovery (but proposals offered by contractors only offered the option of treatment only)
  - with the treated effluent being routed to OETP for salts removal.

- TETP was to be upgraded to IETP
  - to return the remainder of the dry weather process flows from the existing canal infrastructure via an undefined processing route to recover water for re-use within the works.

RPA undertook an holistic assessment of the Vanderbijlpark works as part of a team of consultants assembled by OFT. In conclusion RPA were concerned that with the passage of time, a number of the fundamental design bases had changed and it appeared that not all of these changes had been adequately accommodated in the overall strategy. As a result of these changes, the water management infrastructure would have to handle very much larger volumes of water. Examples of these changes included:

i) Ground water. Previously it was realistic to assume that all that needed to be done was stop or at least reduce further leakage to ground. However following the initial review by the OFT team, interception and recovery of all the contaminated ground water flows became essential.

ii) Discharge criteria for surface water run off. These were amended (September 1999) and as a result, much of the surface water run off which previously could be regarded as "clean enough" would breach the standards that have been set unless it is collected and either used as process water or treated before discharge.

Most particularly, virtually all of this extra water would arrive during and immediately following a rainstorm. Unfortunately, the OETP & IETP proposals in 2000 and the associated infrastructure did not adequately address these updated requirements. The whole strategy therefore needed to be rethought.

Pertinently, RPA thought that the overall strategy did not represent good value for money since Opex costs for the OETP alone amounted to some 28 million Rand per annum. Note the value of the return water is only a fraction of this (12% if return water is valued at 1 SAR/m^3). Iscor had set very high standards for the return water and RPA proposed that this was an unnecessary restriction to the innovation that could have been proposed. Furthermore the CETP replacement was thought to be an unnecessary capital expenditure.

One thing which must be remembered when one is evolving a strategy for process waters and effluents, particularly in the High Veld areas of South Africa (or other net evaporation regions which are distant from the sea), is that treating Steel Works and other similar effluents to a quality which will be acceptable for discharge to the environment is almost always more expensive than treating that same effluent or process water to a standard which would enable the whole volume to be usable elsewhere within the site. In the light of this generally proven experience and the ongoing tightening of standards to which effluents will have to be treated before they can be discharged to the environment, the concept of moving towards a Zero Effluent Discharge (ZED) is both a realistic and a pragmatic concept.

Accordingly, RPA recommended that the identification and quantification of lower grade water consumption users was an essential first step in the process of evolving a cost effective method for achieving ZED. This was particularly important in the light of the additional volumetric throughputs associated with polluted ground and storm waters that had been identified.

In particular, RPA recommended that the following types of questions needed to be answered:

Q) Could partly treated water be used for some lower grade usage so as to prevent or reduce the use of raw water?

Q) Are there input streams to the total source of waste water which (before they mix with the rest) are clean enough to be used elsewhere?

Q) Are there individual effluents which contain components which will assist the treatment of other effluents?

RPA proposed that a suitably holistic approach, with cash flow and value for money at the top of the agenda, a new strategy could be developed which would not only be compliant but also considerably cheaper in terms of both capital and operating costs. To that end RPA as part of the OFT Master Plan Team were engaged to identify a flexible strategy to achieve the Zero Effluent Discharge (ZED) objective.

1.1 RPA'S UNDERSTANDING OF ZED

At this point it is appropriate to set out RPA's understanding as to what is meant by ZED.

When RPA first came to the IVDBS site, the Exemption 1998B was in force as regards all aqueous discharges from the site.

The DWAF granted Exemption 1998B under the terms of section 21 (4) of the Water Act (1956) to IVDBS. At Clause 13.2, this Exemption sets out a sequence of implementation target dates for the plant and equipment, which prior to RPA's involvement had been presented to the DWAF as the proposed means for achieving compliance with Clause 13.3. All this plant and equipment would only have been able to achieve zero dry weather flow, not zero effluent flow. This is because the existing storm water canal infrastructure was being used to collect the majority of the relatively low pollutant content effluents.

At Clause 13.3 Exemption 1998B states:- "No discharge of any effluent, seepage and or polluted Stormwater shall take place after 31st December 2005."

In effect, this defines what was understood by the Authorities as to what was meant by ZED. The only issues that were not made clear by this Clause were what constituted "seepage" and at what level of contamination did clean storm water become "polluted" storm water.

If, rather than looking at all the potential legal arguments and interpretations, one refers to the essential essence of what was driving the terms of the Exemption, then it would be reasonable for a responsible person or body to assume that:-

- seepage only refers to ground water flows or out flows where the quality of that ground water exceeds either the acceptable discharge conditions for the

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receiving water course or the acceptable criteria for the current or likely ground water usage.

- polluted storm water refers to storm water which has become so contaminated that its quality exceeds the acceptable discharge conditions for the receiving water course.

The Exemption sets out what at the time was deemed to be acceptable sets of conditions as regards the relevant qualities of water which could be discharged a) to the RietSpruit Canal and b) to the LeeuSpruit. It would follow, therefore that the applicable water quality conditions, upon which the original commitment to ZED before the end of 2005 were made, would be those that were presented in Exemption 1998B.

Clearly, there would (or should) have been an understanding by all concerned that the relevant water quality criteria would tighten progressively with time. As a result, the fundamental planning and the process designs that were needed in order to achieve ZED had to be such that this progressive tightening could be accommodated by a systematic sequence of upgrades rather than by some form of "start again" approach at some time in the future.

RPA's key role, therefore was to look at all the process effluents and process waters and in conjunction with the rest of the overall Holistic Master Plan Studies, evolve a more appropriate way of achieving compliance with the above concept of ZED. In addition RPA had to define a method by which this ZED could be achieved within the originally agreed time scale of "before the end of 2005".

2. METHODOLOGY AND APPROACH

The detailed scope of the RPA involvement in the Vanderbijlpark Master Plan was set out in document 484/LA012 which was titled "RPA Costs to the point of completion of the Environmental Master Plan for Industrial Water" and dated 13th June 00. In essence the consultancy role was split into the following elements:

- Confirm the alternative strategies / objectives outlined in the previous RPA critique of the OETP based system.
- Using direct contact with plant staff plus existing site data, RPA would characterise all industrial water uses (qualities and quantities) and determined the controlling criteria as to the necessary quality requirements via an appreciation of the technology employed. Similarly the potential for change as a result of planned/possible future plant or process changes was evaluated.
- Review options for reducing effluent flows / concentrations at source or for using local treatment recovery / etc technologies
- Introduce / refine flow and quality measurement arrangements and accumulate / interpret data as necessary
- Run tests / pilot studies for potential re-use / recovery / treatment options (especially for cold and hot mill recycling areas)
- Develop and update overall water and contaminants balance and integrate with surface water balance
- Evolve and rank optional strategies for recycling, re-use and treatment.
- Review bio-treatability options and define any experimental studies that may be required (desk and literature study plus review of experience from operating facilities)
- Revisit OETP technology and options (as proposed in 2000 tenders received)
- Revisit CETP technology / options for upgrade (as proposed in 2000 tenders received)
- Review options for existing bio-plant upgrade
- Review Options for TETP upgrade to IETP (as proposed in 2000)
- Overall integration with surface water, ground water, leachates, air pollution control effluents and any future / possible projects
- Generate Master Plan definition for process waters inclusive of outline budgets and timescales
- Review this proposal with Iscor Management and DWAF and the other interested/affected authorities as required.

It was clearly understood at the time of beginning the process waters Master Plan that the exact definitions of specific inputs from groundwater and surface water would be critical to the development of the Process Waters Master Plan. However, it was also clear that a final definition of these inputs would only become available after the completion of the rest of Master Plan studies. This meant that some of the plan components and the associated designs that have been developed may have to be amended once these other inputs are defined.

RPA therefore sought to have as much definitive input as possible from other OFT Team members plus best estimates and worst case predictions for all undefined / potential aqueous input streams.

The original concepts for the Process Waters Master Plan were evolved during the latter part of 2000 and early 2001. They were drawn together into an overall coherent whole by the middle of 2001.

The integration of the Coal Gas Cleaning Project and the options for integrating the Sinter Off-Gas Cleaning options were then adjusted and shaped to suit this form of the Process Waters Masters Plan.

During early 2002, the time table for achieving ZED by December 2005 necessitated the confirmation of the Process Waters Master Plan so that realistic process designs could be completed and Tender Documents could be prepared. This necessitated that either specific aspects of the remainder of the Master Plan studies had to be finalised or the existing assumptions that had been made by RPA had to be used. Whilst information was received in May 2002 regarding the likely qualities and quantities of ground waters that would have to be handled, assumptions had to be made as regards the following areas:

a) the nature of surface waters that would eventually have to be processed and
b) the nature and the capabilities of the infrastructure which would be available on site for the treatment and disposal of the residues from the ZED infrastructure.

3. BASELINE STUDIES

3.1 SITE WATER USE

3.1.1 WATER CONSUMPTION RATES

ISCOR obtains its water from 3 sources

- Via abstraction from the Vaal River;
- A direct supply from the Vaal Dam; and
- A line connecting the Works with the Domestic water supply reservoir.

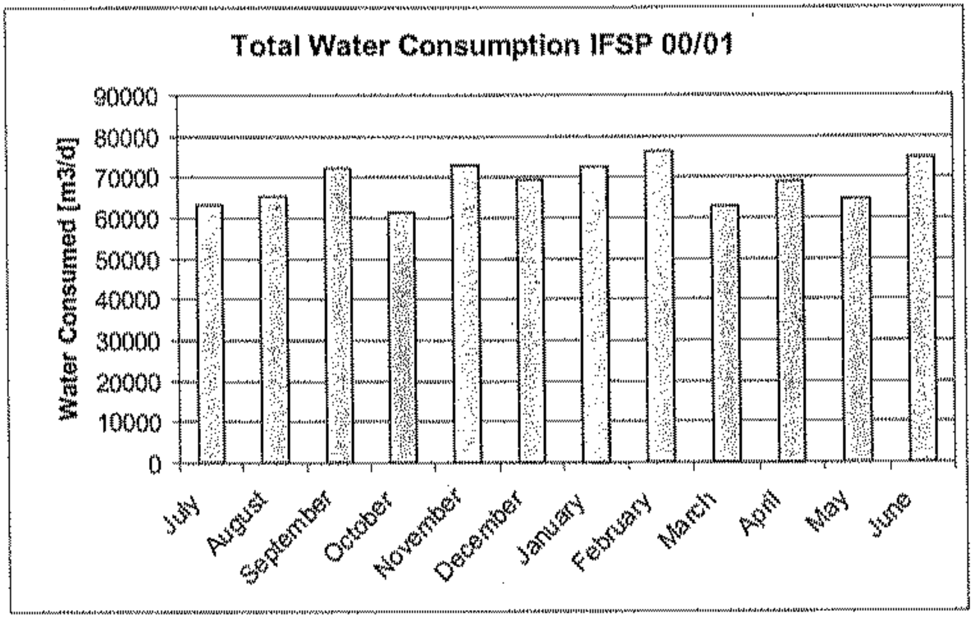
The following table sets out a summary of water usage during the period July 2000 to June 2001

All Flows in m^3	Vaal River	Vaal Dam	Domestic Supply
Average Daily	32,062	32,364	4,883
Average Monthly	971,882	981,373	148,247
Maximum Daily*	35,853	35,196	5,980
Maximum Monthly	1,069,434	1,047,500	185,381

* note the maximum daily is calculated from monthly volume data and hence does not reflect an actual peak value.

3.1.2 WATER CONSUMPTION PROFILE

Consumption is fairly stable throughout the year (The graph below illustrates the monthly water use for 2000/1):



The individual water supply sources from the Vaal River and Vaal Dam are subject to stable consumption patterns. Domestic water consumption is being targeted for a phased reduction.

3.1.3 WATER USE BREAKDOWN (BY BUSINESS UNIT)

The table below illustrates an approximate breakdown of the on-site consumption of Vaal River and Vaal Dam Water. It is based on monthly reported figures between July 2001 and October 2001. During this particular period the water used by the site overall was characterised as follows:

All Flows in m^3	Vaal River	Vaal Dam
Average Daily	36,853	31,770

Process Water Consumption by Plant Area

All flows in m^3/day	Vaal River		Vaal Dam	
	Average	Maximum	Average	Maximum
Coke Ovens Process Waters	**4680**	**5021**	-	-
Coke Quenching, Gas Scrubbing, Cooling water	4680	5021	-	-
Blast Furnace Process	**9543**	**11048**	**16**	**17**
Gas scrubbing, cooling and slag quench top up	3665	4410	-	-
Turbines	5878	6639	-	-
Make up for closed circuit cooling	-	-	16	17
Direct Reduction	**3571**	**4576**	**6755**	**7495**
dust supression, scrubbing, misc	3571	4576	3080	3617
Boilers and water softening demin plant	-	-	3675	3842
Electric Arc Furnaces	**199**	**248**	**1505**	**1754**
Slag Cooling	199	248	1505	1754
Basic Oxygen Furnaces	**3746**	**4878**	**267**	**306**
Gas cleaning	1688	2466	-	-
Gas cleaning LD Furnaces	2059	2412	-	-
Cooling circuit make up and Miscellaneous	-	-	267	306
Continuous Casting	**3602**	**4694**	**1036**	**2047**
cooling water V3, plus minor misc	1228	1585	30	43
Cooling water V1 & V2, plus minor misc	2375	3109	1006	2004
Hot Mills (North & South Works)	**1028**	**1161**	**4476**	**5133**
Hot strip mill north, roll table	-	-	4476	5133
Hot strip mill south	1028	1161	-	-
Cold Mills (North Works)	**0**	**0**	**3725**	**4202**
Electro Galvanising Line	-	-	214	230
Continuous Annealing Line	-	-	518	549
Galvanising Line	-	-	158	220
Pickle Line	-	-	668	728
OTHER: annealing, rolling, compressors	-	-	2168	2476
Cold Mills (South Works)	**0**	**0**	**8794**	**9374**
Paint Line	-	-	158	167
Pickle line	-	-	1383	1592
Rolling, Acid Recovery, Cleaning Lines etc	-	-	4009	4182
Continuous annealing line	-	-	243	354
Tinning Line	-	-	3000	3079
Demin Plant	-	-	**3181**	**3348**
High pressure boilers predominantly	-	-	3181	3348

Water entering the site from the two principal sources (Vaal River & Vaal Dam) is treated separately within dedicated plants prior to distribution through the works. There is a feed of typically 100 000 cubic meters per month of Vaal Dam Water entering the treatment plant for the Vaal River Water supply. Therefore strictly speaking some 10% of the identified Vaal River usage in the above table is in fact Vaal Dam Water. The balance unaccounted for in the above table (less than 10% of the total water supplied) is utilized in a variety of locations around the works, including pump station make up, on-site external companies e.g. Suprachem and centralized functions such as transportation, horticulture, etc

The works has a substantial requirement for steam and for high quality make-up waters for closed circuit cooling systems and within the cold mill operations such as for cold rolling and for surface finish and rinse waters. Also, clarified Vaal Dam water is used for treatment in the demineralisation plants. The demineralised water is used as feed to the steam boilers and for the above high quality uses. The regeneration effluent from the demineralisation plants is almost entirely routed to the desalination plant. Distillate from the desalination plant is recycled back as feed water via the Vaal Dam reservoirs.

3.2 MAIN EFFLUENT SYSTEMS

3.2.1 CENTRAL EFFLUENT TREATMENT PLANT (CETP)

In essence, the central effluent treatment plant receives five different effluent types. These mainly originate from the North and South cold mill area. These effluent streams include:

- Oily effluent (which also contains tallow)
- Chrome containing effluent
- Tin and fluoride containing effluent
- Acidic effluent containing hydrochloric acid, sulphuric acid and ferrous chloride/sulphate
- Alkaline cleaner effluent

The different effluents are combined into an integrated treatment system that maximises the co-treatment possibilities so as to bring about chromium reduction and metals precipitation as well as fluoride and sulphate precipitation. Oil and tallow is recovered for resale. The system is required to generate a final effluent of a quality appropriate for ultimate discharge via the Terminal Effluent Treatment Plant system.

The net dry weather flow from the CETP system including the sludge dam overflow typically averages about 340m^3/hr. RPA have set out in some detail within section 3.4 of this Master Plan report the effluent generation sources together with their qualities and volumes, however by way of an overview summary the following table is presented:

CETP Effluent Sources & Volumes	All flows in m^3/day
Coke Ovens Process Waters	**0**
Blast Furnace Process	**0**
Direct Reduction	**0**
Electric Arc Furnaces	**0**
Basic Oxygen Furnaces	**0**
Continuous Casting	**0**
Hot Mills (North & South Works)	**0**
Cold Mills (North Works)	**2064**
Electro Galvanising Line No 4	72
Continuous Annealing Line No2	72
Oily Effluents (rolling etc)	984
Acid Effluents (Pickle Line)	936
Cold Mills (South Works)	**6144**
Alkaline effluents (Paint Line, DWI, Tin, cleaning)	2640
Acid Effluents (Pickle line)	240
Oily effluent (rolling Lines etc)	960
DWI Mixed effluent	168
Chrome effluent (Tin line)	1296
Stannous Effluents (Tin Line)	840
Demin Plant	**0**

3.2.2 TERMINAL EFFLUENT TREATMENT PLANT

The Terminal Effluent Treatment works (TETP) receives water from the South Works and North Works via a number of canals which discharge into the North Buffer Dam and the South Buffer Dam. In conjunction with IVDBS central services staff the site's effluent generation and routing into the terminal effluent treatment plant was established (see RPA drawing 484/LA1076 below).

The South Works cooling circuits blowdown and similar quality effluents are mainly discharged to these canals and flow down to these Dams. The North Buffer Dam also receives CETP plant effluent as well as all the North Work's cooling circuits blowdown and related effluents. Storm Water from South Works and from the ore, coal, coke and other raw material storage areas is also routed via these canals to these dams.

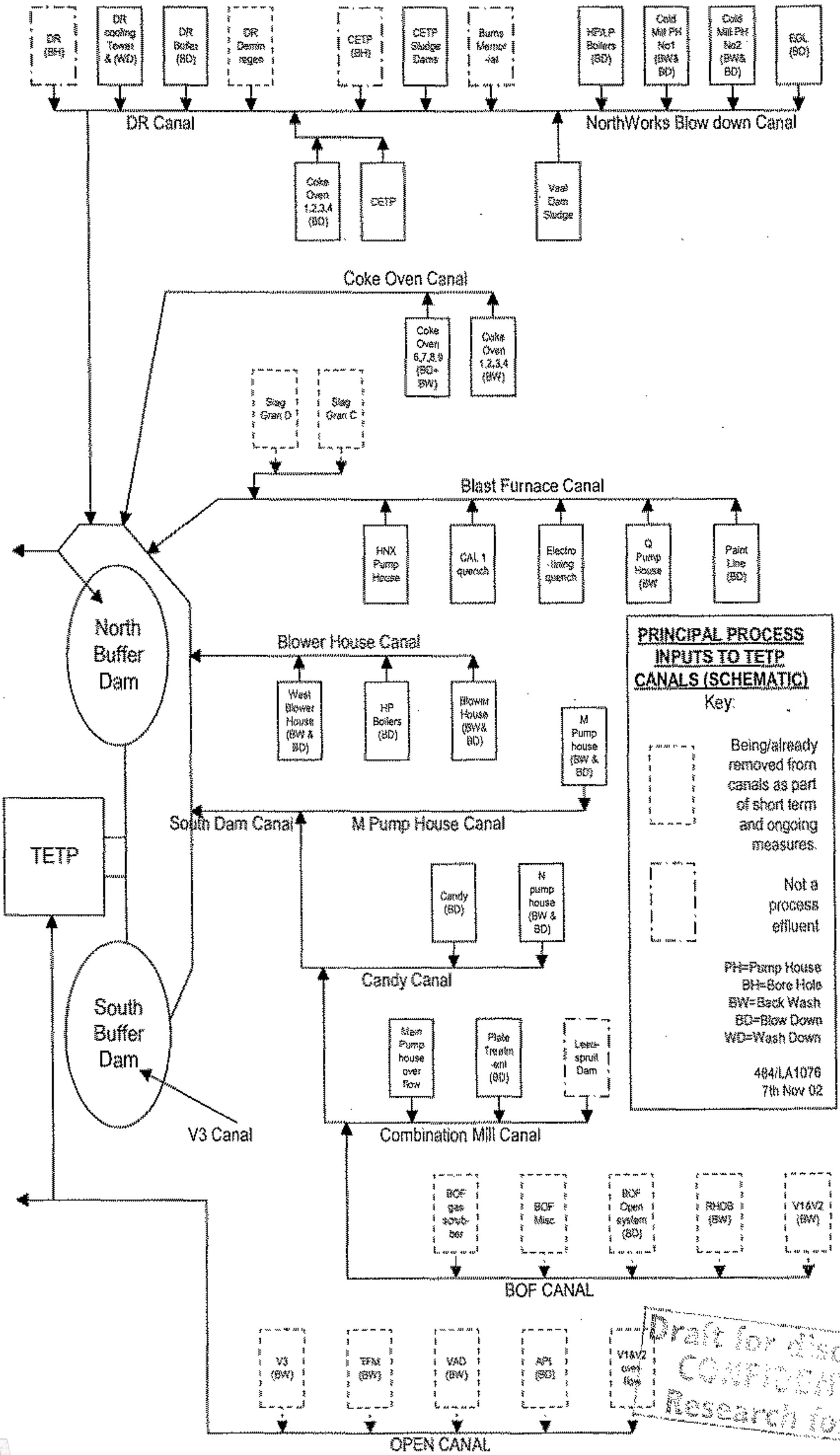
The Terminal Effluent Treatment Plant utilises physical-chemical treatment involving:

- Grit removal
- Oil and grease removal
- Coagulant and flocculant dosing and gravity separation
- Sand filtration
- Chemical biocide dosing

The final treated effluent is discharged to the Reitspruit Canal. Sludge generated by the TETP plant is disposed of to a dedicated sludge dams located next to the plant.

Indicatively the net dry weather flow from the TETP system including the sludge dam overflow is typically between about 1200 and 1300m^3/hr. RPA have set out in some detail within section 3.4 of this Master Plan report the effluent generation sources together with their representative qualities and volumes, however by way of an overview summary the following table is presented:

For specific effluent qualities please refer to the appropriate plant area baseline study information presented with section 3.4 below. Note the canals leading to the TETP infrastructure are subject to regular monitoring by IVDBS central services staff and a typical canal analyses data (dry weather) can be found in the table within section 3.3.1.


DR (BH)
DR cooling Tower & (WD)
DR Boiler (BD)
DR Demin reges
CETP (BH)
CETP Sludge Dams
Burns Memor -ial
HP/LP Boilers (BD)
Cold Mill PH No1 (BW& BD)
Cold Mill PH No2 (BW& BD)
EGL (BD)
DR Canal
NorthWorks Blow down Canal
Coke Oven 1,2,3,4 (BD)
CETP
Vaal Dam Sludge
Coke Oven Canal
Coke Oven 6,7,8,9 (BD+ BW)
Coke Oven 1,2,3,4 (BW)
Slag Gran D
Slag Gran C
Blast Furnace Canal
HNX Pump House
CAL 1 quench
Electro -tining quench
Q Pump House (BW
Paint Line (BD)
North Buffer Dam
Blower House Canal
West Blower House (BW & BD)
HP Boilers (BD)
Blower House (BW& BD)
M Pump house (BW & BD)
TETP
South Dam Canal
M Pump House Canal
Candy (BD)
N pump house (BW & BD)
Candy Canal
South Buffer Dam
Main Pump house over flow
Plate Treatm -ent (BD)
Leeu- spruit Dam
V3 Canal
Combination Mill Canal
BOF gas scrub- ber
BOF Misc
BOF Open system (BD)
RHOB (BW)
V16V2 (BW)
BOF CANAL
V3 (BW)
TFM (BW)
VAD (BW)
API (BD)
V1&V2 over flow
OPEN CANAL
PRINCIPAL PROCESS INPUTS TO TETP CANALS (SCHEMATIC)
Key:
Being/already removed from canals as part of short term and ongoing measures.
Not a process effluent
PH=Pump House
BH=Bore Hole
BW=Back Wash
BD=Blow Down
WD=Wash Down
484/LA1076
7th Nov 02

Assessed Effluent Flows to TETP	All flows in m^3/day
Coke Ovens Process Waters	**1440**
Cooling water only (other effluents routed to bioplant for use at coke quench)	1440
Blast Furnace Process	**4248**
Misc Cooling Blowdown	1608
Gas Scrubbing effluents routed to coke quench	0
Blower house system blowdown	2640
Direct Reduction	**2664**
dust supression, misc	0
Boilers and water softening demin plant plus Cooling tower blowdowns	2664
Electric Arc Furnaces	Effluent systems integrated as part of short term measures. Effluents cascade between plant functions. Ultimately **1968 m^3/d** is routed to slag granulation and then on to the desalination plant. Hence other than for leakages there is zero flow to TETP.
Misc cooling blow down to Slag Cooling	
Basic Oxygen Furnaces	
Gas cleaning	
Gas cleaning LD Furnaces	
Cooling circuit make up and Miscellaneous	
Continuous Casting	
Cooling water V3, plus minor misc	
Cooling water V1 & V2, plus minor misc	
Hot Mills (North & South Works)	**2640**
Hot strip mill north	1128
Hot strip mill south	1512
Cold Mills (North Works)	**1128**
Misc Blowdowns	1128
Cold Mills (South Works)	**4800**
Paint Line	82
Electrotinning Quench	4464
CAL No1 Quench	168
Misc Blowdowns	86
Demin Plant	**0**
Miscellaneous (leakages, pump house overflows)	**4080**
CETP Discharge	**8202**
CETP Effluent discharge	7248
CETP Sludge dams aqueous return	960

3.2.3 EVAPORATION DAMS

The Vanderbijlpark Works site has a number of evaporation and effluent cathcment and containment dams. These include:

- **Dam 10** This dam has been used in the past as a collection point and surface evaporator for all organically or ammonia contaminated waters from the Coke Oven, By-Products and Suprachem areas, together with most of the surface waters from those areas. It has also received effluents which are normally handled by the CETP but which for one reason or another were not able to be treated at the CETP.

  Over the course of the last two years, all such inputs to this Dam have been stopped together with all Stormwater flows from elsewhere on the site. Dam 10 is now being steadily emptied, partly by evaporation, partly to Dams 1 to 4 and partly to process.

- **Evaporation Dams 1-4**. These Dams are now basically a single large surface area evaporation dam. They currently receive waters which are collected by the leachate and surface water run off arrangements that are associated with the main Dump (principally the Du Preez North and South catchment systems). In the past, the Dams also received excess waters which were pumped from Dam 10. Once Dam 10 is emptied, this source will stop. Also, as rehabilitation work progresses on the Dump, the amount of water collected by the Du Preez catchment will reduce and its quality will improve. A Dam 4 pump station collects seepage from the dams and recycles it back to the dams.

- **Maturation Dams.** These Dams receive and evaporate the excess volumes of water produced within the Coke Oven, By-Products and Suprachem areas. Over the course of the last two years the average net quantity of these waters has been reduced to zero. Indeed, an average small net removal is starting to occur.

  Over time, a considerable natural biological treatment capability has evolved within these Dams which has steadily removed the majority of the total organic contaminant load from within the waters contained within the Dams and from much of the sludge which has also accumulated. This natural biological treatment is ongoing.

3.3 SITE PROCESS WATER MASS BALANCE:

A water balance for the site is provided in the attached figure, titled "OVERALL PROCESS WATER BALANCE IFSP" - RPA drawing 484/LA990B. Note that the drawing is an indicative overview picture that concentrates on the net flows currently reaching the Terminal Effluent Treatment Plant as such it does not fully represent all the internal water and effluent recycle systems in place at the works.

3.3.1 CANAL QUALITY & VOLUME DISCREPANCIES

IVDBS have established and have operated for many years a regular monitoring program for the individual canals and this data was regularly forwarded to RPA. Separately, as part of the Master Plan Baseline studies RPA worked closely with the IVDBS central services team to identify and characterise each effluent that is generated at each individual plant area discharge point and to identify the routing of each effluent into the canal infrastructure (see RPA drawing 484/LA1076 within section 3.2.2). RPA then set out to reconcile the aggregated sums of the individual effluent streams in relation to the individual canal sampling data.

RPA were concerned that there appeared to be a consistent difference between the volumetric flows that were measured for both the canals and the TETP final discharge relative to the individually aggregated totals for all the individual inputs to each canal and to the TETP. For example the flow out of TETP was on average about 1800m^3/hr but the identified and accounted total of all the individual flows was on average about 1250m^3/hr, a difference of 550m^3/hr.

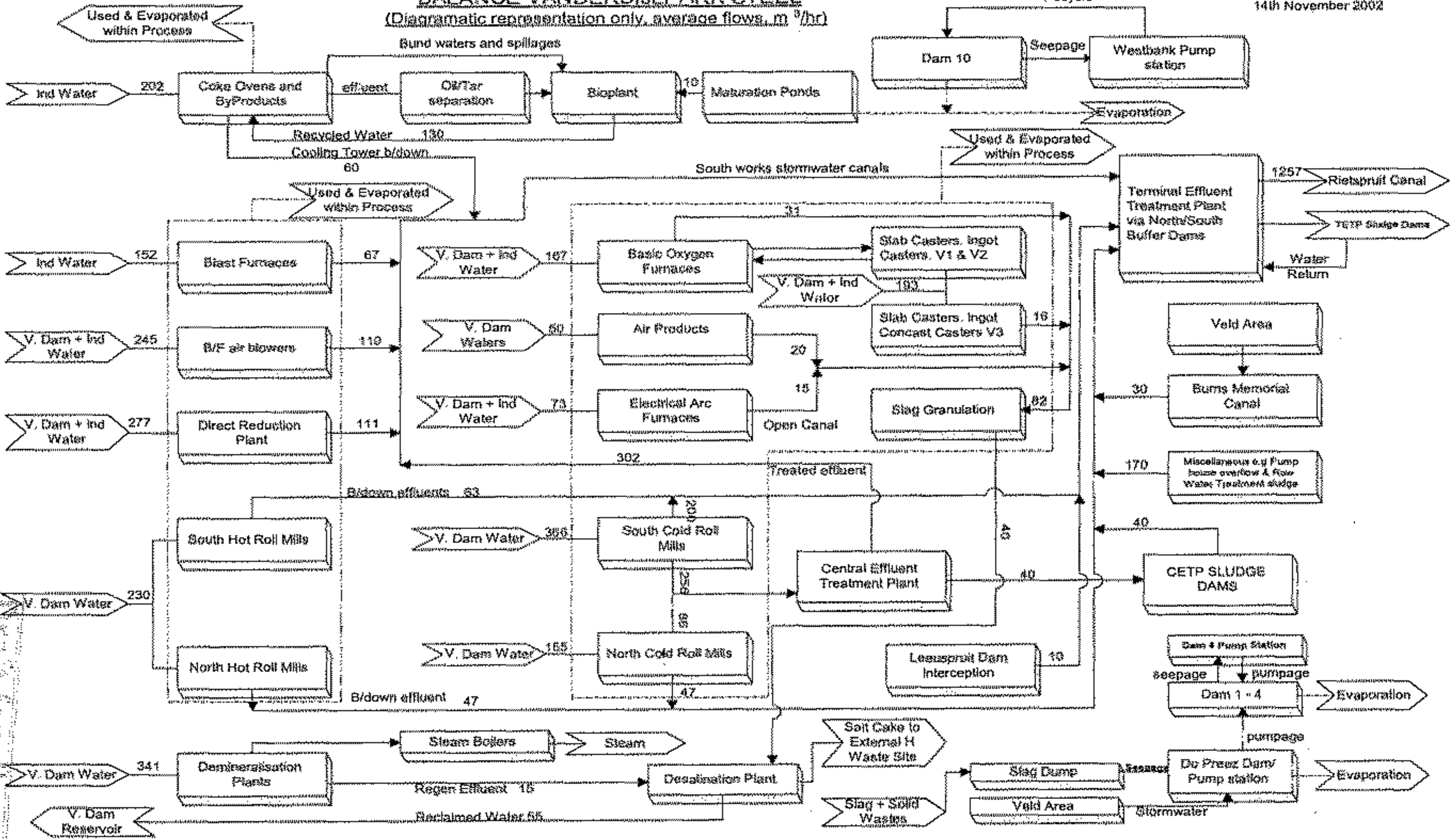
Interestingly, whilst the volume numbers did not agree well between the data sets, the concentrations were equivalent. It was recognised that the canal monitoring stations would account for rainfall that is collected within the same canal infrastructure, whilst the individual process effluents did not include rainfall. However logically one would assume that the higher volumetric flow that was measured in each canal and for the TETP would be associated with a reduction in the respective final effluent concentrations that were recorded (since rainfall should, in theory at least, have a lower concentration of contaminants than the individual effluent inputs).

CURRENT

CURRENT PROCESS WATER AND DRY WEATHER BALANCE VANDERBIJLPARK STEEL

(Diagramatic representation only, average flows, m ^{3}/hr)

R. Paxton and Associates Limited
Drawing 484/LA990-B
14th November 2002



However, the concentrations of the aggregated effluent streams in mg/l terms matched well with the canal monitoring stations. For example, for the DR canal, the calculated chloride concentration from the aggregated sum of the individual effluents was 364mg/l. This agreed well with the average chloride concentration for the DR canal monitoring station of 391mg/l. In fact, if rainfall derived dilution was occurring within the canal, then the DR Canal measured value should, in theory, be less than the 364 aggregate value.

RPA in conjunction with VRF examined the calibration of the flow measuring flumes. Whilst errors were found, these did not account for the majority of the above difference. If the flow and sampling concentrations were representative, then at the TETP the 550m^3/hr of additional effluent (of the same strength as the aggregated effluent streams) would need to be accounted for. This additional amount if it existed) would have a major potential impact on the likely ZED process infrastructure.

RPA carefully examined the individual canal data that had been logged by IVDBS and thoroughly investigated the relationship between the measured canal flow and the associated measured analysis. To that end, each flow and the respective set of analyses for each canal and the respective TETP final discharge data from the monitoring stations were arranged in such a way that new averages could be established based on all data for that canal with a flow rate which was less than an adjustable flow criteria. For example if the total flow out of TETP measured at the monitoring station exceeded 40 000 kl/day then the data for that day was not included within the averaging process. Accordingly RPA established a wide range of averages for individual canals for differently assumed flow criteria.

The table below sets out the canal analysis leading into the Blower House Canal. It is clear that despite a considerable range in the average flow rate criteria, the actual effluent compositions to not vary significantly. Hence RPA deduced that the continuous 24 hour sampling devices that were being used could not be providing a true volume related sample (i.e. if the volume of effluent on a particular day was multiplied by the analysis from this sampler, the result was not representative of the actual amount of dissolved components which had been discharged).

BLOWER HOUSE CANAL						
Average Rule	Flow < (kl/d)	5000	4500	3800	3300	2900
Avg Flow	kl/d	3316	3256	2813	2566	2132
	m^3/hr	138	136	117	107	89
Avg Cond	µS/cm	782	792	818	824	852
Avg Cl	mg/l	77	78	77	75	103
Avg SO_4	mg/l	148	150	162	163	159

RPA discussed this deduction with the relevant IVDBS Central Services personnel and it was agreed that the continuous sampler draws a fixed volume of sample per hour, irrespective of the effluent flow past the sample point. Therefore it would not be valid to assume that the total mass of salts leaving the site can be calculated as the product of the average flow multiplied by the analysis results (in mg/l) from the current sampling mechanisms.

This anomaly will have important consequences if the IVDBS site were to have mass limits imposed rather than concentration limits at the discharge into the Reitkuilspruit.

The table below sets out the average canal analysis summary both into and out of the TETP. The table includes (in un-shaded rows) the aggregated total for all the individual effluents that were obtained from the RPA assessments of individual process areas. The blue shaded areas represent the average canal analyses as provided by IVDBS Central Services for the 6 months up to January 2002. The yellow shaded areas represent the average canal data from October 01 to April 02, whereby the selection and averaging criteria has been defined. Note the criteria that have been selected and presented include analysis data for all flows less than the average flow in the original source data. In other words, if rain derived dilution was occurring, then each analysis value for these lower flows should be consistently higher than the respective average value for the average flow. They are not. Within experimental scatter, they are the same.

It is on this basis that RPA remain confident that the individual dry weather process related effluent streams provide a valid representation of the aggregated dry weather process related effluents arriving at TETP, some 1200 to 1300m^3/hr.

TETP MASS BALANCE

Canal	ANALYSIS BASIS	Flowrate (m^3/h)	Tot hard	Ca hard	P alk	Tot alk	Cl	SO_4	COND	F	Na	NH_3	CN
DR canal	Theoretical from sum of identified streams as part of baseline studies	477	667	556	4.5	94	364	277	2034	4.6	126	1.4	0.09
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	750	594	444	0.0	82	391	256	2741	3.1	84	6.3	0.09
	Canal Analysis Avg (Rule Flow < 17 500 kl/d)	459	670	545	0	78	361	346	1879	4	87	4	0
Coke Oven canal	Theoretical from sum of identified streams as part of baseline studies	137	307	173	5.6	109	97	181	1474	0.5	71	2.2	0.02
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	9	470	291	1.2	93	117	360	1557	1.4	78	12.8	0.17
	Canal Analysis Avg (Rule Flow > 1 200 kl/d)	181	503	358	0.8	94	184	396	1643	2.6	77	3.2	0.06
Blastfurnace canal	Theoretical from sum of identified streams as part of baseline studies	258	333	270	3.7	78	91	303	937	3.6	61	1.1	0.01
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	224	248	163	0.1	96	72	147	751	0.7	40	3.6	0.15
	Canal Analysis Avg (Rule Flow < 5 700 kl/d)	208	298	199	0.0	95	113	213	940	1.1	53	4.7	0.10
Blowerhouse canal	Theoretical from sum of identified streams as part of baseline studies	120	159	93	5.2	109	44	84	556	0.5	32	0.0	0.00
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	185	202	114	1.0	126	39	107	604	0.4	37	0.3	0.04

	Canal Analysis Avg (Rule Flow < 4 800 kl/d)	117	264	172	2.4	108	77	162	818	1.0	52	1.0	0.08
Canal	**ANALYSIS BASIS**	**Flowrate (m^3/h)**	**Tot hard**	**Ca hard**	**P alk**	**Tot alk**	**Cl**	**SO_4**	**COND**	**F**	**Na**	**NH_3**	**CN**
South dam canal	Theoretical from sum of identified streams as part of baseline studies	202	222	128	2.9	119	57	134	851	0.7	50	0.3	0.00
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	172	214	126	3.7	136	53	146	782	1.1	61	0.3	0.06
	Canal Analysis Avg (Rule Flow < 3 800 kl/d)	123	223	124	5.2	154	54	179	854	1.5	68	0.2	0.08
Open canal	Theoretical from sum of identified streams as part of baseline studies	65	463	270	11.1	219	110	318	1314	1.2	104	0.0	0.06
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	76	277	192	20.0	114	67	244	1112	1.6	101	1	0.06
	Canal Analysis Avg (Rule Flow < 2 000 kl/d)	53	307	190	6.7	114	65	284	1061	1.9	82	0.8	0.06
Final effluent	Theoretical from sum of identified streams as part of baseline studies	1258	429	328	4.6	104	186	233	1381	2.8	84	1.1	0.04
	SUM Canal Analysis Avg by Rules stated above	1142	469	352	1	96	211	290	1413	3	73	3	0.08
	Actual Overall Canal Analysis (Nelius Joubert Balance Jan 02)	1798	420	322	0.0	84	223	199	1320	2.2	89	1.1	0.03
	Canal Analysis Avg (Rule Flow < 40 000 kl/d)	1398	449	333	0.0	85	196	255	1343	2.4	78	0.9	0.05

3.4 BASELINE STUDY FINDINGS BY INDIVIDUAL AREA

The following sections within chapter 3 of the Industrial Process Water Master Plan follow the zones identified on FMA drawing "Vanderbijlpark Steel – The Works Study Area and Adjacent Neighbouring Areas *Business Units*" File ref STEEL004. Each plant area in turn is discussed in detail in terms of both water consumption and effluent generation.

SM01 STEELSERVE AREA

Steelserve sump was installed part of Short Term Measures to prevent contaminated waters from running of into Leeuspruit dam from the scrap metal and BOF and EAF slag handling operations. The pumps are rated at 100 m³/hr and they deliver contaminated liquors as make up water into the BOF scrubbing circuits. An analysis of the liquors collected at the Steelserve sump is given below.

Heckett Steelserve Sump - Typical Analysis	
Total Hardness	43 mg/l
Ca Hardness	21 mg/l
P alkalinity	795 mg/l
Total Alkalinity	1180 mg/l
pH	11
Cl	480 mg/l
SO_4-S	3700 mg/l
Conductivity	8900 µS/cm
F	4.7 mg/l
CN	0.1 mg/l
NH_3-N	0.8 mg/l
Phenol	0.1 mg/l
NO_3-N	2.0 mg/l
NO_2-N	1.4 mg/l
P	0.2 mg/l
Na	1420 mg/l
Fe	0 mg/l
K	46 mg/l
Mn	0 mg/l
Cr (total)	0.04 mg/l

SM02 BOF PLANT

The principal active process water related production areas are :

SMO2.1	Basic Oxygen Furnace (BOF)
SMO2.2	Continuous Casting (V1&V2)
SMO2.3	RHOB.

SM02.1 BASIC OXYGEN STEELMAKING

The objective in oxygen steelmaking is to convert, usually by burning (i.e. oxidising) the undesirable impurities contained in the metallic feedstock. The main elements thus converted or oxidized are carbon, silicon, manganese, phosphorus, and sulphur. The purpose of this oxidation process, therefore, is, in conjunction with the associated slag chemistry:

- to reduce the carbon content to a specified level (from approximately 4% to less than 1%, but often lower)
- to adjust the contents of desirable foreign elements
- to remove undesirable impurities to the greatest possible extent

The production of steel by the BOF process is a discontinuous process which involves the following steps:

- transfer and storage of hot metal
- pre-treatment of hot metal (desulphurisation) using calcium carbide.
- oxidation in the BOF (decarbonisation and oxidation of impurities). Three furnaces (LD's) receive molten iron by torpedo from the blast furnaces.
- secondary metallurgical treatment - alloyed in the ladle furnace (190 000 t/m) and the RHOB (21 000 t/m) – see section SMO2.3
- casting (continuous) whereby the steel is cast in a continuous strand - continuous casters V1 and V2. The continuous steel ingot is then cut into lengths with a flame – see section SMO2.2

The relevant sources of wastewater are following:

- scrubbing water from BOF off-gas treatment
- cooling water from within the various BOF cooling circuits
- Sealing and Cleaning System effluents

SMO2.1.1 MAIN COOLING SYSTEM (CLOSED COOLING SYSTEM)

System Characteristics

The main closed cooling system is made up with softened water from a softener on the plant and cools the off-gas ducting, lances and sub-lances. Water is pumped from cold water tanks to the furnaces and the hot water is returned to hot water tanks. From the hot water tanks the water is pumped through a bank of fin-fan tube heat exchangers and a side stream of warm water is pumped through a plate heat exchanger for additional cooling. Water is pumped through a sand filter on a side stream basis for suspended solids removal.

All the water that leaks out of the main cooling system is routed to the miscellaneous cooling system (see section SMO2.1.2 below). Although this is a closed system the make-up often exceeds the standard 2 m^3/hr.

Technical Specifications & Stream Analysis

Main Cooling System – Details	
System Capacity	2100 m^3
Standard make-up rate	10 m^3/hr
Circulation Rate	1720 m^3/hr/furnace in operation
Hot water temperature	55°C
Cold water temperature	45°C
Side Stream filtration	120 m^3/hr
Materials of Construction	Mild Steel, stainless steel, admiralty brass

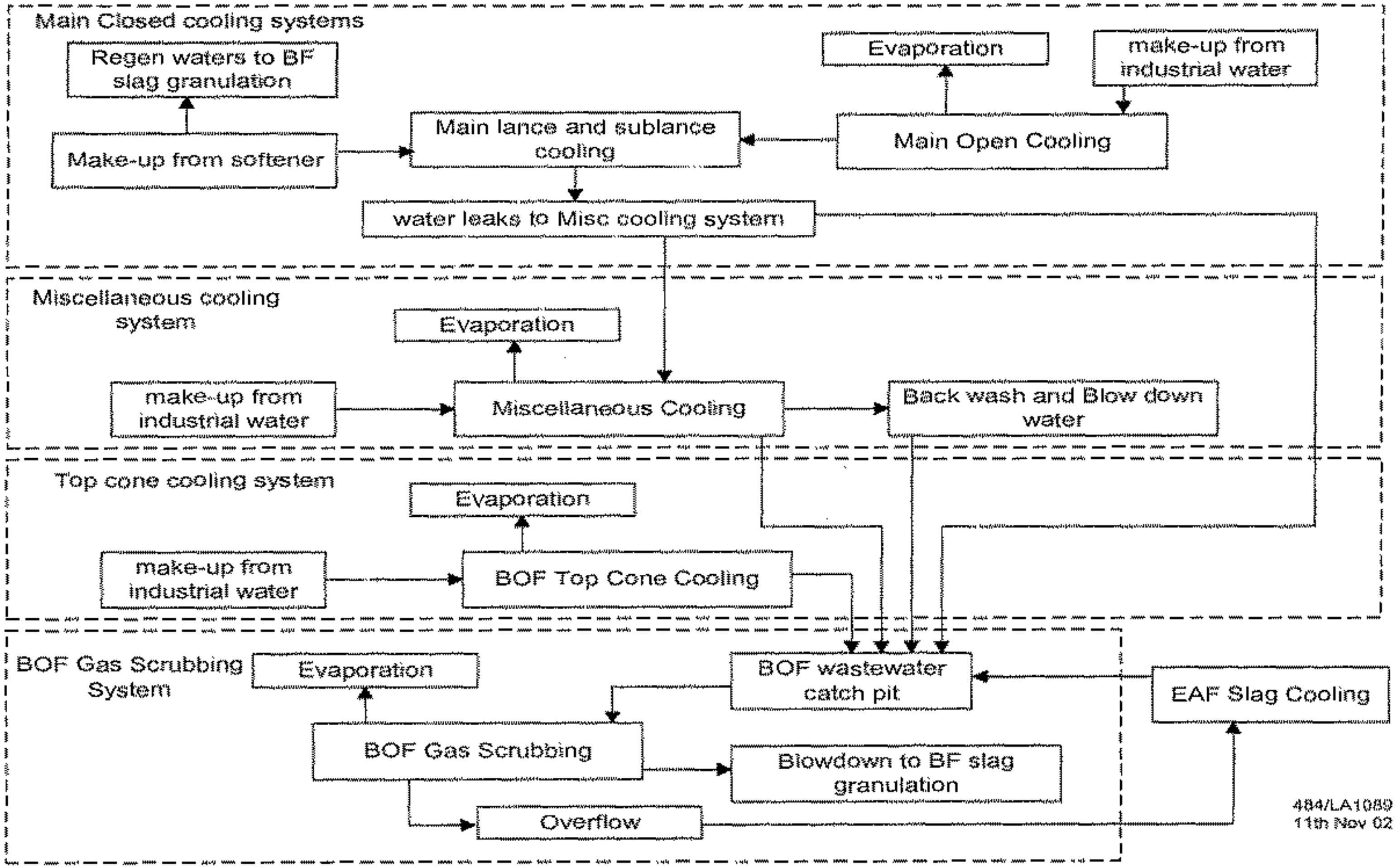
Main Cooling System – Analysis	
Total Hardness	5.2 mg/l
Ca Hardness	2.4 mg/l
P alkalinity	6.3 mg/l
Total Alkalinity	91.8 mg/l
PH	8.8
Cl	13 mg/l
SO_4	18 mg/l
Conductivity	265 µS/cm
Suspended Solids	4.8 mg/l
P	0.8 mg/l
Na	57 mg/l
Fe	1 mg/l

Softener Blow Down

At present the softener is regenerated using normal sodium chloride (brine) solutions. The regeneration effluent is combined with the blow down (purge) from the BOF off-gas cleaning system and is pumped to the Blast Furnace Slag Granulation System.

Unfortunately this increases the overall chloride levels in this system which increases corrosion and severely constrains the capability of the existing Desalination Plant. In order to address this, plans are in hand to supply de-mineralised water from the High Pressure Demineralisation Plant (at the Blast Furnace Boilers) to the closed cooling water systems at the BOF, to the continuous casters V1/V2 and to the other minor plant items in this area. This will reduce the overall chloride input to the site as a whole which is an essential requirement for achieving ZED for a sensible capital and operating cost.

BOF (after short term measures)



SM02.1.2 MISCELLANEOUS COOLING SYSTEM (OPEN COOLING SYSTEM)

System Characteristics

The miscellaneous open cooling systems at the BOF use industrial water from the main pump house for make-up. The miscellaneous system supply cooling water to various components in the plant and the water is cooled via a cooling tower. Water is pumped through a sand filter on a side-stream basis for suspended solids removal.

Because of the high level of leakage from the BOF's closed system cooling water into the open system, little or no theoretical cycles of concentration can be achieved within this open system. Suspended solids, bio-fouling and corrosion rates have to be controlled using specific chemical additives in order to ensure efficient performance.

Technical Specifications & Stream Analysis

Miscellaneous Cooling System – Details	
System Capacity	980 m^3
Standard make-up rate	25 m^3/hr
Circulation Rate	200 m^3/hr/furnace in operation
Hot water temperature	36°C
Cold water temperature	32°C
Side Stream filtration	60 m^3/hr
Materials of Construction	Mild Steel, Stainless Steel

Miscellaneous Cooling System – Analysis	
Total Hardness	204 mg/l
Ca Hardness	119 mg/l
P alkalinity	2 mg/l
Total Alkalinity	120 mg/l
pH	10.1
Cl	91 mg/l
SO_4	155 mg/l
Conductivity	853 µS/cm
Grav TDS	496 mg/l
Suspended Solids	33 mg/l
F	2.4 mg/l
P	0.3 mg/l
Mn	2.5 mg/l

SM02.1.3 TOPCONE COOLING SYSTEM (OPEN COOLING SYSTEM)

System Characteristics

The Topcone cooling systems for the BOF use Vaal River Industrial Water from the main pump station for make-up. The Topcone system is a dedicated system for the cooling of the mouths of the three furnaces and the water is cooled via a cooling tower. Water is pumped through a sand filter on a side stream basis for suspended solids removal.

The system make-up rate is fairly constant. The system blowdown is currently controlled by hand and the blowdown was to the Terminal Effluent Treatment Plant (TETP), but is now in the process of being re-routed to the BOF off-gases cleaning system.

Technical Specifications & Stream Analysis

Topcone Cooling System – Details	
System Capacity	170 m^3
Standard make-up rate	2.5 m^3/hr
Circulation Rate	450 m^3/hr
Hot water temperature	30°C
Cold water temperature	22°C
Side Stream filtration	40 m^3/hr
Materials of Construction	Mild Steel, Stainless Steel

Topcone Cooling System – Analysis	
Total Hardness	567 mg/l
Ca Hardness	324 mg/l
P alkalinity	30 mg/l
Total Alkalinity	257 mg/l
pH	8.5
Cl	240 mg/l
SO_4	437 mg/l
Conductivity	2023μS/cm
Suspended Solids	28 mg/l
P	0.2 mg/l
Fe	0.3 mg/l

SM02.1.4 MAIN OPEN COOLING SYSTEM (OPEN COOLING SYSTEM)

System Characteristics

The main open system for the BOF is a secondary system to the main cooling system and supplies water to the sludge pumps for sealing purposes, and water to the sludge pipes and filter presses for cleaning purposes. Blowdown water from Continuous Casting V1/V2 and industrial water is used for make-up.

The system has a fairly constant make-up rate. The system blowdown is currently controlled by hand and the blowdown was to the Terminal Effluent Treatment Plant, but is now in the process of being re-routed to the BOF off-gases cleaning system.

Technical Specifications & Stream Analysis

Technical Specifications	Main Open Cooling System
System Capacity	200 m^3
Standard make-up rate	16 m^3/hr
Circulation Rate	1300 m^3/hr
Hot water temperature	28°C
Cold water temperature	18°C
Side Stream filtration	60 m^3/hr
Materials of Construction	Mild Steel, Stainless Steel

System Analysis	Main Open Cooling
Total Hardness	482 mg/l
Ca Hardness	300 mg/l
P alkalinity	21 mg/l
Total Alkalinity	170 mg/l
pH	8.3
Cl	214 mg/l
SO_4	365 mg/l
Conductivity	1830 µS/cm
Suspended Solids	10 mg/l
P	1.8 mg/l
Zn	0.9 mg/l

SM02.1.5 GAS SCRUBBING SYSTEM

System Characteristics

Wet scrubbers are used to reduce the contaminant levels in the off-gases from the BOF prior to their routing to the off-gas flares, so as to control emissions to air from the primary off-gases. This wet scrubbing produces a wastewater which is recycled after treatment. This treatment is performed in two steps: separation of coarse particles (> 200 µm grain size) followed by sedimentation in circular settling tanks. Flocculating agents are added to improve sedimentation. The resultant sludge is de-watered by means of chamber filter presses with the sludges returned via open air drying beds to the Sinter.

The system make-up water comes from a number of sources. One source is the fluoride containing blowdown water from the continuous casters (V1 and V2).

The relatively high calcium and magnesium content that the BOF off-gas scrubbing water would normally take on as a result of the burnt lime and dolomite dust that is present in the off-gases is good at removing the fluoride from the blow down from the continuous casters. Fluoride gets into the continuous casters as a result of the flux powders that are used within the continuous casters. It is therefore possible to mutually exchange the water between the continuous casters and the BOF off-gas cleaning circuits until either there would be a risk of scale formation within the continuous caster from other sources or the chloride concentration has got too high.

As a result of the Short Term Measures, collected seepage and surface waters from the Steelserv slag and scrap handling area in the South East corner of the IVDBS site is also pumped to the BOF circuit. This is normally a relatively hard water (which assists further fluoride removal) with a low chloride but high sulphate content. The high hardness helps to further reduce the fluoride concentrations in the above referred mutual exchange of cooling water process.

Also as a result of the Short Term Measures, collected waters from the slag handling area at the Arc Furnace and blow down waters from Air Products can also be pumped back to the BOF off-gas cleaning system. Both of these waters have high levels of hardness (which further assists fluoride removal). Also, the slag handling area water contains significant amounts of very fine slag as a sludge and the de-watering facilities at the BOF are used to assist in the controlling of sludge levels at the Arc Furnace Slag Cooling Area.

Additional make-up for the gas scrubber comes from the pump sealing and the filter press area cleaning systems which are a once through system, using Vaal River (industrial water) or blowdown water from V1/V2. Water is purged from the BOF gas scrubber system to the Blast Furnace Slag Granulation Systems on a semi-continuous basis.

During the summer months sludge from the main purification plant for incoming waters is pumped to the gas scrubber system on a daily basis and during the winter months twice a week (± 2 hours at a time). The sludge is introduced into the system before the clarifiers.

Technical Specifications & Stream Analysis

Gas Scrubber System – Details	
System Capacity	9000 m^3
Standard make-up rate	25 m^3/hr
Circulation Rate	500 m^3/hr/furnace in operation
Hot water temperature	55°C
Materials of Construction	Mild Steel, Stainless Steel

Gas Scrubber System – Analysis	
Total Hardness	28 mg/l
Ca Hardness	21 mg/l
P alkalinity	214 mg/l
Total Alkalinity	450 mg/l
pH	10.5
Cl	332 mg/l
SO_4	474 mg/l
Conductivity	3554 µS/cm
Grav TDS	2028 mg/l
Suspended Solids	57 mg/l
F	72 mg/l
P	0.25 mg/l
Mn	0.31 mg/l
Na	367 mg/l
Fe	8.2 mg/l

SM02.2 CONTINUOUS CASTING

Once the final steel quality has been achieved in the secondary metallurgy operations (at both the oxygen furnaces and electric arc furnace systems) the steel is conveyed in a casting ladle to the casting machines [V1 and V2 serve the BOF and RHOB systems in this SM02 area and V3 serves the EAF in the SM04 area].

Continuous casting is a process which enables the casting of one or a sequence of ladles of liquid steel into a continuous slab. Steel is tapped from the ladle into a tundish from which it is distributed at a controlled rate into water-cooled copper moulds of appropriate dimensions. To prevent the solidified shell from sticking, the mould is oscillated in the direction of casting at a speed greater then the casting speed and a mould lubricant is added.

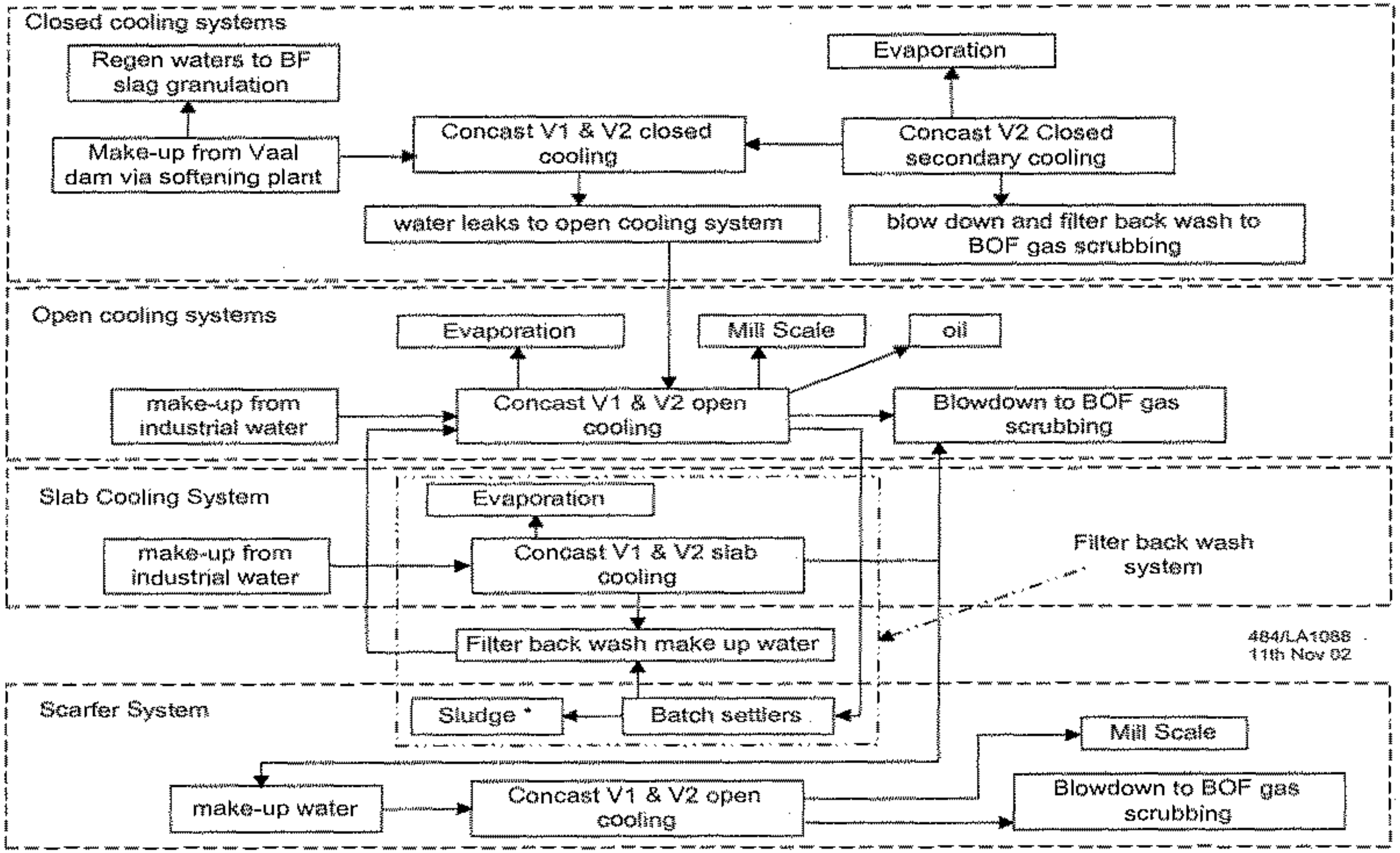
The mould gives the metal the desired shape. When the metal leaves the casting mould, a "skin" of solidified steel has formed and a large number of trundles (the "pinch-rolls") guide the cast steel with a gentle curve toward a horizontal position. The strand is continuously withdrawn and is cooled using direct water sprays. The casting is ultimately cut into pieces with a plasma torch cutter. Slabs are cast in this way.

The semi-molten steel strand, with its solidified surfaces and its molten core, moves through a number of driven and undriven roll pairs which supports the solidified metal shell against the internal weight and pressure from the molten metal within. As the core is still liquid it is sprayed carefully with water and cooled until it is completed solidified (secondary cooling). This process has to be very carefully controlled in order to prevent cracks, initially in the strand surface zone, which is fairly thin at the start of the cooling process and then subsequently to prevent cracks in the centre areas of the strand as the molten core solidifies and shrinks. The water sprays also protect the rolls from overheating.

Emissions to water from continuous casting machines are generated by the direct cooling system. This is used for direct cooling of slabs, blooms, billets and the machine components themselves. The discharge water is contaminated with metal oxides from the hot metal surfaces (typically mill scales), with fluorides from casting fluxes and with oils from bearing and hydraulic leaks. This water is treated locally to remove suspended solids and oils and is recirculated.

The solids that are removed are typically routed to either the Direct Reduction Furnaces or to the Sinter Plant. The oils are passed to an oil reclamation contractor.

Concast V1 & V2 (after short term measures)



* currently to dump (should be suitable for addition to BOF or BF gas scrubbing sludge dewatering)

SM02.2.1 V1 CLOSED COOLING SYSTEM

This system receives demineralised water for make up purposes. Water from the system is used to cool the moulds and the straitener of the machine. Hot water from the machine is cooled by tube-fin air coolers and is returned to the storage sump from where it is pumped back to the machine.

Technical Specifications	**V1 Closed Cooling System**
System Capacity	1000 m^3
Standard make-up rate	10 m^3/hr
Circulation Rate	1080 m^3/hr
Hot water temperature	60°C
Cold water temperature	50°C
Materials of Construction	Mild Steel, Stainless Steel, copper

Stream Analysis	**V1 Closed Cooling System**
Total Hardness	2.8 mg/l
Ca Hardness	1.4 mg/l
P alkalinity	85 mg/l
Total Alkalinity	158 mg/l
pH	10.7
Cl	1.6 mg/l
SO_4	3.2 mg/l
Conductivity	102 µS/cm
TDS	173 mg/l
Suspended Solids	2.6 mg/l
P	0.3 mg/l
SiO_2	7.1 mg/l
Na	72 mg/l
Fe	0.2 mg/l

All the water that leaks out of this system ends up in the flume which returns the spray water from the casting sprays to the mill scale and oil leakage separation pit. Water is mainly lost through leaking rotary couplings and breakage of flexible pipes. Cooling on the copper moulds is critical and any deposition can cause serious heat transfer problems that can have catastrophic consequences.

SM02.2.2 V2 CLOSED PRIMARY COOLING SYSTEM

This system receives demineralised water for make up purposes. Water from the system is then used to cool the moulds and all rolls of the machine, as well as the gega cutting machine rails. Hot water from the machine is cooled by plate heat exchangers and returns to the storage sump from where it is pumped back to the machine.

This system is basically the same as the V1 system. Leaks on this system are generally not as high although the potential is there.

Technical Specifications	V2 Closed Primary Cooling System
System Capacity	1300 m^3
Standard make-up rate	5 m^3/hr
Circulation Rate	2236 m^3/hr
Hot water temperature	50°C
Cold water temperature	43°C
Materials of Construction	Mild Steel, Stainless Steel, copper

Stream Analysis	V2 Closed Primary Cooling System
Total Hardness	5.7 mg/l
Ca Hardness	2.7 mg/l
P alkalinity	13 mg/l
Total Alkalinity	45 mg/l
pH	11.4
Cl	2.1 mg/l
SO_4	7.2 mg/l
Conductivity	89 µS/cm
Suspended Solids	2 mg/l
P	2 mg/l
SiO_2	3.8 mg/l
Na	19 mg/l
Fe	0.8 mg/l

SM02.2.3 V2 CLOSED SECONDARY COOLING SYSTEM

This system cools the plate heat exchangers of V2 Closed Primary system by evaporative cooling. Make-up water is industrial water. A 10% side stream sand filter is used to keep the suspended solids below 10 mg/l.

The 10% side stream sand filter is back washed with system water and this practice is used to control the cycles of concentration. The back washings are directed to the BOF off-gases scrubbing water system, see section SM02.1.5.

Technical Specifications	**V2 Closed Secondary Cooling System**
System Capacity	900 m^3
Standard make-up rate	15 m^3/hr
Circulation Rate	1100 m^3/hr
Hot water temperature	40°C
Cold water temperature	30°C
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**V2 Closed Secondary Cooling System**
Total Hardness	447 mg/l
Ca Hardness	250 mg/l
P alkalinity	30 mg/l
Total Alkalinity	249 mg/l
pH	8.8
Cl	145 mg/l
SO_4	314 mg/l
Conductivity	1491 µS/cm
TDS	1070 mg/l
Suspended Solids	15 mg/l
P	6.6 mg/l
SiO_2	12 mg/l
Na	135 mg/l
Fe	0.7 mg/l

SM02.2.4 OPEN COOLING SYSTEM (SPRAY COOLING)

This system provides metallurgical cooling as well as machine cooling for both the V1 & V2 continuous casting machines. Water is pumped from the cooling tower basin to the machines where it is split up between the two machines. The return water carries scale and oil to the scale pits where the scale is removed. The overflow from the scale pits is pumped to the DAF where oil is removed by dissolved air flotation. The under flow is then pumped through inline sand filters (where the last suspended solids are removed) and then over the cooling towers. This system is continuously contaminated by fluoride and oil.

Make-up water for this system is industrial water, and is controlled by the PLC. Water leaking from the two closed systems ends up in this system, as well as cooling water for the marking machines and air conditioners. Under normal production conditions this additional water entering the system is not a problem.

Oil enters the system from leaks on the machines and is pumped with seepage water from the hydraulic chambers. Floating oil is then removed in the scale pit by rope skimmers. The remainder of the oil is removed in the DAF, and any remaining fine oil droplets are removed in the sand filters with the suspended matter.

This system is contaminated with fluorides emanating from the casting powders being used in the production processes. Fluorides and iron are the major components found in deposits in the pipes. This scale also reduces flow through the spray nozzles which are responsible for cooling the slabs. This can result in uneven cooling of the slabs which can cause steel defects. Equipment failure (e.g. roll damage) can also result because of reduced flow through nozzles. Biological slimes can also clog strainers and nozzles, resulting occasionally in total flow stoppages on the different cooling parts of the machines. Therefore no biological control mishaps can be tolerated on this system and in time (i.e. before the problem occurs) preventative action to curb this is of the utmost importance. The system blow down is currently controlled by hand and the blow down is to the BOF off-gases scrubber water plant (SM02.1.5). Cycles of concentration are maintained fairly easily. Suspended solids, bio-fouling and scaling rates have to be controlled carefully to ensure efficient cooling in the plate heat exchanger.

Technical Specifications	Open Cooling System
System Capacity	3100 m³
Standard make-up rate	30 m³/hr
Circulation Rate	1460 m³/hr
Hot water temperature	65°C
Cold water temperature	35°C
Materials of Construction	Mild Steel, Stainless Steel, brass nozzles

Stream Analysis	**Open Cooling System**
Total Hardness	392 mg/l
Ca Hardness	196 mg/l
P alkalinity	0.7 mg/l
Total Alkalinity	70 mg/l
pH	7.4
Cl	230 mg/l
SO_4	531 mg/l
Conductivity	2357 µS/cm
TDS	1730 mg/l
Suspended Solids	17 mg/l
F	65 mg/l
P	0.3 mg/l
SiO_2	7.0 mg/l
Na	316 mg/l
Fe	0.4 mg/l

SM02.2.5 SLAB COOLING SYSTEM

The system supplies water for the cooling of slabs (by immersion of the slabs within the water) before the slabs are scarfed and transported. Water in this system can reach extremely high temperatures. The water from the system is used for the backwashing of the sand filters. The water is then recovered by batch settling in the dewatering tanks.

The system make-up water is (as a result of the Short Term Measures) from the BOF off-gases scrubber system (SM02.1.5), with industrial water as a back up. Also the open cooling water system is blow down in to this system. The 10% side stream sand filtration of this system returns filtered water to the hot water return basin. The water in this system can become extremely hot because of the rate of slab stacking in the system. Temperatures in excess of 75°C in this system are not uncommon. Blowdown from this system is not continuous but in manually controlled batches to the BOF off-gases scrubber system. Water from this system is used for the backwashing of the Open, Slab and Scarfer systems, and is returned to the system.

Technical Specifications	**Slab Cooling System**
System Capacity	3100 m^3
Standard make-up rate	60 m^3/hr
Circulation Rate	1800 m^3/hr
Hot water temperature	75°C
Cold water temperature	35°C
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**Slab Cooling System**
Total Hardness	506 mg/l
Ca Hardness	286 mg/l
P alkalinity	19 mg/l
Total Alkalinity	176 mg/l
pH	8.5
Cl	272 mg/l
SO_4	567 mg/l
Conductivity	2420 µS/cm
TDS	1782 mg/l
Suspended Solids	17 mg/l
Na	225 mg/l
Fe	0.3 mg/l

SM02.2.6 SCARFER SYSTEM

This system cools and flushes scale from the Scarfing Machines. The return water is received in the scale pit where the solids are removed. Make-up water is from the slab cooling system when required. The dewatering tanks can be drained to the scarfer system too, if required.

This system is mainly a clarification system, consisting of a scale pit and two side stream filters, filtering 33% of the circulating water. This system can also become contaminated with oil from the scarfer machines and this oil is removed in the DAF.

Technical Specifications	**Scarfer System**
System Capacity	1300 m^3
Standard make-up rate	10 m^3/hr
Circulation Rate	2040 m^3/hr High Pressure 480 m^3/hr Low Pressure
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**Scarfer System**
Total Hardness	394 mg/l
Ca Hardness	202 mg/l
P alkalinity	4.3 mg/l
Total Alkalinity	104 mg/l
pH	7.6
Cl	270 mg/l
SO_4	516 mg/l
Conductivity	2225 µS/cm
TDS	1630 mg/l
Suspended Solids	99 mg/l
P	15 mg/l
Na	258 mg/l
Fe	38 mg/l

SM02.3 SECONDARY METALURGY (RHOB WATER PLANT)

The oxidizing process in the converter is usually followed by post-treatment comprising a number of diverse metallurgical operations. Referred to as "secondary metallurgy". The main objectives of secondary metallurgy are:

- mixing and homogenising
- adjustment of chemical compositions to close analysis tolerances
- temperature adjustment in time for the downstream casting process
- deoxidation
- removal of undesirable gases such as hydrogen and nitrogen
- improvement of the oxidic purity by separating non-metallic inclusions.

An important step in secondary metallurgy is vacuum treatment. This mainly serves to remove gaseous hydrogen, oxygen, nitrogen or residual carbon concentrations from the steel at a vacuum of up to 50 Pa.

The following vacuum treatment methods are used:

- ladle stand degassing and
- recirculating degassing (RHOB)

In ladle degassing the ladle containing the oxidised metal is placed in a vacuumised container. An input of additional energy ensures higher reaction speeds and reduces the final concentration of undesirable bath constituents. This agitation may be accomplished by injecting argon through one or more porous plugs in the ladle bottom, by homogenising the melt via a lance, or by an inductive stirring process. Alloying agents are added to the melt in solid form, or enclosed in a hollow wire which is unwound from a reel system, or else by powder injection via lances. Throughout the stirring process, the dust/gas mixture rising up from the ladle is drawn off by a movable fume hood.

In recirculating degassing, the molten metal is vacuum treated continuously. IVDBS utilize multi-stage steam jet pumps (or eductors) and liquid ring pumps to create the vacuum, together with appropriate condenser stages.

SM02.3.1 MACHINE COOLING SYSTEM (CLOSED COOLING SYSTEM)

System Characteristics

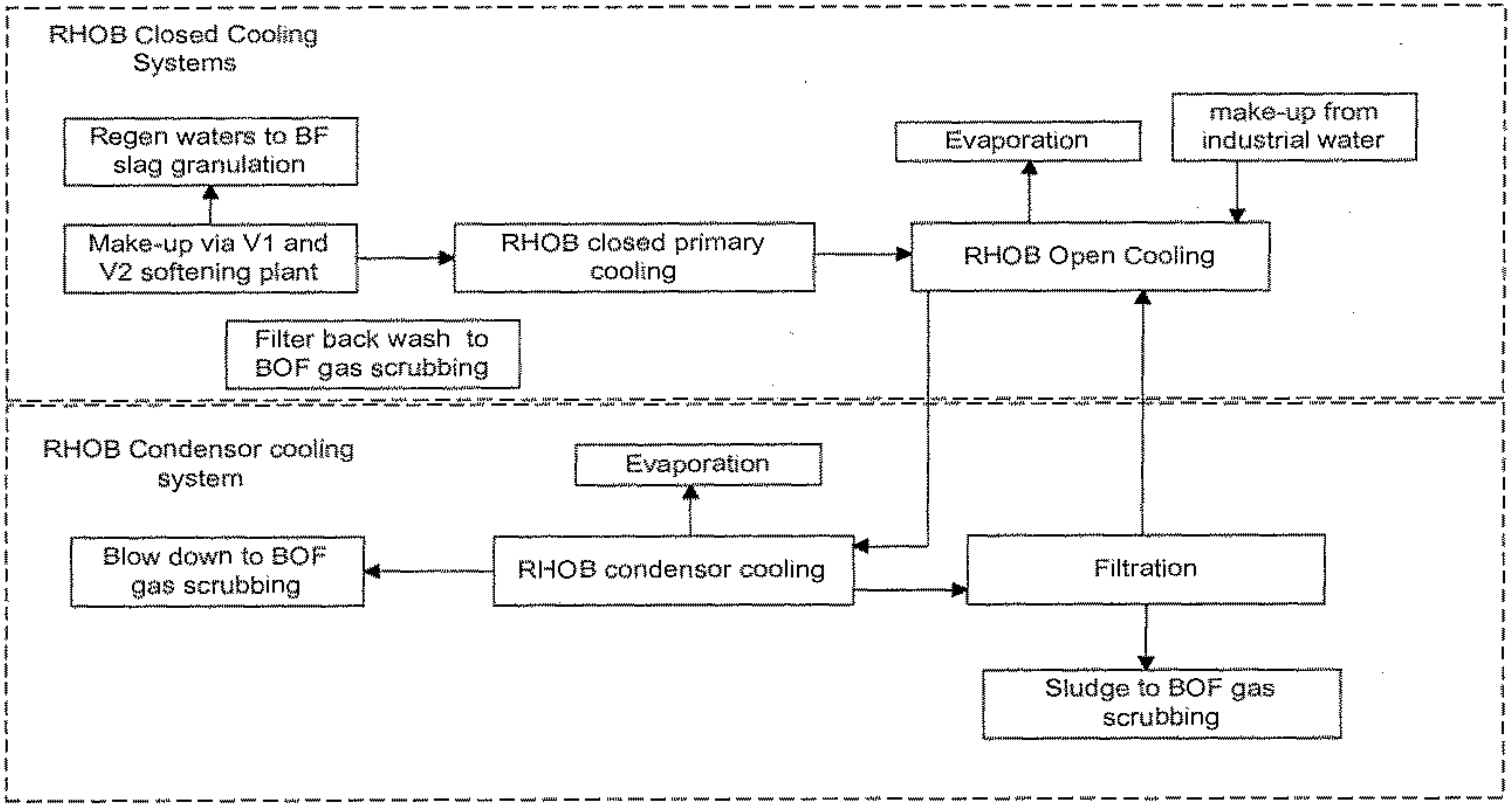
The Machine Cooling System is made up with softened water from the Continuous Caster V1/V2 softener plant. The system supplies cooling water to the ladle furnace roof and cables, the RH vessel flanges, the rotating sight device and the off-gas cooler. The system consists of a holding tank, pumps and 3 plate heat exchangers. The system has a very low make-up rate and the holding tank has a nitrogen blanket.

Technical Specifications & Stream Analysis

Technical Specifications	Machine Cooling System
System Capacity	70 m^3
Standard make-up rate	2 m^3/day
Circulation Rate	414 m^3/hr
Hot water temperature	45°C
Cold water temperature	38°C
Materials of Construction	Mild Steel, Stainless Steel, admiralty brass

Stream Analysis	Machine Cooling System
Total Hardness	5.3 mg/l
Ca Hardness	3.7 mg/l
P alkalinity	0 mg/l
Total Alkalinity	9.1 mg/l
pH	6.2
Cl	1.75 mg/l
SO_4	2.96mg/l
Conductivity	35 µS/cm
Suspended Solids	8.2 mg/l
Na	3.8 mg/l

RHOB Cooling Systems (After Short term measures)



484/LA1086
11th Nov 02

SM02.3.2 MULTI-LANCE COOLING SYSTEM (CLOSED COOLING SYSTEM)

System Characteristics

The system is made up with softened water from the Continuous Caster V1/V2 softener plant and supplies cooling water to the multi-lance. The system consists of a holding tank, pumps and 2 plate heat exchangers. The system has a very low make-up rate.

Technical Specifications & Stream Analysis

Technical Specifications	**Multi-lance Closed Cooling System**
System Capacity	35 m³
Standard make-up rate	1 m³/day
Circulation Rate	90 m³/hr
Hot water temperature	45°C
Cold water temperature	35°C
Materials of Construction	Mild Steel, Stainless Steel, admiralty brass

Stream Analysis	**Multi-lance Closed System**
Total Hardness	31 mg/l
Ca Hardness	20 mg/l
P alkalinity	19 mg/l
Total Alkalinity	171 mg/l
pH	9.1
SO_4	17 mg/l
Conductivity	602 µS/cm
Suspended Solids	5 mg/l
Fe	6.6 mg/l

SM02.3.3 CONDENSER COOLING AND HEAT EXCHANGER COOLING SYSTEMS (OPEN COOLING SYSTEM)

System Characteristics

The systems use industrial water from the main pump house for make-up. The system supplies cooling water to the steam condensers of the vacuum pump system and cooling water for the plate heat exchangers. Water is pumped through 3 sand filters on a side-stream basis for suspended solids removal. The filter backwash water is reclaimed, clarified and re-used in the system, however, over recent years this part of the system has fallen into disuse. It is currently being re-arranged to make it more "user friendly".

The system make-up rate is fairly constant. The system blowdown is currently controlled by hand and the blowdown was to the Terminal Effluent Treatment Plant. The above referred re-arrangements will also direct the blow down to the BOF off-gases cleaning system, see section SM02.1.5. System water is used to backwash the filters. The sludge from the backwash water clarifier is pumped to the BOF. The dirty water for filtration is drawn from the condenser cooling tower cells and the clean filtered water flows back into the Heat Exchanger cooling tower cell. The reclaimed (cleaned) backwash water flows back into the condenser cooling tower cells.

Technical Specifications & Stream Analysis

Technical Specifications	**Condenser and Heat Exchanger Cooling System**
System Capacity	540 m³
Standard make-up rate	10 m³/hr
Circulation Rate	965 m³/hr and 360 m³/hr respectively
Hot water temperature	36°C
Cold water temperature	28°C
Side Stream Filtration	186 m³/hr
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**Condenser Cooling System**
Total Hardness	244 mg/l
Ca Hardness	142 mg/l
P alkalinity	1 mg/l
Total Alkalinity	137 mg/l
PH	8.9
Cl	94 mg/l
SO_4	168 mg/l
Conductivity	873 µS/cm
Suspended Solids	29 mg/l
Na	74 mg/l

Stream Analysis	**Heat Exchanger Cooling System**
Total Hardness	254 mg/l
Ca Hardness	149 mg/l
P alkalinity	0 mg/l
Total Alkalinity	142 mg/l
pH	8.0
Cl	98 mg/l
SO_4	183 mg/l
Conductivity	905 µS/cm
Suspended Solids	16 mg/l
Na	74 mg/l

SM02.3.4 MULTI-LANCE COOLING SYSTEM (OPEN COOLING SYSTEM)

System Characteristics

The system uses industrial water from the main pump house for make-up. The system supplies cooling water to the plate heat exchangers and the water is cooled via a cooling tower. Water is pumped through a sand filter on a side-stream basis for suspended solids removal.

The system has a fairly constant make-up rate. The system blowdown is controlled automatically and the blowdown was to the Terminal Effluent Treatment Plant but is being re-routed to the BOF off-gases cleaning system, see SM02.1.5. Cycles of concentration are maintained fairly easily.

Technical Specifications & Stream Analysis

Technical Specifications	**Multi-lance Open Cooling System**
System Capacity	5 m^3
Standard make-up rate	1 m^3/hr
Circulation Rate	110 m^3/hr
Hot water temperature	38°C
Cold water temperature	28°C
Side Stream Filtration	10 m^3/hr
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**Multi-lance System Open Cooling**
Total Hardness	881 mg/l
Ca Hardness	516 mg/l
P alkalinity	36 mg/l
Total Alkalinity	695 mg/l
pH	8.6
Cl	239 mg/l
SO_4	661 mg/l
Conductivity	2420 µS/cm
Suspended Solids	25 mg/l

SM03 OPEN AREA AND ELECTRO-SLAG AREAS

The majority of this SM03 area is made up of open and mostly unused and grassed areas. The unused areas are mainly on the western side, the north east corner, the south east corner and most of the southern boundary. In the middle and central northern areas of this SM03 area there is the slag handling and cooling area for the Arc Furnaces, together with ladle and steel scrap handling areas and other miscellaneous furnace support activities.

With the exception of slag cooling and the associated collection and recirculation of the cooling water, all of the other activities are non-process effluent activities. However, these dry activities do handle materials which, when contacted by rainfall, by dust suppression water and by general drainage from slag and other product heaps and product transport, they will cause surface and ground water contamination.

At present, the slag is tipped into tipping bays where water is sprayed onto it to both cool and shatter it. The excess water drains to a lined collection lagoon from where it is pumped back to the cooling sprays on the currently operating slag tipping bay.

The liquid level in the lagoon was, in the past not properly controlled. As part of the Short Term Measures, controls were introduced and also the preferred source water was arranged to be a combination of the blow down/overflow from the BOF infrastructure and of the blow down from Air Products. In addition, facilities have been installed to pump the fine silt which accumulates slowly within this lagoon, as a slurry to the BOF gas cleaning circuit clarifiers. This enables the solids at this lagoon to be kept at a realistically low level whilst returning a low fluoride content water to the BOF. Also, the suspended solids that are present have a similar analysis to those of the remainder of the EAF slag. This slag forms a valuable raw material for the Sinter, as does the rest of the sludge that is produced by the BOF off-gases cleaning circuit. Adding these solids to the product sludge from the BOF simply enables these solids to be recycled via a convenient and existing route, rather than continuing the current disposal route to the Dump.

As a result of a combination of leakages and overflows at the lagoon together with general spillage, product drainage and rainfall on the slag and other residues which have been used to make the general working area around the lagoon, there is a considerable amount of local ground and surface water contamination within this area. Some of this contamination could also originate from areas to the east and north of this lagoon.

Before the start of the Master Plan studies, a clay wall was installed as an approximately semi-circular wall around the southern side of the lagoon in order to minimize the escape of these waters. Unfortunately, regular level control mishaps at the lagoon routinely caused the general level of the trapped water to overtop the northern ends of this clay wall enclosure.

Since then, proper silt removal activities have been implemented so as to avoid the need for such high lagoon levels. Also, the lining is being repaired and a pumped catchment sump and trench have been arranged on the western and southern sides of the area (outside the clay wall) to intercept and return all general drainage and spillage waters back to the lagoon.

The interfacing infrastructures between the waters in this lagoon and the BOF systems has already been described in the descriptions given under Area CS02.

The following tables present typical analyses for the lagoon contents and for the return water which is returned from the catchment trench and sump.

EAF Slag Quenching Lagoon – Analysis	
Total Hardness	<5 mg/l
Ca Hardness	<5 mg/l
P alkalinity	3500 mg/l
Total Alkalinity	4350 mg/l
pH	12.3
Cl	570 mg/l
SO_4-S	970 mg/l
Conductivity	11100 µS/cm
F	2 mg/l
CN	0.08 mg/l
NH_3-N	89 mg/l
Phenol	0.07 mg/l
NO_3-N	1 mg/l
NO_2-N	0.8 mg/l
P	<0.2 mg/l
Na	1580 mg/l
Fe	<0.1 mg/l
K	250 mg/l
Sn	<0.1 mg/l
Zn	<0.1 mg/l
Mn	<0.1 mg/l
SiO_2	105 mg/l

Interception Sump at EAF Quench – Analysis	
Total Hardness	11 mg/l
Ca Hardness	8.3 mg/l
P alkalinity	250 mg/l
Total Alkalinity	380 mg/l
pH	11.3
Cl	83 mg/l
SO_4-S	460 mg/l
Conductivity	1750 µS/cm
F	1 mg/l
CN	0.05 mg/l
NH_3-N	20 mg/l
Phenol	0.1 mg/l
NO^{3-}-N	1 mg/l
NO_2-N	0.3 mg/l
P	<0.2 mg/l
Na	220 mg/l
Fe	<0.1 mg/l
K	33 mg/l
Sn	<0.1 mg/l
Zn	<0.1 mg/l
Mn	<0.1 mg/l
SiO_2	13 mg/l

SM04 ELECTRIC ARC FURNACE

The principal active process water related production areas are :

SMO4.1	Electric Arc Furnace Steelmaking (EAF)
SMO4.2	Continuous Casting (V3)

SM04.1 ELECTRIC ARC FURNACE STEELMAKING

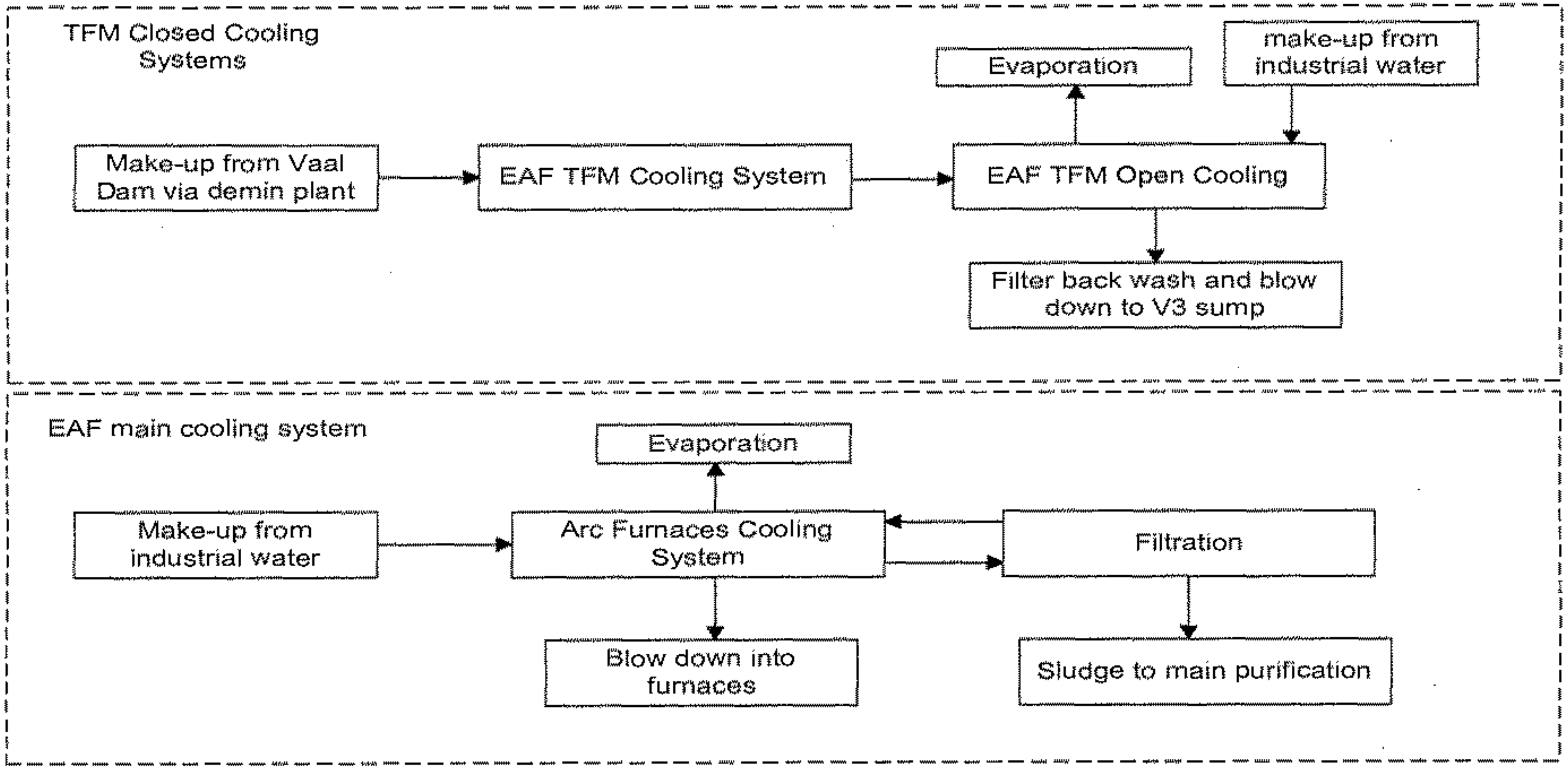
The direct smelting of iron-containing materials, such as scrap and sponge iron (Direct Reduced Iron Ore) is performed in electric arc furnaces (EAF) which play an important and increasing role in modern steel works.

The major feed stock for the EAF is ferrous scrap, which comprises scrap from inside the steelworks (e.g. offcuts), offcuts from steel product manufacturers (e.g. vehicle builders) and capital or post-consumer scrap (e.g. end of life products). Direct Reduced Iron (DRI) is also used as a feedstock due both to its low gangue content and to variable scrap prices. As in the BOF, a slag is formed from lime to remove undesirable components from the steel.

Three arc furnaces with an approximate capacity of 150 tonnes each are utilised at IVDBS; they melt DRI and scrap iron from the rest of the plant and from elsewhere to produce about 83 000 t/m of steel through oxygen refining. The steel goes via the ladle furnace and partly through the vacuum degassing (1 500 t/m) to the continuous caster V3 (76 700 t/m). Mill scale and slag go back to the sinter. The bag filter dust currently goes to the dump but from a metallurgical perspective, it could be returned to the Sinter.

Generally, water is only used in the EAF steel making processes in connection with non-contact cooling. These water usages are managed via the Arc Furnace Water Plant.

Electric Arc Furnace and TFM Cooling Systems (after short term measures)



484/LA1085
11th Nov 02

SM04.1.1 MAIN OPEN COOLING SYSTEM

System Characteristics

The system uses industrial water from the main pump house for make-up. The system supplies cooling water to the furnace off-gas ducting, furnace panels, furnace roofs and ladle furnace roofs. Water is pumped through 3 sand filters on a side-stream basis for suspended solids removal.

The system make-up rate is fairly constant. Blowdown of the system is through the electrode cooling. This water runs into the furnace and is enough to keep the cycles of concentration constant. The backwash water from the filters are reclaimed and pumped to the sludge handling system at the main purification plant for Industrial (River) Water, from where it is pumped (together with the sludges from the Main Purification Plant itself) to the sludge dewatering facilities at the BOF.

Technical Specifications & Stream Analysis

Technical Specifications	**Main Cooling System**
System Capacity	6000 m^3
Standard make-up rate	76 m^3/hr
Circulation Rate	7275 m^3/hr
Hot water temperature	36°C
Cold water temperature	32°C
Side Stream Filtration	500 m^3/hr
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	**Main Open Cooling**
Total Hardness	577 mg/l
Ca Hardness	330 mg/l
P alkalinity	37 mg/l
Total Alkalinity	324 mg/l
pH	8.7
Cl	217 mg/l
SO_4	390 mg/l
Grav TDS	1259 mg/l
Suspended Solids	15 mg/l
F	1.33 mg/l
P	0.61 mg/l
Na	181 mg/l
Fe	0.18 mg/l

SM04.1.2 TRANSFORMER CLOSED COOLING SYSTEMS

System Characteristics

The system is currently made up with demineralised water from its local demineralisation plant, but in the near future the system will get its supply from the supply of demineralised water from the high pressure boilers demineralisation plant which will be replacing the softened water at the continuous Casters V1 and V2. Cooling water is supplied to the roof lifting device, cables, transformers and electrode arms. The system consists of a holding tank, pumps and 4 plate heat exchangers.

The system has a very low make-up rate and the holding tank is nitrogen blanketed.

Technical Specifications & Stream Analysis

Technical Specifications	Transformer Closed Cooling System
System Capacity	900 m^3
Standard make-up rate	1 m^3/day
Circulation Rate	2700 m^3/hr
Hot water temperature	45°C
Cold water temperature	35°C
Materials of Construction	Mild Steel, Stainless Steel, admiralty brass

Stream Analysis	Transformer Closed Cooling
Total Hardness	3.4 mg/l
Ca Hardness	1.9 mg/l
P alkalinity	68 mg/l
Total Alkalinity	109 mg/l
pH	10.9
Cl	1.5 mg/l
SO_4	3.3 mg/l
Conductivity	361 µS/cm
Suspended Solids	2.7 mg/l
Na	57 mg/l
P	1.2 mg/l

SM04.1.3 TRANSFORMER OPEN COOLING SYSTEM

System Characteristics

The system uses industrial water from the main pump house for make-up. The system supplies cooling water to the plate heat exchangers and the water is cooled via cooling towers. Water is pumped through a sand filter on a side-stream basis for suspended solids removal.

The system has a fairly constant make-up rate. The system blowdown is manually controlled and the blowdown is currently to the Terminal Effluent Treatment Plant. However, this is in the process of being changed to blow down to the blow down sump from the Continuous Caster V3 which is pumped to the Blast Furnace Slag Granulation System. Cycles of concentration are maintained fairly easily. System water is normally used to backwash the filter. This achieves the dual purpose of filter backwash and blowdown.

Technical Specifications & Stream Analysis

Technical Specifications	Transformer Open Cooling System
System Capacity	400 m³
Standard make-up rate	10 m³/hr
Circulation Rate	1040 m³/hr
Hot water temperature	38°C
Cold water temperature	32°C
Side Stream Filtration	100 m³/hr
Materials of Construction	Mild Steel, Stainless Steel

Stream Analysis	Transformer Open Cooling
Total Hardness	855 mg/l
Ca Hardness	438 mg/l
P alkalinity	39 mg/l
Total Alkalinity	342 mg/l
pH	8.7
Cl	307 mg/l
SO_4	672 mg/l
Conductivity	2796 µS/cm
Suspension	25 mg/l
Na	279 mg/l

SM04.1.4 VAD COOLING SYSTEM

System Characteristics

The systems use industrial water from the main pump house for make-up. The system supplies cooling water to the steam condensers of the vacuum pump system. Water is pumped through 3 sand filters on a side-stream basis for suspended solids removal. The system blowdown is manually controlled and the blowdown is currently to the Terminal Effluent Treatment Plant. However, this is in the process of being changed to blow down to the blow down sump from the Continuous Caster V3 which is pumped to the Blast Furnace Slag Granulation System.

Due to the vacuum treatment process the system has a very high suspended solids load. The system has a tendency for fouling and iron deposition.

Technical Specifications & Stream Analysis

Technical Specifications	**VAD Cooling System**
Circulation Rate	Not available
Materials of Construction	Mild Steel, Stainless Steel
System Capacity	400 m³/h

Stream Analysis	**VAD Cooling System**
Total Hardness	468 mg/l
Ca Hardness	223 mg/l
P alkalinity	31 mg/l
Total Alkalinity	292 mg/l
pH	8.5
Cl	146 mg/l
SO_4	293 mg/l
Conductivity	1542 µS/cm
Suspended Solids	128 mg/l
Na	129 mg/l

SM04.2 CONCAST V3

Once the final steel quality has been achieved in the secondary metallurgy operations (at both the oxygen furnaces and electric arc furnace systems) the steel is conveyed in a casting ladle to the casting machines [V1 and V2 serve the BOF systems and V3 serves the EAF].

Continuous casting is a process which enables the casting of one or a sequence of ladles of liquid steel into a continuous strand of billet, bloom, slab, beam blank or strip. Steel is tapped from the ladle into a tundish from which it is distributed at a controlled rate into water-cooled copper moulds of appropriate dimensions. To prevent the solidified shell from sticking, the mould is oscillated in the direction of casting at a speed greater then the casting speed and a mould lubricant is added

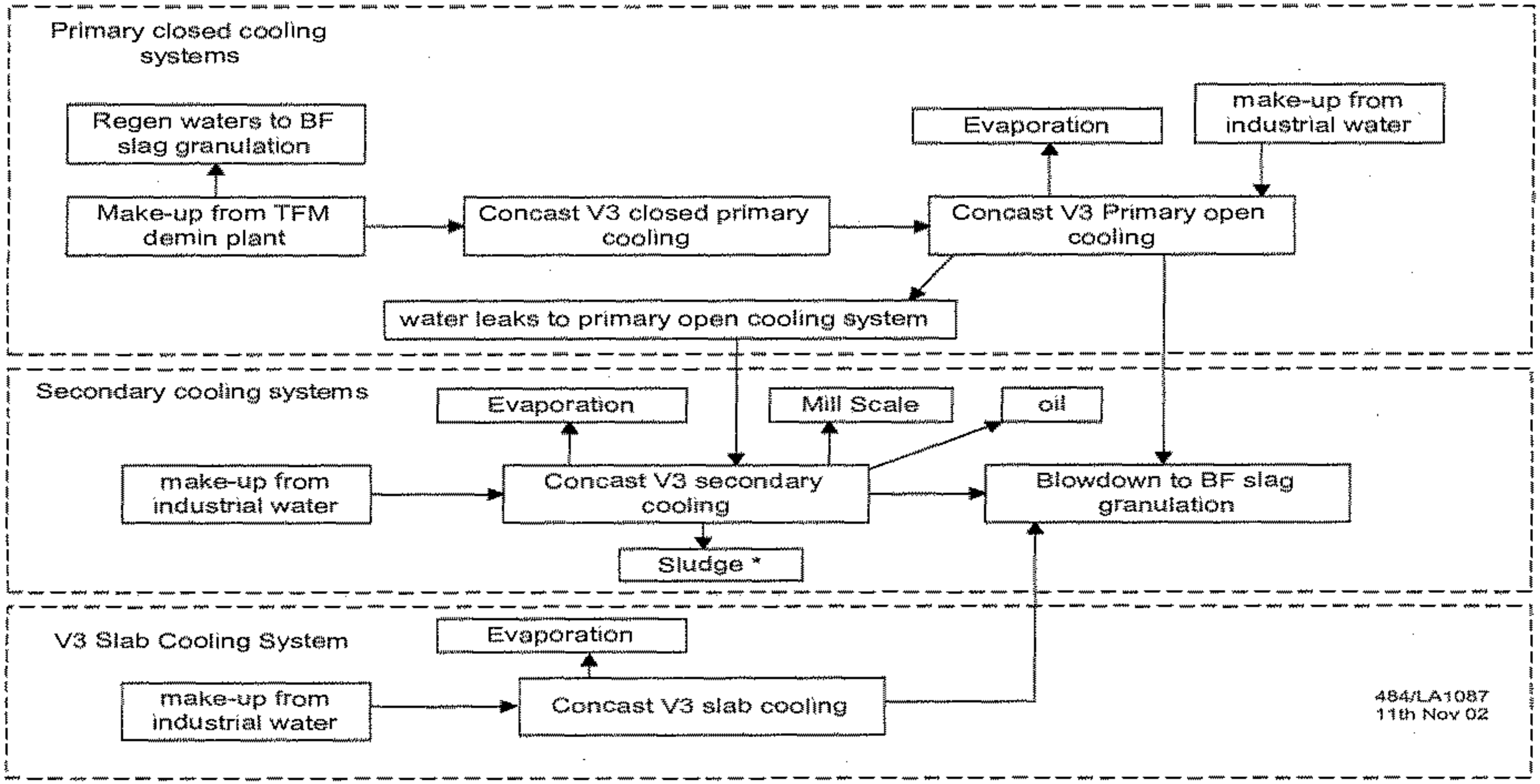
The mould gives the metal the desired shape. When the metal leaves the casting mould, a "skin" of solidified steel has formed and a large number of trundles (the "pinch-rolls") guide the cast steel with a gentle curve toward a horizontal position. The strand is continuously withdrawn and is cooled using direct water sprays. The casting is ultimately cut into pieces with a plasma torch cutter. Slabs, blooms and billets are cast in this way.

The semi-molten steel strand, with its solidified surfaces and its molten core, moves through a number of driven and undriven roll pairs which supports the solidified metal shell against the internal weight and pressure from the molten metal within. As the core is still liquid it is sprayed carefully with water and cooled until it is completed solidified (secondary cooling). This process has to be very carefully controlled in order to prevent cracks, initially in the strand surface zone, which is fairly thin at the start of the cooling process and then subsequently to prevent cracks in the centre areas of the strand as the molten core solidifies and shrinks. The water sprays also protect the rolls from overheating.

Emissions to water from continuous casting machines are generated by the direct cooling system. This is used for direct cooling of slabs, blooms, billets and the machine components themselves. The discharge water is contaminated with metal oxides from the hot metal surfaces (typically mill scales), with fluorides from casting fluxes and with oils from bearing and hydraulic leaks. This water is treated locally to remove suspended solids and oils and is recirculated.

The solids that are removed are typically routed to either the Direct Reduction Furnaces or to the Sinter Plant. The oils are passed to an oil reclamation contractor.

Concast V3 (after short term measures)



* currently to dump (should be suitable for addition to BOF or BF gas scrubbing sludge dewatering)

SM04.2.1 V3 PRIMARY CLOSED COOLING SYSTEM

This system receives demineralised water as make-up water. Water from the system is used to cool the moulds of the machine. Hot water from the machine is cooled by plate heat exchangers and is returned to the emergency tank from where it is pumped back to the machine.

Technical Specifications	**V3 Primary Closed Cooling System**
System Capacity	100 m³
Standard make-up rate	2 m³/hr
Circulation Rate	1080 m³/hr
Hot water temperature	40°C
Cold water temperature	35°C
Materials of Construction	Mild Steel, Stainless Steel, copper

Stream Analysis	**V3 Primary Closed cooling Systems**
Total Hardness	3.4 mg/l
Ca Hardness	1.8 mg/l
P alkalinity	72 mg/l
Total Alkalinity	114 mg/l
pH	10.9
Cl	1.4 mg/l
SO_4	3.6 mg/l
Conductivity	355 µS/cm
Suspended Solids	2.0 mg/l
P	1.5 mg/l
SiO_2	2.5 mg/l
Na	46 mg/l
Fe	0.1 mg/l

All the water that leaks out of this system ends up in the flume which returns the spray water from the casting sprays to the mill scale and oil leakage separation pit. Water is mainly lost through leaking rotary couplings and breakage of flexible pipes. Cooling on the copper moulds is critical and any deposition can cause serious heat transfer problems that can have catastrophic consequences.

SM04.2.2 V3 PRIMARY OPEN COOLING SYSTEM

This system cools the plate heat exchangers which keep the primary closed system cool. This open system is itself cooled by evaporative cooling. The air conditioners, bearing cooling caps, hydraulic and oil coolers of the compressors of the plant are also cooled by this system. Make-up water is industrial water. A 10% side stream filter is used to keep the suspended solids below 10 mg/l. The system leaks continuously to the V3 secondary system because of leaks on the bearing cooling caps.

Technical Specifications	**V3 primary Open Cooling System**
System Capacity	1000 m^3
Standard make-up rate	33 m^3/hr
Circulation Rate	1080 m^3/hr to plate heat exchangers 300 m^3/hr to bearing cooling
Hot water temperature	35°C
Cold water temperature	30°C
Materials of Construction	Mild Steel, Stainless Steel
Number of side stream filters	1 (100m^3/hr)

Stream Analysis	**V3 Primary Open Cooling System**
Total Hardness	254 mg/l
Ca Hardness	147 mg/l
P alkalinity	2.6 mg/l
Total Alkalinity	131 mg/l
pH	7.8
Cl	93 mg/l
SO_4	178 mg/l
Conductivity	890 µS/cm
TDS	617 mg/l
Suspended Solids	15 mg/l
P	1.0 mg/l
SiO_2	6.4 mg/l
Na	77 mg/l
Fe	0.4 mg/l

SMO4.2.3 SECONDARY COOLING SYSTEM

This system provides metallurgical cooling as well as machine cooling for the V3 continuous casting machine. Water is pumped from the cooling tower basin to the machines where it is split between the two machines. The return water carries scale and oil to the scale pits where the scale is removed. The overflow from the sedimentation pit is pumped to the inline sand filters (where the last suspended solids are removed) and then over the cooling towers.

Make-up water for this system is industrial water, and is controlled by the PLC. Water leaking from the Primary Open system ends up in this system, as well as cooling water for the marking machines. The slab cooling system scale flush water enters the system through the scale pit and is also a source of make-up for this system. The pipework on the Secondary and Slab Cooling systems has been modified to interlink the two systems. If too much water is flushed to the system it is returned to the slab system.

Oil and grease enters the system from leaks on the machines. Floating oil and grease is removed from the sedimentation pit by the scraper car skimmer. Any fine droplets of oil are removed in the sand filters with the suspended solids. A backwash aid for the filters in order to free all the retained oil from the sand during backwashing is very important. Water from the cooling tower supply sump is used for backwash of the filters and the water is then recovered to the scale pit through the continuous thickener. Sludge from this thickener joins the sludges at the Main Purification Plant (which are routed to the BOF off-gases sludge handling system, SM02.1.5).

This V3 secondary system is contaminated with fluorides that originate from the casting powders being used in the production processes. Fluorides and iron are the major components that forms deposits in the pipes. Biological slimes can clog strainers and nozzles and can cause total flow stoppages on the different cooling parts of the machine.

The system blowdown is currently controlled by hand and the blowdown is to a sump which is pumped to the Blast Furnace Slag Granulation system.

Technical Specifications	**Secondary Cooling System**
System Capacity	2300 m^3
Standard make-up rate	33 m^3/hr (± 90% from the primary open)
Circulation Rate	1360 m^3/hr
Hot water temperature	45°C
Cold water temperature	30°C
Materials of Construction	Mild Steel, Stainless Steel
Number of inline filters	12 (114 m^3/hr/filter)
Backwash pumps	3 (140 m^3/hr/pump)

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Stream Analysis	V3 Secondary Cooling System
Total Hardness	444 mg/l
Ca Hardness	231 mg/l
P alkalinity	1.5 mg/l
Total Alkalinity	108 mg/l
pH	7.8
Cl	239 mg/l
SO_4	445 mg/l
Conductivity	2031 µS/cm
TDS	1484 mg/l
Suspended Solids	12 mg/l
P	0.3 mg/l
F	60 mg/l
SiO_2	20 mg/l
Na	255 mg/l
Fe	1.0 mg/l
Oil	8.7 mg/l

SM04.2.4 SLAB COOLING SYSTEM

The system supplies water for the cooling of slabs before the slabs are transported. The system make-up water is normally from the secondary cooling water system which can be blown down to this system. Industrial water is available as a back up supply. The water in this system can become extremely hot because of the rate of slab stacking in the system. Temperatures in excess of 75°C are not uncommon in this system.

Technical Specifications	Slab Cooling System
System Capacity	3100 m^3
Standard make-up rate	30 m^3/hr
Circulation Rate	1900 m^3/hr
Hot water temperature	65°C
Cold water temperature	35°C
Materials of Construction	Mild Steel

Stream Analysis	V3 Slab Cooling System
Total Hardness	530 mg/l
Ca Hardness	275 mg/l
P alkalinity	0 mg/l
Total Alkalinity	68 mg/l
pH	7.1
Cl	279 mg/l
SO_4	579 mg/l
Conductivity	2420 µS/cm
Suspended Solids	20 mg/l
P	<0.2 mg/l
F	77 mg/l
SiO_2	26 mg/l
Na	297 mg/l
Fe	0 mg/l
Oil	7.6 mg/l

SM05 DIRECT REDUCTION PLANT

The principal active process water related production areas are :

SM05.1	Direct Reduction Demin Plant
SM05.2	D R Product Cooling System
SM05.3	After Burner Temperature Control
SM05.4	Bore Hole Pumping to keep water out of Below Ground Structures

Direct reduction involves the reduction of iron ore to metallic iron in the solid state. Thus, process temperatures are less than 1000°C. A solid product called direct reduced iron (DRI), is produced. The direct reduced iron is used as feedstock for electric arc furnaces. The main benefit of a direct reduction unit compared to a blast furnace is that the direct reduction unit uses coal as a fuel. Therefore, a coke oven plant is no longer needed, significantly reducing the emissions. The impact on the environment of a direct reduction unit itself is very limited. There is little dust emission, which is easy to collect.

At IVDBS crushed ore and fine dolomite are reduced with fine coal in four rotary kilns to approximately 97% Fe. It is then cooled, screened to remove excess coal and the fine dolomite (dolochar) and conveyed to the blast furnaces – 50 000 t/m. Excess heat (from the combustion of excess carbon monoxide within the off-gases) is used to produce low pressure steam, primarily for use within the coke ovens. Undersized product and the + 2mm Dolochar fraction go to the sinter or are dumped.

SM05.1 DIRECT REDUCTION DEMINERALISATION PLANT

The aim of this plant is to supply demineralised water to the Direct Reduction Boilers. The plant consists of two trains each with one cationic stage and one anionic stage. The resins are regenerated using respectively hydrochloric acid and caustic soda. The regeneration effluents are discharged to the TETP. The demineralised water is pumped to 4 waste heat boilers (15 bar). Boiler conditioning chemicals (phosphate, sulphate and colloid) are also fed into the buffer storage tanks for the boilers.

Technical Specifications	
Capacity	225 m^3/hr
Boiler Capacity	50 ton/hr/boiler

Performance Standards after addition of conditioning chemicals	
Conductivity	<20 mS/cm
Phosphate	15-30 mg/l
Sulphate	20-30 mg/l

The effluent generated from the demineralisation plant (~14m^3/hr) and the blow down effluents from the boiler system (~13m^3/hr) are characterised by the following typical analysis:

Stream Analysis	**DR Demin Regen Effluent**	**DR Boiler blow down**
Total Hardness	563	3.3 mg/l
Ca Hardness	280 mg/l	3.3 mg/l
Total Alkalinity	670 mg/l	
Cl	1061 mg/l	
SO_4	67 mg/l	
Conductivity		250 µS/cm
Suspended Solids	8 mg/l	
P	3.6 mg/l	
F	2.7 mg/l	
NO_3	4.5 mg/l	
Na	1056 mg/l	
Fe	2.9 mg/l	

A new pipeline is currently being commissioned which will bring demineralised water from the High Pressure Demineralisation Plant (see Section CS02.2) to the Direct Reduction waste heat boilers. This will enable this Demineralisation Plant to be shut down and only be used for emergency back up purposes or during maintenance outages.

This same pipe line has been arranged such that if the Direct reduction Demineralisation Plant is brought back on line, then the regeneration effluents will be able to be discharged via this pipe, either to the sump for these effluents which is adjacent to the High Pressure Demineralisation Plant or to the Blast Furnace slag granulation system. This will enable this high salts content effluent to be permanently diverted away from the TETP.

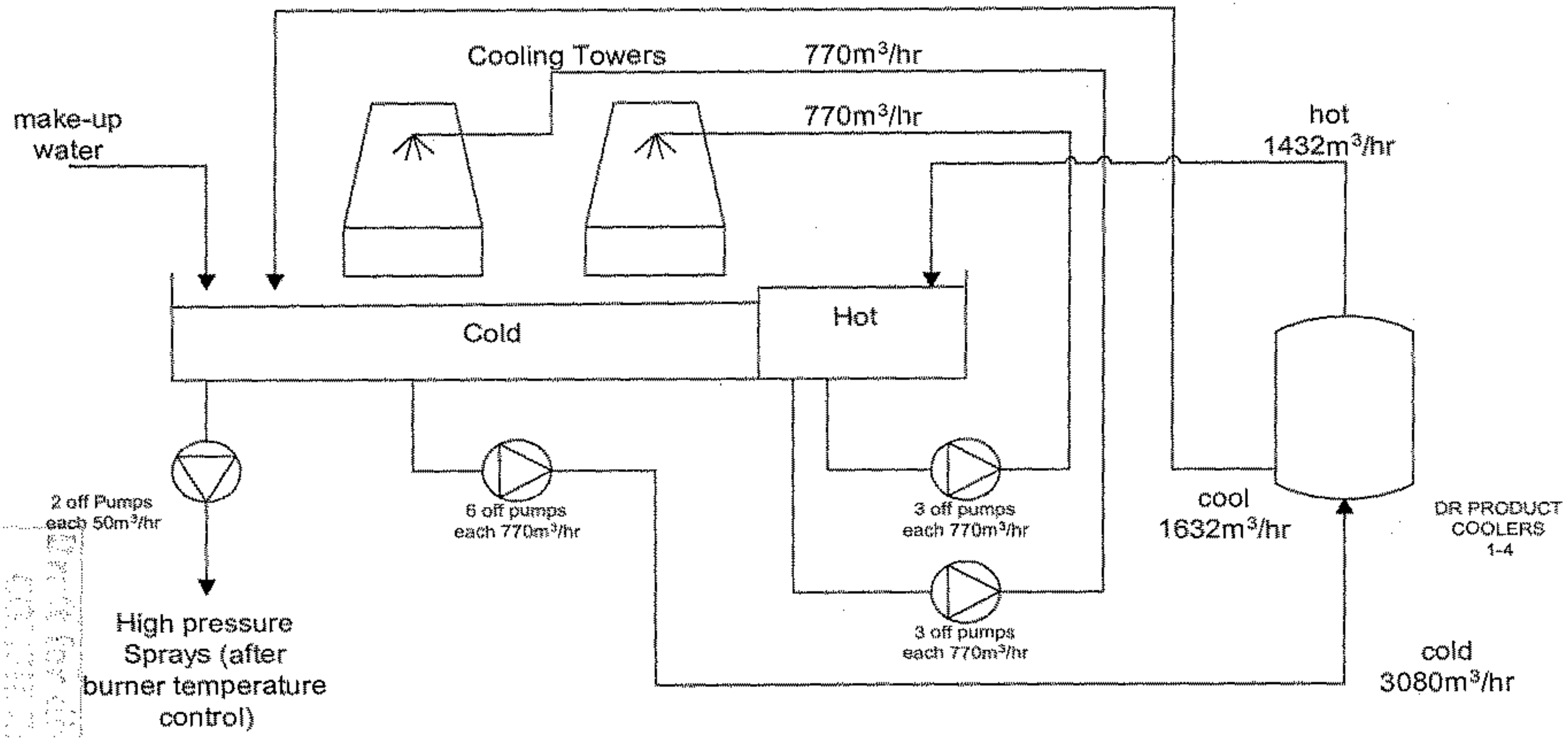
SM05.2 DR PRODUCT COOLING SYSTEM

DR material exiting the kiln is indirectly cooled via a rotary drum arrangement immersed in continuously cooled and circulated cooling water. The normal blow down from the cooling tower system is via the after burner temperature control water sprays. If further blow down is necessary, this is controlled manually and is routed to the Terminal Effluent Treatment Plant (TETP).

Technical Specifications	**DR KILN Cooling System**
System Capacity	Unknown
Standard make-up rate	~ 80 m³/hr
Circulation Rate	3000 m³/hr
Blow Down Rate	50 m³/hr
Hot water temperature	35°C
Cold water temperature	25°C
Materials of Construction	Mild steel and concrete

Stream Analysis	**DR KILN Cooling System**
Total Hardness	249 mg/l
Ca Hardness	175 mg/l
P alkalinity	15 mg/l
Total Alkalinity	140 mg/l
Cl	79 mg/l
SO_4	194 mg/l
Conductivity	886 µS/cm
Suspended Solids	42 mg/l
P	
F	2.7 mg/l
Na	75 mg/l
Fe	2.9 mg/l

DR KILN COOLING TOWER CIRCUIT



Note, overflows and area washdowns are currently routed to TETP.

484/LA1081
11th Nov 02

SM05.3 AFTER BURNER TEMPERATURE CONTROL

The hot gases which leave each direct reduction furnace contain a significant amount of fine dust which has a high carbon content. This high carbon dust is mostly derived from the coal that is fed and results from the abrasive conditions which exist within the kiln. In addition, the gases have a high concentration of carbon monoxide (CO).

The carbon monoxide and most of the carbon content of the dust is burnt in after burner chambers, and then the heat that is produced is used to raise steam in the boilers. In order to prevent the other components in the dusts from reaching a temperature which is above the melting point of components within the dust (i.e. to prevent the dust from forming a "glazed on" deposit on the boiler heat transfer surfaces) the maximum temperature in the after burner is prevented from getting too high using water sprays. The after burner section therefore consists of a carefully arranged array of air inlet nozzles (which also promote intense gas mixing) and water sprays. The air provides the oxygen necessary for combustion and the water provides the cooling.

Temperatures below 850°C (preferably 900°C) have to be avoided, otherwise combustion will be too slow. Also temperatures above 1000°C (preferably 950°C) have to be avoided or dust melting and hence fouling problems will start to occur.

The water sprays are fed with circuit water from the DR product cooling recirculatory cooling system. The flow to each spray nozzle is automatically controlled by the immediately down stream temperature. Each after burner consumes about 10 to 15 m^3/hr (normally about 12 m^3/hr) of water in order for the after burner gases to be as hot as possible as they enter the respective boiler (for maximum steam production) whilst not risking boiler fouling.

Other than reduced steam production, there is no reason why more quench water cannot be supplied to the exit region of the after burner. Indeed, this addition of extra water at this location is the routine way that boiler feed water shortages or feed water pump limitations are overcome.

SM05.4 BORE HOLE PUMPING TO KEEP WATER OUT OF BELOW GROUND STRUCTURES

At the D.R. Plant, there are a number of below ground structures (e.g. cable tunnels and coal ore, dolomite and product conveying systems). The proximity of the plant to Dam 10 and the generally high perched water tables necessitates routine pumping of some boreholes and cable tunnels. A typical average analysis and flow are given below.

Direct Reduction Boreholes – Analyses

	DR1	DR3	DR4
Flow (m^3/hr)	$3m^3$/hr (combined flow)		
Total Hardness (mg/l)	197	513	296
Ca Hardness (mg/l)	133	384	192
P alkalinity (mg/l)	0	0	0
Total Alkalinity (mg/l)	380	33	180
Cl (mg/l)	174	1076	356
S-SO_4 (mg/l)	14	1020	301
Conductivity (µS/cm)	1391	5320	1922
F (mg/l)	0.09	3.1	0.13
CN (mg/l)	0.02	0.09	0.11
NH_3-N (mg/l)	~20	~20	~20
NO_3-N (mg/l)	0.15	2.2	0.44
Na (mg/l)	70	353	91
Fe (mg/l)	6.9	0.9	4.1

CS01 SECONDARY INDUSTRIES AND STORAGE AREA

This area is not applicable to the process waters Master Plan.

CS02 ADMINISTRATION & SERVICES

The principal active process waters related production areas are :

CS02.1	Blower House
CS02.2	High Pressure Boiler
CS02.3	Main purification plant
CS02.4	Mould Foundry
CS02.5	Loco Repair Shop and Workshops

CS02.1 BLOWER HOUSE COOLING WATER SYSTEMS

There are two Blower House Cooling Systems, one East and one West. Both are located just south of the Blast Furnaces and provide compressed air to the Blast Furnaces. Both are in the process of being replaced by the new Blower House. The new system provides more efficient compression and therefore will not have such a high heat removal.

The existing cooling is achieved by a normal recirculating open cooling system using cooling towers with side steam sand filter systems to keep suspended solids at a low level. This system then cools closed cooling systems on the blowers themselves.

The New Blower House has its own dedicated Cooling Towers and water management system. This will work in a similar manner to the East and West systems described below, but the water usage and blow downs from all the Blower House and Generator Systems as a whole will average about 110 m^3/hr instead of the current average of about 140 m^3/hr.

CS02.1.1 EAST BLOWER HOUSE SYSTEM

The East Blower House system is a fairly big system and consists of four natural draught concrete shell cooling towers and five side stream filters. The system is for cooling the condensers on the 5 MW Alternator and for cooling the Blast Furnace C blowers and the compressed air from these blowers. Cooling takes place in horizontal heat exchangers.

The system tends to be scaling in character and iron fouling is also present to some degree. The filtration is poor and suspended solids loads can be high at times. Most of the blowdown water is used as make-up water for the blast furnace open system, while the rest is directed to TETP. Industrial water from the main purification plant is used as make-up water.

Technical Specifications	**Blower House East**
System Capacity	4200 m³
Standard make-up rate	175 m³/hr
Circulation Rate	13500 m³/hr
Two old side-stream filters	180 m³/hr
Three new side-stream filters	270 m³/hr
Delta T	5°C
Cycles of concentration	3

System Analysis	
Total Hardness	785 mg/l
Ca Hardness	463 mg/l
P alkalinity	46 mg/l
Total Alkalinity	295 mg/l
pH	8.9
Cl	232 mg/l
SO_4	584 mg/l
Conductivity	1848 µS/cm
Suspended Solids	30 mg/l
F	2 mg/l

CS02.1.2 WEST BLOWER HOUSE SYSTEM

The West Blower House system consists of a closed system and an open system. The closed system is currently not being treated and only the open system is treated. The system is for cooling the condensers of the 30 MW Alternator and for cooling the Blast Furnace D blower number 8 and the compressed air from this blower.

The open system has a very stable make-up rate and can easily concentrate to very high cycles. The system tends to be scaling in character. Industrial water from the main purification plant is used as make-up water.

Technical Specifications	**Open system**
System Capacity	400 m³
Standard make-up rate	2 m³/hr
Circulation Rate	200 m³/hr
One side-stream filter	35 m³/hr
Delta T	5°C
Cycles of concentration	3

System Analysis	
Total Hardness	924 mg/l
Ca Hardness	678 mg/l
P alkalinity	10 mg/l
Total Alkalinity	142 mg/l
pH	8.3
Cl	441 mg/l
SO_4	532 mg/l
Conductivity	1990 µS/cm
Suspended Solids	20 mg/l

CS02.2 HIGH PRESSURE DEMINERALISATION PLANT

The aim of this plant is to supply demineralised water to the high pressure boilers which supply the 30 MW Alternator, the Blast Furnace blowers and compressor number 41 with high pressure steam. High pressure steam is also de-superheated for the works low steam pressure needs. All the condensate from the alternators and blowers are returned and recycled to the boilers. The cationic and anionic resins are regenerated with sulphuric acid and caustic soda. The regeneration effluents is discharged to a local sump from which it is now (as a result of the Short Term Measures) pumped to the Blast Furnace Slag Granulation System. At slag granulation, both the bulk volume of the system and the nature of the slag buffer, stabilise the pH and reduce the salts content of the regeneration effluents before they are pumped to the MVR evaporator and crystalliser plant (The Desalination Plant). The demineralised water is pumped to 6 boilers (30 bar). Boiler conditioning chemicals (phosphate, sulphate and colloid) are also fed into the boilers.

Technical Specifications	
Capacity of Demin Plant	225 m³/hr
Boiler Capacity	75 ton/hr/ boiler

Performance Standards after addition of conditioning chemicals	
Conductivity	< 10 mS/cm
Phosphate	15-30 mg/l
Sulphate	> 60 mg/l

CS02.3 MAIN PURIFICATION PLANT

Water is pumped from the Vaal River Barage extraction and screening system to the Works for utilization as make-up water to the water plants and the fire hydrant system in the South Works.

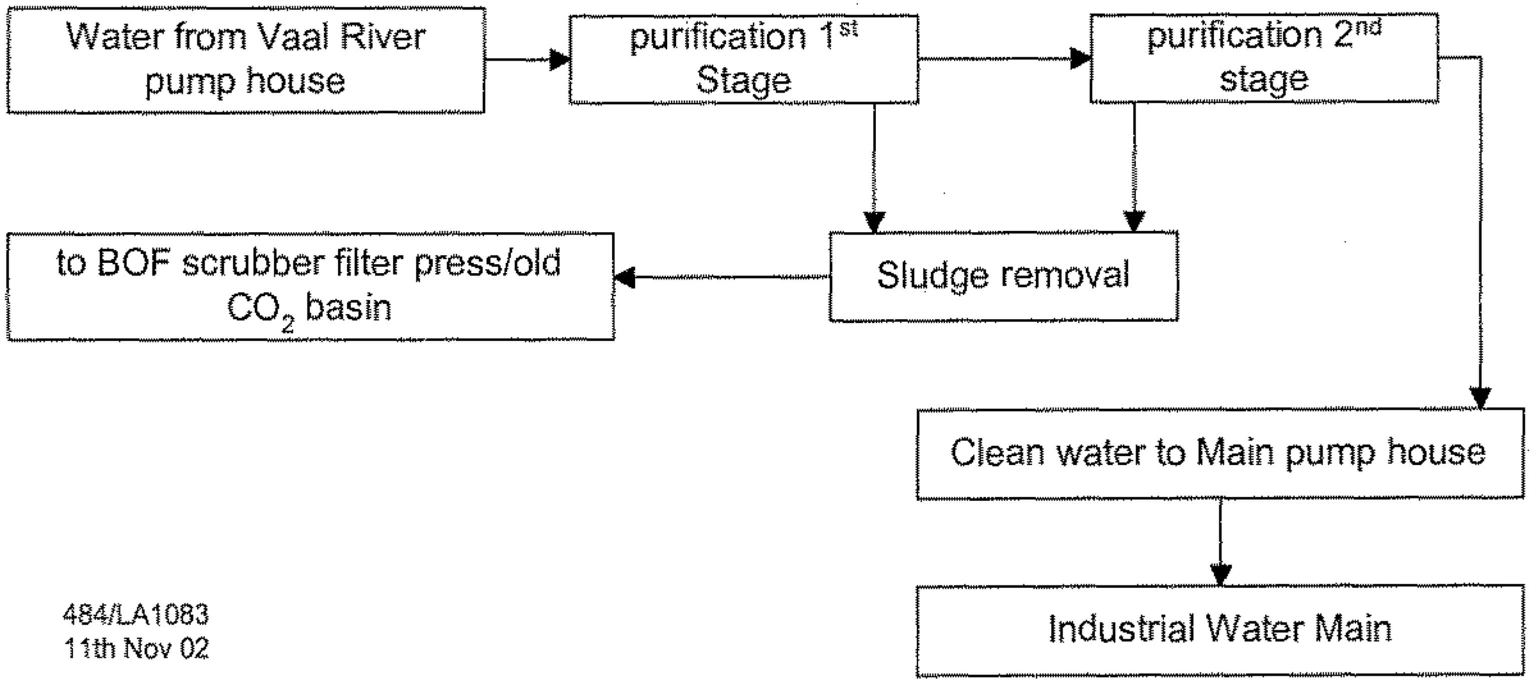
The water is treated with a flocculant (a ferric chloride and polymer mixture) and the suspended solids are removed in sedimentation dams. There are two sets of sedimentation dams which can be used either in series or in parallel. The water is also disinfected using chlorine gas. After clarification the water flows to the Main pumphouse where it is pumped into the Industrial Water Main infrastructure for distribution throughout the works.

Technical Specifications	
Systems Capacity	1960 m³/hr
Materials of construction	Mild steel, concrete

System Analysis	**Average Raw Water Inlet**
Total Hardness	219 mg/l
Ca Hardness	126 mg/l
P alkalinity	4 mg/l
Total Alkalinity	118 mg/l
pH	7.9
Cl	69 mg/l
SO_4	150 mg/l
Conductivity	765 µS/cm
Suspended Solids	36 mg/l
Na	64 mg/l

System Analysis	**Average Main Purification Plant Outlet – Industrial make-up water for South Works**
Total Hardness	217 mg/l
Ca Hardness	127 mg/l
P alkalinity	1 mg/l
Total Alkalinity	114 mg/l
pH	7.8
Cl	71 mg/l
SO_4	149 mg/l
Conductivity	761 µS/cm
Suspended Solids	< 10mg/l
Turbidity	6 NTU's
Na	64 mg/l

MAIN PURIFICATION & PUMP HOUSE FOR VAAL RIVER WATER



484/LA1083
11th Nov 02

CS02.4 MOULD FOUNDRY

CS02.4.1 MOULD FOUNDRY OPEN COOLING SYSTEM

This system provides cooling water to cool the closed system circulation water by means of a plate heat exchanger.

Water is pumped from the cooling tower basin to a plate heat exchanger back to the inlet of the cooling tower. Make-up water is river water (Industrial Water) and the blowdown is controlled automatically. Blowdown is currently used for irrigation of the foundry sand as part of local dust control and mould cooling.

Technical Specifications & Stream Analysis

Mould Foundry Open Cooling System - Details	
Circulation rate	50 m³/hr
System volume	5 m³
Current make-up rate	1.2 m³/hr
Current blow down rate	0.3 m³/hr
Hot water temperature	38°C
Cold water temperature	28°C
Materials of construction	Mild steel, stainless steel

Mould Foundry Open Cooling System – Analysis	
Total Hardness	693 mg/l
Ca Hardness	457 mg/l
P alkalinity	0 mg/l
Total Alkalinity	195 mg/l
PH	7.8
SO_4	469 mg/l
Conductivity	2080 µS/cm
Suspended Solids	15 mg/l

CS02.4.2 MOULD FOUNDRY CLOSED COOLING SYSTEM

This system provides cooling water to cool the Induction furnace of the Mould Foundry plant. Cooling water is required for the cooling of the following equipment: Capacitors, Rectifiers and Inverters for the Induction Furnace.

Make-up water is currently domestic water. The make-up is currently not softened. However, this system is local to the new interconnecting pipe line for feeding demineralised water to the DR from the H.P. Boiler House Demineralisation Plant. A suitable side feed to this system needs to be arranged.

Technical Specifications & Stream Analysis

Mould Foundry Closed Cooling System – Details	
Circulation rate	32 m^3/hr
System volume	NA
Current make-up rate	NA
Current blow down rate	NA
Hot water temperature	50°C
Cold water temperature	32°C
Materials of construction	Mild steel, stainless steel, copper

Mould Foundry Closed Cooling System – Analysis	
Total Hardness	103 mg/l
Ca Hardness	68 mg/l
P alkalinity	0 mg/l
Total Alkalinity	82 mg/l
pH	8.0
SO_4	33 mg/l
Conductivity	359 µS/cm
Suspended Solids	3 mg/l

CS02.5 LOCO REPAIR SHOP AND WORKSHOPS

There are virtually no effluents produced from these areas, the only ones being from machine and parts cleaning and from general routine floor cleaning and house keeping. All these effluents used to be discharged directly to the adjacent surface water drains. However, these areas are currently being upgraded such that all such effluents are or will be discharged to an oil and solids interceptor. The aqueous discharge from this interceptor is routed to the Blower House Canal.

When the ZED Infrastructure is implemented there will be a new collection pipe for the Blower House cooling towers, boiler blow down and the Blast Furnace cooling system blow down, together with a facility for receiving imbalances from the South

Cold Mills area. The Loco Repair Shop and Workshops interceptor will then discharge to this collection pipe.

The expected flow from the interceptor is expected to be less than about 5 m^3/hr peak flow and less than about 1m^3/hr average flow and will consist mainly of water and finely suspended oils and solids plus cleaning agents.

CS03 ELLIS PARK & OPEN AREAS

This area is not applicable to the process waters Master Plan. However, it should be noted that the current source of water for the two ornamental lakes in this area is treated effluent from the TETP, CS05.1. This water source will need to be replaced when the ZED infrastructure is brought on line.

CS04 OLYMPUS SWITCH YARD "C"

This area is not applicable to the process waters master plan.

CS05 TETP PLANT AREA

The principal active process waters relevant production areas are :

CS05.1	TETP
CS05.2	Coke Oven Area Sump
CS05.3	TETP Sludge Drying Drainage and Drying Dams

CS05.1 TERMINAL EFFLUENT TREATMENT PLANT

Brief System Description

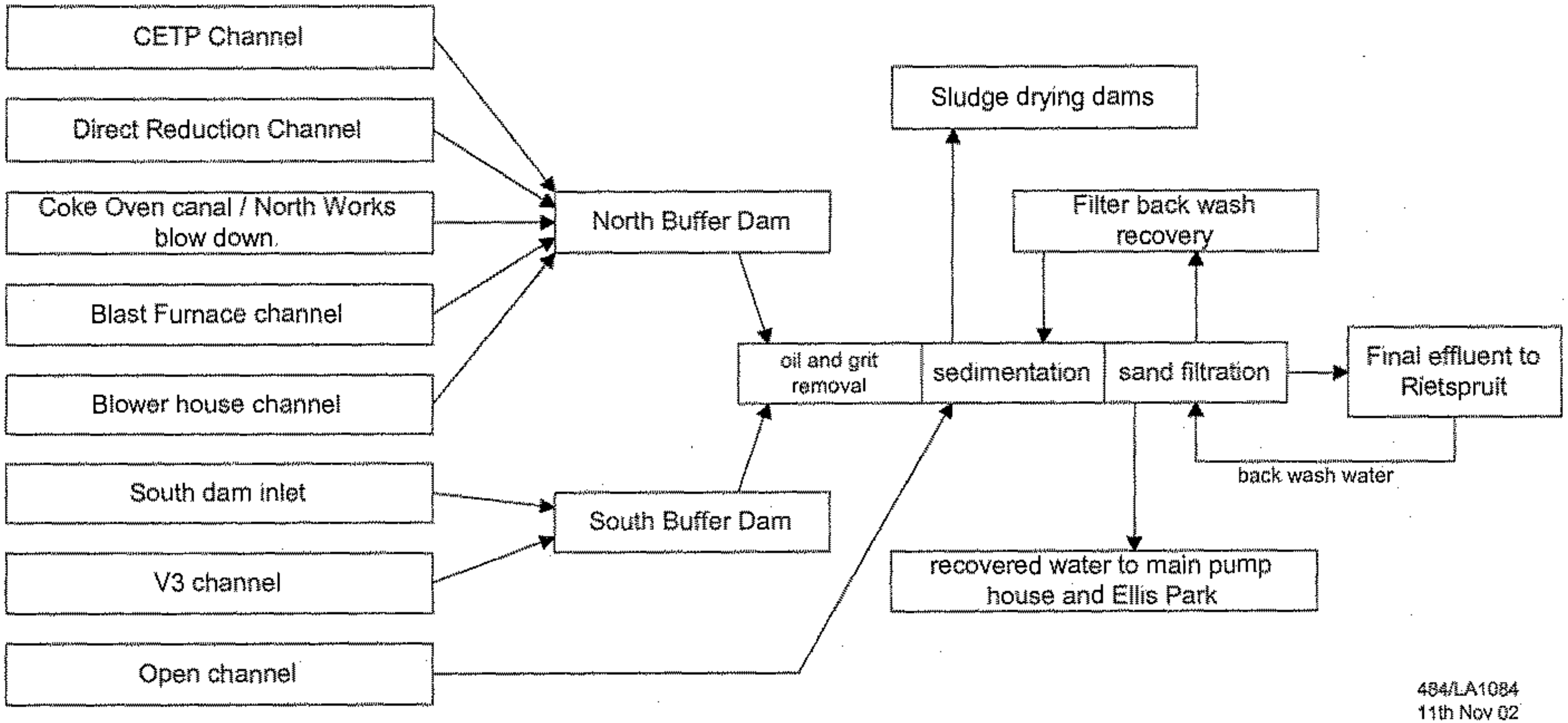
This plant receives treated effluent from the CETP, blow down waters from North Works and South Works and other cooling and quench water discharges, together with surface waters and ground water seepages from within the site area into the overall canal infrastructure. Currently all these waters are routed to either the North or the South buffer Dams from which they are routed under flow control through the TETP. An overview representation of the different canal inputs (as at September 2000) into the TETP and its basic flow diagram is given in RPA Drawing 484/LA1084. Also, the current principal process water sources into the TETP are presented in RPA Drawing 484/LA1076.

At the TETP the waters are put through a grit removal and gross oil removal stage. They are then treated with flocculants to assist gravity separation of oils and suspended solids in the sedimentation clarifiers which form the next part of the plant. The waters are then fed to sand filters before being discharged to the Discharge Canal and eventually to the Rietspruit.

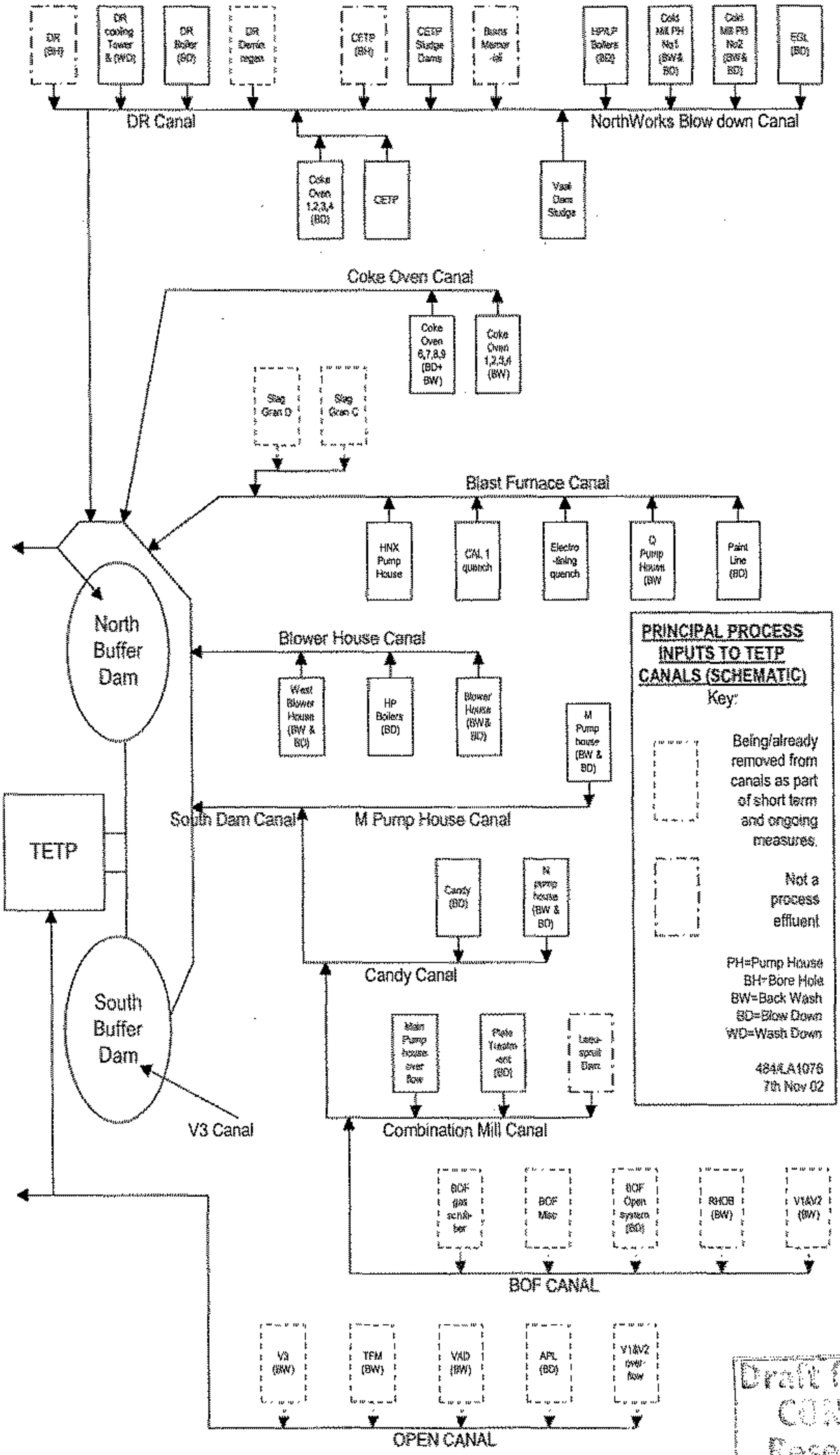
During storm conditions when the surface water flow exceeds the capacity of the two buffer dams, ongoing Stormwater bypasses the two buffer dams and is routed directly via a flow limiting orifice to the Discharge Canal. Any flow which exceeds that which can be passed through the flow limiting orifice is diverted to the West Buffer Dam where it is held until the storm flow has subsided sufficient to allow the flow limiting orifice to pass this stored water to the Discharge Canal.

Some of the treated water is used as the sole water supply to the ornamental lakes which are situated on either side of the Main Entrance Road (Zone CS03). Also facilities exist to pump liquors to the main purification plant and to slag granulating plants C and D; although these uses represent only a minor volume relative to the total. The effluent from the works into the Discharge Canal and to the Rietspruit itself are constantly monitored for pollutant elements by means of continuous analysers.

OPERATING SCHEMATIC FOR TETP as at Sept 00



484/LA1084
11th Nov 02


DR (BH)
DR cooling Tower & (WD)
DR Boiler (BD)
DR Demin regen
CETP (BH)
CETP Sludge Dams
Baars Memor -ial
HP/LP Boilers (BD)
Cold Mill PH No1 (BW& BD)
Cold Mill PH No2 (BW& BD)
EGL (BD)
DR Canal
NorthWorks Blow down Canal
Coke Oven 1,2,3,4 (BD)
CETP
Vaal Dam Sludge
Coke Oven Canal
Coke Oven 6,7,8,9 (BD+ BW)
Coke Oven 1,2,3,4 (BW)
Slag Gran D
Slag Gran C
Blast Furnace Canal
HNX Pump House
CAL 1 quench
Electro -lising quench
Q Pump House (BW
Paint Line (BD)
North Buffer Dam
Blower House Canal
West Blower House (BW & BD)
HP Boilers (BD)
Blower House (BW& BD)
M Pump house (BW & BD)
TETP
South Dam Canal
M Pump House Canal
Candy (BD)
N pump house (BW & BD)
Candy Canal
South Buffer Dam
Main Pump house over flow
Plate Treatm -ent (BD)
Lesu- spruit Dam
V3 Canal
Combination Mill Canal
BOF gas scrub- ber
BOF Misc
BOF Open system (BD)
RHDB (BW)
V1&V2 (BW)
BOF CANAL
V3 (BW)
TFM (BW)
VAD (BW)
APL (BD)
V1&V2 over- flow
OPEN CANAL
PRINCIPAL PROCESS INPUTS TO TETP CANALS (SCHEMATIC)
Key:
Being/already removed from canals as part of short term and ongoing measures.
Not a process effluent
PH=Pump House
BH=Bore Hole
BW=Back Wash
BD=Blow Down
WD=Wash Down
484/LA1075
7th Nov 02

System Characteristics & Technical Specifications

The water from the buffer dams flows through a grit and oil trap where floating oil is skimmed off. The water from both the north and south buffer dams is treated with a flocculant and the suspended solids are removed in the rectangular sedimentation clarifiers. The water is then collected in to sumps from where it is pumped through up to 18 sand filters. Each sand filter has a capacity of up to a little over 300 m^3/hr. The number of sand filters that are on line at any one time is therefore a function of the required total flow through the TETP at the time. After filtration the water is disinfected with an oxidizing biocide. The filter backwash water is reclaimed and flows through a thickener/clarifier where the bulk of the suspended solids are removed. The backwash water is then reintroduced into the sedimentation clarifiers. Due to the nature of the water coming from the different plants, the characteristics and chemical composition can change dramatically within short periods.

Technical Specifications	**Terminal Effluent Treatment Plant**
Systems Capacity	1250 m^3/hr (normal) 5500 m^3/hr (maximum)
Materials of construction	Mild steel, concrete

Typical Characteristics of Input Stream

	units	**DR Canal**	**Coke Oven Canal**	**Blast Furnace Canal**	**Blower House Canal**
Total Hardness	mg/l	594	470	248	202
Ca Hardness	mg/l	444	291	163	114
P alkalinity	mg/l		1.2	0.1	1.0
Total Alkalinity	mg/l	82	93	96	126
Cl	mg/l	391	117	72	39
SO_4	mg/l	256	360	147	107
Conductivity	µS/cm	2741	1557	751	604
F	mg/l	3.1	1.4	0.7	0.4
Na	mg/l	84	78	40	37
NH_3	mg/l	6.3	12.8	3.6	0.3
CN	mg/l	0.09	0.17	0.15	0.04
Dry weather flow (rounded average)	m^3/hr	460	180	210	120

Typical Characteristics of Input Streams

	units	**South Dam Canal**	**Open Canal**	**Final Effluent**
Total Hardness	mg/l	214	277	420
Ca Hardness	mg/l	126	192	322
P alkalinity	mg/l	3.7	20	
Total Alkalinity	mg/l	136	114	84
Cl	mg/l	53	67	223
SO_4	mg/l	146	244	199
Conductivity	µS/cm	782	1112	1320
F	mg/l	1.1	1.6	2.2
Na	mg/l	61	101	89
NH_3	mg/l	0.3	1	1.1
CN	mg/l	0.06	0.06	0.03
Dry weather flow (rounded average)	m^3/hr	120	50	1250

CS05.2 COKE OVEN AREA SUMP

This is a new lined sump for collecting drainage from the bund areas, spillages, process blow downs and other potential discharges which could occur within the Coke Oven, Coal Gas Cleaning Suprachem and the other Coke Oven derived By-Products Processing areas. The lined sump, emptying infrastructure and the collection header which feeds it were installed as part of the Short Term Measures which carried out bunding and containment activities in these areas. This enabled clean surface water run off to occur to the Coke Oven Canal and for all Process waters and potentially contaminated waters to be contained and returned to process.

The construction details for this sump and all the return systems, the area bunding and for the containment and collection systems were all overseen for the Master Plan Process by VRF.

Further details associated with this sump and its operation are presented at Section 5.2.5.

CS05.3 TETP SLUDGE DRAINAGE AND DRYING DAMS

Due west of the Terminal Effluent Treatment Plant (TETP) itself there are two earth walled sludge drainage and drying dams. These dams receive the silts and other suspended solids which are removed from the waters that are processed through the TETP. These solids are separated by a combination of flocculant aided settlement and sand filtration within the TETP and they are conveyed to these dams as a slurry within TETP treated water. The water drains through the earth walls and floor of the dams into the adjacent trenches which lead to the Rietspruit Canal.

Once the ZED infrastructure is in operation all the sludges that are produced within the TETP and the MTP (Main Treatment Plant) (which will also be in this area) will be dewatered using appropriate pressure filtration equipment and the resultant filter cakes will be sent to appropriate disposal facilities (probably on the existing Dump and then on the replacement disposal facility).

These sludge drainage and drying dams can then be dug out the solids removed to appropriate disposal and the areas can be rehabilitated.

CS06 EFFLUENT DAMS

This area is not applicable to the process waters master plan as no more process related waters are discharged to it and the aqueous contents of the dam are likely to be fully removed within the next few months. For further details see Section 5.2.2, 5.2.3, 5.2.5 and 5.2.8.

CS07 SOLID WASTE DUMPS

This area is not applicable to the process waters master plan. Leachates and run off waters are collected in the Du Preez catchment and are pumped to Dams 1 to 4. Once the ZED infrastructure is all in place and working, there will be capacity to progressively empty these Dams through that infrastructure.

CS08 Not Used

CS09 MATURATION PONDS

These Dams currently receive coke oven area waters when there is insufficient space within the Bio-Plant Inlet lagoons for the total flow. As a result of the various Short Term and Ongoing Measures (see Section 5.2.10) the current average input volumes to the Bio-Plant Inlet Lagoons is less than the average output rate and as a result there is now a net output flow from the Maturation Dams that exceeds the input.

For characteristic analysis of the contents of these Dams, see the OFT part of the Master Plan Documents.

CS10 CETP SLUDGE DAMS

These Sludge Dams receive the neutralisation reactor product sludges from the existing CETP. Whilst the current operation of the CETP produces much less sludge than it did in the past (circa 25%) and this sludge has very much less oil and tallow within it, the sludges in these dams do contain substantial amounts of oil and tallow. This oil and tallow content currently represents a significant issue.

a) When dried out, veld fires can cause the sludge to burn. Once a fire has taken hold, it is very difficult to extinguish it without fully flooding the deposit again with water.
b) The sludge is very bio-degradable, despite its heavy metal content.
c) Reed and other water based plant life thrive in it. This makes the control of a) above even more of an issue.

The method of operation of the Dams is as follows:

- Sludges are pumped to the Dams. They enter from the eastern side.
- A series of adjustable overflow weirs are built into the western wall. Clarified liquor flows over these weirs and is directed into a concrete half round drain which runs north-south along the toe of the western wall of the Dams.
- These waters drain to the southern end of this drain where they enter a pipe which leads them by gravity to the North Works Blow Down Canal which then routes them by gravity to the TETP.

This half round drain is currently being replaced with an enclosed pipe so as to prevent overflow problems which can result when a reed or other plant causes a blockage in the currently open drain. The following Table presents a typical analysis of the overflow waters from these Dams. For typical analyses of the solids within the Dams, see the OFT part of the Master Plan Documents.

CETP Sludge Dams Overflow – Analysis	
Flow (m^3/hr)	40
Total Hardness (mg/l)	2268
Ca Hardness (mg/l)	2236
P alkalinity (mg/l)	27
Total Alkalinity (mg/l)	65
pH	8.6
Cl (mg/l)	1273
S-SO_4 (mg/l)	725
Conductivity (µS/cm)	4500
Suspended Solids (mg/l)	-
F (mg/l)	5.59
CN (mg/l)	0.03
NH_3-N (mg/l)	7
Phenol (mg/l)	0.23
NO_3-N (mg/l)	1.4
NO_2-N (mg/l)	0.12
P (mg/l)	0.3
Mn (mg/l)	0.44
Cr^{6+} (mg/l)	
Na (mg/l)	157
Fe (mg/l)	5.11
Zn (mg/l)	3.1
SiO_2 (mg/l)	
Sn (mg/l)	1.3
Cr total (mg/l)	0.19
K	5.0
Oil	3.2

Just south of these Dams, there is a bore hole which also discharges water to the North Works Blow Down Canal. Typical analyses and flows for this borehole are given in the following Table.

CETP Borehole – Analysis	
Flow (m^3/hr)	0-1
Total Hardness (mg/l)	2000
Ca Hardness (mg/l)	1850
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	58
PH	8
Cl (mg/l)	1000
S-SO_4 (mg/l)	450
Conductivity (µS/cm)	4500
F (mg/l)	2.6
CN (mg/l)	0.03
NH_3-N (mg/l)	7
Phenol (mg/l)	0.23
NO_3-N (mg/l)	1.4
NO_2-N (mg/l)	0.12
P (mg/l)	0.48
Mn (mg/l)	1
Cr^{6+} (mg/l)	0.1
Na (mg/l)	144
Fe (mg/l)	1.2
Zn (mg/l)	0.5
Sn (mg/l)	0.5
Cr total (mg/l)	0.12
K	30

CS11 CETP PLANT

The principal active process waters relevant production areas are:

CS11.1	Central Effluent Treatment Plant, CETP

CS11.1 CENTRAL EFFLUENT TREATMENT PLANT

The central effluent treatment plant CETP receives five different effluent types, mainly originating in the cold and hot mill plant sections. The CETP plant is designed to receive those effluents which need chemical and physical treatment in order for them to be suitable for ultimate release via the TETP (Terminal Effluent Treatment Plant) to the final effluent discharge canal. The principal equipment located within the CETP area are storage tanks, reaction vessels, reagent storage, clarifiers and associated pumps and mixers. The effluent streams that are that are treated include:

- Oily effluent from the rolling mills (containing both oil and tallow)
- Chrome, tin and fluoride containing effluents from plating and surface treatment processes for product steel.
- Acidic effluent containing hydrochloric acid, sulphuric acid and ferrous chloride/sulphate rinse waters from pickling processes.
- Alkaline effluent from the degreasing processes in the rolling mills

The different effluents are combined into an integrated treatment system that maximises co-treatment possibilities to bring about chromium reduction, heavy metals precipitation as hydroxides, fluoride and sulphate precipitation, oil and tallow recovery for resale (via an oil skimmer system) and pH control of the final effluent discharged.

The principal chemical utilised at the plant is quick lime (calcium oxide) although specialist emulsion breakers are utilised within the oil recovery processes to improve yields. Note acidic rinses from the pickling processes provide the required Fe^{2+} source to reduce the chrome ($Cr\ 6^{+}$) containing effluents – although spent pickle liquor is available as a back up reagent.

The treated effluent is discharged via an open channel (with some piped sections) into the Direct Reduction Canal and then into the Terminal Effluent Treatment Plant.

The CETP sludges produced are mainly iron with some other metal hydroxides together with oil, and tallow.. The CETP sludges are disposed of in dedicated CETP sludge dams (historically to the dams located in area CS22, but currently to area CS10). These dams were, by today's standards, constructed without adequate and lining systems.

Individual effluents arriving at the CETP from both the North and South Works are identified below together with their average input rates and the relevant master plan area code:

- Chrome Effluent (South Works: CP01.1) via Q pump house : 54m^3/hr
- DWI Mixed Effluent (South Works: CP01.1) via Q pump house : 7m^3/hr
- Stannous Effluent (South Works: CP01.1) via Q pump house : 35m^3/hr
- Acid Effluent (South Works: CP01.1) via Q pump house : 10m^3/hr
- Alkaline Effluent (South Works: CP01.1) via Q pump house : 110m^3/hr
- Oily Effluent (South Works: CP01.1) via Q pump house : 40m^3/hr.
- CAL No 2 (North Works : UP01.6.2) via No1 pump house : 3m^3/hr
- Oily Effluents Cold Mills (North Works : UP01.6.2) via No1 pump house: 41m^3/hr
- Acid Effluent Cold Mills (North Works : UP01.6.2) via No1 pump house: 39m^3/hr
- EGL rinse liquors (North Works : UP01.8) via EGL effluent treatment plant pump house : 3 m^3/hr

For individual stream effluent analysis please refer to the appropriate zone within the Master Plan report.

The CETP infrastructure has been subject to major upgrade and alteration as part of the short term measures. Details of the historic and modified layout arrangements can be found within section 5.2.5 of this report.

The discharge from the CETP is typically characterised as follows:

CETP Discharge – Analysis	
Total Hardness	1450 mg/l
Ca Hardness	1400 mg/l
P alkalinity	140 mg/l
Total Alkalinity	185 mg/l
PH	9.6
Cl	840 mg/l
SO_4	760 mg/l
Conductivity	3800 µS/cm
Suspended Solids	37 mg/l
F	14 mg/l
NH_3	8.8 mg/l
Phenol	0.06 mg/l
NO_3^-	1 mg/l
NO_2	0.4 mg/l
P	0.2 mg/l
Na	170 mg/l
Fe	20 mg/l
Mn	2.4 mg/l
Cr (total)	0.1 mg/l
K	14 mg/l
Zn	7 mg/l
Sn	1 mg/l
Oil	4 mg/l

Flow	$302m^3/hr + 40m^3/hr$ to Sludge Dams

CS12 OPEN AREAS / HEAPS

This area is not applicable to the process waters master plan.

CS13 DAMS 1-4

This area is not applicable to the process waters master plan. It receives water from the Du Preez catchment and stores and evaporates it. It has also received water from Dam 10 but this input will cease entirely during the next few months. Water from Dams 1 to 4 is also used for dust suppression and evaporation spraying on the dump and for filling road spraying vehicles for use on the roads on the Dump.

CS14 NEW WASTE SITE AREA

This area is not applicable to the process waters master plan. It has in the past been irrigated using waters from the former Maturation Dams (area CS22).

CS15 OPEN AREAS / HEAPS

This area is not applicable to the process waters master plan. Product coke and raw material dolomite are regularly stored in this area, resulting in surface water quality issues. As a result of the Ongoing Measures there is now a piped and valved drainage route beneath the railway embankment in the south west corner which enables these surface waters to be released under proper control to the Coke Oven Canal.

Along the northern boundary of this area there is the pipe route for the strong effluents which are pumped from the North Works to the CETP. In addition, the respective strong effluent pipes from South Works follow close to the eastern side of the railway embankment referred to above. It is not unknown (but none the less rare) for one of these strong effluent pipes to rupture causing the resultant leak to accumulate in the south west corner of the area. The valved pipe beneath the railway embankment provides a means whereby any such leakage can be pumped to the CETP, followed, as necessary by subsequent decontamination waters pending the area becoming suitably clean enough for re-connection to the Coke Oven Canal.

The operating instructions are for all discharges from this area to be on a check, release and close off again basis.

CS16 VAAL DAM PLANT

The principal active production areas are :

CS16.1	VAAL DAM WATER CLARIFICATION PLANT
CS16.2	BIOLIGAL TREATMENT PLANT
CS16.3	DESALINATION PLANT

CS16.1 VAAL DAM WATER CLARIFICATION PLANT

Untreated raw water is received from the Vaal Dam via the Rand Water Board pump station. Suspended solids are precipitated in the clarifiers and the overflow is filtered, chlorinated and stored in a 30 000 m^3 reservoir. It is then pumped into the Vaal Dam Water Supply Main for distribution throughout the whole site.

The plant consists of an inline mixer, a mixing and flow splitting chamber, 3 x pulsator clarifiers, 4 rapid gravity sand filters, filtered water sump and a 30 000 m^3 reservoir.

A coagulant is added to the raw water prior to the inline mixer. After the inline mixer, the water proceeds to the mixing and flow splitting chamber from where it enters the three clarifiers. Solids are allowed to agglomerate and settle, the clear water overflows to the inlet of the sand filters. The filtered water is then chlorinated and is piped to the 30 000 m^3 buffer storage reservoir.

The sludge from the clarifiers is removed by adjusting the duration of opening of the pneumatic de-sludge valves as well as the frequency of de-sludging. The sludge is pumped to a thickener where further dewatering takes place. An anionic flocculant is usually used to aid in the solid-liquid separation. The clear overflow of the thickener is returned to the mixing chamber of the plant. The sludge from the thickener used to flow to a local three compartment sludge dam (one receiving, one draining and one being dug out) where it was drained and periodically removed to the main dump. This facility was unlined and unlicenced and has been removed and rehabilitated. The sludge is now pumped to the North Works Blow Down Canal which takes it to the TETP where it is removed in the inlet silt traps.

The sand filters are back-washed once a predetermined pressure differential is reached. The backwash water is pumped from the backwash sump to the above referred thickener for solid/liquid separation.

The system is operated on a 24 hour/day basis.

Technical Specifications	**Vaal Dam Clarification Plant**
Nominal Capacity	1250 m^3/hr
Maximum Capacity	1875 m^3
Clarifier dimensions	12.7m (L) x 5.8m (W) x 5.5m (D)
Materials of Construction	Mild Steel, concrete, SS

System Analysis	**Average Vaal Dam Purification Plant Outlet**
Total Hardness	86 mg/l
Ca Hardness	46 mg/l
P alkalinity	0 mg/l
Total Alkalinity	91 mg/l
pH	7.3
Cl	11 mg/l
SO_4	10 mg/l
Conductivity	257 µS/cm
Suspended Solids	<1 mg/l
Na	18 mg/l
K	3.4 mg/l
SiO_2	4.8 mg/l
F	0.76 mg/l

CS16.2 BIOLOGICAL TREATMENT PLANT

The biological treatment plant was supposed to receive water from the Ammonium Sulphate plants at the Coke ovens, from Suprachem and from the Gas Scrubbers at the Blast Furnaces. The treated effluent from the Biological Plant was to be used for coke quenching at the Coke ovens. Unfortunately, a combination of inappropriate design and higher than specified ammonia and tar contents in the incoming effluent have rendered the plant effectively inoperable. It has been shut down for many years. The proposed re-work of the Coke Oven Gas Cleaning Processes together with the proposals which are included within the ZED proposals will result in there being no longer a need for biological treatment of these effluents.

Effluent water is currently received in one stabilisation dam (other dam is currently being cleaned and is therefore not available) from were it used to be pumped into the biological reactor for treatment. From the reactor the water gravitated to the two clarifiers. The overflow then went to the rapid gravity sand filters and then to the filtered water sump. From the sump the water was pumped for coke quenching.

Whilst the Biological Treatment Plant has been shut down, raw effluent has been pumped to the above referred outlet sump and from there it has been pumped untreated to coke quench. Recently the inlets to these latter pumps have been re-arranged so as to avoid the need to route the liquor through this below ground sump.

Technical Specifications	
Inlet Dam Volume	9 000 m³ each
Reactor Volume	10 800 m³

The following table presents a typical average analysis for the input liquor to the Bio-Plant Inlet Dam.

Bio-Plant Inlet Liquor – Analysis	
Total Hardness	230 mg/l
Ca Hardness	52 mg/l
P alkalinity	1170 mg/l
Total Alkalinity	3900 mg/l
PH	9.2
Cl	480 mg/l
S	660 mg/l
Conductivity	9300 µS/cm
Suspended Solids	430 mg/l
F	15 mg/l
CN	40 mg/l
NH_3-N	1300 mg/l
Phenol	1000 mg/l
NO_3-N	2.5 mg/l
NO_2-N	1.2 mg/l
P	<0.2 mg/l
Na	80 mg/l
Fe	5 mg/l
K	100 mg/l

Once the proposed Coke Oven and gas cleaning upgrade becomes operational, then the analyses for sulphur, cyanide, ammonia and phenol level will change considerably (reduce) In addition, at that time, it is likely that the chloride concentration will also decline.

CS16.3 DESALINATION PLANT

The Desalination Plant consists of the following principal components:

a) Two HDPE lined brine inlet buffer dams.
b) Inlet pumps, pH adjustment systems and heat exchangers.
c) A Mechanical Vapour Recompression (MVR) Evaporator unit with a forced circulation clarifier.
d) Intermediate buffer storage for the product brine slurry from the MVR.
e) A steam heated crystalliser which operates under partial vacuum.
f) A centrifuge for the removal of the crystal products from the crystalliser.
g) Intermediate pumps, heat exchangers and tankage.
h) Product Distillate storage and pumps for pumping the product distilled water to the 30 000 m^3 concrete storage tank for purified Vaal Dam Water.
i) Bunding, sumps and pumps to ensure proper environmental containment

Shortly after the original plant was installed the compressor on the MVR evaporator section was badly damaged, beyond reasonable repair. The intrinsic overall capacity of the plant was around 55 to 60 m^3/hr of input brine. At the time only about 25 m^3/hr of brine from the demineralisation plants was being fed to the plant. The function of the compressor was therefore replaced with a steam ejector which was sufficient to enable the plant to operate at about 25 m^3/hr evaporation capacity.

As part of the Short Term Measures, the compressor was replaced with a turbo fan installation which was capable of achieving the full intrinsic capacity of the plant as a whole. The style of turbo fan that was installed has a good track record around the world for reliability and robustness. The centrifuge also had to be upgraded for both size and maintenance reasons.

The plant is now able to operate at almost 60 m^3/hr of total evaporation capacity and receives its input from the Blast Furnace Slag Granulation Wet Dams (water recirculation dams). These Wet Dams are fed by waters from the BOF, V1, V2, V3, Air Products and the EAF as well as with most of the regeneration effluents from the demineralisation plants that are situated within South Works (the Direct Reduction Plant's demineralisation effluent is still being connected).

The following Table presents a typical analysis for the current feed to the MVR evaporator.

MVR Feed Tank Typical Analysis	
Total Hardness	530 mg/l
Ca Hardness	340 mg/l
P alkalinity	0.4 mg/l
Total Alkalinity	56 mg/l
pH	7
Cl	560 mg/l
SO_4-S	4800 mg/l
Conductivity	10300 µS/cm
F	14 mg/l
NH_3-N	2.4 mg/l
Phenol	1.1 mg/l
NO_3-N	9.1 mg/l
NO_2-N	0.6 mg/l
P	<0.2 mg/l
Na	2180 mg/l
Fe	0.6 mg/l
K	113 mg/l
Mn	0 mg/l
Cr (total)	1.1 mg/l
Sn	1 mg/l

The Desalination Plant has its own cooling tower and cooling water recirculation system. The cooling water is used at the plate heat exchanger of the vacuum system of the crystalliser heater, the crystalliser condenser (shell and tube heat exchanger) and for cooling the compressor motor. Make-up water is Vaal Dam water. Cooling is with a single cell cooling tower.

The cooling system has a fairly constant make-up rate and cycles of concentrations are maintained. The blowdown is automatically controlled and is directed into the feed to the Evaporator Section of the plant. There are 2 x 15 m^3/hr side stream sand filters. The backwash water is also fed to the Evaporator Section, along with the blowdown water.

Technical Specifications of the Cooling System Desalination Plant	
Circulation Rate	120 m^3/hr
System volume	5 m^3/hr
Current make-up rate	2.5 m^3/hr
Current blowdown rate	0.5 m^3/hr
Cycles of concentration	5
Hot water temperature	40°C
Cold water temperature	30°C
Materials of Construction	Mild Steel, 904L SS

System Analysis of the Cooling System Water Desalination Plant	
Total Hardness	364 mg/l
Ca Hardness	92 mg/l
P alkalinity	37 mg/l
Total Alkalinity	294 mg/l
pH	7.9
Cl	137 mg/l
SO_4	196 mg/l
Conductivity	1378 µS/cm

CS17 SUB-STATION AREA

This area is not applicable to the process waters master plan.

CS18 OPEN AREAS

This area is not applicable to the process waters master plan. Within this area, there are two areas which need to be addressed from an environmental point of view.

Firstly, it is understood that there is a small blow down from the computer area air conditioning which goes to foul sewer. This should be re-routed to the nearby EGL (Electrolytic Galvanising Line) effluent sumps which are pumped to the CETP.

Secondly, there is a general transport yard with its own vehicle cleaning and servicing facility. This needs to have all its surface waters, vehicle wash waters and other wash waters routed through a suitable interceptor before they are allowed to be discharged. The contents of this interceptor will need routine emptying. The aqueous layer and oil layer can be discharged to the oil reclaim area north east of the oil skimmer unit at the CETP. Here the oil would be reclaimed and the aqueous part would be returned to the skimmer for treatment and inclusion with the rest of the oily effluent stream.

CS19 SIDING AREA

This area is not applicable to the process waters master plan. Within this area is the BASF paint mixing and blending facilities. Whilst there are no process effluents associated with this activity, it must be recognised that there is a high risk of surface water and ground contamination associated with the storage and blending of drummed paint ingredients. In addition, should a fire occur, then the resultant fire water and foam (if that is used) will represent a further significant problem to the surface and ground water regimes.

It cannot be stressed too strongly that this area must have a properly arranged and large capacity containment arrangement with a suitable mechanism for containing all the potential fire water which could be used.

CS20 KWAMAMDALA & OPEN AREAS

This area is not applicable to the process waters master plan unless its currently designated use is changed.

CS21 OPEN AREAS

This area is not applicable to the process waters master plan other than for its association with the Leuspruit Dam and the Frikkie Meyer Weir.

CS22 CETP SLUDGE DAMS

This area includes the former Maturation Dams which have since been used to receive and drain sludges and oils and tallow from the CETP. To the South and West of these former Maturation Dams there were sludge drying beds (most of which appear to have been cleared when they were abandoned) and the former Bekkers Pond area (a former barrow pit) which has been filled with CETP sludges and oils and tallow. In all these areas and the areas downslope of them, excessive amounts of sludges and oils and tallow have been allowed to overflow, ultimately draining through the Vlai areas into the Burns Memorial Canal.

As noted in the section referring to CS10, these deposits support the growth of reeds and other vegetation which brings with it the risk of the deposits being set on fire as a result of a Veld fire.

MM01 REFRACTORY AREA

This area is not applicable to the process waters master plan as it is a dry goods only area, mostly associated with fire bricks and construction.

MM02 SCRAP AREA

This area is not applicable to the process waters master plan, as it is not an effluent producing area. However, surface run off and ground water issues are present from both the scrap handling and the oil storage facilities.

MM03 PLANT STORE

This area is not applicable to the process waters master plan as it is a dry or fully packaged storage and distribution facility.

MM04 NORTH STORE

This area is not applicable to the process waters master plan as it too is a dry or fully packaged storage and distribution facility.

CP01 SOUTH MILLS AREA

The principal active process waters related production areas are :

CP01.1	Q PUMP STATION
CP01.2	HNX PUMP STATION
CP01.3	PAINT LINE COOLING TOWER
CP01.4	M PUMP STATION (PLATE MILLS SOUTH WORKS)
CP01.5	N3 PUMP STATION (PLATE MILLS SOUTH)
CP01.6	PLATE TREATMENT PLANT WATER SYSTEM
CP01.7	CANDY SOUTH CLARIFICATION PLANT
CP01.8	CONTINUOUS ANNEALING LINE No2
CP01.9	ELECTROLYTIC TIN LINE

Within the South Mills and the North Mills, a number of processes take place. These processes can be broken into two main groups:

A) HOT MILLS - Both the South Works and the North Works have hot mills. The hot mill process involves a sequential process of slab mills, reheating furnaces, parallel plate mills and hot strip mills. Water is primarily used for cooling and temperature control in the hot mill sections. Currently, blowdown from the cooling water circuits is, in the main discharged via the Works effluent canals to the TETP.

B) COLD MILLS - Both the South Works and the North Works have cold mill sections. These sections involve sequential processes of pickling followed by further processing. Continuous annealing and temper milling is also used. The final processing of the products are done in a number of parallel production lines, including:

- a pickling line;
- cold rolling;
- alkaline cleaning lines;
- an annealing and tempering line followed by electrolytic galvanizing (North Works only)
- continuous hot dip galvanizing line (South Works)
- electrolytic tinning line (South Works)
- chrome line (this is a finishing process for tinning and galvanising, not a plating line);
- cleaning and colour coating (painting) line.

Water is utilized for a wide range of purposes in the cold mill sections, ranging from steel washing and cleaning using different pickling processes, chemical make-up and application of the different metal and paint coatings. Effluent is discharged to the Central Effluent Treatment Plant (CETP).

HOT MILLS

Within the Hot Mills, the, shape and metallurgical properties of the steel slabs, are changed by repeatedly compressing the hot metal (temperature ranging from 1050 to 1300°C) between electrically powered rollers.

The hot rolling process comprises the following steps:

- Conditioning of the input (scarfing, grinding).
- Heating to rolling temperature.
- Descaling.
- Rolling (roughing including width reduction, rolling to final dimension and properties).
- Finishing (trimming, slitting, cutting).

Water Utilisation within the Hot Mills

Scarfing: The slabs, can have surface defects, like cracks, folds or seams. Surface preparation of rolling stock is necessary to ensure a flawless rolled product. Scarfing removes surface defects of by using an oxy-fuel flame. The flame is used to rapidly melt and oxidise the steel surface while a separate supply of high pressure oxygen to the cutter propels the molten and oxidising product from the surface.

Descaling: Prior to rolling adherent scale, which forms during reheating must be removed, in order to avoid contamination of the product by scale that has been pressed into its surface by the rolls (so-called 'rolled in matter'). The method of descaling is breaking and spraying off the scale by means of high-pressure water. Power water with pressures of 120 to 250 bar is applied via flat jet nozzles onto the material surface.

Cooling Lines: In connection with an appropriate temperature control within the finishing trains, the cooling line imparts the desired mechanical/temper/etc. parameters to the material. The steel is rapidly cooled using water sprays. Each section is individually controlled so that the desired cooling rate and temperature profile is realised.

Water Circuits / Water Management in Hot Rolling Mills: Throughout the hot rolling process and the associated process steps, water is used for cooling and for specific temperature control. Electric motors, re-heating furnaces, control rooms and power systems, instruments and process control are cooled indirectly. The steel, rolls, saws, croppers, coilers and hot run out tables are cooled directly. Water is also used for scale breaking, flushing scale and for scale transport. Wherever the water is in contact with the rolled material and rolling equipment it becomes contaminated with scale and oil.

Water feeding and treatment systems in the hot mills are complex, with several, partly interconnected water loops and with multiple-stage use of water. In some cases the hot rolling mill water circuits are coupled with water feeding systems of other iron and steel production units, as for example continuous casting, the BOF and Blast Furnace Slag Granulation.

The Waste water from scale removal and flume flushing contains coarse scale, suspended solids and emulsified oil. Large amounts of water are used for roll and material cooling, which also contain oil and suspended solids.

COLD ROLLING MILLS

In cold rolling, the properties of hot rolled strip products, e.g. thickness, mechanical and technological characteristics, are changed by compression between rollers without previous heating of the input.

The processing steps and the sequence of processing in a cold rolling mill depends on the quality of the steel being treated. For the Carbon Steels that are produced at IVDBS processing usually follows the order: pickling, rolling, annealing, temper rolling/skin pass rolling and finishing.

The principal cold mills plant and equipment comprise:

- Continuous pickling line, where the oxide layer formed during the hot rolling is removed by pickling. Mostly hydrochloric acid is used, but for the electrolytic tin (South Mills) and the electrolytic galvanising (North Mills) lines, sulphuric acid is used.
- Cold rolling mill consisting of 5-stand four-high mills, one at North Mills, and one at South Mills. Cold rolling reduces the initial thickness of the hot rolled strip by typically 50 to 80 %.
- Annealing facilities to restore the ductility of the steel strip that is lost as the result of work hardening during the cold rolling.
- Temper mills to give the annealed material the required mechanical properties. The material is subject to a slight skin pass rolling typically on a four-high skin pass mill. The roughness of the work rolls of the mill is transferred to the strip by the roll pressure. Other electrically created surface textures are also applied.
- Inspection and finishing lines, here coils with different length may be welded together to meet the required coil weight, or may be cut to length or slit to the required width. Also coils are cut into sheets with required length and width. At the same time defective sections of strip can be discarded.
- Packaging lines for coils or sheets according to the destination and/or the means of transport.
- Roll shop, where the work rolls and the backup rolls for the cold rolling mill and the temper mill are prepared and repaired.

Pickling: The entire surface of the hot rolled coil is covered with a thin layer of scale containing oxides, which must be removed prior to cold rolling. This is done by pickling mostly with hydrochloric acid but, as mentioned above, sulphuric acid is used for the electrolytic zinc and electrolytic tin lines. Pickling temperatures typically range from 75°C to 95°C. Once the strip or sheet is pickled, it is thoroughly rinsed with de-mineralised, or equal quality (often steam condensate water) and then subsequently dried. Where appropriate, the pickled surface is then oil coated, either with rolling oil or anticorrosive oil.

The pickling is carried out in totally enclosed equipment or tanks fitted with fume hoods. In both cases the fume hoods are under continuous extraction to remove any fumes that are generated. Acid consumption depends, in the main on the specific surface area pickled and the thickness of the oxide layer.

Cold Rolling of the Hot Rolled and Pickled Strip: In cold rolling, the hot rolled and pickled steel is passed through sets of rolls. The strip enters the first roll set (stand) and undergoes an initial thickness reduction, further reductions are achieved in each subsequent stand until the final gauge is attained.

Generally, water containing between about 0.5 and 3% of oil (mostly in a mechanically emulsified form) is intensively sprayed onto the rolls and the in coming steel. This is necessary for

- Lubrication;
- Cooling of the strip;
- Cooling of the work and back-up rolls; and
- Removal of iron-particles.

For optimum strip surface cleanliness it is important to avoid contamination of this coolant emulsion by the hydraulic oil, by the bearing and other mechanical lubricant oils and by grease. Precautions taken to avoid any contamination include:

- Continuous monitoring of oil levels.
- Monitoring of the oil concentration.
- Regular control of hydraulic equipment and bearings.
- Monitoring of temperature, pH value, saponification index, acid value, conductivity.
- Gravity settlement and in line filtration.

At IVDBS, this rolling coolant is drained to a sump where solids (mostly fine iron) and free oil is gravity separated. It is then cooled in a cooling tower and returned to the rolling process cooling sprays. Oil which separates in the gravity separation stage is recovered by contractors. The suspended solids are mostly returned to the sinter mixing bed or to the DR.

Roll lubrication is achieved at IVDBS on an essentially once through basis. In addition to the small amount of dispersed oil in the cooling water, a specifically prepared emulsion of roll lubricant and water is sprayed onto the surface of the steel (on to both sides of the steel) just in front of each roll nip. This water and oil input mixes with the general cooling water flow and becomes a part of the recirculating coolant flow. The used oil separates in the gravity separation stage and any oil which remains as an emulsion circulates back to the roll cooling.

Prior to the start of the Master Plan Studies, the water used for making this fresh emulsion of roll lubricant was fresh de-ionised water and steam condensate with any additional volume (that may be needed over and above the availability of those two sources) coming from clarified Vaal Dam Water. This created a large water input to the system which in turn created a large volumetric blow down. It also created a mechanism whereby salts build up due to the evaporative cooling was more than adequately controlled.

As a result of the Master Plan studies, a sequence modifications are being arranged whereby recirculating water will be used for making up the lubricant emulsion. This is not as simple a process as it sounds as there are a number of secondary issues which have to be dealt with at the same time. Part of these issues relate to the lubricated which is used. This in turn relates to the degree of reduction per pass, maintenance issues, cooling arrangements, etc. Up until the start of the Master Plan Studies, most of these issues had been dealt with on the basis of the local economics and practicalities of the rolling operation with little account being taken as regards the overall effluent issues and the overall interests of the site as a whole. These latter issues have been introduced to the future planning of the rolling processes. However, there is an ongoing need to continue this process progressively with time.

Degreasing /Cleaning by means of alkali: Prior to the annealing process the strip has to be degreased to produce a sufficiently clean surface so that the steel will not have oil and grease derived surface marks after annealing. The cleaning serves to remove oil residues from the steel surface. Where the process is carried out after the rolling process (i.e. South Works) the process is similar to that used for acid pickling except for the chemicals that are used. The cleaning agents are proprietary and mildly alkaline agents.

At North Works the alkaline cleaning stage is carried out at the last roll pair of the 5 stand rolling mill. Instead of adding an emulsion of rolling lubricant to the steel just in front of this roll nip, a supply of freshly fortified cleaner is sprayed on to the steel instead. This necessitates that the degree of metal thickness reduction that can be achieved at this roll is somewhat reduced, but the intense surface forces and relative surface movements at the roll nip mean that the degreasing function can be achieved within the 5 stand, without the need for a separate processing line.

At 5 stand North, therefore, the roll cooling water recirculation system is made up of two separate systems, one for the first four stands and one for the last stand. Inevitably, water over spray around the ends of the rolls and beneath the rolls is carried through the gap between the edges of the steel and the rolls, from the lubricated rolling system to the degreasing system. This carry over essentially governs the rate of blow down from the alkaline cleaning system and in the current system will ultimately limit the extent to which the water make up to the first 4 stands can be reduced.

Continuous Annealing: For continuous annealing the rolled coils are welded together on the entry side of the plant and subjected to the following process steps: a) Alkaline cleaning of the strips, (South Works only); b) Heating and holding at the required annealing temperature: c) Controlled cooling and quenching.

The continuous annealing is carried out by passing the steel strip through a multi-zone heating furnace with a heating chamber, annealing chamber, cooling zone, tempering zone and a second cooling zone. The steel is heated to the appropriate temperature (which is usually within the range of between 650 °C and 830 °C) and then cooled. The rate and type of cooling depends on the desired metallurgical properties and the required surface properties of the steel. For example, in CAL line No. 1 in South Works, water cooling is used and because of the surface finish requirements it is impractical to cool and recirculate the water. At present this high quality water is simply used on a once through basics and discharged to the TETP. The proposed ZED infrastructure will utilize this used water as a process feed water to other local users.

Water is used for rinsing after pickling and to prepare the pickling baths. Three kinds of process water are created during pickling. In addition to the spent pickle acid itself, these comprise water used for rinsing, and water from the fume absorbers associated with the pickling tank exhaust system and flushing water from plant cleaning. The main volume of waste water derives from rinsing. The main chemical load comes from of pickle baths themselves.

Regeneration of the vast majority of the hydrochloric acid pickle liquor is done on-site by Lurgi. Some of this hydrochloric acid based pickle liquor is also sold off site, some is used at the Sinter Plant as a reagent (for potassium removal from the iron ore) and some has been used at the CETP as a reagent. This latter usage is mostly stopped and in the future should only be required when normal output of acid pickle rinse water is stopped for some reason. Essentially, the Lurgi plant decomposes the spent pickling liquid using heat to produce clean hydrochloric acid (fresh pickling acid) and ferric/iron oxide which is very fine and of high purity.

The iron oxide that is produced by the Lurgi Process is treated with various chemicals, including amongst others strontium carbonate. The final product is a very fine magnetic powder which is used for the manufacture of high power magnets, recording tapes, etc.

Pickling – Typical Methods for Reducing Waste Water Volume and Contaminant Loading: For completeness, the following general comments and background are included so as to provide a basis for ongoing discussions with the respective production areas.

Techniques for the reduction of waste water volume and contaminant loading from the pickling processes include:

- Reduction of iron oxide formation during hot rolling and steel handling (e.g. by high pressure descaling, fast cooling, short storage time, corrosion free storage and transport). The acid consumption during pickling is basically proportional to the amount of iron oxide removed from the steel surface. Although the potential for a reduction in oxide formation is limited, control of the cooling rate can modify the structure of the scale. This can influence the pickling speed and thus reduce energy consumption for the process. Fast cooling of the hot rolled strip may be limited however for quality reasons.
- Partial or full replacement of wet pickling processes by waste water free mechanical treatment (mechanical descaling). However, it should be recognised that there is an energy penalty associated with the use of mechanical descaling equipment and the process is usually only applied in new installations.
- Reduction of acid consumption and regeneration costs by adding inhibitor chemicals. However, inhibitors can have a detrimental effect on surface quality (due to the formation of rust).

- Reduction of acid concentration by using higher pickling temperatures. Although a balance has to be reached between acid concentration and pickling temperature. The optimum is a function of equipment and maintenance limitations, acid losses, pickling efficiency and energy consumption.
- Reduction of acid concentration by using electrically assisted processes.
- Minimization of waste water volume by using improved pickling and rinsing equipment.

Strong and Weak Effluents: It can be seen from the above background information that the Cold Mill effluents can be divided into two basic groups: Strong and Weak.

The strong effluents are those which need some form of specific and significant treatment process to enable them to be discharged to a water course or sewer. These strong effluents include all the pickling and plating effluents (including the respective rinse waters) the roll coolants and the alkaline degreasing effluents.

The Weak effluents are those which are derived from essentially clean systems such as cooling tower circuits (where direct contact with the steel or chemicals is prevented) and final cooling and quenching waters, where the water only contacts clean products.

Within South Mills, the strong effluents are all accumulated at the Q Pump House or they go direct to their specific outlet (e.g. spent hydrochloric acid to the Lurgi Acid Recovery Plant or oils to the oil reclaim contractors). This same pump house is also a main hub within the cooling water reticulation system for the majority of the plant areas which are still operating in the South Mills areas.

Within North Mills, the equivalent function to the Q Pump House is the Cold Mills No. 1 Pump House.

CP01.1 Q PUMP STATION

The Q pump station is used for effectively all the cooling requirements in the South Cold Mills area. It supplies a large variety of applications ranging from oil coolers to gearboxes. The maim applications of the water is at the tinning line, the paint line, the 5 stand reduction mill, the pickling line and the galvanizing lines.

The system uses Vaal River Industrial make-up water but also receives recycled Vaal Dam water from production and therefore struggles to maintain any kind of concentration cycles. From time to time it is also polluted with oil.

Technical Specifications	
System Capacity	650 m^3
Measured make-up rate	17 m^3/h
Circulation Rate	1620 m^3/hr
One side-stream filters	60 m^3/hr
Delta T	2 °C
Cycles of concentration	1

System Analysis	
Total Hardness	231 mg/l
Ca Hardness	145 mg/l
P alkalinity	0 mg/l
Total Alkalinity	130 mg/l
pH	7.8
Cl	79 mg/l
SO_4	134 mg/l
Conductivity	645µS/cm
Suspended Solids	16 mg/l

Also located at the Q Pump House are collection sumps, pumps and controls whereby all the effluents from South Works which are to be treated at the CETP are collected and then pumped to the CETP.

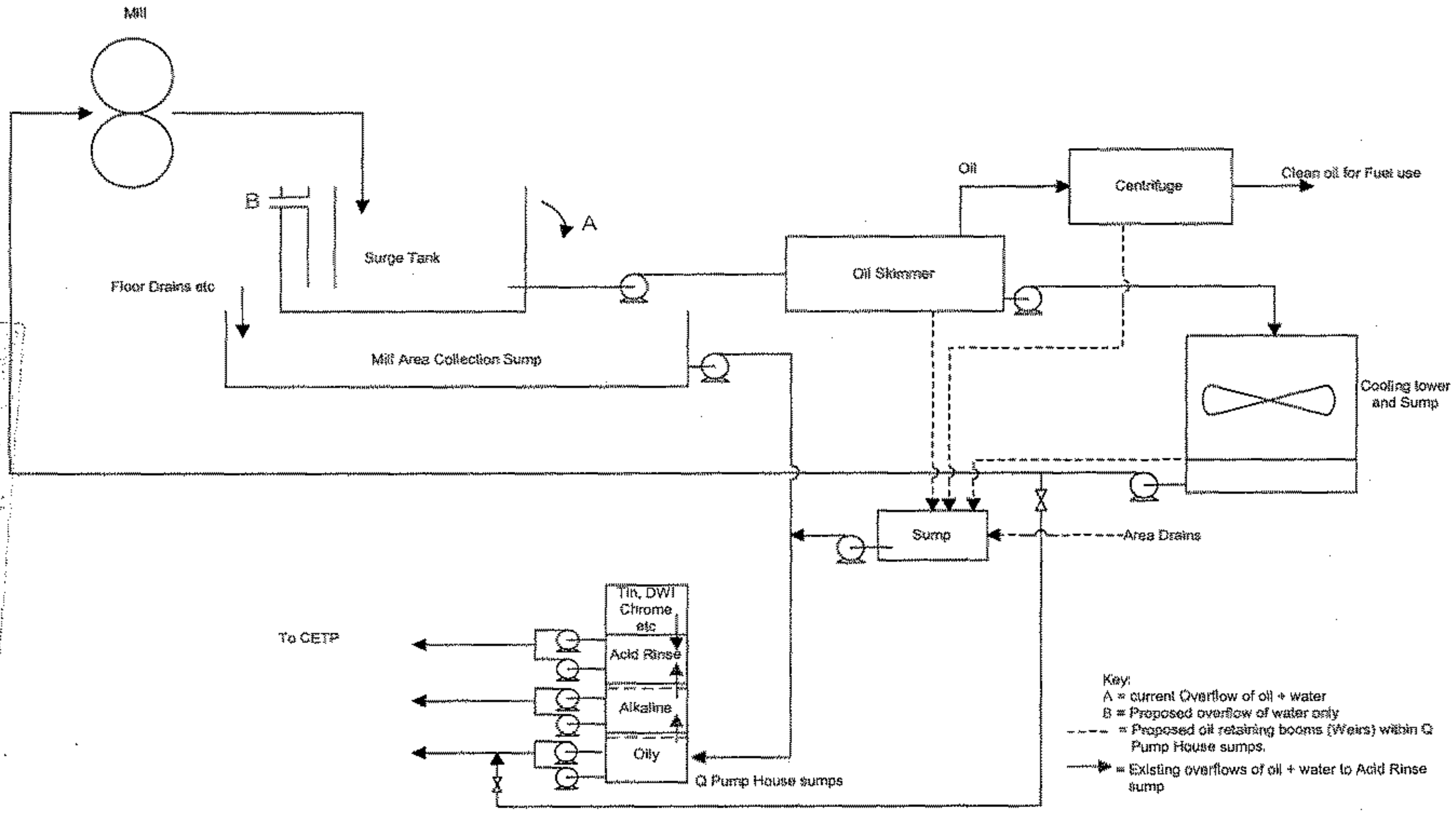
The attached diagram (RPA Drawing LA582A) shows diagrammatically the collection and recycle arrangements for the cooling water for the 5 stand rolling mill and its discharge arrangements to the sumps which are pumped to the CETP. The other inputs to these sumps are derived from the other above referred production lines. The alkaline effluent is derived from the de-oiling and de-greasing of the rolled steel, the acid rinse water is derived from the rinsing process at the end of the acid pickling stage and the tin, DWI and chrome effluents are derived from the specific surface treatment and finishing processes, namely tin plating and hot dip galvanizing. The arrangement of these other production lines and how their effluents are routed to these collection sumps at the Q Pump House are shown on RPA Drawing 484/LA1093.

The following tables characterize the quality of each of these strong effluents from South Mills.

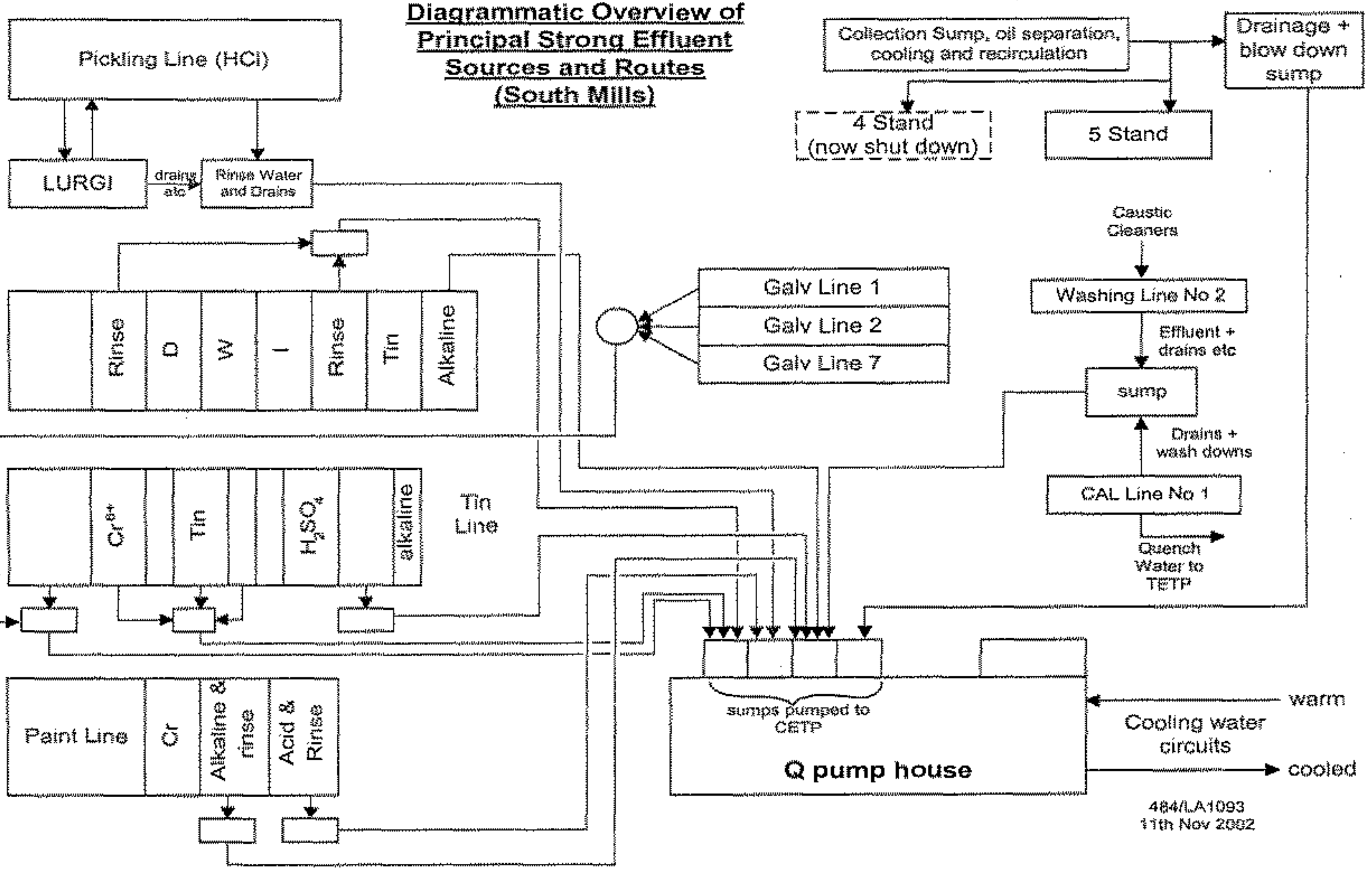
The other pump stations in South Works either handle only weak effluents or they are or will shortly be arranged to route their respective strong blow downs (principally oily) to the oil or alkaline systems which discharge to the Q Pump House.

DWI Mixed Effluent – Analysis	
Flow (m^3/hr)	7
Total Hardness (mg/l)	90
Ca Hardness (mg/l)	41
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	25
pH	4.0
Cl (mg/l)	289
SO_4 (mg/l)	158
Conductivity (µS/cm)	2470
Suspended Solids (mg/l)	-
F (mg/l)	136
CN (mg/l)	1
NH_3-N (mg/l)	2
Phenol (mg/l)	2
NO_3-N (mg/l)	1
NO_2-N (mg/l)	0.
P (mg/l)	0.
Mn (mg/l)	0.
Cr^{6+} (mg/l)	125
Na (mg/l)	364
Fe (mg/l)	7.1
Zn (mg/l)	14
SiO_2 (mg/l)	15
Sn (mg/l)	124
Cr total (mg/l)	125
K	5.0
Oil	-

Diagramatic Schematic of South Works 5 Stand Oily Water System
RPA Drawing LA582A 26th October 2001



Diagrammatic Overview of Principal Strong Effluent Sources and Routes (South Mills)



484/LA1093
11th Nov 2002

Chrome Effluent – Analysis	
Flow (m^3/hr)	54
Total Hardness (mg/l)	173
Ca Hardness (mg/l)	120
P alkalinity (mg/l)	7
Total Alkalinity (mg/l)	75
pH	6.0
Cl (mg/l)	41
SO_4 (mg/l)	45
Conductivity (µS/cm)	661
Suspended Solids (mg/l)	-
F (mg/l)	6.
CN (mg/l)	1
NH_3-N (mg/l)	1
Phenol (mg/l)	0
NO_3-N (mg/l)	1
NO_2-N (mg/l)	0
P (mg/l)	0
Mn (mg/l)	0
Cr^{6+} (mg/l)	67
Na (mg/l)	80
Fe (mg/l)	<1
Zn (mg/l)	1
SiO_2 (mg/l)	2
Sn (mg/l)	0
Cr total (mg/l)	113
K	4
Oil	186

Acid Effluent South – Analysis	
Flow (m^3/hr)	10
Total Hardness (mg/l)	152
Ca Hardness (mg/l)	83
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	0
pH	1.0
Cl (mg/l)	125
S-SO_4 (mg/l)	7765
Conductivity (µS/cm)	22730
Suspended Solids (mg/l)	35
F (mg/l)	1.
CN (mg/l)	0.
NH_3-N (mg/l)	0.
Phenol (mg/l)	0.

NO_3-N (mg/l)	0.
NO_2-N (mg/l)	0.
P (mg/l)	1
Mn (mg/l)	7
Cr^{6+} (mg/l)	-
Na (mg/l)	47
Fe (mg/l)	200
Zn (mg/l)	2
SiO_2 (mg/l)	-
Sn (mg/l)	2
Cr total (mg/l)	2
K	4
Oil	10

Alkaline Effluent South – Analysis	
Flow (m^3/hr)	110
Total Hardness (mg/l)	24
Ca Hardness (mg/l)	12
P alkalinity (mg/l)	185
Total Alkalinity (mg/l)	361
pH	10.0
Cl (mg/l)	26
S-SO_4 (mg/l)	71
Conductivity (µS/cm)	1185
Suspended Solids (mg/l)	115
F (mg/l)	1.0
CN (mg/l)	0.06
NH_3-N (mg/l)	0.13
Phenol (mg/l)	0.5
NO_3-N (mg/l)	0.18
NO_2-N (mg/l)	0.07
P (mg/l)	0.3
Mn (mg/l)	0.08
Cr^{6+} (mg/l)	-
Na (mg/l)	231
Fe (mg/l)	1.8
Zn (mg/l)	0.4
SiO_2 (mg/l)	-
Sn (mg/l)	0.2
Cr total (mg/l)	0.2
K	4.0
Oil	234

Oil Effluent South – Analysis	
Flow (m^3/hr)	40
Total Hardness (mg/l)	92
Ca Hardness (mg/l)	40
P alkalinity (mg/l)	10
Total Alkalinity (mg/l)	81
pH	5.9
Cl (mg/l)	57
S-SO_4 (mg/l)	66
Conductivity (µS/cm)	465
Suspended Solids (mg/l)	125
F (mg/l)	0.8
CN (mg/l)	0.2
NH_3-N (mg/l)	3.6
Phenol (mg/l)	1.2
NO_3-N (mg/l)	0.5
NO_2-N (mg/l)	0.4
P (mg/l)	4.3
Mn (mg/l)	0.3
Cr^{6+} (mg/l)	-
Na (mg/l)	67
Fe (mg/l)	11.5
Zn (mg/l)	0.7
SiO_2 (mg/l)	-
Sn (mg/l)	0.4
Cr total (mg/l)	0.3
K	5.0
Oil	383

Stannous Effluent – Analysis	
Flow (m^3/hr)	35
Total Hardness (mg/l)	120
Ca Hardness (mg/l)	74
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	4
pH	3.0
Cl (mg/l)	392
S-SO_4 (mg/l)	614
Conductivity (µS/cm)	4471
Suspended Solids (mg/l)	0
F (mg/l)	148
CN (mg/l)	2.0
NH_3-N (mg/l)	1.0
Phenol (mg/l)	0.8

NO_3-N (mg/l)	0.6
NO_2-N (mg/l)	0.1
P (mg/l)	0.3
Mn (mg/l)	0.6
Cr^{6+} (mg/l)	10.5
Na (mg/l)	650
Fe (mg/l)	25.0
Zn (mg/l)	0.7
SiO_2 (mg/l)	31.6
Sn (mg/l)	308.7
Cr total (mg/l)	17.6
K	5.2
Oil	-

CP01.2 HNX PUMP STATION

The HNX pump station system is used for all the cooling requirements of the continuous annealing line no. 1 in the cold mills south. It supplies a large variety of applications ranging from oil coolers to gearboxes.

The system has a normal cooling tower and side stream sand filter arrangement and is very stable with a stable make-up rate. Blow down and sand filter back washes are discharged to the TETP.

Technical Specifications	
System Capacity	340 m³
Measured make-up rate	7 m³/hr
Circulation Rate	356 m³/hr
One side-stream filters	30 m³/hr
Delta T	3 °C
Cycles of concentration	1-2

System Analysis	
Total Hardness	262 mg/l
Ca Hardness	153 mg/l
P alkalinity	4 mg/l
Total Alkalinity	148 mg/l
pH	7.9
Cl	128 mg/l
SO_4	157 mg/l
Conductivity	830μS/cm
Suspended Solids	33 mg/l

CP01.3 PAINT LINE COOLING TOWER

The closed untreated system is used for the quenching of the final painted strip. The open treated system receives continuous demineralised water and is therefore always overflowing slightly.

The system has no cycles but a very high tendency for microbiological growth because of the organic load coming from the paint solvents.

Technical Specifications	
System Capacity	15 m^3
Measured make-up rate	2 m^3/hr
Circulation Rate	100 m^3/hr
Hot water temperature	28 °C
Cycles of concentration	1

System Analysis	**Paint Line Cooling Tower**
Total Hardness	86 mg/l
Ca Hardness	46 mg/l
P alkalinity	0 mg/l
Total Alkalinity	91 mg/l
pH	7.3
Cl	11 mg/l
SO_4	10 mg/l
Conductivity	257 µS/cm
Suspended Solids	<1 mg/l
Na	18 mg/l
K	3.4 mg/l
SiO_2	4.8 mg/l
F	0.76 mg/l

CP01.4 M PUMP STATION (PLATE MILLS SOUTH)

The M-pump station supplies cooling water to the two reheat furnaces of the Plate Mill, the Plate Mill oil coolers and the "POQO" Plate Treatment Plant. Suspended matter is controlled by side-stream sand filtration. Backwash water is reclaimed as make-up to the process water system. Blowdown is discharged to the Candy plant. The Cooling water system is chemically treated against corrosion, scaling and microbiological growth.

Technical Specifications	M Pump Station
Cycles	3
Temp Change	3°C
System Volume	800 m^3
Make Up	15 m^3/hr
Circulation	1910 m^3/hr
Materials of Construction	Mild Steel

System Analysis	M Pump Station
Total Hardness	297 mg/l
Ca Hardness	178 mg/l
P alkalinity	5 mg/l
Total Alkalinity	157 mg/l
pH	8.0
Cl	105 mg/l
SO_4	207 mg/l
Conductivity	1020 µS/cm
Suspended Solids	16 mg/l

CP01.5 N3 PUMP STATION (PLATE MILLS SOUTH)

The N3 pump station supplies cooling water to the air compressors. It is treated for corrosion and for micro-organisms. Blowdown water is discharged to the Candy plant. Suspended matter is controlled by side-stream sand filtration. Backwash water is re-used as make-up to the process water system.

Technical Specifications	N3 Pump Station
Cycles	3
Temp Change	3°C
System Volume	550 m^3
Make Up	10 m^3/hr
Circulation	1366 m^3/hr
Materials of Construction	Mild Steel

System Analysis	N3 Pump Station
Total Hardness	316 mg/l
Ca Hardness	185 mg/l
P alkalinity	7 mg/l
Total Alkalinity	161 mg/l
pH	8.0
Cl	123 mg/l
SO_4	221 mg/l
Conductivity	1145 µS/cm
Suspended Solids	44 mg/l

CP01.6 PLATE TREATMENT PLANT WATER SYSTEM

This is divided into two systems:
a) a quench system which supplies water for quenching the plate and
b) furnace cooling system which supplies water for cooling the furnace.

The quench system is not treated but the furnace cooling system is treated for corrosion and for micro-organisms. Blow down is routed to the TETP. Suspended matter is controlled by side-stream sand filtration, the back washes from which also go to the TETP. Both of these discharges are currently being arranged to be diverted to the Candy Plant.

Technical Specifications	Plate Treatment Plant Water System
Cycles	3
Temp Change	5°C
System Volume	52 m^3
Make Up	1.0 m^3/hr
Circulation	143 m^3/hr
Materials of Construction	Mild Steel

System Analysis	Plate Treatment Plant Water System
Total Hardness	689 mg/l
Ca Hardness	390 mg/l
P alkalinity	15 mg/l
Total Alkalinity	295 mg/l
pH	8.4
Cl	235 mg/l
SO_4	582 mg/l
Conductivity	1920 µS/cm
Suspended Solids	8 mg/l

CP01.7 CANDY SOUTH CLARIFICATION PLANT

The A & B pump stations of this Candy Plant (named by reference to its manufacturers Patterson Candy International) supplies process cooling water to the Plate Mill. The process water is recovered and goes via 1-pump station to the Candy plant for clarification and then back to A & B pump station for re-use. Suspended solids and oil are removed in the Candy clarification plant by the addition of a flocculant. Sludge is dewatered and transported by rail to the dump. Recovered oil is passed to a contractor for reclamation.

Technical Specifications	**Candy South Clarification Plant**
Circulation Rate	1145 m³/hr
Materials of Construction	Mild Steel, concrete

System Analysis	**Candy South Clarification Plant**
Suspension	18 m/l
Oil	3.2 mg/l

CP01.8 CONTINUOUS ANNEALING LINE NO1

Water sprays are used at the Continuous Annealing line to control the rate of cooling of the hot annealed strip in order to achieve the desired metallurgical properties. For surface finish reasons, this water has to have both a high purity and to be free from antiscalant and other additives. Direct evaporation to atmosphere occurs at the spray area. The water is collected in an open sump where further evaporative cooling occurs and it is then recirculated as required to the particular spray heads that are appropriate to the particular quality of steel that is being run.

Blow down is by overflow from the sump to Blast Furnace Canal and ultimately TETP.

Technical Specifications	**CAL No2**
Measured make-up rate	10 m³/hr
Estimated Blow-down rate	7 m³/hr
Cycles of concentration	0.5

System Analysis	**CAL No 2**
Total Hardness	129 mg/l
Ca Hardness	69 mg/l
P alkalinity	0 mg/l
Total Alkalinity	136 mg/l
PH	7.3
Cl	17 mg/l

SO_4	15 mg/l
Conductivity	385 µS/cm
Suspended Solids	<1 mg/l
Na	27 mg/l
K	5.1 mg/l
F	1.1 mg/l

CP01.9 ELECTROLYTIC TINNING LINE PRODUCT QUENCH AND RINSING

This is a counter current washing and a product cooling process. For product surface quality reasons, this has to be a once through process using clarified Vaal Dam Water. Up until now, it has been regarded as too expensive relative to the cost of fresh raw water to recover and cool this water in a manner which will guarantee the necessary reliability as to its quality. As a result of the Master Plan Process Waters Study work, actions are in progress within Cold Mills South to collect this water, together with that from CAL No. 1 and to route it to other adjacent uses on the Tin, the DWI, the Acid pickle and on the Rolling and Alkaline Cleaning Lines as a substitute for raw water make up. This method of recycle/re-use has been justified purely on the basis of the water supply cost to these other uses. Until such time as these measures are fully implemented this large but high quality effluent is discharged to the Blast Furnace Canal.

Technical Specifications	Tin & Quench Effluents
Measured make-up rate	186 m³/hr
Blow-down rate	186 m³/hr
Cycles of concentration	0

System Analysis	Tin quench and rinse effluents
Total Hardness	86 mg/l
Ca Hardness	46 mg/l
P alkalinity	0 mg/l
Total Alkalinity	91 mg/l
PH	7.3
Cl	11 mg/l
SO_4	10 mg/l
Conductivity	257 µS/cm
Suspended Solids	<1 mg/l
Na	18 mg/l
K	3.4 mg/l
SiO_2	4.8 mg/l
F	0.76 mg/l
Cr	1.0 mg/l

CP02 VANTEX

This area is not applicable to the process waters master plan.

CP03 OPEN AREA

This area is not applicable to the process waters master plan.

CP04 PVA PLANT

This area is not applicable to the process waters master plan as this activity is no longer in operation.

UP01 NORTH MILLS

The Introductory notes that were presented at the start of the section on area CP01 (South Mills) apply to North Mills as well. The essential differences between the two mill areas are:-

- North Mills is a much more modern basic construction which was designed with strict separation of Process Waters from Surface Waters.
- North Mills does not have a hot dip galvanising process, but an electrolytic galvanising process.
- North Mills does not have a tin line nor a paint line nor a DWI process.

In addition, the cold rolling process at North Works uses a lower tallow content in its rolling oil and the alkaline degreasing section occurs at the last stand of the 5 Stand rolling mill rather than separately as at South Mills. These differences were discussed in the section which described the CP01 area.

The electrogalvanising line uses sulphuric acid pickling followed by zinc plating from a zinc sulphate bath. This bath is prepared on site from zinc ingot and sulphuric acid in a closed reactor. The lead mud by-product (from impurities in the zinc) goes to Holfontein. A portion of the product plate is rolled with chrome as a surface passivator. Total production is 6 000 t/m, used amongst others for motor vehicle panels.

The principal active production areas within the North Works Water Systems are :

UP01.1	INDUSTRIAL PUMP STATION
UP01.2	REHEAT FURNACE NO. 1, 2 AND 3
UP01.3	REHEAT FURNACE NO. 4
UP01.4	PIRO SYSTEM
UP01.5	CANDY NORTH CLARIFICATION PLANT
UP01.6	COLD MILL NO. 1 PUMP STATION
UP01.7	COLD MILL NO. 2 PUMP STATION
UP01.8	ELECTRO GALVANISING LINE WATER TREATMENT PLANT
UP01.9	CONTINUOUS ANNEALING LINE # 2

UP01.1 INDUSTRIAL PUMP STATION

Cooling water is pumped to the Hot Strip Mill North for cooling mainly hydraulic and pneumatic systems by means of shell and tube heat exchangers. Make-up water is from the Vaal Dam supply. The system's water is cooled by a two cell cooling tower.

There is high oil contamination in the cooling water due to a leaking heat exchanger. A side stream pressure sand filter is available but currently not in use because of the oil contamination. Make-up and blowdown is controlled manually. The system usually has sufficient leaks and other losses such that no formal blowdown is required. Should water need to be bled-off the water will flow via the North Works blowdown drain to the Terminal Effluent Treatment Plant (TETP). Should the sand filter be used the backwash water will also go to TETP. Cycles of concentrations are low due to the relatively high circuit losses. Temperature readings are monitored on the cooling tower supply and cold water supply pipe lines.

Technical Specifications	Industrial Pump Station
Circulation Rate	2200 m^3/hr
System volume	950 m^3/hr
Current make-up rate	13 m^3/hr
Current blowdown rate	0 m^3/hr
Cycles of concentration	<2
Hot water temperature	22°C
Cold water temperature	20°C
Materials of Construction	Mild Steel

System Analysis	Industrial Pump Station
Total Hardness	116 mg/l
Ca Hardness	60 mg/l
P alkalinity	0 mg/l
Total Alkalinity	128 mg/l
pH	8.0
Cl	20 mg/l
SO_4	30 mg/l
Conductivity	381 µS/cm
Suspended Solids	175 mg/l (due to oil contamination)
NO_3^-	0.38 mg/l

UP01.2 REHEAT FURNACE NO. 1, 2 AND 3

Softened cooling water is circulated from the hot water sump, through the tube heat exchangers to the furnaces and back to the hot water sump. The sump is open to the atmosphere resulting in evaporation and hence cycles of concentration.

The system consists of two hot water sumps, an L shaped sump and an emergency reservoir.

Water in the emergency reservoir is treated water from Reheat Furnaces Numbers 1, 2 and 3. If a power failure occurs, cooling water from the reservoir is fed to all the furnaces. Returning cooling water from Reheat Furnace Numbers 1, 2, 3 and 4 systems is pumped with a diesel driven pump back to the emergency reservoir.

Make-up water is Vaal Dam water, which is filtered and softened before being added to the hot water sump. The total hardness of the system is maintained under 60 mg/l as $CaCO_3$ but may occasionally exceed this. There is a side stream pressure sand filter to remove suspended solids from the circulating waters.

There are 12 heat exchanger bundles to cool the water and all are usually in use. The bundles can be isolated for cleaning/inspection purposes. There are two fans per bundle and these are operated so as to maintain a cooling water temperature of 55°C.

Sodium Dichromate was used as the corrosion inhibitor but was recently changed to a Zn and Mo program. A biocide is used to keep organic growth under control.

Technical Specifications	**Reheat Furnace No. 1, 2 and 3**
Circulation Rate	2448 m^3/hr
System volume	850 m^3 + 950 m^3 in emergency reservoir if full
Current make-up rate	1.3 m^3/hr
Current blowdown rate	0 m^3/hr
Hot water temperature	< 65°C
Cold water temperature	< 55°C
Side Stream sand filter	50 m^3/hr
Materials of Construction	Mild Steel, 304L SS

System Analysis	**Reheat Furnace No. 1, 2 and 3**
Total Hardness	54 mg/l
Ca Hardness	37 mg/l
P alkalinity	0 mg/l
Total Alkalinity	122 mg/l
pH	8.1
Cl	< 7 mg/l
SO_4	56 mg/l
Conductivity	608 µS/cm
Suspended Solids	1 mg/l

Cr^{6+}	<5 mg/l
Na	106 mg/l
Fe	0 mg/l
Cr	30 mg/l
K	6.3 mg/l

Note: Sodium Dichromate is not used any more, so the level of total Cr will decrease.

UP01.3 REHEAT FURNACE NO. 4

Softened cooling water is circulated from the hot water sump, through the tube heat exchangers to the furnace and back to the hot water sump. The sump is open to the atmosphere resulting in evaporation and hence cycles of concentrations. There is a reservoir that is filled with treated water from Reheat Furnaces Numbers 1, 2 and 3. If a power failure occurs, cooling water from the reservoir is fed to the furnaces numbers 1, 2 3 and 4. A diesel driven pump supplies cooling water from the hot water sump from Reheat Furnaces Numbers 1, 2 and 3 system to the reservoir.

Make-up water is Vaal Dam water, which is filtered and softened before being added to the hot water sump. The total hardness of the system is maintained under 60 mg/l as CaCO3 but may occasionally exceed this. There is a side stream pressure sand filter to remove suspended solids from the circulating water (currently not in use).

There are 4 heat exchanger bundles and all are usually in use. There are 4 fans and these are operated as required in order to maintain a cooling water temperature of 55°C.

Sodium Dichromate was used as the corrosion inhibitor but this was recently changed to a Zn and Mo program. A biocide is used to keep organic growth under control.

It is possible to add water from Reheat Furnaces Numbers 1, 2 and 3 to the hot water sump of Reheat Furnace Number 4. The excess water will then overflow to the L shaped sump for Reheat Furnaces Numbers 1, 2 and 3.

Technical Specifications	**Reheat Furnace No. 4**
Circulation Rate	850 m^3/hr
System volume	400 m^3
Current make-up rate	1.5 m^3/hr
Current blowdown rate	0 m^3/hr
Hot water temperature	< 75°C
Cold water temperature	< 60°C
Side Stream sand filter	32 m^3/hr
Materials of Construction	Mild Steel, 304L SS

System Analysis	Reheat Furnace No. 4
Total Hardness	37 mg/l
Ca Hardness	27 mg/l
P alkalinity	0 mg/l
Total Alkalinity	161 mg/l
pH	7.5
Cl	< 7 mg/l
SO_4	53 mg/l
Conductivity	800 µS/cm
Suspended Solids	1 mg/l
Cr^{6+}	<5 mg/l
Na	100 mg/l
Cr	30 mg/l
K	5 mg/l

Note: Sodium Dichromate is not used anymore, so the level of total Cr will decrease.

UP01.4 PIRO SYSTEM

Softened cooling water is circulated from the cold water tank to the:

- Pyrometers
- Hot metal detectors
- Gamma Cells and
- Closed Circuit TV cameras

It then flows through an evaporative cooling tower and back to the cold water tank. The tank is also open to atmosphere resulting in cycles of concentrations.

Make-up water is received from the softened make-up water system for Reheat Furnace Number 4. The total hardness of the system is maintained under 5mg/l as $CaCO_3$ but may occasionally exceed this.

A small cooling tower cools the circulating water. The cooling tower basin uses softened water as make-up but can use Vaal Dam water as well. The water in the basin is currently not treated for corrosion/scale/biological growth inhibition.

Sodium Dichromate was used as the corrosion inhibitor but this was recently changed to a Zn and Mo program. A biocide is used to keep organic growth under control. Some chromate is still present in the water, see attached analysis, but this is steadily declining.

The circulating water of the Piro System is blown down and drained into Reheat Furnace Number 4 hot water sump.

Technical Specifications	Piro System
Circulation Rate	25 m³/hr
System volume	5 m³
Current make-up rate	Included in Reheat Furnace no. 4
Current blowdown rate	0 m³/hr
Hot water temperature	< 40°C
Cold water temperature	< 30°C
Materials of Construction	Mild Steel, 304L SS

System Analysis	Piro System
Total Hardness	2 mg/l
Ca Hardness	1.2 mg/l
P alkalinity	0 mg/l
Total Alkalinity	90 mg/l
pH	7.7
Cl	< 7 mg/l
SO_4	22 mg/l
Conductivity	316 µS/cm
Suspended Solids	1 mg/l
Na	67 mg/l
Fe	0 mg/l
Cr	5.4 mg/l
K	0.6 mg/l

UP01.5 CANDY NORTH CLARIFICATION PLANT

Process water is required by the Hot Strip Mill North for the following processes:

- Strip Cooling
- Mill Roll Cooling
- De-scaling
- Coiler Cooling
- Scale Flush Water

Water is circulated from the cold water sump to the various processes and returns to the three eastern scale pits and to the two western scale pits. In the scale pits, primary clarification takes place where scale/sludge is mechanically removed. In each scale pit a belt skimmer is installed to remove floating oil. The oil is collected in a tank and removed by a contractor for reclaim. From the scale pits the water flows to the hot water sump and is pumped to the Candy Clarification Plant.

At the Clarification Plant coagulants are dosed into the mixing chamber. The water flows to the 36 Candy tanks, where the suspended particles settle out. The clear water is then pumped to two natural draft cooling towers and it then flows back to the cold water sump.

The Candy tanks are de-sludged manually on a daily basis except at weekends. The sludge is thickened in 4 thickeners and pumped into railroad tankers for removal. It is then de-watered by a filter press at the Candy Clarification Plant. The overflow from the thickeners returns to the West scale pit. Oil and roll bite lubricants are present in varying concentrations.

Technical Specifications	**Candy North Clarification Plant**
Nominal Capacity	12 800 m^3/hr
Maximum Capacity	15 500 m^3/hr
System Volume	20 000 m^3
Hot Water temperature	<40°C
Cold Water temperature	< 33°C
2 x Natural draft cooling towers	4910 m^3/hr per tower
Materials of Construction	Mild Steel, concrete

System Analysis	**Candy North Clarification Plant**
Candy Inlet	
Suspended Solids	15 mg/l
Oil	9 mg/l
Candy Outlet	
Total Hardness	162 mg/l
Ca Hardness	97 mg/l
P Alkalinity	0 mg/l
Total Alkalinity	57 mg/l
pH	7.2
Cl	115 mg/l
SO_4	54 mg/l
Conductivity	593 µS/cm
Suspended Solids	4 mg/l
Oil	2.5 mg/l

UP01.6 COLD MILL NO. 1 PUMP STATION

Cold Mill No. 1 pump station consists of 2 sub-systems:

1. Cooling System
2. Effluent Pump System

UP01.6.1 Cooling System

This system supplies recirculating cooling water to the following:

- Compressor House
- Hotmill temper mill and shearline
- Continuous pickling line Number 3
- 5 Stand reduction mill
- Coil reclamation plant
- Tempermill No. 4 and
- No. 3 & 4 shearlines

The recirculating water is cooled by a forced draught cooling tower which has a side stream filtration arrangement through a sandfilter. Cooling tower make-up is from the clarified Vaal Dam water supply. Blowdown goes to the TETP.

Suspended solids, bio-fouling and corrosion rates have be controlled to ensure efficient plant performance.

The system make-up rate is fairly constant. Make-up is done by a hand valve. No blowdown is necessary, because of losses from the system.

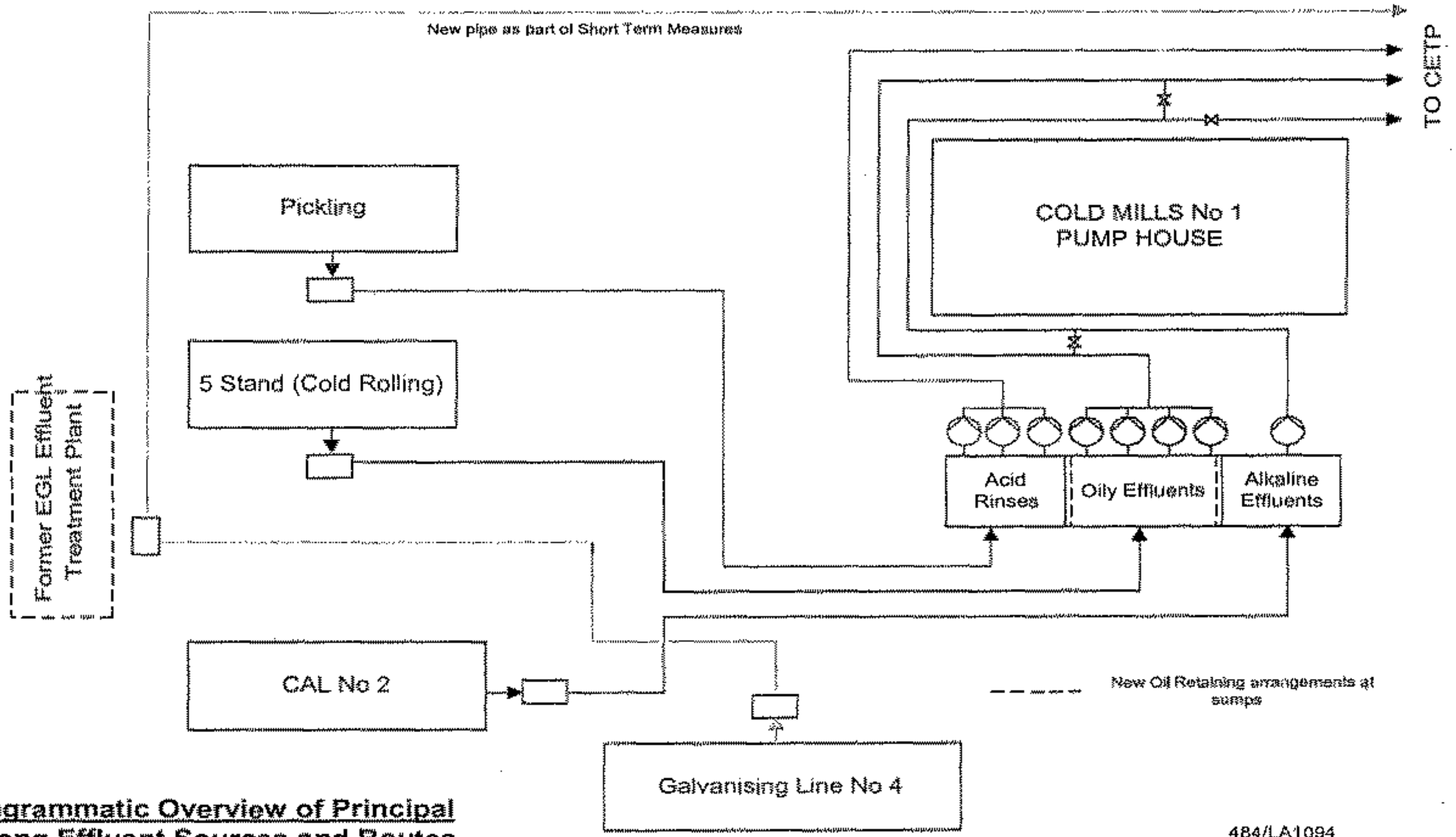
Technical Specifications	**Cold Mill 1 Pump Station**
System Capacity	700 m³/hr
Standard Make-up rate	22 m³ /hr
Circulation Rate	2067 m³/hr
Materials of Construction	Mild Steel
Cycles of concentration	2.8
Hot Water temperature	27°C
Cold Water temperature	25°C
Delta T	2
Sand Filter	60 m³/hr

System Analysis	Cold Mill 1 Pump Station
Total Hardness	241 mg/l
Ca Hardness	124 mg/l
P alkalinity	11 mg/l
Total Alkalinity	249 mg/l
pH	8.0
Cl	50 mg/l
SO_4	65 mg/l
Conductivity	732 µS/cm
Suspended Solids	8 mg/l

UP01.6.2 Effluent Pump Station

These pumps pump effluent to the Central Effluent Treatment Plant. Acidic effluent originates from the rinse station on the Continuous Pickling Line number 3 and oily effluent originates from the 5 Stand cold rolling process, from Tempermill No. 4, from No. 3 & 4 shearlines and from Galvanising line number 4.

No treatment is required at this pump station. The arrangements by which these effluents are collected and delivered to this pump station and then forwarded to the CETP are shown diagrammatically on RPA Drawing 484/LA1094. For simplicity, not all the oily effluent inputs are shown, but the ones which are not shown are only machine coolant and drainage/leak/wash down type effluents, not production effluents.



Diagrammatic Overview of Principal Strong Effluent Sources and Routes (North Mills)

484/LA1094
11th Nov 02

The following tables also characterise the effluents which are handled at this collection and onward pumping facility

CAL No2 Effluent – Analysis	
Flow (m^3/hr)	3
Total Hardness (mg/l)	78
Ca Hardness (mg/l)	37
P alkalinity (mg/l)	203
Total Alkalinity (mg/l)	484
pH	10.0
Cl (mg/l)	30
S-SO_4 (mg/l)	40
Conductivity (µS/cm)	2231
Suspended Solids (mg/l)	72
F (mg/l)	4.7
CN (mg/l)	0.1
NH_3-N (mg/l)	0.8
Phenol (mg/l)	0.5
NO_3-N (mg/l)	2.0
NO_2-N (mg/l)	2.4
P (mg/l)	0.2
Mn (mg/l)	0.03
Cr^{6+} (mg/l)	-
Na (mg/l)	285
Fe (mg/l)	2
Zn (mg/l)	0.9
SiO_2 (mg/l)	-
Sn (mg/l)	0.3
Cr total (mg/l)	0.10
K	6.0
Oil	336

Cold Mills North Oil Effluent – Analysis	
Flow (m^3/hr)	41
Total Hardness (mg/l)	107
Ca Hardness (mg/l)	50
P alkalinity (mg/l)	131
Total Alkalinity (mg/l)	345
pH	7.0
Cl (mg/l)	90
S-SO_4 (mg/l)	74
Conductivity (µS/cm)	1186
Suspended Solids (mg/l)	-
F (mg/l)	7.0

CN (mg/l)	0.0
NH_3-N (mg/l)	15.0
Phenol (mg/l)	8.0
NO_3-N (mg/l)	14.0
NO_2-N (mg/l)	17.0
P (mg/l)	1.4
Mn (mg/l)	0.60
Cr^{6+} (mg/l)	-
Na (mg/l)	133
Fe (mg/l)	13.1
Zn (mg/l)	3.4
SiO_2 (mg/l)	-
Sn (mg/l)	2.5
Cr total (mg/l)	0.3
K	9.8
Oil	1864

Cold Mills North Acid Effluent – Analysis	
Flow (m^3/hr)	39
Total Hardness (mg/l)	124
Ca Hardness (mg/l)	67
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	0
pH	2.1
Cl (mg/l)	2000 to 5000
S-SO_4 (mg/l)	23
Conductivity (µS/cm)	17474
Suspended Solids (mg/l)	113
F (mg/l)	6.1
CN (mg/l)	0.10
NH_3-N (mg/l)	5.0
Phenol (mg/l)	8.4
NO_3-N (mg/l)	2.0
NO_2-N (mg/l)	1.0
P (mg/l)	0.2
Mn (mg/l)	5.6
Cr^{6+} (mg/l)	-
Na (mg/l)	32
Fe (mg/l)	1500-4000
Zn (mg/l)	1.8
SiO_2 (mg/l)	-
Sn (mg/l)	0.6
Cr total (mg/l)	2.3
K	5
Oil	2.0

UP01.7 COLD MILL NO. 2 PUMP STATION

This pump station supplies recirculating cooling water to the following:

- 5 Stand
- The Batch annealing furnaces and
- Galvanising line number 4

The recirculating water is cooled by a forced draught cooling tower which has a side stream filtration arrangements through three sand filters. Cooling tower make-up is from the clarified Vaal Dam water supply. Blowdown goes to the TETP.

Suspended solids, bio-fouling and corrosion rates have to be controlled to ensure efficient plant performance.

Due to losses, the system make-up rate is usually very high. Presently there is a high volume of additional water from the Galvanising Line number 4 quench tanks entering the system, which causes low cycles, no make-up and a continuous overflow to the drain. Make-up is controlled by a hand valve.

Due to a high level of oil contamination the side-stream filters are not in operation at present.

Technical Specifications	**Piro System**
System Capacity	1400 m³/hr
Standard Make-up rate	47 m³ /hr
Circulation Rate	3436 m³/hr
Materials of Construction	Mild Steel
Cycles of concentration	1.2
Hot Water temperature	29°C
Cold Water temperature	25°C
Delta T	4
Sand Filter	3 x 54 m³/hr

System Analysis	**Piro System**
Total Hardness	105 mg/l
Ca Hardness	53 mg/l
P alkalinity	2 mg/l
Total Alkalinity	122 mg/l
pH	8.0
Cl	37 mg/l
SO_4	30 mg/l
Conductivity	342 µS/cm
Suspended Solids	61 mg/l (due to oil contamination)

UP01.8 ELECTRO GALVANISING LINE (EGL)

The system recirculates cooling water to the EGL production line and (at the time of the commencement of the Master Plant Studies) to evaporator plant condensers. However, as part of the Short Term Measures at the CETP the EGL effluent was diverted untreated to the CETP and the local caustic based neutralisation plant and evaporator were shut down. This not only saved operating costs but it also prevented the frequent spillages and other problems which resulted from the unreliability of this plant. The follow Table sets out the average characteristics of this EGL effluent. Since the installation of this pumped system, the non compliance issues at the TETP which used to originate from spillages and failures at the former EGL treatment plant have been sopped entirely. The savings in operating costs and reagents has also been significant.

EGL Effluent – Analysis	
Flow (m^3/hr)	3
Total Hardness (mg/l)	75
Ca Hardness (mg/l)	50
pH	1.0
Cl (mg/l)	15
$S\text{-}SO_4$ (mg/l)	8000
F (mg/l)	0.5
P (mg/l)	1-400
Mn (mg/l)	1.2
Na (mg/l)	120
Fe (mg/l)	160
Zn (mg/l)	2000
Sn (mg/l)	0.5
Cr total (mg/l)	1-100
K	5

The production line cooling water is recirculated and cooled by a forced draught cooling tower which has a side-stream filtration arrangement through a sand filter.

Cooling tower make-up is from the clarified Vaal Dam water supply. Blowdown goes to the TETP via the North Works Blow Down Canal.

Technical Specifications	
System Capacity	120 m^3
Standard Make-up rate	9.2 m^3/hr
Circulation Rate	721 m^3/hr
Materials of Construction	Mild steel, stainless steel
Cycles of concentration	6
Hot Water temperature	31°C
Cold Water temperature	25 °C
Delta T	6
Sand Filter	80 m^3/hr

System Analysis	
Total Hardness	513 mg/l
Ca Hardness	184 mg/l
P alkalinity	104 mg/l
Total Alkalinity	585 mg/l
pH	9.0
Cl	151 mg/l
SO_4	185 mg/l
Conductivity	1730 µS/cm
Suspended Solids	5 mg/l

UP01.9 CONTINUOUS ANNEALING LINE # 2

The system recirculates cooling water to the CAL #2 production line (Continuous Annealing Line). The recirculating water is cooled by a forced draught cooling tower which has a side stream filtration arrangement through a sand filter.

Cooling tower make-up is from the clarified Vaal Dam water supply. Blow down is pumped to the effluent pits from where it goes to the TETP via the North Works Blow Down Canal.

The system make up is fairly constant. Blow down of the system is controlled manually. Normally no blow down is necessary because of the high level of losses from the system.

Technical Specifications	
System Capacity	900 m³
Standard Make-up rate	11 m³/hr
Circulation Rate	879 m³/hr
Materials of Construction	Mild steel
Cycles of concentration	2.2
Hot Water temperature	29°C
Cold Water temperature	25°C
Sand Filter	60 m³/hr

System Analysis	
Total Hardness	173 mg/l
Ca Hardness	90 mg/l
P alkalinity	12 mg/l
Total Alkalinity	190 mg/l
pH	8.0
Cl	33 mg/l
SO_4	42 mg/l
Conductivity	541μS/cm
Suspended Solids	6 mg/l

IM01 BLAST FURNACES

The principal active production areas are :

IM01.1 Blast Furnaces

IM01 .1 BLAST FURNACES

Coarse ore, sinter, coke and dolomite are smelted to form molten slag and molten iron. The iron is poured into rail car mounted torpedo shaped molten metal carriers for transport to the BOF. Most of the slag is sold to the cement industry, after being granulated using water. Some of the granulated slag (which exceeds the marked requirements) and all the so called black granulated slag is removed to the dump. Occasionally (usually because of problems with the granulation equipment) slag from D Furnace is poured into rail car mounted slag carrying pots and is taken to the dump in a molten form. After it has been tipped and allowed to solidify, this slag is broken up and used as aggregate. When there is a problem with the granulation equipment at C Furnace, the slag is poured into an "Abort Area" and flooded with water to cool and shatter it. It is then dug out and taken to the dump, where, after weathering (exposure to further water and carbon dioxide absorption from the atmosphere), it is broken up and used as aggregate.

A further product of the ironmaking process, in addition to molten iron and slag, is hot dirty gases. These gases exit the top of the blast furnace and proceed through gas cleaning equipment (venturi scrubbers) where particulate matter is removed from the gas and the gas is cooled. This gas has a considerable energy value so it is burned as a fuel in the "hot blast stoves" which are used to preheat the air entering the blast furnace so as to create "hot blast". A turbo blower generates the compressed air known as "cold blast" that comes to the stoves for heating to form "hot blast".

Most of the gas not burned in the stoves is sent to the boiler house and is used to generate steam which is used around the site.

- Some of the blast furnace gas is mixed with coal gas and the resultant mixture is used in some of the coke ovens as the necessary fuel supply to these ovens. For a number of reasons (including combustion dynamics, strategic reliability and safety) only a proportion of the blast furnace gas can be used in the coke ovens.

Wastewater emissions arise from the following areas:
- Overflow water from the blast furnace gas scrubbing circuit
- Wastewater from slag granulation
- Blow down from cooling water circuits

IM01.1.1 BF SLAG GRANULATION PROCESSING

Granulation is the most common process used to treat blast furnace slag. The process involves pouring the molten slag through a large flow of water in a granulation unit which is usually located in close proximity to the blast furnace.

After granulation, the slag/water slurry is transported to a drainage system, consisting (at IVDBS) of either horizontal settlement and drainage beds, such as at C Furnace or a rotating de-watering drum (for example the INBA process) as at D Furnace. After initial de-watering the residual moisture of the slag sand is generally around 30-50% by weight. Once the product slag has been allowed to drain fully, then the moisture content is generally around 10%. At the time when the Master Plan Studies commenced, the settlement and drainage beds (or Dry Dams as they are known at IVDBS) were periodically drained and the slag was removed to a drainage area using either a loading shovel and bell trucks at C Furnace or an overhead gantry and clam shell bucket at D Furnace. Similarly, the slag which was filtered from the granulating water by the INBA unit was piled in a heap to drain before it was removed.

These drainage areas, on occasion, created in excess of 60 m^3/hour of drainage flow, most of which drained directly to one or more of the surface water drainage canals in the area. The average routine flow was in of the order of 20m^3/hour, with the majority of this routine flow being derived from D Furnace.

In theory, the water used in the granulation process is all collected and reused so as to generate very small amounts of wastewater.

In addition to the above referred routine loss as a result of slag drainage, there were (at the time of the commencement of the Master Plan Studies) frequent overflows from the collection and return systems, mainly as a result of inadequately understood system dynamics and poor operational control. As a result, sudden discharges of around 100 to 300 m^3 at a time were not uncommon.

The problems of drainage water and these occasional releases, have been addressed progressively over the last 18 months, as a follow on process to the original Short Term Measures. Historical experience with corrosion scale formation and crystal growth when handling these liquors and when arranging more effective drainage of the slag, was carefully assessed. In the light of that experience a specifically arranged system of under drainage pipes have been installed in the C Furnace Dry Dams, together with upgrades to the drainage collection channels and to the level controls on the Wet Dams (the buffer storage dams which enable the granulation liquor to be recycled). As a result, only fully drained slag is now removed from these dams and it can be loaded directly on to the off-site transport arrangements. It is anticipated that the slag handling capacity of the Dry Dams at C Furnace will be such that with perhaps one more Dry Dam, the whole of C Furnace and D Furnace slag granulation can be handled at these Dry Dams. This will enable all of the current facilities for D Furnace to be shut down and the area cleared and rehabilitated.

In the mean while the facilities for D Furnace have been contained and all surface run off from the drainage areas is collected and pumped back to the granulation water recycle system.

A further problem associated with the slag granulation systems for both furnaces was the large amounts of water that was fed to the gland seals on the various recirculation pumps, especially the pumps which pump the hot slurry of granulated slag and water from the granulation unit. In particular, water usage at D Furnace was very high. This has been mostly overcome on an 80:20 type of basis. However, the design of the current slag granulation facilities at D Furnace are such that it is more appropriate to wait for the changed granulation arrangements which will accompany D Furnace Rebuild rather than spend the other “80%” in order to gain the last “20%” or so of benefit.

Note the Blast Furnace Slag granulation process evaporates approximately $40m^3/hr$ in total and this now plays an important function in the integrated effluent management for the site.

Stream Analysis

The following analyses were typical for the two granulation systems in the period up to and during the early part of the Master Plan studies. Since that time the water qualities have been strongly affected by the Short Term Measures, by the other changes that have been referred to above and the by fact that the whole system is now purged to the existing Desalination Plant.

	Units	**Slag Gran. BF C**	**Slag Gran. BF D**
Ca	mg/l	715	105
Mg	mg/l	42	110
P-alk	mg/l	24	2
Total-Alk	mg/l	49	25
pH	-	9	7
Cl	mg/l	704	199
S-SO_4	mg/l	1409	600
Cond	µS/cm	4254	1871
SS	mg/l	221	98
F	mg/l	5.9	15.8
CN	mg/l	0.2	0.0
Tot NH_3-N	mg/l	5.7	2.4
Phenol	mg/l	0.1	0.0
Tot NO_3-N	mg/l	3.3	4.1
Tot NO_2-N	mg/l	2.5	0.4
P	mg/l	<0.2	<0.2
Na	mg/l	284	85
Fe	mg/l	0.7	0.7
Mn	mg/l	0.3	0.4
Cr	mg/l	0.03	0.03
K	mg/l	163	61
Zn	mg/l	1.5	0.8
Sn	mg/l	0.9	0.4

IM01.1.2 BF GAS TREATMENT

Blast furnace gas (BF gas) must be cleaned in order to meet the necessary requirements for it to be piped to and used by suitable users. When leaving the blast furnace, the BF gas (or "top gas") contains particulate matter, cyanides (HCN), ammonia (NH_3) and sulphur compounds.

BF gas is treated in two stages. In the first stage, coarse particulate matter is removed by means of dry cyclones. The coarse particulates that are collected in this way have a high iron content and can be recycled to the sinter plant. In the second stage, particulate matter (including metal oxide particles and carbon coke particles, ammonia and traces of cyanide are removed by wet scrubbing. The blast furnace sludge from most normal steel works contains relatively high concentrations of zinc (Zn) and lead (Pb) which hampers recycling of the sludge into the production process. However at Vanderbijlpark the zinc and lead content of both the raw ores and the Sinter product are unusually low, hence all residues created within the BF gas treatment system are recycled back onto the Sinter Strand.

The water flow generated from the BF gas scrubbing stage contains suspended solids (e.g. carbon and heavy metals), cyanide compounds and ammonia, this water is treated (heavy metal precipitation), cooled and recycled to the scrubber. In most steel works, this circuit is normally purged at about 0.1-3.5 m^3/t of product iron, depending on raw material quality/specification and water availability. At IVDBS, the combined purge from both blast furnaces varies between about 12 and 20 m^3/hr, with the normal average flow being in the range of 13 to 15 m^3/hr. At present this purge from the circuit water is routed to the system which feeds the coke quenching facilities.

System Characteristics

Blast furnace gas at a temperature of 80-600°C is cooled and cleaned in a venturi style of gas scrubber. The dirty hot water flows to 2 clarifiers (normally one for each blast furnace) where chemicals are added to assist solids settlement and to control the pH. The clear overflow flows to a hot water sump from where it is pumped over a forced draft cooling tower. The cooling tower drains to a cold water sump from where the water is pumped back to the scrubber.

The system uses Vaal River Water (Industrial Water) as make-up. Blowdown is controlled manually to the effluent sump at Blast Furnace D from where it is pumped to the effluent collection sump at Blast Furnace C. From here it is pumped to the Oil and Tar Skimming Plant in the Coke Oven Gas Cleaning Area, from where it is pumped to the Biological Treatment Plant inlet dams. The water is currently returned from these dams to the Coke Oven area for use as Coke quench Water.

The removal of suspended solids and the control of fouling rates in the water which is returned to the Blast Furnace Gas Scrubbers is important in order to ensure efficient cooling and cleaning of the off-gas. Sludge produced by the plant is dewatered by a filter-press, dried at an open air drying area and then returned to the Sinter process.

Technical Specification & Stream Analysis for B F Gas Cleaning

The following details are typical for each Blast Furnace (C or D)	
Circulation rate	700 – 1 300 m^3/hr
System volume	2 500 m^3
Current make-up rate	27 m^3/hr (estimated)
Current blow down rate	5 to 10 m^3/hr
Hot water temperature	40 – 60°C
Cold water temperature	35°C
Materials of construction	Mild steel, stainless steel, cast iron

Recent Average Stream Analyses	**BF C**	**BF D**
Ca	481 mg/l	279 mg/l
Mg	106 mg/l	85 mg/l
P alkalinity	0 mg/l	0 mg/l
Total Alkalinity	274 mg/l	376 mg/l
pH	7.1	7.2
Cl	2891 mg/l	1900 mg/l
$S\text{-}SO_4$	1602 mg/l	2024 mg/l
Conductivity	11400 µS/cm	10400 µS/cm
Suspended Solids	172 mg/l	139 mg/l
F	98 mg/l	90 mg/l
$NH_3\text{-}N$	1110 mg/l	1000 mg/l
CN	12 mg/l	15 mg/l

1M01.1.3 BLAST FURNACE OPEN COOLING SYSTEM

The attached RPA Drawing 484/LA1090 presents a simplified schematic of the Blast Furnace open cooling system and the associated closed cooling system (which will be described in the next subsection below).

Cooling water from the cold water sump is circulated to Blast Furnace C and D through a double pipeline system. Returning water is collected in a tun-dish at furnaces C and D and gravitates to the hot water sump of the pump station.

System Characteristics

There are 3 types of make-up water available:

- River Water
- Vaal Dam Water (emergency supply)
- Blower House System Blowdown Water

Under normal operating conditions river water (Industrial Water) is the preferred make-up water. However, due to a leak in the Blower House System from the closed system into the open system that reduces the conductivity and sporadic losses from the Blower House open system, blowdown water from the Blower House System normally provides the total flow of make-up water into the Blast Furnace open system. The re-use of the Blower House blowdown water generates a saving since the blowdown water is already treated with corrosion, scale, and biological growth inhibitors.

Cooling water is supplied to the following sections of the Blast Furnace:

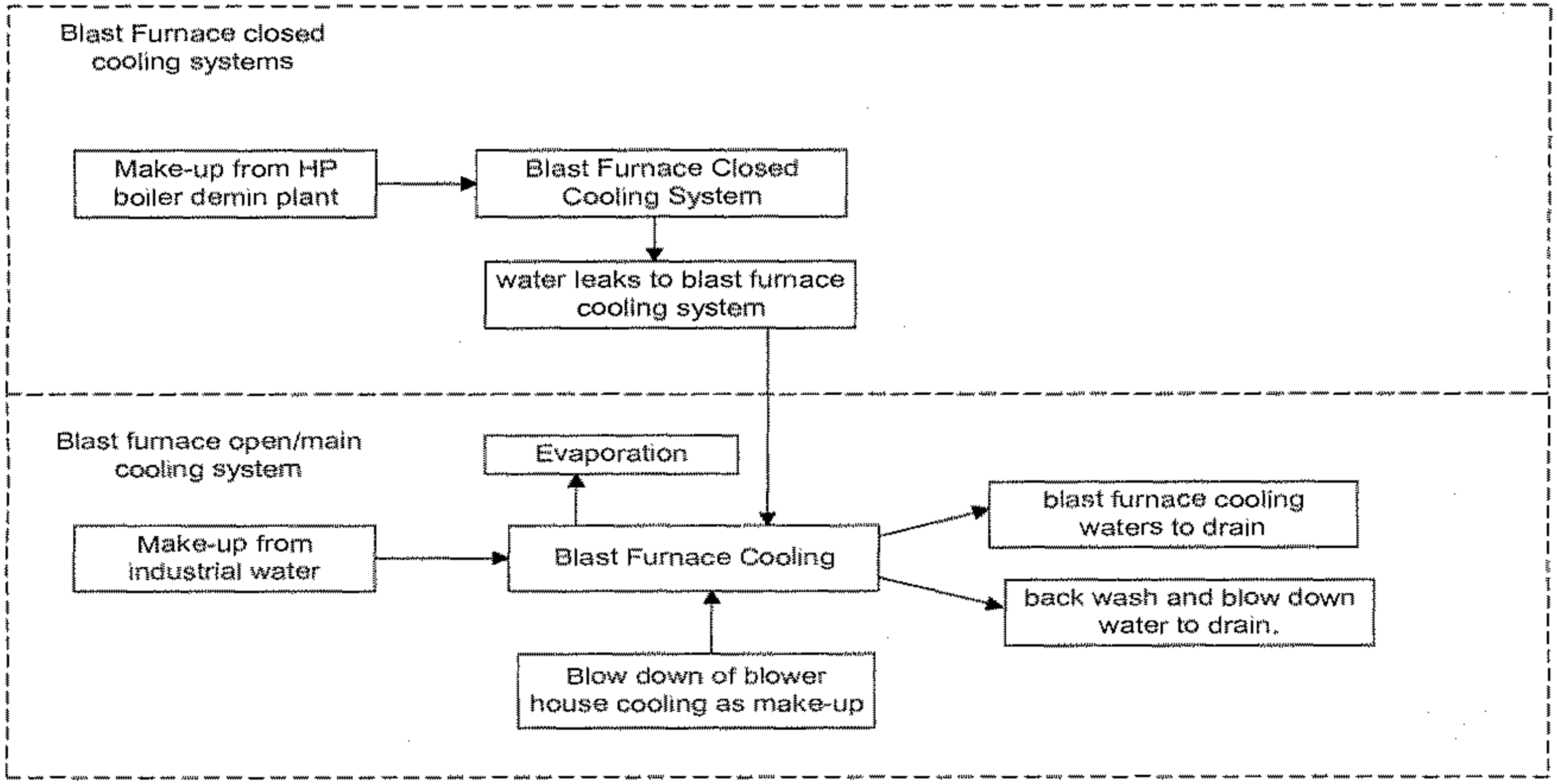
- Burden spray (water does not return back to system, quantity negligible)
- Stack plate coolers
- Tuyere coolers

Technical Specifications & Stream Analysis

General Open Cooling Systems In Blast Furnace Area – Details	
Circulation rate	9 200 m³/hr
System volume	7 000 m³
Current make-up rate	55 m³/hr
Current blow down rate	0 m³/hr
Cycles of concentration	<2
Hot water temperature	38°C
Cold water temperature	32°C
Materials of construction	Mild steel, concrete, copper
Four side stream filters	150 m³/hr per filter

Open Cooling Circuit In Blast Furnace – Analyses	
Total Hardness	471 mg/l
Ca Hardness	290 mg/l
P alkalinity	9 mg/l
Total Alkalinity	207 mg/l
PH	8.5
Cl	110 mg/l
SO_4	297 mg/l
Conductivity	1496 µS/cm
Suspended Solids	16 mg/l

Blast Furnace Cooling Systems



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IM01.1.4 BLAST FURNACE CLOSED COOLING SYSTEMS

Cooling water from the cold water sump is circulated to Blast Furnace C and D for cooling the hot-blast valves of the stoves. Returning water passes through the heat exchangers and flows to the cold water sump.

System Characteristics

Demineralised water is used as make-up for the closed cooling system. The high Pressure Demin Plant supplies the required quantity of demineralised water. There is a dedicated Demineralisation Plant at the blast Furnace Closed Cooling System Pump Station. The hot water is cooled by 8 heat exchanger bundles with 8 fans.

Technical Specifications & Stream Analysis

Blast Furnace Closed Circuit Cooling Waters - Details	
Circulation rate	940 m^3/hr
System volume	600 m^3
Current make-up rate	0.5 m^3/hr
Current blow down rate	0 m^3/hr
Hot water temperature	38°C
Cold water temperature	33°C
Materials of construction	Mild steel, concrete

Blast Furnace Closed Circuit Cooling Waters - Analyses	
Total Hardness	2.0 mg/l
Ca Hardness	0.9 mg/l
P alkalinity	13.2 mg/l
Total Alkalinity	30.8 mg/l
pH	9.8
SO_4	1.5 mg/l
Total dissolve solids	51 mg/l
Suspended Solids	1 mg/l
P	4.2 mg/l

IM01.1.5 SHAFT COOLING SYSTEM

The system supplies cooling water to the upper and middle stack plate coolers of Blast Furnace C.

System Characteristics

A portion of hot water from the open system in the tun-dish at Blast Furnace C is routed to a feed tank for the shaft cooling system. From the tank tbe water is pumped to the upper and middle stack plate coolers and flows back to the tun-dish.

Technical Specifications

Shaft Cooling System – Details	
Circulation rate	900 m³/hr
System volume	NA
Current make-up rate	NA
Current blow down rate	NA
Return water temperature	38°C
Supply water temperature	38°C
Materials of construction	Mild steel, copper

Shaft Cooling System – Analyses	
Total Hardness	471 mg/l
Ca Hardness	290 mg/l
P alkalinity	9 mg/l
Total Alkalinity	207 mg/l
pH	8.5
Cl	110 mg/l
SO_4	297 mg/l
Conductivity	1496 µS/cm
Suspended Solids	16 mg/l

IM01.1.6 BLAST FURNACE D OPEN SYSTEM

This system provides cooling water for the closed system of Blast Furnace D. The closed system is cooled via a plate heat exchanger.

Closed cooling water is required for the cooling of the in-bed probes of Blast Furnace D. Make-up water for the closed system at Blast Furnace D is obtained from the Blast Furnace C Closed Cooling System.

The open system uses river water (Industrial Water) as make-up. Blowdown is controlled automatically and the blowdown flows to TETP. The open system water is pumped from the cold water basin of the cooling tower to a plate heat exchanger and back to the inlet of the cooling tower.

Technical Specifications & Stream Analysis

Blast Furnace D Open Cooling System - Details	
Circulation rate	60 m³/hr
System volume	4 m³
Current make-up rate	0.4 m³/hr
Current blow down rate	NA
Hot water temperature	25°C
Cold water temperature	22°C
Materials of construction	Mild steel, stainless steel, copper

Blast Furnace D Open Cooling System -- Analyses	
Total Hardness	678 mg/l
Ca Hardness	488 mg/l
P alkalinity	27 mg/l
Total Alkalinity	117 mg/l
pH	8.4
Cl	297 mg/l
SO_4	478 mg/l
Conductivity	2186 µS/cm
Suspended Solids	31 mg/l

IM01.1.7 PCI CLOSED & OPEN COOLING WATER SYSTEMS

The PCI cooling systems (so called after the name of the supplier Patterson Candy International) form part of the Blast Furnace Cooling Systems. They are very small systems with effectively trivial effect on the overall process water system. The technical information is as follows:

Closed Cooling System – Details	
System Capacity	10 m^3
Measured make-up rate	NA
Circulation Rate	47.2 m^3/hr
Hot water temperature	43°C
Cold water temperature	30°C

Open Cooling System – Details	
System Capacity	10 m^3
Measured make-up rate	2 m^3/hr
Circulation Rate	120 m^3/hr
Hot water temperature	35°C
Cold water temperature	28°C

IM02 COKE PLANT

The principal active production areas are :

IM02.1	COKE OVEN AREA
IM02.2	SUPRACHEM – See IC01
IM02.3	BRIQUITTING PLANT (Shut Down)

IM02.1 COKE OVEN AREA

Coking coal is dry distilled in seven batteries (namely batteries 1, 3, 4, 6, 7, 8 and 9). Battery 1 is operated by Suprachem. Battery 2 is out of operation and Battery 5 was never built. Each battery consists of a series of narrow vertical cells which are separated from each other by refractory walls. These refractory walls are heated by burners fed with coal gas and/or blast furnace gas. Approximately 158 000 t/m of coal is crushed and screened and then loaded into individual cells by means of conveyor belts, bunkers and loading cars.

Gas is extracted at approximately 55 million Nm^3 per month. After cooling and cleaning, a part is burnt in the heating chambers which are built into the refractory walls which separate each cell from its neighbour. The hot gas is first quenched using a water recycle circuit ("flushing water") and it is then cleaned by removing tars, crude bensol, ammonia and hydrogen sulphide. Tar and crude bensol that are removed are transported to Suprachem. At present, the ammonia is reacted with sulphuric acid to form ammonium sulphate and the H_2S is released unburnt at 70m.

The product coke is currently quenched with excess flushing water and water that is blown down from the ammonia and H_2S removal systems. Bund and spillage waters from the new collection sump are also added to this quenching system, as additional top up water. The quench water develops a high TDS as there are currently no outlets for the dissolved solids other than via the coke itself.

The gas which is not used within the coke ovens as the heating medium is used across the works as fuel gas and a small part of the excess is flared.

IM02.1.1 COKE OVENS COOLING WATER SYSTEMS

Brief System Description

The coke-oven cooling water systems are used at the by-products plant for primary cooling of the quenched coke-oven gas from the batteries. The water is also used for secondary cooling of the gas and various smaller coolers. Primary and Secondary cooling takes place in either vertical or horizontal shell type coolers. There are five separate cooling towers each with it's own side stream filters.

System Characteristics

Due to the nature of the surrounding environment and process leaks, there is a potential for changes in pH of the water, relative to the generally very dusty local environment and for organic and ammonia contamination. Solids removal filtration on these plants is inadequate. High suspended solids contents are therefore a problem on each of these systems. Microbiological control is difficult because of the high organic and ammonia contamination and all of these systems have a tendency to form large amounts of slime (both algal and biological). The materials of construction are mostly stainless steel although in some applications mild steel, brass and copper are also used. Vaal River water from the main purification plant via the Industrial Water Main is currently used on all the coke-oven systems as make-up water.

Technical Specifications & Stream Analysis

Coke-ovens Cooling Tower No. 1&2	
System Capacity	1635 m^3
Standard make-up rate	40 m^3/hr
Circulation rate	1660 m^3/hr
Two side-stream filters	60 m^3/hr each
Delta T	9°C
Cycles of Concentration	2-3

Coke-ovens Cooling Tower No. 3	
System Capacity	750 m^3
Standard make-up rate	24 m^3/hr
Circulation rate	740 m^3/hr
One side-stream filters	30 m^3/hr
Delta T	12°C
Cycles of Concentration	2-3

Coke-ovens Cooling Tower No. 4	
System Capacity	400 m^3
Standard make-up rate	13 m^3/hr
Circulation rate	411 m^3/hr
One side-stream filters	45 m^3/hr
Delta T	12°C
Cycles of Concentration	2-3

Coke-ovens Cooling Tower No. 6 & 7	
System Capacity	1565 m^3
Standard make-up rate	55 m^3/hr
Circulation rate	1940 m^3/hr
One side-stream filters	78 m^3/hr
Delta T	11°C
Cycles of Concentration	2-3

Coke-ovens Cooling Tower No. 8 & 9	
System Capacity	800 m^3
Standard make-up rate	36 m^3/hr
Circulation rate	1220 m^3/hr
One side-stream filters	60 m^3/hr
Delta T	12°C
Cycles of Concentration	2-3

The aggregated make-up water volume into all coke oven cooling tower circuits is therefore 168m^3/hr of which approximately 110m^3/hr represents the evaporative load with the balance, 58m^3/hr being the average blowdown. The cooling tower blowdowns are routed to the site's effluent canal infrastructure and are ultimately treated within the Terminal Effluent Treatment Plant (TETP).

System Analysis

The following represents typical analyses for the current circulation waters within cooling water blowdown systems based on an average analysis of 6 months data.

Coke-ovens Cooling Tower No. 1 & 2	
Total Hardness	468 mg/l
Ca Hardness	273 mg/l
P alkalinity	5 mg/l
Total Alkalinity	186 mg/l
pH	8.1
Cl	173 mg/l
SO_4	346 mg/l
Conductivity	1319 µS/cm
Suspended Solids	28 mg/l
NH_3	5 mg/l
$KMnO_4$	18 mg/l

Coke-ovens Cooling Tower No. 3	
Total Hardness	738 mg/l
Ca Hardness	440 mg/l
P alkalinity	23 mg/l
Total Alkalinity	362 mg/l
pH	8.5
Cl	330 mg/l
SO_4	521 mg/l
Conductivity	1892 µS/cm
Suspended Solids	24 mg/l
NH_3	4 mg/l
$KMnO_4$	18 mg/l

Coke-ovens Cooling Tower No. 4	
Total Hardness	611 mg/l
Ca Hardness	340 mg/l
P alkalinity	17 mg/l
Total Alkalinity	210 mg/l
pH	8.5
Cl	260 mg/l
SO_4	355 mg/l
Conductivity	1572 µS/cm
Suspended Solids	23 mg/l
NH_3	5 mg/l
$KMnO_4$	16 mg/l

Coke-ovens Cooling Tower No. 6 & 7	
Total Hardness	712 mg/l
Ca Hardness	401 mg/l
P alkalinity	0 mg/l
Total Alkalinity	41 mg/l
pH	7.4
Cl	501 mg/l
SO_4	631 mg/l
Conductivity	1850 µS/cm
Suspended Solids	38 mg/l
NH_3	7 mg/l
$KMnO_4$	19 mg/l

Coke-ovens Cooling Tower No. 8 & 9	
Total Hardness	552 mg/l
Ca Hardness	346 mg/l
P alkalinity	5 mg/l
Total Alkalinity	115 mg/l
pH	8.2
Cl	193 mg/l
SO_4	380 mg/l
Conductivity	1420 µS/cm
Suspended Solids	33 mg/l
NH_3	5 mg/l
$KMnO_4$	21 mg/l

IM02.1.2 COKE PUSHING AND QUENCHING

Fully carbonised coke is pushed out of the respective cell of the battery into a container by the ram of the pusher machine. Contact with atmospheric oxygen causes the coke to start burning instantaneously. The container used is a coke quenching car which transports the hot coke to a quenching tower. Here the coke is quenched directly by large volumes of water. The water that does not evaporate is collected and is re-used for quenching the next batch, thus preventing wastewater emissions. Note as part of the Master Plan achievement of ZED the coke quench will be fed with pre-concentrated liquors from the MTP circuits which will then be purged from the coke quench prior to final evaporation.

The existing water source for coke quenching is a combination of Industrial Water (treated Vaal River Water) and effluent water (following tar removal) from the coal gas cleaning and By-Products processes. At present, very little Industrial Water is used, but as the currently planned repairs and upgrades to the coal gas cleaning processes are implemented, less effluent water will be produced and therefore the proportion of Industrial Water could increase.

The current arrangements for the effluent water and for the returned water from the Coke Oven Area bunding arrangements is for them to be pumped to the inlet dams at the Bio-Plant. If there is not enough room in these dams at any given time, then the excess is routed to the Maturation Dams.

Further tar and solids separation occurs within these dams. The normal make up water for coke quench comes from the Bio-Plant inlet dams. Only when there is insufficient water in these dams is the make up water derived from the Industrial Water Main.

At the time of the commencement of the Master Plan Studies, there was no mechanism whereby waters that had been pumped to the Maturation Dams could be returned to process. During early 2002 RPA, in conjunction with the relevant site personnel evolved a way of re-arranging the existing site infrastructure and its controls so as to enable water to be returned from the Maturation Dams on a routine basis so as to always maintain a minimum level within the Bio-Plant inlet dams. As a result, other than during local power outage or during maintenance, no Industrial Water is used for coke quenching.

At present, there is no routine outlet for the dissolved salts and other components which accumulate in the coke quenching waters, other than within the pore water in the coke and as crystals on the surface of the coke. There are occasional discharges to the Coke Oven area bunding arrangements, but these recycle all collected waters ultimately back to the Coke Quench.

Recent developments at each of the four Coke Quench facilities have achieved a particular sequential quenching action which ensures a very low pore water content in the product coke. This in turn ensures minimal (effectively zero) ongoing drainage from the product coke as it is conveyed to the Blast Furnaces and to the Sinter. A previous significant source of ground and surface water contamination has therefore been effectively eliminated.

In addition to the above, extensive bunding and containment infrastructures have been installed in and around the Coke Quenching, the coke rail car route and the handling facilities which receive and drain the fine coke which is routinely dredged from the coke quench recycle sump. These all drain back to the recycle sump.

Finally, each coke quenching tower has been fitted with a specially designed spray and mist eliminating hood which has stopped circa 90% plus of the droplet carry over from these quench stations onto the surrounding land, plant and buildings.

IM02.1.3 COLLECTION AND TREATMENT OF COKE OVEN GAS (COG) WITH RECOVERY OF BY-PRODUCTS

IM02.1.3.1 Brief System Description

The coke oven by-product plant is an integral, part of the coke making process. In the process of converting coal into coke volatile matter in the coal is vaporized and driven off. This volatile matter leaves the coke oven chambers as hot, raw coke oven gas (COG). As this hot gas leaves the coke oven chambers it is quench cooled with a recycled water stream. This part cooled raw coke oven gas is then further cooled, creating a liquid condensate stream and a cool gas stream. The functions of the by-product plant are to take these two streams from the coke ovens, to process them to recover by-product coal derived chemicals and to condition the gas so that it can be used as a fuel gas. The main emphasis of the coke by-product plant is to treat the coke oven gas sufficiently so that it can be used as a clean and environmentally friendly fuel.

Raw COG has a relatively high calorific value due to the presence of hydrogen, methane, carbon monoxide and hydrocarbons. Furthermore, the raw coke oven gas contains valuable products such as tar, light oil (mainly consisting of benzene, toluene and xylenes), sulphur compounds and ammonia.

For several reasons the coke oven gas must be treated before use as a fuel: napthalenes and tars cause clogging; both the sulphur compounds and the ammonia compounds cause corrosion; the sulphur compounds cause emission problems when the gas is burnt and the light oils are a valuable and recoverable commodity.

A number of water flows are generated during the coking process and during coke oven gas cleaning. Some of these flows are related to coking operations themselves and others are related to coke oven gas treatment.

The attached diagram (see section IMO2.1.3.7 below) represents a simplified picture of where the various effluent streams are produced and characterises the typical flow rate for each stream. The diagram is representative of the position <u>prior</u> to the currently planned upgrade project.

IM02.1.3.2 Gas Cooling

Hot crude coke oven gas enters the ascension pipes (one for each cell of each battery) at a temperature of approximately 800°C. In the goose neck it is directly cooled by a quenching spray of recycled water ("flushing liquor") to a steam saturation temperature of around 80°C. This evaporates 2-4 m^3 of flushing liquor for each tonne of coal carbonized. The resultant liquid phase, i.e. the excess flow of flushing liquor and the product condensate, is fed to the tar/water separator, whilst the gas phase is fed to the primary coolers. Here the gases are cooled by indirect heat transfer from a recirculating cooling system which in turn is cooled using an evaporative cooling tower. Within the primary coolers, most of the higher boiling point compounds and the water from the steam fraction of the coke oven gas and the evaporated flushing water will condense. This condensate is returned to the flushing water recycle circuit and the excess is routed to the tar/water separator. Fine water droplets and tar particles which are not removed within the primary coolers are precipitated in the down-stream electrostatic tar precipitators. The precipitate from the electrostatic tar precipitators is also routed to the tar/water separator.

The suction fans (exhausters) down stream of the electrostatic precipitators partially compress the gas in order to overcome all the system pressure drops and to maintain the gas pressure within the coke ovens themselves as close as possible to atmospheric pressure. The attendant increase in the gas temperature (created by the exhausters) has to be removed prior to the down-stream processing stages. This is carried out by the secondary coolers. The secondary coolers are similar to the primary coolers and have similar secondary evaporative cooling systems.

IM02.1.3.3 Tar recovery from the coke oven gas

During the primary and secondary cooling of the coke oven gas, most of the water content and the high boiling point hydrocarbons are condensed. This condensate and that from the electrostatic tar precipitator is routed to the tar/water separator, where the tar is removed. The water phase is separated off as so called "coal water" or "flushing water" and that which is not required for recycling around the "flushing circuit" (the hot gas quenching circuit) is routed to the "fixed ammonia stripper" prior to it being used for coke quenching. The tar that is removed from the condensate is passed to Suprachem. The tar/water separation is done in two stages. The first stage uses a standard gravity separator and the second stage uses a gravel bed filter. This latter functions like a sand filter but has fine gravel as the media instead of sand.

IM02.1.3.4 Desulphurisation of coke oven gas

Coke oven gas contains hydrogen sulphide (H_2S) and various organosulphur compounds (carbon disulphide (CS_2), carbon oxisulphide (COS), mercaptans etc.). Hydrogen sulphide is removed from the coal gas in the combined ammonia (NH_3) and H_2S scrubbing circuit. This scrubbing circuit produces a solution of both H_2S and NH_3 in water (so called "free ammonia liquor") which is routed to the "free ammonia" strippers where the ammonia and H_2S are steam stripped out of the liquor and the stripped liquor is recycled to the scrubbing circuit. The wet ammonia and H_2S gas (which also contains a lot of carbon dioxide, some cyanides and some other sulphur compounds) is currently passed through sulphuric acid in the ammonium sulphate plant where the ammonia and water vapour are absorbed forming ammonium sulphate crystals and the carbon dioxide (CO_2) and H_2S pass through. This substantially ammonia free CO_2 and H_2S-stream is currently vented to atmosphere.

In the past this steam was burnt in air and the combustion products were passed over a vanadium pentoxide catalyst to produce sulphur trioxide which was subsequently cooled and absorbed using a spray of weak sulphuric acid to form more weak sulphuric acid. Note, the large amount of water vapour in this gas stream ensured that the product acid was always relatively weak. This product acid, together with purchased acid made up the necessary input to the above described ammonia absorption stage.

Unfortunately, the maintenance and operating costs on this sulphuric acid manufacturing stage were so high and its reliability was so poor that it was not feasible to keep it working. In addition sudden and frequent leakages were common resulting in safety, effluent and ground pollution issues. As a result, the direct venting of the H_2S and CO_2 to atmosphere was adopted as the best environmental alternative at the time.

The proposed upgrades for the coke oven gas cleaning equipment will incorporate a catalytic oxidation stage to produce elemental sulphur by utilising a reduction-oxidation catalyst to facilitate the wet oxidation of hydrogen sulphide to elemental sulphur whilst at the same time converting the ammonia to elemental nitrogen and steam. The steam will be condensed together with the sulphur and the nitrogen (together with the excess coal gas that is required for this reaction) will be returned to the cleaned coal gas stream for distribution to the gas users.

Once this upgrade project is complete, there will only be a net blow down of about 65 to 70 m^3/hr of water from the bottom of the fixed ammonia strippers. This liquor will then be used as make up water for the Blast Furnace Off-Gas scrubbers and for the Sinter Plant Off-Gas Cleaning rather than for the current coke quench function.

IM02.1.3.5 Recovery of ammonia from the coke oven gas

The ammonia formed during coking appears in both the coke oven gas and the condensate (coal water or flushing liquor) from the gas. At Vanderbijlpark the ammonia is removed from the coke oven gas using an NH_3/H_2S scrubbing circuit. In this process, the ammonia is scrubbed from the coke oven gas using water as a scrubbing liquid. The effluent from the ammonia scrubber is used as a scrubbing liquor in the H_2S scrubber. The effluent from the H_2S scrubber contains H_2S and NH_3 and is led to the ammonia stripper and still. Most of the ammonia is currently recovered as ammonium sulphate, but in the future, the proposal is for it to be converted to nitrogen gas and steam within the proposed elemental sulphur plant, as described in IMO2.1.3.4 above.

IM02.1.3.6 Recovery of light oil from coke oven gas

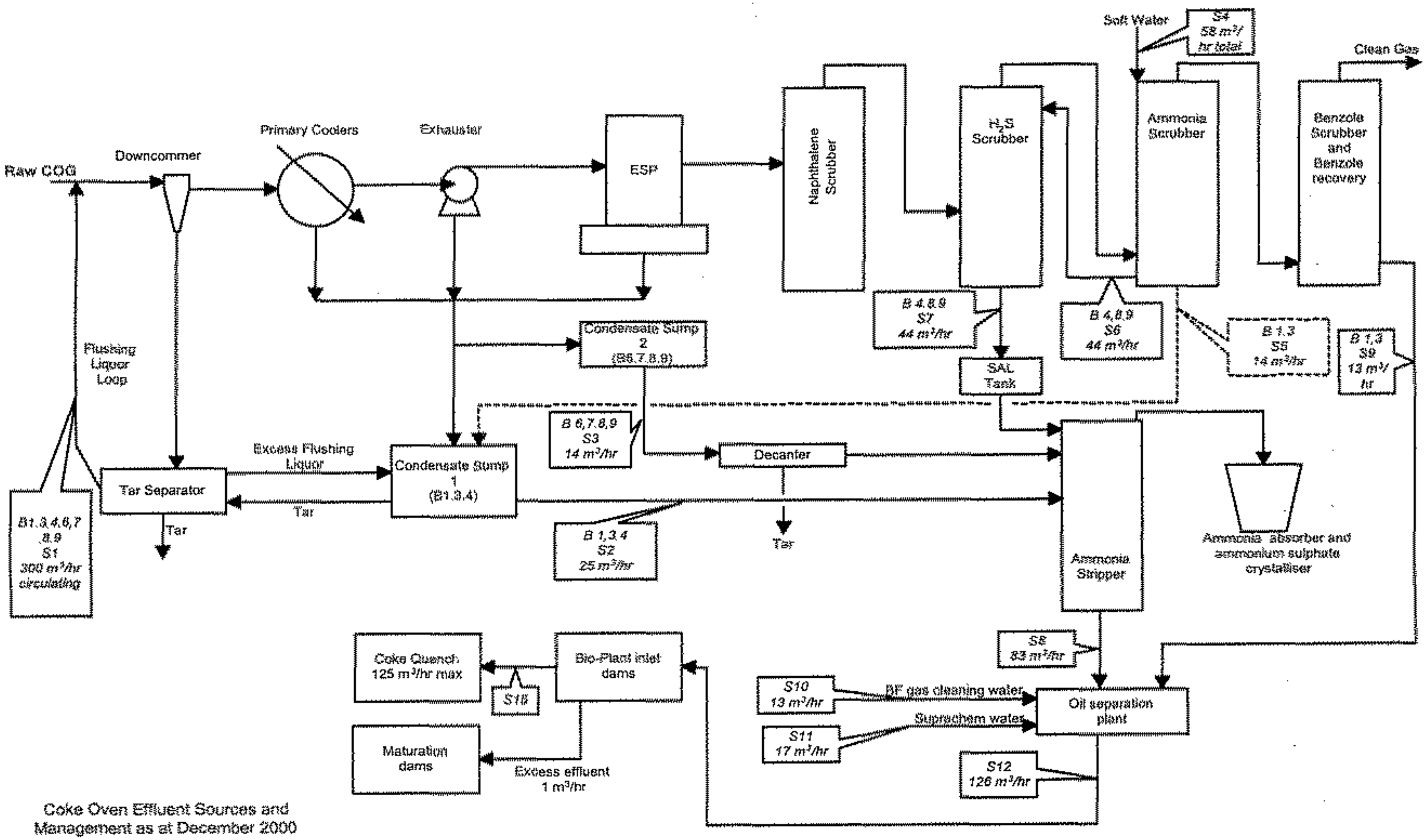
The gas leaving the ammonia absorbers contains a small amount of light oil, which, when condensed, is a clear yellow-brown oil. It is a mixture of coal gasification products with boiling points mostly between 0 and 200°C, containing well over a hundred constituents. Most of these are present in such low concentrations that their recovery is seldom practicable. The light oil is usually referred to as BTX. The principal usable constituents are benzene (60-80%), toluene (6-17%), xylene (1-7%) and solvent naphtha (0.5-3%). The BTX is recovered by washing the COG with a petroleum wash oil (benzole) in the BTX absorber, followed by steam distillation of the enriched absorbent to recover the light oil and to create a re-usable wash oil for recycling to the BTX absorber.

IM02.1.3.7 System Analysis

The existing infrastructure at IVDBS for the coke oven effluent management is detailed in the schematic drawing below. The schematic that is presented is a simplification since there are separate gas cleaning systems for individual coke oven batteries (each with their own specific nuances). However for the purposes of a general overview understanding the schematic that is presented is appropriate. Note each stream is identified by a stream label, S; and where individual battery analysis is available this is given then sub-labeled B.

The results from samples obtained from coke oven gas cleaning process flushing liquor loop, stream 1 (batteries 1-9) are given in the table below. The streams all have comparable high pH values. Stream S1B 6, 7 contains the highest levels of ammonia and inorganic salts. The chloride level in S1B 6,7 is comparable to chloride levels in stream 10 (the Blast Furnace Gas cleaning liquor and is not typical of this type of wastewater.

Variable (mg/l)	S1 B1	S1 B3	S1 B4	S1 B 6,7	S1 B 8,9
pH	9.7	9.6	9.8	9.2	9.8
PO_4^{3-}	54	53	57	52	54
NO_3^-	0.98	0.61	0.35	31.8	1.6
CN	265	68	709	2442	765
H_2S	100	100	200	<100	200
CO_2	3000	3000	7000	3000	5000
NH_3	3700	2800	6700	4300	3500
S	970	490	700	1200	530
Al	0.6	0.8	1.2	5.2	0.8
Fe	6	13	11	22	12
Ca	3	15	6	24	4
Na	5	22	7	69	6
Cl	342	963	783	2783	620
Benzene	<10	<10	<10	<10	<10
Pyridine	50	<10	40	90	<10
Phenol	2140	490	620	640	790
Aniline	50	<10	40	<10	30
o-cresol	140	<10	40	30	60
M,p-cresol	490	90	120	140	220
Naphthalene	<10	40	<10	<10	<10



Coke Oven Effluent Sources and Management as at December 2000
RPA Drawing 484 /LA1044A
4th November 2002

The results from the condensate sump [stream 2 (batteries 1-4)], condensate sump [stream 3] and soft water make-up [stream 4] are given in a separate table below. All streams except stream 4 have high pH values. B1 and B 3,4 streams also have very high ammonia levels. Streams S2B1 and S3 have comparable phenol levels. Stream 4 contains no phenolic compounds which is consistent with a soft water.

Variable (mg/l)	**S2B1**	**S2B3,4**	**S3**	**S4**
pH	9.9	10	9.6	7.4
PO_4^{3-}	53	54	53	<0.5
NO_3^-	0.45	0.4	1	0.26
CN^-	139	508	797	0.4
H_2S	1600	1100	100	<100
CO_2	7000	7000	6000	1000
NH_3	9300	11600	3400	3
S	1900	1300	560	<1
Al	1.7	0.2	0.8	1.1
Fe	9	9	10	2
Ca	6	3	3	13
Na	10	9	5	38
Cl	130	478	794	12
Benzene	50	10	<10	0
Pyridine	140	70	30	0
Phenol	1150	510	1140	0
Aniline	60	30	70	0
o-cresol	100	10	90	0
m,p-cresol	270	80	330	0
Naphthalene	30	10	<10	0

The results from the exiting ammonia scrubber liquor [stream 5 (batteries 1-3)], ammonia scrubber liquor routed to the H_2S scrubber [stream 6] and the scrubber liquor leaving the H2S scrubber [stream 7] are given in the table below. All streams have high pH values. All these streams also have very high ammonia concentrations. Stream 7 has very high sulphur and hydrogen sulphide level which is expected in a hydrogen sulphide scrubber effluent. All four streams also contain low concentrations of phenolic material.

Variable (mg/l)	S5B1	S5B3	S6B4	S7B4
pH	10	10	10	10.1
PO_4^{3-}	<0.5	<0.5	<0.5	<0.5
SO_4^{2-}	691	187	164	169
NO_3^-	<0.5	<0.5	<0.5	<0.5
F	<0.5	<0.5	0.5	<0.5
CN	290	300	531	235
H_2S	0.32	0.25	1200	1900
CO_2	27000	21000	22000	33000
NH_3	21600	14100	20100	23400
S	2600	1750	1543	1835
Al	<1	1	1	<1
Fe	4	5	171	79
Ca	39	40	20	8
Na	24	27	39	24
Cl	14	21	81	31
Acetonitrile	250	80	80	80
Benzene	20	20	10	10
1H-pyrrole	30	10	20	20
Pyridine	160	90	60	60
2-methyl-pyridine	30	10	10	10
Phenol	60	20	40	40
Aniline	20	20	20	20
Benzonitrile	10	10	10	10
o-cresol	20	10	10	10
m,p-cresol	30	20	20	20
Quinoline	90	0	10	10

Ammonia is recovered from the various effluent liquors utilising an ammonia stripper and still to remove the free ammonia and ultimately generate ammonium sulphate. The liquid discharge from the ammonia stills is labelled as stream 8. This liquor together with the discharge from the benzol scrubber (Stream 9), the Blast Furnace gas cleaning liquors (Stream 10), and effluents from Suprachem (Stream 11) are collected and separable oil is recovered. The discharge from the oil separation plant is labelled stream 12. Typical analyses are given in the following table. The effluents are then routed to the bio-plant inlet dams and transferred without treatment to the coke quench towers where they are evaporated.

Note Stream 12 is very high in ammonia. Stream 10 is high in chloride. Both streams S10 and S11 are very low in organic content.

Variable (mg/l)	S8	S10	S11	S12
pH	10	7.3	ND	9.7
PO_4^{3-}	<0.5	<0.5	ND	<0.5
SO_4^{2-}	119	ND	ND	217
NO_3^-	<0.5	0.57	ND	1.35
F	92	ND	ND	430
SiO_2	50	ND	ND	31
CN	41	<100	2.6	190
H_2S	<100	<100	<100	44
CO_2	13000	1000	1000	<100
NH_3	2200	1569	139	8000
S	71	115	20	2200
Al	<1	4.1	0.6	17
Fe	10	19	2	1
Ca	2	275	47	17
Na	13	151	40	7
Cl	543	2790	33	50
Acetonitrile	30			20
Benzene	0			0
1H-pyrrole	20			40
Pyridine	60			40
2-methyl-pyridine	10			10
Phenol	1180	0.001	310	630
Aniline	40			20
Benzonitrile	10			0
o-cresol	110	0.003	70	60
m,p-cresol	370		170	190
2,4-xylenol	30			20
2,5-xylenol	10			10
3,5-xylenol	20			10
Quinoline	30			20
1H-indole	30			20

IM02.1.3.8 Effect of the Proposed Upgrades in the Coke Oven Area on Process Waters

As a result of the proposed upgrades to the Coke Oven Area and the Gas Cleaning Processes, the following essential features will result.

a) The product (cleaned) coal gas will have a low sulphur content, a low ammonia content, a low moisture content and a low naphthalene content. All this means a much cleaner burning gas which can be used by many more on-site gas users, thereby reducing the amount of gas which is wasted by flaring and reducing the import of Sasol Gas to the site.

b) Proper operation of the "free ammonia" strippers such that all the stripped ammonia and H_2S scrubbing waters can be recycled. This will approximately halve the current effluent production.

c) Proper operation of the "fixed ammonia" strippers such that all the flushing liquor and all the collected bund and spillage waters will be stripped effectively free of ammonia, H_2S, other sulphur compounds and volatile organics. The cyanide content should also be mostly removed. This will enable this water to be utilised as a make up water for Blast Furnace Gas Cleaning and for other uses.

d) As a result, all the current sources of effluent in the Coke Oven and By Products area will either not be produced or they will be in a form that can be used by other parts of the site instead of using raw water.

e) The whole of the coke quenching function can therefore be supplied by a suitable inorganics only containing water source. This will create a major reduction in the quantity of sulphur, ammonia and organic emissions that are released from the coke quench stations.

f) In the event of a major accumulation or other form of production of coke oven and by-products area derived bund, spillage or flushing water, which exceeds the capability of the "fixed ammonia" strippers, the proposed routing of these effluents via upgraded gravel filters (both quality and capacity) will enable these waters to be used "as is" at the Blast Furnaces, therehy enabling some or all of the stripped water to be added in a controlled way to the remainder of the MTP infrastructure. Once the particular surge in volume of "fixed ammonia" has been processed away then normal operation as in d) above can be restored.

Overall, therefore, the relatively minor re-directing of the central thrust of the Coke Oven Area upgrade and Gas Cleaning Project that has resulted from RPA's Master Plan and ZED (Zero Effluent Discharge) related work, in conjunction with the specific focussing of the already completed bunding and spill containment works has achieved a situation where the Coke Oven area will become a net effluent user (for coke quench) and a supplier of suitable quality water to other process users (Blast Furnace Gas Cleaning).

IM03 SINTER PLANT

The principal active production areas are :

IM03.1	Sinter Plant
IM03.2	Slag Granulation, wet/dry dams and product drainage area – please refer to text within IM01.1

IM03.1 SINTER PLANT

The management of residues in an integrated steelworks is characterized by advanced techniques for extracting value from the various types of slag and by recycling of most of the residues in the sinter plant, which can be considered the 'digester of an integrated steelworks'. Thus, beside the sintering process itself, the sinter plant plays this important role of recycling residues for which no adequate alternatives exist. Only small parts of the overall quantity of residues need to be landfilled.

Fine ore, fine coke, lime, dolochar and other iron rich fines from Direct Reduction, arc furnace slag, BOF sludge, Blast Furnace gas cleaning sludge, spent pickle liquor (hydrochloric acid with dissolved iron) from the pickling lines and diverse other recycle streams are mixed on the mixing bed and fed into the two sinter lines by means of conveyor belts, bunkers and an agglomeration and mixing unit. The product sinter is cooled, crushed and screened and the coarser fraction is conveyed to the blast furnaces. The fine fraction is recirculated back to the sinter strand.

IM03.1.1 Sinter Plant Cooling water

In the sinter plant, cooling water is used for the cooling of the ignition hoods and the fans as well as for the sinter machines. In an integrated steelworks producing 4 Mt steel per year, the sinter plant cooling would require a water flow of approximately 600 m^3 per hour [EC Haskoning, 1993]. The cooling water is normally completely recycled. At IVDBS, approximately 200 m3/hr of Industrial Water is taken from the Industrial Water Main, put through the various cooling coils and jackets and then pumped back into the Industrial Water Main. This slightly warmed water goes on to supply the various cooling towers within the Coke Oven and Coal Gas Cleaning areas and the Blast Furnaces and compressor areas.

IM03.1.2 Sinter Plant Gas Treatment

Waste water from waste gas treatment will only be generated if a wet abatement system is applied. IVDBS is currently proposing to construct a demonstration scale (circa 25%) dust removal plant at the site.

The proposed gas treatment plant represents novel technology that has to date been trailed on a 1/400th scale pilot plant. Results to date indicate that the system could provide a cost effective alternative which is capable of achieving or bettering the desired off-gas treatment levels that would be comparable with the current Best Available Techniques (BAT) that are used elsewhere in the World. Iscor are committed to developing this novel technology further, to that end capital provision to build a demonstration capacity plant has been agreed.

The water circuit system for this new gas treatment plant will consist of chemical addition, water top-up, solids separation and liquor purge from the system. Note the sinter off-gas treatment system will be a net evaporator of water. The reagents utilized within the full-scale plant have yet to be finalized. However one option undergoing serious evaluation is the use of ammonia contaminated bund waters from the coal gas cleaning plant area. Note when NH_4OH containing water is used as a reagent, an ammonium sulphate based solution is produced. This, in combination with the dissolved potassium chloride fumes which the scrubbing process has to remove from the Sinter Off-Gases may have potential as a fertilizer raw material, with off-site sales potential.

The Scrubber Fluid Composition that will be recirculating within the proposed dust removal plant is anticipated to be the following, assuming a sodium hydroxide reagent and industrial water as the source of top-up water.

		Industrial Water
pH		3 –5
Cl	mg/l	5300
S as SO_4	mg/l	6700
F	mg/l	~2
Na	mg/l	3900
K	mg/l	4000
Ca	mg/l	45
NH_3	mg/l	~1
CO_2	mg/l	Balance
CN	mg/l	0,0
Suspended Solids	mg/l	1200

The effluent generation rate for a 25% scale plant will be 9 to 12 m^3/hr.

The eventual disposal route for the scrubbing fluid effluent that will be generated will be a function of the integrated water circuit arrangements being compiled for the entire site. For the purposes of the demonstration plant (25%) a worst case scenario will be catered for, whereby caustic will be added as the neutralizing agent. The effluent purge from the demonstration plant is likely to be mildly acidic and will contain significant levels of sulphate. It is therefore proposed that the acid sump at Q pumphouse will receive the continual purge effluent and route it to the CETP where it will be treated by pH control with lime (thereby precipitating excess sulphate as gypsum). In addition the clarification systems at CETP will remove the non-water soluble components within the sinter dust.

Depending upon the amount of spent pickle liquor which is being added to the Sinter Plant agglomeration drum at the time, it is possible that the total chloride input to the CETP could be too high for the TETP discharge to remain within its licence conditions. If this is the case, then between the start up of the demonstration scale plant and the completion of the salts removal part of the ZED infrastructure it may be necessary to direct a proportion of the scrubber fluid discharge from the demonstration plant to Dams 1 to 4. Here they will be stored until the salts removal part of the ZED infrastructure is operating, at which time the whole contents of Dams 1 to 4 will be able to be pumped away steadily over time into the ZED infrastructure.

IM04 STACKING AND RECLAIMING OF RAW MATERIALS

This area is not applicable to the process waters master plan. Within the IM04 area, three basic functions are carried out.

a. rail unloading
b. coal stacking and reclaim
c. Sinter strand mixing and blending heap

The rail unloading is a well contained mechanical handling facility which does not create any process waters. Surface water run off and pumped ground water associated with the below ground rail car tipping hoppers and conveying equipment should be the only sources of water. Any ground water that is pumped is already directed into the North Works Blow Down Canal. Any such flows are very small and their effect on the overall flow and quality of the contents of this canal are, for practical purposes, negligible.

The coal stacking and reclaim area is constructed on an engineered clay base with a drainage system between this clay layer and the underside of the stored coal. This drainage layer is drained to the Burns Memorial Canal which is currently drained via the North Works Blow Down Canal to the TETP.

In the future the dry weather flow from this canal will be directed into the ZED infrastructure, as will the waters which will accumulate on the top of the sludges within the CETP Sludge Dams, which are to the west of the IM04 area.

The following Table present a typical average analysis for this canal. It should be noted that the analysis is quite variable, as is the flow rate.

Burns Memorial Canal – Typical Average Analysis (The flow is that which has been assumed for CETP Rearrangement)*	
Flow (m^3/hr)	30
Total Hardness (mg/l)	3600
Ca Hardness (mg/l)	2950
P alkalinity (mg/l)	0
Total Alkalinity (mg/l)	89
pH	8
Cl (mg/l)	1150
S-SO_4 (mg/l)	950
Conductivity (µS/cm)	7000
Suspended Solids (mg/l)	-
F (mg/l)	1.6
CN (mg/l)	0.02
NH_3-N (mg/l)	10
Phenol (mg/l)	0.45
NO_3-N (mg/l)	0.75

NO_2-N (mg/lp	0.5
P (mg/l)	1
Mn (mg/l)	1
Cr^{6+} (mg/l)	0.1
Na (mg/l)	290
Fe (mg/l)	0.7
Zn (mg/l)	2.4
SiO_2 (mg/l)	-
Sn (mg/l)	1.4
Cr total (mg/l)	0.07
K	50

*Surface Water Master Plan by VRF will set out likely future analysis, flows and composition. Since this canal was relocated and deepened and since the CETP sludges have been re-routed to the CETP sludge dams in area IM05, the dry weather flow has reduced to circa 5 m^3/hr. The analysis of this reduced flow is variable but the average is similar to the above analysis.

The Sinter Strand mixing and blending process is a dry mixing and heap blending activity. Normally, all rainfall which lands on the heap or to the east of the heap (between the Burns Memorial Canal and the heap) is absorbed into the dry heap material.

To the west of the heap, waters are trapped in the former drying bed area between the heap and the eastern wall of the CETP Sludge Dams. During and following heavy rain, this trapped water flows around the south side of the CETP sludge Dams and into Dam 10. these waters need to be intercepted and routed into the ZED infrastructure as the equivalent of an "after the storm" controlled flow alongside the Burns Memorial Canal "after the storm" flow.

The proposed North Works Blow Down Canal and CETP Canal arrangements for ZED have made an allowance for incorporating a drain down flow from this area.

IM05 VELD COKE AREA

This area is not applicable to the process waters master plan. This is a dry products storage area. Surface run off waters are likely to drain mostly into Dam 11 with a proportion (especially under heavy rainfall conditions) draining eastward into the former Burns Memorial Canal. Pending the implementation of the Master Plan Proposals, occasional controlled pumping of Dam 11 into the Bums Memorial Canal has been carried out in order to prevent the level in Dam 11 from getting too high.

IC01 SUPRACHEM

Within the Suprachem Area, the tar and benzole products from the Coal Gas Cleaning process areas are processed to create valuable by-products for sale. Most of the processes within Suprachem are distillation or solvent extraction based processes. As a result, the aqueous process effluents that are created are steam condensates from product heaters, aqueous condensates from distillation or separated aqueous fractions.

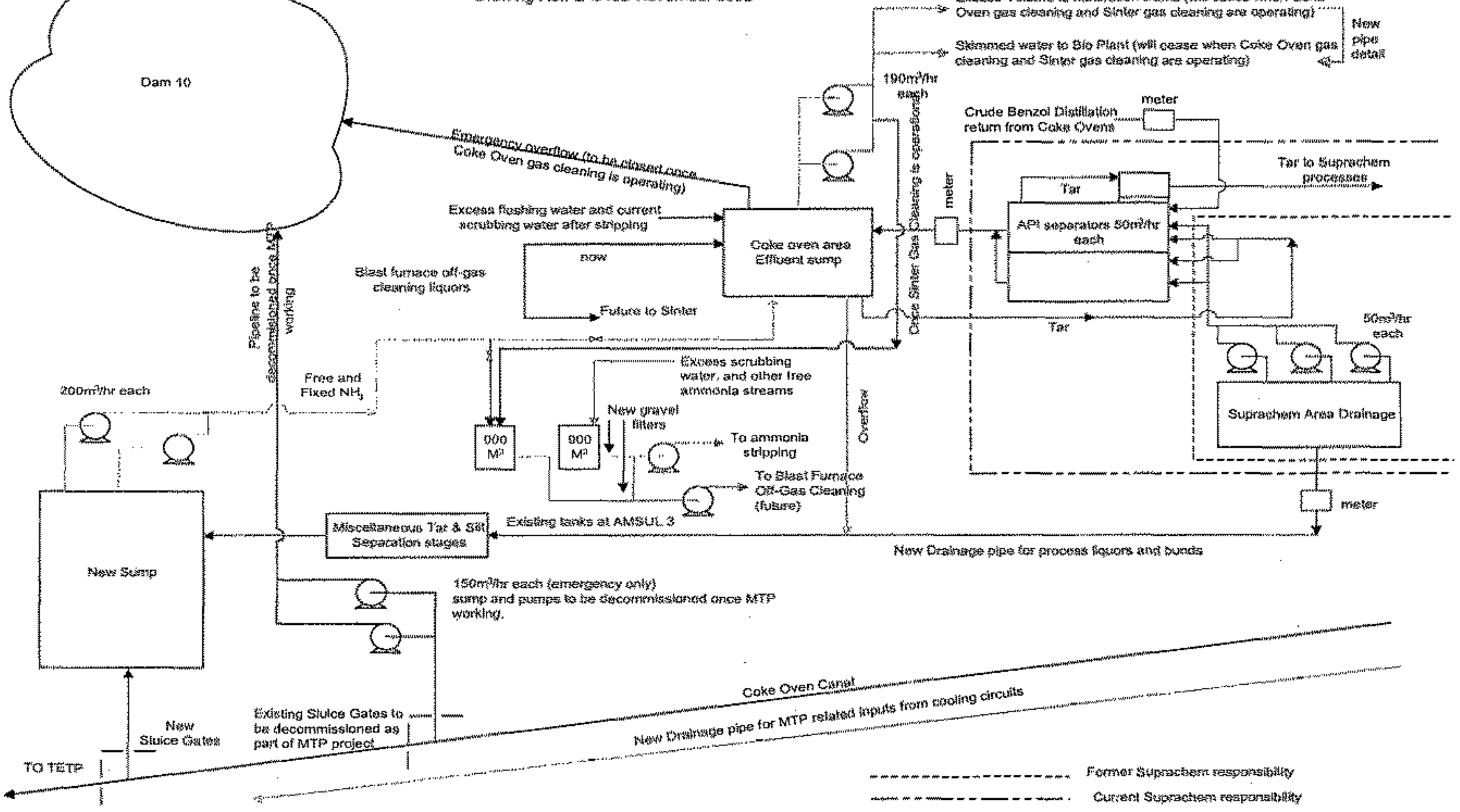
Prior to the Short Term Measures, all these process effluents together with general process area drainage and roof and other clean area drainage was all mixed and accumulated in sumps on site. During dry weather conditions, most of this mixed effluent was returned to the main tar separators in the Coal Gas Cleaning area. From here, the water content was pumped to the Bio-Plant inlet dams and the tar and oil content was combined with further tar from the Coal Gas Cleaning processes and returned to Suprachem. During rain events the capacity of this system was soon overwhelmed and discharges to Dam 10 started. When the capacity of this pipe was exceeded (which was a quite frequent occurrence) then the remainder overflowed to the Coke Oven Canal which was then pumped to Dam 10.

As part of the Short Term Measures and the ongoing bunding and containment programme for the whole of the Coke Oven and Coal Gas Cleaning areas, all the process parts of the Suprachem area were bunded and contained. Also, all the roof and clean area drainage was separately collected and directed to the Coke Oven Canal. Finally, the pumping and other systems capacities for containing without overflow and for removing storm water from the bunded and contained areas were increased such that all overflows to Dam 10 and to the Coke Oven Canal were stopped. The new HDPE pipeline which was designed to handle all potential spillages and bund, etc drainage from the Coal Gas Cleaning areas was connected to the Suprachem System so as to assist this process.

The flow of all effluents to this system from Suprachem are metered, as are all tar and other inputs from the Coke Oven Area to Suprachem. There is now a properly controlled and accounted system between the two process areas and as part of that activity, the ongoing operation and maintenance of the tar separator is now the responsibility of Suprachem. The attached drawing reference 484/LA843B shows how the two infrastructures interface and how they interface with the pumping arrangements to the Bio-Plant Buffer Inlet Dams and the Maturation Dams. This drawing also shows the previous connections to Dam 10 which are currently being retained for emergency only usage. They will be decommissioned and closed during the next two years.

Schematic of Coke Oven Area and Suprachem Process Drainage

R. Paxton and Associates Limited in conjunction with the OFT Master Plan Team
Drawing Ref: LA8438 November 2002



CO01 SECONDARY INDUSTRIES

This area is not applicable to the process waters master plan. This is an area which is occupied by Air Products, who supply compressed gases to the site. Air Products have their own cooling water treatment and recirculation systems. The blow down from this is now pumped, together with waters from their contained/bunded process areas from collection sumps at the eastern and western sides of their plant area to the collection and recirculation infrastructure associated with the EAF slag cooling area and with the BOF off-gas scrubbing activity. These collection and pumping arrangements were put into place as part of the Short Term Measures and the Ongoing Measures.

A typical average analysis and flow for the Air Products effluent is as follows:

Air Products Blow Down – Typical Analysis	
Flow (m^3/hr)	20
Total Hardness	830 mg/l
Ca Hardness	490 mg/l
P alkalinity	22 mg/l
Total Alkalinity	311 mg/l
pH	8
Cl	202 mg/l
SO_4	595 mg/l
Conductivity	2250 µS/cm
Suspended Solids	10 mg/l
P	1.3 mg/l
Na	180 mg/l
Fe	0.1 mg/l

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STRICTLY CONFIDENTIAL
ISCOR VANDERBIJLPARK STEEL PROCESS WATERS MASTER PLAN REPORT
Part 2 of 2

November 2002
RPA Report No: LA1075

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CONTENTS

4. PROCESS EFFLUENT DERIVED ENVIRONMENTAL RISKS

One thing which must be remembered when one is evolving a strategy for process waters and effluents, particularly in the High Veld areas of South Africa (or other net evaporation regions which are distant from the sea), is that treating Steel Works and other similar effluents to a quality which will be acceptable for discharge to the environment is almost always more expensive than treating that same effluent or process water to a standard which would enable the whole volume to be usable elsewhere within the site. In the light of this generally proven experience and the ongoing tightening of standards to which effluents will have to be treated before they can be discharged to the environment, the concept of moving towards a Zero Effluent Discharge (ZED) is both a realistic and a pragmatic concept.

Also, with reference to a risk assessment in relation to process effluents generated from the site, all but the highest quality rinse waters would be a quality that should be considered to be in breech of long-term water quality objectives. Hence future infrastructure to achieve ZED must provide an effective <u>total</u> capture of contaminated and potentially contaminated waters generated on the site, regardless of the source.

Currently, at the works, the effluents are grouped into essentially two categories (denoted "Clean Enough" and "Dirty"). The effluent systems are therefore focussed toward these differing duties.

The "Dirty" effluents are those strong effluents which need some form of specific and significant treatment process to enable them to be discharged to a water course or sewer. Alternatively they are so "Dirty" that they are removed from the effluent system.

These "Dirty" effluents include all the pickling and plating effluents (including the respective rinse waters) the cold rolling coolants and the alkaline degreasing effluents. Clearly, spillages of these types of materials into the effluent collection canal infrastructure leading to receiving environments outside the site boundary will cause difficulties in meeting existing discharge license conditions. Hence an essential element of the necessary site proposals is to ensure containment and re-use of those spillages.

The "Clean Enough" effluents are those which are derived from essentially clean systems such as cooling tower circuits (where direct contact with the potentially contaminated materials or chemicals is prevented) and final cooling and quenching waters, where the water only contacts clean products. These materials are routed directly to the final discharge point of the site without specific chemical treatment (simply solids removal) and admixture with other site derived waters.

The following sections within chapter 4 of the Industrial Process Water Master Plan follow the zones identified on FMA drawing "Vanderbijlpark Steel – The Works Study Area and Adjacent Neighbouring Areas *Business Units*" File ref STEEL004.

Each plant area in turn is discussed in detail in terms of process effluent derived environmental risk. Note where measures have been implemented to mitigate these risks under the short term measures these are described.

SM01 STEELSERV AREA

The Steelserv sump effluent was identified as one of the effluent streams with high fluoride, sodium, chloride and sulphate that represented a risk to any discharge to the Leeuspruit. Its effluent composition rendered it particularly appropriate for it to be cascaded into the BOF cleaning circuits. This has been completed as part of the Short Term Measures. Note a failure of the Steelserv Sump will represent a leakage potential into the Leeuspruit Dam for ultimate discharge to TETP. As part of the Short Term Measures, however, this effluent stream is ultimately evaporated within the circuits of the BOF, V1/2/3, EAF and BF slag granulation systems before finally forming part of the ultimate discharge to the Desalination Plant. At the Desalination Plant the salts content is removed for off-site disposal whilst the water is recovered for re-use within the site. Details of this short-term measures can be found later in the Process Waters Master Plan document within section 5.2.1

SM02 BOF PLANT

SM02.1 BASIC OXYGEN STEELMAKING

SMO2.1.1 MAIN COOLING SYSTEM (CLOSED COOLING SYSTEM)

The water quality within the closed cooling circuit systems is high and does not pose a risk to the outflow from the works. Softeners utilised within the plant area do however contain appreciable salts contents and are accordingly blown down to the integrated water system as described in SMO2.1.5 below.

SM02.1.2 MISCELLANEOUS COOLING SYSTEM (OPEN COOLING SYSTEM)

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5.

SM02.1.3 TOPCONE COOLING SYSTEM (OPEN COOLING SYSTEM)

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5.

SM02.1.4 MAIN OPEN COOLING SYSTEM (OPEN COOLING SYSTEM)

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5.

SM02.1.5 GAS SCRUBBING SYSTEM

Within the existing water circuits associated with the BOF and V1 and V2, there was the facility to return clarified BOF off-gas cleaning circuit water to V1 and V2 as well as for V1 and V2 to blow down their high fluoride content circuit waters to the BOF off-gas cleaning circuit. The chemistry within the BOF circuits enables fluoride levels to be kept relatively low. The existing pipework circuits were upgraded and amended to allow the high fluoride waters from V1 and V2 to be routed to the BOF off-gas cleaning circuit and for clarified BOF water to be returned to V1 and V2. This system is now assisted by the waters being returned from the Steelserv sump, which not only saves industrial water usage, but also reduces input of treatment chemicals.

The blow down from this system and from all the other cooling systems in this area did go to the TETP via the South Dam Canal. However as part of the short term measures (see section 5.2.4) the effluents are routed to slag cooling at the EAF where the high calcium content that is derived from the EAF slag, precipitates much of the fluoride content from the BOF, making much of it suitable for return to the BOF.

This return flow provides a means of removing fine silt from the EAF slag cooling area to the clarifiers and filter presses at the BOF, which in turn provide a means whereby the fine EAF slag solids can be returned to the Sinter Plant where they are able to substitute for raw lime input.

Finally, the combined blow down from this infrastructure is suitable for re-use as make up water at blast furnace slag granulation. V3 blow down was already routed to slag granulation so the blow down from this integrated system was routed to the existing blow down sump for the V3 system.

From slag granulation the collected effluents are ultimately discharged to the desalination plant. At the desalination plant the salts content is removed for off-site disposal whilst the water is recovered for re-use within the site.

All the liquors and slurries within this integrated effluent management system are unsuitable for discharge from the site via the TETP infrastructure. Leakages, infrastructure implementation delays and poor control (particularly at slag granulation) have presented obstacles to this system providing a reliable improvement to the Reitkuilspruit discharge analysis. However recent operating experience has seen reliable performance.

Ultimately the effluents in these areas represent a potential risk to the final discharge due to their high salts contents. Hence reliable and contained operation of this system is essential.

SM02.2 CONTINUOUS CASTING

SM02.2.1 V1 CLOSED COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works. For the purposes of local practicality any spillages or blow downs are routed to the integrated water system as described in SMO2.1.5 above.

SM02.2.2 V2 CLOSED PRIMARY COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works. For the purposes of local practicality any spillages or blow downs are routed to the integrated water system as described in SMO2.1.5 above.

SM02.2.3 V2 CLOSED SECONDARY COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works. For the purposes of local practicality any spillages or blow downs are routed to the integrated water system as described in SMO2.1.5 above.

SM02.2.4 OPEN COOLING SYSTEM (SPRAY COOLING)

This system is contaminated with fluorides emanating from the casting powders being used in the production processes. Fluorides and iron are the major components found in deposits in the pipes. As described in SM02.1.5 above the effluent waters are integrated with the BOF gas scrubbing circuit waters. Note Oil enters the system from leaks on the machines and is pumped with seepage water from the hydraulic chambers. Whilst floating oil is then removed in the scale pit by rope skimmers or removed in the DAF the effluents discharged from this area do pose an additional environmental risk (in addition to the high salts content).

Any non-contained or collected spillages and leaks will represent a contaminated leakage potential into the canal infrastructure for discharge via TETP or they could enter groundwater or other surface water collection mechanisms.

SM02.2.5 SLAB COOLING SYSTEM

The system make-up water is (as a result of the Short Term Measures) from the BOF off-gases scrubber system (SM02.1.5), with industrial water as a back up. Hence the same identified risks regarding non-collected spillages and leaks as described above in SMO2.1.5 apply.

SM02.2.6 SCARFER SYSTEM

The system make-up water is (as a result of the Short Term Measures) from the Slab cooling system (SM02.2.5), with industrial water as a back up. Hence the same identified risks regarding non-collected spillages and leaks as described above in

SMO2.1.5 apply. This system can also become contaminated with oil from the scarfer machines and this oil is removed in the DAF however spillages from this area pose this additional environmental issue.

SM02.3 SECONDARY METALURGY (RHOB WATER PLANT)

SM02.3.1 MACHINE COOLING SYSTEM (CLOSED COOLING SYSTEM)

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

SM02.3.2 MULTI-LANCE COOLING SYSTEM (CLOSED COOLING SYSTEM)

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

SM02.3.3 CONDENSER COOLING AND HEAT EXCHANGER COOLING SYSTEMS (OPEN COOLING SYSTEM)

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5 above.

SM02.3.4 MULTI-LANCE COOLING SYSTEM (OPEN COOLING SYSTEM)

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5 above.

SM03 OPEN AREA AND ELECTRO-SLAG AREAS

With the exception of slag cooling and the associated collection and recirculation of this cooling water, all of the other activities are non-process effluent activities. However, these dry activities do handle materials which, when contacted by rainfall, by dust suppression water and by general drainage from slag and other product heaps and product transport, they will cause surface and ground water contamination.

As a result of a combination of leakages and overflows at the lagoon together with general spillage, product drainage and rainfall on the slag and other residues which have been used to make the general working area around the lagoon, there is a considerable amount of local ground and surface water contamination within this area. Some of this contamination could also originate from areas to the east and north of this lagoon.

The interfacing infrastructures between the waters in this lagoon and the BOF systems has already been described in the descriptions given under Area CS02. Clearly non-contained effluents pose a considerable risk if they become part of the flow discharged from the site through TETP. The effluents in this area are characterized by a relatively low fluoride but very high other dissolved salts (Na, Cl, SO_4).

SM04 ELECTRIC ARC FURNACE

SM04.1 ELECTRIC ARC FURNACE STEELMAKING

SM04.1.1 MAIN OPEN COOLING SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the electrode cooling system.

SM04.1.2 TRANSFORMER CLOSED COOLING SYSTEMS

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

SM04.1.3 TRANSFORMER OPEN COOLING SYSTEM

The system blow down is manually controlled and the blow down is currently to the TETP. However, this is in the process of being changed to blow down to the blow down sump from the Continuous Caster V3 which is pumped to the Blast Furnace Slag Granulation System (as described in SMO2.1.5 above). Cycles of concentration are maintained at a high level within this system and consequently, irrespective of the long-term water supply, discharges or spillages from this area would pose a risk to the current effluent discharge restrictions (the concentration cycles that are achieved ensure that the blow down is approximately twice the strength of that which would be currently allowable within the discharge limits).

SM04.1.4 VAD COOLING SYSTEM

The system blow down is manually controlled and the blow down is currently to the Terminal Effluent Treatment Plant. However, this is in the process of being changed to blow down to the blow down sump from the Continuous Caster V3 which is pumped to the Blast Furnace Slag Granulation System (as described in SMO2.1.5 above). These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters).

SM04.2 CONCAST V3

SM04.2.1 V3 PRIMARY CLOSED COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

SM04.2.2 V3 PRIMARY OPEN COOLING SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into the integrated water system as described in SMO2.1.5.

In reality the system leaks continuously to the V3 secondary system because of leaks on the bearing cooling caps.

SMO4.2.3 SECONDARY COOLING SYSTEM

This system is contaminated with fluorides emanating from the casting powders being used in the production processes. Fluorides and iron are the major components found in deposits in the pipes. As described in SM02.1.5 above the effluent waters are integrated with the BOF gas scrubbing circuit waters. Note Oil enters the system from leaks on the machines and is pumped with seepage water from the hydraulic chambers. Whilst floating oil is then removed in the scale pit by rope skimmers or removed in the DAF the effluents discharged from this area do pose an additional environmental risk (in addition to the high salts content).

Any non-contained or collected spillages and leaks will represent a contaminated leakage potential into the canal infrastructure for discharge via TETP or they could enter groundwater or other surface water collection mechanisms.

SM04.2.4 SLAB COOLING SYSTEM

The system make-up water is normally from the secondary cooling water system SMO4.2.3, hence the same identified risks above apply in this instance.

SM05 DIRECT REDUCTION PLANT

SM05.1 DIRECT REDUCTION DEMINERALISATION PLANT

The regeneration effluents are currently discharged into the TETP infrastructure. These effluents are of a concentration that exceed the allowable discharge from the TETP into the Reitkuilspruit due to the high chloride and sodium concentrations derived from the regeneration chemicals (caustic soda and hydrochloric acid) and the salts which have been removed from the water that has been demineralised. This effluent therefore relies on the dilution from other process effluents discharged to the TETP in order that the overall discharge restrictions are not exceeded.

A new pipeline is currently being commissioned which will bring demineralised water from the High Pressure Demineralisation Plant (see Section CS02.2) to the Direct Reduction waste heat boilers. This will enable the DR Demineralisation Plant to be shut down and only be used for emergency back up purposes or during maintenance outages.

This same pipe line has been arranged such that if the Direct reduction Demineralisation Plant is brought back on line, then the regeneration effluents will be able to be discharged via this pipe, either to the sump for these effluents which is adjacent to the High Pressure Demineralisation Plant or to the Blast Furnace slag granulation system. This will enable this high salts content effluent to be permanently diverted away from the TETP.

SM05.2 DR PRODUCT COOLING SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged to the after burner temperature control total evaporation sprays. On the ideally rare occasions when there is an excess of circuit waters these are discharged to the TETP.

SM05.3 AFTER BURNER TEMPERATURE CONTROL

This is no longer an effluent producing area following the installation of dry coarse dust discharge arrangements at the after burner chamber on each kiln.

SM05.4 BORE HOLE PUMPING TO KEEP WATER OUT OF BELOW GROUND STRUCTURES

These effluents, although not directly process derived, are of a concentration that exceed the allowable discharge from the TETP into the Reitkuilspruit due to the salts and potential organic content - derived from the seepage of Dam 10. This effluent therefore currently relies on the dilution from other process effluents discharged to the TETP in order that the overall discharge restrictions are not exceeded. Note Dam 10 liquid level has been considerably reduced (and continues to reduce) hence the need for this effluent to be generated is reducing.

CS01 SECONDARY INDUSTRIES AND STORAGE AREA

This area is not applicable to the process waters master plan write up.

CS02 ADMINISTRATION & SERVICES

CS02.1 BLOWER HOUSE COOLING WATER SYSTEMS

CS02.1.1 EAST BLOWER HOUSE SYSTEM

The system blow down is currently to the Terminal Effluent Treatment Plant or the blast furnace open cooling system. Cycles of concentration are maintained at a high level within this system and consequently, irrespective of the long-term water supply, discharges or spillages from this area would pose a risk to the current effluent discharge limits (utilising industrial water as a make up, the concentration cycles that are achieved ensure that the blow down exceeds the current allowable discharge limits). This effluent therefore currently relies on the dilution from other process effluents that are discharged to the TETP in order that overall the discharge limits are not exceeded.

CS02.1.2 WEST BLOWER HOUSE SYSTEM

The system blow down is currently to the Terminal Effluent Treatment Plant. Cycles of concentration are maintained at a high level within this system and consequently, irrespective of the long-term water supply, discharges or spillages from this area would pose a risk to the current effluent discharge limits (utilising industrial water as a make up, the concentration cycles that are achieved ensure that the blow down exceeds the current allowable discharge limits). This effluent therefore currently relies on the dilution from other process effluents that are discharged to the TETP in order that overall the discharge limits are not exceeded.

CS02.2 HIGH PRESSURE DEMINERALISATION PLANT

Cationic and anionic resins associated with the demineralisation plant for the high pressure boilers are regenerated using sulphuric acid and caustic soda. The regeneration effluents are discharged to a local sump from which it is now (as a result of the Short Term Measures) pumped to the Blast Furnace Slag Granulation System. At slag granulation, both the bulk volume of the system and the nature of the slag buffer, stabilise the pH and reduce the salts content of the regeneration effluents before they are pumped to the MVR evaporator and crystalliser plant (The Desalination Plant). These effluents are characterised by high concentrations of sulphate and sodium and are specifically routed away from the TETP for this reason.

CS02.3 MAIN PURIFICATION PLANT

The water quality within the water circuit systems (being River Water with its suspended solids removed) should not pose a risk to the ultimate outflow from the works.

CS02.4 MOULD FOUNDRY

CS02.4.1 MOULD FOUNDRY OPEN COOLING SYSTEM

Industrial Water Make-up and blow down are controlled automatically. Blow down is currently used for irrigation of the foundry sand as part of local dust control and mould cooling. Leakage and spillages will consequently find their way into the canal infrastructure where the salts contents of these effluents is either at or just above the limits for the site.

CS02.4.2 MOULD FOUNDRY CLOSED COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

CS02.5 LOCO REPAIR SHOP AND WORKSHOPS

There are virtually no effluents produced from these areas, the only ones being from machine and parts cleaning and from general routine floor cleaning and house keeping. All these effluents used to be discharged directly to the adjacent surface water drains. However, these areas are currently being upgraded such that all such effluents are or will be discharged to an oil and solids interceptor. The aqueous discharge from this interceptor is routed to the Blower House Canal and ultimately to TETP. Failure of the oil interceptor system could therefore cause oil to enter the canal systems. Also, excessive use of detergent based cleaning aids could cause emulsified oils and greases to enter the canal system.

CS03 ELLIS PARK & OPEN AREAS

Not applicable to process waters master plan as there are no process water sources in this area.

CS04 OLYMPUS SWITCH YARD "C"

Not applicable to process waters master plan as there are no process water sources in this area.

CS05 TETP PLANT AREA

CS05.1 TERMINAL EFFLUENT TREATMENT PLANT

This system merely removes suspended solids and separable oils from the site's effluents prior to ultimate discharge. The system does not alter the general composition of the final effluent. Occasionally an aqueous based biocide is dosed into the final effluent. Whilst the delivery systems themselves are highly unlikely to pump sufficient biocide to represent a risk to the receiving water medium, it is possible that a major spillage during delivery of fresh chemicals could introduce a high concentration of biocide into the final effluent.

CS05.2 COKE OVEN AREA SUMP

This is a new lined sump for collecting drainage from the bund areas, spillages, process blow downs and other potential discharges which could occur within the Coke Oven, Coal Gas Cleaning, Suprachem and the other Coke Oven derived By-Products Processing areas.

The lined sump, its emptying infrastructure and the collection header which feeds it were installed as part of the Short Term Measures (see section 5.2.5). This infrastructure has enabled all process waters and potentially contaminated waters to be contained and returned by pump to existing infrastructures which enable it to be returned to process. The overriding objective was to ensure all potentially contaminated surface waters which would not be acceptable for discharge to the TETP together with all process blow downs are contained and recycled to process rather than to be allowed to access the Coke Oven Canal or Dam 10. These effluents are highly variable in nature but are characterised by high organics and ammonia contents, rendering them a risk to the final effluent arrangements at the TETP.

CS05.3 TETP SLUDGE DRAINAGE AND DRYING DAMS

These dams are not applicable to the Process Waters Master Plan write up. However, the long term ZED proposals (see section 5) will seek to utilise sludge dewatering facilities so as to avoid the need for such drainage and drying dams in the future.

CS06 EFFLUENT DAMS

These dams are not applicable to Process Waters Master Plan write up. They will be covered by other OFT team members.

CS07 SOLID WASTE DUMPS

These areas are not applicable to Process Waters Master Plan write up. They will be covered by other OFT team members.

CS08 Not Used

CS09 MATURATION PONDS

The risks associated with these dams are not applicable to Process Waters Master Plan. They will be covered by other OFT team members. It should be noted that there is no longer a net input of Coke Oven and By-products Areas derived waters to these dams and that during the course of about the next two years, there will be a steady increase in the pumped removal rate of waters from these Dams to a net continuous average flow of about 60m^3/hr (see section 5.1.13).

CS10 CETP SLUDGE DAMS

These Sludge Dams receive the neutralisation reactor product sludges from the existing CETP. The sludges in these dams do contain substantial amounts of oil and tallow due to the poor historical performance of the CETP. This oil and tallow content currently represents a significant issue since:

a) When dried out, veld fires can cause the sludge to burn. Once a fire has taken hold, it is very difficult to extinguish it without fully flooding the deposit again with water.
b) The sludge is very bio-degradable, despite its heavy metal content. Reed and other water based plant life thrive in it. This makes the control of a) above even more of an issue

Overflow from the CETP sludge dams is by gravity to the North Works Blow Down Canal which then routes them by gravity to the TETP. This discharge is of a comparable (if slightly poorer) quality to that from CETP (see below). Ultimately, the discharged effluent from CETP sludge dams is only acceptable for discharge via the TETP because of dilution from other process effluents discharged to the TETP.

Note, the half round drain (which currently routes the sludge dam overflow to the North Works Blow Down Canal and which can suffer from overflow problems due to reed or other plant blockages) is being replaced with an enclosed pipe so as to prevent overflow problems into adjoining open areas.

CS11 CETP PLANT

CS11.1 CENTRAL EFFLUENT TREATMENT PLANT

The central effluent treatment plant receives those effluents which need chemical and physical treatment in order for them to be suitable for ultimate release via the TETP. Clearly those individual effluents if received into the canal infrastructure untreated could present a number of potential individual risks in relation to the ultimate TETP discharge:

- Chrome VI (Cr) – from plating lines
- Tin (Sn) – from plating lines
- Iron (Fe) – from pickle lines
- Zinc & Miscellaneous heavy metals
- Chloride (Cl) – from acid pickle rinses
- Sulphate (SO_4) – from galvanising acid rinses
- Sodium (Na) - from alkaline degreasers
- Oil and tallow - from rolling effluents
- Low pH - from acid rinses

In addition the works historically added significant quantities of spent pickle acid (low pH, high iron and high chloride liquor) as a chrome reductant reagent and a "general process improving" reagent. In this latter role the reagent reduced any slightly brown discolouration in the treated liquors and improved the settlement rate of the precipitated solids. These acid pickle inputs required ultimate neutralisation and hence increased both the calcium and chloride contents of the effluent leaving the site.

As part of short term measures (see section 5.2.3) a project was initiated to improve the operating practices undertaken at the treatment plant with a view to using less reagents and consequently lowering the salts concentrations (especially the chloride and calcium concentrations) in the effluents sent to TETP and ultimately discharged into the Reitspruit canal. In essence, components in specific effluent inputs were used to assist the treatment of components in other inputs rather than using as much reagent pickle acid and lime.

In addition to the repair and upgrade of specific items of plant, tanks, clarifiers and other pieces of equipment, the site removed the oil contaminated and most of the salts contaminated soil from within and around the plant and then installed a properly compacted clay seal and then a concrete floor with proper bund walls over all the on-going operational areas and effluent storage areas.

The whole area was also re-graded so that at the same time all the new bunding drained by gravity to the former sludge collection and pumping sump. All bund waters (including all rainfall which lands within the bundled area) are now pumped to the CETP process for treatment along with all the other effluents before release to TETP. The bunding has effectively eliminate the potential for untreated effluents from CETP being discharged to either the TETP or to other areas of the site either through leakage or spillage to surface water collection systems, to surrounding ground or via ground seepage.

Additionally the handling and processing of oily effluents is also being upgraded with a view to (1) simplify operations and maintenance by getting as much as possible of the tallow content out of the incoming effluents out before it has a chance to cool down and solidify; (2) reduce the oil content of the product sludge from the neutralisation reactor; and (3) prevent the various surface active agents which are present in these effluents from causing unacceptable interference to the precipitation processes which are used to control the fluoride, the sulphate and the toxic metal content of the finally treated effluent. Ultimately the upgrades seek to minimise the quantities of organics discharged from the CETP whilst maximising oil recovery economies.

Ultimately however the final effluent from CETP is only acceptable for discharge via the TETP because of dilution from other process effluents discharged to the TETP.

CS12 OPEN AREAS / HEAPS

These areas are not applicable to Process Waters Master Plan write up. They will be covered by other OFT team members.

CS13 DAMS 1-4

These areas are not applicable to Process Waters Master Plan write up. They will be covered by other OFT team members.

CS14 NEW WASTE SITE AREA

These areas are not applicable to Process Waters Master Plan write up. They will be covered by other OFT team members.

CS15 OPEN AREAS / HEAPS

Along the northern boundary of this area there is the pipe route for the strong effluents which are pumped from the North Works to the CETP. In addition, the respective strong effluent pipes from South Works follow close to the eastern side of the railway embankment which bounds the western side of this area. It is not unknown (but none the less rare) for one of these strong effluent pipes to rupture, causing the resultant leak to accumulate in the south west corner of the area.

Clearly those individual effluents if received directly into the canal infrastructure could present a number of potential individual risks in relation to the ultimate TETP discharge. In addition there are the issues of ground contamination:

- Chrome VI (Cr) – from plating lines
- Tin (Sn) – from plating lines
- Iron (Fe) – from pickle lines
- Zinc & Miscellaneous heavy metals
- Chloride (Cl) – from acid pickle rinses
- Sulphate (SO_4) – from galvanising acid rinses
- Sodium (Na) - from alkaline degreasers
- Oil and tallow - from rolling effluents
- Low pH - from acid rinses

As part of the Short Term Measures a valved pipe beneath the railway embankment provides a means whereby any such leakage can be pumped to the CETP, followed, as necessary by subsequent decontamination waters, pending the area becoming suitably clean enough for re-connection to the Coke Oven Canal. The operating instructions for the site require that all ongoing drainage of this corner of the site is to be carried out on a check and release basis only and at all times in between any such releases, the valve should be kept closed.

CS16 VAAL DAM PLANT

CS16.1 VAAL DAM WATER CLARIFICATION PLANT

The water quality within the water circuit systems does not pose a risk to the ultimate outflow from the works.

CS16.2 BIOLOGICAL TREATMENT PLANT

Effluent from the coke oven areas is held within the stabilisation dams within this area. The biological plant itself has been shut down. The liquors themselves contain very high organics (especially phenol and ammonia) and high salts contents. The effluents are totally unsuitable for discharge to TETP and hence are utilised within the evaporative function for coke quench.

Once the proposed Coke Oven and gas cleaning upgrade becomes operational (see section IM02 below), then the analyses for these components will improve considerably. However ultimately this effluent must (as per current arrangements) be prevented from leaving the site via the TETP discharge point.

As part of Short Term Measures, the bunding and containment around the bioplant itself was improved to prevent any re-occurrence of the historical spillages that found their way into the Leeuspruit discharge.

CS16.3 DESALINATION PLANT

The plant is now able to operate at almost 60 m^3/hr of total evaporation capacity and now receives its input from the Blast Furnace Slag Granulation Wet Dams (water recirculation dams). These Wet Dams are fed by waters from the BOF, V1, V2, V3, Air Products and the EAF as well as with most of the regeneration effluents from the demineralisation plants that are situated within South Works (the Direct Reduction Plant's demineralisation effluent is still being connected). Clearly this effluent stream will be totally unacceptable for either discharge or leakage into any of the surface water discharge infrastructure. As part of Short Term Measures, the bunding and containment around the desalination plant itself was improved to prevent any re-occurrence of the historical spillages that found their way into the Leeuspruit discharge.

CS17 SUB-STATION AREA

Not applicable to process waters master plan. There are no process water sources in this area.

CS18 OPEN AREAS

Not applicable to process waters master plan. There are no process water sources in this area.

CS19 SIDING AREA

Within this area is the BASF paint mixing and blending facilities. Whilst there are no process effluents associated with this activity, it must be recognised that there is a high risk of surface water and ground contamination associated with the storage and blending of drummed paint ingredients. In addition, should a fire occur, then the resultant fire water and foam (if that is used) will represent a further significant problem to the surface and ground water regimes.

It cannot be stressed too strongly that this area must have a properly arranged and large capacity containment arrangement with a suitable mechanism for containing all the potential fire water which could be used, otherwise these waters could pose an issue to the ground water quality and at the TETP.

CS20 KWAMAMDALA & OPEN AREAS

Not applicable to process waters master plan. There are no process water sources in this area.

CS21 OPEN AREAS

Not applicable to process waters master plan. There are no process water sources in this area.

CS22 CETP SLUDGE DAMS

In this area and the areas down slope of them, excessive amounts of sludges and oils and tallow have been allowed to overflow, ultimately draining through the Vlai areas into the Burns Memorial Canal. Ongoing storm water flows and other discharges will wash these sludges into the canal infrastructure and thereby pose a threat to the TETP discharge limits.

As noted in the section referring to CS10, these deposits support the growth of reeds and other vegetation which brings with it the risk of the deposits being set on fire as a result of a Veld fire.

MM01 REFRACTORY AREA

Not applicable to process waters master plan. There are no process water sources in this area.

MM02 SCRAP AREA

These areas are not applicable to Process Waters Master Plan. They will be covered by other OFT team members.

MM03 PLANT STORE

Not applicable to process waters master plan. There are no process water sources in this area.

MM04 NORTH STORE

Not applicable to process waters master plan. There are no process water sources in this area.

CP01 SOUTH MILLS AREA

The effluents generated from within the South Mills areas fall broadly into two distinct categories: ***Strong Effluents*** and ***Weak Effluents.***

The Strong Effluents are those which need some form of specific and significant treatment process to enable them to be discharged to a water course or sewer. These strong effluents include all the pickling and plating effluents (including the respective rinse waters), the roll coolants and the alkaline degreasing effluents.

The Weak Effluents are those which are derived from essentially clean systems such as cooling tower circuits (where direct contact with potential contaminants is prevented) and final cooling and quenching waters, where the water only contacts clean products.

Within the Hot Mills sequential processing of slabs through reheating furnaces, parallel plate mills and hot strip mills are carried out. Water is primarily used for cooling and temperature control in the hot mill sections. Currently, blow down from the cooling water circuits is, in the main, discharged via the Works effluent canals to the TETP.

The Cold Mills involve sequential and parallel production lines, including:

- pickling line;
- cold rolling;
- alkaline cleaning lines;
- an annealing and tempering line;
- continuous hot dip galvanizing line;
- electrolytic tinning line;
- chrome line (this is a finishing process for tinning and galvanising, not a plating line);
- Cleaning and coating (paint) line.

Water is utilized for a wide range of purposes in the cold mill sections, ranging through pickling, rinsing, cooling, tempering and a range of coating processes, together with chemical make-up and fume control. Effluents are discharged to the Central Effluent Treatment Plant (CETP) and the weak effluents are routed to the TETP.

CP01.1 Q PUMP STATION

Within South Mills, the strong effluents are all accumulated at the Q Pump House or they go direct to their specific outlet (e.g. spent hydrochloric acid to the Lurgi Acid Recovery Plant or oils to the oil reclaim contractors).

Clearly those individual effluents if received directly into the canal infrastructure from either the collection sumps at Q pump house or via individual process area sumps (RPA Drawing 484/LA1093 contained within section 3 of the baseline studies for area CP01.1) could present a number of potential individual risks in relation to the ultimate TETP discharge:

- Chrome VI (Cr) – from plating lines
- Tin (Sn) – from plating lines
- Iron (Fe) – from pickle lines
- Zinc & Miscellaneous heavy metals
- Chloride (Cl) – from acid pickle rinses
- Sulphate (SO_4) – from galvanising acid rinses
- Sodium (Na) - from alkaline degreasers
- Oil and tallow - from rolling effluents
- Low pH - from acid rinses

Note the collection sumps for the strong effluents are large and interconnected (such that excess overflows are cascaded into adjoining sumps of compatible effluent material. The Q pump house system contains numerous pumps and consequently overflow from the strong effluent collection systems into the adjacent surface water drains (which ultimately discharges to TETP) are not likely to occur.

The liquid levels within the strong effluent sumps are believed to be below the adjacent perched water table and hence leakage to groundwater is not thought likely, rather the reverse situation of groundwater entering the sumps is thought more likely [ground water specialists, JMA within the OFT Master Plan team should confirm this view].

As mentioned above Q pump house is also a main hub within the cooling water reticulation system for the majority of the plant areas which are still operating in the South Works Mills areas. It supplies a large variety of applications ranging from oil coolers to gearboxes, the tinning line, the paint line, the 5 stand reduction mill, the pickling line and the galvanizing lines. The system uses Industrial Water for make-up but also receives recycled Vaal Dam water from production and therefore struggles to maintain any kind of concentration cycles and consequently the salts levels within circuit waters remain below TETP licence limits. From time to time it is polluted with oil which occasionally gets past interception facilities and passes directly into the TETP canal infrastructure.

CP01.2 HNX PUMP STATION

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is Industrial Water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters).

CP01.3 PAINT LINE COOLING TOWER

These effluents represent a low salts risk since the feed water to the system is Vaal Dam water and the cooling towers waters are not subject to cycles of concentration. However solvents from the paint lines ensure that this (small volume) effluent blow down stream does contain an appreciable organic content which is ultimately discharged to TETP.

CP01.4 M PUMP STATION (PLATE MILLS SOUTH)

These effluents represent a low salts risk since the feed water to the system is mostly Industrial Water and the waters are not subject to large cycles of concentration. The effluents are discharged to the Candy Treatment Plant (CP01.7).

CP01.5 N3 PUMP STATION (PLATE MILLS SOUTH)

These effluents represent a low salts risk since the feed water to the system is mostly Industrial Water and the waters are not subject to large cycles of concentration. The effluents are discharged to the TETP.

CP01.6 PLATE TREATMENT PLANT WATER SYSTEM

Blow down is routed to the TETP. Suspended matter is controlled by side-stream sand filtration, the back washes from which also go to the TETP. Both of these discharges are currently being arranged to be diverted to the Candy Plant (CP01.7).

Cycles of concentration are maintained at a high level within this system and consequently, irrespective of the long-term water supply, discharges or spillages from this area would pose a risk to the current effluent discharge limits (utilising industrial water as a make up the concentration cycles that are achieved ensure that the blow down exceeds the current allowable discharge limits). This effluent therefore currently relies on the dilution from other process effluents discharged to the TETP in order that overall the discharge limits are not exceeded.

CP01.7 CANDY SOUTH CLARIFICATION PLANT

Suspended solids and oil are removed in the Candy clarification plant with the aid of a flocculant. Sludge is dewatered and transported by rail to the dump. Recovered oil is passed to a contractor for reclamation. Discharges or spillages from this area into the TETP feed canal infrastructure would pose a risk to the current effluent discharge limits due to both the oil content and the high salts load associated with the evaporative circuits.

CP01.8 CONTINUOUS ANNEALING LINE No 1

High quality water is utilised within this spray cooling system. The waters undergo few cycles of concentration and effluents discharged remain well within the current effluent discharge limits at TETP. It is essentially a high grade water that can be reused within other systems as a make-up water without treatment. Actions are underway to recover this water for re-use in adjacent processes.

CP01.9 ELECTRO-TINNING PRODUCT QUENCH & RINSING

High quality water is used in this counter current washing and product cooling system. Very little evaporation takes place and other than the pick up of traces of chrome (at concentrations below 1ppm derived from the coating finishing processes) the final effluent will be equivalent to the high quality water used in the process. This large volumetric flow (~186 m^3/hr) of essentially clean water is currently discharged to the TETP canal infrastructure. Effluents discharged remain well within the current effluent discharge limits at TETP. Indeed it acts as a major diluent for other effluents arriving at TETP. Actions are underway to recover this water for re-use in adjacent processes.

CP02 VANTEX

Not applicable to process waters master plan. There are no process water sources in this area.

CP03 OPEN AREA

Not applicable to process waters master plan. There are no process water sources in this area.

CP04 PVA PLANT

Not applicable to process waters master plan. There are no process water sources in this area.

UP01 NORTH MILLS

The effluents generated from within the North Mills areas fall broadly into two distinct categories: ***Strong Effluents*** and ***Weak Effluents*** in a manner analogous to the situation set out in section CP01 for the South Mills.

The Strong Effluents are those which need some form of specific and significant treatment process to enable them to be discharged to a water course or sewer. These strong effluents include all the pickling and plating effluents (including the respective rinse waters) the roll coolants and the alkaline degreasing effluents.

The Weak Effluents are those which are derived from essentially clean systems such as cooling tower circuits (where direct contact with the potential contaminants is prevented) and final cooling and quenching waters, where the water only contacts clean products.

Within the Hot Mills sequential processing of slabs through reheating furnaces, parallel plate mills and hot strip mills is carried out. Water is primarily used for cooling and temperature control in the hot mill sections. Currently, blow down from the cooling water circuits is, discharged via the North Works blow down canals to the TETP.

The Cold Mills North involve sequential and parallel production lines, including:

- Pickling line
- Cold rolling
- Annealing and tempering line
- Electrolytic galvanizing line

Water is utilized for a wide range of purposes in the cold mill sections, ranging from steel washing and cleaning using different pickling processes, chemical make-up and application of the different metal and paint coatings. Effluent is discharged to the Central Effluent Treatment Plant (CETP).

UP01.1 INDUSTRIAL PUMP STATION

There is high oil contamination in the cooling water due to a leaking heat exchanger. A side stream pressure sand filter is available but currently not in use because of the oil contamination. Make-up and blowdown is controlled manually. The system usually has sufficient leaks and other losses such that no formal blowdown is required. Should water need to be bled-off the water will flow via the North Works blow down canal to the Terminal Effluent Treatment Plant (TETP).

Should the sand filter be used the backwash water will also go to TETP via this same canal. Cycles of concentrations are low due to the relatively high circuit losses and consequently the salts concentrations within the blow downs and leaks are low.

UP01.2 REHEAT FURNACE NO. 1, 2 AND 3

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

UP01.3 REHEAT FURNACE NO. 4

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

UP01.4 PIRO SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

UP01.5 CANDY NORTH CLARIFICATION PLANT

Water is circulated from the cold water sump to the various processes and returns to the three eastern scale pits and to the two western scale pits. In the scale pits, primary clarification takes place where scale/sludge are mechanically removed. In each scale pit a belt skimmer is installed to remove floating oil. The oil is collected in a tank and removed by a contractor for reclaim. Oil and roll bite lubricants are present in varying concentrations and thus leakages from this system pose a risk to the outflow at TETP. Note there is no routine blow down to TETP from this system.

UP01.6 COLD MILL NO. 1 PUMP STATION

UP01.6.1 COOLING SYSTEM

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

UP01.6.2 EFFLUENT PUMP STATION

These pumps pump effluent to the Central Effluent Treatment Plant. Acidic effluent originates from the rinse station on the Continuous Pickling Line number 3 and os mixture of alkaline and oily effluent originates from the 5 Stand cold rolling process, from Tempermill No. 4, from No. 3 & 4 shearlines and the Galvanising line number 4.

Within North Mills, the strong effluents are all accumulated at the No1 Pump House or they go direct to their specific outlet (e.g. spent hydrochloric acid to the Lurgi Acid Recovery Plant or oils to the oil reclaim contractors).

Clearly those individual effluents if received directly into the canal infrastructure from either the collection sumps at No1 Pump House or via individual process area sumps (RPA Drawing 484/LA1094 contained within section 3 of the baseline studies for area UP01.6.2) could present a number of potential individual risks in relation to the ultimate TETP discharge:

- Iron (Fe) – from pickle lines
- Chloride (Cl) – from acid pickle rinses
- Sodium (Na) - from alkaline degreasers
- Oil - from rolling effluents
- Low pH - from acid rinses and pickle acids

Note the collection sumps for the strong effluents are large and interconnected (such that excess overflows are cascaded into adjoining sumps of compatible effluent material). Overflow from the strong effluent collection systems into the adjacent surface water drains (which ultimately discharges to TETP) are not likely to occur although it remains a low possibility.

The liquid levels within the strong effluent sumps are believed to be below the adjacent perched water table and hence leakage to groundwater is not thought likely, rather the reverse situation of groundwater entering the sumps is thought more likely [ground water specialists, JMA within the OFT Master Plan team should confirm this view].

UP01.7 COLD MILL NO. 2 PUMP STATION

This pump station supplies recirculating cooling water to the 5 Stand rolling mill, the Batch annealing furnaces and Galvanising line number 4. Cooling tower make-up is from the clarified Vaal Dam water supply. Blow down goes to the TETP.

Due to losses, the system make-up rate is usually very high. Presently there is a high volume of additional water from the Galvanising Line number 4 quench tanks entering the system, which causes low cycles, no make-up and a continuous overflow to the drain. The salts loads of these effluents is generally low (less than the acceptable TETP discharge limit), however, oil contamination within these circuits do pose an issue with regard to an acceptable TETP discharge.

UP01.8 ELECTRO GALVANISING LINE (EGL)

The cooling tower system at the EGL treatment plant recirculates cooling water to the EGL production line and (at the time of the commencement of the Master Plant Studies) to evaporator plant condensers. However, as part of the Short Term Measures at the CETP the EGL effluent was diverted untreated to the CETP and the local caustic based neutralisation plant and evaporator were shut down. This not only saved operating costs but it also prevented the frequent spillages and other problems which resulted from the unreliability of this plant. Since the installation of this pumped system, the non compliance issues at the TETP which used to originate from spillages and failures at the former EGL treatment plant have been stopped entirely.

Note the cooling tower blow down effluent into the canal infrastructure is of an acceptable quality for the TETP discharge limits.

Strong effluents from the electro-galvanising line are now pumped direct to CETP for treatment. Clearly these effluents if received directly into the canal infrastructure from either the collection sumps at No4 Galvanising Line or the transfer sumps at the now redundant EGL treatment plant (RPA Drawing 484/LA1094 contained within section 3 of the baseline studies for area UP01.6.2) could present a number of potential individual risks in relation to the ultimate TETP discharge:

- Zinc & Chrome from galvanising lines
- Sulphate (SO_4) – from galvanising acid rinses
- Low pH - from acid rinses

UP01.9 CONTINUOUS ANNEALING LINE # 2

Cooling tower make-up is from the clarified Vaal Dam water supply. Blow down is pumped to the effluent pits from where it goes to the TETP via the North Works Blow Down Canal. Normally no blow down is necessary because of the high level of losses from the system. Consequently the effluent qualities remain high and these effluents represent a low risk in relation to the TETP discharge limits.

IM01 BLAST FURNACES

IM01.1 BLAST FURNACES

IM01.1.1 BF SLAG GRANULATION PROCESSING

The system make-up water is (as a result of the Short Term Measures) from the BOF off-gases scrubber system (SM02.1.5), with industrial water as a back up. Hence the same identified risks regarding non-collected spillages and leaks as described above in SM02.1.5 applies in this instance. It should be noted that until quite recently the leakages around slag granulation have presented obstacles to this system providing a reliable improvement to the Reitkuilspruit discharge analysis. However recent operating experience has seen reliable performance.

IM01.1.2 BF GAS TREATMENT

The water flow generated from the BF gas scrubbing stage contains suspended solids (e.g. carbon and heavy metals), cyanide compounds, salts and ammonia, this water is treated locally (heavy metal precipitation), cooled and recycled to the scrubber. These effluents are not suitable for discharge through the TETP infrastructure and would pose a risk to the current effluent discharge limits if leakages within this area were present to any significant degree.

At IVDBS, the combined purge (from both blast furnaces ~ 15m^3/hr) is routed to the system which feeds the coke quenching facilities (see section IMO2.1.2 and CS16).

IM01.1.3 BLAST FURNACE OPEN COOLING SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Industrial water or blow down water from the Blower House System normally provides the total flow of make-up water into the Blast Furnace open system. The cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into canal infrastructure to TETP.

IM01.1.4 BLAST FURNACE CLOSED COOLING SYSTEMS

The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

IM01.1.5 SHAFT COOLING SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration (although typically still within the current effluent discharge parameters). Ultimately the effluent is discharged into Blast Furnace open system.

IM01.1.6 BLAST FURNACE D OPEN SYSTEM

These effluents represent a low risk dependent upon the feed liquor fed to the system. Currently this is industrial water and the cooling towers waters undergo cycles of concentration such that they are just beyond the current effluent discharge limits. Ultimately the effluent is discharged into TETP. This effluent therefore currently relies on the dilution from other process effluents discharged to the TETP in order that overall the discharge restrictions are not exceeded.

IM01.1.7 PCI CLOSED & OPEN COOLING WATER SYSTEMS

The water quality within the cooling circuit systems does not pose a risk to the outflow from the works.

IM02 COKE PLANT

IM02.1 COKE OVEN AREA

IM02.1.1 COKE OVENS COOLING WATER SYSTEMS

Industrial Water is currently used on all the coke-oven systems as make-up water. Due to the nature of the surrounding environment and process leaks, there is a potential for changes in pH of the water and for organic and ammonia contamination.

The system blow down is currently to the Terminal Effluent Treatment Plant. Cycles of concentration are maintained at reasonably high levels and together with the leakage of ammonia and organics into the cooling systems the discharges or spillages from this area would pose a risk to the current effluent discharge limits. This effluent therefore currently relies on the dilution from other process effluents discharged to the TETP in order that the overall discharge limits are not exceeded.

IM02.1.2 COKE PUSHING AND QUENCHING

The coke quenching car transports the hot coke to a quenching tower where the coke is quenched directly by large volumes of water. The water that does not evaporate is collected and is re-used for quenching the next batch, thus preventing wastewater emissions. Currently the feed liquors are derived from those effluents collected at the bio-plant inlet dams. The liquors themselves contain high organics (especially phenol and ammonia) and high salts contents. The effluents are totally unsuitable for discharge to TETP and hence are utilised within the evaporative function for coke quench. Any leakage or spillage would pose a risk to the TETP discharge license limitations.

At present, there is no routine outlet for the dissolved salts and other components which accumulate in the coke quenching waters, other than within the pore water in the coke and as crystals on the surface of the coke. There are occasional discharges to the Coke Oven area bunding arrangements, but these recycle all collected waters ultimately back to the Coke Quench.

Recent developments at each of the four Coke Quench facilities have achieved a particular sequential quenching action which ensures a very low pore water content in the product coke. This in turn ensures minimal (effectively zero) ongoing drainage from the product coke as it is conveyed to the Blast Furnaces and to the Sinter. A previous significant source of ground and surface water contamination has therefore been effectively eliminated.

In addition to the above, extensive bunding and containment infrastructures have been installed in and around the Coke Quenching, the coke rail car route and the handling facilities which receive and drain the fine coke which is routinely dredged from the coke quench recycle sump. These all drain back to the recycle sump.

Finally, each coke quenching tower has been fitted with a specially designed spray and mist eliminating hood which has stopped circa 90% plus of the droplet carry over from these quench stations onto the surrounding land, plant and buildings.

It is recognised that routing high ammonia and phenol effluents to coke quench transfers an effluent problem into an air emissions problem. However, once the proposed Coke Oven and gas cleaning upgrade becomes operational (see section IM02.1.3 below), then the analyses for these components will improve considerably. However ultimately this effluent must (as per current arrangements) be prevented from leaving the site via the TETP discharge point.

Note as part of the Master Plan achievement of ZED the coke quench will be fed with pre-concentrated liquors from the MTP circuits which will then be purged from the coke quench prior to final evaporation. These liquors will not contain the high ammonia and phenol contents.

IM02.1.3 COLLECTION AND TREATMENT OF COKE OVEN GAS (COG) WITH RECOVERY OF BY-PRODUCTS

As this hot gas leaves the coke oven chambers it is adiabatically quench cooled with a recycled water stream. This part cooled raw coke oven gas is then further cooled, creating a liquid condensate stream and a cool gas stream. The functions of the by-product plant are to take these two streams from the coke ovens, to process them to recover by-product coal derived chemicals and to condition the gas so that it can be used as a fuel gas. The main emphasis of the coke by-product plant is to treat the coke oven gas sufficiently so that it can be used as a clean and environmentally friendly fuel.

The ammonia formed during coking appears in both the coke oven gas and the condensate (coal water or flushing liquor) from the gas. At Vanderbijlpark the ammonia is removed from the coke oven gas using an NH_3/H_2S scrubbing circuit. In this process, the ammonia is scrubbed from the coke oven gas using water as a scrubbing liquid. The effluent from the ammonia scrubber is used as a scrubbing liquor in the H_2S scrubber. The effluent from the H_2S scrubber contains H_2S and NH_3 and is led to the ammonia stripper and still. Most of the ammonia is currently recovered as ammonium sulphate, but in the future, the proposal is for it to be converted to nitrogen gas and steam within the proposed elemental sulphur plant.

None of the effluents generated within the coke oven gas system are suitable for discharge to the TETP and any leakage into the canal infrastructure leading to the TETP would pose considerable difficulties in meeting the overall site discharge limits. Key environmental issues are: high ammonia contents, high organics (especially phenol) and high dissolved salts contents. Currently these effluents are routed via the bio-plant storage facilities to coke quench.

As a result of the proposed upgrades to the Coke Oven Area and the Gas Cleaning Processes, the following essential features will result.

a) The product (cleaned) coal gas will have a low sulphur content, a low ammonia content, a low moisture content and a low naphthalene content. All this means a much cleaner burning gas which can be used by many more on-site gas users, thereby reducing the amount of gas which is wasted by flaring and reducing the import of Sasol Gas to the site.
b) Proper operation of the "free ammonia" strippers such that all the stripped ammonia and H_2S scrubbing waters can be recycled. This will approximately halve the current effluent production.
c) Proper operation of the "fixed ammonia" strippers such that all the flushing liquor and all the collected bund and spillage waters will be stripped effectively free of ammonia, H_2S, other sulphur compounds and volatile organics. The cyanide content should also be mostly removed. This will enable this water to be utilised as a make up water for Blast Furnace Gas Cleaning and for other uses.
d) As a result, all the current sources of effluent in the Coke Oven and By Products area will either not be produced or they will be in a form that can be used by other parts of the site instead of using raw water.
e) The whole of the coke quenching function can therefore be supplied by a suitable inorganics only containing water source. This will create a major reduction in the quantity of sulphur, ammonia and organic emissions that are released from the coke quench stations.

f) In the event of a major accumulation or other form of production of coke oven and by-products area derived bund, spillage or flushing water, which exceeds the capability of the "fixed ammonia" strippers, the proposed routing of these effluents via upgraded gravel filters (both quality and capacity) will enable these waters to be used "as is" at the Blast Furnaces, thereby enabling some or all of the stripped water to be added in a controlled way to the remainder of the MTP infrastructure. Once the particular surge in volume of "fixed ammonia" has been processed away then normal operation as in d) above can be restored.

Overall, therefore, the relatively minor re-directing of the central thrust of the Coke Oven Area upgrade and Gas Cleaning Project that has resulted from RPA's Master Plan and ZED (Zero Effluent Discharge) related work, in conjunction with the specific focussing of the already completed bunding and spill containment works has achieved a situation where the Coke Oven area will become a net effluent user (for coke quench) and a supplier of suitable quality water to other process users (Blast Furnace Gas Cleaning).

IM03 SINTER PLANT

IM03.1 SINTER PLANT

IM03.1.1 SINTER PLANT COOLING WATER

At IVDBS, approximately 200 m^3/hr of Industrial Water is taken from the Industrial Water Main, put through the various cooling coils and jackets and then pumped back into the Industrial Water Main. This slightly warmed water goes on to supply the various cooling towers within the Coke Oven and Coal Gas Cleaning areas and the Blast Furnaces and compressor areas. The water quality within the closed cooling circuit systems does not pose a risk to the outflow from the works.

IM03.1.2 SINTER PLANT GAS TREATMENT

This is not yet applicable, although when the proposed wet scrubbing system is introduced then this effluent stream would not be suitable for discharge through the TETP under the existing license. It is predicted that the effluent would contain very high salts loads and organics loads (especially chlorides and potassium plus ammonia if, as intended, blast furnace scrubber effluents are utilised as make-up water).

IM04 STACKING AND RECLAIMING OF RAW MATERIALS

This area is not applicable to Process Waters Master Plan. It will be covered by other OFT team members.

IM05 VELD COKE AREA

This area is not applicable to Process Waters Master Plan. It will be covered by other OFT team members.

IC01 SUPRACHEM

Within the Suprachem Area, the tar and benzole products from the Coal Gas Cleaning process areas are processed to create valuable by-products for sale. Most of the processes within Suprachem are distillation or solvent extraction based processes. As a result, the aqueous process effluents that are created are steam condensates from product heaters, aqueous condensates from distillation or separated aqueous fractions.

Prior to the Short Term Measures, all these process effluents together with general process area drainage and roof and other clean area drainage was all mixed and accumulated in sumps on site. During dry weather conditions, most of this mixed effluent was returned to the main tar separators in the Coal Gas Cleaning area. From here, the water content was pumped to the Bio-Plant inlet dams and the tar and oil content was combined with further tar from the Coal Gas Cleaning processes and returned to Suprachem. During rain events the capacity of this system was soon overwhelmed and discharges to Dam 10 started. When the capacity of this pipe was exceeded (which was a quite frequent occurrence) then the remainder overflowed to the Coke Oven Canal which was then pumped to Dam 10.

As part of the Short Term Measures and the ongoing bunding and containment programme for the whole of the Coke Oven and Coal Gas Cleaning areas, all the process parts of the Suprachem area were bunded and contained (refer to section 5.2.5 and section CS05.2 above). Also, all the roof and clean area drainage was separately collected and directed to the Coke Oven Canal. Finally, the pumping and other systems capacities for containing without overflow and for removing storm water from the bunded and contained areas were increased such that all overflows to Dam 10 and to the Coke Oven Canal were stopped. The new HDPE pipeline which was designed to handle all potential spillages and bund, etc drainage from the Coal Gas Cleaning areas was connected to the Suprachem System so as to assist this process.

The flow of all effluents to this system from Suprachem are metered, as are all tar and other inputs from the Coke Oven Area to Suprachem. There is now a properly controlled and accounted system between the two process areas and as part of that activity, the ongoing operation and maintenance of the tar separator is now the responsibility of Suprachem.

These effluents are highly variable in nature but are characterised by high organics and ammonia contents rendering them a risk to the final effluent arrangements at the TETP should the Coke Oven Area Sump return arrangements fail.

CO01 SECONDARY INDUSTRIES

The blow down from Air Products contains components which can assist the process chemistry at the BOE and at EAF slag cooling (refer to section SM02.1.5). Pipework and pump infrastructures have been put in place to add this into the above referred infrastructure between the EAF and the BOF. As a result all the system blow downs are to this infrastructure. Cycles of concentration are maintained at a high level within this system and consequently, irrespective of the long-term water supply, discharges or spillages from this area would pose a risk to the current effluent discharge limits.

5. MANAGEMENT OF FACILITIES

This section of the Process Waters Report sets out how the data which is presented in Section 3 and the risk assessment referred to in Section 4 have been evolved into an overall Process Waters Master Plan Strategy for the site as a whole. In addition, it will show how this overall Process Waters Master Plan can be achieved through the "Stepping Stones" of the Short Term Measures and the ZED 2005 proposals.

5.1 THE EVOLUTION OF THE PROCESS WATERS MASTER PLAN CONCEPTS

5.1.1 THE TECHNICAL APPROACH

In order to reach the ultimate Master Plan status, it is necessary to evolve a method of collecting, treating and re-using all of the following:

- All process effluents (both the weak effluents and the strong effluents)
- All the contaminated ground water
- All the contaminated surface water
- All spillages and leaks
- All leachates and seepages from the dump, from the dams and from stock piles
- All the contaminated waters currently stored in dams, lagoons or tanks.

As a first step in the overall Master Plan Process, all the different effluents from the different production units were characterised. This characterisation included:-

- the source location;
- the nature and variability of the production process;
- the water and reagent quality used in that production process;
- the variability in flow and quality of each effluent during normal production and during power outage, maintenance or other non-normal situation;
- the potential for changes to that production process, either now or in the future;
- what significant changes have occurred over recent years, if any;
- what was the nature and status of any existing treatment facilities for these effluents either at source or elsewhere on the site;
- what was the current discharge/outlet arrangement or route;
- and what was the quality criteria or other determinant which required the liquor to be discharged, purged or blown down as an effluent.

In addition, the current water usage arrangements around the site were examined relative to the quality and quantity of water which could be used by each user, if such a quality were available.

5.1.2 THE INITIAL QUALITATIVE FINDINGS

As a result of this approach, a picture emerged of strong process effluents all being handled by specific plants or infrastructures on the site and weak effluents being discharged by various canal infrastructures to the TETP.

The Strong Process Effluents

	Issues
Inputs to the CETP	340 m^3/hr average
• Acid rinses	HCl, H_2SO_4, Fe
• Plating effluents	Cl, Cr, Sn, Zn, F
• Oil-water	Mineral Oils, Tallow
• Alkaline cleaners	Emulsifiers and oils
Spent Pickle liquor	
- Mostly Recovered at Lurgi plant for re-use	Current Practice
- Some used as a reagent at Sinter and CETP	Current Practice
- Rest is sold	Current Practice
Coke Oven area Effluents	All will be re-used
Ion Exchange and Softener Regeneration Effluents	
- go to existing Desalination Plant (DR's being re-routed/shut down)	Current Practice

The Other Process Effluents

Source	Issues
Treated Effluent from CETP	TDS Ca, SO_4, F, Cl, Fe, Mn
Cooling Tower Blow Downs and Sand Filter Back Washes	TDS, SO_4
Rolling Mill Quenches and Circuit Leaks	Volume, Temperature
Boiler Blow Down	PO_4, Temperature
Slag Granulation (drainage)	TDS, SO_4, F, Cl, Ca
Raw Water Treatment	Suspended Solids
North Works	Minor Only
Area Wash Downs (mainly DR)	Suspended Solids

A small number of relatively minor discharges from processes (mainly cooling towers and wash down) to the storm water systems were identified at North Works. These were at variance with the effectively 100% separation at North Works of all process related discharges from the storm water catchment and drainage infrastructure.

At South Works, almost all weak effluents were discharged to the same infrastructure as that for storm water and there were many areas where there was inadequate means for containing process spillages or leakages. In addition, there were relatively few options for returning any spillages or leaks to process or for routing them separately to appropriate disposal. Within the Coke Oven area, the Coal Gas Cleaning area, the By-Products area and the Suprachem area, this inadequacy of containment had resulted in the whole of the drainage and all of the storm water from the whole of the combined area being routed to Dam 10 so as to prevent any spillages or leaks from reaching the RietSpruit.

Water quality records for each drainage canal and from the outlet of the TETP were examined relative to Exemption 1998B and relative to the assembled information. It was clear that "spikes" or other short duration surges in TDS, F, SO_4, Na, Zn, Mn, (NO_3+NO_2), Fe and Cl were causing frequent compliance issues and that TDS, F, SO_4, Na, Mn Fe and Cl were also routinely at or about the compliance limits. In addition, the criteria for chloride was due to change in January 2002 from 350 mg/litre to 250 mg/litre.

Short Term Measures were evolved to address these problems and to achieve a Zero Effluent Discharge for the eastern side of the site into the LeeuSpruit.

5.1.3 THE SHORT TERM MEASURES

These Short Term Measures will be reviewed in detail in Section 5.2, but, in summary they consisted of:-

- Containment walls and bunds together with a sump and pump arrangement at the South East corner of the Steelserv scrap steel and slag handling area, which returned all the surface waters from this area to the BOF (Basic Oxygen Furnace) as part of its necessary make up water.
- Full integration of the water circuits between the BOF, and the Continuous Castors V1 and V2 so as to achieve optimum cascading of water usage from the highest quality type of use to the lowest quality. This system also reduced fluoride levels within the combined system thereby reducing the quantity of blow down that was needed.
- Creation of an effluent and blow down collection main which collected all the effluents and blow downs from the BOF, V1, V2 the Electric Arc Furnace (EAF), EAF Slag Cooling, Air Products and V3 and routed them to the Blast Furnace Slag Granulation area to form the primary water source for Slag Granulation.
- Containing the Slag Granulation water circuits and minimising all inputs of raw water to those circuits (which were mainly from pump seals).
- Restoring the Desalination Plant to its original design capacity. (Note the Desalination plant's original design capacity was sized on the basis of handling the regeneration effluents from all the ion exchange units at the site when they treated only Vaal River Water. Thus when the main turbines failed a few years previously (circa 1997), rather than replacing them, an alternative repair option was selected so as to provide enough capacity on the basis that Vaal Dam Water would be fed to the ion exchange units)
- Purging the Slag Granulation System to the fully restored Desalination Plant whilst keeping the ion exchange units connected to the Vaal Dam Supply.

- Changes to the CETP, primarily to reduce chloride to the new limit, to reduce Ca, F, Mn and Fe slightly and to reduce the frequency and size of surges in the outlet concentrations for each of these components. In addition the CETP Area was properly bunded to prevent leakages of strong effluents and to contain spillages.
- Direct the effluent from the Electrolytic Zinc Process away from the small and dedicated treatment plant at the source and route it to the CETP. This was for two reasons:-

    a) the local plant was about to undergo extensive repairs and upgrades in order to counter the effects of corrosion.
    b) The extra sulphate at CETP would help to reduce the chemical precipitation problems at the CETP resulting from the soaps and other sequestering agents that were present mostly in the effluents from the rolling processes.

- Rearrangement of the canal entry arrangements into the North and South Storm Water Buffer Storage Dams at the TETP so as to exploit their maximum potential for catching and holding "first flush" waters during each rainfall event and for catching and holding any process spillage or other mishaps which could occur within South Works or which could come down the North Works Blow Down Canal.
- Redirecting the few storm water connections for Process effluent, wash downs or spillages that had been found at North Works back to process or to the North Works Blow Down Canal.
- Extending, deepening, concrete lining and increasing the capacity of the Burns Memorial Canal so that it was able to catch and re-direct all storm waters from the east and north of the canal away from Dam 10.

The oil and tallow content of many of the inputs to the CETP meant that the Short Term Measures at the CETP could never provide a complete solution. The oil and tallow based problems are being progressively overcome using a combination of actions at source and by further upgrades at the CETP.

5.1.4 THE OUTCOME OF THE SHORT TERM MEASURES AND A SUMMARY OF THE FOLLOW ON ACTIVITIES

Following on from the immediate Short Term Measures, drainage and spill control within the Coke Oven, Coal Gas Cleaning and By-Products Areas have been extensively upgraded. All this water is now returned to process as a substitute for raw water in many of the processes. The processes themselves are also undergoing a major re-fit and upgrade. The maintenance, repair and detailed design and tendering aspects of this are underway. The remainder awaits the outcome of the EIA processes.

As a result, this whole area is changing from being a major source of effluent into a potentially significant user of contaminated waters. In addition, once all this upgrade is completed and the proposed arrangements for cleaning the Off-Gases from the Sinter are completed, there will no longer be a need to treat any organically contaminated waters (they will all be re-used in the form that they are produced or they will not be produced at all).

As a result of all the above works, together with the upgrades to the Burns Memorial Canal, all process and surface derived inputs to Dam 10 have been stopped. The only current inputs to Dam 10 are rainfall landing directly on the Dam and return water from the leakage collection system.

A further outcome is that there is no longer a need to evaporate water at the Maturation Dams. Pipework infrastructure changes have been introduced which enable water from the Maturation Dams to be returned to process as a substitute for Industrial Water.

With the cessation of all inputs to Dam 10, the only ongoing input to Dams 1 to 4 will be from the Du Preez Catchment.

The Short Term Measures whereby effluents from the Continuous Casters, the BOF and the EAF are routed through Slag Granulation to the upgraded Desalination Plant are now operational. The pipe installation to the Desalination Plant was delayed because of essential safety work on parts of the site's Gas Main which shares the same route.

In addition to the pipe routing and the cascading of usage of the waters through Slag Granulation, the control of drainage waters from the product slag has been a major area of study. Any of this slag which remains in contact with water will over a period of a few weeks set like concrete. These studies have resulted in the development of a practical and easily maintainable drainage system for the slag so that only fully or almost fully drained slag is removed from the granulation processes. Installation of these drainage arrangements is almost complete.

The Process Design for ZED has been completed. This is enabling all the final and detailed integration issues to be confirmed with the rest of the Master Plan proposals and for all the essential "What If" scenarios to be finally confirmed.

5.1.5 THE QUANTATIVE FINDINGS

As a result of the initial findings and the data which became available prior to and as part of the Short Term Measures and the follow on measures, the following summarised picture emerged as regards the principal sources of the inorganic contaminants which are currently discharged into the Rietkeilspruit.

i. Chlorides

1999/2000 average 360 mg/litre

The principal sources of chlorides are

- CETP (as a result, primarily of acid rinse waters from North Works and to a lesser extent the stannous effluent from South Works).
- Cooling Towers
- Other open circuit cooling, quenching and granulation circuits.
- Blast Furnace Off-gas Scrubber Units
- Ion exchange and softener regeneration (especially the DR ion exchange unit)

- Leakage from Dam 10 into below ground cable and conveyor ducts which are pumped/drained to the Drainage Canals.

ii. Sulphates

1999/2000 average 325mg/litre

The principal sources of sulphates are

- CETP (principally from South Works acid rinse)
- EAF Slag Cooling
- Steelserv area South East
- BOF
- Air Products
- Ammonium sulphate plant at the Coal Gas Cleaning Area
- Cooling Towers and other open circuit cooling and quenching circuits.
- Electrolytic galvanising line (which is now routed to the CETP)
- Leakage from Dam 10 into below ground cable and conveyor ducts which are pumped/drained to the Drainage Canals.

iii. Sodium

1999/2000 average 140mg/litre

The principle sources of sodium are

- Heckett area South East
- BOF
- Cooling Towers and other open circuit cooling and quenching circuits.
- Ion exchange and softener regeneration
- Electrolytic galvanising line (which is now routed to the CETP)

iv Manganese

1999/2000 average 0.7mg/litre

The principal sources of manganese are

- CETP sludge dams
- Bums Memorial Canal (mostly from CETP sludge)
- BOF off-gas cleaning blow down

v. Nitrates and Nitrites

1999/2000 average 4.5mg/litre, but very variable.

The principal routine source has been identified as metal cutting fluids used within the Cold Mills.

vi. Ammonia

1999/2000 average 7mg/litre, but this is quite variable.

The principal sources for ammonia are

- Ammonium Sulphate Plant at the Coal Gas Cleaning Area
- Coke ovens and Coal Gas cleaning
- Blast Furnace Off-gas scrubber units
- Condensate from Coal Gas distribution

vii Fluorides

1999/2000 average 2.5 to 3 mg/litre, also variable.

The principal sources for fluorides are

- CÉTP (mainly from the Stannous and DWI effluents from South Works)
- Concasts V1, V2 and V3
- BOF
- Steelserv area (South East)

viii Total Dissolved Solids

1999/2000 average 1500 µs/cm

The principal source is the CETP and leakages from Blast Furnace Slag Granulation.

In addition, the following overview picture emerged as to the current water usage on the site.

TABLE 5.1.5.1 Current Site Water Usage

	(rounded averages, m^3/hr)
Total Intake (Vaal Dam + Vaal River)	2600 – 2700
Total Process Output	1200 – 1300
Evaporation and Quenching	1400
- which is made up of	
Steam (which is not recycled as condensate)	300
Off Gases cleaning and Quench	circa 100
Coke Quench	130
Slag Quench	40
Pore Water (in coke and slag)	< 50
Cooling Towers and metal quench	circa 800
Leakages from Cooling Systems	Vary
- but the leakages are almost entirely to process or to process blow downs	

Clearly, about half of the water which is received by the site is evaporated or removed as pore water with the products. In fact, almost all of this usage is lost as vapour.

Much of the water that is evaporated needs to be supplied to the evaporation mechanisms (e.g. steam raising boilers) as a high quality water, but a significant proportion does not. The evaporation areas which do not need such a high quality of make up water would include gas cleaning, quenching, pore water and many of the cooling towers (especially those within the coke oven area and the iron and steel making areas).

Providing these lower quality water users could be supplied with a water which could be cycled up in concentration by about two or three times without adverse effects on the respective user system, (i.e. by about the same amount as can be achieved with the existing Industrial Water Supply) then there would be little or no difference encountered by that user if such a lower quality water were supplied to that user rather than the current water supply.

The concept therefore arose of taking some of the existing process effluent and treating it appropriately such that it would satisfy the above criteria for re-use at these lower grade users. An assessment was therefore made as to how much of such a water could be used on the site, assuming it could be evaporated to a minimum of three times its feed strength without causing scaling or unduly difficult to control corrosion potentials.

5.1.6 WATER MAKE UP RATES FOR COOLING TOWERS, QUENCH SYSTEMS AND OTHER USERS WHICH WOULD BE ABLE TO UTILISE A SUITABLY TREATED EFFLUENT WATER.

The following data was assembled predominantly from the outsourcing tender enquiry document that was used for the outsourced treatment and management of all the cooling, quenching and other systems at the IVDBS site. The data that is presented represents averaged data which has been accumulated from meter readings and properly quantified mass balances over many years and where necessary has been updated to reflect recent plant and/or production changes. Other data sources and measurements have also been used, where available, in order to confirm the validity of the tender enquiry document data.

The water usage figures are particularly prone to apparent error where leakage occurs either from the relevant system to process or from process to the system. Usually, these leaks are from a cleaner and usually closed loop system. As a result, make up rates to each process area will vary with time. The use of average values and the acceptance of data for one plant item which is apparently at variance with its similar neighbour is therefore seen as a means of defining "likely average real world operating conditions" rather than "as they should be" conditions.

Data presented in brackets in the following tables is an RPA estimate of the expected water usage that will occur when the proposed 20% increase in coke production is achieved. This increase is scheduled to occur before 2005. In estimating this extra, it has been assumed that the extra coke production will be achieved more as a result of coal quality changes and less as a result of increases in coal gas production rates.

The proportion of the feed water which is evaporated has been estimated both on the basis of the operating standards for concentration cycles and also on the basis of the actual average circuit water analyses and feed water analyses.

TABLE 5.1.6.1 Water Make Up, Evaporation and blow Down Rates.

	Make up m³/hr	**Expected average evaporation m³/hr**	**Expected average blow down m³/hr**
Coke Oven Area Cooling Towers			
Cooling Towers 1 and 2	40		
Cooling Tower 3	24		
Cooling Tower 4	13		
Cooling Tower 6 and 7	55		
Cooling Tower 8 and 9	36		
	168	**110**	**58**
Likely situation as a result of coal gas cleaning project	190	125	65
Likely further situation as a result of 20% more coke production	(190)	(125)	(65)
Data agrees with historic water allocation data.			
Blast Furnaces			
Open Cooling system (C and D)	55		
Shaft cooling	<1		
Mould Foundry open cooling	1.2		
D Furnace open system	0.4		
D Furnace gas scrubbing	27		
C Furnace gas scrubbing	27		
	111	**80**	**31**
Data agrees with historic allocation data, except for gas scrubbing where 40 m³/hr is reported for C Furnace and 30 m³/hr for D Furnace. In view of the proposed changes to the operation of the dewatering facilities in these circuits the proposed rebuild and expansion of D Furnace and the potential future closure of C Furnace, the totals from the Tender data will be used.			
Blower Houses			
Blower House East (Tender data)	175	120	55
Blower House West (Tender data)	3	2	1
Total for Tender	**178**	**122**	**56**
Historic Water Allocation data (total)	222	154	68
In the light of the improvements being made in the Blower House, the totals from the Tender data will be used.			
BOF			
Miscellaneous cooling circuit (Tender data)	25		
Top Cone cooling (Tender data)	16		
Main open Cooling (Tender data)	2.5		
Gas scrubber (Tender data)	25		

	Make up m³/hr	**Expected average evaporation m³/hr**	**Expected average blow down m³/hr**
	68.5	**50**	**18.5**
This Data generally agrees with the historic water supply data, except that gas scrubbing usually takes up to 50m³/hr. In view of the system for filling this circuit from the SteelServ sump, a usage of MTP produced water, as above will be assumed.			
Arc Furnace			
Main Open Cooling	76		
Transformer open cooling	10		
VAD cooling	Small		
	86	**61**	**25**
Other separately measured data and historic water supply data generally agrees with this assessment.			
Continuous Casting V1/V2			
V2 closed secondary cooling (Tender data)	15		
Open cooling (Tender data)	30		
Slab cooling (Tender data)	60		
Scarfer (Tender data)	10		
	115	**85**	**30**
Local measurements show an average total of 114 m³ and an average for the combination of Open Cooling and slab cooling of 86 m³/hr with a combined filter and backwash discharge from these two of 22 m³/hr net average. The above figures are therefore regarded as representative and cautious as regards the amount evaporated.			
Continuous Casting V3			
Secondary Open Cooling (Tender data)	30		
Slab Cooling (Tender data)	30		
	60	**44**	**16**
Local measurements and historic water supply data reasonably confirms this data in total, but varies between the two individuals.			
Direct Reduction			
After Burner chamber temperature control	50	50	0
Cooling tower (currently flooded by discharge from "once through" cooling of the compressors, but this is to be changed)	-	30	Varies
Kiln outside cooling (estimate)	?	20	?
Dust conditioning	-	2	-
Approximate total for DR		**100**	
Total for cooling circuit systems (approx) [after coal gas cleaning upgrade(*)	**810 +?**	**670**	**240 +?**

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	Make up m³/hr	**Expected average evaporation m³/hr**	**Expected average blow down m³/hr**
Quench Systems (net evaporation plus product pore water)			
Blast Furnace Slag Granulation		40	
EAF slag cooling		20	
Coke quench (Current) After 20% increase		125 (150)	
Total water evaporated and removed as pore water from above plant areas		**755 (780)**	

In addition, as a part of an overall mass balance cross check, an assessment was made as to the make up rates for all the cooling and quench systems which have to use or circulate a high quality water. The following Table 5.1.6.2 presents the findings. The same comments as are made above regarding the above data apply to this table as well.

TABLE 5.1.6.2 Water Make Up Rates For Cooling And Quench Systems Which Have To Use Or Circulate High Quality Water.

South Works	Make Up m³/hr
Blast Furnace closed	0.5
PCI open	2
BOF main cooling	10
RHOB machine cooling closed	0.1
multi lance closed and open	1
condenser and heat exchanger cooling	10
Arc Furnace transformer closed	<0.1
Compressor VK23	3
V1 closed cooling	10
V2 closed primary cooling	5
V3 primary closed	2
V3 primary open	33
Q pump station	17
HNX pump station	7
Paint line cooling tower	2
M pump station	15
N3 pump station	10
Plate Treatment Plant water system	1
Total for South Works	**128.7**
North Works	
Industrial Pump Station	13
Desalination Plant	2.5
Reheat Furnaces 1, 2 & 3	1.3
Reheat Furnace 4	1.5
Cold Mill 1 pump station	22
Cold Mill 2 pump station	47
Electro Galvanising line	9.2
Continuous anneal line number 2	11
Total for North Works	**107.5**
Overall Total for N and S Works	**236**
The likely net evaporation from these is about	200

As a result and using an approximate estimate for un-condensed steam, plus the above data, the following overall picture emerges.

TABLE 5.1.6.3 Net Evaporation Loads For The Whole IVDBS Site

	Pore Water plus Evaporation m³/hr
Un-condensed steam	300
BOF, V1, V2, V3, EAF, Slag Cooling, etc	260
Coke quench	125 (150)
Direct Reduction After Burner temperature control	50
Cooling Towers in S. Works, gas quench, etc	380
B.F. Slag Granulation	40
High Quality water cooling systems	200
Total	**1355** **(1380)**

Within the overall accuracy of the data, it is clear that the mass balance cross check is reasonably accurate and therefore something of the order of:-

1355 m^3/hr total evaporation
minus 200 m^3/hr of high quality user systems
minus 300 m^3/hr of boiler feed

leaving say 850 m^3/hr of evaporation from "low grade" water.

In order to create this amount of evaporation capacity from a water which can be concentrated up by a factor of around 2.5 to 3 (the current cycles achieved when Industrial Water is supplied to these users), then circa 1400 m^3/hr of "low grade" water would have to be recycled to these users.

In order to create such an amount of recycle water, salts would have to be purged from the resultant concentrate through some form of concentration device, such as an evaporator. This equipment would create a distillate (or a permeate if a reverse osmosis unit (RO) were used) which could be recycled as a part substitute for the high quality source water.

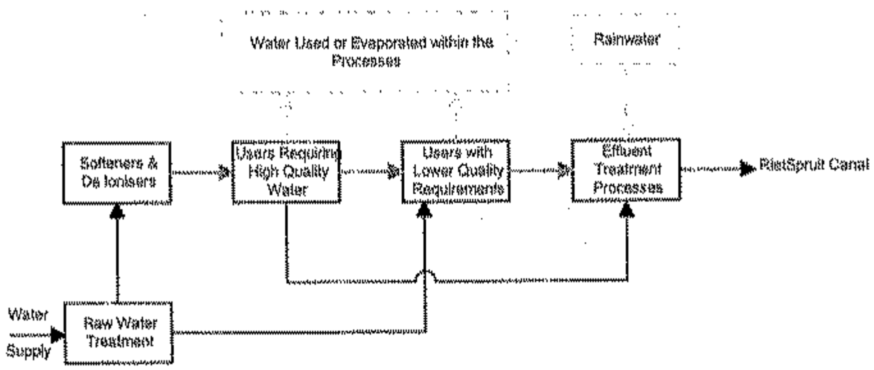
It was clear, therefore that in principal, it was quite feasible to create a zero effluent site simply by returning a suitably treated and softened effluent derived water to selected process users. Also, it was clear that the necessary salts purge would only need to be arranged on the consequent blow down from those (or some of those) process users.

The existing site arrangements for supplying and discharging water can be represented (somewhat simplistically) as shown in the attached RPA Drawing 484/LA996. The above basic concepts for achieving ZED can be represented in outline in the attached RPA Drawing 484/LA997A.

This conceptual method for achieving ZED represents a major change and a major Capex and Opex saving relative to the previous OETP based concepts.

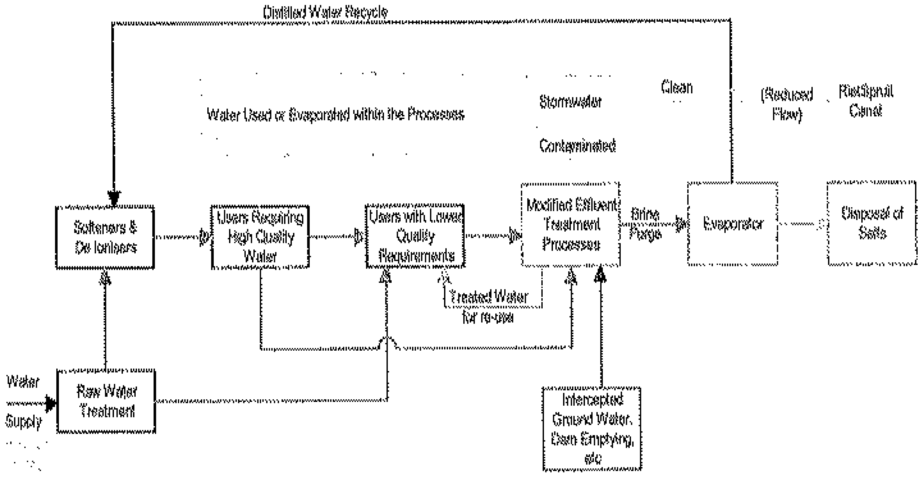
Simplified Overview of Current Water Useage
IVDBS

RPA Drawing 484/LA998



Overview of Proposed Zero Effluent Infrastructure
IVDBS

RPA Drawing 484/LA997A



5.1.7 OTHER RELEVANT ISSUES

Before discussing how the above central concept was built up into an overall strategy, it is necessary to take note of a number of additional items which are relevant.

Firstly, it should be noted that with the current salts content of the water supply coming from the Vaal River, there is no scope for evaporating this water by more than about 2 to 3 times within cooling tower and quench circuits before elements of the salts content within those circuits are too high for that water to be discharged to the Rietspruit Canal. This situation occurs even if there are no contaminant additions from the process itself. This range of evaporation ratios from 2 to 3 times is a function of the river quality at the time.

As a result, the current practice on site is not to cycle up the cooling tower and quench circuit waters to the extent which the equipment would allow, but to purge them at a rate which will enable the blow down and back wash waters (once suspended solids and traces of oils have been removed) to be compliant with the TETP discharge limits.

The knock on effect from this operating practice is that the water supply infrastructure to all of these water users has been sized and installed such that there is enough intrinsic volumetric capacity to continue to supply any suitable water which is capable of being concentrated by about 2.5 or more times.

Secondly, the discharge from the CETP has a much higher total dissolved salts (TDS) content and a much higher calcium and chloride content than can be discharged from the TETP. Also, the concentrations of sulphate, fluoride and other lesser components are higher than the TETP limits, but not by so much of a margin. As a result, the site has been happy to accept excessive blow downs from other areas so that when all of the effluents and blow downs from the site as a whole are combined the resultant mixture is within the overall TETP discharge limits.

The discharge from North Works to the North Works Blow Down Canal is, in general, of a quality which is very similar to River Water. Its flow could he reduced by changing filter back wash practices and overflows, but to date this has not been needed. In any event, the total flow is only around 80 to 90 m^3/hr relative to a total of 1200 to 1300 m^3/hr which is discharged from the TETP. The potential reductions to this 80 to 90 m^3/hr could be as much as about 60 to 70 m^3/hr but the total salts discharge per hour would remain about the same.

Spending money to achieve this in the future could be an economic option relative to installing additional or such large capacity systems in order to handle surface waters, should additional surface water capacity be needed.

A further large source of water into the canal infrastructure is derived from Cold Mills South. Part of this is a result of leakages from old water distribution infrastructures, much of which is buried below ground or in difficult to access tunnels, cellars, etc. The other main source is a deliberate discharge which is necessary for product surface quality reasons. This latter (see section 3, CP01.9) is uneconomic to recycle on that production line relative to sourcing a fresh supply clarified Vaal Dam Water. However, as the proposed ZED infrastructures are put into place, this water will be quite happily used in its entirety by other local users.

The following Table 5.1.7.1 sets out a list of all of the South Mills "essentially clean" discharges (including the above two large value examples) together with the proposed local re-use routing which can be adopted in order to prevent them being discharged to the ZED infrastructure.

TABLE 5.1.7.1 Sources And Handling Proposals For "Essentially Clean Effluent" From S. Works Cold Mills

Blast Furnace Canal	Route it to	M^3/hr
Water Softening regen	Q pump house Acid Rinse sump	0.7
Q Pump house back wash	Q pump house Acid Rinse sump	3
HNX pump house backwash	Q pump house Acid Rinse sump	0.5
HNX pump house blow down	Re-use locally instead of Vaal Dam Water	0
CAL No. 1 Quench	Re-use locally instead of Vaal Dam Water	7
Electro Tinning Quench	Re-use locally instead of Vaal Dam Water	186
Paint Line blow down	Re-use locally instead of Vaal Dam Water	3.4
		200.7
Assume a net blow down and leaks from Q Pump House area to MTP	MTP	20
Blower House Canal		
Leakage etc to drain from Q circuits (need to be cured)	Q circuits	170 approx
Boiler Blow Down	MTP	10
Blower House backwashes	MTP	9
Blower House blow downs	MTP	0
		19
Assume a net input to MTP from the Blast Furnace Canal and Blower House Canal sources of 40 m^3/hr.		

Thirdly, the product water from the type of treatment process that would be needed (in order to make the current type of effluents re-usable for cooling tower and quenching functions and for that water to be capable of achieving a similar concentration ratio within the evaporative cooling circuits relative to that currently achieved using Vaal River Water) will need to be dosed with antioxidants and corrosion inhibitors. The dose rates should be similar for the antiscalants and perhaps slightly elevated for the corrosion inhibitors.

A potential feature of this centralised main treatment and return plant (MTP) would be that these antiscalants and corrosion inhibitors could be dosed into the return water, such that the local dosing facilities at each cooling circuit could be made redundant. This, combined with a clock and timer based make up system (and hence an automatically overflowing purge or blow down system) at each cooling and quenching circuit, should enable most (if not all) of those cooling circuits to be managed from the MTP, entirely remotely.

A further feature will be that all top up water to this system from the Vaal Dam, from the Vaal River or from surface or ground waters would not need to be pre-treated in one of the current pre-treatment plants.

Fourthly, one of the features which will be created by returning a high salts content water to these cooling and quenching systems is that the resultant blow down from these systems will have a considerably higher dissolved salts contents than at present. If these blow downs are collected using the existing surface water canal infrastructures, then the change in quality of the collected waters when rainfall occurs would necessitate the building of a considerably larger and more complex buffer storage and processing plant as well as a larger desalination facility.

Also, the current site drainage system has leaks throughout its whole infrastructure. Thus, if more concentrated liquors are to be discharged to it, these leaks must be cured. In addition, the whole system will need to be made suitably corrosion resistant to the higher salts loads. Especially critical in this regard would be the much higher concentrations of sulphates and chlorides, because of their effects on the concrete structures associated with the existing collection arrangements.

The economic trade off as regards this fourth feature is to go for separate collection for all of the environmentally significant discharges. Practicality and economics have dictated the extent to which minor effluent streams are separately collected. In this regards, the location of the proposed treatment plant has been critical, but, as will be seen later, the outcome of all the ZED related work has enabled a practical and pragmatic approach to be developed which is able to collect into separate collection arrangements <u>all</u> of the process effluents with virtually total exclusion of surface water inputs to these separate collection arrangements.

5.1.8 HOW AND WHERE CAN THE TREATED WATER BE RETURNED ECONOMICALLY

Before a realistic ZED strategy can be finalised, it is necessary to look at how this recovered effluent can be returned economically and practically to as many of the potential users as possible.

The attached RPA Drawing 484/LA1091 shows the principal water distribution pipes for the supply of clarified Vaal Dam Water and Industrial Water to the site.

It will be noticed that North Works does not have a connection to the Industrial Water Supply. Also, within South Works, the Old Combination Mill area is no longer a significant user of water and most of the water used within South Mills has to be Vaal Dam Water or Demineralised water. Thus, whilst much of the supply pipe infrastructure within the eastern side of the South Works area is connected to the Industrial Water supply,

a) not much water is used in those areas and
b) most of what is used comes from the Vaal Dam.

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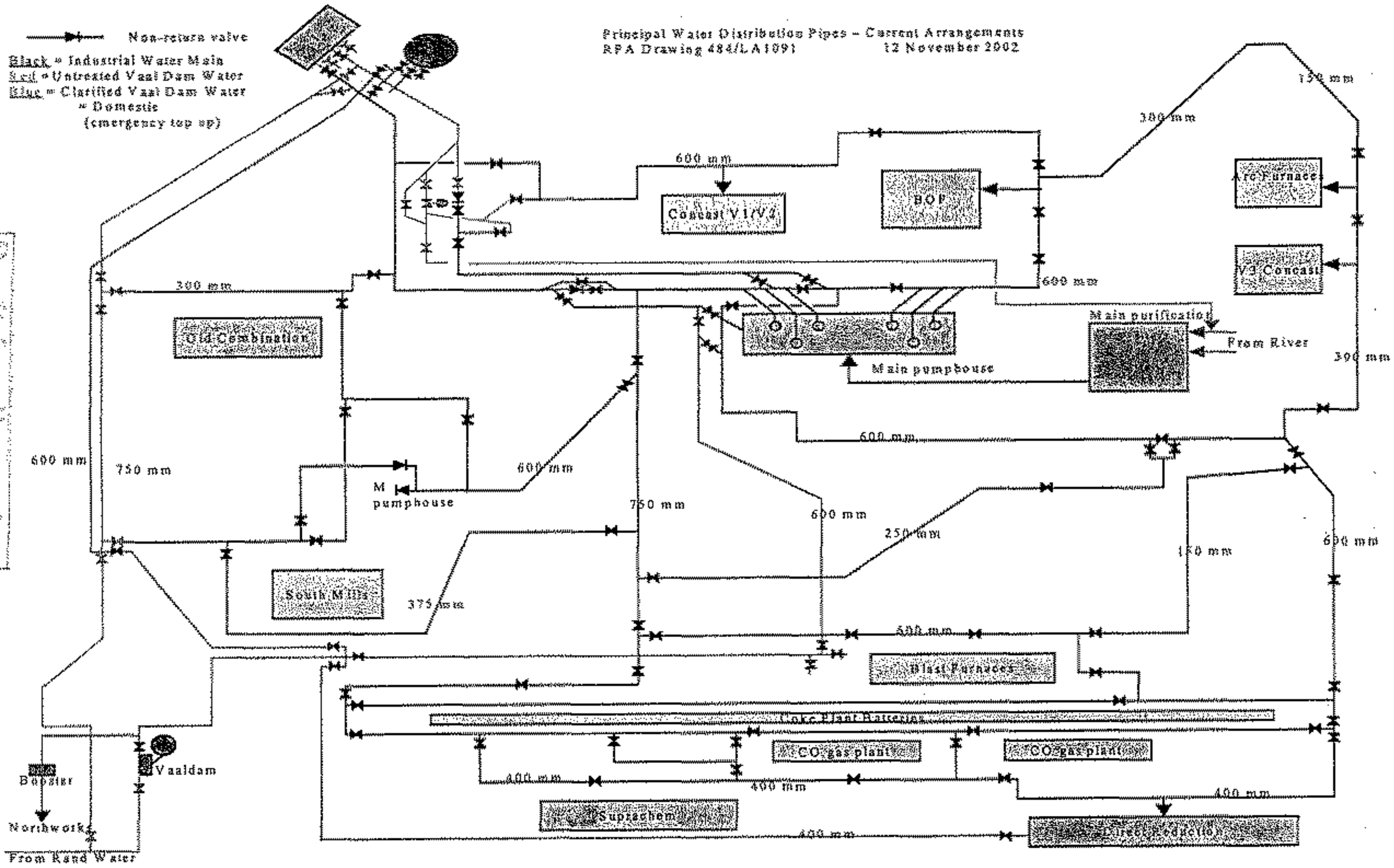
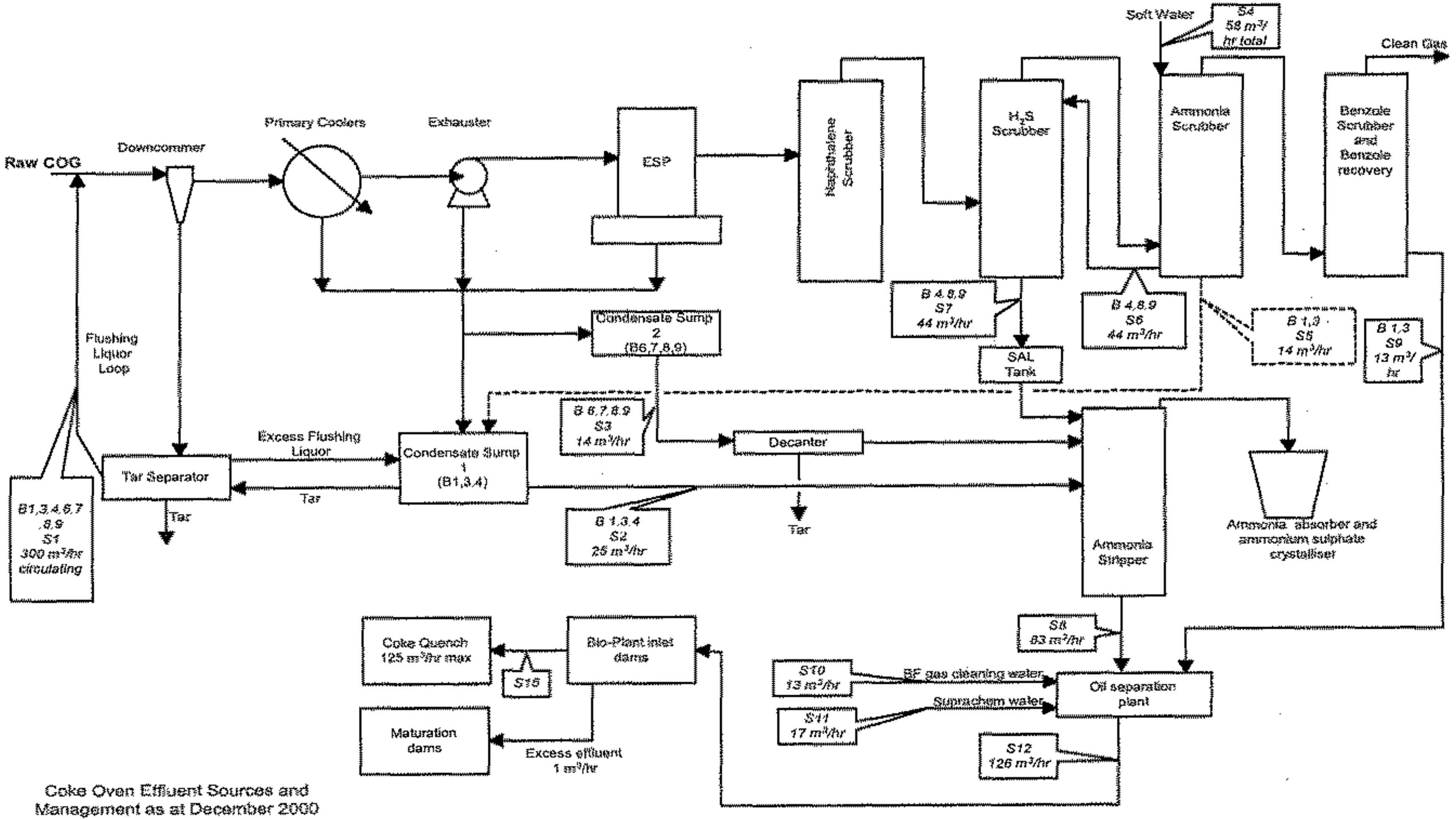


If one looks at the potential users of a return water that are listed in Table 5.1.6.1 above and relates those to this supply pipe infrastructure drawing, then the western side of South Works (covering all the coke oven related areas and the iron and steel making areas) includes all of these potential users. Whilst some users of high quality water are also in this area, there are no other significant users of low quality water who are outside of this western area of South Works.

The concept was therefore developed of feeding recovered water to the Industrial Water Main and for isolating off that part of that main which does not supply this western part of South Works. This isolated off part could then be supplied with clarified Vaal Dam Water, but pumped from the Main Pump House so that all the various back up systems in the works which are designed to fall back on Industrial Water when a problem occurs in the Vaal Dam Supply, could still have an acceptable quality and similar reliability back up supply.

RPA Drawing 484/LA1095 shows how this concept can be achieved. It also shows the proposed relative location for the MTP (the Main Treatment Plant which will treat and return all the collected waters), the connection for the returned waters, the connection for the return of distillate quality water from the necessary brine concentration facilities and the necessary additional section of cross over interconnection (for standby reasons) that will be needed at the Main Pump House. This piece of pipework looks to be quite long, but this is a feature of the diagrammatic nature of the drawing. In reality, it is less than 50 metres of pipe.

One key advantage of using this part of the existing Industrial Water Main for the return of the treated recycle water is that there will be little potential for the various users to be selective about which water they use. As a result, most of the potential issues surrounding, "How do we incentivise the different Business Units so that they will choose to use the recycle water?" are neatly overcome. Similarly, because it will be possible to pre dose the return water with most of the necessary anti scalants and corrosion inhibitors that will be needed, it should be perfectly possible for Central Services (or their outsourced contractor) to take charge of a proper clock and timer controlled make up control system for each user. This will then take away the need for each Business Unit to oversee and supervise these cooling tower and quench systems. As a result, a properly controlled infrastructure with predictable and steady feed and blow down flows can be created. This will be somewhat of an improvement relative to the current system which has to cope with frequent and unpredictable surges in demand and discharge.



Coke Oven Effluent Sources and Management as at December 2000
RPA Drawing 484 /LA1044A
4th November 2002

Draft for discussion
CONFIDENTIAL
Research for MS

The process conditions that are necessary in order to achieve the above improvements to the contaminant removal processes are such that there was little ongoing economic value associated with the removal of Benzoles (which are mostly BTX compounds), particularly as they have a substantial calorific value and can assist in overcoming any blockage issues associated with poor removal of tars and naphthalenes.

The net result of all these measures would be a decreased volume of effluent production (circa 60 to 65 m^3/hr) and a much cleaner effluent mainly in terms of organics and ammonia), despite the proposed 10 to 20% increase in coke production.

5.1.11 THE BLAST FURNACE OFF-GAS SCRUBBING FLUID

The next question therefore was what could be done with the Blast Furnace off-gas scrubbing fluid. This has a lower organics and ammonia content than the flushing liquor from the coal gas quenching, but a much higher chloride content. Indeed, this chloride content would cause too much corrosion within the coal gas cleaning area if it were allowed into that system as part of a recycle loop. Also, this chloride content is causing significant corrosion and related problems in the existing coke quench area, in the coke handling equipment and in the area which is subject to spray fall out from the coke quench units.

It was realised that a relatively well stripped mixture of flushing liquor and purged ammonia scrubbing liquor could be used as the make up water for the Blast Furnace off-gas scrubbing system. This would be instead of the current supply from the Industrial Water Main. The blow down rate from the Blast Furnace off-gas system would have to be increased to ensure that the salt (especially the chloride) content of the circuit water did not get too high, but otherwise this was a technically realistic option.

At present, when the systems are running properly, each Blast Furnace off-gas scrubbing unit has a make up input from the Industrial Water Main of about 27 m^3/hr, giving a total of about 54 m^3/hr over two furnaces. The normal properly operating blow down is about 13m3/hr from them both, yielding a net evaporation through the cooling towers of around 40 m^3/hr.

In the future it is probable that once D Furnace has been rebuilt, then for most of the time only D Furnace will be operating, albeit at a higher capacity than at present. This could mean that the above net evaporation rate could be as low as circa 25 m^3/hr.

With a likely net disposal requirement of stripped scrubbing water and mostly stripped flushing water from the coke oven area of around 60 to 65 m^3/hr (this is the current prediction from the detailed designers of the Coke Oven area upgrade) and allowing for a net extra flow of around 5 to 10 m^3/hr of pump back from the bund sump, then there could be a net average input to the Blast Furnace off-gas cleaning system of around 70m3/hr.

With a likely minimum net average evaporation of 25 m^3/hr the resultant blow down flow should be no more than 50 m^3/hr.

5.1.12 THE SINTER OFF-GAS SCRUBBING PROCESS

At 50 m³/hr, this volume flow from the Blast Furnace would equal or be a little less than the likely requirements for make up water for the Treatment Plant for the Sinter Off-Gases Scrubbing Fluid. From the point of view of off-gas scrubbing, this system can quite happily accept a significant ammonia content within its feed water, because the acidic nature of the off gases will always ensure a very low partial pressure of ammonia above any scrubbing fluid surfaces.

The question that remains is can the system accept the associated corrosion potential and can the final liquor purge system accept the extra ammonia, chloride and sulphate that will be present as well as, potentially, a little higher concentration of difficult organics.

If the VAI Wetfine Process is used for the Sinter Off-Gases, then the impact of the ammonia on corrosion would be higher, but not significantly so. If the IGC Process is used then there would be no significant effect.

As regards the treatment of the purge liquor, there would be very little difference between the needs of the process if the Sinter off-gas cleaning were supplied with Industrial Water or with blow down from the Blast Furnace gas cleaning.

At present, there are two options for handling the blow down from the Sinter off-gas cleaning. One involves a technology (which is still being researched and which may or may not prove to be viable) which could use a currently waste residue from the DR kilns (Dolochar). The other technology is a well tried and tested route using an evaporator and crystalliser.

In either case, the liquor that is purged will need to be pH adjusted, which will precipitate metal hydroxides and, depending upon the neutralising agent, could also precipitate calcium sulphate (gypsum). The mostly potassium chloride fumes and other dusts which would be removed from the Sinter off-gases would either form a reasonably low solubility precipitate with the Dolochar (polyhalite) or it will be crystallised along with the other dissolved salts in a crystalliser.

5.1.13 FINAL REMOVAL OF DIFFICULT ORGANICS

A large proportion of the difficult organics that will be present in the effluent from the Coke Oven and its associated areas will be stripped out of the liquor into the Blast Furnace gas within the gas scrubbers. These will then be destroyed, along with the like compounds which are already present in the raw Blast Furnace gas when the gas is burnt. Any remaining organics will report in varying proportions to each of the outlets from the Sinter off-gases treatment process:-

- chemisorbed/absorbed on to precipitated solids and on to the fine dust that was removed from the Sinter off-gases, all or which will make up the resultant filter cake product.
- be distilled out into the distilled water product from the crystalliser unit (or evaporator unit if the Dolochar route is successful)
- Chemisorbed/absorbed on to the crystal product from a crystalliser.

The latter outlet is unlikely but will need to be confirmed. If it is shown to be the case then selective and controlled use of small amounts of powdered activated carbon or other adsorbents in conjunction with or after the precipitation process but before the filtration process will enable the problem to be resolved.

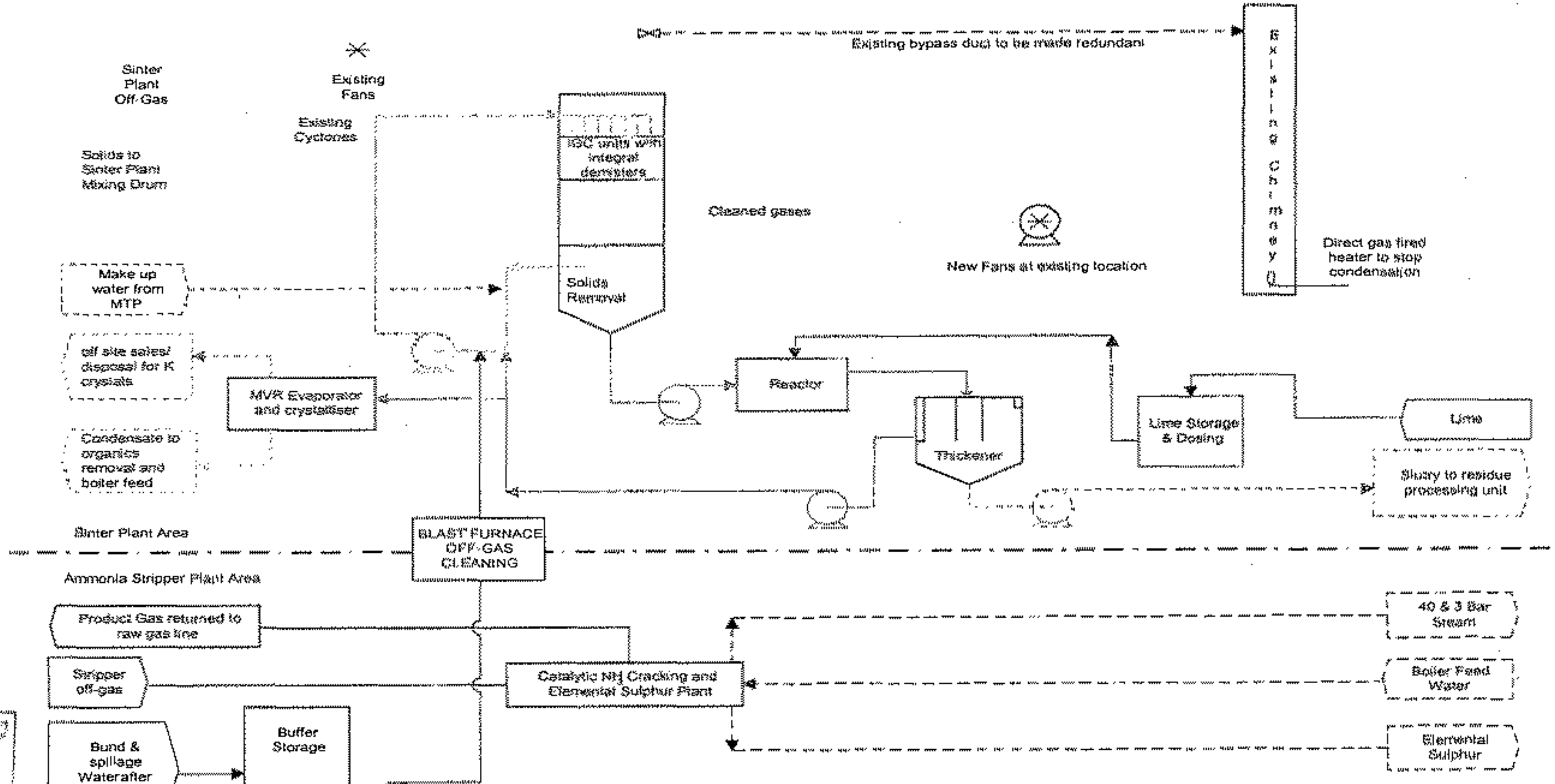
The small amounts of organics that may access the distillate can be removed by passing the distillate through an activated carbon or other suitable adsorbent before the distillate is forwarded to a suitable high quality use such as boiler feed. The used activated carbon could be sent to the coke oven coal feed for disposal.

The above integration options are shown on RPA Drawings 484/LA913A for the Dolochar based route and 484/LA840B for the evaporator crystalliser based route.

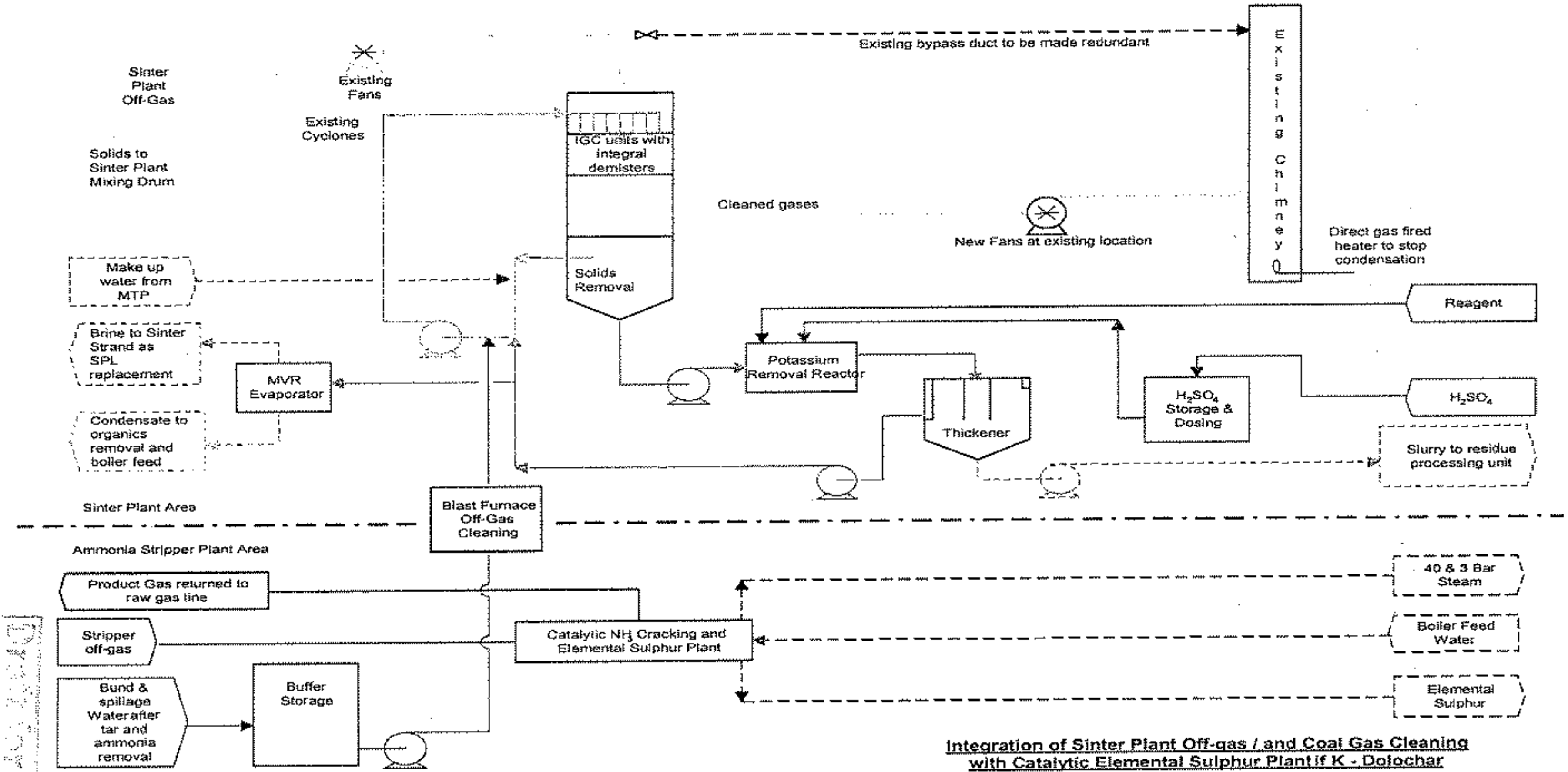
5.1.14 SUMMARY OF THE CONCEPT FOR HANDLING THE ORGANICALLY CONTAMINATED LIQUORS

The essential outcome of the above review and concept development is that it is realistically possible to:-

a) Reduce the amount of effluent created within the coke oven, by products and Suprachem areas to about half of the current amount (i.e. to about 65 to 70 m^3/hr) whilst at the same time achieving all of the gas quality, plant operability, reliability and costs benefits that were desired from the Coke Oven Area Project.
b) Use this effluent from the Coke Ovens as the make up water for the Blast Furnace off-gas treatment plant.
c) Blow down the scrubbing liquor from this off-gas treatment plant to the proposed Sinter off-gas treatment plant (whether the VAI Wetfine process or the IGC process is used).
d) Handle the blow down from the Sinter off-gas treatment process so as to create a nominally 20 to 30 m^3/hr flow of organics free distilled water for use as a boiler feed and to produce optional solid and crystal residues or just solid residues (subject to ongoing testwork) for which sensible disposal arrangements should be possible.



Integration of Sinter Plant Off-gas / and Coal Gas Cleaning with Catalytic Elemental Sulphur Plant If K removed as fertiliser
R. Paxton and Associates Ltd
Drawing 484/LA913A - 12th November 2002



Integration of Sinter Plant Off-gas / and Coal Gas Cleaning with Catalytic Elemental Sulphur Plant if K - Dolochar process is successful
R. Paxton and Associates Ltd
Drawing 484/LA840B - 12 November 2002

As a result, all the ongoing production of organically, ammonia, sulphide and cyanide contaminated waters can be processed and used on site rather than having to be put through separate treatment and disposal facilities.

In other words, a Biological Treatment Plant will not be needed for any of the current IVDBS Process Effluents.

In addition, it will be clear from the above descriptions that the capacity to handle these effluents at each of the successive use points exceeds the production capacity of the respective upstream source. This means that should break downs, plant stoppages, etc occur, there will be available capacity at each stage to work off any resultant backlogs. Obviously, once backlogs have been cleared then any short comings in the rate of supply can be overcome by purging the coke oven areas more rapidly or by adding fresh make up water to the Blast Furnace or Sinter Systems, as appropriate.

A further consequence of the strategy is the fact that there will no longer be a supply of organically contaminated water for quenching the coke once these proposed arrangements are in place.

Also, as a result of the recently completed activities there is already a net removal of water from the Maturation Dams. This means that the already well established biomass in these Dams will be able progressively to remove the bulk of the remaining dissolved organics and to steadily work down the ammonia content.

As the repair and rebuild programme within the ammonia strippers and the ammonia and H_2S absorber areas progresses, then the rate of effluent production within the coke oven area and its associated areas will progressively approach half the current rate. This will mean that during the next circa 12 months the available average removal rate for naturally bio-treated liquors from the Maturation Dams will progressively approach circa 60 m^3/hr.

5.1.15 SOURCES OF SUITABLE COKE QUENCH WATER

Once the Maturation Dams are effectively empty, then there will no longer be a supply of used water for about half of the coke quench requirements.

Once the Sinter Plant Off-Gases Treatment Plant is working and able to receive the blow down from the Blast Furnace off-gas cleaning then there will no longer be any source of used water for the coke quench.

The question, therefore is how best to exploit the evaporative capacity of coke quench without causing unacceptable off-gas emissions, without deleteriously affecting the quality of the coke and without causing corrosion or other maintenance issues within and around the coke quench area.

The above criteria require:-

- The coke quench water to be essentially organics free
- The coke quench water must have a low concentration of alkali metals, so as to avoid problems in the Blast Furnaces.

- Any organics that may be present must be non-hazardous as regards both health issues and safety issues.
- The coke quench water must have reasonably low chloride levels so as to minimise local corrosion issues.
- The source must be reliable or must have a reliable and acceptable quality alternative.

As the concepts for achieving ZED have been developed, in particular as the effluent catchment and separate conveying infrastructure has been developed, it became clear that not only could the blow down from the various users of recycled water be a suitable supply for coke quench, it was possible to conceive a relatively simple way of collecting and supplying it. It also became clear that as a reasonable back up supply, slag granulation water could be used, or the existing connections to the Industrial Water Main could be used.

The above criteria are in reality quite restrictive as regards a recycled water, if the intrinsic potential quality of the coke as it leaves the coke oven is to be exploited in the best interests of the site as a whole. Any recycle water will have a significant content of chloride, sodium and sulphate. Indeed the current Industrial Water (River Water) has a significant concentration of these three components.

At present, the coke quench is arranged as a "closed end" process with all known spillages and leaks being caught and returned. In section 3, at IM02.1.2 it was noted that recent upgrades in the way the quench water is applied have ensured that the product coke is virtually dry when it is tipped out of the coke quench cars. The only way out, therefore, for salts which are fed to the process within the quench water, is for them to be crystallised on to the coke itself or for them to leave via fine droplets in the steam and off gases.

Most alkali metal and chloride salts which could be present in a recycle water have relatively high solubilities. If these are not purged, then any spray, leaks or overflows from the coke quench will have high concentrations of these components.

The concept was therefore evolved of using the coke quench as the first stage of a brine concentrating process. The blow downs (or some of them) from the users of the re-cycled water could be routed to the coke quench units and the blow down (or, rather, controlled overflows) from the coke quench units could be fed to the subsequent stages of the necessary brine concentrating process.

The coke quench process itself is quite tolerant to minor amounts of scale formation such that traces of silicate, aluminate or fluoride scale formation should not be a problem. Because of the slight acidity associated with the process, carbonite scaling should not be (and is currently not) a problem. With the right purge rate, (i.e. with a sufficient feed rate relative to the evaporation rate) then sulphate levels should be low enough to prevent gypsum scaling issues. This same level of purging would ensure that the chloride and the alkali metal levels are also kept low, thereby protecting the Blast Furnaces and ensuring that :-

a) any spray that escapes from the top of the quench units will not be too corrosive and
b) the spray prevention equipment (which is made from 316 stainless steel) should not suffer from too much corrosion or chloride attack.

5.1.16 THE CONSEQUENT STRUCTURE FOR ACHIEVING ZED

With all the issues that have been referred to in the previous sub sections in mind, the overall concepts for ZED and for the final form of the Process Waters Master Plan have been evolved. In summary, the essential structure can be summarised as follows for the basically inorganic process effluents:-

a. Collect together all the
  - Process water effluents
  - CETP effluent and
  - Contaminated surface waters

b. Treat them to create a water which is suitable for
  - Cooling Towers
  - Off-Gas Cleaning
  - Quenching

c. Separately collect the blow downs from these uses
  - put some back to treatment
  - use the rest for Coke Quench

d. Purge Coke quench to an evaporator

e. Use the evaporator distillate to offset raw water supply

f. Use the brine in
  - DR After Burner Quench
  - Solid Residues Processing Plant

g. Alternatively (or in the short term) feed the brine to a crystalliser

h. Add the different quality ground waters to the compatible points in this infrastructure.

i. Add the aqueous contents of the on-site Dams (excluding the Maturation Dams) to the compatible points in this infrastructure.

All of the above processes refer to the inorganic effluents. As regards the organically contaminated effluents, which are not already routed to the CETP:-

A. Until the sinter off-gases treatment process is running, continue with the currently operating and planned system, namely:-
  - Route all Coke Oven area, By-Products area, Suprachem area and BF gas cleaning effluents, including the return water from the Coke Oven area sump through the current tar and solids interceptor and the upgraded gravel filter and pump them to the Bio-Plant Inlet Buffer Dams.
  - Pump any excess amounts of this water to the Maturation Dams.
  - Whenever the Bio-Plant Inlet Buffer Dams get near to low level, prevent them from going to low level by pumping water to them from the Maturation Dams.

- Use the water in the Bio-Plant Inlet Buffer Dams as the only normal source of make up water for Coke Quench. Emergency make up (e.g. during power outage or plant failure) should come from the TETP and later the MTP (when it is running).
- When the Maturation Dams are fully empty of their aqueous contents, use recycle water from the TETP and later the MTP (when it is running) as the secondary top up source for coke quench.

B. Once the sinter off-gases treatment process is running:-

- Route all Coke Oven area, By-Products area, Suprachem area effluents, including the return water from the Coke Oven area sump through the current tar and solids interceptor and the upgraded gravel filter and pump it to the BF gas cleaning process, as the only normal source of make up water. Emergency make up, (e.g. during power outage or plant failure) should come from the TETP and later the MTP (when it is running).
- Pump any excess flows that may occur from time to time to the Bio-Plant Inlet Buffer Dams.
- As space in the tar and solids interceptor outlet pumping sump permits, return all stored waters from the Bio-Plant Inlet Buffer Dams.
- Blow down the B.F. gas cleaning process to the sinter off-gas cleaning process.
- Make up any short falls in the amount of water that is fed to the sinter off-gas cleaning process by adding purge water to the ammonia scrubbers and/or the flushing water circuits within the Coal Gas Cleaning Process.
- Use the Industrial Water Main as the source of emergency only make up water into both the B.F. and the sinter gas cleaning plants.
- The Coke Oven area upgrade activities are already arranging the appropriate emergency only make up connections.

5.1.17 THE NECESSARY TREATMENT TECHNOLOGY FOR THE INORGANIC EFFLUENTS

Precipitation softening would be the normal process selection for the type of liquor that would be blown down by the users of treated and recycled waters together with the further inputs from the CETP, from North Works and from the other effluent sources in the South Works that would not be using recycled water. The essence of this process would be to employ simple pH adjustment to around pH 10.5 to precipitate magnesium and most metals, followed by sodium carbonate addition to precipitate calcium. This would then be followed, after solids removal, by acidification to about pH 6.5 to 7.0 to take the product water away from its carbonate saturation limits.

This standard chemistry is relatively easy to conduct and to control. However, in the situation at IVDBS it would be both expensive to operate and it would not address all the lesser components adequately. These lesser components include fluoride, manganese, phosphates, silicates and aluminates.

In order to overcome these deficiencies and to identify a suitably robust but much more cost effective solution, RPA used their in house adaptations to the standard MINTEQ speciation programmes together with some specifically written software to enable the likely process plant flow diagrams to be modelled so as to model the chemical processes that would occur within a whole range of process plant configurations and operating scenarios. As a result, of many modelling scenarios for many potentially possible process schematics, a general process evolution was achieved which ultimately has been consolidated into the following schematics and proposals. Along the way to creating these schematics and proposals, both Betz and Buckman (current on site outsourced water treatment plant operators and specialists) kindly ran a number of calculated product liquor analyses through their in house cooling tower prediction programmes in order to cross check and verify the RPA predictions. In all cases, the Betz and the Buckman predictions agreed well with each other. Also, they both agreed reasonably well with the RPA predictions, however in all cases the RPA predictions were either similar to or were more conservative (in terms of plant performance and/or operability) than the Betz and Buckman predictions.

Accordingly, RPA felt comfortable that their predictions were both reasonable and, if anything, sensibly cautious.

The modelling work was used to explore the potential operating boundaries as regards what effluent could get treated where, in what way and with or without what other effluents. As a result, a strategy emerged which enabled the essence of the above simple softening concept to be done in two stages, with the first stage being built into the existing CETP operation and the second stage being feasible as a process modification at the TETP.

In addition, some further re-arrangements at the CETP enabled many of the current difficulties associated with the surface active agents which are mostly present in the oily and alkaline effluents to be mostly avoided or at least mitigated. Also, a process modification was evolved which was able to route much of the calcium and chloride content of the current CETP output to the Sinter as a part substitute for a reagent which is currently used at the sinter. This further reduces softening costs and reduces chloride related issues and costs within the overall ZED infrastructure.

However, before going into all the details associated with these developments, it is appropriate to look at where the Short Term Measures and all the subsequent actions have taken the overall site infrastructure. In this way, the starting basis upon which the ZED infrastructure has been built will be clear.

5.2 SHORT TERM MEASURES

As part of the close working relationship between RPA and the IVDBS site personnel a number of measures were pushed through under the OFT Team banner to bring about immediate environmental improvement at the site. These so called Short Term Measures are explained below with particular focus on their importance in the overall process water management infrastructure and the development of ZED.

5.2.1 PREVENTION OF DRY WEATHER INPUTS TO THE LEEUSPRUIT

A scheme to collect all dry weather flows from N. Works which were not caught by the existing Leeuspruit sump was installed which also intercepted and collected all ground water seepages which emerged west of the Frikkie Meyer Boulevard. These were collected upstream of a flow measurement weir which was installed at the entrance to the Frikkie Meyer road bridge where the road passes over the Leeuspruit. All collected waters are pumped using automatic pump control back to the Leeuspruit sump from which they are pumped to the Combination Canal which leads to the South Dam Canal which in turn leads to the TETP.

As a result all dry weather flows and seepage flows are collected and pumped to the TETP. In addition the sump intercepts all first flush waters and the pumps forward all this to the TETP as well.

As a further part of this same scheme the slag and scrap metal processing operations which occur in the Steelserv area in the South East corner of the site have been collected together into a more restricted area and contained with containment beams and a drainage trench. As a second line of defence, prior to final rehabilitation of the area which has been cleared, a graded surface water flow route and a perimeter containment wall was constructed around the south eastern boundary of the site. This drains all surface water flows and any seepage flows up gradient of this perimeter wall into the Leeuspruit sump that was referred to above.

The drainage trench around the newly restricted and contained operating area is drained to a new concrete sump (the Steelserv sump). This sump was initially pumped automatically to the Combination Canal while an approximately 2,5 km pipeline was installed so that this water could be routed to the BOF for use as part of its make up water. This pipeline to the BOF is now complete and working successfully, routing all the waters that are collected in the Steelserv sump to the BOF.

Part of the water pumped from the Leeuspruit sump is diverted to the Steelserv operating area as a water supply for dust suppression and slag cooling.

The final part of this scheme was the identification and stopping of the principal and potential sources for dry weather flow to the Leeuspruit Dam. These were traced to leaks on the large concrete Water Reservoir for Vaal Dam Water and to a number of specific discharges within North Works. These latter were from cooling towers and air conditioning units.

The leaks on the reservoir are an intrinsic part of the design of the reservoir, but the interception arrangements were not pumped back as they should have been. This was probably because the bunding around the adjacent facilities (the Bio-Plant and the Desalination Plant) was inadequate.

These bunding inadequacies were rectified, the leakage water has been directed back to the inlet arrangements of the Treatment Plant for the Vaal Dam Water supply and the identified discharges in North Works were either stopped or routed to an internal re-use or to the North Works Blow Down Canal.

In addition, the operating personnel at North Works were made aware of the need not to allow future wash downs, maintenance activities or other situations to occur which could result in any resultant discharges to the Surface Water Drains.

Status

Leeuspruit Dam - Operating;
Leeuspruit Sump and Pumps - Complete and working;
Containment wall around site boundary - Complete and working;
Clearing of Steel Scrap - Majority has been cleared;
Steelserv Sump - Complete and working;
Pipework to BOF - Complete and working;
Leaks from Vaal Dam Reservoir - Intercepted and returned;
Desalination Plant area Bunding - Complete;
Bio-Plant area Bunding - Complete;
Principal sources of Dry Weather Flow from North Works - Identified and either stopped or directed to North Works Blow Down Canal

Benefits

- Total dry weather flow including ground water ingress <25% of previous;
- All ground water which surfaces West of Frikkie Meyer Boulevard has been caught (deeper ground water awaits Master Plan Proposals from JMA);
- Visible inputs to Leeuspruit only occur during heavy rainfall
- All dry weather surface flows are collected and returned to BOF, Steelserv and TETP.
- All salts inputs to Leeuspruit stopped, except minor surface contamination during heavy storms and except from ground water flowing beneath Frikkie Meyer Boulevard.

A schematic representation of the works carried out and their interaction with the BOF can be found in RPA Drawing 484/LA1096 within Section 5.2.4.

5.2.2 BURNS MEMORIAL CANAL UPGRADE

The old Burns Memorial Drain was very shallow and was unable to cope with a significant rainstorm event. As a result, storm water overflows to Dam 10 occurred regularly. In addition, a significant ground area west and south of Dams 1 to 4 drained to Dam 10, when from a quality point of view it could be drained to TETP. A much deeper concrete lined drain has been inserted along a parallel route.

Status

New Deeper Drain is installed and working - concrete lining of walls and floor of drain complete.

Benefits

- It is preventing storm water overflow into Dam 10, without significantly increasing the flow rate at TETP;
- Has lowered the water levels beneath and around the coke and coal stacking areas;
- Will reduce contaminant levels in the storm water run off, reducing contaminant load on canals during a storm.

- Has reduced the level of the standing water east of the CETP sludge Dams

5.2.3 CENTRAL EFFLUENT TREATMENT PLANT (CETP)

The project was initiated to improve the operating practices undertaken at the treatment plant with a view to using less reagents and consequently lowering the salts concentrations (especially the chloride and calcium concentrations) in the effluents sent to TETP and ultimately discharged into the Reitspruit canal.

In addition to the repair and upgrade of specific items of plant, tanks, clarifiers and other pieces of equipment, three fundamental upgrades were undertaken. The first two are complete and working, the last details of the third are still being completed.

The first changed the basic processing philosophy for the inorganic components of the CETP inputs. In essence, components in specific effluent inputs were used to assist the treatment of components in other inputs rather than using as much reagent. Overall, almost two thirds of the chemical processing equipment was able to be shut down (the remainder was upgraded), by-product sludge production was reduced to about 25%, reagent consumption was greatly reduced, chloride levels in the discharge were reduced to about 25% and calcium levels in the discharge were reduced to about 50%. As a consequence sulphate levels did increase slightly. Process control was also considerably simplified and new control equipment was installed.

A further part of this first group of changes involved the shutting down of the existing dedicated treatment plant for the small amount (3-5 m³/hr) of effluent from the Electrolytic Galvanising Line (EGL) at North Works. At the start of the Master Plan studies this plant was about to be extensively upgraded and repaired. From an overall costs, reliability and holistic environmental point of view it was preferable to shut this plant down and to pump the effluent directly to the CETP. This was done.

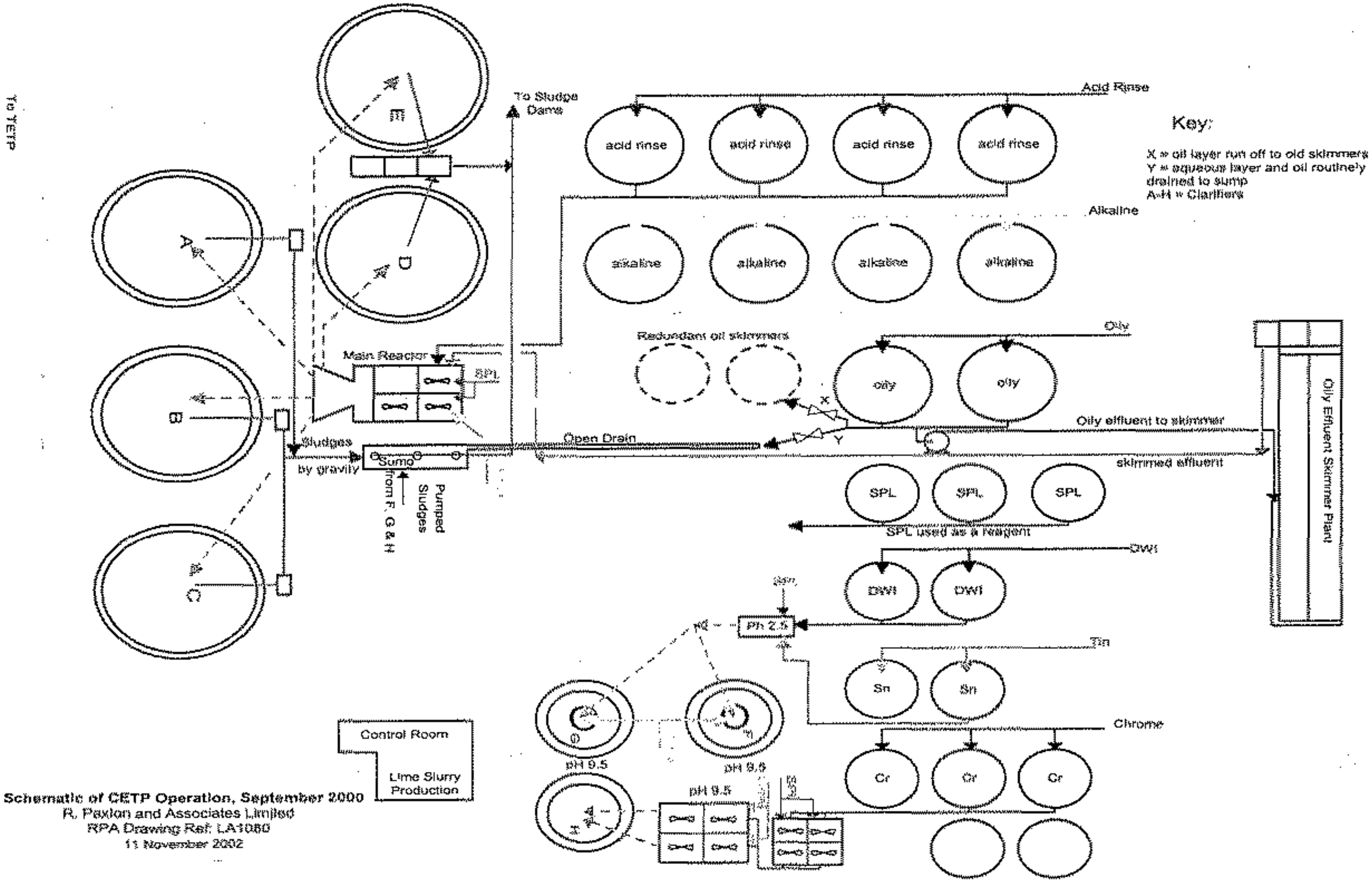
The second upgrade was to remove the oil contaminated and most of the salts contaminated soil from within and around the plant and to properly clay seal the whole area. Then a concrete floor with proper bund walls was installed over all the operational and effluent storage areas that remain in active use. Part of the now redundant equipment was demolished and removed at the same time. The whole area was re-graded so that all the new bunding drained by gravity to the former sludge collection and pumping sump. All bund waters (including all rainfall which lands within the bundled area) are now pumped to the CETP process for treatment along with all the other effluents before release to the TETP.

RPA diagrams 484/LA1080 and 484/LA1082 below show respectively the "before" and "after" arrangements at the CETP.

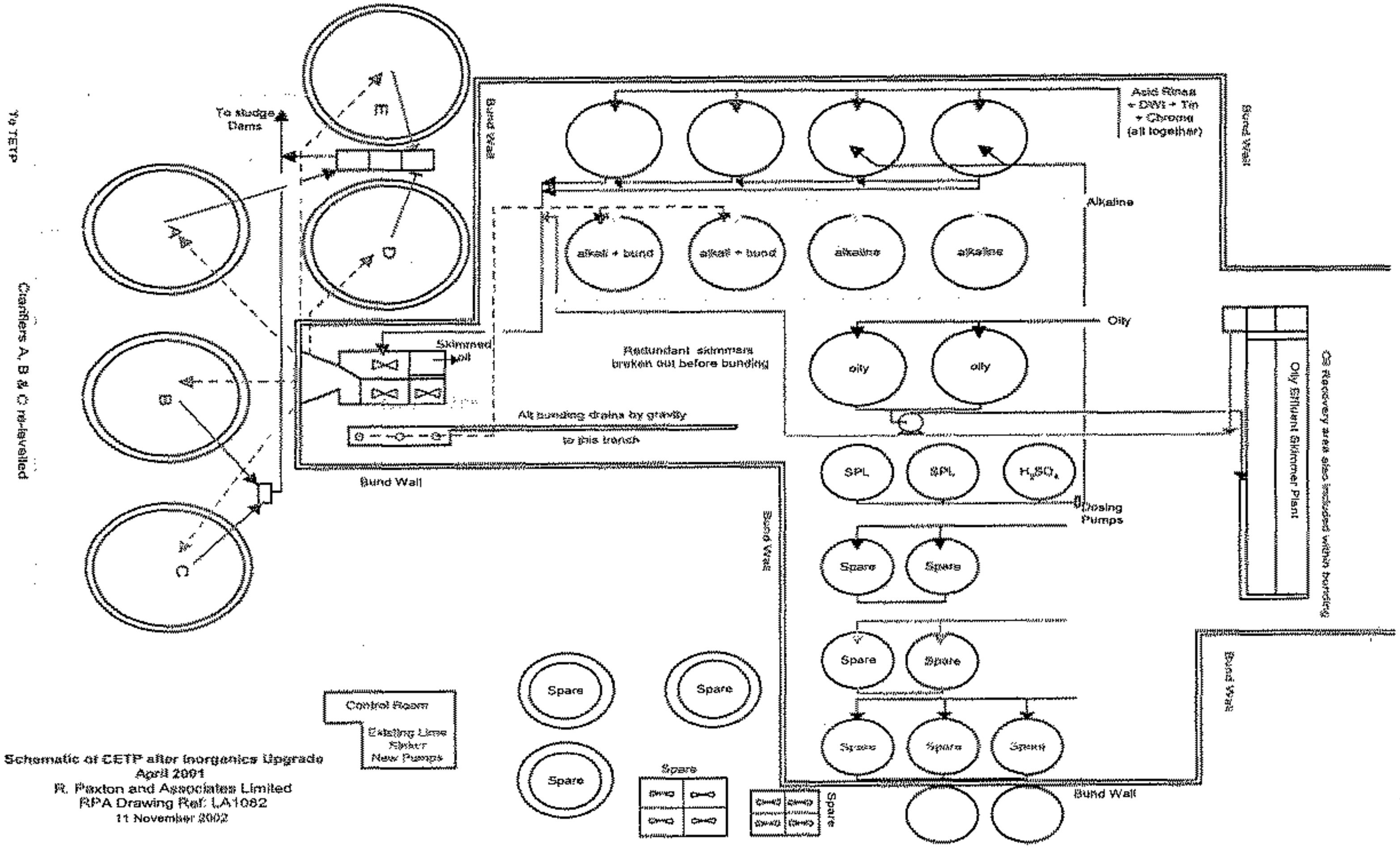
The third upgrade relates to the handling and processing of oily effluents. There were three principal objectives associated with this. The first objective was to simplify operations and maintenance by getting as much as possible of the tallow content out of the incoming effluents before it had a chance to cool down and solidify. The second objective was to reduce the oil content of the product sludge from the neutralisation reactor. The third objective was to prevent the various surface active agents which are present in these effluents from causing unacceptable interference to the precipitation processes which are used to control the fluoride, the sulphate and the toxic metal content of the finally treated effluent. This group of upgrades is effectively complete at the CETP and is ongoing at the various effluent production areas. The group of upgrades is discussed in more detail at 5.2.3.1 below.

Status of CETP upgrades

Existing operating practices amended	- Nov 2000;
Rearrange pipework, clarifiers and neutralisation unit	- Complete and working.
EGL liquor routed to CETP	- Complete and working.
Previous practices of dumping excess oil water effluent to sludge dams and/or Dam 10 have been stopped.	- The amount of dumping was greater than expected - Oily effluent did exceed operating capacity. Upgrades to overcome this are effectively complete at CETP and ongoing at sources.



Schematic of CETP Operation, September 2000
R. Paxton and Associates Limited
RPA Drawing Ref: LA1080
11 November 2002



Schematic of CETP after Inorganics Upgrade
April 2001
R. Paxton and Associates Limited
RPA Drawing Ref: LA1082
11 November 2002

Benefits

- TETP manganese level compliant from November 2000
- TETP conductivity (TDS) reduced to on-average compliant from November 2000
- TETP fluoride level reduced to on-average compliant from November 2000 however, the above referred oily effluent issues did reverse this benefit temporarily.
- Pipework etc rearrangement achieved:
  - About 10% reduction in TDS at TETP;
  - Compliant chloride at TETP approx 200 to 240 mg/l ahead of the limit changing on January 1st 2002 from 350 to 250mg/l.
  - Both the frequency and the magnitude of concentration peaks for sulphate, chloride, iron, manganese, fluoride, TDS, zinc, tin and chrome are all reduced;
  - A slight increase in sulphate at TETP (1 to 2%). The overall sulphate problem was addressed by other Short Term Measures, see section 5.2.4, 5.2.5 and 5.2.7. Thus, whilst there was a short period when there was a slight elevation of sulphate levels, the current sulphate levels at the TETP are well within the licence conditions;
  - Sludge production reduced to about 25%;
  - All CETP discharges into Dam 10 have been stopped.

5.2.3.1. SUMMARY OF THE OILY EFFLUENT PROCESS UPGRADES

This group of upgrades has involved a lot of activity at both the CETP and at all of the individual sources.

The rolling oil used at North Works has a much lower tallow content than that which is used within South Works. If the rolling oil content of the effluent from South Works is allowed to cool to below about 40°C, then it sets, causing severe operating and maintenance issues. In order to prevent any South Works oily effluent from cooling below about 45°C before its oil content has been separated off and removed, the piping arrangements at the CETP were amended such that the South Works oily effluent is directed straight to the oil skimmer plant, by-passing the previous buffer storage facilities. In addition, the skimmer plant has been adapted so that it can absorb and cope with the large surges in flow that this diversion causes.

Also coming from South Works cold rolling area is an alkaline cleaning residue which is derived from the removal of all traces of rolling oil from the rolled product before it is sent to the annealing processes and to other finishing processes. There is also a small flow of alkaline cleaning residues from North Works, not from the rolling process but from other finishing processes. This used alkaline cleaning liquor contains a significant amount of solubalised oil (including tallow). When this liquor is neutralised in the neutralisation reactor it liberates this solubalised oil as fine droplets of oil which stick to the neutralisation sludge. Also, many of the surface active agents that are present in both the rolling oils and the alkaline cleaning agents are liberated at this neutralisation stage. Once they are liberated, many of these surface active agents significantly interfere with the precipitation processes that occur during the neutralisation of the remainder of the CETP input liquors.

In order to overcome this problem, the alkaline cleaning effluents are now directed from their buffer storage tanks through an acidification stage (to reduce the pH to near neutral), through an input and mixing stage for an emulsion breaking additive and into the oil skimmer. For capacity reasons, this liquor is only added during the gaps between the incoming batches of oily effluent from the South Works.

The Oily Effluent from North Works is produced (as a result of the way the rolling operation is arranged) as a mixture of both the oily and the alkaline effluents. With its lower tallow content, the oil-water separation systems at the mill are able to perform more effectively and it is practical to put this mixed effluent into buffer storage without getting a solid layer of solidified tallow on the top of these storage tanks. This effluent is now also fed to the oil skimmer plant during the gaps between discharges from South Works.

In addition to the mechanisms for enabling the oil skimmer plant to absorb the flow surges from South Works, the skimmer plant has been adapted so as to remove most of its frequent maintenance and cleaning requirements and to simplify its operation. In particular the settled sludge handling facilities have been re-arranged so as to avoid the previous operating problems which were a major cause of scraper chain breakage and hence down time.

A further route by which oils and surface active agents gained access to the main neutralisation reactor was as a result of cross mixing at the pumping sumps which transferred the untreated strong effluents from the mill areas to the CETP. For system reliability reasons, the receiving sumps at the mills were arranged such that if both the duty and standby sump emptying transfer pumps failed, or were overwhelmed for a short period, then that sump was able to overflow to an adjacent sump. The overflows were arranged (for safety reasons) on the basis of mutual compatibility of the potential overflow. The oily effluent and the alkaline effluents, being basically high quality water with some oil and some dispersants (all essentially un-reactive with the other strong mill effluents) were arranged as the first to overflow, followed by the various acidic effluents from plating and galvanising with the acid rinse waters as the final recipients.

Unfortunately, these overflow were arranged on a simple overtopping basis from one sump to the next. Inevitably, some of the oil and tallow accumulates as a thick layer on the top of the oily and alkaline effluent sumps. Therefore the first thing to overflow was this oil and tallow. The sumps have now been re-designed and re-arranged such that when one or more of the sumps overflow, the oil is retained in the respective oily and alkaline effluent sumps and only the liquor beneath the oil layer is able to overflow. This has cut almost to zero the amount of oil and therefore the amount of oily effluent derived surface active agents which can gain access to the other effluents and thereby gain access to the neutralisation reactor.

Finally, and most importantly, the oily and alkaline effluents production processes and their operation have been addressed so as to identify ways in which both the production and the CETP related problems and costs can be reduced. In essence, the key criteria are:

a) The alkaline degreasers can only take on so much oil before their performance becomes inadequate and they have to be discharged (usually as a steady purge).

b) The roll coolant (water plus entrained oil) cannot develop too high a dissolved salts content before surface quality criteria in the product steel become a problem. Normally the chloride limit (at about 20 mg/litre) is the first limiting criteria to be approached.
c) When there is an equipment failure, it is often necessary to empty or mostly empty the whole recirculation and cooling system in order to be able to access the component that requires the repair. Until overall system volumes are reduced, sufficient local and suitably clean storage volume is not available.
d) The mill based oil-water separation facilities on the recirculating cooling water are not that effective. In order to prevent significantly sized oil droplets causing surface imperfections on the product, more excessive blow down of the cooling water is practiced than in theory should be necessary.

Changing the rolling oil to one with a reduced tallow content will help d) and may enable a significantly increased scope for on line oil recycle, at least to the first roll sets within the 5 stand. Steady progress in this direction is being made. (Note, the original 4 stand [4 sets of rolls in a single machine] at South Mills has been shut down. This unit would have been more able to have received recycled oil than the remaining 5 stand units).

The performance of the equipment referred to in d) is being driven up with a view to ascertaining if more focussed operation can be sufficiently effective or whether equipment upgrades or new equipment could be justified. Without either new equipment or appropriate upgrades, problem c) cannot be reduced to any significant extent.

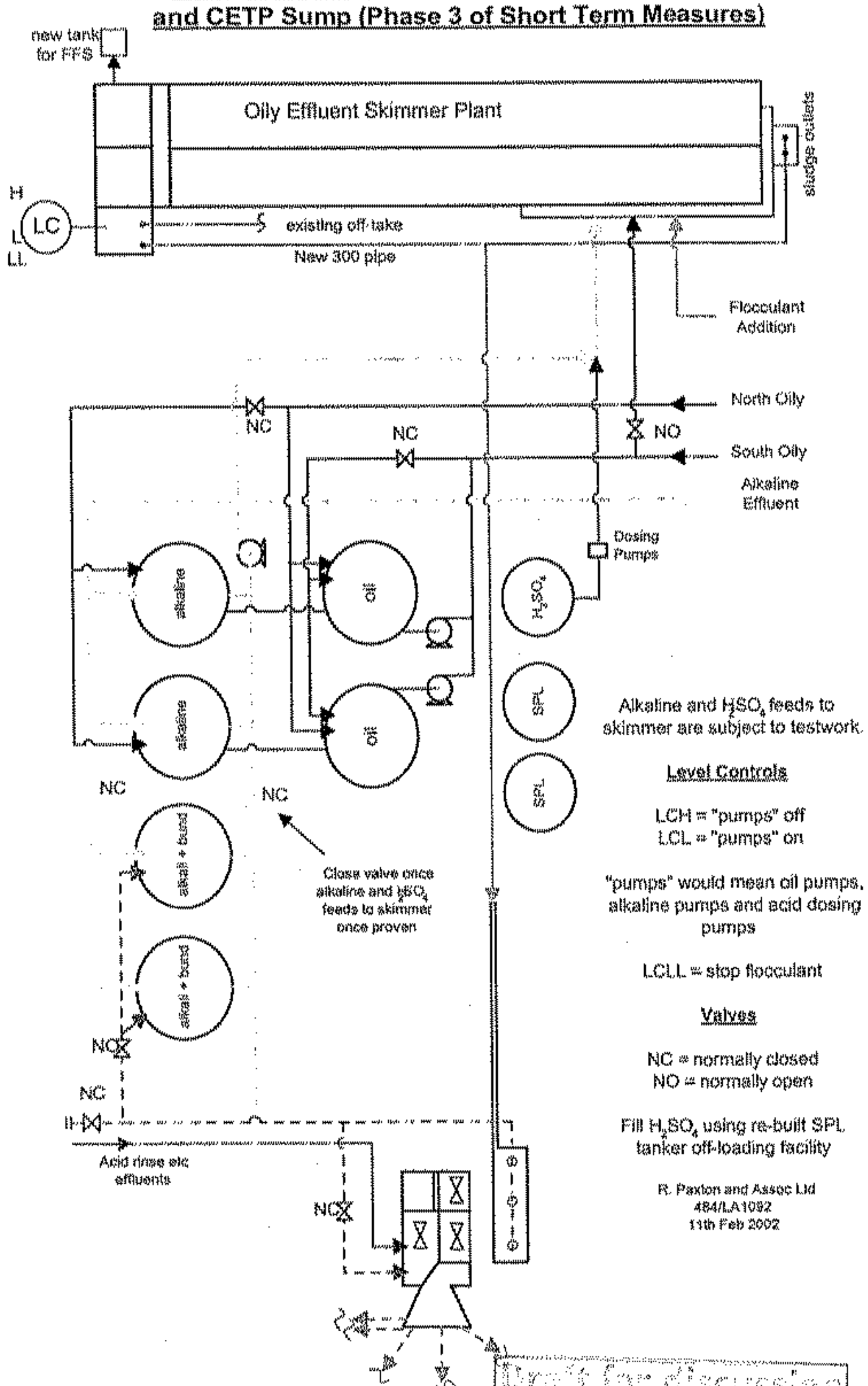
At present, the raw water used to make up the systems are a mixture of spare capacity on the demineralised water installations, steam condensate and clarified Vaal Dam water. Once the issues in d) are resolved then make up volumes will be considerably reduced. This will enable all the make up to be sourced from condensate and demineralised water. The major source of salts within the oily water circuits is the Vaal Dam water that is used for make up. By changing to an effectively salts free make up, criteria b) will no longer be process controlling. This in turn will enable a much reduced blow down to be achieved.

In addition, circuit changes to feed the degreasing station with de-oiled roll coolant blow down will further reduce water consumption and effluent volumes.

All the above rolling mill strategies for effluent reduction and reduced water consumption have been evolved with the help of the relevant staff. This evolution was carried out mostly at the North Works but it is understood that a similar strategy is being worked through at South Works. These strategies need to be progressed urgently by the rolling mills personnel with a strong technical overview from a suitably capable oil-water separation and water treatment specialist.

The CETP related aspects of the above work are effectively all complete and are being brought into action. The modifications to the effluent sumps are almost complete and the steady upgrading and strategy implementation at the rolling mills is ongoing. The arrangements that have been put into place at the CETP under this third phase of the CETP upgrade are given in RPA Drawing 484/LA1092 below.

Proposed Operating Schematic for Oil Skimmer and CETP Sump (Phase 3 of Short Term Measures)



Alkaline and H_2SO_4 feeds to skimmer are subject to testwork.

Level Controls

LCH = "pumps" off
LCL = "pumps" on

"pumps" would mean oil pumps, alkaline pumps and acid dosing pumps

LCLL = stop flocculant

Valves

NC = normally closed
NO = normally open

Fill H_2SO_4 using re-built SPL tanker off-loading facility

R. Paxton and Assoc Ltd
484/LA1092
11th Feb 2002

Draft for discussion
CONFIDENTIAL
Research for FFS

5.2.4 INTEGRATION OF BLOW DOWNS FROM THE BOF, V1, V2, V3, AIR PRODUCTS AND THE EAF

Within the existing water circuits associated with the BOF and V1 and V2, there was the facility to return clarified BOF off-gas cleaning circuit water to V1 and V2 as well as for V1 and V2 to blow down their high fluoride content circuit waters to the BOF off-gas cleaning circuit. The chemistry within the BOF circuits enables fluoride levels to be kept relatively low. The existing pipework circuits were upgraded and amended to allow the high fluoride waters from V1 and V2 to be routed to the BOF off-gas cleaning circuit and for clarified BOF water to be returned to V1 and V2. This system is now assisted by the waters being returned from the Steelserv sump, which not only saves industrial water usage, but also reduces input of treatment chemicals.

The blow down from this system and from all the other cooling systems in this area did go to the TETP via the South Dam Canal. All these blow downs are suitable for use at slag cooling at the EAF where the high calcium content that is derived from the EAF slag, precipitates much of the fluoride content from the BOF, making much of it suitable for return to the BOF. This return flow provides a means of removing fine silt from the EAF slag cooling area to the clarifiers and filter presses at the BOF, which in turn provide a means whereby the fine EAF slag solids can be returned to the Sinter Plant where they are able to substitute for raw lime input. (Note, the remainder of the EAF slag already goes to the Sinter as a lime substitute). A combination of new and re-arranged existing pipework now achieves this.

The blow down from Air Products contains components which can assist the process chemistry at the BOF and at EAF slag cooling. Pipework and pump infrastructures have been put in place to add the total blow down from Air Products into the above referred infrastructure between the EAF and the BOF.

Prior to these changes, about half of the blow down from Air Products used to go to the Open Canal (which bypasses the TETP) and the other half used to go to the South Dam Canal.

Finally, the combined blow down from the whole infrastructure between the BOF area and the EAF is suitable for re-use as make up water at blast furnace slag granulation. V3 blow down was already routed to slag granulation so the blow down from this integrated system was routed (using mostly existing pipework) to the existing blow down sump for the V3 system.

The other blow downs and back washes for the transformer and for the compressor and VAD System at the EAF have now all been routed to this same sump for ongoing pumping to the Blast Furnace Slag Granulation System.

The main result of all this integration has been a significantly reduced use of industrial water, reduced reagent consumption, reduced volume to TETP and reduced salts load to TETP, especially fluoride and sulphate. Note, the full benefit of this scheme has only recently been realised when the desalination plant upgrade was finally completed (see section5.2.7) and the interconnecting pumping system between C and D Furnace Slag Granulation and between C Furnace Slag Granulation Wet Dams and Desalination was completed (see section 5.2.11). This cascaded water system is a good example of the holistic process thinking that RPA have applied to the IVDBS site and critically forms an important part of the overall water management strategy. A pictorial overview of the integration of blow downs can be found in RPA Drawing 484/LA1096 below.

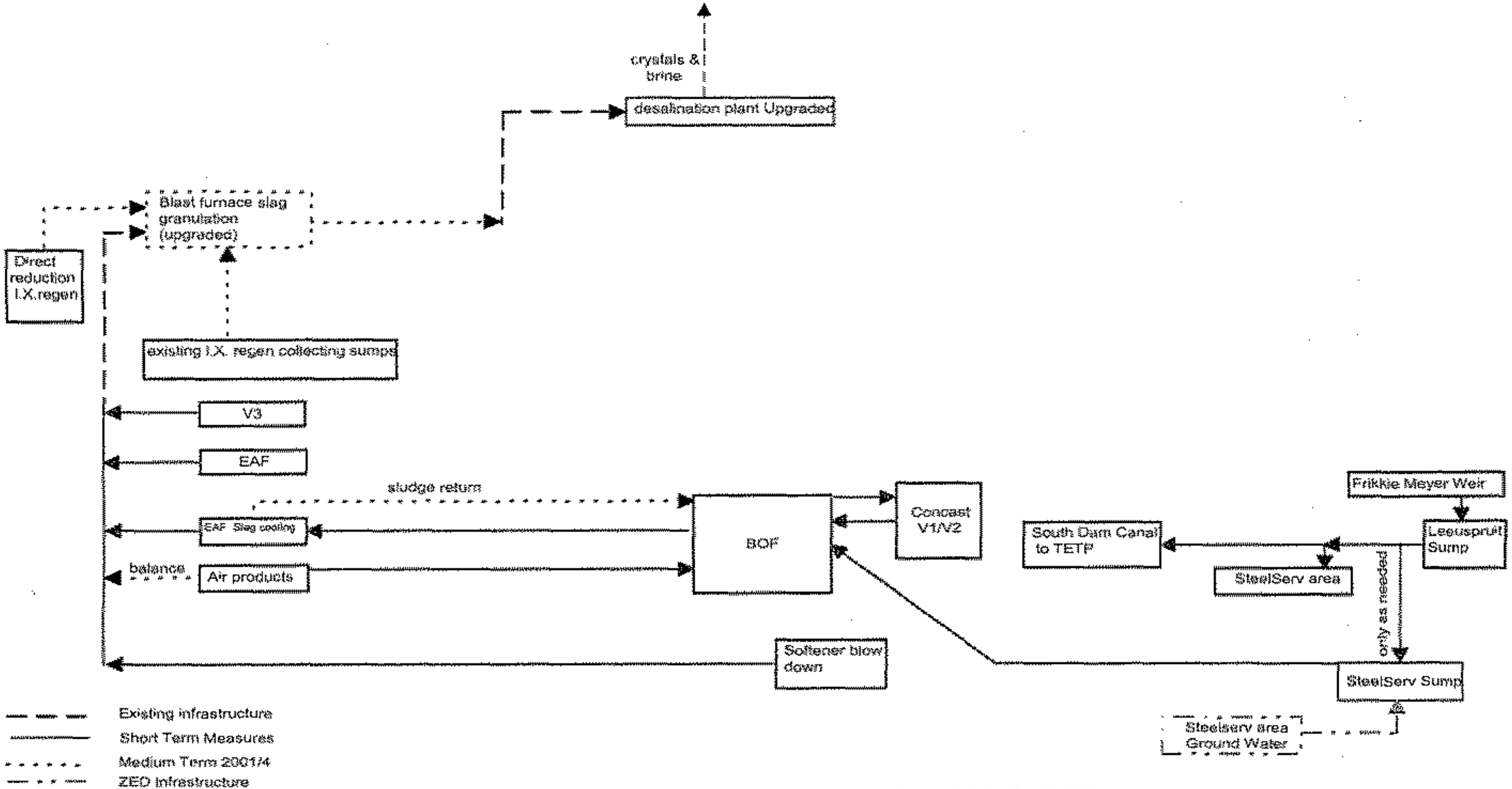
Status

Despite delays caused of pipe infrastructure installation and volume control problems at Slag Granulation the system is now complete and has been working under stable process control since September 2002.

The final connection details for routing the Direct Reduction Demineralisation Plant's Regeneration Effluents to Slag Granulation are still being completed.

Benefits

- Fluoride compliant at TETP
- Compliant sulphate (90-95% of limit) at TETP;
- Reduced dry weather flow (by about 10%). Note other reductions in chemical load will hardly show as TDS and other concentration reductions because of this reduced flow.
- The amplitude of the normal variations in the concentrations of fluoride, sodium, sulphate, calcium, iron and manganese at the TETP has been greatly reduced such that even transient spikes in their concentrations rarely exceed the current limits for TETP discharge.



OVERVIEW FOR HANDLING FORMER INPUTS TO THE SOUTH DAM CANAL - IVDBS

R. Paxton and Associates Ltd
Drawing Ref: 484/LA1096
12 November 2002

5.2.5 COKE OVEN AND SUPRACHEM BUNDING AND DRAINAGE

This project was designed to complete the various localised bunding and other containment works which existed around all the Coal Gas Cleaning plant areas and the associated by-products areas and to connect all of this to a new gravity drainage pipeline. This new pipeline routes all contaminated drainage and spillages from these areas, without the need for pumping, to a new lined sump west of the whole area. Previously many of the bunded areas and sumps required the use of pumps in order to prevent even small spillages from causing overflows to the surface water infrastructure or on to surrounding land. Power outages and motor trips were frequent causes of overtopping.

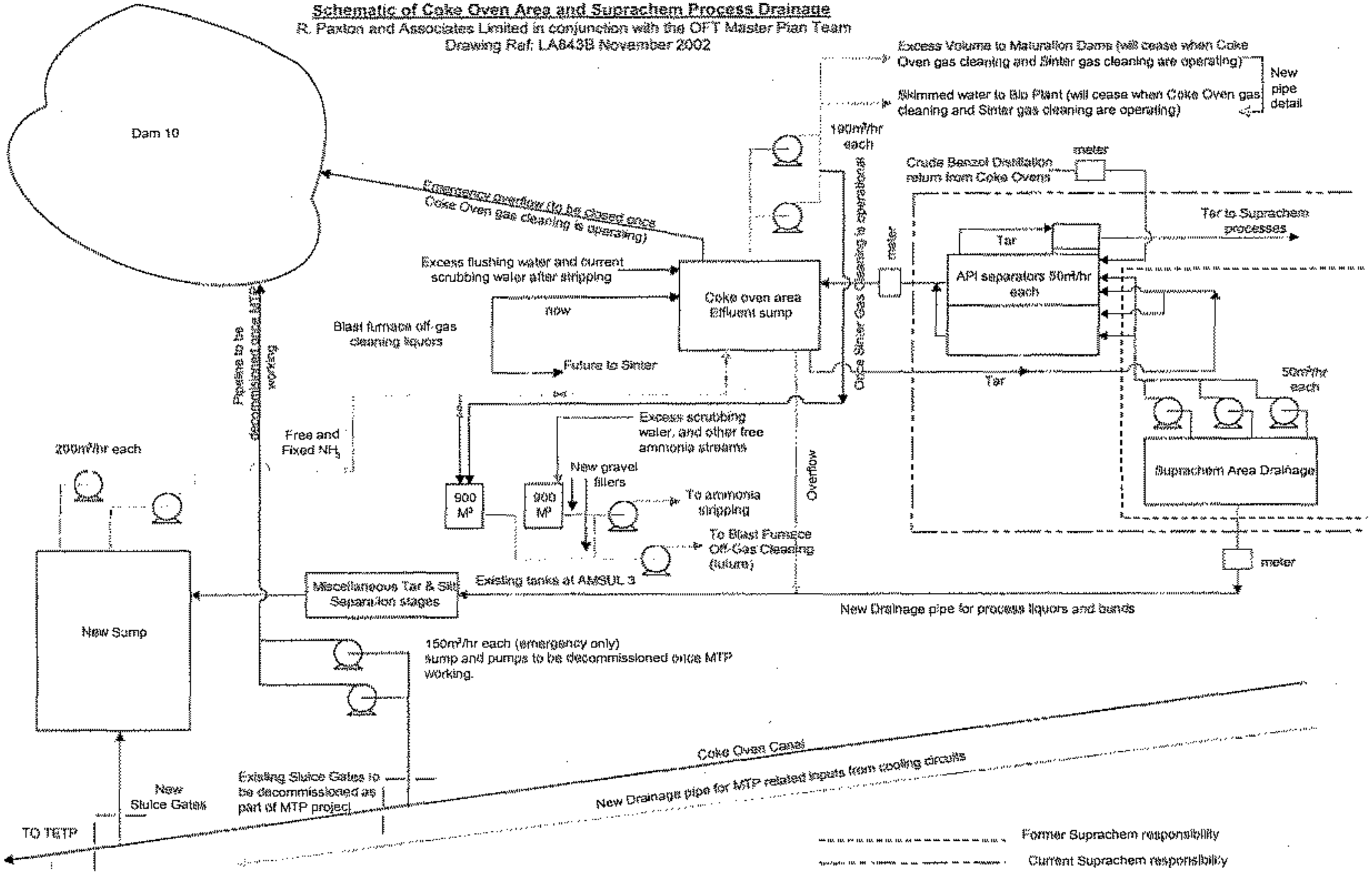
The new sump is equipped with pumps which return all collected waters to the existing infrastructures which enable it to be returned to process. The overriding objective was to ensure all potentially contaminated waters (including surface waters within bunded or otherwise potentially contaminated areas) and which would not be acceptable for discharge to the TETP together with all process blow downs are contained and recycled to process rather than to be allowed to access the Coke Oven Canal.

This infrastructure is complete and working and a schematic representation can be found in RPA Drawing 484/LA843B below.

In addition to the above, extensive bunding and containment infrastructures have been installed in and around the Coke Quenching, the coke rail car route and the handling facilities which receive and drain the fine coke which is routinely dredged from the coke quench recycle sump. These all drain back to the recycle sump.

Also of relevance to this Master Plan Report are the recent developments that have been achieved by the Coke Oven Team themselves. The quenching arrangements at each of the four Coke Quench facilities have been re-arranged and had new controls fitted such that they now achieve a particular sequential quenching action which ensures a very low pore water content in the product coke. This in turn ensures minimal (effectively zero) ongoing drainage from the product coke as it is conveyed to the Blast Furnaces and to the Sinter. A previous significant source of ground and surface water contamination has therefore been effectively eliminated.

Also, the Coke Oven Team has fitted to each coke quenching tower a specially designed spray and mist eliminating hood which has stopped circa 90% plus of the droplet carry over from these quench stations onto the surrounding land, plant and buildings.



Schematic of Coke Oven Area and Suprachem Process Drainage
R. Paxton and Associates Limited in conjunction with the OFT Master Plan Team
Drawing Ref: LA843B November 2002

Benefits

- The new infrastructure integrates with and completes the previous programme of containment activities.
- It has enabled all process and spillage inputs that used to be pumped/drained to Dam 10 to be stopped (until the Coal Gas Cleaning project is complete the volume of this process effluent will frequently exceed the plant's recycle capacity. The Maturation Dam is able to absorb the excess and return it when the plant's recycle capacity can accept it).
- All spillage and rainwater inputs to Dam 10 from this area are now collected for return to process and are used as a substitute for industrial water. (Until the Coal Gas Cleaning and Sinter Off-Gas Cleaning projects are complete, not all of the spillage and bund waters can be recycled immediately. The Maturation Dam is able to absorb the excess and return it when the plant's recycle capacity can accept it).
- At the TETP this infrastructure has:

  - Reduced the ammonia from an average "on the limit" to about 50% of the limit;
  - Reduced the sulphate by about 5 to10%; and
  - Reduced the phenols and other organics from their current on average compliant to routinely compliant
  - Greatly reduced the magnitude and frequency of sudden variations in the concentration of all the above parameters.

5.2.6 UPGRADE OF COAL GAS CLEANING

The current gas cleaning system has a poor removal efficiency for ammonia, sulphur compounds, naphthalenes and moisture. As a result, the end-users of the coal gas have significant operational problems associated with corrosion, burner blockages, control problems and high levels of SOx and NOx in the combustion products. As a result, many users of fuel gas have had to change their supply to Sasol gas. This external Sasol gas has to be purchased for duties where coal gas was used in the past and still could be used if it were clean enough. The large amounts of coal gas which the Sasol gas has replaced is now flared as an excess gas.

The quality of the water used for coke quenching contains high levels of ammonia and organic compounds due to the poor state of the few effluent strippers that remain in service. These strippers should remove the ammonia and the majority of the organics before the effluent is discharged and they should create a recycle flow of circa 60 m^3/hr to the ammonia and hydrogen sulphide absorbers. This recycle does not occur and this results in a much higher effluent flow than necessary from this area. The resultant excess liquids were discharged to the maturation dams adding to an existing problem.

The project currently awaits final EIA and final board approval.

The design concept will upgrade the existing coal gas cleaning plant so as to improve the quality of the gas, to reduce the volume of liquid effluent produced, to create elemental sulphur for sale and to reduce off-gas emissions from both the off-gas cleaning processes and the byproduct handling areas. The gas quality will be improved to such a level that all of it can be utilised within the works rather than having to buy in Sasol gas for those duties where high purity is required. Current corrosion, condensate drainage and blockage problems within the gas mains around the site will also be much improved as a result of the improved gas quality. Ammonia and H_2S emissions to atmosphere will be stopped, emissions of volatiles to atmosphere at coke quench will be greatly improved (the ZED proposals [once the sinter off-gas treatment plant is working] will then eliminated this problem) and smoke and vapour emissions from around the coke ovens themselves will be much improved.

Effluent Related Benefits

At the TETP, the fully upgraded coal gas cleaning will:

- Reduce dry weather flow to about 85 to 90% of the limit;
- Reduce sulphate to about 80% of the limit;
- Reduce sodium to about 75% of the limit;
- Reduce chloride to about 70% of the limit;
- Reduce TDS to about 80% of the limit
- Reduce ammonia, phenol and other water soluble organics to less than half of their respective limits.

5.2.7 UPGRADE OF DESALINATION PLANT

The existing Desalination Plant was handling all the ion exchange regeneration blow downs that could be practically routed to it. In effect, only the regeneration blow down from the Direct Reduction demineralisation plant was not routed to the Desalination Plant.

Shortly after the original plant was installed, the compressor on the MVR evaporator section was badly damaged, beyond reasonable repair. The intrinsic overall capacity of the plant was around 55 to 60 m³/hr of input brine. Only about 25 m³/hr of the brine was being produced by the demineralisation plants. The function of the compressor had therefore been replaced with a steam ejector which was sufficient to enable the plant to operate at about 25 m³/hr evaporation capacity.

As part of the Short Term Measures, the compressor was replaced with a turbo fan installation which was capable of achieving the full intrinsic capacity of the plant as a whole. The style of turbo fan that was installed has a good track record around the world for reliability and robustness. Unfortunately they are long delivery items. The centrifuge also had to be upgraded for both size and maintenance reasons.

The plant is now able to operate at almost 60 m³/hr of total evaporation capacity and the brine source to the units has been extended to include blow down from Blast Furnace slag granulation. This has enabled the extra volume of water referred to in item 5.2.4 above to be routed to desalination thereby removing (considerable amounts of) fluoride, sulphates, chlorides, sodium, potassium, calcium and magnesium from the input to the TETP. It also provided a means whereby the previously frequent overflows and spillages at slag granulation were stopped (see section 5.2.11 below).

In addition to the main compressors, the crystal separating centrifuge has been upgraded and the whole general area around the desalination plant has been properly bunded. This is in addition to the local bunding around the plant itself. This was necessary in order to provide a greater level of security in this area (which would otherwise drain to the Leeuspruit).

5.2.8 DAM 10

Prior to the completion of the bunding work in the Coke Oven, Coal Gas Cleaning and by-Products Areas, all the surface water drainage from within the whole of these areas, all the cooling tower blow downs and back washes and all the waters which accessed the Coke Oven Canal from east of the Coke Oven area (which includes a large Vlai area and surface water catchment area) had to be pumped to Dam 10. This was because the bulk of the relatively clean and TETP acceptable waters were being contaminated with small but none the less polluting quantities of strong process effluents, spillages or surface contaminants. In particular, ammonia, sulphate, phenol and oils and tars were the main pollutants which necessitated this pumping process to Dam 10.

Once the bunding work was complete and the new Coke Oven area sump was working, see Section 5.2.5, a few small, but previously unidentified discharges to the Coke Oven Canal were identified. After these had been dealt with, the water quality within the Coke Oven Canal was monitored as the canal walls and floor cleaned themselves and once the quality was acceptable, the canal flow was diverted to the TETP. This has enabled a dry weather average flow of in excess 100 m^3/hr and all of the storm water which does not land within a bundled area, to be diverted away from Dam 10.

At the same time as this work was carried out, the drainage and containment arrangements in the Suprachem area were re-arranged so that no further discharges were possible to Dam 10 and only organics free surface and roof water was able to be discharged to the Coke Oven Canal.

In addition, the management, maintenance and operation of the main tar skimmer plant in the Coke Oven Gas Cleaning area was handed across to Suprachem. This was for two principal reasons:

a) It enabled Suprachem to control and manage the quality of their principal raw material (the tar) and
b) It enabled Suprachem to control and manage the means by which they disposed of their process effluent and contaminated surface water.

At the same time, the "back door" exits to Dam 10 for process waters from Suprachem and from the tar skimmers were closed.

The other potential net inputs to Dam 10 were overspills from the Burns Memorial Canal, overspills from the clarified water collection header west of the CETP sludge dams and from bund area, bypasses and other discharges from the CETP.

Each of these potential inputs have been addressed and stopped.

Clearly, there is still the ongoing return of seepage water from west of the dam, but in reality this should only be a return of seepage water not a net input.

As a result, Dam 10 has been steadily emptying by both evaporation and by controlled transfer to Dams 1 to 4 so as to keep maximum surface area available at Dams 1 to 4 for evaporation. This steadily emptying has resulted in Dam 10 now being approximately 2m lower than its previous highest level. At this level, it now has circa 30% of the exposed surface area and probably no more than 20% of the contained fluid volume relative to its previous highest level.

This ongoing process for emptying Dam 10 as quickly as possible continues.

5.2.9 DAMS 1 TO 4

The principal ongoing role of Dams 1 to 4 is to receive collected seepage and run off water from the Du Preez catchment system north and west of the dump, to provide an evaporation surface, to provide a source of water for the general dump area and tipping point dust suppression sprays and for the tankers which are used to spray the various roadways on the dump.

Once Dam 10 is empty, then the net water input to Dams 1 to 4 should be significantly less than its evaporative capability and the level in the dam will steadily decline. This rate of decline will be greatly assisted if maximum use is made of the water in Dams 1 to 4 for dust suppression and roadway watering.

In addition, as the ZED infrastructure comes on line, there will be capacity at least during each dry season, to take in some of the contents of Dams 1 to 4 into the MTP.

The available capacity for receiving Dams 1 to 4 liquors during the wet season will depend upon the amount and quality of surface water which has to be handled and on the proportion of Vaal River Water which the site takes in as raw water relative to Vaal Dam Water.

As the existing Dump Site is re-shaped and capped, so the amount of leachate and seepage water that is produced by the Dump will decline. This should reduce both the amount and the salts content of the water which will be caught and returned by the Du Preez catchment system.

Between the completion of the ZED infrastructure and the ultimate construction and operation of the consolidated Residues Management Facility (CRMF) the ZED infrastructure has been designed to be able to accept an equivalent leachate to that which will be produced by the CRMF at up to about 40 m^3/hr. The liquor in Dams 1 to 4 should have a relatively similar composition to CRMF leachate, but by that time, the concentration may be somewhat higher than CRMF leachate. This would mean that the acceptable flow rate into the ZED infrastructure may have to be reduced proportionately.

5.2.10 MATURATION DAMS

The Maturation Dams are used to accept the excess flow of organically contaminated waters from the Coke Oven area which cannot be used by the Coke Quench.

Until recently, the production rate of organically contaminated waters and the usage rate at the coke quench were reasonably well balanced with only a relatively nominal extra flow to the Maturation Dams. As a result of the coke oven bunding activities, there are occasional significant excess return flows from the bund collection sump. These occasional high returns greatly exceed the buffering capacity of the one operational Bio-Plant buffer storage dam (note, the other dam is currently being cleaned out). This excess volume has to be routed to the Maturation Dams.

As a result of the current steady upgrading that is occurring to the arrangement and operation of the coal gas cleaning processes, the normal requirement for these effluent waters at coke quench is now greater than their normal production rate. As a result, the Bio-Plant buffer storage dams have frequently become empty and the short fall was made up using Industrial Water.

Once this usage of Industrial Waster for coke quenching became a routine occurrence, a scheme was developed and implemented whereby the valving and controls for the existing pipework infrastructure to the Bio-Plant buffer storage dams and to the Maturation Dams were re-arranged so that the contents of the Maturation Dams could be emptied to the Bio-Plant buffer storage dams as and when there was capacity within these buffer storage dams. This mechanism will not remove very much water until the rebuild and maintenance programme within the coal gas cleaning area has progressed more substantially. However, by about the end of 2003, this mechanism for emptying the Maturation Dams should be achieving a net removal rate of the order of 50 to 80 m^3/hr.

This net removal rate together with evaporation should see the water content of these dams being effectively fully removed during the latter part of 2004 or the early part of 2005.

In this regard, the recent trial work using Archaea for digesting the organic content of the various organically contaminated dams needs to be considered with a degree of urgency. This is because the type of sludge that will be present within the bottom of the Maturation Dams will be much more easily handled whilst it is beneath a mobile aqueous layer rather than when it is an exposed and semi dry silt.

5.2.11 BF SLAG GRANULATION

The Slag Granulation process involves pouring the molten slag through a large flow of water in a granulation unit, one for C Furnace and one for D Furnace.

After granulation, the slag/water slurry is pumped to a drainage system. At C Furnace, this consists of horizontal settlement and drainage beds. At D Furnace it consists of both a rotating de-watering drum (the INBA Unit) and a set of horizontal settlement and drainage beds. After initial de-watering the residual moisture of the slag sand is generally around 30-50% by weight. Once the product slag has been allowed to drain fully, then the moisture content is generally around 10%. At the time when the Master Plan Studies commenced, the settlement and drainage beds (or Dry Dams as they are known) were periodically drained and the slag was removed to a drainage area. At C Furnace this is done using a loading shovel and Bell Trucks. At D Furnace or overhead gantry and clam shell bucket is used. Similarly, the slag which was filtered from the granulating water by the INBA unit was piled in a heap to drain before it was removed.

Collectively, the drainage areas, on occasion, created in excess of 60 m^3/hour of drainage flow, most of which drained directly to one or more of the surface water drainage canals in the area. The average routine flow was of the order of $20m^3$/hour, with the majority of this routine flow being derived from D Furnace.

In theory, the water used in the granulation process is all collected and reused so as to generate very small amounts of wastewater.

In addition to the above referred routine loss as a result of slag drainage, there were (at the time of the commencement of the Master Plan Studies) frequent overflows from the collection and return systems, mainly as a result of inadequately understood system dynamics and poor operational control. As a result, sudden discharges of around 100 to 300 m^3 at a time were not uncommon.

A further problem associated with the slag granulation systems for both furnaces was the large amounts of water that was fed to the gland seals on the various recirculation pumps, especially the pumps which pump the hot slurry of granulated slag and water from the granulation unit. In particular, water usage at D Furnace was very high.

The initial thrust of the Short Term Measures was to reduce this seal water usage as the total usage exceeded about 40 m3/hr.

It should be noted that the Blast Furnace Slag granulation process for both Furnaces evaporates approximately $40m^3$/hr in total, and therefore spillage and overflows were going to be inevitable until this problem was controlled.

RPA worked with the respective maintenance departments and with the pump supply and contract maintenance company for the specific pumps. As a result, the problem of excessive seal water usage has been mostly overcome on an 80:20 type of basis. However, the design of the current slag granulation facilities at D Furnace are such that it is more appropriate to wait for the changed granulation arrangements which will accompany D Furnace Rebuild rather than spend the other "80%" in order to gain the last "20%" or so of benefit.

Following on from these Short Term Measures, the problems of drainage water and the occasional overflows and pump outs to prevent local plant area flooding, have been addressed progressively over the last 18 months. Historical experience with corrosion, scale formation and crystal growth when handling these liquors and when arranging more effective drainage of the slag, was carefully assessed. In the light of that experience a specifically arranged system of under drainage pipes have been installed in the C Furnace Dry Dams, together with upgrades to the drainage collection channels and to the level controls on the Wet Dams (the buffer storage dams which enable the granulation liquor to be recycled). As a result, only fully drained slag is now removed from these dams and it can be loaded directly on to the off-site transport arrangements. It is anticipated that the slag handling capacity of the Dry Dams at C Furnace will be such that with perhaps one more Dry Dam, the whole of C Furnace and D Furnace slag granulation can he handled at these Dry Dams. This will enable all of the current facilities for D Furnace to be shut down and the area cleared, rehabilitated and got ready for usage as part of the D Furnace re-build.

In the mean while the facilities for D Furnace have been contained and all surface run off from the drainage areas is collected and pumped back to the granulation water recycle system.

As a result of being able realistically to contain the slag granulation operation it was appropriate to continue and complete the originally planned Short Term Measures which were to:-

- Collect together all the effluents with high sulphate, fluoride, manganese and sodium from around the BOF, EAF slag cooling, Air Products, the EAF itself and the Continuous Casters V1, V2 and V3.
- Route these effluents as a combined stream to Slag Granulation

- Make this liquor the primary make up water to the granulation system.
- Route the liquors currently collected in the sump for the used regenerating liquors from the Demineralisation Units to the Slag Granulation System as a further supply of make up water. This was to use the slag to pH stabilise these blow downs and to precipitate as much calcium, sulphate, magnesium and other salts as possible (so as to minimise reagent usage at the Desalination Plant and to stop crystal build up in the inlet buffer dams at the Desalination Plant).
- Reconnect the pipeline from the sump for the used regenerating liquors to the Desalination Plant to outlet pumps from the C Furnace Wet Dams so as to provide Slag Granulation water as the only brine input to the Desalination Plant.
- Arrange for the input waters from the V3 sump and for all the used regeneration liquors to feed normally to the D Furnace system, for the D Furnace system to be pumped to the C Furnace system and for the C Furnace system to be pumped to the Desalination Plant.
- Arrange suitable cross over pipework and controls for achieving an equivalent scheme when one of the Blast Furnaces is off line.
- Arrange the overall controls such that at each stage in the overall process of cascading the effluents, the specific stage was arranged to have an open inlet pipe to the blow down from the preceding stage and that it pumped forward to the following stage on the basis of simple level control. Then, if the flows to the Desalination Plant were too high, then the make up rates to the BOF, to Air Products and to the EAF cooling systems had to be reduced. Likewise, if the flows to the Desalination Plant were too little, then either more blow down from these sources could be sent forward or the extra volume could be made up using other brine sources, such as the CETP Canal or Dam 10.

Now that the system as a whole has been operating smoothly for almost three months, it is clear that the normal Desalination Plant capacity appears to be able to maintain comfortably within specification concentrations of dissolved components within the BOF, EAF slag cooling and all the other areas. There does not appear to be any significant spare capacity for long term disposal of other liquors, but short term capacity (to handle specific incidents) is available.

5.3. THE ZED INFRASTRUCTURE

5.3.1. COMPLETION OF THE WATER TREATMENT CONCEPTS

From the point of view of simplifying what chemical treatment processes were needed in order to reach ZED, the Short Term Measures and their follow on activities have achieved a number of benefits. These are:-

- The main process plant sources of calcium, magnesium, sulphate, manganese and fluoride (i.e. excluding raw water make up to cooling towers, etc) other than from the CETP are routed through slag granulation to the existing desalination plant.
- Waters with organic, ammonia and sulphide contaminants from the Coke Oven and related areas and from the Blast Furnaces have been separated out from the rest and can be handled by the existing outlets pending the full implementation of the MTP and the Sinter Off-Gas Cleaning Plant.
- The sequestering agent and other related problems at the CETP have been identified and segregated into operable systems.
- Process and external surface water derived inputs to Dam 10 and to the Maturation Dams have been stopped and the Dams are steadily being emptied. Dam 10 is almost empty and

the rate of emptying of the Maturation Dams should steadily increase to about 60 m3/hr during the next 12 months.

As a result, in order to achieve and maintain ZED, it will not be necessary to process waters from Dam 10 and from the Maturation Dams through any ZED treatment processes. Also, the process concepts which were reviewed through Sections 5.1.9 to 5.1.14 will be able to handle (with capacity to spare) all the ongoing production of organically contaminated waters from within the Coke Oven and its related areas and from within the Blast Furnace Off-Gas Cleaning Process.

As the chemical speciation based modelling work (Section 5.1.17) was developed it became clear that providing:

- All the output from the CETP had a low magnesium content
- The other potentially high magnesium content process waters were routed to BF Slag Granulation or to the CETP

Then all the magnesium, manganese and fluoride contents resulting from normal cooling tower blow down was not high enough to cause an MTP processed water to be unable to be concentrated by about 3 times without scale formation.

This meant that the normal chemical precipitation based softening process could be greatly simplified for all these waters.

Sufficient magnesium was, as a matter of course being removed at the CETP, because the final treatment pH had to be about 10.5 in order to remove the optimum amount of manganese and for the surface active agents to interfere the least. It should be noted that at pH 10.5, magnesium hydroxide is at its lowest solubility and that magnesium hydroxide at this pH represents the lowest solubility form of any practical form of magnesium.

Also the BOF, etc effluents are now being handled successfully through slag granulation and the Desalination Plant.

Therefore, all that remained was to identify

- a standby route for slag granulation liquors, should the Desalination Plant go off line for an extended period and
- which of the ground waters that needed to be intercepted had too high a magnesium content.

The pipeline leading from Slag Granulation to the Desalination Plant passes close to the Q Pump House. It would be relatively simple to discharge the Slag Granulation Waters into the DWI and stannous effluent sump for ongoing pumping to the CETP. Note, the acid rinse sump should not be used because of the risk of scale formation resulting from the high calcium content of the slag water and the high sulphate content of some of the acid rinse water. For CETP plant capacity reasons as well as chemistry reasons (see later) the slag water should not be added to either the oily or the alkaline effluents.

The situation with the ground waters has been basically defined and it was clear that a suitable separation of high and low magnesium content liquors also followed a logical high and low chloride separation. Both of these issues will be discussed in more detail later.

For now, it is enough to know that the concept of not needing to remove magnesium hardness at the Main Treatment Plant (MTP) was viable.

This concept therefore meant that all that was needed at the proposed MTP was:-

- to control calcium hardness
- to remove suspended and precipitated solids
- to remove traces of oil

The modelling showed that the amount of precipitated calcium sludge would be well within the settling and sand filtering capacity of one of the two halves of the TETP. The site infrastructure issues had shown a gravity discharge arrangement to the TETP area for all the process waters was feasible and being gravity discharge all the way, it would be intrinsically very reliable and easy to maintain.

The concept was therefore evolved of creating the MTP out of half of the existing TETP and to use the existing North and South Buffer Dams as part of the necessary buffer dam requirements that would be needed.

The North buffer dam was ideally located relative to the current canal infrastructure to take on the role of buffer storage for the incoming process waters and also to receive any dry weather seepages and spillages. It could also take on at least part of any necessary First Flush requirement, if such a requirement was found to be necessary.

The South buffer dam was too small for those roles but it was well positioned relative to the canal infrastructure and the existing TETP to take on the role of buffer collection dam for the concentrated brine that needed to be evaporated. It was also well positioned with respect to the strong ground waters which needed to be intercepted west of Dam 10 and west of the Dump (see later for details). From the point of view of process control, plant management and ease of equipment monitoring and maintenance, it would be preferable to keep the brine evaporation process close to the MTP, and preferably part of it.

5.3.2 BRINE DISPOSAL

In the light of the previous section, the remaining question was "What can be done with the brine?" In this regard a number of issues are most important:-

- Crystallisers which handle variable site effluents have notoriously poor reliability and high maintenance costs.
- Crystallisers for these types of brine are in general expensive and they tend to have components which require long outage periods when they either fail or need major repair.
- If the brine is converted to crystals, how are the crystals to be disposed of with controllable and minimum liability?
- The higher the chloride content of the brine, the higher the capital cost and (normally) the higher the maintenance costs. For metallurgical reasons, these rising capital costs tend to have large stepwise increases.
- High chloride contents must also be avoided within the return water or else high corrosion costs will be encountered within the users of the MTP product water. The principal chloride source is the acid rinse water input to the CETP from North Works (see later for how this is to be mitigated)

- From an equipment costs, operating costs and reliability point of view it is best to concentrate the brine to a point where it has a small enough volume for it to be used by one or more activities.

On the basis of the above issues, it was clear that if on-site or off-site users could be found for the brine, then that should be regarded as the preferred option. Following extensive investigations, two potential uses were identified:-

a) use as the mixing water for the likely solidification and stabilisation process that was most likely to be required for the bulk of the non-recyclable/non re-usable solid residues on the site.
b) Use as a substitute or part substitute quench water for the cooling sprays in the D.R. kiln after burners.

At present, each DR after burner consumes about 12 m^3/hr of water. The off-gases then go on to boilers which proceed to raise about 45 to 50 tonne per hour of steam from the product gases from each after burner. Whenever there is a shortage of boiler feed water or there are not enough users for the steam (which is frequently the case), it is normal practice to increase the flow of quench water so as to produce less steam. Indeed, it is possible to avoid making steam altogether.

For an evaporator and crystalliser stage and probably for the last stages of evaporation as well, the energy that would be needed to evaporate the water from the brine would be most economically supplied by steam. For process efficiency reasons a little over one tonne of steam would be required for every tonne of water evaporated. It would therefore be more energy efficient and massively cheaper to evaporate the brine in the DR after burner system rather than to create steam at these after burners and use the steam to provide the energy input to a crystalliser.

The only environmental issue therefore would be, would the salts that would become deposited on the DR dust make that dust significantly more difficult to dispose of? On the basis of RPA's experience elsewhere and on the basis of the analyses and leach analyses for DR dust, these salts would not make the dust significantly more difficult to dispose of.

On the face of it, therefore, there is a potential brine consumption capacity of up to about 250 m^3/hr if all four DR kilns are operating. It is very rare for more than one kiln to be off line at a time and when that does occur, that situation invariably lasts for only a few hours. Theoretically, therefore, it would be quite possible to purge a steady flow of at least 150m3/hr if that were needed. However, a more realistic purge of around 50 m^3/hr would represent the optimum from an overall site energy usage basis.

A secondary potential problem which may occur with the DR after burners and which can only be characterised by specific plant based trails is just how much of the likely salts can the after burner take before the dusts (which are subsequently removed by electrostatic precipitators (ESPs) down stream of the boilers) become too sticky or otherwise difficult to remove from the off-gases. This is unknown territory. Experience elsewhere with ESPs handling dusts from cement kilns where high NaCl and KCl contents were introduced into the dusts do show some types of ESP to be affected, but only when the total NaCl and KCl content exceeded about 5% by weight in the dust. With current dust production levels on the DR kilns this limit would appear to be clear of most realistic potential operating scenarios.

On the basis of the currently expected tonnages of non-recyclable/non re-useable solid residues that will have to be routed to the Dump, then a stabilisation and solidification process should be able to absorb about 40 m^3/hr of brine. This is based on test work and large scale pilot scale trials with similar texture but significantly more hazardous solid residues. This test work was conducted under RPA's supervision. This test work showed that if the process was set up and operated appropriately then the type and quantity of crystal residues currently produced by the Desalination Plant could also be incorporated into this stabilisation process, subject also to the landfill operation being conducted appropriately.

On the face of it, therefore, the brine could be used in two locations and that the usage rate could be of the order of 40 m^3/hr in a solid residues processing plant and of the order of 50 m^3/hr (or more up to a short duration maximum of around 250 m^3/hr and a routine maximum of around 150m$_3$/hr) in the DR after burners.

In order to be able to exploit these options for the on site use and/or disposal of brine, specific confirmatory test work will be required, followed by the inclusion of those results in the ultimate EIA processes for changes to the DR and for the Residues Management Facility. These processes will take time, but with the right prioritisation could be complete within the necessary time frame to enable the necessary equipment to be ordered and installed before the ZED 2005 dead line.

As a back up (but a very expensive back up) an evaporator and crystalliser could be added to the ZED infrastructure. This would produce a reasonably dry crystalline product which could be transported to a suitable off-site disposal outlet. Leaving economic issues to one side, RPA has very serious doubts as to whether a crystalliser and off-site disposal represents an appropriate way forward when viewed from the point of view of an overall holistic environmental stand point. However, time expediency may require this option to be considered.

5.3.3.SUMMARY OF BASIC ZED CONCEPT

The attached RPA Drawing 484/LA975A sets out the basic concepts for the additional ZED infrastructure which would need to be added to the existing systems. These existing systems include the BOF integration and the whole infrastructure from the BOF via V3 to slag granulation and on to the Desalination Plant, together with the use of slag granulation for the pH and quality stabilisation of the regeneration effluents from the various dimineralisation plants.

The leachates and other potentially high magnesium, manganese and fluoride containing waters from around the site are shown being routed to the upgraded CETP, together with the strong effluents from the Cold Mills. The North Works Blow Down and that which will remain from South Works will all be suitably low in magnesium, manganese and fluoride. This enables them to be routed directly to the MTP.

The output from the MTP is routed to the selected process users in South Works via the selected section of the existing Industrial Water Main. These users then direct their blow downs via a combination of new and existing infrastructures, partly to the MTP for further recycle and partly to the Coke Quench. This separation of the return flows is conveniently achieved using the collection arrangements and the simple geography of the site. Essentially those which are convenient to direct to Coke Quench are sent there, the rest (from further south in the site) conveniently return to the MTP. Any balancing that is needed is arranged by either overflow to the MTP from the collection arrangements which serve the Coke Oven Feed or (on the rare occasions when there is not enough blow down following that route) by direct feed from the MTP.

Each Coke Quench station then gravity overflows to the evaporator feed.

There will be a connection from the MTP direct to the evaporators for potential top up reasons and to cover all the potential "what if" scenarios.

The necessary make up water to the system is shown as being prioritised towards contaminated surface waters which will have arrived by gravity in the North Buffer Dam or they will have been pumped from wherever they have occurred/been intercepted to either the North Buffer Dam or to an appropriate part of the Process Waters Catchment system.

Other collected storm waters from elsewhere on the site are then the second priority source for make up water with either Vaal Dam or Vaal River water being the lowest priority source.

Obviously, there would be a preference to use Vaal Dam Water as opposed to Vaal River because of its reduced salts content. However, the DWAF are likely to have a preference for the site to use River Water. Because of the in built salts handling concept, this should not present any technical problems, but it will create capacity and cost implication.

This will be especially the case if the crystalliser route is taken. If the DR afler burner route is taken and if the DR dust disposal issues prove to be as RPA expect them to be, then the extra costs to the IVDBS site associated with using River Water rather than Dam Water for this top will be trivial, probably indistinguishable.

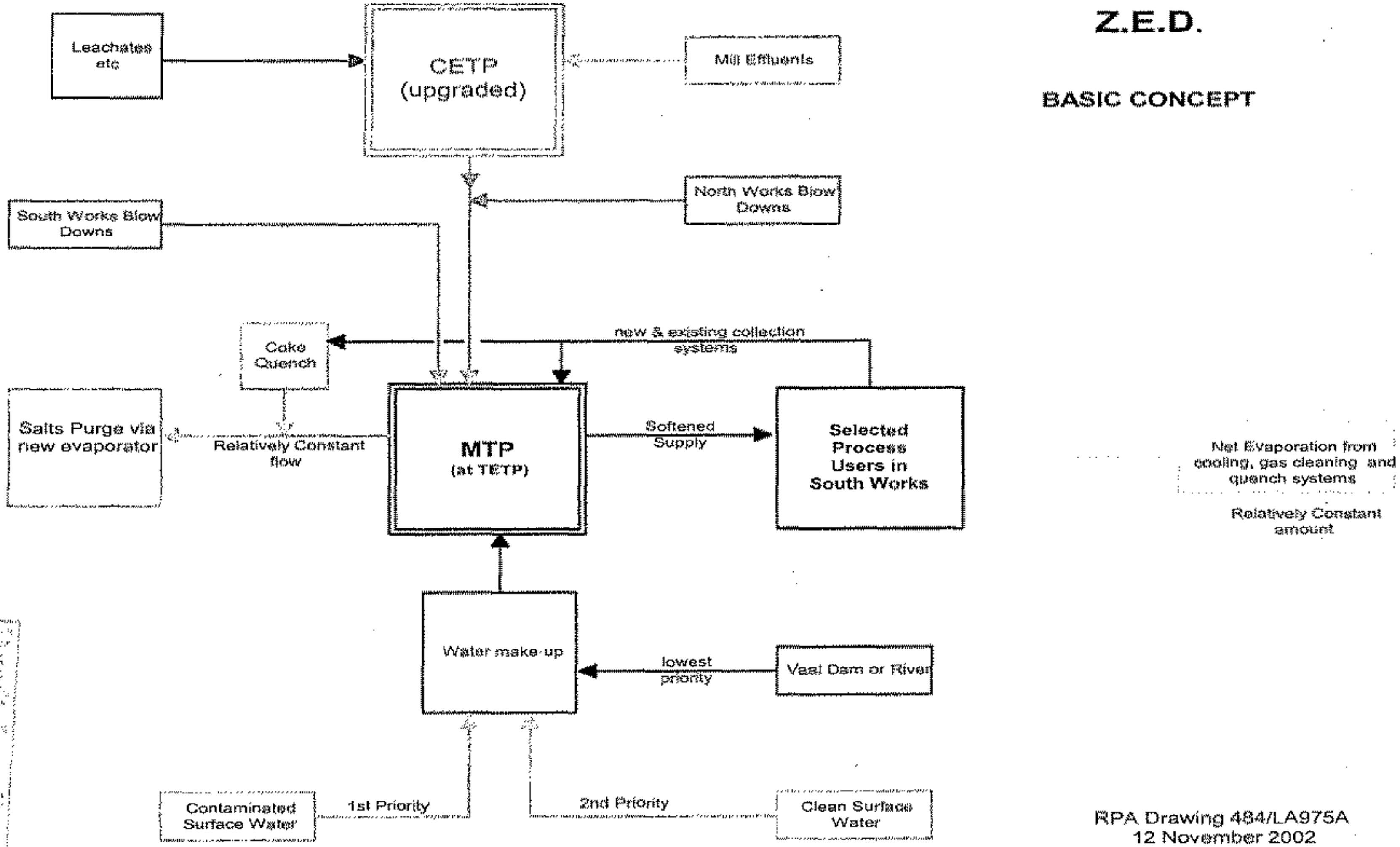
5.3.4. GROUND WATERS

On the basis of the interpretations of the ground water situation that have been made by JMA, it would appear that the only ground waters that will need to be pumped are from the northern end of the eastern boundary, the south east corner of the site and the middle region of the western boundary. In addition, the waters along this part of the western boundary have widely varying chloride contents. About half are anticipated to have a high chloride concentrations and most of the rest should have relatively low chloride concentrations.

On the basis of the data provided by JMA to RPA, RPA were able to predict the following anticipated characteristic analyses for these ground water groupings.

Z.E.D.

BASIC CONCEPT



RPA Drawing 484/LA975A
12 November 2002

Table 5.3.4.1. Anticipated Analyses and Flows of Intercepted Ground Waters

		Dam 10 Area	**Dump + Dams 1-4**	**North East Perimeter**	**South East Corner**
Total hardness	mg/l				
Ca Hardness	mg/l				
P Alk	mg/l				
Total Alk	mg/l	152	94	81	225
TDS	mg/l				
NH_3	mg/l				
P	mg/l				
SiO_2	mg/l	27	19	24	12
Oil	mg/l				
Phenol	mg/l				
pH		7.2	7.2	7.3	7.5
Anions					
Cl	mg/l	852	916	148	205
SO_4	mg/l	474	693	94	556
F	mg/l	1.2	0.36	0.43	0.91
CN	mg/l				
NO_3	mg/l	2.4	0.5	60	100
NO_2	mg/l				
OH					
PO_4	mg/l				
CO_3	mg/l				
SiO_3	mg/l	34	24	30	15
Cations					
Mn	mg/l	1.7	1	0.5	1.6
Na	mg/l	136	146	31	264
Fe	mg/l	11	29	10	2.7
Zn	mg/l				
Sn	mg/l				
Cr	mg/l				
K	mg/l	14	5.8	6.7	51.7
Ca	mg/l	334	324	93	295
Mg	mg/l	167	203	73	70
NH_4	mg/l				
Flow	m^3/hr	40	68	40	20

The ground water from the south eastern corner of the site appears to be quite compatible with the water collected in the SteelServ sump and which is currently being pumped to the BOF as part of its make up. If this ground water is pumped to the SteelServ sump then there should be no reason why it could not be routed with the rest to the BOF, subject only to the ground water pumps being controlled by the level in this sump. Should the level in the sump rise to high level alarm (e.g. as a result of peak storm conditions, power outage, pump failure or a blockage somewhere) then, in addition to the appropriate alarm functions, the ground water pumps must be stopped. When normal level control is re-established then the ground water pumps should restart automatically.

The high chloride content ground waters from the west of the site have chloride levels which are too high for the Coke Quench. Unacceptable chloride attack problems are likely if these ground waters were to be introduced anywhere upstream of the softening stage in front of the new MVR evaporator stages.

The ground water from the west of the site with reasonably low chloride contents are also expected to have reasonably low magnesium, silica, alumina and fluoride levels. This means that they could be added to the overall MTP process at a point just upstream of the final calcium removal stage (providing all the other inputs to this stage are pre-treated to a sufficiently low level as regards these components).

All the comments that apply to the low chloride western ground water would also appear to apply to the ground water from the northern end of the eastern boundary.

These same comments would also appear to apply to the combined effluents that are discharged to the North Works Blow Down Canal from the whole of North Works and from the treatment plant for the Vaal Dam Water Supply.

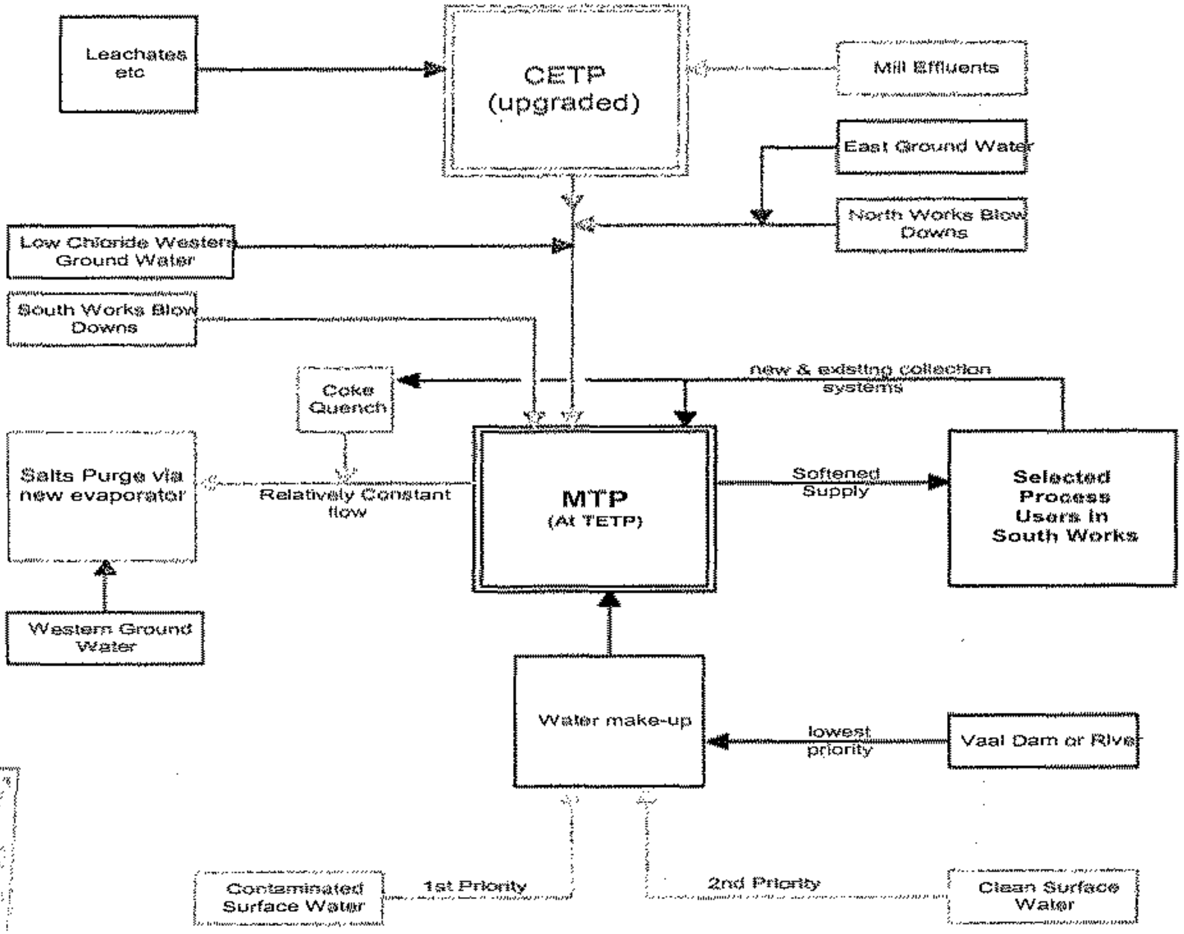
As a result of the above interpretations, the proposed ground water addition locations have been added to the basic concept drawing and are presented in RPA Drawing 484/LA974A. The ground water in the South East corner is not shown on this drawing because it will be routed to the BOF.

RPA Drawing 484/LA1097 shows the basic concepts together with the proposed interconnections for the brine disposal which were discussed earlier.

The next issue that had to be resolved was what further actions needed to be carried out at the CETP in order to enable the much simplified process at the MTP to be achieved. In order to appreciate all the relevant issues, it is appropriate to summarise the concepts thus far.

Z.E.D.

BASIC CONCEPT (Including Ground Water)



Net Evaporation from cooling, gas cleaning and quench systems

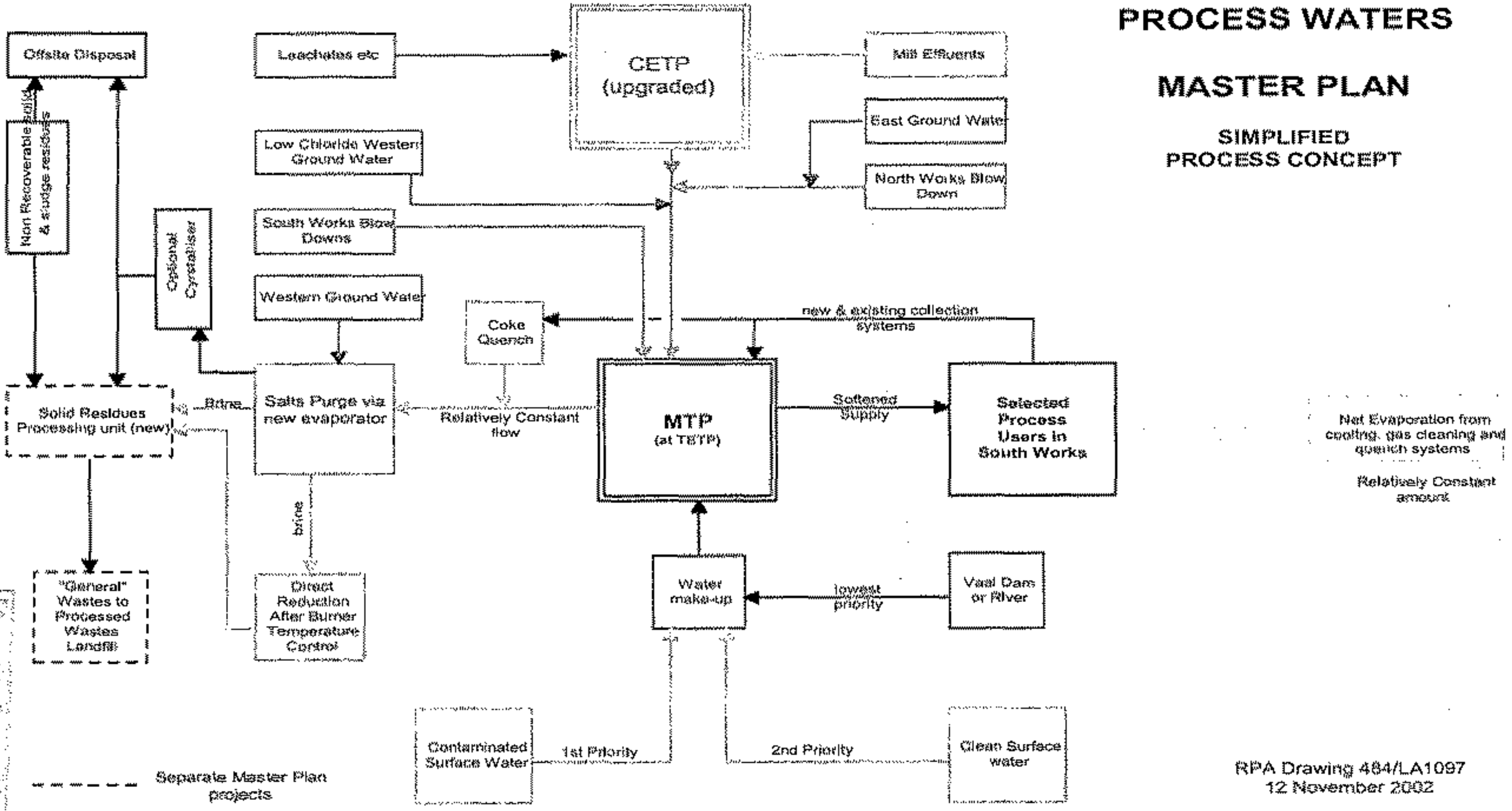
Relatively Constant amount

RPA Drawing 484/LA974A
12 November 2002

PROCESS WATERS

MASTER PLAN

SIMPLIFIED PROCESS CONCEPT



RPA Drawing 484/LA1097
12 November 2002

5.3.5. SUMMARY OF THE ZED PROCESS CONCEPTS

The basic concept behind the ZED proposals is to collect together all the current process derived inputs to the TETP and to:-

a) Recycle most of the essentially clean effluents directly to alternative users as a substitute for their current supply of Vaal Dam or Vaal River water. (This applies to about 200 m³/hr of mostly quench waters produced in the South Mills area. The bulk of these waters are to be re-used locally. The remainder of these waters will be fed to rolling coolant circuits as part of their make up waters). Much of this recycle work is already being arranged by the mill areas themselves for reasons of immediate cost reductions.
b) Collect the rest together, add contaminated ground waters, potentially contaminated storm waters, other collected spillage and surface waters plus make up water, as needed, from the Vaal Dam or the Vaal River and suitably "soften" this overall total flow in order to enable it to be used as the sole make up water in selected evaporative cooling and evaporative quench systems including the continuous casting activities. This "softening" has to be such that the product water can be used by all these users without creating a potential scale formation problem and without significantly affecting corrosion within these user circuits. In this instance, the necessary softening has to control a number of other components in addition to the normal calcium and magnesium.
c) Direct some of the blow downs and the back wash waters from the user circuits in b) to secondary uses where further increases in the quantity of dissolved salts and the consequent potential for scale formation and corrosion will not cause significant operational problems. These secondary users include coke quenching and the various slag quenching and granulation functions. The quantity of waters that are directed to these secondary uses has to be controlled not on the basis of how much water these secondary users normally use but on the basis of blowing down sufficient of the more concentrated b) circuit waters from the b) circuits so as to purge enough dissolved salts and thereby prevent the build up of these salts to levels where corrosion or other unacceptable problems could occur within the b) user circuits.
d) Direct the remainder of the blow downs and back wash waters from the user circuits in b) back to the input and treatment arrangements for b).
e) Purge the secondary users water circuits of their excess volumetric feed to evaporator pre-treatment and then Mechanical Vapour Recompression (MVR) evaporators in order to remove all the various dissolved salts which have accumulated from the source waters and (where appropriate) from the particular secondary users. If necessary purge more volume than the above excess volumes, if this is required in order to keep the dissolved salts content within acceptable limits.
f) Feed the concentrated brine product from the MVR evaporators
    - partly to a crystalliser (namely the one at the desalination plant [subject to its available capacity]),
    - partly to the cooling sprays in the DR furnace after burner chambers as part of their control system for preventing over-temperature issues and
    - partly to the probable Solid Residues Processing Facility as its necessary input of mixing water.

In addition to the second and third of the above brine outlet options, a crystalliser has been included within the Tender Enquiry Documents as an alternative to one or both of these two. This has been done so as to cater for potential project timing or other difficulties that may be incurred by these options.

g) Remove trace organics from the distillate from the new MVR evaporators (and the crystalliser, if it is built) using activated carbon or another type of adsorbent and then feed the distillate to a selected location within the Vaal Dam water distribution system so that it can be used as make up water to the Main High Pressure Boilers, where its higher purity with respect to Vaal Dam Water will be best exploited.

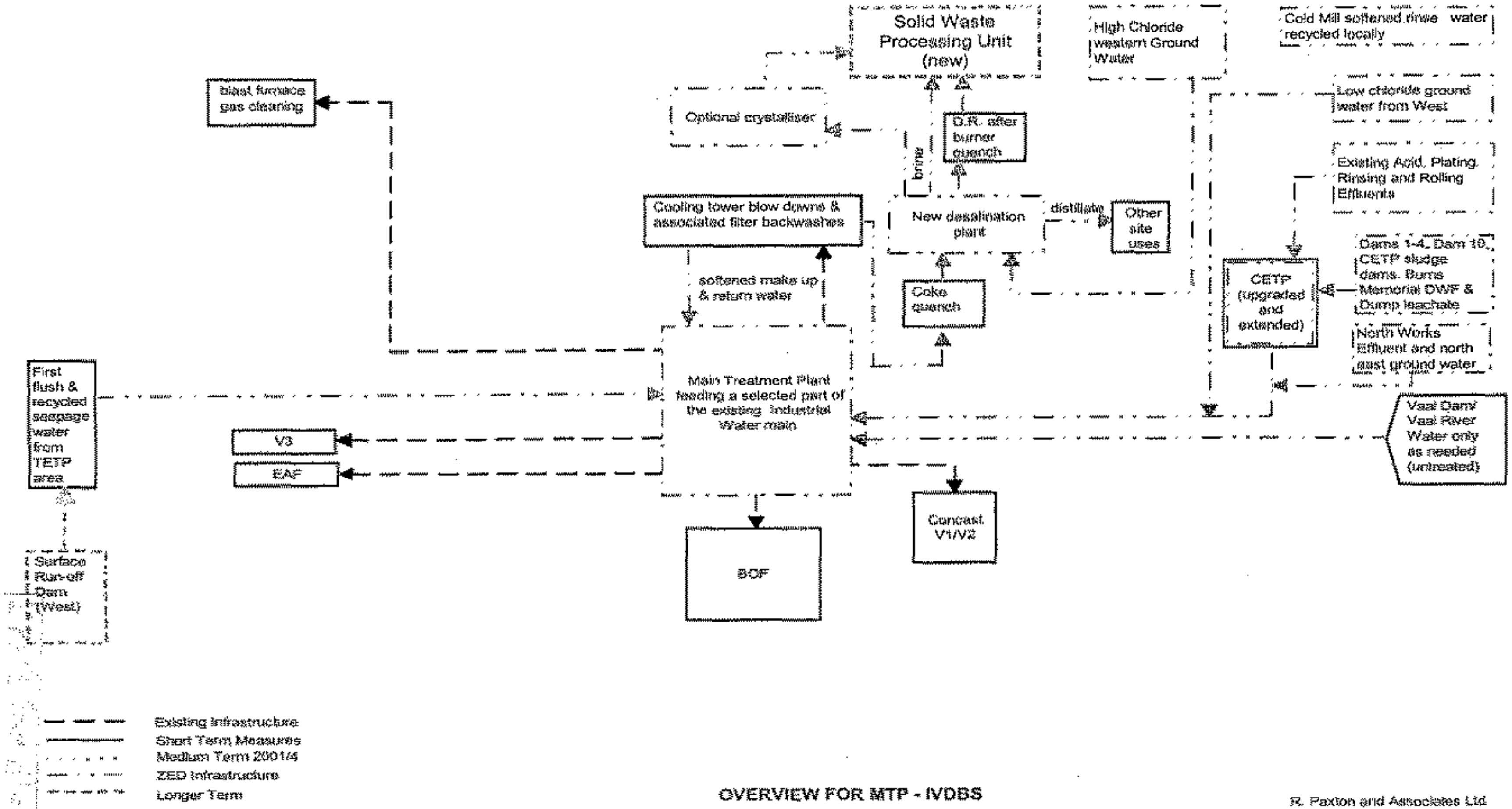
These concepts are presented diagrammatically on the following two RPA Drawings. 484/LA839E shows how all the different source waters are routed to the CETP and the MTP and how the product waters are distributed to the different key user areas of the site. Drawing 484/LA837D adds to this the rest of the overall infrastructure including the BOF, the EAF area, the continuous casters, slag granulation, the ion exchange regeneration effluents and the existing Desalination Plant.

Both of these drawings use different line types and colours to show how the whole strategy is built up over time. It exploits as much as possible the existing infrastructure. Then the Short Term Measures are added followed by the Medium Term (or Ongoing Measures), with the Process Waters side of the whole being completed with the ZED infrastructure. For simplicity of presentation, the Ground Water inputs are shown as being part of the ZED infrastructure. The integration of all these developments into the overall Master Plan for the site as a whole is shown as Longer Term items. These latter include the treatment of the Sinter Off-Gases, Surface Water Management and the handling of solid residues.

The overall mass balance associated with all this infrastructure is shown on the attached RPA Drawing 484/LA1000A. Within this drawing a number of process streams have been allocated a flow range of from 0- a number. These are "Steelserv area," "Surface Water," "Leeuspruit Dam" and "Vaal Dam/Vaal River". These ranges are not mutually additive. The total average input for all four of these sources cannot be higher than 240 m^3/hr unless other inputs such as from ground water are reduced, otherwise the system will not balance. Also, during maintenance or other issues associated with "New MVR Evaporator" (the brine concentration stage) the throughput of these evaporation units will reduce, probably by the order of as much as 70 m^3/hr. The above referred 240 m^3/hr will have to be reduced by the same amount during those periods. The flow range on the MTP product feed to the BOF reflects the variable feed associated with rainfall variations at the Steelserv sump.

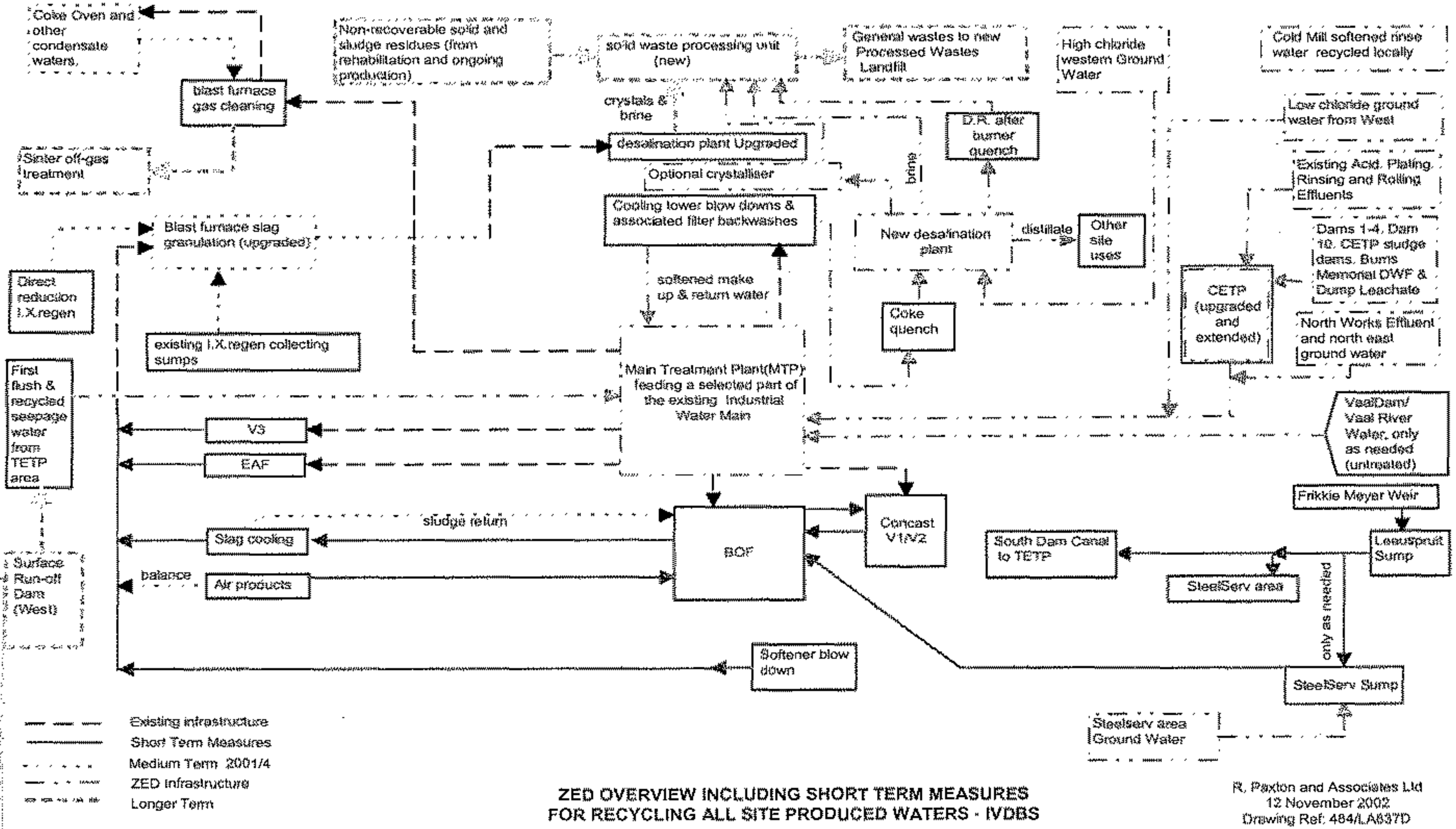
All the other flows are the current best assessments of the likely routine average flows.

For reference, the "Current Process Water and Dry Weather Balance" (RPA Drawing 484/LA990B) which was presented in Section 3 is included here as well.



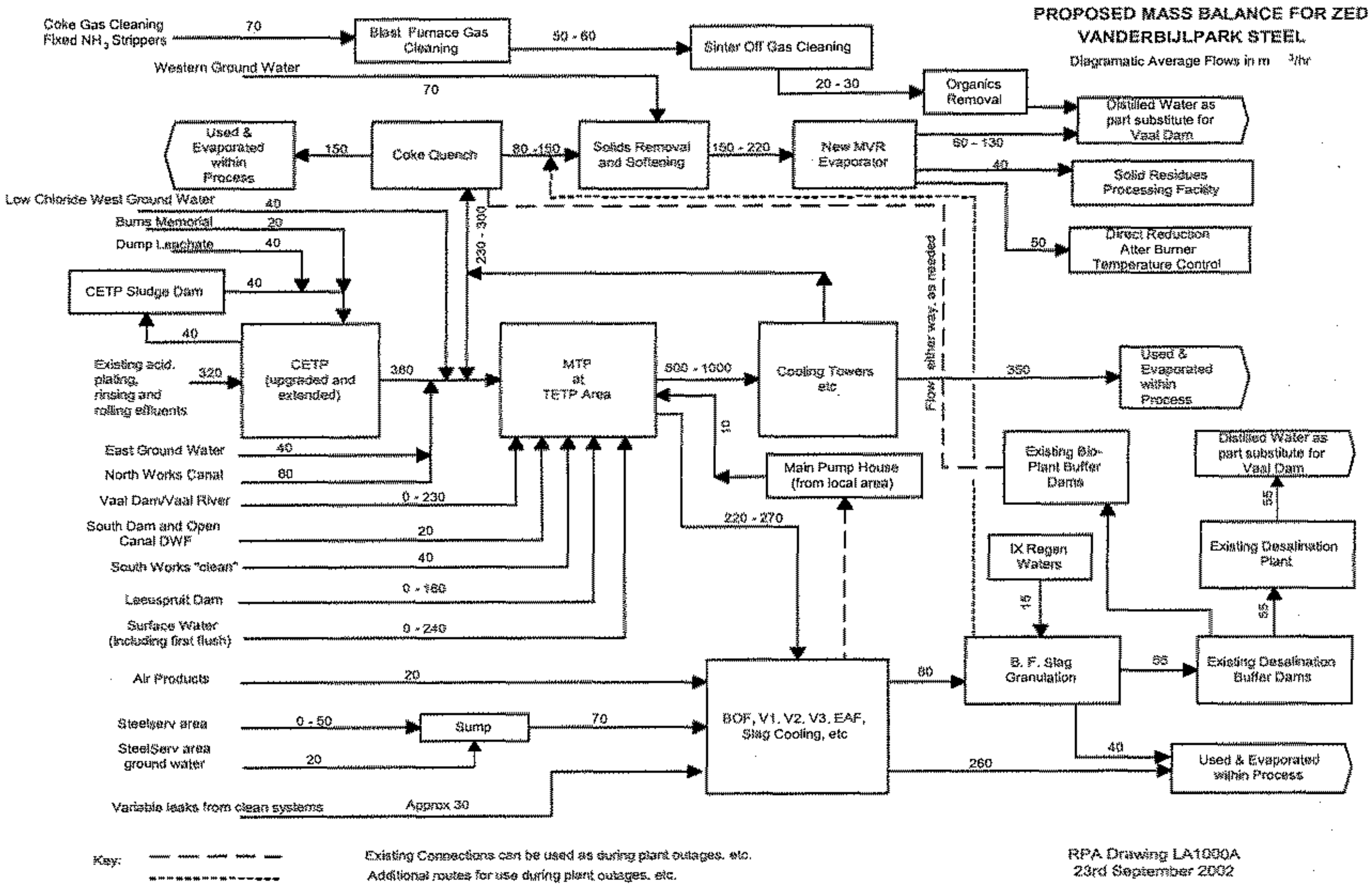
OVERVIEW FOR MTP - IVDBS

R. Paxton and Associates Ltd
12 November 2002
Drawing Ref: 484/LA839E



ZED OVERVIEW INCLUDING SHORT TERM MEASURES FOR RECYCLING ALL SITE PRODUCED WATERS - IVDBS

R. Paxton and Associates Ltd
12 November 2002
Drawing Ref: 484/LA637D

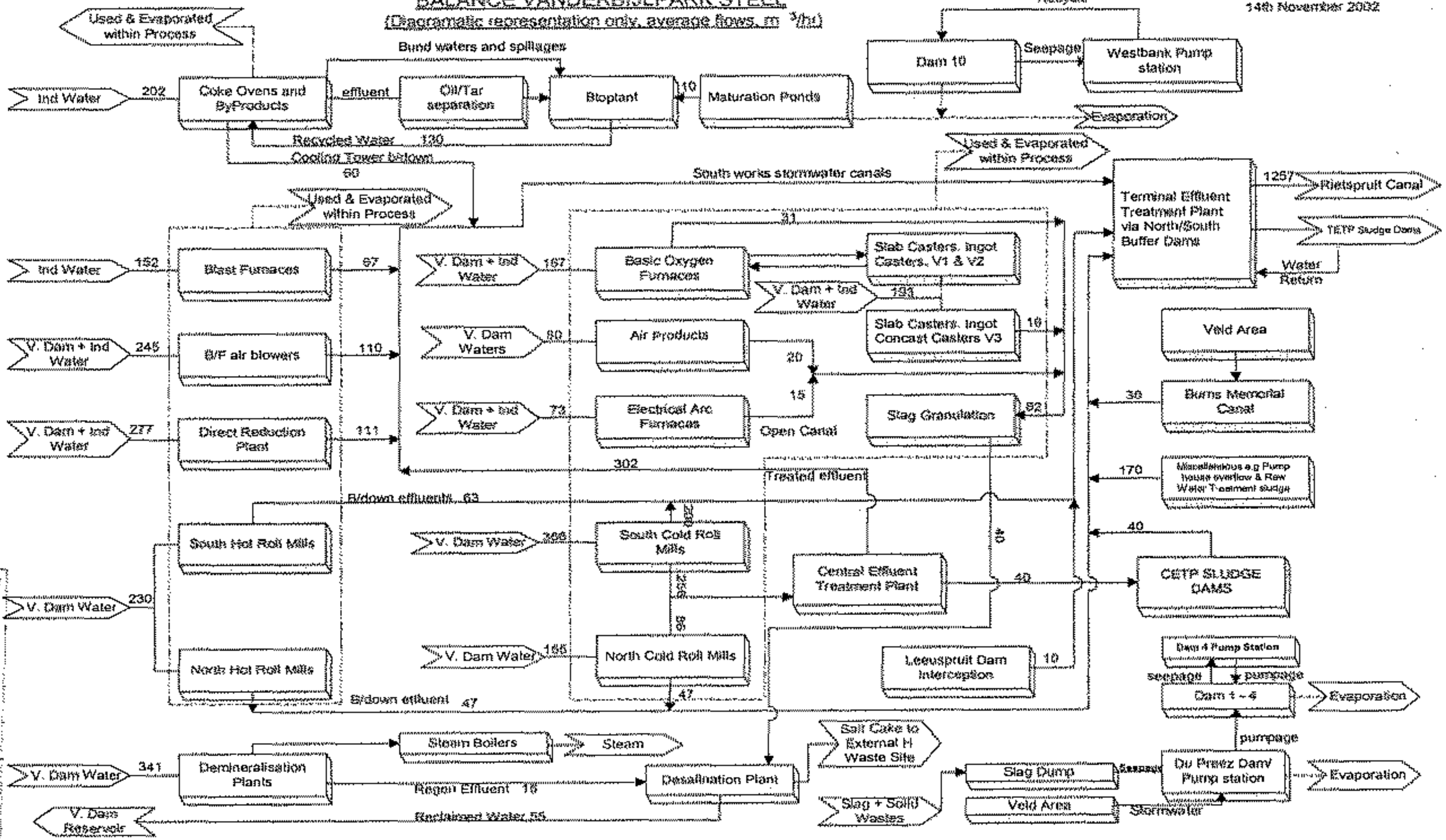

PROPOSED MASS BALANCE FOR ZED VANDERBIJLPARK STEEL
Diagramatic Average Flows in m³/hr
Coke Gas Cleaning Fixed NH₃ Strippers
70
Blast Furnace Gas Cleaning
50 - 60
Sinter Off Gas Cleaning
Western Ground Water
70
20 - 30
Organics Removal
Distilled Water as part substitute for Vaal Dam
Used & Evaporated within Process
150
Coke Quench
80 - 150
Solids Removal and Softening
150 - 220
New MVR Evaporator
60 - 130
40
Solid Residues Processing Facility
50
Direct Reduction After Burner Temperature Control
Low Chloride West Ground Water
40
Burns Memorial
20
Dump Leachate
40
230 - 300
CETP Sludge Dam
40
40
Existing acid, plating, rinsing and rolling effluents
320
CETP (upgraded and extended)
360
MTP at TETP Area
500 - 1000
Cooling Towers etc
350
Used & Evaporated within Process
Flow either way, as needed
10
Main Pump House (from local area)
East Ground Water
40
North Works Canal
80
Vaal Dam/Vaal River
0 - 230
South Dam and Open Canal DWF
20
South Works "clean"
40
Leeuspruit Dam
0 - 160
Surface Water (including first flush)
0 - 240
220 - 270
Existing Bio-Plant Buffer Dams
Distilled Water as part substitute for Vaal Dam
55
IX Regen Waters
15
Existing Desalination Plant
55
Air Products
20
BOF, V1, V2, V3, EAF, Slag Cooling, etc
80
B. F. Slag Granulation
55
Existing Desalination Buffer Dams
Steelserv area
0 - 50
Sump
70
SteelServ area ground water
20
40
260
Used & Evaporated within Process
Variable leaks from clean systems
Approx 30
Key:
Existing Connections can be used as during plant outages, etc.
Additional routes for use during plant outages, etc.
RPA Drawing LA1000A
23rd September 2002

CURRENT

CURRENT PROCESS WATER AND DRY WEATHER BALANCE VANDERBIJLPARK STEEL

(Diagramatic representation only, average flows, m ^{3}/hr)

R. Paxton and Associates Limited
Drawing 484/LA990-B
14th November 2002



5.3.6. THE CONSEQUENT ISSUES AND OPPORTUNITIES

Now that:

h) the Short Term Measures Infrastructure handling all the Blow downs and back washes from the whole of the process areas at the BOF, V1, V2, the EAF and V3 via slag granulation to the upgraded Desalination Plant is working properly and

i) all spillage and slag drainage issues from the slag granulation area are almost fully resolved then the only significant source of fluoride for the MTP will be from the CETP, from the CETP sludge dams, from Burns Memorial and from leachate from the dump. These fluoride sources are also major sources of silica, alumina, sulphate, calcium and magnesium.

The key, therefore was could all these components in all these streams be reduced to sufficiently low levels by re-arranging, upgrading and/or extending the CETP?

Also, if the calcium level in such a combined discharge from the CETP could be low enough, then the amount of calcium that needed to be precipitated at the rest of the MTP would be relatively low, producing probably less than 600 mg/litre of precipitated solids during that treatment stage.

Therefore, if the CETP were able to be upgraded to achieve the above level of treatment, then the TETP (with virtually no amendments) could remove the suspended solids that would be produced by the final chemical processing stage of the MTP. This would enable considerable equipment savings to be made.

In addition, the TETP was originally designed and built to be able to be operated as two equal capacity but entirely separate processing units. Only one such unit would be needed for the MTP function. The other unit can continue to be used for surface waters and can be arranged to provide a complete standby plant for the MTP. Once all the currently planned and budget approved TETP maintenance is completed this second unit would be able to process almost 3000 m^3/hr of surface waters.

5.3.7. THE TECHNICAL BASIS FOR THE PROPOSED UPGRADES AT THE CETP

The principal aim behind the recent improvements that have been made at the CETP was to enable the chloride levels at the TETP to be reduced so that they would comply with the changed criteria within the Water Licence Exemption 1998B. It was also the intention to improve the stability of the operation, to make the whole plant easier to operate and to prevent any future potential for discharges, bypasses and overflows to Dam 10 and/or to the sludge dams.

These objectives were all achieved.

Recently, much work has been done to improve the effectiveness and ease of operation of the oily effluents processing facilities at the CETP. In addition, the large percentage of tallow relative to the mineral oil content that is used with the South Mills rolling oils is being reduced. This high tallow percentage is the principal cause of much of the processing difficulties with the oily effluents. It is anticipated that the South Mills rolling oils will change to or at least towards a similar composition to those used in the North Mills.

The aqueous fraction of all these oily effluents and of their associated alkaline cleaners are all derived from high quality water (almost entirely either softened or de-ionised). These waters do, however, routinely contain around 7mg/litre of fluoride. Part of this contamination results from cross contamination of the oily circuits with plating and other surface finishing effluents/production streams but probably most is derived from the fluoride rich fluxing powders used at the continuous casters. Either way, as far as the MTP and the current Water Licence is concerned, low but none the less very significant fluoride concentrations are present.

At the moment, these oily waters, following the removal of all physically separable oils and emulsified mineral oils, contain a significant amount of emulsified and/or dissolved soaps. These are mostly tallow based soaps which form during the rolling process as a result of the extreme pressures and shear conditions at the nip of the rolls. These soaps can be precipitated as a calcium salt if the dissolved calcium concentration is high enough and the pH is raised to around 10 to 11. At present this is achieved within the main neutralisation reactor at the CETP.

Within this main reactor, metal hydroxides, manganese, fluorides and sulphates are all precipitated from the other inorganic based effluents which are received at the CETP.

All precipitation reactions take time for the concentration of the particular component in solution to be reduced to the theoretical equilibrium solubility product concentration. With very low solubility materials, it can take many hours to get to even twice the equilibrium solubility product value. Frequently this time is extended (often by orders of magnitude) by the presence of specific surface active agents. Many of these agents are purposely present in most proprietary plating and surface finishing products, because of their benefits to the quality or appearance of the surface finish. Also, the tallow based soaps, the break down products from mineral based rolling oils and the sparingly soluble additives that are put in by the rolling oil manufacturers are all effective surface active agents.

In trying to keep key components out of the total discharge from the CETP, the following points need to be noted.

If part of the total input does not contain a particular ion (say manganese for example) then mixing it with the rest of the total volume and then precipitating manganese from the total volume will mean less total mass of manganese will be precipitated.

By way of illustration, if manganese solubility is y and there is A m^3 of manganese containing effluent and B m^3 with zero manganese then precipitating manganese from a mixture of A and B will leave $(A + B)y$ of manganese in solution. If the same precipitation occurs in only volume A then there will only be Ay of manganese left in solution. If B is small relative to A then process simplification and practical economics are likely to outweigh the benefit that can be gained by keeping the streams separate. However, if B is not small, then when it is necessary to achieve a tight constraint (as is the case with fluoride and manganese) then treating the streams separately could be justified.

An alternative strategy (which is frequently more economic) is to arrange the combined precipitation such that the precipitation is driven much closer to the theoretical equilibrium solubility product. This requires a combination of reactor design, reaction time and a strategy which wipes out or significantly reduces the effect of any surface active agents. This latter can be achieved either by strategic pH control or by chemisorbing them out on an earlier and less sensitive precipitate. Calcium sulphate and iron hydroxides, especially ferrous hydroxide ($Fe(OH)_2$) are particularly good in this respect.

In addition to the above, it is essential that every opportunity that is possible should be taken to reduce the chloride output from the CETP. This is because as the chloride quantities are reduced, so both the necessary evaporator capacity is reduced and the necessary materials of construction costs within the evaporator are reduced.

Previously, spent hydrochloric acid pickle liquor (SPL) was used as an essential treatment reagent. The recent improvements at the CETP have enabled the use of this reagent to be almost entirely stopped. Its ongoing use is being stopped completely.

The remaining principal source of chloride is from the North Works Acid Rinse Water. This effluent is derived from de-ionised water. It therefore contains only iron and hydrochloric acid. If it is neutralised with lime it would create a clean calcium chloride solution and a precipitate of iron hydroxides.

The iron content is needed to treat the chrome 6 in the rest of the inorganic effluents, but the calcium and the chloride content are not needed. If the iron hydroxides are settled and a thickened slurry of all these hydroxides is added in a controlled way to the other inorganic effluents (which are also quite strongly acidic), this will be equally effective as regards the necessary chrome 6 reduction.

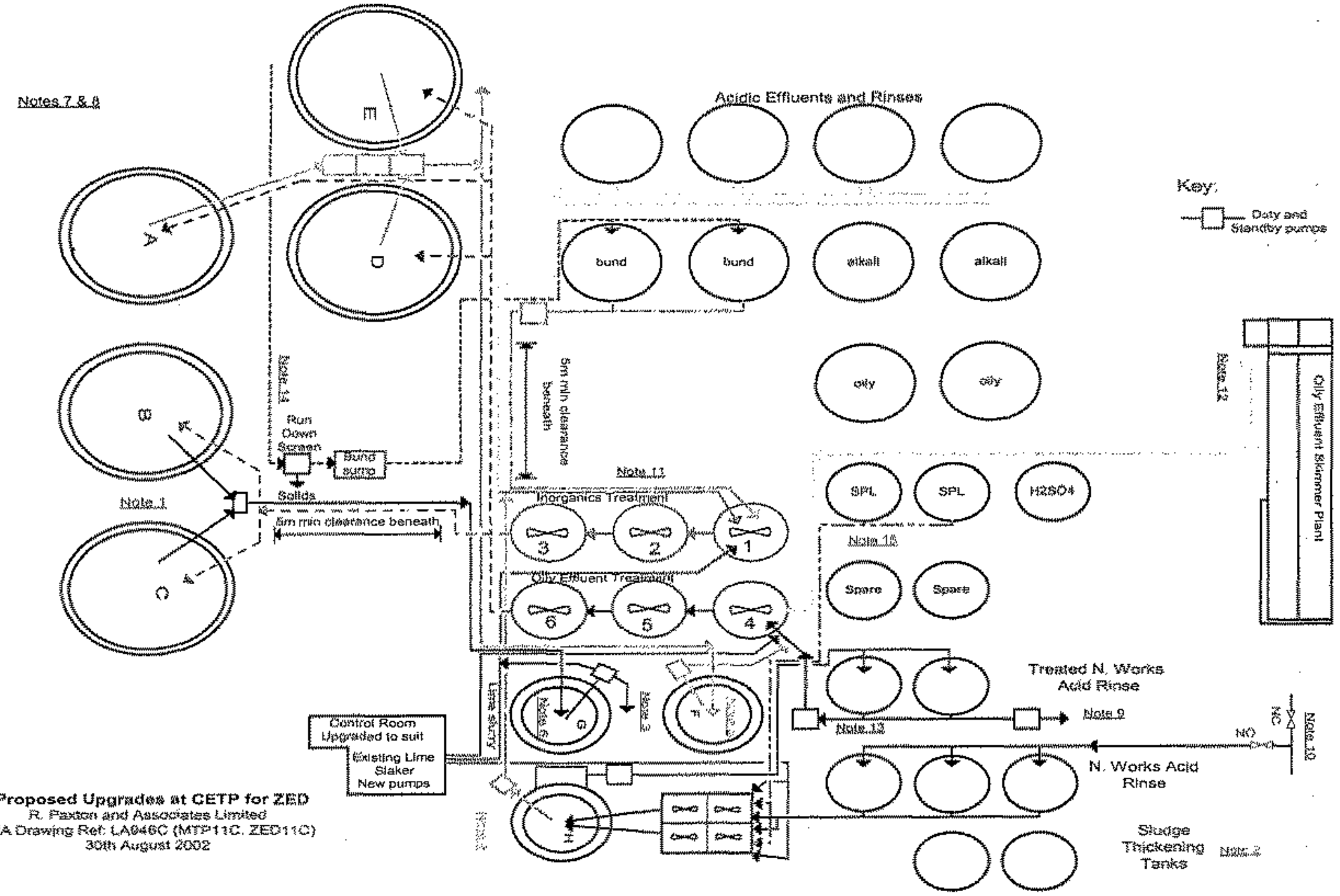
About half of the remaining calcium chloride solution, together with pH control will be sufficient to treat the whole of the oily effluent to remove the soaps and to create a clear and otherwise acceptable input to the TETP (under its current acceptance criteria) and to the MTP (in the future).

The rest of the calcium and its chloride content can (in theory) be fed to the Sinter Plant Agglomeration Unit as the necessary agglomeration water. This would take about a third of the current effluent based chloride input to the CETP out of the CETP effluent, and there would be a small but significantly saving in the amount of pickle liquor that would be needed to be purchased by the Sinter Plant.

One of the techniques for driving the concentration of a precipitating salt more quickly towards its equilibrium solubility product concentration is to provide a large surface area of crystals of that salt within the precipitating mixture. This can be done by recycling sludge from the subsequent clarification stage back to the precipitation stage. This technique can also be exploited to create a smaller number of larger sized precipitate crystals from the same total mass of precipitate. Larger crystals settle more quickly into a generally higher solids content underflow stream from the clarifier. The more rapid settlement leads to lower suspended solids within the clarifier overflow and can also enable more flow to be put to a given size of clarifier.

5.3.8 THE PROPOSED UPGRADES TO THE CETP

As a result of the process concepts and other criteria discussed above, the following re-arrangements and upgrades have been evolved. These are all shown on the attached diagrammatic plant layout drawing 484/LA946C. The detailed notes on this drawing are referred to in the next section.



Proposed Upgrades at CETP for ZED
R. Paxton and Associates Limited
RPA Drawing Ref: LA046C (MTP11C, ZED11C)
30th August 2002

5.3.8.1. The North Works Acid Rinse Water should be diverted to the former chrome effluent buffer storage tanks, for buffer storage. It should then be neutralised with lime using the former (currently redundant) chrome effluent lime neutralisation reactor and then fed to the former (currently redundant) treated chrome effluent clarifier.

The thickened sludge underflow from this clarifier should be pumped at a steady flow into the acidic effluent feed pipe leading to the proposed new Inorganic effluent Treatment Reactors. This will recover all the ferrous (Fe^2) ions for chrome 6 reduction.

The clarified supernatant should be collected and pumped to the two currently redundant former buffer storage tanks just north of the former chrome effluent tanks. From here, as much liquor as can be used at the Sinter Agglomeration Unit should be pumped to that unit. This pumped output will amount to an average of around 150 to 400 m^3/day. The remainder should be more than enough to provide the necessary calcium input to the proposed Oily Effluent Treatment Reactors.

Should either more calcium be needed for the Oily Effluents or more iron for the Acidic Effluents, then the existing (currently redundant) connection from the SPL storage tanks to the former chrome effluent chrome reduction reaction tanks can be used (following appropriate re-routing) to create the necessary extra calcium or iron.

5.3.8.2. The oily effluents, including the alkaline degreaser effluents should be routed through the Oily Effluent Skimmer Plant, using a combination of sulphuric acid addition (if needed) and polymer flocculant to the Oily Effluents and the Alkaline Effluents to ensure maximum separation of all free oils and all emulsified mineral oils. The product should then be pumped to three sequential stages of treatment process, where the Skimmer Plant effluent should be mixed thoroughly in the first stage with

j) Lime slurry to bring the pH up to about 10.5
k) The clarified liquor from the treatment of N. Works Acid Rinse Water (to provide the necessary calcium input)
l) Recycled sludge from the subsequent product clarifier to provide extra crystal surface area of calcium soaps and calcium fluoride, so as to speed up the rate at which the calcium soaps and the calcium fluoride approach their respective equilibrium solubility product concentrations.

The fully mixed mixture should then overflow to the second reactor in the three stage sequence where further precipitation time and temperature stabilisation will occur.

The purpose of the third reactor is to further extend this precipitation time and temperature stabilisation.

Temperature stabilisation is also important if the clarification stage downstream of the reactors is to perform optimally.
Recent test work would indicate that with about 50% of the reactor product sludge content being recycled and with about 2 hours of total reactor residence time, the fluoride concentration will be less than 1mg/litre and the precipitatable soap concentrations will be within about 20% of their respective equilibrium solubility product concentrations.

It is important to note that in order to achieve optimum removal of fluoride, manganese and soaps whilst at the same time maximising the settleability of the precipitated solids, it is essential that the three inputs a), b) and c) above are pre-mixed in pipe before they are introduced into the first reactor. This is to achieve maximum control over supersaturation levels and hence crystal nucleation rates.

5.3.8.3. The product slurry from these three Oily Effluent Treatment Reactors should then be fed by gravity to the three existing south western most clarifiers using new gravity input and flow distribution pipes. The thickened underflow from these clarifiers should all be pumped to the western most of the former (currently redundant) reactor-clarifiers for the stannous and DWI effluents. Further thickening should occur here so as to produce a thickened slurry of product solids (i.e. calcium fluoride and calcium soaps) for return to the input of the Oily Effluent Treatment Reactors. About half of this slurry should be returned to the reactors, and the remainder disposed of. The proportion of return solids can be adjusted if necessary, (within the range of about 30 to 70% recycle of calcium soaps) in order to maintain the degree of removal of fluoride and soaps.

The disposal options for the precipitated soaps may be to specific reclamation options (which are currently being investigated by another company), to a bio-degradation process for the recovery of calcium as a finely dispersed carbonate or to an off site disposal site.

Once the organic content of the sludge has been removed (e.g. by bio-degradation) the resultant calcium carbonate sludge would be acceptable as an input stream for the probable Solid Residues Processing Plant, or for input to the Sinter Plant Mixing Bed as a calcium source which will not create volatile organics when heated.

5.3.8.4. The essentially Inorganic Effluents (which consist of Acidic Effluents and Rinses) need to be pumped at a reasonably steady flow rate to the proposed Inorganics Treatment Reactors. Again the same concepts for controlling supersaturation levels have to be applied to these reactors, in order to optimise the settleability of the precipitated solids and to achieve their full precipitation potential.

Chrome reduction and the initial reduction of the free acid content of the Acidic Effluents and Rinses can be achieved by pre-mixing them with the underflow slurry (basically iron hydroxide slurry) from the neutralisation of the N. Works Acid Rinse Waters.

The lime slurry should be diluted (so as to speed up its dispersion within the first stage reactor) using the return slurry. This return slurry will also ensure maximum available surface area for crystal growth within the very area where the cause for precipitation (namey the dissolving lime particles) are present.

Recent test work would indicate that with about 50% of the reactor product sludge content being recycled and with about 2 hours total residence time, the fluoride concentration should be less than about 1 to 2 mg/litre and that most other very low solubility components should be within about 30% of their respective equilibrium solubility product concentration.

Historic and existing performance at the CETP, together with these test work results would suggest that any reduction in the number or size of these tanks should not be considered.

5.3.8.6. The proposed total volumetric input to the Inorganic Treatment Reactors is about half of the total CETP input. Virtually all of the sulphates that arrive at the CETP are within this inorganic input. This means that the total calcium sulphate in the total CETP discharge will be about halved and the total calcium would he reduced to about three quarters. This latter would be before any benefit from exporting calcium chloride to the Sinter is taken into account. With this benefit added as well, then the total calcium output would be approximately 50 to 60% of the present value.

For the same reasons the output of virtually all the toxic metals, magnesium and manganese will be approximately halved because of this net volume of effluent effect and they will be reduced considerably further by the much improved approach to their equilibrium solubility product concentration.

5.3.8.6. As a result of precipitating more calcium sulphate and by doing this in the presence of only about half the volume of effluent (i.e. in the presence of only those surface active agents which are associated with plating and surface finishing) then there will be much better removal of the surface active agents which could affect the precipitation of fluoride and the various metal hydroxides. As a result, the degree to which fluorides and metals can be removed within the Inorganic Effluents Treatment Reactors should be considerably improved relative to that which can be achieved at present. This effect is over and above the effects that can be achieved as a result of sludge recycle, reaction time and the reagent input arrangements.

5.3.8.7. As explained previously, one of the key reasons for looking carefully at what could be achieved at the CETP by process and other changes, was the following. Once key input streams are removed from the input to the evaporative cooling towers, etc circuits and are either added later in the overall process concept or added to the CETP input, then providing the fluoride, manganese, magnesium, silica and alumina contents of the overall CETP output are low enough, the only process function needed at the MTP would be calcium reduction followed by suspended solids removal. Without this strong emphasis on achieving a high level of performance at the CETP, then it would be necessary to have a two stage precipitation process at the MTP. The first stage would be needed to remove magnesium (by pH adjustment) and to remove fluoride, sulphates, phosphates, silica and alumina as their calcium salts by adding large amounts of calcium. The second stage would then have to take out the excess calcium. Re-arranging the overall site arrangements, therefore not only enables a stage in the overall MTP to be removed, it also removes the major part of the reagent requirements and the consequent by products production.

5.3.9. NOTES REFERRING TO RPA DRAWING LA946C

Introductory Note

For the purposes of ZED it will not be necessary for the sludges produced by the CETP treatment processes to be dewatered mechanically. However, during the course of the next three to five years, mechanical dewatering equipment will need to be installed and the inputs to the existing sludge dams will need to be stopped. The sludge dams will then need to be made safe and the areas rehabilitated. This making safe operation is likely to involve treatment followed by some form of stabilisation process.

For long term economic reasons, therefore, the earlier the mechanical dewatering plant is installed and made operational, the better.

Note 1

Until filter pressing of CETP sludge starts, pump one clarifier underflow to CETP sludge dams and pump the other clarifier to thickener G for sludge recycle. When the CETP sludge filter presses are installed, pump all the sludge from clarifiers D and E to thickener G.

Note 2

These tanks (or their equivalent) can be used as sludge holding tanks for the CETP sludge filter presses.

Note 3

Until filter pressing of CETP sludge starts, pump all the sludge from this thickener clarifier to the first stage of the Inorganic Treatment Reactors.

When filter pressing of CETP sludge starts, pump approximately half of the sludge from this thickening clarifier to the first stage of the Inorganic Treatment Reactors and pump the remainder to the sludge holding tanks referred to in Note 2. Control the amount removed to filtration on the basis of removing as little sludge as possible from the thickener G subject to maintaining a safe enough sludge level in the thickener to prevent excessive solids carry-over to the CETP Canal.

Note 4

By either adapting the existing clarified liquor overflow collection box, or otherwise, create a sump for the clarified liquor from this thickener which will enable it to be pumped to the two existing lined storage tanks just north of the three former chrome effluent storage tanks. Install duty and standby magnetic drive all plastic pumps to pump this liquor. The pumps should preferably be mounted at ground level, which means that the pumps should be automatically self priming and they should be capable of running "on snore" so as to avoid the need for frequent on-off controls or for a large sump to be created.

The connection between the existing clarified liquor drainage channel and that which interconnects clarifiers F and G with clarifiers A, B and C must be blocked off permanently. This blocking off should be engineered in such a way that should the pumps fail or should the receiving tanks reach high level, then clarified liquor will overflow the blockage and flow into the above referred interconnecting channel without overflowing anywhere else.

Pump the thickener underflow sludge to the combined acidic effluents and rinses input pipe to the Inorganics Treatment Reactors to provide chrome 6 reductant and to reduce the free acid content of the combined acidic effluents upstream of the reactors. Pumping should be continuous with the flow rate controlled preferably using a variable speed drive and using the same sludge level control concepts as in Note 3 above. On-off control of this sludge pumping activity will not be suitable.

Note 5

Allow the clarified liquor to flow as now via the existing pipe to the existing concrete trench leading to the CETP Canal. The other alternative outlet connections for the clarified liquor overflow should be permanently disconnected and removed.

Pump about half of the thickened underflow on a continuous basis to the lime slurry and treated N. Works acid rinse water combined feed pipe so that all three liquors mix thoroughly in pipe before they enter the first stage of the Oily Effluent Treatment Reactors.

Depending upon the current test work results, pump the other half of the thickened underflow (using the same sludge level control concepts as in Note 3 above) to the western CETP Sludge Dams.

Note 6

Allow the clarified liquor to flow as now via the existing pipe to the existing concrete trench leading to the CETP Canal. The other alternative outlet connections from the clarified liquor overflow should be permanently disconnected and removed.

Note 7

Allow the clarified liquor from Clarifiers A, B, C, D and E to joint the flow from clarifier thickeners F and G and to flow as now to the existing concrete trench leading to the CETP Canal.

Note 8

From the point where the output from Clarifiers D and E joins the output from the others, all the way to the start of the existing piped Canal, a fully sealed pipe should be inserted into the existing open trench, or into a new trench alongside the existing trench (see separate note for details).

Note 9

A new 100 mm NB HDPE or PP 6 bar rated pressure pipe, should be routed to the existing line of trestles east of the CETP (using a thrust bored sleeve beneath the rail tracks) and should then be routed along the trestle line to the Sinter Plant feed agglomeration unit at the Sinter Plant. (See separate note for details)

The Sinter agglomeration unit uses an average of about 300 m^3/day of water (varying from about 150 to 400 m^3/day depending upon the moisture content of the feed materials). By using this amount of treated N. Works acid rinse water, around 30% of the current effluent derived chloride output from the CETP can be avoided.

This in turn will reduce significantly the MVR evaporator capacity required to keep the chloride concentration within acceptable limits at the inputs to the cooling towers that are fed from the MTP.

In addition, purchases of spent pickle liquor by the Sinter for its essential chloride input will be reduced significantly.

Note 10

The existing feed pipe feeding N. Works Acid Rinse effluent to the Acidic Effluents and Rinse Waters Storage Tanks will need to have a T piece and valves fitted as shown so that the valves can be arranged to:-

- Normally feed all the acid rinse water from N. Works to the three former chrome effluent buffer storage tanks.
- In the event of a plant outage within or down stream of these tanks, the acid rinse water can be diverted temporarily to the Acidic Effluents and Rinse Waters Storage Tanks.

If the nominal bore of the existing feed pipe and isolation valves feeding the three former chrome effluent buffer storage tanks are smaller than that of the existing acid rinse water pipe from N. Works then they may need to be replaced with suitably sized equipment (Hendry du Preez and/ or Nelius Joubert are to check what the maximum pumping rate can be for this rinse water from N. Works and will confirm what size these connections need to be.)

Note 11

The 6 new stirred tank reactors should all be constructed to be the same. They should be set on different height plinths so as to achieve gravity overflow from the first in the line to the second, from the second to the third and from the third into flow divided outputs to the respective clarifiers. (See separate note for details of these reactor tanks). The reason for using raised plinths is to enable easier vessel maintenance and to allow a suitable bypass duct to be fitted should it be necessary to bypass a tank for maintenance etc reasons. Equivalent capability alternative options will be considered.

Note 12

The Oily Effluent Skimmer Plant has been re-arranged recently so that it can absorb surge flows in its input and enable a relatively constant removal rate of skimmed oily effluent to be achieved. There will be occasions, however, when the removal rate will need to be either increased or reduced in order to accommodate large changes in the output flows from the Mills. The level within the skimmer output tank should therefore be used to make these adjustments. There should be a wide band of levels over which the pump speed is not changed, but pumps at a set speed which will need to be determined during commissioning. At lower liquid levels there should be an effectively proportional action function which progressively reduces pump speed as the level continues to fall below this band, and progressively increases the speed again as the level rises to this band. Similarly, above this band there should be a similar proportional action function which progressively increases the pump speed as the level continues to rise above the upper end of the level band and progressively reduces the speed again as the level falls to this band.

Maintaining a wide middle band within which the output pumps do not change speed is an essential feature necessitated by the arrangements which are needed to enable all the different batch inputs to the skimmer to be controlled and co-ordinated automatically. Outside of this middle band, pump speed will have to respond quite sharply to any ongoing level changes.

The existing inputs to the skimmer unit are controlled on the following basis:

a) Inputs from South Mills are pumped on an "on-off" basis as determined by the sump levels or other activities at South Mills.

  - The oily effluent goes direct to the skimmer.
  - The alkaline effluent goes to the Alkaline Effluents buffer storage tanks.

b) Inputs from North Works Cold Rolling are pumped on an "on-off" basis as determined by the sump levels or other activities at North Works Cold Rolling. This effluent includes a proportion of alkaline cleaning effluent. The combined effluent goes to the Oily Effluent buffer storage tanks.

c) Flocculant is added on a continuous basis to the inlet launder to the skimmer.

d) When a surge of input a) arrives, the liquid level in the skimmer and its output tank rises. The existing level controls in this tank respond to this level increase by stopping the inputs of oily and alkaline effluents from the above referred two sets of buffer storage tanks. In addition the acid dosing and additional flocculant inputs associated with the alkaline effluents are also stopped.

e) The skimmer is arranged to be able to absorb the full normal surges in flow and all likely surges in flow from South Mills, without overtopping. It is also equipped with an overflow leading to the CETP bund area sump.

f) Following the batch input from South Mills, the level within the skimmer will begin to fall again. When this level is low enough, the pumped inputs from the Oily Effluent and the Alkaline Effluent buffer storage tanks are both restarted automatically, together with the necessary acid and additional flocculant for the Alkaline Effluent.

g) When the levels in one or both of the sets of the buffer storage tanks get to low level then the respective transfer and dosing pumps stop automatically until the respective low level has cleared.

h) This mode of operation continues until situation d) above occurs again.

It is because it is essential that the effluent from South Mills goes direct to the skimmer without any potential for additional cooling that the above control methodology has been installed. This methodology must be maintained. Alternatively an equivalent capability control arrangement will be considered.

Note 13

The Treated N. Works Acid Rinse Water should be pumped continuously using all plastic, duty and standby pumps preferably with variable speed magnetic drives to the combined lime slurry and recycled slurry feed pipe feeding the Oily Effluent Treatment Reactors. All three liquors should be fully mixed in pipe before they are introduced into the reactors.

The reactors should be controlled to a pH of about 10 and the flow of Treated N. Works Acid Rinse Water should be controlled so as to provide just enough total calcium to ensure that the oily effluent is fully clarified.

The required amount of Treated N. Works Acid Rinse Water per unit volume of Skimmed Oily Effluent should not change significantly over time. Control should therefore be based upon a volumetric ratio control with the ratio being operator adjustable depending upon specific product sample analyses.

The output flow rate from the Oily Effluent Skimmer Plant pumps and the Treated N. Works Acid Rinse Water pumps should both be measured and the speed of the Treated Rinse Water pumps should be adjusted automatically to maintain the required volumetric ratio.

Note 14

It is expected that dump leachate will be pumped at no more than 40 m^3/hr to the north end of the existing, but to be upgraded collection pipe for the overflow from the western CETP sludge dams. It is anticipated that the upgrading work on this collection pipe will enable the CETP sludge dam overflow (plus any dump leachate that may be being pumped) to flow by gravity to a new sump at or near the southern end of the Burns Memorial Canal. This sump will also receive the dry weather flow from the Burns Memorial Canal. In addition, it may become necessary at some time in the future, but not in the early years of ZED operation, for the low chloride western ground water to be pumped to either this sump or to somewhere along the CETP overflow collection pipe. (At the moment, this part of the western ground water is relatively low in fluoride, manganese, magnesium and calcium. With time many of these components are likely to increase, necessitating pre-treatment at the CETP).

All these liquors will need to be pumped from this new sump for pre-treatment at the CETP to remove fluoride, manganese, magnesium, silica, alumina and as much sulphate and calcium as possible. The required pumping rate is 100m^3/hr (minimum). Should the pumps at this sump fail then the sump should be arranged to overflow into the CETP Canal. Only if overflow to the CETP Canal is fundamentally impractical, should overflow to the North Works Blow Down Canal be considered.

It should be noted that by the time it may become necessary to pump the western low chloride ground water to the CETP for treatment, the use of the CETP sludge dams will have stopped. Therefore the expected 40 m^3/hr of ground water will be able to substitute the then zero flow of CETP sludge dam return water, which is currently determined as being 40 m^3/hr.

At the CETP, the liquors should be discharged over a new wedge wire run down screen (sieve bend) to remove all +2mm particles and then flow to the existing bund sump. The pumps in this sump have more than enough spare capacity to pump this additional flow to the two former Alkaline Effluent holding tanks which are used as buffer storage for bund, etc, waters.

Note 15

In the event that more Fe^2 is required for chrome 6 reduction or more $CaCl_2$ solution is needed for the Oily Effluents Treatment (e.g. as a result of reduced pickling at North Works) then Spent Pickle Liquor (SPL) should be added to the available flow of N. Works Acid Rinse Water or to sufficient effluent from clarifier F (the neutralisation mixture from SPL alone will create too thick a slurry to handle in the neutralisation tanks) to provide the necessary amount of Fe^2 or $CaCl_2$.

General Notes

A. A large part of the proposed equipment consists of existing old and currently redundant equipment being re-used in a new manner. All this equipment must be repaired, refurbished and serviced as appropriate in order to put it back into a fully functional and realistically reliable condition. In addition, a suitable stock of ready to use spares and/or standby equipment must be assembled for all this equipment as well as for all the new equipment.

B. All the existing and currently operating equipment at the CETP must be kept working whilst the modifications and additions are carried out. Afterwards, the existing neutralisation reactor and all its existing inlet and outlet pipework should be demolished and removed together with all the support structures and other equipment and cables that become redundant.

Before the new and refurbished/amended equipment is brought on line, the existing bunding must be extended to encompass the whole of the equipment and tankage that is shown.

This bunding must include the current acid offloading facilities. Alternatively, new acid offloading facilities may be arranged within the existing bunded area, north of the SPL and H_2SO_4 storage tanks.

All new bunding should drain by gravity, without any additional gulleys or channels, to the existing bund sump. Alternatively, or a new sump can be used, again, without any additional gulleys or channels. If a new sump is used, it shall be equipped with duty and standby pumps and HDPE pipework which should be arranged to be capable of pumping at $100m^3/hr$ directly to the bund liquor storage tanks. The pumps should start and stop automatically on the basis of level switches in this new collection sump. The pumps should be automatically prevented from pumping should the level in one or both of the receiving tanks reach the high level alarm level. The pumps should be automatically enabled again once the respective tank level(s) have fallen below the high level alarm reset level.

5.3.10.OVERVIEW OF WHAT NEEDS TO BE DONE BY THE MTP

In order to convert the "Dirty" side of the TETP into the MTP, it is appropriate firstly to understand the role that is needed and how it should integrate with the rest of the ZED and long term Master Plan infrastructure.

The upgraded CETP will continue to receive all of its existing strong effluent inputs. In addition it will receive the following effluents:

- CETP Sludge Dam overflow
- Burns Memorial Dry Weather Flow
- Leachate from the new Processed Wastes Landfill

The upgraded CETP will process all these inputs using the same but re-arranged basic reaction chemistry using new and enlarged main reactors.

The reactor products will be clarified using the existing clarifiers and clarified effluent will be routed to the MTP together with the North Works effluent, low chloride content ground water from the West of the site and ground water from the North East of the site.

All these effluent streams will be conveyed using dedicated and sealed pipes. Where the existing arrangements use sections of open trenches, these will be replaced with appropriately sized pipework.

As a result of it becoming possible to use gravity drainage for all the process effluents to west of the railway lines (i.e. to the TETP area) and the fact that the main sludge producing part of the ZED process chemistry can now be performed at the CETP, it is practical to utilise the TETP itself and its adjacent area for the remainder of the MTP.

The MTP will receive:

- Drain down from CETP.
- North Works effluent.
- Low chloride content ground water from the West of the site.
- Ground water from the North East of the site.
- Dry weather flow from the Open canal and South Dam Canal (assumed to be ground water as all the process effluents are separately connected).
- Waters from the Leeuspruit Dam.
- Contaminated storm water and other collected surface waters.
- Blow down from the "clean" circuits within the South Mill area.
- Return water from all the cooling and quench circuits which are fed with MTP product water (except those which are already connected to Blast Furnace Slag Granulation).
- Make up water (as needed) from storm waters, the Vaal Dam or the Vaal River.

The overall MTP infrastructure will blow down a brine stream which will he evaporated initially within Coke Quench. It will then be softened before it is further concentrated in an MVR type of evaporator and the concentrated brine will probably be used:-

- as a replacement for the industrial water currently used within the Direct Reduction After Burner Chambers for quench sprays for temperature control purposes.
- as part of the necessary water input to the likely solid wastes processing facilities for handling non-recoverable solid residues to convert them from "HH" classification to the more environmentally friendly "General" form, and
- as an alternative to these two preferred outlets for the brine and (potentially) whilst one or both of these two preferred outlets is completing its necessary authorisation and/or licencing processes, a crystalliser has been included within the scope of the Tender Enquiry.

5.3.11.INCORPORATION OF THE EXISTING TETP INFRASTRUCTURE INTO THE MTP

As a result of the extended role of the CETP, the only physical and chemical treatment processes which need to be performed by the MTP will be

a) general oil, grease and silt removal
b) a controlled amount of additional softening
c) sand filtration (or equivalent) for fine solids removal
d) buffer storage
e) pump back to the selected section of the Industrial Water Ring Main
f) MVR Evaporation and the associated pre-softening, brine pumping and buffer storage facilities.
g) Crystallisation, if that is needed.

The TETP already has facilities for a, c and d, all at a considerably higher volumetric throughput capacity than will be needed by the MTP. Because of the chemical precipitation that will be carried out at the CETP, the amount and nature of solids that will be created at the MTP softening stage will be such that the existing TETP infrastructure can handle them.

The only additional equipment that would be needed at the TETP will therefore be:

- The chemical storage, dosing and reactor equipment needed for the softening.
- The pump back facilities and pipeline connection
- The MVR and its related softening, pumping and buffer storage infrastructure.
- Sludge thickening and dewatering instead of the current sludge dams.

5.3.12. INTEGRATION WITH THE TETP STORAGE DAMS

The ZED concepts assume that the western side of the existing North Dam (see the next section for further details) at the TETP will be used to catch potentially contaminated storm water and to direct that water to the MTP for use as make up water, including any suspended solids and traces of oil that it may contain.

Depending upon the outcome of the detailed surface water management modelling work that is being carried out as part of the Master Plan Studies and depending upon the long term Water Licence discharge criteria, the North Dam and/or the West Dam may need to be extended or adapted and/or additional storage facilities may be required in order to accommodate storm and surface water flows.

The current function of the West Dam is to absorb storm water peak flows such that the existing volume flow capacity within the Rietkuil Spruit Canal is not exceeded.

If these constraints cannot be suitably relaxed or relocated, then it may be appropriate to modify the way the West Dam operates. By:

- incorporating the storm water canal west and north of the Dam into the Dam
- by deepening the Dam (if necessary)
- by modifying the inlet details and the outlet from the Dam
- by incorporating the currently unused area north of the storm water canal as an area capable of absorbing peak surge flows during a storm.

The Dam can be arranged so that it would provide both a buffer storage and flow control for storm events (as it does now) and a suitably large clarifier for the suspended solids in the after the "first flush" waters. In this form, part or all of the West Dam can also provide emergency storage for any contaminated waters that may result from a mishap or other occurrence on the site and which was unable to be contained adequately by any of the other up-stream containment facilities.

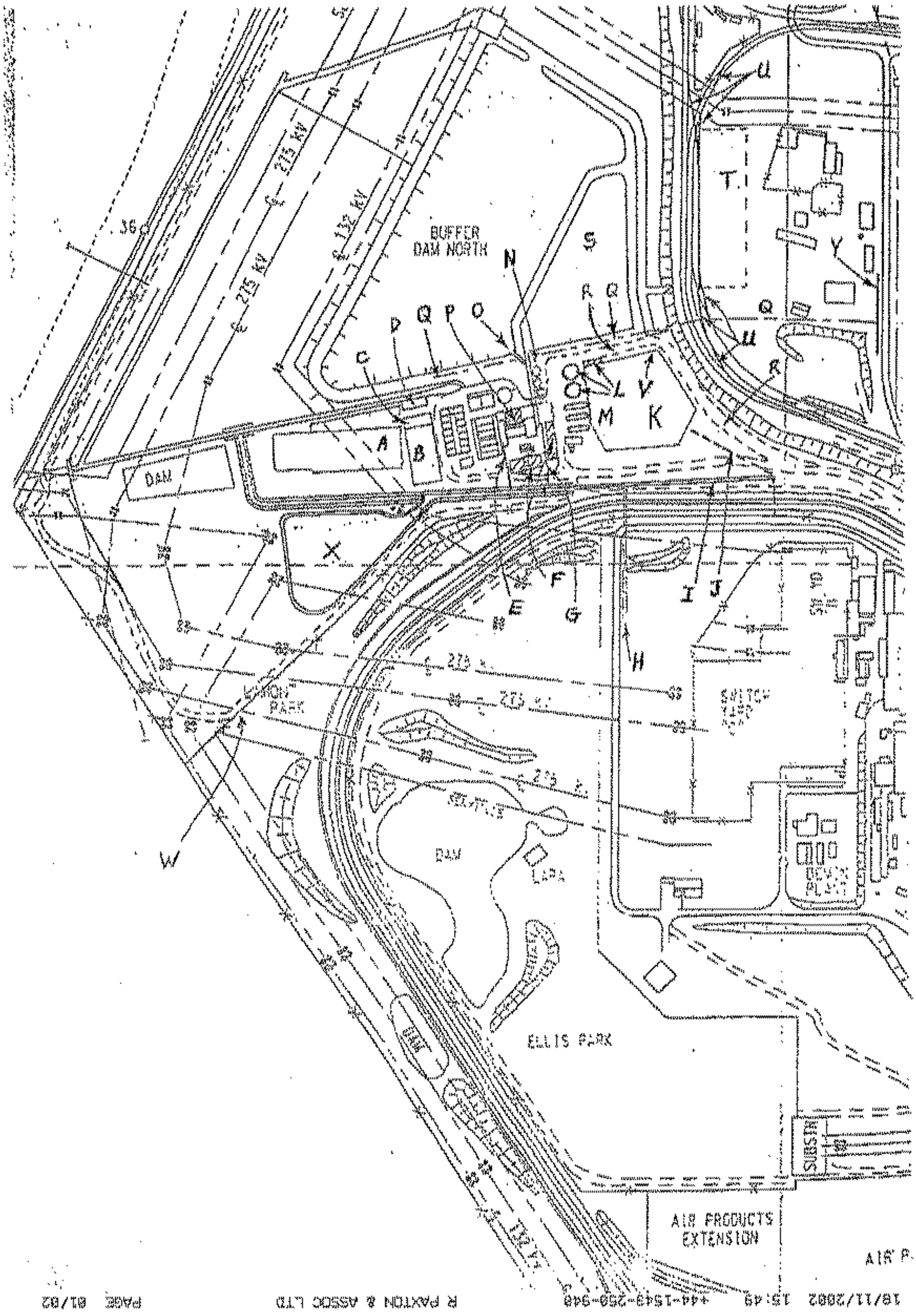
5.3.13 DETAILS OF THE NECESSARY CHANGES AT THE TETP

General Note

The following area plans are not intended to represent a definitive plan. They represent just one of many potential layouts. This layout has been developed on the basis of assumed equipment types and sizes which Tenderers may wish to amend.

The following notes relate to this assumed layout.

Area Plan for MTP



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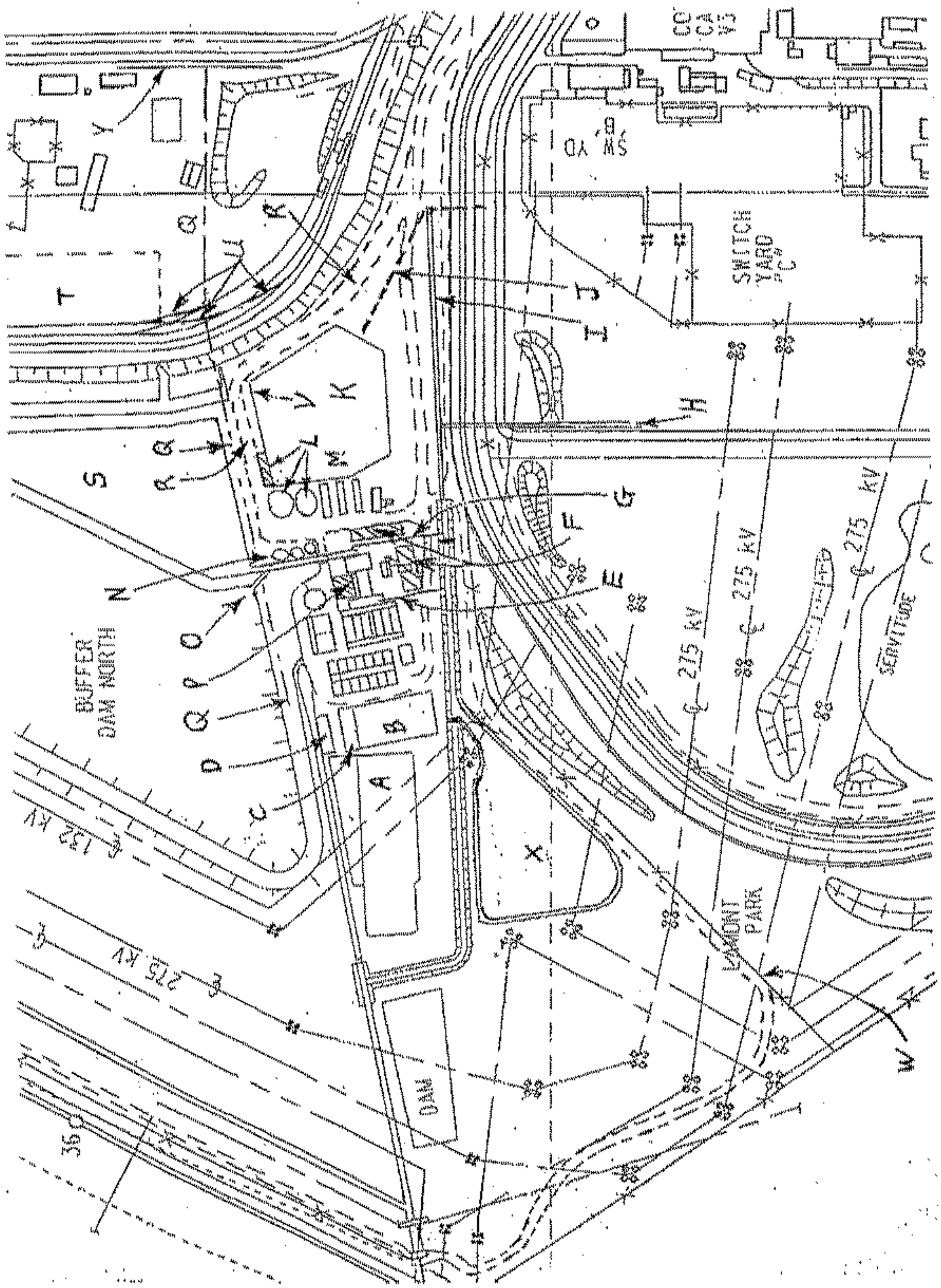

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Item A

The eastern end of the existing sludge dam should be removed prior to ZED to allow items B, C and D to be installed.

Once the ZED infrastructures are operating, then this sludge dam and the one west of it will become redundant. Once they have subsequently dried out, the contents should be dug out, the walls removed and the areas levelled and graded flat with respect to the surrounding ground, top soiled and grassed.

Item B

This is a new HDPE lined buffer storage dam for the product water from the MTP. The lining and other associated details should all be designed, agreed and installed to the latest requirements of the Minimum Requirements.

This dam would receive MTP treated water from what will become the so called "dirty" sand filters of the TETP. The collector header from the current discharges from these sand filters needs to be adapted so as to route this sand filtered water only to this dam.

The dam should have a minimum volume of about 5000 m³. It should be kept about two thirds full so as to provide about three hours of buffer should the MTP go off line, for example as a result of a power outage or equipment failure. The three hours should be long enough to enable sufficient of the system to be brought back on line, for the "clean" side of the TETP to be brought on line instead, or for Vaal Dam water to be fed into the Industrial Water Main.

By not exceeding about two thirds full, there should also be enough room to buffer short term demand changes should some of the key product water users require either significantly more or significantly less water.

Item C

This is the proposed new Pump House with duty and standby pumps for pumping MTP product water to the Industrial Water Main. Each pump should be fitted with variable speed drives and suitable controls so as to be able to supply water from B to the selected section of the Industrial Water Main at whatever flow is needed in order to maintain the required pressure in the Main.

Item D

Proposed Maintenance Area

Item E

This is the existing inlet from the Open Canal to the clean side of the TETP. This is to be fitted with a valve which is only opened after the collection dam X for intercepting any contaminated waters has been filled to a defined level and after either instrument readings or initial quick test results show the ongoing flow of water is of a suitable quality.

In addition, this valve would only be opened if it is proposed to allow the ongoing flow of water to be discharged from the site rather than to be kept for re-use on site.

Item F

These are alternative locations for the necessary sludge thickening and dewatering facilities which will replace the sludge dam A and the one west of A. The western most option of the two optional locations would be preferred for space and access reasons but it would require the demolition of existing buildings and structures. These buildings and structures are associated with the former lime and ferric dosing which used to be carried out, which is now redundant and which will not be needed for the MTP nor the ongoing functions of the "clean" side of the TETP.

Item G

By re-arranging the existing open drain (or otherwise) together with an overflow weir in the main channel of the Open Canal, just down stream of this offtake point, arrange a pumped flow from the open channel to the "dirty" side of the inlet works of the TETP (i.e. into the MTP inlet). The flow should be arranged such that any dry weather flow from the Open Canal and the V3 Canal (see I and J below) will be directed to the MTP inlet.

The height of the weir just down stream of this offtake must be no more than 200 mm below the level of the weir downstream of the inlet to the new dam X.

In order to achieve the above requirements it may be necessary to raise the height of the sides of this open section of the Open Canal (i.e. between the end of the piped section to the east and the weir downstream of the new dam X).

Item H

This is the existing route of the Open Canal. West of the Switch yard it is an open channel. It is then piped beneath the Main Entry Road to the Vanderbijlpark Steel site. On the north side of the road the pipe turns approximately 90° west. There is an inspection chamber at this change of direction.

Item I

The V3 Canal is piped beneath the Main Entry Road to the Vanderbijlpark Steel site, approximately 230 metres east of where the Open Canal crosses beneath this road. At an inspection chamber just north of this road, the pipe changes direction to an approximately north westerly direction, leading to the existing South Buffer Dam. A new pipe is required between this inspection chamber and the one at the north end of the road crossing for the Open Canal. This pipe should be capable of carrying the whole of the potential flow in the V3 Canal.

If necessary, the pipe between the inspection chamber at the north end of the road crossing for the Open Canal and the open channel section should be enlarged, or the pipe I should be directed alongside this east-west piped section of the Open Canal and it should discharge into the subsequent open channel upstream of offtake G.

As a preferred alternative to enlarging the pipe or laying pipe I alongside, the water which cannot be carried by this section of pipe should be allowed to pond south of the road until the intensity of the storm event has subsided and the water can get away.

This preferred option must not be used if there is a possibility that the resultant ponding could cause flooding of the Switch yard, flooding of the Main Entry Road, or for the lifting of the inspection chamber cover on the V3 Canal (which is within the site exit lane of the Main Entry road).

Item J

Once I has been completed, then this section of the V3 Canal should be concreted off at its South Eastern end, the concrete works at its entry into the South Buffer Dam should be removed entirely and the pipe should either be removed or it should be grouted full using a suitable low permeability grout (such as a pumped and properly formulated slurry of posalanic fly ash, Portland cement or lime and fine sand).

It is essential that this abandoned pipe is prevented from being able to collect and transmit ground or other waters.

Where the existing concrete entry works enter the South Buffer Dam, the ground and all the backfill material which was placed around the pipe should be dug back to undisturbed original ground to a minimum of 3m clear of the edge of the dam. This excavation should be back filled and properly compacted using low permeability material so as to ensure that any water flow within the pipe surround cannot access the dam via the pipe route but is either trapped or forced into the surrounding original ground.

Item K

The existing South Buffer Dam is to take on a new duty. In future it will provide buffer storage upstream of the MVR evaporators and their pre-treatment facilities.

For this duty the dam will need to be lined. The liquor that will be stored in the dam will have a high dissolved salts content with a particularly high level of chlorides, sodium and potassium. HDPE should be a suitable lining material. The development of the specification as regards the construction must strictly follow that of the Minimum Requirements, once the following amendments to its shape and connections have been carried out.

The existing entry to the Dam from the Blowerhouse Canal and the interlink between the Dam and the North Buffer Dam at V need to be removed and walled off. All the associated concrete works that will become redundant by this closing off process needs to be removed, the ground needs to be dug back to undisturbed original ground and properly compacted low permeability backfill put back, effectively as described in J above. In this instance, the backfilling must also be suitable for the construction of an access and maintenance roadway around this side of the Dam.

At the western extremity of the existing dam, the dam should be cleared out and, as necessary, backfilled to create a suitable place for the new clarifiers and reaction tanks L to be build, or for the new MVR evaporators to stand.

Note, the arrangement shown on the attached optional area plan shows the MVR evaporators to the south of the clarifiers. If improved construction economics can be achieved by reversing this arrangement, then this can be done subject to sufficient space being left to enable up to a total of four MVR evaporator units to be arranged side by side.

The existing building south of the two clarifiers L is hardly used and can be made redundant and demolished if that assists overall economics. This building must not be demolished or otherwise interfered with without prior written permission from Vanderbijlpark Steel.

The existing connection between the Dam and the entry works of the existing TETP should be concreted off at the TETP entry works and the connecting pipe and its exit works from the Dam should be either removed entirely or dealt with as described in J above.

The most likely route for the process water input to this dam will be via a polypropylene or HDPE pipe which will be hung from the roof of the Blast Furnace Canal and then passed beneath the roadway at V into the Dam. The pipe should preferably pass over the top of the lining for the Dam. If it has to pass through the lining, it should do so as high up the lining as possible, subject to maintaining a continuous fall within the pipe.

The high chloride content pumped ground waters from the west of the site should follow a convenient pipe route to the point V in the Dam and discharge into the Dam alongside the process water input. If possible, this pipe should be routed over the lining for the Dam. Both pipes should discharge onto a suitably reinforced splash area with, preferably, both pipe ends above the maximum liquid level. In any event, the end of the ground water pipe should be above the maximum liquid level.

The working capacity of the Dam should be 15 000 m^3. In order to achieve this volume, the bottom of the Dam should be deepened. This, together with the slightly reduced surface area, should create a shape which is reasonably close to the economic ideal for a lined Dam of this capacity. Note, water removal from the dam will be via a pumped offtake.

Normally the Dam should be maintained at a normal average level of 5 000 m^3 so that quality surges are attenuated and to enable a controlled change over of the evaporators to MTP product or to MTP feed water in the event of problems at Coke Quench.

The 10 000 m^3 of surge capacity is necessary to enable a major plant outage at the MTP to be resolved or for a spillage/pipe burst within the Coke Quench area to be absorbed.

If there is a major plant outage at the MTP such that Vaal Dam Water has to be supplied to the normal users of MTP water, then

a) Blow downs from the users of MTP product water can be virtually stopped while Vaal Dam water continues to be supplied.
b) The east and west ground water pumps would have to be turned off (but the south east ones feeding the BOF could stay on) until the MTP was operating again and the normal operating space within the various dams had been recovered.
c) Part of the CETP and North Works effluent can be directed to Coke Quench using the proposed gravity interconnection between the sump at the end of the coke oven area cooling tower, etc blow downs collection main and the CETP Canal.
d) The remainder of the MTP input (over and above what Dam S can contain) can be added to the MVR input.
e) The excess MTP input would accumulate within this MVR input buffer dam (at approximately 200 to 250 m^3/hr in dry weather).

This would give a maximum of about 40 hours to get the MTP back up at full capacity or to start to divert the waters to other emergency dams (initially the bio plant buffer dams and then the currently being arranged emergency dams north of the CETP area, or in the interim the Maturation Dams or Dams 1 to 4).

In wet weather, this maximum of 40 hours will be considerably less.

Item L

The waters collected in Dam K need to be softened before they can be fed to the style of evaporators that are presently perceived as being appropriate, given the potential chloride concentrations that can be achieved within them. The softening will probably be achieved using a chemical precipitation process followed by clarifiers to remove the solids and then by pH adjustment using acid. Reagent storage would be shared with that which is necessary for the main MTP softening process.

Two clarifiers are shown each with an upflow settling area equivalent to about 22m diameter, or its equivalent if a high rate clarification plant (such as a tilted plate clarifier) were used. It is important to have two units so that sufficient performance can be achieved using one unit while the other unit if off line for repairs, etc. Normally, such repairs and maintenance should be programmed for the dry season when the volumetric load on the evaporators can be reduced for extended periods.

Because of the presence of a whole range of surface active agents within the effluent streams, this softening stage (and indeed all softening and precipitation stages) must be designed with adequate reaction time and adequate sludge recycle, or the necessary functionality will not be achieved reliably. With good sludge recycle and the equivalent of good stirring throughout the softening reactions reactor(s) then a minimum of 1 hour's hold up within this reaction stage is regarded as essential. With less intense stirring or with little or no sludge recycle then longer reaction times will be needed, or alternative but suitably effective techniques will need to be adopted.

The softening reactors could be a cascade arrangement of at least two stirred reactors, each with a capacity of about 100 m^3. They should be above ground units and could be similar to (ideally the same as) the new units specified for the CETP. Reagent input would be to the first reaction tank with standby arrangements to the second tank when the first tank is out of service.

After the clarifiers, there should be an in line acid dosing arrangement to reduce the pH to the optimum required by the manufacturers of the MVR evaporators (probably to about a pH of 6 to 7)

Item M

The MVR evaporator units that are suggested are a mostly plastic construction (including the heat transfer area) with the remaining metal parts made from a grade of stainless steel with a very high tolerance to chloride attack. The suggested units are basically modular in form, each unit occupying a foot print of about 25m by 4m (including walkways), with a height of about 8.5m. Two such units will be needed initially for ZED and depending on the ultimate requirements for processing contaminated surface waters, more may be needed. Space for three units (with maintenance vehicle access in between each unit) has been shown on the indicative layout.

Item N

Three reagent storage vessels have been shown, based on the three reagents necessary for both the MTP and the softening plant for the MVR evaporators. If the proposed carbon dioxide production process from the off-gases from the BOF goes ahead, then only two brought in to the site reagents will be necessary, plus a piped supply of carbon dioxide (CO_2).

The three reagents are

a) sulphuric acid
b) sodium hydroxide (caustic soda) solution
c) sodium carbonate solution

Reagent c) can be purchased as solid soda ash and dissolved in and dispensed from a salt saturator type of vessel so as to simplify its use within the reactors.

Reagents a) and b) would be delivered in bulk road tankers as concentrated solutions in very much the same way as it is delivered at present to other parts of the Vanderbijlpark Steel site.

Reagent c) could be made in situ at the MTP by reacting diluted sodium hydroxide solution with the piped in carbon dioxide. It is likely that this option would be preferable from the point of view of operating and maintenance costs. The assessment between these two options will be based upon a combination of capital, operating and maintenance costs together with reliability and "what if" considerations.

The reagent storage tanks need to be sited adjacent to a little used roadway so as to simplify unloading requirements. They also need to be conveniently located relative to their point of use for both safety and ease of maintenance.

The acid tank must be located in its own separate and acid resistant bund. An HDPE or a resin and flake glass lining is recommended for this bund. Acid resistant tiles or bitumen based linings should not be used.

The sodium hydroxide and the sodium carbonate can share the same bund. A well compacted and low permeability concrete should be quite suitable for this bund.

Tanker unloading should be via fixed, permanently piped pumps with their suctions connected via in-line debris collection filters and suitable flexible connections to the tanker outlets. For safety reasons, the practice of blowing off the load should be avoided if possible. However this may be determined by the delivery vehicles used by the reagent suppliers.

Item O

The existing channel which connects the North Buffer Dam to the TETP should be re-arranged at the Dam end so that it will normally accept liquor from the area S and that this flow can be topped up from the North Buffer Dam. It is essential that this arrangement is never able to back flow liquor from the lined area S into the North Buffer Dam, even if this dam is subsequently lined. This is because liquor can back flow from the Buffer Dam into the feed channels and percolate to ground from these channels.

During the construction of area S and during the installation of the MTP and its associated infrastructure, the TETP (working in its current mode of operation) will need to be able to receive its normal input from the North Buffer Dam. This will be especially the case once the South Buffer Dam is converted to its new role (see K above). It is likely therefore that a convenient method of achieving the required functionality will be to make a concrete channel at O and then subsequently fit a sluice gate so that this channel can be closed off.

After ZED this channel should be closed permanently and variable speed pumps (duty and standby) should be used to provide the necessary flow from the Buffer Dam (which would then be a collection dam for storm water and for any contaminated waters that may occur).

This arrangement should preferably be arranged so that each pump has its own outlet pipe and that the pipe from each pump outlet is discharged at a level above the maximum possible level within area S so that there is no potential for a back flow from S.

This option will give a high level of environmental security and will lend itself to easy and accurate control room based operation.

Item P

This is where the chemical addition and reactors for the MTP process need to be sited. The incoming waters need to be de-gritted and any free oil needs to be separated before this reaction stage. The comments made in relation to item L regarding surface active agents and adequate reaction time apply equally to this area as well. In this instance, reaction times of circa 20 minutes should be adequate rather than the one hour referred to at item L. It is suggested that a set of four reactors will be used in series. The outlet from the de-gritting and oil skimming area should flow into the first of the four reactors. It is suggested that the reactors should preferably be arranged in a square block with a flow channel going around the outside. The flow channel should have baffle positions or sluices which would enable the flow either to enter and leave an individual reactor or to bypass it. In this way, when a reactor needs to be repaired, desludged or whatever, then it can be isolated from the flow and worked on while the other three remain on line.

Each reactor should have a minimum working liquid volume of 100 m^3 minimum. It is suggested that square reactors about 5m square by 4m liquid depth and about 0.5m of freeboard should be suitable.

The pH in all the tanks should be above pH 7 at all times such that the tanks can be concrete or coated mild steel and the stirrer can be coated mild steel, subject to a 2mm corrosion allowance on all wetted steel surfaces.

Reagent input should be to the first reaction tank with standby arrangements to the second tank when the first tank is out of service.

Item Q

This is the proposed above ground pipeline route for the MTP product water to be pumped to the existing 600 mm diameter Industrial Water Main at Y.

This same route should be followed for the brine and distillate from the MVR evaporators, plus steam and other services including instrument and control communications between the probable Solid Residues Processing Plant and the TETP area.

It is also proposed that there is an easily traversed routine pedestrian access route constructed alongside the pipe route, for the purposes of:-

- Intercommunication between the TETP area and the Solid Residues Processing Plant (if it is built at item T, see below)
- Maintenance and Inspection of the pipework and services,
- Routine "high point" inspection of the status of the North Buffer Dam and Dams S, K and X.

Item R

The existing gravel road between the bottom of the embankment for the western railway lines and Dam K should be extended around the north edge of Dam K and over the area V so as to provide maintenance access and a suitable route for reagent delivery.

Item S

This south east corner of the existing Northern Buffer Dam needs to be sectioned off, deepened by approximately 1m and lined in accordance with The Minimum Requirements. HDPE will be quite suitable as the lining material.

The Dam needs to extend reasonably well to the north in order to simplify the input of the main input gravity flow to this Dam (namely the HDPE pipe which is likely to be slung from the roof of the DR Canal). By reducing the length of this pipe from where it exits from the DR Canal, the maximum level in the Dam can be raised (without risk of the pipe backing up) thereby minimising the required surface area.

The Dam should be constructed to have a capacity of 10 000 m³ down to the invert of the existing outlet channel leading to the TETP. It should then extend a minimum of a further 1m deeper over its whole area so as to create a buffer blending capability for the incoming waters and to provide some capacity for suspended solids to accumulate (up to a maximum operating sludge depth at the north end of 0.8m). The buffer blending capability is essential in order to reasonably stabilise the input water quality to the MTP.

So far as possible, all the inputs to the MTP (other than from the North Buffer Dam itself, as discussed in O above and from Dam X) should all enter at the northern end of this dam.

Item T

This is an area which can be set aside for the probable Solid Residues Processing Plant. It is envisaged that this plant will be a continuous or semi continuous mixing and blending plant which will receive train loads of residues from the SteelServ areas and from the DR dust removal systems plus lesser amounts by road from elsewhere in the site, including granulated black slag and excess white slag from the Blast Furnaces.

Item U

It is suggested that additional points will need to be arranged within the rail infrastructure at the places shown so as to enable maximum flexibility for delivering the solid residues to the Residues Processing Plant.

Item V

The current concrete channel and baffle wall at the end of the Blower House Canal and the southern end of the concrete interlinking channel between the North and the South Buffer Dams needs to be removed as described in S above. Also the exit from the Blower House Canal will need new concrete works to feed it only towards the North along the channel around Dam S to the north end of the Northern Buffer Dam.

Item W

In order to build the proposed Collection Dam X for intercepting any contaminated water and to create a safe area for this at the western end of the Lamont Park area, the security fence needs to be relocated, reasonably as shown. The gravel road which follows the route of this boundary fence will also need to be relocated, reasonably as shown.

Item X

This is the proposed replacement contaminated waters interception and Collection Dam for the V3 Canal and the Open Canal. The optional layout that is shown is based on the option of gravity flowing as much as possible of the collected water back to the "clean" side of the TETP if its contents are found to be of an acceptable quality for discharge and its volume is not needed as a raw water source by the MTP.

The Dam should be lined. HDPE should be a suitable lining material. The specification as regards the design and construction of the dam must meet with the Minimum Requirements. It may be that a deeper and smaller surface area Dam may be more appropriate. In which case entry to the Dam can be west of the pylon rather than as shown.

Pumping from the Dam in order to return all the water will be needed for a deeper Dam.

Pumping from the Dam will be needed in any event in order to return any contaminated water to the MTP. Therefore the use of a deeper and thereby smaller surface area Dam could be appropriate in any event, subject to local ground water levels in the area.

A weir needs to be provided in the open channel of the Open Canal just downstream of the entry to this Dam. The level of this weir must be no more than 200mm higher than that of the weir at the offtake point G from this channel and it must be at a level at which the volume within Dam X is sufficient to meet any so called "First Flush" or potential spillage/leakage needs of the catchments served by the V3 Canal and the Open Canal.

The embankment around the Dam X and (if they are not already high enough) the side walls of the open channel may need to be raised in order for them to be just above the level of a 1 in 100 year flood event.

Item Y

This is the route of the 600 mm diameter Industrial Water Main into which the MTP product water should be added. This pipe is on an existing line of trestles. The MVR Evaporator Distillate will also need to follow this pipe trestle route to its proposed connection with input water to the Main Boiler House Deionising Plant.

5.3.14. LIMITATIONS WITHIN THE PROPOSED PROCESS WATERS MASTER PLAN SPECIFICATIONS

5.3.14.1. The sizing and capability of the proposed MTP facilities have been evolved on the following assumptions.

b. Until the existing dump has been capped and rehabilitated and until the leachate flow handled by the Du Preez catchment facilities has dropped effectively to zero, then all leachates from the current dump area will be routed to Dams 1 to 4 and not the MTP.
c. All future residues management facilities (including those currently planned) will be designed, built and operated in conformity with current international standards as regards

- ensuring that <u>virtually all</u> rainfall landing on the facilities and that <u>all</u> rainfall landing on the surrounding areas runs off as uncontaminated surface run off.
- ensuring minimum contamination within all leachate flows.
- ensuring that only leachate needs to be removed
- the leachate only needs to be removed at a steady average flow rate.

d. The maximum total leachate flow will be less than 40m^3/hr.

These limitations are constrained by potential salts load issues, not water volume issues.

If the proposed designs or operating modes for the solid residues management necessitate higher leachate flows then larger MVR evaporation and brine handling facilities will be needed.

5.3.14.2. The recently constructed Coke Oven Area Sump is able to collect and contain all the potential spillage and pipe burst type of events that were envisaged when it was designed. However, the sump must be emptied quickly to a suitable intermediate storage area in order to enable sufficient space to be made available in the sump for the potential results from a flushing liquor pipeline burst. This potential occurrence, whilst unlikely, represents the largest potential input to the sump and was the principal determinant for the sizing of the sump.

Currently, the storage dams at the Bio-Plant and the Maturation Dams together with the recently installed return infrastructure at the Maturation Dams provide the necessary buffer storage for this excess and the necessary return mechanism to process.

The two storage dams at the Bio-Plant have a combined volume equal to that of the Coke Oven Area Sump. Theoretically, therefore, once the Coal Gas Cleaning Project is complete, a combination of these two dams plus the volume of the Bio-Reactor itself (as it can be used as a simple storage vessel) should be sufficient to provide the necessary buffer storage capacity. However, these dams and the Bio-Reactor are not located strategically with respect to the Coke Oven Area Sump. They are strategically located with respect to the existing

Desalination Plant. Ongoing operating experience at the Desalination Plant may indicate that additional buffer storage capacity for input brine may be needed.

Should this brine capacity be required then it may be appropriate to use one of the Bio-Plant Inlet Buffer Dams for this duty and to create additional buffer storage facilities for the Coke Oven Waters nearer to the Coke Ovens. A suitable location may be in the area just to the north of the CETP.

5.3.15 COLLECTION ARRANGEMENTS FOR THE INDIVIDUAL PROCESS WATERS FROM WITHIN SOUTH WORKS.

Within North Works, all the process waters are currently either routed to the CETP or they are discharged to the North Works Blow Down Canal. Unfortunately, within South Works, the only effluents that are kept separate from the storm water system are those which are currently pumped to the CETP, or those which are part of the organically contaminated group of effluents from the Coke Oven, By-Products, Suprachem and Blast Furnace Gas Cleaning areas or those which are routed via slag granulation to the Desalination Plant. In order to arrange the ZED and the Process Waters Master Plan, separate collection and other arrangements are needed, both to the CETP and to the MTP.

5.3.15.1. The additional inputs to the CETP, are from

a. the CETP Sludge Dams
b. Dry Weather flow in the Burns Memorial Canal
c. Leachate from the ultimate Consolidated Residues Management Facility (CRMF) in the long term and in the short term, drain down from Dams 1 to 4.

The aqueous part of the sludge which is pumped to the CETP sludge Dams is essentially the same as the water that is discharged from the CETP itself. However, within the long pipe run to the sludge dam and within the Dam itself, reaction completion (which causes the pH to fall), reaction with atmospheric and biologically produced carbon dioxide and the effect of biologically reducing conditions all combine to cause the dissolved manganese, fluoride and magnesium concentrations to be higher in the water which leaves the Dams than in the water which leaves the CETP.

Because of the previous disposal of CETP sludge within the Burns Memorial Catchment, the dry weather flow in the Burns Memorial Canal has similar problems. In addition there are leachates and drainage from the coal stacking area from some of the coke storage area and from the sludge drying area.

Part of the ZED proposals are to install dewatering equipment at the CETP for the ongoing sludge production. Once this is working, then the flow from the CETP Sludge Dam will decline to virtually zero (and should become zero during each dry season).

As part of the CRMF, or in the interim, it may be appropriate to route leachate from the existing Dump area to the current collection pipe for the CETP Sludge Dam overflow (which runs north-south along the western side of the sludge dams).

The proposal therefore is to:-

- Gravity flow to a conveniently located sump the CETP sludge dam overflow (20-40 m^3/hr) and all waters from the adjacent boreholes (circa 1 m^3/hr).
- Make an allowance for dump leachate (either now or in the future) to either join this CETP sludge dams overflow or come via another route to this sump at a flow rate of up to 40 m^3/hr;
- Combine this flow (also by gravity) with the Burns Memorial Dry weather flow (10-30 m^3/hr) and

- Pump this combined flow (30-70 m³/hr) plus dump leachate if it is added to this flow, to the CETP bund area collection sump via a debris removal screen situated adjacent to this sump (this screen is part of proposed MTP infrastructure at the CETP).
- From here it will be pumped automatically, along with general bund drainage water to buffer storage within the CETP for treatment at a steady rate together with the rest of the basically inorganic effluents.

5.3.15.2. There are then the main effluent and blow down routes to the MTP: The largest single source is from the CETP. Part of the proposed ZED infrastructure is to change those parts of the current CETP Canal which are open trench to a properly constructed and buried HDPE pipe. Indeed, subject to a proper survey of the existing piped sections, then much of the currently piped parts may be abandoned and replaced with a new HDPE pipe, or a HDPE sleeve may be inserted into them as a permanent liner.

The treated and clarified CETP effluent will by gravity discharge from the CETP clarifiers to the upgraded CETP Canal and routed to the CETP Canal's present junction with the Direct Reduction (DR) Canal.

The clarified water should then continue to flow by gravity through a new HDPE pipe (probably mounted from the roof of the DR Canal) to the western side of the railway lines.

The clarified water should then continue to flow by gravity in a new section of HDPE pipe to the new MTP infrastructure at the TETP area.

As this HDPE pipe progresses along the DR Canal route, the various effluents and blow downs that are produced within the DR area should be discharged to this HDPE pipe. These effluents include:

- Cooling Tower Blow Down
- Kiln Shell cooling
- Blow Down from internally recycled Kiln Shell cooling water and from general wash down and dust control waters.

Where it is convenient for any or all of these DR related effluents to be directed to the proposed enlarged sump at the western end of the proposed Coal Gas Cleaning and Coke Oven Area collection pipe (see section 5.3.15.5) then these effluents should be directed to this sump instead.

It should be noted that the regeneration effluents from the DR Demineralisation Plant should already be being discharged to BF Slag Granulation. Indeed, under the site's present operational policy, this Demineralisation Plant should be shut down for most of the time.

5.3.15.3 At some convenient point in the North Works Canal upstream of the junction between the North Works Blow Down Canal and the Burns Memorial Canal, the total flow in the North Works Blow Down Canal (namely North Works Blow Down and ground water from the east side of the site) should be discharged into the CETP Canal. This will require a sump with duty and standby pumps. The expected average flow rate that will be in this section of the North Works Blow Down will be about 130 m³/hr.

5.3.15.4 There are then the essentially clean blow downs and back washes from the Cold Mills areas, which have already been referred to in Section 5.1.7. These should be routed and re-used as described in that section.

5.3.15.5 The next major source of water is from the cooling tower blow downs and filter backwashes from the cooling systems in the Coal Gas Cleaning areas and the Suprachem areas. Associated with these are the de-sludging blow downs from the cooling waterside of the primary coolers, from all the different steam condensates and from water softeners and air conditioning units.

A new HDPE gravity flow drain is proposed just north of and running parallel to the existing Coke Oven Canal. Blow downs from the cooling tower circuits all the way along Suprachem and the Coal Gas Cleaning infrastructures, including sand filter backwashes and the de-sludging of blow down from the cooling water side of the primary coolers should be directed into this new drain.

Where it is convenient, steam condensate can be kept out of this drain and added to the nearest cooling tower circuit, (if this option is chosen, then the make up water valve timer settings for the receiving cooling tower will need to be adjusted accordingly).

All spillage, blow down and bund waters associated with the coal gas cleaning and related activities should continue (as now) to be routed to the existing (but new) Coke Oven Area Drainage Sump.

Waters which are removed from bore holes, cable tunnels and other below ground structures in the coke oven and coal gas cleaning areas should continue to be routed to the Coke Oven Area Drainage Sump, if they have a significant COD (>300 mg/litre) or a significant NH_4 (>50 mg/litre) or H_2S (>20 mg/litre) content. However, all such waters which have lower concentrations for all three of these materials should be routed to the new drain for the cooling towers, etc.

The peak flow to this new drain will result from sand filter back washing. This is a manually controlled activity which is carried out by one man who steadily progresses through the whole area and then starts again. Accordingly, only one set of sand filters will be back washed at a time. As a result the likely average flow along this drain will steadily increase from zero at the eastern end of the coke ovens to about 100 to 150 m^3/hr at the western end of the coke ovens. To this, will then be added a surge flow of up to 150 m^3/hr for up to ten minutes from each (in turn) of the sand filters.

The new drain should terminate in a sump at or near to the site to the previous Coke Oven Canal Pump Station (which used to pump to Dam 10) and this sump should be pumped to the four Coke Quench Stations as their make up water. A new supply pipe will be needed, preferably HDPE or polypropylene. Ideally, it should be routed as a single supply to the eastern most quench and then each quench sump should overflow to the next sump west.

By routing this collected water direct to the Coke Quench Stations, a new gravity drain route beneath the ore stocking area and beneath the adjacent western railway lines can be avoided.

Additional feed water from the adjacent Blower House Canal, from the DR area or alternatively, direct from the MTP at the TETP will be needed to make up the necessary total supply that is needed for the Coke Quench.

In order to accommodate the situation that would occur should the sump pumps (duty and automatic standby) both fail, then it is proposed that an overflow arrangement will be piped through to the HDPE pipe within the DR Canal, probably connecting with it south of the ore stock pile and west of the railway lines.

Alternatively, it may be possible to arrange an equivalent overflow to a similarly arranged HDPE pipe within the Blower House Canal. The feasibility of such an option is still being investigated.

While the sump pumps are not working, then the Coke Quench units can be fed using their existing top up arrangements from the Industrial Water Main. It will be necessary to modify the control valves at each Quench Station and to modify their control mechanism relative to their current arrangements. This section of the Industrial Water Main will be fed from the MTP at the TETP so that the net evaporative use of MTP water will remain the same.

The proposed amendments to the water input controls at each Quench Station will ensure that sufficient MTP product water is fed to each Quench Station to keep full capacity operation at the MVR evaporators. This in turn will ensure that the salts content of the MTP product water will not increase by much even if the sump pumps are off line for a number of days.

5.3.15.6 A further dedicated blow down pipe is needed from each of the four Coke Quench Stations in order to purge the dissolved salts to the MVR evaporators. The ideal and simplest to control logic for controlling the coke quench liquors would be to feed the whole flow to the eastern most quench station and then to overflow the excess to the next quench station west. This station would then overflow to the next station west, etc, thereby feeding all four quench stations. It will probably be necessary to pump the overflow from the eastern quench station to the eastern one of the two middle quench stations, gravity overflow to the next and then pump the overflow from there to the western most quench station. HDPE or PP pipe should be used.

From the western most quench station, a gravity HDPE or PP drain should follow the same pipe trench route as the overflow from the gravity sump referred to in 5.3.15.5 above. Once west of the railway lines, this drain should follow a southerly route, parallel to that of the HDPE pipe carrying the CETP discharge and the North Works and DR area process waters, all the way to the lined inlet buffer dam for the MTP Evaporators (Dam K).

It is anticipated that this route will enable the addition of an emergency pumped or preferably gravity overflow from the slag granulation wet dams into this new HDPE or PP drain. This will provide an emergency option for controlling the level within these dams should the pump based level control to the existing Desalination Plant fail (e.g. as a result of pump or local power failure).

It should be noted that this overflow route should not be used if the existing Desalination Plant goes down or cannot cope with the necessary load. The preferred option in this situation would be for the excess volume (over and above that which can be held in the Desalination Plant Buffer Dams) to be passed across to the adjacent Bio Plant Inlet Buffer Dams. From here there is existing infrastructure for feeding this liquor to the Coke Quench. At the Coke Quench, part of the hardness in the Slag Granulation waters will be removed automatically (without causing a problem to coke quality), thereby reducing operating and load problems at the softening plant for the new MVR evaporators when handling this extra volume.

5.3.15.7 As one moves further south through the South Works, the next Canal into which there are process discharges is the Blast Furnace Canal.

Once the Blast Furnace Slag Granulation upgrades have been completed and the above referred changes have been made to the essentially clean effluents in the South Cold Mill area, then there should be no further process derived inputs to the Blast Furnace Canal, other than the blow down from the boilers. It is proposed to re-direct this blow down to the Blower House Cooling Towers (see 5.3.15.8 below).

5.3.15.8 At present the only process discharges to the Blower House Canal are from the Blast Furnace Open Cooling Circuit servicing both furnaces, from the Blower House Cooling Towers, from the boilers, from the locomotive Repair Workshops and from the other Workshops in the area. Once the MTP is operating, there will be a need to receive blow down from the Mould Foundry Open Cooling and any use of this water for irrigation purposes other than for mould preparation, for moulding sand handling and for dust suppression activities will have to be stopped.

In order to avoid temperature problems in the proposed process waters collection pipework, it is proposed that the boiler blow downs should be routed to the recirculation sumps for the cooling towers.

A new HDPE pipe should then be arranged, probably hung from the roof of the Blower House Canal, to collect the Blast Furnace, Blower House and the Mould Foundry Cooling Tower Blow Downs together with their Sand Filter Back Washes and to route them to the new MTP infrastructure at tbe TETP area.

At present, all the Workshop areas simply discharge wash down and equipment/component cleaning waters to the Blower House Canal. It is understood that proposals are currently in hand for all these effluents to be routed to one or more new oil and solids interceptors (as suits the current drain details) in order to retain oil spillages and oil which may be washed off components/equipment. These interceptors will need to discharge by gravity to this new HDPE pipe.

Average flow rates down this new HDPE pipe should not exceed 80 m^3/hr with a combined peak flow (during a sand filter back wash) of less than 220 m^3/hr.

5.3.15.9 The South Dam Canal is a collector canal which is fed by four sub-canals:-

M Pump House Canal
Candy Canal
Combination Mill Canal
BOF Canal

The majority of the process effluents that are discharged to these canals come from various "semi-clean" cooling etc. circuits within the South Mills area. Some of these "semi clean" circuits are supplied with Industrial Water, some are fed with Vaal Dam Water and some are fed with softened or otherwise upgraded water.

Once the ZED infrastructure is operating, the Industrial Water main within this area will be supplied with Vaal Dam Water. Evaporator distillate will be returned to the main HP Boilers area and should the flow of this distillate exceed the particular boiler requirements at the time, then the excess will backfeed into the Vaal Dam supply pipe which feeds this area. This water will have a dissolved salts content similar to that of de-ionised water. Whichever water is actually fed at the time, the volume of the blow downs from all clean and "semi clean" systems in the South Mills will, as a result, be able to be reduced considerably.

The M Pump House Canal

The M Pump House itself used to discharge to the M Pump House Canal. This has been stopped and the Pump House now discharges to the Candy Plant. There are no other process inputs to this Canal.

The Candy Canal

There are three process inputs to this canal,

i. Blow Down and Back Wash from the cooling towers at the former Air Products Plant. These should be re-routed to the sludge handling facilities at the Main Pump House.

ii. The Candy Plant itself currently has a continuous overflow to the Canal. Maintaining a continuous overflow from this plant is a convenient way of monitoring operational control with what was a very large and complex plant serving very many more activities than at present. Most of the activities it used to serve are closed down permanently. It is apparent that by a combination of specific permanent isolations and specific by- passing of some of the redundant functions together with a re-arrangement of some of the process controls, the overflow from the Candy plant can be reduced to less than 20% of the present amount. These changes should not make the plant unrealistic as regards operational simplicity and reliability. Indeed, these changes should make the situation much better.

These measures should be implemented and then the remaining overflow or blow down should be pumped to the South Mills 5 Stand oily wastes sump for inclusion with the oily wastes input to the CETP. This additional input to 5 stand should be less than 5 m^3/hr

iii. In addition to discharges from the Candy, N Pump House discharges a combination of backwashes and blow downs. The principal amount is blow downs. The volumes of these blow downs will reduce as the Industrial water is replaced by a combination of Vaal Dam and Evaporator distillate.

The remaining blow downs should be routed to the Candy system and added to that which is sent to the 5 Stand oily wastes sump.

The Combination Mill Canal

This canal receives a small Blow Down from Plate Treatment (average of about 0.2 m^3/hr), an overflow from the Main Pump House (currently about 100 m^3/hr) and first flush, etc water which is pumped from the Leeuspruit Dam.

For the purposes of ZED, water collected within the Leeuspruit Dam is regarded as "first flush" and not a process effluent. It is proposed that this water will continue to be allowed to flow via this canal to the South Dam Canal where it will join the rest of the Vanderbijlpark Steel dry weather and first flush waters which will then be returned to the MTP as make up water. Only that part of the Leeuspruit Dam waters that are pumped during a rainstorm and which are not collected as part of the "first flush" and the "after the storm" or other "collected waters" (for return to the MTP) will be discharged to the Rietkuil Spruit and/or the RietSpruit Canal.

The blow down from Plate Treatment should be routed to the Candy Plant infrastructure for routing to the 5 Stand.

The overflow from the Main Pump House will no longer be necessary once the ZED infrastructure is operating, as River Water will no longer need to be pre-treated here. Any River water that is needed to be used as make up water can be simply directed to the MTP as untreated raw water for inclusion into the MTP make up.

The existing canal infrastructure would represent a convenient route for directing this make up to the MTP.

Similarly, if Vaal Dam Water is to be used as make up it too can be added at this location.

The Main Pump House also accumulates sludges and other blow downs from surrounding production plant and processes (e.g. from the former Air Products Plant, as above, and from the RHOB and its related areas, as discussed below). The Main Pump House has an existing 150mm pipe connection between it and the TETP. This pipe connection should be used to transfer all these accumulated discharges to the MTP at the TETP area.

The BOF Canal

The only process inputs to this canal are from the BOF, V1, V2 and RHOB areas. All these discharges are now going to the infrastructure which was developed for the Short Term measures and which has now been completed. This infrastructure is designed to take all these waters to Slag Granulation which in turn will have its liquors purged to the upgraded Desalination Plant.

It is understood that part of the originally installed blow down and sludge handling equipment at the RHOB is currently out of commission/re-arranged. This will need to be put back into proper operation and re-connected to the Short Term Measures integration with the BOF circuits.

5.3.15.10 The same infrastructure as referred to under the BOF Canal above is designed to handle all the process discharges to the Open Canal, including that from Air Products.

Once the ZED infrastructure is working, Air Products will be supplied with Vaal Dam water. The blow down flow from Air Products will therefore reduce considerably, reducing the expected total flow from the current approximately 30 m^3/hr to about 15 m^3/hr. For safety, the ZED mass balance has assumed 20 m^3/hr for this flow.

5.3.16 EXPECTED ANALYSES OF THE MTP INPUT AND OUTPUT STREAMS

The following tables are based on an average assessment of all the input streams and upon speciation and mass balance calculations around the whole MTP infrastructure. In creating these tables, a whole range of "what if" and "worst case" scenarios were investigated. For simplicity, only the worst "worst case" scenario is presented here.. This scenario results from the potential for a period of high chloride input as a result of a potential problem within acid pickling and rinsing within North Works. The worst case assessments in this instance are shown in brackets after the normally expected values.

It should be clear from all the above text that a truly defensive design concept has been evolved and that further numerical evaluations of possible fault conditions are not necessary.

Table 5.3.16.1 Expected MTP Input and Output Stream Analyses 1 of 3

	Units	MTP Product Water	Returned MTP Water from Cooling Towers	North Works Canal	CETP discharge	East Ground Water
Chloride	mg/l Cl	233 (629)	420 (1132)	50	400 (1000)	148
Sulphate	mg/l SO_4	345	621	100	500	94
Fluoride	mg/l F	1.0	1.6	0.8	1	0
Cyanide	mg/l CN	<0.1	0.1	0.7	0.1	
Nitrate	mg/l NO_3	5.2	9.3	1.6		60
Nitrite	mg/l NO_2	<0.1	<0.1	0.3		
Phosphate	mg/l PO_4	<0.005	<0.005	0.6	0.6	
Silica	mg/l SiO_3	12.3	22.1	6	6	30
Sodium	mg/l Na	157 (473)	284 (853)	60	140	31
Potassium	mg/l K	7.5	13.5	5	5	7
Calcium	mg/l Ca	60	108	40	340 (770)	93
Magnesium	mg/l Mg	22	39	20	10	78
Iron	mg/l Fe	<0.1	<0.1	0.4	0.2	11
Zinc	mg/l Zn	<0.1	<0.1	2	0.5	0.1
Tin	mg/l Sn	0.4	0.7	0.3	0.2	0.1
Manganese	mg/l Mn	0.3	0.5	0.2	0.2	0.5
Chrome	mg/l Cr	<0.1	<0.1	0.1	0.1	<0.1
Ammonia	mg/l NH_4	0.9	1.6	0.3		5
PH		7-8	7-8	6.5	10.5	7.3
Total Alk	mg/l as $CaCO_3$			170	55	80

Note: numbers in brackets correspond to the operation of the CETP and hence the MTP system with high chloride and associated high calcium levels.

Table 5.3.16.1 Expected MTP Input and Output Stream Analyses 2 of 3

	Units	Western Low Cl Ground water	Western High Cl Ground Waters	Returned Water ex-Coke quench	Mixed feed liquor to MTP
Chloride	mg/l Cl	84	955	3300	233 (629)
Sulphate	mg/l SO_4	66	620	1800	337 (372)
Fluoride	mg/l F	0.3	0.9	5	0.9
Cyanide	mg/l CN			0.2	<0.1
Nitrate	mg/l NO_3	1.9	1.8	28	5.2
Nitrite	mg/l NO_2			0.04	<0.1
Phosphate	mg/l PO_4			<0.002	0.3
Silica	mg/l SiO_3	27	31	68	12.3
Sodium	mg/l Na	25	135	2350	114 (241)
Potassium	mg/l K	3	12	40	7.5
Calcium	mg/l Ca	57	380	386	172 (342)
Magnesium	mg/l Mg	33	200	116	22
Iron	mg/l Fe	18	17.5	<0.1	1.2
Zinc	mg/l Zn	0.1	0.1	<0.1	0.4
Tin	mg/l Sn	0.1	0.1	2.3	0.4
Manganese	mg/l Mn	1.0	1.3	1.4	0.3
Chrome	mg/l Cr	<0.1	<0.05	<0.05	<0.1
Ammonia	mg/l NH_4	5	5	5	0.8
PH		7.5	7.2	7	7-8
Total Alk	mg/l as $CaCO_3$	130	128		

Note: numbers in brackets correspond to the operation of the CETP and hence the MTP system with high chloride and associated high calcium levels.

Table 5.3.16.1 Expected MTP Input and Output Stream Analyses 3 of 3

	Units	Vaal Dam Water	Vaal River Water	South Dam and Open Canal DWF	South Works "Clean"	Leeuspruit Dam / other Surface Waters
Chloride	mg/l Cl	9	65	70	15	45
Sulphate	mg/l SO_4	8	200	200	20	120
Fluoride	mg/l F	0.4	0.8	1	0.4	0.6
Cyanide	mg/l CN			0.1	0	
Nitrate	mg/l NO_3	0.4	5		1.3	10
Nitrite	mg/l NO_2				0.1	
Phosphate	mg/l PO_4			1		
Silica	mg/l SiO_3	7.5	12	13	13	19
Sodium	mg/l Na	11	60	60	22	40
Potassium	mg/l K	2.9	10	5	5	5
Calcium	mg/l Ca	15.2	80	56	40	48
Magnesium	mg/l Mg	7.5	25	19	12	19

Iron	mg/l Fe	0.07	0.1	0.2	0.14	5
Zinc	mg/l Zn		0.1	0.8	0.7	0.1
Tin	mg/l Sn		0.1	1.2	0.9	0.1
Manganese	mg/l Mn		0.1	0.3	0.2	0.2
Chrome	mg/l Cr			0.01	0	
Ammonia	mg/l NH_4			0	4.3	3
PH		6.5	7.5	8.5	7.1	7.5
Total Alk	mg/l as $CaCO_3$	60	120	90	100	122

Note: numbers in brackets correspond to the operation of the CETP and hence the MTP system with high chloride and associated high calcium levels.

6. MONITORING AND MANAGEMENT SYSTEMS

6.1 USAGE OF THE RECYCLE WATER

One of the key concerns that had to be addressed during the evolution of both the ZED concepts and the extension of those concepts to the overall Process Waters Master Plan was "How does one ensure that the various water users actually use the water that is returned to them rather than connecting themselves to fresh raw water?"

Most of those concerns disappeared when it was clear that the Industrial Water Main could be used as the distribution main for all these users. By ensuring that there is no alternative supply connection to those users, then there would be no alternative but to have to use the recycled water for that particular use. Also, by ensuring that there was a back up water source actually within the inputs to the Industrial Water Main, then there was no reason nor excuse for those water users to make another arrangement for another supply source to be connected to their specific use.

A further method of ensuring continuing usage of the return water was to install a feed and blow down mechanism at each use point which did not require any actions or monitoring functions to be undertaken routinely by the local production (or business) unit. Providing they were, for example, always able to rely on the operation of their cooling towers and the associated infrastructure was not corroding, blocking or scaling, then those users would be able to essentially forget about that production related worry and concentrate on other issues. With the water related issues not on their regular agenda, then the likelihood of someone seeking to change the arrangements would be very much reduced.

A key feature, therefore, of the proposed ZED infrastructure is not only the use of the Industrial Water Main but also the way the water supply to each user is controlled. The concept of a clock and timer based input control to each user may not achieve theoretical optimum cycle up in strength before it is blown down. However, it will always ensure that the system is never cycled up too much, that it is always kept fully topped up and therefore it can always take whatever load is needed (up to its maximum capability) without operator intervention.

A further benefit of the clock and timer based system is that the controls can be set by suitably qualified and authorised personnel on the basis of current/expected or (if necessary) maximum production levels with the aid of proper laboratory based analyses. These control settings will then be able to cope with whatever work load is expected or could occur without further attention.

There would be no need to clean and re-calibrate conductivity, pH and other analysis probes in order to achieve this control. Such devices would be unnecessary and should be removed.

Routinely, say weekly, circuit water samples would be taken from each user and laboratory analyses would be carried out for the essential parameters, (probably chloride, pH and conductivity) that would control make up rates. If these parameters were running a little high or low, then the timer settings could be adjusted to suit. However, before making any such adjustment the responsible person should check with the production unit to ascertain whether or not production fluctuations were the principal cause of any non-ideal analyses and what the likely loading would be in future. Then on the basis of analyses, historical usage and expected future usage, adjustments could be determined, or (as would be more likely once the systems have all settled down) the stable settings would be left as they are.

The whole control of water usage should therefore require little or no input from the water user and can be operated as a Central Services function or an outsourced function reporting to Central Services.

The other reason for using clock and timer based controls on the input to the system (as referred to in Section 5.1) is to set up as steady a flow as possible out of the MTP into the Industrial Water Main and to achieve as steady a flow as possible down the return infrastructure. By controlling a steady input to each system, the automatic level controls (usually overflows) on the user systems will create a steady output flow.

6.2. SYSTEM CONTROLS

The other control and management issues that have to be monitored and managed relate to

- The CETP
- Level controls in the collection dams at the MTP (Dams S and K)
- Level controls on the MTP product buffer dam B (These have already been addressed in Section 5.3.13).
- Pump out rates from the remainder of the North Buffer Dam and any other collection arrangement or extension for receiving contaminated surface waters and other surface waters.
- Make up rates from the Vaal Dam or Vaal River Supplies.
- Input rates of ground water
- Output of product brine from the MTP evaporators.
- The strategies for handling mishaps, spillages, plant outages and other forms of plant performance reductions.

These latter items have all been referred to in detail at the respective points in Section 5 where the strategies and proposed infrastructures were developed and discussed.

6.2.1. CETP CONTROLS

Probably the most important issue that has to be accepted is that the CETP (like the MTP) has to take and handle what is sent to it. As a result, if problem liquors arrive, the operators of the CETP may have to take extraordinary measures and they may have to make representations to the relevant effluent producers, but essentially once something has been pumped to the plant, it has to handle it.

The large capacity buffer storage and other infrastructures at the CETP enable the CETP to handle essentially all of the surges and other demands to which it is subjected. In the past, the CETP was able to neatly off load most of these problems to Dam 10 or to the Sludge Dams. These options have all been removed, but the intrinsic flexibility and capability of the plant has been greatly improved.

There has been a steady improvement in the level of understanding within the different Business Units at the IVDBS site in relation to what causes difficulties at the CETP. There has also been a growing recognition of the fact that it is the site as a whole which will be judged for environmental compliance, not a specific Business Unit.

Overall, therefore, the general arrangements at the CETP and its relations with the different effluent suppliers is adequate, is improving and ongoing improvements will continue to be in the interests of IVDBS as a whole.

The detailed controls within the CETP have been arranged to provide stable and easily managed control, with essentially all of the controls being automatic. Most of these controls are based on levels. Some of the effluent flows or the addition of polymer flocculants or emulsion breaking additives are arranged on a flow proportional basis. These are, as far as possible set up so as to use motor speed rather than instruments to determine the appropriate set point for the complementary addition.

Treatment quality is based on continuous pH control, with the set point being determined and adjusted on the basis of a combination of on site rapid analyses which are routinely confirmed by proper laboratory analyses.

These control arrangements are very similar to the current arrangements. These current arrangements have been steadily settling down over the last 12 months and are seen as being appropriate and workable.

6.2.2. The levels in the two dams S and K need to be kept reasonably low so as to preserve as much buffer capacity as possible for handling any plant outages, spillages, pipe bursts, circuit emptying at one of the water users(e.g. for maintenance), etc. However, the levels need to be kept above a reasonable minimum of say 25% so as to enable sudden quality changes in the influents to be reasonably attenuated such that down stream plant control is not too severely affected. This minimum level will ultimately be determined more by experience than by theoretical analysis.

In the ultimate analysis, the level in Dam S will be controlled by the rate of water make up to the whole ZED infrastructure. Therefore water input from the North Buffer Dam and (if necessary) from Ground Water sources will be used as the essential means of maintaining a reasonably low level in Dam S. When the level begins to get below the optimum, then more water should be added to dam S firstly by returning the ground water pumping feeding dam S to its normal level (if it had been reduced) and secondly by a greater input from the North Buffer Dam.

When the North Buffer Dam starts to get to a low level, then water will need to be added, firstly from any compatible quality surface waters which have been retained elsewhere and secondly (when those inputs are exhausted) from either the Vaal River or the Vaal Dam. These latter supplies would, for convenience, be discharged untreated into the surface water canals at the Main Purification Plant. The canal infrastructure would deliver this water to the North Buffer Dam from which the normal controls and pumps would deliver it to the MTP.

6.2.3. The ground waters can be divided into four basic groupings, on the basis of their source location and (as regards the western ground waters) their analysis, as follows:

A. Those from the north east side of the site. [circa 40 m^3/hr]

B. Those from the south east corner of the site. [circa 20 m^3/hr]

C. Those from the west side of the site which individually have chloride levels which are generally below about 150 to 170 mg/litre (i.e. about half of those in the area west of Dams 1 to 4). [circa 40 m^3/hr]

D. The remaining ground waters along the western boundary. [circa 70 m^3/hr]

The Group A ground waters are envisaged as being pumped to a convenient location within the North Works Blow Down Canal. This Canal is located along the western side of North Works with a number of feeder sections reaching east west into the heart of North Works at the northern, middle and southern ends of the North Works. Under certain storm, wet weather or plant outage, etc, conditions it may be necessary to suspend the pumping of these waters for a few days in order to enable the MTP infrastructure to have greater available capacity for dealing with process and surface derived waters.

The Group B ground waters are envisaged as being pumped to the existing SteelServ Sump (that was installed as part of the Short Term Measures) at the south eastern corner of the SteelServ area. The pumping of these waters can be continuous other than if or when the sump reaches high level alarm, at which condition all these ground water pumps should be stopped automatically. They should be restarted automatically once the high level alarm has cleared. High level alarm should only occur during heavy rainfall, a local power failure or the failure of both the duty and the standby pumps at the sump.

The Group C ground waters are envisaged as being pumped to a convenient point along the new gravity flow HDPE drain which will probably be slung from the roof of the Direct Reduction (DR) Canal and which will ultimately discharge into the northern end of Dam S. Alternatively, the Group C ground waters can be routed directly to the northern end of Dam S. Under certain storm, wet weather or plant outage, etc, conditions it may be necessary to suspend the pumping of these waters for a few days, as described for group A ground waters above.

The Group D ground waters are envisaged as being pumped to the buffer storage Dam K. These ground waters should enter the Dam at V where they will mix with the other input waters to the softening plant which will feed the evaporators. Under certain storm, wet weather or plant outage, etc, conditions it may be necessary to suspend the pumping of these waters for a few days, as described for group A ground waters above.

6.2.4. The proposed routing and therefore the control of the output brine from the brine concentration stage of tbe MTP infrastructure very much depends upon the choices that are made as to whether or not to use a crystalliser or whether to forward the brine mostly to the DR After Burners and partly to the likely Solid Residues Processing Plant.

The preferred option, and by far the lowest cost (both Capex and Opex) option is to forward as much brine as is needed to the Solid Residues Processing Plant and to forward the rest to the DR After Burners.

The DR After Burners have two basic zones within which the MTP brine (or any compatible water) can be used. The first zone is the temperature control zone where the temperature has to be kept as high as possible (>900°C ideally) to ensure complete combustion and the temperature has to be quenched to below the temperature at which the kiln dust starts to become "sticky", i.e. below about 1000°C. The second zone, (at the top of the after burner as the gas duct turns through a 180° bend from vertically upwards flow to vertically downwards flow into the boiler) is where additional water is sprayed when, for operational or steam demand issues, less steam is to be produced.

Brine can be added to the first zone on a temperature controlled basis to ensure full combustion without excessive temperatures and brine can be added to the second area on the basis of whatever flow is needed (up to a maximum of about 50 m^3/hr per after burner) in order to accommodate the necessary brine removal rate. Clearly, it would be necessary to limit the maximum flow of brine input to a maximum mass of salts input rate which would be consistent with dust disposal and ESP performance, but for normal routine operation of the overall ZED infrastructures, the mass flow of salts would be relatively steady. Therefore, if there were a volume handling issue within the MTP, more volume of weaker brine could be sent to the after burners in order to alleviate the volume problem.

7. COST ESTIMATES AND TIME SCALES

The following Table 7.1 sets out the expected implementation strategy (costs and timing) for all the projects referred to above. The costs are based on the capacities referred to in the mass balances presented within the relevant preceding sections together with the limitations and other constraints that were presented at each stage.

At the time of writing this report, it is not clear whether or not there is a need for such a large emergency holding dam and hence, such a large cost as is presented in this table. Once the second Bio Plant Inlet Buffer Dam is cleaned and back in service, and the benefits of the early part of the coal gas cleaning project are more clearly defined, a more fully informed decision can be taken. In the interim, the Maturation Dams have more than sufficient capacity to accommodate the sort of eventuality that this dam would be intended to manage.

Table 7.1 COST ESTIMATES AND PROGRAMME

Project Description	Total Plan	FY2003	FY2004	FY2005	FY2006	FY2007
CENTRAL SERVICES						
BUDGET APPROVED						
MTP HOLDING DAM (Emergency Dam)*	17.000	-	17.000	-	-	-
CRYSTALLISER	50.000	-	10.000	40.000	-	-
OPEN + V3 CANALS FIRST FLUSH (DAM X)	2.000	-	-	2.000	-	-
MAIN TREATMENT PLANT	150.000	-	30.000	101.000	19.000	-
CLEANING OF COKE OVENS GAS AND WATER	182.900	60.541	102.098	9.400	-	-
FULLY CONTAIN BF SLAG GRANULATION	3.013	2.000	-	-	-	-
ISCOR CLEAN GAS DEMONSTRATION PLANT	15.000	13.900	0.242	-	-	-
SINTER OFF-GAS TREATMENT PLANT	152.000	-	-	20.000	82.000	50.000
SLAG GRAN WATER LEVEL CONTROL	3.298	-	-	-	-	-

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SLAG GRAN WATER LEVEL CONTROL	3.298	-	-	-	-	-

*See Notes in Section 7.

8. CONCLUSIONS

When RPA first became involved with the start of the Master Plan Process (mid 2000), the standards of operation and compliance as regards process waters were poor. The different parts of the overall strategy that existed for improvement and for reaching ZED 2005 (as had been promised to the Authorities) did not link together adequately, and in places there were serious gaps that would have needed major amounts of additional plant and equipment in order to close them. In particular, the concepts would only have been able to have achieved zero effluent discharge during dry weather. During wet weather, the majority of the "as now" discharges to the RietSpruit Canal would have been discharged to the canal in admixture with surface waters.

A further major problem with the proposals was the "end of pipe" thinking. There had been little apparent effort to examine what could be achieved at the effluent sources in terms of reduced flows, less pollutants per unit volume, internal re-use at or near to source, etc..

The Short Term Measures did a lot to improve the situation, especially as regards discharges from the eastern side of the site to the Leeuspruit. The Short Term Measures also mitigated most of the peak exceedances as regards the inputs to the RietSpruit Canal.

Following on from the initial impact of the Short Term Measures, the Coke Oven area effluent separation and bunding project, the ongoing works at the CETP and the rebuilding and extension of the Burns Memorial Drain have enabled all inputs to Dam 10 (both process and surface waters) to be stopped and for Dam 10 to be steadily emptied. It now contains about 20% of its maximum and it is continuing to be emptied.

Inputs to the Maturation Dams are much reduced and a system for pumping back to process has been added. Now there is a small net removal rate from these Dams in addition to evaporation and seepage.

As a result of well co-ordinated and integrated thinking, the final form of the upgrade project for the Coke Oven area and for Coal Gas Cleaning was such that the effluent production volumes will be slightly more than halved and the quality will be such that it will be able to be used "as is" within the Blast Furnace gas cleaning system and then within the proposed Gas Cleaning Process for the Sinter Off-Gases. This latter use is irrespective of whether the VAI Wet Fine Process or the Iscor Gas Cleaning Process is used.

All these developments mean that the IVDBS will no longer need a Biological Effluent Treatment Plant.

Also, Coke Quench will (following ZED and the completion of the Sinter Off-Gas Cleaning Project) no longer use organically and ammonia contaminated water for its quench. This will have major benefits as regards atmospheric releases, general corrosion within the whole of the iron making and Direct Reduction areas and as regards coke quality.

This removal of the organically contaminated liquors from the overall effluent picture has enabled major savings to be achieved within the rest of the ZED infrastructure and within the ultimate Process Waters Master Plan.

By following back to source the major problems which the CETP was encountering, significant savings both at the CETP and at the source areas are being achieved. There is considerable potential for more savings, primarily at the sources. These are being worked on.

A strategy has been evolved for converting all the aqueous effluents and blow downs into an acceptable quality recycle water for the principal cooling tower and quench functions within the iron making and the steel making areas of South Works.

This strategy includes the use of the existing Industrial Water Main within these areas as the means of returning that recycle water to the identified users. The principal problem of "How do you get the business units to use the recycled water rather than fresh raw water?" is therefore neatly avoided. They will have no other supply.

Blow down of the used waters from these users will be via coke quench (which will, in effect, act as a first stage brine concentrator) and then through evaporative brine concentrators.

Low cost on-site outlets for the brine have been identified but their coordination through the rest of the Master Plan has not been fully confirmed and the necessary EIA processes may conflict with the required time scales for ZED.

The tender documents for the ZED infrastructure (which are currently being finalised) therefore include a take out option for a suitably sized crystalliser. This will be an expensive capex and opex alternative to the proposed on-site disposal option and RPA strongly recommend that it should be avoided if at all possible.

The proposed brine outlets are:-
- -the necessary mixing water that will be needed for the likely solid residues processing plant
- -temperature control and further cooling water within the Direct Reduction After Burners.

This latter option has the potential for avoiding most of the necessary evaporation capacity that would otherwise be needed for a crystalliser.

The overall ZED infrastructure has been arranged such that its central core structure will be capable of carrying all of the ground and surface waters which will (at some point in time) need to be treated. As these waters are added, so add ons to that core will probably be needed.

However, the necessary spare capacity that is needed in order to provide the level of reliability needed for the ZED infrastructure will mean that the currently expected ground water can be handled for most, if not all of the time. Alternatively, a steady input from Dams 1 to 4 can be absorbed by the ZED infrastructure.

The ZED infrastructure will have a routine requirement for about 260 m³/hr of makeup water. This will be sourced on a priority basis from
- contaminated surface waters, spillages, etc
- other collected surface waters
- the Vaal River or Vaal Dam supplies

Increases in this capacity for receiving surface waters can probably be achieved as a result of further improvements at the effluent sources which feed the CETP and at North Works. These potential improvements are not immediate, but could enable as much as a further 200 m³/hr of capacity to become available relatively cheaply in comparison to the otherwise necessary treatment plants that would be needed to convert those surface waters that have to be recycled into an acceptable quality water for input elsewhere into the IVDBS site.

The ZED strategy has been evolved on the basis that Vaal Dam water will be the normal fresh water supply for all the fresh water inputs to the site. If DWAF or others require Vaal River Water to be used instead, then the nature of all the infrastructures on the site is such that the only practical way of using that water would be to treat it (probably using reverse osmosis (RO) units) to at least Vaal Dam quality before it is fed into the on site water distribution systems.

The brine that would be produced from such a treatment plant would require the proposed brine handling facilities that have been included within the ZED infrastructure to be enlarged if a crystalliser is used. If the DR After Burners are used, such an upgrade could almost certainly be avoided.