DIGBY WELLS ENVIRONMENTAL

Section 102 EMP Amendment for Lanxess Chrome mine

Surface Water Assessment Report

Project Number:

LAN3111

Prepared for:

Lanxess Chrome Mine Pty (Ltd)

April 2015

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Report Type:	**Surface Water Assessment Report**
Project Name:	**Section 102 EMP Amendment for Lanxess Chrome mine**
Project Code:	**LAN3111**

Name	**Responsibility**	**Signature**	**Date**
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1 Introduction

Lanxess Rustenburg Chrome mine is a well-established chrome mine in the Rustenburg area and has been operational since 1958. The Lanxess Chrome Mine is located 7 km east of Kroondal and 11 km south-east of Rustenburg and falls within the Rustenburg local municipality in the North West Province (Figure 1-1)

Currently only the underground mining of chrome is taking place at the site, with the mined chromite ore being used in the ferrochrome industry as well as the production of chrome chemicals where the primary use is as leather tanning agents.

Lanxess Mining (Pty) Ltd (Lanxess) has proposed an expansion of their existing underground chrome operations into neighbouring farm portions, as well as the establishment of an open pit operation within their existing mining rights area. The current mining rights of Lanxess cover various portions of the farms Kroondal 304 JQ, Rietfontein 338 JQ and Klipfontein 300 JQ. The process will involve the authorisation of the proposed open pit mining operation on the farm of Rietfontein 338 JQ (owned by the mine) and the proposed underground mining operations on portions of the farms Kroondal 304 JQ, Klipfontein 300 JQ and Brakspruit 299 JQ.

The proposed project is obligated to comply with the requirements of the Minerals and Petroleum Resources Development Act (MPRDA), (no 28 of 2002), and the Environmental Impact Assessment Regulations (2014), promulgated in terms of Sections 24(5) and 44 of the National Environmental Management Act (NEMA) (1998), (GN R982 of 4 December 2014).

Lanxess currently has an Environmental Impact Assessment and Environmental Management Plan (EIA/EMP) in line with the MPRDA and would therefore; need to amend the existing approved document to include the details of the proposed opencast mining operations as well as the extension of the underground sections (Segment 1, 2, 3 and 4) as part of a section 102 amendment. An amendment to the existing Integrated Water Use License Application (IWULA) submitted to the Department of Water and Sanitation (DWS) will also be required.

This report details the surface water assessment completed for the proposed expansion area mentioned.

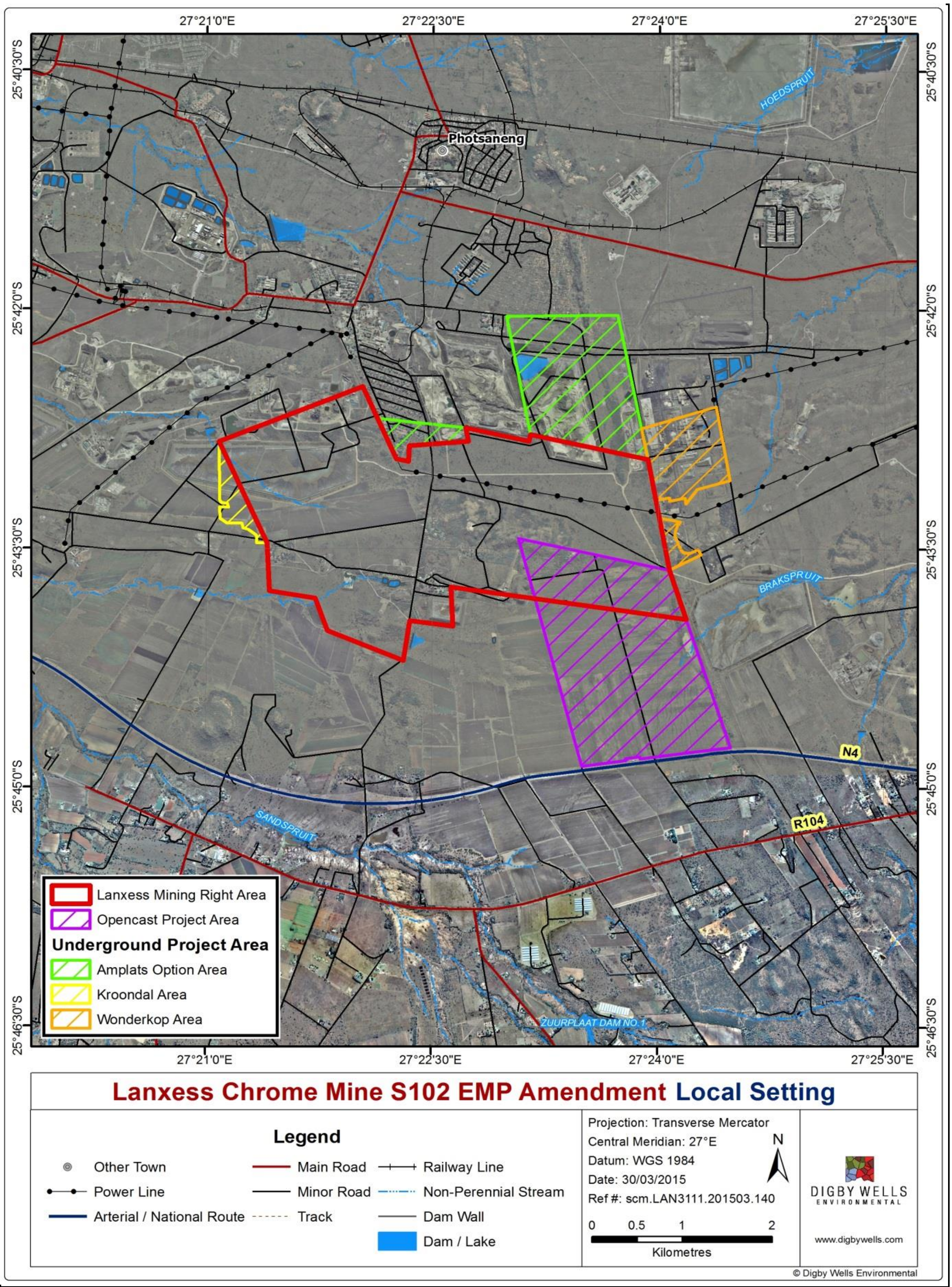

Figure 1-1 Locality Map

1.1 Hydrological setting

1.1.1 Introduction

South Africa is divided into 19 water management areas (WMA) (National Water Resource Strategy, 2004), managed by its separate water board. Each of the water management areas (WMA) is made up of quaternary catchments which relate to the drainage regions of South Africa, ranging from A – X (excluding O). These drainage regions are subdivided into four known divisions based on size. For example, the letter A represents the primary drainage catchment, A2 for example will represent the secondary catchment, A21 represents the tertiary catchment and A21D would represent the quaternary catchment which is the lowest subdivision in the WR2005 manual. Each of the quaternary catchments have associated hydrological parameters including area, mean annual precipitation (MAP) and mean annual runoff (MAR) to name a few.

1.1.2 Regional hydrology

The project area is located in the Crocodile West and Marico Water Management Area (WMA 3) within the A22H quaternary catchment. The eastern boundary of the project

lies on the catchment divide between A22H and A21K. This is shown in

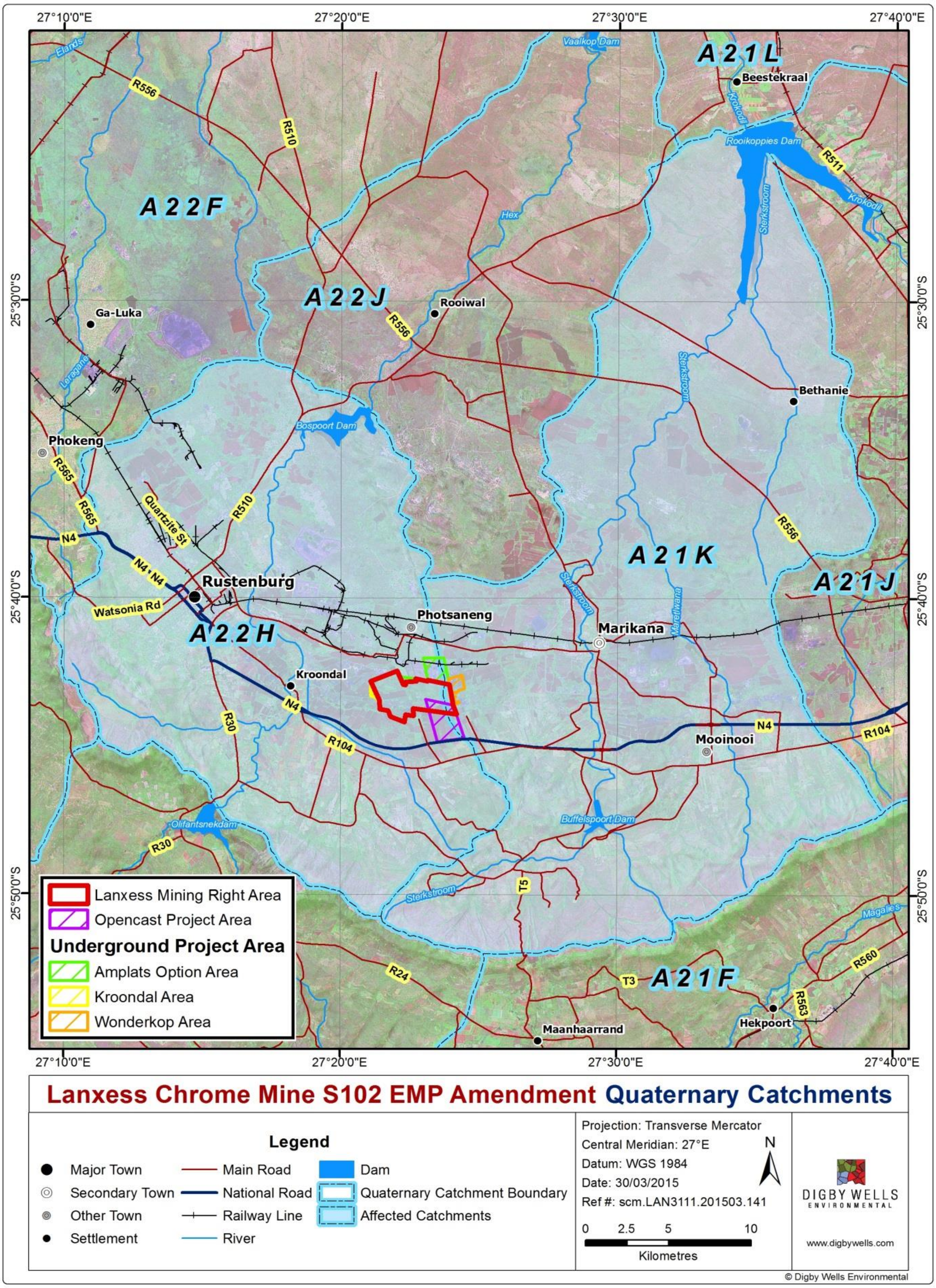

Figure 1-2.

The surface water attributes of the affected catchments namely the mean annual precipitation (MAP), mean annual runoff (MAR) and mean annual evaporation (MAE) are summarised in Table 1-1 (WRC, 2005) below.

Table 1-1: Summary of the surface water attributes of the two quaternary catchments

Quaternary Catchment	Total Area (km^2)	MAP (mm)	MAR $m^3 * 10^6$	MAE (mm)
A22H	579	658	9.11	1700
A21K	865	651	14.07	1700

The precipitation, evaporation and run-off characteristics as displayed in the table above, was obtained using the WR2005 manual.

The A22H quaternary catchment area is 579 km^2, and has an MAR of 14.07 million cubic meters (mcm). Runoff emanating from this quaternary catchment drains in a north easterly direction via the Hex River.

Elevations in the A22H quaternary range from 1220 meters above mean sea level (mamsl) at the highest point within the catchment, and drop to 1112 mamsl at the outlet of the catchment.

The A21K quaternary catchment area is 865 km^2, and has an MAR of 9.11 million cubic meters (mcm). Runoff emanating from this quaternary catchment also drains in a north easterly direction via the Sterkstroom River.

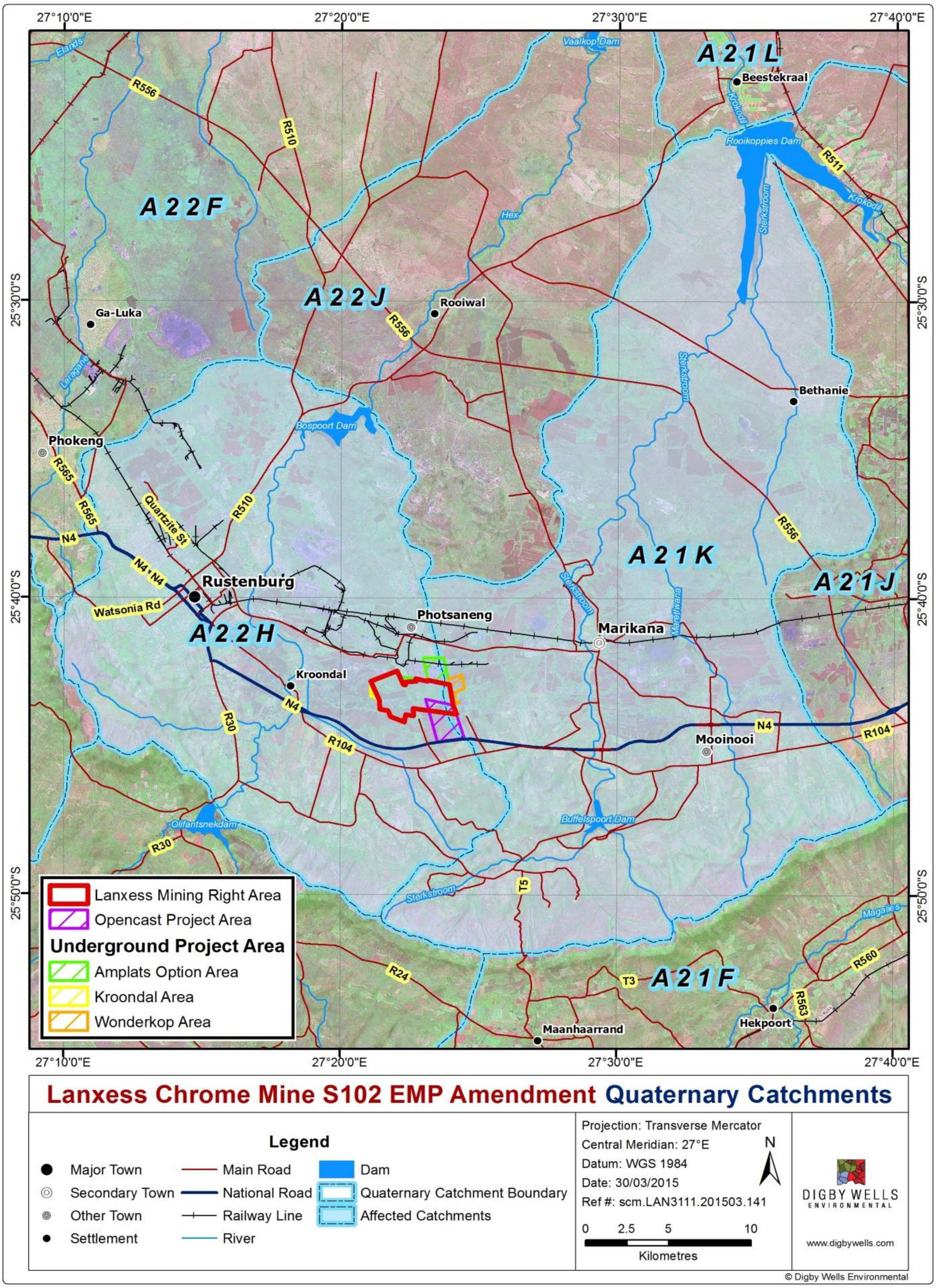

Figure 1-2 Regional Hydrological Setting

1.1.3 Topography

The project area is located in south-eastern side of the A22H quaternary catchment on the watershed between A22H and A21K quaternary catchment. Average slopes for the western project boundary range from 0.7 % to -1.0 % for majority of the area, whilst the steeper slopes located at the western and eastern sides of the project area boundary range from 0.3 % to -2.1%.

1.1.4 Rivers and drainage

The main water course in the A22H quaternary catchment is the Hex River found on the western side of the project area, this river joins the Elands River which is a tributary to Crocodile River.

There are two major tributaries to the Hex River namely the Sandspruit and Waterkloofspruit. The Sandspruit flows from the south of the project area towards the north-west direction joining the Hex River and

Waterkloofspruit is located on the western side of the Hex River and it flows towards the eastern direction to join the Hex River.

On the eastern side of the project area is the A21K quaternary catchment which consist of three rivers/streams namely the Sterkstroom, Kleinwater, Tshukutswe and the Maretlwana River. The Sterkstroom River is the main river in the mentioned quaternary and it drains in a north east direction into the Crocodile River which is a tributary to the Limpopo River.

Within the project boundary, no streams or any other water resource was identified during the site visit.

1.2 Climate

1.2.1 Rainfall

The rainfall data was extracted using the Design Rainfall program for South Africa (Smithers and Schulze, 2003). The program extracts MAP data from the 6 closest rainfall stations to the project site (Table 1-2). The average annual rainfall obtained from the 6 nearest rainfall stations is 652.5 mm.

Table 1-2: Summary of the rainfall data extracted from the Design Rainfall Estimation Program

Station Name	SAWS Number	Distance km	Record Length (years)	Lat (°) (')	Long (°) (')	MAP (mm)
KLIPFONTEIN	0511672_W	5.1	71	25° 41'	27° 21'	633
RUSTENBURG-AGR.	0511523_A	9.0	41	25° 43'	27° 18'	639
KROONDAL	0511523_W	9.0	33	25° 43'	27° 18'	639
KROONDAL	0511554_W	9.0	40	25° 43'	27° 18'	639
WATERKLOOF	0511524_W	10.9	82	25° 44'	27° 17'	684
MARIKANA	0511851_W	11.4	25	24° 41'	27° 29'	681
Average MAP						**652.5**

The MAP for quaternary catchment A22H was investigated since majority of the project area falls within the mentioned quaternary catchment .The MAP obtained from the WR2005 manual for quaternary catchment A22H amount's to 658 mm as indicated in Table 1-3 below. This MAP correlates well with the MAP obtained in Table 1-2.

Since the MAP obtained from the WR2005 manual is slightly more conservative (658 mm versus 652.5 mm), the WR2005 MAP for quaternary catchment A22H is selected as the representative MAP for the project area.

Table 1-3: Summary of rainfall data extracted from the WR2005

Month	MAP
October	62.2
November	99.4
December	103.6
January	121.4
February	93.7
March	83.5
April	40.9
May	17.3
June	6.8
July	5.1
August	5.5
September	18.6
MAP	**658**

1.2.2 Evaporation

Monthly evaporation data was obtained from the WR2005 manual, (WR2005, 2009). The project area lies predominantly within quaternary catchments A22H, which has a MAE of 1700 mm.

The evaporation obtained is based on Symons pan evaporation measurements and needs to be converted to lake evaporation. This is due to the Symons pan being located below the ground surface, and painted black which results in the temperature in the water being higher than that of a natural open water body. The Symons pan is then multiplied by a lake evaporation factor[1] to obtain the adopted lake evaporation. Below in Table 1-4 is a summary of the adopted evaporation for the project site.

Table 1-4: Summary of evaporation data

Months	Symons Pan Evaporation (mm)	Lake Evaporation Factor	Lake Evaporation (mm)
January	181.9	0.81	150.3684
February	151.8	0.82	144.5578
March	147.2	0.83	159.1608
April	116.1	0.84	152.796
May	98.8	0.88	133.5928
June	81.36	0.88	129.5536
July	90.1	0.88	102.1768
August	119.3	0.87	85.9299
September	155.9	0.85	69.071
October	185.6	0.83	74.783
November	176.3	0.81	96.6654
December	191.8	0.81	129.438
Total	**1700**	**N/A**	**1428.1**

1.2.3 Storm Rainfall Depths

Storm rainfall depths were extracted from the 6 closest rainfall stations obtained from the Design Rainfall Estimation Programme (Smithers and Shulze). The 24 hour gridded rainfall depths which are the average rainfall depths of the 6 closest stations (see section 1.2.1, Table 1-2) is shown in Table 1-5 below.

[1] Evaporation factor obtained from WR2005

Table 1-5: Calculated 24 hour design rainfall depth

Return period (years)	1:2	1:5	1:10	1:20	1:50	1:100	1:200
24 hour peak rainfall depths (mm)	68.0	92.4	109.9	127.8	152.8	172.9	194.3

1.3 Surface Water Use

The mine does not utilise water from any local surface water resources for its activities, with Rand Water being the primary supplier of water to the mine. The water make up requirements are approximately 1000 m^3/ day. Below is a summary of the water requirements for the mine.

- The water in circulation is estimated to be 175 000 m^3/month, of which most is recycled.
- The HMS plant uses 40% of the total water consumption (70 000 m^3/month).
- The gravity plant uses 60% of the water consumption (105 000 m^3/month).
- The mine's domestic consumption averages 8 200 m^3/month (IWWMP, 2010).

Due to the non-perennial nature of the unnamed streams around the project area, there are limited surface water users that are registered on the Department of Water and Sanitation (DWS) Water Users Registration Management Systems (WARMS) database. The farmers downstream (west of the project area) utilise water from small farm dams together with the Holthausen Dam, which is 4 km away from the site, for agricultural purposes such as irrigation, stock feed and livestock watering. Other surface water uses identified for A22H quaternary catchment include:

- Industry (Urban); and
- Mining.

1.4 Water Authority

The DWS (North West Province) is the responsible water authorities

1.5 Surface Water Quality

Lanxess mine conduct monthly surface water monitoring as part of the Environmental Management Plan (EMP) commitments. The mine maintains a closed water system that separates clean and dirty water and ensures that their zero discharge policy is implemented at all times. However, the IWWMP compiled in 2010 indicated that excess water will only be discharged if it meets statutory requirements.

Therefore, it is essential that the mine water should try at all times to maintain the water quality on acceptable levels of concentrations set as standards by DWS.

Table 1-6 below present the water quality data benchmarked with the South African National Standard (SANS) 241: 2011 drinking water standards.

The monitoring is conducted at the slimes dam, HMS Plant Circular dam, Gravity Plant dam and Return Water dam (RWD).

1.5.1 Results

Water chemistry in 2010 (Table 1-6) show that the Total Dissolved Solids (TDS), Magnesium (Mg), Sulphate (SO_4), Calcium (Ca), Sodium (Na), Potassium (K), Manganese (Mn), Electrical Conductivity (Ec) and pH of the samples collected in the HMS Plant, Circular dam, Gravity Plant dam (GRA) and Return Water dam fluctuates from Class I to Class II over the three month period (February to March 2010). These parameters were however within the SANS 241: 2011 acceptable limits.

Elevated levels of Nitrates (NO_3) have been observed in all the dams for the period of February to March 2010. Manganese (Mn) and Aluminium (Al) in the Gravity Plant dam has also exceeded the set limits during February 2010. The water quality results can be seen on Table 1-6 and Table 1-7 below for 2010 and 2014 respectively.

Elevated levels of Nitrates (NO_3) have again been observed in all the dams on the 2014 monitoring results. This has not shown any improvement as these levels were also exceeding the limits in 2010 except for the Rand water supply used for drinking. The elevated levels of Nitrates (NO_3) could possibly be as a result of contamination of water from the explosives waste material.

Ammonia (NH_4) and Aluminium (Al) in the GRA and HMS dams is were also above the limits in November to December 2014 monitoring period. Other water quality parameters were found to be within the limits. Although Sulphate (SO_4), Magnesium (Mg) and Manganese (Mn) were above the recommended aesthetic quality limits, they were still within the maximum allowable water quality limits.

In general, all the water in the three dams is regarded as waste water and cannot be used for drinking.

Table 1-6: Historical surface water chemical results (December, 2010) of Lanxess monitoring points benchmarked with SANS 241: 2005 Water quality guidelines

Sample ID		Total Dissolved Solids	Nitrate NO3 as N	Chlorides as Cl	Total Alkalinity as CaCO3	Sulphate as SO4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminum as Al	Free and Saline Ammonia as N	Fluoride as F
Class 0	(Ideal)	<450	<6.0	<100	N/S	<200	<80	<30	<100	<25	<0.01	<0.05	<70	6.0-9.0	<0.15	N/S	<0.5
Class I	(Acceptable)	450-1000	6.0-10.0	100-200	N/S	200-400	80-150	30-70	100-200	25-50	0.01-0.2	0.05-0.1	70-150	5-6 or 9.0-9.5	0.15-0.3	N/S	0.5-1
Class II	(Max. Allowable)	1000-2400	>10-20	>200-600	N/S	>400-600	>150-300	>70-100	200-400	50-100	>0.2-2	>0.1-1	>150-370	4-5 or 9.5-10	>0.3-0.58	N/S	1-1.5
Class III	(Exceeding)	>2400	>20	>600	N/S	>600	>300	>100	>400	>100	>2	>1	>370	<4 or >10	>0.58	N/S	>1.5
February HMS		620.00	14.60	78.90	196.00	174.00	63.30	75.80	33.00	7.90	0.828	<0.040	93.00	7.76	0.422	0.48	0.23
GRA		1170.00	87.00	77.10	116.00	288.00	131.00	105.00	97.90	17.10	0.96	0.064	176.00	6.99	0.936	11.20	0.34
March RWD		650.00	22.70	38.10	156.00	96.00	47.00	71.30	37.30	9.40	0.014	<0.040	97.00	8.19	<0.014	0.70	0.19
HMS		1200.00	62.00	119.00	176.00	189.00	72.60	97.90	123.00	18.20	0.56	<0.040	180.00	7.12	0.44	13.70	0.19
April RWD		730.00	38.80	50.50	168.00	150.00	48.60	100.00	42.10	8.90	0.2	<0.040	110.00	8.09	0.60	0.25	0.24

Note: the unit for parameter used is mg/l with the exception of pH and other specified parameters.

Table 1-7: Surface water chemical results (November & December 2014) of Lanxess monitoring points benchmarked with SANS 241: 2011 Water quality guidelines

Sample ID	Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe (µg/l as Fe)	Manganese as Mn (µg/l as Mn)	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminium as Al (µg/l as Al)	Free and Saline Ammonia as N	Fluoride as F
(Aesthetic quality Recommended)	<1200	<10	<300	N/S	<250	<150	<70	<200	<50	<300	<100	<170	5-9.5	<300	<1.5	<1
(Drinking water quality Max. Allowable)	2400	11	600	N/S	500	300	100	400	100	<2000	500	370	4-5 or 9.5-10	0.5	2	1.5
Exposure Duration (years)	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs	70yrs
Slimes Dam-HMS	1371	189.00	85.2	0	253.0	134.0	93.8	132.0	15.10	14270.00	135.00	163.0	7.05	1777.00	21.80	0.69
Slimes Dam-GRA	854	104.00	61.0	0	168.0	92.6	45.6	85.5	12.60	41.00	0.00	141.0	7.23	17.00	8.50	0.58
Slimes Dam-RWD	996	98.00	132.0	0	256.0	67.0	98.9	119.0	10.80	0.00	0.00	162.0	8.91	0.00	0.00	0.60
Slimes Dam-HMS	725	121.00	74.0	0	246.0	99.9	40.1	98.7	8.80	1170.00	155.00	165.0	7.62	803.00	10.60	0.71
Slimes Dam-GRA	755	118.00	66.8	0	221.0	107.0	56.0	95.2	10.70	606.00	146.00	165.0	7.88	810.00	7.10	0.68
Slimes Dam-RWD	715	70.00	132.0	0	256.0	50.3	86.7	85.2	6.80	24.00	19.00	154.0	9.21	12.00	0.00	0.65
Rand water(Domestic Use)	133	1.0	12.2		15.6	24.5	6.7	11.6	3.9	37	0.00	28.0	7.66	0.00	0.00	0.38

Note: the unit for parameter used is mg/l with the exception of pH and other specified parameters.

2 Potential Surface Water Impacts Assessment

2.1 Impact Assessment Methodology

The impact assessment methodology has been utilised on the subsequent EIA phase for the proposed expansion project and will consist of impact identification and impact significance rating.

Impacts and risks will be identified based on a description of the existing and proposed activities to be undertaken as part of the extension. Once impacts have been identified, a numerical environmental significance rating process will be undertaken that utilises the probability of an event occurring and the severity of the impact as factors to determine the significance of a particular environmental risk.

The severity of an impact is determined by taking the spatial extent, the duration and the severity of the impacts into consideration. The probability of an impact is then determined by the frequency at which the activity takes place or is likely to take place and by how often the type of impact in question has taken place in similar circumstances.

Following the identification and significance ratings of potential impacts, mitigation and management measures will be incorporated into an EMP.

The significance rating process follows the established impact formula shown below:

Significance = Consequence x Probability

Where

Consequence = Severity + Spatial Scale + Duration

And

Probability = Likelihood of an impact occurring

The matrix calculates the rating out of 147, whereby Severity, Spatial Scale, Duration and Probability are each rated out of seven as indicated in Table 2-1. The weight assigned to the various parameters for positive and negative impacts is provided for in the formula.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure proposed in this report. The significance of an impact is then determined and categorised into one of four categories, as indicated in Table 2-3, which is extracted from Table 2-2. The description of the significance ratings is discussed in Table 2-4.

Table 2-1: Impact Assessment Parameter Ratings

Rating	Severity		Spatial scale	Duration	Probability
	Environmental	*Social, cultural heritage*			
7	Very significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage.	Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	International The effect will occur across international borders.	Permanent: No Mitigation No mitigation measures/ natural process will reduce the impact after implementation.	Certain/ Definite. The impact will occur regardless of the implementation of any preventative or corrective actions.
6	Significant impact on highly valued species, habitat or ecosystem.	Irreparable damage to highly valued items of cultural significance or breakdown of social order.	National Will affect the entire country.	Permanent: Mitigation Mitigation measures of natural process will reduce the impact.	Almost certain/Highly probable It is most likely that the impact will occur.
5	Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate.	Very serious widespread social impacts. Irreparable damage to highly valued items.	Province/ Region Will affect the entire province or region.	Project Life The impact will cease after the operational life span of the project.	Likely The impact may occur.
4	Serious medium term environmental effects. Environmental damage can be reversed in less than a year.	On-going serious social issues. Significant damage to structures / items of cultural significance.	Municipal Area Will affect the whole municipal area.	Long term 6-15 years.	Probable Has occurred here or elsewhere and could therefore occur.

Rating	Severity		Spatial scale	Duration	Probability
	Environmental	*Social, cultural heritage*			
3	Moderate, short-term effects, but not affecting ecosystem functions. Rehabilitation requires intervention of external specialists and can be done in less than a month.	On-going social issues. Damage to items of cultural significance.	Local Local extending only as far as the development site area.	Medium term 1-5 years.	Unlikely Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants.	Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Limited Limited to the site and its immediate surroundings.	Short term Less than 1 year.	Rare/ improbable Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.
1	Limited damage to minimal area of low significance that will have no impact on the environment.	Low-level repairable damage to commonplace structures.	Very limited Limited to specific isolated parts of the site.	Immediate Less than 1 month.	Highly unlikely/None Expected never to happen.

Table 2-2: Probability Consequence Matrix

Significance										
		Consequence (Severity + Scale + Duration)								
		1	3	5	7	9	11	15	18	21
Probability / Likelihood	1	1	3	5	7	9	11	15	18	21
	2	2	6	10	14	18	22	30	36	42
	3	3	9	15	21	27	33	45	54	63
	4	4	12	20	28	36	44	60	72	84
	5	5	15	25	35	45	55	75	90	105
	6	6	18	30	42	54	66	90	108	126
	7	7	21	35	49	63	77	105	126	147

Table 2-3: Significance Threshold Limits

Significance		
High	108 - 147	
Medium-High	73 - 107	
Medium-Low	36 - 72	
Low	0 - 35	

Table 2-4: Significance Rating Description

Score	Description	Rating
≤35	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.	Low / Negligible
36 - 72	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	Medium-Low / Minor

Score	Description	Rating
73 - 108	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.	Medium-High / Moderate
>108	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are immitigable and usually result in very severe effects, or very beneficial effects.	High / Major

2.2 Description of Environmental Issues and Potential Impacts

Table 2-5 provides the list of activities that will be undertaken during this project. The activities are detailed for the different phases namely: Construction, Operational, Decommissioning and Post-closure Phase of the Project.

Table 2-5: Project activities in the construction, operational and decommissioning phases

Activity No.	Activity
Construction Phase	
1	The transportation of construction material to the project site via national, provincial and local roads.
2	Storage of fuel, lubricant and explosives in temporary facilities for the duration of the construction phase.
3	Site clearance and topsoil removal prior to the commencement of physical construction activities across the project area.
4	The construction of waste rock dumps.
5	The construction of topsoil stockpiles.
6	The establishment of the initial boxcut and access ramps to the open-pit mining areas.
7	The establishment of underground access shaft.

Activity No.	Activity
8	The construction of haul roads on site
9	The construction of the access or service road.
10	The construction of the hard park area (this is made up of the workshop, office block and parking lot).
Operational Phase	
11	Drilling and blasting of the overburden rock for easy removal by excavators and dump trucks.
12	Dumping of waste rock and maintenance of waste rock dump
13	Removal and loading of ore onto trucks (O/C) or conveyor (U/G) to the plant.
14	Continuing operation of existing processing plant (Crusher, settler, gravity plant and reclamation plant).
15	Storage of fuel in diesel tanks, as well as lubricant and explosives in facilities for the duration of the project.
16	Vehicular activity on the proposed roads and maintenance activities
17	The operation of the TSF (dirty water from stormwater and dewatering mining activities) and the connected return water dam
18	Continuing operation and maintenance of the stockpiles, including topsoil and ROM stockpiles.
19	Waste and sewage generation and disposal.
20	Maintenance of secondary infrastructure (offices, parking)
21	Concurrent replacement of overburden and topsoil and the re-vegetation of mined out strips. The mined strip will be backfilled with the overburden and compacted. Subsequently, the topsoil will be placed on top of the overburden and the area will be vegetated.
Decommissioning Phase	
22	Removal of surface infrastructure (Plant machinery, shafts, conveyors)

Activity No.	Activity
23	Decommissioning of services (if necessary, depending on post land use) incl. waste treatment and removal, power & water facilities)
24	Rehabilitation of roads and cleared areas (offices and workshop area)
25	Removal of fuel, lubricant and explosives
26	Safe closure of shafts and mine access ramps
27	Final replacement of overburden and topsoil and the establishment of vegetation on the final open cast void. Overburden will be backfilled into the final void and compacted. Subsequently, topsoil will placed and the area vegetated.
28	Waste handling of scrap metal and used oil as a result of the Decommissioning Phase will be undertaken.
Post-closure Phase	
29	Post-closure monitoring and rehabilitation will determine the level of success of the rehabilitation, as well as to identify any additional measures that have to be undertaken to ensure that the mining area is restored to an adequate state. Monitoring will include surface water, groundwater, soil fertility and erosion, natural vegetation and alien invasive species and dust generation from the discard dumps.

2.3 Identified Potential Surface Water Impacts

The potential surface water impacts for the proposed open cast and extension of underground mine are discussed below. These impacts have been discussed on different phases of the project namely construction, operation, decommissioning and post-closure phase.

2.3.1 Construction Phase

The following impacts are anticipated:

- Increase in turbidity of surface water runoff during construction caused by an increase in runoff from the cleared and stripped areas or from topsoil stockpiles which is high in suspended solids; and

- Impacts on surface water quality as a result of accidental spillages of hazardous substances (hydrocarbons) from construction vehicles used during site clearing and grubbing.

2.3.1.1 Mitigation Measures for the Construction Phase

The following mitigation measures are recommended:

- Clearing of vegetation should be limited to the project site, and the use of existing access roads should be prioritized so as to limit the construction of new access roads in these areas;
- The construction phase should be limited to the dry months of the year (May-October) to limit mobilisation of sediments or hazardous substances from construction vehicles used during site clearing and grubbing;
- The removed topsoil should be covered or vegetated as soon as possible to prevent sediment erosion;
- Haul roads need to be well compacted to avoid erosion of the soil into the stream.

2.3.2 Operational Phase

The following impacts are anticipated:

- Unconfined stormwater runoff from dirty water areas in the mine have the potential to contaminate the natural water resources;
- Diversion of clean water runoff upstream of the mine dirty water area. Water upstream of the mine area is considered clean and will have to be separated from the dirty water area;
- Blasting material during operational phases releases ammonium nitrates from the explosive residues. This chemical contaminates the water in the pit and can potentially contaminate the streams if water is discharge into the natural environment. Nitrates and ammonia from blasting residues, can lead to eutrophication (nutrient enrichment) of water bodies. They may also be converted into toxic nitrites. Ammonia (NH_3 as opposed to NH_4^+) is highly toxic to fish and many aquatic organisms at even low (µg/l) concentrations;
- Impacts on surface water quality as a result of mobilized hazardous substances (hydrocarbons) from trucks and machinery during operation of mine; and
- Inadequate storm water management and soil stabilisation measures in cleared areas could lead to erosion that may result in siltation of nearby watercourses.

2.3.2.1 Mitigation Measures for the Operational Phase

The following mitigation measures are recommended:

- Dust suppression measures should be implemented to prevent the spread of dust and erosion of loose materials;
- The topsoil stockpiles should be vegetated as soon as possible to prevent dust, erosion and siltation of the water bodies;
- The storage facilities of fuel, lubricant and explosives must be a hard standing area (paved or concrete surface), roofed and bunded. This will prevent mobilization of leaked hazardous substances. Emergency spillage response plan should in place and accessible to the responsible monitoring team;
- All the water being pumped from the pit should be stored in the pollution control dams (PCD's) for re-use on the mine so as to prevent unnecessary discharge into the environment;
- Based on Reg 704 requirements regarding storm water management for mining activities it is noted that all clean and dirty water must be separated. Therefore clean water emanating from upstream of the mine will be diverted away and discharged to the nearby watercourse or environment. The clean water diversion will be sized to accommodate the 1:50 year storm event.
- Should the contained water be more than the water use requirement, the BPGs advices that the water be recycled or as the last resort be treated to acceptable levels and discharged either to the natural environment or be supplied to other industries as a lower grade of water; and
- As the opencast mining progresses, continuous rehabilitation should be implemented by backfilling the voids. This will ensure that the dirty water footprint area is decreased so that the volume of dirty water runoff required to be pumped out of the pit is significantly reduced.

2.4 Decommissioning Phase

- Mobilization of leaked/spilled contaminants (hazardous and hydrocarbon containing material) from trucks and machinery during decommissioning phase could have an impact on the quality of water in the nearby streams; and
- Backfilling of open cast voids and re-vegetation of the rehabilitated area will have a positive impact on the quantity of water reporting to the rivers as natural drainage pattern will be restored.

2.4.1 Mitigation Actions for the Decommissioning Phase

The following mitigation measures are recommended:

- Use of accredited contractors for removal or demolition of infrastructures should be ensured;
- The backfilled areas should be vegetated as soon as possible to prevent dust and siltation of the water bodies;
- Inspection of the rehabilitated areas need to be undertaken to ensure that the surface profile encourages natural drainage, such that no ponding or standing water occurs after a rainfall event.
- Where rehabilitation (grass seeding of topsoil cover) is not effective, sedimentation should be mitigated by installing silt traps at areas where the surface runoff enters the surface water resources; and
- Water quality monitoring should continue to enable the detection of decant when it occurs so immediate mitigation measures can be implemented.

2.5 Post Closure Phase

- Decant of poor quality groundwater from the mining areas may have a negative impact on the surrounding surface water resources.

2.5.1 Mitigation Measures

- Surface water quality monitoring should continue to ensure that there is no impact on the surrounding water resources emanating from the mine area.

2.6 Impact Ratings on Different Phases of the Project

Table 2-6 presents the impact ratings (before and after mitigation) for the identified surface water impacts due to the proposed mining activities. Note that the rating was only done for the negative impacts that were identified.

Table 2-6: Summary of identified and their significance ratings on different phases

2.6.1 Construction Phase

Activity/Impact	Impacts on surface water during construction phase				
Criteria	**Details / Discussion**				
Description of impact	The following impacts are anticipated: ■ Increase in turbidity of surface water runoff during construction caused by an increase in runoff from the cleared and stripped areas or from topsoil stockpiles; and ■ Impacts on surface water quality as a result of accidental spillages of hazardous substances (hydrocarbons) from construction vehicles used during site clearing and grubbing.				
Mitigation required	The following mitigation measures are recommended: ■ Clearing of vegetation should be limited to the project site, and the use of existing access roads should be prioritized so as to limit the construction of new access roads in these areas; ■ The construction phase should be limited to the dry months of the year (May-October) to limit mobilisation of sediments or hazardous substances from construction vehicles used during site clearing and grubbing; ■ The removed topsoil should be covered or vegetated as soon as possible to prevent sediment erosion; ■ Haul roads need to be well compacted to avoid erosion of the soil into the stream.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significance rating*
Pre-Mitigation	3	2	4	9	54
Post-Mitigation	2	2	3	7	28

2.6.2 Operational Phase

Activity/Impact	Impacts on surface water during operational phase
Criteria	**Details / Discussion**

Activity/Impact	Impacts on surface water during operational phase
Criteria	**Details / Discussion**
Description of impact	The following impacts are anticipated: ■ Unconfined stormwater runoff from dirty water areas in the mine have the potential to contaminate the natural water resources; ■ Diversion of clean water runoff upstream of the mine dirty water area Water upstream of the mine area is considered clean and will have to be separated from the dirty water area. ■ Blasting during the operational phase will release ammonium nitrates from the explosive residues. This chemical will contaminate the water in the pit and may potentially contaminate the streams if water is discharged into the natural environment. Nitrates and ammonia from blasting residues, can lead to eutrophication (nutrient enrichment) of water bodies. They may also be converted into toxic nitrites. Ammonia (NH_3 as opposed to NH_4^+) is highly toxic to fish and many aquatic organisms at even low (µg/l) concentrations; ■ Impacts on surface water quality as a result of mobilized hazardous substances (hydrocarbons) from trucks and machinery during operation of mine; and ■ Inadequate storm water management and soil stabilisation measures in cleared areas could lead to erosion that may result in siltation of nearby watercourses.
Mitigation required	The following mitigation measures are recommended: ■ Dust suppression measures should be implemented to prevent the spread of dust and erosion of loose materials; ■ The topsoil stockpiles should be vegetated as soon as possible to prevent dust, erosion and siltation of the water bodies; ■ The storage facilities for fuel, lubricant and explosives must comprise a hard standing area (paved or concrete surface) and be roofed and bunded. This will prevent mobilisation of leaked hazardous substances. Emergency spillage response plan should in place and accessible to the responsible monitoring team; ■ All the water being pumped from the pit should be stored in the pollution control dams (PCD's) for re-use on the mine so as to prevent unnecessary discharge into the environment;

Activity/Impact	Impacts on surface water during operational phase				
Criteria	**Details / Discussion**				
	■ Based on Reg 704 requirements regarding storm water management for mining activities it is noted that all clean and dirty water must be separated. Therefore clean water emanating from upstream of the mine must be diverted away and discharged to the nearby watercourse or environment. The clean water diversion must be sized to accommodate the 1:50 year storm event. ■ Should the contained water be more than the water use requirement, the BPGs advises that the water be recycled or as the last resort be treated to acceptable levels and discharged either to the natural environment or be supplied to other industries as a lower grade of water; and ■ As the open pit mining progresses, continuous rehabilitation should be implemented by backfilling the voids. This will ensure that the dirty water footprint area is decreased so that the volume of dirty water runoff required to be pumped out of the pit is significantly reduced.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significance rating*
Pre-Mitigation	3	5	4	5	60
Post-Mitigation	1	4	3	4	32

2.6.3 Decommissioning Phase

Activity/Impact	Impacts on surface water during decommissioning phase
Criteria	**Details / Discussion**
Description of impact	The following impacts are anticipated: ■ Mobilization of leaked/spilled contaminants (hazardous and hydrocarbon containing material) from trucks and machinery during decommissioning phase could have an impact on the quality of water in the nearby streams; and ■ Backfilling of open cast voids and re-vegetation of the rehabilitated area will have a positive impact on the quantity of water reporting to

Activity/Impact	Impacts on surface water during decommissioning phase				
Criteria	**Details / Discussion**				
	the rivers as the natural drainage pattern i.e. runoff, will be restored.				
Mitigation required	The following mitigation measures are recommended: ■ Use of accredited contractors for removal or demolition of infrastructures should be ensured; ■ The backfilled areas should be vegetated as soon as possible to prevent dust and siltation of the water bodies; ■ Inspection of the rehabilitated areas need to be undertaken to ensure that the surface profile encourages natural drainage, such that no ponding or standing water occurs after a rainfall event. ■ Where rehabilitation (grass seeding of topsoil cover) is not effective, sedimentation should be mitigated by installing silt traps at areas where the surface runoff enters the surface water resources; and ■ Water quality monitoring should continue to enable the detection of decant when it occurs so immediate mitigation measures can be implemented.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significance rating*
Pre-Mitigation	3	5	4	4	48
Post-Mitigation	2	2	3	3	21

2.6.4 Closure/Post Closure Phase

Activity/Impact	Impacts on surface water during closure/post closure phase
Criteria	**Details / Discussion**
Description of impact	The following impacts are anticipated: ■ Decant of poor quality groundwater from the mining areas may have a negative impact on the surrounding surface water resources.
Mitigation required	The following mitigation measures are recommended: ■ Surface water quality monitoring should continue to ensure that there

Activity/Impact	Impacts on surface water during closure/post closure phase				
Criteria	**Details / Discussion**				
	is no impact on the surrounding water resources emanating from the mine area.				
Parameters	*Spatial*	*Duration*	*Intensity*	*Probability*	*Significance rating*
Pre-Mitigation	3	2	4	6	54
Post-Mitigation	2	2	3	4	28

3 Monitoring Programme

A monitoring programme is an essential management tool to detect negative impacts on water as they arise resulting from the existing mining activities as well as the newly proposed mine extension. This helps to ensure that the necessary mitigation measures are implemented.

A monitoring programme is already in existence. Both surface and groundwater is monitored on a monthly basis from local boreholes in the vicinity of the mining area and on the mine water dams. Monitoring reports are attached in Appendix A. Detailed water monitoring reports are attached in (Appendix A).

It is also necessary to monitor the surrounding water quality on the nearby streams in order to ensure no polluted water is reaching the local water resources.

4 Conclusion

Mining activities have variety of impacts (quality and quantity) on the natural water resources. The extent and nature of impacts can range from minimal to significant depending on a range of factors associated with ongoing mining processes as well as post mining management of the affected environment. Therefore, certain recommendations for the proposed Lanxess extension mine have been made as mitigation measures for the identified potential surface water impacts are described under section on 2.3 of this report.

5 References

Department of Water Affairs (DWA), 2006. Best Practice Guideline series.

South African Bureau of Standards (SABS). 2011. South African National Standard (SANS): 241-1:2011 Drinking Water.

Water Research Commission (WRC), 2005. Water Resources of South Africa.

Appendix A: Monitoring Reports

LANXESS
Energizing Chemistry

MONTHLY MONITORING

SURFACE WATER, GROUNDWATER, NOISE AND AIR QUALITY

JUNE 2010

LANXESS MINING (PTY) LTD

COMPILED BY C. KOBUE

ENVIRONMENTAL OFFICER

EXECUTIVE SUMMARY

Monthly monitoring of surface and groundwater, noise and air quality are regularly undertaken at RCM to ensure compliance with the various obligations in terms of environmental management. This quarterly report has been compiled to provide management of an overview for the results from February 2010 till April 2010 for surface water and groundwater. The findings suggest that:

- There is elevated nitrate and magnesium levels within sampling points BH 3, 10,12 13, 17 and HMS Plant Circular dam, Gravity Plant dam and Return Water dam over the three month period. These results fall in Class I to Class III of the drinking water standards.
    - It is recommended that the background water quality data be reviewed to confirm the long term results and trends.
- There is an increasing trend of microbial contamination in the groundwater samples from February 2010 to April 2010. No apparent sources of contamination are known which may suggest contamination during the period. The most likely cause of contamination is the sampling points which may be due to surface inflow of water. It is recommended that:
    - A background check on the level for Nitrates and Mg be conducted to identify the source of contamination;
    - A long term quality survey of including the Nitrates and Mg levels for all the surface and groundwater sampling points be conducted to monitor
    - The sampling procedure be checked for consistency and that a sampling audit be carried out internally or externally;
    - The rainfall records for this period be confirmed and the sampling points be visually inspected to confirm the hypothesis that surface ingress could be responsible.

Apart from the above the results indicate that the operations are operating in accordance with the EIA/EMP and its requirements.

1 INTRODUCTION

As part of the Environmental (EMPR) commitments, monitoring of water, air and noise should be undertaken on a monthly/quarterly or annual schedule. This report presents finding of the monitoring of surface water and groundwater monitoring for the period February to April 2010.

2 OBJECTIVES

2.1 Surface water

- Surface water – to maintain closed water system that separates clean and dirty water, and ensure zero discharge policy;
- To monitor and identify the impacts of the mining activities on the water quality and quantity of the receiving environment; and
- To report on the compliance of the analytical results against standards and guidelines in order to identify problem areas and make recommendations for remedial actions.

2.2 Groundwater

- Groundwater – to monitor and identify the impacts of the mining activities on the water quality and quantity; and
- To report on the compliance of the analytical results against standards and guidelines in order to identify problem areas and make recommendations for remedial actions.

2.3 Air Quality

2.4 Noise

Based on the objectives, a commitment was made to routinely (annually/quarterly) submit copies of the monitoring reports to the relevant authorities by Lanxess Mining. This report is compiled for internal use only.

3 RESULTS

See Table 1 and 2 for chemical and microbiological findings (Plan 1 for the location of the sampling points) which can be summarized as:

- For the chemical results (Table 1), Nitrate (NO_3) and Magnesium (Mg) concentration for the sampling points BH 3, 10,12 13, 17 and HMS Plant Circular dam, Gravity Plant dam and Return Water dam fluctuates from Class I to Class III over the three month period
- The other constituents lie in the Class I to Class II of the acceptable drinking water standards;
- For the microbiological results (Table 2), there is increasing bacterial contamination at some sampling points that are not necessarily located in proximity to either sewage tanks nor the septic tanks. Presence of E coli at points BH 3 and BH 13 does suggest faecal contamination which may be attributed to human or warm blooded animals.

Table 1: surface and groundwater chemical results of Lanxess monitoring points benchmarked with SANS 241 Water quality guidelines

Sample ID	Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminum as Al	Free and Saline Ammonia as N	Fluoride as F
Class 0 (Ideal)	<450	<6.0	<100	N/S	<200	<80	<30	<100	<25	<0.01	<0.05	<70	6.0-9.0	<0.15	N/S	<0.5
Class I (Acceptable)	450-1000	6.0-10.0	100-200	N/S	200-400	80-150	30-70	100-200	25-50	0.01-0.2	0.05-0.1	70-150	5-6 or 9.0-9.5	0.15-0.3	N/S	0.5-1
Class II (Max. Allowable)	1000-2400	>10-20	>200-600	N/S	>400-600	>150-300	>70-100	200-400	50-100	>0.2-2	>0.1-1	>150-370	4-5 or 9.5-10	>0.3-0.58	N/S	1-1.5
Class III (Exceeding)	>2400	>20	>600	N/S	>600	>300	>100	>400	>100	>2	>1	>370	<4 or >10	>0.58	N/S	>1.5
February HMS	620.00	14.60	78.90	196.00	174.00	63.30	75.80	33.00	7.90	0.828	<0.040	93.00	7.76	0.422	0.48	0.23
GRA	1170.00	87.00	77.10	116.00	288.00	131.00	105.00	97.90	17.10	0.96	0.064	176.00	6.99	0.936	11.20	0.34
BH 10	1040.00	58.50	55.00	204.00	228.00	78.70	134.00	37.40	5.30	0.290	<0.040	157.00	6.37	0.140	7.90	0.29
BH 12	570.00	15.40	27.50	188.00	150.00	61.50	72.30	27.60	7.20	0.084	<0.040	85.40	7.72	0.08	<0.15	0.25
BH 17	840.00	29.40	13.80	420.00	159.00	54.90	144.00	13.10	1.30	0.932	<0.040	126.00	7.30	0.56	<0.15	0.20
BH 18	1310.00	65.00	87.20	292.00	414.00	92.10	194.00	79.00	3.50	0.586	<0.040	198.00	7.36	0.1	<0.15	0.32
March RWD	650.00	22.70	38.10	156.00	96.00	47.00	71.30	37.30	9.40	0.014	<0.040	97.00	8.19	<0.014	0.70	0.19
HMS	1200.00	62.00	119.00	176.00	189.00	72.60	97.90	123.00	18.20	0.56	<0.040	180.00	7.12	0.44	13.70	0.19
BH 10	850.00	14.20	23.80	440.00	162.00	42.20	135.00	15.00	1.70	<0.01	<0.040	128.00	7.25	<0.014	<0.15	0.23
BH 12	530.00	11.70	28.60	184.00	132.00	52.00	57.80	23.50	7.30	<0.01	<0.040	78.50	7.55	<0.014	<0.15	0.15
BH 13	930.00	42.00	47.60	224.00	244.00	75.00	123.00	19.80	0.77	0.04	<0.040	139.00	7.39	0.02	<0.15	0.24
BH 16	150.00	2.20	4.80	68.00	12.00	21.20	7.70	10.70	2.80	<0.01	<0.040	21.10	7.25	<0.014	<0.15	0.10
April RWD	730.00	38.80	50.50	168.00	150.00	48.60	100.00	42.10	8.90	0.2	<0.040	110.00	8.09	0.60	0.25	0.24

Sample ID		Total Dissolved Solids	Nitrate NO_3 as N	Chlorides as Cl	Total Alkalinity as $CaCO_3$	Sulphate as SO_4	Calcium as Ca	Magnesium as Mg	Sodium as Na	Potassium as K	Iron as Fe	Manganese as Mn	Conductivity at 25° C in mS/m	pH-Value at 25° C	Aluminum as Al	Free and Saline Ammonia as N	Fluoride as F
Class 0	(Ideal)	<450	<6.0	<100	N/S	<200	<80	<30	<100	<25	<0.01	<0.05	<70	6.0-9.0	<0.15	N/S	<0.5
Class I	(Acceptable)	450-1000	6.0-10.0	100-200	N/S	200-400	80-150	30-70	100-200	25-50	0.01-0.2	0.05-0.1	70-150	5-6 or 9.0-9.5	0.15-0.3	N/S	0.5-1
Class II	(Max. Allowable)	1000-2400	>10-20	>200-600	N/S	>400-600	>150-300	>70-100	200-400	50-100	>0.2-2	>0.1-1	>150-370	4-5 or 9.5-10	>0.3-0.58	N/S	1-1.5
Class III	(Exceeding)	>2400	>20	>600	N/S	>600	>300	>100	>400	>100	>2	>1	>370	<4 or >10	>0.58	N/S	>1.5
HMS		16.00	30.00	179.00	88.00	1200.00	70.20	40.30	184.00	18.20	0.28	<0.040	180.00	8.14	0.16	0.48	162.00
GRA		1070.00	69.00	68.80	164.00	260.00	78.10	108.00	66.00	14.90	0.24	<0.040	161.00	7.16	0.180	2.50	0.29
BH 3		1260.00	64.80	138.00	280.00	342.00	65.50	185.00	65.60	3.20	0.3	<0.040	191.00	7.07	<0.014	<0.15	0.28
BH 12		580.00	42.70	32.10	208.00	153.00	56.50	81.00	26.70	7.50	0.08	<0.040	87.20	7.39	<0.014	<0.15	0.17
BH 13		1010.00	57.20	55.00	300.00	230.00	79.60	154.00	22.60	0.77	3.92	<0.040	153.00	7.20	1.3.	<0.15	<0.10
BH 17		950.00	0.00	41.30	340.00	192.00	48.60	165.00	13.60	1.30	0.240	<0.040	141.00	7.36	0.174	<0.15	0.18

Table 2: Microbiological results for surface and groundwater at BRCM from February to April 2010.

February	Ecoli (count/100ml)	Total coliform bacteria (count/100ml)	Heterotrophic plate count (count/ml)
Alert level	Nil	10	5000
HMS	0	4	136
GRA	0	642	1000
BH 10	0	>1000	704
BH 12	0	872	400
BH 17	0	>1000	2898
BH 18	0	0	21

March	Ecoli (count/100ml)	Total coliform bacteria (count/100ml)	Heterotrophic plate count (count/ml)
Sample point			
RWD	0	0	484
HMS	0	254	462
BH 10	0	0	1166
BH 12	0	>1000	1056
BH 13	0	>1000	1276
BH 16			
Alert level	**Nil**	**10**	**5000**

April	Ecoli (count/100ml)	Total coliform bacteria (count/100ml)	Heterotrophic plate count (count/ml)
Sample point			
RWD	0	>1000	6510
HMS	0	>1000	1980
GRA	0	404	2250
BH 3	>1000	>1000	18480
BH 12	0	>1000	15390
BH 13	100	>1000	10540
BH 17	0	>1000	14440
Alert level	Nil	10	5000

In the month of February, a total of six samples were collected and analysed at the laboratory. These included two surface water samples and four groundwater samples, namely: HMS, GRA and BH 10, BH 12, BH 17 as well as BH 18 (Plan 5).

Surface water samples had elements Al, Mn and Fe levels exceeding (SANS 241) concentrations. This may be attributed to the geology of the area, although it could not be confirmed in this report.

Sample GRA had an additional NO_3 and Mg occurring in similar concentrations, (Table 1):

Groundwater sample BH 10 had concentration of Al, Mg, Fe, Mg, and nitrate exceeding target levels for Class I potable water. These were found to exceed SANS 241. The rest of the constituents had concentrations that fell within allowable limits (Level III). Similar constituent concentrations were detected for samples BH 17 and BH 18 while BH 12 only had three highly concentrated elements namely Fe, Mn and Al.

For the month of March, surface water samples RWD and HMS were highly concentrated in nitrate (N), with the rest of the chemicals occurring in ideal required concentrations. The groundwater samples BH 10, BH 12, BH 13 and BH 16 had Fe, Mn and Al occurring in exceeding concentrations with an additional Mg for BH 10 and BH 13 as well as N for BH 13.

The month of April had only sample RWD which contained exceeding concentrations of N (nitrate), Fe, Mn, and Al and the rest of the chemical elements are within allowable limits.

3.1 Microbiological analysis

The heterotrophic plate count results for the surface and groundwater samples over a three month fell below the alert level (5000 count per ml) in February and March ranging from 21 – 2898 counts per ml, but increased above the Alert level in April for 5 of the 7 points sampled ranging from 6500 – 184480 counts per ml (Table 2). This indicates bacteriological contamination of the water resources and/or inefficiency of water treatment and disinfection process for the boreholes. As the water is used in the process circuit it is not of concern, none of the water should be used for potable use or for washing by people or within a food preparation environment. The only exception is the HMS Plant Circular dam and the Gravity Plant dam at 1980 and 2250 counts per ml respectively. Therefore, it is more likely contamination in the boreholes than treatment, whereas in the Return Water dam.

The total coliform bacteria count indicates bacterial contamination of all the Gravity Plant dam, BH 10, 12, 13, and 17 in February and March with counts per 100 ranging from 254 - >1000 (Table 2). The Return Water and HMS Plant Circular dams, BH 10, and 18 all fell below the Alert level (10 counts per 100 ml over the same period. However, all the points sampled in April exceed the Alert level of 10 counts per 100 ml. Total coliform bacteria should not be detectable in treated water supplies and often indicate inadequate treatment, post-treatment contamination and to some extents excessive concentration of nutrients (SA Water Quality Guidelines, 1996). Water in the process circuit is not of concern, however water from the boreholes should not be used for potable use, washing of people or within an environment dealing with the preparation of food.

The *Escherichia coli* is highly specific for faecal contamination originating from humans and warm-blooded animals (SA Water Quality Guidelines, 1996), and the presence of *E. coli* at BH points 3 and 13 indicates faecal contamination in April (Table 2). However, the other samples do not indicate faecal contamination over the three month monitoring period.

4 CONCLUSIONS

The following conclusions can be drawn:

- The chemical results show elevated levels of Mn, Fe, and Al in all the surface water and ground water points monitored over a three month period that exceed the acceptable limit for the SANS 241 drinking water standards;
- Microbial monitoring shows exceedance of SANS levels, however as the water is in the process circuit it is not of concern.

5 RECOMMENDATIONS

Action	**Person responsible**	**Deadline**
Check background level for Nitrates and Mg	Environmental Officer	End of June 2010
Check long term trends for Nitrates and Mg for all points.	Environmental Officer	End of June 2010
Check sampling protocol to ensure source of microbiological contamination is not the sampling procedure.	Environmental Officer	End of June 2010
Undertake a sampling audit internally or externally to verify procedures.	Environmental Officer or External consultant	End of June 2010

6 REFERENCES

South African Water Quality Guidelines (1996). Volume 1 Domestic Water Use

Department of Water Affairs (DWA), 2006. Best Practice Guidelines Series.

South African Bureau of Standards, 2005. South African National Standards (241) drinking water.

Government Notice Regulations (GN R) 704 of the National Water Act 1998 (NWA)

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APPENDIX

7 METHODOLOGY

The methodology undertaken for monitoring entails:

- Field investigation – where samples are collected from identified sites and submitted for analysis as accredited laboratories. All samples were collected in accordance with the DWAF, Department of Health & Water Research Commission: 2000: "Quality of Domestic Water Supplies: Volume 2: Sampling Guide".
- Data analysis and interpretation – where the data received from the laboratory is compared to standards relevant to each analysis; and
    - Surface and groundwater – SANS 241 (2005) for dinking water quality;
- Report compilation – where the interpreted data is compiled into a monthly (for internal filing), quarterly (for internal filing) and annual report (for submission to the DME/DWA).

7.1 Field Methodology

7.1.1 Surface Water

A one litre bottle is used to collect water samples from various identified surface water sampling points (Plan 5) including streams, dams and water channels on and around the site. The collected sample is submitted to the Laboratory (Rustenburg) for chemical (Table 1) and Bacteriological analyses (Table 2) for the relevant variables.

7.1.2 Groundwater

Similar to surface water samples, groundwater samples are collected from the monitoring boreholes on site. Prior to sample collection, borehole water levels, as well as elevation of the borehole were noted.

7.2 Data analysis and interpretation

The collected data from the laboratory was compared to the following standards:

- Water chemical –
- Water bacteriological –

7.3 Report compilation

This report details the findings of monitoring for the period February to April.

The chemical and bacteriological analysis was undertaken by Regen Waters Laboratories and then sent through to DWA.

The chemical and bacteriological results were evaluated by making use of the Windows Interpretation System for Hydrologists (WISH).

These results were then further analysed, compared and interpreted making use of the following documentation:

- SANS 241: 2005: “South African Drinking Water Standards”

All samples within the target water quality range are considered good or ideal water quality. For constituents exceeding the target range, health and/or aesthetic effects are associated with the water with long term use.

A.L. ABBOTT AND ASSOCIATES (PTY) LTD

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Doc.No. 5.10/1 Rev.3

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sanas Testing Laboratory

(No. T0276)

No. 1, Vine Park
Vine Road
7925
P.O. Box 483
WOODSTOCK, CAPE
7915

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02 **OUR REF. :** 2014/12/02/24225

DATE ANALYSED : 2014/12/02 **REPORT NO . :** 4186

	Sample Number	24225	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	7.44	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	-0.84	N/A
9	Conductivity (mS/m) (at 25 °C)	21.5	≤170 Aesthetic
27	Turbidity (NTU)	215	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	10	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	74.2	N/A
Calc	Total Hardness (mg/l as CaCO3)	75.7	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	49.5	N/A
92	Calcium (mg/l as Ca)	19.8	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	26.2	N/A
92	Magnesium (mg/l as Mg)	6.4	N/A
96	Chloride (mg/l as Cl)	13.0	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.39	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	9.2	≤200 Aesthetic
92	Potassium (mg/l as K)	2.0	N/A
92	Zinc (mg/l as Zn)	0.08	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	<0.10	≤1.5 Aesthetic
100	Nitrate & Nitrite Nitrogen (mg/l as N)	0.97	N/A
Calc	Nitrate Nitrogen (mg/l as N)	0.77	≤11.0 Acute Health-1
99	Nitrite Nitrogen (mg/l as N)	<0.20	≤0.90 Acute Health-1
102	Sulphate (mg/l as SO4)	15.9	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02

DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24225

REPORT NO . : 4186

	Sample Number	24225	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	110	≤1200 Aesthetic
92	Iron (µg/l as Fe)	63	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	19	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	14	≤300 Operational
84	E.coli (count per 100 ml)	<1	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	<1	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	<1	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	13.6	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	0.80	N/A
92	Total Chromium (µg/l as Cr)	<7	≤50 Chronic Health

Sampler : Unknown

This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02 **OUR REF. :** 2014/12/02/24225

DATE ANALYSED : 2014/12/02 **REPORT NO . :** 4186

	Sample Number	24225	
Mthd ALA No	Analyses	Results	SANS 241-1:2011

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
11 December 2014

TO: Fraser Alexander Water Treatment
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR G. BOKS

Sampler : Unknown

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Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/11/04

DATE RECEIVED : 2014/11/06

DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21984

REPORT NO . : 3777

	Sample Number	21984	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	7.66	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	-0.68	N/A
9	Conductivity (mS/m) (at 25 °C)	28.0	≤170 Aesthetic
27	Turbidity (NTU)	0.90	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	5	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	53.2	N/A
Calc	Total Hardness (mg/l as CaCO3)	88.7	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	61.3	N/A
92	Calcium (mg/l as Ca)	24.5	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	27.5	N/A
92	Magnesium (mg/l as Mg)	6.7	N/A
96	Chloride (mg/l as Cl)	12.2	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.38	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	11.6	≤200 Aesthetic
92	Potassium (mg/l as K)	3.9	N/A
92	Zinc (mg/l as Zn)	0.06	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	<0.10	≤1.5 Aesthetic
100	Nitrate & Nitrite Nitrogen (mg/l as N)	1.2	N/A
Calc	Nitrate Nitrogen (mg/l as N)	1.0	≤11.0 Acute Health-1
99	Nitrite Nitrogen (mg/l as N)	<0.20	≤0.90 Acute Health-1
102	Sulphate (mg/l as SO4)	15.6	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/11/04

DATE RECEIVED : 2014/11/06

DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21984

REPORT NO . : 3777

	Sample Number	21984	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	133	≤1200 Aesthetic
92	Iron (µg/l as Fe)	37	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	<19	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	<12	≤300 Operational
84	E.coli (count per 100 ml)	<1	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	<1	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	462	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	10.2	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	1.1	N/A
92	Total Chromium (µg/l as Cr)	<7	≤50 Chronic Health

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Water Analysis

Lanxess Rand Water

DATE SAMPLED : 2014/11/04

DATE RECEIVED : 2014/11/06 **OUR REF. :** 2014/11/04/21984

DATE ANALYSED : 2014/11/06 **REPORT NO . :** 3777

	Sample Number	21984	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
14 November 2014

TO: Fraser Alexander Water Treatment
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR G. BOKS

Sampler : Unknown

This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

A.L. ABBOTT AND ASSOCIATES (PTY) LTD
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EXECUTIVE SUMMARY

LANXESS

SEWAGE TREATMENT PLANT

DATE OF INSPECTION : 04 November 2014

---

1. The final effluent complied with the General Limit, except for marginally high nitrate/nitrite nitrogen.

2. Disinfection was poor (>2419 Faecal Coliforms per 100 ml).

3. An average daily flow of 243 m^3/d was recorded in October.

4. The organic load decreased to only 35.0 kg COD/d, down from 198 kg COD/d.

5. The septic tank performed well, reducing the COD by 46.3%.

6. All shafts of discs operational and performance were excellent.

....

pp **R. VAN DER MEULEN Pr.Sci.Nat.**
DIRECTOR

022/1/1/3774
12 November 2014

FRASER ALEXANDER WATER TREATMENT
(a division of Fraser Alexander Pty Ltd)
P O Box 1215
RUSTENBURG
0300

Att. : MR G. BOKS

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e-Mail Address :
info@alabbott.co.za

TYPE OF PLANT : SEWAGE TREATMENT

TREATMENT PROCESS : BIODISC

DATE OF SAMPLING : 04 November 2014

A. MANAGEMENT DATA

1.	PLANT NAME :	**LANXESS STP**
2.	LOCATION :	RUSTENBURG
3.	TEL. NO. :	-
4.	NAME OF SUPERINTENDENT :	MICHAEL THLAPI (ph 083-6275412)
5	NAME OF SENIOR OFFICIAL INTERVIEWED :	GRANT BOKS (ph 082-8076471)
6.	REGION :	NORTHERN BUSINESS UNIT

B. PLANT CAPACITY

	PARAMETER	UNITS	EST. CAPACITY	PRESENT
1.	Average Daily Flow (*from C15)	m^3/d	90.0	243
2.	Maximum Daily Flow (*from C15)	m^3/d	-	405
3.	Date of Maximum	-	-	03-October
4.	Organic Load	kg COD/d	35.0	34.9
5.	Population Equiv.	-	350	349

C. INTAKE WORKS

1	INTEGRATED FLOWS :				
	Totalizer Reading on 1st of month	01-Oct.	131 782	01-Nov.	139 314
	*Daily Flow (m^3/d)	Average	243	Maximum	405
	Totalizer Reading during sampling	03-Nov.	139 720	04-Nov.	139 890
	Daily flow (m^3/d)	Sampling	170	Rainfall Month (mm)	4.0
2.	RAW SEWAGE	COD (mg/l)	205	COD (kg/d)	34.9
		TKN (mg/l)	23.8	NH_3N (mg/l)	19.4
		pH	7.50	Settleable Solids (ml/l)	2.0
	Ratios	TKN : COD	0.12	P : COD	0.02

continued/....

C. INTAKE WORKS (continued)	
3.	**COMMENTS :**
	An average daily flow of 243 m^3/d was recorded in October, up from 193 m^3/d.
	The raw sewage was weak, with 205 mg COD/l
	The organic load consequently decreased to 34.9 kg COD/d, down from 198 kg COD/d.

D. SEPTIC TANK

1.	Dimensions (m)	Number	1	Depth	2.5
		Length	9.0	Width	4.0
2.	Volume (m^3)	Each	90.0	Total	90.0
3.	Loading Rate	m^3/cap	0.08	g COD/m^3	113
4.	Crust Apparent	Yes		No	+
5.	Settleable Solids	ml/l	0.20	% removal	90.0
6.	Settled Sewage	pH	7.30		
7.	Chemical Oxygen Demand	mg/l	110	% removal	46.3
8.	**COMMENTS :**				
	Phase separation was virtually complete across the septic tank, and good reduction in COD was achieved. Sludge levels are reportedly high in septic tank. Desludging is required.				

E. BIOLOGICAL CONTACTORS

1.	Number of Filters	Provided	3	Series	1
2.	Discs per Shaft	No	130	Diameter (m)	2
3.	Surface Area (m^2)	Total	2 250	In Use	2 250
4.	Appearance of Surface	Grey		Brown	+
5.	Settled Sewage COD	mg/l	110	Drive	Gearbox
6.	Loading Rate	kg/d	18.7	g COD/m^2/d	8.31
7.	pH in Effluent	Units	7.50		
8.	COD in Effluent	mg/l	33.5	Removal %	69.5
9.	Ammonia Nitrogen in Effluent	mg/l	<0.10	Removal %	>99
10.	**COMMENTS :** *				
	All shafts operating.				
	Purification was excellent, the nitrification of ammonia being essentially complete.				

continued/....

F. HUMUS TANK

1.	Type of Tank	Dortmund	+	Scraped	
2.	Number of Tanks	Provided	1		
3.	Dimensions (m)	Diameter (m)	2.7	Area (m^2)	5.73
4.	Upflow m/h	ADF	2.0	Maximum measured	1.0
5.	Scum Removal Equipment	Present		Absent	+
6.	Desludge Equipment	Manual	+	Automatic	
7.	Frequency Desludged	Per Day	Twice	Per Hour	
8.	Rising Sludge Apparent	Yes	-	No	+
9.	Bubbling Due To :	Scrapers		Desludge	+
10.	Appearance of Tanks	Good	+	Unsatis-factory	
11.	Settleable Solids	ml/l	0.30	% removal	92.9
12.	Effluent Quality (mg/l)	COD	45.1	Ammonia	0.12
13.	Effluent	DO (mg/l)	1.8	pH	7.40
14.	**COMMENTS :**				
	The effluent was clear and of very good chemical quality.				

G. FINAL EFFLUENT

1.	pH	Units	7.10		
2.	Settleable Solids	ml/l	<0.10		
3.	Dissolved Oxygen	mg/l	2.1		
4.	Appearance :	Clear	+	Turbid	
		Algae			
5.	**COMMENTS :**				
	The final effluent complied with the General Limit, except for nitrate/nitrite nitrogen.				

H. DISINFECTION

1.	Is Effluent Chlorinated :	Yes			
2.	Type of Chlorinator :	HTH Chlorine Chips			
	Gas (Dose)	g/h	-	mg/l	-
	HTH (Dose)	tablets per day	-		
	Sodium Hypochlorite (Dose)	ml/min	-		
3.	Is the Equipment Operational?	Yes	+	No	

continued/....

H.	DISINFECTION (continued)				
4.	Residual Chlorine	Free	1.0	Total	1.4
5.	Faecal coliforms	org./100 ml	>2419		
6.	**COMMENTS :**				
	The chlorine residuals were high.				
	Disinfection was poor.				

....

R. VAN DER MEULEN Pr.Sci.Nat.
DIRECTOR

022/1/1/3774
12 November 2014
cc/RvdM/bdm

FRASER ALEXANDER WATER TREATMENT
(a division of Fraser Alexander Pty Ltd)
P O Box 1215
RUSTENBURG
0300

<u>Att.</u> : MR G. BOKS

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SOUTH AFRICA

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Sewage Treatment Plant

Grab samples of raw sewage and various process effluents collected on 04 November 2014 **Report no.: 3774**

SAMPLE	Raw Sewage	Septic Tank	Biofilter	Humus Tank	Final Effluent					General Limit
pH (at 25 °C)	-	-	-	-	-	-	-	-	-	5.5-9.5
pH (at 25 °C) Field	7.50	7.30	7.50	7.40	7.10	-	-	-	-	5.5-9.5
Settleable Solids (ml/l)	2.0	0.20	4.2	0.30	<0.10	-	-	-	-	N/A
Conductivity (mS/m) (at 25 °C)	-	-	-	-	98.5	-	-	-	-	150(F + 70)
Faecal Coliforms (count per 100 ml)	-	-	-	-	>2419	-	-	-	-	1000 Max.
Chemical Oxygen Demand (mg/l)	205	110	33.5	45.1	46.7	-	-	-	-	75.0 Max.
Chemical Oxygen Demand (Filtered) (mg/l)	-	-	-	-	28.0	-	-	-	-	(Algae removed)
Total Kjeldahl Nitrogen (mg/l as N)	23.8	14.0	-	-	-	-	-	-	-	N/A
Ammonia Nitrogen (mg/l as N)	19.4	9.0	<0.10	0.12	0.16	-	-	-	-	6.0 Max.
Nitrate Nitrogen. (mg/l as N)	-	-	15.0	-	16.9	-	-	-	-	15.0 Max.
Nitrite Nitrogen (mg/l as N)	-	-	2.0	-	0.77	-	-	-	-	
Total Suspended Solids (mg/l)	-	-	-	-	8	-	-	-	-	25 Max.
Volatile Suspended Soilds (mg/l)	-	-	-	-	-	-	-	-	-	N/A

Report no: 3774

SAMPLE	Raw Sewage	Septic Tank	Biofilter	Humus Tank	Final Effluent					General Limit
Total Phosphate (mg/l as P)	4.8	-	-	-	-	-	-	-	-	N/A
Ortho Phosphate (mg/l as P)	-	-	-	-	2.9	-	-	-	-	10 Max.
Free Chlorine (mg/l)	-	-	-	-	1.0	-	-	-	-	0.25 Max.
Total Chlorine (mg/l)	-	-	-	-	1.4	-	-	-	-	N/A
Dissolved Oxygen (mg/l)	-	-	1.6	1.8	2.1	-	-	-	-	N/A

F = Feed water

To : FRASER ALEXANDER WATER TREATMENT
P O Box 1215
RUSTENBURG
300

N.VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR

Attention. : GRANT BOKS

Control Temperature Measured : 24 °C

APPENDIX 1 : SPECIFIC METHODS USED FOR THE ANALYES OF PARAMETERS INDICATED IN THIS REPORT

ALA Method No.	Parameter	Method	Limit of Detection
45	Acidity (mg/l)	STD Method 2310 B (1992)	-
94	Alkalinity (mg/l as $CaCO_3$) *	Discrete Analyzer using the Gallery	11
92	Aluminium (µg/l as Al) *	Based on SANS 11885:2008 (ICP)	12
3	Ammonia (mg/l as N) *	STD Method 4500-NH_3:C (1992)	0.15
95	Ammonia (mg/l as N) *	Discrete Analyzer using the Gallery	0.10
92	Antimony (µg/l as Sb) *	Based on SANS 11885:2008 (ICP)	10
92	Arsenic (µg/l as As) *	Based on SANS 11885:2008 (ICP)	10
92	Barium (µg/l) *	Based on SANS 11885:2008 (ICP)	1
92	Beryllium µg/l as Be) *	Based on SANS 11885:2008 (ICP)	1
Calc	Bicarbonate (mg/l)	Calculation	-
47	Boron (mg/l as B)	Lovibond Method	0.1
N/A	Bromine (mg/l as Br)	*(Outsourced)*	1.0
92	Cadmium (µg/l as Cd) *	Based on SANS 11885:2008 (ICP)	1
92	Calcium (mg/l as Ca) *	Based on SANS 11885:2008 (ICP)	0.32
Calc	Calcium Carbonate Precipitation Potential	Calculation	0.01
Calc	Calcium Hardness	Calculation	-
2	Chemical Oxygen Demand (mg/l) *	SANS 6048 (2005)	8
25	Chloride (mg/l as Cl) *	SABS 202 (2nd Revision)	1
96	Chloride (mg/l as Cl) *	Discrete Analyzer using the Gallery	0.41
69	Chlorine Demand (mg/l)	STD Method 2350 B (1992)	-
92	Cobalt (µg/l as Co) *	Based on SANS 11885:2008 (ICP)	14
97	Colour (mg/l as Pt) *	Discrete Analyzer using the Gallery	4
9	Conductivity (mS/m) (at 25 °C) *	STD Method 2501 A (1992)	0.1
92	Copper (µg/l as Cu) *	Based on SANS 11885:2008 (ICP)	6
5	Cyanide (µg/l as CN^-)	SABS 204	50
N/A	Cytopathic Viruses (count per 10 litres)	Membrane / Culture	-
105	Dissolved Organic Carbon (mg/l as C)	Hach 10128	1.0
68	Dissolved Oxygen (mg/l)	STD Method 4500 O-G	1
78	Dissolved Solids (mg/l)	STD Method 2501 A (1992)	-
84	E.coli (count per 100 ml) *	SABS 221 (2002) / Colilert	1
87	Enterococci (count per 100 ml) *	Enterolert-24 / Quanti-Tray	1
86	Faecal Coliforms (count per 100 ml) *	SABS SM 221 (2002) / Colilert	1
87	Faecal Streptococcus (count per 100 ml) *	Colilert	1
29	Fluoride (mg/l as F) *	Hach 8029	0.1
98	Fluoride (mg/l as F) *	Discrete Analyzer using the Gallery	0.06
66	Free Chlorine (mg/l)	Lovibond Method 3	0.05
88	Heterotrophic Plate Count (count per ml) *	Petrifilm ™ Aqua	1
N/A	Hexavalent Chromium (mg/l)	*(Outsourced)*	1.0
46	Hydrogen Sulphide (mg/l)	Hach 8051	1.0
92	Iron (µg/l as Fe) *	Based on SANS 11885:2008 (ICP)	24
92	Lead (µg/l as Pb) *	Based on SANS 11885:2008 (ICP)	7
92	Lithium (mg/l as Li)	*(Outsourced)*	-
92	Manganese (µg/l as Mn) *	Based on SANS 11885:2008 (ICP)	19
92	Magnesium (mg/l as Mg) *	Based on SANS 11885:2008 (ICP)	1.1
Calc	Magnesium Hardness	Calculation	-
92	Mercury (µg/l as Hg)	Based on SANS 11885:2008 (ICP)	1
N/A	Monochloramine (mg/l)	Lovibond Method	-
92	Molybdenum (µg/l as Mo) *	Based on SANS 11885:2008 (ICP)	91
N/A	Microcystin (µg/l as LR)	(Outsourced)	-
92	Nickel (µg/l as Ni) *	Based on SANS 11885:2008 (ICP)	1
4A	Nitrate Nitrogen (mg/l as N) *	Hach 8150 *(Applicable to Sewage Analysis)*	0.2
4B	Nitrate & Nitrite Nitrogen (mg/l as N) *	Lovibond Method using Brucine *(Applicable to Water Analysis)*	0.05
100	Nitrate Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.02
5	Nitrite Nitrogen (mg/l as N) *	Lovibond Method	0.05
99	Nitrite Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.01
Calc	Nitrate Nitrogen (mg/l as N) *	Calculation	-
18	Oil & Grease (mg/l)	SABS 1051 (Nov. 1982)	1

ALA Method No.	Parameter	Method	Limit of Detection
76	Odour (Threshold Odour Number)	STD Method 2150 (B)	1
10	Ortho Phosphate (mg/l as P) *	Hach 8114	0.2
101	Ortho Phosphate (mg/l as P) *	Discrete Analyzer using the Gallery	0.02
1	Oxygen Absorbed (mg/l as O) *	SANS 5220 : 2005	-
19	pH (at 25 °C) – Lab *	SABS 11 : (1990 – 3rd Revision)	-
19	pH (at 25 °C) – Field	SABS 11 : (1990 – 3rd Revision)	-
52	Phenols (mg/l)	SABS 211 (1992)	0.01
92	Potassium (mg/l as K) *	Based on SANS 11885:2008 (ICP)	0.32
92	Selenium (µg/l as Se) *	Based on SANS 11885:2008 (ICP)	10
67	Settleable Solids (ml/l)	STD Method 2540 F (1992)	0.1
92	Silica (mg/l) *	Based on SANS 11885:2008 (ICP)	-
32	Sodium (mg/l as Na) *	SANS 6050 (2004)	0.13
N/A	Somatic Coliphages (count per 10 ml)	*(Outsourced)*	-
92	Strontium (mg/l) *	Based on SANS 11885:2008 (ICP)	4
24	Sulphate (mg/l as SO_4) *	Hach 8051	4
102	Sulphate (mg/l as SO_4) *	Discrete Analyzer using the Gallery	0.28
46	Sulphide (mg/l as S^{2-})	STD Method 4500-S^{2}D (1992)	-
92	Tin (µg/l as Sn) *	Based on SANS 11885:2008 (ICP)	10
92	Titanium (mg/l as Ti)	*(Outsourced)*	-
28	Total Alkalinity (mg/l as $CaCO_3$)	STD Methods 2320 (1992)	1
66	Total Chlorine	Lovibond Method 3	0.05
92	Total Chromium (µg/l as Cr) *	Based on SANS 11885:2008 (ICP)	7
85	Total Coliforms Bacteria (count per 100 ml) *	SABS 221 (2002) / Colilert	-
7	Total Dissolved Solids	STD Method 2501 A (1992)	1
Calc	Total Hardness (mg/l as $CaCO_3$)	Calculation	1
15	Total Kjeldahl Nitrogen (mg/l)	Hach 8075	0.15
105	Total Organic Carbon (mg/l as C)	Hach 10128	1.0
11	Total Phosphate (mg/l as P)	STD Method 4500-PB (1992) / Hach 8114	0.2
13	Total Plate Count (count per ml) *	Petrifilm ™	1
N/A	Total Trihalomethanese (µg/l)	(Outsourced)	-
N/A	Trihalomethane (Chloroform)	(Outsourced)	-
N/A	Trihalomethane (Bromodichloromethane)	(Outsourced)	-
N/A	Trihalomethane (Dibromochloromethane)	(Outsourced)	-
N/A	Trihalomethane (Bromoform)	(Outsourced)	-
28	Turbidity (NTU) *	Hach 8237	0.01
6A	Suspended Solids (mg/l) *	STD Method 2540 D (1992)	4
N/A	TOX (mg/l)	(Outsourced)	-
92	Uranium (µg/l as U)	Based on SANS 11885:2008 (ICP)	-
92	Vanadium (µg/l as V) *	Based on SANS 11885:2008 (ICP)	139
17	Volatile Fatty Acids (mg/l)	STD Method 5560 C (1992)	-
68	Volatile Suspended Solids (mg/l)	STD Method 2540 E (1992)	4
92	Zinc (mg/l as Zn) *	Based on SANS 11885:2008 (ICP)	1

NOTE : ***Tests marked "SANAS Accredited" in this report and are included in the SANAS Schedule of Accreditation for this laboratory.**
Schedule of Accreditation excludes Sampling
All bacteriological analyses carried out by Colilert Method unless otherwise indicated on the Certificate of Analysis.
Uncertainty of Measurement and Method Descriptions will be provided upon request.

TERMS AND CONDITIONS OF BUSINESS

All work is undertaken by A.L. Abbott and Associates (Pty) Ltd, (hereinafter called "the Company") on the following conditions :

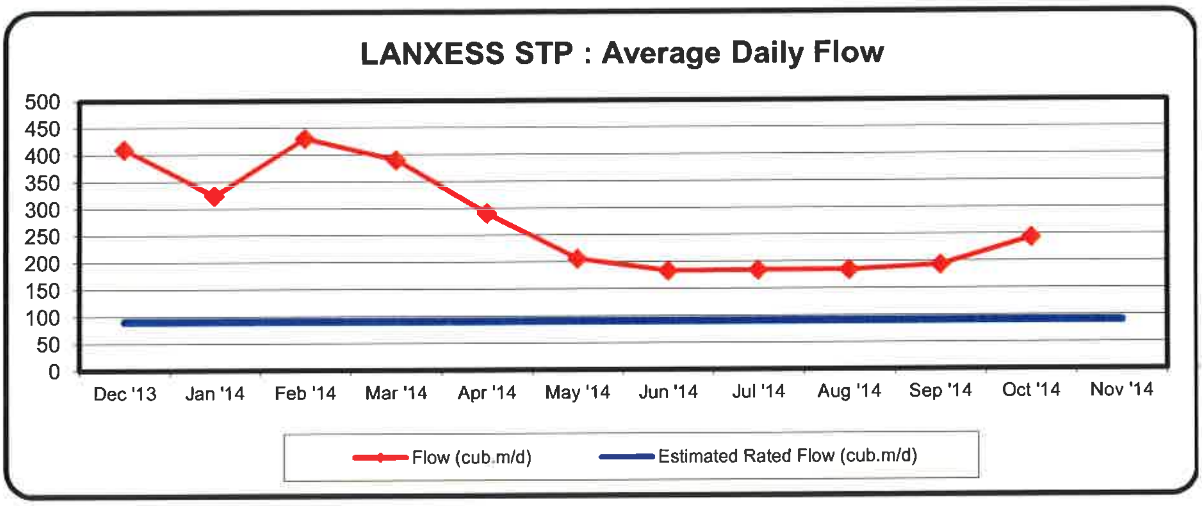
(i) That the total liability of the Company, its officers, servants, agents or sub-contractors for any loss or damage caused by or resulting from improper or negligent performance, purported performance or non-performance of such work shall not exceed the sum equal to fifteen times the fee payable by the client or R6000, whichever is the lesser sum.

(ii) That the person with whom the Company shall have contracted to have performed the said work will indemnify the Company, its said officers, servants, agents and sub-contractors against all claims made by the third parties consequent upon the performance, purported performance or non-performance of such work to the extent to which the aggregate of such claims exceeds the maximum liability specified in paragraph (i) above.

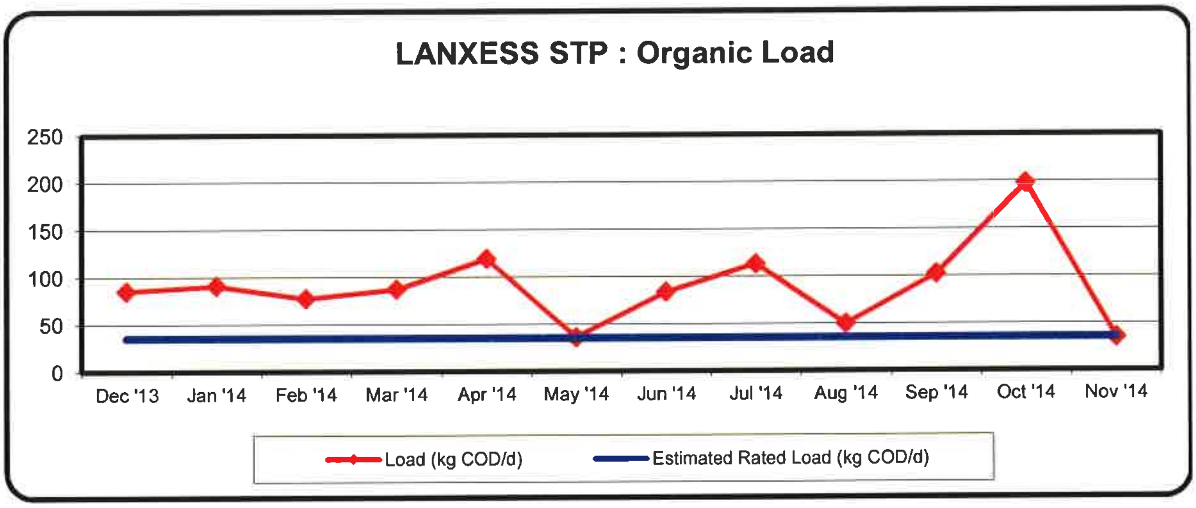
(iii) Without the prejudice to the foregoing every person who is or becomes an officer, servant, agent or sub-contractor of the Company shall have the benefit of the limitation of liability and indemnity contained in these conditions as if they were expressly made for his benefit and so far as relates to such conditions any contract entered into by the Company is entered into not only on its own benefit but also as agent and trustee for every such person as aforesaid.

(iv) No employee, agent or representative of the Company (other than a Director) has authority to alter or waive or make any representation which will in any way conflict with or override any of the terms of these conditions.

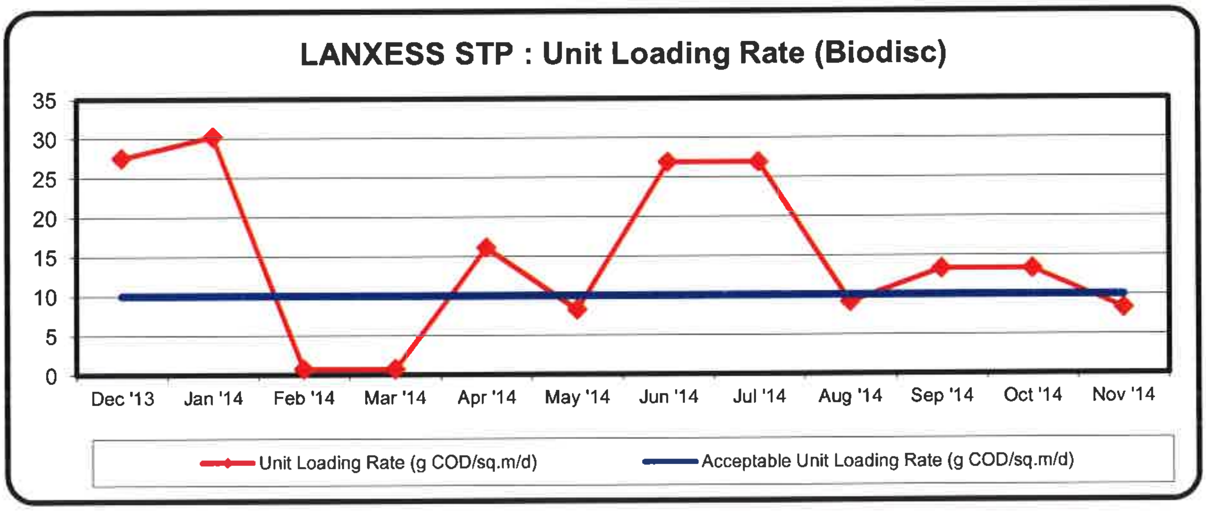
(v) The present conditions shall be governed by South African law and all disputes arising in relation thereto and/or in connection therewith shall be determined by the South African courts.



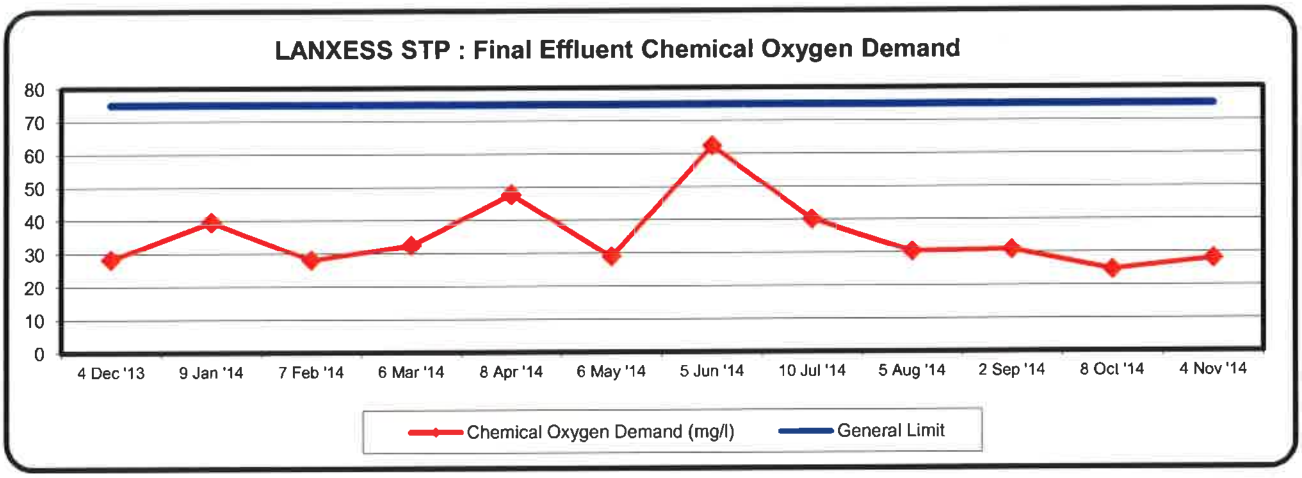
LANXESS STP : Average Daily Flow
500
450
400
350
300
250
200
150
100
50
0
Dec '13
Jan '14
Feb '14
Mar '14
Apr '14
May '14
Jun '14
Jul '14
Aug '14
Sep '14
Oct '14
Nov '14
Flow (cub.m/d)
Estimated Rated Flow (cub.m/d)

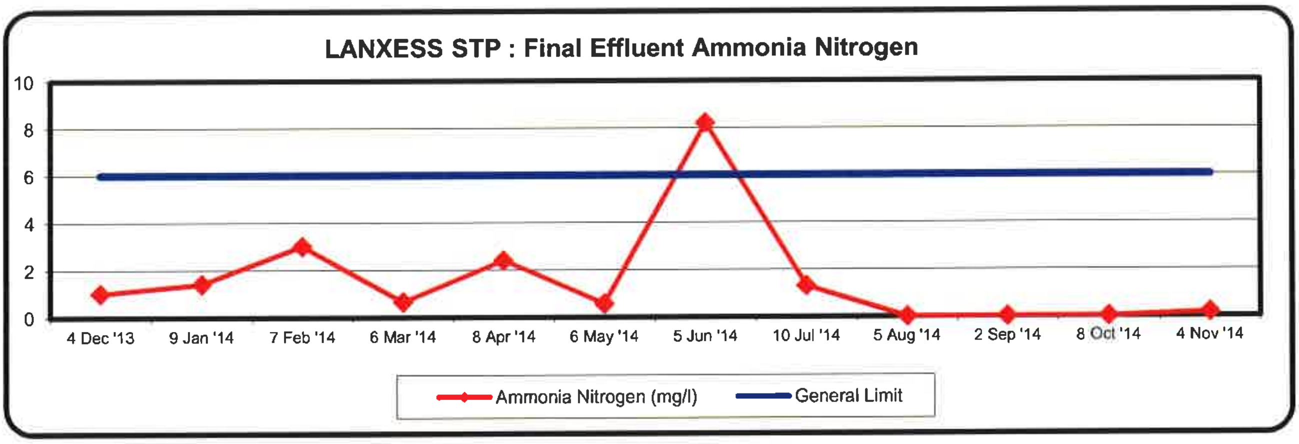


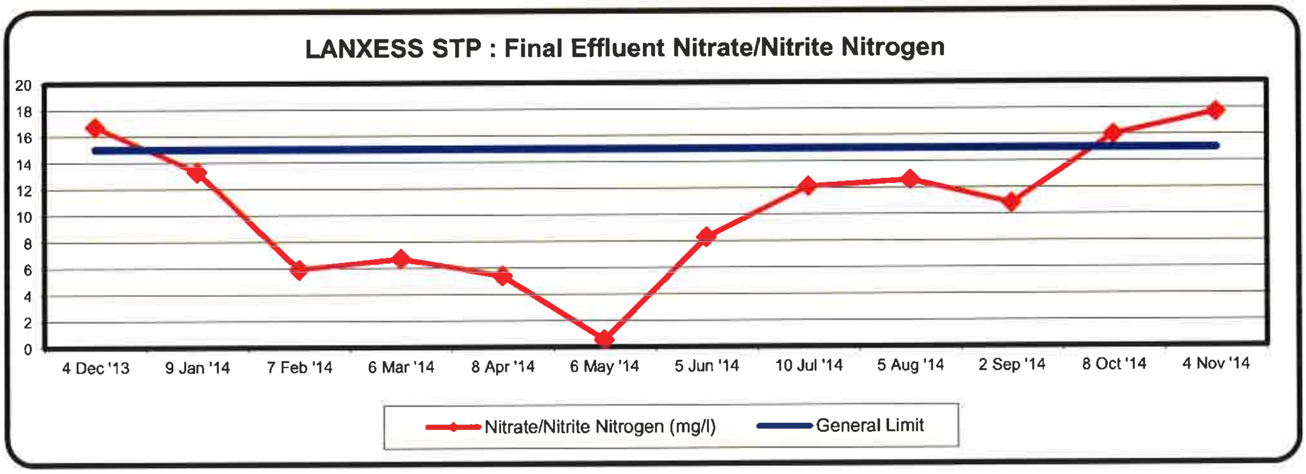
LANXESS STP : Organic Load
250
200
150
100
50
0
Dec '13
Jan '14
Feb '14
Mar '14
Apr '14
May '14
Jun '14
Jul '14
Aug '14
Sep '14
Oct '14
Nov '14
Load (kg COD/d)
Estimated Rated Load (kg COD/d)

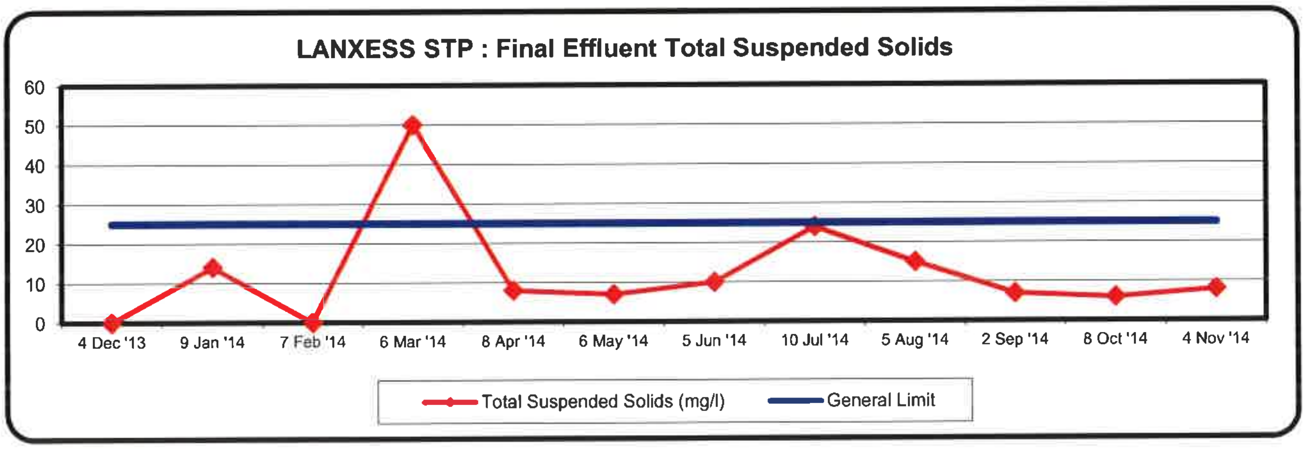


LANXESS STP : Unit Loading Rate (Biodisc)
35
30
25
20
15
10
5
0
Dec '13
Jan '14
Feb '14
Mar '14
Apr '14
May '14
Jun '14
Jul '14
Aug '14
Sep '14
Oct '14
Nov '14
Unit Loading Rate (g COD/sq.m/d)
Acceptable Unit Loading Rate (g COD/sq.m/d)


LANXESS STP : Final Effluent Chemical Oxygen Demand
80
70
60
50
40
30
20
10
0
4 Dec '13
9 Jan '14
7 Feb '14
6 Mar '14
8 Apr '14
6 May '14
5 Jun '14
10 Jul '14
5 Aug '14
2 Sep '14
8 Oct '14
4 Nov '14
Chemical Oxygen Demand (mg/l)
General Limit


LANXESS STP : Final Effluent Ammonia Nitrogen
10
8
6
4
2
0
4 Dec '13
9 Jan '14
7 Feb '14
6 Mar '14
8 Apr '14
6 May '14
5 Jun '14
10 Jul '14
5 Aug '14
2 Sep '14
8 Oct '14
4 Nov '14
Ammonia Nitrogen (mg/l)
General Limit


LANXESS STP : Final Effluent Nitrate/Nitrite Nitrogen
20
18
16
14
12
10
8
6
4
2
0
4 Dec '13
9 Jan '14
7 Feb '14
6 Mar '14
8 Apr '14
6 May '14
5 Jun '14
10 Jul '14
5 Aug '14
2 Sep '14
8 Oct '14
4 Nov '14
Nitrate/Nitrite Nitrogen (mg/l)
General Limit


LANXESS STP : Final Effluent Total Suspended Solids
60
50
40
30
20
10
0
4 Dec '13
9 Jan '14
7 Feb '14
6 Mar '14
8 Apr '14
6 May '14
5 Jun '14
10 Jul '14
5 Aug '14
2 Sep '14
8 Oct '14
4 Nov '14
Total Suspended Solids (mg/l)
General Limit

A.L. ABBOTT AND ASSOCIATES (PTY) LTD

(Reg. No. 1982/004379/07) Established 1964

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Telefax (021)448 6342
e-Mail Address :
info@alabbott.co.za

022/1/1/2775
NvB/sp

17 November 2014

Fraser Alexander Water Treatment
P O Box 1215
RUSTENBURG
0300

Attention : MR GRANT BOKS

Dear Sirs,

DAM WATER ANALYSIS - LANXESS MINE

We enclose our Certificate of Analysis relative to analysis of three dam waters, received on 4th November 2014.

The following parameters exceeded the chemical limits of SANS 241-1:2011.

HMS	GRA	RWD
Turbidity	Turbidity	Turbidity
Nitrate Nitrogen	Nitrate Nitrogen	Nitrate Nitrogen
Ammonia Nitrogen	Ammonia Nitrogen	-
Nitrite Nitrogen	Nitrite Nitrogen	-
Sulphate	-	Sulphate
Total Dissolved Solids	-	-
Iron	-	-
Manganese	-	-
Aluminium	-	-
Chromium	-	-

The bacteriological quality of both samples was poor.

Yours faithfully,

....

N. VAN BINSBERGEN Pr.Sci.Nat.
DIRECTOR

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(Reg. No. 1982/004379/07)

Doc.No. 5.10/1 Rev.3

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WOODSTOCK, CAPE
7915

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex RWD

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21978
REPORT NO. : 2775

	Sample Number	21978	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	8.91	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	1.0	N/A
9	Conductivity (mS/m) (at 25 °C)	162	≤170 Aesthetic
27	Turbidity (NTU)	5.7	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	13	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	65.5	N/A
Calc	Total Hardness (mg/l as CaCO3)	573	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	168	N/A
92	Calcium (mg/l as Ca)	67.0	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	405	N/A
92	Magnesium (mg/l as Mg)	98.9	N/A
96	Chloride (mg/l as Cl)	132	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.60	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	119	≤200 Aesthetic
92	Potassium (mg/l as K)	10.8	N/A
92	Zinc (mg/l as Zn)	0.006	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	<0.10	≤1.5 Aesthetic
99	Nitrite Nitrogen (mg/l as N)	0.57	≤0.90 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	98.6	N/A
Calc	Nitrate Nitrogen (mg/l as N)	98.0	≤11.0 Acute Health-1
102	Sulphate (mg/l as SO4)	256	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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sanas Testing Laboratory (No. T0276)

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex RWD

DATE SAMPLED : 2014/11/04

DATE RECEIVED : 2014/11/06

DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21978

REPORT NO . : 2775

	Sample Number	21978	
Mthd ALA No	Analyses	Results	SANS 241-1:2011
7	Total Dissolved Solids (mg/l)	996	≤1200 Aesthetic
92	Iron (µg/l as Fe)	<24	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	<19	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	<12	≤300 Operational
84	E.coli (count per 100 ml)	79	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	>2419	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	>5000	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	24.4	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	1.1	N/A
92	Total Chromium (µg/l as Cr)	9	≤50 Chronic Health

Sampler : Unknown

This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

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Doc.No. 5.10/1 Rev.3

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Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex RWD

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21978
REPORT NO . : 2775

	Sample Number	21978	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
14 November 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR GRANT BOKS

Sampler : Unknown

This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

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Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21976
REPORT NO . : 2775

	Sample Number	21976	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 ºC)	7.23	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	-0.47	N/A
9	Conductivity (mS/m) (at 25 ºC)	141	≤170 Aesthetic
27	Turbidity (NTU)	2.2	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	10	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	69.9	N/A
Calc	Total Hardness (mg/l as CaCO3)	418	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	232	N/A
92	Calcium (mg/l as Ca)	92.6	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	187	N/A
92	Magnesium (mg/l as Mg)	45.6	N/A
96	Chloride (mg/l as Cl)	61.0	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.58	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	85.5	≤200 Aesthetic
92	Potassium (mg/l as K)	12.6	N/A
92	Zinc (mg/l as Zn)	0.01	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	8.5	≤1.5 Aesthetic
Calc	Nitrate Nitrogen (mg/l as N)	104	≤11.0 Acute Health-1
99	Nitrite Nitrogen (mg/l as N)	2.4	≤0.90 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	106	N/A
102	Sulphate (mg/l as SO4)	168	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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(No. T0276)

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7915

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : **2014/11/04**

DATE RECEIVED : **2014/11/06**

DATE ANALYSED : **2014/11/06**

OUR REF. : **2014/11/04/21976**

REPORT NO . : **2775**

	Sample Number	21976	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	854	≤1200 Aesthetic
92	Iron (µg/l as Fe)	41	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	<19	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	17	≤300 Operational
84	E.coli (count per 100 ml)	365	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	2419	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	2948	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	18.2	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	14.1	N/A
92	Total Chromium (µg/l as Cr)	17	≤50 Chronic Health

Sampler : Unknown

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WOODSTOCK, CAPE
7915

(No. T0276)

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21976
REPORT NO . : 2775

	Sample Number	21976	
Mthd ALA No	Analyses	Results	SANS 241-1:2011

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
14 November 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR GRANT BOKS

Sampler : Unknown
This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

A.L. ABBOTT AND ASSOCIATES (PTY) LTD
(Reg. No. 1982/004379/07)

Consulting Analytical & Industrial Chemists
Specialists in Water & Waste Water Treatment
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Telefax (021)448 6342
e-Mail Address :
info@alabbott.co.za

sanas Testing Laboratory (No. T0276)

Doc.No. 5.10/1 Rev.3

No. 1, Vine Park
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P.O. Box 483
WOODSTOCK, CAPE
7915

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex HMS

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21977
REPORT NO. : 2775

	Sample Number	21977	
Mthd ALA No	Analyses	Results	SANS 241-1:2011
19	pH (at 25 ºC)	7.05	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	-0.35	N/A
9	Conductivity (mS/m) (at 25 ºC)	163	≤170 Aesthetic
27	Turbidity (NTU)	363	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	6	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	97.7	N/A
Calc	Total Hardness (mg/l as CaCO3)	720	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	335	N/A
92	Calcium (mg/l as Ca)	134	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	385	N/A
92	Magnesium (mg/l as Mg)	93.8	N/A
96	Chloride (mg/l as Cl)	85.2	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.69	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	132	≤200 Aesthetic
92	Potassium (mg/l as K)	15.1	N/A
92	Zinc (mg/l as Zn)	0.1	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	21.8	≤1.5 Aesthetic
99	Nitrite Nitrogen (mg/l as N)	7.1	≤0.90 Acute Health-1
Calc	Nitrate Nitrogen (mg/l as N)	189	≤11.0 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	196	N/A
102	Sulphate (mg/l as SO4)	253	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex HMS

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21977
REPORT NO. : 2775

	Sample Number	21977	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	1371	≤1200 Aesthetic
92	Iron (µg/l as Fe)	14270	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	135	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	1777	≤300 Operational
84	E.coli (count per 100 ml)	61	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	>2419	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	>5000	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	51.3	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	28.8	N/A
92	Total Chromium (µg/l as Cr)	205	≤50 Chronic Health

Sampler : Unknown

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Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex HMS

DATE SAMPLED : 2014/11/04
DATE RECEIVED : 2014/11/06
DATE ANALYSED : 2014/11/06

OUR REF. : 2014/11/04/21977
REPORT NO. : 2775

	Sample Number	21977	
Mthd ALA No	Analyses	Results	SANS 241-1:2011

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
14 November 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR GRANT BOKS

Sampler : Unknown
This report relates only to the samples tested and is issued subject to the company's standard terms and conditions of business.

APPENDIX 1 : SPECIFIC METHODS USED FOR THE ANALYES OF PARAMETERS INDICATED IN THIS REPORT

ALA Method No.	Parameter	Method	Limit of Detection
45	Acidity (mg/l)	STD Method 2310 B (1992)	-
94	Alkalinity (mg/l as $CaCO_3$) *	Discrete Analyzer using the Gallery	11
92	Aluminium (µg/l as Al) *	Based on SANS 11885:2008 (ICP)	12
3	Ammonia (mg/l as N) *	STD Method 4500-NH_3:C (1992)	0.15
95	Ammonia (mg/l as N) *	Discrete Analyzer using the Gallery	0.10
92	Antimony (µg/l as Sb) *	Based on SANS 11885:2008 (ICP)	10
92	Arsenic (µg/l as As) *	Based on SANS 11885:2008 (ICP)	10
92	Barium (µg/l) *	Based on SANS 11885:2008 (ICP)	1
92	Beryllium µg/l as Be) *	Based on SANS 11885:2008 (ICP)	1
Calc	Bicarbonate (mg/l)	Calculation	-
47	Boron (mg/l as B)	Lovibond Method	0.1
N/A	Bromine (mg/l as Br)	*(Outsourced)*	1.0
92	Cadmium (µg/l as Cd) *	Based on SANS 11885:2008 (ICP)	1
92	Calcium (mg/l as Ca) *	Based on SANS 11885:2008 (ICP)	0.32
Calc	Calcium Carbonate Precipitation Potential	Calculation	0.01
Calc	Calcium Hardness	Calculation	-
2	Chemical Oxygen Demand (mg/l) *	SANS 6048 (2005)	8
25	Chloride (mg/l as Cl) *	SABS 202 (2nd Revision)	1
96	Chloride (mg/l as Cl) *	Discrete Analyzer using the Gallery	0.41
69	Chlorine Demand (mg/l)	STD Method 2350 B (1992)	-
92	Cobalt (µg/l as Co) *	Based on SANS 11885:2008 (ICP)	14
97	Colour (mg/l as Pt) *	Discrete Analyzer using the Gallery	4
9	Conductivity (mS/m) (at 25 °C) *	STD Method 2501 A (1992)	0.1
92	Copper (µg/l as Cu) *	Based on SANS 11885:2008 (ICP)	6
5	Cyanide (µg/l as CN^-)	SABS 204	50
N/A	Cytopathic Viruses (count per 10 litres)	Membrane / Culture	-
105	Dissolved Organic Carbon (mg/l as C)	Hach 10128	1.0
68	Dissolved Oxygen (mg/l)	STD Method 4500 O-G	1
78	Dissolved Solids (mg/l)	STD Method 2501 A (1992)	-
84	E.coli (count per 100 ml) *	SABS 221 (2002) / Colilert	1
87	Enterococci (count per 100 ml) *	Enterolert-24 / Quanti-Tray	1
86	Faecal Coliforms (count per 100 ml) *	SABS SM 221 (2002) / Colilert	1
87	Faecal Streptococcus (count per 100 ml) *	Colilert	1
29	Fluoride (mg/l as F) *	Hach 8029	0.1
98	Fluoride (mg/l as F) *	Discrete Analyzer using the Gallery	0.06
66	Free Chlorine (mg/l)	Lovibond Method 3	0.05
88	Heterotrophic Plate Count (count per ml) *	Petrifilm ™ Aqua	1
N/A	Hexavalent Chromium (mg/l)	*(Outsourced)*	1.0
46	Hydrogen Sulphide (mg/l)	Hach 8051	1.0
92	Iron (µg/l as Fe) *	Based on SANS 11885:2008 (ICP)	24
92	Lead (µg/l as Pb) *	Based on SANS 11885:2008 (ICP)	7
92	Lithium (mg/l as Li)	*(Outsourced)*	-
92	Manganese (µg/l as Mn) *	Based on SANS 11885:2008 (ICP)	19
92	Magnesium (mg/l as Mg) *	Based on SANS 11885:2008 (ICP)	1.1
Calc	Magnesium Hardness	Calculation	-
92	Mercury (µg/l as Hg)	Based on SANS 11885:2008 (ICP)	1
N/A	Monochloramine (mg/l)	Lovibond Method	-
92	Molybdenum (µg/l as Mo) *	Based on SANS 11885:2008 (ICP)	91
N/A	Microcystin (µg/l as LR)	(Outsourced)	-
92	Nickel (µg/l as Ni) *	Based on SANS 11885:2008 (ICP)	1
4A	Nitrate Nitrogen (mg/l as N) *	Hach 8150 *(Applicable to Sewage Analysis)*	0.2
4B	Nitrate & Nitrite Nitrogen (mg/l as N) *	Lovibond Method using Brucine *(Applicable to Water Analysis)*	0.05
100	Nitrate Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.02
5	Nitrite Nitrogen (mg/l as N) *	Lovibond Method	0.05
99	Nitrite Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.01
Calc	Nitrate Nitrogen (mg/l as N) *	Calculation	-
18	Oil & Grease (mg/l)	SABS 1051 (Nov. 1982)	1

ALA Method No.	Parameter	Method	Limit of Detection
76	Odour (Threshold Odour Number)	STD Method 2150 (B)	1
10	Ortho Phosphate (mg/l as P) *	Hach 8114	0.2
101	Ortho Phosphate (mg/l as P) *	Discrete Analyzer using the Gallery	0.02
1	Oxygen Absorbed (mg/l as O) *	SANS 5220 : 2005	-
19	pH (at 25 °C) – Lab *	SABS 11 : (1990 – 3rd Revision)	-
19	pH (at 25 °C) – Field	SABS 11 : (1990 – 3rd Revision)	-
52	Phenols (mg/l)	SABS 211 (1992)	0.01
92	Potassium (mg/l as K) *	Based on SANS 11885:2008 (ICP)	0.32
92	Selenium (µg/l as Se) *	Based on SANS 11885:2008 (ICP)	10
67	Settleable Solids (ml/l)	STD Method 2540 F (1992)	0.1
92	Silica (mg/l) *	Based on SANS 11885:2008 (ICP)	-
32	Sodium (mg/l as Na) *	SANS 6050 (2004)	0.13
N/A	Somatic Coliphages (count per 10 ml)	*(Outsourced)*	-
92	Strontium (mg/l) *	Based on SANS 11885:2008 (ICP)	4
24	Sulphate (mg/l as SO_4) *	Hach 8051	4
102	Sulphate (mg/l as SO_4) *	Discrete Analyzer using the Gallery	0.28
46	Sulphide (mg/l as S^{2-})	STD Method 4500-S^2D (1992)	-
92	Tin (µg/l as Sn) *	Based on SANS 11885:2008 (ICP)	10
92	Titanium (mg/l as Ti)	*(Outsourced)*	-
28	Total Alkalinity (mg/l as $CaCO_3$)	STD Methods 2320 (1992)	1
66	Total Chlorine	Lovibond Method 3	0.05
92	Total Chromium (µg/l as Cr) *	Based on SANS 11885:2008 (ICP)	7
85	Total Coliforms Bacteria (count per 100 ml) *	SABS 221 (2002) / Colilert	-
7	Total Dissolved Solids	STD Method 2501 A (1992)	1
Calc	Total Hardness (mg/l as $CaCO_3$)	Calculation	1
15	Total Kjeldahl Nitrogen (mg/l)	Hach 8075	0.15
105	Total Organic Carbon (mg/l as C)	Hach 10128	1.0
11	Total Phosphate (mg/l as P)	STD Method 4500-PB (1992) / Hach 8114	0.2
13	Total Plate Count (count per ml) *	Petrifilm ™	1
N/A	Total Trihalomethanese (µg/l)	(Outsourced)	-
N/A	Trihalomethane (Chloroform)	(Outsourced)	-
N/A	Trihalomethane (Bromodichloromethane)	(Outsourced)	-
N/A	Trihalomethane (Dibromochloromethane)	(Outsourced)	-
N/A	Trihalomethane (Bromoform)	(Outsourced)	-
28	Turbidity (NTU) *	Hach 8237	0.01
6A	Suspended Solids (mg/l) *	STD Method 2540 D (1992)	4
N/A	TOX (mg/l)	(Outsourced)	-
92	Uranium (µg/l as U)	Based on SANS 11885:2008 (ICP)	-
92	Vanadium (µg/l as V) *	Based on SANS 11885:2008 (ICP)	139
17	Volatile Fatty Acids (mg/l)	STD Method 5560 C (1992)	-
68	Volatile Suspended Solids (mg/l)	STD Method 2540 E (1992)	4
92	Zinc (mg/l as Zn) *	Based on SANS 11885:2008 (ICP)	1

NOTE : ***Tests marked "SANAS Accredited" in this report and are included in the SANAS Schedule of Accreditation for this laboratory.**
Schedule of Accreditation excludes Sampling
All bacteriological analyses carried out by Colilert Method unless otherwise indicated on the Certificate of Analysis.
Uncertainty of Measurement and Method Descriptions will be provided upon request.

TERMS AND CONDITIONS OF BUSINESS

All work is undertaken by A.L. Abbott and Associates (Pty) Ltd, (hereinafter called "the Company") on the following conditions :

(i) That the total liability of the Company, its officers, servants, agents or sub-contractors for any loss or damage caused by or resulting from improper or negligent performance, purported performance or non-performance of such work shall not exceed the sum equal to fifteen times the fee payable by the client or R6000, whichever is the lesser sum.

(ii) That the person with whom the Company shall have contracted to have performed the said work will indemnify the Company, its said officers, servants, agents and sub-contractors against all claims made by the third parties consequent upon the performance, purported performance or non-performance of such work to the extent to which the aggregate of such claims exceeds the maximum liability specified in paragraph (i) above.

(iii) Without the prejudice to the foregoing every person who is or becomes an officer, servant, agent or sub-contractor of the Company shall have the benefit of the limitation of liability and indemnity contained in these conditions as if they were expressly made for his benefit and so far as relates to such conditions any contract entered into by the Company is entered into not only on its own benefit but also as agent and trustee for every such person as aforesaid.

(iv) No employee, agent or representative of the Company (other than a Director) has authority to alter or waive or make any representation which will in any way conflict with or override any of the terms of these conditions.

(v) The present conditions shall be governed by South African law and all disputes arising in relation thereto and/or in connection therewith shall be determined by the South African courts.

A.L. ABBOTT AND ASSOCIATES (PTY) LTD
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Established 1964

Process & Chemical Consultants
Specialists in Water & Waste Water Treatment

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e-Mail Address :
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022/1/1/4187
NvB/sp

12 December 2014

Fraser Alexander Water Treatment
P O Box 1215
RUSTENBURG
0300

Attention : MR GRANT BOKS

Dear Sirs,

DAM WATER ANALYSIS - LANXESS MINE

We enclose our Certificate of Analysis relative to analysis of three dam waters, received on 3rd December 2014.

The following parameters exceeded the chemical limits of SANS 241-1:2011.

HMS	GRA	RWD
-	Turbidity	Turbidity
Nitrate Nitrogen	Nitrate Nitrogen	Nitrate Nitrogen
Ammonia Nitrogen	Ammonia Nitrogen	-
Nitrite Nitrogen	Nitrite Nitrogen	-
-	-	Sulphate
Iron	Iron	-
Manganese	Manganese	-
Aluminium	Aluminium	-
-	-	-

The bacteriological quality of both samples was poor.

Yours faithfully,

N. VAN BINSBERGEN Pr.Sci.Nat.
DIRECTOR

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex HMS

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02

DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24227

REPORT NO . : 4187

	Sample Number	24227	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	7.62	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	-0.03	N/A
9	Conductivity (mS/m) (at 25 °C)	165	≤170 Aesthetic
27	Turbidity (NTU)	0.76	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	4	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	73.8	N/A
Calc	Total Hardness (mg/l as CaCO3)	414	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	250	N/A
92	Calcium (mg/l as Ca)	99.9	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	164	N/A
92	Magnesium (mg/l as Mg)	40.1	N/A
96	Chloride (mg/l as Cl)	74.0	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.71	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	98.7	≤200 Aesthetic
92	Potassium (mg/l as K)	8.8	N/A
92	Zinc (mg/l as Zn)	0.03	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	10.6	≤1.5 Aesthetic
99	Nitrite Nitrogen (mg/l as N)	6.4	≤0.90 Acute Health-1
Calc	Nitrate Nitrogen (mg/l as N)	121	≤11.0 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	127	N/A
102	Sulphate (mg/l as SO4)	246	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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OUR REF. : 2014/12/02/24227
REPORT NO . : 4187

	Sample Number	24227	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	725	≤1200 Aesthetic
92	Iron (µg/l as Fe)	1170	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	155	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	803	≤300 Operational
84	E.coli (count per 100 ml)	6	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	649	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	>5000	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	30.5	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	18.0	N/A
92	Total Chromium (µg/l as Cr)	44	≤50 Chronic Health

Sampler : Unknown

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DATE SAMPLED : 2014/12/02
DATE RECEIVED : 2014/12/02
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OUR REF. : 2014/12/02/24227
REPORT NO . : 4187

	Sample Number	24227	
Mthd ALA No	Analyses	Results	SANS 241-1:2011

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
11 December 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
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0300

Att: MR GRANT BOKS

Sampler : Unknown

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Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : 2014/12/02
DATE RECEIVED : 2014/12/02
DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24226
REPORT NO . : 4187

	Sample Number	24226	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	7.88	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	0.32	N/A
9	Conductivity (mS/m) (at 25 °C)	165	≤170 Aesthetic
27	Turbidity (NTU)	178	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	<4	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	84.9	N/A
Calc	Total Hardness (mg/l as CaCO3)	497	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	268	N/A
92	Calcium (mg/l as Ca)	107	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	230	N/A
92	Magnesium (mg/l as Mg)	56.0	N/A
96	Chloride (mg/l as Cl)	66.8	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.68	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	95.2	≤200 Aesthetic
92	Potassium (mg/l as K)	10.7	N/A
92	Zinc (mg/l as Zn)	0.02	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	7.1	≤1.5 Aesthetic
Calc	Nitrate Nitrogen (mg/l as N)	118	≤11.0 Acute Health-1
99	Nitrite Nitrogen (mg/l as N)	4.2	≤0.90 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	122	N/A
102	Sulphate (mg/l as SO4)	221	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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A.L. ABBOTT AND ASSOCIATES (PTY) LTD

(Reg. No. 1982/004379/07)

Doc.No. 5.10/1 Rev.3

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sanas Testing Laboratory
(No. T0276)

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Vine Road
7925
P.O. Box 483
WOODSTOCK, CAPE
7915

Certificate of Analysis

FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02

DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24226

REPORT NO . : 4187

	Sample Number	24226	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	755	≤1200 Aesthetic
92	Iron (µg/l as Fe)	606	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	146	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	810	≤300 Operational
84	E.coli (count per 100 ml)	172	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	>2419	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	>5000	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	16.9	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	11.0	N/A
92	Total Chromium (µg/l as Cr)	30	≤50 Chronic Health

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex GRA

DATE SAMPLED : 2014/12/02
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REPORT NO . : 4187

	Sample Number	24226	
Mthd ALA No	Analyses	Results	SANS 241-1:2011

p.p.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
11 December 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR GRANT BOKS

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex RWD

DATE SAMPLED : 2014/12/02

DATE RECEIVED : 2014/12/02

DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24228

REPORT NO . : 4187

	Sample Number	24228	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
19	pH (at 25 °C)	9.21	≥5 - ≤9.7 Operational
Calc	Langelier Saturation Index (at 25 °C)	1.4	N/A
9	Conductivity (mS/m) (at 25 °C)	154	≤170 Aesthetic
27	Turbidity (NTU)	1.1	≤5 Aesthetic ≤1 Operational
97	Colour (mg/l as Pt)	10	≤15 Aesthetic
94	Total Alkalinity (mg/l as CaCO3)	103	N/A
Calc	Total Hardness (mg/l as CaCO3)	481	N/A
Calc	Calcium Hardness (mg/l as CaCO3)	126	N/A
92	Calcium (mg/l as Ca)	50.3	N/A
Calc	Magnesium Hardness (mg/l as CaCO3)	355	N/A
92	Magnesium (mg/l as Mg)	86.7	N/A
96	Chloride (mg/l as Cl)	132	≤300 Aesthetic
98	Fluoride (mg/l as F)	0.65	≤1.5 Chronic Health
92	Sodium (mg/l as Na)	85.2	≤200 Aesthetic
92	Potassium (mg/l as K)	6.8	N/A
92	Zinc (mg/l as Zn)	0.004	≤5.0 Aesthetic
95	Ammonia Nitrogen (mg/l as N)	<0.10	≤1.5 Aesthetic
99	Nitrite Nitrogen (mg/l as N)	0.57	≤0.90 Acute Health-1
100	Nitrate & Nitrite Nitrogen (mg/l as N)	70.6	N/A
Calc	Nitrate Nitrogen (mg/l as N)	70.0	≤11.0 Acute Health-1
102	Sulphate (mg/l as SO4)	256	≤250 Aesthetic ≤500 Acute Health-1

Sampler : Unknown

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FRASER ALEXANDER WATER TREATMENT : NORTHERN

Lanxess Slime Dam Water Analysis

Lanxess Slime Dam ex RWD

DATE SAMPLED : 2014/12/02
DATE RECEIVED : 2014/12/02
DATE ANALYSED : 2014/12/02

OUR REF. : 2014/12/02/24228
REPORT NO. : 4187

	Sample Number	24228	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**
7	Total Dissolved Solids (mg/l)	715	≤1200 Aesthetic
92	Iron (µg/l as Fe)	<24	≤300 Aesthetic ≤2000 Chronic Health
92	Manganese (µg/l as Mn)	<19	≤100 Aesthetic ≤500 Chronic Health
92	Aluminium (µg/l as Al)	<12	≤300 Operational
84	E.coli (count per 100 ml)	2	Not Detected Acute Health-1
85	Total Coliform Bacteria (count per 100 ml)	308	≤10 Operational
88	Heterotrophic Plate Count (count per ml)	2888	≤1000 Operational
2	Chemical Oxygen Demand (mg/l)	21.4	N/A
15	Total Kjeldahl Nitrogen (mg/l as N)	4.0	N/A
92	Total Chromium (µg/l as Cr)	<7	≤50 Chronic Health

Sampler : Unknown

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REPORT NO . : 4187

	Sample Number	24228	
Mthd ALA No	**Analyses**	**Results**	**SANS 241-1:2011**

P.P.

N. VAN BINSBERGEN (Pr.Sci.Nat.)
DIRECTOR
11 December 2014

TO: Fraser Alexander Tailings
Northern Business Unit
PO Box 1215
RUSTENBURG
0300

Att: MR GRANT BOKS

Sampler : Unknown

APPENDIX 1 : SPECIFIC METHODS USED FOR THE ANALYES OF PARAMETERS INDICATED IN THIS REPORT

ALA Method No.	Parameter	Method	Limit of Detection
45	Acidity (mg/l)	STD Method 2310 B (1992)	-
94	Alkalinity (mg/l as $CaCO_3$) *	Discrete Analyzer using the Gallery	11
92	Aluminium (µg/l as Al) *	Based on SANS 11885:2008 (ICP)	12
3	Ammonia (mg/l as N) *	STD Method 4500-NH_3:C (1992)	0.15
95	Ammonia (mg/l as N) *	Discrete Analyzer using the Gallery	0.10
92	Antimony (µg/l as Sb) *	Based on SANS 11885:2008 (ICP)	10
92	Arsenic (µg/l as As) *	Based on SANS 11885:2008 (ICP)	10
92	Barium (µg/l) *	Based on SANS 11885:2008 (ICP)	1
92	Beryllium µg/l as Be) *	Based on SANS 11885:2008 (ICP)	1
Calc	Bicarbonate (mg/l)	Calculation	-
47	Boron (mg/l as B)	Lovibond Method	0.1
N/A	Bromine (mg/l as Br)	*(Outsourced)*	1.0
92	Cadmium (µg/l as Cd) *	Based on SANS 11885:2008 (ICP)	1
92	Calcium (mg/l as Ca) *	Based on SANS 11885:2008 (ICP)	0.32
Calc	Calcium Carbonate Precipitation Potential	Calculation	0.01
Calc	Calcium Hardness	Calculation	-
2	Chemical Oxygen Demand (mg/l) *	SANS 6048 (2005)	8
25	Chloride (mg/l as Cl) *	SABS 202 (2nd Revision)	1
96	Chloride (mg/l as Cl) *	Discrete Analyzer using the Gallery	0.41
69	Chlorine Demand (mg/l)	STD Method 2350 B (1992)	-
92	Cobalt (µg/l as Co) *	Based on SANS 11885:2008 (ICP)	14
97	Colour (mg/l as Pt) *	Discrete Analyzer using the Gallery	4
9	Conductivity (mS/m) (at 25 °C) *	STD Method 2501 A (1992)	0.1
92	Copper (µg/l as Cu) *	Based on SANS 11885:2008 (ICP)	6
5	Cyanide (µg/l as CN^-)	SABS 204	50
N/A	Cytopathic Viruses (count per 10 litres)	Membrane / Culture	-
105	Dissolved Organic Carbon (mg/l as C)	Hach 10128	1.0
68	Dissolved Oxygen (mg/l)	STD Method 4500 O-G	1
78	Dissolved Solids (mg/l)	STD Method 2501 A (1992)	-
84	E.coli (count per 100 ml) *	SABS 221 (2002) / Colilert	1
87	Enterococci (count per 100 ml) *	Enterolert-24 / Quanti-Tray	1
86	Faecal Coliforms (count per 100 ml) *	SABS SM 221 (2002) / Colilert	1
87	Faecal Streptococcus (count per 100 ml) *	Colilert	1
29	Fluoride (mg/l as F) *	Hach 8029	0.1
98	Fluoride (mg/l as F) *	Discrete Analyzer using the Gallery	0.06
66	Free Chlorine (mg/l)	Lovibond Method 3	0.05
88	Heterotrophic Plate Count (count per ml) *	Petrifilm ™ Aqua	1
N/A	Hexavalent Chromium (mg/l)	*(Outsourced)*	1.0
46	Hydrogen Sulphide (mg/l)	Hach 8051	1.0
92	Iron (µg/l as Fe) *	Based on SANS 11885:2008 (ICP)	24
92	Lead (µg/l as Pb) *	Based on SANS 11885:2008 (ICP)	7
92	Lithium (mg/l as Li)	*(Outsourced)*	-
92	Manganese (µg/l as Mn) *	Based on SANS 11885:2008 (ICP)	19
92	Magnesium (mg/l as Mg) *	Based on SANS 11885:2008 (ICP)	1.1
Calc	Magnesium Hardness	Calculation	-
92	Mercury (µg/l as Hg)	Based on SANS 11885:2008 (ICP)	1
N/A	Monochloramine (mg/l)	Lovibond Method	-
92	Molybdenum (µg/l as Mo) *	Based on SANS 11885:2008 (ICP)	91
N/A	Microcystin (µg/l as LR)	(Outsourced)	-
92	Nickel (µg/l as Ni) *	Based on SANS 11885:2008 (ICP)	1
4A	Nitrate Nitrogen (mg/l as N) *	Hach 8150 *(Applicable to Sewage Analysis)*	0.2
4B	Nitrate & Nitrite Nitrogen (mg/l as N) *	Lovibond Method using Brucine *(Applicable to Water Analysis)*	0.05
100	Nitrate Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.02
5	Nitrite Nitrogen (mg/l as N) *	Lovibond Method	0.05
99	Nitrite Nitrogen (mg/l as N) *	Discrete Analyzer using the Gallery	0.01
Calc	Nitrate Nitrogen (mg/l as N) *	Calculation	-
18	Oil & Grease (mg/l)	SABS 1051 (Nov. 1982)	1

ALA Method No.	Parameter	Method	Limit of Detection
76	Odour (Threshold Odour Number)	STD Method 2150 (B)	1
10	Ortho Phosphate (mg/l as P) *	Hach 8114	0.2
101	Ortho Phosphate (mg/l as P) *	Discrete Analyzer using the Gallery	0.02
1	Oxygen Absorbed (mg/l as O) *	SANS 5220 : 2005	-
N/A	Pesticides	*(Outsourced)*	-
19	pH (at 25 °C) – Lab *	SABS 11 : (1990 – 3rd Revision)	-
19	pH (at 25 °C) – Field	SABS 11 : (1990 – 3rd Revision)	-
52	Phenols (mg/l)	SABS 211 (1992)	0.01
92	Potassium (mg/l as K) *	Based on SANS 11885:2008 (ICP)	0.32
92	Selenium (µg/l as Se) *	Based on SANS 11885:2008 (ICP)	10
67	Settleable Solids (ml/l)	STD Method 2540 F (1992)	0.1
92	Silica (mg/l) *	Based on SANS 11885:2008 (ICP)	-
32	Sodium (mg/l as Na) *	SANS 6050 (2004)	0.13
N/A	Somatic Coliphages (count per 10 ml)	*(Outsourced)*	-
92	Strontium (mg/l) *	Based on SANS 11885:2008 (ICP)	4
24	Sulphate (mg/l as SO_4) *	Hach 8051	4
102	Sulphate (mg/l as SO_4) *	Discrete Analyzer using the Gallery	0.28
46	Sulphide (mg/l as S^{2-})	STD Method 4500-S^2D (1992)	-
92	Tin (µg/l as Sn) *	Based on SANS 11885:2008 (ICP)	10
92	Titanium (mg/l as Ti)	*(Outsourced)*	-
28	Total Alkalinity (mg/l as $CaCO_3$)	STD Methods 2320 (1992)	1
66	Total Chlorine	Lovibond Method 3	0.05
92	Total Chromium (µg/l as Cr) *	Based on SANS 11885:2008 (ICP)	7
85	Total Coliforms Bacteria (count per 100 ml) *	SABS 221 (2002) / Colilert	-
7	Total Dissolved Solids	STD Method 2501 A (1992)	1
Calc	Total Hardness (mg/l as $CaCO_3$)	Calculation	1
15	Total Kjeldahl Nitrogen (mg/l)	Hach 8075	0.15
105	Total Organic Carbon (mg/l as C)	Hach 10128	1.0
11	Total Phosphate (mg/l as P)	STD Method 4500-PB (1992) / Hach 8114	0.2
13	Total Plate Count (count per ml) *	Petrifilm ™	1
N/A	Total Trihalomethanese (µg/l)	(Outsourced)	-
N/A	Trihalomethane (Chloroform)	(Outsourced)	-
N/A	Trihalomethane (Bromodichloromethane)	(Outsourced)	-
N/A	Trihalomethane (Dibromochloromethane)	(Outsourced)	-
N/A	Trihalomethane (Bromoform)	(Outsourced)	-
28	Turbidity (NTU) *	Hach 8237	0.01
6A	Suspended Solids (mg/l) *	STD Method 2540 D (1992)	4
N/A	TOX (mg/l)	(Outsourced)	-
92	Uranium (µg/l as U)	Based on SANS 11885:2008 (ICP)	-
92	Vanadium (µg/l as V) *	Based on SANS 11885:2008 (ICP)	139
17	Volatile Fatty Acids (mg/l)	STD Method 5560 C (1992)	-
68	Volatile Suspended Solids (mg/l)	STD Method 2540 E (1992)	4
92	Zinc (mg/l as Zn) *	Based on SANS 11885:2008 (ICP)	1

NOTE : ***Tests marked "SANAS Accredited" in this report and are included in the SANAS Schedule of Accreditation for this laboratory.**
Schedule of Accreditation excludes Sampling
All bacteriological analyses carried out by Colilert Method unless otherwise indicated on the Certificate of Analysis.
Uncertainty of Measurement and Method Descriptions will be provided upon request.