DIGBY WELLS
ENVIRONMENTAL

EMP Consolidation for Thubelisha, Trichardsfontein and Vaalkop Mining Area

Consolidated Surface Water Assessment Report

Project Number:

SAS3869

Prepared for:

Sasol Mining (Pty) Ltd

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DECLARATION OF INDEPENDENCE

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22/08/2017

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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sasol Mining (Pty) Ltd (hereafter Sasol) to undertake a Section 102 process in accordance with the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA) in support of the required environmental authorisations for the four (4) ventilation shafts, amendment of the Trichardsfontein Environmental Management Plan Report (EMPR) and consolidation of the Twistdraai Colliery: Thubelisha Shaft (TCTS) EMPR, Vaalkop EMPR and the Trichardsfontein EMPR which is referred to as the Thubelisha Project. The project area is located northeast of Secunda in Mpumalanga province.

A surface water assessment for the new Vaalkop underground mine was conducted to include this area together with the consolidation of the other two existing surface water assessment studies.

Due to the depth of the coal resource (i.e. 160 m to 180 m), underground mining will be used to access the coal seam. A high extraction method of mining using bord-and-pillar mining with pillar extraction is currently being used at the Twistdraai Colliery: Thubelisha Shaft and is proposed to be utilised at the Trichardsfontein and Vaalkop Mines. In mechanised bord and pillar mining, extraction is achieved by developing a series of roadways (bords) in the coal seam connected by splits (cut-through) to form pillars. In high extraction mining, all the pillars are extracted to allow the roof to collapse in a controlled manner (also known stooping). Initially mining will occur in the east and west and move towards the north and south. As per GN704 regulation, stooping will occur outside of the 1:100 floodlines and/or 100 m from the streams, whichever is greater.

The project area is situated in the headwaters of the Trichardstspruit, Steenkoolspruit, Krapfonteinspruit, Debeerspruit and Piekespruit catchments. These catchments form part of the Witbank Dam catchment, and are within quaternary catchments B11C and B11D of the Olifants Water Management Areas (WMA). Runoff from this area drains towards the north and eventually joins the Olifants River via the Steenkoolspruit, which then feeds into the Limpopo River.

Water quality samples were collected within the project area and the surrounding streams to determine a baseline water quality status prior to commencement of the proposed project. The results indicated some existing impacts on the streams within the area, with parameters such as Total Dissolved Solids, Chloride, Phosphate and Ammonia exceeding the target water quality range for the irrigational use as set in the South African Water Quality Guidelines (DWAF, 1996) and the Olifants River Water Quality Management Objectives.

The existing and proposed mining of the Vaalkop area, together with the associated activities have the potential to impact on the surface water resources within and around the project area.

The identified potential surface water impacts include but are not limited to:

- Siltation of surface water resources leading to deteriorated water quality as a result of eroded material reporting into the streams;
- Contamination of surface water resources when contaminated water runoff from the dirty mine areas reports into the nearby streams;
- Possible decant after cessation and closure of mining activities leading into contamination of the natural streams; and
- Reduction in runoff and catchment yield into the natural streams when all the surface water runoff is contained within the stooped areas due to subsidence.

Subsequent to that, appropriate mitigation and management measures were recommended to either prevent and/or minimise the identified potential impacts and risks. This included the following:

- Limiting vegetation clearing to the development footprint;
- Implementation of dust suppression measures during construction and operational activities;
- All bulk fuel storage areas should be appropriately bunded and spill kits should be in place to contain and immediately clean up any potential leakages of fuels and oils;
- To ensure that all the dirty water emanating from the dirty water areas is contained within the mine site for re-use to prevent unnecessary discharge into the environment;
- Conveyor lines must be covered on top and at the bottom, to avoid spillage of contaminants from the coal into the nearby streams;
- Should subsidence occur during operation, measures to rehabilitate the surface area should be implemented as soon as possible to avoid impoundment of surface water;
- Water quality monitoring should continue on the existing monitoring points to ensure detection of impacts;
- Use of accredited contractors for removal or demolition of infrastructures; this will reduce the risk of waste generation and accidental spillages;
- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage off subsided areas. This will ensure improvement or increased catchment yield on to the surrounding streams and the prevention of erosion;
- Should decant occur, decant water should be captured before it flows into the streams. The water should then be treated prior to discharge into the streams.

Thus, with all the recommended mitigation measures in place to ensure the prevention and/or reduction of the identified potential surface water impacts, the project is unlikely to pose a significant threat to the surface water resources and thus no fatal flaws were found.

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TABLE OF ABREVIATIONS AND ACCRONYMS

DMR	Department of Mineral Resources
DWS	Department of Water and Sanitation
ECO	Environmental Control Office (
EIA	Environmental Impact Assessment
EMPR	Environmental Management Programme Report
IWUL	Integrated Water Use Licence
IWWMP	Integrated Water and Waste Management Plan
Km	kilometre
km2	Square meters
m	meter
MAE	Mean Annual Evaporation
MAR	Mean Annual Runoff
MAP	Mean Annual Precipitation
MPRDA	Mineral and Petroleum Resources Development Act
Mm3	Million cubic meters (
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act, 1998 (Act No. 36 of 1998)
RWQO	Resource Water Quality Objectives
SANAS	South African national Accreditation System
SWMP	Storm Water Management Plan
SAWQG	South African Water Quality Guidelines
TCTS	Twistdraai Colliery: Thubelisha Shaft
WRC	Water Research Commission

1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sasol Mining (Pty) Ltd (hereafter Sasol) to undertake a Section 102 process in accordance with the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRDA). The section 102 amendment will be in support of the required environmental authorisations for the four ventilation shafts, amendment of the Trichardsfontein Environmental Management Programme Report (EMPR) and consolidation of the Twistdraai Colliery: Thubelisha Shaft (TCTS) EMPR, Vaalkop EMPR and the Trichardsfontein EMPR (referred to as the Thubelisha Project) located northeast of Secunda in Mpumalanga province.

1.1 Project Background

The consolidation project area owned by Sasol Mining Twistdraai Thubelisha Colliery comprises three mining right areas namely TCTS, Trichardtsfontein and Vaalkop. Twistdraai Thubelisha Colliery is currently mining TCTS and proposes to start mining Trichardtsfontein within the next few months. Vaalkop mining area although a priority to Twistdraai Thubelisha Colliery will only start mining in 2029. To ensure the mines operate in a more efficient and effective manner Twistdraai Thubelisha Colliery intends to compile (Vaalkop) and consolidate all amended EMPrs into one merged EMPr.

The Trichardtsfontein project area is 3 170 ha in size, but only an area of approximately 1 382 ha will be undermined. The coal seam depth at Trichardtsfontein is estimated to be at an approximate depth of 140 – 160 m below surface. The infrastructure (including access shafts) will be on the adjacent mining property of Sasol Mining at the TCTS. However, two ventilation shafts (up and downcast) have been proposed to be construction on TCTS and two ventilation shafts (up and downcast) have been proposed to be construction on Trichardtsfontein which will assist in providing sufficient ventilation to the underground mining area.

The Vaalkop project area is approximately 8 600 ha in extent. The initial mining activities in this area will be conducted as green field operations as no existing infrastructure for coal mining exists in the area. It is foreseen that the Thubelisha conveyor could possibly be utilised. All mining activities will be conducted by means of underground mining operations, such as the bord-and-pillar and high extraction mining method. No infrastructure will be constructed on the Vaalkop project area as all required infrastructure will be located at the TCTS site. It is estimated that the coal seam depth at Vaalkop is approximately 80 - 120 m below surface.

The TCTS project area is 7 200 ha in size. The coal seam depth at TCTS is estimated to be at a depth of 140 - 170 m below the surface and the seam is approximately 2 – 5 m thick.

In all mining right areas will only mine the No 4 seam as it is the only seam of coal that is economically viable.

Due to the variation in depth of mining and coal seam an assumption has been made that mining will be undertaken between 30 m and 215 m. Therefore all impact assessments and specialist studies have assessed the impacts of mining utilising bord and pillar with high extraction at this depth.

Historically, a large part of the areas has been utilised as agricultural farmland, predominately under maize and soya beans, with stretches of grazing land.

1.2 Project Location and Description

The Thubelisha Project which includes the Trichardsfontein Mine, Vaalkop and TCTS is located between the town of Trichardt and Bethal in the province of Mpumalanga (Figure 1-1 and Figure 1-2). The town of Evander is 17 km to the West and Secunda is 10 km southwest of the Trichardsfontein and TCTS mining area. Vaalkop is located 5 km southeast of Bethal and 17 km southwest of Trichardt. The Thubelisha Project area and coal reserve are located within the Highveld East Magisterial District, the Gert Sibande District Municipality and the Govan Mbeki Local Municipality.

The Thubelisha Project is situated within a region that is characterised by coal mining activities and cultivation which includes maize cropping and grazing. The Isibonelo and Syferfontein coal mines are situated to the northwest of the Thubelisha Project area.

1.3 Project Overview

The consolidation project area owned by Sasol Mining Twistdraai Thubelisha Colliery comprises three mining right areas namely TCTS, Trichardtsfontein and Vaalkop. Twistdraai Thubelisha Colliery is currently mining TCTS and proposes to start mining Trichardtsfontein within the next few months. Vaalkop mining area although a priority to Twistdraai Thubelisha Colliery will only start mining in 2029. To ensure the mines operate in a more efficient and effective manner Twistdraai Thubelisha Colliery intends to compile (Vaalkop) and consolidate all amended EMPrs into one merged EMPr.

The Trichardtsfontein project area is 3 170 ha in size, but only an area of approximately 1 382 ha will be undermined. The coal seam depth at Trichardtsfontein is estimated to be at an approximate depth of 140 – 160 m below surface. The infrastructure (including access shafts) will be on the adjacent mining property of Sasol Mining at the TCTS. However, two ventilation shafts (up and downcast) have been proposed to be construction on TCTS and two ventilation shafts (up and downcast) have been proposed to be construction on Trichardtsfontein which will assist in providing sufficient ventilation to the underground mining area.

The Vaalkop project area is approximately 8 600 ha in extent. The initial mining activities in this area will be conducted as green field operations as no existing infrastructure for coal mining exists in the area. It is foreseen that the Thubelisha conveyor could possibly be utilised. All mining activities will be conducted by means of underground mining operations, such as the bord-and-pillar and high extraction mining method. No infrastructure will be constructed on the Vaalkop project area as all required infrastructure will be located at the TCTS site. It is estimated that the coal seam depth at Vaalkop is approximately 80 - 120 m below surface.

The TCTS project area is 7 200 ha in size. The coal seam depth at TCTS is estimated to be at a depth of 140 - 170 m below the surface and the seam is approximately 2 – 5 m thick.

In all mining right areas will only mine the No 4 seam as it is the only seam of coal that is economically viable.

Due to the variation in depth of mining and coal seam an assumption has been made that mining will be undertaken between 30 m and 215 m. Therefore all impact assessments and specialist studies have assessed the impacts of mining utilising bord and pillar with high extraction at this depth.

1.4 Mining Method

Due to the depth of the resource (i.e 30 - 215 m) which includes all coal seams over the three mining areas), underground mining will be used to access the ore body. A high extraction method of mining using bord-and-pillar mining with pillar extraction is currently being used at the TCTS and is proposed to be utilised at the Trichardtsfontein and Vaalkop reserve areas. In mechanised bord and pillar mining, extraction is achieved by developing a series of roadways (bords) in the coal seam connected by splits (cut-throughs) to form pillars. In high extraction mining, all the pillars are extracted to allow the roof to collapse in a controlled manner (Stooping). Initially mining will occur to the east and west and move towards the north and south. As per GN704 regulation, stooping will occur outside of the 1:100 floodlines and/or 100 m from the streams, whichever is greater.

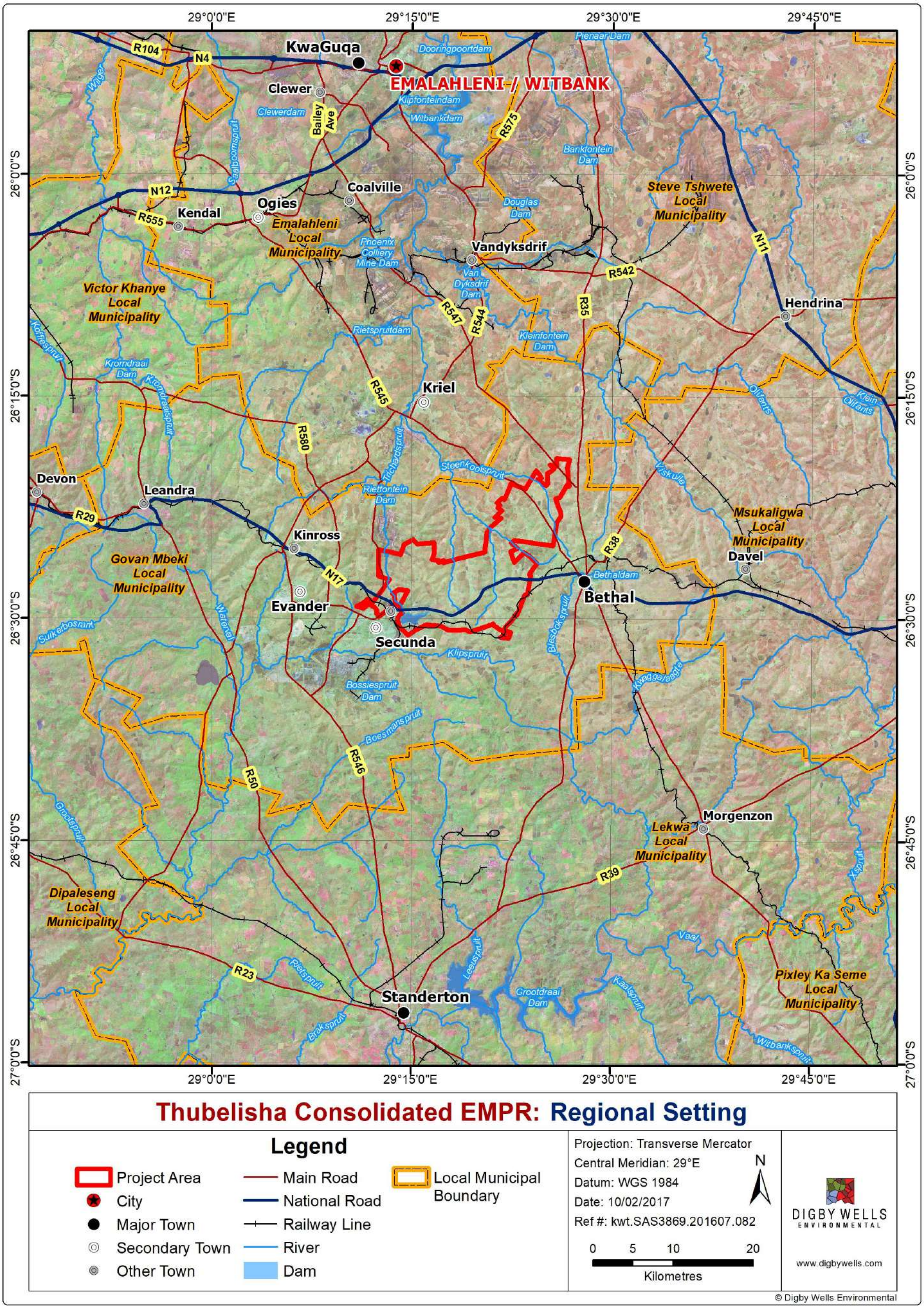


Figure 1-1: Regional Setting

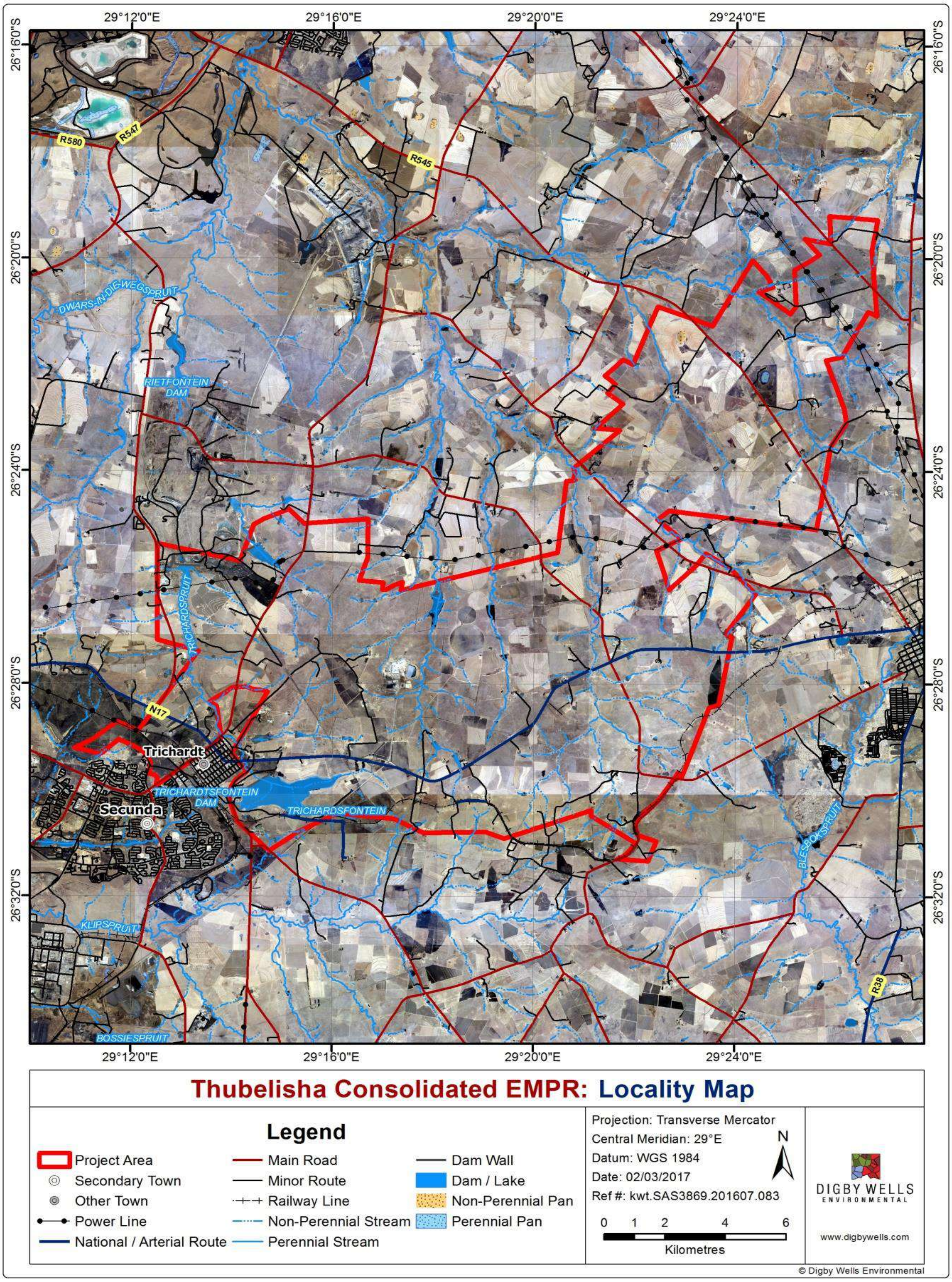


Figure 1-2: Local Setting

2 Terms of Reference

A surface water impact assessment will include the following:

- Site assessments to verify the hydrological characteristics of the project area and the surrounds;
- Baseline hydrology (hydrological setting, climate, stream flows and surface water quality);
- Amend or update the existing water balance to include the additional volumes from Vaalkop mining areas;
- Conduct a detailed impact assessment to identify the potential surface water impacts that could emanate from the project and its associated activities; and
- Consolidate the findings together with the Thubelisha and Trichardsfontein EMPr's in one report.

2.1 Methodology

2.1.1 Literature Review

Existing surface water reports compiled for Twistdraai Colliery Thubelisha Shaft and for Trichardsfontein mine have been reviewed and information from these two reports was used in the consolidation of the surface water report whilst updating the baseline and assessing the potential impacts for the Vaalkop mining area. Other reports and documents that were reviewed when compiling this report include:

- Department of Water and Sanitation (DWS formerly DWAF), 2006. Best Practice Guideline Series;
- Twistdraai Colliery: Thubelisha Shaft, June 2016. Monitoring and Reporting Programme, Revision 1. Sasol Mining;
- Oryx Environmental, April 2008. Surface Water Inputs to the EMPR for Twistdraai Colliery Thubelisha Shaft (TCTS) Report No.: JW51/08/A815; and
- Water Resources of South Africa, 2012 Study (WR2012), Water Research Commission, Pretoria.

2.1.2 Fieldwork/Site Assessment

A site visit has been undertaken in March 2017 to assess and verify the onsite hydrological characteristics, and for the specialist to familiarise themselves with the onsite current activities thereby enabling the identification of existing and potential future surface water impacts.

Surface water quality samples have been collected at the upstream and downstream of the proposed mining area to determine the baseline water quality prior to mining of the Vaalkop mining area.

2.1.3 Baseline Hydrology

The baseline assessment was conducted by utilising existing information together with additional information generated for Vaalkop to describe the hydrological characteristics of the affected catchments, i.e. climate (rainfall and evaporation), topography and baseline water quality. New information is mainly obtained from the Surface Water Resources of South Africa series of reports.

2.1.4 Water Balance

It is likely that water from groundwater inflows will need to be pumped from the underground voids and stored, and potentially re-used. Therefore, the exisiting water balance will need to be updated to reflect the expected groundwater volumes from the Vaalkop shafts and the increased mining area. This will help to determine the appropriate water management measures. The following tasks will be completed as part of the water balance update:

- An excel based schematic process flow diagram will be developed based on the existing water balance provided by Sasol;
- A summary of the average monthly flow volumes will be extracted from the existing water balance and depicted on the process flow together with inclusion of the expected Vaalkop flows.

2.1.5 Impact Assessment

A surface water impact assessment has been conducted for the Vaalkop mining area to identify potential impacts that the Board and Pillar and in some areas high extraction and stooping may have on the receiving environment, and also to provide mitigation measures for those identified impacts.

A monitoring program and Environmental Management Plan (EMP) that will be used as a tool to detect any surface water impacts has been compiled.

2.2 Details of the Specialist

Mashudu Rafundisani is a surface water consultant (hydrologist) with 4 years working experience in Digby Wells Environmental. He holds an Honours Degree in Environmental Management from the University of Venda (South Africa). Mashudu has completed numerous surface water specialist studies which includes, but not limited to; floodline modelling, development of Storm Water Management Plans, Water and Salt Balances, sampling and analysis/ interpretation of surface water quality, surface water specialist studies for input into Environmental Impact Assessments and Environmental Management Plans, Integrated Water and Waste Management Plans (IWWMP), Water Use Licence

Applications (IWULA) and auditing. He has working experience on projects within South Africa, Mali, Ivory Coast, Malawi and other parts of Africa.

3 Assumptions and Limitations

The following defines the assumptions and limitations applicable to the Hydrological Assessment:

- The surface water impact assessment was done based on the proposed mining methods and activities. Changes to the mine plans after completion of this report will not form part of the impact assessment;
- TCTS mining area had a total area of 72 km^2 with which only 25 km^2 (30 %) of that area was mined through high extraction method. The same percentage has been assumed for the Vaalkop area to enable quantification of the loss in mean annual runoff due to stooping; and
- The provided water balance done by Jones and Wagner contains actual measured data for up to year 2016. Therefore the average monthly water balance in this report will be based on the 2016 water balance.

4 Baseline Environment

4.1 Surface Water Hydrology

Surface water baseline information for the project area was obtained from a literature survey, fieldwork conducted from January – October 2007, and modelling of various hydrological parameters, such as Mean Annual Runoff (MAR) and Dry Weather Flows (DWF) were computed using the WRSM2000 synthetic streamflow generation model. Flood peaks for various recurrence intervals were computed using the Rational Method, the Standard Design Flood Method, Unit Hydrograph Method and the TR137 method (Oryx Environmental, 2008b).

4.1.1 Catchment characterisation

The project area is situated in the headwaters of the Trichardstspruit, Steenkoolspruit, Krapfonteinspruit, Debeerspruit and Piekespruit catchments. These catchments form part of the Witbank Dam catchment, and are within quaternary catchments B11C and B11D of the Olifants Water Management Area. (WMA) (Revised National Water Resource Strategy, 2012).

The surface water attributes of the affected catchments, namely the MAR in million cubic metres (Mm3), MAP (mm) and MAE (mm) are summarised in Table 4-1 (WRC, 2012).

Table 4-1: Summary of the surface water attributes of the B11C and B11D quaternary catchments

Quaternary Catchment	Total Area (km^2)	MAP (mm)	MAR (Mm^3)	MAE (mm)
B11C	371	673	21.55	1550
B11D	537	671	26.41	1600

4.1.2 Rivers and Drainage

The western portion of the mining area (within B11D) drains into the Trichardstspruit, while the central and eastern portions (within B11C) drain into Debeerspruit, and Piekespruit, both of which are tributaries of the Steenkoolspruit. The Trichardstspruit joins the Dwars-in-die-Wegspruit, which in turn joins the Steenkoolspruit. The Steenkoolspruit drains into the Olifants River, which flows through the Witbank and Loskop Dams, then through the central part of the Kruger National Park and into Mozambique. It eventually joins the Limpopo River and discharges to the Indian Ocean on the east African coastline.

4.2 Mean Annual Runoff

The B11C quaternary catchment (where the Vaalkop area is located) has a net area of 371 km^2 and has an MAR of 21.55 million cubic meters (Mm^3). Runoff emanating from this quaternary catchment drains in a north-westerly direction via the Steenkoolspruit, towards the Olifants River.

In areas where high extraction mining (stooping) takes place, subsidence will occur, this will cause containment or ponding of runoff during rainfall events and thereby loss of runoff catchment yield onto the natural streams.

The Vaalkop Project area is approximately 86 km^2 in total, however, only limited areas will be mined through high extraction method while the rest of the area will be mined through bord-and-pillar mining method. TCTS mining area had a total area of 72 km^2 with which only 25 km^2 (30 %) of that area was mined through high extraction method. The same percentage has been assumed for the Vaalkop area to try and quantify the loss in mean annual runoff due to stooping.

Therefore, the total area to be stooped will amount to approximately 30 km^2. The percentage loss in MAR for this quaternary catchment due to stooping will amount to approximately 8% of the total MAR and will be 0.8 % on the Witbank catchment which has an area of 3627 km^2, as shown in Table 4-2.

Table 4-2 Loss in MAR due to Proposed Infrastructure

Quaternary Catchment	Total Area (km^2)	MAR (m^3* 10^6)	Infrastructure Area (km^2)	Percentage decrease in MAR (%)	Loss in MAR (m^3* 10^6)
B11C	371	21.55	30.00	8.09	1.743

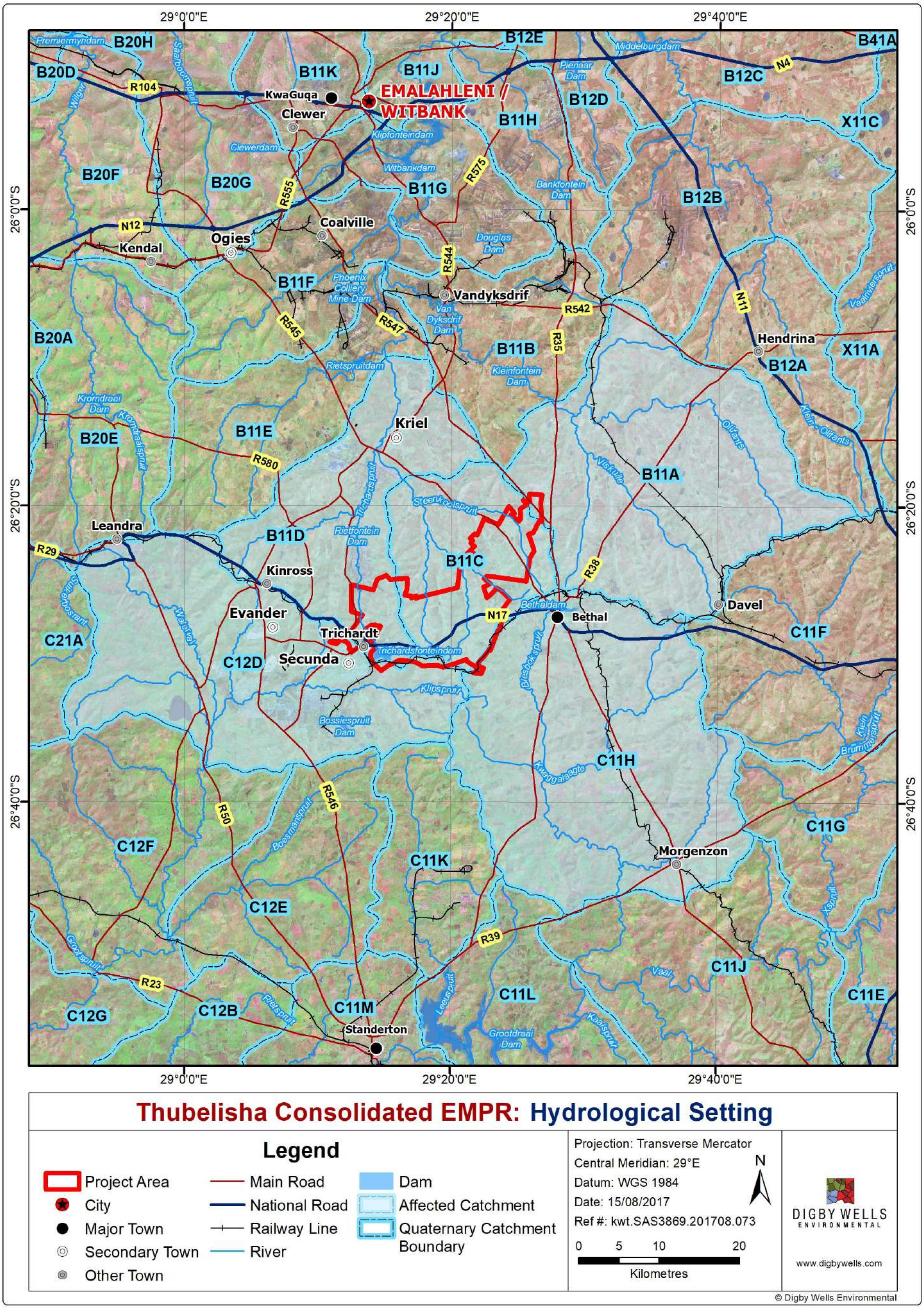


Figure 4-1: Hydrological Setting

4.3 Climate

This section provides a summary of the climate data for rainfall and evaporation which represents the baseline climatic conditions for the project area.

4.3.1 Rainfall

Table 4-3 presents the average monthly rainfall for the quaternary catchments B11C and B11D. This is based on the averages of monthly rainfall data from the period 1920 to 2009.

Table 4-3: Summary of rainfall data extracted from the WR2012

Month	MAP (mm)	
	B11C	**B11D**
January	118.8	118.4
February	89.0	88.8
March	76.1	75.9
April	38.5	38.4
May	17.3	17.2
June	7.7	7.6
July	5.8	5.8
August	7.4	7.4
September	25.3	25.2
October	69.6	69.4
November	107.3	107.0
December	110.2	109.8
MAP	**673**	**671**

From the rainfall data above, higher rainfall averages in the B11C quaternary catchment (107.3 mm, 110.2 mm and 118.8 mm) were recorded for the months of November, December and January respectively whilst on the B11D higher rainfall averages occurs on similar months within the B11C quaternary. The lowest average rainfall was recorded in July for both the quaternary catchments. In general, these two catchments receive an average rainfall of 673 mm and 671 mm per annum for B11C and B11D respectively. The summarised climatic data for this quaternary is also graphically presented in Figure 4-2.

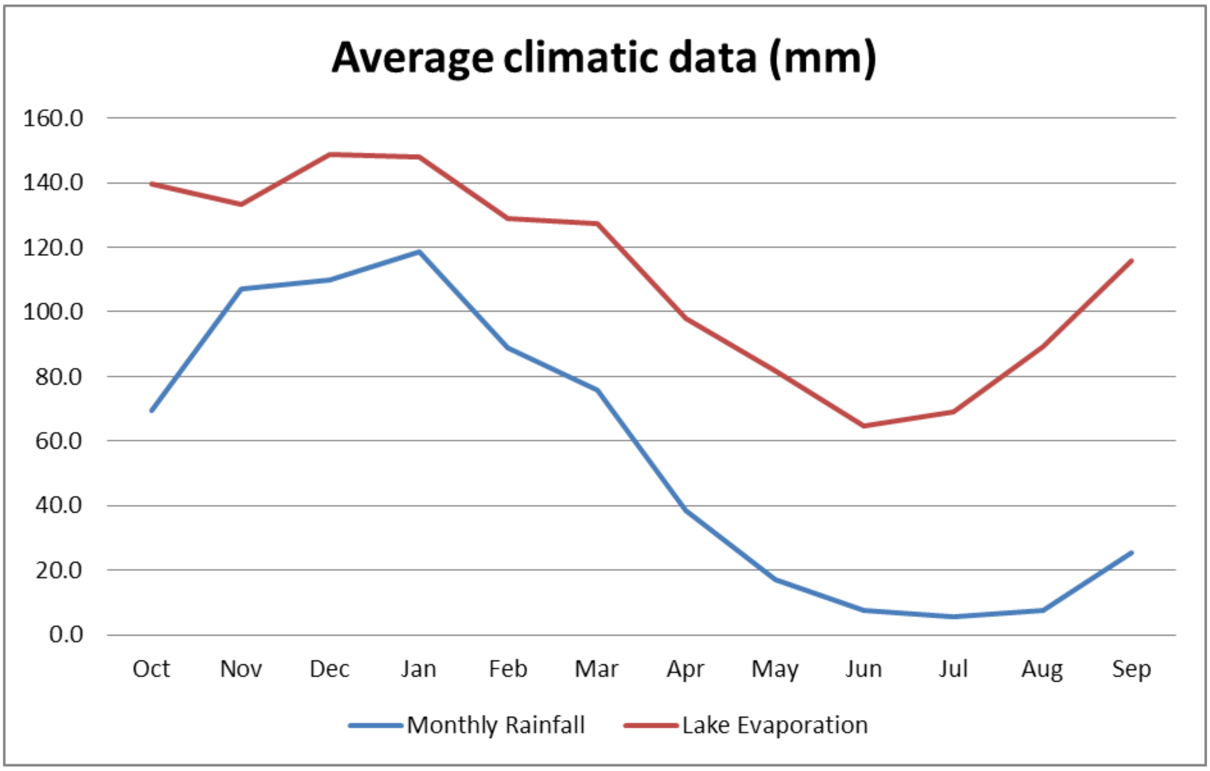


Figure 4-2: Summary of the average monthly climatic data for B11C quaternary

4.3.2 Evaporation

As classified in the WR2012 manual, the B11C and B11D quaternaries are both located within the 4A evaporation zone, in which average monthly evaporation data has been provided. However, the available evaporation data 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 figure is then multiplied by a lake evaporation factor to obtain the adopted lake evaporation figure which presents the monthly evaporation rates of a natural open water body, this was calculated to be a total average of 1 345 mm and 1303 mm per annum for B11C and B11D respectively, the summary of the average monthly evaporation for the two catchments is presented in Table 4-4 and Figure 4-3.

Table 4-4: Summary of evaporation data

Months	Symonds Pan Evap (B11C)	Symonds Pan Evap (B11D)	Lake Evaporation Factor	Lake Evaporation (mm)	
				B11C	B11D
January	170.5	176.0	0.84	147.8	143.2
February	142.1	146.7	0.9	129.1	125.1
March	140.3	144.8	0.9	127.4	123.4
April	107.9	111.4	0.9	98.0	94.9
May	90.8	93.8	0.9	81.6	79.0
June	73.8	76.2	0.9	64.7	62.7
July	80.8	83.4	0.8	69.2	67.0
August	107.0	110.4	0.8	89.4	86.6
September	138.6	143.0	0.8	115.9	112.2
October	167.1	172.5	0.8	139.7	135.3
November	157.6	162.7	0.82	133.4	129.3
December	173.6	179.2	0.83	148.7	144.1
Total	**1550**	**1600**	**N/A**	**1345**	**1303**

In this area, higher potential evaporation rates are expected during the months of October to March for both quaternaries whilst the low potential evaporation is expected on April until August.

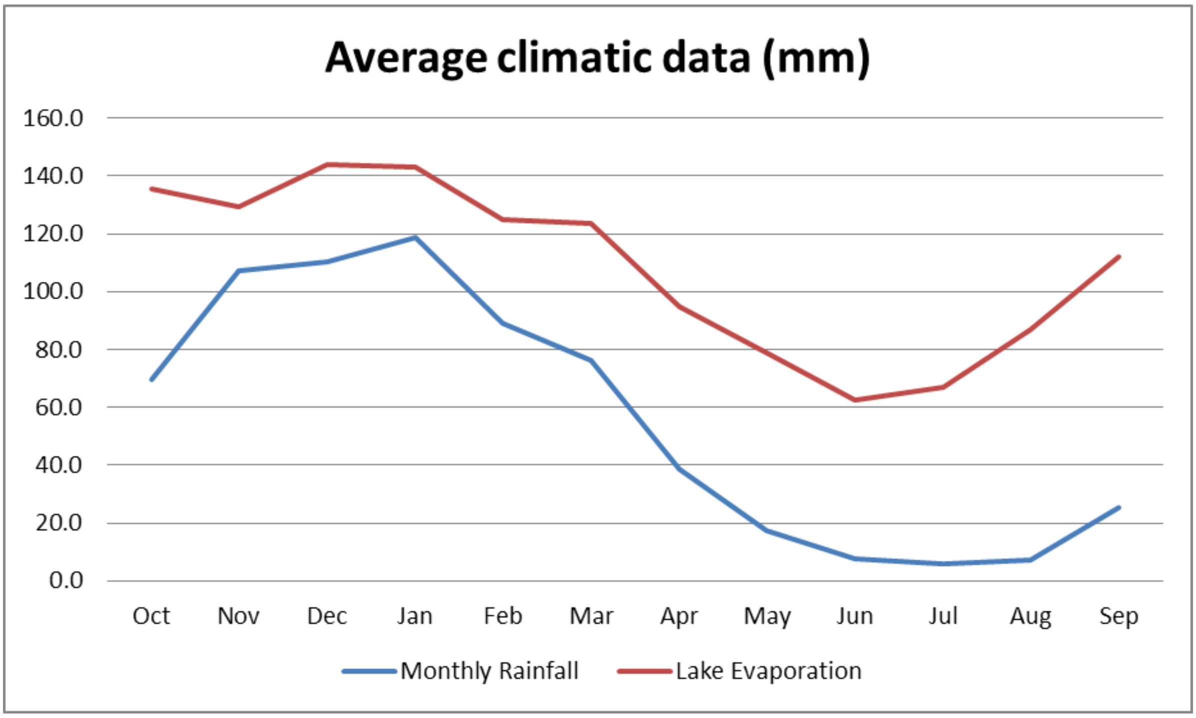


Figure 4-3: Summary of the average monthly climatic data for B11D quaternary

5 Water Quality

5.1 Sample point locations

Surface water monitoring on the Twistdraai Colliery, Thubelisha Shaft (TCTS) mining area was undertaken at the locations indicated in (Figure 5-1) during the baseline assessment conducted in 2007. Monitoring was again conducted during July 2011, September 2011 and September 2012. The results from these sampling periods, which were provided as background water quality, were compared to the South African Water Quality Guidelines (DWAF, 1996) and the Interim Resource Water Quality Objectives (RWQO) for the Management Unit 1 (MU1) in which TCTS is located. Coordinates of these monitoring points are provided in Table 5-1 and also shown in Figure 5-1.

Digby Wells undertook a site visit March 2017 to collect water samples from the streams within and around the project area, 11 samples were collected (6 new sites and 5 TCTS existing sites) and submitted to Aquatico Laboratory (Pty) Ltd, a SANAS accredited laboratory, in Pretoria for analyses of physical and chemical water quality parameters. The results of the surface water quality analysis are presented in Table 5-3.

The water quality results were benchmarked with the Olifants RWQO to determine the baseline or current water quality status of the project area.

The predominant water use around the project area is agriculture (irrigation) and for that reason the results were also benchmarked against the South African Water Quality Guidelines for Agricultural Use: Irrigation (DWAF, 1996).

Table 5-1: Surface water sampling as recommended by Jones & Wagener in the 2013 IWWMP

Sample point (Jones & Wagener)	Sample point name in the Sasol database	Latitude	Longitude
R2	T14002W	S 26°27’27.68’’	E 29°13’11.48’’
R3	F14201W	S 26°26’6.95’’	E 29°15’3.85
R4	G29317W	S 26°31’13.46’’	E 29°14’44.00’’
R5	G29318W	S 26°32’44.04’’	E 29°17’10.68’’
R6	G29319W	S 26°32’11.52’’	E 29°16’36.43’’
R7	G29320W	S 26°31’54.62’’	E 29°18’13.52’’
R8	n/a	S 26°27’11.08’’	E 29°17’57.61’’
R9	Z14501W	S 26°27’0.55’’	E 29°19’13.31’’
R10	n/a	S 26°26’33.97’’	E 29°19’13.24’’
R11	E14701W	S 26°28’27.84’’	E 29°21’13.96’’

Table 5-2: Surface water sampling points (Vaalkop, 2017)

Sample point (Jones & Wagener)	Sample point name in the Sasol database	Latitude	Longitude
SASSW01	n/a	S 26°24'31.78"	E 29°25'55.97"
SASSW02	n/a	S 26°20'42.32"	E 29°24'6.34"
SASSW03	n/a	S 26°26'0.77"	E 29°24'9.50"
SASSW04	n/a	S 26°24'5.40"	E 29°21'9.70"
SASSW05	n/a	S 26°22'27.86"	E 29°22'41.51"
SASSW06	n/a	S 26°26'32.92"	E 29°21'10.61"
R 11	E14701W	S 26°28’27.84’’	E 29°21’13.96’’
Site A	Site A	S 26°28'34.44"	E 29°17'47.08"

Sample point (Jones & Wagener)	Sample point name in the Sasol database	Latitude	Longitude
R14402W	R14402W	S 26°29'38.68"	E 29°16'39.89"
R14403W	R14403W	S 26°30'29.85"	E 29°16'01.33"
T14003W	T14003W	S 26°30'50.15"	E 29°15'12.68"

5.2 Water Chemistry

The status of surface water quality during the TCTS and the recent Vaalkop monitoring period have been provided below.

5.2.1 TCTS Monitoring Results

The TCTS monitoring results was summarised as follows:

5.2.1.1 pH

From the 2007 assessment, values for the sampling sites ranged between 7 and 9, which fall within the South African Target Water Quality range for domestic use (6 - 9) (DWAF, 1996). The elevated reading of pH 9 for sampling site R6 is above the recommended levels for full contact recreational, industrial and irrigation use. Sampling sites R5, R7 and R11 were above the recommended pH levels for industrial (6.5 - 8.0).and irrigation use (6.5 - 8.4).

When compared to the interim RWQO for MU1, the measured pH levels were mostly between the lower pH objective of 6.5 and the upper pH objective of 8.4, with the exception of sampling points R5, R7, R10 and R11. For the latter, the objective was exceeded slightly on a number of occasions.

No specific trend was observed between the results of the analyses conducted in 2007 and 2011/2012, (J&W, 2009).

5.2.1.2 Electrical Conductivity

In the 2007 assessment, the Electrical Conductivity (EC) levels observed was generally close to potable water limits of 70 mS/m, with nine sites between 21.1 and 67.2 mS/m. This indicates a relatively un-impacted environment. However, sampling sites R5 and R11 showed slightly elevated EC values of 100 mS/m and 90.8 mS/m respectively.

However, when compared to the interim RWQO for EC in MU1 of the Witbank Dam catchment, the objective of 35 mS/m was exceeded at all sampling occasions at sampling points R3, R5, R6, R7, R10 and R11. The objective is exceeded on some occasions at sampling points R4, R8 and R9.

The impacts observed at sampling points R5, R6 and R7 could be attributed to upstream mining activities. Land uses upstream of sampling points R10 and R11 are limited to agricultural activities and the source of elevated EC levels are uncertain.

In general, the EC levels measured in 2011/2012 were higher than those measured in 2007 indicating increased salt concentrations.

5.2.1.3 Sulphate

In the 2007 assessment, the sulphate levels for the sampling sites ranged between 11 and 79 mg/ℓ, which were found to be well below the domestic acceptable target of 200 mg/ℓ. Sampling site R5 had the highest value at 145 mg/ℓ (J&W, 2009).

However, the interim RWQO of 30 mg/ℓ for sulphate for MU1 of the Witbank Dam catchment was exceeded on most occasions at all sampling sites. A significant increase in sulphate levels was observed at R3, R5, R8, R10 and R11 between the 2007 and 2011/2012 sampling indicating an impact from upstream activities.

5.2.1.4 Calcium

During the 2007 baseline assessment it was found that five of the sample sites (R3, R5, R7, R10 and R11) showed calcium levels above the recommended target of 24 mg/ℓ for domestic use, with a mean concentration for all sites of 32.9 mg/ℓ. All sites were well within the levels required for livestock watering (0 – 1000 mg/ℓ).

When compared to the interim RWQO of 24 mg/ℓ, the objective was exceeded at sampling sites R3, R5, R6, R7, R8, R10 and R11 on all sampling occasions. The objective was exceeded at R1, R8 and R9 on some occasions. No specific trend is observed between the results of the 2007 and 2011/2012 sampling.

5.2.1.5 Iron

During the 2007 baseline assessment it was found that most sites exceeded the recommended levels for iron of 0.1 mg/ℓ for domestic use and 0.3 mg/ℓ for industrial use. The average for all sites was 1.10 mg/ℓ the highest level of 5.52 mg/ℓ measured at site R9, which was within the acceptable levels for livestock watering (0 – 10 mg/ℓ) and slightly above the range for irrigation (0 – 5 mg/ℓ).

The interim RWQO for MU1 was exceeded on a limited number of occasions at R2, R8 and R9.

5.2.1.6 Manganese

During the 2007 assessment, the manganese values were all within the guideline limits for domestic, industrial and aquatic water uses, with the exception of site R2. The average for all sites was 0.162 mg/ℓ and R2 had the highest value (0.277 mg/ℓ).

The interim objective for manganese within MU1 was exceeded on a limited number of occasions at some of the monitoring points during the 2007 sampling.

5.2.1.7 Magnesium

During the 2007 baseline assessment it was found that the magnesium levels were generally below the recommended limit of 30 mg/ℓ for domestic use, with the average of 34.5 mg/ℓ. Sites R7, R10 and R11 had slightly raised levels of 50 mg/ℓ, 34 mg/ℓ and 74 mg/ℓ respectively. Site R5 had the highest value at 111 mg/ℓ (J&W, 2009).

When compared to the interim RWQO of 15 mg/ℓ, the objective was exceeded on all monitoring occasions during 2007 and 2011/2012 at R3, R5, R6, R7, R10 and R11 and on some occasions at R8 and R9.

5.2.1.8 Aluminium

The interim objective for aluminium of 0.02 mg/ℓ is exceeded on most occasions at all of the monitoring points. In conclusion, the water quality in the area has been impacted due to existing land uses (mining and farming), and the interim RWQO for a number of constituents are exceeded. MU1 of the Witbank Dam catchment represents the head waters of the catchment. No further contribution to the deteriorating water quality as a result of activities at TCTS should be allowed.

5.2.2 Vaalkop (2017) Monitoring Results

The 2017 water quality results were benchmarked with the Olifants RWQO and the South African Water Quality Guidelines for Agricultural Use: Irrigation to determine the baseline or current water quality status of the project area. The water quality results can be summarised as follows:

- Elevated level (basic) pH which exceeds the Olifants RWQO of (6.5 - 8.4) was observed at monitoring point SASSW1.
- All other monitoring points except for Site A, R14403W and T14403W also have shown a basic pH. However, these were still within the Olifants RWQO. The north eastern part of the project area is predominantly comprised of cultivated land. Most Highveld soils are naturally acidic, and for that reason, farmers mostly add lime to their soils. Runoff from these soils is likely the cause of elevated level of pH.
- In all the monitoring points, EC exceeded the target water quality range (<40 mS/m) of the SAWQG Irrigation standards. There is no set EC/TDS limit or standard for the Olifants catchment.
- Also, elevated levels of Chlorides which exceeds the Olifants RWQO (5 ug/l or 0.005mg/l) were observed in all the monitoring sites. Chloride inputs to surface waters can arise from irrigation return flows, sewage effluent discharges and discharges various industrial processes (SAWQG)

- Elevated Ammonia levels exceeding the Olifants RWQO (0.1 mg/l) were observed at monitoring point SASSW03, SASSW04, SASSW05 and R14403W. This may be associated with organic decomposition from mostly animal waste in the streams, since there is no sewage discharge in the affected streams.

Table 5-3: Water Quality Results benchmarked against the Olifants RWQO and SWQG: Irrigation use guidelines

Sample ID		pH	EC (mS/m)	TDS (mg/l)	Cl (mg/l)	SO_4 (mg/l)	NO_3 (mg/l)	NH_4 (mg/l)	PO_4	F (mg/l)	Ca (mg/l)	Mg (mg/l)	Na (mg/l)	TSS (mg/l)	Fe (mg/l)
Olifants RWQO		**6.5 - 8.4**	**111**	**N/A**	**0.005**	**500**	**4**	**0.1**	**0.125**	**3**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
SWQG: Agriculture Use: Irrigation (Target water quality)		**<6.5 - >8.4**	**40**	**N/A**	**140**	**N/A**	**N/A**	**N/A**	**N/A**	**2**	**N/A**	**N/A**	**70**	**N/A**	**5**
SASSW01	10/03/2017	8.5	60.2	408.0	23.7	58.7	0.35	0.07	0.04	0.8	46.8	30.3	42.3	15.0	-0.004
SASSW02	10/03/2017	8.4	41.8	262.0	17.7	33.4	0.37	0.05	0.03	0.7	29.6	23.6	22.1	21.0	-0.004
SASSW03	10/03/2017	8.3	71.7	444.0	21.1	59.5	0.20	0.34	0.03	3.1	62.9	49.1	29.4	2226.0	-0.004
SASSW04	10/03/2017	8.1	54.9	366.0	29.2	76.4	-0.19	0.67	0.03	0.7	38.9	26.4	31.9	805.0	0.464
SASSW05	10/03/2017	8.1	71.1	464.0	83.1	8.4	0.24	1.00	-0.01	0.5	66.5	37.6	28.8	468.0	3.370
SASSW06	10/03/2017	8.1	41.9	252.0	7.4	43.1	0.25	0.1	0.0	0.4	31.4	28.7	13.8	7.0	-0.004
SASSW07	10/03/2017	8.3	41.7	208.0	13.1	33.7	0.39	0.0	0.0	0.5	33.1	22.6	18.4	15.0	-0.004
R 11	10/03/2017	8.18	92.4	550	10.7	123	0.383	0.042	0.192	0.591	75.8	73.5	24.8	606	-0.004
Site A	10/03/2017	7.81	42.5	246	13.5	31.8	0.422	0.058	0.077	0.536	36.4	24.6	13.5	140	-0.004
R14402W	10/03/2017	8.29	74.1	464	17.2	89.3	0.625	0.055	0.072	0.67	49.2	49.7	43.7	10	-0.004
R14403W	10/03/2017	7.79	34.7	254	9.69	37.2	0.334	0.147	0.163	0.613	20.8	20.2	19.9	42	-0.004
T14003W	10/03/2017	7.62	19.7	154	6.54	18.2	0.285	0.058	0.057	0.516	10.6	8.65	13.1	65	0.079

Negative figure = below detection limit

N/A = No specified Guidelines value

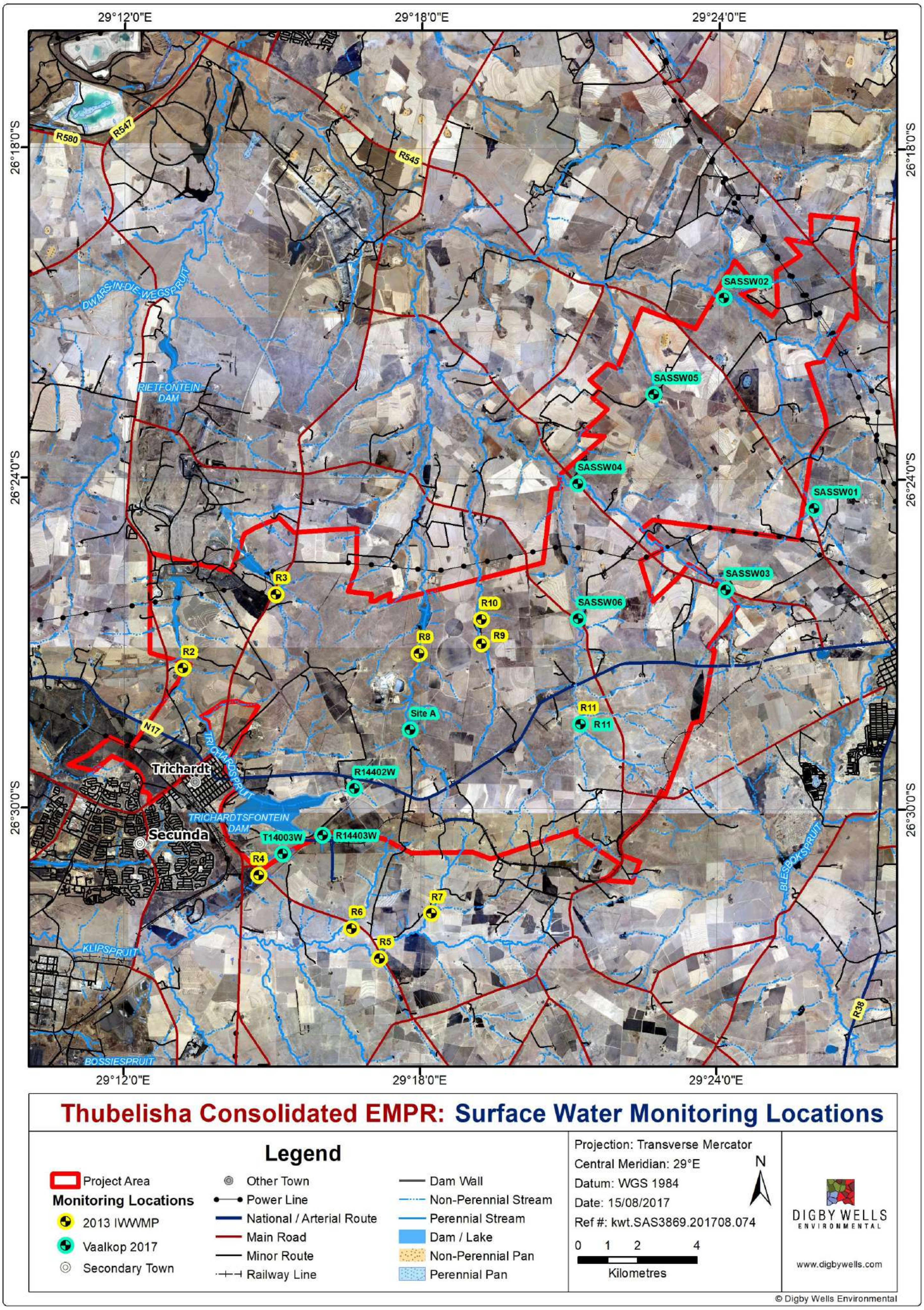


Figure 5-1: Surface Water Monitoring Locations

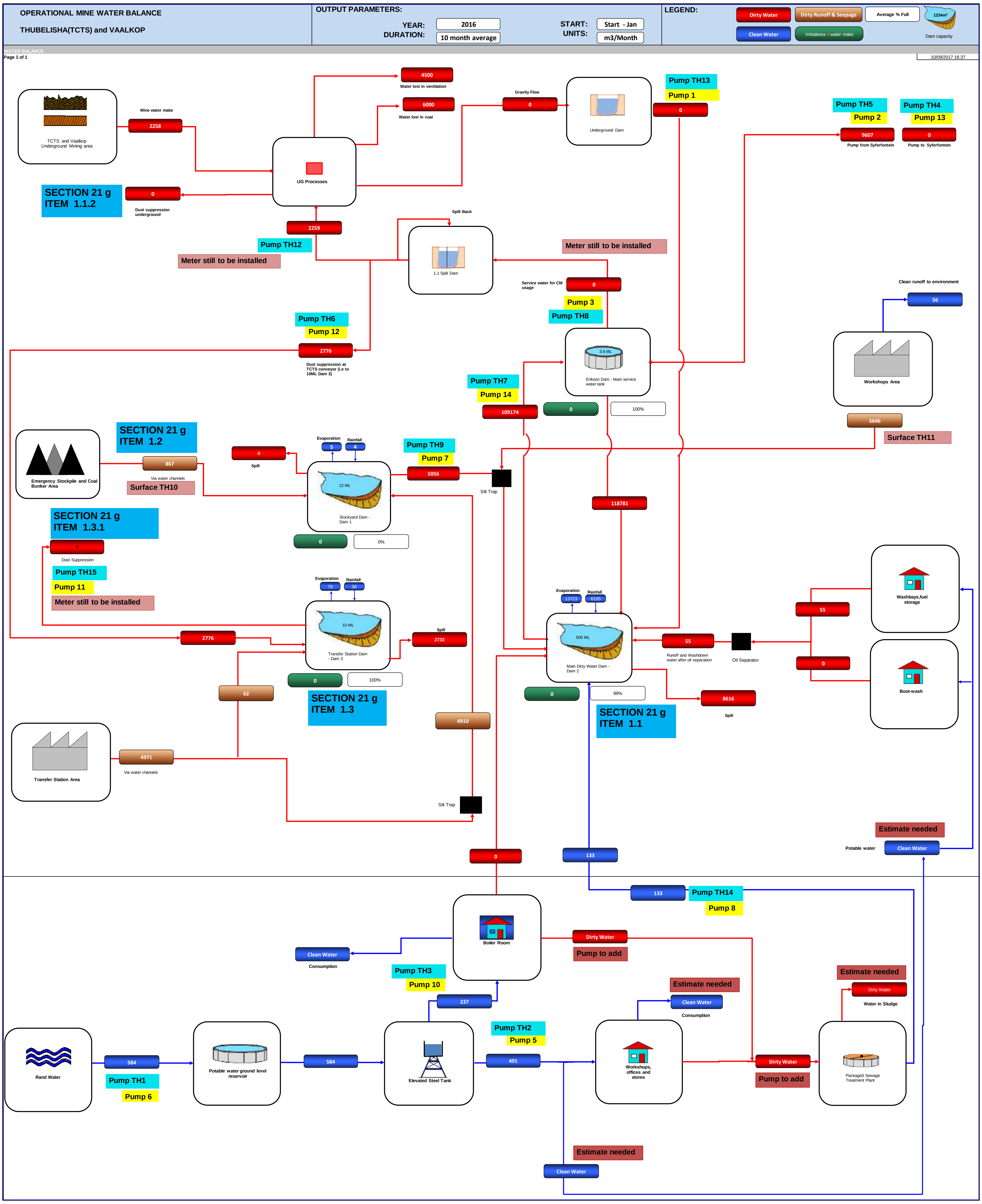
6 Water Balance

A macro mine wide water balance was developed by Jones and Wagner in 2016 for TCTS mining area. It is proposed that no surface infrastructure will be constructed within the Mining Right area as it will be accessed via the TCTS (Except for the proposed ventilation shafts), therefore the process flow or the mine water reticulation system will likely remain the same. The underground inflows and underground water demand will also be more or less the same as the current situation.

These inflows will vary as the mine progresses, an overview of the estinamted inflows into the underground mine has been presented in the Groundwater report. The actual inflows will then be used to calibrate and update the water balance.

Figure 6-1 present the 2016 average monthly water balance inclusive of Sasol TCTS and Vaakop mining areas. The following key water uses can be noted on the water balance:

- Portable water is sourced from Rand Water and an average of 584 m^3 is used on a monthly basis;
- Dirty water runoff from the mine area and the groundwater is contained in the mine dirty water dam for re-use for machine cooling and dust suppression on the underground areas. from the existing 2016 water balance, it is indicated that there was an average spill of 8616 m^3 from the main dirty water dam.



Source: Jones and Wagner

Figure 6-1: Sasol Water Balances

7 Impact Assessment

7.1 Methodology used in Determining and Ranking the Nature, Significance, Consequence, Extent, Duration and Probability of Potential Environmental Impacts and Risks

Details of the impact assessment methodology used to determine the significance of physical, bio-physical and socio-economic impacts are provided below.

The significance rating process follows the established impact/risk assessment formula:

Significance = Consequence x Probability x Nature

Where

Consequence = Intensity + Extent + Duration

And

Probability = Likelihood of an impact occurring

And

Nature = Positive (+1) or negative (-1) impact

Note: In the formula for calculating consequence, the type of impact is multiplied by +1 for positive impacts and -1 for negative impacts

The matrix calculates the rating out of 147, whereby Intensity, Extent, Duration and Probability are each rated out of seven as indicated in Table 7-3. The weight assigned to the various parameters is then multiplied by +1 for positive and -1 for negative impacts.

Impacts are rated prior to mitigation and again after consideration of the mitigation measure in this EIA/EMP Report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 7-2, which is extracted from Table 7-1. The description of the significance ratings is discussed in Table 7-3.

It is important to note that the pre-mitigation rating takes into consideration the activity as proposed, i.e. there may already be certain types of mitigation measures included in the design (for example due to legal requirements). If the potential impact is still considered too high, additional mitigation measures are proposed.

Table 7-1: Impact Assessment Parameter Ratings

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
7	Irreplaceable loss or damage to biological or physical resources or highly sensitive environments. Irreplaceable damage to highly sensitive cultural/social resources.	Noticeable, on-going natural and / or social benefits which have improved the overall conditions of the baseline.	International The effect will occur across international borders.	Permanent: The impact is irreversible, even with management, and will remain after the life of the project.	Definite: There are sound scientific reasons to expect that the impact will definitely occur. >80% probability.
6	Irreplaceable loss or damage to biological or physical resources or moderate to highly sensitive environments. Irreplaceable damage to cultural/social resources of moderate to highly sensitivity.	Great improvement to the overall conditions of a large percentage of the baseline.	National Will affect the entire country.	Beyond project life: The impact will remain for some time after the life of the project and is potentially irreversible even with management.	Almost certain / Highly probable: It is most likely that the impact will occur. <80% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
5	Serious loss and/or damage to physical or biological resources or highly sensitive environments, limiting ecosystem function. Very serious widespread social impacts. Irreparable damage to highly valued items.	On-going and widespread benefits to local communities and natural features of the landscape.	Province/ Region Will affect the entire province or region.	Project Life (>15 years): The impact will cease after the operational life span of the project and can be reversed with sufficient management.	Likely: The impact may occur. <65% probability.
4	Serious loss and/or damage to physical or biological resources or moderately sensitive environments, limiting ecosystem function. On-going serious social issues. Significant damage to structures / items of cultural significance.	Average to intense natural and / or social benefits to some elements of the baseline.	Municipal Area Will affect the whole municipal area.	Long term: 6-15 years and impact can be reversed with management.	Probable: Has occurred here or elsewhere and could therefore occur. <50% probability.

Rating	Intensity/Replicability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	**Positive Impacts (Nature = +1)**			
3	Moderate loss and/or damage to biological or physical resources of low to moderately sensitive environments and, limiting ecosystem function. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some elements of the baseline.	Local Local extending only as far as the development site area.	Medium term: 1-5 years and impact can be reversed with minimal management.	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. <25% probability.
2	Minor loss and/or effects to biological or physical resources or low sensitive environments, not affecting ecosystem functioning. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by a small percentage of the baseline.	Limited Limited to the site and its immediate surroundings.	Short term: Less than 1 year and is reversible.	Rare / improbable: Conceivable, but only in extreme circumstances. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures. <10% probability.

<table>
<tr><th rowspan="2">Rating</th><th colspan="2">Intensity/Replicability</th><th rowspan="2">Extent</th><th rowspan="2">Duration/Reversibility</th><th rowspan="2">Probability</th></tr>
<tr><th>Negative Impacts (Nature = -1)</th><th>Positive Impacts (Nature = +1)</th></tr>
<tr><td>1</td><td>Minimal to no loss and/or effect to biological or physical resources, not affecting ecosystem functioning. Minimal social impacts, low-level repairable damage to commonplace structures.</td><td>Some low-level natural and / or social benefits felt by a very small percentage of the baseline.</td><td><u>Very limited/Isolated</u> Limited to specific isolated parts of the site.</td><td>Immediate: Less than 1 month and is completely reversible without management.</td><td>Highly unlikely / None: Expected never to happen. <1% probability.</td></tr>
</table>

Table 7-2: Probability/Consequence Matrix

		Significance																																					
Probability	7	-147	-140	-133	-126	-119	-112	-105	-98	-91	-84	-77	-70	-63	-56	-49	-42	-35	-28	-21	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147
	6	-126	-120	-114	-108	-102	-96	-90	-84	-78	-72	-66	-60	-54	-48	-42	-36	-30	-24	-18	18	24	30	36	42	48	54	60	66	72	78	84	90	96	102	108	114	120	126
	5	-105	-100	-95	-90	-85	-80	-75	-70	-65	-60	-55	-50	-45	-40	-35	-30	-25	-20	-15	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105
	4	-84	-80	-76	-72	-68	-64	-60	-56	-52	-48	-44	-40	-36	-32	-28	-24	-20	-16	-12	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84
	3	-63	-60	-57	-54	-51	-48	-45	-42	-39	-36	-33	-30	-27	-24	-21	-18	-15	-12	-9	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60	63
	2	-42	-40	-38	-36	-34	-32	-30	-28	-26	-24	-22	-20	-18	-16	-14	-12	-10	-8	-6	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
	1	-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		-21	-20	-19	-18	-17	-16	-15	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		Consequence																																					

Table 7-3: Significance Rating Description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive) (+)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive) (+)
36 to 72	A positive impact. These impacts will usually result in positive medium to long-term effect on the natural and / or social environment	Minor (positive) (+)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the natural and / or social environment	Negligible (positive) (+)
-3 to -35	An acceptable negative impact for which mitigation is desirable. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative) (-)
-36 to -72	A minor negative impact 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 negative medium to long-term effect on the natural and / or social environment	Minor (negative) (-)
-73 to -108	A moderate negative impact may prevent the implementation of the project. These impacts would be considered as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe changes.	Moderate (negative) (-)
-109 to -147	A major negative impact 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. The impacts are likely to be irreversible and/or irreplaceable.	Major (negative) (-)

7.2 Potential Surface Water Impact Assessment

The mining method will be bord-and-pillar with stooping (high extraction). Subsidence will occur in the areas where bord-and-pillar mining taking place. Access to the underground reserves will be via a shaft and coal will be brought to the surface by a conveyor via a shaft. The coal brought to the surface will be then transported via an overland conveyor to the existing Plant where it will be washed. Two satellite ventilation shafts will be constructed using either raise bore methods so that all spoils fall into mine or blind shaft sinking.

7.2.1 Construction Phase

The assessed activities related to the construction phase include site clearance of the footprint area and the construction of ventilation shafts, access and service roads. These activities have the potential to impact on the surface water resources as discussed in the section below.

Table 7-4: Interactions and Impacts of Activity

Interaction	Impact
Removal of vegetation and exposure of soils	Siltation/Sedimentation of surface water resources leading to deteriorated water quality
Movement of heavy machinery and vehicles during the construction phase,	Alteration in surface water drainage patterns and river banks
	Contamination of the natural streams through dirty runoff from the construction areas

7.2.1.1 *Impact Description: Siltation of Surface Water Resources*

Clearing of vegetation leaves the soils prone to erosion during rainfall events, and as a result runoff from these areas which will be high in suspended solids and will cause an increase in turbidity in the nearby surface water resource/ stream.

Dust generated during the construction activities and caused by increased vehicle movements can also be deposited into the local water courses, thereby contributing to the accumulation of suspended solids in the water course, leading to the siltation of these water bodies.

7.2.1.2 *Impact Description: Water Contamination leading to deterioration of water quality*

Dirty or contaminated runoff emanating from fuels storage areas, other liquid waste and general waste areas have the potential to contaminate the nearby streams.

During construction activities, various types of wastes will be generated paper, glass, plastic, biological sewage waste and other hazardous waste. Handling and disposal of these waste may poses a risk to the surrounding streams if not managed appropriately.

This may lead to the deterioration of water quality which in turn affects the aquatic life and the downstream water users.

7.2.1.3 Management/ Mitigation Measures

The following mitigation measures are recommended:

- Clearing of vegetation must be limited to the development footprint area, and use of existing access roads must be prioritized so as to minimise construction of new access roads;
- If possible, construction activities must be prioritised to the dry months of the year to limit mobilisation of sediments, dust generation and hazardous substances (oil, diesel, etc.) from construction vehicles used during site clearing;
- Dust suppression with water on the haul roads and cleared areas must be undertaken to limit dust. During dry times, this could be undertaken on a daily basis where there is visible dust being generated. ;
- Construction work closer to the streams should be suspended during heavy rains to avoid erosion and sedimentation of the streams and unnecessary vehicle movement should be avoided;
- Water quality monitoring should continue on the existing monitoring points to ensure detection of impacts;
- All fuel storage areas should be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills;
- Vehicles should regularly be maintained as per the developed maintenance program. This should also be inspected on a daily basis before use to ensure there are no leakages underneath
- Mobile chemical ablutions for construction workers and general waste bins should be provided andbe maintained as per the developed mine's maintenance schedule; and
- Ensure placement of storm water management structures.

7.2.1.4 Impact Ratings

Table 7-5: Impact Rating for the Construction Phase

Dimension	Rating	Motivation	Significance
Impact: Siltation of surface water resources leading to deteriorated water quality			
Pre-Mitigation			

Dimension	Rating	Motivation	Significance
Duration	Medium term (3)	With no measures in place, siltation may occur for as long as the construction takes place	Minor - negative (70)
Extent	Local (3)	The impacts will be localized to the nearby water resources from where the silt is being generated and the immediate downstream	
Intensity x type of impact	Moderately high - negative (-4)	This may have moderate impacts on the downstream users	
Probability	Certain (7)	Without appropriate mitigation there will definitely be significant erosion	
Mitigation/ Management Actions			
▪ Clearing of vegetation must be limited to the development footprint area, and the use of existing access roads must be prioritized so as to minimize construction of new access roads in these areas; ▪ If possible, construction activities must be prioritized to the dry months of the year to limit mobilization of sediments or hazardous substances (oil, diesel, etc.) from construction vehicles used during site clearing; ▪ Dust suppression on the haul roads and cleared areas must be regularly undertaken. During dry times, this could be undertaken on a daily basis where there is visible dust being generated.			
Post-Mitigation			
Duration	Medium term (3)	As for pre-mitigation	Minor - negative (36)
Extent	Local (3)	As for pre-mitigation	
Intensity x type of impact	Moderate - negative (-3)	Mitigation will reduce the impacts	
Probability	Probable (4)	Necessary mitigations will reduce the erosion probability significantly	

Dimension	Rating	Motivation	Significance
Impact Description: Alteration of surface water drainage patterns and river banks			
Pre-Mitigation			

Dimension	Rating	Motivation	Significance
Duration	Permanent (7)	Alteration or disturbance of the stream banks will remain far beyond the life of the project if the banks and floodline areas are impacted on.	Minor (negative) – 56
Extent	Limited (2)	Limited to the site and immediately downstream	
Intensity x type of impact	Long term - negative (-5)	Environmental damage may take long to restore or rehabilitate	
Probability	Highly probable (4)	It is probable that the impact may occur during construction.	
Mitigation/ Management actions			
• Construction work closer to the streams should be suspended during heavy rains to avoid erosion and sedimentation of the streams and unnecessary vehicle movement should be avoided. • Use of existing roads should be maximised to avoid this impact as new roads ara constructed over the drainage line and stream crossings			
Post- mitigation			
Duration	Permanent (7)	Alteration or disturbance of the stream banks will remain beyond the life of the project if the banks and floodline areas are impacted on.	Negligible (negative) – 26
Extent	Very Limited (1)	Limited to the site and immediately downstream	
Intensity x type of impact	Long term - negative (-5)	Environmental damage may take long to restore or rehabilitate	
Probability	Likely (2)	All the possible shaft locations are more than 100 meters away from drainages and it is unlikely that the impact will occur	

Dimension	Rating	Motivation	Significance
Impact: Deterioration of water quality due to dirty water reporting into natural water resources			
Pre-Mitigation			
Duration	Medium term (3)	With no measures in place, this impact may occur for as long as the construction takes place.	Minor - negative (55)

Dimension	Rating	Motivation	Significance
Extent	Local (3)	The impacts will be localized to the nearby streams and the immediate downstream	
Intensity x type of impact	Moderately high - negative (-5)	This may have serious impacts on the downstream water users due to elevated hydrocarbon levels	
Probability	Likely (5)	Without appropriate mitigation, the impact is likely to occur	
Mitigation/ Management Actions			
▪ All fuel storage areas should be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits, to contain and immediately clean up any potential leakages or spills; ▪ Vehicles should regularly be maintained as per the mine's developed maintenance program. This should also be inspected on a daily basis before use to ensure there are no leakages underneath ▪ Ablutions facility for construction workers and general waste bins should be provided. An accredited contractor should be appointed to properly dispose the waste; and ▪ Not dirty water should be allowed off site and into a stream.			
Post-Mitigation			
Duration	Medium term (3)	With no measures in place, this impact may occur for as long as the construction takes place.	Negligible - negative (33)
Extent	Local (3)	The impacts will be localized to the nearby streams and the immediate downstream	
Intensity x type of impact	Moderate - negative (-5)	This may have serious impacts on the downstream water users due to elevated hydrocarbon levels	
Probability	Probable (3)	Impact occurrence will be unlikely	

7.2.2 Operational Phase

Activities that may have surface water impacts during the operational phase include subsidence during high extraction mining, stockpiling of coal before transporting to processing plant and conveying of coal from the shaft to the storage bunker, etc.

Table 7-6: Interactions and Impacts of Activity

Interaction	Impact
Runoff from the dirty water areas (product stockpile)	Runoff reporting into the nearby streams resulting in water contamination or the deterioration of the water quality
Ponding of water due to changes to topography and surface hydrology, and operation of the shaft areas	Reduction of Catchment Yield as runoff will be contained in the subsided areas

7.2.2.1 Impact Description: Water Contamination leading to deterioration of water quality

Dirty water runoff laden with carbonaceous material from the contaminated surfaces (emergency coal stockpile) has the potential to contaminate and silt up the natural water resources or streams. This impact will therefore deteriorate the water quality and hence impact the downstream water users and the aquatic life.

7.2.2.2 Impact Description: Reduction of Catchment Yield

The proposed mining method will result in subsidence on areas where high extraction of coal is taking place. This may results into ponding of surface runoff in areas where subsidence has occurred. As a result, this reduces the amount of runoff reporting to the nearby streams. A decrease in the catchment yield may have an impact on the downstream water users as they may not have sufficient water for their needs, while also decreasing the flow required for the ecological reserve.

Subsidence underneath the streams is not expected as it has been stated that high extraction mining (Stooping) will not take place within the 1:100 floodlines and/or 100 m from the streams, whichever is greater.

Therefore, the total area to be stooped will amount to approximately 30 km^2. The percentage loss in MAR for this quaternary catchment due to stooping will amount to approximately 8% of the total MAR

7.2.2.3 Management/ Mitigation Measures

The following mitigation measures are recommended:

- As proposed in the project activities, ensure that all the dirty water emanating from the dirty water areas is contained for re-use within the mine, to prevent unnecessary discharge into the environment;
- Where subsidence will occur during operation, measures to rehabilitate the surface area should be implemented as soon as possible to avoid impoundment of surface water; and

- Water quality monitoring should continue on the existing monitoring points to ensure detection of impacts.

7.2.2.4 Impact Ratings

Table 7-7: Impact Rating for the Operation Phase

Dimension	Rating	Motivation	Significance
Impact: Water Contamination leading to deterioration of water quality			
Pre-Mitigation			
Duration	Project Life (5)	Due to the nature of the mining activities the contamination of water resources may occur over the project life if mitigation measures are not in place.	Moderate - negative (84)
Extent	Municipal (4)	The impacts may affect the nearby streams and surroundings	
Intensity	Serious - negative (-5)	This may have serious impacts on the water quality that will be made available to the downstream water users (agricultural- livestock watering and crop irrigation)	
Probability	Almost Certain (6)	Without appropriate mitigation, there probability of the impact occurring is almost certain <80 %	
Mitigation Measures			
▪ As proposed in the project activities, ensure that all the dirty water emanating from the dirty water areas is contained for re-use within the mine, to prevent unnecessary discharge into the environment; ▪ No discharge of polluted water should be planned for or allowed; ▪ Where subsidence will occur during operation, measures to rehabilitate the surface area should be implemented as soon as possible to avoid impoundment of surface water. Details on rehabilitation measures can be found in the Rehabilitation and Closure report (Digby Wells, 2017); and ▪ Water quality monitoring should continue on the existing and newly proposed monitoring points to ensure detection of impacts.			
Post-Mitigation			
Duration	Medium term (5)	Impact may occur over the project life if mitigation measures are not in place	Minor - negative (42)
Extent	Municipal (4)	The impacts may affect the nearby streams and surroundings	

Dimension	Rating	Motivation	Significance
Intensity	Moderate - negative (-5)	This may have serious impacts on the water quality that will be made available to the downstream water users (agricultural- livestock watering and crop irrigation)	
Probability	Probable (3)	Necessary mitigations will reduce the probability of impact occurrence significantly (<25 %)	

Impact Description: Reduction in catchment yield			
Prior To Mitigation/ Management			
Duration	Project life (5)	Loss of catchment yield will occur for the entire project life	Minor - negative (70)
Extent	Local (3)	Loss of catchment yield will affect the contribution of water from the local catchment	
Intensity	Low negative - (2)	Loss of catchment yield is will have an impact; however the volume lost will be very less.	
Probability	Certain (7)	It is certain that runoff water will be contained within the stooped areas, so this will result in a reduction of catchment yield	
Mitigation/ Management Actions			
▪ There is no mitigation for the loss of catchment yield. However, the area to be stooped is assumed to be approximately 30 km^2 and makes up 8% of the total quaternary catchment of 371 km^2; ▪ Clean water from upstream should be diverted around these areas and report to the natural streams; ▪ The percentage decrease in MAR amounts to 8 % for B11C quaternary catchment (where the proposed new mining areas is located). Therefore, the loss in MAR for the quaternary catchment is considered to be of moderately low significant			

7.2.3 Closure and Rehabilitation Phase

Activities during this phase include dismantling and removal of infrastructure and surface rehabilitation. The major impacts to consider in the decommissioning and rehabilitation of the site will be siltation of surface water resources as a result of soil erosion influenced by removal of infrastructures and water contamination, should there be decant after closure.

Groundwater model to simulate possibilities of decant after closure has not been finalised, this impact may or may not occur. The rating and possible management measures of decant have been provided below but this may need to be updated upon finalisation of the groundwater report.

Table 7-8: Interactions and Impacts of Activity

Interaction	Impact
Exposure of soils after the removal of infrastructure	Siltation of surface water resources leading to deteriorated water quality.
Mine decant	Deterioration of surface water quality on the surrounding streams

7.2.3.1 Impact Description: Siltation of Surface Water Resources

Removal of infrastructure will expose the soil surfaces and leave it prone to erosion, resulting in siltation of the nearby streams when runoff reports to these rivers. This will deteriorate the water quality and hence impact the downstream agricultural water users.

7.2.3.2 Management/ Mitigation Measures

These impacts can be prevented and/or reduced by implementing the following measures:

- Use of accredited contractors for removal or demolition of infrastructures; this will reduce the risk of waste generation and accidental spillages;
- Rehabilitated and backfilled areas (where subsidence has occurred) must be seeded as soon as possible to avoid siltation due to erosion;
- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams;
- Should decant occur, decant water should be captured before it flows into the streams. The water should then be treated prior to discharge into the streams. Please refer to the ground water report for detailed decant simulation results and management measures.

7.2.3.3 Impact Ratings

Table 7-9: Impact Rating for the Closure and Rehabilitation Phase

Dimension	Rating	Motivation	Significance
Impact: Siltation Of Surface Water Resources Leading To Deteriorated Water Quality			
Pre-Mitigation			
Duration	Medium term (3)	Equal to the duration of 1-5 years during which decommission will occur	Minor - negative (70)

Dimension	Rating	Motivation	Significance
Extent	Local (3)	Siltation may only affect the nearby streams	
Intensity	serious - negative (-4)	This may have serious impacts on the downstream agricultural water users	
Probability	Certain (7)	Without appropriate mitigation there will definitely be erosion	
Mitigation Measures			
▪ Use of accredited contractors for removal or demolition of infrastructures; this will reduce the risk of waste generation and accidental spillages; ▪ Rehabilitated and backfilled areas (where subsidence has occurred) must be seeded as soon as possible to avoid siltation due to erosion; ▪ Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams.			
Post-Mitigation			
Duration	Medium term (3)	Equal to the duration of 1-5 years during which decommission will occur	Minor - negative (36)
Extent	Local (3)	Siltation may only affect the nearby streams	
Intensity	Moderate - negative (-3)	This may have serious impacts on the downstream agricultural water users	
Probability	Probable (4)	Necessary mitigations will reduce the erosion probability significantly	

Dimension	Rating	Motivation	Significance
Impact: Decant of mine water leading to deterioration of water quality in the nearby streams			
Pre-Mitigation			
Duration	Permanent (7)	Decant occurs far beyond the project life:	Moderate - negative (90)
Extent	Municipal (4)	Water deterioration may affect the whole municipal area	
Intensity	Serious - negative (-5)	This may have serious impacts on the downstream aquatic habitat and the downstream water users	
Probability	Likely (6)	Based on analytical modelling, it is highly probable that there will be a decant after mine closure	

Dimension	Rating	Motivation	Significance
Mitigation Measures			
▪ Should decant occur, decant water should be captured before it flows into the streams. The water should then be treated to acceptable levels (Olifants RWQO or WUL) prior to discharge into the streams. Water quality monitoring must continue to enable the detection of decant when it occurs so immediate mitigation measures can be implemented. Monitoring should continue for as long as decant is taking place.			
Post-Mitigation			
Duration	Long term (6)	Decant occurs far beyond the project life:	Negligible - negative (33)
Extent	Municipal (4)	Water deterioration may affect the whole municipal area	
Intensity	serious - negative (1)	Treatment of the decant water prior to discharge will avoid contamination of water and result in a reduce impact on water quality	
Probability	Unlikely (3)	It is unlikely that water quality will be impacted if these mitigation measures are implemented.	

8 Cumulative Impacts

Mining activities may have negative impacts on the surface water quality. All runoff draining from the project area via the Trichardtspruit, Krapfonteinspruit, Debeerspruit and Piekespruit will eventually report into the Olifants River.

The baseline water quality showed poor qualities of water as TDS/EC, ammonia and chloride were exceeding the water quality guidelines for irrigation, this is likely due to runoff from cultivated areas with fertilizers, pesticides etc. The Olifants River has several tributaries downstream of the project area; where there are different activities (irrigation, mining, domestic uses and livestock watering) taking place along its catchment. The Olifants River is already under stress regarding the quality status due to coal mines within the catchment, impacts from all these activities may result in a significant impact and further deterioration of water quality in the Olifants River.

A loss in the Witbank Dam catchment runoff yield has been determined to be 0.7% due to subsidence at the TCTS mining area and approximately 8% loss due to the proposed Vaalokop will come in as an addition to the existing loss. Although the initial TCTS loss was considered to be insignificant as compared to the total runoff yield, additional loss due to Trichardsfontein and Vaalkop mining area will also add into this impact and further stress on the Witbank Dam and Olifants River thereof.

However, implementation of the recommended mitigation and management measures (presented in this report) will prevent or minimise further deterioration of water quality and impact on water quantity to the Olifants River (due to this project) may be avoided.

9 Unplanned Events and Low Risks

The potential risks or unplanned events involve accidental spillages of hazardous substances (e.g. hydrocarbons) from vehicles or other machineries and from waste storage facilities during construction, operation and closure phases. This may lead to impacts on water quality in the surrounding streams, should runoff from these contaminated areas enter the system.

A summary of the risks or unplanned events, together with the management measures are presented in Table 9-1.

Table 9-1: Unplanned Events, Low Risks and their Management Measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hydrocarbons and any hazardous material spillage	Surface water contamination	Vehicles must only be serviced within designated service bays. The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to the appropriate disposal sites. The fuel, lubricant and explosives storage facilities must be located on a hard standing area (paved or concrete surface that is impermeable), roofed and bunded in accordance with SANS1200 specifications. This will prevent mobilization of leaked hazardous substances. An emergency spillage response plan and spill kits should be in place and accessible to the responsible monitoring team. The Material Safety Data Sheets (MSDS) should be kept on site for the Life of Mine for reference to anytime in terms of handling, storage and disposal of materials.
Subsidence of undermined areas	This may result in impoundment of surface water and reduces quantity of water reporting into the streams	Should a subsidence occur during operation, measures to rehabilitate the surface area should be implemented as soon as possible to avoid impoundment of surface water.

10 Surface Water Monitoring Programme

A monitoring programme is essential as a management tool to detect negative impacts as they arise and to ensure that the necessary mitigation measures are implemented, it also ensures that storm water management structures are in good working order. Sasol has a monitoring and reporting programme in place and this was revised in June 2016. This section below will provide a summary of the existing monitoring and reporting programme, this will also include the recommended additional monitoring points that were sampled by Digby Wells as part of determining baseline water quality on the Vaalkop mining area.

The existing monitoring and reporting programme is based upon the recommendations made in the environmental monitoring chapter of the Environmental Management Plan (EMP) for the Twistdraai Colliery: Thubelisha Shaft (TCTS) as well as monitoring requirements specified in the approved Water Use License (license no: 04/B11C/ACGIJ/995) issued for the TCTS operation, with the objective of the programme is to gather baseline information, spatial and temporary variability of water quality and water quantity with clearly defined monitoring and reporting frequencies.

The monitoring and reporting programme states that the monitoring points, as provided in the Water Use License (license no: 04/B11C/ACGIJ/995) which are points along the conveyor, not regarded as effective use of resources as the impact of the conveyor is perceived to be very low or insignificant. It then recommended that sampling on these 17 points will be continued on a monthly basis until June 2017 to gather sufficient data for a motivation to remove this requirement from the Thubelisha IWUL.

Water quality monitoring at the locations where sampling was undertaken during this study is recommended to be continued for a period until the baseline has been established, continuous monitoring can be done by an in-house Environmental Control Office (ECO) as it has been done for TCTS monitoring. Table 10-1 and Table 10-2 provide the coordinates of the monitoring locations and these are also shown in Figure 10-1.

Table 10-1 : Surface Water Monitoring Locations (TCTS)

Site name	Latitude	Longitude	Monitoring frequency	Description
F14205W	S 26°28'16.14"	E 29°17'14.76"	Monthly	Upstream monitoring point for conveyor crossing 1 of tributary of Debeerspruit
F14206W	S 26°28'15.81"	E 29°17'20.80"	Monthly	Downstream monitoring point for conveyor crossing 1 of tributary of Debeerspruit
R14301W	S 26°28'51.48"	E 29°17'19.97"	Monthly	Monitoring point for conveyor crossing 2 of tributary of Debeerspruit

Site name	Latitude	Longitude	Monitoring frequency	Description
R14401W	S 26°29'46.79"	E 29°16'54.88"	Monthly	Surface water monitoring point for conveyor crossing 3 of tributary of Trichardtsfontein Dam
R14402W	S 26°29'38.68"	E 29°16'39.89"	Monthly	Surface water monitoring point for conveyor crossing 3 of tributary of Trichardtsfontein Dam
R14403W	S 26°30'29.85"	E 29°16'01.33"	Monthly	Monitoring point for conveyor crossing 4 of tributary of Trichardtsfontein Dam
R14404W	S 26°30'28.72"	E 29°15'48.27"	Monthly	Downstream monitoring point for conveyor crossing 4 of tributary of Trichardtsfontein Dam
T14003W	S 26°30'50.15"	E 29°15'12.68"	Monthly	Monitoring point for conveyor crossing 5 of tributary of Klip Spruit
G58401W	S 26°31'13.84"	E 29°14'56.78"	Monthly	Monitoring point for conveyor crossing 6 of tributary of Klip Spruit
G58402W	S 26°31'32.26"	E 29°14'39.99"	Monthly	Upstream monitoring point for conveyor crossing 7 of tributary of Klip Spruit
G58403W	S 26°31'29.03"	E 29°14'35.21"	Monthly	Downstream monitoring point for conveyor crossing 7 of tributary of Klip Spruit
G29012W	S 26°32'15.02"	E 29°13'44.72"	Monthly	Upstream monitoring point for conveyor crossing 8 of Klip Spruit
D13702W	S 26°32'15.07"	E 29°13'34.14"	Monthly	Downstream monitoring point for conveyor crossing 8 of Klip Spruit
G29013W	S 26°32'47.29"	E 29°12'52.42"	Monthly	Upstream monitoring point for conveyor crossing 9 of tributary of Klip Spruit
D13703W	S 26°32'44.33"	E 29°12'50.78"	Monthly	Downstream monitoring point for conveyor crossing 9 of tributary of Klip Spruit
G29014W	S 26°33'00.44"	E 29°12'35.36"	Monthly	Upstream monitoring point for conveyor crossing 10 of tributary of Klip Spruit
G29015W	S 26°32'56.63"	E 29°12'31.77"	Monthly	Downstream monitoring point for conveyor crossing 10 of tributary of Klip Spruit

Site name	Latitude	Longitude	Monitoring frequency	Description
Site A	S 26°28'34.44"	E 29°17'47.08"	Monthly	Upstream point in the Debeerspruit. Coincide with the upstream biomonitoring point.
Site B	S 26°27'27.58"	E 29°17'53.44"	Monthly	Downstream point in the Debeerspruit. Coincide with the downstream biomonitoring point.
Site C	S 26°27'7.86"	E 29°17'17.35"	Monthly	Downstream of the TCTS in the unnamed tributary of the Debeerspruit.
F14203W	S 26°27'54.03"	29°54'41.01"	Monthly	500Ml pollution control dam at Thubelisha shaft.
F14204W	S 26°27'34.90"	29°34'30.77"	Monthly	20Ml pollution control dam at Thubelisha shaft.
Sewage final	S 26°27'35.03"	E 29°17'32.61"	Biweekly	Final effluent from the treated domestic wastewater plant
Storm1	S 26°27'55.61"	E 29°17'18.87"	Ad hoc after rain storms	Clean stormwater discharge to the environment

Geographic Coordinate System WGS84 Datum

Table 10-2 : Surface Water Monitoring Locations (Vaalkop, 2017)

Site name	Latitude	Longitude	Monitoring frequency	Description
SASSW01	S 26°24'31.78"	E 29°25'55.97"	Monthly	Upstream point on the Steenkoolspruit
SASSW02	S 26°20'42.32"	E 29°24'6.34"	Monthly	Downstream point on the Steenkoolspruit
SASSW03	S 26°26'0.77"	E 29°24'9.50"	Monthly	Upstream point on the east-Piekespruit
SASSW04	S 26°24'5.40"	E 29°21'9.70"	Monthly	Downstream point on the east-Piekespruit
SASSW05	S 26°22'27.86"	E 29°22'41.51"	Monthly	Unnamed tributary of the Steenkoolspruit within the project area
SASSW06	S 26°26'32.92"	E 29°21'10.61"	Monthly	monitoring point on the west-Piekespruit within project area
R 11	S 26°28'27.84''	E 29°21'13.96''	Monthly	Unnamed tributary of the Piekespruit within the project area

Site name	Latitude	Longitude	Monitoring frequency	Description
Site A	S 26°28'34.44"	E 29°17'47.08"	Monthly	Upstream point in the Debeerspruit. Coincide with the upstream biomonitoring point.
R14402W	S 26°29'38.68"	E 29°16'39.89"	Monthly	Surface water monitoring point for conveyor crossing 3 of tributary of Trichardtsfontein Dam

Geographic Coordinate System WGS84 Datum

10.1 Sampling variables and frequency

A monthly sampling schedule and analysis followed is indicated in Table 10-3.

Table 10-3 : Surface water quality variables, monitoring frequencies and limits

Variable	Unit	Frequency	Limits (IWUL)
pH		monthly	
Conductivity	mS/m	monthly	70
TDS	mg/ℓ	monthly	-
Dissolved oxygen	mg/ℓ	monthly	6
Suspended Solids	mg/ℓ	monthly	25
S04	mg/ℓ	monthly	200
Mn	mg/ℓ	monthly	-
Ca	mg/ℓ	monthly	-
Mg	mg/ℓ	monthly	-
Na	mg/ℓ	monthly	-
Cl	mg/ℓ	monthly	-
N03/ N02 as N (mg/ℓ)	mg/ℓ	monthly	-
NH4 as N	mg/ℓ	monthly	-
P04 as P	mg/ℓ	monthly	-
Alkalinity	mg/ℓ	monthly	-
B	mg/ℓ	quarterly	-
Al	mg/ℓ	monthly	-
F	mg/ℓ	monthly	-
Cd	mg/ℓ	quarterly	-

Variable	Unit	Frequency	Limits (IWUL)
Pb	mg/ℓ	quarterly	-
Ni	mg/ℓ	quarterly	-
Cu	mg/ℓ	quarterly	-
Zn	mg/ℓ	quarterly	-
Total Hardness	mg/ℓ	monthly	-
Fe	mg/ℓ	monthly	-

10.2 Methods to be followed

The method of surface water monitoring will be undertaken following the procedure outlined below:

- Only grab samples will be collected using a clean sterilised plastic bottles.
- Recording of the time, date and person that collected the sample will be done on each sample collected.
- Samples will be stored in a cool place prior to delivery to the laboratory.

10.3 Data quality control

Once the data has been received from the laboratory, error checking will be done, comparing the new set of data with historic records. An ion balance error of ± 10% will be used as an acceptable range. The data is then stored on WISH database.

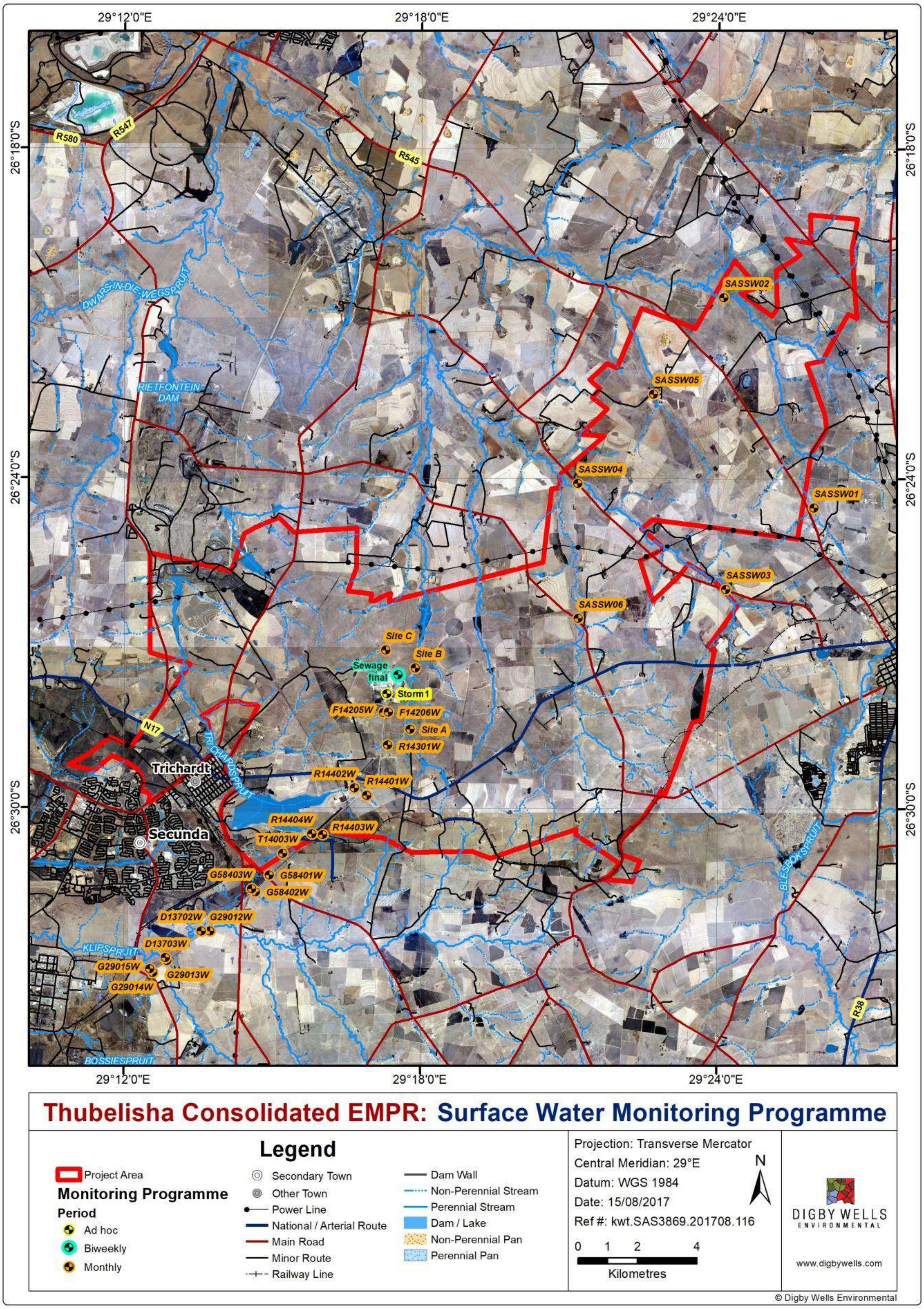


Figure 10-1: Surface Water Monitoring Points

11 Conclusion and Recommendations

Water quality samples were collected within the project area and the surrounding streams to determine a baseline water quality status prior to commencement of the proposed project. The results indicated some impacts on the streams within the area, parameters such Total Dissolved Solids, Chloride, Phosphate and Ammonia were exceeding the target water quality range for the irrigational use as set in the South African Water Quality Guidelines (DWAF, 1996) and the Olifants River Water Quality management Objectives.

The existing and proposed mining of the Vaalkop area, together with the associated activities have the potential to impact on the surface water resources within and around the project area. The identified potential surface water impacts include but not limited to:

- Siltation of surface water resources leading to deteriorated water quality as a result of eroded material reporting into the streams;
- Contamination of surface water resources when contaminated water runoff form the dirty mine areas reports into the nearby streams;
- Possible decant after cessation and closure of mining activities leading into contamination of the natural streams; and
- Reduction in runoff catchment yield in to the natural streams when all the dirty water runoff is contained within the stooped areas due to subsidence.

Subsequent to that, appropriate mitigation and management measures were provided to either prevent and/or minimise the identified potential impacts and risks. This included the following recommendations:

- Limiting the vegetation clearing to the development footprint;
- Implementation of dust suppression measures during construction and operational activities;
- All bulk fuel storage areas should be appropriately bunded and spill kits should be in place to contain and immediately clean up any potential leakages of fuels and oils;
- To ensure that all the dirty water emanating from the dirty water areas is contained within the mine site for re-use to prevent unnecessary discharge into the environment;
- Should a subsidence occur during operation, measures to rehabilitate the surface area should be implemented as soon as possible to avoid impoundment of surface water;
- Water quality monitoring should continue on the existing monitoring points to ensure detection of impacts
- Use of accredited contractors for removal or demolition of infrastructures; this will reduce the risk of waste generation and accidental spillages;

- Surface inspection on the fully rehabilitated areas must be undertaken to ensure a surface profile that allows good drainage. This will ensure improvement or increased catchment yield on to the surrounding streams;
- Should decent occur, decant water should be captured before it flows into the streams. The water should then be treated prior to discharge into the streams.

Thus, with all the recommended mitigation and measures in place to ensure the prevention and/or reduction of the identified potential surface water impacts, the project is unlikely to pose a significant threat to the surface water resources and can therefore go ahead.

12 References

Development of an Integrated Water Quality Management Plan for the Vaal River System, Integration of Resource Water Quality Objectives, September 2009.

Digby Wells Environmental, 2014. Environmental Impact Assessment and Environmental Management Programme for the Trichardtsfontein Project

Government Notice No. 39943, 22 April 2016. Classes and Resource Quality Objectives of Water Resources for the Olifants Catchments

Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources. Published in Government Gazette 20119.

Oryx Environmental, April 2008. Surface Water Inputs to the EMPR for Twistdraai Colliery Thubelisha Shaft (TCTS) Report No.: JW51/08/A815

Twistdraai Colliery: Thubelisha Shaft, June 2016. Monitoring and Reporting Programme, Revision 1. Sasol Mining

WRC (Water Research Commission) , 2009, “Water Resources of South Africa, 2012 Study (WR2012)”, Water Research Commission, Pretoria.

Appendix A: Water Quality Monitoring Results

aquatico Laboratories (Pty). Ltd.

Test Report

Client: Digby Wells & Associates
Address: 48 Grosvenor Road, Turnberry Office Park, Bryanston, 2191
Report no: 38846
Project: Digby Wells & Associates

Date of certificate: 31 March 2017
Date accepted: 22 March 2017
Date completed: 31 March 2017
Revision: 0

Lab no:				44038	44039	44040	44041	44042	44043	44044
Date sampled:				10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017
Sample type:				Water	Water	Water	Water	Water	Water	Water
Locality description:				SASSW01	SASSW02	SASSW03	SASSW04	SASSW05	SASSW06	SASSW07
	Analyses	**Unit**	**Method**							
A	pH @ 25°C	pH	ALM 20	8.51	8.38	8.30	8.11	8.13	8.11	8.29
A	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	60.2	41.8	71.7	54.9	71.1	41.9	41.7
A	Total Dissolved solids @ 180°C	mg/l	ALM 24	408	262	444	366	464	252	208
A	Total alkalinity	mg CaCO3/l	ALM 01	258	189	368	205	285	193	187
A	Chloride (Cl)	mg/l	ALM 02	23.7	17.7	21.1	29.2	83.1	7.42	13.1
A	Sulphate (SO_4)	mg/l	ALM 03	58.7	33.4	59.5	76.4	8.39	43.1	33.7
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.354	0.373	0.196	<0.194	0.238	0.245	0.385
A	Nitrite (NO_2) as N	mg/l	ALM 07	0.260	0.285	0.140	0.129	0.146	0.233	0.220
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.070	0.046	0.337	0.666	0.996	0.052	0.046
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.043	0.030	0.029	0.033	<0.005	0.032	0.017
A	Fluoride (F)	mg/l	ALM 08	0.821	0.682	3.10	0.711	0.463	0.402	0.453
A	Calcium (Ca)	mg/l	ALM 30	46.8	29.6	62.9	38.9	66.5	31.4	33.1
A	Magnesium (Mg)	mg/l	ALM 30	30.3	23.6	49.1	26.4	37.6	28.7	22.6
A	Sodium (Na)	mg/l	ALM 30	42.3	22.1	29.4	31.9	28.8	13.8	18.4
A	Aluminium (Al)	mg/l	ALM 31	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
A	Iron (Fe)	mg/l	ALM 31	<0.004	<0.004	<0.004	0.464	3.37	<0.004	<0.004
A	Total suspended solids (TSS)	mg/l	ALM 25	15	21	2226	805	468	7.0	15
N	Dissolved oxygen (DO)	mg/l	ALM 28	4.09	4.00	2.65	2.89	2.95	4.10	4.19
N	Acidity	mg CaCO3/l	ALM 60	<0.001	<0.001	35.2	7.42	6.62	6.84	5.69

A = Accredited N = Non accredited O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine
The results relates only to the test item tested.
Results reported against the limit of detection.
Results marked 'Not SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory.
Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation.

Client:	Digby Wells & Associates
Address:	48 Grosvenor Road, Turnberry Office Park, Bryanston, 2191
Report no:	38846
Project:	Digby Wells & Associates
Date of certificate:	31 March 2017
Date accepted:	22 March 2017
Date completed:	31 March 2017
Revision:	0

Lab no:				44045	44046	44047	44048	44049
Date sampled:				10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017	10-Mar-2017
Sample type:				Water	Water	Water	Water	Water
Locality description:				R 11	Site A	R14402W	R14403W	T14003W
	Analyses	**Unit**	**Method**					
A	pH @ 25°C	pH	ALM 20	8.18	7.81	8.29	7.79	7.62
A	Electrical conductivity (EC) @ 25°C	mS/m	ALM 20	92.4	42.5	74.1	34.7	19.7
A	Total Dissolved solids @ 180°C	mg/l	ALM 24	550	246	464	254	154
A	Total alkalinity	mg CaCO3/l	ALM 01	418	193	316	144	70.5
A	Chloride (Cl)	mg/l	ALM 02	10.7	13.5	17.2	9.69	6.54
A	Sulphate (SO_4)	mg/l	ALM 03	123	31.8	89.3	37.2	18.2
A	Nitrate (NO_3) as N	mg/l	ALM 06	0.383	0.422	0.625	0.334	0.285
A	Nitrite (NO_2) as N	mg/l	ALM 07	0.169	0.186	0.220	0.226	0.254
A	Ammonium (NH_4) as N	mg/l	ALM 05	0.042	0.058	0.055	0.147	0.058
A	Orthophosphate (PO_4) as P	mg/l	ALM 04	0.192	0.077	0.072	0.163	0.057
A	Fluoride (F)	mg/l	ALM 08	0.591	0.536	0.670	0.613	0.516
A	Calcium (Ca)	mg/l	ALM 30	75.8	36.4	49.2	20.8	10.6
A	Magnesium (Mg)	mg/l	ALM 30	73.5	24.6	49.7	20.2	8.65
A	Sodium (Na)	mg/l	ALM 30	24.8	13.5	43.7	19.9	13.1
A	Aluminium (Al)	mg/l	ALM 31	<0.002	<0.002	<0.002	0.008	0.148
A	Iron (Fe)	mg/l	ALM 31	<0.004	<0.004	<0.004	<0.004	0.079
A	Total suspended solids (TSS)	mg/l	ALM 25	606	140	10.0	42	65
N	Dissolved oxygen (DO)	mg/l	ALM 28	3.78	3.64	3.90	3.57	3.68
N	Acidity	mg CaCO3/l	ALM 60	6.98	7.20	7.63	8.28	8.57

A = Accredited N = Non accredited O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine
The results relates only to the test item tested.
Results reported against the limit of detection.
Results marked 'Not SANAS Accredited' in this report are not included in the SANAS Schedule of Accreditation for this laboratory.
Uncertainty of measurement available on request for all methods included in the SANAS Schedule of Accreditation.

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Appendix B: TCTS Monitoring and Reporting Programme

MONITORING AND REPORTING PROGRAMME

Twistdraai Colliery: Thubelisha Shaft

License no: 04/B11C/ACGIJ/995

Revision number: 1

Authors:

T. Mafanya, J. Linde and J. Muller

Reviewed:

P. Vorster, E. Schubach

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1 INTRODUCTION

This monitoring programme is based upon the recommendations made in the environmental monitoring chapter of the Environmental Management Plan (EMP) for the Twistdraai Colliery: Thubelisha Shaft (TCTS) as well as monitoring requirements specified in the approved Water Use License (license no: 04/B11C/ACGIJ/995) issued for this operation. The programme is aimed at providing a holistic and integrated management plan for the TCTS. The approved EMP for this operation, it states that:

- A monitoring network should be established prior to the commencement of mining to ensure there is sufficient baseline information on surface water resources and groundwater resources within the vicinity of the operation;
- The monitoring network should aim at monitoring on-site and regional water quality monitoring of the coal seam aquifer, overlying aquifer (where landowners tap water from) and surface water sources (receiving environment).

The approved EMP therefore touches on the fundamental aspects which should form the basis of water resource monitoring without going into for instance the detail of the actual points that need to be monitored. This document outlines the detailed information of the what, when and where with regards to the various monitoring requirements for the TCTS.

1.1 Objectives

The main objective of the programme is to gather baseline information, spatial and temporary variability of water quality and water quantity with clearly defined monitoring and reporting frequencies. This information will provide early warning of potential impacts to water resources, thus allowing the management and to act on eliminating and minimizing impacts. The main aim of the monitoring program is therefore to identify and address impacts proactively. The data collected for the different aquifers will be used to compile and update the water model and water balances to better identify the potential level of impact on groundwater users and the nearby riparian habitats. Results from the monitoring programme can also be assessed in the future to better define the interaction between surface water and groundwater.

1.2 Monitoring Programme Manager

The monitoring programme manager will coordinate the collection of physical, chemical, and biological samples from the identified monitoring and ensure that the samples are delivered at the lab for data generation. This data will be used to:

- Characterize existing conditions or identify emerging problems;
- Evaluate the effectiveness of water quality control programs;

- Identify trends;
- Ensure that redundant/ vandalized water monitoring sources are restored; and
- Report to the authorities regarding compliance with approved environmental authorizations.

Essentially, the results of the monitoring programme will provide a basis for effective management and protection of water resources within the jurisdiction of TCTS.

2 GROUNDWATER MONITORING

The groundwater monitoring plan for TCTS will concentrate on the following groundwater impacts, namely:

- The potential impact of bord and pillar mining activities on groundwater yield and groundwater quality of external users in the shallow weathered aquifers.
- The potential impact of high extraction mining activities on groundwater yield and groundwater quality of external users in the shallow weathered aquifers.
- The impact of waste management sites e.g. dams and other resources e.g. coal stockpiles that can potentially affect groundwater quality.

The groundwater monitoring network will be used to provide a snapshot of the baseline hydrogeological conditions and temporal changes in groundwater conditions. The network will also be monitored in the long term (i.e. during and post mining) to provide ongoing measurement of quality and quantity, including temporal and seasonal changes. In addition to providing baseline information, the results from the groundwater monitoring undertaken will provide a measurement of any impacts that are occurring.

The groundwater monitoring network currently comprises 27 boreholes. These boreholes are located at twenty sites with some featuring a pair of groundwater boreholes, one targeting the shallow seepage zone (about 15m deep) and the other targeting the weathered aquifer above the B4 dolerite sill (about 30m deep). The paired boreholes have been strategically placed to monitor any potential impacts associated with seepage through the dam basin or the dam wall. If there is seepage from the dam, then management options for seepage will need to be investigated and implemented. The rest of the boreholes are strategically placed and cover most of mining area for TCTS. Figure 1 shows the distribution of the boreholes currently monitored for TCTS whilst Table 1 indicates the details including the depths of the boreholes.

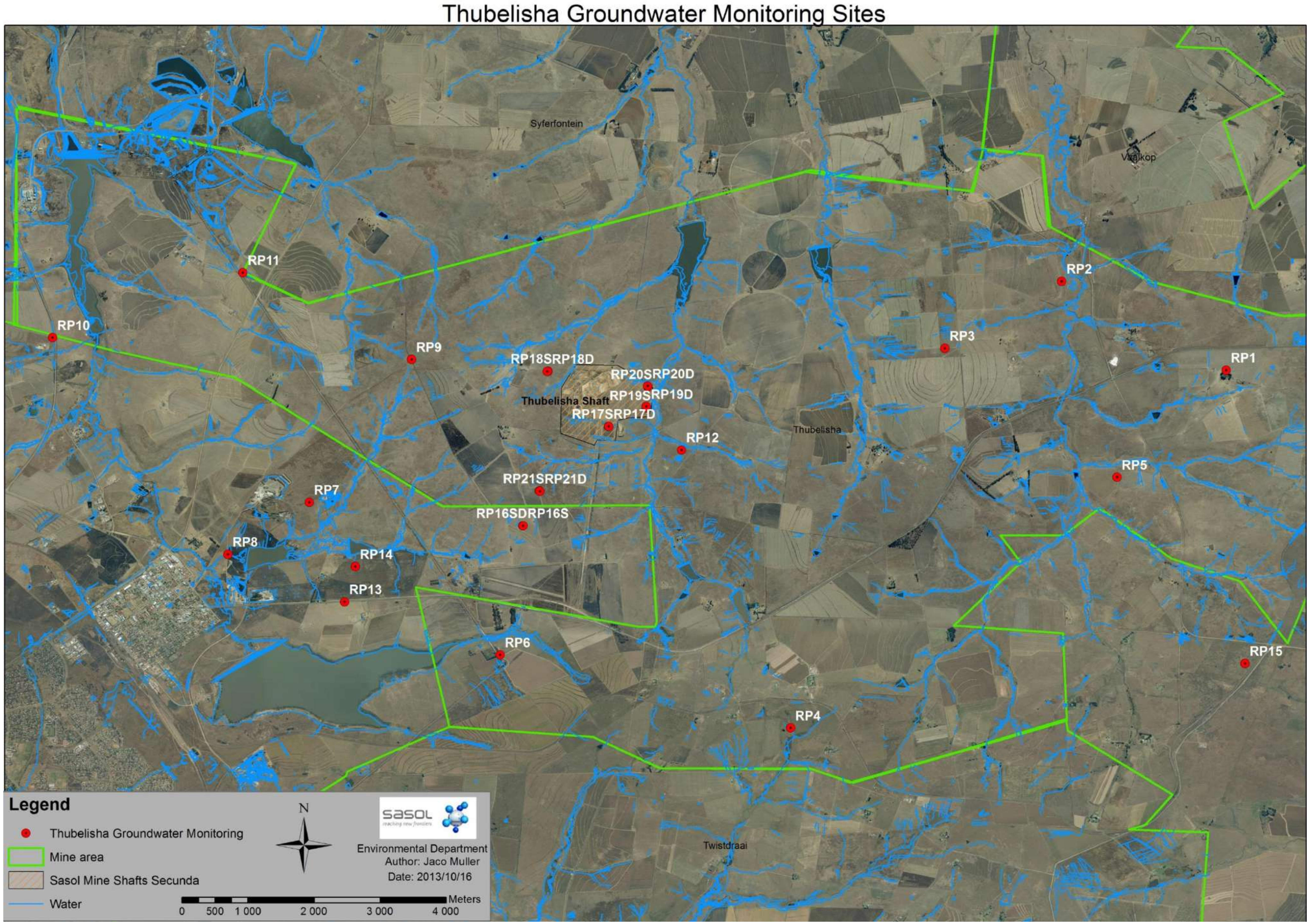

Figure 1: Groundwater monitoring points for Thubelisha

Table 1: Thubelisha groundwater monitoring sites

Site Name	Latitude [°]	Longitude [°]	Zcoord	Site Type	Depth (m)	Description
RP-1	26.45872151	29.37432746	1666	b	30	Monitors dewatering impacts
RP-2	26.44661193	29.3518895	1604	b	30	Monitors dewatering impacts
RP-3	26.45575674	29.33596404	1655	b	30	Monitors dewatering impacts
RP-4	26.50753018	29.31490702	1658	b	30	Monitors dewatering impacts
RP-5	26.47332678	29.35944181	1624	b	30	Monitors dewatering impacts
RP-6	26.49756641	29.27528845		b	30	Monitors dewatering impacts
RP-7	26.47676492	29.2492641		b	30	Monitors dewatering impacts
RP-8	26.4838601	29.23813636	1611	b	30	Monitors dewatering impacts
RP-9	26.45727147	29.26321049	1683	b	30	Monitors dewatering impacts
RP-10	26.4542937	29.21422189	1607	b	30	Monitors dewatering impacts
RP-11	26.44542539	29.24019361	1675	b	30	Monitors dewatering impacts
RP-12	26.46962759	29.30002243	1619	b	25	Monitors dewatering impacts
RP-13	26.49034004	29.25406754	1648	b	30	Monitors dewatering impacts
RP-14	26.48552675	29.25555145		b	30	Monitors dewatering impacts
RP-15	26.49873374	29.37690413	1657	b	30	Monitors dewatering impacts
RP-16S	26.47995151	29.27836585		b	15	Monitors dewatering impacts
RP-16D	26.47995139	29.27842603		b	30	Monitors dewatering impacts
RP-17S	26.46639888	29.29006628		b	15	Monitors seepage from potential pollution source
RP-17D	26.46639884	29.29008633		b	30	Monitors seepage from potential pollution source
RP-18S	26.45886984	29.28183508		b	15	Monitors seepage from potential pollution source
RP-18D	26.45889713	29.28172484		b	30	Monitors dewatering impacts
RP-19S	26.46386117	29.29523434	1609	b	15	Monitors seepage from potential pollution source
RP-19D	26.46369871	29.29523393	1609	b	30	Monitors seepage from potential pollution source
RP-20S	26.46099063	29.29542762		b	15	Monitors seepage from potential pollution source
RP-20D	26.46090044	29.29539731		b	30	Monitors seepage from potential pollution source
RP- 21S	26.47519057	29.28062096	1652	b	15	Monitors seepage from potential pollution source
RP-21D	26.47525357	29.28071138	1652	b	30	Monitors seepage from potential pollution source

b- borehole

2.1 Monitoring frequency

The programme followed looks into measurement of water levels quarterly. This results in four records of water levels per borehole per year, thus giving enough variation for the wet and dry season. Water quality is analysed twice a year for the variables indicated in Table 2.

Table 2: Analyses followed for groundwater

Sampling schedule	Variables to analyse for.
Bi-annually	Electrical Conductivity, pH, TDS, Mg, Ca, Cl, B, Na, K, SO4, T-Alk, P-Alk, Fe, SS, Al, Zn, NO_3 as N, F, NH_4, PO_4

Historically Cd, Pb, Ni and Cu were found to be below detection limit in the groundwater samples which was analysed and are also not expected pollutants from the mining operations. They are therefore excluded from the list of variables specified in Appendix III Table 5.2 of the TCTS water use license. There is also no source of pathogens related to mining operations which is expected to impact on groundwater resources whereby it is also excluded for the list of variables which are analysed for.

2.2 Methods to be followed

The method of groundwater monitoring will be undertaken following the procedure outlined below:

- Depth to water table will be measured using a Solinst interface meter (quarterly);
- Only grab samples will be collected using a clean re-usable plastic bailer (twice a year). A detergent specifically designed for cleaning sampling material will be utilised to ensure bailers are cleaned.
- Recording of the time, date and person that collected the sample will be done on each sample collected.
- Samples will be stored in a cool place prior to delivery to the laboratory.
- The laboratory currently used for analysis is ISO 9001 accredited and participates in regular inter laboratory proficiency testing.

2.3 Data quality control

Once the data has been received from the laboratory, error checking will be done, comparing the new set of data with historic records. An ion balance error of ± 10% will be used as an acceptable range. The data is then stored on WISH database.

3 SURFACE WATER MONITORING

The planning, design and management of the Thubelisha Mine was done to minimize the impact of the mining operation on water resources and downstream users. The objective of the surface water monitoring system is to monitor the efficiency of the water management and pollution control systems, to act as a pollution early warning system, to verify compliance with license requirements and for reporting purposes. Monitoring both upstream and downstream of the TCTS site and sites along the conveyor are followed in order to detect potential impacts on the water system.

The monitoring requirements for surface water stipulated in the Thubelisha Water Use License (license no. 04/B11C/ACGIJ/995) include up and downstream points of the conveyor/stream crossings (clause 3.3.1 in appendix II), and commitments in the report in support of the Water Use License Application (7.2.1 in appendix III), and treated sewage discharged into the pollution control dam (clause 7.6.2.1 of appendix III).

It is therefore important to understand the recommendations in the report submitted in support of the Water Use Application (WULA). The baseline surface water report[1] recommended the following with respect to surface water monitoring:

"*The sampling points will be upstream and downstream of mining and coal handling facilities, with additional points on the mine (for dirty water) added as required. It is proposed to regularly sample (monthly) for those constituents expected to be elevated in the mine water i.e. electrical conductivity, pH, TDS, SS, Cl, SO4, Na, F, Fe, Al, Mn, Zn, total alkalinity, Ca, Mg, K, and total hardness. Analyses to 95% charge balance will be undertaken at 6 monthly intervals, including all metals.*"

The Environmental Management Program (EMP)[2] has similar wording to the base line surface water report:

"*Implement water quality monitoring upstream and downstream of the site at sampling sites used in the baseline study and for the following constituents: electrical conductivity, pH, TDS, SS, Cl, SO4, Na, F, Fe, Al, Mn, Zn, total alkalinity, Ca, Mg, K, and total hardness.*"

The Integrated Water and Waste Management Plan (IWWMP) prepared by Jones & Wagener[3] recommend the following surface sampling as indicated in Table 3. The referred IWWMP was not submitted in support of the WULA.

[1] **ORYX ENVIRONMENTAL,** Surface Water Inputs To The EMPR For Twistdraai Colliery Thubelisha Shaft (TCTS), Report No.: JW51/08/A815, April 2008.

[2] **ORYX ENVIRONMENTAL***,* Environmental Impact Assessment and Management Programme for the Twistdraai Colliery: Thubelisha Shaft, Main Report, Volume 1, July 2008

[3] **JONES AND WAGENER,** Twistdraai Colliery Thubelisha Shaft Integrated Water and Waste Management Plan, Report No.: JW046/12/C166 – Rev 2, March 2013.

Table 3: Surface water sampling as recommended by Jones & Wagener in the 2013 IWWMP.

Sample point (Jones & Wagener)	Sample point name in the Sasol database	Latitude	Longitude	Frequency	Parameters
R2	T14002W	S 26°27'27.68"	E 29°13'11.48"	Quarterly	Electrical conductivity, pH, Total Dissolved Solids (TDS), suspended solids (SS), chloride (Cl), sulphate (SO4), sodium (Na), fluoride (F), iron (Fe), aluminium (Al), manganese (Mn), total alkalinity, calcium (Ca), magnesium (Mg), total hardness, NO3/NO2 as N, NH4 as N, PO4 as P, *E. coli,* boron (B), cadmium (Cd), lead (Pb), nickel (Ni), copper (Cu), zinc (Zn) (mg/l)
R3	F14201W	S 26°26'6.95"	E 29°15'3.85		
R4	G29317W	S 26°31'13.46"	E 29°14'44.00"		
R5	G29318W	S 26°32'44.04"	E 29°17'10.68"		
R6	G29319W	S 26°32'11.52"	E 29°16'36.43"		
R7	G29320W	S 26°31'54.62"	E 29°18'13.52"		
R8		S 26°27'11.08"	E 29°17'57.61"		
R9	Z14501W	S 26°27'0.55"	E 29°19'13.31"		
R10		S 26°26'33.97"	E 29°19'13.24"		
R11	E14701W	S 26°28'27.84"	E 29°21'13.96"		

It was concluded from reviewing the proposed monitoring schedule by Jones & Wagener that the objective would be catchment monitoring. The potential impact of the Thubelisha operation on surface water quality can best be monitor by up and downstream monitoring points of the Thubelisha shaft and surface operations. The catchment monitoring points as suggested by Jones & Wagener would therefore not satisfy the objectives as stated earlier in this document. **It is therefore recommended not to implement the monitoring as proposed by Jones & Wagener.**

The Thubelisha Water Use License (license no. 04/B11C/ACGIJ/995) requires the monitoring of the potential impact of the conveyor (condition 3.3.1 in appendix II). The impact of the conveyor is perceived to be very low or insignificant and the implementation of the monitoring program as required in the referred condition is not regarded as effective use of resources**.** This is due to the non-perennial nature of the stream systems where sampling is only possible during the brief periods following large rainfall events with the potential impacts on these tributary systems not being limited to the operation of the conveyer. The properties along the length of the conveyor are not owned by Sasol and impacts related to agricultural activities could also potentially reflect at the conveyor crossings where sampling is undertaken. **It is therefore recommended that the sampling of the 17 points be continued on a monthly basis until June 2017 to gather sufficient data for a motivation to remove this requirement from the Thubelisha IWUL.**

The 20 and 500 ML dams are currently monitored as potential pollution sources. The treated domestic wastewater is also monitored by the service provider appointed by Sasol Mining to operate the domestic wastewater plant. **It is recommended that the monitoring of the pollution control dams and domestic wastewater plant be continued on a monthly and biweekly respectively.**
The stormwater system at the Thubelisha shaft and surface operations was designed to comply with the Government Notice 704 regulations. Dirty stormwater is routed to the pollution control dams and clean stormwater is routed to the environment. **A stormwater monitoring point denoted as *Storm 1* (see Table 4 and Figure 3) has been established to demonstrate that clean stormwater is discharged to the environment.**

The proposed surface water monitoring for the TCTS can be summarised as follow:

Table 4: Proposed surface water monitoring plan for the TCTS.

Site name	Latitude	Longitude	Monitoring frequency	Description
F14205W	S 26°28'16.14"	E 29°17'14.76"	Monthly	Upstream monitoring point for conveyor crossing 1 of tributary of Debeerspruit
F14206W	S 26°28'15.81"	E 29°17'20.80"	Monthly	Downstream monitoring point for conveyor crossing 1 of tributary of Debeerspruit
R14301W	S 26°28'51.48"	E 29°17'19.97"	Monthly	Monitoring point for conveyor crossing 2 of tributary of Debeerspruit
R14401W	S 26°29'46.79"	E 29°16'54.88"	Monthly	Surface water monitoring point for conveyor crossing 3 of tributary of Trichardtsfontein Dam
R14402W	S 26°29'38.68"	E 29°16'39.89"	Monthly	Surface water monitoring point for conveyor crossing 3 of tributary of Trichardtsfontein Dam
R14403W	S 26°30'29.85"	E 29°16'01.33"	Monthly	Monitoring point for conveyor crossing 4 of tributary of Trichardtsfontein Dam
R14404W	S 26°30'28.72"	E 29°15'48.27"	Monthly	Downstream monitoring point for conveyor crossing 4 of tributary of Trichardtsfontein Dam
T14003W	S 26°30'50.15"	E 29°15'12.68"	Monthly	Monitoring point for conveyor crossing 5 of tributary of Klip Spruit
G58401W	S 26°31'13.84"	E 29°14'56.78"	Monthly	Monitoring point for conveyor crossing 6 of tributary of Klip Spruit
G58402W	S 26°31'32.26"	E 29°14'39.99"	Monthly	Upstream monitoring point for conveyor crossing 7 of tributary of Klip Spruit
G58403W	S 26°31'29.03"	E 29°14'35.21"	Monthly	Downstream monitoring point for conveyor crossing 7 of tributary of Klip Spruit
G29012W	S 26°32'15.02"	E 29°13'44.72"	Monthly	Upstream monitoring point for conveyor crossing 8 of Klip Spruit
D13702W	S 26°32'15.07"	E 29°13'34.14"	Monthly	Downstream monitoring point for conveyor crossing 8 of Klip Spruit
G29013W	S 26°32'47.29"	E 29°12'52.42"	Monthly	Upstream monitoring point for conveyor crossing 9 of tributary of Klip Spruit
D13703W	S 26°32'44.33"	E 29°12'50.78"	Monthly	Downstream monitoring point for conveyor crossing 9 of tributary of Klip Spruit
G29014W	S 26°33'00.44"	E 29°12'35.36"	Monthly	Upstream monitoring point for conveyor

				crossing 10 of tributary of Klip Spruit
G29015W	S 26°32'56.63"	E 29°12'31.77"	Monthly	Downstream monitoring point for conveyor crossing 10 of tributary of Klip Spruit
Site A	S 26°28'34.44"	E 29°17'47.08"	Monthly	Upstream point in the Debeerspruit. Coincide with the upstream biomonitoring point.
Site B	S 26°27'27.58"	E 29°17'53.44"	Monthly	Downstream point in the Debeerspruit. Coincide with the downstream biomonitoring point.
Site C	S 26°27'7.86"	E 29°17'17.35"	Monthly	Downstream of the TCTS in the unnamed tributary of the Debeerspruit.
F14203W	S 26°27'54.03"	29°54'41.01"	Monthly	500Ml pollution control dam at Thubelisha shaft.
F14204W	S 26°27'34.90"	29°34'30.77"	Monthly	20Ml pollution control dam at Thubelisha shaft.
Sewage final	S 26°27'35.03"	E 29°17'32.61"	Biweekly	Final effluent from the treated domestic wastewater plant
Storm1	S 26°27'55.61"	E 29°17'18.87"	Ad hoc after rain storms	Clean stormwater discharge to the environment

As mentioned earlier, it should also be recognised that most of the streams in the TCTS mining rights area are non-perennial. During the dry season and periods of low rainfall water will probably become stagnant in most of not all of the streams where the monitoring points are located. Sampling stagnant water would then not be representative of the stream quality and sampling will then only focus on the perennial streams. During sampling of the monitoring points the sampling conditions (stream flow conditions, visual observations etc.) will be noted and records kept thereof.

The geographical distribution of the sampling points are illustrated in Figure 2

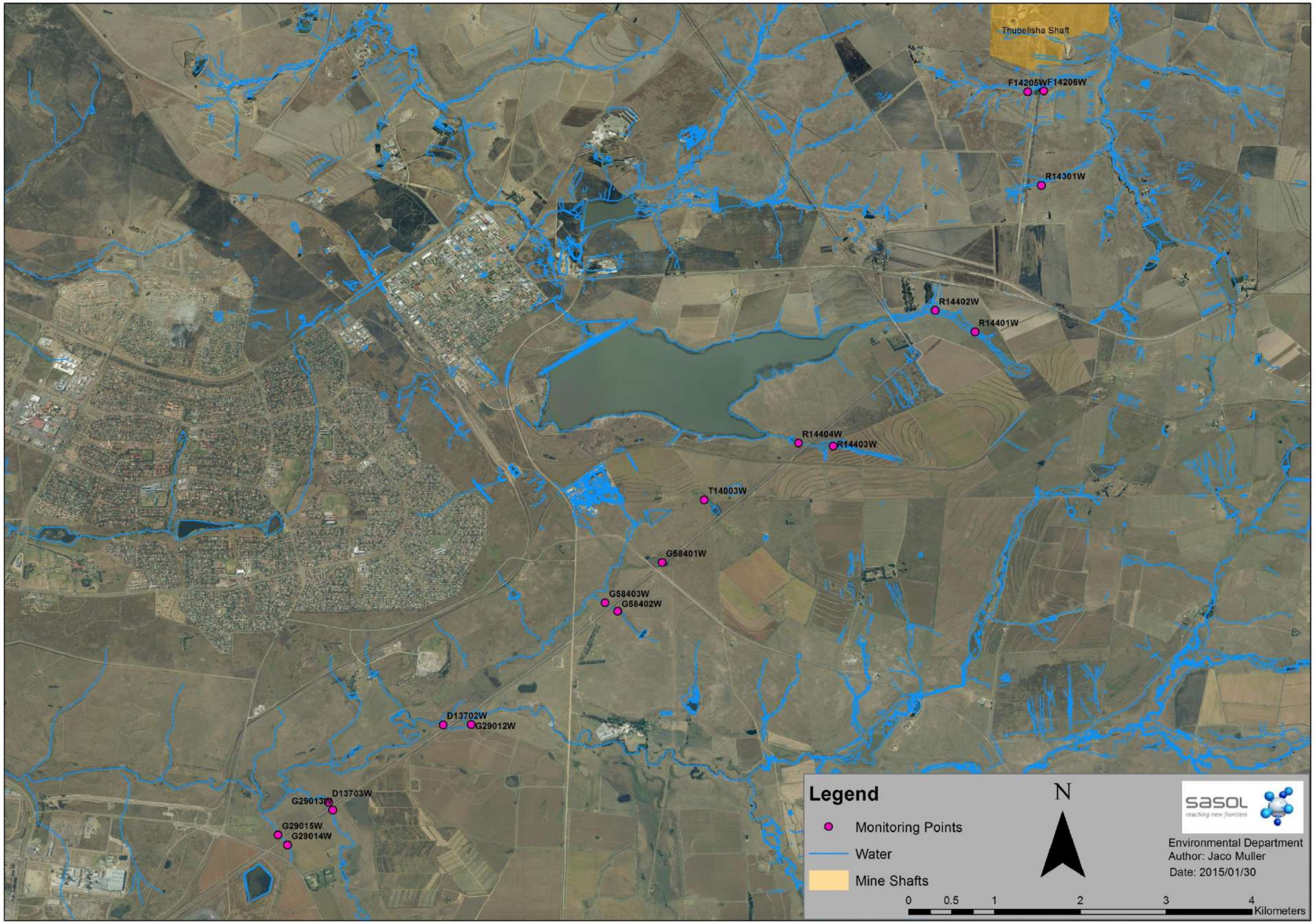

Figure 2: Surface water monitoring points (up and downstream to monitor potential impacts from the conveyor) for Thubelisha

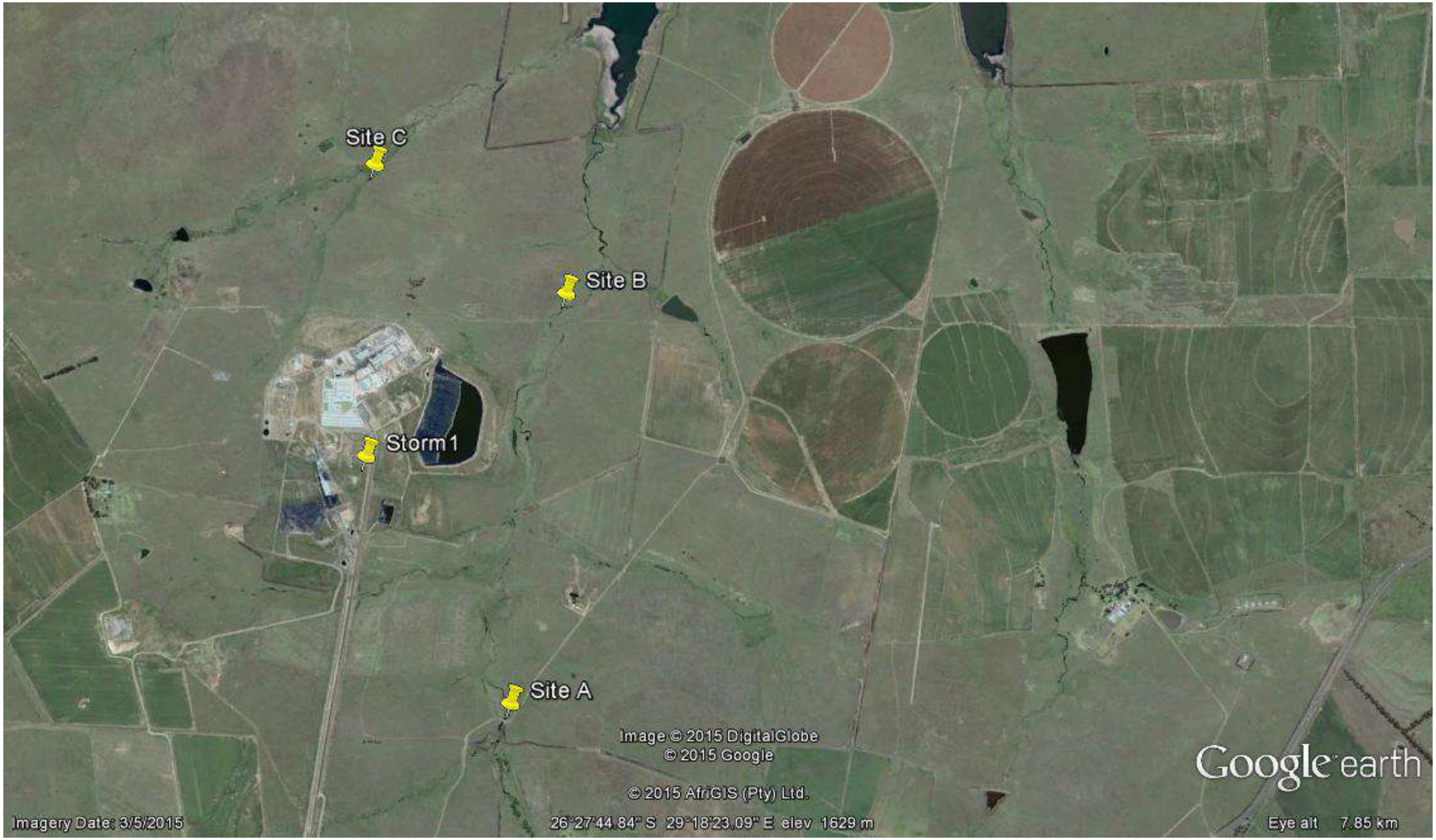

Figure 3: Surface water monitoring points (up and downstream to monitor potential impact from shaft) for Thubelisha

3.1 Sampling variables and frequency

A monthly sampling schedule and analysis followed is indicated in Table 5.

Table 5: Surface water quality variables, monitoring frequencies and limits

Variable	Unit	Frequency	Limit
pH		monthly	6.5 – 9.0
Electrical Conductivity	mS/m	monthly	70
TDS	mg/ℓ	monthly	-
Dissolved oxygen	mg/ℓ	monthly	6
Suspended Solids	mg/ℓ	monthly	25
$S0_4$	mg/ℓ	monthly	200
Mn	mg/ℓ	monthly	-
Ca	mg/ℓ	monthly	-
Mg	mg/ℓ	monthly	-
Na	mg/ℓ	monthly	-
Cl	mg/ℓ	monthly	-
$N0_3$/ $N0_2$ as N (mg/ℓ)	mg/ℓ	monthly	-
NH_4 as N	mg/ℓ	monthly	-
$P0_4$ as P	mg/ℓ	monthly	-
Alkalinity	mg/ℓ	monthly	-
B	mg/ℓ	quarterly	-
Al	mg/ℓ	monthly	-
F	mg/ℓ	monthly	-
Cd	mg/ℓ	quarterly	-
Pb	mg/ℓ	quarterly	-
Ni	mg/ℓ	quarterly	-
Cu	mg/ℓ	quarterly	-
Zn	mg/ℓ	quarterly	-
Total Hardness	mg/ℓ	monthly	-
Fe	mg/ℓ	monthly	-

In comparison to the monitoring requirements specified in Appendix II Table 2 and Appendix III Table 5.1 of the TCTS Water Use License, E. Coli and Turbidity has been omitted.

The treated effluent from the sewage treatment works located at TCTS is discharged directly to the 500 Ml pollution control dam. Therefore, in the absence of a pathogen source from the mining operations which could potentially impact on the surface water resources, monitoring for E. Coli is not regarded as being viable.

Suspended solids is regarded as a good indicative parameter for measuring the potential impact from the mining operation on surface water resources. The additional requirement to also analyse for turbidity is regarded as duplication due to the close relationship between the two parameters especially considering the potential impacts related to the mining activities.

3.2 Field methods

Just like with groundwater, grab samples are collected. A procedure for sample handling and dispatching to the lab is similar to the one outlined for groundwater.

3.3 Data control and storage

Similar procedure as outlined for groundwater is followed.

4 BIO-MONITORING

4.1 Identification of Monitoring Points

The identified monitoring points are indicated in Figure 4, and described in Table 6. More detailed descriptions are provided in section 4.2 and section 1.1.

4.2 Methodology for site selection

Bio-monitoring sites were allocated by applying the methodology below was applied.

1. The sites were chosen in relation to the existing infrastructure and activities of the area (as understood by the aquatic ecologists):
    - which is representative of the potential impacts related to the licensee; and
    - to minimize the inclusion of impacts related to water users and uses not associated with the licensee
2. How readily a site could be accessed by vehicle to allow for the transportation of equipment.
3. Specific sites were selected where:
    - There were good habitat conditions with as good level of biotope diversity as possible;
    - A site is able to support as diverse aquatic community as possible;
    - To coincide with current surface water monitoring plan in order to relate the water quality variables with the biological communities to expand the depth of interpretation of potential environmental impacts; and
    - The monitoring points were selected by considering the baseline monitoring survey that was done to delineate the sensitive environments (wetlands and FEPA’s).
4. It was clearly communicated that the outcomes should reflect the potential impacts of the licensee and not arbitrary unrelated data.
5. With regards to the TCTS monitoring sites, sites were allocated in the Debeerspruit to reflect the upstream (u/s) and downstream (d/s) conditions related to shaft and associated surface infrastructure/ activities.

Table 6: Biological Monitoring sites for Twistdraai Colliery: Thubelisha Shaft

Monitoring site	Latitude [°]	Longitude [°]	Site type	Description
Site A	S 26°28'34.44"	E 29°17'47.08"	sw-b	Debeerspruit u/s of Thubelisha Shaft
Site B	S 26°27'27.58"	E 29°17'53.44"	sw-b	Debeerspruit d/s of Thubelisha Shaft

sw-b: surface water bio-monitoring

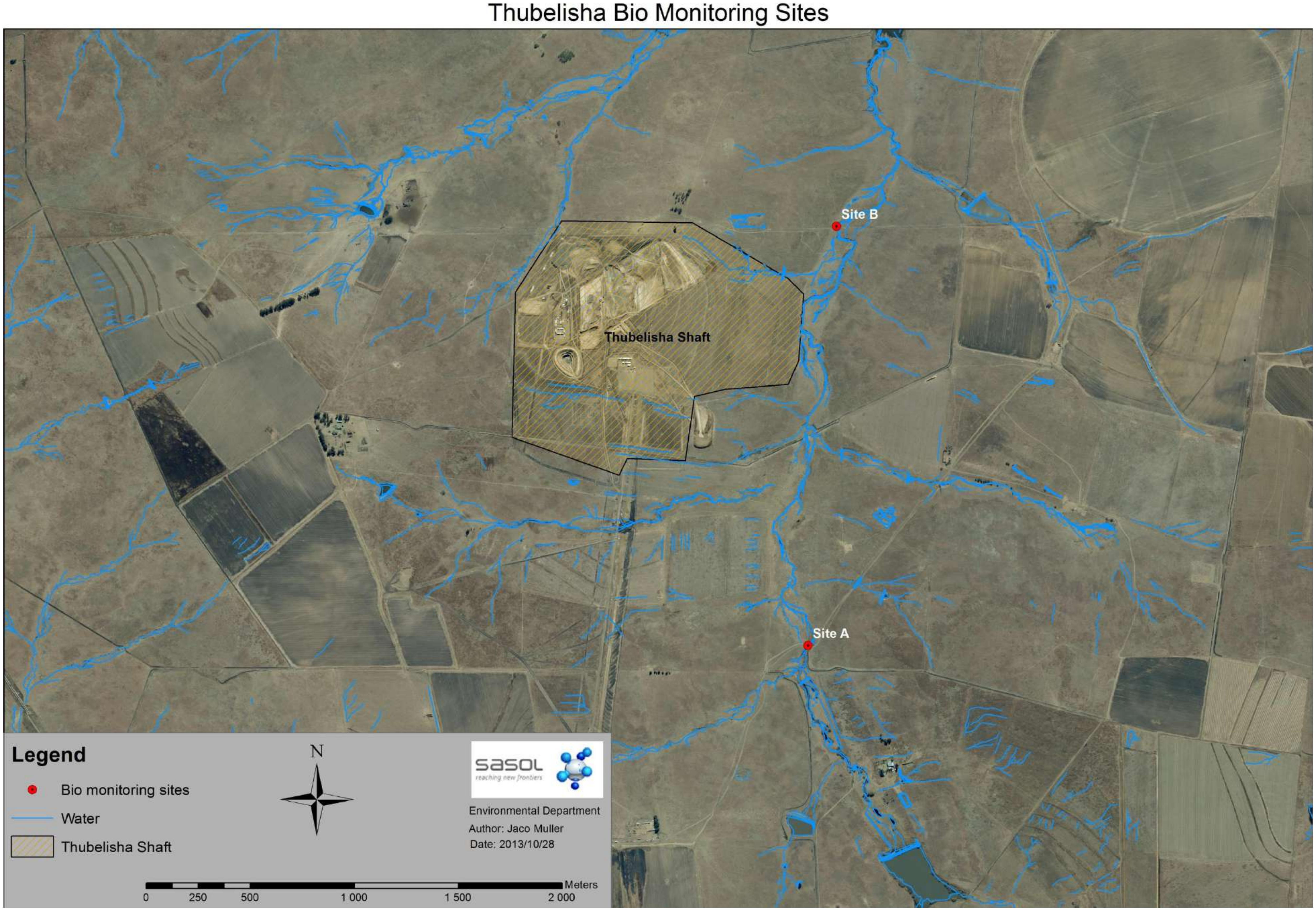

Figure 4: Bio-monitoring sites

4.3 Habitat assessments

An evaluation of habitat quality and availability to biota is critical to any assessment of ecological integrity and is conducted at each site at the time of biological sampling. On site habitat assessments are also conducted using the habitat evaluation indices of McMillan (IHAS, 1998). Habitat assessments are critical due to the fact that changes in habitat can be responsible for changes in SASS5 scores.

The use of a SASS orientated habitat assessment index, namely the Invertebrate Habitat Assessment System (IHAS), is therefore important to determine the relative “health” or “availability” of sufficient habitat for the establishment or maintenance of viable biological communities. The IHAS index is specifically designed to assess habitat and also to form a significant part of the final biological assessment of rivers. This system is also endorsed by River Health Program (www.csir.co.za/rhp), and it can be used with confidence throughout South Africa.

4.4 Sample collection - Aquatic invertebrate

An invertebrate net (30 x 30cm square with 0.5 mm mesh netting) is used for the collection of the organisms. Various different biotopes are sampled, and each of the biotopes is sampled with different methods. The biotypes sampled at the monitoring points were Vegetation (VG) Biotopes, Stone and Rock (S) Biotopes as well as Gravel, Sand and Mud (GSM) Biotopes.

4.4.1 Stone (S) Biotopes

Stones in current (SIC) or any solid object**:** Movable stones of at least cobble size (3cm diameter) to approximately 25 cm in diameter, within the fast and slow flowing sections of the river. Kick sampling is used to collect organisms in this biotope. This is done by putting the net on the bottom of the river, just downstream of the stones to be kicked, in a position where the current will carry the dislodged organisms into the net. The stones are then kicked over and against each other to dislodge the invertebrates (kick sampling) for ± 2 minutes.

Stones out of current (SOOC), bedrock or any solid object out of the current: Movable stones of at least cobble size (2 cm diameter) to approximately 25 cm in diameter that are out of current where fine sediments are able to settle on their surfaces. The stones are then kicked over and against each other to dislodge the invertebrates (kick sampling) for ± 1min. Biological Monitoring August 2012-SASOL Thubelisha Report No: 201208/Sasol/TBA 14. Both SIC and SOOC samples are combined into a single Stones sample.

4.4.2 Vegetation (VG) Biotopes

Marginal vegetation (MV): This is the overhanging grasses, bushes, twigs and reeds growing on the edge of the stream, often emergent, both in current (MvegIC) and out of current (MvegOOC). Sampling is conducted by holding the net perpendicular to the vegetation (below the surface) and sweeping back and forth through the vegetation (± 2 m of vegetation). This sampling is spread over a stretch of the river. Dominant plant species may be recorded. Submerged vegetation (AQV): This vegetation is totally submerged and includes filamentous algae and the roots of floating aquatics such as water hyacinth. This is sampled by pushing the net (under the water) against and through the vegetation in an area of approximately one square meter.

4.4.3 Gravel, Sand and Mud (GSM) Biotopes

Sand: This includes sandbanks within the river, small patches of sand in hollows at the side of the river or sand between the stones at the side of the river. These biotopes were sampled by stirring the substrate by shuffling or scraping of the feet.

Gravel: Gravel typically consists of smaller stones (2-3 mm up to 3 cm). Sampling was similar to that of sand.

Mud: It consists of very fine particles, usually as dark-coloured sediment. Mud usually settles to the bottom in still or slow flowing areas of the river. Sampling was similar to that of sand. All three biotopes are sampled for a collective total of 1min and then combined into a single GSM (Gravel, Sand and Mud) sample.

4.4.4 Hand picking and visual observation

Before, during and after sampling the site, approximately 1 minute of "hand-picking" for specimens that may have been missed by the sampling procedures is carried out. Visual observation is also carried out during sampling.

5 LAND OWNERS BOREHOLES

The baseline information for the surrounding landowners' boreholes has been gathered during the EIA/ EMP data gathering stage. This information is again gathered when mining operations approach a certain area in order to verify the recent information with baseline information. During this stage, the landowners are informed accordingly about the mining activities that will take place as well as the mining method to be followed by the Sasol Mining Rights Department (SMRD). Where deemed necessary, borehole yield evaluations are done so that the delivery rate of the boreholes are understood and confirmed, and if there any complaints relating to dewatering, the landowner can be compensated with water of the same quality and quantity. This compensation is only done after investigation by a qualified geohydrologist and a report compiled with conclusions and recommendations. The mine monitoring boreholes as indicated in Table 1 also provide valuable information about the aquifer behaviour where dewatering claims are made.

6 INSPECTIONS AND ELEVATION MONITORING

As per Appendix II conditions 3.3.5 and 4.8.1.3, regular inspections of the conveyor crossings and watercourse affected by undermining should be undertaken and recorded. Inspections of the conveyor crossings will be conducted on a ~~daily~~/ weekly basis and coal spillages cleaned within 24 hours of detection. The full length of the watercourse affected by undermining will be inspected on a bi-annual basis and a report compiled by surveyors detailing any anomalous observations.

Section on elevation monitoring in compliance of Appendix II conditions 4.8.1.1 – 4.8.1.5.

The 500Ml pollution control dam has been registered as a dam with a safety risk at the Dam Safety Office. The first dam safety inspection report was compiled in August 2015 and which needs to be reevaluated before August 2020.

7 REPORTING OF MONITORING RESULTS

Reporting of monitoring results to the authorities will be monthly and bi-annually as per the Appendix II condition 4.3 of the water use license. This report should include the following:

- Latest mine plan indicating the regulated areas (1:100 year floodline, riparian habitat and 100m radius from the boundary of any wetland) and the mining footprint related to the kind of mining employed. All monitoring points in relation to condition 4.8 must be indicated on the plan.
- Elevation monitoring results of the undermined watercourses (Appendix II condition 4.8.1.1 - 4.8.1.2, 4.8.1.4 - 4.8.1.5)
- Bi-annual watercourse inspection report (Appendix II condition 4.8.1.3)
- Bio-monitoring report (Appendix II condition 4.8.1.8; Appendix III condition 10.4)
- Surface and Groundwater monitoring results for the bi-annual reporting period.

However, where pollution occurs, reporting will be done within 24 hours as per the Sasol/ DWS protocol for reporting of pollution incidents. Such reports will be in the form of water quality/ quantity trends compared against the historic data as well as water quality objectives as prescribed in the water use license.

Feedback on the recommendations highlighted by the APP in the most recent Dam Safety Inspection report for the 500Ml pollution control dam must be sent to the Dam Safety Office on a bi-annual basis (DW 19E form).