DIGBY WELLS ENVIRONMENTAL

Millsite TSF Reclamation Project

Surface Water Assessment Report

Project Number:

SIB4276

Prepared for:

Sibanye Stillwater

November 2017

This document has been prepared by Digby Wells Environmental.

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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sibanye Gold Limited (Sibanye) to undertake a Surface Water Assessment in support of the Water Use License Application (WULA) for the reclamation of the Millsite tailings complex in the West Rand District, Gauteng Province. Sibanye has existing operations supplying its Cooke Plant with ore, both from reclaimed sand and tailings. This ore feed currently comes from reclamation of Dump 20 as well as the Cooke Shafts 1, 2 and 3.

The project entails the mechanical reclamation of sand which is transported by train to the Cooke Plant as well as the hydraulic reclamation of the Dump 20 slimes tailings residue and hydraulic transportation of the mixture from the existing Dump 20 booster station to the existing Cooke Plant for gold recovery, via a dedicated pipeline. The resultant residue tailings are disposed of into several open cast mining pits, namely the Millsite, Battery 1 & 2, Porges, SRK 2 & 3 and Training open pits. Theses open pits formed part of the historical Lindum Reefs Operations which were previously dormant and required rehabilitation.

The Dump 20 and the Lindum resource is nearing its end and Sibanye now intends to reclaim the Millsite Tailings Storage Facility (TSF) which is located adjacent to Sibanye's Water Treatment Plant and Dump 20. From the operational water balance, the water requirements for the reclamation of Millsite Complex will be approximately 31 500 m3/day and this will be sourced from the old underground workings (8 shaft). This is the same amount of water being currently used on mining of Dump 20 and Lindum.

The surface water assessment report also serves to assess the potential impacts on the surface water resources that may result from the reclamation or inclusion of the Millsite TSF into the existing Cooke Operations and the specific activities to be undertaken.

The Millsite Complex is located in the A21D quaternary catchments of the Limpopo WMA (previously known as Crocodile West and Marico) while Cooke Plant is located within C23E quaternary catchment of the Vaal WMA (previously known as Upper Vaal). The main or perennial river within A21D quaternary catchment is the Tweelopiespruit West/Bloubankspruit River which flows from south towards the north eastern side where the catchment outlet is situated while the Wonderfonteinspruit is the main river within the C23D quaternary catchment. Runoff emanating from this quaternary catchment drains in a south westerly direction into the Wonderfonteinspruit.

Sibanye has been conducting surface and ground water monitoring over a long period of time (ranging from 2012 to 2017) on their existing operations and the surrounds. The existing water quality monitoring data was utilised to analyse and interpret the historical and current water quality status and water quality trends analysis over time to enable monitoring of the surface water impacts that may result from the proposed reclamation of the Millsite Complex.

In the Wonderfonteinspruit, several parameters are within the Mooirivier RQO, although Cooke 1 discharge result in slight increase of certain parameters, the quality remains within

the Mooirivier RQO for most parameters and thereby Cooke 1 discharge does not significantly impact on the Wonderfonteinspruit. With the coming reduction in mining activities within Sibanye operations, a reduction on most metals and suspended solids is expected over time.

From January 2012 to October 2017, water quality at Cooke 1 (W14) and Cooke 2 (W16) discharge has shown fluctuating levels of parameters such Suspended Solids, Iron, Sulphates, Manganese etc. except for iron, most of the parameters have indicated quality which is above the discharge limits as provided in the Water Use license. A21D quaternary catchment

On A21D quaternary catchment, where Millsite Complex is located, the average (January 2012 to March 2017) water quality along the Tweelopiespruit East was benchmarked with the TCTA directives limits. On. Amongst all the parameters with set limits, only Iron and Manganese are exceeding the TCTA directives limit at 17 Winze (untreated) monitoring points. Electrical Conductivity, pH and Sulphates has been within the TCTA's limits along all the monitoring points. The Bloubankspruit/Tweelopiespruit West, parameters such as Uranium, Manganese and Sulphate levels are mostly above the proposed Bloubankspruit RQO's.

The existing and proposed TSF reclamation, 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 clean water runoff by mixing up with dirty water runoff emanating from construction areas;
- Runoff from the tailings will contain high level of dissolved minerals which may result in water contamination or the deterioration of the water quality; and
- Improvement of the surface water quality as a result of complete removal of the pollution source

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:

- Clearing of vegetation must be limited to the development footprint area, and the use of existing access roads must be prioritized to minimize construction of new access roads, hence potential for erosion;
- Implementation of dust suppression measures during construction and operational activities;
- All fuel storage areas should be appropriately bunded and spill kits should be in place, and construction workers 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;
- Ablutions facility for construction workers and general waste bins should be provided. An accredited contractor should be appointed to properly dispose the waste;
- The storm water management as detailed in section 7 of this report to ensure separation of clean and dirty and water runoff, as stated, the temporary surface water ditches are to be constructed on the upstream boundary of the TSF, which will meet GN 704 requirements regarding the separation of clean and dirty water runoff. All clean water runoff will therefore be diverted away from the cleared area. The temporary surface ditches or trenched are to be sized such that the 1:50 year peak discharge can be contained within it.
- Surface water quality monitoring should continue on the monitoring locations indicated in section 5 of this report to enable detection of the water quality impacts and therefore ensure that necessary mitigation measures are immediately implemented;
- Ensure emergency procedures in the event of power failure such as operational modifications and the use of a stand-by generator to operate the pump station should the sump be getting full;
- Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; and
- Ensure that the surface profile is rehabilitated to promote natural runoff drainage and avoid ponding of water within the rehabilitated area. Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site.

With all the recommended mitigation measures in place to ensure the prevention and/or minimisation 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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1 Introduction

Digby Wells Environmental (hereafter Digby Wells) has been appointed by Sibanye Stillwater to undertake a Surface Water Assessment for the reclamation of the Millsite tailings complex in the West Rand District, Gauteng Province. The Surface Water Assessment is conducted in support of the Water Use Licence and Environmental Applications.

1.1 Project Background

Sibanye Stillwater (Sibanye) has existing operations supplying its Cooke Plant with ore, both from reclaimed sand and tailings. This ore feed currently comes from reclamation of Dump 20 as well as the Cooke Shafts 1, 2 and 3 situated in the West Rand District, Gauteng Province (the Cooke Project). The regional and local setting maps are shown on Figure 1-2 and Figure 1-3 while the site specific setting is shown in Figure 1-4.

Sibanye is the holder of a converted Mining Right (reference number: GP 30/5/1/2/2 (173) MR – valid until 6 May 2039) on certain portions of the Farms Randfontein 247 IQ, Waterval 174 IQ, Uitvalfontein (including East Reef Millsite Area of Farm Uitvalfontein 244 IQ) and Rietvalei 241 IQ. Sibanye also has a converted Mining Right (reference number: 30/5/1/2/2 (07) MR – valid until 17 December 2037) on certain portions of Farms Randfontein 247 IQ, Uitvalfontein 244 IQ and Rietvalei 241 IQ. Through these Mining Rights, Sibanye is permitted to mine gold, uranium, silver, nickel, sulphides and pyrite. Together these Mining Rights make up the Rand Uranium/Cooke Operations situated in Randfontein and Westonaria, in the West Rand District Municipality, Gauteng Province.

The underground gold mining consists of Cooke Shafts 1, 2 and 3 which produce up to 1 200 000 tons/annum of gold ore which is currently treated on a toll basis at the Harmony Doornkop Gold Plant. The tailings and sand material is treated in the Cooke Metallurgical Plant and is then backfilled into underground workings to support the underground workings and improve the geotechnical stability (86 400 m^3/annum) and the remainder is placed into various open pits.

For the surface operations, Sibanye Stillwater is currently reclaiming gold from the Lindum tailings dam and from Dump 20 which consists of a mixture of sand and slimes material. The project entails the mechanical reclamation of sand which is transported by train to the Cooke Plant as well as the hydraulic reclamation of the Dump 20 slimes tailings residue and hydraulic transportation of the mixture from the existing Dump 20 booster station to the existing Cooke Plant for gold recovery, via a dedicated pipeline. The resultant residue tailings are disposed of into several open cast mining pits, namely the Millsite, Battery 1 & 2, Porges, SRK 2 & 3 and Training open pits. Theses open pits formed part of the historical Lindum Reefs Operations which were previously dormant and required rehabilitation.

The Dump 20 and the Lindum resource is nearing its end and Sibanye Stillwater now intends to reclaim the Millsite Tailings Storage Facility (TSF) which is located adjacent to Sibanye's

Water Treatment Plant and Dump 20. The focus of this document is on the inclusion of the Millsite TSF into the existing Cooke Operations and the specific activities to be undertaken.

The Millsite deposit consists of dams 38, 39, 40 and 41 under the Mining Right GP 30/5/1/2/2 (173) MR, MR 09/2008 and 190/2008.

1.2 Proposed Reclamation Activity

The hydraulic reclamation activity to be followed is identical to the current approved activities for Dump 20. An existing Booster Pump Station (BPS) is currently in place at Dump 20 which will remain and be utilised for the reclamation of the Millsite TSF and pumping it to the Cooke plant. A finger screen will be put in place at the toe of the Millsite TSF from where the slurry material will enter a sump. A drain pipe will be put in place from the sump to a vibrating screen prior to entering tank from where it will be pumped in a slurry pipeline that will convey the tailings to the BPS at Dump 20. This slurry pipeline will be a 450 mm diameter pipeline with a 6mm rubber lining.

Water for this process will be obtained from 8 Shaft which has approved water abstraction authorisation in place (Water Use Licence No. 03/A21D/AFGJ/2382). Water from 8 Shaft will be stored in a tank at the Water Treatment Plant adjacent to the Millsite TSF. The water pipeline will be utilised to convey water to the Millsite TSF.

From the BPS, the slurry will be pumped to the Cooke Plant for processing. The resultant tailings material will be disposed of into the open pits utilising the existing pipelines which are currently in use. Three pipelines are in place for this process which includes one 450 mm diameter water line, one 400 mm feed slurry line and one 450 mm tailings pipeline. The 450 mm pipe is a multidirectional water line between the Cooke Plant and BPS at Dump 20; the 450 mm is for the sand and residue tailings being reclaimed and pumped to the plant; the 450 mm pipe is to pump residue from the plant to the pits for final deposition. Initially 200 000 tonnes/month of the tailings from the Millsite TSF will be reclaimed, ramping up to 450 000 tonnes/month. It is anticipated that the ramp-up period will take 10 months. This tonnage will merely be a replacement for what is currently being reclaimed from Dump 20 and Lindum Dump

The residue is to be deposited into the open pit voids at the rate of 400 000 tons/month. Cyanide destruction will take place in the Cooke Plant before the residue is deposited and will be below 20 ppm (total CN) as per mining guidelines. The figure below provides an illustration of the process to be followed.

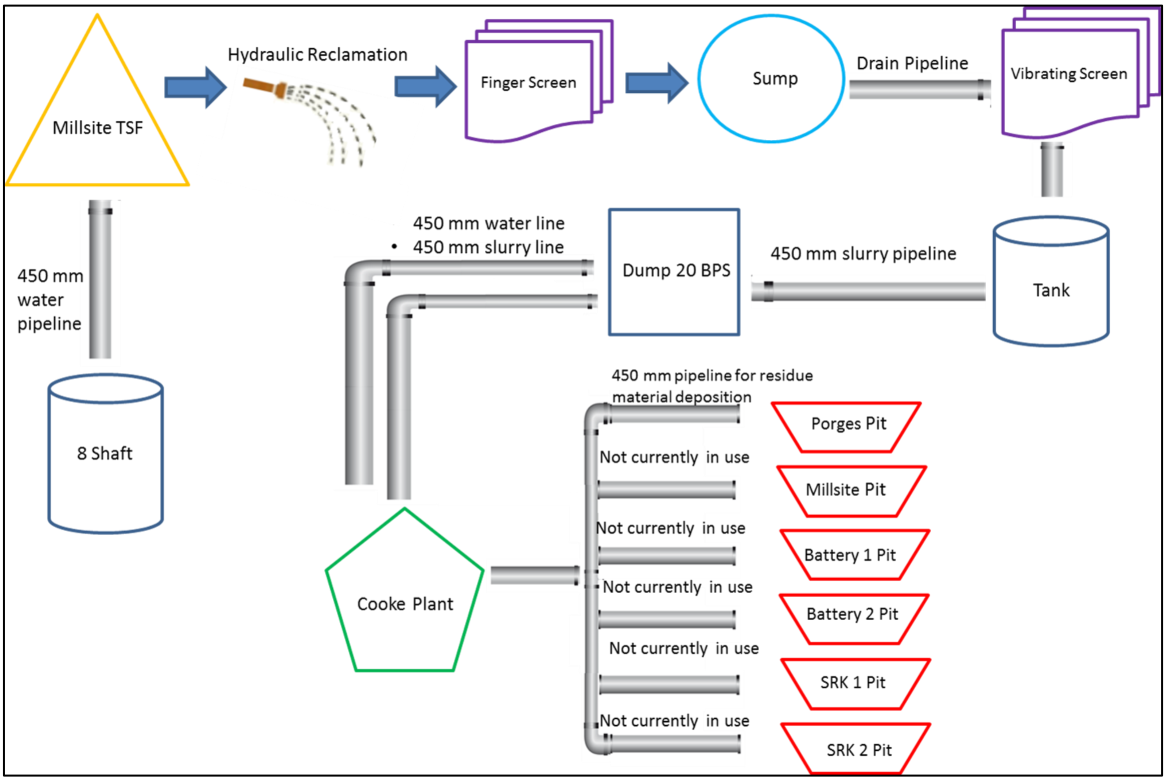


Figure 1-1: Millsite TSF Reclamation Process

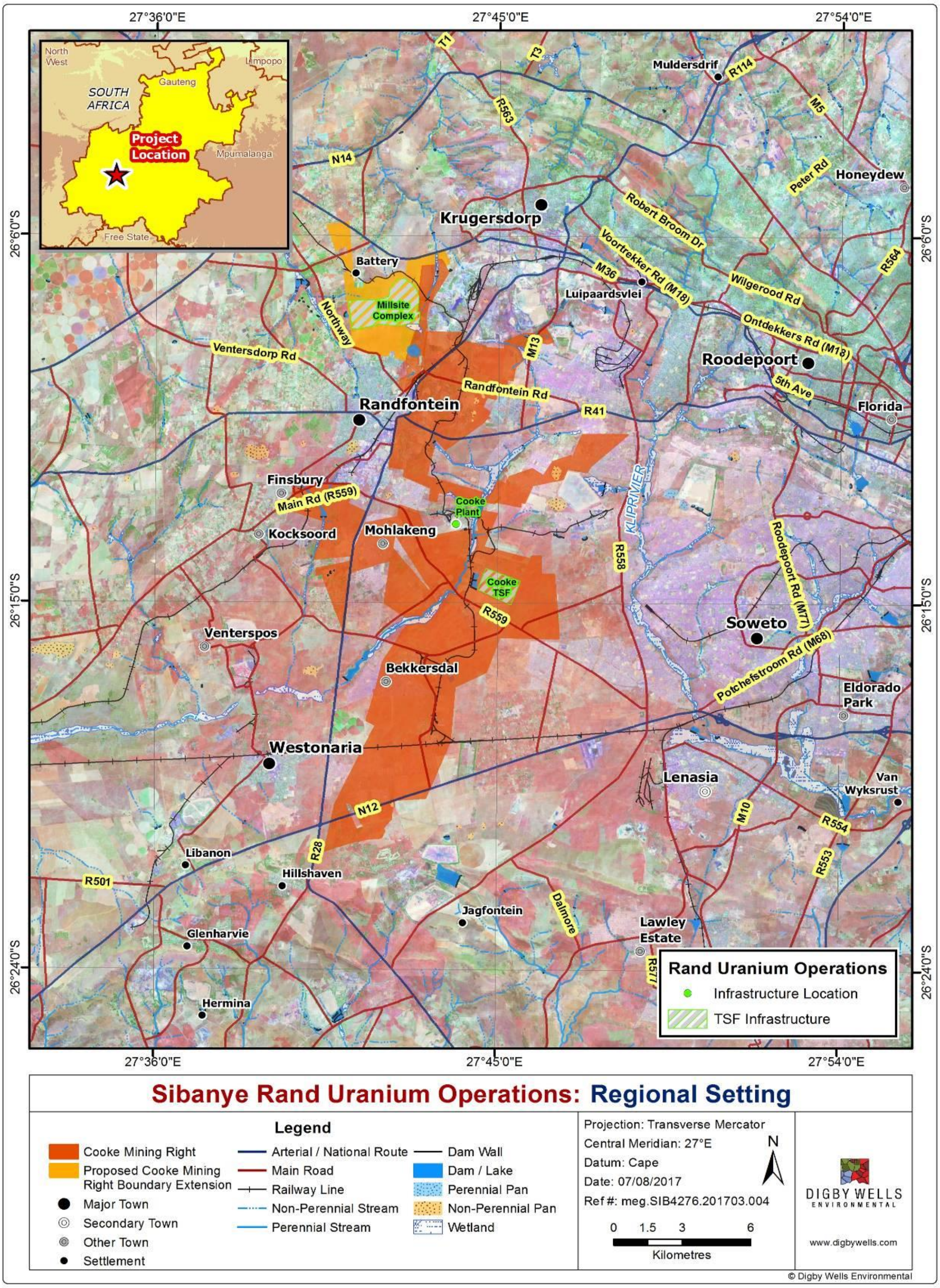


Figure 1-2: Regional Setting

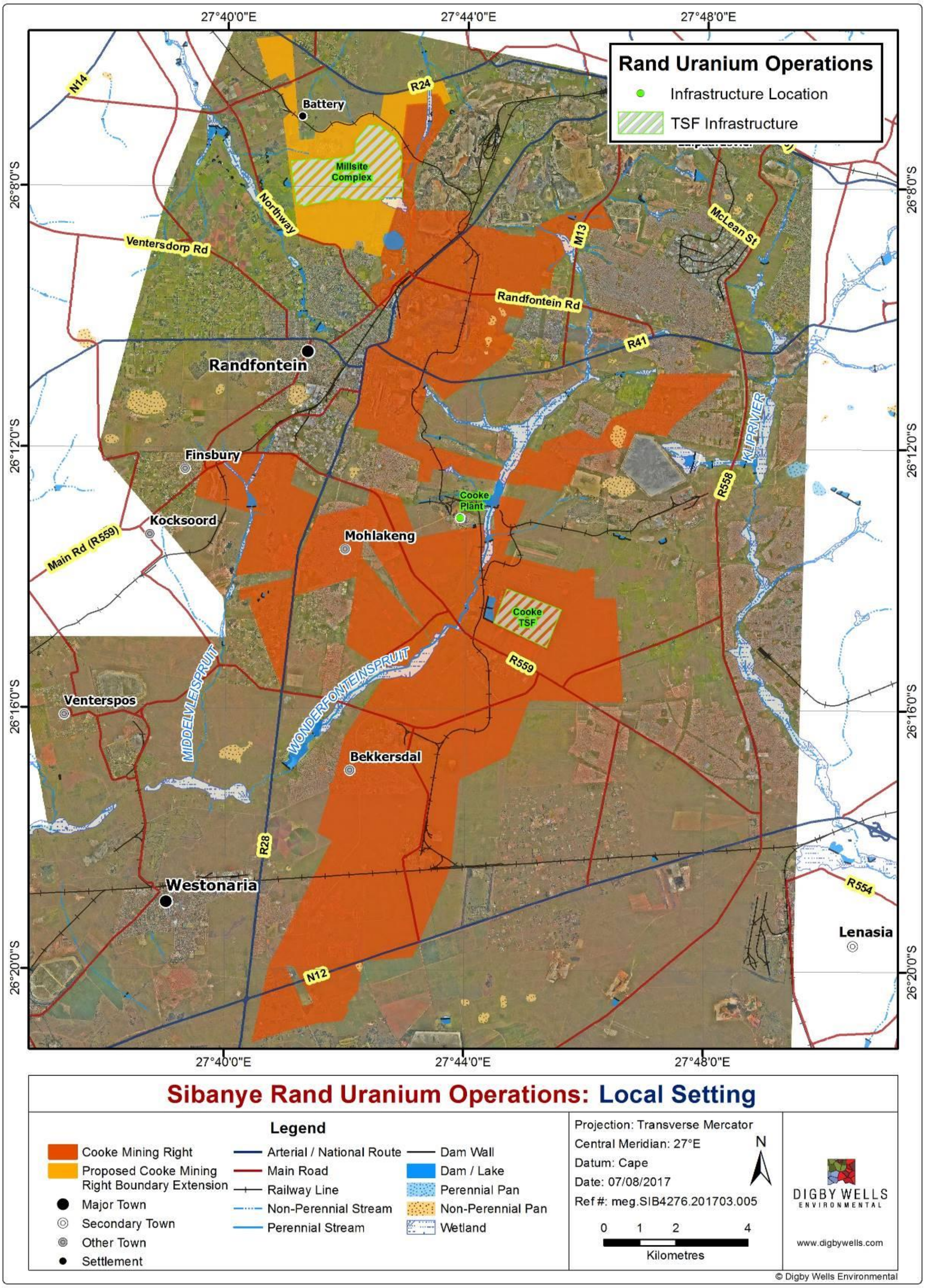


Figure 1-3: Local Setting

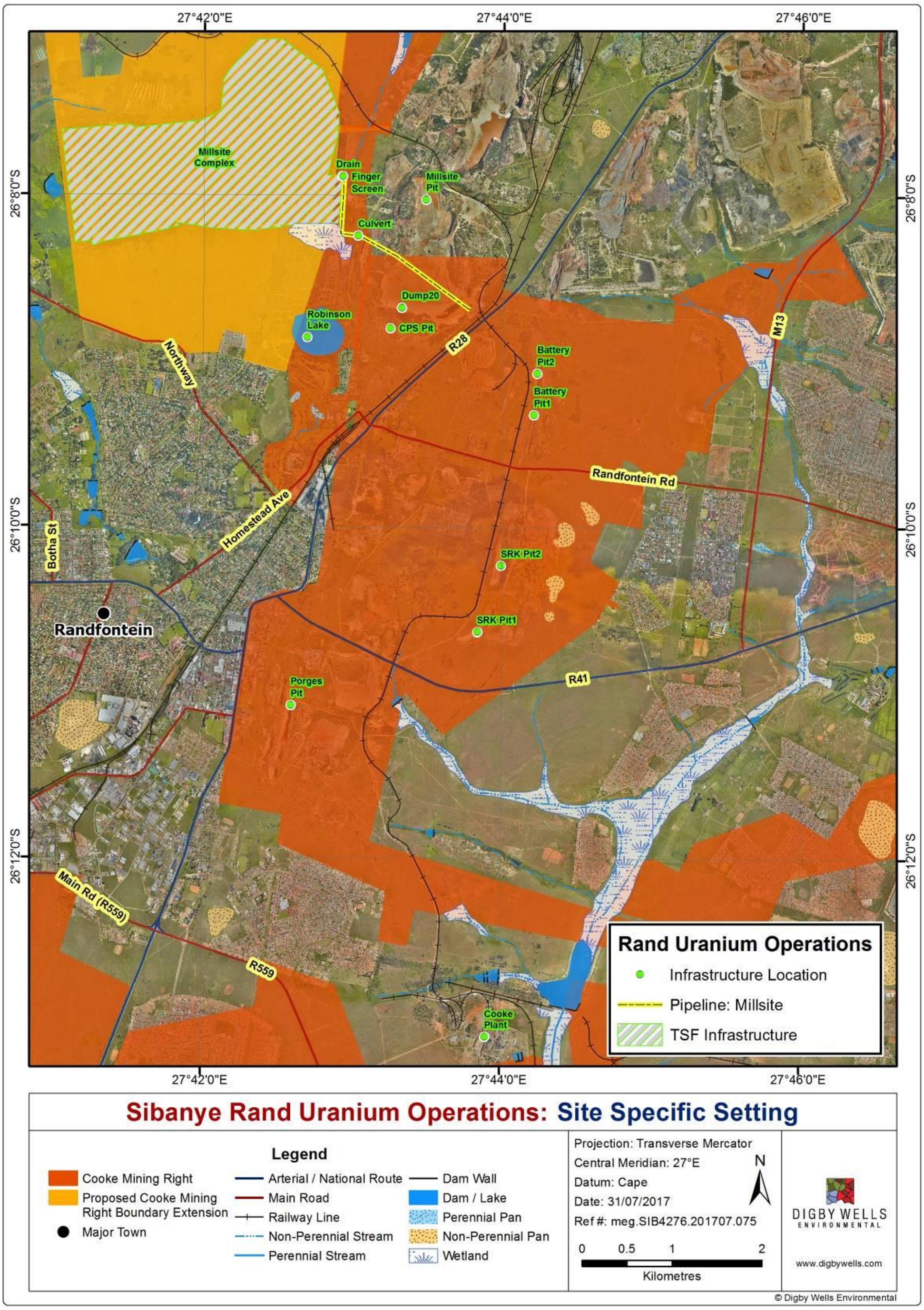


Figure 1-4: Site Specific Setting

2 Terms of Reference

A detailed surface water impact assessment has been conducted to assess and identify potential impacts that may arise from the proposed reclamation of the Millsite complex and associated activities.

2.1 Study Objectives

The objectives of this surface water impact assessment include:

- Site assessments to verify the hydrological characteristics of the project area and the surrounds;
- Describe the hydrological baseline of the project area prior to commencement of the project;
- Update the side wide water balance to include the Millsite reclamation and other additional water requirements;
- Develop a conceptual storm water management plan to ensure separation of clean and dirty water; and
- Conduct a detailed impact assessment to identify the potential surface water impacts that could emanate from the project and its associated activities.

2.2 Methodology

2.2.1 Literature Review

Digby Wells has in 2015 completed an Environmental Impact Assessment Study for the West Rand Tailings Retreatment Project where in the currently affected C23D quaternary catchment was also part of the study. Also, various studies and reports exist for the current Cooke operations and some of the information from these reports was used to obtain most of the baseline information for this area whilst updating the baseline where necessary with new information. Other reports and documents that were reviewed when compiling this report include:

- Department of Water and Sanitation (formerly DWAF), 2006. Best Practice Guideline Series;
- Digby Wells, April 2015. Environmental Impact Assessment for the West Rand Tailings Retreatment Project;
- Water Resources of South Africa, 2012 Study (WR2012), Water Research Commission, Pretoria.

2.2.2 Fieldwork/Site Assessment

A site visit has been undertaken in July 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 surface water impacts.

2.2.3 Baseline Hydrology

The baseline assessment was determined by:

- Describing and characterising all surface water features (rivers/streams, pans and dams) that could potentially be affected by the proposed reclamation of the Millsite complex and associated activities within and around the project area;
- Description of the affected catchment characteristics, climate (rainfall and evaporation), topography and baseline water quality. This information is mainly obtained from the Surface Water Resources of South Africa series of reports; and
- Description and interpretation of historical and current water quality status was completed based on the water monitoring results provided by Sibanye. This provides a baseline water quality prior to commencement of the proposed project.

2.2.4 Storm water management plan

A storm water management plan has been developed in accordance with the Best Practice Guideline G1: Storm Water Management by Department of Water and Sanitation (DWS), 2006 and all the recommendations will be in line with the Government Notice 704 (GN 704) of the National Water Act 1998 (Act 36 of 1998) (NWA), which relates specifically to the separation of clean and dirty water within mining or related activities. The following tasks will be completed:

- Delineation of clean and dirty catchment areas;
- Calculation of the 1:50 year peak flows originating from clean and dirty water catchments; and
- Conceptual placement of clean and dirty water structures is indicated on a plan.

2.2.5 Water Balance

In order to update and compile the mine water balance, Digby Wells will undertake the following tasks:

- Review the proposed water management plan and existing water balance to gain an understanding of the entire mine water system, and explaining the drivers of water within the system and management thereof, for example:
  - process flows and volumes;
  - capacities of water storage facilities;

- water inflows required to be pumped to storage dams for use within the system;
- rainfall and runoff volumes from the clean and dirty areas;
- Develop an excel based water balance which indicates the inflows, potential losses & outflows and transfers within the mine system

2.2.6 Impact Assessment

A detailed surface water impact assessment will be conducted in the following manner:

- Defining potential surface water impacts that could result from the proposed project and its associated activities. Once impacts have been identified, a rating system that takes into consideration the intensity, duration, spatial scale and probability of the impact will be utilised to determine the significance of the identified impacts;
- Recommending mitigation measures to prevent and/or minimise the identified potential surface water impacts over the life of project; and
- Recommend monitoring program and Environmental Management Plan (EMP) that will be used as a tool to detect any surface water impact.

2.3 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.

Andy Pirie is a Hydrologist at Digby Wells Environmental. Andy graduated with a M.Sc. Water Resource Management (with distinction) from the University of Pretoria. Work experience includes rainfall runoff modelling, floodplain delineation modelling, storm water management plans, water and salt balance modelling, setup of water monitoring networks and programmes, analysis of surface water quality and quantity, and surface water specialist studies for environmental and social impact assessments. He has worked on projects in South Africa, Senegal, Mali, Democratic Republic of the Congo, Botswana, Zambia and Namibia.

The Curriculum Vitae for the specialist involved are attached in Appendix A.

3 Assumptions and Limitations

The following assumptions and limitations are applicable to this surface water assessment:

- The surface water impact assessment was conducted based on the provided project descriptions with the associated proposed activities. Additional activities and infrastructure which may form part of this project after issuance of this report may require an update on this study;
- Water quality data was provided by Sibanye for Digby Wells to analyse and interpret on the baseline water quality descriptions

4 Baseline Environment

4.1 Surface Water Hydrology

South Africa is divided into 9 Water Management Areas (WMA) (Revised National Water Resource Strategy, 2012), managed by their own water boards. Each of the WMAs is made up of quaternary catchments which relate to the drainage regions of South Africa, ranging from A to X (excluding O). These drainage regions are subdivided into four known divisions based on size. For example, the letter A represents the primary drainage catchment; A2 for example will represent the secondary catchment; A21 represents the tertiary catchment and A21D would represent the quaternary catchment which is the lowest subdivision in the Water Resources of South Africa, 2012 manual. Each of the quaternary catchments has associated hydrological parameters including total catchment area, Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE), and Mean Annual Runoff (MAR) etc.

As per the revised water management area boundary descriptions (government gazette No. 35517) in 2012, Millsite Complex is located in the A21D quaternary catchments of the Limpopo WMA (previously known as Crocodile West and Marico) while Cooke Plant is located within C23E quaternary catchment of the Vaal WMA (previously known as Upper Vaal). The hydrological setting of this affected area is shown in Figure 4-1.

The surface water attributes of the affected catchments, namely the MAR in million cubic metres (Mm^3), MAP (mm) and MAE (mm) are summarised in Table 4-1 (WRC, 2012).

Table 4-1: Summary of the surface water attributes of the A21D and C23D quaternary catchments

Quaternary Catchment	Total Area (km^2)	MAP (mm)	MAR (Mm^3)	MAE (mm)
A21D	372	714	11.27	1700
C23D	510	664	9.12	1650

A21D quaternary catchment has a total area of 372 km^2 with an MAR of 11.27 Mm^3 whilst the C23D quaternary catchment area is 510 km^2 and has an MAR of 9.12 Mm^3.

4.2 Catchments, Rivers and Drainage

The main or perennial river within A21D quaternary catchment is the Tweelopiespruit West/Bloubankspruit River which flows from south towards the north eastern side where the catchment outlet is situated. The Tweelopiespruit West/Bloubankspruit is approximately 800 m from the Millsite Complex. There are also a few non-perennial drainages/streams that exist within this catchment and is a tributary of the Crocodile River which the feeds into Hartbeespoort Dam.

The unnamed stream is the closest (approximately 100 m) on the northern side of Millsite Complex. On the eastern side of the complex, the catchment is drained by the Tweelopiespruit East located approximately 1km away from Millsite

Wonderfonteinspruit is the main river within the C23D quaternary catchment. Runoff emanating from this quaternary catchment drains in a south westerly direction into the Wonderfonteinspruit. C23D quaternary catchment is a contributing catchment to C23E, and therefore all runoff from C23D eventually drains into Mooirivierloop of the C23E quaternary catchment.

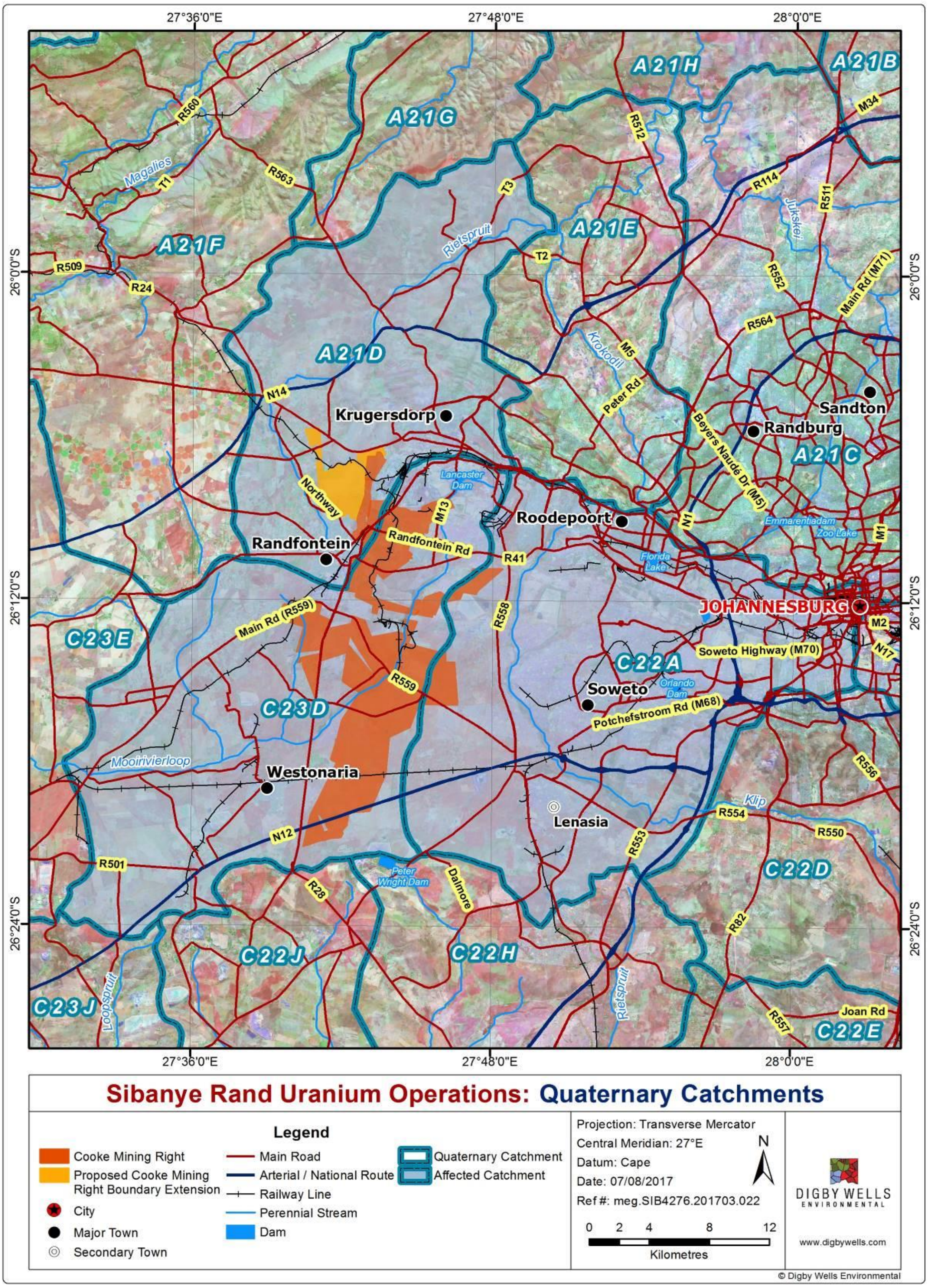


Figure 4-1: Hydrological Setting

4.3 Climate

This section provides a summary of the climate data specifically the WRC adopted rainfall and evaporation figures which represent the baseline climate conditions on the project area.

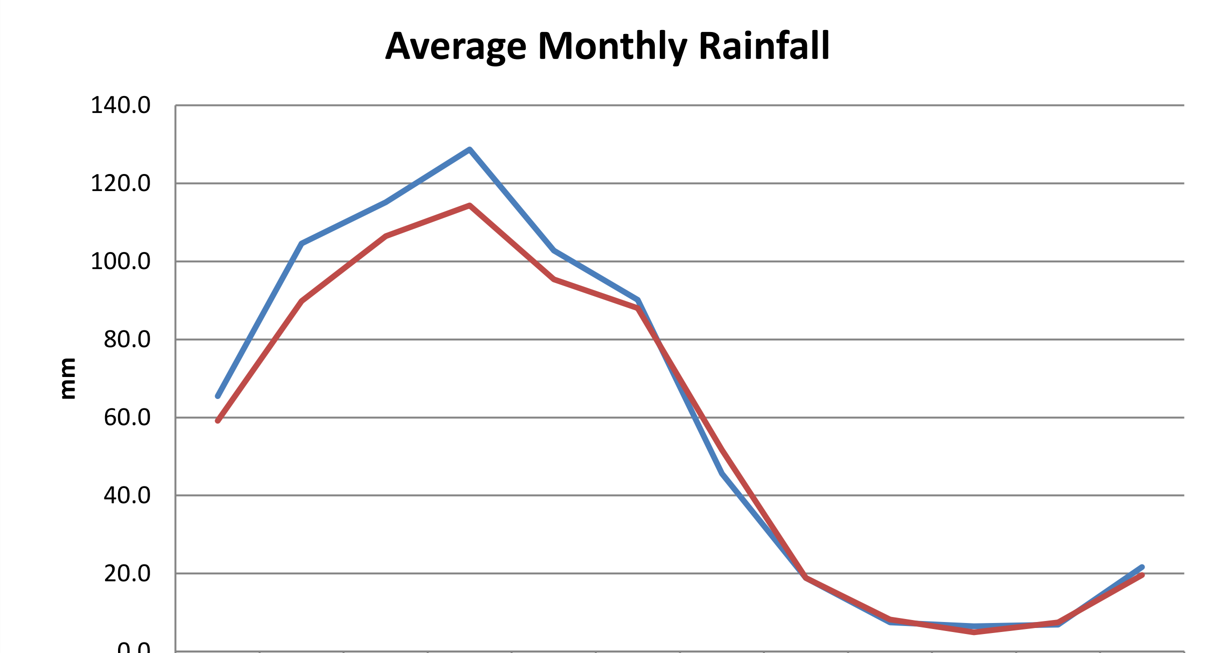
4.3.1 Rainfall

Table 4-2 present the average monthly rainfall for the quaternary catchments A21D and C23D. This is based on the averages of monthly rainfall data from a period of 1920 to 2009.

Table 4-2: Summary of rainfall data extracted from the WR2012

Month	MAP (mm)	
	A21D	C23D
January	128.7	114.3
February	102.8	95.4
March	90.2	88.0
April	45.6	51.7
May	18.8	18.9
June	7.5	8.2
July	6.5	4.9
August	6.9	7.4
September	21.6	19.6
October	65.5	59.2
November	104.6	89.8
December	115.2	106.4
MAP	**664**	**714**

From the rainfall data above, higher rainfall averages in the A21D quaternary catchment (104.6 mm, 115.2 mm and 128.7 mm) were recorded for the months of November, December and January respectively whilst on the C23D higher rainfall averages occurs on December, January and February. The lowest average rainfall was recorded in July for both the quaternary catchments. In general, these two catchments receive an average rainfall of 664 mm and 714 mm per annum for A21D and C23D respectively.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
A21D	65.5	104.6	115.2	128.7	102.8	90.2	45.6	18.8	7.5	6.5	6.9	21.6
C23D	59.2	89.8	106.4	114.3	95.4	88.0	51.7	18.9	8.2	4.9	7.4	19.6

Figure 4-2: Summary of the average monthly rainfall for the two quaternaries

4.3.2 Evaporation

As classified in the WR2012 manual, the A21D quaternary is located in the 3A evaporation zone whilst the C23D is within 10A 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 1427 mm and 1385 mm per annum for A21D and C23D respectively, the summary of the average monthly evaporation for the two catchments is presented in Table 4-3 and Figure 4-3.

Table 4-3: Summary of evaporation data

Months	Lake Evaporation Factor	Lake Evaporation (mm)	
		A21D	C23D
January	0.84	159.9	159.1
February	0.9	137.6	130.4
March	0.9	127.2	118.0
April	0.9	95.4	91.9
May	0.9	75.0	75.8
June	0.9	57.7	58.5
July	0.8	65.2	67.2
August	0.8	93.4	93.2
September	0.8	128.6	124.4
October	0.8	158.6	148.5
November	0.82	160.9	155.1
December	0.83	167.3	162.6
Total	**N/A**	**1427**	**1385**

In this area, higher potential evaporation rates are expected during the months of November, December and January whilst the low potential evaporation is expected on May, June and July for both the A21D and C23D quaternary catchments. The potential evaporation rates in these two catchments exceed the average mean annual rainfall, thereby rendering this area as semi-arid.

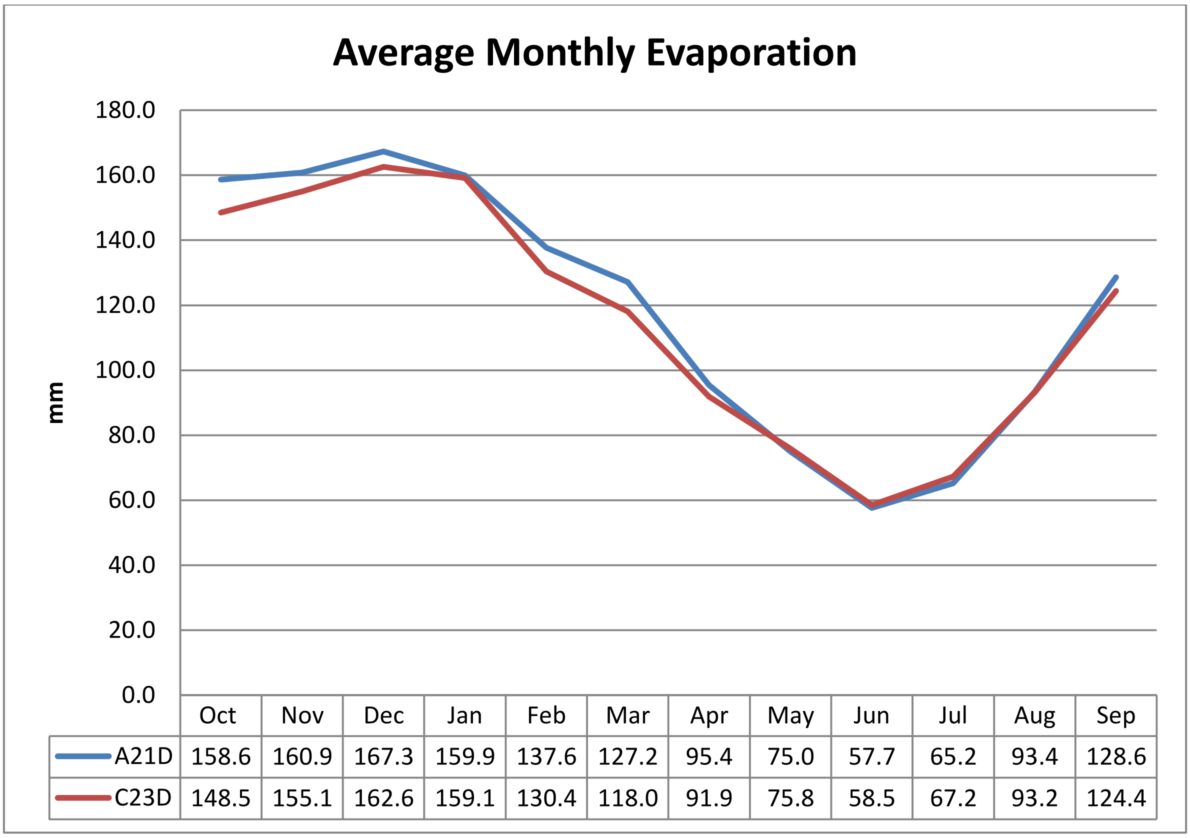


Figure 4-3: Summary of the average monthly evaporation for the two quaternaries

5 Water Quality

Sibanye has conducted surface and ground water monitoring over an extended period of time on their existing operations and the surrounds. For the purpose of this study, Sibanye provided Digby Wells with their existing water quality monitoring database (ranging from 2012 to 2017) to enable interpretation of the data, water quality trend analysis over time, and to establish the current water quality status prior to the proposed reclamation of the Millsite TSF Complex.

As mining and reclamation activities can impact on water resources, water quality monitoring also serves to quantify and characterise the impact that the mining activity has on the immediate and greater catchment.

Sibanye has an existing WUL with conditions associated with the discharge of excess water from underground into the Wonderfonteinspruit. There is an existing licenced discharge point (W14) below Cooke Shaft 1, downstream of the Cooke plant, where underground fissure water is discharged into the Wonderfonteinspruit. Underground water from Cooke 2 and 3 shafts is also discharged into the Magazine Pan, from where the water either seeps back into the underground workings or evaporates from the pan.

Water is pumped out of the Western Basin at the historical shafts known as 8 Shaft and 9 Shaft, to be treated in the exiting West Rand Acid Mine Drainage Treatment Facility, managed by the Tran-Caledon Tunnel Authority (TCTA). From here, treated water is discharged into the Tweelopiespruit. In addition to the water pumped at the shafts, water is captured from some decant points, namely the Winze area and the BRI Dam and is then pumped to the treatment plant. If the water needing to be pumped from the decant points exceeds the water treatment plant capacity then this water is discharged without treatment.

Water quality results on the Wonderfonteinspruit monitoring points were benchmarked with the water use license discharge limits that were provided for Cooke 1 and Cooke 2 Discharge. The results at the Tweelopiespruit catchment were benchmarked with the TCTA directives or limits provided by DWS. This was done to determine the water quality trends over time, parameters of concern and the baseline water quality prior to undertaking the proposed projects.

Table 5-1 provides an annual average water quality analysis of the current discharge from Cooke 1 and Cooke 2 (January 2017 – October 2017) monitoring points benchmarked with the water use license discharge limits and the proposed Resource Quality Objectives (RQO) for Mooiriver catchment has also been included in the benchmark. The parameters of concern during the recent period (March 2017 – October 2017) include but not limited to EC, TDS, SS, SO_4, U, Al and Pb on the Wonderfonteinspruit monitoring points.

Table 5-1: Average Water Quality at the Cooke 1 and Cooke 2 Shaft Discharge Monitoring Point (January 2017 – October 2017)

Variables	Unit	Proposed RQO's for Mooiriver catchment	WUL Limits	W14	W16
pH			5.5-9.5	7.6	8.7
Electrical conductivity	mS/m	111	115	105.8	139.1
Total dissolved solids	mg/ℓ		750	839.2	1054.2
Suspended solids	mg/ℓ		55	83.3	203.4
Sulphate	mg/ℓ	500	600	417.8	699.9
NO3 as N	mg/ℓ	4		3.2	3.8
PO4 as P	mg/ℓ	0.125		0.7	0.1
Total cyanide	mg/ℓ		0.5	0.7	0.2
Calcium	mg/ℓ		90	116.6	197.8
Chloride	mg/ℓ		50	39.4	34.6
Fluoride	mg/ℓ	3	0.1	0.4	0.5
Magnesium	mg/ℓ		70	30.3	25.7
Sodium	mg/ℓ		70	80.9	99.6

Uranium	mg/ℓ	0.015	0.07	0.10	0.11
Aluminum	mg/ℓ	0.15	0.5	0.8	0.6
Boron	mg/ℓ		0.5	0.2	0.2
Cadmium	mg/ℓ	0.005	0.01	0.03	0.0
Copper	mg/ℓ	0.008	0.1	0.1	0.1
Iron	mg/ℓ		0.2	0.2	0.2
Lead	mg/ℓ	0.013	0.1	0.027	0.024
Manganese	mg/ℓ	1.3	0.1	1.1	0.2
Nickel	mg/ℓ		0.2	1.3	0.2
Zinc	mg/ℓ	0.036	0.08	0.7	0.05

(yellow)	Exceeding WUL
(orange)	Exceeding RQO

Table 5-2 provides an annual average water quality analysis of water discharged into the Tweelopiespruit by the TCTA's treatment facility. Two points have been selected, one (17 Winze) where uncontrolled overflow enters the Tweelopiespruit and the other (V1B) where treated water is discharged from the TCTA Water Treatment Plant. These discharges have been compared to the TCTA's directive discharge limits prescribed by DWS and the proposed RQS for Bloubankspruit. The parameters of concern include but not limited to TDS, SS, SO4, CN, Fe, Mn and Zn.

Table 5-2: Annual Average Water Quality of Water Discharged into the Tweelopiespruit

				March 2016 - March 2017	March 2015 - March 2016	March 2016 - March 2017	March 2015 - March 2016
Variables	**Unit**	**Proposed RQS Bloubankspruit**	**TCTA Directive**	**17 Winze (untreated)**		**V1B (treated)**	
pH		6.5-8.5	6.5-9.5	6.4	6.2	8.61	7.69
Electrical conductivity	ms/m		450	321.10	378.25	349.86	327.50
Total dissolved solids	mg/ℓ			3225.60	3969.17	3585.17	3410.09
Suspended solids	mg/ℓ			23.1	116.17	11.59	10.80
Sulphate	mg/ℓ	40	3000	2023.34	2446.17	2401.52	2178.98
Total cyanide	mg/ℓ	0.11		0.64	0.58	0.50	0.50
Calcium	mg/ℓ			561.28	583.92	666.61	602.00
Chloride	mg/ℓ			55.48	52.33	48.07	47.39

Fluoride	mg/ℓ			0.37	0.41	0.78	0.81
Magnesium	mg/ℓ			112.78	145.58	99.30	104.82
Sodium	mg/ℓ			141.53	144.67	158.30	131.98
Uranium	mg/ℓ	0.03		0.043	0.036	0.015	0.014
Aluminium	mg/ℓ	0.1	1	0.042	0.029	0.059	0.068
Boron	mg/ℓ			0.25	0.425	0.62	0.44
Cadmium	mg/ℓ			0.008	0.001	0.002	0.001
Copper	mg/ℓ			0.019	0.004	0.004	0.006
Iron	mg/ℓ	0.3	<1	37.15	83.67	0.51	0.36
Lead	mg/ℓ			0.025	0.001	0.003	0.001
Manganese	mg/ℓ	0.15	<10	23.03	30.67	2.51	3.18
Nickel	mg/ℓ	0.07		0.23	0.081	0.051	0.069
Zinc	mg/ℓ	0.002		0.08	0.034	0.024	0.037
Phosphate	mg/ℓ	0.125					

(yellow)	Exceeding TCTA's Directive
(orange)	Exceeding RQO

5.1.1.1 Description of the Selected Monitoring Locations

As mentioned above, Sibanye has an extensive monitoring programme. Representative samples have been selected to interpret the surface water quality. The sample points comprise of upstream and downstream points of the operations. The coordinates and descriptions of the selected monitoring locations have been provided Table 5-3 below.

Table 5-3: Selected Water Monitoring Points

Name/ID	Descriptions	X co-ord	Y co-ord
Sibanye's Monitoring Points in Wonderfonteinspruit			
W4	West Rand slimes effluent (trench)	26° 8'29.59" S	27° 45'53.30" E
W5	Wonderfonteinspruit at Kagiso low bridge	26° 9'20.82" S	27° 45'52.42" E
W6	Wonderfonteinspruit at Rndfntn/Rdprt bridge no. 450	26° 9'51.57" S	27° 46'0.13" E
W7	Wonderfonteinspruit at Kagiso bridge	26° 10'2.77" S	27° 46' 39.9" E
W8	Wonderfonteinspruit upstream of Flip Human STP	26° 10'39.19"S	27° 45'57.20" E
W9	Flip human STP effluent discharge	26° 10'55.2" S	27° 46'12.35"E
W10	Attenuation dam outlet	26° 12'58.04"S	27° 44'28.66"E
W12	Wonderfonteinspruit before Cooke TSF	26° 13'58.27"S	27° 44'12.03"E
W13	Wonderfonteinspruit after Cooke TSF	26° 14'29.9" S	27° 44'0.71"E
W14	Cooke 1 shaft discharge to the Wonderfonteinspruit	26° 14' 56.9"S	27° 44' 4.9"E
W15	Wonderfonteinspruit at bridge before Cooke 2 shaft	26° 15'56.3"S	27° 41'55.4"E

TCTA's Monitoring Points in Tweelopiespruit West			
POINT2	Tweelopies West Point 2 overflow near Greenhills Avenue	26° 9'56.30"S	27°41'16.20"E
POINT4	Tweelopies West Point 4 bridge on dirt road below slimes dam 41	26° 8'29.68"S	27°40'32.06"E
POINT6	Tweelopies West Point 6 bridge Krugersdorp/ Venterdorp road	26° 6'54.93"S	27°39'41.41"E
POINT7	Tweelopies WEST Point 7 Dirk Mellet Plot 129	26° 7'45.51"S	27°40'36.23"E
TCTA's Monitorign Points in Tweelopiespruit East			
TCTA (V2)	BRI Dam mixture to HDS Plant	26° 6 55.67S	27° 43 22.31E
TCTA V1.A	Uncontrolled Overflow into collection pond (trench)	26° 6 27.50S	27° 43 20.54E
TCTA V1.B	RU Treated water before game reserve - collection pond (trench)	26° 7 15.61S	27° 43 11.73E
8 Shaft	Water pumped from western basin void (Shaft)	26° 08 07.42S	27° 43 10.15E
TCTA V1.C	Uncontrolled and Treated water combined into game reserve (mixing sump)	26° 6 24.96S	27° 43 20.16E
17 Winze	Shaft overflow to Tweelopiespruit east	26° 7'17.10"S	27°43'17.82"E
18 Winze	Shaft decant to BRI dam	26° 6'54.50"S	27°43'29.59"E

5.1.1.2 Water Chemistry Discussion

The summary of the chemistry results is presented on the figures below and the chemistry can be interpreted as follows:

5.1.1.2.1 C23D quaternary catchment

- In the Figure 5-1 and Figure 5-2 below, total dissolved solids, sulphates and electrical conductivity only showed elevated levels which are above the proposed Mooirivier quality objectives at the W4 upstream monitoring point. This could be as result of the contaminated slimes effluent/seepage from the West Rand slimes dam into the Wonderfonteinspruit, it should be noted that the referred to West Rand slimes is a property of Sibanye and Sibanye but of other parties around the area. A significant improvement in these parameters occurred as you downstream until the last monitoring points.
- A slight increase has been observed along Cooke 1 discharge point. However, the quality remained within the Mooirivier quality objectives and this could have been due to dilution of the mine water discharge as it enters the stream.
- Elevated levels of Uranium has been observed downstream of Cooke 1 discharge (W14) whilst Manganese levels have improved along or downstream of Cooke 1 discharge.

From January 2012 to October 2017, water quality at Cooke 1 (W14) and Cooke 2 (W16) discharge has shown fluctuating levels of parameters such Suspended Solids, Iron, Sulphates, Manganese etc. except for iron, most of the parameters have indicated quality which is above the discharge limits as provided in the Water Use license. In the Wonderfonteinspruit, several parameters are within the Mooirivier RQO, although Cooke 1 discharge result in slight increase of certain parameters, the quality remains within the Mooirivier RQO for most parameters and thereby Cooke 1 discharge does not significantly impact on the Wonderfonteinspruit (See Figure 5-1). With the coming reduction in mining activities within Sibanye operations, a reduction on most metals and suspended solids is expected over time.

5.1.1.2.2 A21D quaternary catchment

- On A21D quaternary catchment, where Millsite Complex is located, the average (January 2012 to March 2017) water quality along the Tweelopiespruit East was benchmarked with the TCTA directives limits. On. Amongst all the parameters with set limits, only Iron and Manganese are exceeding the TCTA directives limit at 17 Winze (untreated) monitoring points. Electrical Conductivity, pH and Sulphates has been within the TCTA's limits along all the monitoring points.
- Manganese is showing fluctuating concentrations and elevated levels exceeding the TCTA limits are observed at 17 Winze shaft (untreated). However, a significant decrease of Manganese levels is then observed going downstream of the Tweelopiespruit East.
- On the Bloubankspruit/Tweelopiespruit West, parameters such as Uranium, Manganese and Sulphate levels are mostly above the proposed Bloubankspruit RQO's.

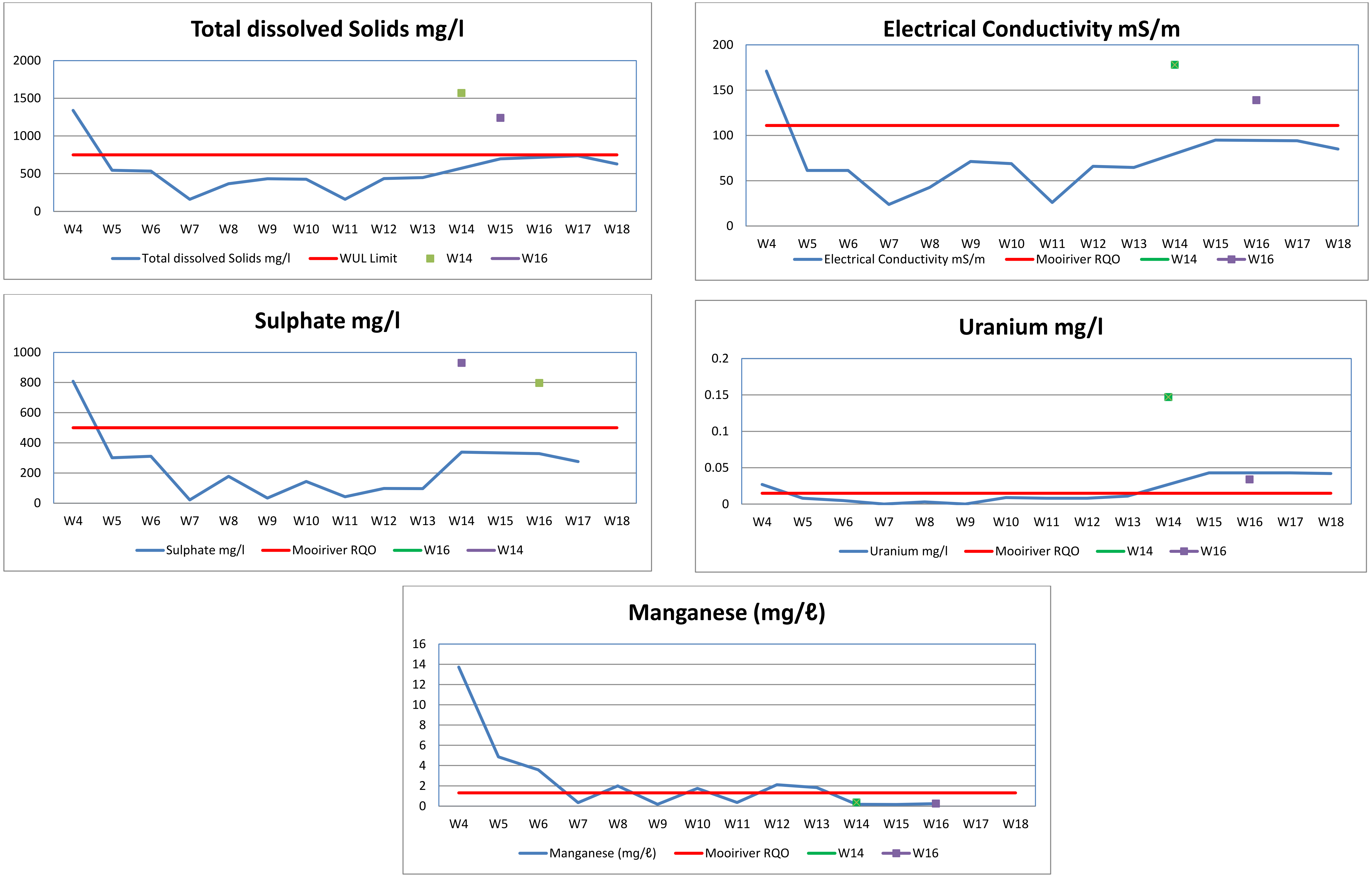


Figure 5-1: Summarised average water quality trends from upstream to downstream of the Wonderfonteinspruit (January 2012 to October 2017)

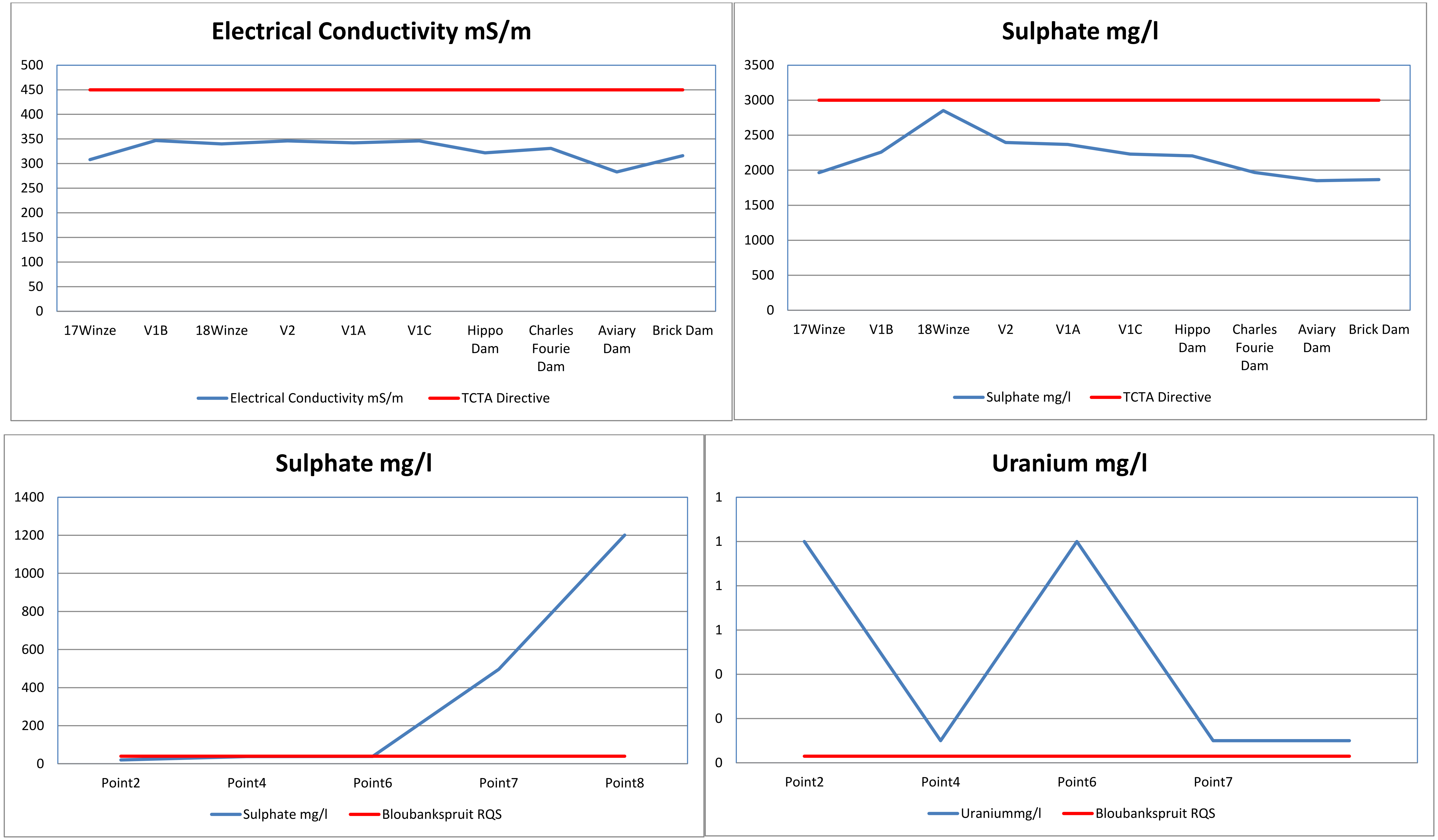
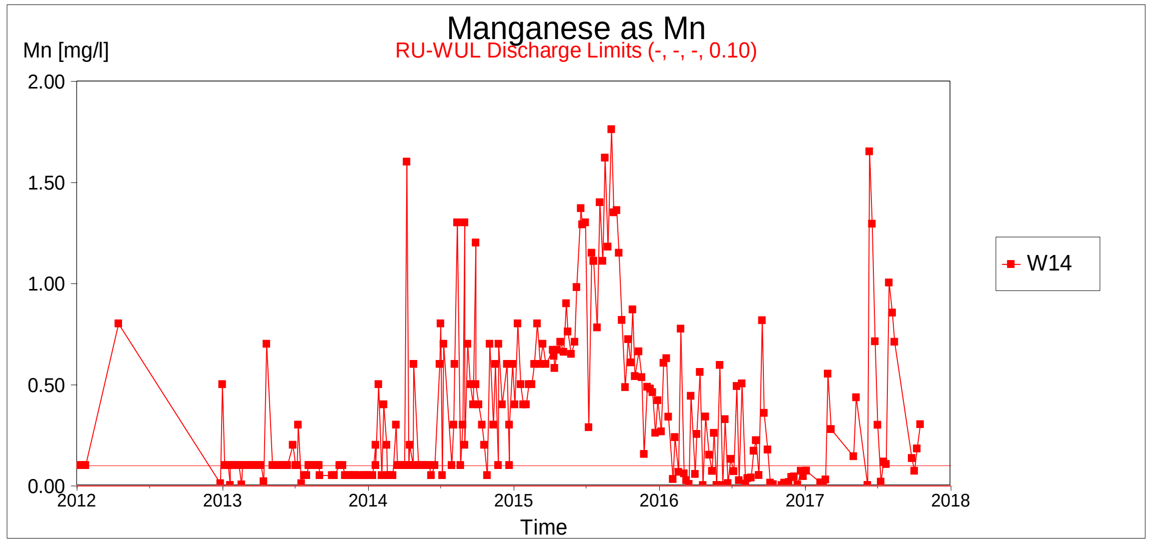
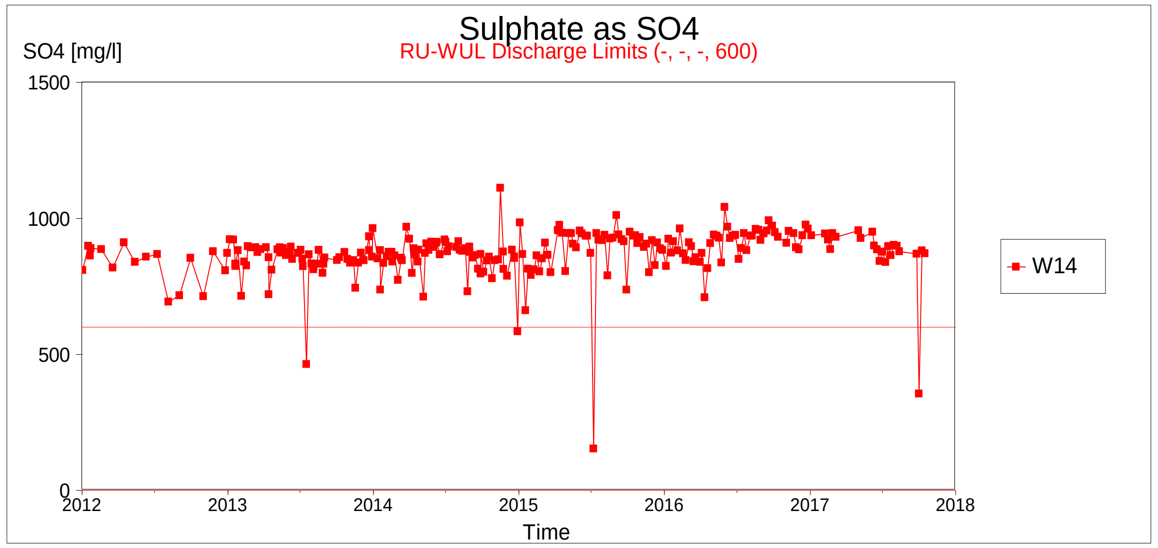
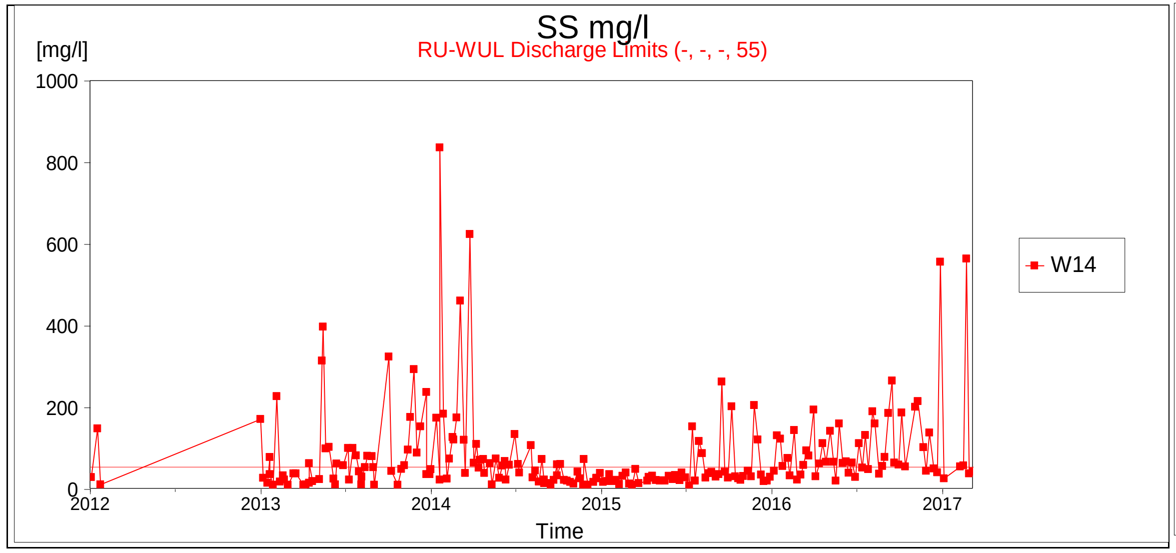
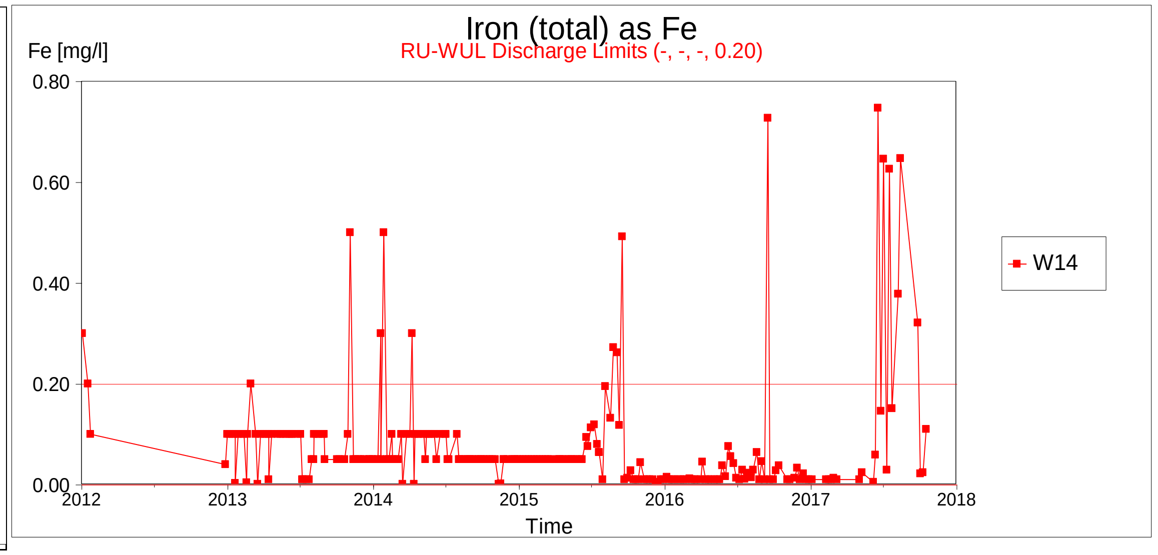


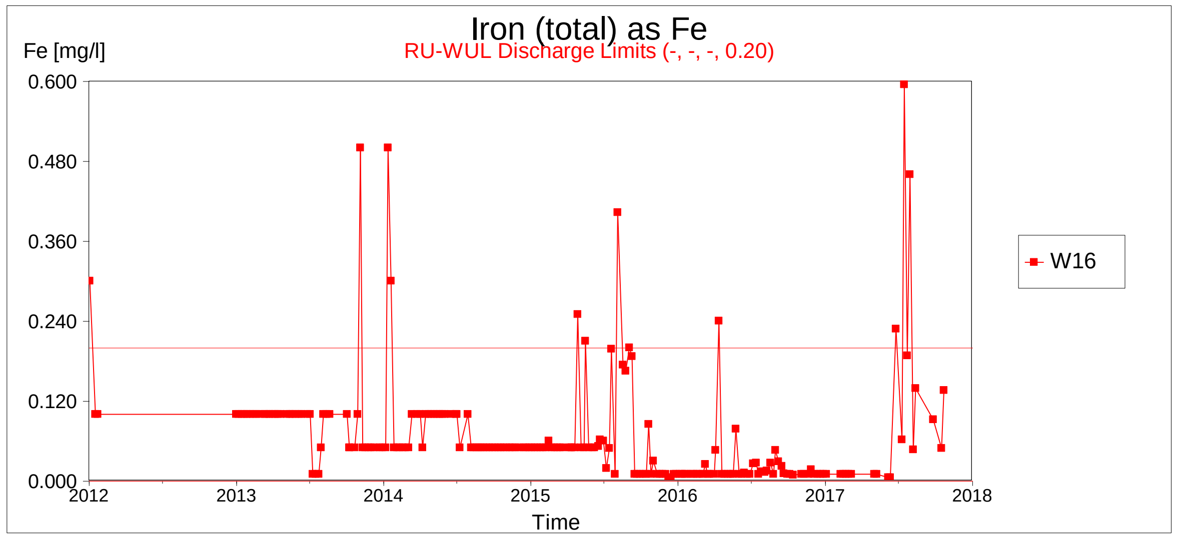
Figure 5-2: Summarised average water quality trends from upstream to downstream of the Tweelopiespruit West and East (January 2012 to March 2017).

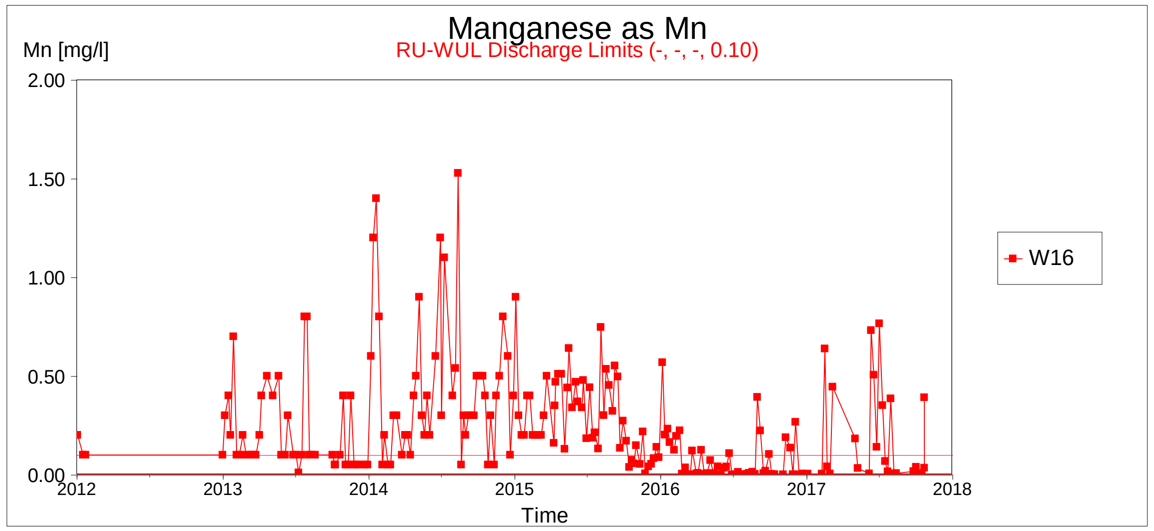

Manganese as Mn
RU-WUL Discharge Limits (-, -, -, 0.10)
Mn [mg/l]
2.00
1.50
1.00
0.50
0.00
2012
2013
2014
2015
2016
2017
2018
Time
W14

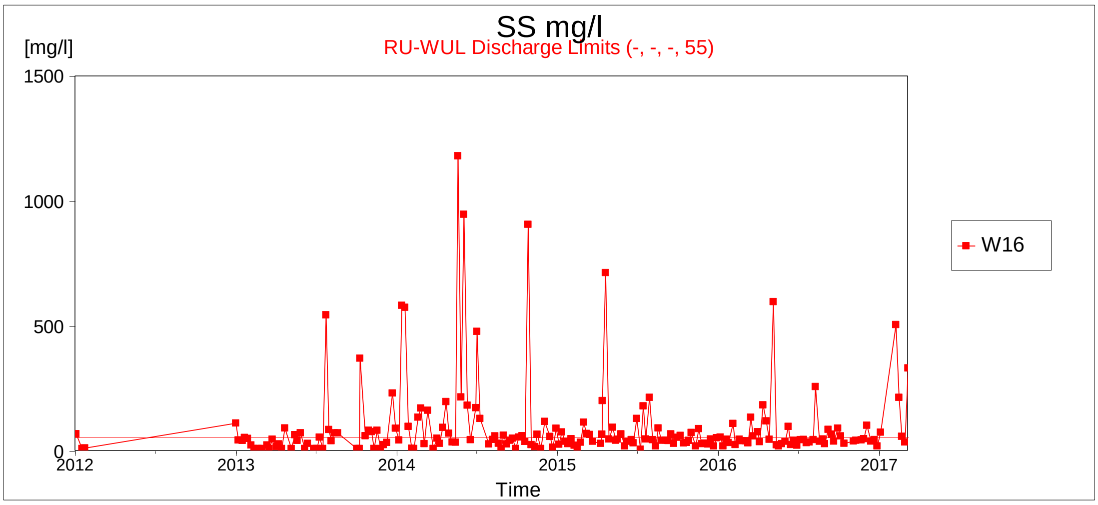

Sulphate as SO4
RU-WUL Discharge Limits (-, -, -, 600)
SO4 [mg/l]
1500
1000
500
0
2012
2013
2014
2015
2016
2017
2018
Time
W14


SS mg/l
RU-WUL Discharge Limits (-, -, -, 55)
[mg/l]
1000
800
600
400
200
0
2012
2013
2014
2015
2016
2017
Time
W14


Iron (total) as Fe
RU-WUL Discharge Limits (-, -, -, 0.20)
Fe [mg/l]
0.80
0.60
0.40
0.20
0.00
2012
2013
2014
2015
2016
2017
2018
Time
W14


Iron (total) as Fe
RU-WUL Discharge Limits (-, -, -, 0.20)
Fe [mg/l]
0.600
0.480
0.360
0.240
0.120
0.000
2012
2013
2014
2015
2016
2017
2018
Time
W16


Manganese as Mn
RU-WUL Discharge Limits (-, -, -, 0.10)
Mn [mg/l]
2.00
1.50
1.00
0.50
0.00
2012
2013
2014
2015
2016
2017
2018
Time
W16



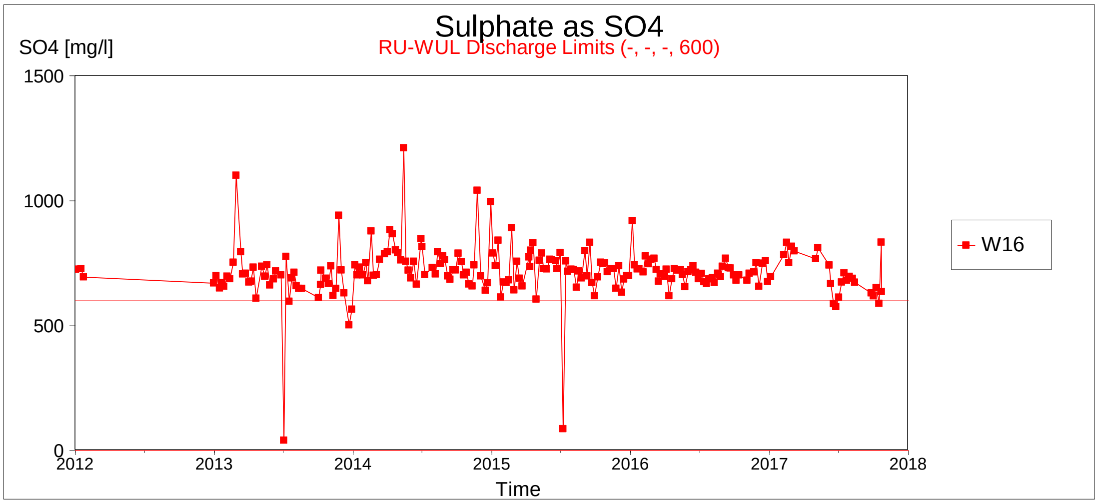


Figure 5-3: Water quality trend (January 2014 to October 2017) at Cooke 1 and Cooke 2 Discharge

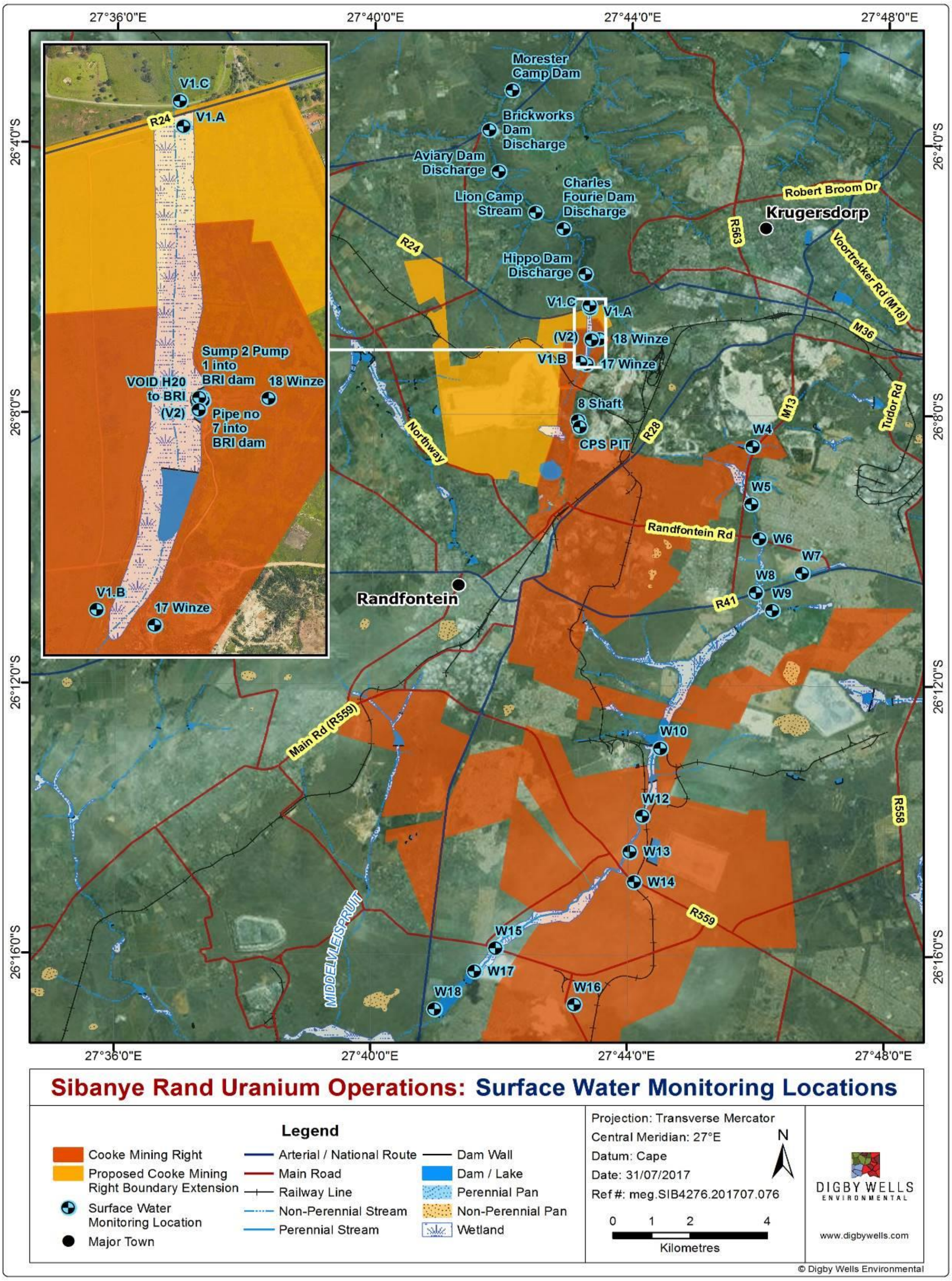


Figure 5-4: Monitoring Locations

6 Water and Salt balance

A site-wide water balance model has been prepared to understand flows within the Rand Uranium operational water circuit. The operational water volumes for the period of 2015 – 2017 were provided by Sibanye together with a schematic process flow diagram for Rand Uranium operation. As mentioned in section 1.2, Sibanye is currently reclaiming gold from the Lindum tailings dam and Dump 20 which the resource is nearing its end and Sibanye now intends to reclaim the Millsite Tailings Storage Facility (TSF) which is located adjacent to Sibanye's Water Treatment Plant and Dump 20.

6.1 Objectives

The presented water balance will be used by the mine in support of the Water Use Licence (WUL) application as well as a water management tool to achieve the following key principles of water management:

- Understand water circuit at the mine;
- Estimate makeup water volumes required during periods of deficit;
- Estimate volumes of excess water during periods of surplus; and
- Assess areas within the mine water circuit, where opportunities to conserve and re-use water can be implemented.

6.1.1 Water Balance Components

A summary of the information used in the water balance include:

- Climate data which includes rainfall and evaporation; and
- Mine water requirements obtained from the applicant, which include potable water and water uses at operational phase.

Existing water sources (inflows) include:

- Fissure water/groundwater on old underground working pumped out through the old shafts;
- Storm water collected from dirty catchments and conveyed to PCD;
- Rainfall and runoff from the western void; and
- Potable water supply from municipality and boreholes.

Water sinks (losses) include:

- Evaporation;
- Plant loses;
- Discharges into WWTP, Magazine pan, Wonderfonteinspruit, Tweelopiespruit; and

- Water consumption.

6.2 Results

The summary of the daily average water balance is in Figure 6-1. The water balance results are summarised as follows:

- The water requirements for the reclamation of Millsite Complex will be approximately 31 500 m^3/day that will be sourced from the old underground workings (8 shaft). This is the same amount of water being currently used on mining of Dump 20 and Lindum.
- A total of 21,850 m^3/day is sent to Cook plant to satisfy the entire plant requirement. 950 m^3 of this is Randfontein municipal water and 3,700 m^3 recovered from the underground where backfill is taking place, while the remaining is the slurry water from the Millsite TSF.
- An average of 18,000 m^3/day of the resultant residue tailings is disposed interchangeably into various open cast mining pits, namely the Millsite, Battery 1 & 2, Porges, SRK 2 & 3 and Training open pits.
- From the salt balance, as discussed in section 5 as well, there are some parameters on the discharge water which are above the discharge limits as provided in the Water Use license. The concentrations from the abstraction points and discharge points have also been indicated in Figure 6-1 below.

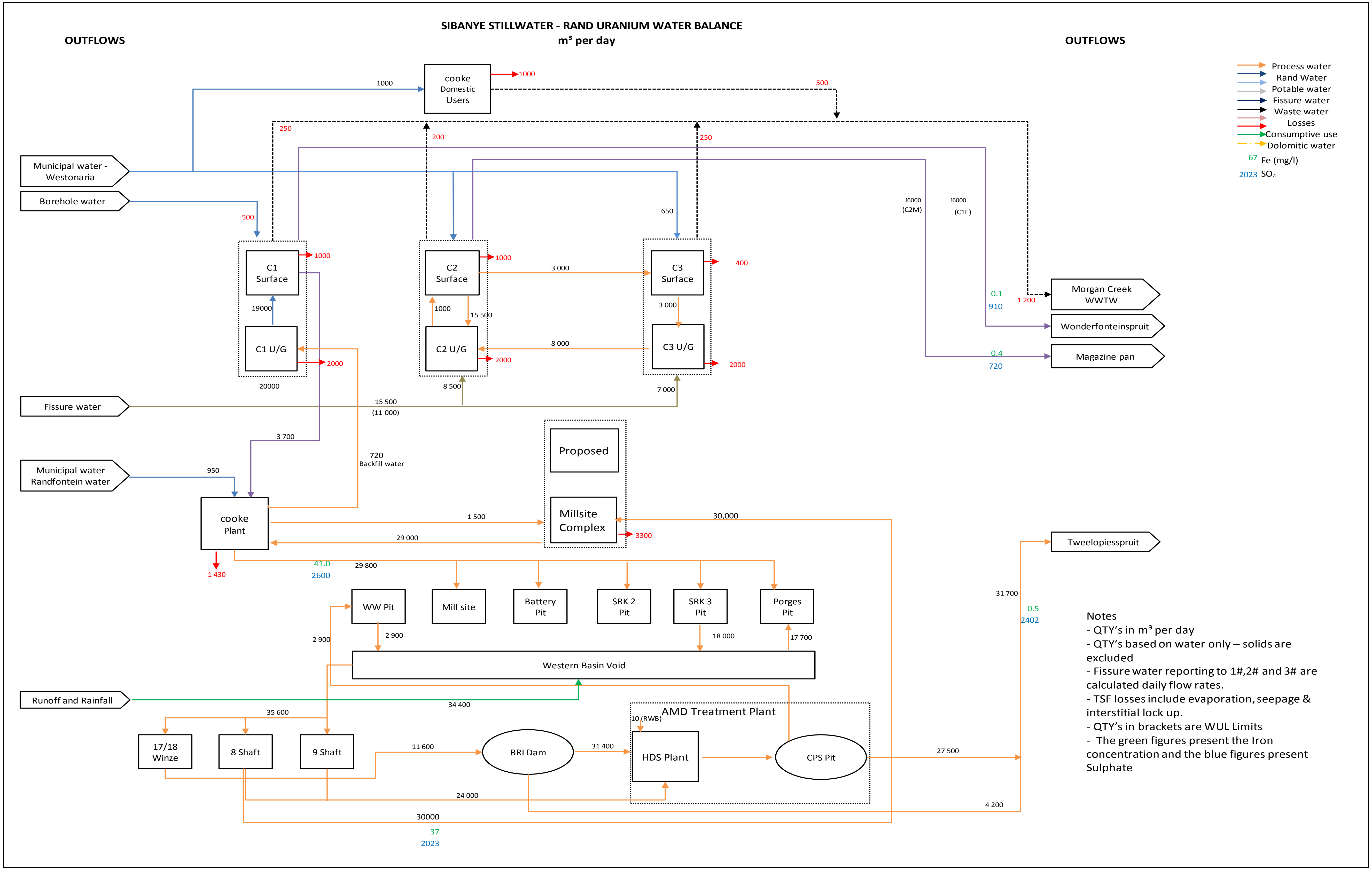


Figure 6-1: Water and Salt Balance (m3/day)

7 Storm Water Management Plan

The stormwater management plan (SWMP) has been compiled for the purposes of the water use license application (WULA) for the Millsite Complex Reclamation Project.

Mining, reclamation and processing operations have the potential to impact on water quality in the following ways:

- Bulk earthworks will expose top soils and sub-soils. Stormwater flows are likely to erode and remove loosened soils thereby increasing the levels of suspended solids within nearby watercourses;
- Spillages in the processing plant may contain slimes material and processing chemicals which need to be contained to prevent pollution of surrounding water resources:
- The reclamation of an existing slimes dam exposes new surfaces to erosion, removes existing water control structures, and introduces extra water for the hydraulic reclamation of the slimes material; and
- Storage and usage of process chemicals and hydrocarbons may, if not properly managed, be washed by stormwater into local watercourses and water features.

A negative impact on the baseline water quality by mining operations will likely affect aquatic ecosystems and local populations, who use the water for drinking, washing, irrigating and livestock watering. In addition to the above, storm water may pose a risk of flooding if not managed correctly.

The aim of this conceptual SWMP is to mitigate the above impacts by fulfilling the requirements of the National Water Act, 1998 (Act No.36 of 1998), and more particularly Government Notice 704 (Government Gazette 20118 of June 1999) (GN704). GN704 was established to provide regulations on the use of water for mining and related activities aimed at the protection of water resources.

7.1 Scope and Objectives

This SWMP deals with the Cooke Plant and the proposed Millsite tailings reclamation area. The objectives are to:

- Provide a brief outline of key SWMP definitions, guidelines, legislative requirements and design principles applicable to the Project;
- Delineate clean and dirty water catchments;
- Provide the conceptual placement of structures to seperate clean and dirty water areas; and
- Provide a stormwater structure (SWS) monitoring plan.

7.2 Definitions

The following definitions were taken from the GN704 regulations. These are provided here for clarity, as they are commonly referred to in this report:

- **Clean water system:** This includes any dam, other form of impoundment, canal, works, pipeline and any other structure or facility constructed for the retention or conveyance of clean unpolluted water;
- **Dam:** This includes any return water dam, settling dam, tailings dam, evaporation dam, catchment or barrier dam and any other form of impoundment used for the storage of unpolluted water or water containing waste (i.e. contain polluted water);
- **Dirty area:** This refers to any area at a mine or activity which causes, has caused or is likely to cause pollution of a water resource (i.e. generate polluted water);
- **Dirty water system:** This includes any dam, other form of impoundment, canal, works, pipeline, residue deposit and any other structure or facility constructed for the retention or conveyance of water containing waste; and
- **Activity:** means any mining related process on the mine including the operation of washing plants, mineral processing facilities, mineral refineries and extraction plants; the operation and the use of mineral loading and off-loading zones, transport facilities and mineral storage yards, whether situated at the mine or not; in which any substance is stockpiled, stored, accumulated, dumped, disposed of or transported.

7.3 Guidelines and Legislative Requirements

The conceptual SWMP has been prepared according to the following guidelines and legislative requirements:

- Department of Water and Sanitations (DWS) Best Practice Guideline (BPG) G1: Storm Water Management;
- DWS BPG A4: Pollution Control Dams;
- DWS BPG A5: Water Management for Surface Mines; and
- GN704: Regulations on the use of water for mining and related activities aimed at the protection of water resources.

The five main conditions of GN704 applicable to this project are:

Condition 4: which defines the area in which, mine workings or associated structures may be located, with reference to a watercourse and associated flooding. Any residue deposit, dam, reservoir together with any associated structure or any other facility should be situated outside the 1:100 year flood-line. Any underground or opencast mining, prospecting or any other operation or activity should be situated or undertaken outside of the 1:50 year flood-line. Where the flood-line is less than 100 meters away from the watercourse, then a minimum watercourse buffer distance of 100 meters is required for infrastructure and activities.

Condition 5: which indicates that no residue or substance which causes or is likely to cause pollution of a water resource may be used in the construction of any dams, impoundments or embankments or any other infrastructure which may cause pollution of a water resource.

Condition 6: which describes the capacity requirements of clean and dirty water systems. Clean and dirty water systems must be kept separate and must be designed, constructed, maintained and operated to ensure conveyance of flows of a 1:50 year recurrence event. Clean and dirty water systems should not spill into each other more frequently than once in 50 years. Any dirty water dams should have a minimum freeboard of 0.8m above full supply level.

Condition 7: which describes the measures which must be taken to protect water resources. All dirty water or substances which may cause pollution should be prevented from entering a water resource (by spillage, seepage, erosion etc.) and ensure that water used in any process is recycled as far as practicable.

Condition 10: which describes the requirements for operations involving extraction of material from the channel of a watercourse. Measures should be taken to prevent impacts on the stability of the watercourse, prevent scour and erosion resulting from operations, prevent damage to in-stream habitat through erosion, sedimentation, alteration of vegetation and flow characteristics, construct treatment facilities to treat water before returning it to the watercourse, and implement control measures to prevent pollution by oil, grease, fuel and chemicals.

7.4 Design Principles

The following design principles have been formulated from the above guidelines and legislative requirements and form the backbone of this SWMP:

- Confine or divert any unpolluted water to a clean water system, and polluted water to a dirty water system;
- Clean and dirty water systems should be designed and constructed to prevent cross contamination between the clean and dirty water systems;
- Clean and dirty water systems should contain the 50 year storm event, and should not lie within the 100 year flood line or within a horizontal distance of 100 m from any watercourse, whichever is the greater of the two; and
- Appropriate maintenance and management of stormwater related infrastructure should be ensured.

7.5 Cooke Plant Conceptual Stormwater management Plan

7.5.1 Existing Infrastructure

According to the staff at the Cooke Plant, there is no existing layout plans indicating SWS at the Plant. Existing SWS were therefore drawn in from aerial imagery supplied by the client, and were confirmed as far as possible on a site visit conducted on 16 August 2017. These are indicated on Figure 7-1. The site slopes in a south-easterly direction towards Wonderfonteinspruit located at the bottom of the site. Existing SWS are described in Table 7-1.

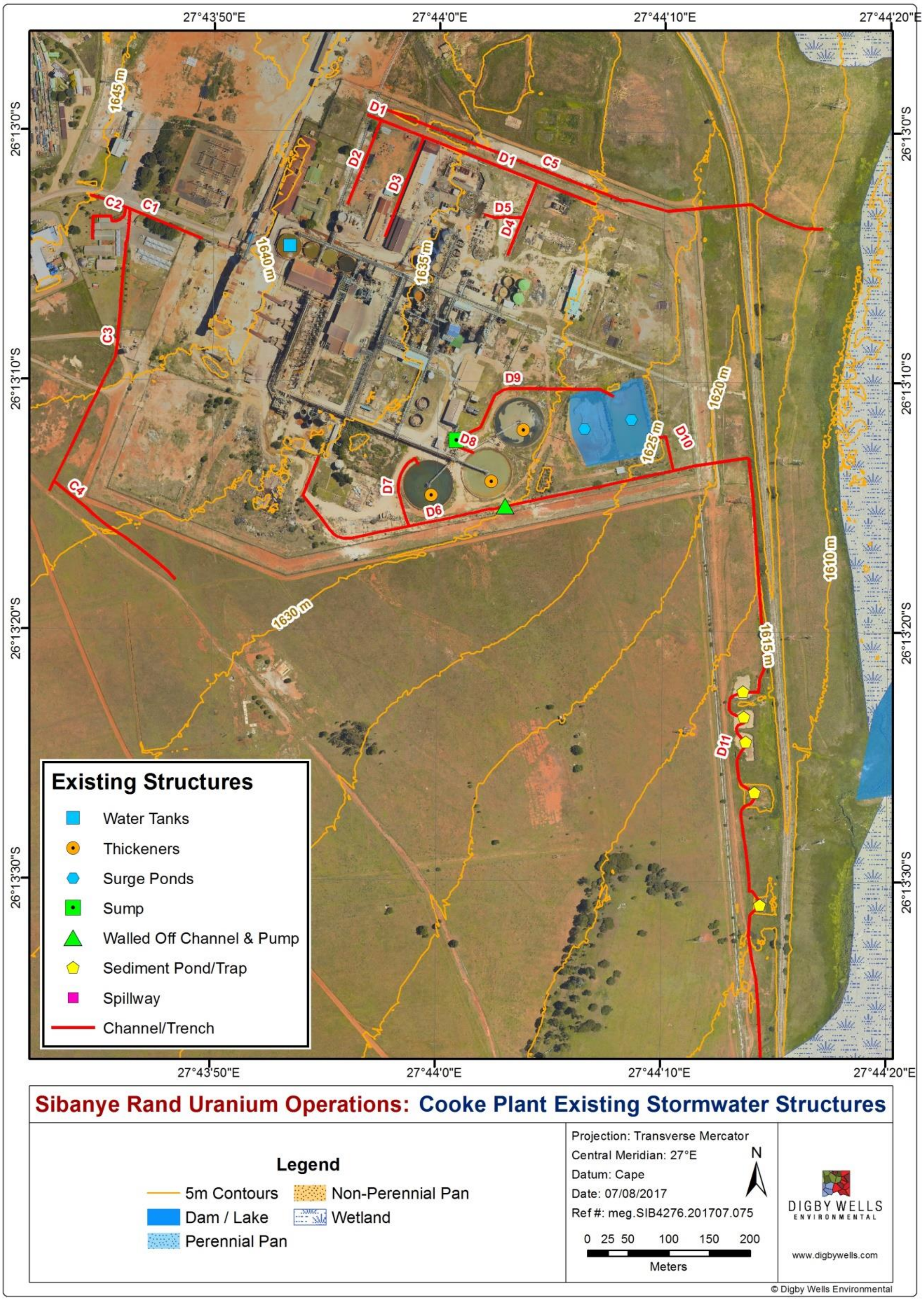


Figure 7-1: Existing stormwater structures

Table 7-1: Existing stormwater structures

Infrastructure	Description
Channel C1 and C2 	Lined channels leading towards the entrance of the plant. Contains some silt and debris in places. This channel drains the western area around the offices.
Channel C3 	Lined channel on the western side of the plant. Contains vegetation, silt and debris in places.
Channel C4 	Eroded channel on the south-western side of the plant.
C5 	Lined channel on the northern side of the plant. Contains some silt and debris in places.

Infrastructure	Description
Channel D1 	Lined channel containing vegetation, silt and debris. This channel drains the northern areas of the plant. The channel was found to contain green vegetation in the dry season indicating that water flows down here. Communication with personnel at Sibanye revealed that it could be from seepage from underneath the plant, but that it would need to be investigated further.
Channels D2, D3, D4 and D5	These are smaller channels draining the northern side of the plant into D1. Some of these channels were found to be silted up.
Channel D6 	Lined channel on the southern side of the plant. This channel drains the southern areas of the plant, and also receives spillages / overflows from the western most thickener. The channel was found to be heavily silted up.
Channel D7	This channel receives spillages / overflows from the western most thickener, and drains into D6.
Walled off channel structure on Channel D6 	This structure prevents overflow from the western most thickener and upslope dirty water, from flowing past this point. It is fitted with an automatic pump, that pumps water into the middle thickener. It is also fitted with an emergency overflow pipeline, whereby overflow water is transported to the surge ponds.
Channel D8	Overflow channel for the middle most

Infrastructure	Description
	thickener. This drains into a sump, and the water from this sump is reused as process water.
Channel D9	Overflow channel for the sump. When the sump overflows, water is transported to the surge ponds.
Channel D10	This is a spillage or overflow channel for the surge ponds that drains into D10.
Channel D11 	This is an unlined vegetated channel running below an elevated railway track towards a number of sediment ponds or traps.
Sediment Ponds / Traps 	These are a series of five sediment ponds or traps located downslope of the plant. They were found to be silted up.
Surge Ponds	These are two unlined dams located downslope of the plant that receive spillage from the thickeners and runoff from the plant. On the site visit, it was noted that surge ponds were heavily silted up; however, surge pond no. 2 (western surge pond) was being desilted and is proposed to be lined. The surge ponds were estimated to be 4 m deep.

7.5.2 Proposed Stormwater Management Plan

The proposed SWMP for the Cooke plant is indicated on Figure 7-2 and is described below.

7.5.2.1 Clean Water Channels

Upslope water will be diverted around the plant, towards the Wonderfonteinspruit located at the bottom of the site towards the east. This will minimise the amount of water to be handled within the plant area. Two new clean water channels are proposed, namely, C6 and C7. C6 will divert water around the north-western side of the plant, into channel C5, while C7 will convey upslope water around the southern part of the plant, linking up with C8. The proposed clean water channels do not need to be lined, but should be vegetated with indigenous stoloniferous (creeping) grass to prevent erosion. Channel C4 will need to be upgraded, as it is currently eroded (Table 7-1), and will need to be vegetated with indigenous stoloniferous grass. All existing clean water channels and culverts need to be cleaned of debris and silt, and should be sized appropriately to accommodate the 1 in 50 year 24 hour storm event, as required by GN704.

7.5.2.2 Dirty Water Channels

All dirty water from the plant area will be captured by existing and proposed dirty water channels. It is proposed that channel D12 is constructed to ensure that no dirty water emanating from the northern side of the plant, reports to the Wonderfonteinspruit, but instead to the existing surge ponds. Channel D13 will capture dirty water from the western side of the plant, and convey it into channel D6. Channel D14 will ensure that the plant area is a closed off circuit, capturing any water below the walled off structure on D6, and conveying it into the surge ponds. All proposed dirty water channels should be constructed similar to the existing dirty water channels, and should be concrete lined, to prevent seepage of water into groundwater, as required by GN704. It should also be ensured that they are designed to accommodate the 1 in 50 year 24 hour storm event. Most of the current drains are trapezoidal to prevent the build-up of silt and this design should be used for all channels which could convey solids from spillages. Lastly, it was noted that many of the existing channels and culverts were silted up, or contained debris, and require cleaning. If needed, these should be replaced by suitably sized and lined trapezoidal channels and culverts.

7.5.1 Dirty Water Containment

All dirty water from the plant will ultimately be captured and contained in the surge ponds, and should be reused as process water. It may be required that the wall is heightened to accommodate excess dirty water runoff from the plant, as a result of channels D12 and D14. It must be ensured that the surge ponds are able to accommodate the 1 in 50 year 24 hour storm event, including operational capacity volumes, and a freeboard of 0.8 m, as required by GN704 and the DWS Best Practice Guideline A4: Pollution Control Dams. This can be done by operating the ponds as empty as far as possible. It was noted that the ponds were heavily silted up on the site visit, but that they were in the process of being desilted.

The root cause of spillages into this area needs to be analysed and suitable measures put in place to prevent this from occurring. This will reduce the amount of water reporting to these ponds. A maintenance programme also needs to be drawn up (should one not exist), and implemented, to ensure that the ponds are kept free of slime and silt, and to guarantee sufficient capacity and freeboard. This is discussed in further detail in section 12.

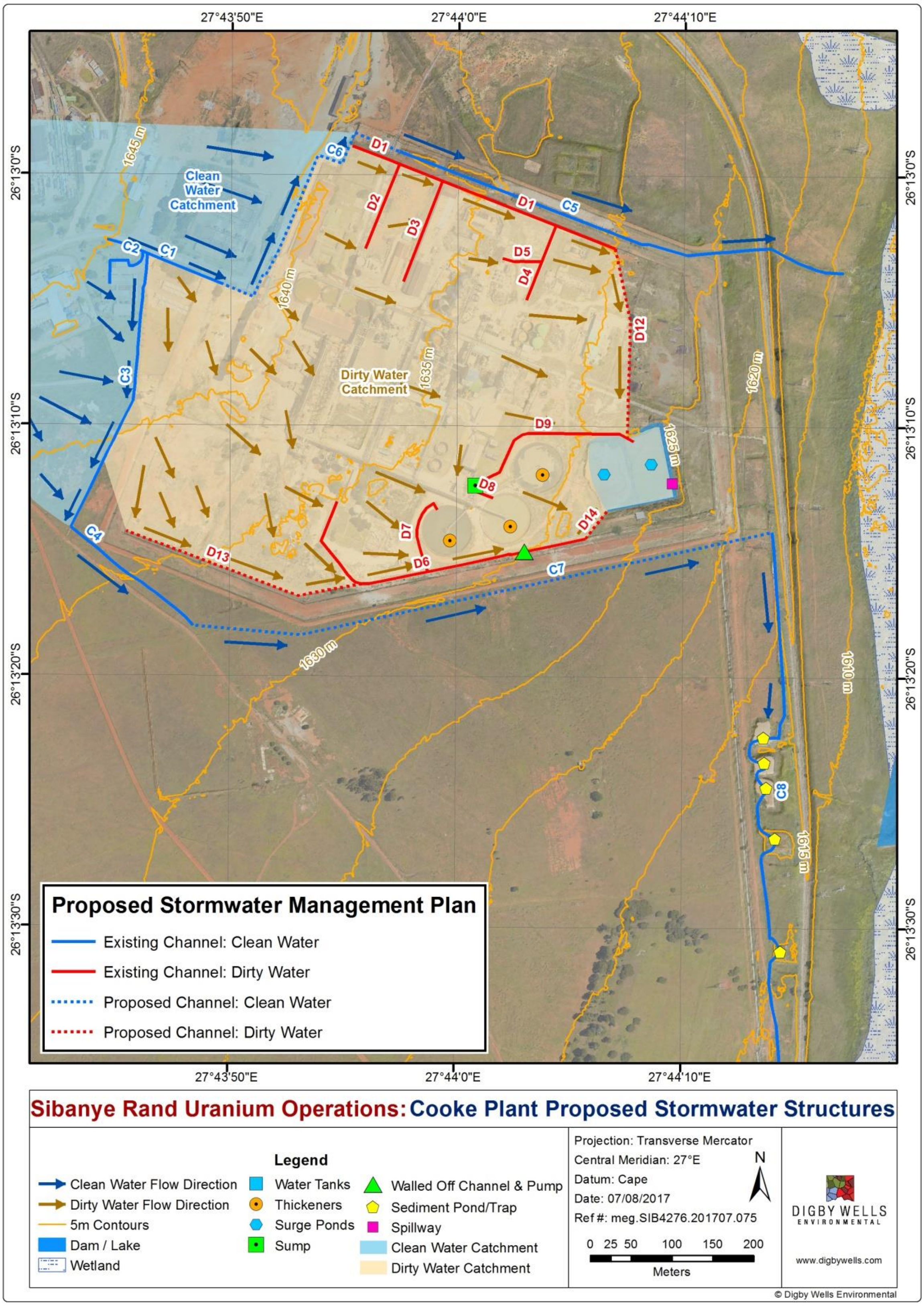


Figure 7-2: Proposed stormwater management plan for the Cooke Plant

7.6 Millsite TSF Complex Stormwater Management Plan

7.6.1 Existing Infrastructure

The Millsite TSF Complex (TSF) is situated on top of a gentle north-easterly aligned ridge. As such, water drains off the TSF site towards three surrounding non-perennial streams and the Robinson Lake. Figure 7-4 indicates the existing TSF SWS that were digitised from aerial imagery. These include the following:

- Paddocks surrounding the northern, north-eastern and western side of the TSF. Paddocks were found be eroded and silted up in places;
- Berms on the northern, eastern and western side of the TSF (Figure 7-3). Breaches in berms were witnessed in places;

Figure 7-3: Berm located on the north-eastern side of the TSF

- Trenches or channels on the southern, north-eastern and eastern sides of the TSF. In places, trenches were eroded and silted up; and
- An eroded and silted up evaporation pond / sediment trap, located on the northern side of the TSF.

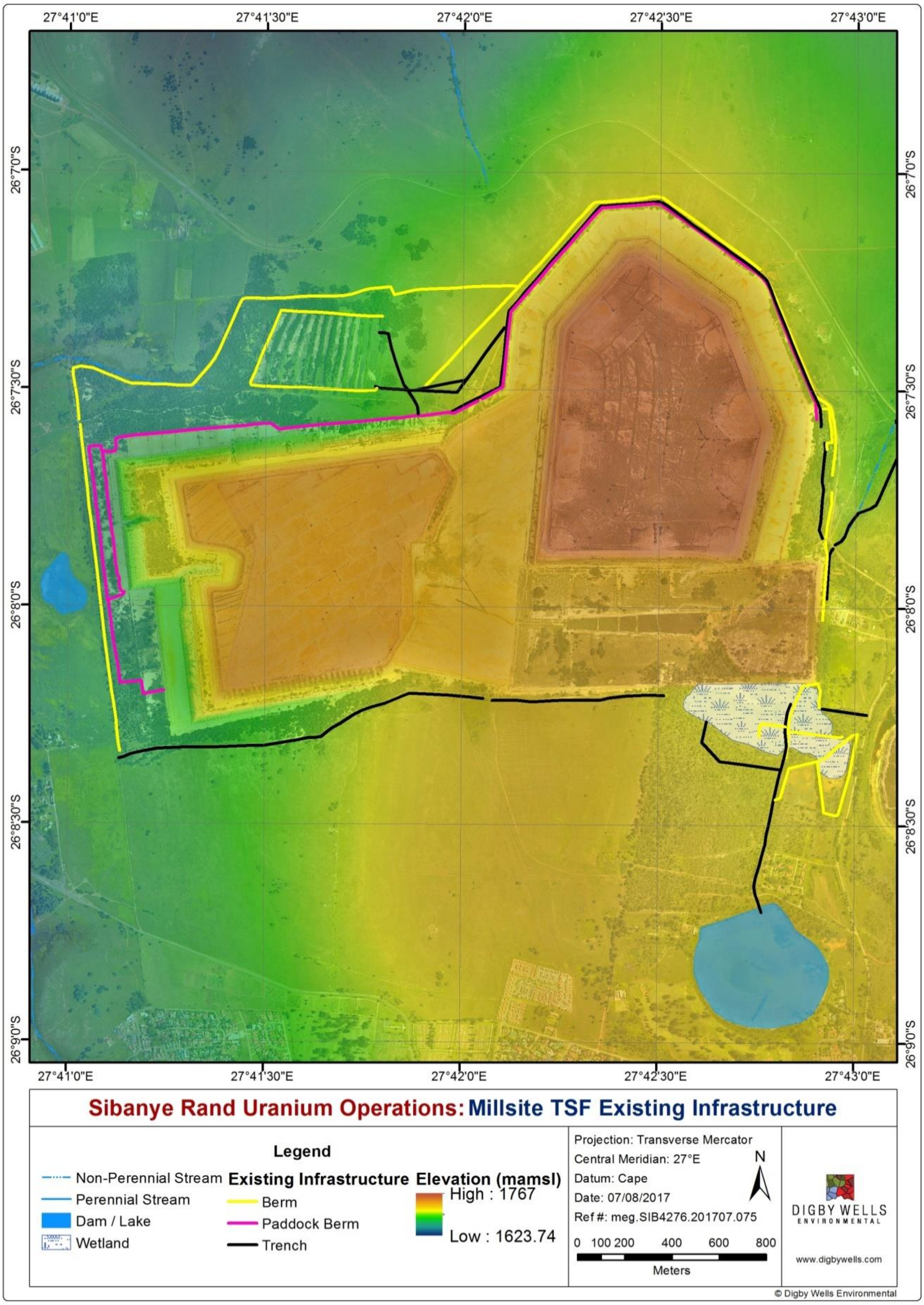


Figure 7-4: Existing stormwater infrastructure for the Millsite TSF Complex

7.6.2 Proposed Stormwater Management Plan

The proposed SWMP for the TSF is indicated on Figure 7-7. As mentioned previously, the TSF is located on a north-easterly aligned ridge, with natural ground level topographic highs occurring at the north-eastern (1709 mamsl) and southern (1721 mamsl) points of the TSF (Figure 7-7). Two topographical low points exist on either side of the ridge line, one at the far north-western side (1659 mamsl) of the TSF, and the other on the eastern side (1700 mamsl), where the reclamation sump is proposed to be located. Based on this ridge line, the SWMP is proposed to be split into two sections – all water draining east, and all water draining west. Reclamation of the TSF is set to begin on the eastern side of the TSF, near to where the proposed reclamation sump (slurry collection point) is located. It is therefore proposed that the SWMP east of the ridge line is implemented first, and when reclamation activities progress westerly over the ridge, that SWMP on that side is implemented. This will allow for all water from the TSF reclamation activities to drain towards topographical low points, where sumps, berm walls and silt traps can be constructed.

The SWMP will make use of existing perimeter channels and berms, which will need to be desilted and repaired in sections. This will be supplemented with proposed new channels and berms that will be constructed to accommodate the 1:50 year 24 hour storm event, as required by GN704 (Figure 7-7). Berms will be constructed from the material taken from the excavation of new channels, and will be vegetated with indigenous stoloniferous grass species, to prevent erosion. The proposed reclamation sump will be constructed within the current TSF perimeter berm, with an additional berm wall constructed around the sump.

It is also proposed that as reclamation progresses, that the outer areas of the TSF should be left intact, which will ensure that all dirty water is contained within the reclaimed and cleared areas, and will not be allowed to flow out towards the proposed SWS. An example of this is indicated in Figure 7-5. The proposed SWS indicated on Figure 7-7 will therefore act as a final barrier to contain all dirty water generated.

Figure 7-5: An example of the outer areas of a TSF acting as walls and containing dirty water runoff

It is also recommended that as areas of the TSF are cleared, that paddocks are constructed out of natural ground material, created to be sufficient to contain the 1 in 50 year storm event. This will ensure that runoff is captured and erosion reduced. An example of this is provided in Figure 7-6. These paddocks can then be vegetated, and once reclamation activities are complete, removed, to emulate the natural topography of the site. Vegetation can once again be established, to ensure that there is no risk of erosion occurring.

Figure 7-6: An example of a reclaimed TSF site containing paddocks

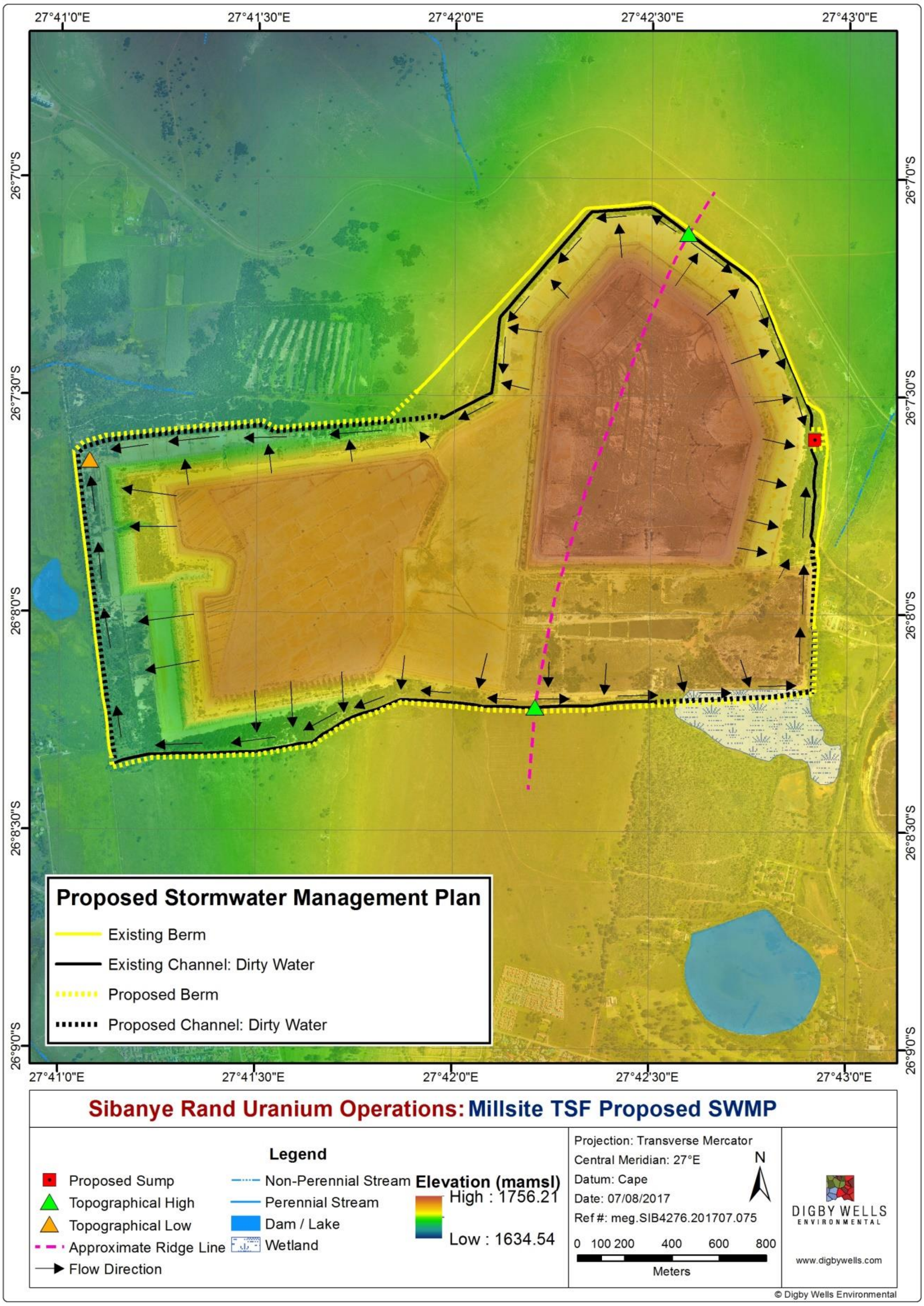


Figure 7-7: Proposed stormwater management plan for the Millsite TSF Complex

8 Impact Assessment

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 8-3. 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 proposed in this Hydrological Impact Assessment report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 8-2, which is extracted from Table 8-1. The description of the significance ratings is discussed in Table 8-3.

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 8-1: Impact Assessment Parameter Ratings

Rating	Intensity/Replacability		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/Replacability		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/Replacability		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.

Rating	Intensity/Replacability		Extent	Duration/Reversibility	Probability
	Negative Impacts (Nature = -1)	Positive Impacts (Nature = +1)			
1	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.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited/Isolated Limited to specific isolated parts of the site.	Immediate: Less than 1 month and is completely reversible without management.	Highly unlikely / None: Expected never to happen. <1% probability.

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

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

Table 8-3: Significance Rating Description[1]

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) (-)

[1] It is generally sufficient to only monitor impacts that are rated as negligible or minor

Score	Description	Rating
-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) (-)

8.1.1 Construction Phase

The assessed activities under construction phase include site clearance or removing vegetation prior to reclamation, construction of collection sump and paddocks, installation of pipelines, access roads, booster and pump stations, storm/dirty water trenches. These activities have the potential to impact on the surface water resources as discussed in the sections below.

Table 8-4: Interactions and Impacts of Activity

Interaction	Impact
Exposure of soils due to loss of vegetation (site clearance).	Siltation of surface water resources leading to deteriorated water quality.
Construction the surface infrastructure (collection sump and paddocks, installation of pipelines, access roads)	Contamination of clean water runoff by mixing up with dirty water runoff emanating from construction areas;

8.1.1.1 *Impact Description: Siltation of Surface Water Resources*

Clearing and stripping of vegetation during construction leaves the soils prone to erosion during rainfall events, and as a result runoff from these areas which will be high in suspended solids may cause siltation on the Tweelopiespruit, Bloubankspruit and the unnamed stream north of Millsite complex when it reports into these streams.

Dust generated during the construction activities and caused by increased vehicular movements and excavation of sumps can also be deposited into these rivers, thereby contributing to the accumulation of suspended solids in the rivers, leading to the siltation of the water bodies.

8.1.1.2 *Impact Description: Water Contamination*

Dirty or contaminated runoff emanating from fuels storage areas, other liquid waste and general waste have the potential to contaminate the closest rivers as explained above.

Human activity will generate waste which includes general wastes (paper, glass, plastic and cans), biological sewage waste and other hazardous waste that may be exposed during construction. The handling and disposal of these wastes may have an impact on the surrounding streams if not managed appropriately.

These impacts will lead to the deterioration of water quality, thereby impacting the aquatic life and the downstream water users as well. Measures presented in Table 8-5 must be implemented to prevent and/or reduce these potential impacts.

8.1.1.3 Impact Ratings and the Recommended Mitigation/Management Measures

Table 8-5 present the significance rating of the identified potential impacts together with the appropriate mitigation and/or management measures

Table 8-5: Impact Rating for the Construction Phase

Dimension	Rating	Motivation	Significance
Impact: Siltation of surface water resources leading to deteriorated water quality			
Pre-Mitigation			
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 will have moderate impacts resulting reduction in water quality for local downstream users and aquatic life	
Probability	Certain (7)	Without appropriate mitigation there will definitely be significant erosion on the TSF.	
Mitigation/ Management Actions			
▪ Clearing of vegetation must be limited to the development footprint area, and the use of existing access roads must be prioritized to minimize construction of new access roads, hence potential for erosion; ▪ If possible, construction activities must be prioritized to the dry months of the year (May-October) to limit mobilization of sediments or hazardous substances during site clearing; ▪ Vegetation along the edges of the dumps (where reclamation is not active) should be left as is, and only be removed when the rest of the dump has been reclaimed; ▪ Dust suppression on the haul roads and cleared areas must regularly be undertaken; and ▪ An appointed Environmental Control Officer (ECO) must always be available to ensure implementation of the recommended mitigation/management measures during construction, operational, and decommissioning of the project.			

Post-Mitigation			
Duration	Medium term (3)	As for pre-mitigation	Minor - negative (36)
Extent	Limited (2)	The impact may be limited to the site and its immediate surroundings	
Intensity x type of impact	Moderate - negative (-3)	Mitigation will reduce the impacts	
Probability	Probable (4)	Necessary mitigations will reduce the erosion probability significantly	

<table>
<tr><th>Dimension</th><th>Rating</th><th>Motivation</th><th>Significance</th></tr>
<tr><td colspan="4">Impact: Deterioration of water quality due to dirty/contaminated runoff from the project reporting into the surrounding streams</td></tr>
<tr><td colspan="4">Pre-Mitigation</td></tr>
<tr><td>Duration</td><td>Medium term (3)</td><td>With no measures in place, this impact may occur for as long as the construction takes place.</td><td rowspan="4">Minor - negative (60)</td></tr>
<tr><td>Extent</td><td>Municipal (4)</td><td>The impacts may be limited to the provincial scale from where the contaminated runoff enters the stream and the downstream</td></tr>
<tr><td>Intensity</td><td>Serious loss (-5)</td><td>This may have serious impacts on the downstream water users due to elevated hydrocarbon levels, salts and other dissolved minerals from the tailings in the surrounding streams</td></tr>
<tr><td>Probability</td><td>Likely (5)</td><td>Without appropriate mitigation, the probability of the impact occurring is <65%</td></tr>
<tr><td colspan="4">Mitigation/ Management Actions</td></tr>
<tr><td colspan="4">
All fuel storage areas should be appropriately bunded and spill kits should be in place, and construction workers 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;
Ablutions facility for construction workers and general waste bins should be provided. An accredited contractor should be appointed to properly dispose the waste;
The storm water management as detailed in section 7 to ensure separation of clean and dirty and water runoff, as stated, the temporary surface water ditches are to be constructed on the upstream boundary of the TSF, which will meet GN 704 requirements regarding the separation of clean and dirty water runoff. All clean water runoff will therefore be diverted away from the cleared area. The temporary surface ditches are to be sized such that the 1:50 year peak discharge can be contained within it.
Surface water quality monitoring should continue on the monitoring locations indicated in section 5 to enable detection of the water quality impacts and therefore ensure that necessary mitigation measures are immediately implemented
</td></tr>
<tr><td colspan="4">Post-Mitigation</td></tr>
<tr><td>Duration</td><td>Medium term (3)</td><td>As for pre-mitigation</td><td rowspan="2">Negligible - negative (33)</td></tr>
<tr><td>Extent</td><td>Local (3)</td><td>As for pre-mitigation</td></tr>
</table>

Intensity	Serious loss (-5)	As for pre-mitigation	
Probability	Probable (3)	Necessary mitigations will reduce the probability of impact occurrence significantly (<25%)	

8.1.2 Operational Phase

Activities that may have surface water impacts during the operational phase include hydraulic reclamation of the dump, pumping through a proposed pipeline and runoff containment within the site.

Table 8-6: Interactions and Impacts of Activity

Interaction	Impact
Runoff from the dirty water areas (reclamation site)	Runoff from the tailings will contain high level of dissolved minerals which may result in water contamination or the deterioration of the water quality

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

Normally, hydraulic reclamation will be done by spraying water into the tailings material to dissolve the material. Slimes will then be collected in a sump where pumping will be done to transport this into the reclamation plant at Cooke plant. This runoff may find its way into the Tweelopiespruit, Bloubankspruit and the unnamed stream north of Millsite complex and that may result in the deterioration of the water quality and hence impact the downstream water users and the aquatic life.

Runoff from the fuel storage areas may also contaminate these streams when runoff reports into them during operational phase.

8.1.2.1.1 Impact Ratings and the recommended mitigation/management measures

Table 8-7: Impact Rating for the Operational Phase

Dimension	Rating	Motivation	Significance
Impact: Water Contamination leading to deterioration of water quality			
Pre-Mitigation			
Duration	Project Life (5)	For as long as reclamation activity is taking place, this potential surface water impact may occur	Minor - negative (70)

Dimension	Rating	Motivation	Significance
Extent	Municipal (4)	Contaminated runoff from the tailings may affect the quality of the surrounding streams and the impact can be felt on the municipal level	
Intensity	Serious - negative (-5)	This may have serious impacts on the water quality in the surrounding streams and their downstream water users (agricultural- livestock watering and crop irrigation)	
Probability	Likely (5)	Without appropriate mitigation, the probability of the impact occurring is <65%	
Mitigation Measures			
▪ All fuel storage areas should be appropriately bunded and spill kits should be in place, and construction workers 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; ▪ Ablutions facility for construction workers and general waste bins should be provided. An accredited contractor should be appointed to properly dispose the waste; ▪ The storm water management as detailed in section 7 to ensure separation of clean and dirty and water runoff, as stated, the temporary surface water ditches are to be constructed on the upstream boundary of the TSF, which will meet GN 704 requirements regarding the separation of clean and dirty water runoff. All clean water runoff will therefore be diverted away from the cleared area. The temporary surface ditches or trenched are to be sized such that the 1:50 year peak discharge can be contained within it. ▪ Surface water quality monitoring should continue on the monitoring locations indicated in section 5 to enable detection of the water quality impacts and therefore ensure that necessary mitigation measures are immediately implemented; and ▪ Ensure emergency procedures in the event of power failure such as operational modifications and the use of a stand-by generator to operate the pump station should the sump be getting full.			
Post-Mitigation			
Duration	Project Life (5)	As for pre-mitigation	Minor - negative (42)
Extent	Municipal (4)	As for pre-mitigation	
Intensity	Serious - negative (-5)	As for pre-mitigation	
Probability	Probable (3)	Necessary mitigations will reduce the probability of impact occurrence significantly (<25 %)	

8.1.3 Decommissioning

Once the full reclamation processes have been completed on all of the dumps, decommissioning will commence with the removal of infrastructure such as pump stations, sumps, pipelines, removal of berms, paddocks, pipelines and anything else installed during construction. Rehabilitation will take place as decommissioning has been completed to try and restore or re-establish the natural surface condition similar to the pre-TSF conditions.

During the decommissioning activities, there could still be impacts on the Tweelopiespruit, Bloubankspruit and the unnamed stream. The slimes will normally be reclaimed down to the topsoil level where this will now be prone to erosion as it's exposed, this may easily erode onto the mentioned streams thereby causing siltation of this water course.

However, the complete removal of these slimes dam will have a positive impact on the surrounding natural water resources as the pollution source has been cleaned out.

Table 8-8: Interactions and Impacts of Activity

Interaction	Impact
Runoff from the dirty water areas (reclamation site)	Runoff from the tailings will contain high level of dissolved minerals which may result in water contamination or the deterioration of the water quality
Complete removal of the TSF and rehabilitation	Improvement on the surface water quality as a result of complete removal of the pollution source

8.1.3.1 Impact Ratings and the Recommended Mitigation/Management Measures

Table 8-9 present the significance rating of the identified potential impacts together with the appropriate mitigation and/or management measures.

Table 8-9: Impact Rating for the Construction Phase

Dimension	**Rating**	**Motivation**	**Significance**
Impact: Siltation of surface water resources leading to deteriorated water quality			
Pre-Mitigation			
Duration	Medium term (3)	Siltation impact may occur for as long as the decommissioning takes place	Minor - negative (50)
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 will have moderate impacts resulting reduction in water quality for downstream users and aquatic life	
Probability	Likely (5)	Without appropriate mitigation, it is likely (<65%) that erosion may occur during this phase	
Mitigation/ Management Actions			
▪ Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; ▪ The constructed storm water management infrastructure will have to remain until post closure to ensure dirty water is captured and contained during removal of infrastructures; ▪ Ensure that the infrastructure (pipelines, fuel storage areas, pumps) are first emptied of all residual material before decommissioning. This can be input of the standard operation procedures at each of the dumps to ensure it's carried out; and ▪ Ensure that the surface profile is rehabilitated to promote natural runoff drainage and avoid ponding of water within the rehabilitated area. Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site.			
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: Siltation of surface water resources leading to deteriorated water quality			
Pre-Management or Enhancement Measures			
Duration	Medium term (7)	Impact may permanently occur for as the area has been rehabilitated	Moderate - negative (80)
Extent	Provincial (4)	The impacts will be felt on the downstream water resources	
Intensity x type of impact	Moderately high - negative (5)	There will be great improvement to the overall surface water quality on the surrounding streams	

Probability	Likely (5)	Without appropriate mitigation, it is likely (<65%) that erosion may occur during this phase	
Mitigation/ Management Actions			
▪ Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; ▪ Ensure that the surface profile is rehabilitated to promote natural runoff drainage and avoid ponding of water within the rehabilitated area. Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site.			
Post-Mitigation			
Duration	Medium term (7)	Impact may permanently occur for as the area has been rehabilitated	Minor - negative (66)
Extent	Provincial (4)	The impacts will be felt on the downstream water resources	
Intensity x type of impact	Moderately high - negative (5)	There will be great improvement to the overall surface water quality on the surrounding streams	
Probability	Highly probable (6)	Necessary mitigations will reduce the erosion probability significantly	

9 Cumulative Impacts

The current water quality on the Tweeloopiespruit and the Wonderfonteinspruit is of poor quality when benchmarked with WUL limits. This is mainly due to decant from the old mine workings and also discharge of partially treated mine water. There is also a Waste Water Treatment Plant that discharges into the Wonderfonteinspruit and this could possibly have contributed onto this water quality status.

The reclamation of the gold dumps mobilises and expose sulphide minerals such a pyrite (FeS_2) that when exposed to air and water, will oxidize and release large quantities of iron and sulphate into solution, which is very acidic and thereby referred to as acid mine drainage (AMD). Therefore, without adequate and effective mitigation measures, the proposed project may further deteriorate the quality of water in the surrounding streams.

10 Unplanned Events and Low Risks

There are potential risks or unplanned events that could occur and potentially impact on the surface water resources during the three phases (construction, operational, decommissioning) of the proposed reclamation project.

- The risk of pipeline bursts and seeps from sumps, wet screens (which are used for screening material from the reclamation site) will contribute to the degradation of surface water quality from the spillages of the slurry which could contain AMD related contaminants; and
- Potential hydrocarbon and construction material spillages from the construction sites, pump stations and heavy construction machinery could result in surface water quality deterioration as it can be carried to the nearby streams by runoff water.

A summary of the risks or unplanned events, together with the management measures are presented in Table 10-1.

Table 10-1: 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 other hazardous 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.
Overflow of sumps	Surface water contamination	Paddocks should be placed adjacent to the collection sump or PCD to contain any spill and prevent erosion and contamination of the streams
Slurry pipeline burst	Surface water contamination	Electronic monitoring of pipeline pressure to identify a burst as soon as possible. Should it occur, emergency valves need to be shut down to prevent spillage of hazardous material. Existing monitoring data should continuously be utilized to establish or monitor impacts from any leakages or spills

11 Environmental Management Plan

The assessment of potential surface water impacts associated with the reclamation of the various dumps identified several impacts. The more significant impacts from the proposed activities are listed in Table 11-1.

Table 11-1: Potentially Significant Impacts

Activity	Aspects	Potential Significant Impacts
Construction of infrastructures (pipelines, sumps, pump stations, return water dam).	Project area	Mixing of upstream clean water runoff with dirty water runoff from cleared site areas resulting in dirty water reporting to the downstream clean water catchment.
Operation of sumps and pumps	Mine dirty areas	Contamination of the surrounding streams when the dirty water from the dumps reports into the streams

11.1 Summary of Mitigation and Management Measures

Section 8 provides a description of the potential impacts together with the appropriate mitigation and management options for the environmental impacts anticipated during the construction, operational, decommissioning and closure phases.

Table 11-2 and Table 11-3 provide a summary of the proposed project activities, environmental aspects and impacts on the receiving environment. Information on the frequency of mitigation, relevant legal requirements, recommended management plans, timing of implementation, and roles / responsibilities of persons implementing the EMP.

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Table 11-2: Impacts, Objectives and Outcomes of the EMP

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Site clearing and grubbing/excavating	Construction	All surface infrastructure area	Clearing of vegetation must be limited to the development footprint area, and the use of existing access roads must be prioritized so as to minimise construction of new access roads in these areas; If possible, construction activities must be prioritised to the dry months of the year (May-October) to limit mobilisation of sediments or hazardous substances from construction vehicles used during site clearing; Haul roads must be well compacted to avoid erosion of the soil into the streams; Dust suppression on the haul roads and cleared areas must be regularly undertaken; All dirty water channels must be constructed and placed within the dirty water infrastructure areas, such that all dirty water runoff emanating from these areas are captured and contained to a dirty water containment facility. The proposed channels should be sized to cater for the 1:50 year storm event.	Based on the GN 704 requirements regarding storm water management for mining activities it is noted that all clean and dirty water must be separated. The clean water diversion will be sized to accommodate the 1:50 year storm event. The containment facility should be sized to accommodate the anticipated dirty water runoff as a result of the 1:50 year storm event.	Water storage and conveyance structures should be sized accurately for the life of project.
Construction and operation of infrastructures (pipelines, sumps, pump stations, return water dam).	Construction	All surface infrastructure area	As proposed, ensure all the dirty water emanating from the dirty water areas will be collected via silt traps before entering the containment facility. This water should be stored for re-use within the mine so as to prevent unnecessary discharge into the environment. Should the contained water be more than the water use requirement, the Best Practice Guidelines (BPGs) advise that the water be recycled or as the last resort be treated to acceptable levels and discharged either to the natural environment or be supplied to other industries as a lower grade of water.	DWS Best Practice Guideline G4: Impact prediction Based on GN 704, the mine infrastructure in question should fall outside of the 1:100 year floodline or 100 m, whichever is greater.	During the construction and operation of the entire infrastructure.

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Potential spillages on Storage of fuel areas, workshops and heavy machinery on site	Operational		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.	SANS1200 specifications.	During the entire project life.
Removal of infrastructure and surface rehabilitation	Decommissioning and Closure	Removal of infrastructure and surface rehabilitation	Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; The constructed storm water management infrastructure will have to remain until post closure to ensure dirty water is captured and contained during removal of infrastructures; Ensure that the infrastructure (pipelines, fuel storage areas, pumps) are first emptied of all residual material before decommissioning. 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.ps to ensure it's carried out.	GN 704 *Condition* 9 describes the temporary or permanent cessation of mine or activity. At cessation of operations, the persons operating a mining activity should ensure that all pollution control measures have been designed, modified, constructed and maintained so as to comply with these regulations.	During cessation of operations

Table 11-3: Prescribed environmental management standards, practice, guideline, policy or law

Specialist field	Applicable standard, practice, guideline, policy or law	
Hydrology/Surface water	National Water Act, 1998 (Act No. 36 of 1998) National Environmental Management Act, 1998 (Act No.	Department of Water Affairs and Forestry, 2006, "*Best Practice Guideline No. G1: Storm Water Management*" Government Notice 704 (GN704). Regulations on the Use of Water for Mining and Related Activities Aimed at the

	107 of 1998), as amended (NEMA), GNR 544 and GNR 545 (Section 24 (1)).	Protection of Water Resources. Published in Government Gazette 20119.

12 Surface Water Monitoring Program

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 working order. Monitoring should be implemented throughout the project life.

Continuous water quality monitoring should be undertaken, the monitoring data should be benchmarked with the existing WUL limits to determine deviations from the baseline water quality so as to establish if the reclamation project is impacting on the Blesbokspruit.

Water quality monitoring should continue at the existing locations indicated in table **Table 5-3** and on the proposed monitoring locations indicated in Table 12-1 below. This should be undertaken for all the constituents that already exist in the monitoring programme.

Table 12-1 : Surface Water Proposed Monitoring Locations

Site	Description	Latitude	Longitude
SW1	Upstream of the Unnamed Stream (North of Millsite)	26° 6'16.73"S	27°41'36.61"E
SW2	Downstream of the Unnamed Stream West (North of Millsite)	26° 5'19.57"S	27°42'18.93"E

Geographic Coordinate System WGS84 Datum

12.1 Storm Water Management Plan

SWS (channels, berms, sumps, etc.) should be monitored every year in September before the rainy season begins, to ensure that any blockages, silted up structures, or breaches in structures, are repaired and are in good working order for the rainy season. They should further be monitored immediately after every storm event during the rainy season. Should blockages, silted up structures or breaches occur, immediate action should be undertaken to remove debris and / or repair breaches. In the event of any spillage of slime occurring, the slime and silt must be cleaned up as soon as possible, to ensure that the SWS can continue to function as they have been designed. Monitoring should be undertaken by the onsite Environmental Control Officer (ECO) or maintenance manager. Inspections must be recorded and should include the following:

- Date of inspection;
- Rainfall amount received;
- Photographs of blockages, spills, silted up structures or breaches witnessed;
- What action was undertaken to fix issues, and the amount of time taken to address them; and
- Photographs post action taken.

Inspection reports should be kept ready and supplied to the DWS when requested, or as part of the WUL conditions.

13 Conclusion and Recommendation

Reclamation at Dump 20 and t Lindum TSF's is nearing its end and Sibanye now intends to reclaim the Millsite Tailings Storage Facility (TSF) which is located adjacent to Sibanye's Water Treatment Plant and Dump 20. From the operational water balance, the water requirements for the reclamation of Millsite Complex will be approximately 31 500 m3/day and this will be sourced from the old underground workings (8 shaft). This is the same amount of water being currently used on mining of Dump 20 and Lindum.

The surface water assessment report also serves to assess the potential impacts on the surface water resources that may result from the reclamation or inclusion of the Millsite TSF into the existing Cooke Operations and the specific activities to be undertaken.

The Millsite Complex is located in the A21D quaternary catchments of the Limpopo WMA (previously known as Crocodile West and Marico) while Cooke Plant is located within C23E quaternary catchment of the Vaal WMA (previously known as Upper Vaal). The main or perennial river within A21D quaternary catchment is the Tweelopiespruit West/Bloubankspruit River which flows from south towards the north eastern side where the catchment outlet is situated while the Wonderfonteinspruit is the main river within the C23D quaternary catchment. Runoff emanating from this quaternary catchment drains in a south westerly direction into the Wonderfonteinspruit.

Sibanye has been conducting surface and ground water monitoring over a long period of time (ranging from 2012 to 2017) on their existing operations and the surrounds. The existing water quality monitoring data was utilised to analyse and interpret the historical and current water quality status and water quality trends analysis over time to enable monitoring of the surface water impacts that may result from the proposed reclamation of the Millsite Complex.

In the Wonderfonteinspruit, several parameters are within the Mooirivier RQO, although Cooke 1 discharge result in slight increase of certain parameters, the quality remains within the Mooirivier RQO for most parameters and thereby Cooke 1 discharge does not significantly impact on the Wonderfonteinspruit. With the coming reduction in mining activities within Sibanye operations, a reduction on most metals and suspended solids is expected over time.

From January 2012 to October 2017, water quality at Cooke 1 (W14) and Cooke 2 (W16) discharge has shown fluctuating levels of parameters such Suspended Solids, Iron, Sulphates, Manganese etc. except for iron, most of the parameters have indicated quality which is above the discharge limits as provided in the Water Use license. A21D quaternary catchment

On A21D quaternary catchment, where Millsite Complex is located, the average (January 2012 to March 2017) water quality along the Tweelopiespruit East was benchmarked with the TCTA directives limits. On. Amongst all the parameters with set limits, only Iron and Manganese are exceeding the TCTA directives limit at 17 Winze (untreated) monitoring points. Electrical Conductivity, pH and Sulphates has been within the TCTA's limits along all the monitoring points. The Bloubankspruit/Tweelopiespruit West, parameters such as Uranium, Manganese and Sulphate levels are mostly above the proposed Bloubankspruit RQO's.

The existing and proposed TSF reclamation, 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 clean water runoff by mixing up with dirty water runoff emanating from construction areas;
- Runoff from the tailings will contain high level of dissolved minerals which may result in water contamination or the deterioration of the water quality; and
- Improvement on the surface water quality as a result of complete removal of the pollution source

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:

- Clearing of vegetation must be limited to the development footprint area, and the use of existing access roads must be prioritized to minimize construction of new access roads, hence potential for erosion;
- Implementation of dust suppression measures during construction and operational activities;
- All fuel storage areas should be appropriately bunded and spill kits should be in place, and construction workers 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;
- Ablutions facility for construction workers and general waste bins should be provided. An accredited contractor should be appointed to properly dispose the waste;
- The storm water management as detailed in section 7 of this report to ensure separation of clean and dirty and water runoff, as stated, the temporary surface water ditches are to be constructed on the upstream boundary of the TSF, which will meet GN 704 requirements regarding the separation of clean and dirty water runoff. All clean water runoff will therefore be diverted away from the cleared area. The

temporary surface ditches or trenched are to be sized such that the 1:50 year peak discharge can be contained within it.

- Surface water quality monitoring should continue on the monitoring locations indicated in section 5 of this report to enable detection of the water quality impacts and therefore ensure that necessary mitigation measures are immediately implemented;
- Ensure emergency procedures in the event of power failure such as operational modifications and the use of a stand-by generator to operate the pump station should the sump be getting full; and
- Use of accredited contractors for removal or demolition of infrastructure is recommended; this will reduce the risk of waste generation and accidental spillages; and
- Ensure that the surface profile is rehabilitated to promote natural runoff drainage and avoid ponding of water within the rehabilitated area. Surface inspection should be continuously undertaken to allow runoff to drain onto the natural streams until vegetation has fully established on the site.

With all the recommended mitigation measures in place to ensure the prevention and/or minimisation 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.

14 References

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