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Environmental Impact Assessment for Sibanye Gold Limited's West Rand Tailings Retreatment Project

Aquatic Ecology Report

Project Number:

GOL2376

Prepared for:

Sibanye Gold Limited

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Project Name:	**Environmental Impact Assessment for Sibanye Gold Limited's West Rand Tailings Retreatment Project**
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This is undertaken under oath with respect to:

- the correctness of the information provided in the report;
- the inclusion of comments and inputs from stakeholders and I&APs;
- the inclusion of inputs and recommendations from other specialist reports, where relevant; and
- any information provided by the EAP to interested and affected parties and any responses by the EAP to comments or inputs made by interested or affected parties

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EXECUTIVE SUMMARY

Digby Wells Environmental (Digby Wells) was commissioned by Sibanye Gold Ltd (SGL) as the environmental consultant for the West Rand Tailings Retreatment Project (WRTRP). As part of this appointment Digby Wells was to conduct an aquatic ecology specialist study to inform the project. This aquatic ecology study involved an ecological assessment of the potentially affected river systems located within the Upper Vaal Water Management Area (WMA). The potentially affected river systems include the Wonderfonteinspruit, Loopspruit, Leeuspruit and the Kleinwes Rietspruit.

This report should be read in conjunction with the various other specialists studies undertaken as part of the Digby Wells Environmental Impact Assessment, with specific reference the Surface Water, Wetland Ecology and Groundwater studies.

Methods applied included a literature survey which was utilised to collate available data on the Present Ecological Status (PES) of the potentially affected river systems. River systems for which data was unreliable were surveyed using the standard River Health Programme (RHP) methods.

The results of a screening assessment show that no Rare Threatened or Endangered aquatic biota is present within the study area. Further, the overall results of the sensitivity analysis revealed that no sensitive aquatic systems, rated above moderate sensitivity, are present within the study area.

Kloof Mining Right Area

Baseline results show that the overall PES of the Leeuspruit and Loopspruit were found to be in a largely modified (class D) state due to poor water quality and modification to instream and riparian habitats.

No significant impacts are expected in the Loopspruit as a result of the proposed activities. The impact assessment revealed potential significant impacts as a result of contaminated seepage and runoff emanating from the Regional Tailings Storage Facility (RTSF). Due to the largely modified state of the Leeuspruit, this impact on water quality would contribute toward the cumulative decline in the PES of the Leeuspruit. However, should mitigation actions be followed the likelihood of the impact occurring can be reduced. The primary mitigation actions which will be implemented at the RTSF to reduce contamination of the nearby Leeuspruit include the construction of a blast curtain which will capture contaminated seepage.

Dewatering and a reduction of flows in the Leeuspruit within the vicinity of the blast curtain are anticipated. However, stream flow within the Leeuspruit will likely continue due to the low permeability of the river bed. In addition, the discharge of 15 Ml/day of treated water from the Advanced Water Treatment Facility will likely serve to increase flows downstream of the RTSF. Further, dilution as a result of the abovementioned discharge will further reduce the baseline salt loads within the Leeuspruit and thus serve to improve water quality

downstream. These abovementioned aspects are elaborated on in the surface water report for this proposed project.

Ezulwini Mining Right Area

Baseline results show that the PES of the Kleinwes Rietspruit is largely modified, primarily due to instream habitat modification. The impact assessment for the proposed project in this mining right area revealed impacts assessed and classified as minor significant to the Kleinwes Rietspruit following the implementation of mitigation actions.

Cooke Mining Right Area

The overall PES of the reach of the Wonderfonteinspruit assessed in this study was found to be largely/seriously modified (class D/E) as a result of extensive habitat modification compounded by water quality impacts. The impact assessment of the proposed project revealed minor impacts to the Wonderfonteinspruit system after mitigation actions. Due to the limited nature of impacts, the cumulative impacts are considered negligible.

Driefontein Mining Right Area

The overall PES of the reach of the Wonderfonteinspruit and Carletonville Tributary assessed in this study was found to be largely/seriously modified (class D/E) as a result of extensive habitat modification compounded by water quality impacts. The impact assessment for the proposed project revealed minor impacts to the abovementioned river systems following the implementation of mitigation actions.

Recommendations

Mitigation actions in case of planned and unplanned events have been provided. Furthermore, an environmental monitoring and management plan has been provided in this report.

Considering the completed baseline and impact assessment, on condition that mitigation actions are in place, the proposed project will likely not significantly affect the aquatic ecology within the above mentioned river systems.

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1 Introduction

There is a long history of gold and uranium mining in the broader West Rand area with an estimated 1.3 billion tonnes of surface tailings, containing in excess of 170 million pounds of uranium and 11 million ounces of gold. Sibanye Gold Limited (SGL) currently owns the majority of the tonnage and its gold and uranium content. SGL plans to ultimately exploit all these resources to develop a strong, long life and high yield surface business. Key to the successful execution of this development strategy is the West Rand Tailings Retreatment Project (WRTRP). The concept of the WRTRP is well understood with an 8 year history of extensive metallurgical test work, feasibility studies and design by a number of major mining houses. A pre-feasibility study (PFS) completed during 2013 for the WRTRP has confirmed that there is a significant opportunity to extract value from the SGL surface resources in a cost effective sequence.

The ultimate WRTRP involves the construction of a large-scale Central Processing Plant (CPP) for the recovery of gold, uranium and sulfur from the available resources. The CPP, centrally located to the West Rand resources, will be developed in phases to eventually treat up to 4mt/month of tailings inclusive of current arisings. The resultant tailings will be deposited on a modern tailings storage facility (TSF) called the regional TSF (RTSF).

1.1 Project Background

Simplistically, SGL's surface historical TSF holdings in the West Rand can be divided into three blocks; the Northern, Southern and Western Blocks. Each of these blocks contains a number of historical TSFs. Each of the blocks will be reclaimed in a phased approach. Initially the Driefontein 3 TSF (Western Block) together with the Cooke TSF (Northern Block) will be reclaimed first. Following reclamation of Driefontein 3 TSF, Driefontein 5 TSF (Western Block) and Cooke 4 Dam south (C4S) (Southern Block) will be reclaimed.

- Western Block comprises: Driefontein 1, 2, 3, 4 and 5 TSF, and Libanon TSF. Once the Driefontein 3 and 5 TSFs have been depleted the remainder of the Driefontein TSFs, namely Driefontein 1, 2 and 4 and the Libanon TSF, will be processed through the CPP;
- Northern Block comprises: Cooke TSF, Venterspost North TSF, Venterspost South TSF and Millsite Complex (38, 39 and 40/41 and Valley). Venterspost North and South TSFs and Millsite Complex (38, 39 and 40/41 and Valley) will be processed with the concurrent construction of Module 2 float and gold plants; and
- Southern Block comprises: Kloof No.1 TSF, Kloof No.2 TSF, South Shaft TSF (future), Twin Shaft TSF (future), Leeudoorn TSF and C4S TSF. Following completion of the Module 3 float and gold plants, Kloof 1 and 2 TSFs, South Shaft TSF (future), Twin Shaft TSF (future) and Leeudoorn TSF will be reclaimed.

Once commissioned the project will initially reclaim and treat the TSFs at a rate of 1.5 Mt/m (1Mt/m from Driefontein 3 (followed sequentially by Driefontein 5 and C4S) and 0.5 Mt/m from Cooke TSF). Reclamation and processing capacity will ultimately ramp up to 4 Mt/m over an anticipated period of 8 years. At the 4Mt/m tailings retreatment capacity, each of the blocks will be reclaimed and processed simultaneously.

The tailings material will be centrally treated in a CPP. In addition to gold and uranium extraction, sulfur will ultimately be extracted to produce sulphuric acid, an important reagent required for uranium leaching.

To minimise the upfront capital required for the WRTRP, only essential infrastructure will be developed during initial implementation. Use of existing and available already authorised infrastructure may be used to process gold and uranium until the volumetric increase in tonnage necessitates the need to expand the CPP.

The authorisation, construction and operation of a new deposition site for the residue from the CPP will be located in an area that has been extensively studied as part of the original WWP and CUP projects. The “deposition area” on which the project is focussing, has been termed the RTSF and is anticipated to accommodate the entire tonnage from the district. The RTSF if proved viable will be one large facility as opposed to the two independent deposition facilities proposed by the WWP and CUP respectively.

Note: Amendments to various MWPs and EMPs will be applied for in due course pending the inclusion of additional TSFs as the WRTRP grows to process 4 Mt/m. The RTSF will be assessed for the complete footprint to ensure that the site is suitable for all future deposition requirements.

The WRTRP has recognised that water is a scarce and strategic commodity and hence mine impacted water will be used preferentially over Rand Water or other higher quality sources. Water will be supplied to the reclamation areas from the identified sources via water storage facilities. A number of water sources have been identified from which water will be abstracted and supplied to the surface reclamation operations, these include:

- 20 Mℓ/d from K10 Shaft (Kloof MRA; catchment C23D);
- 12 Mℓ/d from Cooke 1 Shaft (Cooke MRA; catchment C23D); and
- Cooke 4 South Shaft (Ezulwini MRA; catchment C22H).

Approximately 30 Mℓ/day is being discharged into the Wonderfonteinspruit from the K10 Shaft together with additional discharges of 15 Mℓ/d from Cooke 1 (refer to the Surface Water Report, Digby Wells, 2015), thus total flows discharged to the Wonderfonteinspruit currently amounts to 45 Mℓ/day. The above listed water abstraction amounts of 20 Mℓ/day and 15 Mℓ/day therefore will decrease this by an estimated 32 Mℓ/day to only to 13 Mℓ/d being discharged into the Wonderfonteinspruit.

Once the impacted mine water has been used in the hydraulic reclamation process, it will be pumped with the slurry to the RTSF. As water builds up in the RTSF it will be drained to the RWD and treated at the AWTF. The water will then be treated to acceptable standards and this will be discharged into the Leeuspruit due east of the AWTF in the Kloof MRA. Approximately between 11 Mℓ/day and 18 Mℓ/day will be discharged into the river and this relates to an increase of an estimated 35% in the river flows (Surface Water Report, Digby Wells, 2015f).

The project therefore incorporates a proposed inter-basin transfer as water is being abstracted from quaternary catchments C23D and C22H, where after it is being discharged into catchment C22J. The direct and cumulative as well as the local and catchment scale impacts of the water abstraction and discharge are incorporated into this report and are captured the Kloof MRA operational phase. It is also important to note that other aspects of this impact are discussed in the surface water and wetland reports

1.2 Initial Implementation

Due to capital constraints in developing a project of this magnitude, it needs to be implemented over time. The initial investment and development will be focused on those assets that will put the project in a position to partially fund the remaining development.

This entails the design and construction of the CPP (gold module, floatation plant, uranium plant, acid plant and a roaster), to retreat up to 1.5 Mt/m from the Driefontein 3 and 5 TSFs, C4S TSF and the Cooke TSF. Driefontein 3, 5 and C4S TSFs will be mined sequentially over 11 years, whilst the Cooke TSF will be mined concurrent to these for a period of 16 years. The resultant tailings will be deposited onto the new RTSF.

A high grade uranium concentrate, produced at the CPP, will be transported to Ezulwini (50k tonnes per month) for the extraction of uranium and gold. The tailings from this process will be deposited on the existing operational Ezulwini North TSF.

The activities listed in Table 1-1 will be assessed in this impact assessment and baseline study.

Table 1-1: Primary activities of the WRTRP

Category	Activity
Infrastructure	Pipeline Routes (water, slurry and tailings).
	West, North and South Block Thickeners (WBT, NBT and SBT) and West, North and South Bulk Water Storage (BWS) complexes.
	Cooke thickener.
	Collection sumps and pump stations at the Driefontein TSF 3 and 5, Ezulwini South TSF and Cooke TSF.
	CPP incorporating Module 1 float and gold plants and No1 uranium, roaster and acid plants) and RTSF.
	RTSF Return Water Dams (RWD) and the Advanced Water Treatment Facility (AWTF).
Processes	Abstraction of water: K10 shaft, Cooke 1 and 2 Peter Wright Dam
	Disposal of the residue from the AWTF.
	Hydraulic reclamation of the TSFs (which include temporary storage of the slurry in a sump).
	Gold, uranium and sulfur extraction at the CPP (tailings to RTSF) and possible uranium extraction at Ezulwini (tailings to Ezulwini North Dump).
	Water distribution at the AWTF for discharge or sale.
Pumping in Western Block	Pumping water from K10 to the BWSF located next to the WBT.
	Pumping water from the BWSF to the Driefontein TSFs that will be reclaimed.
	Pumping slurry from the TSF sump to the WBT (for Driefontein TSF 3 and 5).
	Pumping the thickened slurry from the WBT to the CPP (2 pipeline route options).
Pumping in Southern Block	Possible pumping 50 kt/m of uranium and sulfur rich slurry from the CPP to Ezulwini for extraction of uranium.
	Pumping of up to 1.5 Mt/m of tailings to the RTSF.
	Pumping water from the RTSF return water dams to the AWTF.
	Discharging treated water to the Leeuspruit.
	Pumping of 1 Mt/m of tailings from the C4S to the SBT.
	Pumping from the SBT to the CPP.
	Pumping residue from the AWTF to the RTSF.

Category	Activity
Pumping in Northern Block	Pumping 500 kt/m of tailings from the Cooke Dump to the Cooke thickener.
	Pumping from the Cooke thickener to the CPP.
Electricity supply	Power supply from West Drie 6 substation to Driefontein TSF 3.
	Power supply from West Drie Gold substation to Driefontein TSF 5.
	Power supply from East Drie Shaft substation to WBT and BWSF.
	Power supply from Kloof 1 substation to the CPP.
	Power supply from Kloof 4 substation to the RTSF and AWTF.
	Power supply from the Cooke substation to the Cooke thickener.
	Power supply from the Cooke Plant to the Cooke TSF
	Power supply from Ezulwini plant to the C4S TSF

1.3 Terms of Reference

The agreed Terms of Reference (ToR) includes a desktop review, field investigation and report compilation. The methodologies employed are detailed in Section 4 of this report.

1.3.1 Literature and Desktop Review

The desktop review required compilation of relevant information for the greater study area from reliable and recognised resources. The desktop review considered the following:

- The baseline scoping information was compiled using the most recent version of the "Desktop Assessment for the PES, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches (SQRs) of Secondary Catchments in South Africa" (DWS, 2013).

Previous studies that were considered included:

- Integrated Water and Waste Management Plan for South Deep Gold Mine, Golder Associates Africa 2010;
- Aquatic Specialist Study for the Pyrite Storage Facility Associated with Rand Uranium (Pty) Ltd, Golder Associates Africa 2010;
- Aquatic Specialist Assessment for the proposed Geluksdal Tailings Storage Facility and Pipeline infrastructure, Digby Wells Environmental, RAN1386, 2012;
- Instream biological/chemical integrity of the surface streams at Sibanye Gold (Kloof operations), based on the assessment of macroinvertebrate communities and hydrochemistry, African Environmental Development, Report Number AED0289/2014; and

- Instream biological/chemical integrity of the surface streams at Driefontein Gold Mine, based on the assessment of macroinvertebrate communities and hydrochemistry, African Environmental Development, Report Number AED0180/2010.

1.3.2 Screening Assessment

The proposed project will be implemented over the next 10 years. However, this study will complete a screening assessment in order to identify any potential sensitive or Rare, Threatened and Endangered (RTE) taxa within the river systems associated with the proposed study area.

1.3.3 Field Study

Field investigations took place in summer (March 2015) and winter (June 2015) for the following basic areas:

- Western Block which comprises of Driefontein 1, 2, 3, 4 and 5 TSF, and Libanon TSF;
- Northern Block comprises which comprises of: Cooke TSF, Venterspost North TSF, Venterspost South TSF and Millsite Complex (38, 39 and 40/41 and Valley); and
- Southern Block which comprises of: Kloof No.1 TSF, Kloof No.2 TSF, South Shaft TSF (future), Twin Shaft TSF (future), Leeudoorn TSF and C4S TSF.

The agreed upon ToR for the field work component of the study were to include:

- Establishment of the baseline Present Ecological Status (PES) and ecological sensitivities of the river systems associated with the abovementioned blocks.
- To determine the potential impacts of the proposed project on any aquatic ecosystems within the project area; and
- To determine mitigation measures for the identified impacts in order to reduce the severity of these impacts.

1.3.4 Report Compilation

- Description of the PES of each of the potentially affected river systems.
- Description of potential impacts;
- Description of recommended mitigation actions; and
- Review of relevant legislation applicable to the study.

2 Details of the Specialist

Russell Tate is a specialist aquatic ecologist with three and a half years in the Biophysical Department of Digby Wells. He is a Professional Natural Scientist who holds a Master's degree in aquatic health from the University of Johannesburg (South Africa). Russell has published various scientific papers on several aspects of aquatic ecology including lake assessments, invertebrate as well as ecotoxicological assessments. Russell has completed numerous aquatic assessments in several African countries including Botswana, Democratic Republic of the Congo (DRC), Mali, Sierra Leone, Senegal, Ivory Coast, South Africa, and Mozambique, Cameroon, Liberia and Ghana.

3 Aims and Objectives

This report aims to establish the baseline PES of the river systems associated with the proposed mining project. Furthermore, this study aims to complete a basic screening assessment to ascertain potential fatal flaws of the larger (ultimate) project. Additionally, this report aims to complete an impact assessment, based on the established baseline conditions, for the proposed project and provide mitigation and management actions where required.

4 Methods

4.1 Gap Analysis

After the review of the available documentation four reports were found to contain relevant information for reaches of the Wonderfonteinspruit, Leeuspruit and Loopspruit. The titles of these reports are:

- Integrated Water and Waste Management Plan for South Deep Gold Mine, Golder 2010;
- Aquatic Specialist Study for the Pyrite Storage Facility Associated with Rand Uranium (Pty) Ltd, Golder 2010;
- Aquatic Specialist Assessment for the proposed Geluksdal Tailings Storage Facility and Pipeline infrastructure, Digby Wells Environmental, RAN1386, 2012; and
- Aquatic Biomonitoring Report for the Goldfields – Kloof Gold Mine, as required by their Water Use Licence No 20027695.

The available aquatic information is predominantly for the Kloof area, in systems surrounding the CPP and South Deep Mine. Limited information for the Cooke area is available and is predominantly associated with the Cooke Plant.

4.1.1 Integrated Water and Waste Management Plan for South Deep Gold Mine

An aquatic ecological study was completed in 2005 upon which the IWWMP findings are based. Although the 2005 report is quoted and results from the report are discussed, the title or origin of the report cannot be identified as it is not referenced, nor is it present in the available documentation. However, key findings contained within the IWWMP report will be of use.

The results, which are briefly discussed, indicate that the aquatic assessment was conducted in 2005 and that the focus of this assessment was on the Loopspruit, Kariegaspruit and Leeuspruit aquatic ecosystems surrounding South Deep. Although this information is relevant, the detail provided in the IWWMP is not sufficient for future authorisations.

4.1.2 Aquatic Specialist Study for the Pyrite Storage Facility Associated with Rand Uranium

This recent study (2010) focused on aquatic conditions of a tributary and section of the Wonderfonteinspruit. The study contained relevant information pertaining to *in* situ water quality, macroinvertebrates and fish populations of the Wonderfonteinspruit. This report would be suitable to base an impact assessment on for the relevant section of the Wonderfonteinspruit.

4.1.3 Aquatic Specialist Assessment for the proposed Geluksdal Tailings Storage Facility and pipeline infrastructure

This recent study (2012) focused on aquatic ecology in the Leeuspruit, Loopspruit, Wonderfonteinspruit associated with the Cooke Plant and South Deep. The study contained relevant information pertaining to *in* situ water quality, macroinvertebrates and fish populations and is seen as a reliable source of information pertaining to aquatic conditions around Cooke Plant and South Deep.

4.2 Fieldwork and Seasonal Influence

4.2.1 Surveys

Two surveys of the relevant aquatic systems were completed for this assessment. A high flow survey, completed during March 2015, and a low flow survey completed during June 2015. During the low flow survey, the Southern Block river systems were completed during to confirm the desktop classification obtained from the literature review.

4.2.2 Present Ecological Status

The Present Ecology Status (PES) of the associated aquatic ecosystems was determined using the River Health Programme (RHP) Ecological Classification manuals (Kleynhans and

Louw, 2007). The PES was derived through the characterisation of the various biophysical attributes for the considered river systems as presented in the sections below.

4.2.3 Water Quality

Water quality was measured using a calibrated Extech DO 700 multimeter. Constituents used in this study included temperature (ºC), pH, dissolved oxygen (mg/l) and conductivity (µS/cm). The results of the Digby Wells surface water assessment, in which the chemical analysis of water was completed, was used to supplement these results.

4.2.4 Habitat Quality

The availability and diversity of aquatic habitat is important to consider in assessments due to the reliance and adaptations of aquatic biota to specific habitats types (Barbour *et al*., 1996). Habitat quality and availability assessments are usually conducted alongside biological assessments that utilise fish and macroinvertebrates. Aquatic habitat (habitat) was assessed through observations on each river system considered. The methods used for the assessment are set out by Bain and Stevenson (1990), Vannote *et al*., (1980), and Gerber and Gabriel (2002).

4.2.4.1 Intermediate Habitat Integrity Assessment

To define a general habitat, for baseline purposes, the instream and riparian habitat was assessed and characterised according to “Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999”.

The Intermediate Habitat Integrity Assessment (IHIA) model was used to assess the integrity of the habitats from a riparian and instream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996). The criteria utilised in the assessment of habitat integrity in the current study are presented in Table 4-1.

Table 4-1: Criteria in the Assessment of Habitat Integrity (Kleynhans, 1996).

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.

Criterion	Relevance
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon *et al*., 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon *et al*., 1992).
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon *et al*., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

The relevant criteria is then weighted and scored according to Kleynhans (1996), as seen in the tables below (Table 4-2 and Table 4-3).

Table 4-2: Table giving descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996)

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not influenced.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 4-3: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996)

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**	**TOTAL**	**100**

Scores are then calculated based on ratings received from the assessment. The estimated impacts of the criteria are summed and expressed as a percentage to arrive at a provisional habitat integrity assessment. The scores are placed into the IHIA categories (Kleynhans, 1996) as seen in Table 4-4.

It should be noted that the IHIA was based on regions assessed in the current studies and therefore may only constitute the assessment of conditions within the considered Sub Quaternary Reach (SQR) length.

Table 4-4: Intermediate habitat integrity categories (Kleynhans, 1996)

Category	Description	Score
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

4.2.5 Macroinvertebrates

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al*., 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al*., 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

4.2.5.1 Integrated Habitat Assessment System

The Integrated Habitat Assessment System (IHAS) was specifically designed to be used in conjunction with the South African Scoring System 5 (SASS5), benthic macroinvertebrate assessment. The IHAS assesses the availability of the biotopes at each site and expresses the availability and suitability of habitat for macroinvertebrates, this is determined as a percentage, where 100% represents "ideal" habitat availability. A description based on the IHAS percentage scores is presented in Table 4-5.

Table 4-5: Description of IHAS scores with the respective percentage category (McMillan, 1998)

IHAS Score (%)	Description
>75	Very Good
65–74	Good
55–64	Fair/Adequate
<55	Poor

4.2.5.2 South African Scoring System (version 5)

The SASS5 is the current biological index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Muscidae and Psychodidae) to highly sensitive families (e.g. Oligoneuridae). SASS5 results are expressed both as an index score (SASS5 score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the “Aquatic Invertebrates of South African Rivers” Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al*., 1995; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Highveld lower ecoregion. This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database. The table and figure below illustrate the biological banding and classification (Table 4-6 and Figure 4-1).

Table 4-6: Highveld low biological banding

Class	SASS5 Score	ASPT	Condition
A	>123	>5.6	Natural/unmodified
B	83-122	5.5–5.8	Minimally modified
C	64–82	5.1–5.5	Moderately modified
D	51–63	4.6–5.1	Largely modified
E	<50	<4.6	Seriously modified

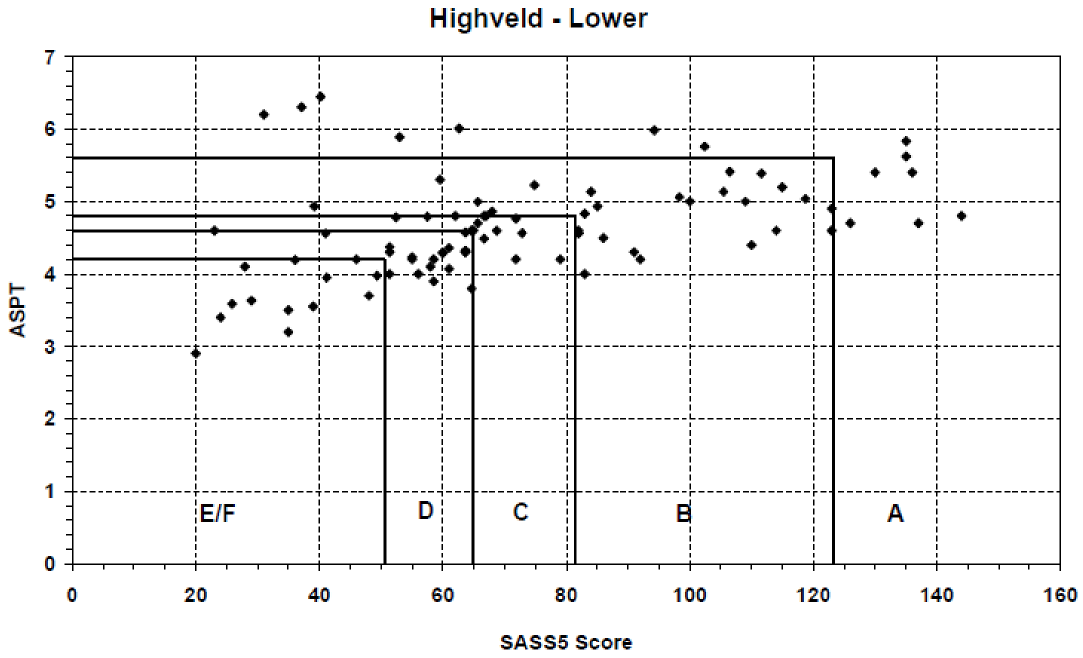

Figure 4-1: Guidelines used for the interpretation and classification of the SASS5 scores (Dallas, 2007)

The SASS5 biotope scores will be used for habitat diversity comparison due to limitations in the IHAS methodology (Tate and Husted, 2015).

4.2.5.3 *Macroinvertebrate Response Assessment Index*

The Macroinvertebrate Response Assessment Index (MIRAI) was used to provide a habitat-based cause-and-effect foundation to interpret the deviation of the aquatic invertebrate community from the calculated reference conditions for the Highveld Lower. This does not preclude the calculation of SASS5 scores if required (Thirion, 2007). The four major components of a stream system that determine productivity for aquatic macroinvertebrates are as follows:

- Flow regime;
- Physical habitat structure;
- Water quality; and
- Energy inputs from the watershed Riparian vegetation assessment.

The results of the MIRAI will provide an indication of the current ecological category and therefore assist in the determination of the PES.

4.3 Study Area

The focus areas of this study will be separated into three categories (clusters). Furthermore these clusters will be associated with their respective Water Management Areas (WMA) and quaternary catchments which are presented in the table below (Table 4-7). An overview of the clusters and their locations is also presented in Figure 4-2.

Table 4-7: Mining Right Areas and their associated WMA and quaternary catchments.

Mining Right Area	Quaternary catchments
WMA	**Upper Vaal (WMA8)**
Cooke Mining Right Area	C22A, C23D
Driefontein Mining Right Area	C23D, C23E
Kloof Mining Right Area	C22J, C23J,
Ezulwini Mining Right Area	C22H

As observed in the above table (Table 4-7), the project boundaries are located within the Upper Vaal WMA. Based on the layout of the project boundaries a total of seven quaternary catchments could potentially be affected by the proposed project. The various blocks, their respective quaternary catchments and their associated primary draining features (rivers) are presented in the table below (Table 4-8).

Table 4-8: Rivers potentially affected by the proposed project and their respective Sub Quaternary Reaches (SQR).

Mining Right Area	Quaternary Catchment	River System	SQR
Cooke Mining Right Area	C23D	Wonderfonteinspruit	C23D-01313; C23D-01365; C23D-01384
Driefontein Mining Right Area	C23D	Wonderfonteinspruit	C23D-01384
	C23E	Mooirivierloop	C23E-01368; C23E-01436;
Kloof Mining Right Area	C22J	Loopspruit	C23J-01487
	C23J	Leeuspruit	C22J-01468; C22J-01466
Ezulwini Mining Right Area	C22H	Kleinwes Rietspruit	C22H-01464

The above table (Table 4-8) shows a total of six river systems and ten Sub-Quaternary Reaches (SQRs) will potentially be affected by the proposed project. The abovementioned Mining Right Areas and their respective river systems are presented in the figure below (Figure 4-2).

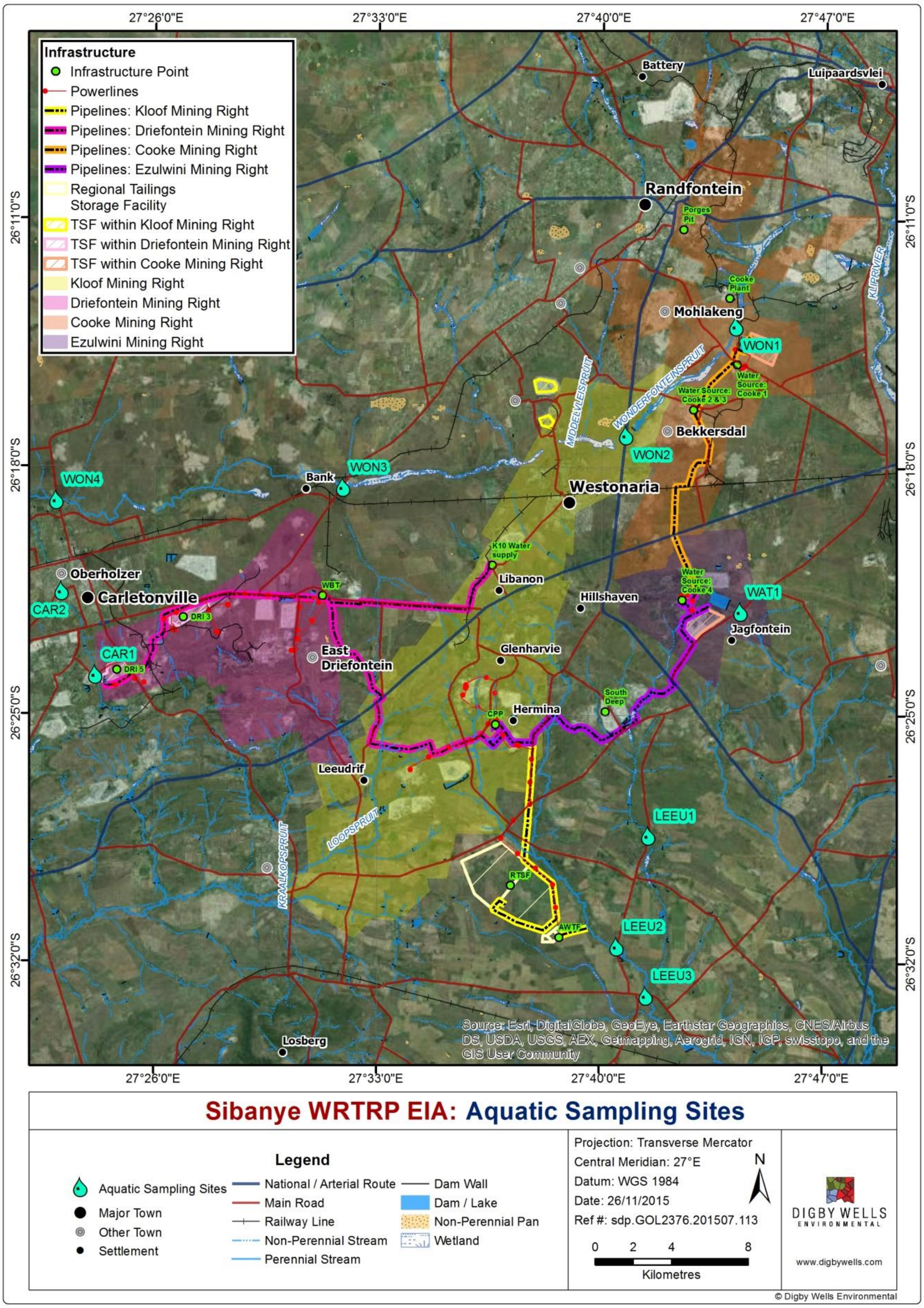

Figure 4-2: River systems, study sites and the various mining right areas

4.3.1 National Freshwater Protection Areas

The layout of the proposed project, with respect to the National Freshwater Ecosystem Priority Areas (NFEPA) information (WRC, 2011), indicates:

- All clusters' have multiple SQRs that are NFEPA fish support areas. These include the following SQRs: C23D-1313, C23D-1343, C23D-1384, C23E-1368, and C23J-1487.
- The fish support areas are important catchments connected to Freshwater Ecosystem Priority Areas (FEPA) Rivers.
- According to the WRC (2011), the fish support area's need to be maintained in a condition that will support the expected fish populations.

4.3.2 Study Sites for the Field Survey

Sites were selected according to the results of the gap analysis (Digby Wells, 2014). It includes sites in the Wonderfonteinspruit and upper Mooirivierloop for biannual assessment. Sites within the Loopspruit were ground-truthed to confirm their current ecological classification (Digby Wells, 2012). The location of the sites in relation to the project areas are provided in Figure 4-2. Photographs of the sites considered in the field assessment are provided in Table 4-9.

Table 4-9: Photographs of the various sites during the aquatic surveys (2015)

Site	Photograph
Wonderfonteinspruit	
WON1 -26.233083° 27.736658°	

Site	Photograph
WON2 -26.284837° 27.679378°	
WON3 -26.309656° 27.531613°	

Site	Photograph
WON4 -26.315890° 27.381958°	
Carletonville Tributary	
CAR1 -26.398234° 27.402494°	

Site	Photograph
CAR2 -26.358874° 27.384778°	
Leeuspruit	
LEEU1 27.692109° -26.473372°	
LEEU2 -26.525621° 27.675833°	

Site	Photograph
LEEU3 -26.548756° 27.691188°	
Kleinwes Rietspruit	
EZUL1 -26.367667° 27.739540°	

5 Assumptions and Limitations

The baseline assessment is based predominantly on desktop information with two surveys completed for the Wonderfonteinspruit and a single survey on the Leeuspruit and Kleinwes Rietspruit. Sufficient data is available for the Loopspruit, negating the need for a field survey.

6 Screening Assessment

6.1 The Cooke Mining Right Area

To maintain a clear understanding of each potentially affected SQR, each will be considered separately.

6.1.1 Wonderfonteinspruit

The Wonderfonteinspruit is the primary draining feature of the northern cluster. This river system can be separated into three SQRs within the northern cluster. These are the upper Wonderfonteinspruit (C23D-01313), the middle Wonderfonteinspruit after its confluence with the Middelvleispruit (C23D-01365) and the lower Wonderfonteinspruit after its confluence with the Rietfonteinspruit (C23D-1384).

6.1.1.1 Upper Wonderfonteinspruit: C23D-01313

Based on the Department of Water Affairs (DWA) (2013) the upper Wonderfonteinspruit is currently in a seriously modified state (class E; Table 6-1). This status is as a result of large habitat impacts within the system. These impacts include road crossings and sinkholes with the largest impact being the physical piping of the river system just upstream of the Middelvleispruit confluence. Compounding the habitat impacts is the origin of the river system which occurs within a heavily industrialised area and contains multiple TSF's. Further water quality impacts are also known to occur as a result of urban runoff, exacerbated by sewage effluent and solid waste disposal within the catchment. A total of three fish species are expected to be present in this SQR. These expected taxa are tolerant to water quality modification but rely heavily on the volumes of water currently in the SQR and as such their ecological importance is viewed as moderate. Due to the tolerance of the expected taxa, the sensitivity of the SQR is viewed as low. Water quality impacts are therefore seen as important factors to consider in this SQR.

Table 6-1: Desktop ecological information available for the C23D-01313 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C23D-01313
Present Ecological Status	class E (Seriously modified)
Ecological Importance	Moderate
Ecological Sensitivity	Low

6.1.1.2 Middle Wonderfonteinspruit: C23D-01365

The middle Wonderfonteinspruit is located below the confluence of the Middelvleispruit and upstream of the confluence with the Rietfonteinspruit. The SQR is only approximately 4 km in length. According to available desktop information the PES of this SQR is seriously modified (class E; Table 6-2). This PES differs from the desktop information (DWA, 2013) because based on aerial imagery of the middle Wonderfonteinspruit it appears that this section is completely *piped* and therefore serious instream modification has occurred. In spite of this, the riparian habitat is still largely intact and therefore is rated as moderately modified. Only two species of fish are expected to be present within this SQR. Due to the piping of the river as well as the presence of several barriers (impeding biota movement) the biota currently present in the SQR are viewed as of moderate ecological importance. Due to the large reliance of this remaining aquatic biota on the remaining water in the SQR the ecological sensitivity is viewed as moderate. Water quantity is therefore seen as an important factor to consider in this SQR.

Table 6-2: Desktop ecological information available for the C23D-01365 Sub Quaternary Reach (DWA, 2013). *Note adjusted PES*

Component/Catchment	C23D-01365
Present Ecological Status	class E (Seriously modified)
Ecological Importance	Moderate
Ecological Sensitivity	Moderate

6.1.1.3 Lower Wonderfonteinspruit: C23D-01384

The lower Wonderfonteinspruit, otherwise known as the Mooirivierloop occurs after the confluence with the Rietfonteinspruit and the C23E-01266 SQR. The PES of the lower Wonderfonteinspruit is seriously modified (class E). This PES is largely attributed to industrial activities, waste water treatment works, townships and instream habitat modification (DWA, 2013; Table 6-3). In addition to the abovementioned impacts the SQR is also piped and therefore serious instream modification has occurred. Due to the presence of substantial impacts and the low confidence in the presence of fish in the SQR the ecological importance and sensitivity is viewed as low. It is noted here that this SQR is also potentially affected by the western cluster.

Table 6-3: Desktop ecological information available for the C23D-01384 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C23D-01384
Present Ecological Status	class E (Seriously modified)
Ecological Importance	Low
Ecological Sensitivity	Low

6.1.2 Conclusion on Baseline Status of the Cooke Mining Right Area

The findings for each potentially affected SQR indicate the majority of river systems are largely modified. The modification is attributed to the location of the rivers' sources, which are in urban and industrial areas. Existing instream impacts in the region are impoundments, water quality modification (industrial runoff), sewage effluent and solid waste disposal. Riparian impacts in the northern cluster are vegetation removal, channel and bed modification and urban/industrial encroachment. Overall, only moderately important and sensitive aquatic ecosystems are found (based on desktop information) with no Red Data aquatic taxa expected to be present. It is further stated that the majority of the Wonderfonteinspruit exists within a pipeline which presents serious instream modification. Based on the absence of RTE taxa as well as the classification of aquatic ecology as moderately important and sensitive, no fatal flaws are expected within this mining right area.

6.2 The Driefontein Mining Right Area

Activities in this mining right area will potentially affect the lower Wonderfonteinspruit and the upper Mooirivierloop.

6.2.1 Mooirivierloop

There are two SQRs potentially affected, namely the Mooirivierloop: C23E-01378 and Mooirivierloop: C23E-01436.

6.2.1.1 Mooirivierloop: C23E-01378

This SQR is the first section of the Mooirivierloop which is the downstream region of the Wonderfonteinspruit. Due to its presence downstream of the Wonderfonteinspruit it can be assumed that similar impacts will be anticipated. When considering available desktop information (DWA, 2013) the PES of the SQR is seriously modified (class E). This modified PES is a result of serious instream habitat modification, physico-chemical modification and riparian zone modification. The presence of waste water treatment works and informal townships in the catchment have resulted in serious water quality deterioration. Road crossings and abstraction has also resulted in the formation of large pools in the associated wetland systems and as such the presence of serious instream habitat modification. Due to current serious modification of the aquatic environment the ecological importance and sensitivity is viewed as low.

Table 6-4: Desktop ecological information available for the C23E-01378 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C23E-01378
Present Ecological Status	class E (Seriously modified)
Ecological Importance	Low
Ecological Sensitivity	Low

6.2.1.2 Mooirivierloop: C23E-01436

This tributary of the Mooirivierloop runs in between the town of Carletonville and is approximately 14 km long. According to desktop information (DWA, 2013) this tributary has a PES which is considered to be largely modified (class D; Table 6-5). This modified status was determined to be a result of instream modification through the presence of impoundments, road crossings as well as bed and channel modification. Approximately 5 km of the river system runs adjacent to urban areas, 4 km runs adjacent industrial activities and the remaining extent is generally agricultural. Little to no natural riparian vegetation remains in this SQR and as such serious modification is likely present. Water quality impacts are expected in the upper reaches as these areas are highly industrialised. In the lower reaches of the SQR concentrated livestock agricultural activities takes place and therefore it is likely that water quality impacts are present in the lower reaches to. Only three fish species are expected in the SQR and these taxa are tolerant to habitat and water quality modification. Due to the high level of modification in the SQR the presence of ecologically important taxa is unlikely. As such the ecological importance of the SQR was reduced to low. Due to the presence of largely tolerant taxa the ecological sensitivity is also viewed as low.

Table 6-5: Desktop ecological information available for the C23E-01436 Sub Quaternary Reach (DWA, 2013). ***Note Ecological importance has been adjusted***

Component/Catchment	C23E-01436
Present Ecological Status	class D (Moderately modified)
Ecological Importance	Low
Ecological Sensitivity	Low

6.2.2 Conclusion on Baseline Status of the Driefontein Mining Right Area

The PES of the two SQRs are heavily modified (class E and class D). Due to the nature of the impacts associated within these SQRs, aquatic biota is of low importance with low sensitivities. Dominant impacts in the SQRs were water quality modification from industrial, agricultural and sewage treatment activities. Instream and riparian habitat was largely modified as a result of urbanisation as well as industrial activities in the upper reaches of the tributary considered. It is further stated that the literature review has revealed consistent classifications with the abovementioned rivers systems within this cluster. No fatal flaws could be identified in this mining right area.

6.3 The Kloof Mining Right Area

The river systems potentially affected within this mining right area are the Loopspruit and Leeuspruit water courses.

6.3.1 Loopspruit: C23J-01487

The Loopspruit within the SQR (C23J-01487) is approximately 16 km in length with its source located within a relatively natural catchment. Near the middle reaches of the considered SQR, agricultural activities occur adjacent to the river system and an industrial zone on the opposite bank. Immediately downstream of these areas is a mine TSF. Due to the presence of these activities water quality impacts may be expected. According to available desktop information the considered SQR has a PES that is largely modified (Class D; Table 6-5). This is largely attributed to serious physico-chemical modification with large impacts on instream habitat resulting in large flow modification. A total of four fish taxa that are sensitive to flow modification are expected in this SQR and as such ecological sensitivity and importance is viewed as moderate. Water quantity is important in this SQR.

According to the report AED (2014) the Loopspruit is currently in a class C or moderately modified status. However, this report has not taken into consideration the ecological category of fish and therefore is most likely more impacted than reported on. As such the class D category is maintained.

Table 6-6: Desktop ecological information available for the C23E-01487 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C23J-01487
Present Ecological Status	class D (Moderately modified)
Ecological Importance	Moderate
Ecological Sensitivity	Moderate

6.3.2 Leeuspruit

6.3.2.1 Leeuspruit: C22J-01468

This SQR is the western tributary of the source zone for the Leeuspruit and is approximately 23 km long. The source of this SQR is located within a heavily industrialised area for approximately 2 km, the river then flows through agricultural lands and eventually drains two separate gold mine TSF's. Based on this description water quality impacts can be anticipated in this SQR. When considering the desktop information (DWA, 2013) the PES of the SQR is provided as seriously modified (class E; Table 6-7). This modified status was determined due to serious instream habitat modification and serious physico-chemical modification. The ecological importance of the SQR is considered to be moderate. This moderate rating is likely due to the diversity of fish potentially located within the SQR. The ecological sensitivity of the SQR was provided as high. This high ecological sensitivity is likely due to the presence of sensitive fish species such as *Labeobarbus aeneus*. Based on the sensitivities water quantity is important factor to consider for this SQR.

Table 6-7: Desktop ecological information available for the C22J-01468 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C22J-01468
Present Ecological Status	class E (Seriously modified)
Ecological Importance	Moderate
Ecological Sensitivity	High

6.3.2.2 Leeuspruit: C22J-01466

This SQR is the eastern tributary of the Leeuspruit source zone. Much like the western tributary this SQR has its source nears to a gold mine TSF from where it flows adjacent a gold processing plant and a large TSF. Based on the location of these structures with the catchment area of the SQR it is likely that water quality impacts are present. When considering desktop information the PES of the SQR is largely modified (class D; Table 6-8). This PES was derived due to the presence of the abovementioned industrial activities compounded by local agricultural activities. A total of eight fish species are expected to be present. These expected species include *Labeobarbus aeneus.* Based on the desktop information available the SQR is considered to have moderately sensitive aquatic biota which is of moderate importance.

Table 6-8: Desktop ecological information available for the C22J-01466 Sub Quaternary Reach (DWA, 2013)

Component/Catchment	C22J-01466
Present Ecological Status	class D (Moderately modified)
Ecological Importance	Moderate
Ecological Sensitivity	Moderate

6.3.3 Conclusion on Baseline Status of the Kloof Mining Right Area

Based on the findings of the desktop assessment it is clear that the aquatic ecosystems associated with the southern cluster are impacted. The PES of the SQRs are impacted on through water quality modification predominantly near the source of the SQRs. Habitat modification is largely present but not at the extent observed in the other clusters. More sensitive taxa are expected to be present within the considered SQRs of the southern cluster. However, these taxa are sensitive to habitat modification and therefore water quantity is an important factor to consider. No fatal flaws could be identified in this mining right area.

7 Baseline Environment

The results sections are based on the results field work completed and described in section 4. For ease of reading, the results will be separated into each of the abovementioned river systems, namely, the Wonderfonteinspruit, Mooirivierloop, Carletonville Tributary, Leeuspruit, Loopspruit and the Kleinwes Rietspruit.

7.1 The Wonderfonteinspruit, Mooirivierloop and Carletonville Tributary

7.1.1 Water Quality

The results of the water quality analysis during the high and low flow are presented in the tables below (Table 7-1 and Table 7-2).

Table 7-1: *In situ* water quality results from the high flow survey

Constituent	Guideline	WON1	WON4	CAR1
Temperature (ºC)	5-25	16	13.8	17.6
pH	6-9	7.5	8.6	8.6
Conductivity (µS/cm)	<700	774	1035	1228
Dissolved oxygen (mg/l)	>5	3.77	8.6	6.9
Dissolved oxygen saturation (%)	>50	38	81	61
*Red colour denotes constituent exceeding recommended guideline values (DWAF, 1996)				

When considering the *in situ* results from the high flow survey, temperatures are observed to range between 13.8ºC at WON4 to 17.6ºC at CAR1. The pH levels obtained during the survey ranged between 7.5 at WON1 to 8.6 at WON4 and CAR1. The conductivity recordings obtained during the survey ranged from 774 µS/cm at WON1 to 1035 µS/cm at WON4. Concentrations of dissolved oxygen ranged between 3.7 mg/l and 38% at WON1 to 8.6 mg/l and 81% at WON4.

Table 7-2: *In situ* water quality results from the low flow survey

Constituent	Guideline	WON1	WON4	CAR1
Temperature (ºC)	5-25	9.5	13.8	7.5
pH	6-9	7.8	8.6	8.1
Conductivity (µS/cm)	<700	879	1035	1164
Dissolved oxygen (mg/l)	>5	4.5	6.34	7.22
Dissolved oxygen saturation (%)	>50	40	61	63
*Red colour denotes constituent exceeding recommended guideline (DWAF, 1996)				

The *in situ* water quality results obtained during the low flow survey indicate temperature ranges between 7.5ºC at CAR1 to 13.8ºC at WON4. The pH ranges obtained during the survey were between 7.8 at WON1 to 8.6 at WON2. Conductivity was observed to range between 879 µS/cm at WON1 to 1164 µS/cm at CAR1. Concentrations of dissolved oxygen fluctuated between 4.5 mg/l and 40% at WON1 to 7.2 mg/l and 63% at CAR1.

7.1.1.1 Water Quality Discussion

Water temperatures and pH levels during the assessment (surveys) were observed in natural ranges with no negative effects on aquatic biota anticipated.

The conductivity observed at all of the sites was above the threshold values at which sensitive aquatic biota are negatively affected. The increased conductivity provides an indication that land use within the Wonderfonteinspruit and Carletonville Tributary catchments are increasing the concentrations of dissolved solids.

Dissolved oxygen was limited at WON1 during both the high and low flow surveys. This lowered state of oxygen saturation can negatively affect local aquatic biota. The central cause for the lowered dissolved oxygen state can be attributed to the excessive nutrient input into the river system via waste water treatment facilities as well as informal settlements.

7.1.2 Intermediate Habitat Integrity Assessment

The results of the IHIA completed for the Wonderfonteinspruit are presented in Table 7-3 and Table 7-4.

Table 7-3: IHIA for Instream Habitat for the Wonderfonteinspruit

Instream	Average Score	Score
Water abstraction	13.33	7.46
Flow modification	25	13
Bed modification	25	13
Channel modification	25	13
Water quality	11.66	6.53
Inundation	20.33	8.13
Exotic macrophytes	8	2.88
Exotic fauna	10	3.2
Solid waste disposal	11.66	2.8
Total Instream	**29.98**	
Category		**class E**

Table 7-4: IHIA for Riparian Habitat for the Wonderfonteinspruit

Riparian	Average Score	Score
Indigenous vegetation removal	13	6.76
Exotic vegetation encroachment	10	4.8
Bank erosion	10	5.6
Channel modification	21	10.08
Water abstraction	8.33	4.33
Inundation	21	9.24
Flow modification	22	10.56
Water quality	11.66	6.06
Total Riparian	**42.56**	
Category		**class D**

Within the SQRs of the Wonderfonteinspruit, the IHIA results of the instream habitats are classified as class E or seriously modified, with the riparian habitat as class D or largely modified.

The results of the IHIA completed for the Carletonville tributary are presented in Table 7-5 and Table 7-6.

Table 7-5: IHIA for Instream Habitat for the Carletonville Tributary

Instream	Average Score	Score
Water abstraction	10	5.6
Flow modification	23	11.96
Bed modification	23	11.96
Channel modification	23	11.96
Water quality	11.66	6.53
Inundation	5	2
Exotic macrophytes	8.33	3
Exotic fauna	13.33	4.26
Solid waste disposal	10	2.4
Total Instream	**40.3**	
Category		**class D**

Table 7-6: IHIA for Riparian Habitat for the Carletonville Tributary

Riparian	Average Score	Score
Indigenous vegetation removal	11.66	6.06
Exotic vegetation encroachment	15	7.2
Bank erosion	10	5.6
Channel modification	18	8.64
Water abstraction	8.33	4.33
Inundation	5	2.2
Flow modification	18.66	8.96
Water quality	10	5.2
Total Riparian	**51**	
Category		**class D**

The IHIA results of the instream and riparian habitats within the SQR of the Carletonville tributary are classified as class D or largely modified.

7.1.2.1 Habitat Discussion

The instream aquatic habitat of the Wonderfonteinspruit is critically impacted through the presence of the pipeline system which drains much of the upper Wonderfonteinspruit. As a result of this structure, the overall IHIA status for the instream habitat was determined to be class E or seriously modified. Due to the presence of the pipeline, the current riparian habitat of the Wonderfonteinspruit is largely composed of wetland adapted non-woody species which are common in the Highveld. However, the impacts of flow modification as well as inundation in the lower reaches were found to be the central causes for the overall largely modified status of the riparian habitat of the Wonderfonteinspruit.

The Carletonville Tributary was also determined to have largely modified instream habitat as a result of the canalisation and piping of much of its upper reaches. As a result of the piping and canalisation of the river system the riparian habitat has been degraded in the upper reaches resulting in an overall largely modified status.

7.1.3 Macroinvertebrates

7.1.3.1 Integrated Habitat Assessment System and Biotope Assessment

The results of the IHAS completed during the surveys are presented in the table below (Table 7-7).

Table 7-7: IHAS results for the 2014/2015 surveys

Site	WON1	WON4	CAR1
Flow	Moderate	Fast	Slow/Standing
Score	63	60	42
Suitability	Fair	Fair	Poor

The results of the IHAS show that invertebrate habitat is suitable or fair at WON1 and WON4 with poor habitat at CAR1. The results of the biotope diversity assessments are presented in Table 7-8. The table is compared to the biotope ratings in Tate and Husted (2015).

Table 7-8: Invertebrate biotope diversity (2015)

Biotope	WON1	WON4	CAR1
Stones in current	4	4	2
Stones out of current	1	0	1
Bedrock	4	0	0
Aquatic Vegetation	1	3	0
Marginal Vegetation In Current	3	3	0
Marginal Vegetation Out Of Current	4	0	0
Gravel	3	0	0
Sand	3	2	3
Mud	2	3	3
Biotope Score	25	15	9
Biotope Score (%)	**56**	**33**	**20**
Biotope suitability	**Good**	**Fair**	**Poor**

The biotope assessment revealed that the biotope diversity ranged from 20 at CAR1 and 56 at WON1.

7.1.3.2 South African Scoring System

The results of the SASS5 assessments completed for the study are presented in Table 7-9 and Table 7-10.

Table 7-9: SASS5 results of the high flow survey

Site	WON1	WON4	CAR1
SASS5	35	62	47
Taxa	10	16	12
ASPT	3.5	3.8	3.9
Category	E	D	E

The SASS5 scores obtained during the low flow survey ranged from 35 at WON1 to 62 at WON4. The taxa diversity at the sites ranged from 10 at WON1 to 16 at WON4. The ASPT values derived from the SASS5 scores ranged from 3.5 at WON1 to 3.9 at CAR1.

Table 7-10: SASS5 results of the low flow survey

Site	WON1	WON4	CAR1
SASS5	36	56	39
Taxa	10	12	11
ASPT	3.6	4.6	3.5
Category	E	D	E

The SASS5 scores obtained during the high flow survey ranged from 36 at WON1 to 56 at WON4. The taxa diversity at the sites ranged from 10 at WON1 to 12 at WON4. The ASPT values derived from the SASS5 scores ranged from 3.5 at CAR1 to 4.6 at WON4.

7.1.3.3 Macroinvertebrate Assessment Index

The results of the MIRAI assessment in the river system considered are presented in the table below (Table 7-11).

Table 7-11: MIRAI scores for the 2015 surveys on the Wonderfonteinspruit

Invertebrate Metric Group	Score Calculated
Flow modification	45.7
Habitat	52.5
Water Quality	40.1
Connectivity and seasonality	24.6
Ecological Score	**41**
Invertebrate Category	**class D**

The result of the MIRAI shows that the ecological category of the Wonderfonteinspruit reaches considered were determined to be a class D or largely modified.

7.1.3.4 Macroinvertebrate Discussion

The results of the IHAS and SASS5 biotope assessment indicates that aside from CAR1 there is sufficient habitat to support a diverse community of macroinvertebrates at the sites considered in the Wonderfonteinspruit system.

Despite the available habitat, seriously and largely modified classes were derived for the SASS5 assessments. These low scores are expected to be related to poor water quality in the river systems, flow modification which has occurred as well as a loss of connectivity between the downstream and upstream regions of both river systems due to piping and canalisation.

Considering the overall results of the macroinvertebrate system, it is clear that water quality and connectivity within the considered river systems are negatively influencing aquatic biota.

7.1.4 Present Ecological Status

The results of the ecological classification and PES for the river reach considered are provided in Table 7-12.

Table 7-12: The Present Ecological Status of the river reach in this study

Category	Score	Ecological category
Riparian Habitat Ecological Category	42	Largely modified
Macroinvertebrate Ecological Category	39	Largely modified
Ecostatus		**Largely/Seriously modified**

The results of the ecological classification indicate that the PES of the reach assessed in this study is a class D/E or largely/seriously modified.

7.1.4.1 Present Ecological Status Discussion

The overall PES of the Wonderfonteinspruit, as well as the Carletonville Tributary are in a largely modified state due to poor water quality, impacts to instream and riparian habitats as well as a general loss of connectivity.

7.2 The Leeuspruit, Loopspruit and Kleinwes Rietspruit

7.2.1 Water Quality

The results of the water quality analysis during the low flow are presented in Table 7-13.

Table 7-13: *In situ* water quality results from the high flow survey

Constituent	Guideline	LEEU1	LEEU2	LEEU3	EZUL1
Temperature (ºC)	5-25	9.8	11.1	10	12.2
pH	6-9	6.7	7.3	7.3	7.07
Conductivity (µS/cm)	<700	1909	1318	1122	864
Dissolved oxygen (mg/l)	>5	8.6	7.2	5.14	7.27
Dissolved oxygen saturation (%)	>50	73.6	66	62	69
*Colour denotes constituent exceeding recommended guideline (DWAF, 1996)					

When considering the *in situ* results from the low flow survey temperatures are observed to range from 9.8ºC at LEEU1 to 12.2ºC at EZUL1. The pH levels obtained during the survey ranged from 6.7 at LEEU1 to 7.3 at LEEU2 and LEEU3. The conductivity recordings obtained during the survey ranged from 864 µS/cm at EZUL1 to 1909 µS/cm at LEEU1. Concentrations of dissolved oxygen ranged from 5.14 mg/l and 62% at LEEU3 to 8.6 mg/l and 73% at LEEU1.

7.2.1.1 Water Quality Discussion

Water temperatures, pH and oxygen levels during the assessment were observed in natural ranges with no negative effects on aquatic biota anticipated.

The conductivity observed at all of the sites considered was above the threshold values at which sensitive aquatic biota are negatively affected. The increased conductivity at the sites can be attributed to the presence of multiple TSF's in the upstream catchments.

7.2.2 Intermediate Habitat Integrity Assessment

The results of the IHIA completed for the Leeuspruit are presented in Table 7-14 and Table 7-15.

Table 7-14: IHIA for Instream Habitat for the Leeuspruit

Instream	Average score	Score
Water abstraction	8.33	4.67
Flow modification	16.67	8.67
Bed modification	18.33	9.53
Channel modification	15.00	7.80
Water quality	17.00	9.52
Inundation	11.67	4.67

Instream	Average score	Score
Exotic macrophytes	5.00	1.80
Exotic fauna	11.67	3.73
Solid waste disposal	10.00	2.40
Total Instream	**47.2**	
Category		**class D**

Table 7-15: IHIA for Riparian Habitat for the Leeuspruit

Riparian	Average score	Score
Indigenous vegetation removal	11.00	5.7
Exotic vegetation encroachment	10.00	4.8
Bank erosion	13.33	7.5
Channel modification	15.00	7.2
Water abstraction	6.67	3.5
Inundation	8.33	3.7
Flow modification	13.33	6.4
Water quality	16.67	8.7
Total Riparian	**52.6**	
Category		**class D**

Within the SQRs of the Leeuspruit, the IHIA results of the instream and riparian habitats are classified as class D or largely modified.

The results of the IHIA completed for the Kleinwes Rietspruit are presented in Table 7-16 and Table 7-17.

Table 7-16: IHIA for Instream Habitat for the Kleinwes Rietspruit

Instream	Average score	Score
Water abstraction	5	2.8
Flow modification	20	10.4
Bed modification	20	10.4
Channel modification	20	10.4
Water quality	15	8.4

Instream	Average score	Score
Inundation	15	6
Exotic macrophytes	5	1.8
Exotic fauna	5	1.6
Solid waste disposal	5	1.2
Total Instream	**47**	
Category		**class D**

Table 7-17: IHIA for Riparian Habitat for the Kleinwes Rietspruit

Riparian	Average score	Score
Indigenous vegetation removal	5	2.6
Exotic vegetation encroachment	5	2.4
Bank erosion	15	8.4
Channel modification	17.6	8.48
Water abstraction	11	5.72
Inundation	11.6	5.1
Flow modification	15	7.2
Water quality	10	5.2
Total Riparian	**54**	
Category		**class D**

The IHIA results of the instream and riparian habitats within the SQR of the Kleinwes Rietspruit are classified as class D or largely modified.

7.2.2.1 Habitat Discussion

The instream habitat of the Leeuspruit was assessed to be largely modified due to the frequency of large impacts within the flow, riverbed and channel modification criterions. The central cause for these impacts is due to the various impoundments within the catchment; these effects are compounded by abstraction which further decreases the available flow. Furthermore, water input from various gold mining operations in the upstream regions has resulted in further flow modifications. Considering the water quality results obtained, it is clear that dissolved solids from various TSF’s are impacting on the conductivity and as a result the water quality conditions.

Agriculture and mining in the catchments of the Leeuspruit considered have negatively impacted on the natural riparian habitats of the river system. The alteration of flows and the presence of impoundments have resulted in large ratings for the channel and flow modification criteria. Furthermore, the presence of alien vegetation as well as the removal of natural vegetation for agricultural activities has also reduced the integrity of the riparian zone within the considered river system.

The instream and riparian habitat of the Kleinwes Rietspruit was also assessed to be largely modified. This class was defined due to the poor flows as well as bed modification within the upper reaches of the rivers system.

7.2.3 Macroinvertebrates

7.2.3.1 Integrated Habitat Assessment System and Biotope Assessment

The results of the IHAS completed during the survey are presented in Table 7-18 below.

Table 7-18: IHAS results for the 2015 survey

Site	LEEU1	LEEU2	EZUL1
Flow	Slow	Slow	Moderate
Score	33	44	55
Suitability	Poor	Poor	Poor

The results of the IHAS show that invertebrate habitat is poor at all of the sites considered. The results of the biotope diversity assessments are presented in the Table 7-19 below.

Table 7-19: Invertebrate biotope diversity (2015)

Biotope	LEEU1	LEEU2	EZUL1
Stones in current	3	1	2
Stones out of current	2	1	2
Bedrock	0	1	1
Aquatic Vegetation	0	0	2
Marginal Vegetation In Current	2	2	3
Marginal Vegetation Out Of Current	3	3	0
Gravel	3	1	4
Sand	3	1	3
Mud	2	3	1

Biotope	LEEU1	LEEU2	EZUL1
Biotope Score	18	13	
Biotope Score (%)	40	28	40
Biotope suitability	Fair	Poor	Fair

The biotope assessment revealed that the biotope diversity ranged from 28% (poor) at LEEU2 and 40% (fair) at LEEU1 and EZUL1.

7.2.3.2 South African Scoring System

The results of the SASS5 assessments completed for the study are presented in Table 7-9 and Table 7-10.

Table 7-20: SASS5 results of the high flow survey

Site	LEEU1	LEEU2	EZUL1
SASS5	18	58	60
Taxa	6	14	12
ASPT	3	4.14	5
Category	E	D	C

The SASS5 scores obtained during the low flow survey ranged from 18 at LEEU1 to 60 at EZUL1. The taxa diversity at the sites ranged from 6 at LEEU1 to 14 at LEEU2. The ASPT values derived from the SASS5 scores ranged from 3 at LEEU1 to 5 at EZUL1.

7.2.3.3 Macroinvertebrate Assessment Index

The results of the MIRAI assessment in the river system considered are presented in Table 7-21 and Table 7-11. The desktop SASS5 data was used to supplement the findings of the low flow survey in the MIRAI index.

Table 7-21: MIRAI scores for the 2015 surveys on the Leeuspruit

Invertebrate Metric Group	Score Calculated
Flow modification	52
Habitat	55
Water Quality	50
Connectivity and seasonality	72
Ecological Score	**57.3**
Invertebrate Category	**class D**

The result of the MIRAI shows that the ecological category of the Leeuspruit reaches considered were determined to be a class D or largely modified.

Only one site was considered in the Kleinwes Rietspruit, as such very low confidence was placed in the MIRAI results and as such the results were not included in the assessment.

7.2.3.4 Macroinvertebrate Discussion

The results of the IHAS and SASS5 biotope assessment indicate that there is sufficient habitat to support a diverse community of macroinvertebrates at the sites considered in the Leeuspruit and Ezulwini river systems.

Although sufficient habitat was present at LEEU1 and LEEU2 the results of the SASS5 assessment indicates that water quality was impacted within the sites considered. This is further confirmed with the impacted ratings obtained from the MIRAI.

Considering the taxa present within the Kleinwes Rietspruit it can be concluded that the water quality is sufficient to support moderately sensitive taxa and therefore indicates only moderately modified water quality.

In conclusion, the macroinvertebrate assemblage within the Leeuspruit is negatively affected by water quality, whereas the assemblage in the Kleinwes Rietspruit is only moderately affected.

7.2.4 Present Ecological Status

The results of the ecological classification and PES for the river reach considered are provided in Table 7-22 and Table 7-23. Due to insufficient data, the MIRAI was not completed for the Kleinwes Rietspruit. To compensate for this, the class rating derived from SASS5 will be used.

Table 7-22: The PES of the Leeuspruit

Category	Score	Ecological category
Riparian Habitat Ecological Category	52	Largely modified
Macroinvertebrate Ecological Category	57.3	Largely modified
Ecostatus		**Largely modified**

The results of the ecological classification indicate that the PES of the Leeuspruit reach assessed in this study was found to be a class D or largely modified.

Table 7-23: The PES of the Kleinwes Rietspruit

Category	Score	Ecological category
Riparian Habitat Ecological Category	54	Largely modified
Macroinvertebrate Ecological Category	60	Largely modified
Ecostatus		**Largely modified**

The results of the ecological classification indicate that the PES of the Kleinwes Rietspruit reach assessed in this study was found to be a class D or largely modified.

7.2.4.1 Present Ecological Status Discussion

The overall PES of the reach of the Leeuspruit, as well as the Kleinwes Rietspruit are in a largely modified state due to poor water quality as well as impacts to instream and riparian habitats.

8 Sensitivity Analysis and No-Go Areas

The results of the screening assessment indicated that moderately sensitive aquatic biota were present in the river systems potentially affected by the proposed project. The completion of surveys confirmed the presence of moderately sensitive taxa as well as the absence of sensitive aquatic biota in the abovementioned river systems. However, the baseline conditions revealed the modification of instream and riparian aquatic habitats that have negatively influenced the PES of the local aquatic biota.

In general, riparian habitats are regarded as sensitive (WRC, 2011). The proposed projects infrastructure layout shows that only pipeline infrastructures will be within close proximity to this sensitive habitat type with the larger infrastructure generally away from the riparian habitats (Figure 8-1).

However, according to the results of the screening assessment and classification by DWA (2014), the following additional aspects are regarded as sensitive in each of the following mining right areas.

8.1 Sensitivities in the Cooke Mining Right Area

The water quality of the upper Wonderfonteinspruit is modified and therefore further modification should be avoided. As such water quality can be regarded as a sensitive aspect to consider in this region.

The middle Wonderfonteinspruit has a large portion of its water resources diverted within a pipeline and therefore water quantity modification in this region is an important aspect to consider.

8.2 Sensitivities in the Driefontein Mining Right Area

No sensitivities, other than riparian zones, identified within this mining right area.

8.3 Sensitivities in the Kloof Mining Right Area

The results of the screening assessment indicated the presence of habitat sensitive taxa such as *Labeobarbus aneneus*. Therefore the water quantity in this mining right area is regarded as a sensitive aspect.

8.4 Sensitivities within the Ezulwini Mining Right Area

Other than the sensitive nature of the riparian habitats no sensitive aquatic aspects could be defined in this mining right area.

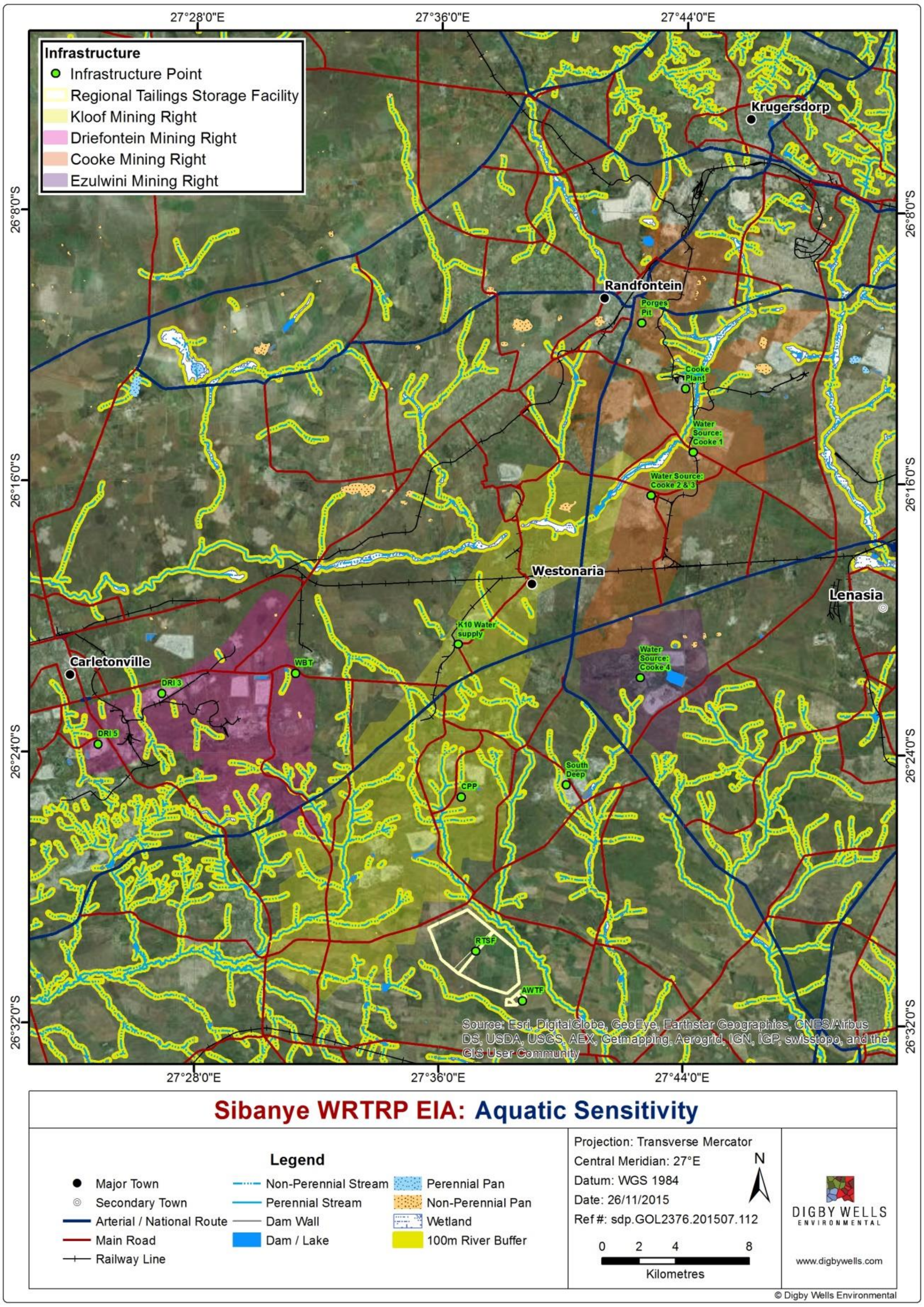

Figure 8-1: Recommended buffer zones and infrastructure layout

9 Impact Assessment

The impacts are assessed based on the impact's magnitude as well as the receiver's sensitivity, culminating in an impact significance which identifies the most important impacts that require management.

Based on international guidelines and South African legislation, the following criteria are taken into account when examining potentially significant impacts:

- Nature of impacts (direct/indirect, positive/ negative);
- Duration (short/medium/long-term, permanent (irreversible) / temporary (reversible), frequent/seldom);
- Extent (geographical area, size of affected population/habitat/species);
- Intensity (minimal, severe, replaceable/irreplaceable);
- Probability (high/medium/low probability); and
- Possibility to mitigate, avoid or offset significant adverse impacts.

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 9-1. 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 aquatic impact assessment report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table 9-2, which is extracted from Table 9-1. The description of the significance ratings is discussed in Table 9-1.

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 9-1: Impact Assessment Parameter Ratings

RATING	INTENSITY/REPLACABILITY		EXTENT	DURATION/REVERSIBILITY	PROBABILITY
	Negative impacts	Positive impacts			
7	Irreplaceable damage to highly valued items of great natural or social significance or complete breakdown of natural and / or social order.	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 damage to highly valued items of natural or social significance or breakdown of natural and / or social order.	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.
5	Very serious widespread natural and / or social baseline changes. 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	On-going serious natural and / or social issues. Significant changes to structures / items of natural or social 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	**Positive impacts**			
3	On-going natural and / or social issues. Discernible changes to natural or social baseline.	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 natural and / or social impacts which are mostly replaceable. Very little change to the baseline.	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.
1	Minimal natural and / or social impacts, low-level replaceable damage with no change to the baseline.	Some low-level natural and / or social benefits felt by a very small percentage of the baseline.	Very limited 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 9-2: Probability/Consequence matrix

Significance

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

Consequence

Table 9-3: Significance rating description

Score	Description	Rating
109 to 147	A very beneficial impact that may be sufficient by itself to justify implementation of the project. The impact may result in permanent positive change	Major (positive)
73 to 108	A beneficial impact which may help to justify the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term positive change to the (natural and / or social) environment	Moderate (positive)
36 to 72	An important positive impact. The impact is insufficient by itself to justify the implementation of the project. 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 but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in negative medium to short term effects on the natural and / or social environment	Negligible (negative)
-36 to -72	An important negative impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in negative medium to long-term effect on the natural and / or social environment	Minor (negative)
-73 to -108	A serious negative impact which may prevent the implementation of the project. These impacts would be considered by society as constituting a major and usually a long-term change to the (natural and / or social) environment and result in severe effects	Moderate (negative)
-109 to -147	A very serious negative impact which 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)

9.1 Kloof Mining Right Area Impact Assessment

9.1.1 The no-go option in the Kloof Mining Right Area

The assessment of baseline conditions provides an indication that the activities within the rivers associated with the Kloof mining right area are currently largely modified. The no go option impact assessment will therefore take this into account and assess the impact of the current activities with their effect on the Leeuspruit and Loopspruit river systems. The results of this impact assessment are provided in the table below (Table 9-4).

Table 9-4: Impact assessment for the no-go option in the rivers of the Kloof Mining Right Area

Activities within the Loopspruit and Leeuspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	The impacts are potentially irreversible (6)	The impacts have been present for a long period of time and are mostly related to permanent impacts.	91 (Moderate)
Extent	Local (3)	The impacts effect a local area of the river system.	
Intensity	Significant changes to structures (-4)	The rivers are largely modified indicating a significant impact on aquatic biota.	
Probability	Certain (7)	The impacts were measured and therefore rated as certain.	
Nature	Negative		

9.1.2 Kloof Mining Right Area Impact Assessment

Activities within this mining right area will potentially impact the Leeuspruit (C22J-01468 and C22J-01466) as well as the Loopspruit (C23J-01487). As described above these systems are currently in a largely modified state (class D). The potential impacts of the proposed project will be viewed in light of this classification.

This impact assessment does not take into consideration the potential risk and impacts of unplanned events.

Table 9-5: Interactions and impacts of the Kloof Mining Right Area Infrastructure.

Interaction	Impact
Site clearing for infrastructure placement	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
Construction and removal of infrastructure	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
RTSF storage/operation:	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.
Discharge of treated water into the Leeuspruit	Modification of instream aquatic habitat features including channel, flow and bed modification resulting in potential direct loss of aquatic biodiversity. This activity can also dilute pollutants and improve habitat diversity resulting in an increase biodiversity.
Drawdown of water from the Leeuspruit as a result of the blast curtain	As detailed below, the predicted dewatering cone of the blast curtain may potentially impact on the water quantity in the nearby Leeuspruit. The exact water volume which may potentially be lost due to dewatering is detailed in the surface water report. This dewatering is effected through various factors such as stream bed permeability which makes an accurate quantitative assessment of the potential impacts difficult.
Removal of water 10 Ml/d in the Wonderfonteinspruit	Potential habitat quality modification is expected as a result of water loss in the Wonderfonteinspruit.

9.1.2.1 Impact description: water and habitat quality modification

Potential water and habitat quality degradation causing resultant negative impacts on local aquatic ecology. Water quality impacts may include increased dissolved/suspended solids as well as potential persistent pollutants. In addition, general water chemistry modification may occur as a result of increased metals and nutrients as well as modified pH balances. Habitat quality impacts may include sedimentation, bed, channel and flow modification. The interactions of the activities, their physical impact and resulting biological impact are illustrated in Table 9-5.

9.1.2.2 Management Objectives

The objective is to preserve the PES and prevent further degradation of local aquatic environments. This objective can be achieved through the management of potential water and habitat quality impacts as listed in the section below.

9.1.2.3 Management Actions

General mitigation actions provided in the surface and groundwater studies (Digby Wells, 2015) for this project should be used to guide the effective management of aquatic resources potentially affected by the proposed project. However, important management actions are briefly listed below.

The establishment of a buffer zone, which is defined as a region of natural vegetation between the river and the proposed activity, is the primary management action that should take place. Literature suggests that a buffer zone can reduce aquatic habitat and water quality impacts of large developments, making this management action of particular importance (WRC, 2014). According to GDARD 2014, a buffer zone of 32 m (from the 1:100 year floodline or defined wetland/riparian zone) is required in urban and 100 m in non-urban regions. However, according to WRC (2014) the efficacy of a buffer is related to the distance between the river system and the zone of disturbance. Therefore by increasing the length of a buffer, the potential aquatic modification related to the proposed activity is reduced. Considering this, it is recommended that, if possible, a buffer of zone 500m is placed between large infrastructure and riparian zones or the 1:100 floodline (whichever is largest). The designated buffer zones should then be demarcated using signage.

During the construction and decommissioning phases vehicles will be used in proximity to aquatic resources. The use of these vehicles presents risk of persistent hydrocarbon pollution events which can be avoided through the use of the following management actions:

- Hydrocarbon spill kits and employee training in their use;
- Regular inspection for leakages and subsequent repair (maintenance); and
- The refuelling/oiling of vehicles in contained areas (bunded areas) built to the capacity of the facility provided with sumps.

The removal of vegetative cover as well as the construction of roads has been recognised as being responsible for increased runoff, sedimentation and subsequent water and habitat quality degradation in downstream portions of river systems (WRC, 2014). As such the careful management of vegetation removal and sedimentation control should take place. This can be achieved through the brief points below:

- Minimise the removal of vegetation in the infrastructure footprint area;
- Revegetation of the construction footprint as soon as possible;
- Where storm water enters river systems, sediment/silt and debris trapping, as well as energy dissipation control measures must be put in place;
- Storm water must be diverted from construction activities and managed in such a manner to disperse runoff and prevent the concentration of storm water flow;
- Sequential removal of the vegetation (not all vegetation immediately); and
- The vegetation of unpaved roadsides.

During the various phases of the proposed project, runoff and seepage of contaminated water from the RTSF, and CPP can cause aquatic state degradation. In order to prevent this, the use of diversion and containment management is of importance. This can be achieved through effective ground and surface water management as per the Digby Wells surface and groundwater studies (2015); however management actions are briefly listed below:

- Diversion trench and berm systems which diverts clean storm water around pollution sources and convey and contain dirty water to central pollution control impoundments;
- Barrier systems, including synthetic, clay and geological or other approved mitigation methods to minimise contaminated seepage and runoff from entering the local aquatic systems;
- Where storm water enters river systems from disturbed sites, sediment and debris trapping, as well as energy dissipation control measures must be put in place.
- The planting of indigenous vegetation around pollution control impoundments and structures should be completed as this has been shown to be effective in erosion and nutrient control.

The construction and operation of pipeline infrastructure over the various river systems would potentially negatively influence the local aquatic habitat. As such, it is important to consider the following management actions:

- No crossings over riffle/rapid habitats should be avoided as these are the most sensitive; slow deep/shallow habitats should be favoured;
- The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation;

- Structures must not be damaged by floods exceeding the magnitude of those which may occur on average once in every 50 years;
- The indiscriminate use of heavy vehicles and machinery within the instream and riparian habitat will result in the compaction of soils and vegetation and must be controlled;
- Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation;
- The crossing points should be unobtrusive (outside riparian and instream habitat) to prevent the obstruction and subsequent habitat modification of downstream portions;
- Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff;
- Soils adjacent the river that have been compacted must be loosened to allow for germination;
- Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river;
- Unpaved roads used to inspect and construct the pipelines should have their sides vegetated;
- No hinges/flanges should be present within the pipeline over the river system as these points are prone to leakages. Therefore, a section devoid of flanges/hinges should be used; and
- Should a spillage occur an emergency management plan, including rehabilitation plan, with emergency cut off valves should be in place.

During the operation of the proposed project, treated water will be discharged into the Leeuspruit. Although the discharge of treated water is likely to improve the downstream water quality (from dilution), the management of the potential habitat impacts is important. At the point of discharge aquatic impacts may include the modification to the river bed and channel thus resulting in the alteration of aquatic habitat. Important management actions at this discharge point are provided below:

- Energy dissipation should occur at the site to slow water flow and control erosion;
- Following energy dissipation silt collection should take place to avoid siltation in the river system;
- The discharge point should be stabilized and be able to withstand a 1:100 flood event;
- Discharge point should be placed in an area whereby pooling may occur immediately downstream;

- Discharge should not allow for the creation of pools and should flow freely downstream; and
- Ideally, the discharge point should be vegetated to provide cover for fish species.

Further to the abovementioned mitigation actions, the proposed RTSF has the potential to negatively impact the groundwater (and subsequently the surface water) through seepage of undesired contaminants as discussed in detail in the groundwater report (Digby Wells, 2015). A number of options have been considered to minimise the potential impact of the RTSF where a blast curtain design (or extended depth cut off perimeter drains) is the preferred option. The blast curtain operates on the principle of dewatering along the RTSF boundaries to intercept the contaminant plume. This will have a side effect as a cone of dewatering will be formed. This is illustrated in Figure 9-1 below. This creates sensitive areas defined in terms of the area that will be impacted by the cone of dewatering and this is significant for the watercourses associated with the RTSF. The water level will be lowered by at least 10 m in an area of 23.7 km^2 (Figure 9-2).

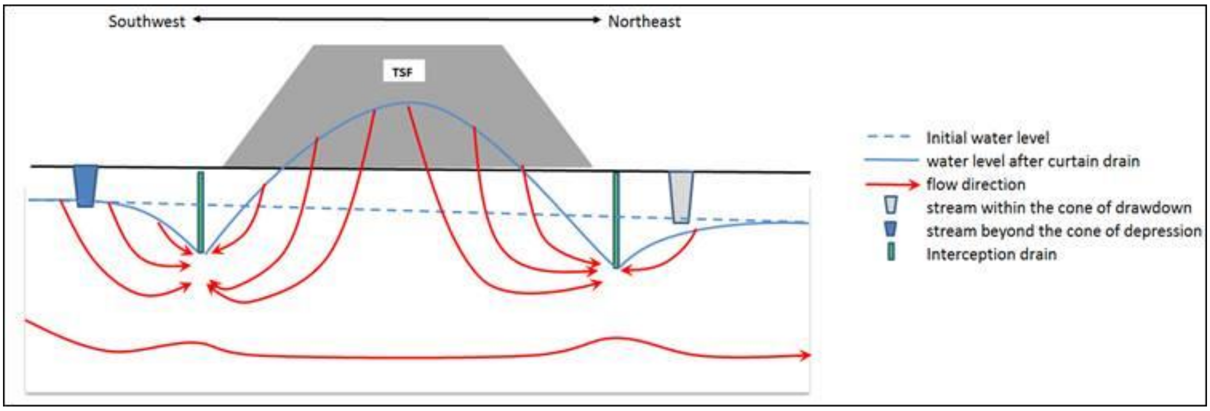

Figure 9-1: General conceptual design of the blast curtain

Dewatering and a reduction of flows in the Leeuspruit within the vicinity of the blast curtain are anticipated. However, stream flow within the Leeuspruit will likely continue due to the low permeability of the river bed. In addition, the discharge of 15 Ml/day of treated water from the Advanced Water Treatment Facility will likely serve to increase flows downstream of the RTSF. Further, dilution as a result of the abovementioned discharge will further reduce the current salt loads within the Leeuspruit and thus serve to improve water quality downstream.

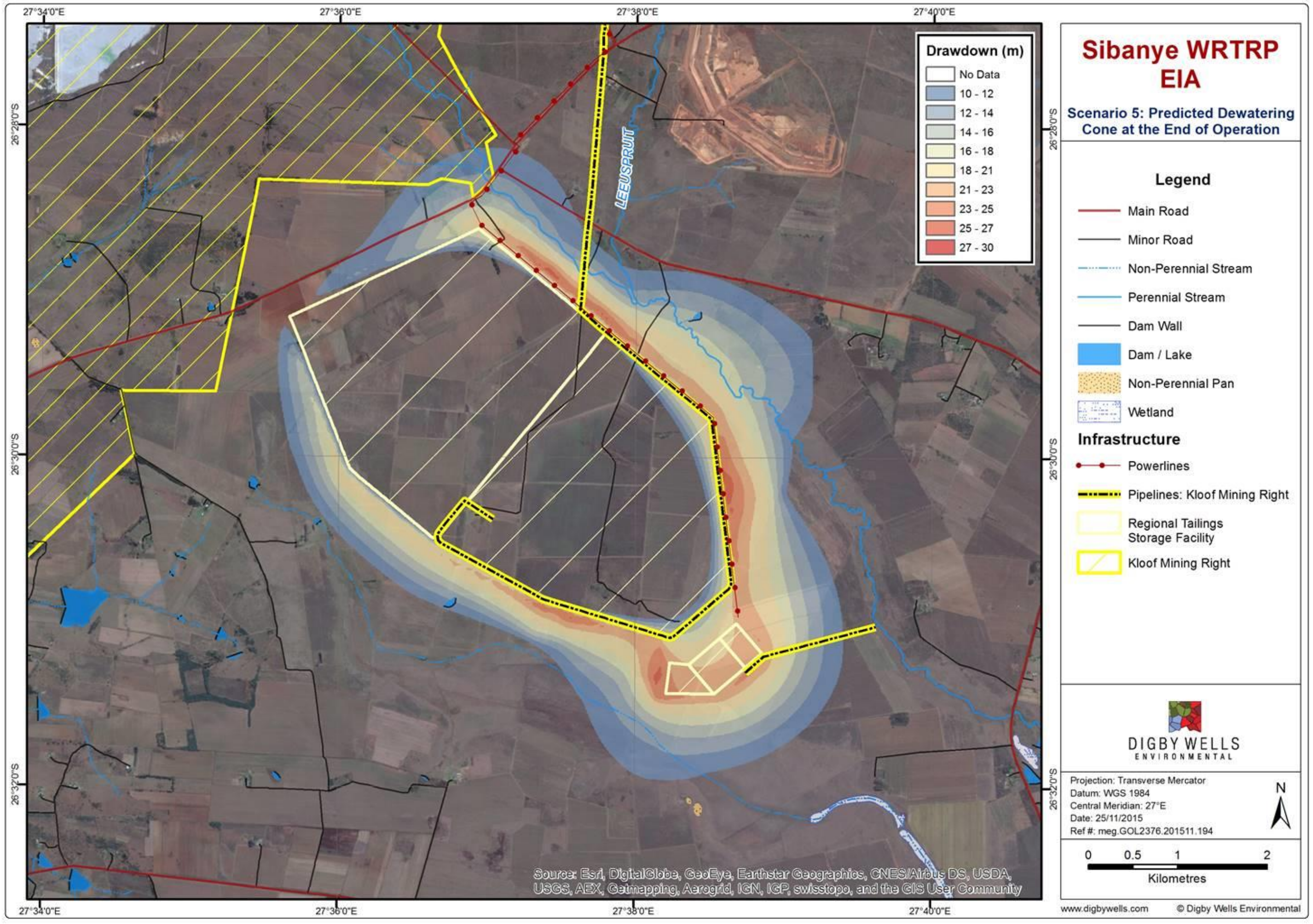

Figure 9-2: Predicted cone of dewatering from the implementation of the blast curtain

9.1.2.4 Management Targets

To monitor the impacts of the proposed project effectively, aquatic biomonitoring methods applied in the River Health Programme and this study will take place bi-annually throughout the life of the project. The specific methods which should be applied include the following:

- Water Quality (*in situ*);
- SASS5 and MIRAI;
- Fish Response Assessment Index; and
- Ecostatus Determination

The primary target for management is to maintain the PES of the river systems. However, more specific targets are described below.

The monitoring for presence of the fish species below, *Barbus anoplus* and *Pseudocrenilabrus philander* (Figure 9-3 and Figure 9-4), should be completed downstream of the activities. These species have been recorded in abundance in both the Leeuspruit and Loopspruit. Although the species are relatively tolerant to poor water quality they are dependent on suitable aquatic habitat and therefore are considered in fish assessments.

Figure 9-3: *Barbus anoplus*

Figure 9-4: *Pseudocrenilabrus philander*

The SASS5 and ASPT index monitoring will take place bi-annually. Values should not reduce by more than 30% as a result of activities related to the proposed project.

9.1.2.5 Impact Rating

9.1.2.5.1 Construction phase

Table 9-6: Potential water and habitat quality impacts during the construction phase

Activity and Interaction: Site clearing for infrastructure placement (CPP and Pipelines)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	48 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Leeuspruit and Loopspruit.	
Intensity	Discernible change (-3)	Water and habitat quality deterioration will be expected to occur downstream of the various activities.	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary. Construction sequencing is proposed. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	21 (Negligible)

Extent	Limited (2)	The mitigation measures will allow the impacts to be kept to a locally impacted extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

Activity and Interaction: Site clearing for infrastructure placement (RTSF)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	54 (Minor)
Extent	Local (3)	The impacts are anticipated to occur around the activities which are located in proximity to the Leeuspruit and Loopspruit.	
Intensity	Discernible change (-3)	Water and habitat quality deterioration is will be expected to occur downstream of the various activities.	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ Construction sequencing is proposed.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	24 (Negligible)
Extent	Local (3)	The mitigation measures will allow the impacts to be kept to a locally impacted extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	

Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		
Activity and Interaction: Construction of infrastructure (CPP, Pipelines and RTSF)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Short term (2)	The impact will only occur during the construction and decommissioning phase.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Construction sequencing is proposed. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ Unobtrusive infrastructure design over river systems. ▪ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ▪ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ▪ Soils adjacent the river that has been compacted must be loosened to allow for germination. ▪ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river. ▪ No crossings should take place over riffle/rapid habitats as these are the most sensitive.			

Post- mitigation			
Duration	Short term (2)	The impact will only occur during the construction and decommissioning phase.	30 (Negligible)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.1.2.5.2 Operation Phase

Table 9-7: Potential water and habitat quality impacts during the operation phase

Activity and Interaction: RTSF storage/operation:			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	78 (Moderate)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	Seepage and runoff from the RTSF will contain pollutants and will potentially negatively influence downstream water quality.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	

Nature	Negative		
Mitigation/ Management actions			
- Establish riparian buffer up to 500m (minimum 100m). - Silt traps placed within clean water return channels. - The planting of indigenous trees around the RTSF and pollution control facilities. - Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. - Groundwater management according to the ground water study (Digby Wells, 2015).			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately > 15years.	39 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	Seepage and runoff from the RTSF will contain pollutants and will potentially negatively influence downstream water quality.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		
Activity and Interaction: Discharge of treated water into the Leeuspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately > 15years.	78 (Moderate)
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area. Water quality impacts will also most likely only impact a local area.	
Intensity	Very serious (-5)	Habitat impacts attributed to erosion, flow and bed modification are serious impacts.	

Probability	Almost certain (6)	The impact will almost certainly occur if mitigation actions are not implemented.	
Nature	Negative		
Mitigation/ Management actions			
▪ Energy dissipation and siltation avoidance.			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	33 (Negligible positive)
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area. Water quality impacts will also most likely only impact a local area.	
Intensity	Average on going positive benefits (+3)	If habitat impacts are mitigated, the treated discharge will likely improve water quality downstream. Furthermore, presently stream flow is modified. Improved streamflow will increase habitat diversity and subsequently aquatic biodiversity.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Positive		
Activity and Interaction: Drawdown and dewatering of the Leeuspruit as a result of the blast curtain			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately > 15years.	39 (Minor)
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area (Figure 9-2).	
Intensity	Very serious (-5)	Habitat impacts attributed to flow and bed modification is serious impacts.	

Probability	Unlikely (3)	The impact will almost certainly occur as described in the groundwater report. However, due to the permeability of the streambed and flow of water, a significant loss of water is unlikely.	
Nature	Negative		
Mitigation/ Management actions			
▪ Although water will be removed via drawdown, the water is treated and pumped back into the Leeuspruit. Further, based on the permeability of the stream bed as well as the flow a significant loss of water from the Leeuspruit is unlikely. However, the extent of dewatering of the Leeuspruit is investigated in the surface water report.			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately > 15years.	39 (Minor)
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area (Figure 9-2).	
Intensity	Very serious (-5)	Habitat impacts attributed to flow and bed modification is serious impacts.	
Probability	Unlikely (3)	The impact will almost certainly occur as described in the groundwater report. However, due to the permeability of the streambed and flow of water, a significant loss of water is unlikely.	
Nature	Negative		
Activity and Interaction: Removal of water from the Wonderfonteinspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	

Intensity	Minor (-2)	The removal of water from the Wonderfonteinspruit will likely reduce the overall available habitat. However, the flows at present are already artificial which has resulted in inundation of typically terrestrial regions. Therefore, the removal of water may result in a reduction of inundation.	
Probability	Almost certain (6)	The impact will almost certainly occur.	
Nature	Negative		
Mitigation/ Management actions			
Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used.			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Minor (-2)	The removal of water from the Wonderfonteinspruit will likely reduce the overall available habitat. However, the flows at present are already artificial which has resulted in inundation of typically terrestrial regions. Therefore, the removal of water may result in a reduction of inundation.	
Probability	Almost certain (6)	The impact will almost certainly occur.	
Nature	Negative		

9.1.2.5.3 Decommissioning Phase

Table 9-8: Potential water and habitat quality impacts during the decommissioning phase

Activity and Interaction: Demolition and removal of infrastructure (CPP, Pipelines and RTSF)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			

Duration	Short term (2)	The impact will only occur during the decommissioning phase.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	
Nature	Negative		
Mitigation/ Management actions			
Establish riparian buffer up to 500m (minimum 100m). Silt traps placed within clean water return channels. Re-vegetation of construction footprint and unpaved roads as soon as possible. Construction sequencing is proposed. Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. Soils adjacent the river that has been compacted must be loosened to allow for germination. Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river.			
Post- mitigation			
Duration	Short term (2)	The impact will only occur during the construction and decommissioning phase.	30 (Negligible)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	

Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.1.3 Conclusions on the Impact Assessment for the Kloof Mining Right Area

Following the completion of the impact assessment on aquatic biota for the Kloof mining right area the following conclusions can be drawn.

- The clearing of vegetation for the various infrastructures such as the CPP and the RTSF will likely result in impacts which are regarded as having negligible significance after management actions have taken place
- The impact of the construction activities for the various infrastructure, including the CPP and RTSF on aquatic biota was assessed have short term impacts rated as being negligibly significant.
- The discharge of treated water into the Leeuspruit was assessed to have an impact which was negligibly positive in significance after mitigation actions.
- Dewatering and a reduction of flows in the Leeuspruit within the vicinity of the blast curtain are anticipated. However, stream flow within the Leeuspruit will likely continue due to the low permeability of the river bed. In addition, the discharge of 15 Ml/day of treated water from the Advanced Water Treatment Facility will likely serve to increase flows downstream of the RTSF. Further, dilution as a result of the abovementioned discharge will further reduce the current salt loads within the Leeuspruit and thus serve to improve water quality downstream.

9.2 Ezulwini Mining Right Area Impact Assessment

9.2.1 The no-go option in the Ezulwini Mining Right Area

The assessment of baseline conditions provides an indication that the activities within the rivers associated with the Ezulwini mining right area are currently largely modified. The results of this impact assessment are provided in the table below (Table 9-9).

Table 9-9: Impact assessment for the no-go option in the rivers of the Ezulwini Mining Right Area

Activities within the Kleinwes Rietspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			

Duration	The impacts are irreversible or require extensive rehabilitation (6)	The impacts have been present for a long period of time and are mostly related to permanent impacts (TSF and impoundments).	98 (Moderate)
Extent	Local (3)	The impacts are present in the upper catchment.	
Intensity	Very serious impacts (-5)	The rivers are largely modified indicating a significant impact on aquatic biota.	
Probability	Certain (7)	The impacts were measured and therefore rated as certain.	
Nature	Negative		

9.2.2 Ezulwini Mining Right Area Impact Assessment

Activities within this mining right area will potentially impact the Kleinwes Rietspruit (C22H-01464). As described above these systems are currently in a largely modified state (class D). The potential impacts of the proposed project will be viewed in light of this classification.

This impact assessment does not take into consideration the potential risk and impacts of unplanned events. In addition, the pipeline infrastructure will not affect the river systems considered in this study and therefore have not been included.

Table 9-10: Interactions and impacts of the Ezulwini Mining Right Area Infrastructure

Interaction	Impact
Reclamation activities	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.

9.2.2.1 Impact description: water and habitat quality modification

Potential water and habitat quality degradation causing resultant negative impacts on local aquatic ecology. Water quality impacts may include increased dissolved/suspended solids as well as potential persistent pollutants. In addition, general water chemistry modification may occur as a result of increased metals and nutrients as well as modified pH balances. Habitat quality impacts may include sedimentation, bed, channel and flow modification. The interactions of the activities, their physical impact and resulting biological impact are illustrated in Table 9-10.

9.2.2.2 Management Objectives

The objective is to maintain the PES and prevent further degradation of local aquatic environments. This objective can be achieved through the management of potential water and habitat quality impacts as listed in the section below.

9.2.2.3 Management Actions

Effective management actions are provided in Section 9.1.2.3.

9.2.2.4 Management Targets

The improvement and maintenance of the PES of the Kleinwes Rietspruit is the overall management target in this mining right area. However, more specific management targets are provided below.

Using the sites assessed in this study, the SASS5 and ASPT values should not be reduced by more than 25% of this baseline study. More specific taxa that should be monitored, as well as the impactions of their presence/absence in the monitoring program are provided in the table below (Table 9-11).

Table 9-11: Monitoring taxa, threshold diversity/abundance and relevance in monitoring program

Taxa	Diversity/abundance	Relevance
Aeshnidae	Presence/A	Baseline maintenance
Baetidae	>2 species/B	Baseline maintenance

9.2.2.5 Impact Rating

9.2.2.5.1 Construction phase

No impacts to aquatic ecology are anticipated in this phase.

9.2.2.5.2 Operation Phase

Table 9-12: Potential water and habitat quality impacts during the operation phase

Activity and Interaction: Reclamation activities			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	78 (Moderate)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	

Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	
Nature	Negative		

Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ The planting of indigenous trees around the TSF and pollution control facilities. ▪ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ▪ Groundwater management according to the ground water study (Digby Wells, 2015).			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	39 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.2.2.5.3 Decommissioning Phase

No impacts to aquatic biota are anticipated in this phase.

9.2.3 Conclusions on the Impact Assessment for the Ezulwini Mining Right Area

Following the completion of the impact assessment on aquatic biota for the Ezulwini mining right area the following conclusions can be drawn.

- Reclamation activities have the potential to produce moderate significant rated impacts before mitigation and minor after mitigation actions. No impacts are anticipated during the construction and decommissioning phases.

- The reduction in flow in the Klein Wes Rietspruit will most likely not significantly negatively influence aquatic biota in the river.

9.3 Cooke Mining Right Area Impact Assessment

9.3.1 The no-go option in the Cooke Mining Right Area

The assessment of baseline conditions provides an indication that the activities within the rivers associated with the Cooke mining right area are currently largely/seriously modified. The no go option impact assessment will therefore take this into account and assess the impact of the current activities on the upper Wonderfonteinspruit River. The results of this impact assessment are provided in the table below (Table 9-13).

Table 9-13: Impact assessment for the no-go option in the rivers of the Cooke Mining Right Area

Activities within the Wonderfonteinspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	The impacts are potentially irreversible (6)	The impacts have been present for a long period of time and are mostly related to permanent impacts (pipeline etc.).	105 (Moderate)
Extent	Municipal (4)	The impacts affect a large area of the river system.	
Intensity	Very serious impacts (-5)	The rivers are largely/seriously modified indicating a significant impact on aquatic biota.	
Probability	Certain (7)	The impacts were measured and therefore rated as certain.	
Nature	Negative		

9.3.2 Cooke Mining Right Area Impact Assessment

Activities within this mining right area will potentially impact the main stem of the Wonderfonteinspruit (C23D-01313; C23D-01365; C23D-01384). As described above these systems are currently in a largely/seriously modified state (class D/E). The potential impacts of the proposed project will be viewed in light of this classification.

This impact assessment does not take into consideration the potential risk and impacts of unplanned events.

Table 9-14: Interactions and impacts of the Cooke Mining Right Area Infrastructure

Interaction	Impact
Site clearing for infrastructure placement	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
Construction and removal of infrastructure	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
Reclamation activities	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.
Removal of water 10 Ml/d in the Wonderfonteinspruit	Potential habitat quality modification is expected as a result of water loss in the Wonderfonteinspruit.

9.3.2.1 Impact description: water and habitat quality modification

Potential water and habitat quality degradation causing resultant negative impacts on local aquatic ecology. Water quality impacts may include increased dissolved/suspended solids as well as potential persistent pollutants. In addition, general water chemistry modification may occur as a result of increased metals and nutrients as well as modified pH balances. Habitat quality impacts may include sedimentation, bed, channel and flow modification. The interactions of the activities, their physical impact and resulting biological impact are illustrated in Table 9-14.

9.3.2.2 Management Objectives

The objective is to preserve the PES and prevent further degradation of local aquatic environments. This objective can be achieved through the management of potential water and habitat quality impacts as listed in the section below.

9.3.2.3 Management Actions

Effective management actions are provided in Section 9.1.2.3.

9.3.2.4 Management Targets

The improvement and maintenance of the PES of the Wonderfonteinspruit is the overall management target in this mining right area. However, more specific management targets are provided below.

Using the sites assessed in this study, the SASS5 and ASPT values should not be reduced by more than 25% of this baseline study. More specific taxa that should be monitored, as well as the impactions of their presence/absence in the monitoring program are provided in the table below (Table 9-15).

Table 9-15: Monitoring taxa, threshold diversity/abundance and relevance in monitoring program

Taxa	Diversity/abundance	Relevance
Hydropsychidae	>2 species/B	Baseline maintenance
Caenidae	Presence/A	Baseline maintenance
Baetidae	>2 species/B	Baseline improved
Heptageniidae	Presence/A	Baseline improved

9.3.2.5 Impact Rating

9.3.2.5.1 Construction phase

Table 9-16: Potential water and habitat quality impacts during the construction phase

Activity and Interaction: Site clearing for infrastructure placement (Pipelines)			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	42 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Wonderfonteinspruit	

Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
- Establish riparian buffer up to 500m (minimum 100m). - Silt traps placed within clean water return channels. - Re-vegetation of construction footprint and unpaved roads as soon as possible. - Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary with construction sequencing is proposed. - Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	21 (Negligible)
Extent	Limited (2)	The mitigation measures will allow the impacts to be kept to a limited extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		
Activity and Interaction: Construction of infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	42 (Minor)

Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Wonderfonteinspruit	
Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
- Establish riparian buffer up to 500m (minimum 100m). - Silt traps placed within clean water return channels. - Re-vegetation of construction footprint and unpaved roads as soon as possible. - Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary. - Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. - Construction sequencing is proposed.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	21 (Negligible)
Extent	Limited (2)	The mitigation measures will allow the impacts to be kept to a limited extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.3.2.5.2 *Operation Phase*

Table 9-17: Potential water and habitat quality impacts during the operation phase

Activity and Interaction: Reclamation activities			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	78 (Moderate)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ▪ Groundwater management according to the ground water study (Digby Wells, 2015).			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	39 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	

Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Activity and Interaction: Removal of water from the Wonderfonteinspruit			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Minor (-2)	The removal of water from the Wonderfonteinspruit will likely reduce the overall available habitat. However, the flows at present are already artificial which has resulted in inundation of typically terrestrial regions. Therefore, the removal of water may result in a reduction of inundation.	
Probability	Almost certain (6)	The impact will almost certainly occur.	
Nature	Negative		
Mitigation/ Management actions			
▪ Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used.			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately >15 years.	60 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	

Intensity	Minor (-2)	The removal of water from the Wonderfonteinspruit will likely reduce the overall available habitat. However, the flows at present are already artificial which has resulted in inundation of typically terrestrial regions. Therefore, the removal of water may result in a reduction of inundation.	
Probability	Almost certain (6)	The impact will almost certainly occur.	

9.3.2.5.3 Decommissioning Phase

Table 9-18: Potential water and habitat quality impacts during the decommissioning phase

Activity and Interaction: Removal of infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure removal will occur and potentially recover within a three-five year period during the rehabilitation of TSF footprint after the completion of the reclamation process.	42 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Wonderfonteinspruit	
Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		

Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Construction sequencing is proposed. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ▪ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ▪ Soils adjacent the river that has been compacted must be loosened to allow for germination. ▪ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river.			
Post- mitigation			
Duration	Short term (2)	The impact will only occur during the construction and decommissioning phase.	30 (Negligible)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		
Activity and Interaction: Removal of the TSF material			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Duration	Beyond Project Life (6)	The impact will remain for some time after the project has been completed.	60 (Minor))
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area. Water quality impacts will also most likely only impact a local area.	

Intensity	Discernible changes (3)	Water quality will likely improve and thus more sensitive aquatic biota will return.	
Probability	Likely (5)	The impact will likely occur after the completion of the project.	
Nature	Positive		

9.3.3 Conclusions on the Impact Assessment for the Cooke Mining Right Area

Following the completion of the impact assessment on aquatic biota for the Cooke mining right area the following conclusions can be drawn.

- Minor impacts to local aquatic biota can be expected in the Wonderfonteinspruit before mitigation actions, with negligible impacts after mitigation actions in the construction and decommissioning phase; and moderate impacts were derived for the reclamation activities before mitigation with minor impacts anticipated after mitigation in the Wonderfonteinspruit. The reclamation activities are therefore seen as the most significant activity to consider in the Mining Right Area.

9.4 Driefontein Mining Right Area Impact Assessment

9.4.1 The No-Go Option in the Driefontein Mining Right Area

The assessment of baseline conditions provides an indication that the activities within the rivers associated with the Driefontein mining right area are currently largely/seriously modified. The no go option impact assessment will therefore take this into account and assess the impact of the current activities on the lower Wonderfonteinspruit River. The results of this impact assessment are provided in the table below (Table 9-13).

Table 9-19: Impact assessment for the no-go option in the rivers of the Driefontein Mining Right Area

Activities within the Wonderfonteinspruit and Carletonville Tributary			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	The impacts are irreversible or require extensive rehabilitation (6)	The impacts have been present for a long period of time and are mostly related to permanent impacts (pipelines and canals etc.).	105 (Moderate)
Extent	Municipal (4)	The impacts affect a large area of the river system.	

Intensity	Very serious impacts (-5)	The rivers are largely/seriously modified indicating a significant impact on aquatic biota.	
Probability	Certain (7)	The impacts were measured and therefore rated as certain.	
Nature	Negative		

9.4.2 Driefontein Mining Right Area Impact Assessment

Activities within this mining right area will potentially impact the main stem of the Wonderfonteinspruit (C23D-01384, C23E-01368, C23E-01436). As described above these systems are currently in a largely/seriously modified state (class D/E). The potential impacts of the proposed project will be viewed in light of this classification.

This impact assessment does not take into consideration the potential risk and impacts of unplanned events.

Table 9-20: Interactions and impacts of the Driefontein Mining Right Area Infrastructure

Interaction	Impact
Site clearing for infrastructure placement	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
Construction and removal of infrastructure	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.
Reclamation activities	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.

9.4.2.1 Impact description: water and habitat quality modification

Potential water and habitat quality degradation causing resultant negative impacts on local aquatic ecology. Water quality impacts may include increased dissolved/suspended solids as well as potential persistent pollutants. In addition, general water chemistry modification may occur as a result of increased metals and nutrients as well as modified pH balances. Habitat quality impacts may include sedimentation, bed, channel and flow modification. The interactions of the activities, their physical impact and resulting biological impact are illustrated in Table 9-20.

9.4.2.2 Management Objectives

The objective is to preserve the PES and prevent further degradation of local aquatic environments. This objective can be achieved through the management of potential water and habitat quality impacts as listed in the section below.

9.4.2.3 Management Actions

Effective management actions are provided in Section 9.1.2.3.

9.4.2.4 Management Targets

The improvement and maintenance of the PES of the Wonderfonteinspruit and Carletonville Tributary is the overall management target in this mining right area. However, more specific management targets are provided below.

Using the sites assessed in this study, the SASS5 and ASPT values should not be reduced by more than 25% of this baseline study. More specific taxa that should be monitored, as well as the impactions of their presence/absence in the monitoring program are provided in the table below (Table 9-21).

Table 9-21: Monitoring taxa, threshold diversity/abundance and relevance in monitoring program

Taxa	Diversity/abundance	Relevance
Hydropsychidae	>2 species/B	Baseline maintenance
Aeshnidae	Presence/A	Baseline maintenance
Baetidae	>2 species/B	Baseline maintenance

9.4.2.5 Impact Rating

9.4.2.5.1 Construction phase

Table 9-22: Potential water and habitat quality impacts during the construction phase

Activity and Interaction: Site clearing for infrastructure placement (Pipelines)			
Dimension	Rating	Motivation	Significance

Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	42 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Carletonville Tributary and subsequently with the Wonderfonteinspruit downstream.	
Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary with construction sequencing is proposed. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	21 (Negligible)
Extent	Limited (2)	The mitigation measures will allow the impacts to be kept to a limited extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

Activity and Interaction: Construction of infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure placement will occur and potentially recover within a three-five year period	42 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Wonderfonteinspruit	
Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ Construction sequencing is proposed.			
Post- mitigation			
Duration	Medium term (3)	The construction will be short term and if mitigated so will the impacts be short term.	21 (Negligible)
Extent	Limited (2)	The mitigation measures will allow the impacts to be kept to a limited extent.	
Intensity	Discernible change (-2)	Impacts limited due to mitigation actions.	

Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.4.2.5.2 Operation Phase

Table 9-23: Potential water and habitat quality impacts during the operation phase.

Activity and Interaction: Reclamation activities			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately 15> years.	78 (Moderate)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Almost certain (6)	The impact will almost certainly occur if activities are to occur within proximity to the river systems without mitigation actions.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ The planting of indigenous trees around the TSF and pollution control facilities. ▪ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ▪ Groundwater management according to the ground water study (Digby Wells, 2015).			
Post- mitigation			
Duration	Project life (5)	The impact will occur for the duration of the project which is approximately 15> years.	39 (Minor)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	

Intensity	Very serious (-5)	Runoff from the exposed TSF material during the reclamation would likely enter and degrade local aquatic ecosystems.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		

9.4.2.5.3 Decommissioning Phase

Table 9-24: Potential water and habitat quality impacts during the decommissioning phase.

Activity and Interaction: Removal of infrastructure			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Prior to mitigation/ management			
Duration	Medium term (3)	The site clearing and infrastructure removal will occur and potentially recover within a three-five year period	42 (Minor)
Extent	Limited (2)	The impacts are anticipated to occur around the activities which are located in proximity to the Wonderfonteinspruit	
Intensity	Minor natural impacts (-2)	Water and habitat quality deterioration will be expected to occur downstream of the various activities. Although these impacts are limited due to the small size of the infrastructure (limited clearing required)	
Probability	Almost certain (6)	Pollution from the proposed activities is almost certainly going to occur as the activities, especially without mitigation, are located within proximity to various river systems.	
Nature	Negative		
Mitigation/ Management actions			
▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation;			

▪ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ▪ Soils adjacent the river that has been compacted must be loosened to allow for germination. ▪ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river.			
Post- mitigation			
Duration	Short term (2)	The impact will only occur during the construction and decommissioning phase.	30 (Negligible)
Extent	Local (3)	The impacts will only occur within the local area. Even water quality impacts would only occur until dilution can occur within short distance downstream regions.	
Intensity	Very serious (-5)	The habitat and water quality within the local extent can be a very serious impact. Especially to aquatic habitat which is difficult to rehabilitate.	
Probability	Unlikely (3)	Probability reduced due to mitigation actions.	
Nature	Negative		
Activity and Interaction: Removal of the TSF material			
Dimension	**Rating**	**Motivation**	**Significance**
Impact Description: Water and habitat quality modification			
Duration	Beyond Project Life (6)	The impact will remain for some time after the project has been completed.	60 (Minor)
Extent	Local (3)	The impacts, especially habitat impacts, will only occur within the local area. Water quality impacts will also most likely only impact a local area.	
Intensity	Discernible changes (3)	Water quality will likely improve and thus more sensitive aquatic biota will return.	
Probability	Likely (5)	The impact will likely occur after the completion of the project.	
Nature	Positive		

9.4.3 Conclusions on the Impact Assessment for the Driefontein Mining Right Area

Following the completion of the impact assessment on aquatic biota for the Driefontein mining right area the following conclusions can be drawn.

- Minor impacts to local aquatic biota can be expected in the Wonderfonteinspruit and Carletonville Tributary before mitigation actions, with negligible impacts after mitigation actions in the construction and decommissioning phase.
- Moderate impacts were derived for the reclamation activities before mitigation with minor impacts anticipated after mitigation in the Wonderfonteinspruit and Carletonville Tributary. The reclamation activities are therefore seen as the most significant activity to consider in the Mining Right Area.

10 Cumulative Impacts

10.1 Kloof Mining Right Area

10.1.1 The Leeuspruit

The PES of the Leeuspruit is currently largely modified as a result of poor water quality compounded by habitat modification. The proposed project, through the creation of the RTSF, would potentially contribute toward increasing the dissolved solid component of the downstream aquatic regions. Thus, the proposed project would potentially contribute toward further water quality degradation (should no mitigation be implemented) within the Leeuspruit within a long term period.

The Leeuspruit will be traversed by pipelines in three separate regions. The placement of these pipelines would degrade marginal aquatic habitat. However, on a large scale the impacts would be negligible.

10.1.2 The Loopspruit

The Loopspruit is also currently in a largely modified state due to critical water and large habitat modification. No reclamation activities will be taking place within the Loopspruit catchment area. However, several pipeline crossings will be constructed and therefore will degrade marginal aquatic habitat. This impact was assessed to be on a local scale and therefore would result in a negligible cumulative impact, specifically on the marginal aquatic habitat.

10.2 Ezulwini Mining Right Area

10.2.1 The Kleinwes Rietspruit

The river system was found to be in an impacted state due to water and habitat quality degradation. In the short term, the proposed project would likely increase the dissolved and suspended solids within the river system resulting in further impacts to its current status. However, due to the largely modified nature of the aquatic ecology it is unlikely that the PES would further degrade within the considered reach of this river system.

10.3 Cooke and Driefontein Mining Right Area

10.3.1 The Wonderfonteinspruit

With reference to long term cumulative impacts within the Wonderfonteinspruit, positive impacts can be expected. The positive impacts would be expressed through the removal of large sources of contaminated seepage and runoff, resulting in potential water quality improvement within the river system. Short term cumulative impacts, specifically on aquatic ecology would involve impacts arising from potential increased concentrations of dissolved and suspended solids. Specifically, contaminated runoff or seepage from reclamation activities may temporarily increase the conductivity of the Wonderfonteinspruit, especially during rainfall periods. However, due to the currently largely modified status of the ecology within the river system, the presence of largely tolerant species exist and therefore this increase in dissolved solids may have a potentially lower effect than would be expected in an aquatic ecosystem with largely sensitive species.

11 Unplanned Events and Low Risks

Low risks can be monitored to determine if any changes to the baseline are occurring and if so what mitigation measures will be required. Table 11-1 details the most common of the unplanned events as well as some of their mitigation measures. It is noted that a buffer zone in this report is defined as a section of land where vegetation, preferably natural, is present. The buffer zones will lie between the edge of the defined wetland/riparian areas and the activity.

Table 11-1: Unplanned events, low risks and their management measures

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Hydrocarbon Spillage	Water quality degradation	▪ Bunded storage of hydrocarbons outside 1:100 floodline or 500m buffer, whichever is greater. ▪ Hydrocarbon spill kits and employee training in their use; ▪ Regular inspection for leakages and subsequent repair (maintenance); and ▪ The refuelling/oiling of vehicles in contained areas (bunded areas) built to the capacity of the facility provided with sumps.

Unplanned event	Potential impact	Mitigation/ Management/ Monitoring
Leakage and rupturing of pipelines	Water quality degradation	■ No flanges should be installed over river systems or within the buffer zones. ■ Cut-off and continuous spillage monitoring systems. ■ Emergency remediation plan should spillage occur.
Flood	Water quality degradation	■ Construction should occur outside 1 in 100 year flood lines (excluding pipeline crossings). ■ Emergency remediation plan should overflow or bursts occur.

12 Environmental Management Plan

12.1 Project Activities with Potentially Significant Impacts

Table 12-1 summarises the most significant potential impacts arising from the proposed project at each considered Mining Right Area.

Table 12-1: Potentially significant impacts of the prosed project

Aspects	Potential Significant impacts
Kloof Mining Right Area	
Seepage from the RTSF	Potential further water quality degradation within the Leeuspruit as a result of the RTSF. Water quality degradation would occur as a result of seepage and the inflow of contaminated runoff during rainfall.
Driefontein Mining Right Area	
No significant impacts anticipated	
Cooke Mining Right Area	
No significant impacts anticipated	
Ezulwini Mining Right Area	
No significant impacts anticipated	

12.2 Summary of Mitigation and Management Measures

Various mitigation actions, aspects and information pertaining to the various management measures suggested are presented in the tables below.

Table 12-2: Impacts and mitigation measures for the proposed project

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Kloof Mining Right Area					
Site clearing for infrastructure placement	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary with Construction sequencing. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.	National Water Act (1998)	Construction phase
Construction and removal of infrastructure	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Construction sequencing is proposed. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ■ Unobtrusive infrastructure design over river systems. ■ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ■ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ■ Soils adjacent the river that has been compacted must be loosened to allow for germination. ■ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river. ■ No crossings should take place over riffle/rapid habitats as these are the most sensitive.	National Water Act (1998)	Construction phase

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
RTSF storage/operation	Operation	Local	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ The planting of indigenous trees around the RTSF and pollution control facilities. ■ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ■ Groundwater management according to the ground water study (Digby Wells, 2015).	National Water Act (1998)	Operational phase
Discharge of treated water into the Leeuspruit	Operation	Local	■ Energy dissipation and siltation avoidance.	National Water Act (1998)	Operational phase
Ezulwini Mining Right Area					
Reclamation activities	Operation	Local	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ■ Groundwater management according to the ground water study (Digby Wells, 2015).	National Water Act (1998)	Operation Phase
Cooke Mining Right Area					
Site clearing for infrastructure placement	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary with Construction sequencing. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.	National Water Act (1998)	Construction phase

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
Construction and removal of infrastructure	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Construction sequencing is proposed. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ■ Unobtrusive infrastructure design over river systems. ■ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ■ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ■ Soils adjacent the river that has been compacted must be loosened to allow for germination. ■ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river. ■ No crossings should take place over riffle/rapid habitats as these are the most sensitive.	National Water Act (1998)	Construction phase
Reclamation activities	Operation	Local	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ■ Groundwater management according to the ground water study (Digby Wells, 2015).	National Water Act (1998)	Operation phase
Driefontein Mining Right Area					
Site clearing for infrastructure placement	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Minimise vegetation removal to infrastructure		

Activities	Phase	Size and scale of disturbance	Mitigation Measures	Compliance with standards	Time period for implementation
			footprint. Clearing and grading should only occur where absolutely necessary with Construction sequencing. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.		
Construction and removal of infrastructure	Construction	Footprint area	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Re-vegetation of construction footprint and unpaved roads as soon as possible. ■ Construction sequencing is proposed. ■ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ■ Unobtrusive infrastructure design over river systems. ■ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ■ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ■ Soils adjacent the river that has been compacted must be loosened to allow for germination. ■ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river. ■ No crossings should take place over riffle/rapid habitats as these are the most sensitive.		
Reclamation activities	Operation	Local	■ Establish riparian buffer up to 500m (minimum 100m). ■ Silt traps placed within clean water return channels. ■ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ■ Groundwater management according to the ground water study (Digby Wells, 2015).		

Table 12-3: Objectives and Outcomes of the EMP.

Activities	Potential impacts	Aspects affected	Phase	Mitigation	Standard to be achieved/objective
Site clearing for infrastructure placement	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.	Aquatic Ecology	Construction	▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Minimise vegetation removal to infrastructure footprint. Clearing and grading should only occur where absolutely necessary with Construction sequencing. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff.	Maintain PES
Construction and removal of infrastructure	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.	Aquatic Ecology	Construction	▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Re-vegetation of construction footprint and unpaved roads as soon as possible. ▪ Construction sequencing is proposed. ▪ Diversion trenches and berms should convey dirty water to temporary ditches so as to contain runoff. ▪ Unobtrusive infrastructure design over river systems. ▪ The crossing points should be stabilised to reduce the resulting erosion and downstream sedimentation; ▪ Erosion prevention mechanisms must be employed to ensure the sustainability of all structures to prevent instream sedimentation. ▪ Soils adjacent the river that has been compacted must be loosened to allow for germination. ▪ Stockpiling of removed soil and sand must be done outside the 1:100 floodline or delineated riparian habitat (whichever is greater). This will prevent solids from washing into the river.	Maintain PES

Activities	Potential impacts	Aspects affected	Phase	Mitigation	Standard to be achieved/objective
				▪ No crossings should take place over riffle/rapid habitats as these are the most sensitive.	
Reclamation activities	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.	Aquatic Ecology	Operation	▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ▪ Groundwater management according to the ground water study (Digby Wells, 2015).	Maintain PES
RTSF storage/operation	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.	Aquatic Ecology	Operation	▪ Establish riparian buffer up to 500m (minimum 100m). ▪ Silt traps placed within clean water return channels. ▪ The planting of indigenous trees around the RTSF and pollution control facilities. ▪ Surface and storm water management should capture and store dirty water and divert clean water. Mitigation actions provided in the surface water report (Digby Wells, 2015) should be used. ▪ Groundwater management according to the ground water study (Digby Wells, 2015).	Maintain PES
Discharge of treated water into the Leeuspruit	Modification of instream aquatic habitat features including channel, flow and bed modification resulting in potential direct loss of aquatic biodiversity. This activity can also dilute pollutants and improve habitat diversity resulting in an increase biodiversity.	Aquatic Ecology	Operation	▪ Energy dissipation and siltation avoidance.	Maintain PES

Table 12-4: Mitigation.

Activities	Potential impacts	Aspects affected	Mitigation type	Time period for implementation	Compliance with standards
Site clearing for infrastructure placement	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.	Aquatic Ecology	Surface and groundwater management	Before and during construction phase	The mitigation aims to comply with the National Water Act (1998).
Construction and removal of infrastructure	Increased runoff as a result of cover loss could result in instream and riparian habitat modification or destruction through erosion, flow, bed, channel and water quality modification. Water quality modification can be related to an increase in the amount of suspended/dissolved solids which can result in increased sedimentation and changes to the physical chemistry of the water in downstream regions. These physical impacts could lead to reduced aquatic biodiversity.	Aquatic Ecology	Surface and groundwater management	Before and during construction phase	The mitigation aims to comply with the national water act (1998).
RTSF storage/operation:	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.	Aquatic Ecology	Surface and groundwater management	Construction and operation phase	The mitigation aims to comply with the national water act (1998).
Discharge of treated water into the Leeuspruit	Modification of instream aquatic habitat features including channel, flow and bed modification resulting in potential direct loss of aquatic biodiversity. This activity can also dilute pollutants and improve habitat diversity resulting in an increase biodiversity.	Aquatic Ecology	Surface and groundwater management	Construction and operation phase	The mitigation aims to comply with the national water act (1998).
Reclamation activities	Potential persistent pollutant contamination with increased suspended and dissolved solids resulting in water and habitat quality modification and subsequent loss of sensitive aquatic biota and a reduction in overall aquatic biodiversity.	Aquatic Ecology	Surface and groundwater management	Operation phase	The mitigation aims to comply with the national water act (1998).

Table 12-5: Prescribed environmental management standards, practice, guideline, policy or law.

Specialist field	Applicable standard, practice, guideline, policy or law
Aquatics	National Water Act (1998); GDARD (2012), National Freshwater Priority Areas.

12.3 Monitoring Plan

An aquatic biomonitoring programme is an essential management tool. The monitoring programme should be designed to enable the detection of potential negative impacts brought about by the proposed project.

Aquatic biotas have been proven to be excellent indicators of water quality and ecosystem health. In addition, aquatic biota can detect slight changes in the aquatic environment, which have been shown to be a fluctuating system. Table 12-1, highlights some important aspects to monitor in reference to aquatic biota for the duration of the proposal.

Table 12-1: Aquatic ecology monitoring programme.

Location	Monitoring objectives	Frequency of monitoring	Parameters to be monitored
Current sites used in this study will suffice.	Determine if habitat deterioration is occurring.	Bi-annual	Water clarity should not vary between surveys, by more than 40%.
Current sites used in this study will suffice.	Determine if water quality deterioration is occurring.	Bi-annual	SASS5 scores should not decrease as a result of the WRTRP (currently impacts are related to sewage/urban runoff).
Site used in this study and the surface water assessment.	Determine if water quality deterioration is occurring.	Monthly	Standard water quality monitoring, as per the surface water specialist report.
Current sites used in this study will suffice.	Determine if water/habitat quality deterioration is occurring.	Bi-annual	Monitor for presence of fish.

Key performance indicators for the aquatic biomonitoring study would be an improvement of SASS5 scores, ASPT values and the increased presence of fish (when compared to this study).

13 Comments and Responses

No comments have been received at this point with regards to the scope of this study.

14 Conclusion and Recommendation

The results of the screening assessment show that no RTE aquatic biota is present within the study area. The results of the sensitivity analysis revealed that no sensitive aquatic systems rated above moderate sensitivity are present within the study area.

14.1 Kloof Mining Right Area

Baseline results show that the overall PES of the reach of the Leeuspruit and Loopspruit as was found to be in a largely modified (class D) state due to poor water quality and modification to instream and riparian habitats.

The impact assessment revealed potential significant impacts due to seepage and runoff from the RTSF. Due to the largely modified state of the Leeuspruit, the impact of the RTSF on water quality will contribute toward the cumulative decline in the PES. However, should mitigation actions be followed the likelihood of the impact occurring can be reduced.

No significant impacts are expected in the Loopspruit as a result of the proposed activities.

14.2 Ezulwini Mining Right Area

Baseline results show that the PES of the Kleinwes Rietspruit is largely modified primarily due to instream habitat modification. The impact assessment for the proposed project in this mining right area revealed impacts assessed as minor significant impacts to the Kleinwes Rietspruit following the implementation of mitigation actions.

14.3 Cooke Mining Right Area

The overall PES of the reach of the Wonderfonteinspruit assessed in this study was found to be largely/seriously modified (class D/E) as a result of extensive habitat modification compounded by water quality impacts. The impact assessment of the proposed project revealed minor impacts to the Wonderfonteinspruit system after mitigation actions. Due to the limited nature of impacts the cumulative impacts are considered negligible.

14.4 Driefontein Mining Right Area

The overall PES of the reach of the Wonderfonteinspruit and Carletonville Tributary assessed in this study was found to be largely/seriously modified (class D/E) as a result of extensive habitat modification compounded by water quality impacts. The impact assessment revealed minor impacts on the abovementioned systems following mitigation actions.

14.5 Recommendations

Mitigation actions in case of unplanned events have been provided. Furthermore, an environmental monitoring and management plan has been provided in this report.

Considering the completed baseline and impact assessment, on condition that mitigation actions are in place, the proposed project will likely not significantly affect the aquatic ecology within the above mentioned river systems.

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