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Pan African Resources PLC (PAR) Environmental Application Process

Surface Water Impact Assessment

Prepared for:

Pan African Resources PLC (PAR)

Project Number:





PAR7273

June 2022



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 - I declare that there are no circumstances that may compromise my objectivity in performing such work;
 - I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and

- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.



February 2022

Signature of the Specialist

Date

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EXECUTIVE SUMMARY

Digby Wells Environmental (hereafter Digby Wells) has been appointed to undertake an Environmental Application Process and associated specialist studies for the Mogale Cluster - Mining Right (GP) 30/5/1/2/2 (206) Mining Right (MR) and, more specifically for the proposed construction of a large-scale gold tailings retreatment operation. Pan African Resources PLC (PAR) has entered into a Sale and Purchase Agreement for the acquisition of the shares in and claims against Mogale Gold (Pty) Ltd (Mogale Gold). The agreement was entered into between PAR and the liquidators of Mintails Mining SA (Pty) Ltd (in liquidation) (MMSA). MMSA is the holding company of Mogale Gold. The intended transaction is subject to a due diligence investigation which is in the process of being concluded.

The project entails the reclamation of historical unlined Tailings Storage Facilities (TSFs). The reprocessed tailings will be first discarded into West Wit Pit and possibly other nearby small pits. Any extra processed tailings will be stored on a ground TSF. The new TSF will also be unlined.

Water quality of water resources in proximity to TSFs indicates contamination (high acidity, elevated sulphates and TDS) including at the Lancaster Dam, upstream of the Wonderfontein spruit and in tributaries of the Rietspruit.

Mapped results show that most of the infrastructure fall outside the delineated 1:50-year and 1:100-year floodlines. Portions of the TSF 1L23-25 South and the RWD, however, do encroach into the flood waterway of the 1:50-year and 1:100-year flood events. A berm constructed on the edges of the right riverbank at the point of contact will help to ensure separation of water resources from potentially contaminating TSF and RWD structures.

Adequate water supply for the proposed PAR Mogale Cluster project is indicated by the calculated water balance. Water supply from the Lancaster Dam, West Wits Pit and the #17 Winze was determined to be 4 842 857 m³/annum, 13 293 028 m³/annum and 13 538 428 m³/annum, respectively. This water is pumped to the Process Water Dam from where it is then pumped to the Processing Plant for gold recovery processes.

On average the Processing Plant will receive a total volume of 17 251 776 m³/annum from the Process Water Dam, while 175 680 m³/annum of potable water will be obtained from the Rand Water Board for gold elution. Potable water required for washing, sanitation and consumption by mine personnel and contractors at the Workshop, Change Houses and Processing Plant was determined to be 39 084 m³/annum.

A volume of 131 872 m³/annum for dust suppression in access and haul roads at the project site, which is expected to come from the WWP and passively treated before being used in order to minimise contamination of watercourses and the environment within and around the project site.

The current and proposed storm water storage structures which include paddocks, berms and RWDs in the reclamation areas, should be adequate to contain storm water on site. The recommended structures include a berm and drainage channel along the western and

southern boundaries of the 1L23-25 TSF. It was further proposed that diversion berms should be constructed around the North Sand dump and the WWP TSF site. In the plant area, a dirty water channel with a berm reporting to the pollution control dam would suffice to direct all the dirty water away from the clean water areas.

Generally, impacts on surface water resources of the proposed gold reclamation project include potential sedimentation resulting from dust generation from reclamation activities. Spillages and leakages of hydrocarbon and general waste also pose as potential pollutant sources. Implementation of adequate storm water, erosion and sediment management measures will reduce the significance of the identified potential impacts. It is also noteworthy that this site is already impacted from AMD decant some of which emanates from the TSFs. Once the existing TSFs are removed through the proposed reclamation project considerable reduction of pollutant sources is envisaged.

TABLE OF CONTENTS

1.	Introduction	1
2.	Project Description	1
2.1.	Project Locality	2
2.2.	Proposed Infrastructure and Activities	4
3.	Relevant Legislation, Standards and Guidelines	5
4.	Methodology.....	5
4.1.	Baseline Hydrology	5
4.2.	Water Quality Assessment	5
4.3.	Floodline Assessment	6
4.3.1.	Peak Flows	6
4.3.2.	Floodlines Modelling	6
4.4.	Surface Water Management.....	6
4.4.1.	Water Balance	7
4.5.	Storm Water Management Plan	7
4.6.	Impact Assessment	7
5.	Findings and Discussion	9
5.1.	Baseline Hydrology	9
5.2.	Hydrometeorology	11
5.3.	Water Quality	13
5.3.1.	Sampling Localities	13
5.3.2.	Historical Water Quality	15
5.3.3.	Recent (October 2021) Surface Water Quality	27
5.4.	Floodline Assessment	29
5.4.1.	Peak Flows	29
5.4.2.	Floodlines	32
5.5.	Water Management and Water Balance	34
5.5.1.	Water Use/Demand	34
5.5.2.	Water Sources	34

5.5.3.	Water Storages/ Containment Facilities	34
5.5.4.	Mine Water Management Infrastructure	35
5.5.5.	Information and Data Used in Water Balance Calculations	35
5.5.6.	Water Balance Findings	38
5.6.	Existing Stormwater Management Infrastructure	42
5.7.	Stormwater Management Plan	43
5.8.	Sizing of Stormwater Management Structures.....	46
6.	Impact Assessment.....	47
6.1.	Construction Phase	47
6.1.1.	Impact Description: Sedimentation and Siltation of Nearby Watercourses	47
6.1.2.	Surface Water Contamination Leading to Deterioration of Water Quality	47
6.2.	Operational Phase.....	50
6.2.1.	Impact Description: Sedimentation and siltation of watercourses leading to deteriorated water quality.....	50
6.2.2.	Impact Description: Surface water contamination from hydrocarbon and chemical spillages and leakages.....	50
6.3.	Decommissioning Phase	53
6.3.1.	Impact Description: Sedimentation and siltation of nearby watercourses and deterioration of water quality	53
6.3.2.	Impact Description: Improvement of streamflow regime and water quality in nearby watercourses.....	53
7.	Environmental Management Plan	56
8.	Monitoring Plan	59
9.	Conclusion and Recommendations	63
10.	References.....	65
11.	Appendix	1

LIST OF FIGURES

Figure 2-1: Project Locality.....	3
Figure 5-1: Hydrological Setting of the Gold Recovery Project Site	10

Figure 5-2: Distribution of mean annual rainfall within the Randfontein region	11
Figure 5-3: Distribution of mean annual runoff within the Randfontein region	12
Figure 5-4: Potential evaporation and rainfall depths for the Randfontein region.....	12
Figure 5-5: Surface water sampling localities at the Randfontein Cluster project site	14
Figure 5-6: Sulphate trends.....	16
Figure 5-7: TDS trends.....	17
Figure 5-8: Manganese trends	18
Figure 5-9: Uranium trends	19
Figure 5-10: Aluminium trends	20
Figure 5-11: Nickel trends	21
Figure 5-12: Cadmium trends.....	22
Figure 5-13: Nitrate trends	23
Figure 5-14: Chloride trends.....	24
Figure 5-15: pH levels	25
Figure 5-16: Electrical Conductivity	26
Figure 5-17: Delineated Catchments.....	31
Figure 5-18: Modelled Floodlines	33
Figure 5-19: Water Flow Diagram with Daily Average Water Balance	39
Figure 5-20: SWMP for Mintails Mogale Cluster at the IL23-25 Operation with the Proposed Structures	44
Figure 5-21: SWMP for Mintails Mogale Cluster in the West Wits Pit Operation with the Proposed Structures	45

LIST OF TABLES

Table 2-1: Summary of the PAR Project Location Details	2
Table 2-2: Project Phases and Associated Activities	4
Table 3-1: Applicable Legislation, Regulations, Guidelines and By-Laws	5
Table 5-1: Surface water sampling points at the Randfontein Cluster project site	13
Table 5-2: Baseline water quality in streams draining the Randfontein Cluster project area	28
Table 5-3: 24-hour Design Rainfall Depths.....	29

Table 5-4: Calculated Peak flows	30
Table 5-5: Average monthly rainfall for the Mogale City region	36
Table 5-6: Average monthly Symons Pan evaporation for the Mogale City region	36
Table 5-7: Processing Plant water requirements	36
Table 5-8: Summary of key constants and assumptions	37
Table 5-9: Potable Water Requirements	37
Table 5-10: Annual Average Water Balance	40
Table 5-11: Monthly Average Water Balance	41
Table 6-1: Interactions and Impacts of Activity	47
Table 6-2: Impact Significance Rating for the Construction Phase (Sedimentation and Siltation).....	48
Table 6-3: Impact Significance Rating for the Construction Phase (Surface Water Contamination).....	49
Table 6-4: Interactions and Impact Activity.....	50
Table 6-5: Impact Significance Rating for Operational Phase (Sedimentation and Siltation).....	51
Table 6-6: Impact Significance Rating for the Operational Phase (Surface Water Contamination).....	52
Table 6-7: Interactions and Impact Activity.....	53
Table 6-8: Impact Significance Rating for Decommissioning Phase and Closure Phase (Sedimentation and Siltation)	54
Table 6-9: Impact Significance Rating for Decommissioning Phase and Closure Phase (Streamflow Regime and Water Quality)	55
Table 7-1: Environmental Management Plan	57
Table 8-1: Surface water monitoring plan for the proposed Project	60

LIST OF APPENDICES

Appendix A: Impact Assessment Methodology

ACRONYMS, ABBREVIATIONS AND DEFINITION

DMRE	Department of Mineral Resources and Energy
DWS	Department of Water and Sanitation
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme Report
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRA	Mining Rights Area
MTIS	Mineable tonnes in-situ
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
NWA	National Water Act
RWD	Return Water Dam
TSF	Tailing Storage Facility
WFD	Water Flow Diagram
WMA	Waste Management Act
WML	Waste Management License
WUL	Water Use License

Legal Requirement		Section in Report
(1)	A specialist report prepared in terms of these Regulations must contain-	
(a)	details of- (i) the specialist who prepared the report; and (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Refer to Specialist Declaration
(b)	a declaration that the specialist is independent in a form as may be specified by the competent authority;	Refer to Specialist Declaration
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Refer to Section 1, 2 and 4

Legal Requirement		Section in Report
cA	And indication of the quality and age of the base data used for the specialist report;	Refer to Section 4 below and Section 5 below
cB	A description of existing impacts on site, cumulative impacts of the proposed development and levels of acceptable change;	Refer to Section 5 and 6 below
(d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Refer to Section 5
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of the equipment and modelling used;	Refer to Section 4
(f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure inclusive of a site plan identifying site alternatives;	Refer to Section 5
(g)	an identification of any areas to be avoided, including buffers;	Refer to Section 5
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Refer to Section 5
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Refer to Section 5.5.5.3
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;	Refer to Section 5 and 6
(k)	any mitigation measures for inclusion in the EMPr;	Refer to Section 7
(l)	any conditions/aspects for inclusion in the environmental authorisation;	Refer to Section 9
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Refer to Section 8
(n)	a reasoned opinion (Environmental Impact Statement) -	Refer to Section 9
	whether the proposed activity, activities or portions thereof should be authorised; and	
	if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Refer to EIA CRR

Legal Requirement		Section in Report
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Refer to EIA CRR
(q)	any other information requested by the competent authority.	Refer to EIA CRR

1. Introduction

Digby Wells Environmental (hereafter Digby Wells) has been appointed to undertake an Environmental Application Process and associated specialist studies for the Mogale Cluster - Mining Right (GP) 30/5/1/2/2 (206) Mining Right (MR) and, more specifically for the proposed construction of a large-scale gold tailings retreatment operation. Pan African Resources PLC (PAR) has entered into a Sale and Purchase Agreement for the acquisition of the shares in and claims against Mogale Gold (Pty) Ltd (Mogale Gold). The agreement was entered into between PAR and the liquidators of Mintails Mining SA (Pty) Ltd (in liquidation) (MMSA). MMSA is the holding company of Mogale Gold. The intended transaction is subject to a due diligence investigation which is in the process of being concluded.

Mogale Gold owns the right to extract and process gold from tailings recourses by reprocessing old gold mine slimes dams and sandy mine dumps left by the extensive historic mining activities that have taken place in the area since 1888. PAR is only interested in the surface operations associated with Mining Right (MR) 206 (i.e., **Tailings Storage Facilities (TSFs) for reclamation, processing and deposition**), and therefore the focus of this application process.

The project consists of 120 Mt of tailings to be reprocessed and firstly deposited into the West Wits Pit (current authorisation in place for in-pit deposition) and then undertake deposition of the footprint of 1L23-1L25 footprint (New Tailings Facility) once capacity has been reached within the West Wits Pit.

Alternatives are being considered for potential deposition of tailings material into the other pits associated such as Monarch and Emerald Pits.

It must be noted that once the West Wits Pits reaches capacity the surface deposition will extend in a northern direction from the pit onto surface, expanding the deposition footprint associated with West Wits Pit.

There are six dumps being considered to be reprocessed, the largest of which amounts to 57.9 Mt, while the smallest contains 0.57 Mt. The primary location of processed tailings storage has been earmarked for deposition in the West Wits Pit. There are three smaller dumps which could also be included and reprocessed as part of the project namely 1L4, 1L5 and 1L6.

2. Project Description

PAR plan to undertake activities relating to reclamation associated with gold-bearing Tailings Storage Facility (TSFs) through hydraulic reclamation. Digby Wells were appointed as the Independent Environmental Consultant to undertake the EIA Application process which comprises of an Air Emission Licence (AEL) and Water Use Licence (WUL) for the proposed gold-bearing tailings storage facility (TSFs).

The site is located in the West Rand, in Gauteng Province. The site comprises of existing infrastructure such as sand dumps, Lancaster Dam and an open pit that will be used for the

deposition of tailings materials. A process plant, overland pumping and piping inclusive of associated water management infrastructure will form part of the proposed infrastructure that will require an authorisation. Once the open pit is filled to capacity, a new TSF will potentially be constructed on the footprint area of one of the reclaimed TSF sites (1L23-1L25) (Figure 2-1). The footprint of the area is 2,923.3 ha which considers MR 206 and associated infrastructure.

Ancillary infrastructure such as pipelines, powerlines and pumps will be required for the proposed reclamation activities and will be included in support of the Environmental Application Process, which will be undertaken.

2.1. Project Locality

The Mining Right Area of the Mintails Mogale Cluster includes: G1, G2 plant; Cams North Sand; South Sand; 1L23; 1L28; 1L13; 1L8; 1LI0; West Wits Pit (WWP) and Lancaster Dam. An existing Water Use License (WUL) No. 27/2/2/C423/1/1 was issued on 22 November 2013 to Mintails Mining SA (Pty) Ltd: Mogale Gold. The mining right is located on Portions 66 and 99 of the farm Waterval 174 IQ and portions 136 and 209 of the farm Luipaardsvlei 246 IQ.

The project is within the Mogale City Local Municipality (MCLM), which is located within the West Rand District Municipality (WRDM). MCLM is the regional services authority and the area falls under the jurisdiction of the Krugersdorp Magisterial District.

The site is located in the catchment of the Upper Wonderfonteinspruit, quaternary catchment C23D, which forms part of the Vaal River Water Management Area (WMA) within the Vaal Catchment Management Agency (CMA). The project is about 4 km south of Krugersdorp and north-east of Randfontein, approximately 10 km off the N14 National Road in the Gauteng Province, in an area that has been transformed by past gold mining activities (Table 2-1).

The project locality of the site is illustrated in Figure 2-1.

Table 2-1: Summary of the PAR Project Location Details

Province	Gauteng
District Municipality	West Rand District Municipality
Local Municipality	Mogale Local Municipality
Nearest Town	Krugersdorp (4 km), Randfontein (4 km)
GPS Co-ordinates (relative centre point of study area)	26°07'45.54"S
	27°45'40.85"E, 26°07'45.54"S

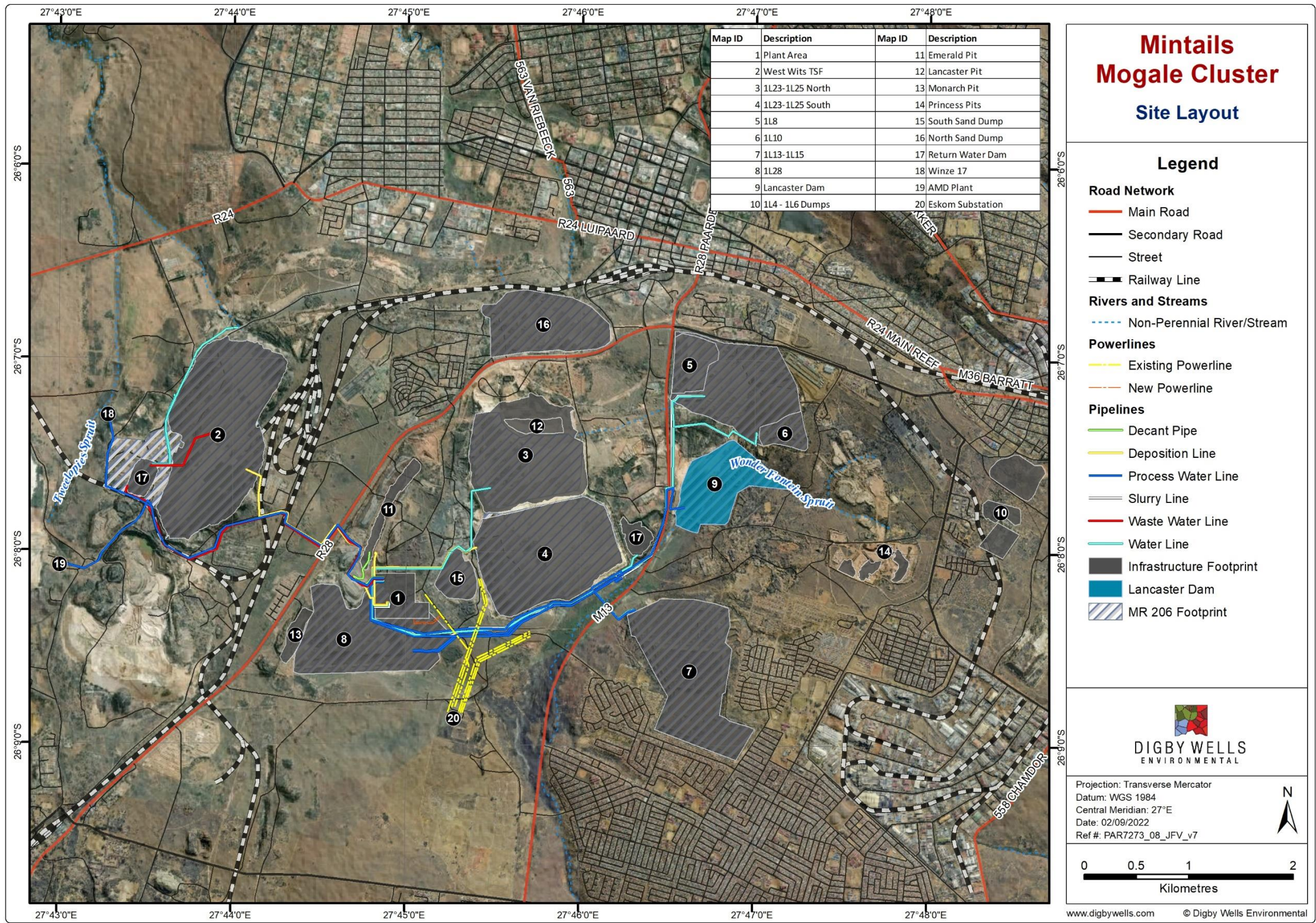


Figure 2-1: Project Locality

2.2. Proposed Infrastructure and Activities

Table 2-2: Project Phases and Associated Activities

Project Phase	Associated Activities
Construction Phase	Site clearing for the construction of the new processing plant facility and ancillary infrastructure such as pipelines, pump stations, electrical supply etc.
	Construction of the new processing plant and ancillary infrastructure such as pipelines, pump stations, electrical supply etc.
	Employment and procurement for construction related activities.
Operational Phase	Hydraulic reclamation of the associated historic tailings facilities and sand dumps
	Operation of pump stations during the operational phase.
	Maintenance of pipeline routes during the operational activities.
	Infilling of processed tailings material into the West Pits Pit and other potential pits.
	Surface tailings deposition within the West Wits Pit.
	Tailings deposition onto the historic footprint of 1L23-1L25.
	Production of Gold.
	Progressive rehabilitation of the new tailings facility footprints (West Pits TSF and 1L23-1L25 TSF).
	Employment and procurement for operational related activities.
Decommissioning Phase	Removal, decommissioning and rehabilitation of surface infrastructures such as pipelines, powerlines, pumps etc. footprints.
	Removal, decommissioning and rehabilitation of the processing plant footprint.
	Rehabilitation of the old TSF footprints.
	Rehabilitation of the old Mintails Processing Plant footprint.
	Final rehabilitation of the this facility.
	General rehabilitation of the surrounding area, including wetland rehabilitation.

3. Relevant Legislation, Standards and Guidelines

The relevant legislation and where it applies within the study are summarised in Table 3-1.

Table 3-1: Applicable Legislation, Regulations, Guidelines and By-Laws

Legislation, Regulation, Guideline or By-Law	Applicability
The Constitution Act (Act 108 of 1996), Section 24 on environmental rights;	Impact Assessment
National Environmental Management Act (Act 107 of 1998), (NEMA) as amended	
Environmental Impact Assessment Regulations of 2010	
National Environmental Management Waste Act (Act 59 of 2008), (NEMWA); and	Water Quality Assessment, Water balance and Floodline modelling
NWA amendment as per Regulation 704 (GN R 704, (1999)) on use of water for mining and related activities aimed at the protection of water resources	
Government Notice 718 of 2009	

4. Methodology

The Scope of Work (SoW) and methodology followed to complete the surface water study are described below:

4.1. Baseline Hydrology

Rainfall and runoff data obtained from the database of the Water Resources Commission of South Africa 2012 study (WRC, 2015) was analysed to determine the Mean Annual Precipitation (MAP), Mean Annual Evaporation (MAE) and the Mean Annual Runoff (MAR) for the Randfontein Cluster Project Site. Historical rainfall-runoff data from 1920 to 2009 (89 years) was adequate to determine mean hydro-meteorological parameters for the Project Area. This analysis was useful to provide insight into the general rainfall-runoff and evaporation dynamics at the site, which informed the surface water impact assessment study.

4.2. Water Quality Assessment

Chemistry results of water samples collected in nearby natural water bodies upstream and downstream of the Project Site were assessed and interpreted to provide baseline conditions prior to commencement of reclamation activities. Collected samples were analysed at a South African National Standards (SANAS) accredited laboratory.

The Department of Water and Sanitation (DWS) water quality guidelines for Livestock watering, irrigation and aquatic ecosystems were used as benchmarks against the laboratory

results (DWA, 1996). These guidelines were selected based on dominant water uses in the area and downstream of the catchment in which the Mogale Cluster is located.

4.3. Floodline Assessment

4.3.1. Peak Flows

Catchment delineation was undertaken in Quantum GIS (QGIS) using Advanced Land Observing Satellite (ALOS) World 3D – 30m (AW3D30) global digital surface model (DSM) data (JAXA, 2015). This dataset is stored in a raster GeoTIFF format referenced to the Hartebeesthoek 94 Datum (WGS84 ellipsoid). The ALOS data showed a higher resolution than a Digital Elevation Model (DEM) generated from 5 m contours for the area (National Geospatial Institute, 2013).

Widely used and recommended methods including the Rational Method Alternative 3 (RM3), Standard Design Flood (SDF) and the Midgley & Pitman (MIPI) were used to calculate the 1:50-year and 1:100-year peak flows for the delineated subcatchments at the Project Area (SANRAL, 2013). Design rainfall depths were determined using the Design Rainfall Programme for South Africa and the modified Hershfield equation as input to the RM3 and SDF methods, respectively

4.3.2. Floodlines Modelling

Hydraulic modelling was conducted in HEC-RAS 6.01 which allows pre-processing within the in-built RAS Mapper module. A Digital Terrain Model (DTM) was generated from the Advanced Land Observing Satellite (ALOS) Digital Surface Model (DSM) for the area to make the topographic data compatible with RAS Mapper. The pre-processing involved generation of the channel geometry, including the river network, banks, flow paths and cross sections.

The HEC-RAS model simulates total energy of water by applying basic principles of mass, continuity, and momentum as well as roughness factors between all cross sections (US Army Corps of Engineers, 1995). A height is calculated at each cross-section, which represents the level to which water will rise at that section, given the calculated initial peak flows for the 1:50 year and 1:100-year events on all river sections.

Analyses are performed by modelling flows at the sub-catchment outlet of stream or channel sections first, moving upstream. Manning's Roughness Coefficients (n) for the channels were set at 0.03, and those for riverbanks were determined to be 0.1 representing natural channels with weeds, reeds and brush on the banks (Chow, 1959).

4.4. Surface Water Management

Water management is the control and movement of water resources to minimize damage to life and property and to maximize efficient beneficial use. Sustainable water management systems make the most efficient use of limited water supplies for a particular purpose without

depriving other sectors the opportunity to access available water. Actions such as water budgeting and changing practices, such as limiting abstraction rates and allocation of water to different purposes are enshrined within the concept of water management.

Based on identified potential water sources, required volumes for the proposed reclamation project and need to sustain natural ecosystems possibilities for conservation of water through recycling, re-use and treatment of wastewater were explored and their feasibility evaluated for the proposed development.

4.4.1. Water Balance

The Water Balance was calculated based on the Water Flow Diagram (WFD) that was confirmed by the client. The WFD describes a concept water balance indicating, water sources, transfers of water within the site, abstractions, water storage and discharge. Results of the hydrological assessment including rainfall, runoff and evaporation were used as inputs into water balance calculations. Other water uses such as processing & consumption volumes used were either calculated or adapted from previous reports to suit the proposed reclamation activities. Where information gaps were identified, assumptions were made and are presented in Section 5.5.5.3 of this report.

4.5. Storm Water Management Plan

A conceptual Storm Water Management Plan (SWMP) was developed considering the proposed activities relating to reclamation, processing and deposition at the WWP and North and South 1L23-25 TSFs. The conceptual SWMP provides the delineation of contaminated water catchments and an indication of the placement of required storm water management infrastructure (drains, berms, PCDs etc.). An effective storm water management system is essential to ensure that the reclamation operations are uninterrupted and that the surrounding natural water resources are protected. The purpose of this conceptual SWMP is to ensure that the risk of polluting water resources downstream of the WWP and 1L23-25 TSFs is minimised. Therefore, this entails managing dirty water generated at infrastructure areas including the TSFs, processing plant and any fuel and hydrocarbon stores.

4.6. Impact Assessment

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

The significance rating formula is as follows:

$$\text{Significance} = \text{Consequence} \times \text{Probability}$$

Where

$$\text{Consequence} = \text{Type of Impact} \times (\text{Intensity} + \text{Spatial Scale} + \text{Duration})$$

And

Probability = Likelihood of an Impact Occurring

In addition, the formula for calculating consequence:

Type of Impact = +1 (Positive Impact) or -1 (Negative Impact)

The weighting assigned to the various parameters for positive and negative impacts is provided for in the above formula and is presented in **Appendix 11** Table A-1. The probability consequence matrix for impacts is displayed in Table A-2, with the impact significance rating described in Table A-3. Impacts are rated prior to mitigation and again after consideration of the mitigation measure(s) in this report. The significance of an impact is then determined and categorised into one of eight categories, as indicated in Table A-2, which is extracted from Table A-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.

5. Findings and Discussion

5.1. Baseline Hydrology

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

The study area is located on a watershed divide of quaternary catchments A21D and C23D within the Vaal Water Management Area (WMA 5) as revised in the 2012 water management area boundary descriptions. It is located within the Western Water Basin of the West Rand area in Gauteng. The basin, as well as the proposed gold recovery operations are situated on the continental watershed divide for two major transboundary rivers in South Africa (the Orange River and the Limpopo River). The Tweelopiesspruit runs adjacent to the proposed project site, drains through the Krugersdorp Game Reserve and further downstream, joins the Limpopo River. The Wonderfonteinspruit runs through the operations and feeds into the Orange River within the Vaal Water Management Area. For the relevant quaternary catchments refer to Figure 5-1.

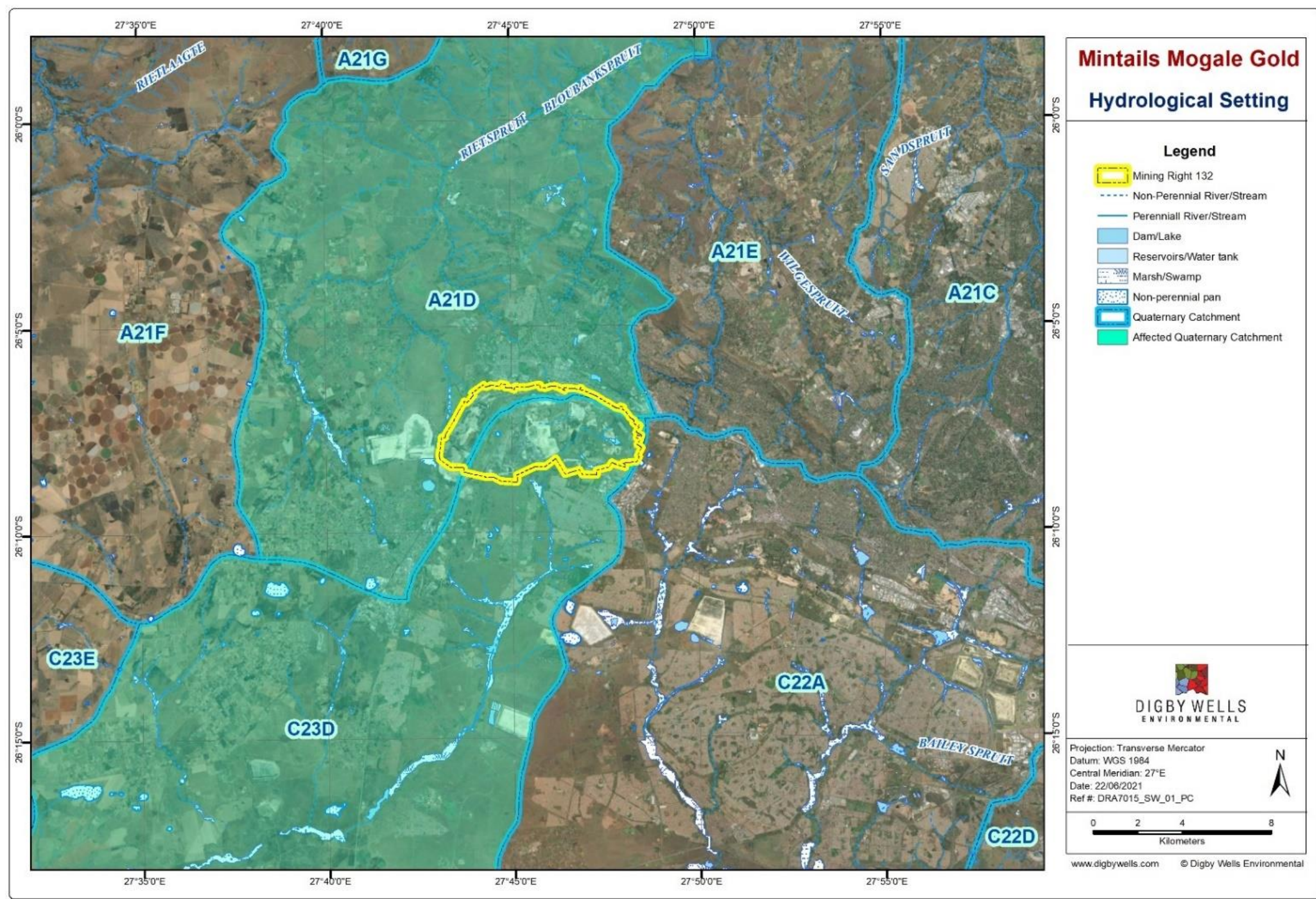


Figure 5-1: Hydrological Setting of the Gold Recovery Project Site

5.2. Hydrometeorology

The Project Area experiences temperate climate with cool dry winters and warm summers. Precipitation of the driest month in winter is less than 1 tenth of the wettest month precipitation in summer (Cannon, 2011). The Mean Annual Precipitation (MAP) of the region is 688 mm which is likely to be distributed as indicated in Figure 5-2 (WRC, 2015). The 90th percentile of the wettest month (January) is 180 mm while the 10th percentile is indicated to be 64 mm. This implies that this region generally receives moderate to high rainfall during the rainy season.

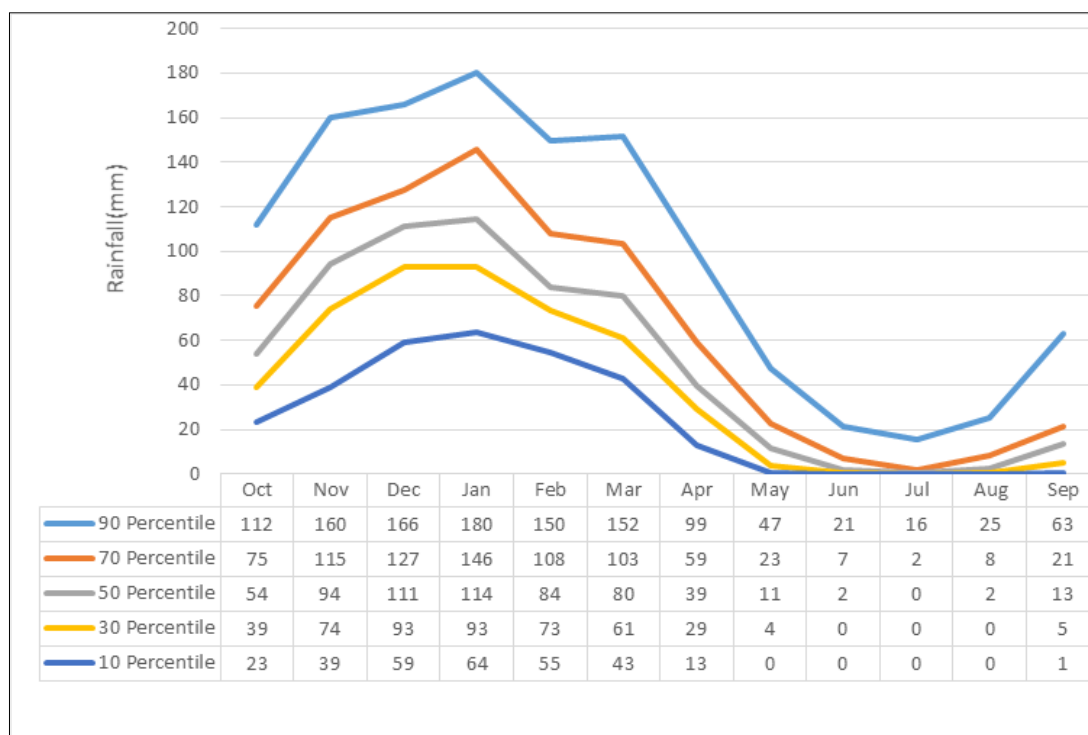


Figure 5-2: Distribution of mean annual rainfall within the Randfontein region

The Mean Annual Runoff (MAR) depth for the area was calculated to be 18.72 mm. This runoff accounts for approximately 8% of the MAP for the area. The 90th and 10th percentiles of runoff during the wettest month of January are 3.1 mm and 0.9 mm, respectively. Owing to build-up of antecedent soil moisture in the following months (February and March) the 90th percentile values increase to 3.9 mm and 4.1 mm, respectively (See Figure 5-3).

The Mean Annual Evaporation (MAE) for the region (1675 mm) is more than twice as much as the MAP (688 mm) for the area which indicates a region characterised by distinct dry and wet season (WRC, 2015). The monthly distribution of potential evaporation and rainfall can be seen in Figure 5-4.

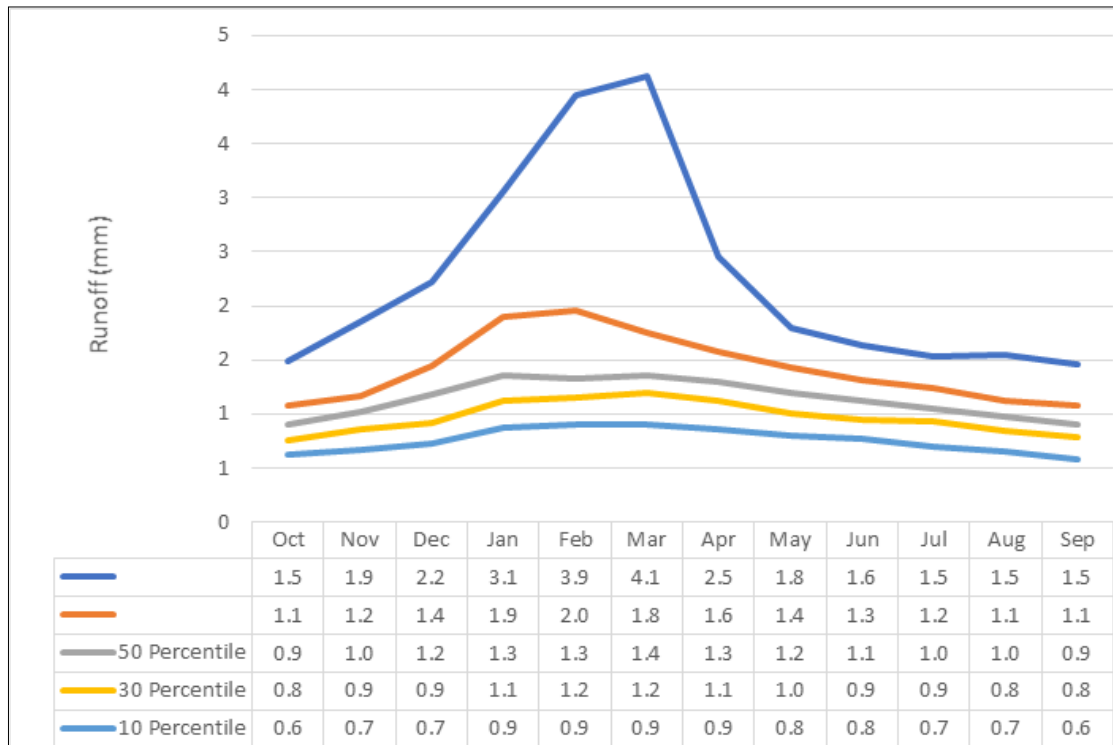


Figure 5-3: Distribution of mean annual runoff within the Randfontein region

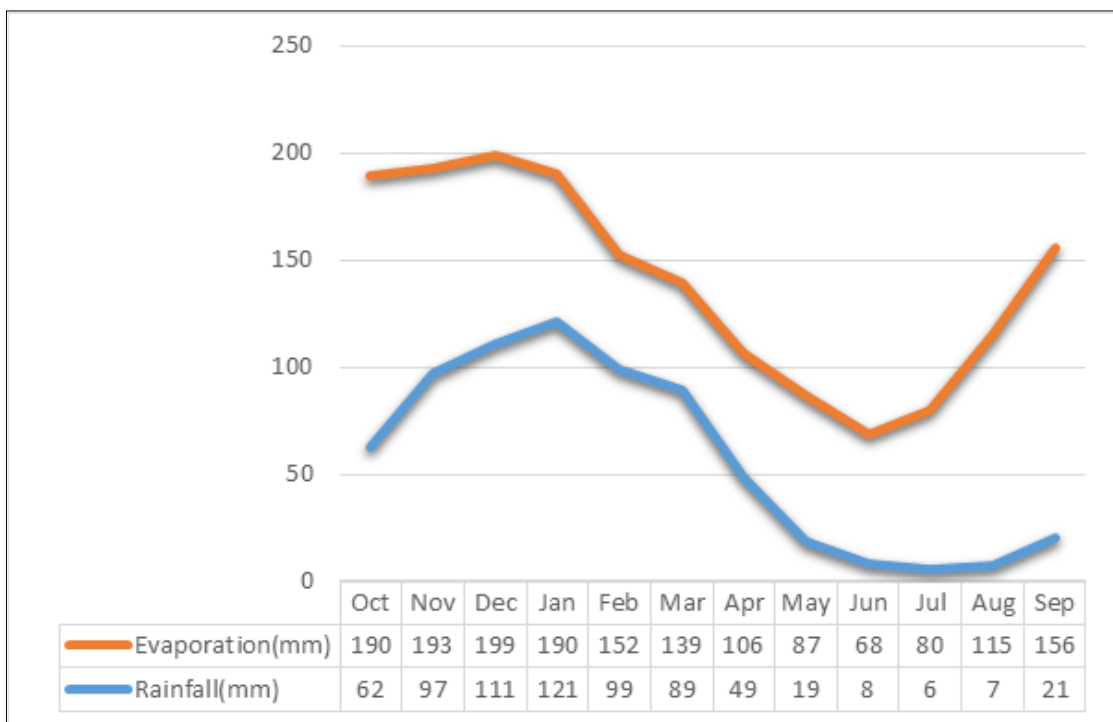


Figure 5-4: Potential evaporation and rainfall depths for the Randfontein region

5.3. Water Quality

5.3.1. Sampling Localities

Since the Project Site is situated on a watershed, four (4) samples were collected on radiating rivers downstream of the site, while additional samples were collected in storage infrastructure including the Lancaster Dam and Coronation Dam. In October 2021 sampling sites Princess Pit, SW2_DST and SW3_UST were dry and could not be sampled. The surface water monitoring was designed to determine baseline water quality before the proposed gold reclamation project commences. The surface water quality localities and their descriptions are indicated in Table 5-1 and presented in Figure 5-5.

Table 5-1: Surface water sampling points at the Randfontein Cluster project site

Site	Description	Coordinates	
		Latitude	Longitude
SW1_DST	West of the Randfontein Cluster project site on Rustenburg Road bridge crossing	-26.107243	27.72212
SW2_DST	South of Randfontein Cluster project site on Wonderfonteinspruit R28 Road or Azaardville Bridge	-26.147606	27.76273
SW3_DST	East of Mogale Cluster project site, on a stream adjacent to Impala Road	-26.135056	27.82335
SW4_DST	North of Mogale Cluster project site, on the Van Riebeek Road bridge crossing	-26.096462	27.76246
SW5@9Shaft	Surface water adjacent the 9 Shaft area	-26.127221	27.717738
SW7_LD	Lancaster Dam on the Wonderfonteinspruit	-26.128728	27.777567
SW8_CD	Surface water at the Coronation Dam	-26.104820	27.786273
Princess Pit	Wonderfonteinspruit at Princess Pit, upstream of the Lancaster Dam	-26.130416	27.794822

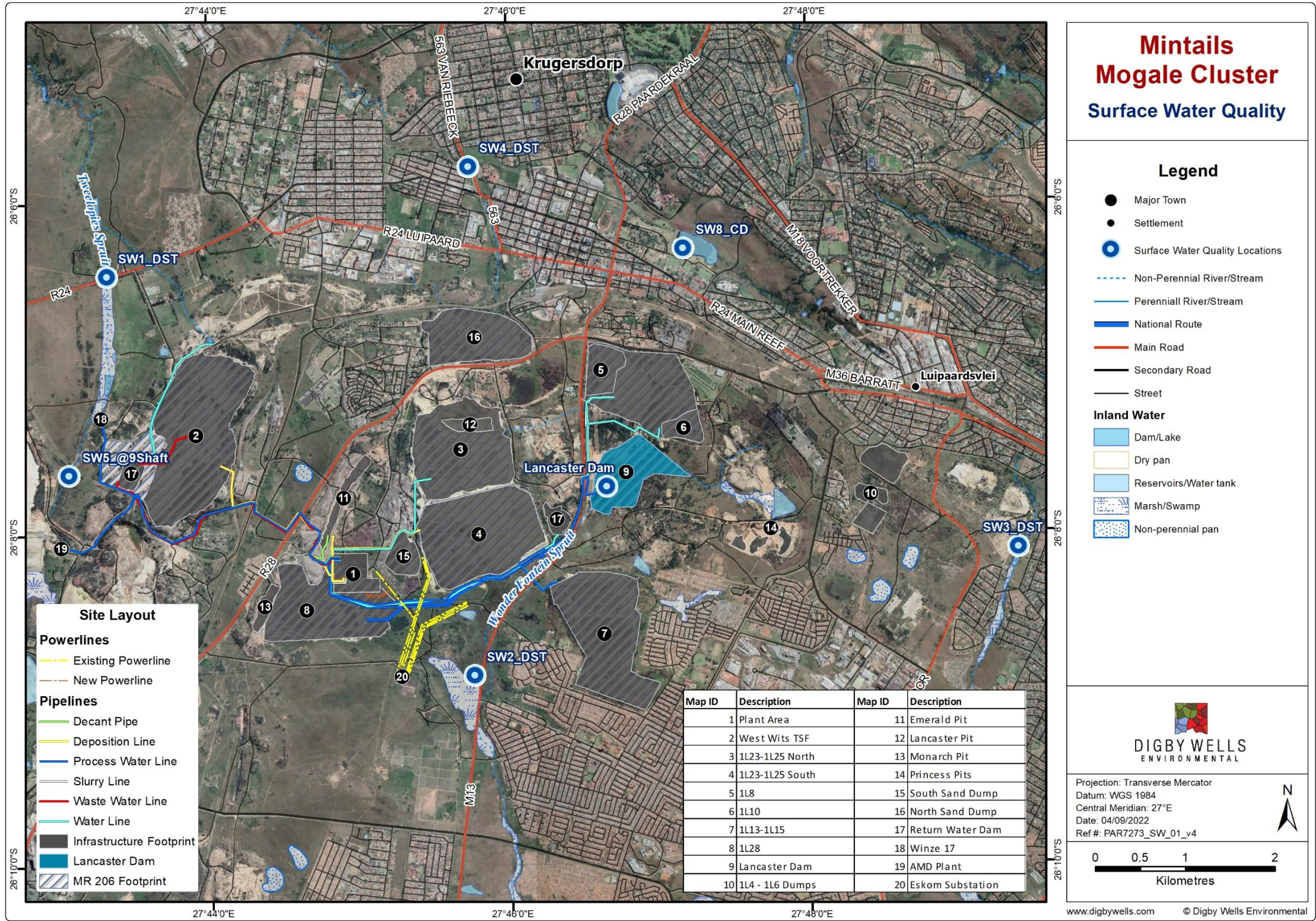


Figure 5-5: Surface water sampling localities at the Randfontein Cluster project site

5.3.2. Historical Water Quality

Historical surface water quality from 2012 to 2018 for selected points relevant to the currently proposed project is described in this section. Water quality results were benchmarked against the Vaal Resource Quality Objectives (RQO) since the Wonderfonteinspruit is a tributary for the Mooi River and the Vaal River. Where deemed appropriate the Department of Water and Sanitation (DWS) water quality guidelines were used.

Sulphate (SO_4) levels at most monitoring sites, except at SW8 (Coronation Dam) and Princess Pit, exceed the Vaal RQO (Figure 5-6). While there is no Vaal RQO for Total Dissolved Solids (TDS), the parameter exceeds the DWS guideline of 1000 mg/L at most sites except at SW8 and Princess Pit. The high SO_4 levels at SW7_LD (Lancaster Dam) and the Azaardville Bridge (at SW2_DST) on the Wonderfonteinspruit are likely due to seepage from adjacent Tailings Storage Facilities (TSFs) which are proposed for re-mining. When these TSFs are re-mined it is envisaged that the water quality at the mentioned points will likely improve.

Elevated levels of Uranium (Au) and Manganese (Mn) are indicated especially at SW7_LD, which are likely emanating from seepage from the northern and western TSFs (Figure 5-8 and Figure 5-9).

Nickel (Ni), Cadmium (Cd) and Aluminium (Al) show elevated levels during the monitoring period, especially at the Lancaster Dam (SW7_LD), Azaardville Bridge (SW2_DST) and at SW4_DST (Figure 5-10 to Figure 5-12).

Nitrate (NO_3) levels are within the DWS guidelines from mid-2016 to the last monitoring run in October 2021 at all monitoring points (Figure 5-13). On the other hand, Chloride (Cl) levels variably exceed the Vaal RQO at all monitoring points, especially at Lancaster Dam and the Azaardville Bridge (SW2_DST) (Figure 5-14).

pH levels are variably low at the Princess Pit, the Azaardville Bridge (SW2_DST) and at SW4_DST, constantly low at the Lancaster Dam (SW7_LD) and SW4_DST. The acidic pH at most of the monitoring points confirms contamination by Acid Mine Drainage (AMD) within the catchment (Figure 5-15). Conversely, pH levels at Coronation Dam (SW8_CD), SW1_DST and SW3_DST are within the DWS water quality guidelines.

Electrical Conductivity (EC) exceeds RQO at the SW1_DST, SW2_DST, SW4_DST and SW7_LD, while compliant levels below the guideline range are observed at SW3_DST and at the Coronation Dam (SW8_CD) (Figure 5-16).

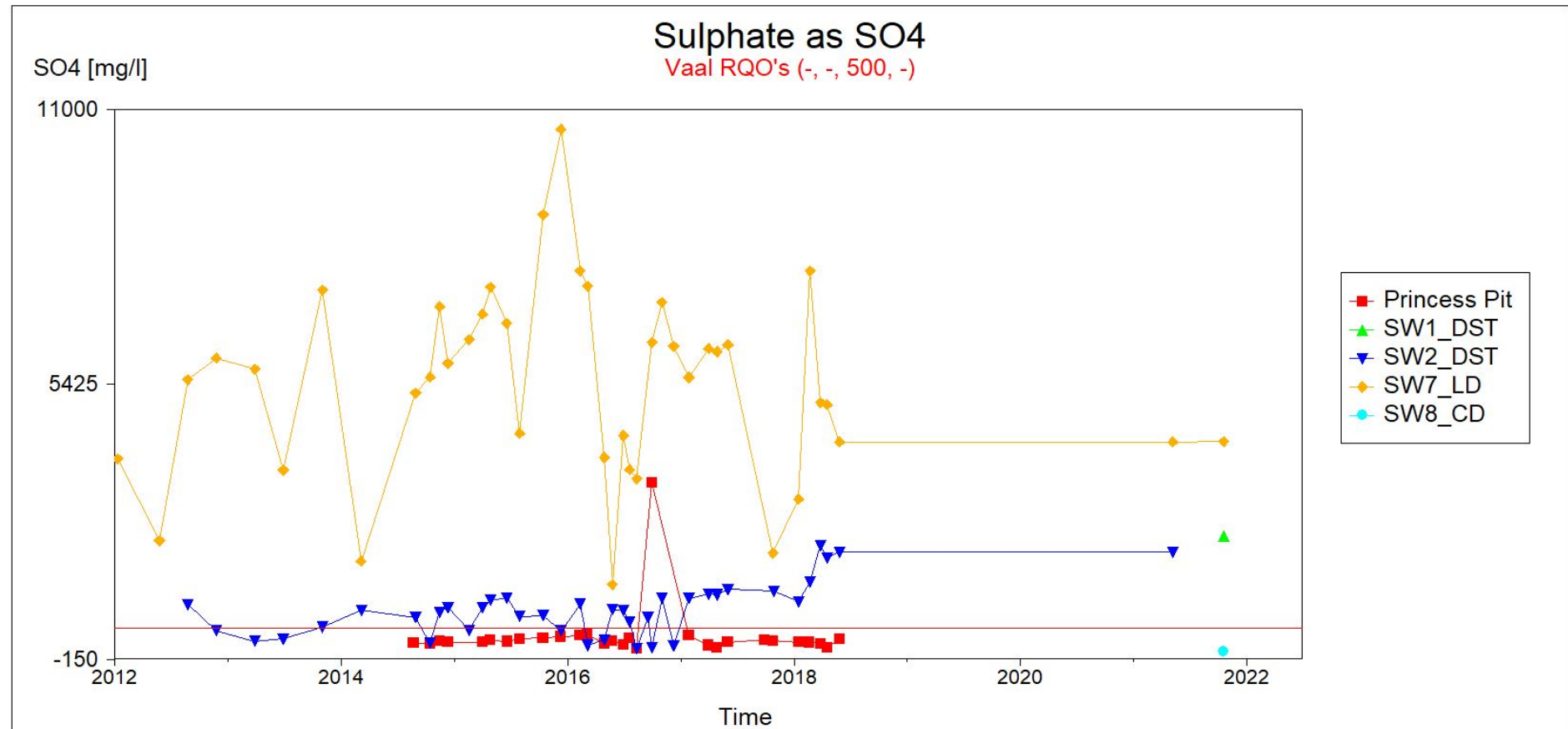


Figure 5-6: Sulphate trends

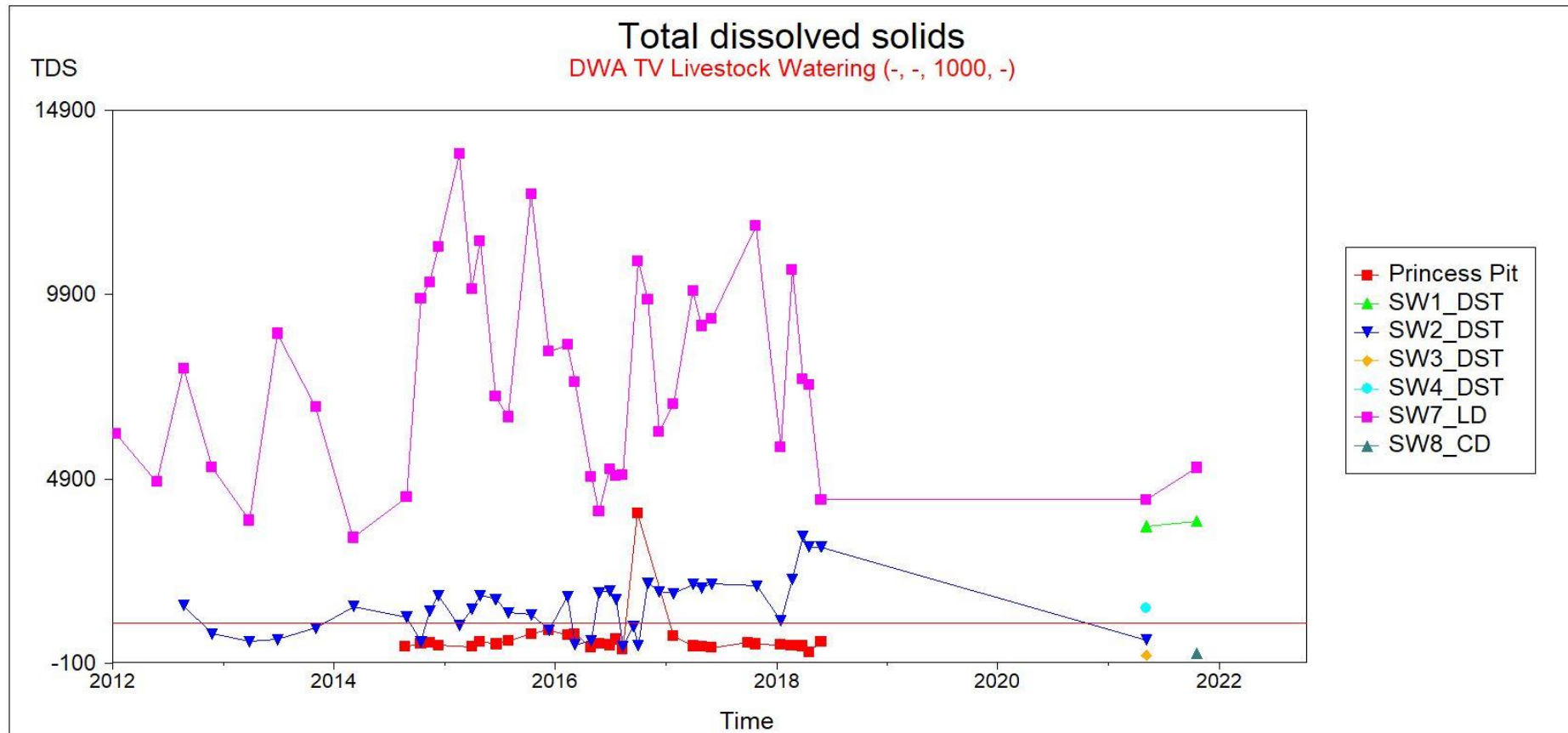


Figure 5-7: TDS trends

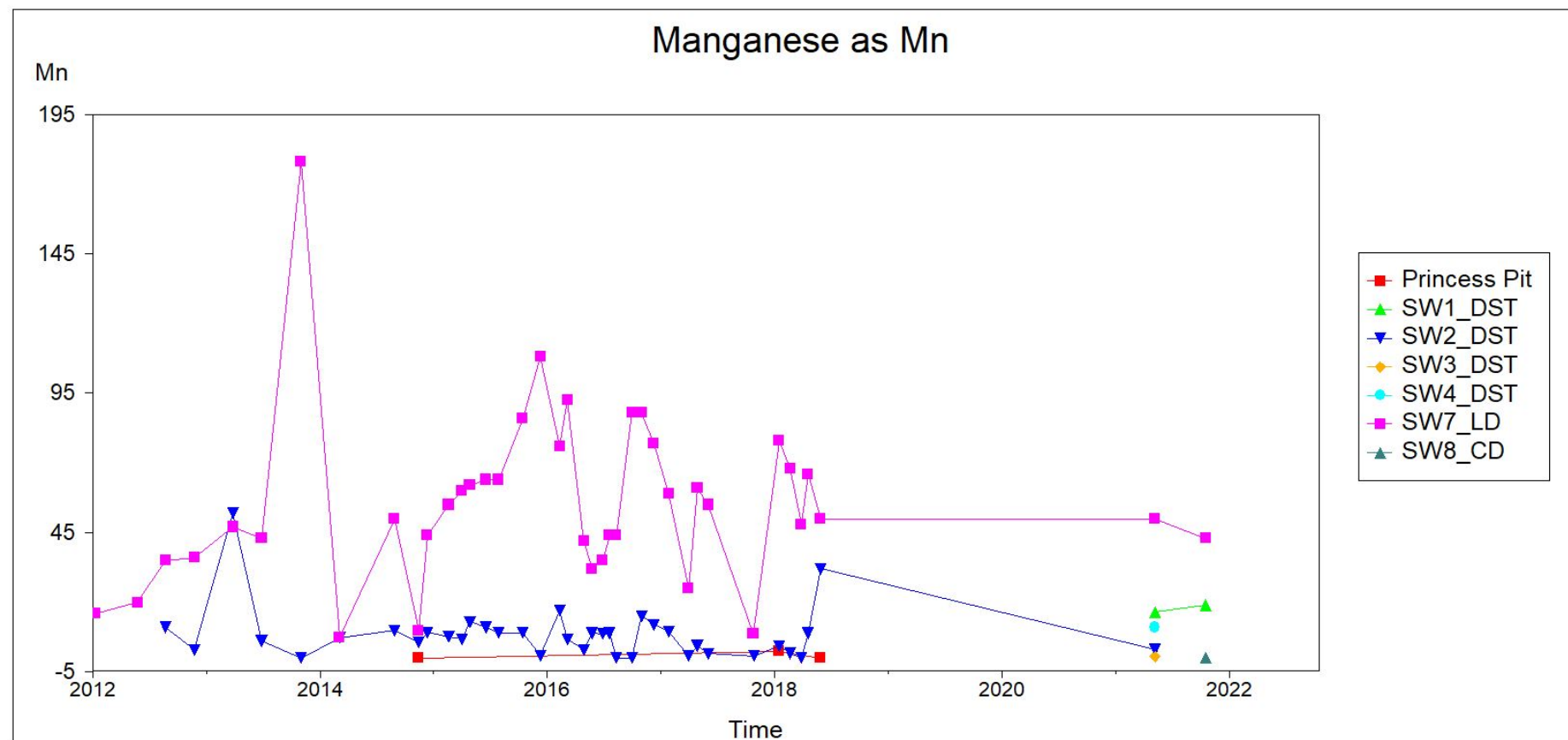


Figure 5-8: Manganese trends

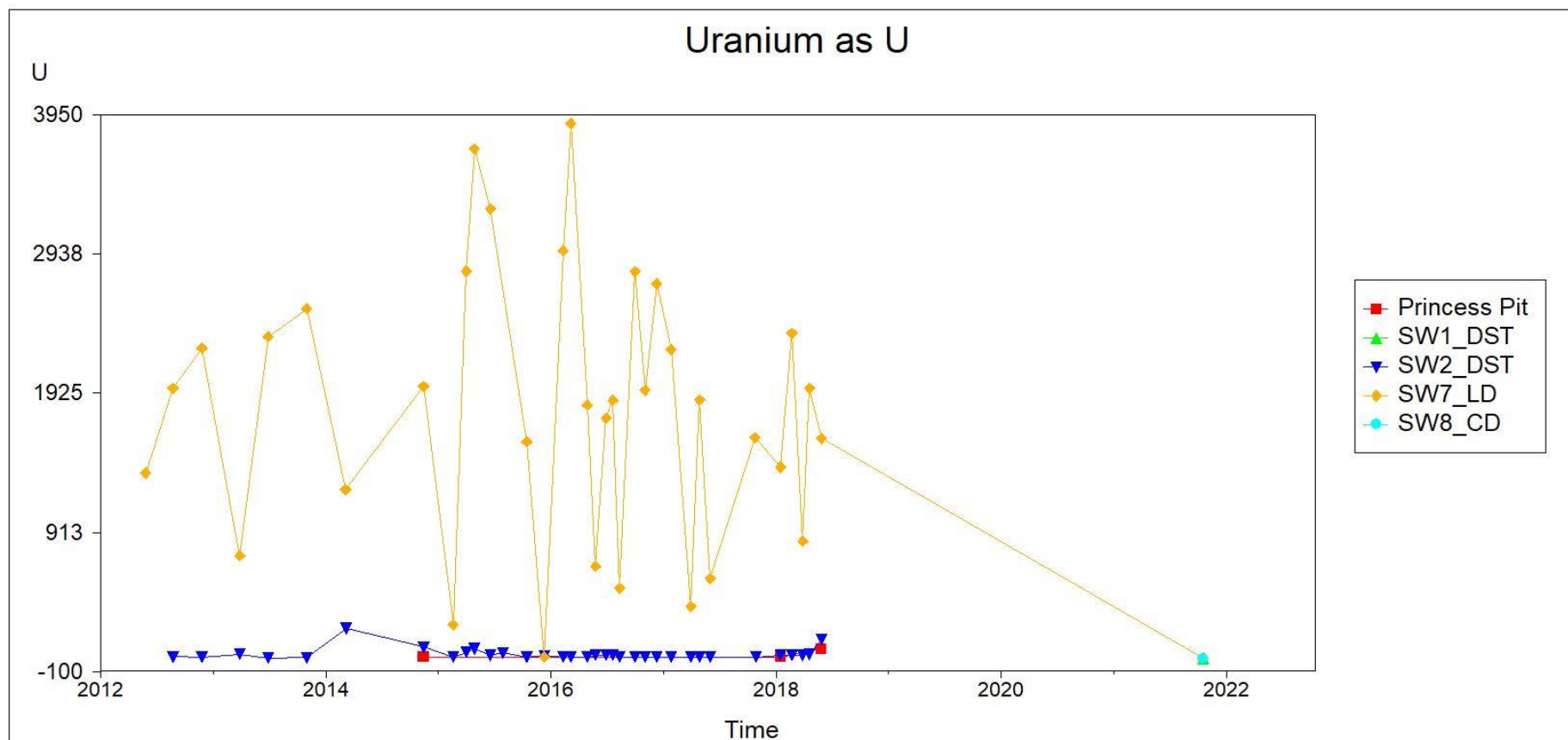


Figure 5-9: Uranium trends

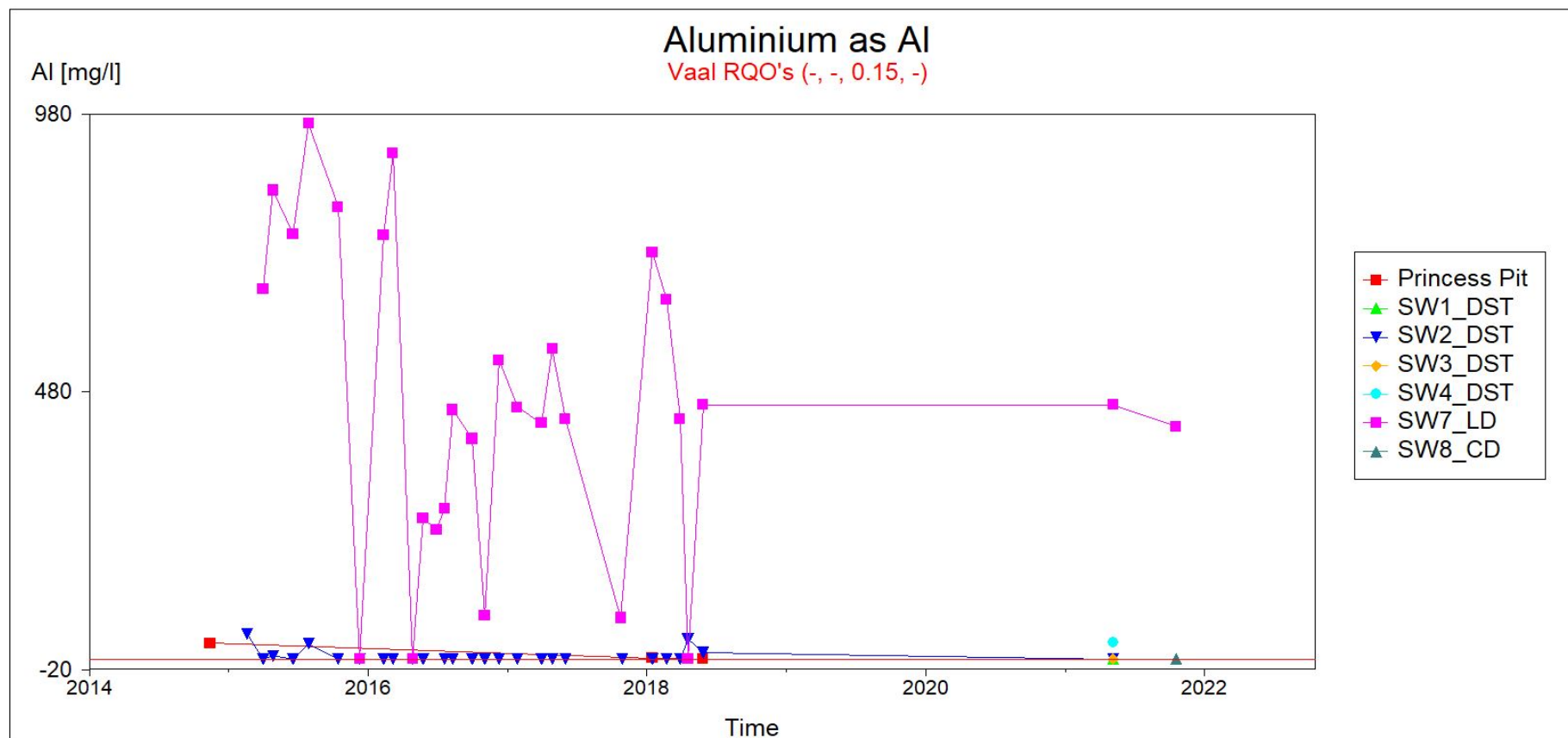


Figure 5-10: Aluminium trends

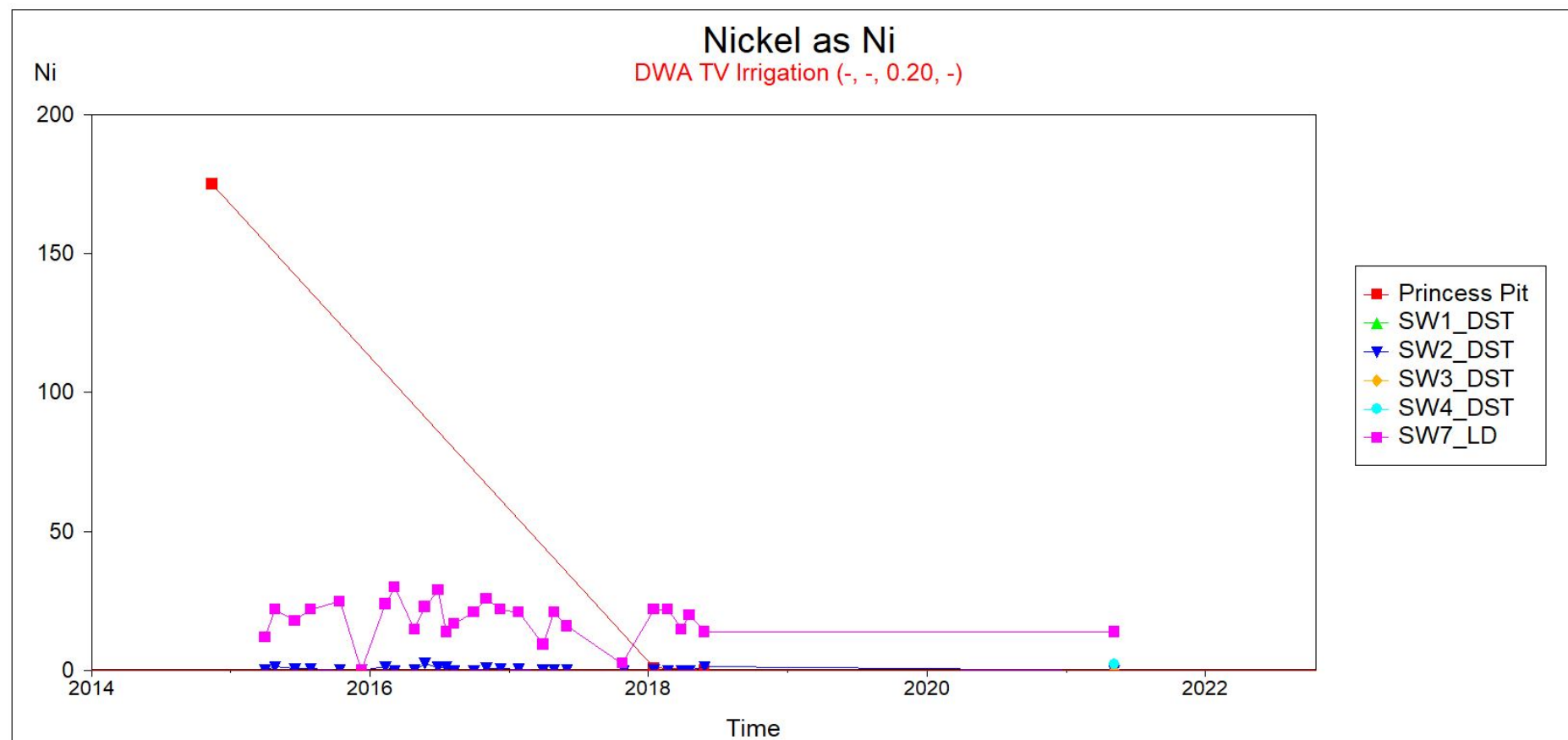


Figure 5-11: Nickel trends

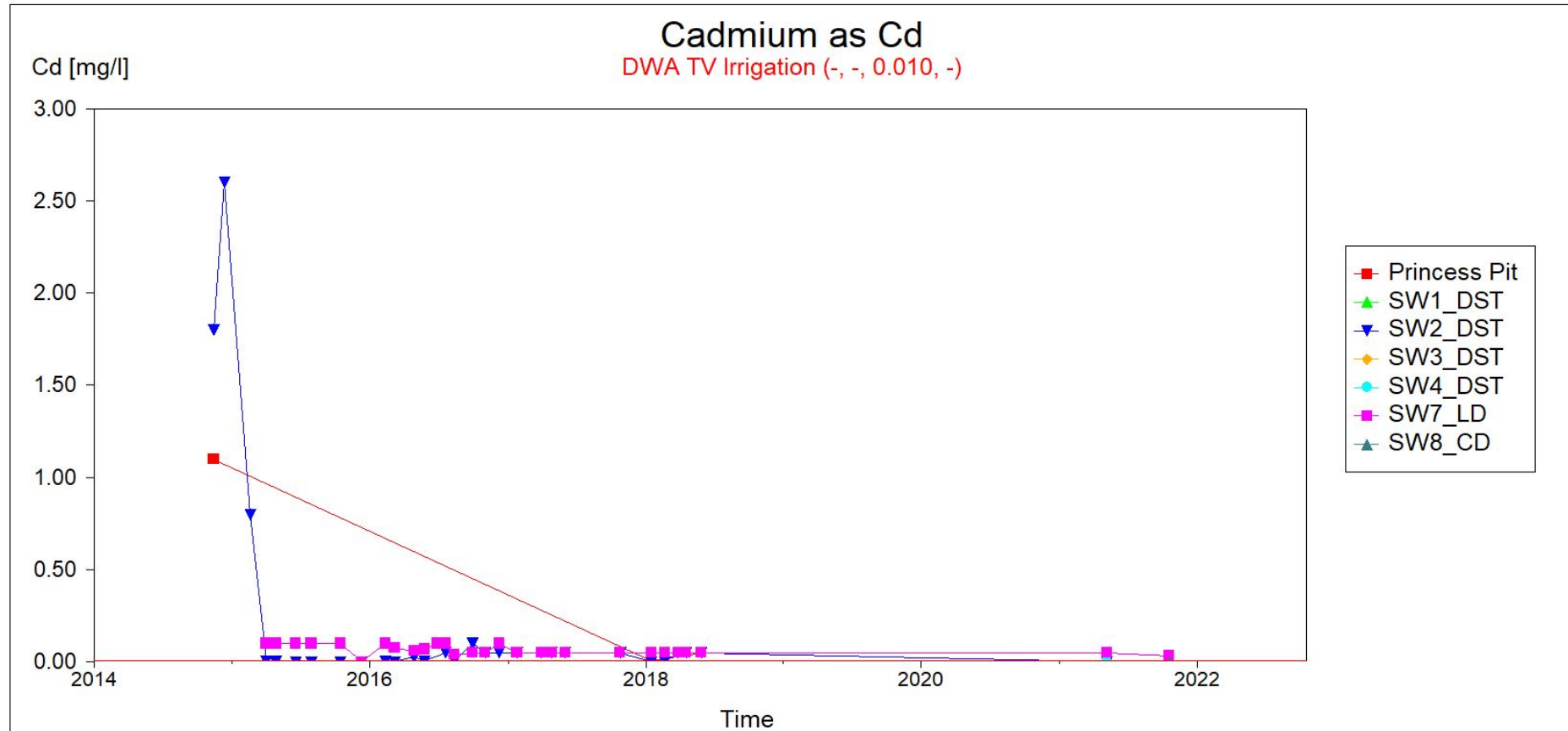


Figure 5-12: Cadmium trends

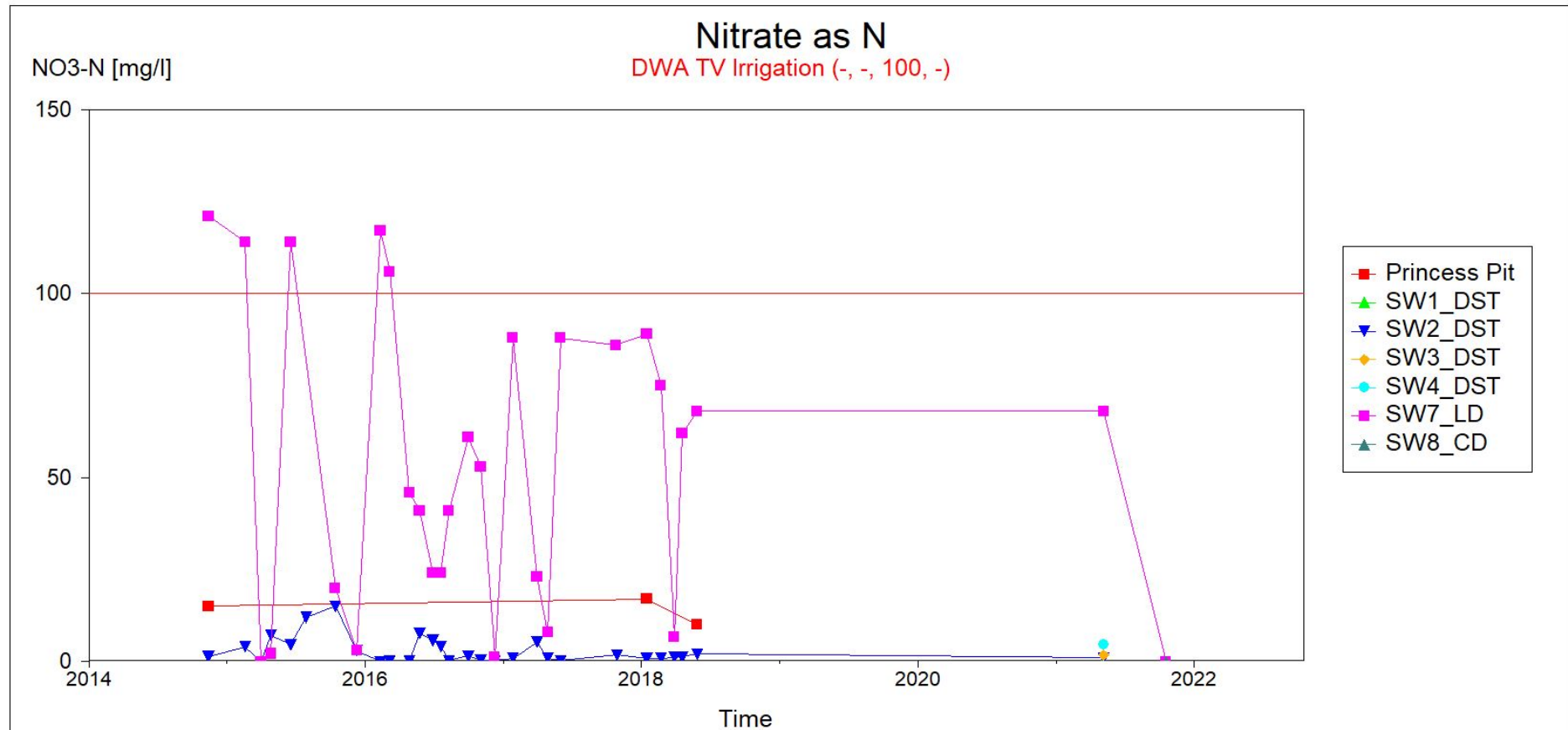


Figure 5-13: Nitrate trends

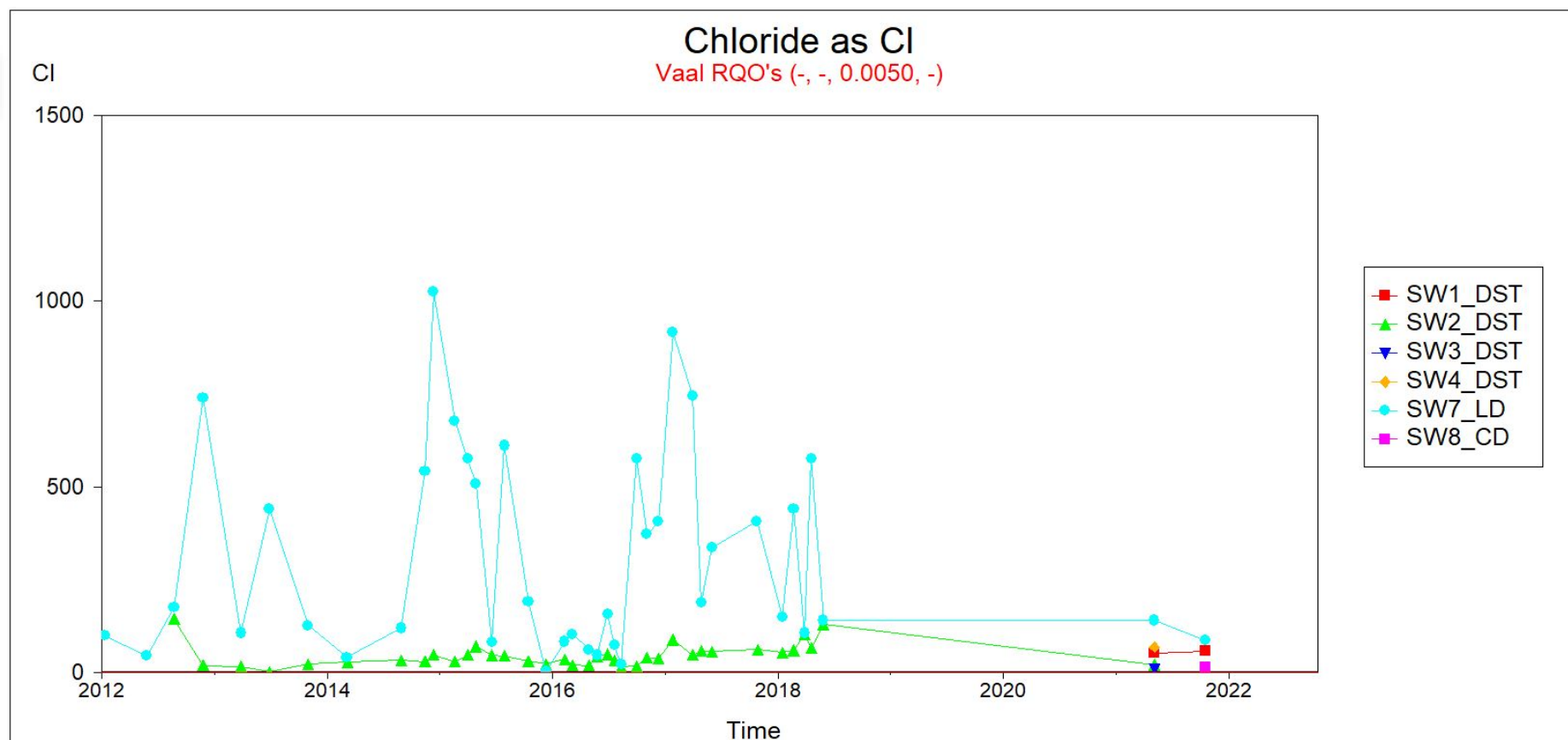


Figure 5-14: Chloride trends

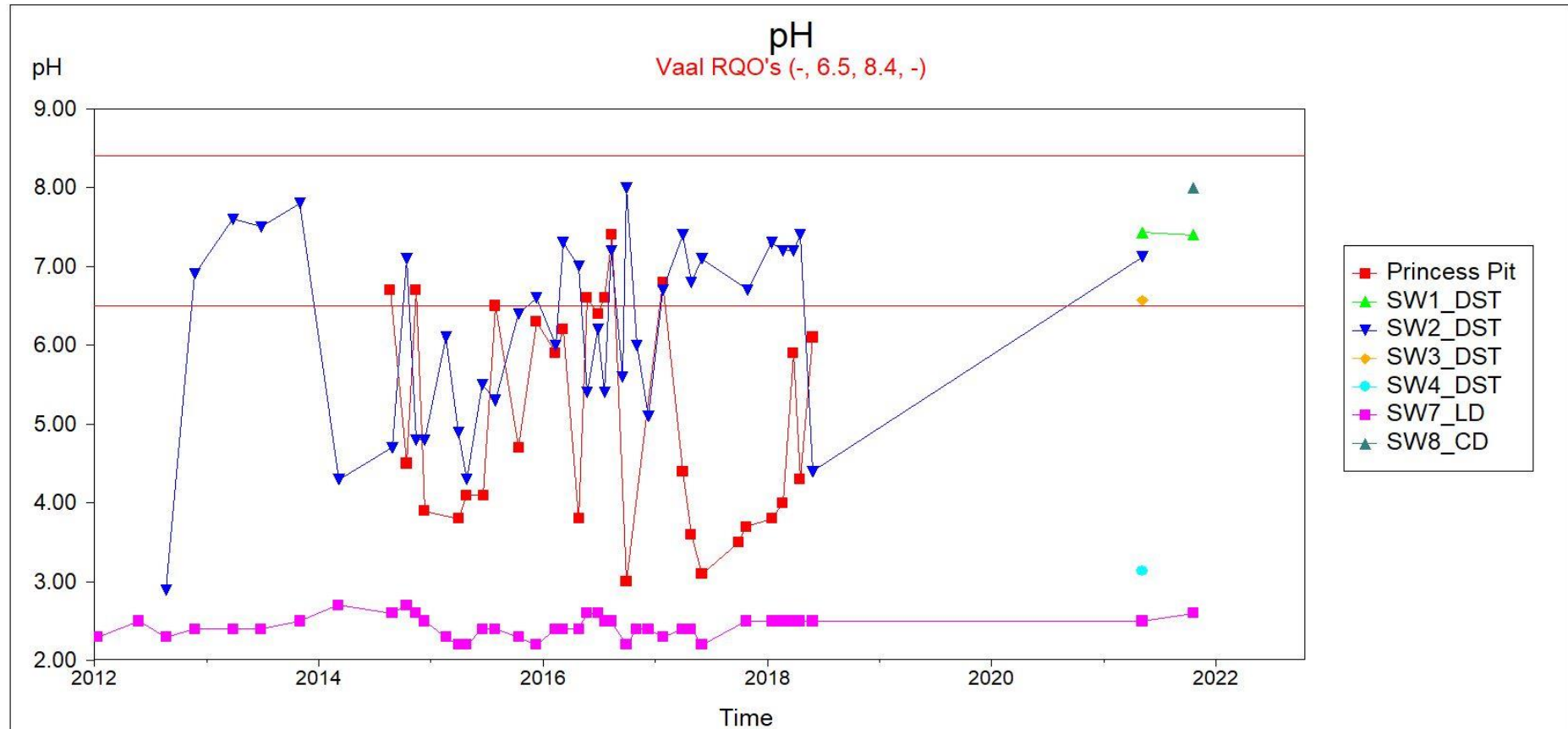


Figure 5-15: pH levels

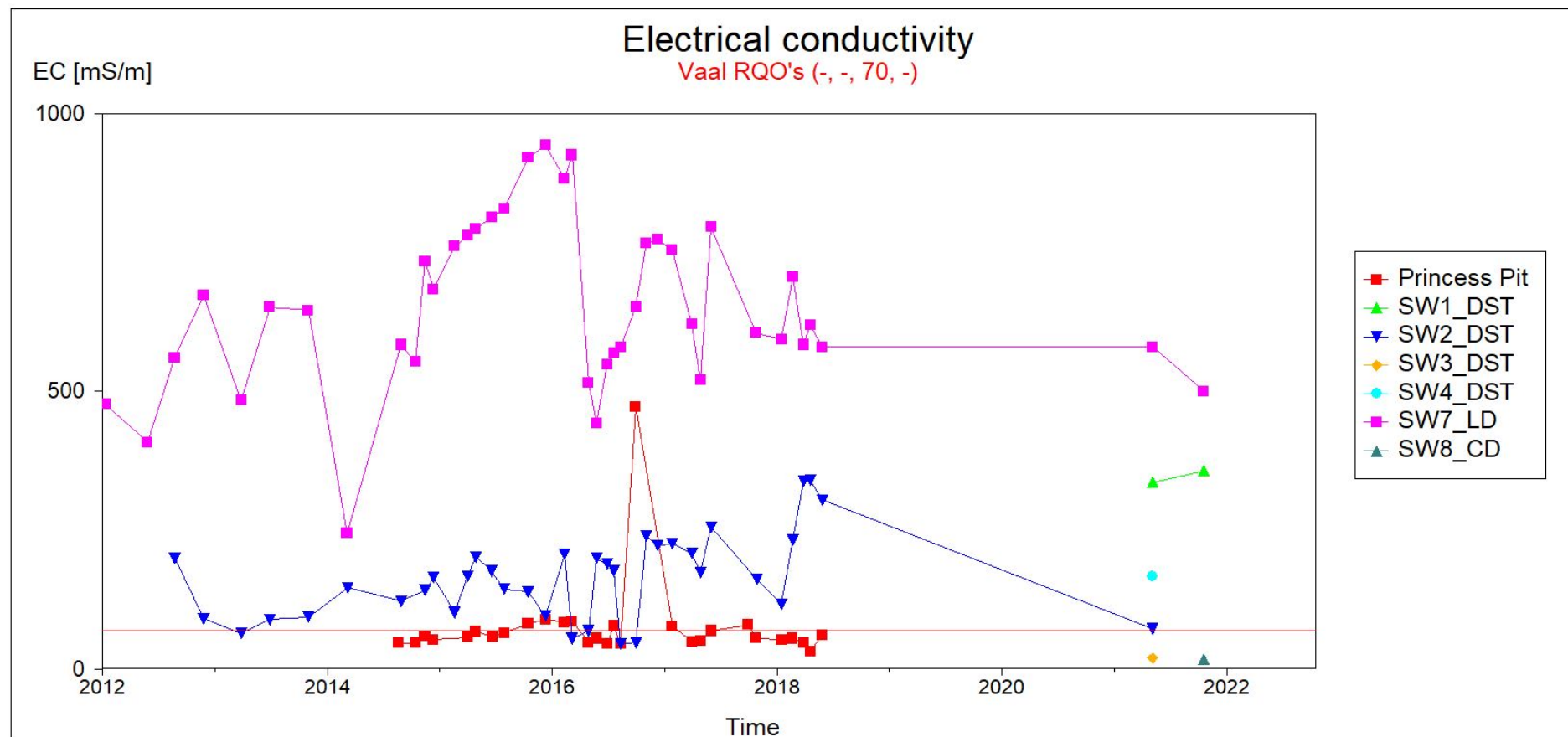


Figure 5-16: Electrical Conductivity

5.3.3. Recent (October 2021) Surface Water Quality

Electrical Conductivity (EC), TDS, Total Suspended Solids (TSS), SO_4 and Chloride (Cl) show elevated levels at the SW4_DST (on the Rietspruit, north of the project site boundary), Lancaster Dam, and SW2_DST (downstream of Wonderfonteinspruit south of the project site boundary) (Table 5-2).

Heavy metals including Manganese (Mn), Molybdenum (Md), Nickel (Ni), Lead (Pb), Selenium (Se) and Zinc (Zn) show variable exceedances of the Vaal RQO and the Department of Water and Sanitation (DWS) water quality guidelines as indicated in Table 5-2.

pH levels are within acceptable limits at SW1_DST, SW2_DST and SW3_DST, except for SW4_DST on the Rietspruit and at the Lancaster Dam (SW7_LD) where low pH levels were recorded (Table 5-2).

Table 5-2: Baseline water quality in streams draining the Randfontein Cluster project area

Parameter	SW1_DST	SW2_DST	SW3_DST	SW4_DST	SW7_LD	SW8_CD	DWA TV Aquatic Ecosystem	DWA TV Livestock Watering	DWA TV Irrigation
		(Azaardville Bridge)			(Lancaster Dam)	(Coronation Dam)			
	(mg/L, unless otherwise stated)								
pH, at 25°C (pH meter units)	7.4	7.12	6.57	3.14	2.6	8.0	NS	NS	6.5 - 8.4
Electrical Conductivity, (mS/m)	358	73.4	21.4	167	500	18.5	NS	NS	NS or <70
Total Dissolved solids (TDS)	3762	540	122	1404	5206	174	NS	<1000	NS
Total Suspended Solids (TSS)	12.0	<1	<1	1042	27	9.3	NS	NS	<50
Ammonium as NH ₄	10.07	<0.1	0.43	3.08	<0.1	-	NS	NS	NS
Ammonia as N	7.83	<0.1	0.334	2.4	49	-	NS	NS	NS
Chloride	59	22	9.46	14	87		NS	<1500	<100
Chromium Hexavalent (Cr6+)	<0.01	<0.01	<0.01	<0.01	0.041	<0.010	0.007	<1	<0.1
Fluoride	0.2	0.1	<0.1	<0.1	0.2	0.4	<0.75	<2	<2
Nitrate as NO ₃	<0.1	1.1	1.82	4.66	<0.1	<0.1	NS	<200	100
Nitrite as NO ₂	<0.1	0.15	<0.1	<0.1	<0.05	<0.05	NS	<10	NS
Phosphate, as PO ₄	0.356	0.15	<0.1	0.266	<0.08	-	NS	NS	NS
Total Cyanide	<0.01	<0.01	<0.01	<0.01	<0.01	-	NS	NS	NS
Free Cyanide	<0.01	<0.01	<0.01	<0.01	<0.010	<0.010	NS	NS	NS
WAD Cyanide	<0.07	<0.01	<0.01	<0.01	<0.07	<0.07	NS	NS	NS
Magnesium	140	22.89	4.32	55.77	110	5	NS	<500	NS
Potassium	12.5	1.44	1.16	6.26	5.6	1.9	NS	NS	NS
Calcium as Ca	643	112	22.85	158	353	17	NS	<1000	NS
Sodium as Na	148	37.1	13.15	51.16	64	10	NS	<2000	<70
Aluminium	0.175	0.033	<0.017	29.46	418	0.111	<0.01	<5	<5
Arsenic as As	<0.001	<0.003	<0.003	<0.003	0.049	<0.001	<0.1	≤1	<0.1
Cadmium	<0.001	<0.001	<0.001	0.003	0.035	<0.001	<0.00015	<0.01	<0.01
Cobalt	0.187	0.022	0.043	0.952	7.33	<0.025	NS	<1	<0.05
Copper	0.018	<0.002	<0.002	0.299	2.74	0.022	<0.0003	<0.5	<0.2
Iron	3.10	<0.003	0.014	44.56	108	0.183	NS	<10	<5
Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.04	<1	NS
Manganese	19	3.12	0.553	11.06	43	<0.025	<0.18	<10	<0.02
Molybdenum	<0.025	<0.001	<0.001	<0.001	<0.025	<0.025	0.04	0.01	0.01
Nickel	0.686	0.013	0.07	2.21	15	<0.025	NS	<1	<0.2
Lead	<0.001	<0.001	<0.001	0.006	0.005	<0.001	<0.0002	<0.1	<0.2
Selenium	0.001	0.01	<0.001	<0.001	0.018	0.002	<0.002	<0.05	<0.02
Zinc	0.258	0.018	0.072	4.54	21	<0.025	<0.002	<20	<1
Sulphate	2363	2030	-	-	4268	20	NS	<1000	NS
Uranium	0.018	-	-	-	1.86	<0.001	NS	NS	<0.01
KEY:									
-				-	-				
Exceeds one or more of the reference standards				-	-				
No Standard				NS					

5.4. Floodline Assessment

The 1:50-year and 1:100-year floodline were analysed to evaluate the risk associated with potential flooding and their potential impacts on the infrastructure and water resources. In this study, the only floodlines modelled were for the streams within the proximity of the project area.

5.4.1. Peak Flows

5.4.1.1. Design rainfall depths

the rainfall depths were derived from the Design Rainfall Software for South Africa (Smither and Schulze, 2000) and these are presented on Table 5-3. The peaks were calculated from rainfall depths equalling the time of concentration (T_c) using the RM3 method. While the modified Hershfield equation was used to calculate point precipitation depths which were applied in the SDF method for peak flows calculation.

Table 5-3: 24-hour Design Rainfall Depths

Duration	Return Period (Years)					
	2year	5year	10year	20year	50year	100year
5 m	8.9	12.3	14.9	17.6	21.6	25
10 m	12.8	17.6	21.3	25.2	30.9	35.7
15 m	15.8	21.9	26.5	31.3	38.4	44.3
30 m	20.3	28	33.9	40.1	49.1	56.7
45 m	23.4	32.3	39.1	46.3	56.8	65.5
1 h	26	35.8	43.3	51.3	62.9	72.6
1.5 h	30	41.4	50.1	59.2	72.6	83.9
2 h	33.6	46.4	56	66.3	81.3	93.9
4 h	40.2	55.5	67.1	79.4	97.3	112.4
6 h	44.6	61.6	74.5	88.2	108.1	124.9
8 h	48.1	66.4	80.3	95	116.5	134.5
10 h	51	70.3	85.1	100.7	123.4	142.5
12 h	53.4	73.7	89.2	105.5	129.4	149.4
16 h	57.6	79.5	96.1	113.7	139.4	161
20 h	61	84.2	101.8	120.5	147.7	170.6
24 h	65.2	90.1	108.9	128.9	158.1	182.5

5.4.1.2. Delineated sub catchments and peak flows

Three catchments were delineated (Figure 5-17) for streams within and in proximity to the PAR Mogale Cluster project boundary. Peak flows were calculated for the delineated catchments using the Rational Method (Alternative 3 (RM3), The Standard Design Flood (SDF) and the Midgley and Pitman (MIPI) methods. Results of the RM3 method were used in hydraulic modelling because they were representative of the area due to site-specific runoff coefficients generated using an in-built RM3 module. The MIPI results helped in the selection of suitable peak flows because they were of the same order of magnitude as the RM3 method. The SDF results were deemed an over-estimate of peak flows for the site due to higher regionalised runoff coefficients. Calculated peak flows are presented in Table 5-4.

Table 5-4: Calculated Peak flows

Catchment	Method					
	RM3		SDF		MIPI	
	1:50yr	1:100yr	1:50yr	1:100yr	1:50yr	1:100yr
	(m ³ /s)					
C1	102.12	142.14	94.22	120.11	72.59	91.69
C2	30.64	42.64	28.27	36.03	21.78	27.51
C3	80.36	111.78	84.41	106.90	85.68	108.22

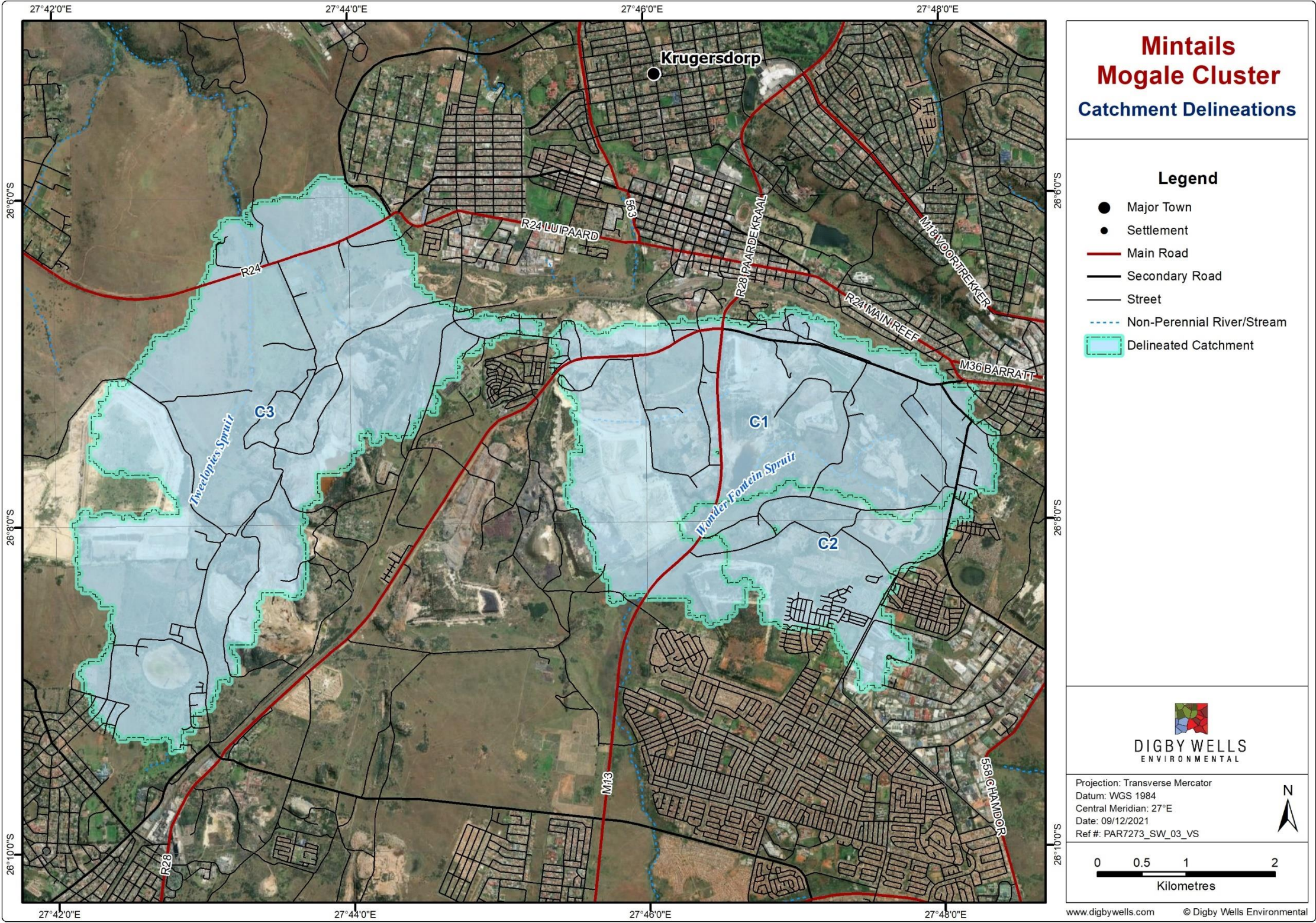


Figure 5-17: Delineated Catchments

5.4.2. Floodlines

The 1:50-year and 1:100-year floodlines for the tributaries traversing or in proximity to the project site were modelled and mapped. From the mapped results, most of the infrastructure are outside the delineated 1:50-year and 1:100-year floodlines (Figure 5-18). Portions of the TSF 1L23-25 South and the RWD, however, do encroach into the flood waterway of the 1:50-year and 1:100-year flood events. A berm constructed on the edges of the right riverbank at the point of contact will help to ensure separation of water resources from potentially contaminating TSF and RWD structures.

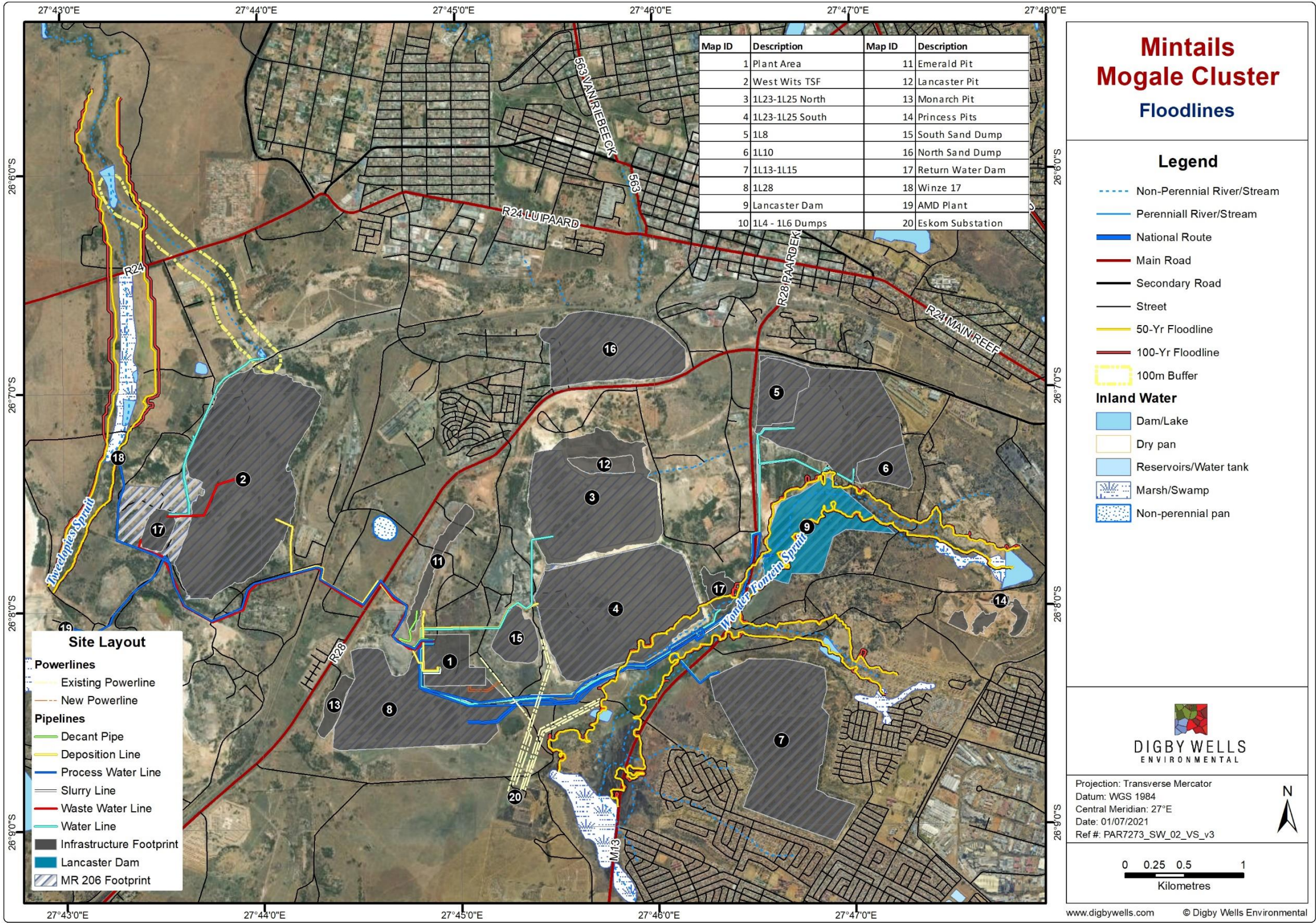


Figure 5-18: Modelled Floodlines

5.5. Water Management and Water Balance

In line with the DWS's best practice guidelines, a clear definition and understanding of the boundaries of the water system and layout of the water circuits are required to develop the water balance for a mine. This water and salt balance serves as the mine water management tool that assists with reporting on water usage and water use efficiency of the mine, water management decision making and risk evaluations.

The water management boundaries are categorised into water demand, water sources and water storage:

5.5.1. Water Use/Demand

PAR require water for the following uses, at the minimum:

- Process water at the Processing Plant;
- Process Spray Water;
- Rand Water (Clean water for soft elution);
- Dust suppression water; and
- Potable water for drinking and other domestic uses at workshops, change houses and at the Processing Plant.

5.5.2. Water Sources

Identified water sources for the PAR reclamation project are as follows:

- Lancaster Dam;
- West Wits Pit Void;
- #17 Winze; and
- Rand Water for potable and clean water elution purposes.

5.5.3. Water Storages/ Containment Facilities

The water storage infrastructure includes:

- Lancaster Dam;
- West Wits Pit (WWP);
- Return Water Dams (RWDs); and
- Process Water Dam (PWD).

5.5.4. Mine Water Management Infrastructure

This section provides an overview of the water management facilities on which the water balance is based and summarises the mine water reticulation system for the proposed PAR operations.

Processing Plant

Water is conveyed to the Processing Plant from the WWP, Lancaster Dam and the #17 Winze for gold recovery processes. The water that comes from the WWP is treated before it is pumped to the Processing Plant. The Rand Water Board will supply additional clean water for elution processes that specifically require clean water. Return water from the Plant will be recycled back to the Plant from the Process Water Dam as a water saving measure during the gold reclamation process. When water in the Lancaster Dam is used up, the dam will be decommissioned and the site rehabilitated.

Offices, Workshop and Change House

Offices, workshop and change houses receive water from the Rand Water Board for consumption and other domestic uses including ablution and washing. Sewage effluent will be conveyed and integrated into the local Municipal Sewer System.

Pollution Control Dam and the Event Pond

Runoff from dirty areas on the project site which include the Workshop, Wash Bay, Tailings Bay and the Processing Plant will be channelled to the PCD for containment. If the PCD overflows, the water spills over to the adjacent Event Pond which is specifically designed for that purpose.

Water Treatment Plant

Acidic water from the WWP is neutralised in the water treatment plant facility (passive treatment technology) and used as process water in the gold reclamation operations. It is envisaged that most of the water requirements for the PAR gold reclamation project will be met through re-use of process water.

Rand Water Board

Water obtained from the Rand Water Board will mainly be for consumption by mining personnel and contractors. A portion of the Rand Water will be directed to the Processing Plant for use in elution processes that require clean water.

5.5.5. Information and Data Used in Water Balance Calculations

5.5.5.1. Rainfall and Evaporation

Monthly average rainfall data which was used in the water balance is indicated in Table 5-5 whilst Symons Pan potential monthly evaporation data is indicated in Table 5-6.

Table 5-5: Average monthly rainfall for the Mogale City region

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall (mm)	66	102	111	125	96	88	44	18	7	6	6	20

Table 5-6: Average monthly Symons Pan evaporation for the Mogale City region

Month	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Evaporation (mm)	160	159	168	161	135	123	99	84	69	77	107	144

5.5.5.2. Processing Plant Water Requirements

The Processing Plant water requirements for the gold recovery project are presented in Table 5-7.

Table 5-7: Processing Plant water requirements

Processing Plant	m ³ /hour
1L23-25 Process Water Supply	700
Process Spray Water	58
Process Water Dam – Re-mining water supply	1494
Rand Water (Clean water soft for elution)	480
Lancaster Dam – Process water supply	1964
#17 Winze- Process water supply	1964
West Wits Pit – Decant water supply	700
Dilution water / make up water	169.20

5.5.5.3. Constants and Assumptions

While most of the information (water requirement volumes) was provided by PAR, information was also gathered from previous or existing reports and by use of Geographic Information Systems (GIS) spatial platform to measure infrastructure surface areas at the project site (dams, runoff catchment areas). Table 5-8 presents some of the key constants and assumptions that were applied on this water balance, while potable water requirements which will be obtained from the Rand Water Board are indicated in Table 5-9.

Table 5-8: Summary of key constants and assumptions

Description of Assumptions and Constants	Value	Unit	Source
Lancaster Dam Catchment area	7 203 013	m ²	Measured/GIS
Lancaster Dam surface area	100 000	m ²	Measured/GIS
West Wits Pit Beach (Runoff)	646 000	m ²	Measured/GIS
West Wits Pit Surface (Direct rainfall)	832 000	m ²	Measured/GIS
West Wits Pit Return Water Dam (RWD)	75 000	m ²	Measured/GIS
Process Water Dam surface area	2 500	m ²	Measured/GIS
1L23-25 TSF Return Water Dam (RWD)	70 000	m ²	Measured/GIS
1L23-25 TSF Return Water Dam (RWD) runoff area	1 196 490	m ²	Measured/GIS
1L23-25 TSF	2 056 000	m ²	Measured/GIS
95% of inflows into the WWP is treated at the WTP	95	%	Assumed % of total inflow
Seepage from unlined storage facilities assumed to be 1% of pit inflows	1	%	Assumed % of total inflow
Return Water Dam seepage assumed to be 1% of inflows	1	%	Assumed % of total inflow
Process Plant losses assumed to be 1% of inflows	1	%	Assumed % of total inflow
Plant water requirement	1 541.26	m ³ /hr	DRA, 2021
Return water	844.77	m ³ /hr	DRA, 2021
West Wits Pit RWD supply to Process Water Dam	844.77	m ³ /hr	DRA, 2021
Return Water from West Wits & Emerald Pits	844.77	m ³ /hr	DRA, 2021
#Winze 17 Process water supply	1 541.26	m ³ /hr	DRA, 2021
Lancaster Dam water supply	1 541.26	m ³ /hr	DRA, 2021
1L23-25 Process water supply	844.77	m ³ /hr	DRA, 2021
Municipal Sewer volume, as a function of water used	5	%	Assumed % of total inflow
Sewer system losses as percentage of inflows	1	%	Assumed % of total inflow
Potable water (Consumption)	32.5	m ³ /day	DRA, 2021
Processing Plant Elution water	254.76	m ³ /day	DRA, 2021
Processing Plant Reagents water	602.01	m ³ /day	DRA, 2021
Remainder personnel for distribution to satellite areas (Offices, Workshops & Change Houses)	106.79	m ³ /day	Calculated for 345 personnel in satellite areas

Table 5-9: Potable Water Requirements

Description	Quantity	Unit	Source
Processing Plant Elution water	254.76	m ³ /day	DRA, 2021
Processing Plant Reagents water	602.01	m ³ /day	DRA, 2021
Plant Personnel Consumption (105)	32.50	m ³ /day	DRA, 2021
Remainder personnel for distribution to satellite areas (Offices, Workshops & Change Houses) (345)	17.25	m ³ /day	DRA, 2021

5.5.6. Water Balance Findings

The site-wide water balance calculated for the Gold Recovery Project was based on a Water Flow Diagram (WFD) shown in Figure 5-19. This WFD also shows a daily water balance for the reclamation project. The annual and monthly average water balances (DWS format) are presented in Table 5-10 and Table 5-11, respectively.

The annual average water balance indicates water supply from the Lancaster Dam, West Wits Pit and the #17 Winze to be 4 842 857 m³/annum, 13 293 028 m³/annum and 13 538 428 m³/annum, respectively. This water is pumped to the Process Water Dam from where it is then pumped to the Processing Plant for gold recovery processes. As soon as water in the Lancaster Dam is used up, the dam will be decommissioned, and the site rehabilitated.

On average the Processing Plant will receive a process water volume of 13 538 428 m³/annum and 325 473 m³/annum of potable water which will be obtained from the Rand Water Board. The Rand Water volume will be used for gold elution and dilution of reagents. Potable water required for washing, sanitation and consumption by mine personnel and contractors in satellite areas (Offices, Workshop & Change Houses) was determined to be 39 084 m³/annum.

A volume of 131 872 m³/annum for dust suppression in access and haul roads at the project site, which is expected to come from the WWP and passively treated before being used in order to minimise contamination of watercourses and the environment within and around the project site.

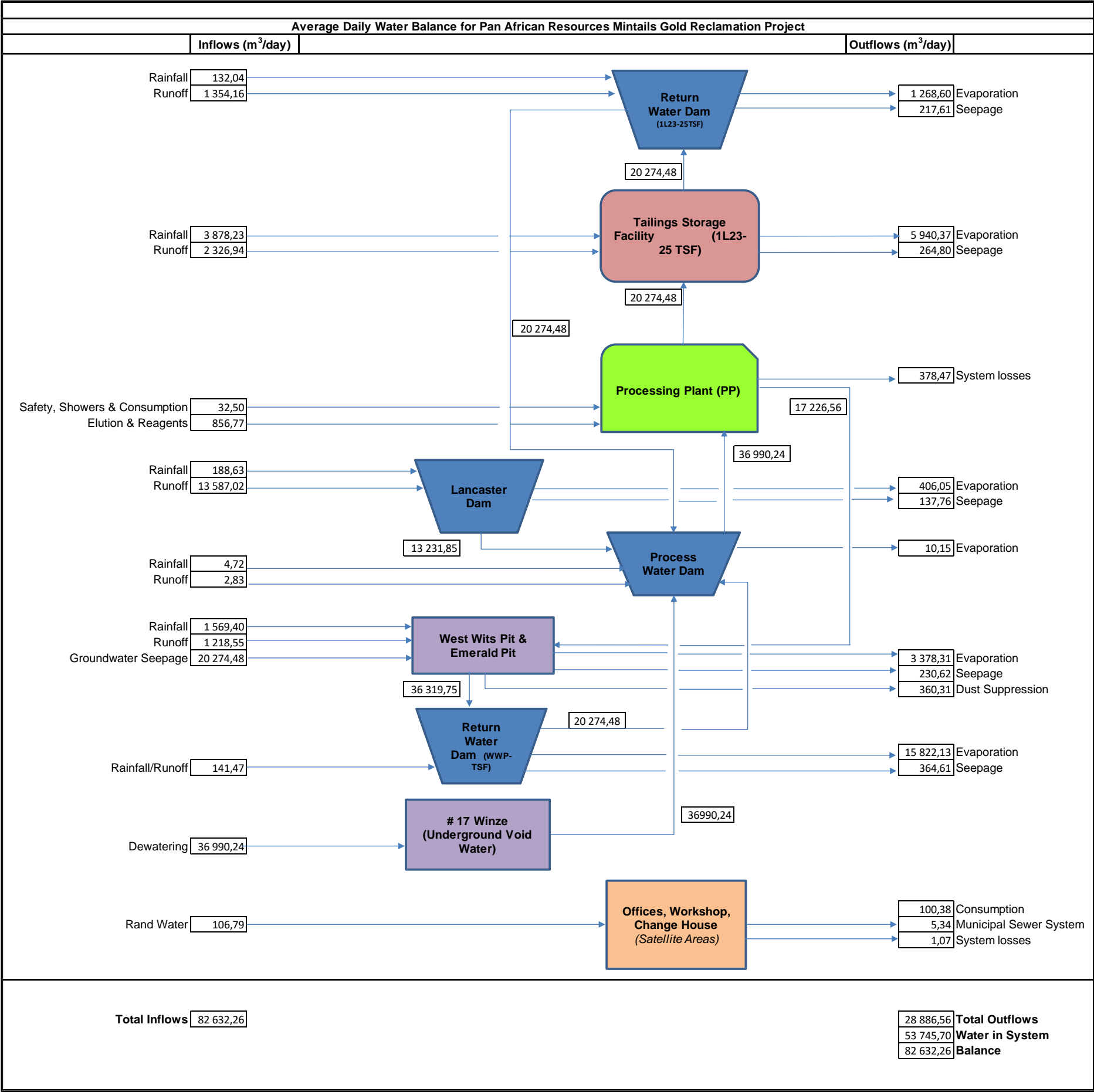


Figure 5-19: Water Flow Diagram with Daily Average Water Balance

Table 5-10: Annual Average Water Balance

Annual Average Water Balance for Pan African Resources Mintails Gold Reclamation Project					
		Water In		Water Out	Balance
Facility Name	Water Circuit/stream	Quantity (m ³ /Annum)	Water Circuit/stream	Quantity (m ³ /Annum)	
Return Water Dam (1L23-25)	From: Rainfall	48 327	To: Process Water Dam	7 420 460	
	From: Runoff	495 623	To: Evaporation	464 306	
	From: 1L23-25 TSF	7 420 460	To: Seepage	79 644	
	Total	7 964 409,73		7 964 409,73	-
Tailings Storage Facility (1L23-25)	From: Rainfall	1 419 431	To: Return Water Dam	7 420 460	
	From: Runoff	851 659	To: Evaporation	2 174 174	
	From: Processing Plant	7 420 460	To: Seepage	96 915	
	Total	9 691 549,56		9 691 549,56	-
Processing Plant	From: Potable Water (Safety, Showers & Consumption)	11 895	To: 1L23-25 TSF	7 420 460	
	From: Elution & Reagents	313 578	To: West Wits Pit	6 304 921	
	From: Process Water Dam	13 538 428	To: System losses	138 520	
	Total	13 863 900,66		13 863 900,66	-
Lancaster Dam	From: Rainfall	69 038	To: Process Water Dam	4 842 857	
	From: Runoff	4 972 851	To: Evaporation	148 613	
			To: Seepage	50 419	
		5 041 889,26		5 041 889,26	-
Process Water Dam	From: Rainfall	1 726	To: Processing Plant	13 538 428	
	From: Runoff	1 036	To: Evaporation	3 715	
	From: 1L23-25 RWD	7 420 460	To: Storage	19 682 823	
	From: Lancaster Dam	4 842 857			
	From: West Wits Pit RWD	7 420 460			
	From: #17 Winze (Underground Mine Void)	13 538 428			
	Total	33 224 966,10		33 224 966,10	-
West Wits Pit & Emerald Pit	From: Rainfall	574 400	To: Return Water Dam (WWP-TSF)	13 293 028	
	From: Runoff	445 989	To: Dust Suppression	131 872	
	From: Groundwater Seepage	7 420 460	To: Evaporation	1 236 460	
	From: Processing Plant	6 304 921	To: Seepage	84 408	
		14 745 769,36		14 745 769,36	-
Return Water Dam (WWP TSF)	From: Rainfall/Runoff	51 779	To: Process Water Dam	7 420 460	
	From: West Wits Pit TSF	13 293 028	To: Evaporation	5 790 900	
			To: Seepage	133 448	
	Total	13 344 807,32		13 344 807,32	-
#17 Winze (Underground Mine Void)	From: Dewatering	13 538 428	To: Process Water Dam	13 538 428	
	Total	13 538 427,84		13 538 427,84	-
Offices, Workshop & Change House (Satellite Areas)			To: Consumption	36 739	
	From: Rand Water	39 084	To: Municipal Sewer	1 954	
			To: System losses	391	
	Total	39 083,57		39 083,57	-
Total Water Balance		111 454 803,39		111 454 803,39	

Table 5-11: Monthly Average Water Balance

Monthly Average Water Balance for Pan African Resources Mintails Gold Reclamation Project					
		Water In		Water Out	Balance
Facility Name	Water Circuit/stream	Quantity (m ³ /month)	Water Circuit/stream	Quantity (m ³ /month)	
Return Water Dam (1L23-25)	From: Rainfall	4 027	To: Process Water Dam	618 372	
	From: Runoff	41 302	To: Evaporation	38 692	
	From: 1L23-25 TSF	618371,64	To: Seepage	6 637	
	Total	663 700,81		663 700,81	-
Tailings Storage Facility (1L23-25)	From: Rainfall	118 286	To: Return Water Dam	618 372	
	From: Runoff	70 972	To: Evaporation	181 181	
	From: Processing Plant	618 372	To: Seepage	8 076	
	Total	807 629,13		807 629,13	-
Processing Plant	From: Potable Water (Safety, Showers & Consumption)	991,3	To: 1L23-25 TSF	618 372	
	From: Elution & Reagents	26 131	To: West Wits Pit	525 410	
	From: Process Water Dam	1 128 202	To: System losses	11 543	
	Total	1 155 325,06		1 155 325,06	-
Lancaster Dam	From: Rainfall	5 753	To: Process Water Dam	403 571	
	From: Runoff	414 404	To: Evaporation	12 384	
			To: Seepage	4 202	
		420 157,44		420 157,44	-
Process Water Dam	From: Rainfall	144	To: Processing Plant	1 128 202	
	From: Runoff	86	To: Evaporation	310	
	From: 1L23-25 RWD	618 372	To: Storage	1 640 235,24	
	From: Lancaster Dam	403 571			
	From: West Wits Pit RWD	618 372			
	From: #17 Winze (Underground Mine Void)	1 128 202			
	Total	2 768 747,17		2 768 747,17	-
West Wits Pit & Emerald Pit	From: Rainfall	47 867	To: Return Water Dam (WWP-TSF)	1 107 752	
	From: Runoff	37 166	To: Dust Suppression	10 989	
	From: Groundwater Seepage	618 372	To: Evaporation	103 038	
	From: Processing Plant	525 410	To: Seepage	7 034	
		1 228 814,11		1 228 814,11	-
Return Water Dam (WWP TSF)	From: Rainfall/Runoff	4 315	To: Process Water Dam	618 372	
	From: West Wits Pit TSF	1 107 752	To: Evaporation	482 575	
			To: Seepage	11 121	
	Total	1 112 067,28		1 112 067,28	-
#17 Winze (Underground Mine Void)	From: Dewatering	1 128 202	To: Process Water Dam	1 128 202	
	Total	1 128 202,32		1 128 202,32	-
Offices, Workshop & Change House (Satellite Areas)			To: Consumption	3 062	
	From: Rand Water	3 257	To: Municipal Sewer	163	
			To: System losses	33	
	Total	3 256,96		3 256,96	-
Total Water Balance		9 287 900,28		9 287 900,28	

5.6. Existing Stormwater Management Infrastructure

Stormwater management structures at the 1L23-25 TSFs site include the following:

- There are catchment paddocks running along the north, east and south borders of the 1L23-25 TSFs to impede and capture runoff and sediment from the side slopes; and
- There is a berm on the eastern fringe of the 1L23-25 TSFs to prevent clean water flowing into the site.

Even though there are existing infrastructures, they are not as interact (i.e., during past operations) and will need to be refurbished. Examples of stormwater infrastructure are presented in Plate 5-1 and Plate 5-2. Section 5.7 below describes the proposed SWMP for the 1L23-25, WWP reclamation sites.



Plate 5-1: Depiction of a Stormwater Channel Overgrown with Grass



Plate 5-2: Broken Pipeline Observed on Site

5.7. Stormwater Management Plan

The SWMP was designed to adhere to the GN704 regulation conditions and the Best Practise Guidelines. Figure 5-20 and Figure 5-21 indicates the proposed SWMP for the Mogale Cluster project site.

As part of the SWMP, Digby Wells proposes the following:

- A berm and drainage channel along the western (covering the South Sand dump) and southern side of the IL23-25 TSF which will report to the RWD;
- There is an existing channel along the eastern side of the IL23-25 TSF which drains to a smaller dam, it proposed that this channel is diverted to the larger RWD (see Figure 5-20);
- A dirty water channel with a berm around the plant area reporting to the pollution control dam;
- A dirty water diversion berm is recommended around the North Sand dump;
- A dirty water diversion berm around the WWP TSF site.

In order for these structures to operate optimally, they will require continuous maintenance.

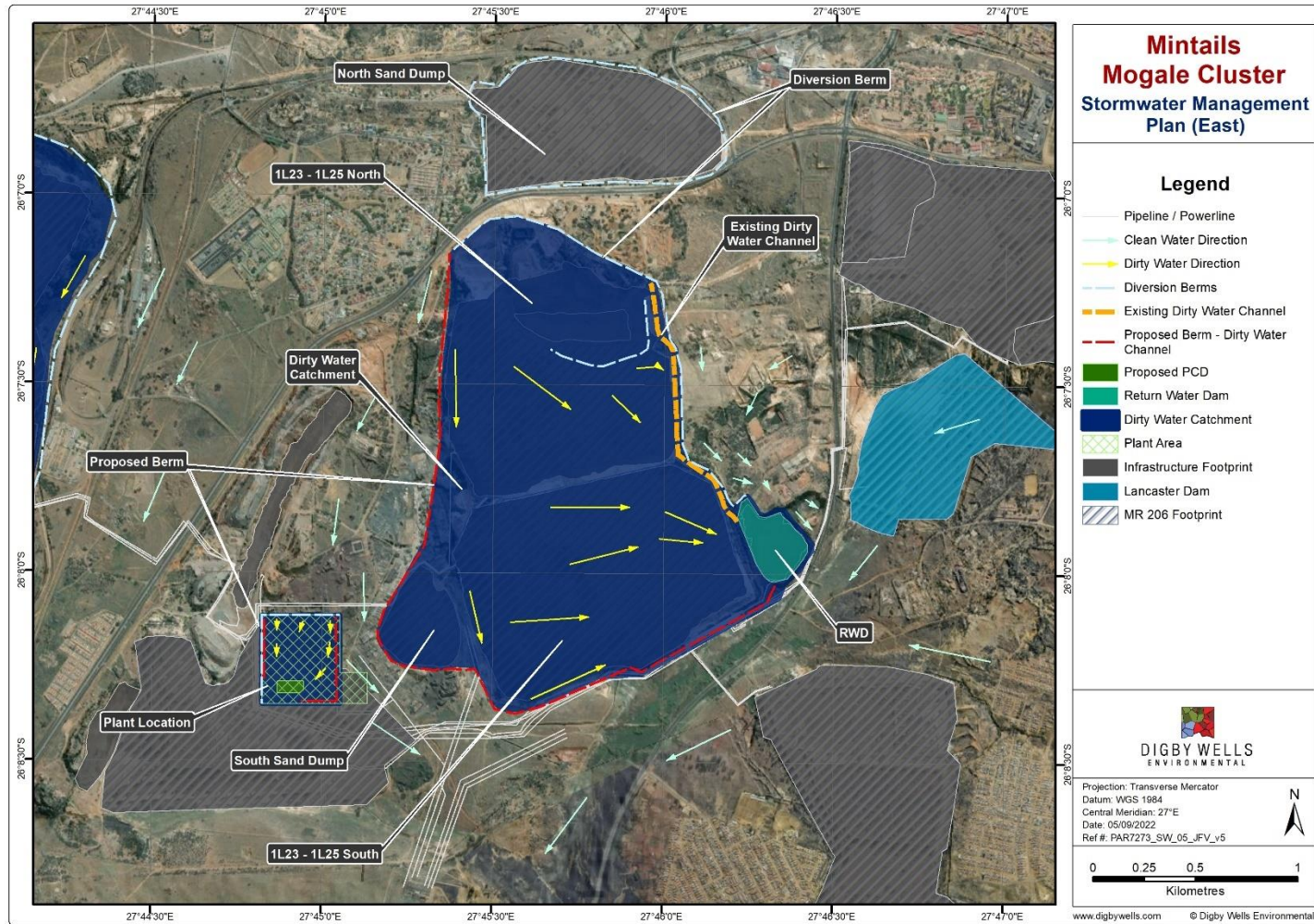


Figure 5-20: SWMP for Mintails Mogale Cluster at the IL23-25 Operation with the Proposed Structures

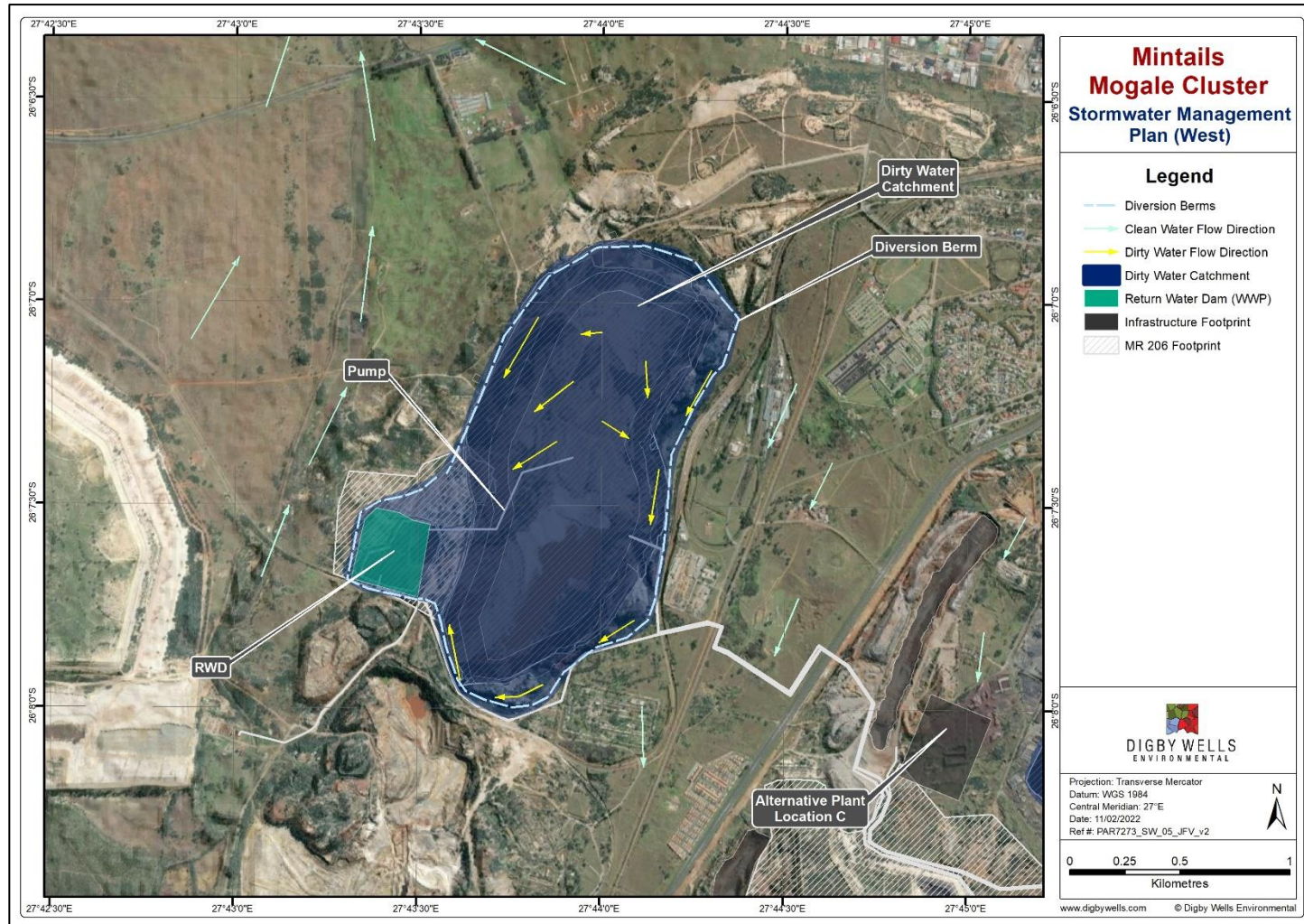


Figure 5-21: SWMP for Mintails Mogale Cluster in the West Wits Pit Operation with the Proposed Structures

5.8. Sizing of Stormwater Management Structures

As all dirty water from reclamation activities ultimately reports to the RWD, an exercise was undertaken to determine the capacity of the containment facilities in order to accommodate the 1:50 year 24-hour storm event, as required by GN704 regulations.

Storm rainfall depths for the 1:50 year 24-hour storm event was obtained from the Design Rainfall Estimation in South Africa program (Smithers and Schulze, 2002) for the six closest rainfall stations. The 1:50 year 24-hour storm depth was calculated to be **158.1 mm** (see **Section 5.4.1.1**).

The Soil Conservation Services method for South Africa (SCS-SA) was used to calculate the runoff volume for the two reclamation sites with the all the runoff reporting to the RWDs (see Figure 5-20 and Figure 5-21):

The SCS-SA storm flow depth equation is given below:

$$Q = \frac{(P - I_a)^2}{(P - I_a + S)} \quad \text{for } P > I_a$$

Where:

- Q = storm flow depth (mm);
- P = daily rainfall depth (mm), input as the 24-hour design rainfall for a given return period;
- S = potential maximum soil water retention (mm), index of the wetness of the catchments soil prior to a rainfall event; and
- I_a = Initial losses (abstractions) prior to the commencement of storm flow, comprising of depression storage, interception and initial infiltration (mm), which equals $0.1S$.

The stormflow depth produced from the above equation is multiplied by the catchment area to obtain a volume. Due to the varying ground conditions across the two reclamation sites, different Curve Number (CN) were used. CN is an index of hydrological response according to the land use (from 0 to 100). For example, a CN of 50 is characterised by good drainage and a catchment with moderate water retention.

A CN ranging between 55 and 60 were applied for the 1L23-25 and WWP sites as well as the plant area. The estimated surface runoff area for the 1L23-25 and WWP sites and the plant area is 1.19 km², 0.65 km² and 0.12 km², respectively. According to the SCS-SA calculation, the 1L23-25 and WWP RWDs would need to accommodate a 1:50 year storm volume of approximately 65 369 m³ and 41 461 m³, respectively. And the proposed PCD in the plant area would need to be approximately 6 627 m³ to accommodate a 1:50 year storm volume. These dams do not include the allowance for a 0.8 m freeboard as required by GN704. Any evaporation, seepage and outflow from the RWDs and PCD were not considered. However, the water balance set-up in Section 5.5 provides estimation of these parameters.

6. Impact Assessment

6.1. Construction Phase

Activities during the construction phase that may have potential impacts on the surface water resources are described and the appropriate management/mitigation measures are provided below in Table 6-1.

Table 6-1: Interactions and Impacts of Activity

Interaction	Impact
Site preparation including vegetation clearance and excavations, construction of processing plant and associated infrastructure; leading to exposure of soils; construction/installation of reclamation infrastructure.	Sedimentation and siltation of watercourses leading to deteriorated water quality.
Handling of chemicals and other construction material; loading, hauling and transportation of product.	Surface water contamination leading to deterioration of water quality.

6.1.1. Impact Description: Sedimentation and Siltation of Nearby Watercourses

Clearing or removal of vegetation leaves the soils prone to erosion during rainfall events, and as a result, runoff from these areas will be high in suspended solids increasing turbidity and sediment transport in the natural water resources. Dust generated during construction and vehicle movements can be conveyed into the watercourses, thereby contributing to the sedimentation and possible siltation of these water bodies. The preferred location of the plant is approximately 3 km from the nearest watercourse and delineated floodlines, and the area is not pristine. However, as indicated above, without any mitigation, construction would result in soil erosion during rainfall events.

6.1.2. Surface Water Contamination Leading to Deterioration of Water Quality

Handling of general and hazardous waste during site clearance and construction. Spillages of hydrocarbons such as oils, fuels and grease have potential to contaminate nearby water resources when washed off into rivers, streams and pans.

6.1.2.1. Management Objectives

Management objectives during the construction phase are mainly to minimize the potential contamination of receiving waterbodies as a result of siltation, spillages, and hazardous chemical leaks associated with the construction activities.

6.1.2.2. Management Actions

- If possible, construction activities must be prioritised to the dry months of the year (May to September) to limit mobilisation of sediments, dust generation from construction vehicles used during construction phase;
- Dust suppression on the haul roads and other cleared areas must be undertaken on regular basis to prevent or limit dust generation;
- Hazardous waste storage facilities must be appropriately bunded to ensure that leakages can be contained. Spill kits should be in place and construction workers should be trained in the use of spill kits to contain and immediately clean up any leakages or spills;
- Construction vehicles should regularly be maintained as per a developed maintenance program and also be inspected daily before use to ensure there are no leakages;
- Drip trays must be used to capture any oil leakages. Servicing of vehicles and machinery should be undertaken at designated hard park areas. Any used oil should be disposed of by accredited contractors;
- Ensuring implementation of a stormwater management plan to prevent the mixing of clean and dirty water; and
- Re-profiling disturbed channel geometry to allow free drainage at pipeline/river crossings.

6.1.2.3. Impact Ratings

Table 6-2 and Table 6-3 below rate the impacts for the construction phase of the reclamation project:

Table 6-2: Impact Significance Rating for the Construction Phase (Sedimentation and Siltation)

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses			
Duration	5	The impact will likely occur during construction (limited to the site)	-48 Minor (negative)
Intensity	4	Serious to medium term environmental effects	
Spatial scale	3	Impact has the potential to extend across the site and to nearby water resources.	
Probability	4	Almost certain that the impact will occur	
Post-mitigation			

Dimension	Rating	Motivation	Significance
Duration	2	The impact will only likely occur in the short term given implementation of recommended mitigation measures	-18 Negligible (negative)
Intensity	2	Minor effects on biological or physical environment are expected if silt traps and soil stabilisation procedures are followed	
Spatial scale	2	With proper management, the impact will be localized to the immediate downstream of the site	
Probability	3	There is a possibility that the impact will occur	

Table 6-3: Impact Significance Rating for the Construction Phase (Surface Water Contamination)

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination leading to deterioration of water quality			
Duration	5	The impact will likely occur for the life of the project	-55 Minor (negative)
Intensity	3	This will moderately impact the water quality and the ecosystem functionality for downstream users	
Spatial scale	3	The impacts will be localized extending across the site and downstream	
Probability	5	The impact will likely occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	18-Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact will have low intensity	
Spatial scale	2	With proper management, the impact will be localized to sites where incidents occur	
Probability	2	The possibility of the impact occurring is very low as a result of implementation of adequate mitigation measures	

6.2. Operational Phase

Activities during the operational phase that may have potential impacts on surface water resources are summarised in Table 6-4 and further described together with recommended management/mitigation measures in the following subsections.

Table 6-4: Interactions and Impact Activity

Interaction	Impact
Dust generation during the excavation and reclamation of TSFs.	Sedimentation and siltation of watercourses leading to deteriorated water quality.
Handling of hydrocarbon (oils, fuels and grease); Spillages and leakages hydrocarbons and process water from equipment and infrastructure; Runoff from the dirty water areas.	Surface water contamination by waste and deterioration of water quality.

6.2.1. Impact Description: Sedimentation and siltation of watercourses leading to deteriorated water quality

Dust generation during excavation of TSF material in preparation for reclamation processes.

6.2.2. Impact Description: Surface water contamination from hydrocarbon and chemical spillages and leakages

Operational machinery, transportation and storage at the mine site are potential sources of chemical spills and leakages. Pollution Control Dams (PCDs) breaching and overland pipeline bursts can occur. When not properly managed, chemical spills and leakages will be washed away with the runoff generated on site and thereby contaminates surface water resources within and in proximity to the project area.

6.2.2.1. Management Objectives

Management objectives during the operational phase are mainly to minimize the potential contamination of receiving waterbodies as a result of mine contaminated runoff, spillages, and hazardous chemical leaks associated with the operational activities.

6.2.2.2. Management Actions

The following mitigation measures are recommended:

- Runoff from dirty areas should be directed to the storm water management infrastructure and should not be allowed to flow into the natural environment, unless DWS discharge authorisation and compliance with relevant discharge standards as stipulated in the NWA is obtained;
- The existing water quality monitoring program should be continued for the life of the reclamation project;

- The management of general and other forms of waste must ensure collection and disposal into clearly marked skip bins that can be collected by approved contractors for disposal to appropriate disposal sites;
- Overall housekeeping and maintenance of storm water infrastructure (including berms, de-silting of dams and conveyance channels and clean-up of leaks) must be adhered to throughout the life of mine;
- Fuel and hazardous material storage areas must be located on hard-standing (paved or concrete surface that is impermeable) and bunded facilities in accordance with SANS1200 specifications. This will prevent mobilisation of leaked hazardous substances;
- Training of mine personnel and contractors in proper hydrocarbon and chemical waste handling procedures is recommended; and
- Implement an effective surface water management plan

6.2.2.3. Impact Ratings

The following tables (Table 6-5 and Table 6-6) rate the impacts for the operational phase:

Table 6-5: Impact Significance Rating for Operational Phase (Sedimentation and Siltation)

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses			
Duration	5	The impact will likely occur during operation phase	-66 Minor (negative)
Intensity	3	Discernible medium term negative environmental effects due to dust generation from TSFs	
Spatial scale	3	Localised but impact may extend across the site and to nearby water resources.	
Probability	6	Almost certain that the impact will occur	
Post-mitigation			
Duration	2	The impact will only likely occur in the short term given implementation of recommended mitigation measures	-18 Negligible (negative)
Intensity	2	Minor effects on biological or physical environment are expected if silt traps and soil stabilisation procedures are followed	

Dimension	Rating	Motivation	Significance
Spatial scale	2	With proper management, the impact will be localized to the immediate downstream of the site	
Probability	3	There is a possibility that the impact will occur	

Table 6-6: Impact Significance Rating for the Operational Phase (Surface Water Contamination)

Dimension	Rating	Motivation	Significance
Impact: Surface water contamination from hydrocarbon and chemical spillages and leakages			
Duration	5	The impact will likely occur for the duration of the operational phase	-72 Minor (negative)
Intensity	4	Moderate impacts to water quality and ecosystem functionality are expected	
Spatial scale	3	The impact may extend across the site and to nearby settlements if contaminants are washed into proximal watercourses	
Probability	6	It is most likely that the impact will occur	
Post-mitigation			
Duration	5	The impact will likely occur for the life of the project	-36 Negligible (negative)
Intensity	2	With proper management of hydrocarbon and chemicals on site the impact intensity will be low	
Spatial scale	2	With proper management, the impact will be localised to incident sites, where contaminants will quickly be cleaned up	
Probability	4	The impact may occur	

6.3. Decommissioning Phase

Activities during the decommissioning and closure phase that pose potential impacts on surface water resources are summarised in Table 6-7 and further described together with recommended management/mitigation measures in the following subsections.

Table 6-7: Interactions and Impact Activity

Interaction	Impact
Demolition of mine infrastructure (e.g., workshops, haul roads, processing plant) Disturbance of soils and erosion by overland flow.	Sedimentation and siltation of nearby watercourses and deterioration of water quality.
Removal of Potential Acid Forming (PAF) TSF material; rehabilitation and re-profiling of disturbed sites.	Improvement of streamflow regime and water quality in nearby watercourses.

6.3.1. Impact Description: Sedimentation and siltation of nearby watercourses and deterioration of water quality

During the decommissioning phase demolition of infrastructure, will cause disturbance and subsequent erosion of soils into nearby watercourses. This will result in higher rates of sedimentation and siltation in nearby streams thereby reducing their flow/storage capacities and their ability to sustain aquatic ecosystems. The quantity and quality of water for downstream water users will thus be compromised.

6.3.2. Impact Description: Improvement of streamflow regime and water quality in nearby watercourses

Positive impacts are envisaged due to removal of PAF TSF material through the gold reclamation project. Rehabilitation (re-profiling and revegetation) of disturbed landscapes will allow free drainage to downstream water users thus increasing available water.

6.3.2.1. Management Objectives

The management objectives for the decommissioning and closure phase are to minimize potential contamination of receiving waterbodies as a result of the associated decommissioning activities. Furthermore, strategic removal of surface infrastructure should be implemented so that potentially contaminated runoff is diverted away from designated clean water areas. This may be achieved by temporarily retaining stormwater infrastructure to divert dirty water from clean areas while the potentially contaminating sources are decommissioned.

6.3.2.2. Management Actions

The following mitigation measures are recommended:

- Re-profile the rehabilitated landscapes to suit desired post-mining land use as much as is practically possible;
- Immediate revegetation of cleared areas;
- Where practical, decommissioning activities should be prioritized during dry months of the year (May to September);
- Movement of demolition machinery and vehicles should be restricted to designated access roads to minimise the extent of soil disturbance and subsequent erosion;
- Use of accredited contractors for removal or demolition of infrastructure during decommissioning is recommended; this will reduce the risk of waste generation and accidental spillages; and
- Ensure that the infrastructure (e.g., pipelines, fuel storage areas) are first emptied of all residual material before decommissioning.

6.3.2.3. Impact Ratings

The following tables (Table 6-8 and Table 6-9) rate the impacts for the decommissioning and closure phases:

Table 6-8: Impact Significance Rating for Decommissioning Phase and Closure Phase (Sedimentation and Siltation)

Dimension	Rating	Motivation	Significance
Impact: Sedimentation and siltation of nearby watercourses and deterioration of water quality			
Duration	2	The impact will be short term during the decommissioning phase	-63 Minor (negative)
Intensity	4	Serious to medium term environmental effects	
Spatial scale	3	The impacts might extend across the site and to nearby streams	
Probability	7	Without appropriate mitigation, it is probable that this impact will occur	
Post-mitigation			
Duration	5	The impact will likely occur for the LoM	-36 Negligible (negative)
Intensity	2	The intensity will be low due to implementation of mitigation measures	
Spatial scale	2	The impacts will be localized to sites where demolition will be undertaken and contained by silt traps on site	

Dimension	Rating	Motivation	Significance
Probability	4	The possibility of the impact occurring is very low due to implementation of adequate mitigation measures	

Table 6-9: Impact Significance Rating for Decommissioning Phase and Closure Phase (Streamflow Regime and Water Quality)

Dimension	Rating	Motivation	Significance
Impact: Improvement of streamflow regime and water quality in nearby watercourses			
Duration	7	The impact will remain long after the life of the project	112-Major (positive)
Intensity	4	The impact leads to significant increase in the water quality of the receiving environment	
Spatial scale	5	The impact may extend across the project area and to nearby stream	
Probability	7	It is definite that this positive impact will occur (there is no mitigation for this impact)	

7. Environmental Management Plan

The environmental management plan (EMP) presented here will assist in avoiding or preventing adverse effects of the reclamation activities during the construction, operational and decommissioning phase. Potential impacts of each phase and the possible mitigation measures are presented in Table 7-1.

Table 7-1: Environmental Management Plan

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
<ul style="list-style-type: none"> Vegetation clearing; Construction of infrastructure including the culvert, haul road and diversion of the provincial road; and Loading and transportation of materials including topsoil and discard to designated dumps and stockpile areas. 	<ul style="list-style-type: none"> Sedimentation and siltation of water sources due to increased soil erosion. 	Surface Water quantity and Quality	Construction	<ul style="list-style-type: none"> Strategically clear all vegetation within the development site and limit disturbing the soil; Encourage the use of existing access roads and minimise creating new ones as to limit soil disturbances; Avoid stockpiling close to the drainage lines and construction must be done mostly during drier periods to minimise erosion; and Maintain vehicles and machinery regularly to avoid leakages. 	Control by implementing proposed stormwater management plan to minimise impacts on the environment.	During the construction phase
<ul style="list-style-type: none"> Flow of dirty water from haul roads and blasting sites; and Hydrocarbon spillages and leakages from equipment, moving heavy vehicles and machinery. 	<ul style="list-style-type: none"> Hydrocarbon contamination of water resources 	Surface Water Quality and Quantity	Operational	<ul style="list-style-type: none"> Installation of effective drainage systems with sediments filtration material is recommended to reduce siltation and sedimentation in watercourses; Ensure that water quality complies with DWS guidelines if it will be discharged to the environment; Storage facilities for hydrocarbon fuels, oils and grease must be equipped to contain leakages and spills and must be on impermeable surface (concrete or paved) and should be an enclosed area built in accordance with the SANS1200; All mining personnel must be trained and educated on proper handling and disposal of hazardous material; All operational vehicles should be maintained and washed in a single designated area and all the runoff water should be diverted to the PCD and all mine waste should be handled by a trained contractor; Water quality monitoring should be effectively implemented to ensure adherence to the stipulated water quality standards, and through this, any water quality problems arising because of the reclamation activities can be detected and dealt with early; The water requirements should be clearly stated and frequently reviewed as to not compromise the Reserve; and Recycling and reusing of water (for the reclamation) is highly recommended to reduce the abstraction of freshwater resources. 	Control by implementation of proposed SWMP and regular monitoring of water quality and quantity to minimise the negative impacts of the reclamation activities; and Regular maintenance of SWMP to ensure effective functioning of storm water structures.	During the operational phase

Activity/ies	Potential Impacts	Aspects Affected	Phase	Mitigation Measure	Mitigation Type	Time period for implementation
<ul style="list-style-type: none"> Decommissioning and removal of mine infrastructure will result in the disturbance of soils thereby accelerating soil erosion; Handling hydrocarbon material and potential leakage and spillage from moving vehicles and machinery; and Backfilling, re-profiling and revegetation of disturbed landscapes. 	<ul style="list-style-type: none"> Sedimentation and siltation of watercourses subsequently affecting water quality and flow of streams; Contamination of water resources due to chemical contamination such as hydrocarbons as result of mishandling; Contamination of water resources from decant of Acid Mine Drainage (AMD) at low-lying riverine areas; and Allowing free drainage and possible increase of streamflow regimes. 	Water Quality and Water quantity	Decommissioning	<ul style="list-style-type: none"> Soil disturbances during decommissioning should be restricted to the relevant footprint area; All decommissioning debris must be cleared as soon as practically possible, and it is recommended that demolition of infrastructure be conducted during the dry season to minimise chances of soil erosion to watercourses; Movement of heavy vehicles and machinery must be restricted to existing roads to avoid further disturbance of landscapes thus minimising soil erosion; In the event of decanting, passive treatment should be applied to neutralise and treat the AMD before being discharged back into freshwater resources. If passive treatment fails, active treatment by a conventional Water Treatment Plant should be considered; and Backfilled, top-soiled areas should be re-profiled and revegetated to allow free drainage that is close to pre-reclamation conditions. 	Monitoring of water quality and quantity post-closure; and Rehabilitation of disturbed landscapes monitoring and maintenance of rehabilitated areas until vegetation has fully been established.	During the decommissioning phase

8. Monitoring Plan

The monitoring program assists with the early detection of water contamination thereby allowing mitigation or management strategies to be implemented at an early stage, thus minimising the significance of potential impacts on water resources. Table 8-1 presents the proposed surface water monitoring plan to ensure sustainability of reclamation activities within the Mogale Cluster at the 1L23-25 and WWP TSFs and the plant area. The frequency of mitigation, timing of implementation and the responsible persons in ensuring the implementation of the EMP are indicated.

Table 8-1: Surface water monitoring plan for the proposed Project

Monitoring Element	Comment	Frequency	Responsibility
Water quality	<ul style="list-style-type: none"> • Ensure water quality monitoring as per existing baseline monitoring programme. Parameters to be analysed are indicated in Table 5-2; • All monitoring points for existing Mogale Mine which are relevant to the reclamation process should continue to be monitored. These are indicated in the monitoring plan and can be reviewed as the reclamation activities progress, if necessary; and • It is recommended to monitor water quality within the mine water dams or water containment facilities to determine the concentration levels in case of an overflow or need to discharge. 	<ul style="list-style-type: none"> • Monthly prior to construction, during construction, operation, and decommissioning phases (hydrocarbons done on a quarterly basis). • Monitoring needs to carry on five (5) years after the project has ceased, as is standard practice to detect residual impacts. 	Environmental Practitioner

Monitoring Element	Comment	Frequency	Responsibility
Water quantity	<ul style="list-style-type: none"> Flow monitoring should also be conducted on water circuits and storage dams at the mine in order to update the water balance with measured figures as reclamation activities progress. 	<ul style="list-style-type: none"> In operational areas where automatic flow meters are in place, daily records should be kept. 	Environmental Practitioner
Physical structures and Storm Water Management Plan (SWMP) performance	<ul style="list-style-type: none"> Personnel should carry out regular inspection around facilities to determine their condition and identify any anomalies such as leaks or overflows and system malfunctions. Storm water channels, paddocks and existing dams are to be inspected for siltation and blockages; Pipelines or drains should be inspected for hydraulic integrity; and The overall SWMP performance should be monitored. 	<ul style="list-style-type: none"> Continuous process and yearly formal report 	Environmental Practitioner

Monitoring Element	Comment	Frequency	Responsibility
Meteorological data	<ul style="list-style-type: none">Measure rainfall	<ul style="list-style-type: none">Real-time rainfall measurements using a tipping bucket rain gauge, if possible.Alternatively, a bulk rain gauge can be used to capture the total amount of rainfall for each event.	Environmental Practitioner

9. Conclusion and Recommendations

Water quality of water resources in proximity to TSFs indicates contamination (high acidity, elevated sulphates and TDS) including at the Lancaster Dam and upstream of the Wonderfonteinspruit and in tributaries of the Rietspruit.

Mapped results show that most of the infrastructure fall outside the delineated 1:50-year and 1:100-year floodlines. Portions of the TSF 1L23-25 South and the RWD, however, do encroach into the flood waterway of the 1:50-year and 1:100-year flood events. A berm constructed on the edges of the right riverbank at the point of contact will help to ensure separation of water resources from potentially contaminating TSF and RWD structures.

Adequate water supply for the proposed PAR Mogale Cluster project is indicated by the calculated water balance. Water supply from the Lancaster Dam, West Wits Pit and the #17 Winze was determined to be 4 842 857 m³/annum, 13 293 028 m³/annum and 13 538 428 m³/annum, respectively. This water is pumped to the Process Water Dam from where it is then pumped to the Processing Plant for gold recovery processes. Once water in the Lancaster Dam is used up, the dam will be decommissioned, and the site rehabilitated.

On average the Processing Plant will receive a total volume of 17 251 776 m³/annum from the Process Water Dam, while 175 680 m³/annum of potable water will be obtained from the Rand Water Board. The Rand Water volume will be used for gold elution and dilution of reagents. Potable water required for washing, sanitation and consumption by mine personnel and contractors in satellite areas (Offices, Workshop & Change Houses) was determined to be 39 084 m³/annum.

A volume of 131 872 m³/annum for dust suppression in access and haul roads at the project site, which is expected to come from the WWP and passively treated before being used in order to minimise contamination of watercourses and the environment within and around the project site.

The current and proposed storm water storage structures which include paddocks, berms and RWDs in the reclamation areas, should be adequate to contain storm water on site. The recommended structures include a berm and drainage channel along the western and southern boundaries of the 1L23-25 TSF. It was further proposed that diversion berms should be constructed around the North Sand dump and the WWP TSF site. In the plant area, a dirty water channel with a berm reporting to the pollution control dam would suffice to direct all the dirty water away from the clean water areas.

Generally, impacts on surface water resources resulting from the proposed gold reclamation project include potential sedimentation resulting from dust generation from reclamation activities. Spillages and leakages of hydrocarbon and general waste also pose as potential pollutant sources. Implementation of adequate storm water, erosion and sediment management measures will reduce the significance of the identified potential impacts. It is also noteworthy that this site is already impacted from AMD decant some of which emanates from the TSFs. Once the existing TSFs are removed through the proposed reclamation project

considerable reduction of pollutant sources is envisaged. An EMP and monitoring plan have been provided for the reclamation activities and if these programs are followed, potential negative effects will be highly minimised.

10. References

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11. Appendix

Appendix A: Impact Assessment Methodology

Table A1: Surface water Impact Assessment Parameter ratings

Rating	Intensity		Spatial scale	Duration	Probability
	<i>Negative Impacts</i> (Type of Impact = -1)	<i>Positive Impacts</i> (Type of Impact = +1)			
7	High significant impact on the environment. Irreparable damage to highly valued species, habitat or ecosystem. Persistent severe damage. Irreparable damage to highly valued items of great cultural significance or complete breakdown of social order.	Noticeable, on-going social and environmental benefits which have improved the livelihoods and living standards of the local community in general and the environmental features.	<u>International</u> The effect will occur across international borders.	<u>Permanent: No Mitigation</u> The impact will remain long after the life of the Project.	<u>Certain/ Definite.</u> There are sound scientific reasons to expect that the impact will definitely occur.
6	Significant impact on highly valued species, habitat or ecosystem. Irreparable damage to highly valued items of cultural significance or breakdown of social order.	Great improvement to livelihoods and living standards of a large percentage of population, as well as significant increase in the quality of the receiving environment.	<u>National</u> Will affect the entire country.	<u>Beyond Project Life</u> The impact will remain for some time after the life of a Project.	<u>Almost certain/Highly probable</u> It is most likely that the impact will occur.

Rating	Intensity		Spatial scale	Duration	Probability
	<i>Negative Impacts</i> (Type of Impact = -1)	<i>Positive Impacts</i> (Type of Impact = +1)			
5	<p>Very serious, long-term environmental impairment of ecosystem function that may take several years to rehabilitate.</p> <p>Very serious widespread social impacts. Irreparable damage to highly valued items.</p>	<p>On-going and widespread positive benefits to local communities which improves livelihoods, as well as a positive improvement to the receiving environment.</p>	<p><u>Province/ Region</u></p> <p>Will affect the entire province or region.</p>	<p><u>Project Life</u></p> <p>The impact will cease after the operational life span of the Project.</p>	<p><u>Likely</u></p> <p>The impact may occur.</p>
4	<p>Serious medium-term environmental effects. Environmental damage can be reversed in less than a year.</p> <p>On-going serious social issues. Significant damage to structures / items of cultural significance.</p>	<p>Average to intense social benefits to some people. Average to intense environmental enhancements.</p>	<p><u>Municipal Area</u></p> <p>Will affect the whole municipal area.</p>	<p><u>Long term</u></p> <p>6-15 years.</p>	<p><u>Probable</u></p> <p>Has occurred here or elsewhere and could therefore occur.</p>

Rating	Intensity		Spatial scale	Duration	Probability
	<i>Negative Impacts</i> (Type of Impact = -1)	<i>Positive Impacts</i> (Type of Impact = +1)			
3	Moderate, short-term effects but not affecting ecosystem functions. Rehabilitation requires intervention of external specialists and can be done in less than a month. On-going social issues. Damage to items of cultural significance.	Average, on-going positive benefits, not widespread but felt by some.	<u>Local</u> Extending across the site and to nearby settlements.	<u>Medium term</u> 1-5 years.	<u>Unlikely</u> Has not happened yet but could happen once in the lifetime of the Project, therefore there is a possibility that the impact will occur.
2	Minor effects on biological or physical environment. Environmental damage can be rehabilitated internally with/ without help of external consultants. Minor medium-term social impacts on local population. Mostly repairable. Cultural functions and processes not affected.	Low positive impacts experience by very few of population.	<u>Limited</u> Limited to the site and its immediate surroundings.	<u>Short term</u> Less than 1 year.	<u>Rare/ improbable</u> Conceivable, but only in extreme circumstances and/ or has not happened during lifetime of the Project but has happened elsewhere. The possibility of the impact materialising is very low as a result of design, historic experience or implementation of adequate mitigation measures.



Rating	Intensity		Spatial scale	Duration	Probability
	<i>Negative Impacts</i> (Type of Impact = -1)	<i>Positive Impacts</i> (Type of Impact = +1)			
1	Limited damage to minimal area of low significance that will have no impact on the environment. Minimal social impacts, low-level repairable damage to commonplace structures.	Some low-level social and environmental benefits felt by very few of the population.	<u>Very limited</u> Limited to specific isolated parts of the site.	<u>Immediate</u> Less than 1 month.	<u>Highly unlikely/None</u> Expected never to happen.

Table A2: Probability Consequence Matrix for Impacts

Probability	Significance																																									
	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 A3: Significance Threshold Limits

Score	Description	Rating
109 to 147	A very beneficial impact which 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 social and/or natural environment.	Minor (positive)
3 to 35	A small positive impact. The impact will result in medium to short term effects on the social and/or natural 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 social and/or natural 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 social and/or natural 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)



Score	Description	Rating
-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.	Major (negative)