Hydrological Assessment for a Proposed Railway Link at Beeshoek Iron Ore Mine

Project Number:

ENG039

Prepared for:

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DISCLAIMER

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DECLARATION OF INDEPENDENCE

I, Andy Pirie declare that:

- I act as an independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have the expertise in conducting the specialist study relevant to this application, including knowledge of the various acts, regulations and any guidelines that have relevance to the proposed project;
- I will comply with the acts, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the study;
- 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; and
- All the particulars furnished by me are true and correct.

Andy Pirie
Hydrologist
Pr.Sci.Nat (reg no. 114988)

ACRONYMS AND ABBREVIATIONS

BA	Basic Assessment
DEM	Digital Elevation Model
DWS	Department of Water and Sanitation
km	Kilometres
mamsl	metres above mean sea level
MAE	Mean Annual Evaporation
MAP	Mean Annual Precipitation
mm	Millimetres
MPRDA	Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002)
MRA	Mining Right Area
Pr.Sci.Nat.	Professional Natural Scientist
SACNASP	South African Council for Natural Scientific Professions
S-Pan	Symon's Pan
t	Tons
TFR	Transnet Freight Rail
WR 2012	Water Resources of South Africa, 2012 Study

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1 INTRODUCTION AND BACKGROUND

1.1 Terms of Reference

Hydrospatial (Pty) Ltd was appointed by EnviroGistics (Pty) Ltd to assess an area where a railway line is proposed to be constructed at the Beeshoek Iron Ore Mine (hereafter referred to as "Beeshoek" or the "Mine"). The proposed railway line will link the existing railway siding at Beeshoek to the existing Transnet Freight Rail (TFR) line. The purpose of the assessment was to determine whether the proposed railway link route will impact on any watercourses.

This report has been prepared for a Basic Assessment (BA) which forms part of an environmental authorisation process for the proposed railway link.

1.2 Project Location

The proposed railway link is located within the Beeshoek Mining Right Area (MRA), approximately 9 kilometres (km) north-west of the town of Postmasburg in the Northern Cape Province (Figure 1-1). The Mine is divided into two areas that are separated by the R385 regional road that runs in a north-westerly direction between the towns of Postmasburg and Olifantshoek. The North Mine is located to the north of the R385, whilst the South Mine is located to the south.

1.3 Project Description

Mining at the Beeshoek was established in 1964 with a basic hand sorting operation. In 1975 a full Washing and Screening Plant was installed. Because of increased production, Beeshoek South, a southern extension of the Beeshoek Mine, was commissioned during 1999 on the farms Beesthoek and Olynfontein.

Assmang (Pty) Ltd is the holder of the new order rights in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) in respect of high-grade hematite iron ore deposits at Beeshoek on the farms Beesthoek and Olynfontein. The mining method currently entails an opencast mining operation, which consists of five (5) active opencast pits (Village Opencast Pit, HF Opencast Pit, BF Opencast Pit, East Opencast Pit, BN Opencast Pit). Although other opencast pits are dormant at this time, these are continuously assessed in terms of their economic value for intended remining. The current resources of the mine is approximately 87 million tonnes with a reserve of about 26 million tonnes.

Beeshoek can be broadly categorised as follows:

- Northern mining area (North Mine): This area comprises active as well as historical mining areas. A number of small quarries and mine residue dumps of various categories are located within this area. The area also includes the Iron Ore Beneficiation Plant, Slimes Dam, as well as the Beeshoek North Opencast Pit (BN Opencast Pit).
- Main Offices, Village (demolished) and recreational area; and
- Southern mining area (South Mine): This area comprises of large opencast pits and associated Waste Rock Dumps (WRDs). The Village Opencast Pit and associated

WRD are the main activities in this area. This area also includes a crushing and screening area as pre-preparation of the run of mine iron ore before being routed by overland conveyor to the Iron Ore Beneficiation Plant located at North Mine.

In order to allow Beeshoek to export iron ore through the Saldanha Port in the Western Cape Province, a railway line that links the existing siding at the Mine to the existing TFR line is required. The proposed railway will comprise a 2.8 km main link line from the existing TFR Postmasburg line, crossing under the R385 regional tar road before linking to the existing TFR Yard that services Kolomela Mine. A gravel service road will be constructed within the planned link line servitude to allow for access where required. The project requirements will include:

- Overall Design:
  - Railway formation – 5.5 m;
  - Bulk fill – 5 m;
  - One service road – 4 m; and
  - Buffer – 8 m on each side.
- TFR train design:
  - 348 wagons (3 x 116 rakes); and
  - 30 ton (t) axle load.
- Beeshoek Traffic:
  - 1 x 116 rake (Saldanha traffic); and
  - 30 t axle loads.

1.4 Details of the Specialist

The study was undertaken by Andy Pirie who is a senior surface water hydrologist at Hydrospatial (Pty) Ltd. Andy graduated with a Master of Science in Water Resource Management (cum laude). He is registered as a Professional Natural Scientist (Pr.Sci.Nat) (registration number: 114988) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). Work experience includes rainfall – runoff modelling, floodline determinations, stormwater management plans, water and salt balance modelling, setup of water monitoring networks and programmes, analysis of surface water quality and quantity, and surface water specialist studies for environmental and social impact assessments. He has worked on projects in South Africa, Cameroon, Senegal, Mali, Democratic Republic of the Congo, Botswana, Zambia and Namibia. A curriculum vitae is provided in Appendix A.

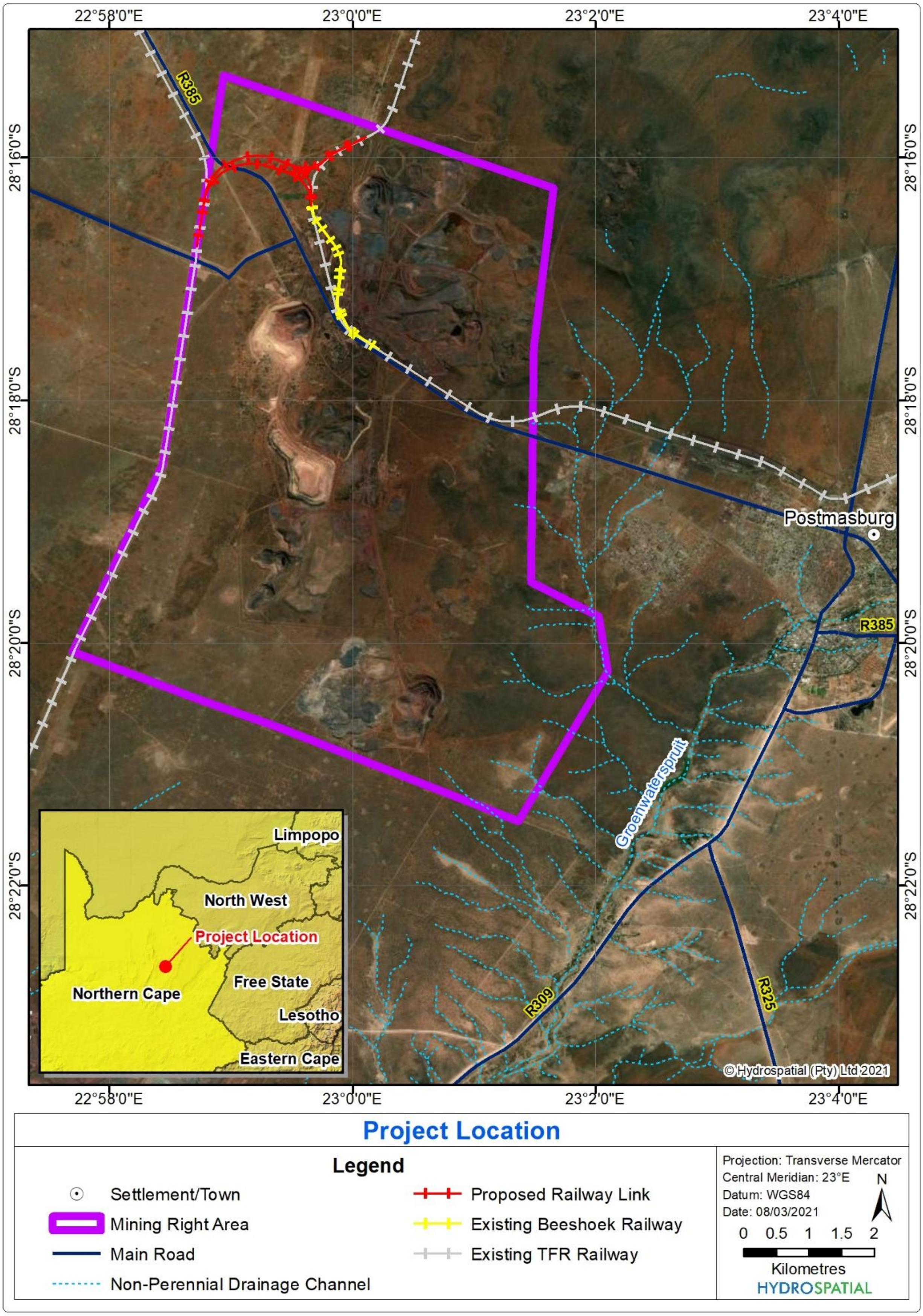

Figure 1-1: Location of the project

2 METHODOLOGY AND SCOPE OF WORK

The methodology and scope of work included the following:

2.1 Desktop Assessment of Contours

Detailed 0.5 m contours of the Beeshoek MRA was provided by the Mine. The contours were converted into a 0.5 m spatial resolution Digital Elevation Model (DEM). The DEM was assessed for any depressions that may be watercourses within the vicinity of the proposed railway link.

2.2 Site Investigation

An initial site investigation visit of the proposed railway link area was undertaken on 26 October 2020. A further site investigation was undertaken on 3 February 2021, due to a change in the railway link route. The purpose of the site investigations was to conduct a walkthrough the railway route, to assess whether any watercourses would be impacted by the construction and operation of the railway.

2.3 Impact Assessment

The impact assessment methodology used to rate the potential surface water impacts pre- and post-mitigation is provided below. The evaluation of impacts is conducted in terms of the criteria detailed in Table 2-1 to Table 2-6. The various impacts of the project are discussed in terms of impact status, extent, duration, probability and intensity. Impact significance is the sum of the impact extent, duration, probability and intensity, and a numerical rating system is applied to evaluate impact significance. Therefore, an impact magnitude and significance rating is applied to rate each identified impact in terms of its overall magnitude and significance in Table 2-6. The various components of impact methodology are discussed below.

2.3.1 Impact Status

The nature or status of the impact is determined by the conditions of the environment prior to construction and operation. The nature of the impact can be described as negative, positive or neutral (Table 2-1).

Table 2-1: Impact status

Rating	Description	Quantitative Rating
Positive	A benefit to the receiving environment.	P
Neutral	No cost or benefit to the receiving environment.	-
Negative	A cost to the receiving environment.	N

2.3.2 Impact Extent

The extent of an impact is considered as to whether impacts are either limited in extent or affects a wide area. Impact extent can be site-specific (within the boundaries of the development area), local, regional or national and/or international (Table 2-2).

Table 2-2: Extent of the impact

Rating	Description	Quantitative Rating
Low	**Site-specific**; occurs within the site boundary.	1
Medium	**Local**; extends beyond the site boundary; affects the immediate surrounding environment (i.e. up to 5 km from the project site boundary).	2
High	**Regional**; extends far beyond the site boundary; widespread effect (i.e. 5 km and more from the project site boundary).	3
Very High	**National and/or international**; extends far beyond the site boundary; widespread effect.	4

2.3.3 Impact Duration

The duration of the impact refers to the time scale of the impact or benefit (Table 2-3).

Table 2-3: Duration of the impact

Rating	Description	Quantitative Rating
Low	**Short-term**; quickly reversible; less than the project lifespan; 0 – 5 years.	1
Medium	**Medium-term**; reversible over time; approximate lifespan of the project; 5 – 17 years.	2
High	**Long-term**; permanent; extends beyond the decommissioning phase; >17 years.	3

2.3.4 Impact Probability

The probability of the impact describes the likelihood of the impact actually occurring (Table 2-4).

Table 2-4: Probability of the impact

Rating	Description	Quantitative Rating
Improbable	Possibility of the impact materialising is negligible; chance of occurrence <10%.	1
Probable	Possibility that the impact will materialise is likely; chance of occurrence 10 – 49.9%.	2
Highly Probable	It is expected that the impact will occur; chance of occurrence 50 – 90%.	3
Definite	Impact will occur regardless of any prevention measures; chance of occurrence >90%.	4
Definite and Cumulative	Impact will occur regardless of any prevention measures; chance of occurrence >90% and is likely to result in in cumulative impacts.	5

2.3.5 Impact Intensity

The intensity of the impact is determined to quantify the magnitude of the impacts and benefits associated with the proposed project (Table 2-5).

Table 2-5: Intensity of the impact

Rating	Description	Quantitative Rating
Maximum Benefit	Where natural, cultural and / or social functions or processes are positively affected resulting in the maximum possible and permanent benefit.	+5
Significant Benefit	Where natural, cultural and / or social functions or processes are altered to the extent that it will result in temporary but significant benefit.	+4
Beneficial	Where the affected environment is altered but natural, cultural and / or social functions or processes continue, albeit in a modified, beneficial way.	+3
Minor Benefit	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are only marginally benefited.	+2
Negligible Benefit	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are negligibly benefited.	+1
Neutral	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are not affected.	0
Negligible	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are negligibly affected.	-1
Minor	Where the impact affects the environment in such a way that natural, cultural and / or social functions or processes are only marginally affected.	-2
Average	Where the affected environment is altered but natural, cultural and / or social functions or processes continue, albeit in a modified way.	-3
Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will temporarily cease.	-4
Very Severe	Where natural, cultural and / or social functions or processes are altered to the extent that it will permanently cease.	-5

2.3.6 Impact Significance

The impact magnitude and significance rating is utilised to rate each identified impact in terms of its overall magnitude and significance (Table 2-6).

Table 2-6: Impact magnitude and significance rating

Impact	Rating	Description	Quantitative Rating
Positive	**High**	Of the highest positive order possible within the bounds of impacts that could occur. +	+12 to -16
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. Other means of achieving this benefit are approximately equal in time, cost and effort	+6 to -11
	Low	Impacts is of a low order and therefore likely to have a limited effect. Alternative means of achieving this benefit are likely to be easier, cheaper, more effective and less time-consuming	+1 to –5
No Impact	No Impact	Zero Impact	
Negative	**Low**	Impact is of a low order and therefore likely to have little real effect. In the case of adverse impacts, mitigation is either easily achieved or little will be required, or both. Social, cultural, and economic activities of communities can continue unchanged.	-1 to -5
	Medium	Impact is real, but not substantial in relation to other impacts that might take effect within the bounds of those that could occur. In the case of adverse impacts, mitigation is both feasible and fairly possible. Social cultural and economic activities of communities are changed but can be continued (albeit in a different form). Modification of the project design or alternative action may be required	-6 to -11
	High	Of the highest order possible within the bounds of impacts that could occur. In the case of adverse impacts, there is no possible mitigation that could offset the impact, or mitigation is difficult, expensive, time-consuming or a combination of these. Social, cultural and economic activities of communities are disrupted to such an extent that these come to a halt.	-12 to -17

3 HYDROLOGICAL SETTING

3.1 Climate

Rainfall data for the period of 1920 – 2010 was obtained from the Postmasburg weather station (0321110 W), whilst Symon's Pan (S-Pan) evaporation data was obtained from the Olifantshoek Dam weather station (D4E002), and was available for the period of 1960 – 2000.

Figure 3-1 indicates the mean monthly rainfall and evaporation of the area. Majority of the rainfall occurs over the summer months of November to April, with February and March being the highest rainfall months. Although much higher than rainfall, evaporation follows a similar trend, with the warmer summer months of September to March having the highest evaporation. The Mean Annual Precipitation (MAP) of the area is 317 mm, whilst the Mean Annual Evaporation (MAE) is 2 213 mm. The area can be described as having a semi-arid to arid climate, with evaporation far exceeding rainfall.

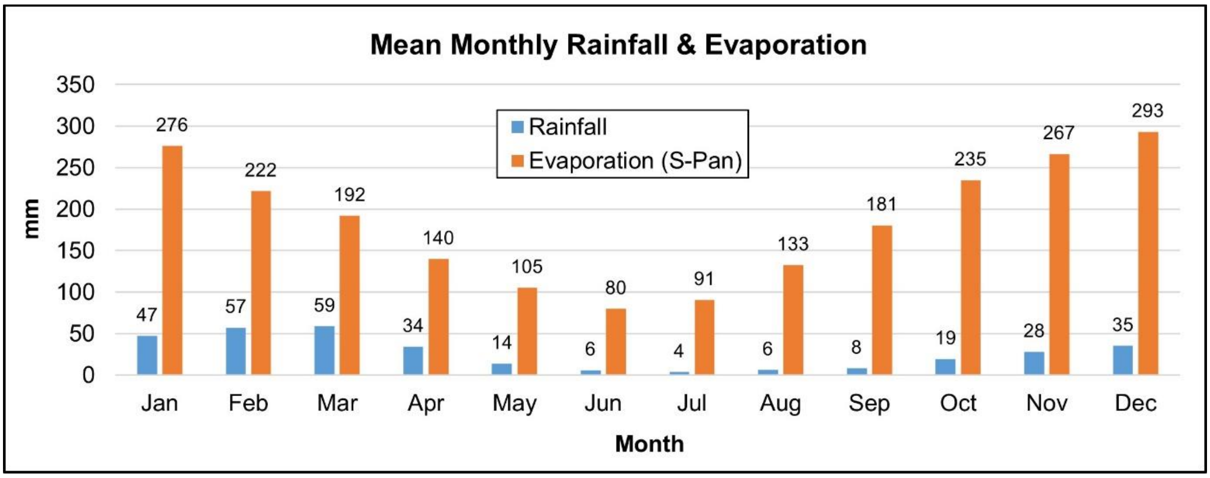

Figure 3-1: Mean annual rainfall and evaporation for the area

3.2 Regional Catchments

Beeshoek is located in quaternary catchment D73A within the Vaal Water Management Area. According to the Water Resources of South Africa Study 2012 (WR 2012), quaternary catchment D73A is endoreic, meaning that surface water runoff does not flow out of the catchment, and that water is lost to evaporation and infiltration. This is mostly due to the low rainfall and high evaporation of the area.

3.3 Topography

The topography of the proposed railway link dips very gradually in an east to west direction, with the elevation varying from 1 319 metres above mean sea level (mamsl) on the eastern side of the railway link, to 1 302 mamsl in the west (Figure 3-2). This equates to a slope of less than 1 %, which can be considered flat terrain. A seasonal depression as well as excavated areas (which appear to be borrow pits) occur within the general vicinity of the railway link, and are discussed in further under the findings of this report.

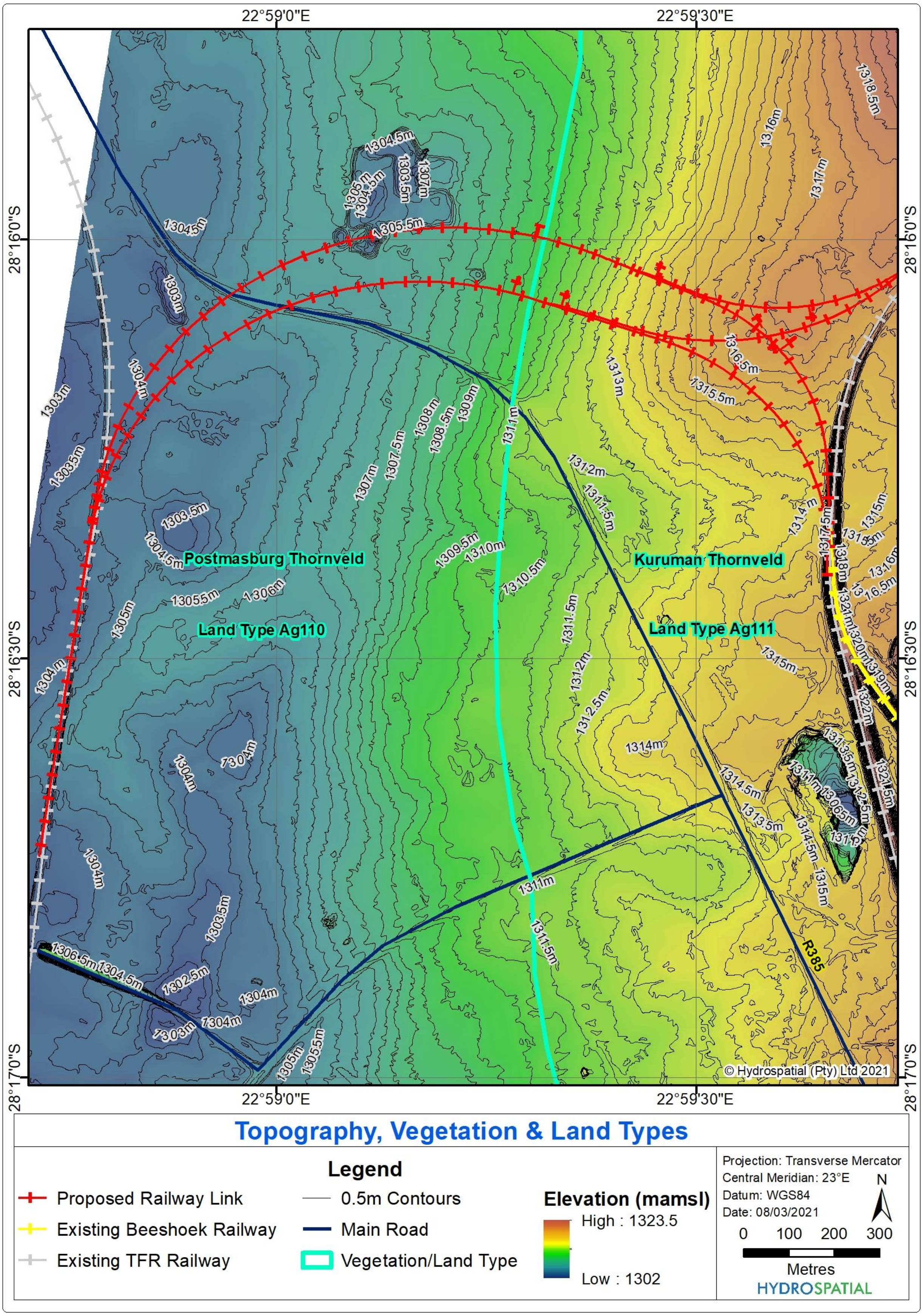

Figure 3-2: Topography, vegetation and Land Types

3.4 Vegetation and Soils

According to Mucina and Rutherford (2006), two vegetation types split the railway link in two, namely, Postmasburg Thornveld to the west and Kuruman Thornveld to the east (Figure 3-2). These vegetation types are characterised by shrubby vegetation. Following the same boundary as the vegetation, the railway link falls over two Land Types, namely, Ag110 to the west and Ag111 to the east. According to the Land Type database (Land Type Survey Staff, 1972 - 2006), these Land Types are dominated by Hutton and Mispah soils, that are generally shallow, and semi-permeable to permeable in nature.

3.5 Surface Water and Groundwater

The nearest defined watercourse to the Mine is the Groenwaterspruit (EnviroGistics, 2018), which is located approximately 1.5 km east of the south-eastern MRA boundary. As previously mentioned, Beeshoek falls within an endoreic quaternary catchment, and therefore, very little to no surface water is expected to be generated.

Groundwater levels in the vicinity of the railway link vary from 1 290 mamsl to 1 310 mamsl (GPT, 2021), which is approximately 10 m to 30 m below ground level.

4 FINDINGS

Features located within the vicinity of the proposed railway link are indicated on Figure 5-1. The desktop assessment of contours and site investigation findings revealed the following:

- A number of man-made excavated areas that appear to be old borrow pits occur within the vicinity of the proposed railway;
- An artificial drainage channel, that begins at a culvert where the proposed railway link ties into the existing Beeshoek Railway, and flows in a westerly direction, has been created due to what appears to be a leaking pipe. Should the leak be fixed, then this drainage channel would cease to exist; and
- A seasonal / ephemeral depression is located approximately 125 m east of the point where the proposed railway link ties into the existing TFR railway line. According to the Wetland Specialist, although one floral species associated with wetlands was found, the soils did not show any morphological characteristics consistent with wetland conditions, and therefore, the depression was classified as a seasonal / ephemeral depression and not a wetland. More details can be found in the wetland assessment.

Based on the above, it can be concluded that there are no natural watercourses within the vicinity of the proposed railway link.

5 IMPACT ASSESSMENT

The potential surface water impacts pre- and post-mitigation for the construction, operational and decommissioning and closure phases are provided in Table 5-1.

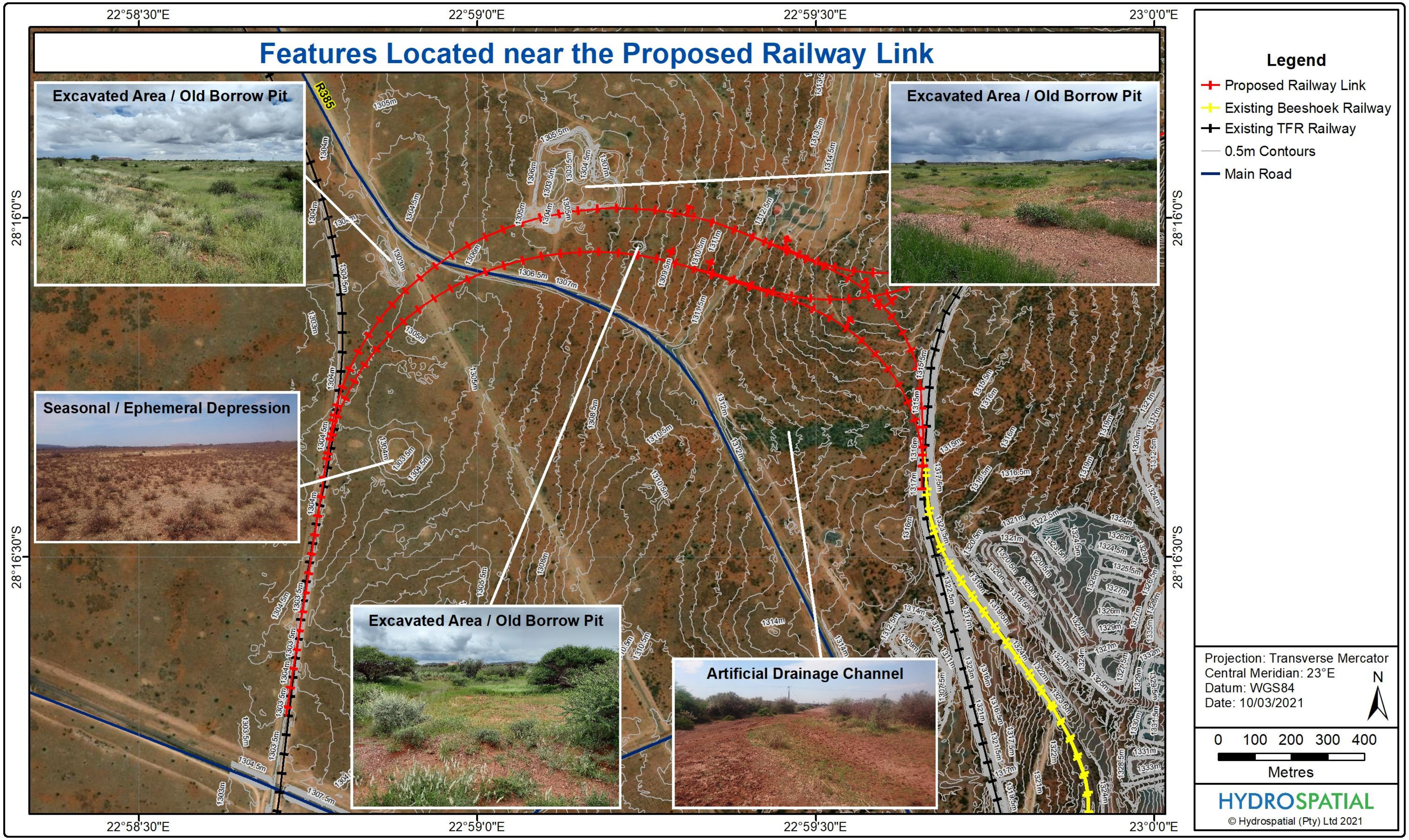

Figure 5-1: Features located near the proposed railway link

Table 5-1: Impact assessment and mitigation measures

Phase	Activity	Impact Description	Pre-Mitigation					Mitigation/Management Measures & Recommendations	Post-Mitigation				
			Extent	Duration	Probability	Intensity	Significance		Extent	Duration	Probability	Intensity	Significance
Construction Phase	Removal of vegetation for the railway link and service roads. Stripping and stockpiling of topsoils. Construction of a potential railway embankment.	Erosion of exposed soils leading to siltation and sedimentation of downslope drainage channels.	Local (2)	Short-term (1)	Probable (2)	Minor (-2)	Medium (-6 to -11)	Vegetation clearance should be kept to an absolute minimum. Temporary erosion measures should be employed at exposed areas. Exposed areas should be vegetated as soon as possible. The topsoil stockpiles must be managed according to a topsoil management plan and should be vegetated. Should a railway embankment be constructed, then the side slopes should not be steep (i.e. slopes should not be less than a 1:3 slope). The railway embankment should be vegetated as soon as possible.	Site-specific (1)	Short-term (1)	Improbable (1)	Negligible (-1)	Low (-1 to -5)
Construction Phase	Use of heavy machinery, trucks and vehicles for construction purposes.	Potential hydrocarbon spillages washed into downslope drainage channels.	Local (2)	Short-term (1)	Probable (2)	Average (-3)	Medium (-6 to -11)	Machinery, trucks and vehicles must be well maintained and serviced regularly as per a recommended service guide. Refuelling must be undertaken over hard park bunded areas that adequately sized to capture and contain spillages. Machinery and vehicles should be parked on appropriately lined areas. Drip trays must be employed under stationary machinery. Spillages should be reported immediately, and spill kits should be readily available at all times.	Site-specific (1)	Short-term (1)	Improbable (1)	Negligible (-1)	Low (-1 to -5)

Phase	Activity	Impact Description	Pre-Mitigation					Mitigation/Management Measures & Recommendations	Post-Mitigation				
			Extent	Duration	Probability	Intensity	Significance		Extent	Duration	Probability	Intensity	Significance
Construction Phase	Construction of a potential railway embankment.	Cutting off of the natural drainage of the area leading to the ponding of water.	Local (2)	Long-term (3)	Highly Probable (3)	Average (-3)	Medium (-6 to -11)	Implementation of suitably sized culverts at appropriate positions along the railway embankment to ensure effective drainage.	Site-specific (1)	Medium-term (2)	Improbable (1)	Negligible (-1)	Low (-1 to -5)
Operational Phase	Build-up of sediment and debris at culverts.	Cutting off of the natural drainage of the area leading to the ponding of water.	Local (2)	Long-term (3)	Highly Probable (3)	Average (-3)	Medium (-6 to -11)	Regular inspections and clearing of culverts particularly after high rainfall events.	Site-specific (1)	Medium-term (2)	Improbable (1)	Negligible (-1)	Low (-1 to -5)
Closure & Decommissioning Phase	Removal and rehabilitation of the railway link and associated infrastructure.	The removal of the railway link and associated infrastructure can potentially result in exposed soils that can be washed into downslope drainage channels. If rehabilitation is not done correctly in terms of removing any barriers (e.g., railway embankment), then ponding of water could become a long-term issue.	Local (2)	Long-term (3)	Highly Probable (3)	Average (-3)	Medium (-6 to -11)	Temporary erosion measures should be employed at exposed areas. Barriers such as the railway embankment should be removed, and the topography should be returned to its former state. Exposed areas should be vegetated as soon as possible. The topsoil stockpiles should be used to fill in areas and to create a suitable substrate to re-vegetate areas.	Site-specific (1)	Medium-term (2)	Improbable (1)	Negligible (-1)	Low (-1 to -5)

6 CONCLUSIONS AND RECOMMENDATIONS

A desktop assessment, two site investigations and a surface water impact assessment were undertaken to assess the impact of the proposed railway on the surface water hydrology of the area.

The proposed railway link is located in a flat area that has a semi-arid to arid climate. Quaternary catchment D73A, in which the railway link is proposed to be located, is endoreic, and therefore, very little surface water is expected to be generated.

The desktop assessment of contours and site investigation findings revealed that there are no natural watercourses near the proposed railway link.

The impact assessment indicated that all potential impacts can be mitigated to a low significance.

From a surface water hydrological perspective, it is the opinion of the specialist that the proposed railway link can be implemented, provided that the proposed mitigation measures are adhered to.

7 REFERENCES

EnviroGistics. 2018. Integrated Water and Waste Management Plan Update.

GPT. 2021. Hydrogeological Impact Assessment for Beeshoek Mine.

Land Type Survey Staff. 1972 - 2006. Land types of South Africa; Digital Map (1:250 000 scale) and Soil Inventory Database. Pretoria: ARC-Instatute for Soil, Climate, and Water.

Mucina L. and Rutherford M.C. 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute. Pretoria.

Water Resources of South Africa, 2012 Study (WR 2012). WRC Project No. K5/2143/1).

APPENDIX A: CURRICULUM VITAE

Curriculum Vitae – Andy Pirie – Hydrologist

Details

Name and Surname:	Andy Pirie
Occupation:	Senior Hydrologist
Company:	Hydrospatial (Pty) Ltd
Address:	17 Sonop Place, Randpark, Johannesburg, 2194
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Andy Pirie is a senior hydrologist at Hydrospatial (Pty) Ltd. Andy graduated with a Master of Science (M.Sc.) in Water Resource Management (cum laude). He is registered as a Professional Natural Scientist (Pr.Sci.Nat.) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). He has worked on projects in South Africa, Cameroon, Senegal, Mali, Democratic Republic of the Congo (DRC), Botswana, Zambia and Namibia, for clients such as Assmang, Anglo American, Randgold Resources (now Barrick Gold), Sibanye-Stillwater, Birimian, Exxaro, Sasol, Eskom, Assore and SAFCOL. He has more than 9 years' experience in hydrological assessments and Geographical Information Systems (GIS). His expertise include the following:

- Floodline determinations;
- Mine water and salt balance modelling;
- Stormwater management plans;
- Surface water quality monitoring and assessment;
- Rainfall - runoff modelling;
- Catchment yield assessments;
- Sizing of dams and channels;
- Crop irrigation requirement calculations;
- Environmental flow requirement assessments;
- Surface water impact assessments; and
- GN704 Regulation audits.

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Email: andy@hydrospatial.co.za

Education

- 2013: M.Sc. Water Resource Management (cum laude) (University of Pretoria).

Membership in Professional Associations

- Registered as a Professional Natural Scientist (Pr.Sci.Nat.) in Water Resources Science with the South African Council for Natural Scientific Professions (SACNASP). Registration number: 114988.

Employment

- March 2018 – Present: Senior Hydrologist at Hydrospatial (Pty) Ltd.
- June 2012 – February 2018: Hydrologist and GIS specialist at Digby Wells Environmental.

Selected Project Experience

Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng / North-West Province	Sibanye Gold	Hydrological Study for the Sibanye Driefontein Operations EMP and WULA Update	• Baseline hydrological assessment. • Water quality assessment. • Stormwater management plan update. • Water and salt balance update. • GN704 and GN509 exemption assessment.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	African Realty Trust	Hydrological Opinion on an Unsuccessful Water Use Licence Application for Two Proposed Balancing Dams at Letaba Estates	• Letaba catchment water resource assessment. • Catchment runoff modelling using the Pitman model. • Assessment of the impact of the dams on the Letaba catchment hydrology. • Testimony at the Water Tribunal hearing.

Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	SAFCOL	Streamflow Reduction Modelling due to Genus Exchange of Eucalyptus for Pine at the SAFCOL Berlin Plantations	• Setup of the WRSM/Pitman model. • Calculation of the allowable genus exchange area using the Gush Tables. • Reporting. • Presentation of study and hand over of reports.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	Transvaal Gold Mining Estates	Hydrological Study for the Proposed Theta Mine Project	• Calculation of the water use freed up through the proposed removal of pine, eucalyptus and wattle in the Blyde River catchment for an offset strategy for the mine. • Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis. • Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Development of a water balance model. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling to determine the 1:50 and 1:100 year floodlines. • Reporting.

Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo, South Africa	Lunsklip Farming	Hydrological Study for the Lunsklip Irrigation Dam	• Catchment runoff modelling using the WRSM/Pitman model which included afforested areas. • Calculation of the farm irrigation requirements. • Quantification of the irrigation dam water balance.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Mpumalanga South Africa	Anglo American	Surface Water Assessment for the Proposed Leslie 1 Coal Mine	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis. • Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Development of a water balance model. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling to determine the 1:50 and 1:100 year floodlines. • Reporting.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assmang	GN704 Legal Compliance Audit of the Dwarsrivier Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.

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Company	Position	Project Location	Client	Project	Responsibilities
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assmang	Floodline Determination for the Resource and Reserve Drilling Project at the Dwarsrivier Chrome Mine	• Catchment delineation. • Hydrological assessment to calculate the 1:50 and 1:100 year peak flows. • Hydraulic modelling of 18 river reaches to determine the 1:50 and 1:100 year flood water elevations.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assore	GN704 Legal Compliance Audit of the Rustenburg Minerals Development Company Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng South Africa	Fry's Metals	Stormwater Management Plan for the Fry's Metal Factory	• Audit of site stormwater infrastructure. • Calculation of peak flows and stormwater volumes. • Calculation of stormwater channel capacities to assess whether capacities comply with regulatory requirements.
Hydrospatial (Pty) Ltd	Senior Hydrologist	North West South Africa	Assore	Hydrological Study for the Wonderstone Mine	• Baseline hydrological study. • Surface water impact assessment. • Water quality Assessment. • Development of a stormwater. management plan. • River diversion assessment.
Hydrospatial (Pty) Ltd	Senior Hydrologist	KwaZulu-Natal, South Africa	The Biodiversity Company	Water Quality Monitoring and Assessment for the Edendale	• Setup of a water monitoring network. • Surface water sampling. • Assessment of water quality results.

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				Bulwer Housing Development	
Hydrospatial (Pty) Ltd	Senior Hydrologist	Gauteng South Africa	Eskom	Hydrological Assessment of a Tributary of the Braamfonteins pruit near Sandton, Johannesburg	• Site assessment. • Peak flow calculations. • Storm event assessment. • Hydraulic structure assessment. • Assessment of gabion retaining wall failure. • Hydraulic modelling of watercourse.
Hydrospatial (Pty) Ltd	Senior Hydrologist	Limpopo South Africa	Assore	GN704 Legal Compliance Audit of the Zeerust Chrome Mine	• Site audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704 regulations.
Digby Wells Environmental	Hydrologist	Mali	Birimian	Hydrological Study for the Environmental and Social Impact Assessment for the Goulamina Lithium Project	• Baseline hydrological study. • Development of a water and salt balance. • Modelling of catchment flood hydrology. • Calculation of storm rainfall depths. • Stormwater management plan. • Surface water impact assessment.
Digby Wells Environmental	Hydrologist	Senegal	Randgold Resources	Hydrological Study for the Randgold Massawa Gold Project ESIA	• Baseline hydrological study. • Floodline determination. • Development of a water and salt balance. • Modelling of catchment hydrology. • Environmental flow requirement calculations. • Stormwater

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					management plan. • Surface water impact assessment.
Digby Wells Environmental	Hydrologist	Cameroon	Caminex SA	Hydrological Study for the Environmental and Social Impact Assessment for the Ntem Iron Ore Project	• Baseline hydrological study. • Surface water impact assessment.
Digby Wells Environmental	Hydrologist	Gauteng South Africa	Sibanye-Stillwater	Sibanye Gold Millsite TSF Reclamation Project EIA	• Audit of existing stormwater management controls. • Development of a stormwater management plan to satisfy GN704 Regulation requirements. • Development of a stormwater control monitoring programme. • Water conservation and water demand management plan
Digby Wells Environmental	Hydrologist	Gauteng South Africa	Sibanye-Stillwater	Sibanye Gold Kloof Floodline Determination	• Site visit to assess channel and floodplains and to measure hydraulic structures. • DEM creation from lidar dataset. • Catchment delineation. • Catchment assessment of soils, vegetation, slope and land cover to obtain suitable runoff coefficients. • Calculation of peak flows using Rational and SDF methods. • Hydraulic modelling in HEC-RAS for approximately 25 river reaches to determine the 1:50

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					and 1:100 year surface water elevations.
Digby Wells Environmental	Hydrologist	Free State South Africa	Bothma and Son Transport	Stormwater management plan for the Bothma Sand Mine	• Audit of existing stormwater management structures. • Rainfall assessment. • Sizing of channels. • Development of a stormwater management plan to satisfy GN704 conditions. • Development of a stormwater structure monitoring programme. • Development of a PCD rehabilitation action plan. • Reporting.
Digby Wells Environmental	Hydrologist	Free State South Africa	Sasol Mining	Sasol Defunct Mines Surface Flow Analysis	• Project manager. • Creation of detailed DEMs from Lidar data for 4 of Sasol's defunct subsided collieries. • Modelling of surface water flow directions and accumulations to determine areas that are not free draining.
Digby Wells Environmental	Hydrologist	Gauteng South Africa	DRD Gold	DRD Gold Stormwater Management Plans for the Ergo Elsburg & Van Dyk Tailings Dams	• Project manager. • Site visit audit of stormwater management structures. • Flood peak calculations. • Stormwater structure sizing. • Management measures to ensure that stormwater structures are maintained. • Reporting.

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Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Exxaro	Exxaro Surface Water Study for the Environmental Authorisation for the Proposed Schoonoord Underground Mine, Arnot Coal, Mpumalanga	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and analysis of results. • Setup of a water monitoring network and programme. • Stormwater structure placement and sizings of structures. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling using the HEC-RAS model to determine the 1:50 and 1:100 year floodlines. • Reporting.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	Exxaro	Exxaro Floodline Determination for the Closure Environmental Management Plan for the Tshikondeni Coal Mine	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment characteristics, methods and results obtained.

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Digby Wells Environmental	Hydrologist	Botswana, Zambia and Namibia	Botswana Government	Kazungula Bridge Project Surface Water Quality Monitoring	• Setup of a water quality monitoring network and programme. • Monthly water sampling from the Zambezi and Chobe Rivers over a 6 year period to determine whether the construction and operation of the Kazungula Bridge is impacting on the water quality. • Analysis of water quality results. • Monthly monitoring reports describing the water quality for the month and identifying possible sources of pollution as well as providing mitigation measures.
Digby Wells Environmental	Hydrologist	Free State South Africa	Sibanye-Stillwater	Sibanye Beatrix ESIA	• Baseline hydrological study. • Surface water impact assessment. • Water quality and trend analysis.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Anker Coal	Anker Coal Elandsfontein Colliery Stormwater Management Plan	• Site visit audit of stormwater structures. • Review of existing stormwater management plan. • Recommendations for the improvement of existing stormwater management plan
Digby Wells Environmental	Hydrologist & GN704 Auditor	Northern Cape, South Africa	Assmang	GN704 Legal Compliance Audit for the Khumani Iron Ore Mine	• Project manager. • Preparation of an audit checklist. • Audit of the mine to GN704 regulations. • Reporting on findings and recommendations for improvement to comply with GN704

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					regulations.
Digby Wells Environmental	Hydrologist	Okavango, Botswana	Botswana Government	Mohembo Bridge Surface Water Baseline and Monitoring Programme	• Setup of a surface water quality monitoring network and programme. • Surface water quality sampling and analysis of results. • Analysis of streamflows from the Mohembo discharge gauging station. • Climate assessment.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Sasol Mining	Sasol Surface Water Study for the Environmental Authorisation for the Imvula Coal Mining Project	• Baseline hydrological study. • Surface water impact assessment. • Terrain modelling and catchment delineation using ArcGIS software. • Land cover and soil hydrological assessment. • Surface water report writing and compilation.
Digby Wells Environmental	Hydrologist	North-west South Africa	Sun International	Sun City Drinking Water Quality Analysis	• Sampling of drinking water at Sun City. • Interpretation of water quality results. • Reporting.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	De Groote Boom Minerals	Surface Water Study for the Mining Permit Application for the De Groote Boom Project	• Baseline hydrological study. • Surface water impact assessment. • Water quality sampling and assessment of water quality results. • Setup of a water quality monitoring programme. • Reporting.

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Digby Wells Environmental	Hydrologist	South Africa	Fountain Capital	Floodline Determination for Proposed Development of an Open Pit Coal Mine and Associated Infrastructure near Bronkhorstspruit, Gauteng	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment characteristics, methods and results obtained.
Digby Wells Environmental	Hydrologist	Limpopo South Africa	Pamish Investments No. 39	Floodline Determination for the Proposed Open Pit Magnetite Mine and Concentrator Plant, Mokopane, Limpopo Province	• Catchment assessment of rainfall, topography, soils and land cover. • Determination of the 1:50 and 1:100 year peak flows. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting on catchment characteristics, methods and results obtained.
Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Eskom	Eskom Surface Water Study for the Mashala Resourses 22kV Power Line	• Baseline hydrological study • Surface water impact assessment. • Hydraulic modelling using HEC-RAS to determine the 1:50 and 1:100 year floodlines. • Reporting.

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Digby Wells Environmental	Hydrologist	Mpumalanga South Africa	Msobo Coal	Msobo Coal Surface Water Study for the Sara Buffels A and B: IWULA and IWWMP for Opencast and Underground Mining Activities	• Surface water impact assessment. • Terrain modelling and catchment delineation using ArcGIS software. • Land use and soil assessment. • Determination of Peak flows for the 1:50 and 1:100 year storm event. • Hydraulic modelling using the HEC-RAS model to determine the 1:50 and 1:100 year floodlines. • Reporting.
Digby Wells Environmental	Hydrologist	Mali	Randgold Resources	Randgold Surface Water Study for the Morila Gold Mine Agri-Assessment Project	• Review of reports, mine layout plan and water quality data. • Classification of clean and dirty water areas based on the above. • Recommendations on water sources and areas for agri-business post mine closure.