HYDROLOGICAL ASSESSMENT OF THE HARMONY KALGOLD EXPANSION PROJECT

SCOPING REPORT

Project No. EIM-005

Version 2

March, 2021

HYDROLOGIC CONSULTING

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HYDROLOGICAL ASSESSMENT OF THE HARMONY KALGOLD EXPANSION PROJECT

SCOPING REPORT

Prepared For

EIMS (PTY) LTD

Prepared By

Hydrologic Consulting (Pty) Ltd

Project No. EIM-005

Version 2

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EXECUTIVE SUMMARY

Hydrologic Consulting has been appointed by Environmental Impact Management Services (EIMS) to undertake a hydrological assessment of the proposed Harmony Kalgold expansion, located approximately 32km north-east of the town of Setlagole, in the North West Province of South Africa.

This hydrological assessment is aimed specifically at the potential hydrological (surface water) impacts related to the proposed expansion and associated works and will form part of the overall Scoping Report for the site in accordance with the NEMA EIA regulations, 2014, Government Notice (GN) R 982 (as amended). Additional regulations in the form of Government Notice 704 (Government Gazette 20118 of June 1999 GN704) and Section 21 water uses as defined by the National Water Act (Act No 36 of 1998) have also been considered.

This report informs the Scoping Phase of the proposed expansion and will be followed by a more detailed report as part of the Environmental Impact Assessment (EIA) Phase.

Content from a previous Scoping Report for the proposed Harmony Kalgold expansion (completed by WSP[1] in 2019) has been utilised in some instances, although revisions have been extensive due to changes in the proposed site layout.

PROPOSED EXPANSION

The existing Harmony Kalgold operation wishes to expand its current production from the current production rate of 130 000 tons per month to 300 000 tons per month. A pre-feasibility study has been undertaken. The findings of the pre-feasibility study have concluded that the following new activities and expansions must be provided for:

1. The pit footprint will increase;
2. Larger dewatering pipelines;
3. Extension to Spanover waste rock dump;
4. Road from the pit to new ROM pad;
5. New ROM pad;
6. New plant;
7. Recommission old Tailings Storage Facility (TSF) at low deposition rate;
8. Increase tailings deposition rate at D-zone pit;
9. Install pipeline from Central dam to the new processing plant;
10. Install a tailings pipeline from the new processing plant to old TSF and D-zone pit;
11. Install pipeline from old processing plant raw water pond to the new plant (D-zone return water);
12. Install two power lines from Ferndale substation to the new processing plant;
13. Install evaporators at Central dam (to get rid of excess water);
14. Install a water treatment plant at the new plant;
15. Relocate and expand the explosives magazine; and
16. Additional new road from the plant to the N18.

[1] WSP. Hydrological Assessment for the Harmony Kalgold Expansion Project. Scoping Report. Project No.: 41101239. April 2019

INITIAL IDENTIFIED SITE SENSITIVITIES

Figure 3-1 presents the results of the initial identified site sensitives as they relate to the surface water environment. This figure illustrates that the proposed expansion infrastructure falling within an identified area of sensitivity includes:

- Tailings and return water pipeline corridor;
- Powerlines;
- Water pipeline; and
- D-Zone Pit.

IDENTIFIED IMPACTS

Eroded soils have the potential to cause sedimentation of downstream watercourses. Disturbed areas should consequently be stabilised with erosion control methods used where stabilisation is not possible. A rehabilitation plan for the site inclusive of topsoil replacement, a re-vegetation strategy and maintenance/aftercare and should be developed for disturbed areas.

Operation of earth moving machinery or maintenance vehicles on site during construction, operation, decommissioning and rehab/closure (including the possible storage or handling of hydrocarbons) poses a potential source of hydrocarbon contamination with regards to the surface water environment. An emergency response plan for unforeseen hydrocarbon spills should be developed while the existing surface water monitoring should be reviewed to ensure adequate coverage of the proposed expansion. A storm water management plan is a necessary part of the development of the expansion (as per GN704) and will form an integral mitigation measure with regards to the management of dirty areas.

An increase in runoff could be expected due to the proposed construction of infrastructure which will increase impermeable hardstanding and compaction from movement of machinery and use of laydown areas. The necessary introduction of a storm water management plan will, however, result in containment of much of the aforementioned area, thereby effectively decreasing runoff from the site. A decrease in runoff is a typical impact associated with the containment of dirty areas on mines and the mitigation of this impact is often not practical or possible with a reduction in mean annual runoff an expected outcome.

Flood risk is an impact to the proposed Kalgold Expansion Project and not the environment as with the other impacts identified in this report. This risk is expected to be present during the construction, operational and decommissioning phases due to the existence of infrastructure/works that could be flooded and the presence of personnel who might be caught in flood waters. Some infrastructure (roads and power lines) are proposed over the Morokwa River and have a certain flood risk (on the basis of intersection with a watercourse). Other infrastructure located near a watercourse (specifically the Morokwa River) may have a flood risk, however, without quantitative flood modelling, an assessment of this flood risk is not possible at this time. Nevertheless, the greatest impact from flooding is likely to opencast pits near a watercourse, such as D-Zone. Flood risk will be assessed further in the EIA phase given current uncertainty regarding both previous modelling and the relevance of infrastructure (due to the consideration with regards to existing works/infrastructure that is not covered by this assessment of the proposed expansion).

PLAN OF STUDY FOR EIA

Following this desktop surface water scoping report, a detailed hydrological assessment will be undertaken within the EIA Phase of this study. This will include the following studies as they relate to the proposed expansion (and not existing works/infrastructure:

- A conceptual storm water management plan (SWMP);
- A water balance; and
- A detailed impact assessment.

ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The risk/impact assessment undertaken within this study is a preliminary risk assessment based on a desktop assessment. All identified risks/impacts and proposed mitigation measures will be verified in the EIA phase of the hydrological assessment. Impact calculations tables as per EIMS methodology will be included in the detailed hydrological impact report.

Flooding is potentially the impact with the greatest significance (whether indicated by an impact table or not). This risk needs to be clearly understood, particularly in the event that any opencast pits near the Morokwa River are to be assessed during the EIA phase. This is due to the possible loss of life and and/or the potential interruption in mining activities in the event that an opencast pit becomes flooded as a result of an extreme flood event which is routed along the Morokwa River.

SPECIALIST DECLARATION

Mark Bollaert as the appointed surface water (hydrological) specialist hereby declares that:

- Other than fair remuneration for work performed/to be performed in terms of this application, he has no business, financial, personal or other interest in the activity or application and that there are no circumstances that may compromise their objectivity
- He has expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and guidelines that have relevance to the proposed activity;
- They undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required; and
- He is aware that a false declaration is an offence in terms of regulation 48 of the 2014 NEMA EIA Regulations.

EXPERTISE OF AUTHOR

Mr Mark Bollaert has over 15 years of experience working as consulting hydrologists in the United Kingdom and South Africa since having completed his Master of Science (MSc) degrees in Hydrology at the University of KwaZulu-Natal. Mark has since supplemented his tertiary education with professional qualifications which represent his on-going effort towards maintaining a professional approach and continuing in their professional development. These include qualifications from the UK (Chartered Scientist, Chartered Environmentalist and Chartered Water and Environmental Manager) and South Africa (Professional Natural Scientist in Water Resources and Earth Science respectively).

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HYDROLOGICAL ASSESSMENT FOR THE HARMONY KALGOLD EXPANSION PROJECT – SCOPING REPORT

1 INTRODUCTION

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Content from a previous Scoping Report for the proposed Harmony Kalgold expansion (completed by WSP[2] in 2019) has been utilised in some instances, although revisions have been extensive due to changes in the proposed site layout.

1.1 SCOPE OF WORK AND TERMS OF REFERENCE

Kalgold mine is an open pit mining operation located some 60km South West of Mahikeng in the North West Province. The mine is owned and operated by Harmony Gold, who acquired the mine in 1999. The mine is located in the Kraaipan Greenstone Belt, which is part of the large Amalia-Kraaipan Greenstone terrain. The largest ore body is found in the D-Zone, which was mined out by a single pit operation along a strike length of 1 300m and to a depth of approximately 290m below surface. Mining at Kalgold Mine continued at the A-Zone, Windmill and Watertank Open Pits, which are all relatively new opencast operations. Figure 1-1 presents the regional setting of the proposed Kalgold Expansion Project (hereafter also referred to as the site), while Figure 1-2 presents the layout of the Project.

[2] WSP. Hydrological Assessment for the Harmony Kalgold Expansion Project. Scoping Report. Project No.: 41101239. April 2019

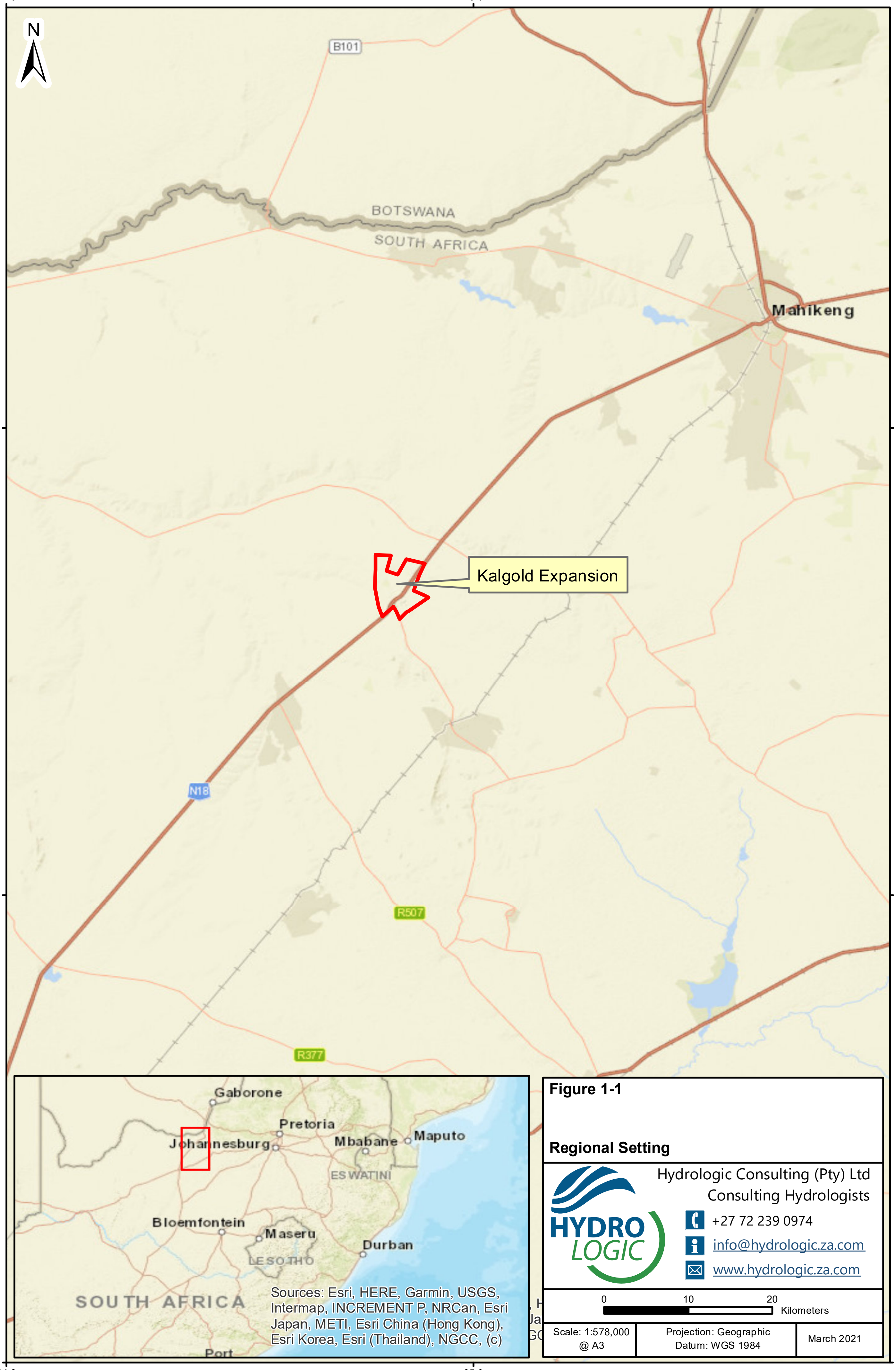

Figure 1-1

Regional Setting

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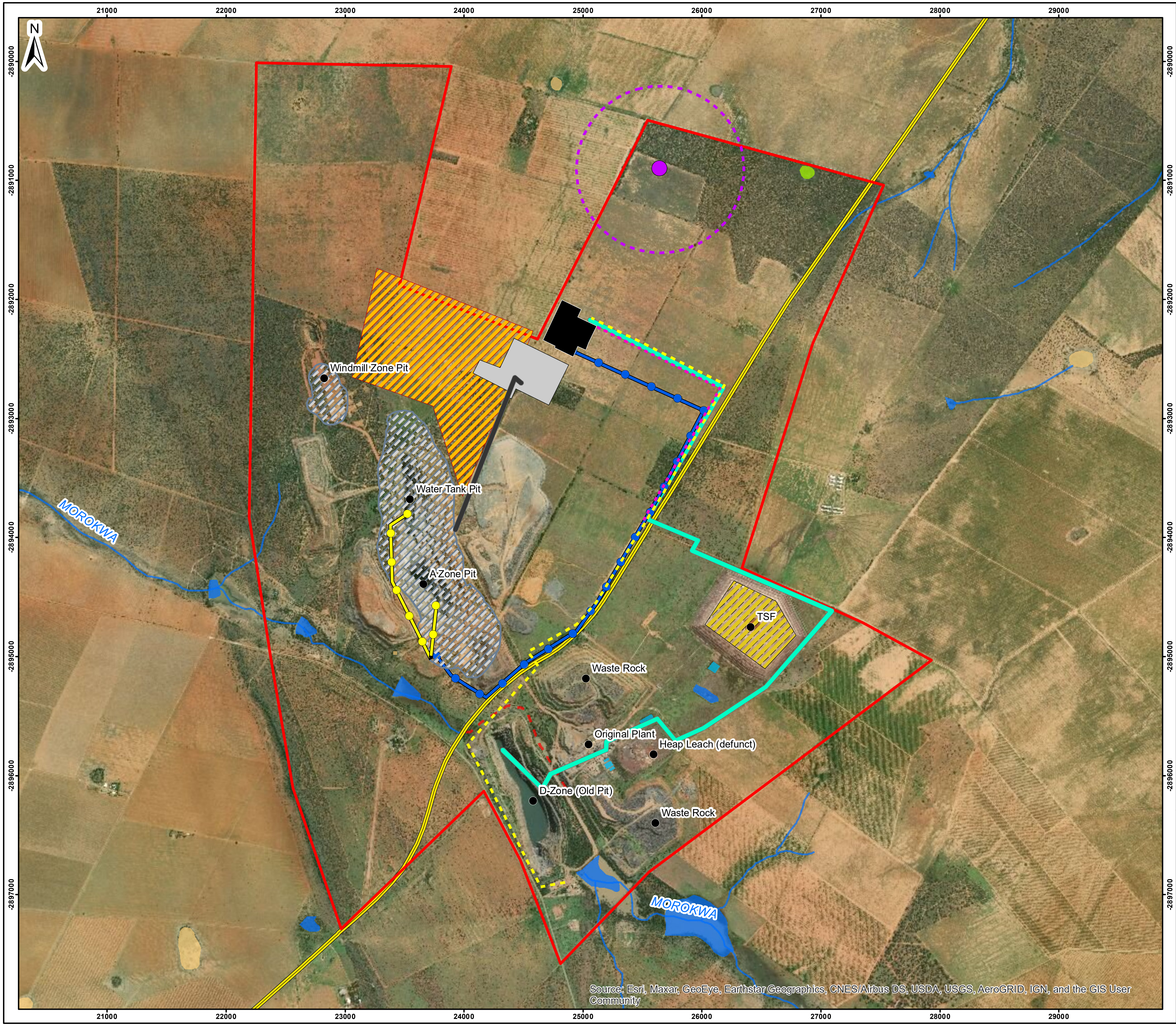
Scale: 1:578,000 @ A3	Projection: Geographic Datum: WGS 1984	March 2021



Legend

- Expansion Affected Properties
- Increased Pit Footprint
- Spanover Waste Rock Dump Extension
- New Plant
- New ROM Pad
- Recommissioned Tailings Facility
- Explosives Magazine
- Explosives Magazine Clearance Radius
- Haul Road to New ROM Corridor
- New Plant Road
- Power Lines
- Tailings & Return Water Pipeline Corridor
- Water Pipeline
- Dewatering Pipelines
- N18 National Road (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River Centre line
- Dam (50K Topo)
- Non-Perennial pan (50K Topo)
- Open Reservoir (50K Topo)
- Perennial Pan (50K Topo)

Figure 1-2

Layout

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0 1,000 Meters

Scale: 1:28,600 @ A3

Projection: Transverse Mercator
Datum: Hartebeeshoek, LO27

March 2021

The existing Harmony Kalgold operation wishes to expand its current production from the current production rate of 130 000 tons per month to 300 000 tons per month. A pre-feasibility study has been undertaken. The findings of the pre-feasibility study have concluded that the following new activities and expansions must be provided for:

1. The pit footprint will increase;
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14. Install a water treatment plant at the new plant;
15. Relocate and expand the explosives magazine; and
16. Additional new road from the plant to the N18.

1.2 PROJECT OBJECTIVES

The objectives of the study are as follows:

- The objective of this scoping phase of the study is to provide a baseline assessment of the mine site and provide a plan of study for the EIA (Phase 2), and
- The objective of the overall study is to provide the hydrological impact assessment as input into EIA and WULA applications.

In order to meet the scoping stage objectives, the following scope of work has been undertaken:

- Desktop review;
- Hydrological characterisation;
- Sensitivity mapping;
- Preliminary impact assessment;
- Plan of study for EIA, and
- Reporting

1.3 LEGISLATIVE AND POLICY FRAMEWORK

The following documents form the legislative and policy framework:

- The National Water Act, Act 36 of 1998 (hereafter referred to as NWA);
- Department of Water and Sanitation (DWS) Government Notice No.704 (GN704);
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A2: Water Management for Mine Residue Deposits, July 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A4: Pollution Control Dams, August 2007.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series A: Best Practice Guideline A6: Water Management for Underground Mines, July 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G1: Storm Water Management, August 2006.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G2: Water and Salt Balances, August 2006.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G4: Impact Prediction, December 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series G: Best Practice Guideline G5: Water Management Aspects for Mine Closure, December 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H1: Integrated Mine Water Management, December 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H2: Pollution Prevention and Minimization of Impacts, July 2008.
- Best Practice Guidelines for Water Resource Protection in the SA Mining Industry, Series H: Best Practice Guideline H3: Water Reuse and Reclamation, June 2006.

2 DESCRIPTION OF THE RECEIVING ENVIRONMENT

Baseline information in this section includes discussions on the rainfall, evaporation, design event rainfall, soils, vegetation, and land cover, as well as site topography and regional and local catchment hydrology.

2.1 RAINFALL

Various weather stations managed by both the South African Weather Services (SAWS) and the Department of Water and Sanitation (DWS) were considered in this project. These, together with their proximity to the site can be seen in Figure 2-1.

Numerous SAWS and DWS stations are located about the site, with the closest station (470516 W) located approximately 2.7km north-east of the site boundary. SAWS data requires purchasing and alternative sources of average monthly site-specific data were instead utilised, sourced from Pegram (2016). Table 2-1 presents the summary of the site-specific Pegram (2016) average monthly rainfall distribution. Pegram (2016) calculates the mean annual precipitation of the site as 483mm which is the dataset used in Figure 2-1 to illustrate rainfall variation.

TABLE 2-1: AVERAGE MONTHLY RAINFALL DISTRIBUTION (PEGRAM, 2016)

Month	Rainfall (mm)
Jan	91
Feb	76
Mar	71
Apr	42
May	16
Jun	7
Jul	4
Aug	6
Sep	13
Oct	18
Nov	55
Dec	71
Total	**470**

*Estimates were sourced for the centre of the site.

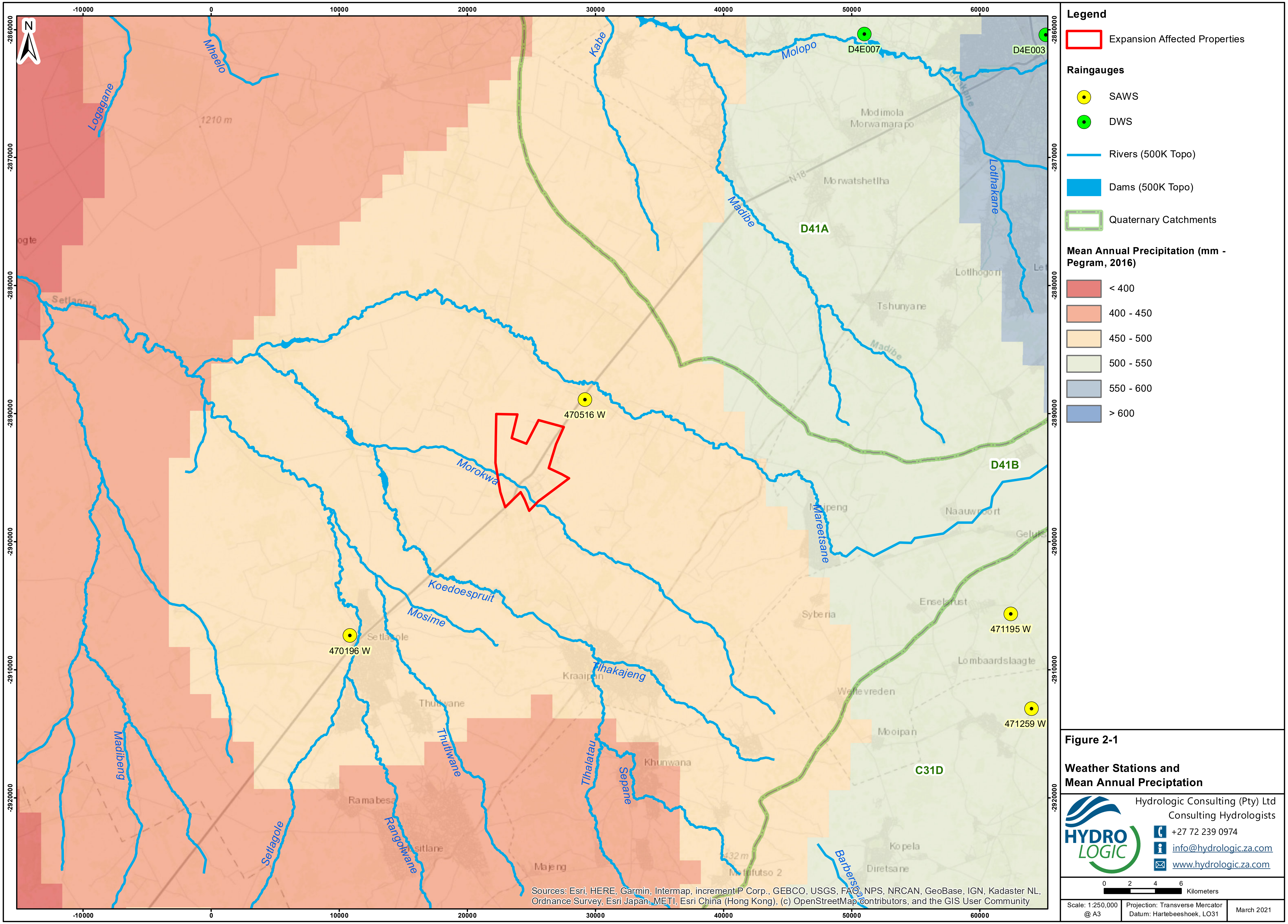

Figure 2-1

Weather Stations and Mean Annual Preciptation

2.2 1-DAY DESIGN RAINFALL DEPTHS

For the development of a storm water management plan (to be completed during the EIA phase), design rainfall is the most important rainfall variable to consider as it is the driver behind peak flows.

Design storm estimates for various recurrence intervals (RI) and storm durations were sourced from the Design Rainfall Estimation Software for South Africa (DRESSA), developed by the University of Natal in 2002 as part of a WRC project K5/1060 (Smithers and Schulze, 2002). This method uses a Regional L-Moment Algorithm (RLMA) in conjunction with a Scale Invariance approach to provide site-specific estimates of design rainfall (depth, duration and frequency), based on surrounding station records. WRC Report No. K5/1060 (WRC, 2002) provides more detail on the verification and validation of the method. Table 2-2 presents the 24-hour storm depths for various recurrence intervals.

TABLE 2-2: 24-HOUR STORM DEPTH

Recurrence Interval (Years)	Rainfall Depth (24 hour) (mm)
2	57.1
5	77.8
10	91.9
20	105.9
50	124.5
100	138.8
200	153.5

*Estimates were sourced for the centre of the site.

It is important to note, that no allowances for climate change have been made. A risk analysis using the expected life of a structure or process will indicate the relevance of considering climate change (i.e. as the expected life increases the influence of climate change increases).

2.3 EVAPORATION

Evaporation data was sourced from the South African Atlas of Climatology and Agrohydrology (Schulze and Lynch, 2006) in the form of A-Pan equivalent potential evaporation. The average monthly evaporation distribution is presented in Table 2-3 and shows the site has an annual potential evaporation of 2739mm.

TABLE 2-3: AVERAGE MONTHLY A-PAN EQUIVALENT EVAPORATION

Month	Evaporation(mm)
Jan	319
Feb	248
Mar	223
Apr	172
May	146
Jun	111
Jul	129
Aug	181
Sep	247
Oct	302
Nov	330
Dec	331
Total	**2739**

*Estimates were sourced for the centre of the site.

2.4 AVERAGE CLIMATE

The average climate for the site is presented in Figure 2-2 using the outcome of the investigation into rainfall and evaporation for the site. The combination of rainfall (Pegram, 2016) and evaporation and temperature (Schulze and Lynch, 2006) result in a hot air steppe climate according to the Köppen-Geiger climate classification[3].

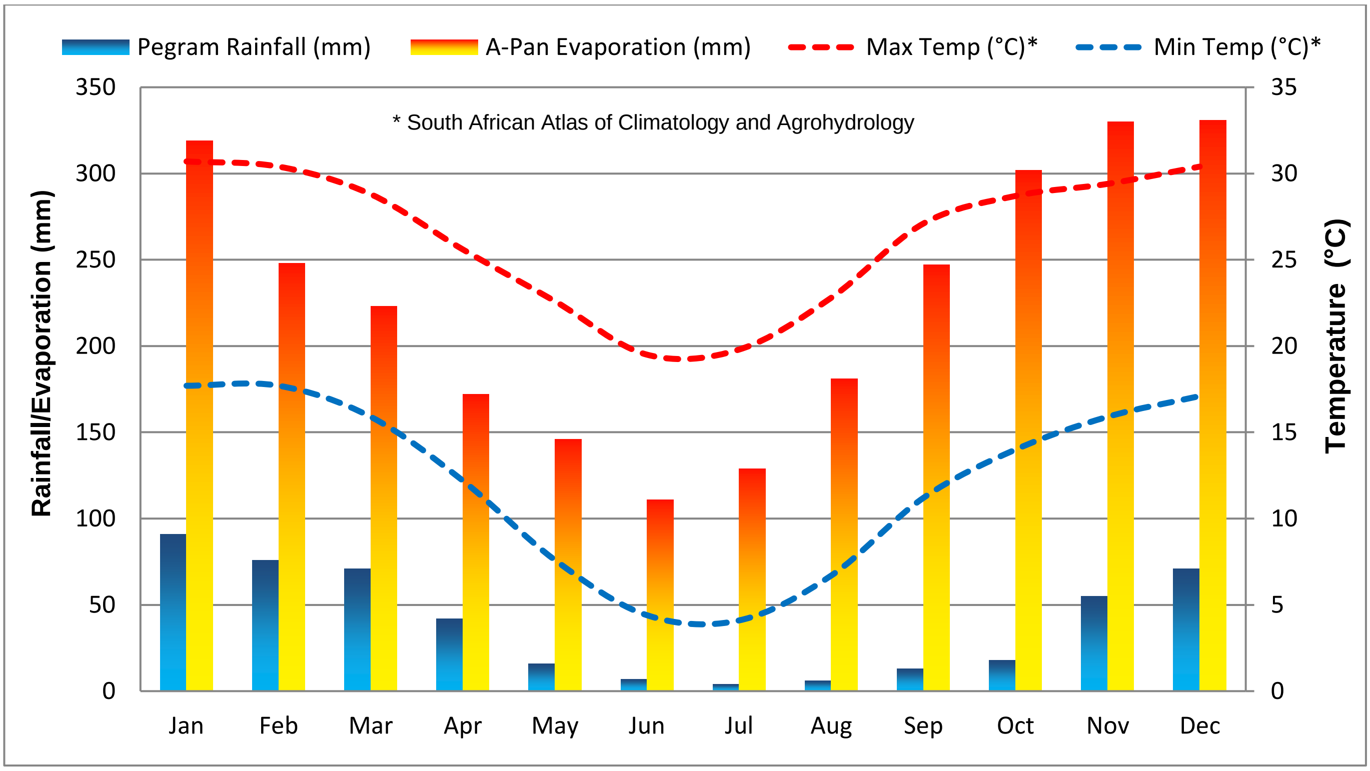

FIGURE 2-2: AVERAGE MONTHLY CLIMATE FOR THE SITE

[3] http://stepsa.org/climate_koppen_geiger.html

2.5 TERRAIN

Three initial datasets were used to assess the elevation of the site and surrounds, namely:

1. A point cloud dataset (*General Surface Plan 2019.11.08.csv)* provided by the client which was interpolated to a 2m digital elevation model (DEM);
2. A 25m DEM sourced from a National Geo-spatial Information (NGI) dataset; and
3. NGI 1:50,000 topographical map 5m contours.

The three elevation datasets utilised are illustrated in Figure 2-3.

The 2m DEM provides an elevation (surface) dataset with a resolution of 2m, however, its coverage of the site was intermittent as illustrated in Figure 2-3. This DEM was derived through the interpolation (triangulation) of the point data, using a maximum interpolation length of 250m. The capture date of this elevation data is from 2019 and represents the latest site terrain, compared to the NGI datasets.

The 25m NGI DEM was used to supplement areas of missing terrain data and is illustrated using a faded colour palette in Figure 2-3. This data as the name suggests, is presented using a 25m cell size and provides a general understanding of the terrain of the site and surrounds. The capture date of this data is unknown.

The 5m NGI contours were used as a final terrain dataset to illustrate the general 'lie of the land' and illustrates that elevations on site approximate 1240mAMSL.

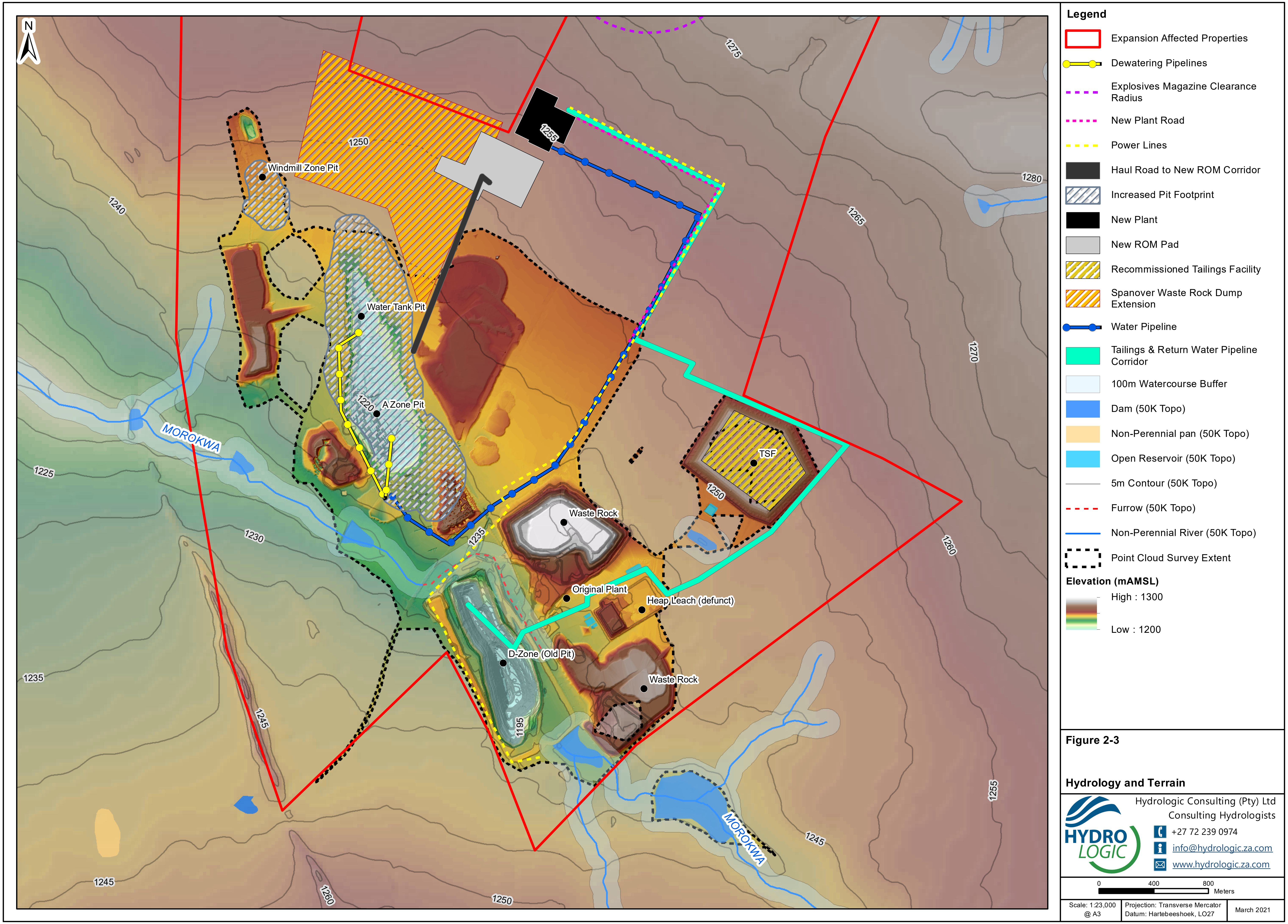

Figure 2-3

Hydrology and Terrain

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0 400 800 Meters

Scale: 1:23,000 @ A3	Projection: Transverse Mercator Datum: Hartebeeshoek, LO27	March 2021

2.6 HYDROLOGY

Figure 2-3 also illustrates the hydrological setting of the site, while Figure 2-1 presents the river network of the greater region. The site is positioned within quaternary catchment D41B which is drained by the primary Setlagole River.

The site is intersected by the Morokwa River which is the most significant watercourse in the region (about the site). The Morokwa River is classified as a non-perennial river according to the NGI's 1:50,000 topographical map data. Two minor non-perennial tributaries to the Morokwa River intersect the site, while a third minor non-perennial river (which is not a tributary to the Morokwa River), intersects the north-eastern corner of the site.

A few dams are also noted within the site (according to the NGI's 1:50,000 topographical map data), and are generally located along the Morokwa River. One exception to this is the small dam to the south-west of the TSF. Open reservoirs are also noted, although these are understood to be part of the mining operation and thereby not fed by natural upstream/upslope catchments.

A 100m watercourse buffer including both rivers and dams has been presented in Figure 2-3 as it is applies to GN704.

This report does not account for the presence or significance of any wetlands/vleis, which would require consideration by a wetland specialist.

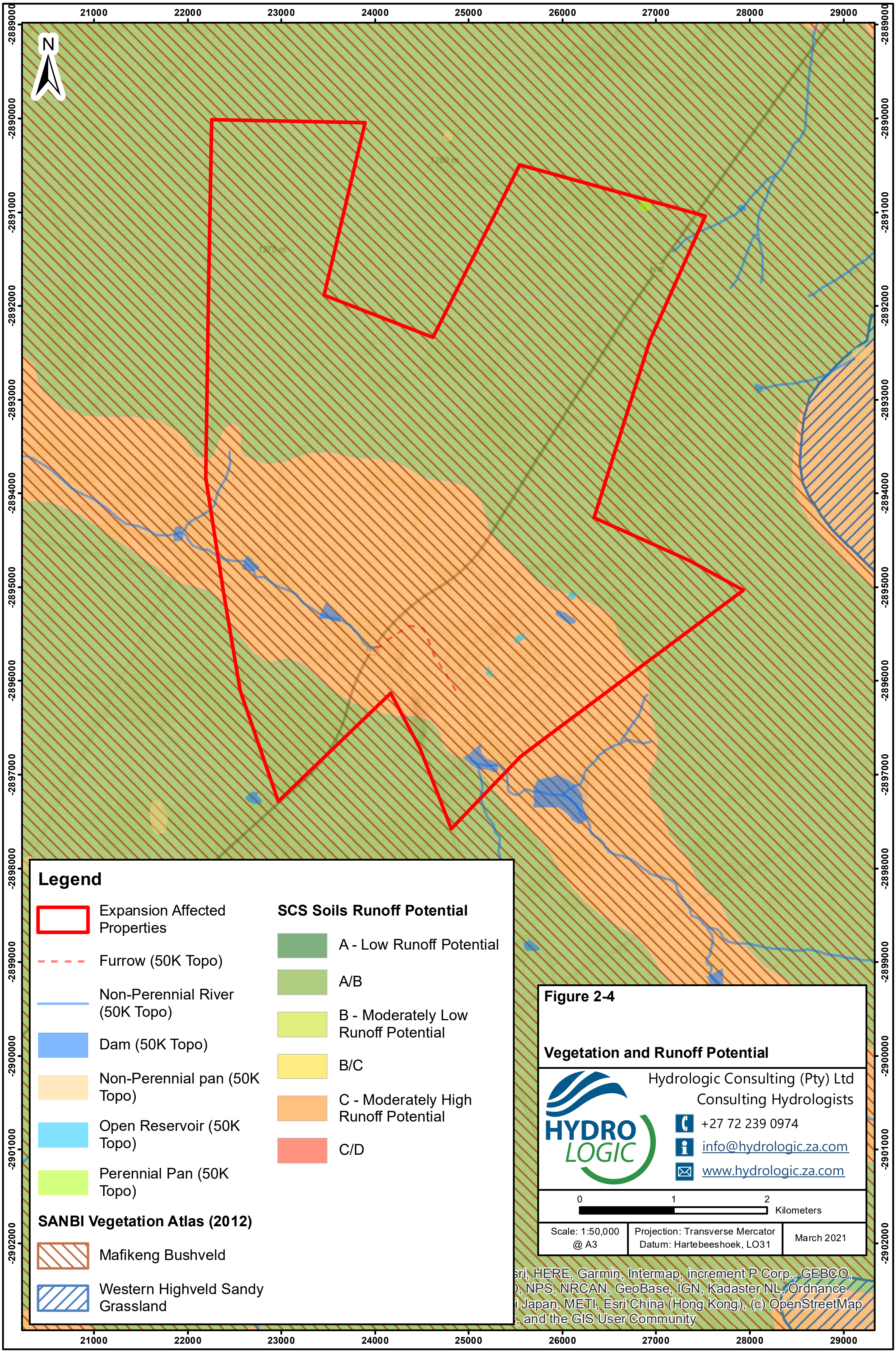
2.7 SOILS, VEGETATION AND LAND-COVER

In considering the Soil Conservation Service for South Africa (SCS-SA) dataset of the site, soils are classified as being either within hydrological soil group A/B (low to moderately low runoff potential) adjacent the Morokwa River, or within C group soils (moderately high runoff potential) present within the remaining areas of the site.

The natural vegetation of the site is classified as Mafikeng Bushveld (according to SANBI, 2012).

Some of the current land-cover of the site is unsurprisingly classified as 'mines and quarries' according to the Department of Environmental Affairs (DEA) 2018 dataset and matches up well with the known areas of exposed mining on site. 'Cultivated' and 'Grassland' also commonly occur over the site, however, cultivated areas area expected to have been historically present with cultivation having since stopped. Scatterings of 'Forested Land' also occur within grassland areas, while 'Waterbodies' and 'Built-up' areas are also identifiable.

The distributions of the SCS soil types and natural vegetation are illustrated in Figure 2-4 while Figure 2-5 presents the land-cover about the site.



21000
22000
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24000
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26000
27000
28000
29000
-2889000
-2890000
-2891000
-2892000
-2893000
-2894000
-2895000
-2896000
-2897000
-2898000
-2899000
-2900000
-2901000
-2902000
N
Legend
Expansion Affected Properties
Furrow (50K Topo)
Non-Perennial River (50K Topo)
Dam (50K Topo)
Non-Perennial pan (50K Topo)
Open Reservoir (50K Topo)
Perennial Pan (50K Topo)
SANBI Vegetation Atlas (2012)
Mafikeng Bushveld
Western Highveld Sandy Grassland
SCS Soils Runoff Potential
A - Low Runoff Potential
A/B
B - Moderately Low Runoff Potential
B/C
C - Moderately High Runoff Potential
C/D
Figure 2-4
Vegetation and Runoff Potential
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www.hydrologic.za.com
0
1
2
Kilometers
Scale: 1:50,000 @ A3
Projection: Transverse Mercator
Datum: Hartebeeshoek, LO31
March 2021
sri, HERE, Garmin, Intermap, increment P Corp., GEBCO,
), NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance
i Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap
, and the GIS User Community

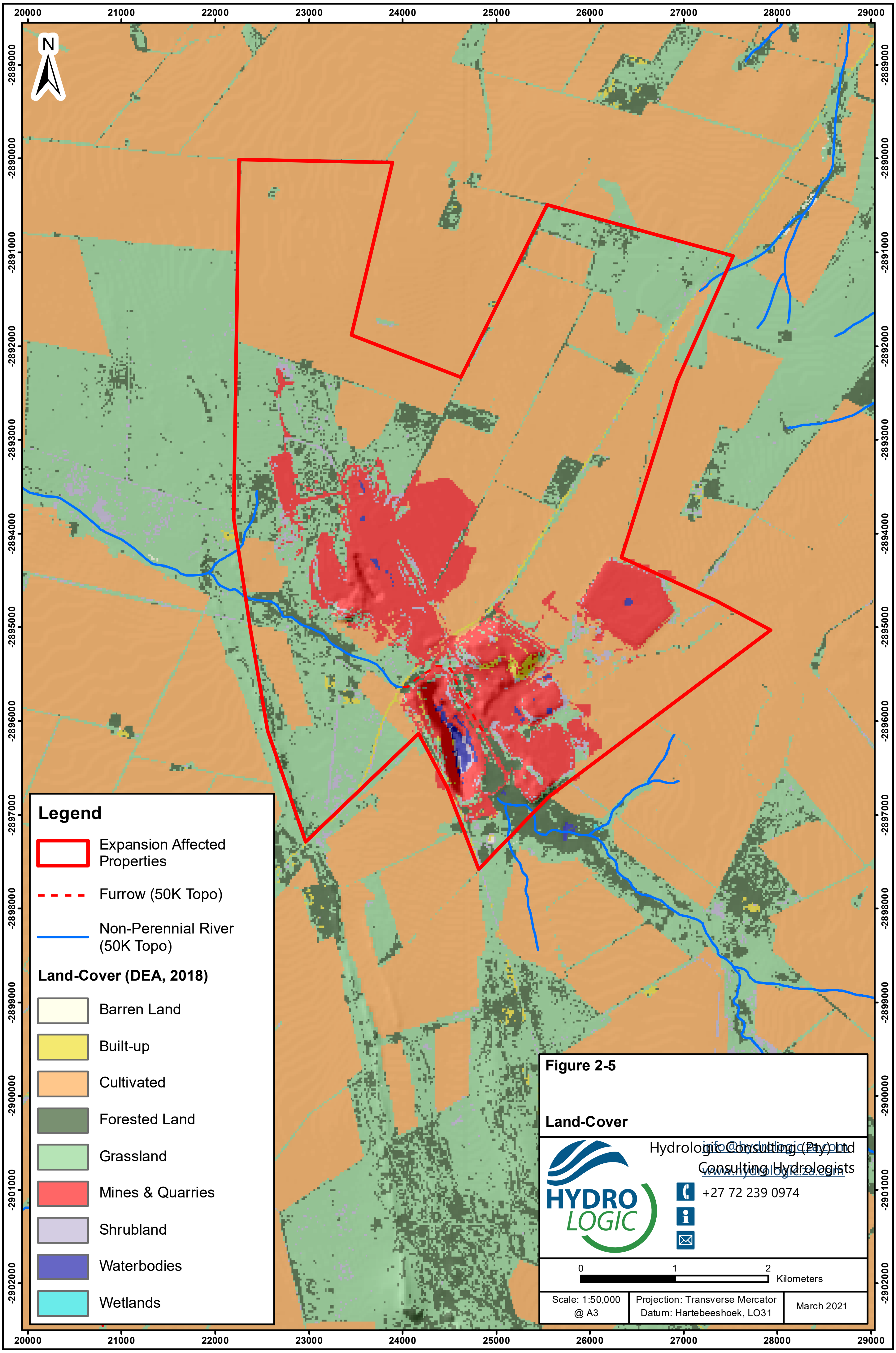

Figure 2-5

Land-Cover

3 INITIAL IDENTIFIED SITE SENSITIVITIES

Sensitivity mapping was undertaken in order to identify sensitive features relating to hydrological (surface water) environment within the site.

The Department of Water Affairs and Forestry (now the Department of Water and Sanitation), established GN704 to provide regulations on the use of water for mining and related activities aimed at the protection of water resources. This includes the following condition:

Condition 4 – Restrictions on locality – No person in control of a mine or activity may:

(a) locate or place any residue deposit, dam, reservoir, together with any associated structure or any other facility within the 1:100 year flood-line or within a horizontal distance of 100 metres from any watercourse or estuary, borehole or well, excluding boreholes or wells drilled specifically to monitor the pollution of groundwater, or on water-logged ground, or on ground likely to become water-logged, undermined, unstable or cracked;

The 100m watercourse buffer is consequently one of the main guiding aspects in the assessment of site sensitivities given its relevance to GN704, and its applicability to both flooding and the potential for contaminants to enter a watercourse (i.e. a wider river buffer is more likely to keep infrastructure/works outside of areas prone to regular or irregular flooding while enabling more time for containments within runoff, to settle out before entering the watercourse).

The GN704 condition outlined above also mentions the 1:100 year flood-line, however, no flood modelling is known to have occurred at the site and the area applicable with regards to the 1:100 year flood-line can consequently not be accounted for within the site sensitivities identified, with watercourse buffers instead informing flood potential in a general sense.

Watercourse buffers have been derived from the 1:50,000 topographical map watercourse datasets. Two exceptions include a small length of river to the east of D-Zone (missing from the NGI data) and the extent of the dam to the south-east of D-Zone which was significantly larger than the extent identified by the 1:50,000 topographical map data (based on Google Imagery with a capture date of 2nd May 2019). Watercourse buffers are technically applicable from the edge (top of bank) of the watercourse and not from the centreline (as in the case of rivers). The absence of a river survey means that the 1:50,000 topographical map river centreline dataset has nevertheless been used to define buffers.

A 100m watercourse buffer distance is, however, limited in its application since site works/infrastructure will either fall within or without this buffer distance, with no grading in site sensitivity possible. An expanded approach to the 100m river buffer was consequently adopted which includes the following:

- 25m watercourse buffer:
  - Intended to define the actual watercourse given the potential inaccuracy in the NGI's 1:50,000 topographical map data. This distance (25m) is also considered a minor offset from the watercourse which accounts for areas adjacent the watercourse with the most likely flooding potential and potentially part of the functional watercourse (due to NGI inaccuracy).
  - All development should be prevented in this area unless water compatible or otherwise traversing the river (e.g. a power line).

- 50m watercourse buffer:
    - A 50m buffer acts as a middle-ground between no buffer and GN704's 100m buffer and accounts for the increased flood-risk expected.
    - There is a strong disincentive towards development within this area.
- 100m watercourse buffer:
    - This buffer distance matches GN704's prescribed buffer distance and is the minimum distance to a watercourse requiring a motivation if works/infrastructure are going to be permitted, including a written exemption from the Minister of the Department of Water and Sanitation.
    - There is a medium disincentive towards development within this area.
- 200m watercourse buffer:
    - This buffer distance is a reasoned maximum distance from a watercourse which in most instance will contain all areas of flooding (up to the 1:100 year flood event).
    - There is a low disincentive towards development within this area.
- Remainder:
    - There is currently no sensitivity classification for the remainder of the site.

GN704 restricts development within 100m of a watercourse (i.e. dam or river) and the above outline does not attempt to remove this restriction but is instead a high-level 'scaled' version of this buffer distance.

Figure 3-1 presents the results of the initial identified site sensitives as they relate to the surface water environment. This figure illustrates that the proposed expansion infrastructure falling within an identified area of sensitivity includes:

- Tailings and return water pipeline corridor;
- Powerlines;
- Water pipeline; and
- D-Zone Pit.

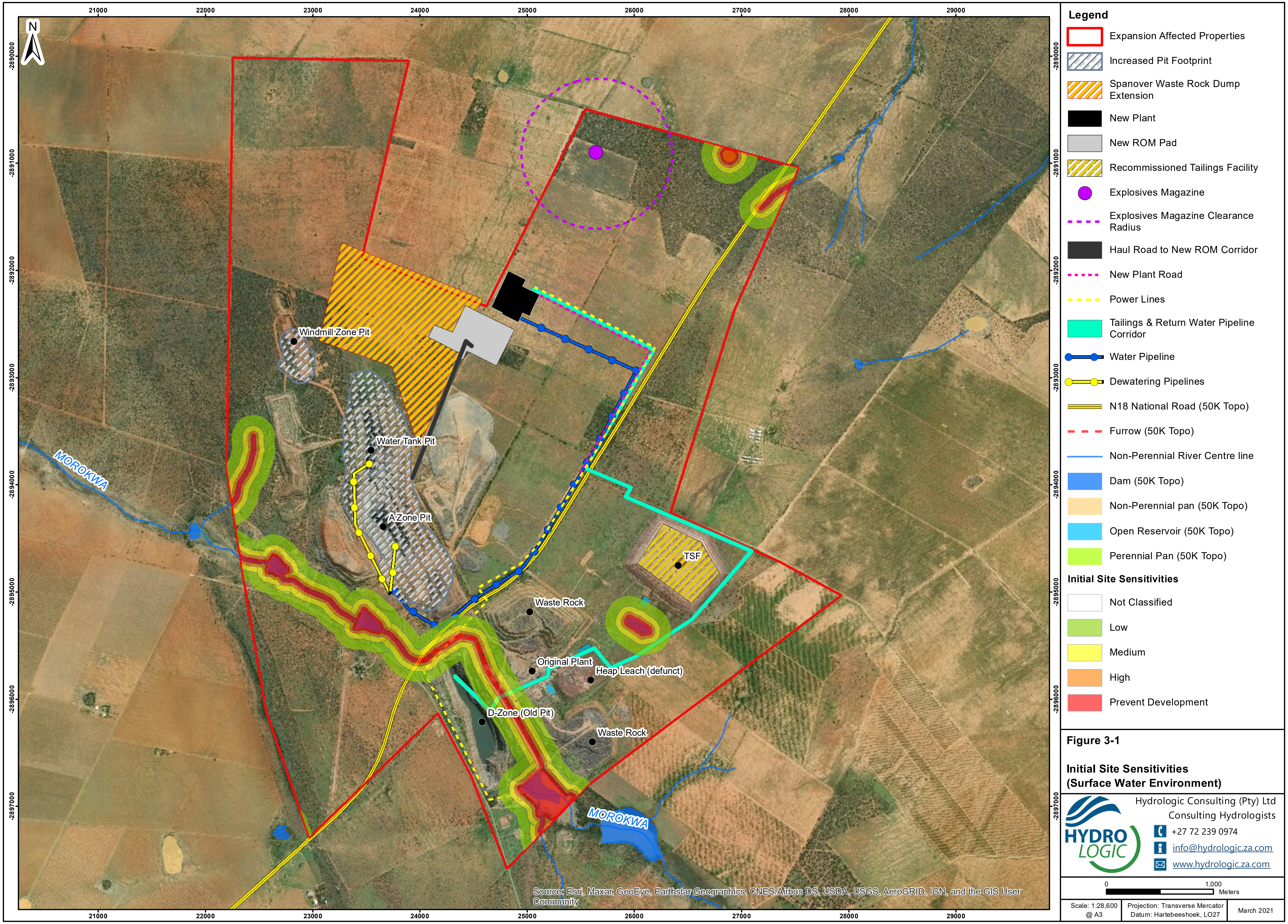

Figure 3-1

Initial Site Sensitivities (Surface Water Environment)

4 HYDROLOGICAL IMPACTS AND MITIGATION MEASURES

An impact is essentially any change (positive or negative) to a resource or receptor brought about by the presence of the project component or by the execution of a project related activity.

The potential impacts of the project have been evaluated using a recognised risk assessment methodology developed to ensure communication of the potential consequences or impacts of activities on the hydrological (surface water) environment as set out in the National Environmental Management Act (NEMA). A quantitative approach was taken in determining environmental significance since this enables a cross-disciplinary assessment of impact whereby the interpretation of impact significance is the same (i.e. a high impact on the surface water environment has the same interpretation as a high impact on ecology).

4.1 METHOD OF ASSESSING IMPACTS

The broad approach to the significance rating methodology is to determine the environmental risk (ER) by considering the consequence (C) of each impact (comprising Nature, Extent, Duration, Magnitude, and Reversibility) and relate this to the probability/likelihood (P) of the impact occurring. This determines the environmental risk. In addition other factors, including cumulative impacts, public concern, and potential for irreplaceable loss of resources, are used to determine a prioritisation factor (PF) which is applied to the ER to determine the overall significance (S).

4.1.1 DETERMINATION OF ENVIRONMENTAL RISK

The significance (S) of an impact is determined by applying a prioritisation factor (PF) to the environmental risk (ER).

The environmental risk is dependent on the consequence (C) of the particular impact and the probability (P) of the impact occurring. Consequence is determined through the consideration of the Nature (N), Extent (E), Duration (D), Magnitude (M), and reversibility (R) applicable to the specific impact.

For the purpose of this methodology the consequence of the impact is represented by:

$$C = \frac{E + D + M + R}{4} \times N$$

Each individual aspect in the determination of the consequence is represented by a rating scale as defined in Table 4-1.

TABLE 4-1: CRITERIA FOR DETERMINING IMPACT CONSEQUENCE

Aspect	Score	Definition
Nature	- 1	Likely to result in a negative/ detrimental impact
	+1	Likely to result in a positive/ beneficial impact
Extent	1	Activity (i.e. limited to the area applicable to the specific activity)
	2	Site (i.e. within the development property boundary),
	3	Local (i.e. the area within 5 km of the site),
	4	Regional (i.e. extends between 5 and 50 km from the site
	5	Provincial / National (i.e. extends beyond 50 km from the site)
Duration	1	Immediate (<1 year)
	2	Short term (1-5 years),
	3	Medium term (6-15 years),
	4	Long term (the impact will cease after the operational life span of the project),
	5	Permanent (no mitigation measure of natural process will reduce the impact after construction).
Magnitude/ Intensity	1	Minor (where the impact affects the environment in such a way that natural, cultural and social functions and processes are not affected),
	2	Low (where the impact affects the environment in such a way that natural, cultural and social functions and processes are slightly affected),
	3	Moderate (where the affected environment is altered but natural, cultural and social functions and processes continue albeit in a modified way),
	4	High (where natural, cultural or social functions or processes are altered to the extent that it will temporarily cease), or
	5	Very high / don't know (where natural, cultural or social functions or processes are altered to the extent that it will permanently cease).
Reversibility	1	Impact is reversible without any time and cost.
	2	Impact is reversible without incurring significant time and cost.
	3	Impact is reversible only by incurring significant time and cost.
	4	Impact is reversible only by incurring prohibitively high time and cost.
	5	Irreversible Impact

Once the C has been determined the ER is determined in accordance with the standard risk assessment relationship by multiplying the C and the P. Probability is rated/scored as per Table 4-2.

TABLE 4-2: PROBABILITY SCORING

Probability Score	Description
1	Improbable (the possibility of the impact materialising is very low as a result of design, historic experience, or implementation of adequate corrective actions; <25%),
2	Low probability (there is a possibility that the impact will occur; >25% and <50%),
3	Medium probability (the impact may occur; >50% and <75%),
4	High probability (it is most likely that the impact will occur- > 75% probability), or
5	Definite (the impact will occur),

The result is a qualitative representation of relative ER associated with the impact. ER is therefore calculated as follows:

$$ER = C \; x \; P$$

TABLE 4-3: DETERMINATION OF ENVIRONMENTAL RISK

Consequence						
	5	5	10	15	20	25
	4	4	8	12	16	20
	3	3	6	9	12	15
	2	2	4	6	8	10
	1	1	2	3	4	5
		1	2	3	4	5
	Probability					

The outcome of the environmental risk assessment will result in a range of scores, ranging from 1 through to 25. These ER scores are then grouped into respective classes as described in Table 4-4.

TABLE 4-4: SIGNIFICANCE CLASSES

Environmental Risk Score	Description
< 9	Low (i.e. where this impact is unlikely to be a significant environmental risk),
≥9 & <17	Medium (i.e. where the impact could have a significant environmental risk),
≥ 17	High (i.e. where the impact will have a significant environmental risk).

The impact ER will be determined for each impact without relevant management and mitigation measures (pre-mitigation), as well as post implementation of relevant management and mitigation measures (post-mitigation). This allows for a prediction in the degree to which the impact can be managed/mitigated.

4.1.2 IMPACT PRIORITISATION

In accordance with the requirements of Regulation 31 (2)(l) of the EIA Regulations (GNR 543), and further to the assessment criteria presented in the Section above, it is necessary to assess each potentially significant impact in terms of:

- Cumulative impacts; and
- The degree to which the impact may cause irreplaceable loss of resources.

In addition, it is important that the public opinion and sentiment regarding a prospective development and consequent potential impacts is considered in the decision-making process.

To ensure that these factors are considered, an impact prioritisation factor (PF) will be applied to each impact ER (post-mitigation). This prioritisation factor does not aim to detract from the risk ratings but rather to focus the attention of the decision-making authority on the higher priority/significance issues and impacts. The PF will be applied to the ER score based on the assumption that relevant suggested management/mitigation impacts are implemented.

TABLE 4-5: CRITERIA FOR DETERMINING PRIORITISATION

Public Response (PR)	Low (1)	Issue not raised in public response.
	Medium (2)	Issue has received a meaningful and justifiable public response.
	High (3)	Issue has received an intense meaningful and justifiable public response.
Cumulative Impact (CI)	Low (1)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is unlikely that the impact will result in spatial and temporal cumulative change.
	Medium (2)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is probable that the impact will result in spatial and temporal cumulative change.
	High (3)	Considering the potential incremental, interactive, sequential, and synergistic cumulative impacts, it is highly probable/definite that the impact will result in spatial and temporal cumulative change.
Irreplaceable Loss of Resources (LR)	Low (1)	Where the impact is unlikely to result in irreplaceable loss of resources.
	Medium (2)	Where the impact may result in the irreplaceable loss (cannot be replaced or substituted) of resources but the value (services and/or functions) of these resources is limited.
	High (3)	Where the impact may result in the irreplaceable loss of resources of high value (services and/or functions).

The value for the final impact priority is represented as a single consolidated priority, determined as the sum of each individual criteria represented in Table 4-5. The impact priority is therefore determined as follows:

$$Priority = PR + CI + LR$$

The result is a priority score which ranges from 3 to 9 and a consequent PF ranging from 1 to 2 (Refer to Table 4-6).

TABLE 4-6: DETERMINATION OF PRIORITISATION FACTOR

Priority	Ranking	Prioritisation Factor
3	Low	1
4	Medium	1.17
5	Medium	1.33
6	Medium	1.5
7	Medium	1.67
8	Medium	1.83
9	High	2

To determine the final impact significance the PF is multiplied by the ER of the post mitigation scoring. The ultimate aim of the PF is to be able to increase the post mitigation environmental risk rating by a full ranking class, if all the priority attributes are high (i.e. if an impact comes out with a medium environmental risk after the conventional impact rating, but there is significant cumulative impact potential, significant public response, and significant potential for irreplaceable loss of resources, then the net result would be to upscale the impact to a high significance).

TABLE 4-7: FINAL ENVIRONMENTAL SIGNIFICANCE RATING

Rating	Description
< 10	Low (i.e. where this impact would not have a direct influence on the decision to develop in the area),
≥10 & <20	Medium (i.e. where the impact could influence the decision to develop in the area),
≥ 20	High (i.e. where the impact must have an influence on the decision process to develop in the area).

4.2 PROJECT PHASES

The Kalgold Expansion Project involves the addition and expansion of surface infrastructure. This impact assessment has been developed on the understanding that the project is comprised of the following phases including an outline as it applies to surface water (hydrology):

- Construction – surface infrastructure will be built on land cleared for that purposes;
- Operation – mining operations will commence;
- Decommissioning – all mining operations will cease with surface infrastructure removed; and
- Rehab/Closure – disturbed surface areas will undergo rehabilitation as part of the mine's closure plan.

Both a preceding 'planning' phase and 'post closure phase' are intended for the project, however, for the purposes of this scoping phase report, it is assumed that no changes will have yet occurred to surface water environment (planning phase) or the rehabilitation would have reinstituted the pre-development hydrological regime (post closure phase).

No alternatives are relevant to this scoping report.

4.3 IDENTIFIED IMPACTS

4.3.1 EROSION OF SOILS

Eroded soils have the potential to cause sedimentation of downstream watercourses. The construction/expansion of infrastructure will lead to new areas being disturbed, resulting in the potential for soil erosion to occur during times of rainfall, while the decommissioning of this infrastructure will result in the same. If not mitigated, erosion could continue during the operational phase, although it is expected soils would settle to a degree, reducing the potential volume of erosion for any given rainfall event. The rehab/closure phase may have an overall positive impact on any existing erosion without formal erosion mitigation in place, although there could also be some increase in erosion due to earthworks. Potential erosion is exacerbated by the moderately high runoff potential (see Section 2.7) of soils in parts of the site, which would cause a higher proportion of rainfall to be converted into runoff, thereby increasing the runoff's potential erosivity, although the limited surface area to be disturbed will limit the overall erosion of soils on site during all project phases.

Disturbed areas should consequently be stabilised with erosion control methods used where stabilisation is not possible. A rehabilitation plan for the site inclusive of topsoil replacement, a re-vegetation strategy and maintenance/aftercare and should be developed for disturbed areas.

TABLE 4-8: EROSION OF SOILS IMPACT TABLE

Impact	Project Phase	Pre-Mitigation Score	Post-Mitigation Score	Final Significance
Erosion of soils	Construction	-11	-2.5	-2.92
	Operation	-8.25	-2.5	-2.92
	Decommissioning	-11	-2.5	-2.92
	Rehab and closure	-11	-2.5	-2.92

Proposed Preliminary Mitigation

- Suitable erosion control should be utilised where necessary.
- Disturbed areas or areas rehabilitated with soils should be stabilised as soon as possible using plants (e.g. grass) or other mechanical methods (e.g. profiling or erosion control blankets).
- A rehabilitation plan for the site inclusive of topsoil replacement, a re-vegetation strategy and maintenance/aftercare and should be developed for disturbed areas.

4.3.2 POLLUTANTS ENTERING THE SURFACE WATER ENVIRONMENT

Operation of earth moving machinery or maintenance of vehicles on site during construction, operation, decommissioning and rehab/closure (including the possible storage or handling of hydrocarbons) poses a potential source of hydrocarbon contamination with regards to the surface water environment. An emergency response plan for unforeseen hydrocarbon spills should be developed while the existing surface water monitoring should be reviewed to ensure adequate coverage of the proposed expansion.

A storm water management plan is a necessary part of the development of the expansion (as per GN704) and will form an integral mitigation measure with regards to the management of dirty areas. Uncontrolled release of tailings or contaminated water (e.g. due to a pipeline failure) is possible and would be considered a residual risk (post mitigation).

Important. This section only considers the surface water impact from the proposed surface activities. It is expected that the groundwater specialist assessing the potential impact of possible seepage of contaminated groundwater into surface water resources.

TABLE 4-9: POLLUTANTS ENTERING THE SURFACE WATER ENVIRONMENT IMPACT TABLE

Impact	Project Phase	Pre-Mitigation Score	Post-Mitigation Score	Final Significance
Pollutants entering the surface water environment	Construction	-17.5	-6.5	-7.58
	Operation	-20	-8	-9.33
	Decommissioning	-17.5	-6.5	-7.58
	Rehab and closure	-13	-6.5	-6.50

Proposed Preliminary Mitigation

- Implement a storm water management plan inclusive of containment of dirty water areas.

- Ensure the tailings facility and return water dam have adequate capacity to contain both operational water and the relevant design storm (e.g. probable maximum precipitation) and that all are adequately engineered to prevent failure (e.g. of embankments or side slopes).
- Keep tailings pipelines (and any other pipelines with possible contaminants) within the managed dirty water footprint where possible.
- Store hydrocarbons off site where possible, or otherwise implement hydrocarbon storage.
- Handle hydrocarbons carefully to limit spillage.
- Ensure vehicles are regularly serviced so that hydrocarbon leaks are limited.
- Designate a single location for refuelling and maintenance where possible.
- Keep a spill kit on site to deal with any hydrocarbon leaks.
- Remove soil from the site which has been contaminated by hydrocarbon spillage.
- Undertake surface water monitoring to enable change detection related to contaminants originating from the site.

4.3.3 DECREASE IN RUNOFF

An increase in runoff could be expected due to the proposed construction of infrastructure which will increase impermeable hardstanding and compaction from movement of machinery and use of laydown areas. The necessary introduction of a storm water management plan will, however, result in containment of much of the aforementioned area, thereby effectively decreasing runoff from the site.

A decrease in runoff is a typical impact associated with the containment of dirty areas on mines and the mitigation of this impact is often not practical or possible with a reduction in mean annual runoff an expected outcome.

Important. This section only considers the surface water impact from the proposed surface activities. It is expected that the groundwater specialist assessing the potential impacts of the dewatering of proposed works.

TABLE 4-10: DECREASE IN RUNOFF IMPACT TABLE

Impact	Project Phase	Pre-Mitigation Score	Post-Mitigation Score	Final Significance
Decrease in runoff	Construction	-13	-13	-15.17
	Operation	-14	-14	-16.33
	Decommissioning	-14	-14	-16.33
	Rehab and closure	-12	-12	-14.00

Proposed Preliminary Mitigation

- Keeping the contained dirty area to a minimum thereby limiting this impact.
- Discharge excess water of an acceptable quality back into the surface water environment (river).

4.3.4 FLOOD RISK (RIVER)

Flood risk is an impact to the proposed Kalgold Expansion Project and not the environment as with the other impacts identified in this report. This risk is expected to be present during the construction, operational and decommissioning phases due to the existence of infrastructure/works that could be flooded and the presence of personnel who might be caught in flood waters.

Some proposed infrastructure (tailings & return water pipeline and power lines) crosses the Morokwa River and have a certain flood risk (on the basis of intersection with a watercourse). This infrastructure, however, likely has a low flood vulnerability thereby limiting the potential impact of flooding. Other infrastructure located near a watercourse (specifically the Morokwa River) may have a flood risk, however, without quantitative flood modelling, an assessment of this flood risk is not possible at this time. Nevertheless, the greatest impact from flooding is likely to opencast pits near a watercourse, such as D-Zone. Flood risk will be assessed further in EIA phase given current uncertainty regarding both previous modelling and the relevance of infrastructure (due to the consideration with regards to existing works/infrastructure that is consequently not covered by this assessment of the proposed expansion).

Important. It should, however, be noted that the potentially severe impact of flood risk is not adequately conveyed by the impact table below since the probability of extreme flooding is low, resulting in the impact appearing less significant than is likely warranted.

TABLE 4-11: FLOOD RISK IMPACT TABLE

Impact	Project Phase	Pre-Mitigation Score	Post-Mitigation Score	Final Significance
Flood risk (river)	Construction	-5.5	-2.75	-2.75
	Operation	-5.5	-2.75	-2.75
	Decommissioning	-5.5	-2.75	-2.75

Proposed Preliminary Mitigation

- Ensure adequate offset of power line pylons and pipelines.
- Works should ideally not take place, nor infrastructure placed within 100m of the river or within the 1:100 year flood-line so as to limit the applicability of Section 21 water uses and GN704 Condition 4.
- The 1:100 year flood-line should be defined for infrastructure or works near a watercourse, while the expansion of excavated areas (i.e. pits) should be assessed with regards to the potential that flood waters could enter them. This would necessitate the use of extreme flood event modelling (less common than the 1:100 year flood), that while highly unlikely to occur, would factor in the potential loss of life due to a flood event that spills into a pit.
- Flood protection in the form of berms or increased flood conveyance (through river engineering) may be necessary where a flood risk exists.
- If determined to be relevant to the proposed expansion, flood modelling should be undertaken to define the flood risk and consequently the expected impact (in the event that flood modelling has not been previously undertaken or is otherwise outdated/inadequate).

5 PLAN OF STUDY FOR EIA

Following this desktop surface water scoping report, a detailed hydrological assessment will be undertaken within the EIA Phase of this study. This will include the following studies.

5.1 CONCEPTUAL STORM WATER MANAGEMENT PLAN

- A conceptual storm water management plan (SWMP) for the proposed expansion will be developed. This will exclude existing infrastructure where possible, which is expected to already have an acceptable SWMP in place.
- A single layout will be considered.
- In accordance with Best Practice Guidance G1: Storm Water Management the SWMP will include the following:
  - Clean and dirty water areas will be identified and delineated;
  - Catchment attributes will be defined with subsequent design and sizing of containment and diversions; and
  - Storm water flows and volumes (1:50 year recurrence intervals) for both the dirty and clean water areas will be calculated. For storm water containment purposes, the volumes for longer storm durations (24 hours) will also be determined.
- Long-term simulation is not included with regards to the long-term performance of containment facilities. These will be sized utilising the expected runoff volume (from the wettest month) plus the addition of the 1:50 year storm, thereby resulting in a recommended containment volume and minimum containment volume respectively. Process water will not be included in the conceptual design.
- The SWMP design will be conceptual and while containment facilities and channels will be represented, specific control structures such as spillways will not be represented while diversions will be conceptual (e.g. use of uniform channel sizes)
- Placement of proposed storm water infrastructure will utilise the position of existing storm water layout insofar as is possible (where provided or visible in imagery). Sizing of this infrastructure will not necessarily conform to existing given the intention to simplify proposed design using uniform channel dimensions (for example).
- Internal site drainage (e.g. french drains, gutters or storm water pipes) will not form part of the SWMP which will instead focus on the larger subcatchments draining to or from within the site with channels/berms largely being recommended.
- PCSWMM storm water modelling software will be utilised as it offers a robust approach to SWMP development due to its ability to handle both conceptual and detailed design.
- The conceptual SWMP will be illustrated through mapping and indicative design drawings.
- Details regarding the removal of water (whether by treatment or evaporators) will need to be provided by the client.

5.2 WATER BALANCE

- The existing water balance for the site will be updated to include the proposed expansion.
- A single layout will be considered.

- The Water Balance modelling / calculations will be conducted in accordance with the relevant DWA regulations (DWA BPG G2: Water and Salt Balances), with a static wet and dry season monthly water balance being produced.
- The following inputs from the client (or other specialists) will be required:
  - Groundwater - regarding all flows to and from the surface (this includes dewatering requirements);
  - Plant and other operational water volumes (e.g. dust suppression, potable water, new or altered pollution control dams and new infrastructure).
- Inputs to the water balance arising from rainfall and associated runoff will be calculated as will evaporative losses and seepage losses from containment facilities (expect for losses due to the use of evaporators – these volumes will need to be provided by the client).

5.3 DETAILED IMPACT ASSESSMENT

A detailed impact and mitigation assessment will be undertaken with adherence to EIMS' environmental risk/impact assessment methodology for planning and construction, operational and decommissioning, rehabilitation and closure phases of the preferred alternatives. This methodology accounts for the magnitude, significance and duration of the proposed risk/impact and assigns each risk/impact a status (High, Medium or Low). Mitigation measures for each risk/impact will be recommended and the potential risk/impact status will be reassessed assuming the proposed mitigation measures are put in place. Risk/Impact calculations tables as per EIMS' methodology will be included in the detailed hydrological impact report.

6 ASSUMPTIONS, UNCERTAINTIES AND GAPS IN KNOWLEDGE

The risk/impact assessment undertaken within this study is a preliminary risk assessment based on a desktop assessment. All identified risks/impacts and proposed mitigation measures will be verified in the EIA phase of the hydrological assessment. Impact calculations tables as per EIMS methodology will be included in the detailed hydrological impact report.

Flooding is potentially the impact with the greatest significance (whether indicated by an impact table or not). This risk needs to be clearly understood, particularly in the event that any opencast pits near the Morokwa River are to be assessed during the EIA phase. This is due to the possible loss of life and and/or the potential interruption in mining activities in the event that an opencast pit becomes flooded as a result of an extreme flood along the Morokwa River.

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