APPENDIX H

Preliminary Design Report for South Pit Discard Dump

REPORT

Conceptualisation of the Coarse Discard Dump configuration over infilled Atcom South open pit as part of integrated pit closure

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Table of Contents

1.0 INTRODUCTION

In the past Glencore Operations South Africa (Pty) Ltd (Glencore) planned to construct a new discard dump over the old semi-rehabilitated Atcom South open pit at their iMpunzi Complex. Owing to the recorded elevated surface temperatures from spontaneous combustion of the spoils, this option was discarded and only the construction of fines paddocks over the already “cool” areas of the infilled spoils was taken forward. The construction of these paddock embankments with coarse discard is now being undertaken based on an engineering design by Golder Associates.

A recent thermal scan shows that much of the previous hot areas have now cooled and may be suitable for discard deposition while other areas for discard disposal closer to the coal beneficiation plant are being prepared. The mine requested Golder to conceptualise to prefeasibility level a new discard dump on the remainder of the Atcom South infilled pit to dispose of approximately 29 million m³ coarse discard.

This document describes the design approach and outcome of the prefeasibility engineering conducted.

2.0 PROJECT OBJECTIVES

The project objective was to conduct the prefeasibility work of the possible coarse discard dump on the remainder of the infilled Atcom South pit, with associated pit drainage considerations, that will have a disposal capacity of approximately 29 million m³, giving specific attention to at least the following:

- A long-term stable landform;
- The fact that a portion of the discard dump could be located over a portion of the infilled spoils and/or areas that are possibly prone to burning;
- Surface water drainage around the discard dump and linking this to the Triangle pit drainage corridor to route excess runoff from the rehabilitated pit to the nearby Steenkoolspruit and/or diversion; and
- Assessment on available capacity for discard disposal in the nearby existing pit.

3.0 BATTERY LIMITS

During a meeting with the mine on 19 September 2017 the following battery limits was agreed on:

- The maximum height of the dump should not exceed 30m from the immediate surrounding ground elevations;
- The mine intends to submit this design for regulatory approval, therefore it was agreed to develop the discard dump for the total planned discard volume (29 million m³) even though there were some capacity available in the Triangle pit to dispose of discard. It is assumed that, as with the fines paddocks, no dedicated liner systems would be required as seepage during construction and post-closure will be abstracted by the groundwater abstraction system and eventually treated. The cover of the dump would therefore be limited to a 500mm deep soil cover as growth medium;
- A single discard dump was to be considered and should not extend south of the existing haul road that connects the Triangle pit with the ROM pad and plant; and
- Material placement on the South pit area was to a significantly higher elevation than the profile developed as part of the detailed landform and drainage design for the Atcom South open pit area as well as the conceptual design of a long-term post-mining landform and drainage for the overall Atcom mining areas. The mine indicated that the additional placed material over the South pit will not be moved again and the general topography of the area should be considered as permanent.

4.0 SITE DATA

4.1 Topographical survey

The topographical survey dated 28 July 2017 was provided by the mine. The survey was converted by Golder into AutoCAD Civil 3D to produce a 3D DTM model. This model formed the basis of the geometric modelling and design of the dump. The elevations of the area are shown in Figure 1.

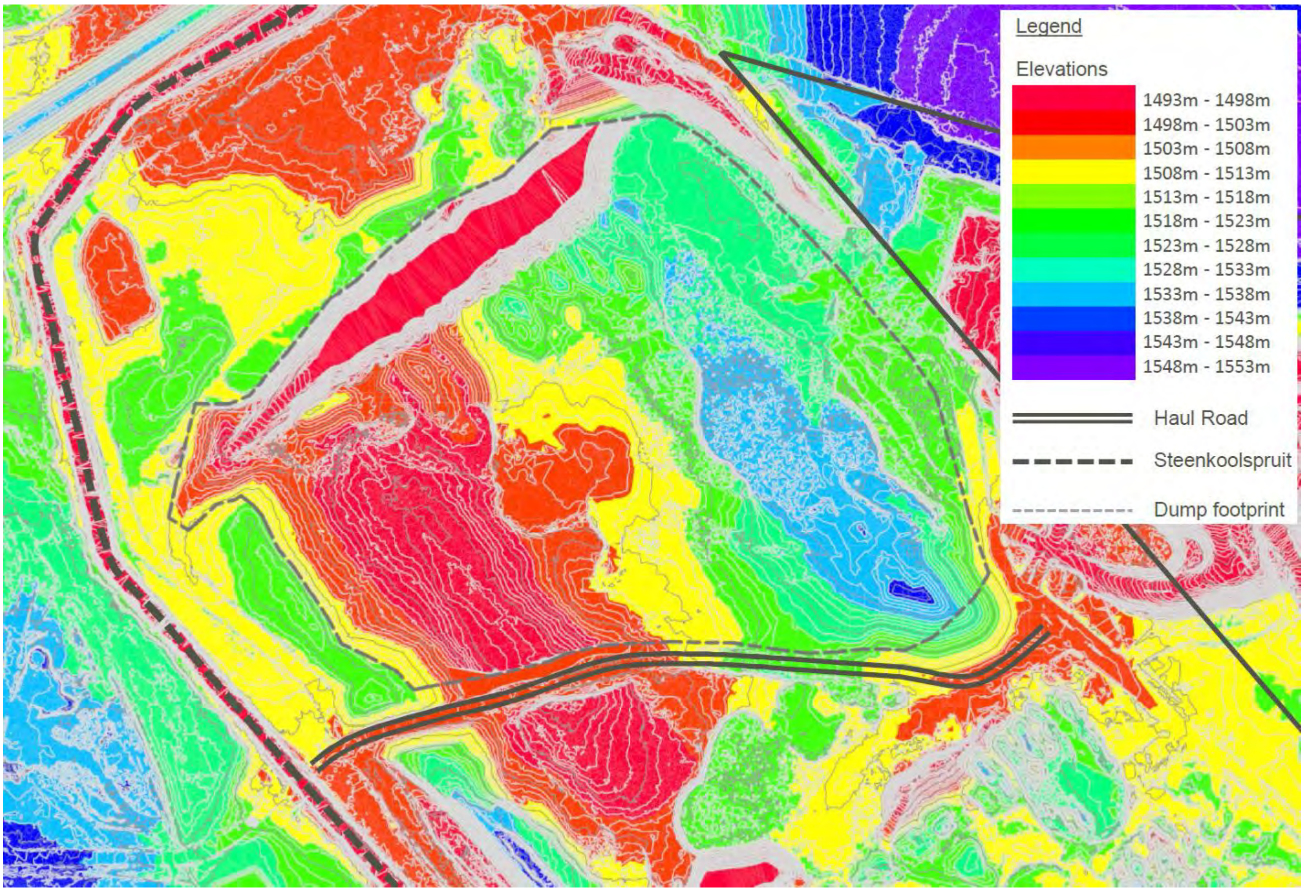

Figure 1: Elevation map

It is noted that Golder previously conducted a detailed landform and drainage design for the Atcom South open pit area as well as the conceptual design and optimization of a long-term post-mining landform and drainage, to guide materials movement as part of integrated rehabilitation planning for the Triangle area. It was recommended to revise this as part of the discard dump conceptualisation specifically to inform the drainage regime of the area with the inclusion of the discard dump and taking account of changes to the surrounding topography to date. The mine indicated that this work will only be done in 2019. The drainage regime was therefore based on the latest available topographical survey and proposed discard dump design.

4.2 Thermal Survey

Southern Mapping conducted a thermal scan on 24 July 2017. The recorded temperatures, ranging from 0 to 160 degrees Celsius, are shown in Figure 2 (Southern Mapping, 2017). High temperatures that are indicative of spontaneous combustion are indicated in the red boundary.

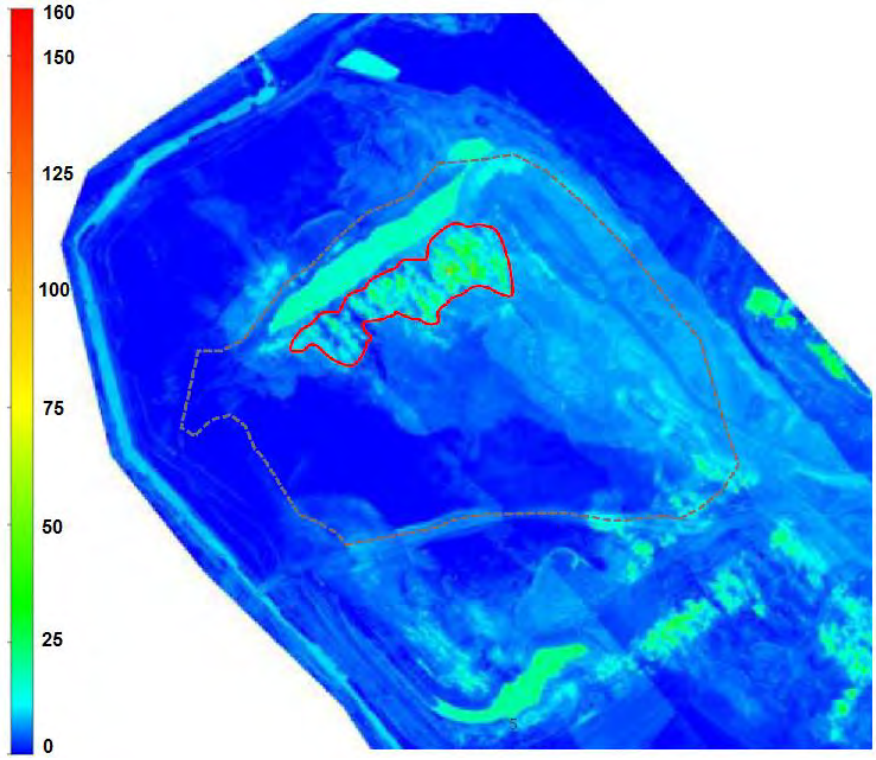

Figure 2: Thermal survey temperature map

5.0 BASIS OF DESIGN

The dump was designed to accommodate 29 million m³ coarse discard. A phased construction approach of the dump was considered to minimize the need for clean and dirty water separation measures as well as to allow for the timeous construction of blanket layers on hot areas. This also assisted to determine the final footprint of the dump indicated in Figure 3. Based on the findings of the geotechnical work supporting the stability of the fine paddocks, the stability of the discard dump is implied for the purpose of the prefeasibility design.

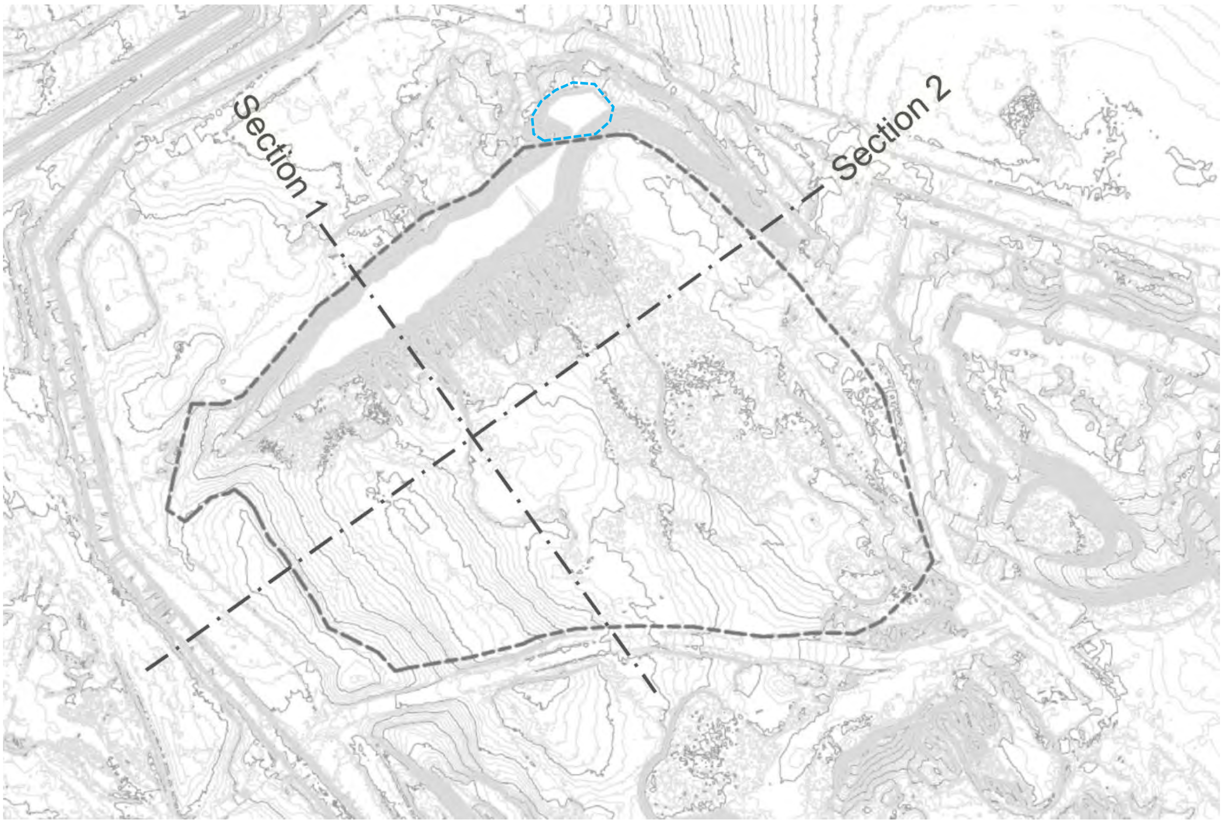

Figure 3: Dump footprint and sections

Discard volumes was provided by Rohan Roach on 29 June 2017 and are shown in Figure 4.

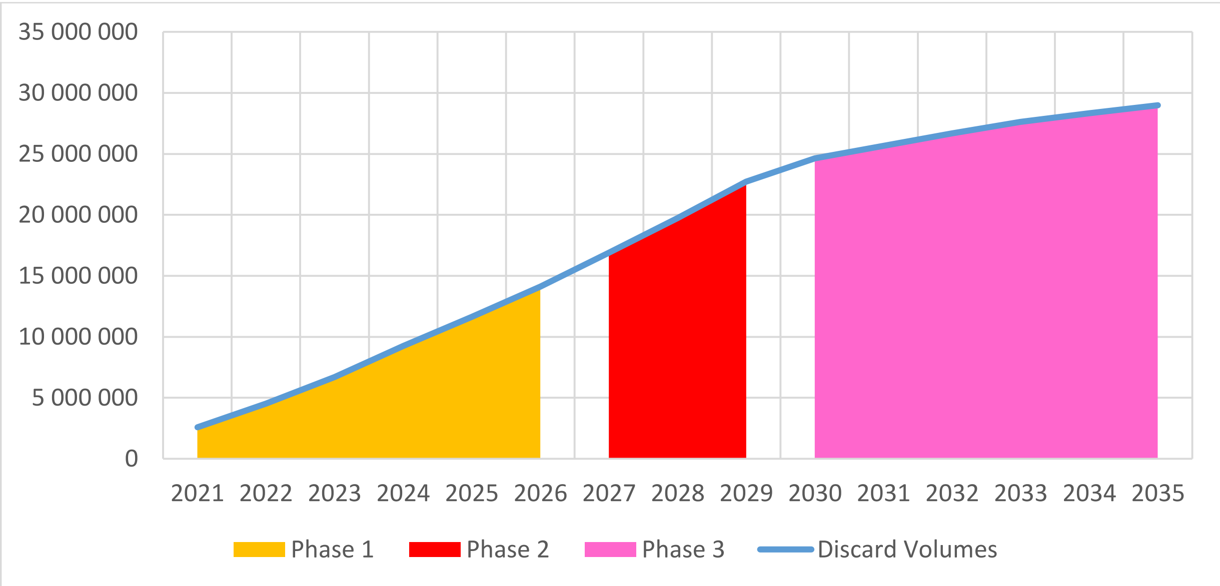

Figure 4: Discard Volumes (m³)

Figure 5 and Figure 6 shows a section of the combined three phases that forms the final profile of the dump. The blue line shows the elevation of the last conceptual post-mining landform design conducted by Golder. The brown line shows the elevations of the latest topographical survey.

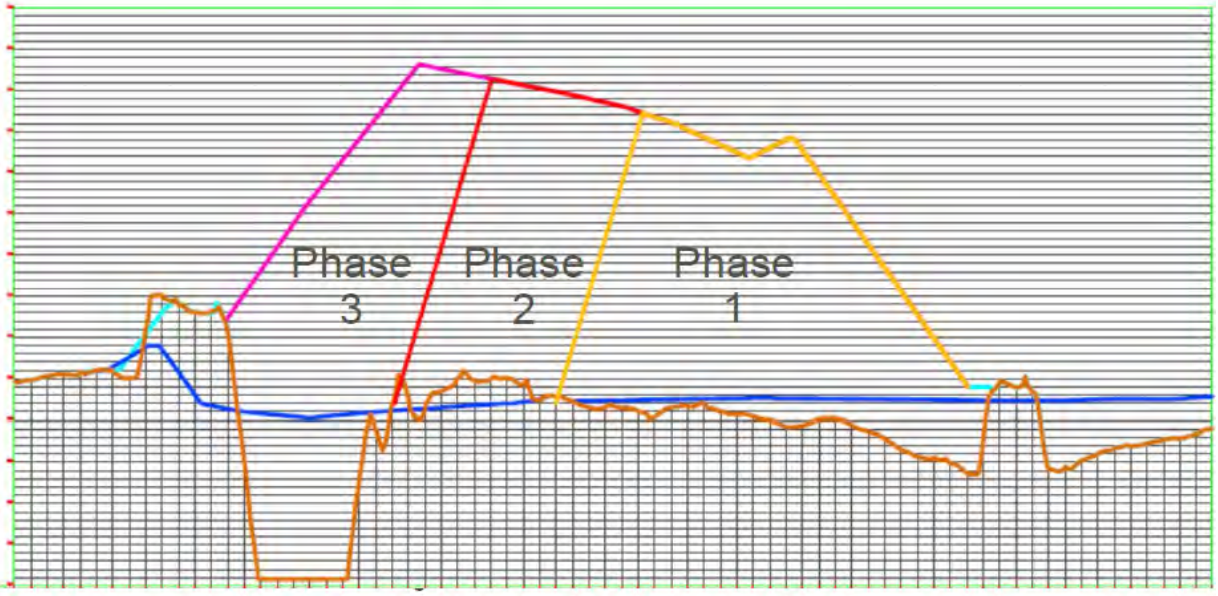

Figure 5: Section 1

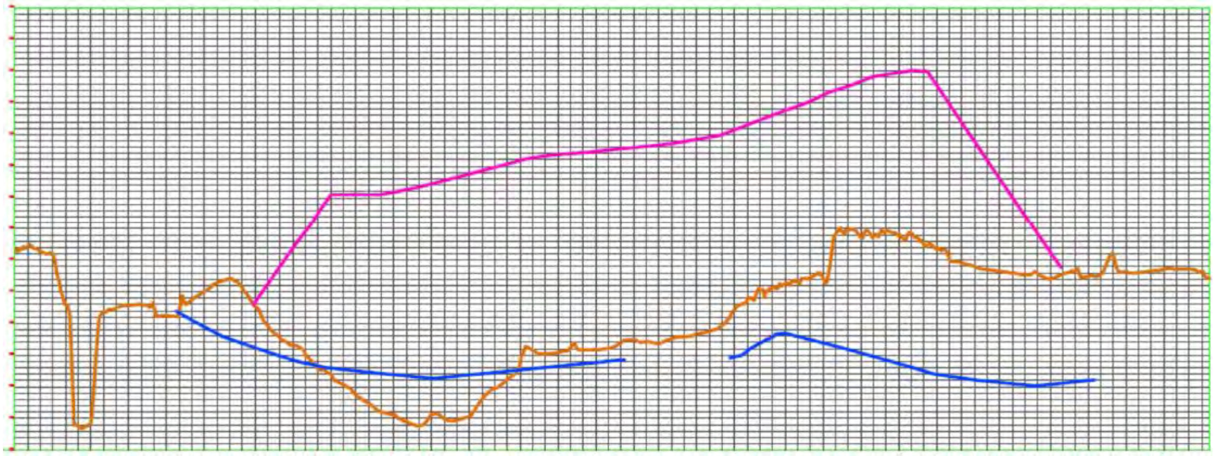

Figure 6: Section 2

5.1 Side slope design

The available footprint and height restriction allowed to make use of side slopes of 1:7. This was selected for the following reasons:

- The slopes would be flat enough to also function as a stable landform for closure. The dump would therefore not require any further shaping and concurrent topsoil placement and vegetation can take place when the outer slopes of the phases are completed; and
- The flatter outer slopes allowed for easier and safer implementation of the rehabilitation measures.

The discard should be compacted sufficiently directly after placement to avoid oxygen ingress and consequently spontaneous combustion. The side slopes of the advancing face of the dump were therefore designed to a slope of 1:3. Discard should not be steeper than a slope of 1:3 during any stage of discard placement to allow for safe access of construction and compaction vehicles.

5.2 Blanket layers

Heat flux modelling (Golder report no. 12593-9906-4) was conducted to inform the design of the coarse and fines paddocks currently being constructed on the cooler areas of the South pit. Relevant aspects of the report are mentioned as a basis to determine the requirement and suitability of a blanket/isolation layer to reduce temperatures on the surface to such an extent that the discard could be safely placed on this barrier.

The following two options were considered:

- Option 1: Isolation layer open to the atmosphere; and
- Option 2: Isolation layer covered by discard.

The report concluded that weather conditions were very important to allow for sufficient cooling. The immediate covering of the isolation layer with discard was hence not recommended as an option.

Figure 7 shows the modelling results of the surface temperature of the isolation layer for various waste temperatures and wind speeds. The isolation layer considered was a 1m thick soil layer compacted to a density of 2000 kg/m³.

Given the average wind speed of 4m/s in the northern parts of South Africa and maximum measured temperatures of 160 degrees Celsius on the South pit, it is inferred that a similar blanket layer can successfully be applied as a cooling mechanism prior to the placement of discard on hot areas as shown in Figure 2.

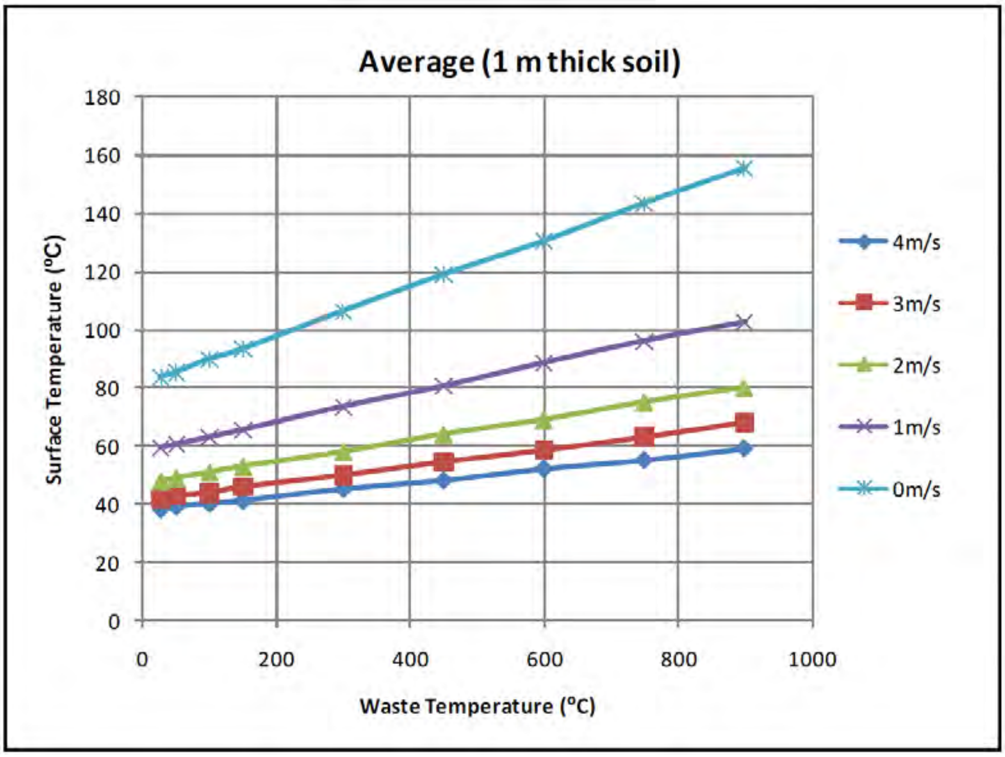

Figure 7: Average surface temperature with varying spoils (waste) temperature and wind speed

5.3 Phase 1

Phase 1 (Figure 8) was located on the cooler areas with no significant hot spots. The footprint area is 83.3 ha providing placement capacity to mid-2026 of approximately 15 000 000 m³. The upper surface of the dump was designed to drain to the western side of the dump. The rehabilitated high lying area to the west provides a natural cut-off for dirty water and is directed to the north into ramp currently being used as a dirty water management facility. The northern and eastern areas are considered to be dirty water catchments and can receive run-off from the dump directly. Dirty run-off from the southern side slopes drain towards a low lying area. Similar to the planned draining of low areas at the fine paddocks, a new borehole/s will collect the run-off and act as a conduit to provide temporary drainage to the underground workings during construction of the dump. No additional clean/dirty water separation measure will be required for this phase.

Construction of the first phase will last approximately 6.5 years which allows for sufficient time to level and construct a blanket layer to cool down the hot areas indicated with the dotted red line.

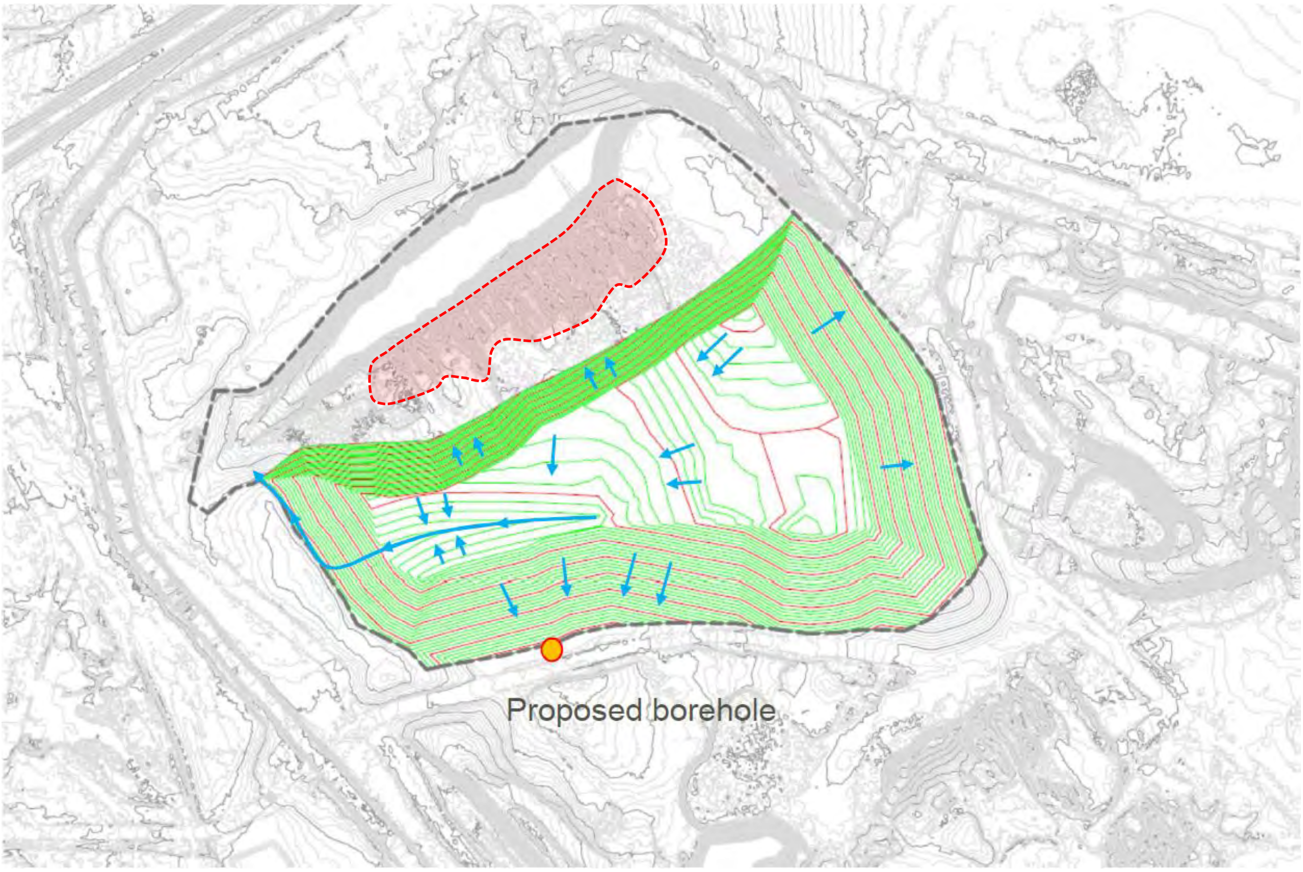

Figure 8: Phase 1 layout

5.4 Phase 2

Phase 2 (Figure 9) was located on the hot areas that should at time of construction, have cooled off sufficiently with the construction of the blanket layer during the first phase. The footprint area is 23.6 ha providing placement capacity to mid-2029 of approximately 7 730 000 m³. The run-off from the extended northern and eastern side slopes will again drain into the surrounding dirty catchments. No additional clean/dirty water separation measure will be required.

Figure 9: Phase 2 layout

5.5 Phase 3

The third and final phase (Figure 10) was located on and over the ramp/water management facility. The footprint area is 21.6 ha providing placement capacity to 2035 of approximately 6 250 000 m³. The run-off from the extended northern and eastern side slopes will again drain into the surrounding dirty catchments. During the final stages when discard placement extends past the ramp, a temporary cut-off berm will have to be constructed. Dirty run-off will be separated from the clean area to the north by the berm until the completed side slope has been vegetated. Careful consideration should be given to the level of rehabilitation of the Triangle pit that has taken place as at and during Phase 3. If the receiving catchment is then considered to be clean, a smaller unfilled section can be left in the ramp to receive dirty water from the dump via a cut-off berm. The last unfilled section of the ramp will act as a pollution control dam and can be closed and rehabilitated when the remainder of the dump have been rehabilitated and considered to be clean.

The void (approximately 300 000m³) indicated with the dotted blue line Figure 3 and Figure 10 will have to be filled with waste or discard prior to the completion of phase 3.

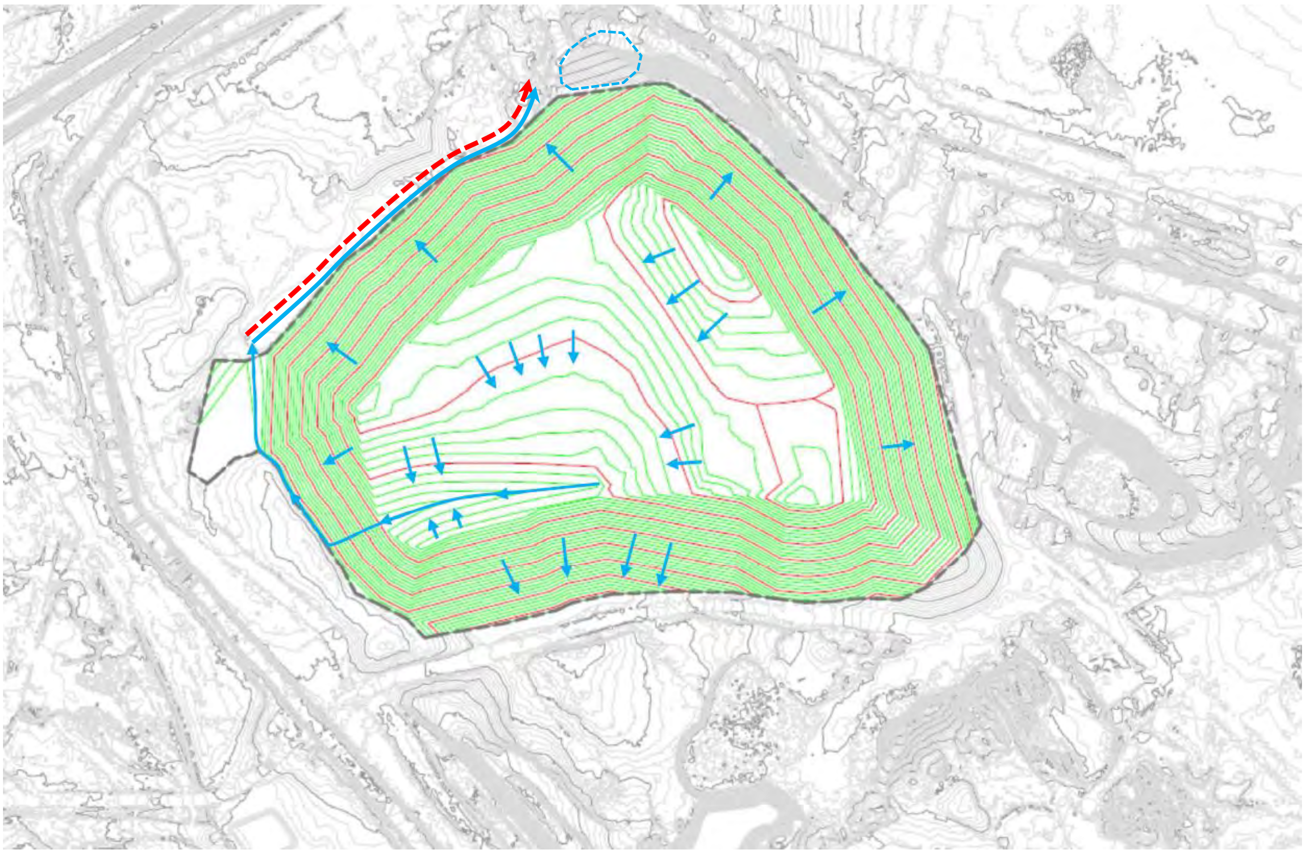

Figure 10: Phase 3 layout

5.6 Dump closure and drainage regime

No additional shaping will be required after the completion of the last phase. Topsoil placement and vegetation can commence at any time once the outer slope and upper surface elevations have been reached.

Final drainage at closure is shown in Figure 11. Catchment areas on the dump will be considered clean at successful vegetation establishment when after the temporary cut-off berm can be removed. Run-off from the eastern side slope will drain into a new clean water drainage line that will be established during the rehabilitation of the Triangle. The low lying area to the south of the dump will have to be filled to be to free-draining to comply with the general mine closure requirement to ensure that all clean water can be free draining post-mining. This provides for a possible route to the Steenkoolspruit to drain the run-off from the southern side slopes. The borehole can consequently be decommissioned.

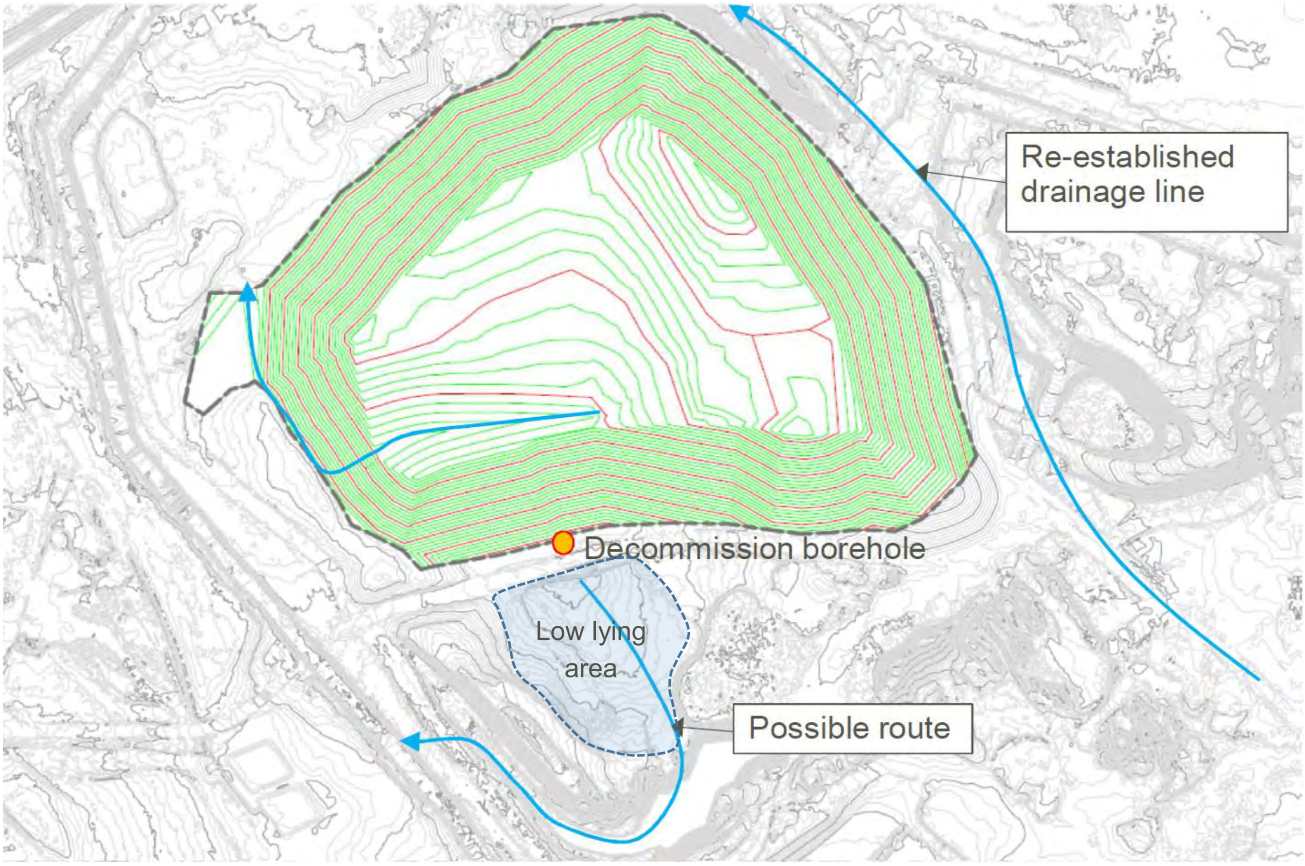

Figure 11: Final closure layout and drainage

6.0 CONCLUSION

The mine requested Golder to conceptualise to prefeasibility level a new discard dump on the remainder of the Atcom South infilled pit to dispose of approximately 29 million m³ coarse discard. The above prefeasibility discard dump design was presented to the mine during a meeting on 06 February 2018.

The following conclusions are made:

- There is sufficient space available within the battery limits to construct a discard dump of 29 million m³;
- Burning/hot areas can be sufficiently cooled with blanket layers to safely receive discard by means of a phased approach;
- Clean and dirty water separation measures are limited to the construction of one cut-off berm on the northern side of the dump and a temporary borehole as a drainage conduit to the underground workings on the southern edge of the dump;
- The side slopes and upper surface of the dump was designed to be aligned with a suitable profile for final closure. No additional shaping will be required for rehabilitation or closure purposes;
- Topsoil placement and vegetation can commence at any time once the outer slope and upper surface elevations have been reached for a specific area; and
- The cut-off berm and borehole can be decommissioned and removed after rehabilitation of the dump and low lying area south of the dump.

It is finally concluded that the discard dump design, at a prefeasibility level, is practical and viable and can be taken to a feasibility level detail.

The following recommendations are made:

- Update the conceptual landform designs for the overall Atcom mining areas;
- Investigate the use of the proposed borehole as drainage conduit to a suitable level of detail;
- Include differential settlement and low wall stability analysis in the next design phase; and
- Hydrological modelling should be done to determine how run-off from the upper surface can best be drained with a dedicated engineered channel on the western side.

7.0 REFERENCES

Southern Mapping. (2017). *Glencore Impunzi Colliery Thermal Survey Report.* Emalahleni: Southern Mapping.

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APPENDIX A

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APPENDIX I

Preliminary Design Report for Venture Co-disposal Facility

REPORT

Technical Design Report for Venture Co-Disposal Facility

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Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX A
Venture Co-disposal Facility - Design Drawings

1.0 INTRODUCTION

Golder Associates Africa Pty (Ltd) (Golder) has been appointed by Glencore Coal South Africa (GCSA) to design a co-disposal facility as an extension to the existing Venture Coal Discard Dump (Venture Dump) located at their iMpunzi mine in Mpumalanga Province.

The new co-disposal facility, called Venture Co-disposal Facility, had been designed to store approximately 2.16 Mm^3 of coal fines material and 5.8 Mm^3 of coarse coal discard material. The coarse discard material will be placed and compacted to form an impounding embankment within which the coal fines will be hydraulically placed and stored.

The new co-disposal facility will be located adjacent to the existing Venture Dump and founded on backfill material placed within a previous opencast pit. The total facility footprint will exist within the surface extents of this previous opencast pit.

2.0 BACKGROUND

2.1 Project evolution

Golder was originally contracted to provide a design for an extension to the existing coarse discard facility Venture Dump. However, upon consideration of the life of mine at the iMpunzi mine GCSA identified the need for additional fines storage capacity. The original design intent was then changed to the provision of a new design for a co-disposal facility adjacent to the Venture Dump and located within the extents of a previously backfilled pit. This change was intended to provide storage capacity for coal fines material whilst still allowing for storage of coarse discard material.

A concept level design was completed for the coarse discard Venture Dump extension prior to the change in design intent. This design is detailed in the report 1784077-318290-1 *Concept Engineering Design for Venture Coal Discard Dump at iMpunzi Mine Complex*, Golder Associates Africa, March 2018 (Golder, 2018).

2.2 Site location

The iMpunzi Mine Complex is located in Mpumalanga Province, approximately 17 km south of Emalahleni and 43 km south-west of Middelburg. The Venture Co-disposal site is situated within the iMpunzi Complex, approximately 0.5 km north of the mine’s Central Plant and 0.8 km west of the R547 road. The locality map of the mine is shown in Figure 1 below.

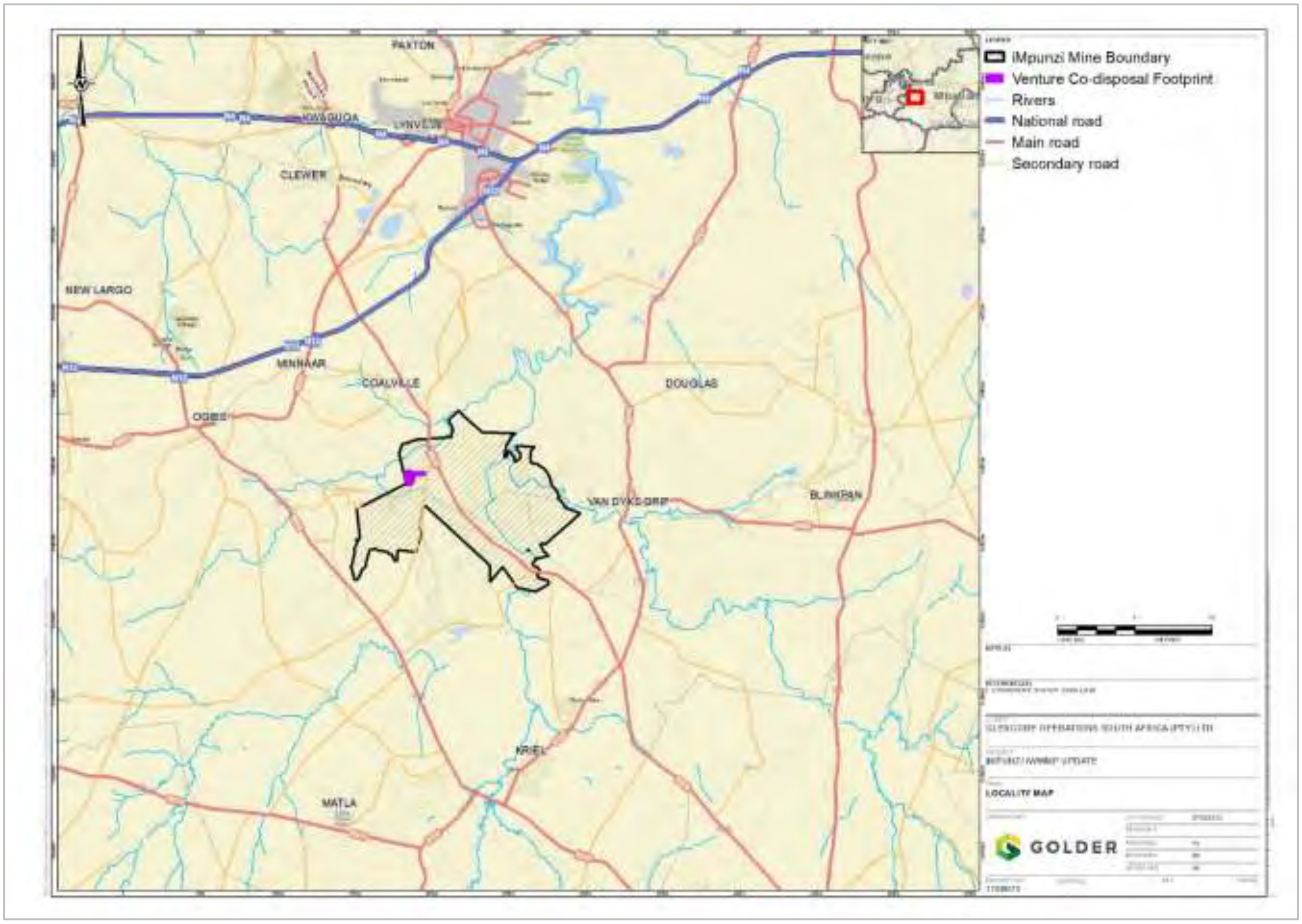

Figure 1: Locality of Venture Co-Disposal.

2.3 Site selection

The positioning of the facility was initially guided by the original design intent in which only an expansion of the existing Venture Dump was to be built. This expansion was originally planned to extend in the south-east and northwest directions from the current Venture Dump configuration. Upon initiation of work for the concept design of this expansion however, sinkholes were identified in the ground surface to the south-east of Venture Dump. A surface subsidence assessment was completed, and the findings indicated that the surface subsidence features were the result of partial collapse of closed underground workings underlying the area. It was noted that further collapse of these workings was likely, and thus posed a hazard to any construction activities at the surface (Golder, 2018). Based on the findings of the surface subsidence assessment, the design of the planned expansion of Venture Dump to the south-east was not conducted and an expansion to the north-west only was completed.

When the design of the facility was changed from a coarse discard only facility to a co-disposal facility it was decided that the location of the facility would not change. This decision was primarily based on the previous function of the area as an opencast pit which had been subsequently backfilled and rehabilitated. The full footprint of the facility was intended to remain within the surface limits of the previous pit and thus the facility would be located on an area already impacted by mining activities. This was considered a significant environmental advantage for the site and one which would not be present for any other sites within the iMpunzi Mine Complex.

2.4 Project objectives

The primary objectives of the project were to provide a detailed design for a coal waste co-disposal facility which would be fully compliant to applicable regulations and provide storage for a certain volume of coal fines and coal discard material as specified by GCSA.

3.0 DESIGN CRITERIA

The design criteria for the co-disposal facility was generated taking the project site and material-specific characteristics into account. The design of the facility and associated infrastructure was completed in compliance with the following applicable regulations and guidelines.

- Government Notice 704, (Regulations on use of water for mining and related activities aimed at the protection of water resources, 1999) promulgated in terms of the National Water Act, 1998 (Act No. 36 of 1998).
- The (National Environmental Management: Waste Act, 2008) (Act No. 59 of 2008).
- South African National Standards 10286:1998 Code of Practice Mine Residue.

The latest design criteria used in the design of the facility is summarized in Table 1 below.

Table 1: Venture Co-disposal Facility Design Criteria.

Parameter	Design Input	Source	Notes
Life of Mine			
Life of facility	9 years	GCSA	Originally 2018 – 2026. Approximately 2021 - 2030
Facility start date	June 2021	GCSA	GCSA requirement
Total tonnage	Coal Fines = 2 160 00 tonnes Coal course discard = 5 805 00 tonnes	GCSA	
Coal Fines Characteristics			
Design slurry density (solids concentration)	25% solids by mass *(Range from 16.8 to 29.6%)*	GCSA	
Particle size distribution and plasticity	Nominally 49% passing 75 µm, non-plastic	STL	From geotechnical laboratory test results
Average tailings solids density (Specific gravity)	1.77 t/m^3	Golder	No change from existing, laboratory testing

Parameter	Design Input	Source	Notes
Average in situ dry density	1.0 t/m^3	Golder	Conservative assumption based on typical density ranges for coal fines material.
Beach slope	1:200 (V:H)	Golder	Conservative assumption based on typical beach slopes of similar facilities.
Shear strength	Test work in progress	Golder	
NEMWA R635 waste type	Type 3	(Golder, 2018a)	
Coal Discard Characteristics			
Compacted dry density	1.6 t/m^3	Golder	Based on compactions achieved at the South Pit Fines Paddocks facility (SPFP)
Shear strength parameters	No test work completed; Φ = 35° c' = 0 kPa	Golder	Based on parameters noted in (Chamber of Mines, 1996)
Design Stormwater Management			
1 in 50-year, 24-hour event	126 mm	Golder	
Average annual rainfall	745 mm	Golder	(Golder, 2020)
Average evaporation loss	1471 mm	Golder	(Golder, 2020)
TSF decant pond maximum size during operation	15% of operating basin area	Golder	(Golder, 2020)
Minimum Freeboard Requirement	1 m (0.8 m + 1:50 year, 24 storm event = 0.933 m)	GN 704	GN 704 prescribes minimum freeboard required for mine waste facilities
Geometric Design			

Parameter	Design Input	Source	Notes
Embankment design	Crest widths = 5 m (starter wall) – 30 m (final) Crest slope = 2% towards upstream crest margin Upstream slope = 1V:3H Downstream slope = 1V:5H Downstream raises	Golder	Consistent with geometry used at other co-disposal facilities within the GCSA operations.
Estimated maximum embankment height	20 m	Golder	
Basin area	369 242 m^2	Golder	

3.1 Deposition tonnages

Figure 2 below shows the expected coal fines and discard material production tonnages which are to be stored in the Venture Co-disposal over the life of the facility. The start of the facility was originally planned for 2018 however the start date was pushed back and is now planned for 2021. The tonnages shown in Figure 2 were those planned for the original start of the facility however GCSA has confirmed that the same tonnage profile is expected for the 2021 start date. The tonnages of coal fines and coal discard material were specified as 240 000 tonnes per annum and 1 032 000 tonnes per annum respectively and were to remain constant over the nine-year life of the facility resulting in total stored masses of 2 160 000 tones of coal fines and 9 288 000 tones of coal discards. Using the assumed dry densities of 1t/m^3 and 1.6t/m^3 for the coal fines and discards respectively the required storage capacities per year were 240 000 m^3 for the coal fines and 645 000 m^3 for the discards. The total volumes stored at the end of the nine-year life would be 2 160 000 m^3 of coal fines and 5 805 000 m^3 of coal discards.

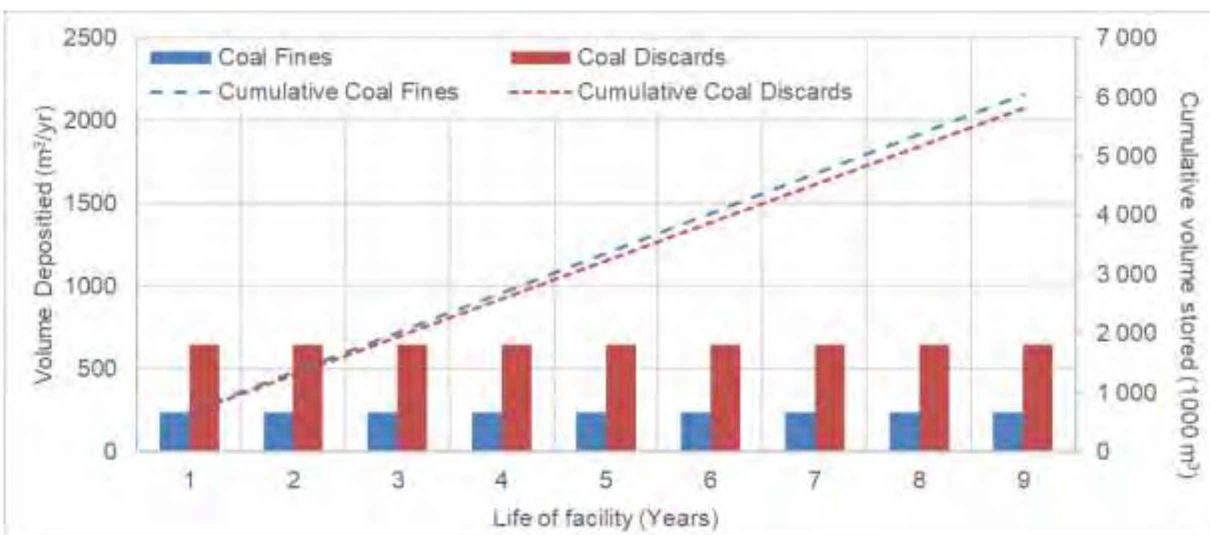

Figure 2: Required Storage Capacities for Venture Co-disposal.

4.0 CO-DISPOSL DESIGN

4.1 Site description

The Venture Co-disposal site is located north west of the existing Venture Dump and north of the Central plant. Vacant but previously disturbed land is present to the north and west and the Saaiwaterspruit stream a drainage path leading into Phoenix dam is located approximately 900 m northwest to north of the site. The western boundary of the site lies closely adjacent to the western property boundary of the iMpunzi mine.

The planned footprint of the facility lies entirely within the surface limit of the previous (and now backfilled and rehabilitated) opencast pit. This includes the planned footprint areas of the retaining embankments.

The Pollution Control Dam (PCD) of the existing Venture Dump currently lies within the planned footprint of the co-disposal. This PCD will be decommissioned and removed prior to the start of construction of the co-disposal. A new return water dam (RWD) structure is planned to be constructed to the north of the co-disposal footprint, adjacent to the northwestern corner of the facility. This new PCD structure will serve to collect and store water from the surface water management channels to be constructed around the co-disposal as well as decant water pumped from the basin area of the facility.

4.2 Material Characterisation

The particle size distribution (PSD) of the coal fines material is shown in Figure 2. These were results of the foundation indicator testing completed on the coal fines material collected from the slurry delivery line currently transporting fines material to the South Pit Fines Paddocks (SPFP) facility. The material was collected in slurry form and dried to remove all water. These results thus represent the full PSD of fines material expected to be deposited to the Venture Co-disposal Facility.

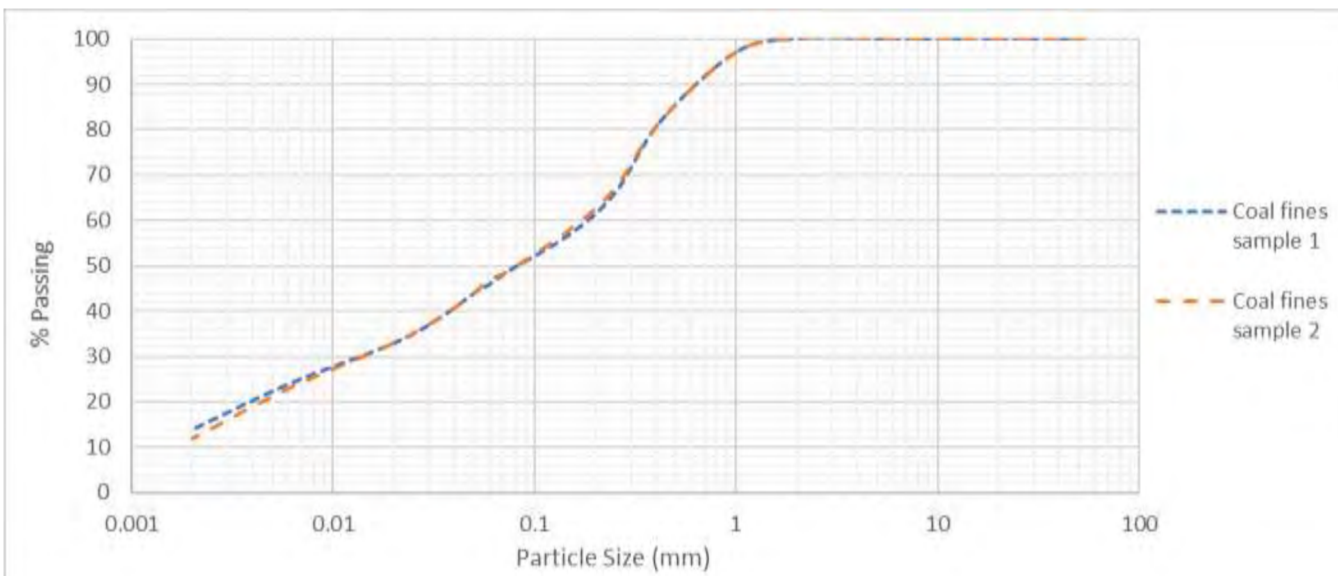

Figure 3: PSD of Coal Fines.

Additional geotechnical investigative work will be undertaken to form input to the final WUL application. This work will include the following:

- Foundation assessment of the material used to backfill the previous pit. This will include in situ investigations and laboratory testing of sampled materials to conceptualize the type and condition of the backfill material.
- Laboratory testing of the discard material.

The Minimum Requirements for Waste Disposal by Landfill, second addition of 1998 describes the geotechnical characteristics required for the design of waste facilities. In addition, the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) also prescribes the characterisation of residue stockpiles and residue deposits and geotechnical investigative work required.

Apart from the regulatory requirements, Golder will utilise the information generated from the additional geotechnical investigative work to update the stability analysis and to complete the design of the facility (e.g. founding conditions for structures, embankment construction, etc.).

4.3 Progressive facility development

The co-disposal facility will be constructed in phases to allow for accommodation of the full volumes of both coal fines and discard material, at the rate of production specified by GCSA. There are five main phases of the facility as detailed in sections 4.3.1 to 4.3.5 below.

4.3.1 Phase 1

The objective of Phase 1 is the construction of a starter embankment to a sufficient height, at which point the fines deposition may begin without encroachment into the required minimum freeboard of 1 m. The starter embankment will be constructed from the coal discards material and compacted to a target density of 1.6 t/m^3. The embankment will have a 5 m wide crest to allow for one-way traffic, and downstream and upstream slopes of 1V:5H and 1V:3H respectively. The width of this embankment is purposefully limited to produce an increased rate of rise and thus achieve the target height in a minimal amount of time. The starter embankment will be built to an elevation of 1533 meters above mean sea level (mamsl) and will have a maximum height of 7 m (lowest point along toe line is 1526 mamsl).

Deposition of the fines will begin when the starter embankment reaches 1533 mamsl along its entire length. It will take approximately 7 months from the start of construction for the starter embankment to reach the target elevation of 1533 mamsl at the prescribed rates of discard production.

The construction of the starter embankment will continue to an elevation of approximately 1535 mamsl along its full length, at which point Phase 2 will begin. This will take approximately an addition 3.5 months from the start of deposition of the fines material.

A layout of the Phase 1 footprint is shown in Figure 4 and included in APPENDIX A.

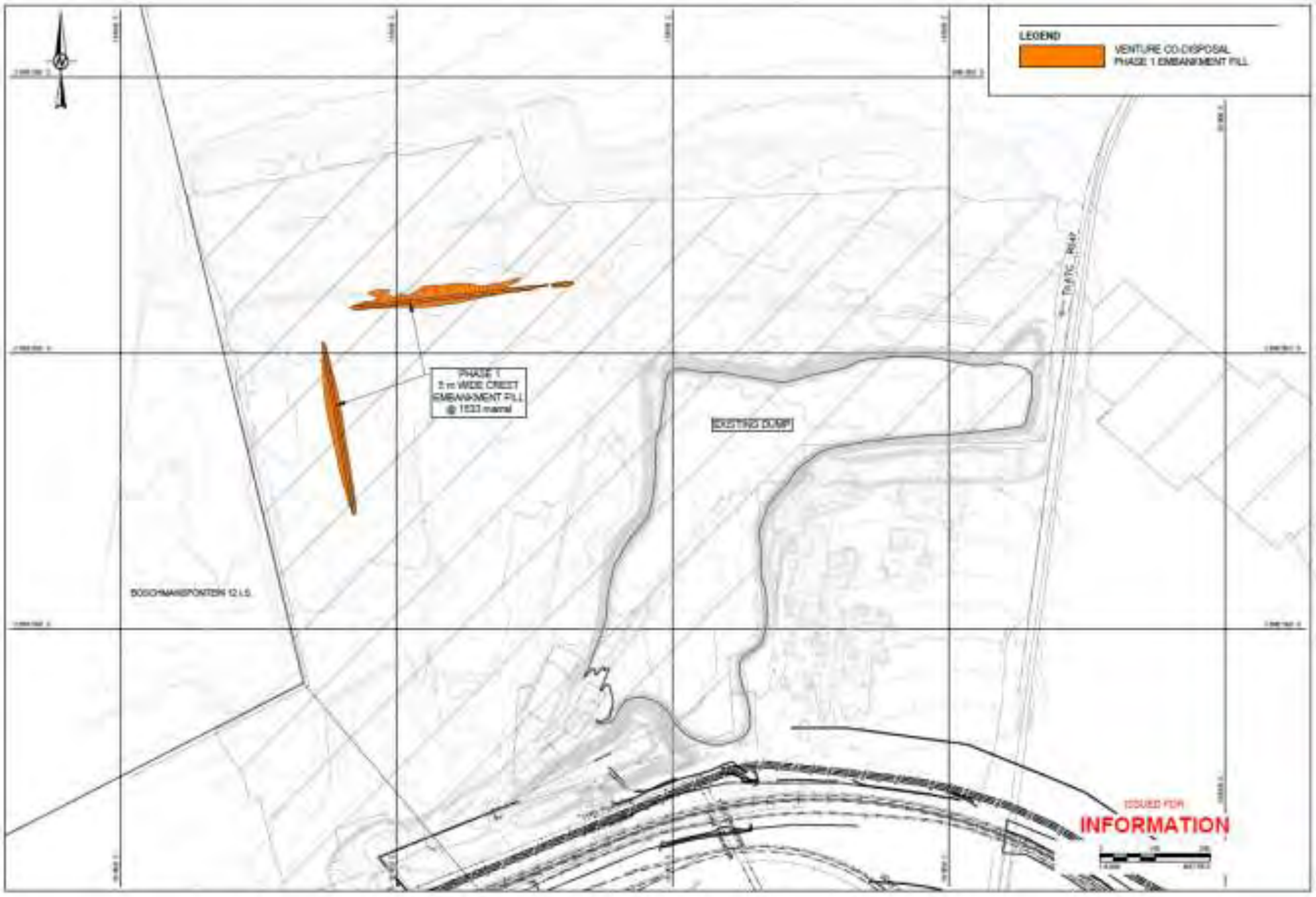

Figure 4: Phase 1 Layout - Venture Co-disposal Facility.

4.3.2 Phase 2

The objective of Phase 2 is to start increasing the width of the starter embankment to provide greater lateral support as the height of retained fines material grows. Construction of the starter embankment structure will continue around the upstream crest line of the final embankment configuration however at the start of this phase one third of the discards material production will be diverted to start the 25 m, downstream, crest extension of the starter embankment. The extension to the starter embankment will ultimately result in a retaining embankment with a 30 m wide crest and downstream and upstream slopes of 1V:5H and 1V:3H respectively.

The 25 m crest extension will begin when the starter embankment has reached an elevation of 1535 mamsl along its full length. At this point the fines in the basin area is predicted to be at an elevation of 1533.5 mamsl based on the prescribed rates of coal fines deposition. Phase 2 will begin approximately 10.5 months from the start of construction.

The construction of the starter embankment and the embankment extension will continue with the constant split of two-thirds to one third (respectively) of the discards production rate, until the start of Phase 3.

A layout of the Phase 2 footprint is shown in Figure 5 and included in APPENDIX A.

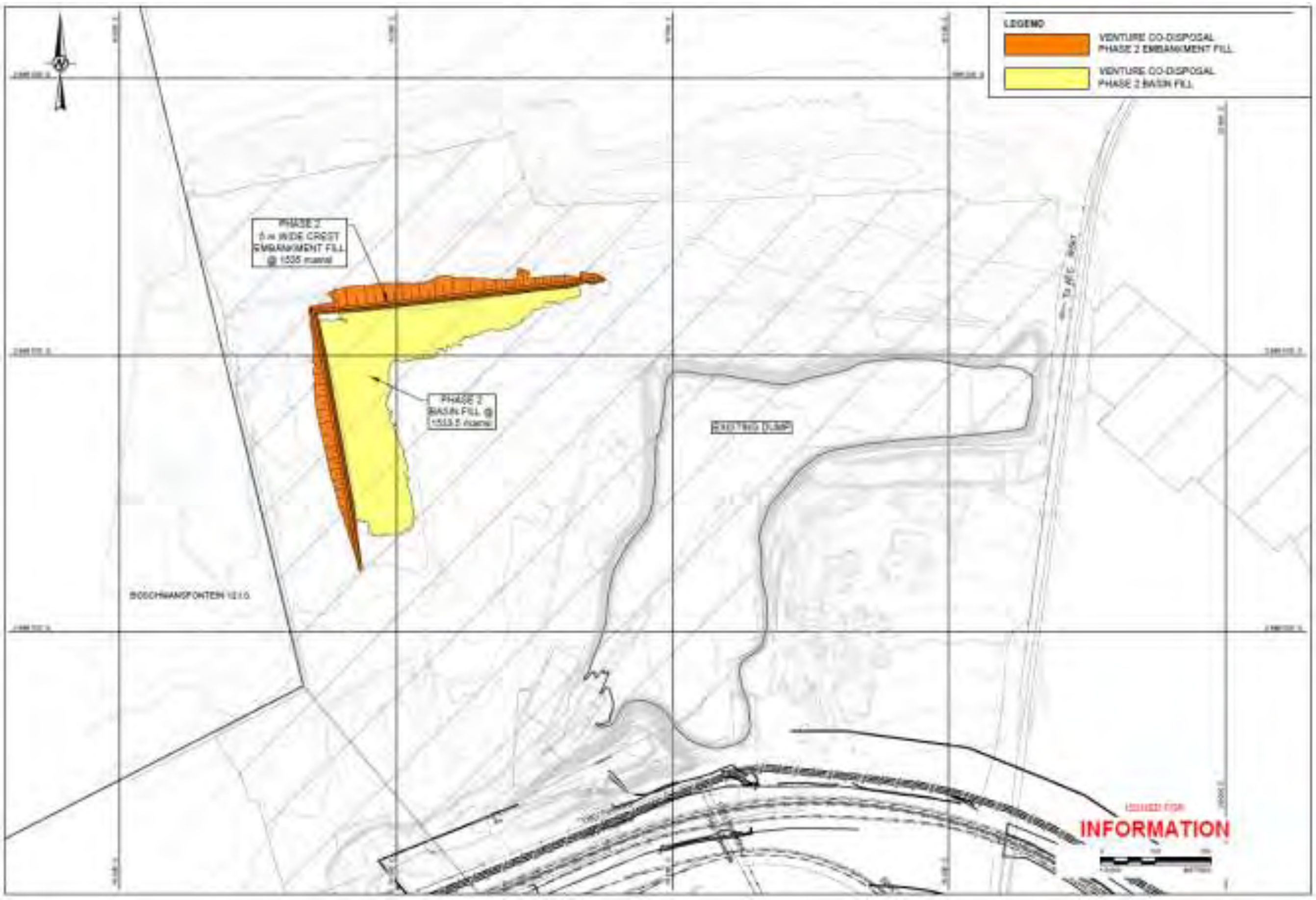

Figure 5: Phase 2 Layout - Venture Co-disposal Facility.

4.3.3 Phase 3

The objective of Phase 3 is to increase the rate of construction of the starter embankment extension. Phase 3 will begin when the 5 m starter embankment has reached the final elevation of 1545 mamsl. Upon completion of the starter embankment the full discard tonnage will be directed to the construction of the 25 m downstream crest extension embankment. Phase 3 will begin approximately 31 months from the start of construction. At the start of phase 3 the fines in the basin area is predicted to be at 1536.8 mamsl.

Deposition of discards to the 25 m extension embankment will continue until the final elevation of 1545 mamsl is reached along the full length. The completion of the extension embankment and the starter embankment will form a combined retaining embankment of 30 m crest width and downstream and upstream slopes of 1V:5H and 1V:3H respectively.

A layout of the Phase 3 footprint is shown in Figure 6 and included in APPENDIX A.

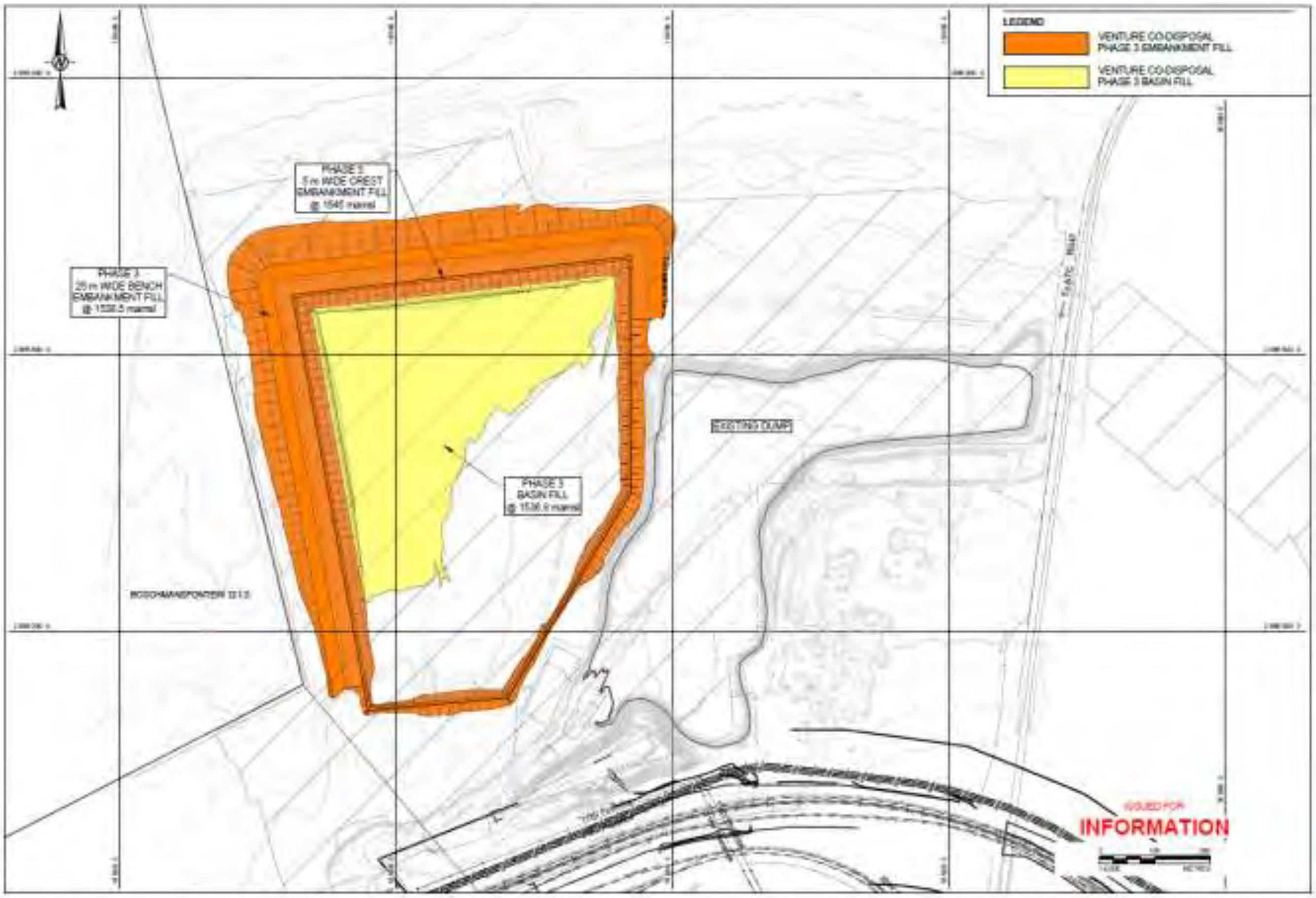

Figure 6: Phase 3 Layout - Venture Co-disposal Facility.

4.3.4 Phase 4

Phase 4 will begin when the extension embankment reaches the final elevation of 1545 mamsl along its full length, approximately 37 months from the start of construction. At this point the full discard tonnage will be redirected to the construction of the northern embankment extension. This extension will serve primarily to provide storage capacity for the discard material. Discard deposition will continue at the northern embankment until the final elevation of 1545 mamsl is reached along the entire embankment area. At the start of Phase 4 the fines in the basin is predicted to be at 1537.5 mamsl.

The starting layout of the Phase 4 footprint is shown in Figure 7 and the final footprint of Phase 4 is shown in Figure 8. Both drawings are included in APPENDIX A.

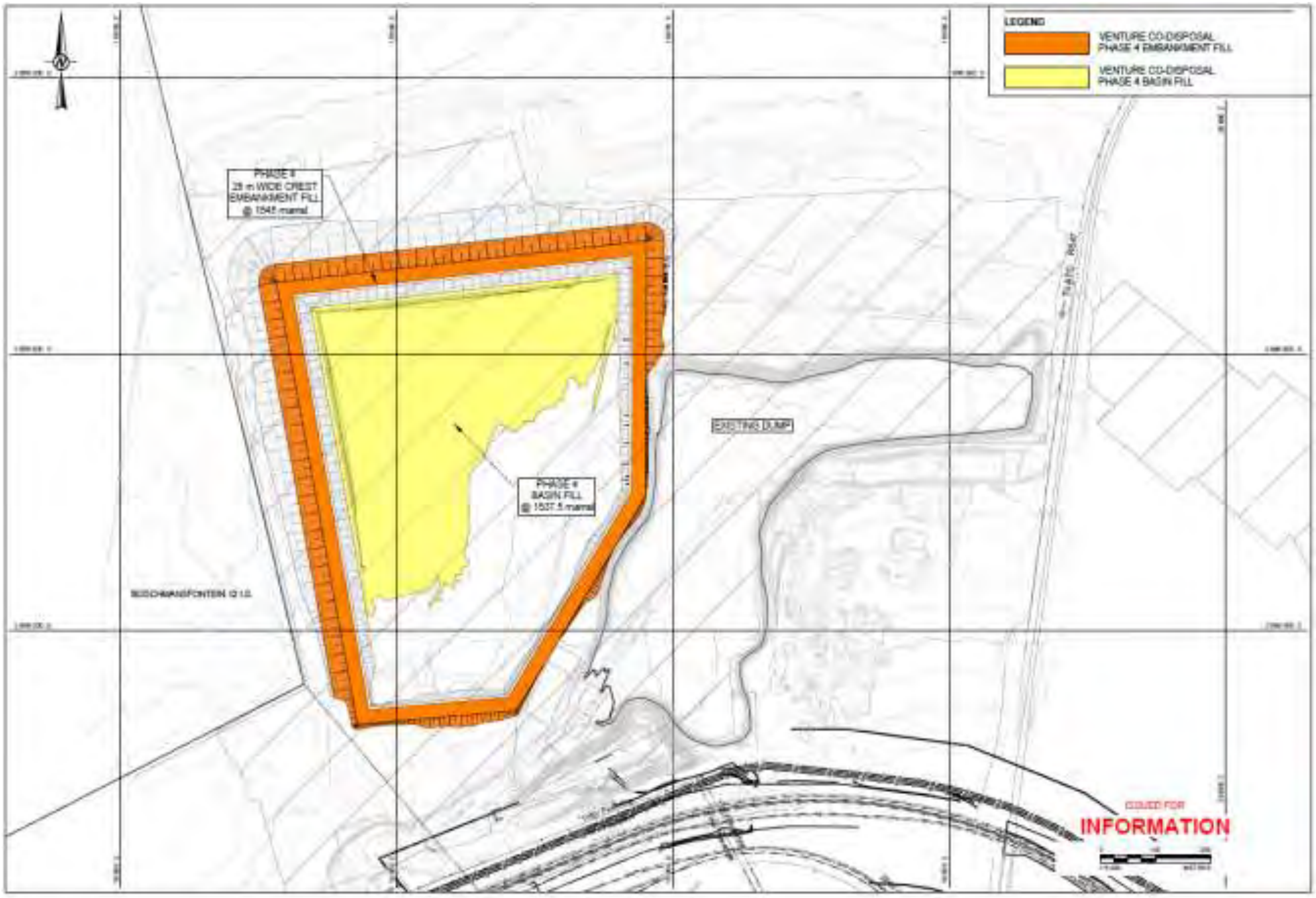

Figure 7: Phase 4 Start Layout - Venture Co-disposal Facility.

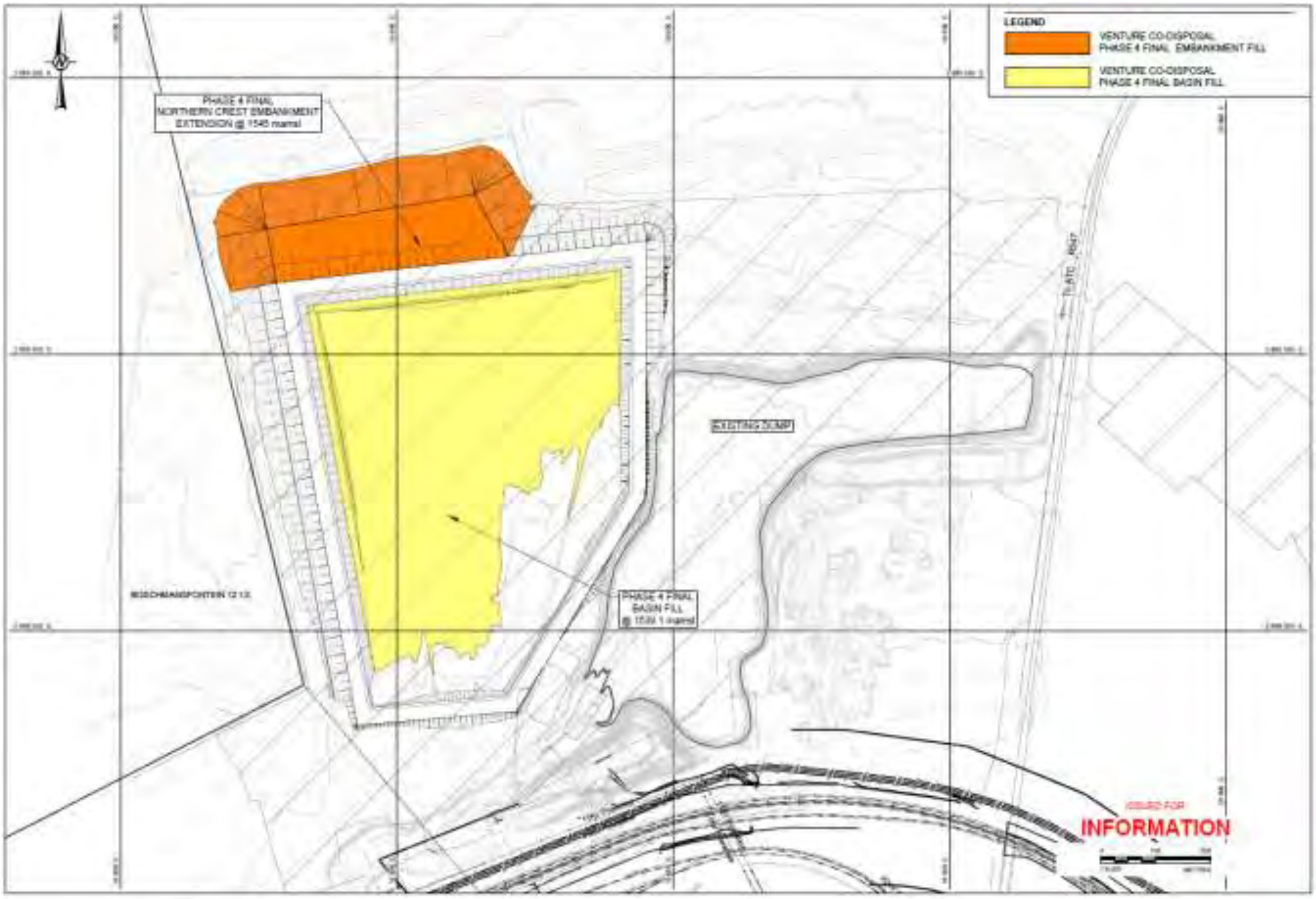

Figure 8: Phase 4 Final Layout - Venture Co-disposal Facility.

4.3.5 Phase 5

Phase 5 will begin when the northern embankment reaches the final elevation of 1545 mamsl along its full length, approximately 54 months from the start of construction. At this point the full discard tonnage will be redirected to the construction of the eastern embankment extension. This extension will serve primarily to provide storage capacity for the discard material. Discard deposition will continue at the eastern embankment until the final elevation of 1560 mamsl is reached along the entire embankment area. At the start of Phase 5 the fines in the basin is predicted to be at 1539.1 mamsl.

Deposition will continue at the eastern embankment and in the basin area for the discards and fines material respectively, until the end of life of the facility. At the end of life the 30 m embankment and the northern embankment extension will be at a final elevation of 1545 mamsl. The eastern embankment will be at a final elevation of 1560 mamsl and the fines in the basin area will be at a final elevation of 1543.0 mamsl.

A layout of the Phase 5 final footprint is shown in and included in APPENDIX A.

Figure 9: Phase 5 Final Layout - Venture Co-disposal Facility.

4.4 Water management

Supernatant water resulting from the slurry deposition of the fines material will be managed in a centralized pool within the basin area of the facility. The pool level shall be maintained by decanting of excess water via a pump barge system. Excess water pumped from the facility shall be transported to the RWD located north of the facility from where the water shall be piped back to Central Plant for reuse. A pump capacity of 250 m^3/day is required to maintain the operational pool at 0.5 m depth (approximately 13 420 m^3).

4.5 Storm water management

The operational storm water management plan was developed to fulfil the requirements of the National Water Act, 1998 (Act 36 of 1998) (NWA) and particularly, Government Notice 704 contained in Government Gazette 20118 of June 1999 (hereafter referred to as GN 704), which deals with the separation of clean and dirty water. The NWA published by the Department of Human Settlement, Water and Sanitation (DHSWS) requires adequate separation of clean and contaminated storm water and the protection of the water resources from contaminated water sources. These regulations were used to guide the design of the storm water drainage plan and the applicable recurrence interval for the design (the post closure channels were sized for the 1:100-year 24-hour storm event).

The full stormwater management plan for the Venture Co-disposal facility is found in (Golder, 2020).

4.6 Liner requirement

4.6.1 Legislative background

The management of mine residues (stockpiles and waste deposits) is governed by regulations under the National Environmental Management: Waste Act (Act 59 of 2008): *Regulations regarding the planning and management of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation* (GN R632 of 2015), which allows for the characterisation of mine residues (all forms of mine waste and stockpiles) as the basis for a risk assessment.

When promulgated, GN R632 of 2015 also provided that the pollution control barrier system be driven by the Waste Classification and Management Regulations (GN R634-636 of 2013), based upon the leachable and total concentrations of specified constituents of concern. GN R632 of 2015 was, however, amended on 21 September 2018, removing the reference to the Waste Classification and Management Regulations, and instead, requiring that the pollution control barrier system be driven by a risk assessment based upon the geochemical hazard and toxicology of the waste material and the risk of the water resource and other receptors.

In addition to the waste licence application, the disposal or stockpiling of mining residues typically requires a water use licence (WUL) in terms of Section 21(g) of the National Water Act (Act 36 of 1998). The *regulations on use of water for mining and related activities, aimed at the protection of water resources* (GN R704 of 1999) provide for the protection of the water resource in the context of mining and related activities, notably:

- Regulation 7(a) which requires the prevention of water containing waste or any substance which is likely to cause pollution from entering a water resource
- Regulation 7(e) which requires that residue deposits and stockpiles be designed with suitable barriers that prevent the leaching of materials from the residue into the water resource.

The standard that is applied by the Department of Water and Sanitation (DWS) in considering the acceptability of a pollution control barrier system, in this regulatory context, is either:

- A ‘compliant design’, which the DWS bases on the Waste Classification and Management Regulations (GN R634-636 of 2013), notwithstanding these regulations no longer being applicable in terms of the amended GN R632 of 2015; or
- A ‘risk-based approach’ to pollution control barrier design, per the exchange of memoranda between the DWS and the Minerals Council (ref. WULA/1/2016 and EPC/60/16, respectively).

If the risk assessment required for the purpose of compliance with GN R632 of 2015 demonstrates that a proposed pollution control barrier provides an acceptable outcome in terms of environmental impact, then it is likely that DWS may also accept the proposed pollution control barrier as a risk-based design.

4.6.2 Approach for Venture Co-disposal

Although a Class C barrier design is required to contain a Type 3 waste in terms of a compliant design, it is proposed to demonstrate that a similar level of protection of the resource can be achieved with the application of alternative intervention measures and design features. These measures include decreasing the volume of dirty water by use of a cover, and interception of dirty water by means of a pressure barrier created in groundwater by pumping wells, which prevents decant from the pit. This approach was based on the premise that the additional waste load from the facility through seepage could be intercepted and managed without unacceptable risk to the environment through the post-closure pit water regime. This methodology was previously approved at the SPFP co-disposal facility also located at and operated by the iMpunzi mine.

5.0 STABILITY ANALYSIS

The stability analyses of two selected discard facility sections were undertaken using Slide (2018), a computer software program produced by RocScience. The ‘Method of Slices’, as proposed by Morgenstern-Price, was used to assess the two-dimensional stability. This method is based on limit equilibrium principles, which satisfy both force and moment equilibrium under either constant or variable ratios of horizontal to vertical inter-slice forces.

5.1 Available information

At the time of conducting the stability analysis no shear strength information about the coal fines, coal discards or foundation material was yet available. Literature values for the two waste materials were thus sourced and used in the analysis while the shear strength of the foundation material was assumed to be that of high strength rock fragment materials where the overall shear strength is further increased based on the confinement provided by the pit shell which would prevent the propagation of a rotational failure through the foundation.

5.2 Model geometry

Figure 10 shows the locations of the two selected critical sections adopted for the stability analysis and Figure 11 and Figure 12 show the geometry of these two sections. These sections were selected as they represented the narrowest sections along the retaining discards embankment and thus represent the most critical sections in terms of stability. The water table was based on the likely position of the supernatant pool at a distance from the retaining embankment and the assumption that the embankment would be free draining based on the gravel and larger particle sizes of the material which would result in large pore sizes and thus drained behavior.

5.3 Target Factors of Safety

The industry accepted standard Factors of Safety (FoS) against failure under static conditions were used as the target FoS for the Venture co-disposal, these were:

- FoS > 1.3 – No loss of containment
- FoS > 1.5 – Loss of containment
- FoS > 1.0 to 1.2 – Post seismic conditions (depending upon the confidence of parameters assigned).

Figure 10: Positions of the Two Sections Included in the Stability Analysis.

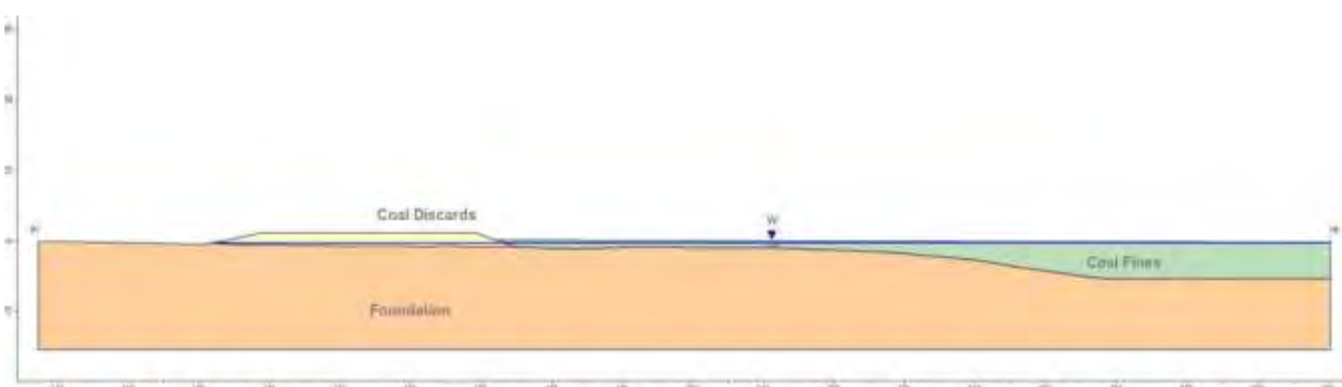

Figure 11: Section A Geometry.

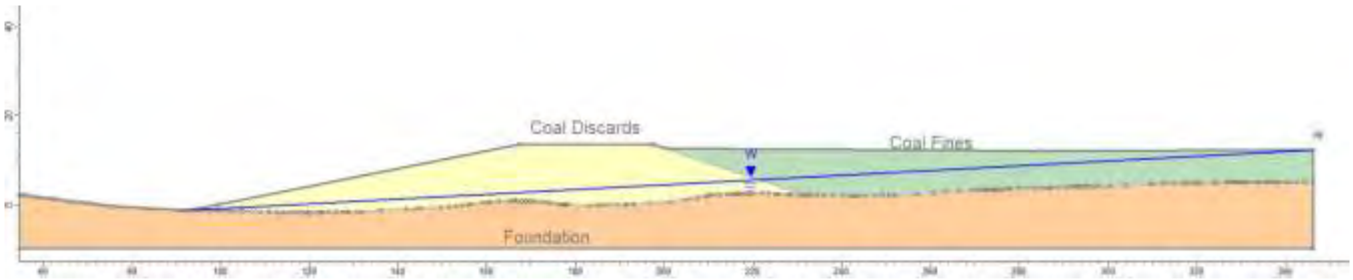

Figure 12: Section B Geometry.

5.4 Material properties

The material strength parameters used in the slope stability analyses are shown in Table 2 below. These strength parameters were derived from the reported values in (Chamber of Mines, 1996) and (Vick, 1983) and the selected values for use in this analysis were the lowest reported values to ensure a conservative approach.

Table 2: Stability Analysis Material Parameters.

Material	Colour Identifier	Unit Weight (kN/m^3)	Apparent Cohesion (kPa)	Friction Angle (ϕ’)
Coal Fines		9.8	0	22˚
Coal Discards		15.7	0	35˚
Foundation		20	0	38˚

5.5 Model approach

The Mohr-Coulomb strength model was used to simulate the shear strength of the discard material and coal fines by defining values for both the friction angle and the apparent cohesion. Drained shear strength parameters were, therefore, applied to the model. Drained conditions were assumed appropriate for the embankment material due to the expected large pore sizes for which undrained conditions would be highly unlikely. A static stability analysis only was considered as the potential for undrained conditions in the discard materials even in post-seismic occurrence is unlikely.

5.6 Model results

The resultant safety factors for the static analyses were 3.9 for Section A and 3.4 for Section B. Thus, the factors of safety were consistently greater than the minimum requirement of 1.5. Based on the conditions analysed in this assessment, the stability of the discard dump is considered to be safe.

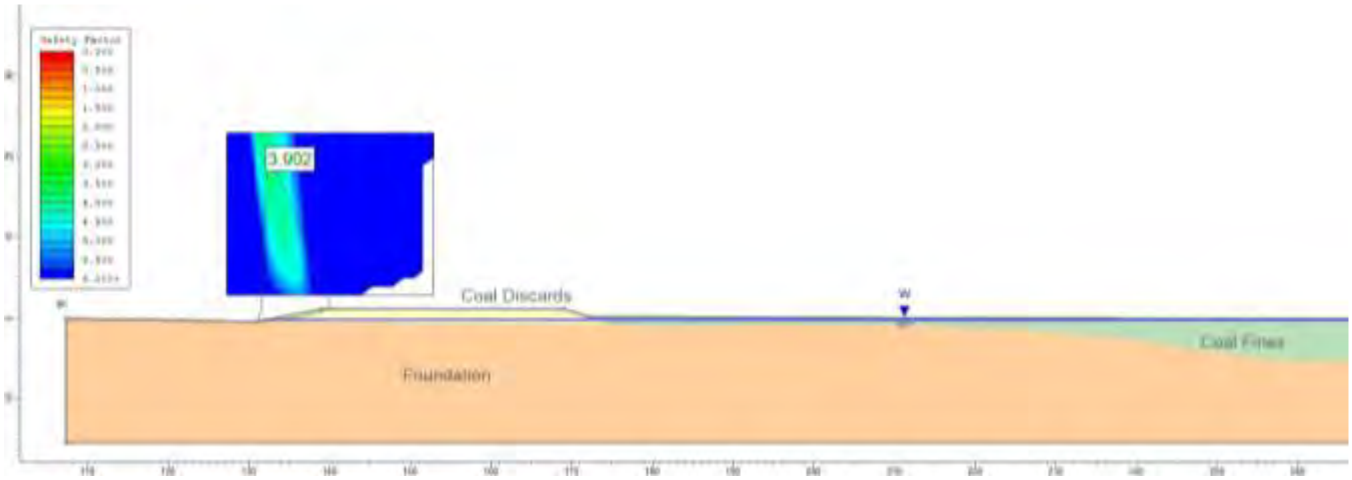

Figure 13: Section A minimum Factor of Safety.

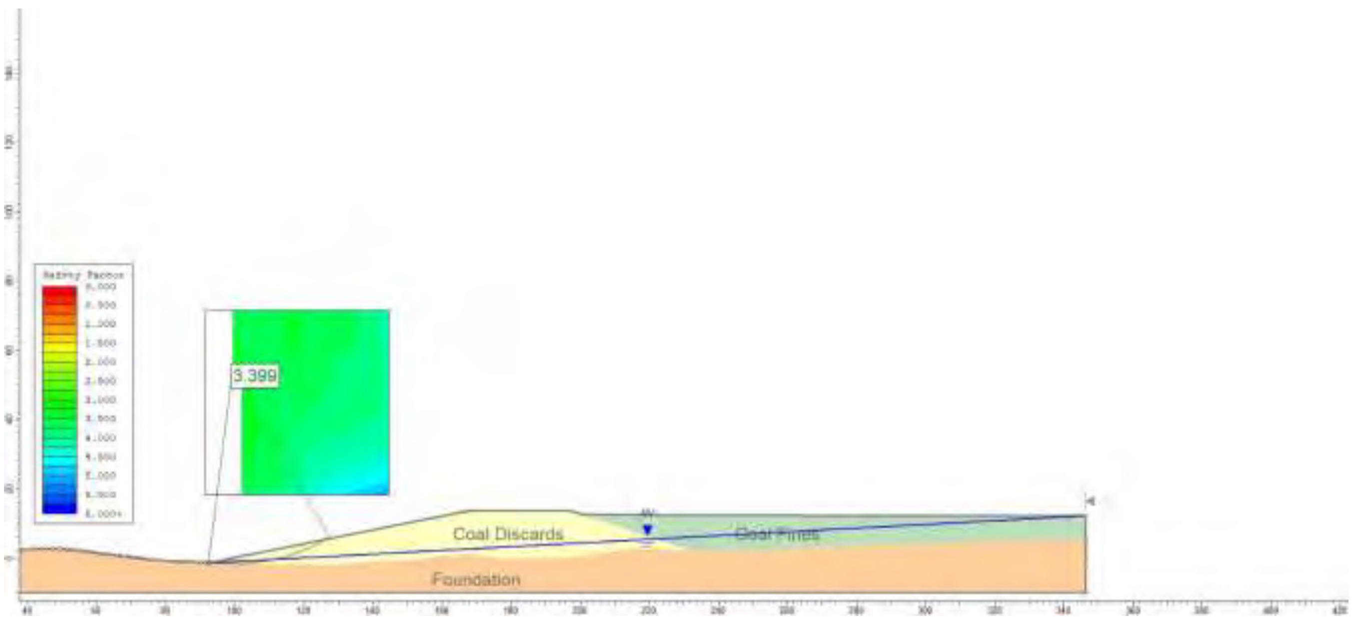

Figure 14: Section B minimum Factor of Safety.

6.0 CONCLUSIONS

The following conclusions have been made:

- The Venture Co-Disposal Facility is located above a previously backfilled opencast pit structure and the total footprint remains within the surface limits of the previous pit preventing extension of the facility onto the surrounding natural ground.
- The facility will store totals of 2.16 Mm^3 of coal fines material and 5.81 Mm^3 of coal discards.

- The stormwater management system for the discard facility will be compliant with the NWA GN 704 regulations in which the clean and dirty water systems are separated and the water routing structures have been designed to contain the 1:50 year, 24-hour storm event.
- The factors of safety for stability were consistently greater than the minimum requirement of 1.5 The facility as designed is thus considered safe in terms of stability.

7.0 REFERENCES

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Golder. (2018a). *Geochemistry Study in terms of the iMpunzi Water Use Licences Preliminary Report.* Golder Associates Africa.

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Regulations on use of water for mining and related activities aimed at the protection of water resources, GN 704 (National Water Act. 1998 (Act No. 36 of 1998) June 4, 1999).

Vick, S. J. (1983). *Planning, Design and Analysis of Tailings Dams.* John Wiley & Sons Inc.

Signature Page

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Mondli Mazibuko (Pr.Eng)
Senior Tailings Engineer

SM/MM/sm

Reg. No. 2002/007104/07

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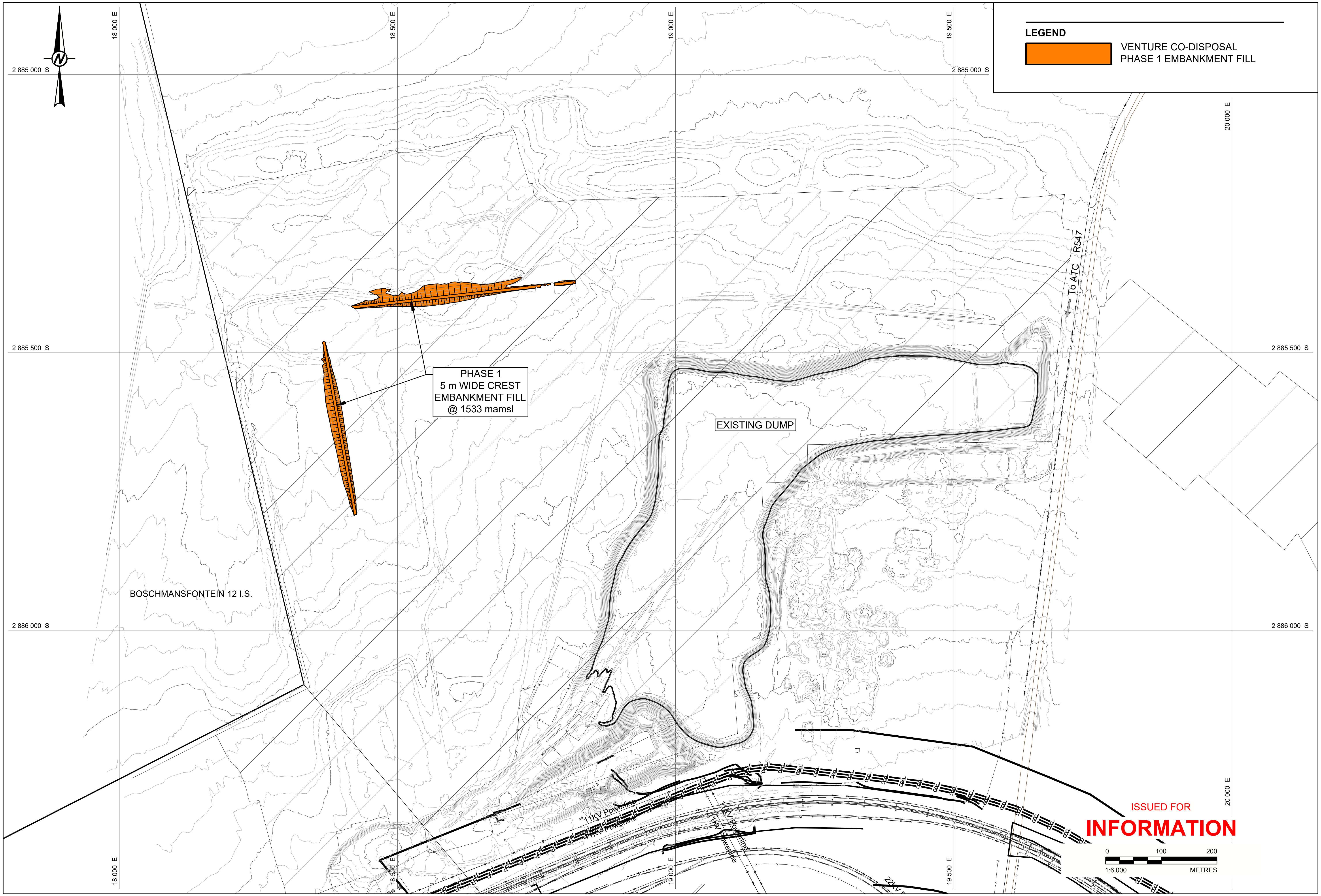
APPENDIX A

Venture Co-disposal Facility - Design Drawings



LEGEND
VENTURE CO-DISPOSAL
PHASE 1 EMBANKMENT FILL
PHASE 1
5 m WIDE CREST
EMBANKMENT FILL
@ 1533 mamsl
EXISTING DUMP
BOSCHMANSFONTEIN 12 I.S.
To ATC
R547
11KV Powerline
ISSUED FOR
INFORMATION
1:6,000
METRES
0
100
200
18 000 E
18 500 E
19 000 E
19 500 E
20 000 E
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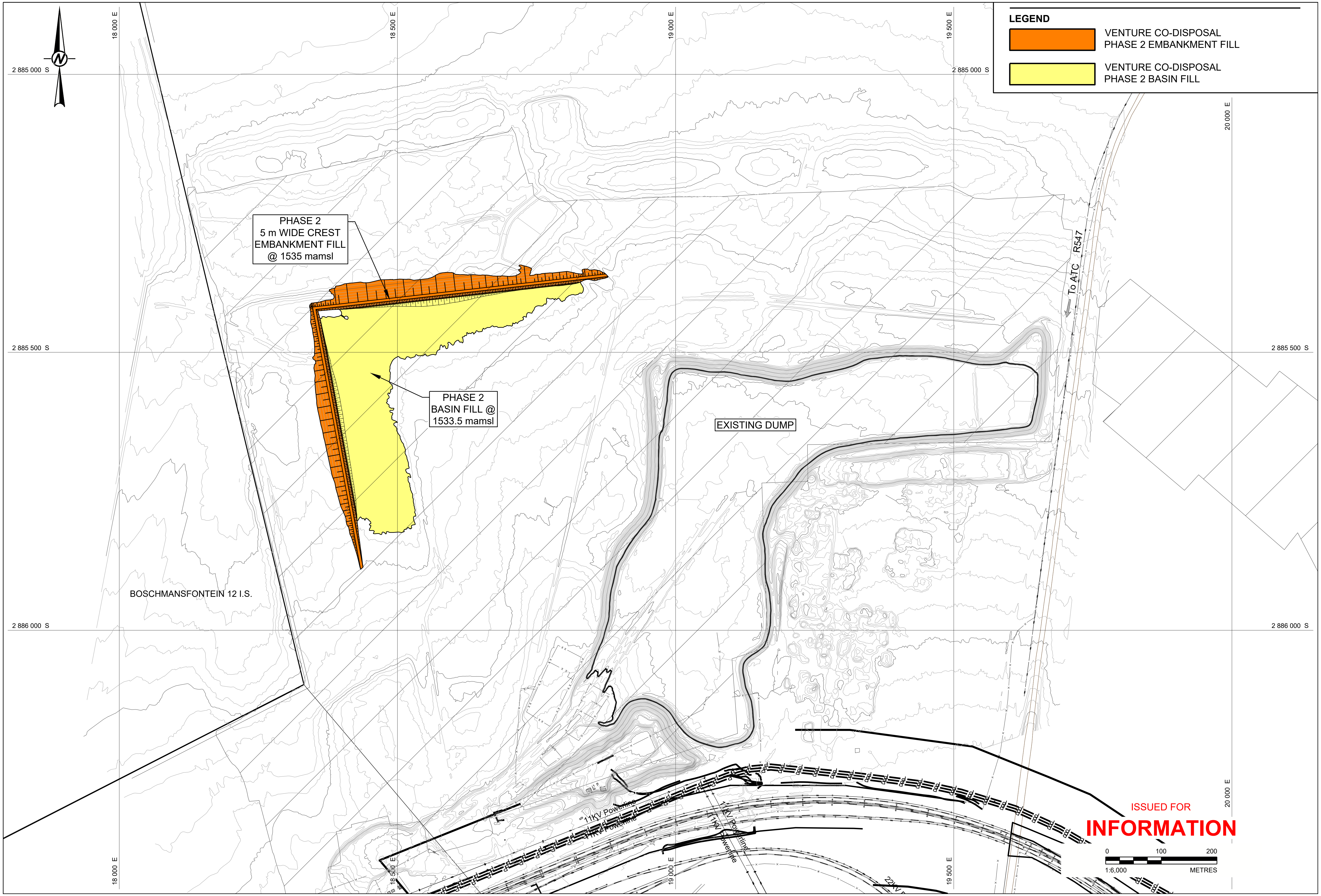

LEGEND
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VENTURE CO-DISPOSAL PHASE 2 BASIN FILL
18 000 E
18 500 E
19 000 E
19 500 E
20 000 E
2 885 000 S
2 885 500 S
2 886 000 S
PHASE 2
5 m WIDE CREST
EMBANKMENT FILL
@ 1535 mamsl
PHASE 2
BASIN FILL @
1533.5 mamsl
EXISTING DUMP
BOSCHMANSFONTEIN 12 I.S.
To ATC
R547
11KV Powerline
ISSUED FOR
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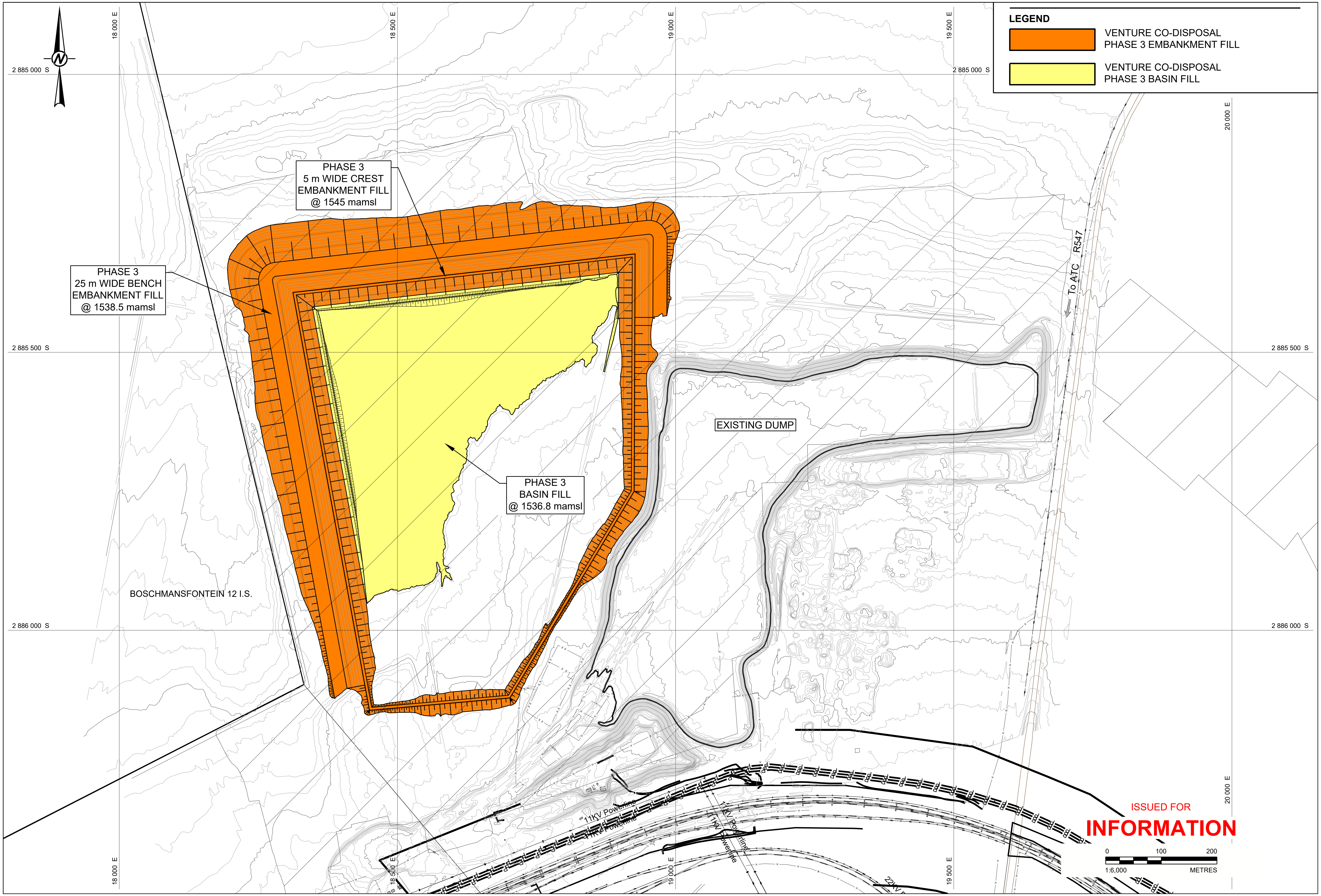

LEGEND
VENTURE CO-DISPOSAL PHASE 3 EMBANKMENT FILL
VENTURE CO-DISPOSAL PHASE 3 BASIN FILL
PHASE 3
5 m WIDE CREST
EMBANKMENT FILL
@ 1545 mamsl
PHASE 3
25 m WIDE BENCH
EMBANKMENT FILL
@ 1538.5 mamsl
PHASE 3
BASIN FILL
@ 1536.8 mamsl
EXISTING DUMP
BOSCHMANSFONTEIN 12 I.S.
To ATC
R547
11KV Powerline
2 885 000 S
2 885 500 S
2 886 000 S
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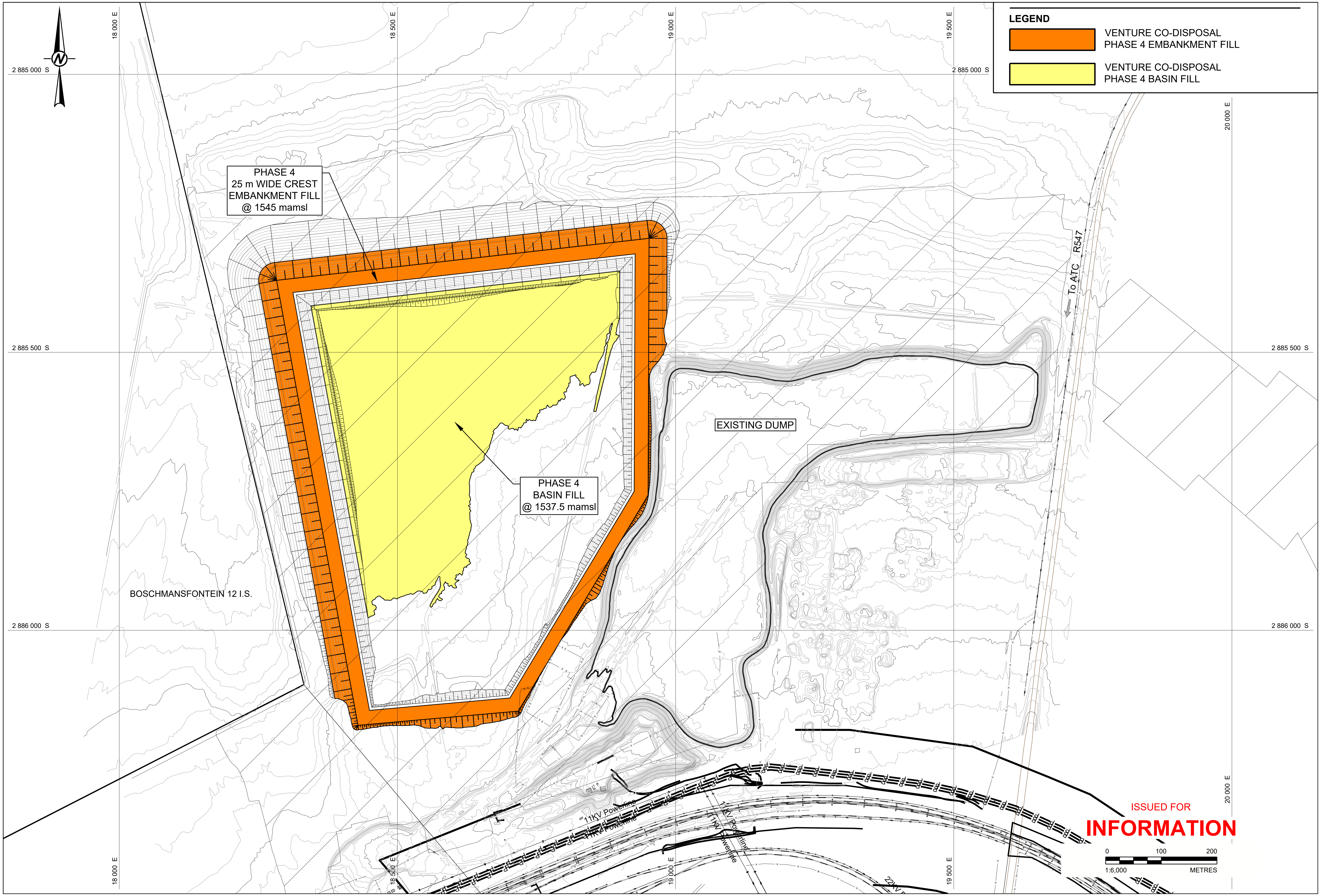

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VENTURE CO-DISPOSAL PHASE 4 BASIN FILL
PHASE 4
25 m WIDE CREST
EMBANKMENT FILL
@ 1545 mamsl
PHASE 4
BASIN FILL
@ 1537.5 mamsl
EXISTING DUMP
BOSCHMANSFONTEIN 12 I.S.
To ATC
R547
11KV Powerline
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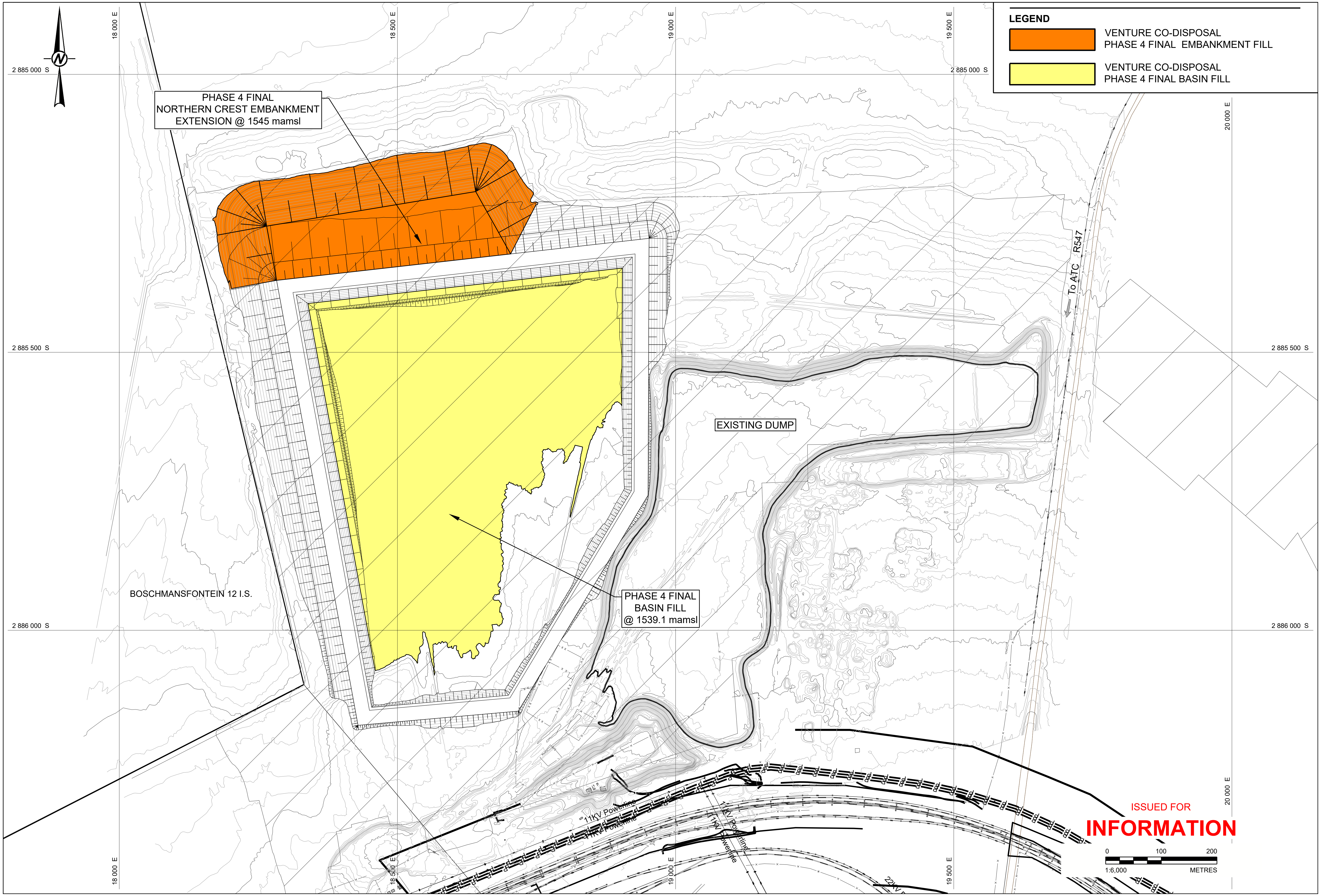
LEGEND
VENTURE CO-DISPOSAL
PHASE 4 FINAL EMBANKMENT FILL
VENTURE CO-DISPOSAL
PHASE 4 FINAL BASIN FILL
PHASE 4 FINAL
NORTHERN CREST EMBANKMENT
EXTENSION @ 1545 mamsl
EXISTING DUMP
PHASE 4 FINAL
BASIN FILL
@ 1539.1 mamsl
BOSCHMANSFONTEIN 12 I.S.
To ATC
R547
11KV Powerline
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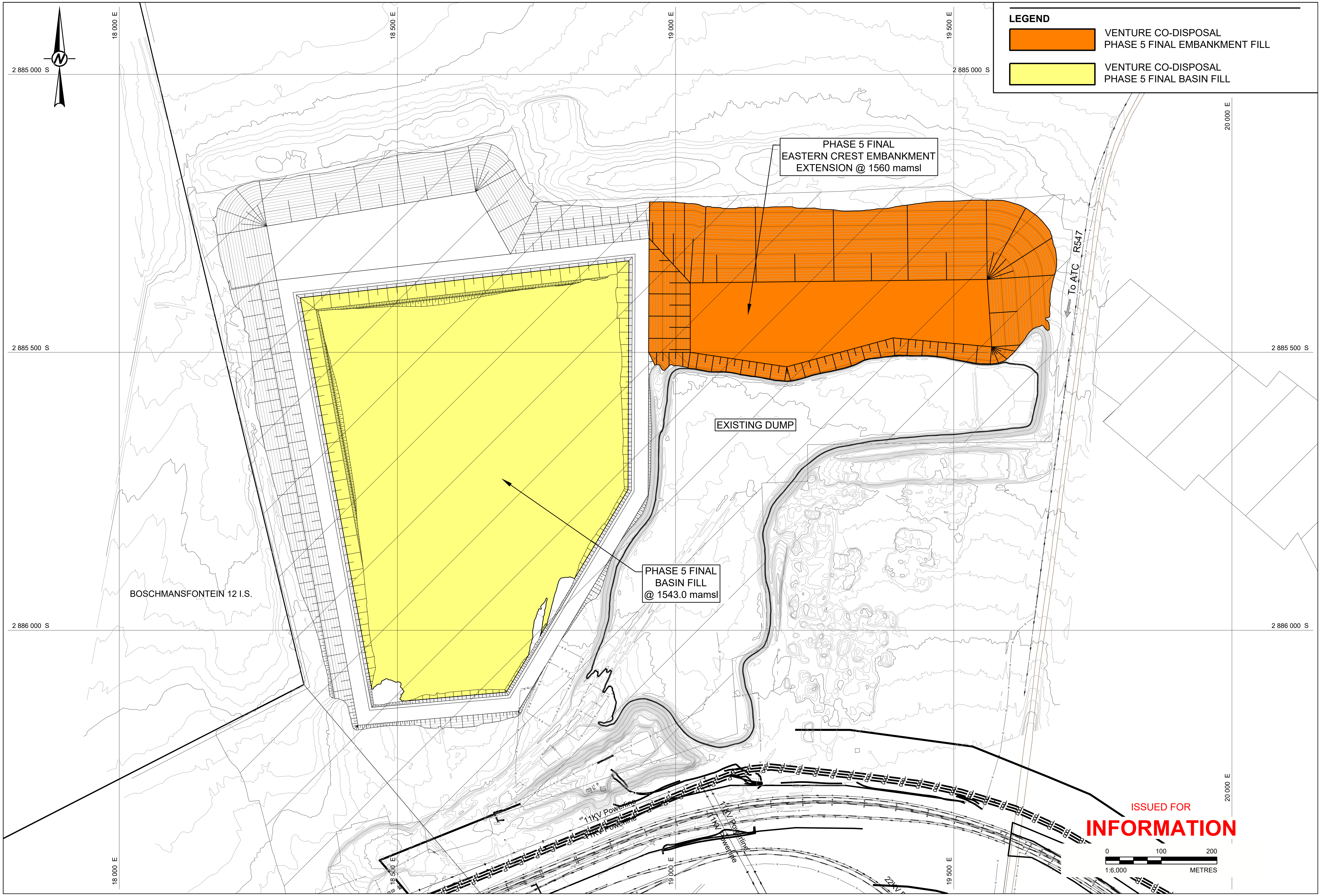

LEGEND
VENTURE CO-DISPOSAL PHASE 5 FINAL EMBANKMENT FILL
VENTURE CO-DISPOSAL PHASE 5 FINAL BASIN FILL
PHASE 5 FINAL EASTERN CREST EMBANKMENT EXTENSION @ 1560 mamsl
EXISTING DUMP
PHASE 5 FINAL BASIN FILL @ 1543.0 mamsl
BOSCHMANSFONTEIN 12 I.S.
R547
To ATC
11KV Powerline
2 885 000 S
2 885 500 S
2 886 000 S
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APPENDIX J

Storm Water Management of the South Pit Discard Dump

1.0 INTRODUCTION

TECHNICAL MEMORANDUM

DATE 28 March 2020 **Project No.** 1669034 Memo 001

TO Tebogo Chauke, Glencore Operations South Africa (Pty) Ltd

CC

FROM P Barnard **EMAIL** pbarnard@golder.co.za

CONCEPTUALISATION OF THE CLEAN AND DIRTY RUNOFF FOR THE COARSE DISCARD DUMP AT ATCOM IMPUNZI

Glencore Operations South Africa (Pty) Ltd (Glencore) planned to construct a new discard dump over the old semi-rehabilitated ATCOM South open pit at their iMpunzi Complex. Owing to the recorded elevated surface temperatures from spontaneous combustion of the spoils, this option was discarded and only the construction of fines paddocks over the already "cool" areas of the infilled spoils was taken forward. The construction of these paddock embankments with coarse discard is now being undertaken based on an engineering design by Golder Associates.

A recent thermal scan shows that a large portion of the "so called" previous hot areas have now cooled and may be suitable for discard deposition while other areas for discard disposal closer to the coal beneficiation plant are being prepared. The mine requested Golder to conceptualise to prefeasibility level a new discard dump on the remainder of the ATCOM South infilled pit to dispose of approximately 29 million m³ coarse discard.

This document describes the clean and dirty water separation for the conceptualised coarse discard dump.

2.0 LOCATION

The ATCOM iMpunzi complex falls within the jurisdiction of the eMalahleni Local Municipality. ATCOM iMpunzi is located approximately 20 km south east of the town Ogies and 23km south of eMalahleni (Witbank). The planned Discard Facility is situated on the upper reach of B11E quaternary catchments, with the Steenkoolspruit River diversion running along the south west of the planned open pit.

3.0 RAINFALL

The 24 hour storm rainfall gridded data for the 1:2, 1:5, 1:10, 1:20, 1:50, 1:100 and 1:200-year recurrence intervals was abstracted from the database using the Design Rainfall Estimation Programme (Smithers & Schulze, 2002) from the closest rainfall station. South African Weather Services (SAWS) Rainfall station 0478546_W (Van Dyksdrift Station) was used for this work.

The selection of station 0478546_W was based on the fact that this is the closest station to the study area with a reliable record. The rainfall distribution on site is classified as a type 3 design rainfall distribution. Table 1 presents the station's information while the rainfall depths are presented in Table 2.

Table 1: Mean annual precipitation and the relevant rainfall station

Name of rainfall station	Rainfall station number	Distance (km)	Latitude (°)(‘)	Longitude (°)(‘)	Record (Years)	MAP(mm)
Van Dyksdrift	0478546_W	14.5	26° 06’	29° 19’	70	679

Table 2: Computed 24-Hour Storm Rainfall Depths (mm)

Return Period (years)	1:2	1:5	1:10	1:20	1:50	1:100	1:200
Rainfall Depth (mm)	62.0	83.3	98.4	113.9	135.3	152.5	170.6

For the channel sizing, the 1:50 year 24 hour rainfall depth was used.

4.0 GENERAL DESIGN GUIDELINES

The general design guidance applied for the rerouting of clean stormwater is as follows:

- Separate clean runoff from the contributing sub-catchments and isolate from potentially dirty runoff from mining activities;
- Divert/rerouting of surface runoff from the upslope contributing catchments away from the planned open pit, isolating this area from the contributing clean areas in accordance with the requirements of GN 704; and
- Collect and route of dirty runoff from active mining areas to an in-pit dirty stormwater management system that will be designed by others.

5.0 MODELLING THE STORMWATER SYSTEM

The PCSWMM® model was used as the flood analysis model to determine the drainage corridor sizing for the ATCOM south pit discard facility. PCSWMM® is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity.

The model was set up for the localised ATCOM south pit discard facility site to predict the relevant flood peaks as well as the associated sizing of the conveyance structures (channels).

6.0 DISCARD DUMP PHASES

6.1 Phase 1

Phase 1 (Figure 1) was located on the cooler areas with no significant hot spots. The footprint area is 83.3 ha providing placement capacity to mid-2026 of approximately 15 000 000 m³. The upper surface of the dump was designed to drain to the western side of the dump. The rehabilitated high lying area to the west provides a natural cut-off for dirty water and is directed to the north into ramp currently being used as a dirty water management facility. The northern and eastern areas are dirty water catchments and can receive run-off from the dump directly. Dirty run-off from the southern side slopes drain towards a low-lying area. A new borehole will collect the run-off and act as a conduit to provide temporary drainage to the underground workings during construction of the dump. No additional clean/dirty water separation measure will be required for this phase.

Construction of the first phase will last approximately 6.5 years which allows for enough time to level and construct a blanket layer to cool down the hot areas indicated with the dotted red line.

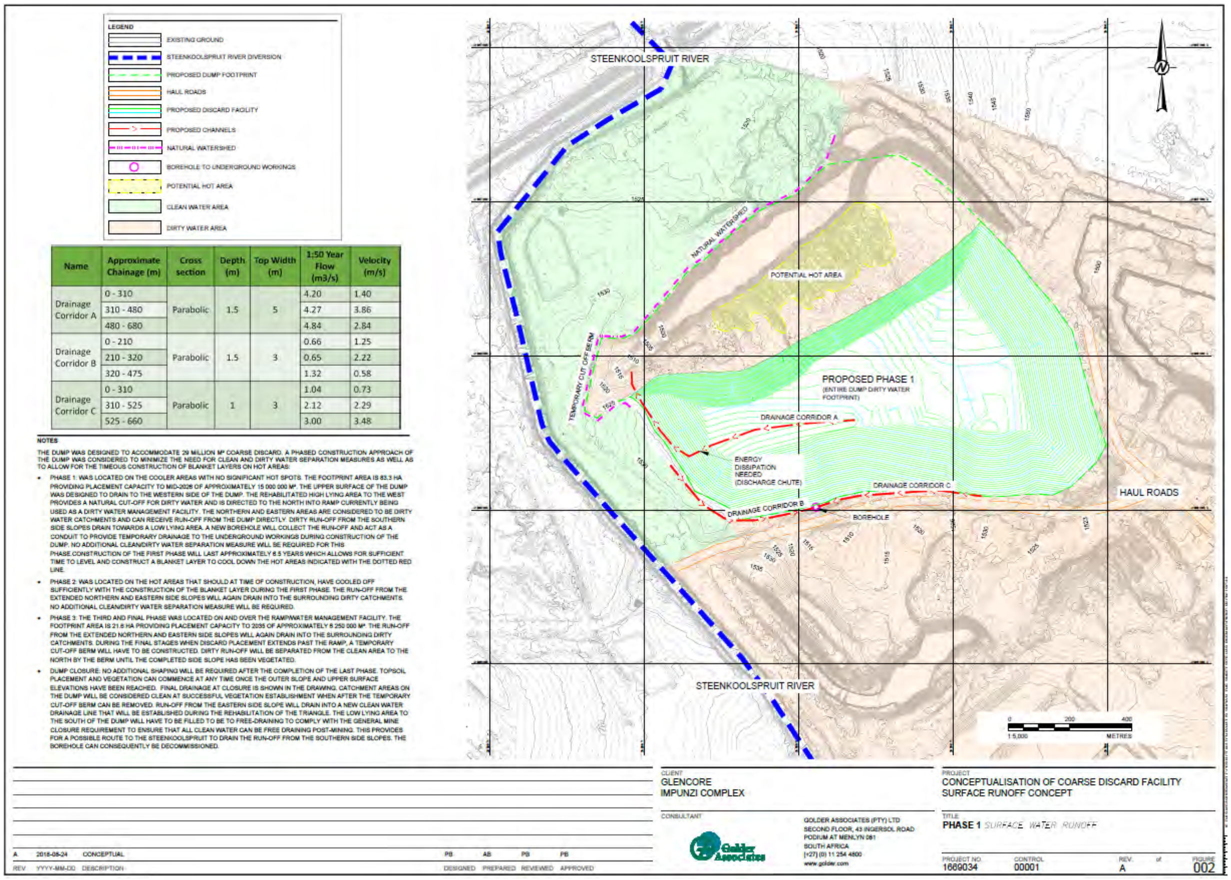
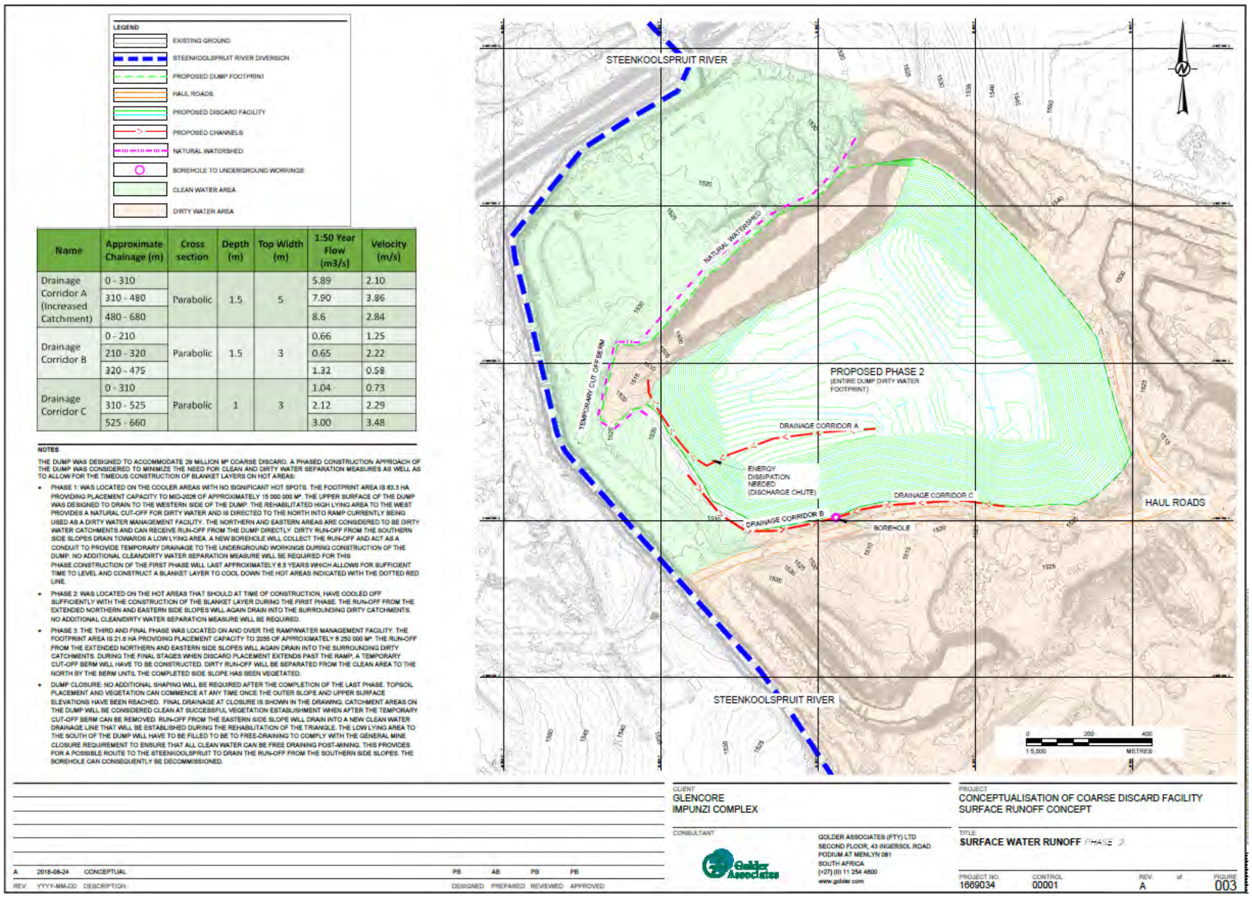


Figure 1: Phase 1 layout

6.2 Phase 2

Phase 2 (Figure 2) was located on the hot areas that should at time of construction, have cooled off sufficiently with the construction of the blanket layer during the first phase. The run-off from the extended northern and eastern side slopes will again drain into the surrounding dirty catchments. No additional clean/dirty water separation measure will be required.

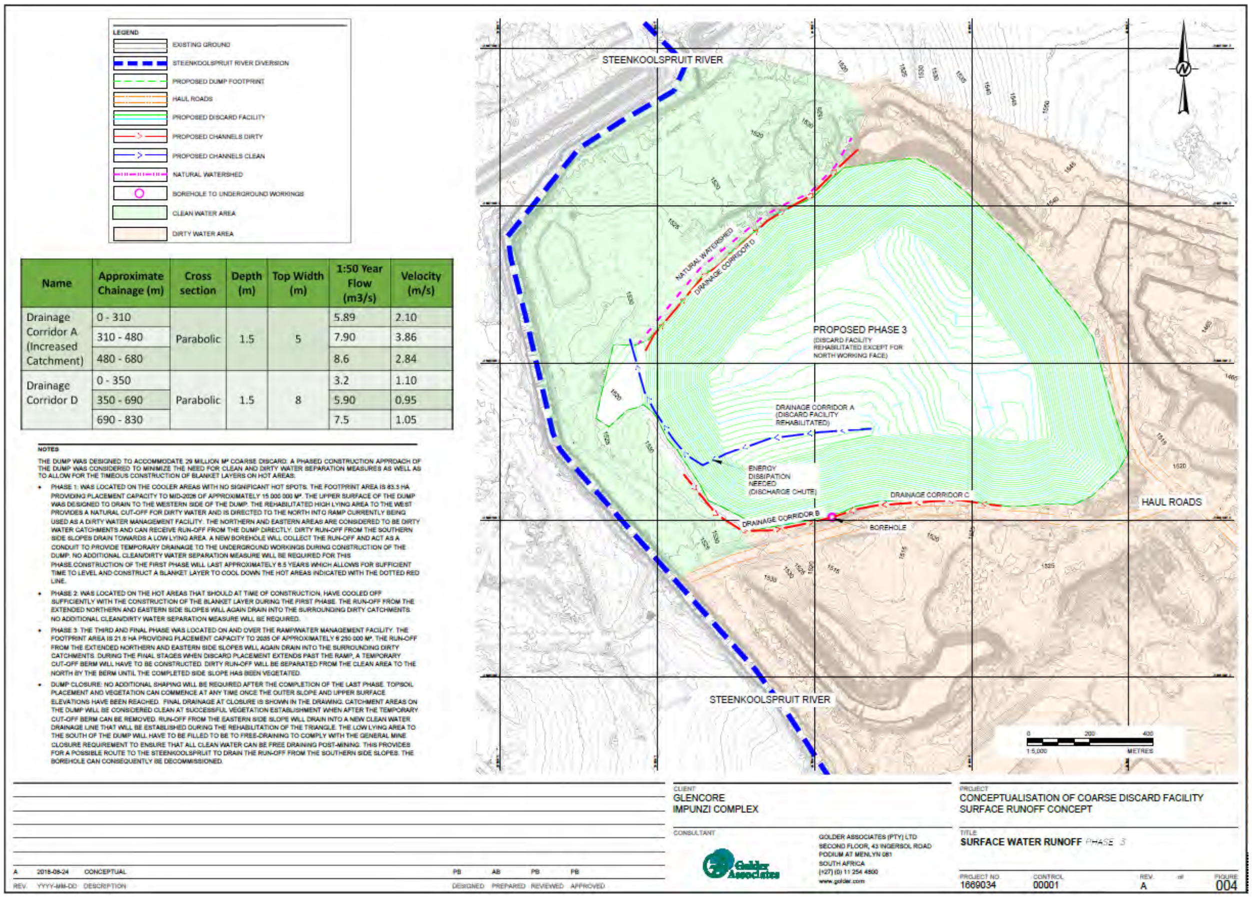


Name	Approximate Chainage (m)	Cross section	Depth (m)	Top Width (m)	1:50 Year Flow (m3/s)	Velocity (m/s)
Drainage Corridor A (Increased Catchment)	0 - 310	Parabolic	1.5	5	5.89	2.10
	310 - 480				7.90	3.86
	480 - 680				8.6	2.84
Drainage Corridor B	0 - 210	Parabolic	1.5	3	0.66	1.25
	210 - 320				0.65	2.22
	320 - 475				1.32	0.58
Drainage Corridor C	0 - 310	Parabolic	1	3	1.04	0.73
	310 - 525				2.12	2.29
	525 - 660				3.00	3.48

Figure 2: Phase 2 layout

6.3 Phase 3

The third and final phase (Figure 3) was located on and over the ramp/water management facility. The footprint area is 21.6 ha providing placement capacity to 2035 of approximately 6 250 000 m³. The run-off from the extended northern and eastern side slopes will again drain into the surrounding dirty catchments. During the final stages when discard placement extends past the ramp, a temporary cut-off berm will have to be constructed. Dirty run-off will be separated from the clean area to the north by the berm until the completed side slope has been vegetated.



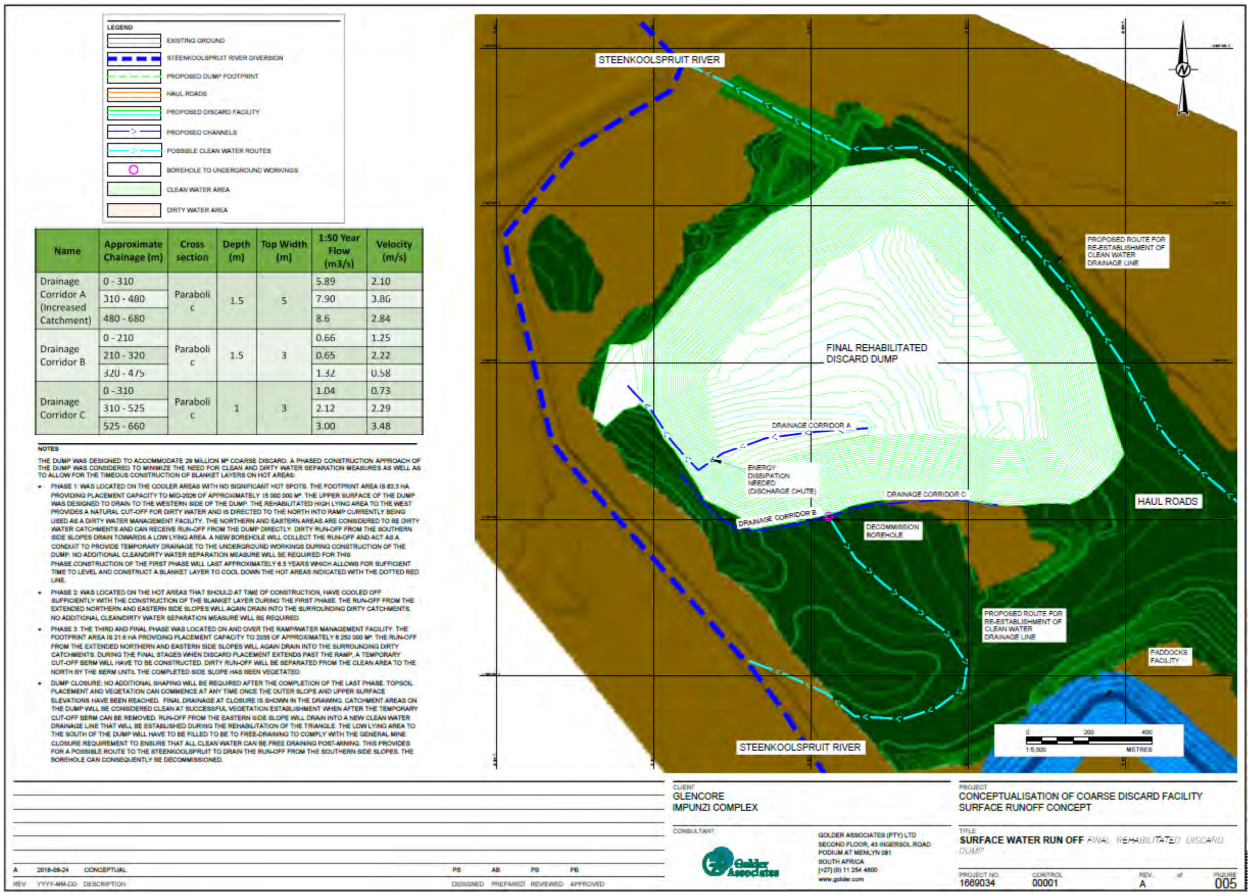
Name	Approximate Chainage (m)	Cross section	Depth (m)	Top Width (m)	1:50 Year Flow (m3/s)	Velocity (m/s)
Drainage Corridor A (Increased Catchment)	0 - 310	Parabolic	1.5	5	5.89	2.10
	310 - 480				7.90	3.86
	480 - 680				8.6	2.84
Drainage Corridor D	0 - 350	Parabolic	1.5	8	3.2	1.10
	350 - 690				5.90	0.95
	690 - 830				7.5	1.05

Figure 3: Phase 3 layout

6.4 Dump Closure

No additional shaping will be required after the completion of the last phase. Topsoil placement and vegetation can commence at any time once the outer slope and upper surface elevations have been reached.

Final drainage at closure is shown in Figure 4. Catchment areas on the dump will be considered clean at successful vegetation establishment when after the temporary cut-off berm can be removed. Run-off from the eastern side slope will drain into a new clean water drainage line that will be established during the rehabilitation of the Triangle. The low-lying area to the south of the dump will have to be filled to be to free-draining to comply with the general mine closure requirement to ensure that all clean water can be free draining post-mining. This provides for a possible route to the Steenkoolspruit to drain the run-off from the southern side slopes. The borehole can consequently be decommissioned.



Name	Approximate Chainage (m)	Cross section	Depth (m)	Top Width (m)	1:50 Year Flow (m3/s)	Velocity (m/s)
Drainage Corridor A (Increased Catchment)	0 - 310	Parabolic	1.5	5	5.89	2.10
	310 - 480				7.90	3.86
	480 - 680				8.6	2.84
Drainage Corridor B	0 - 210	Parabolic	1.5	3	0.66	1.25
	210 - 320				0.65	2.22
	320 - 475				1.32	0.58
Drainage Corridor C	0 - 310	Parabolic	1	3	1.04	0.73
	310 - 525				2.12	2.29
	525 - 660				3.00	3.48

Figure 4: Final closure layout and drainage

7.0 HYDROLOGICAL ANALYSIS

7.1 Sub-catchment characteristics

This section reflects the parameters used to model the overland flow, the Manning's 'n' coefficient used with the modelling for pervious areas and the curve number used for the different areas are shown in (Table 3). The sub-catchments' numbering correspond to the labels in (Figure 5).

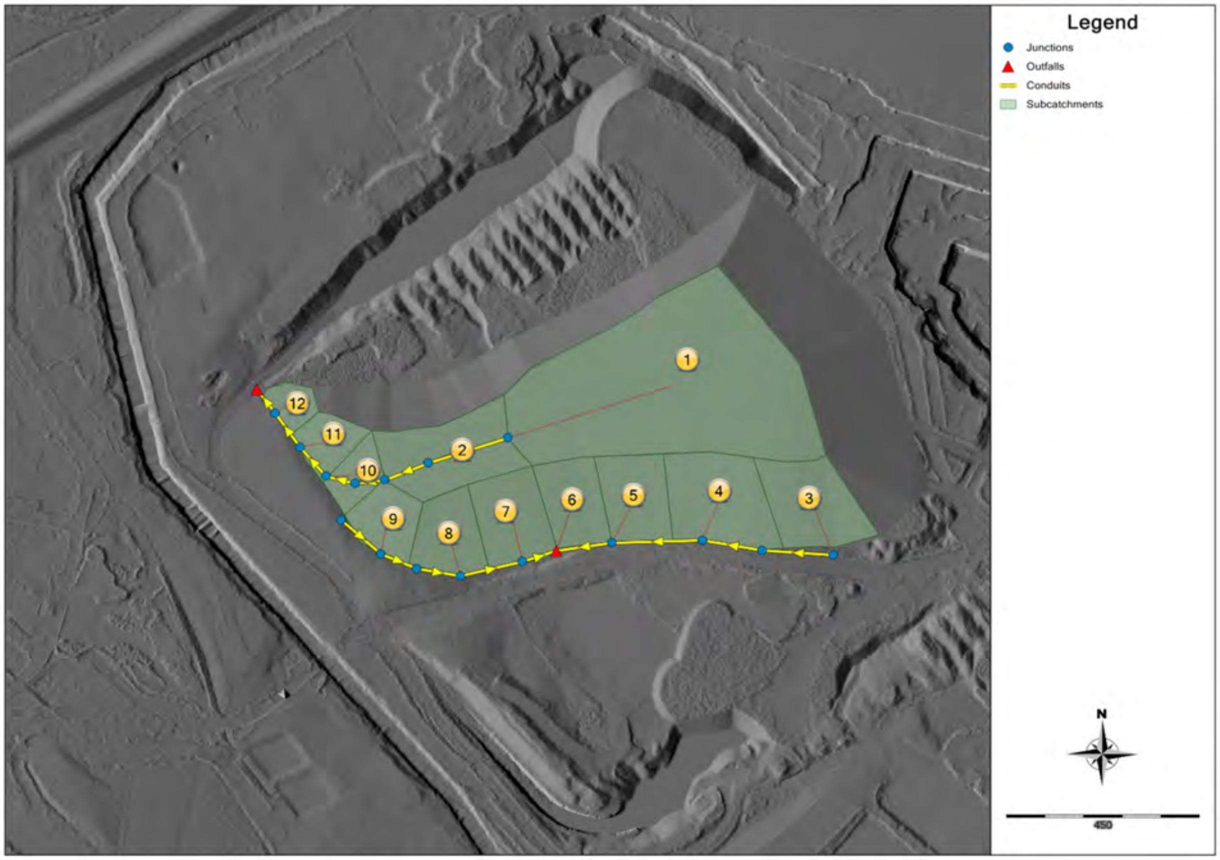


Figure 5: Sub-catchments for discard facility Phase 1

Table 3: Sub-catchments characteristics Phase 1

Catchments	Roughness coefficient	CN	Slope (%)	Area (ha)
Phase 0				
S1	0.025	58	2.3	23.0
S2	0.025	58	1.4	5.2
S3	0.025	58	9.8	4.2
S4	0.025	58	13.2	5.0
S5	0.025	58	13.4	3.1
S6	0.025	58	12.3	2.8
S7	0.025	58	10.5	3.5
S8	0.025	58	8.5	2.8
S9	0.025	58	9.5	2.2
S10	0.025	58	13.5	1.4
S11	0.025	58	12.2	1.6
S12	0.025	58	11.8	1.0

This section reflects the parameters used to model the overland flow, the Manning's 'n' coefficient used with the modelling for pervious areas and the curve number used for the different areas are shown in (Table 4). The sub-catchments numbering correspond to the labels in (Figure 6).

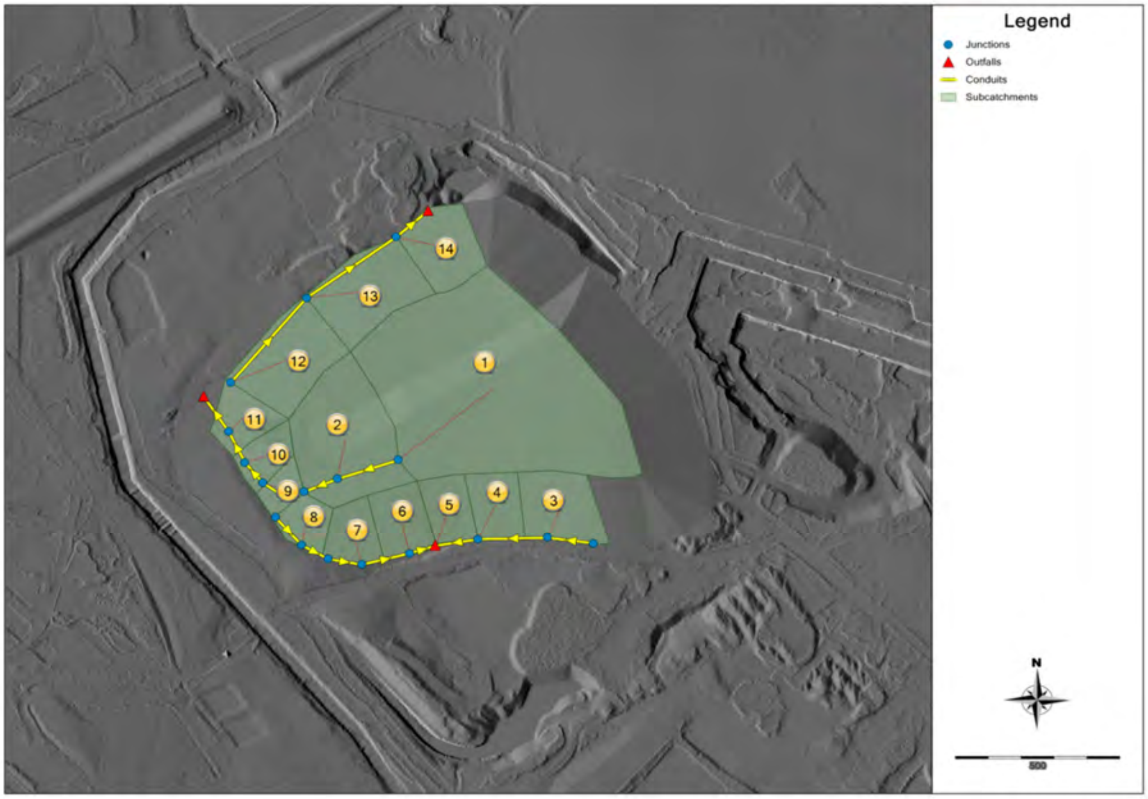


Figure 6: Sub-catchments for discard facility Phase 2,3 & Closure

Table 4: Sub-catchments characteristics Phase 1,2,3 & Closure

Catchments	Roughness coefficient	CN	Slope (%)	Area (ha)
Phase 0				
S1	0.025	58	2.3	23.0
S2	0.025	58	1.4	5.2
S3	0.025	58	9.8	4.2
S4	0.025	58	13.2	5.0
S5	0.025	58	13.4	3.1
S6	0.025	58	12.3	2.8
S7	0.025	58	10.5	3.5
S8	0.025	58	8.5	2.8
S9	0.025	58	9.5	2.2
S10	0.025	58	13.5	1.4
S11	0.025	58	12.2	1.6
S12	0.025	58	10.4	7.2
S13	0.025	58	11.4	7.2
S14	0.025	58	12.2	4.9

7.2 Drainage corridor characteristics

The modelled dimensions of the required channels are presented in Table 5.

Based on the description of the existing channels, the Manning's 'n' coefficient used for the planned channels was set to 0.04 (Chow, 1959).

Table 5: Dimensions of the planned channels

Name	Approximate Chainage (m)	Cross section	Depth (m)	Top Width (m)	1:50 Year Flow (m3/s)	Velocity (m/s)
Drainage Corridor A	0 - 310	Parabolic	1.5	5	4.20	1.40
	310 - 480				4.27	3.86
	480 - 680				4.84	2.84
Drainage Corridor B	0 - 210	Parabolic	1.5	3	0.66	1.25
	210 - 320				0.65	2.22
	320 - 475				1.32	0.58
Drainage Corridor C	0 - 310	Parabolic	1	3	1.04	0.73
	310 - 525				2.12	2.29
	525 - 660				3.00	3.48

Name	Approximate Chainage (m)	Cross section	Depth (m)	Top Width (m)	1:50 Year Flow (m3/s)	Velocity (m/s)
Drainage Corridor A (Increased Catchment)	0 - 310	Parabolic	1.5	5	5.89	1.80
	310 - 480				7.90	3.86
	480 - 680				8.6	2.84
Drainage Corridor D	0 - 350	Parabolic	1.5	8	3.2	1.10
	350 - 690				5.90	0.95
	690 - 830				7.5	1.05

Note: *When constructing the clean and dirty water channels all the material should be place upslope of the channel and nominally compacted in layers to provide additional stormwater capacity. The berm placed upslope acts as a last resort barrier especially in Channels A and D where there is minimal freeboard. All section of channels with velocities in excess of 2.1m/s should be lined to prevent erosion. Channels should be equipped with energy dissipation measures before flow is released.*

7.3 Flow velocity

The velocity of flow within the respective channels gives an indication of the type of lining/protection (if any) that is required per section of the drainage corridor. Consequently, sections of drainage corridor with predicted flow velocities in excess of 0.8 m/s need to be provided for with a lining system (waste rock overlay). Most of the channels therefore need erosion protection however drainage corridor A has extremely high velocities of up to 3.86 m/s. Drainage corridor A has high velocities as it is routing clean water off the top of the discard facility down to the natural ground level. In order to handle the high velocities a discharge chute is proposed for this section. A typical chute details can be seen in (Figure 7). Presently, these structures are conceptual only and further preliminary and detailed design must follow as the project progresses.

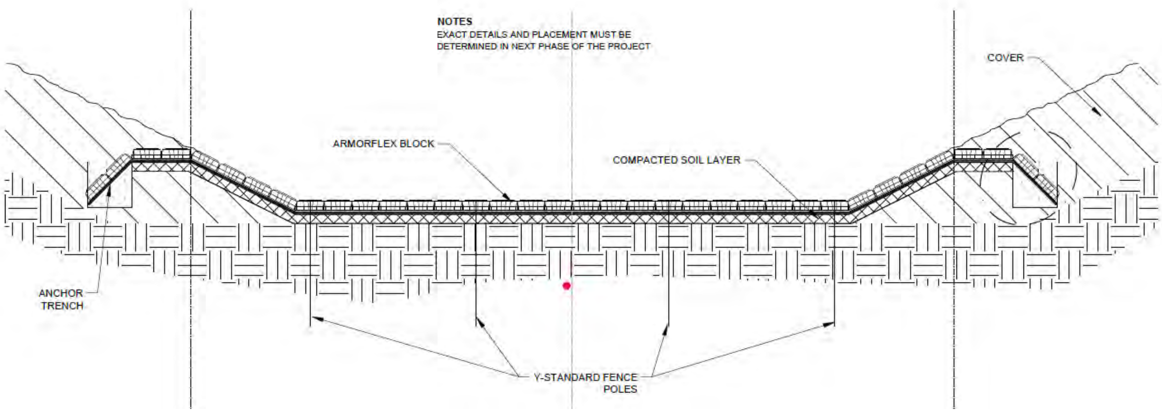


Figure 7: Details of a typical discharge chute

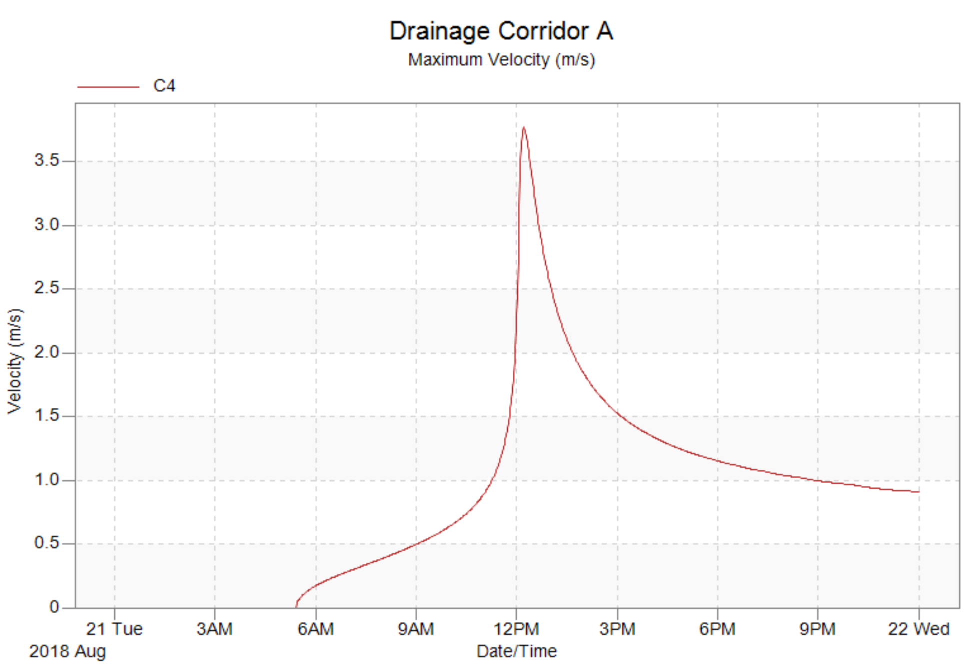


Figure 8: Maximum Velocity in Drainage Corridor A

7.4 Energy dissipation

Stormwater runoff generated from Channels A and D within the study area, will be discharged as diffused flow, over a wider area and directly into the surrounding clean and dirty water areas respectively.

Attenuation/dispersion embankments/berms constructed from "clean" waste rock are planned along the outlet points of these drainage corridors, where such discharges are anticipated, to ensure that the discharge does not upset the current drainage morphology, hydrology, etc. This will be done by encouraging the dispersion/ diffusion of flow over a wider/broader area.

Hydraulic conditions at the structures (Figure 9) are envisaged to encourage/facilitate silt and debris deposition upstream of these structures, which could be removed as routine maintenance during operations as required. Presently, these structures are conceptual only and further preliminary and detailed design must follow as the project progresses.

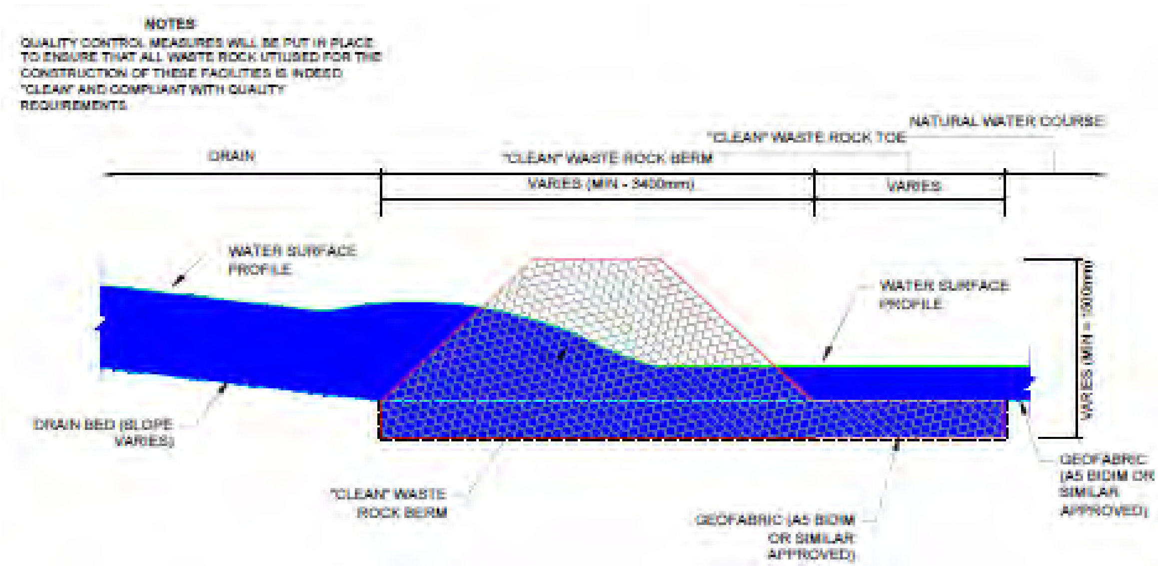


Figure 9: Typical conceptual energy dissipation structure

8.0 CONCLUSION AND RECOMMENDATION

As the work reflected in this technical memo is based on single storm event modelling, the possibility exists that the reflected measures could be inundated under very wet weather conditions followed by a large rainfall event, all measures were, however, designed for a "routine" 1:50 year storm event.

When constructing the drainage corridors, all of the material should be placed upslope of the channel and nominally compacted in layers to provide additional stormwater routing capacity. Further consideration must be given to stabilising this material.

It is also recommended that erosion protection measures (discharge chutes, dissipation structures and rock overlay/Armoflex) are put in place along the flow paths of the respective drainage corridor with predicated high flow velocities to prevent possible damage to the receiving environment and the cover during heavy rainfall events.

Further hydraulic analysis and design must be carried out prior to construction as the designs presented in this memo are conceptual only. The Department of Water and Sanitation (DWS) Civil Design may require additional details to inform the WULA.

The cut-off berm and borehole can be decommissioned and removed after rehabilitation of the dump and low-lying area south of the dump are completed. Further analysis of the borehole and possible silt traps upstream of the borehole will need to be investigated. Cooling of spoils and discard will have to be confirmed prior to construction of any works associated with the closure of the facility.

It is finally concluded that the discard dump design, at a prefeasibility level, is practical and viable and can be taken forward to a feasibility level detail.

Yours sincerely,

Golder Associates Africa (Pty) Ltd

P. Barnard
Senior Engineer

JJ Jordaan PrEng
Senior Engineer

PB/JJ/nbh

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APPENDIX A

Document Limitations

APPENDIX B

Specialist Declaration

SPECIALIST DECLARATION

As required under Appendix 6 of the Environmental Impact Assessment Regulations, 2014 (as amended), I, **Phillip Barnard**, 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 expertise in conducting the specialist report relevant to this application, including knowledge of Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with all applicable Acts and Regulations in compiling this report;
- I have not, and will not engage in conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing:
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signature of the specialist:

Phillip Barnard
Associate
GOLDER

Golder Associates Africa (Pty) Ltd

Name of company (if applicable):

27 March 2020

Date:

APPENDIX K

Storm Water Management of the Venture Co-disposal Facility

REPORT

Stormwater Management Plan for Venture Dump at iMpunzi Mine Complex

Glencore South Africa (Pty) Ltd

Submitted to:

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Submitted by:

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1788675-330328-3

27 March 2020

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Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

The Venture Dump at the iMpunzi Mining Complex (iMpunzi) of Glencore South Africa (Glencore) is an operational coarse coal discard dump expanding at a notable pace. During the last couple of years, the stormwater measures around the dump (albeit temporary) were improved with dedicated stormwater routing berms, a silt trap and an associated lined pollution control dam.

Discussions with the mine personnel indicated that that the Venture dump was growing faster than anticipated and it was also likely to exceed its originally planned footprint area. Additionally, the surface area earmarked for dump footprint expansion suffers from surface subsidence. To mitigate the risk identified by a recent dedicated risk assessment with regards to surface subsidence and the expansion of the dump, Golder Associates Africa (Golder) was requested to revisit and update the latest engineering designs for the dump. Subsequent to the abovementioned discussions with the mine, it was also decided that the coarse coal discard dump would be retrofitted to become a co-disposal facility.

This document reflects the conceptual design of the Venture dump stormwater management plan by describing the design approach and design standards.

2.0 PROJECT OBJECTIVES

The project objectives, as they relate to the stormwater management of the Venture dump, can be summarised as follows:

- Formulation and preliminary design of the stormwater management at the iMpunzi Venture dump.
- Model the runoff from the various areas in relation to the Venture dump.
- Estimate the position and size of the stormwater measures, to separate clean and dirty stormwater for the 1:50 year 24-hour storm event (GN704).
- Model the proposed stormwater management of the Venture dump to estimate the required size of a pollution control dam with a spillage frequency of less than 1 in 50 years.

3.0 SITE DATA

3.1 Location

The iMpunzi Mine Complex Venture dump is located within the eMalahleni Municipal Area (Nkangala District Municipality), 25 km south of eMalahleni and 15 km south east from the town of Ogies.

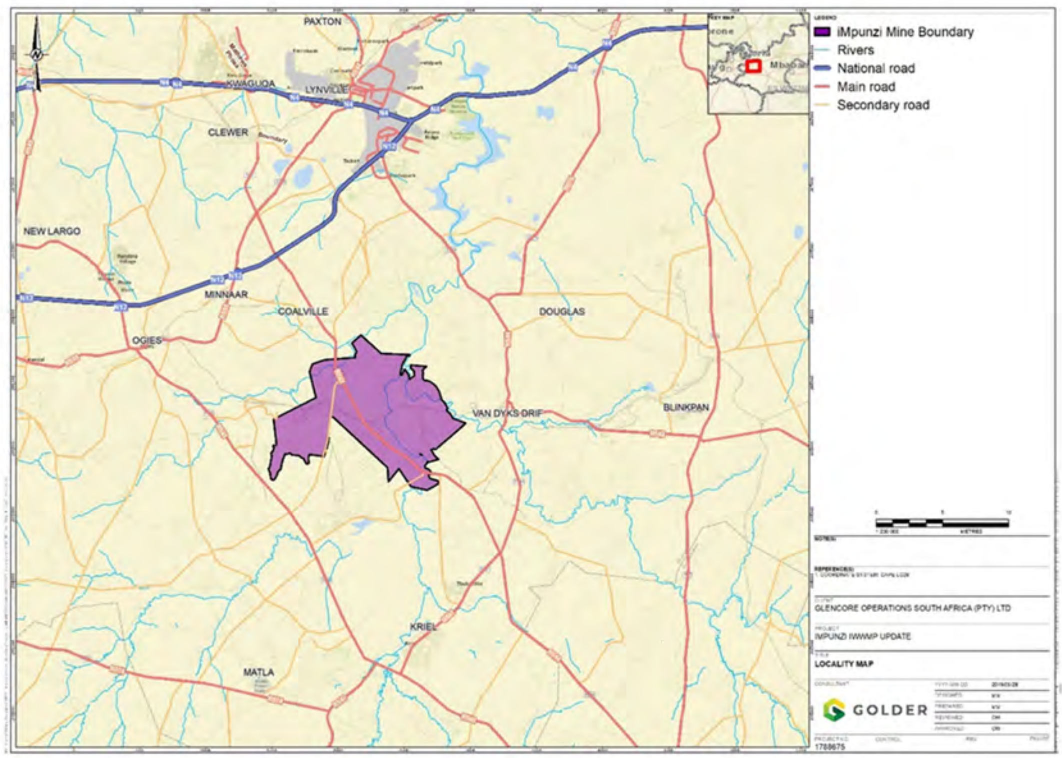

Figure 1: iMpunzi Mine Complex locality

3.2 Rainfall Data

The conceptual design reflected in this report includes the surface runoff regime related to the reconfigured co-disposal dump.

The daily rainfall data for the stormwater analysis for the above purpose was obtained from six rainfall gauges using the proprietary Daily Rainfall Data Extraction (Kunz, 2004). The details of the rain gauges are given in Table 1. The 24-hour rainfall depths were obtained for the rain gauges by utilizing the Design Rainfall Estimation program.

Table 1: Rain gauge details and records

Station Name	SAWS Number	Distance to site (km)	Record (years)	Latitude	Longitude	MAP (mm)
Waterpan	0515270_W	9.7	42	26°0'	29°9'	695
Vandyksdrift	0478546_W	14.5	70	26°6'	29°19'	679
Ogies	0478093_W	14.8	92	26°3'	29°3'	745
Clydesdale	0515266_W	16.6	36	25°56'	29°9'	768
Cologne	0478008_W	18.4	74	26°7'	29°1'	683
Bombardie Estate	0478039_W	18.5	40	26°10'	29°2'	665

TR102 report on South African Storm Rainfall (Department of Environment Affairs, 1983) was also reviewed to obtain the storm rainfall depths for the recurrence intervals. In order to size the surface water collection infrastructure for the Venture dump, the following 24-hour design storm return period data was utilised (Table 2).

Table 2: Return period data for 24-hour design storm

Return Period	Depth (mm)
1:2	55
1:5	74
1:10	89
1:20	104
1:50	126
1:100	145
1:200	165

In order to have a first order sizing of the Return Water Dam (RWD), the daily rainfall records were utilised. Rainfall data was collected from 0478093_W (Ogies) rainfall station. This data is patched data from the Ogies rainfall station. The record runs from January 1920 to December 2000, totalling 80 years of rainfall data (Figure 2).

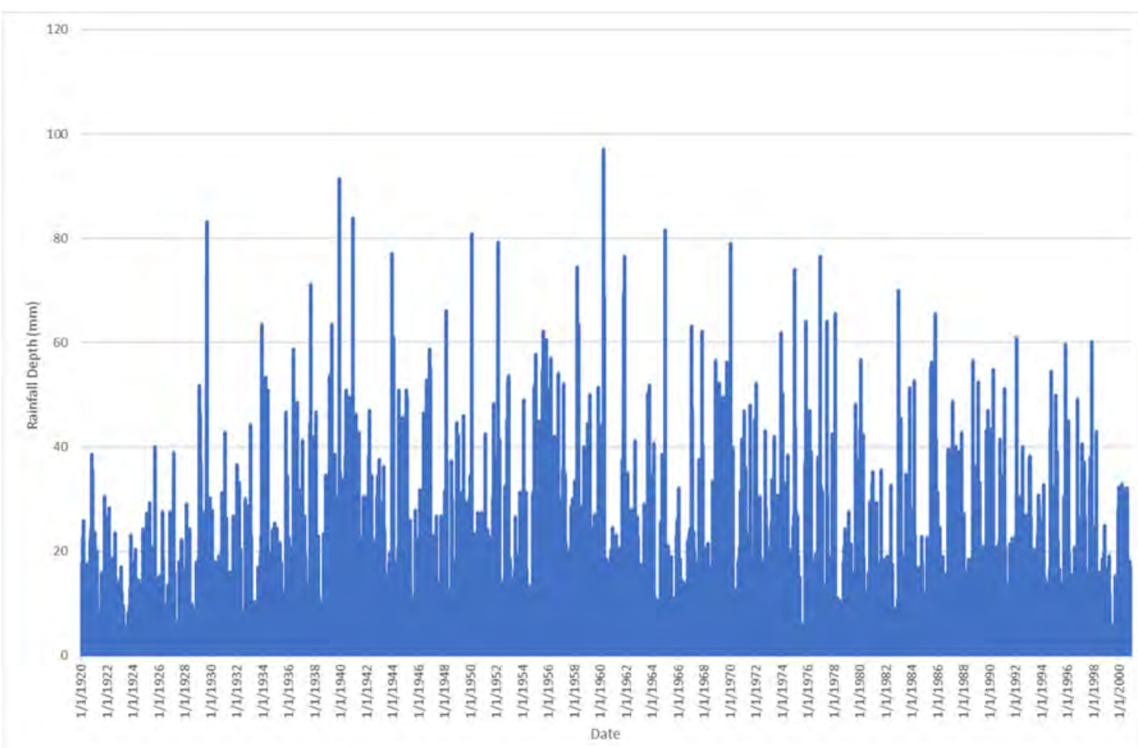

Figure 2: Venture dump historical rainfall

4.0 BASIS OF DESIGN

The current silt trap, drainage corridors and stormwater dam were all designed as temporary measures as the dump at the time had a limited remaining operational life. When the dump is finally rehabilitated with an appropriate engineered cover, runoff from the dump, will be clean and can drain into the receiving catchment.

In the interim, while the dump is operated as the newly designed co-disposal facility, the contaminated runoff from the dump will be routed to a newly constructed RWD, and water abstracted from the dam pumped to the iMpunzi operations for the use as process water. As evident from the stormwater analysis the capacity of the current stormwater dam is not adequate to receive the runoff from the extended discard dump and newly proposed co-disposal facility, without spilling more than once in a 50-year period. The basis of design and analysis methodology is discussed in the following sections.

The PCSWMM® (refer www.chiwater.com) commercial software package, developed by Computational Hydraulics International (CHI) was used as the analysis tool. PCSWMM® is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity. The runoff component of SWMM operates on a collection of sub-catchment areas that receive precipitation and simulate runoff overland and underground through a system of pipes, channels, storage and treatment devices, pumps, and regulators.

PCSWMM tracks the quantity of runoff generated within each sub-catchment, and the flow rate, flow depth and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

4.1 Storm Water Management Strategy

A Stormwater Management Plan (SWMP) is a statutory requirement for mining and related activities in South Africa and is defined by General Notice 704 of the National Water Act (Act 36 of 1988). No water use licences in terms of this act will be granted without an approved SWMP. The purpose of a SWMP is to prevent the pollution of water resources in and around mining areas, or areas where mining related activity occurs. Regulations define a methodological approach to preventing and/or containing pollution on mining sites, set design standards and specify measures that must be taken to monitor and evaluate the efficacy of pollution control measures that are implemented.

The basic principles of a SWMP include:

- Separation of clean and dirty water - clean water should, as far as possible, be kept separate from dirty water. Water from clean water areas should be diverted away from dirty water areas and should be allowed to pass through to downstream users. Dirty water must be contained and captured on site. Spillage of dirty water is not allowed except during extreme flood events that are, on average, exceeded no more than once in 50 years.
- Containment of dirty water - reasonable measures must be taken to ensure that dirty water is contained. All dirty water must be captured and transported in lined channels (capable of containing 1:50-year design floods) to prevent the seepage of contaminated water into groundwater resources. Dirty water runoff must be stored in a Pollution Control Dam (PCD) or a Return Water Dam (RWD), where reasonable precautions are taken to prevent leaks or seepage. PCDs and RWDs may not spill more often than (on average) once in 50 years. Design storage volumes are a function of peak storage requirements that often correspond to abnormally wet conditions that continue for an extended period of time, and not to a specific flood event.
- Reuse and recycling of dirty water - regulations stipulate a clear hierarchy of water use. First reuse any captured dirty water. Recycle as much water as possible. Minimise the import and use of clean water resources. Excess water released from a dirty water area must be treated to a standard agreed to by the regulator and any plan to treat and release excess water must be approved and licensed.

- Preventing the pollution of water resources - exposure between water and potential pollutants should be reduced to a minimum. Special precautions may be required to prevent the transport of pollutants in water. Oil traps should be specified below workshops, fuel depots and vehicle wash-bays to prevent the flow of hydrocarbons into PCDs. Silt traps may be constructed where surface runoff is likely to lead to the transport of suspended sediments and the like. Under similar circumstances, wash-water should be separated from conventional water-borne sewage and treated separately.

4.1 Proposed Storm Water Management Plan

The site-wide framework for the SWMP is to separate the clean and dirty catchments. The clean water runoff being generated from the upslope clean water catchments will be diverted away from the area producing dirty water. The dirty water runoff generated from the site infrastructure will be contained for reuse or treatment. The proposed storm water management strategy is detailed below and should be read in conjunction with Figure1:

- The general gradient of the site is from the southeast to the northwest at an average slope of 0.5 %. To the south of the dump is a railway line with box culverts conveying runoff from the south under the railway towards the Venture dump area. These areas (sub-catchments S1 and S2) were classified as clean water catchments. The clean surface water runoff generated from these catchments will be collected in unlined trapezoidal clean water cut-off channels (C1 and C2, located adjacent to the railway) and diverted for discharge (OF1) into the environment (located west of the site). North of the railway line an additional clean water catchment was identified (S5), this water will also be collected in the C2 unlined channel for discharge into the environment.
- Clean water catchments (S3 and S4) were identified south east to the existing dump. The clean surface water runoff generated from this catchment will be collected in an unlined trapezoidal clean water cut-off channel (C3) and diverted for discharge (OF3) into the environment located east of the site.
- Clean water catchment S8 was identified south of the proposed dump extension. The clean surface water runoff generated from this catchment will be collected in an unlined trapezoidal clean water cut-off channel (C4) and diverted for discharge (OF2) into the environment located west of the site.
- The existing dump as well as the proposed extension are considered dirty water catchments (S7-S14). The surface water run-off generated from these catchments will be captured by concrete lined perimeter channels (C5-C10), the water will be diverted to a proposed new RWD (HDPE lined). The capacity of the existing RWD is not adequate to receive the runoff and operational slurry return water from the newly proposed co-disposal facility. A new RWD will be constructed, inclusive of a new silt trap, and the old RWD will become redundant. A silt trap will be required to remove sediment from the water to ensure that the RWD does not fill up with sediment generated from the captured surface water runoff.
- The catchment immediately south of the dump extension was also identified as a dirty water catchment (S6). This catchment drains towards the east where the old adit is located. Currently water pools in this adit as it is the lowest point in the catchment. The catchment is relatively small generating approximately 2360 m3 of surface runoff during the 1 in 50-year event. It is therefore recommended that the surface water runoff collected in the adit be pumped to the dirty water perimeter channel C5 where it will be diverted to the new RWD. The surface water collected in the adit should be pumped immediately to channel C5 ensure to ensure that no water is being stored in the adit void.
- The slurry pool level will be regulated using a barge-pump system. The barge-pump system will route all slurry water inflow and runoff (maintaining the pool level below the pre-defined maximum water level), to the perimeter dirty stormwater channels from where it will be routed to the new RWD.

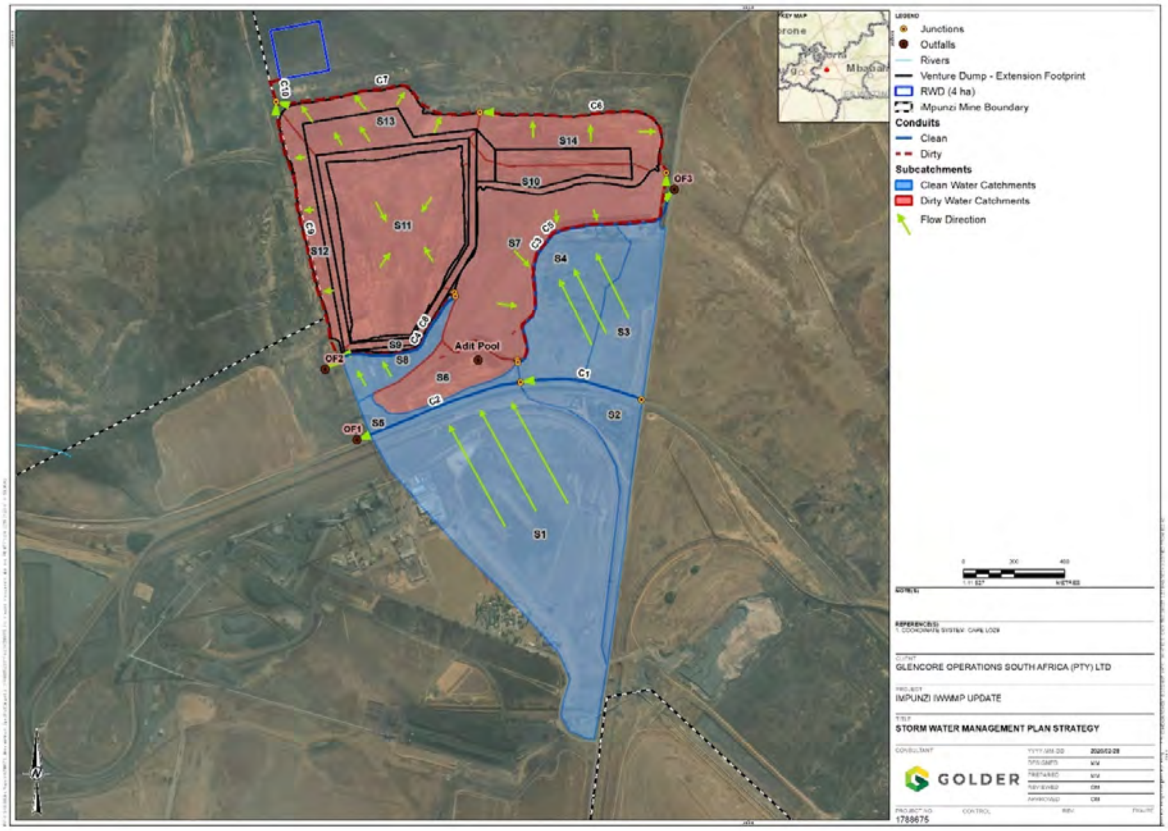

Figure 3: Storm Water Management strategy

4.1.1 Delineation of Clean and Dirty Water Catchments

Discretisation into sub-catchments is based on the topography of the study area. The designation of the clean and dirty water catchments was based on the land usage. The layout and extent of the clean and dirty water catchments is shown in Figure 4. The parameters used to model the overland flow are listed in Table 3. Manning's 'n' coefficient used in the model for the impervious areas and pervious areas were 0.015 (float finish, concrete) and 0.15 (veld type vegetation), respectively (McCuen, 1996).

The soils were identified as being in the sandy loam group (WR2012). The model uses these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The sandy loam group resulted in a Suction Head of 110.1 mm, a Hydraulic Conductivity of 21.8 mm/hr and an Initial Deficit of 0.25 being used in the modelling. Simulated runoff volumes are summarised in Table 3 for the 50-year recurrence interval storm event.

Table 3: Catchment parameters used in the modelling of the overall SWMP and results

Name	Description	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m^3)	Peak Runoff (m^3/s)
S1	Clean	67	1122	1.22	5200	1.72
S2	Clean	11	409	1.7	1770	0.76
S3	Clean	13	554	1.78	1880	0.75

Name	Description	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m³)	Peak Runoff (m³/s)
S4	Clean	18	540	1.81	2640	1.06
S5	Clean	3	91	2.23	840	0.62
S6	Dirty	8	291	1.5	2360	1.73
S7	Dirty	26	300	20	12490	13.22
S8	Clean	6	122	1.75	1510	0.98
S9	Dirty	2	47	20	780	1.16
S10	Dirty	8	141	20	3160	4.45
S11	Dirty	37	285	2	11680	9.17
S12	Dirty	8	101	20	3180	4.59
S13	Dirty	13	222	20	4960	6.56
S14	Dirty	14	178	20	5460	7.49

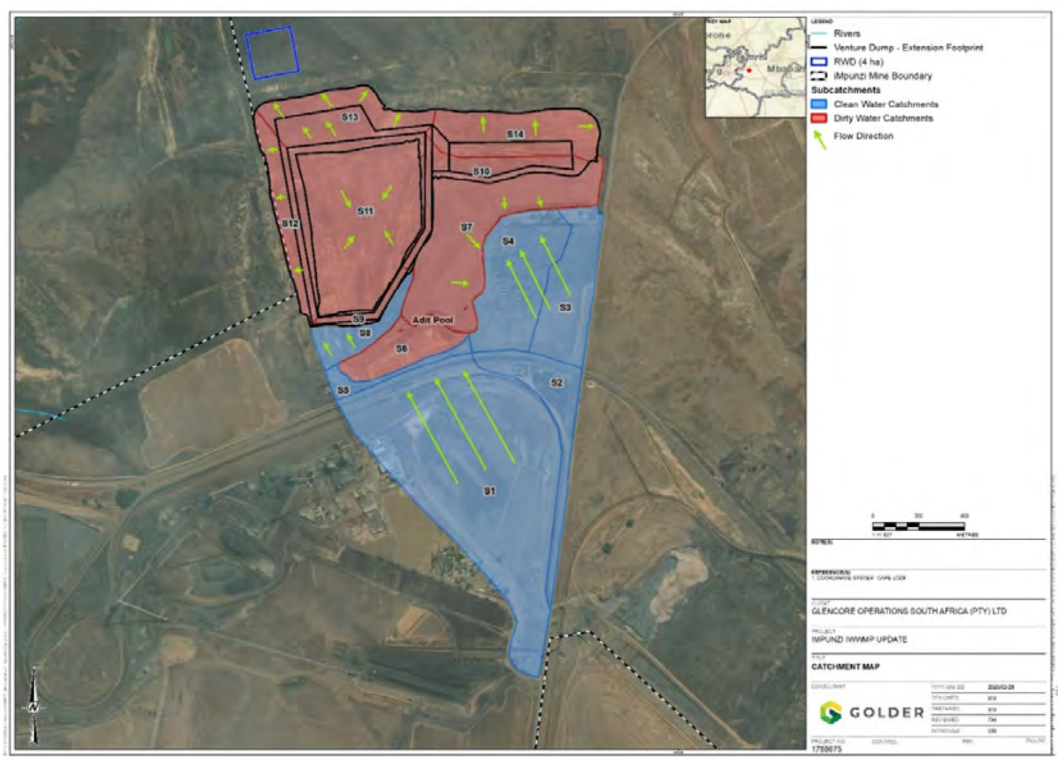

Figure 4: Layout and extent of clean and dirty water catchments

4.1.2 Channel Sizing

The diversion channels have been sized to divert the clean and dirty water runoff for the 50-year return period flood peak, as per GN704 (shown in Table 4). The proposed conceptual clean and dirty water diversion channel layout can be seen in Figure 5. The Manning's roughness assumed for the channels was 0.035 (vegetation-lined channels) and 0.02 (Concrete lined channel) (Hicks et al., 1998). Freeboard was included in the sizing calculations using the Guidelines for the design of canals and related structures (DWA, 1980). The equations utilised are shown below where:

$$f = 0.2Y_n + \frac{v^2}{2g}$$ Sub-critical flow

$$f = 0.35\sqrt{1.2Y_n}$$ Super-critical flow

Where:

- f is the freeboard depth (m).
- Y_n is the normal depth in the channel (m).
- V is the velocity in the channel (m/s).
- g is gravity (m/s^2).

The results show that channels C5-C10 (dump perimeter channels) have maximum flow velocities greater than 4 m/s. The high velocities are due to the catchment gradients present on the site. The channels will be concrete lined and as such the velocities should not create any issues with the concrete lining.

Table 4: Channel characteristics and results

Name	Description	Length (m)	Roughness	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (1:H)	Right Slope (1:H)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. |Velocity| (m/s)
C1	Clean	490	0.035	TRAPEZOIDAL	1	1	2	2	0.007	0.7	1.01
C2	Clean	689	0.035	TRAPEZOIDAL	1	1	2	2	0.013	2.8	1.81
C3	Clean	1131	0.035	TRAPEZOIDAL	1	1	2	2	0.003	1.5	1.31
C4	Clean	646	0.035	TRAPEZOIDAL	1	1	2	2	0.003	0.8	0.98
C5	Dirty	1179	0.015	TRAPEZOIDAL	1	1.5	2	2	0.009	12.0	4.62
C6	Dirty	925	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.010	16.2	4.86
C7	Dirty	860	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.006	28.5	4.73
C8	Dirty	584	0.015	TRAPEZOIDAL	1	1	2	2	0.004	0.9	1.9
C9	Dirty	1040	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.014	4.5	4.15
C10	Dirty	120	0.015	TRAPEZOIDAL	1.8	2	2	2	0.007	32.3	4.76

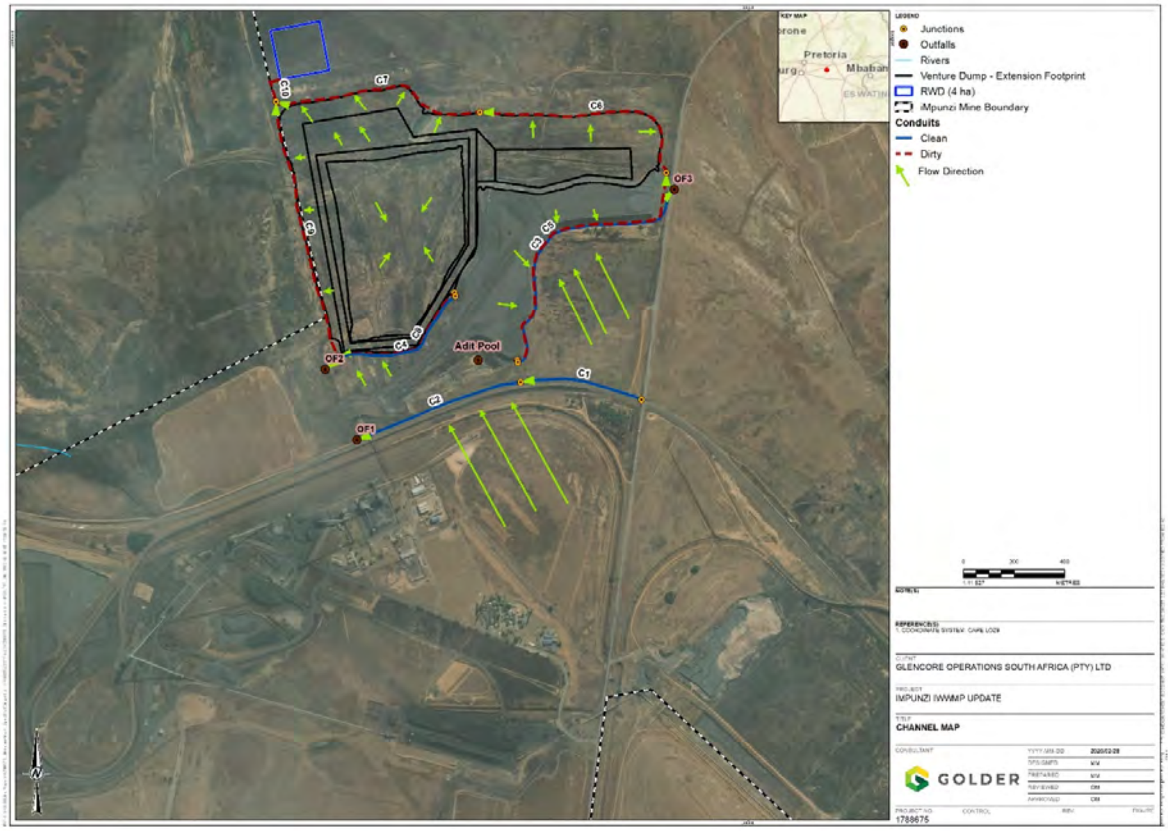

Figure 5: Layout and extent of the clean and dirty water diversion channels

4.2 Return Water Dam and Slurry Pool

4.2.1 Existing Pollution Control Dam

The existing pollution control dam capacity is not adequate to receive the total runoff and slurry return water from the Venture Dump co-disposal facility without spilling more than once in a 50-year period.

For this reason, it is envisaged that the existing PCD will not form part of the stormwater management of the newly proposed co-disposal facility.

4.2.2 New Return Water Dam

Based on the hydrological inputs from the stormwater runoff model constructed in PCSWWM, the geometrical inputs from the conceptual Venture Dump co-disposal facility and the assumptions and calculations made on the slurry pool operation, a daily time step simulation model was set up to determine the required size of the new RWD.

A stochastic rainfall generator was coded and calibrated within the simulation model, based on the Ogies historical dataset. This allows the model to generate random sequences of rainfall with similar statistical characteristics as the original data (Boughton, 1999).

The monthly mean evaporation measured at the Witbank evaporation station (B1E001) was used in this model. The selection was based on the station being close to the site (approximately 24 km away) with a reasonably long and reliable data set (1963-2008).

A number of simulations were carried out with various RWD capacities and abstraction rates in order to determine the capacity required to ensure that the RWD will not spill more than once in 50 years. A 1000 different realizations were run and various RWD sizes were tested until a spillage frequency of 1 in 50 years was obtained. A new RWD size of 56 000 m^3 was found to be adequate.

The model was run with the following assumptions:

- A fixed abstraction of water of 450 m^3/day from the new RWD, pumped to the iMpunzi mine operations for the use as process water. This assumption will be verified and updated in the final design report.
- The projected slurry and discard volumes used in the slurry pool simulation are shown in Table 5. The slurry Moisture Content (MC) was assumed to be 75%, with a specific gravity (SG) of 1.47. Based on these assumptions, the water present in the slurry contributes on average 304 m^3/d to the slurry pool.

Table 5: Plant discard volumes (million tonnes)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Plant feed	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	21.60
Clean coal	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	10.15
Discard	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	9.29
Slurry	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	2.16

- The slurry pool stage-storage curve used in the analysis is shown in Figure 6 below. The slurry pond has a max depth of 2.3 m with a maximum capacity of 535 021 m^3. A freeboard requirement of 1 m was included in the analysis, resulting in a maximum operation pool depth of 1.3 m.

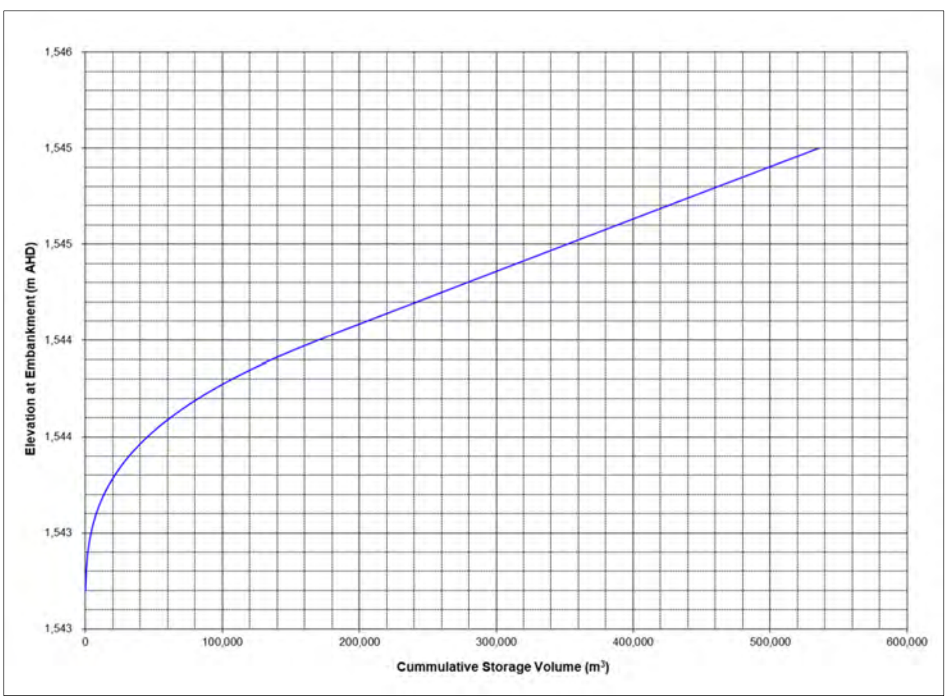

Figure 6: Slurry pool stage storage curve

The envelope of simulated water depth of the slurry pool for the entire operational duration (9 Years) of the Venture Dump is shown in Figure 7. The slurry pool does not exceed the maximum operation pool depth (1.3 m) throughout the simulation when the barge pump has a maximum pumping capacity of 250 m^3/d.

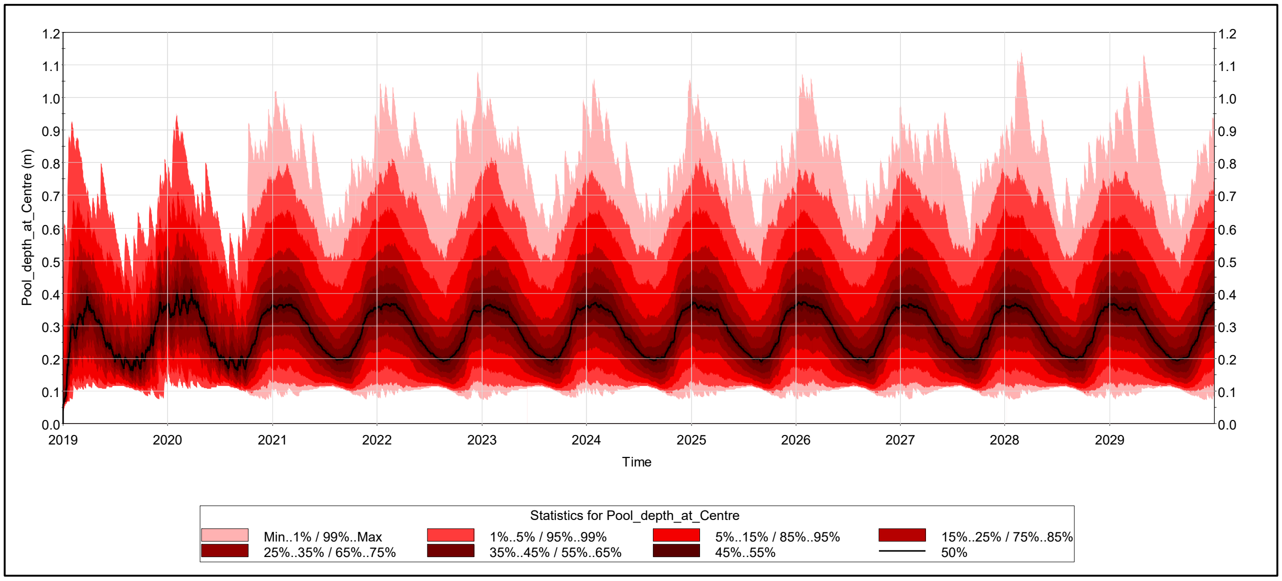

Figure 7: Envelope of simulated water depth - Slurry pool

The envelope of simulated water volume stored in the new RWD over the entire operational period is shown in Figure 8.

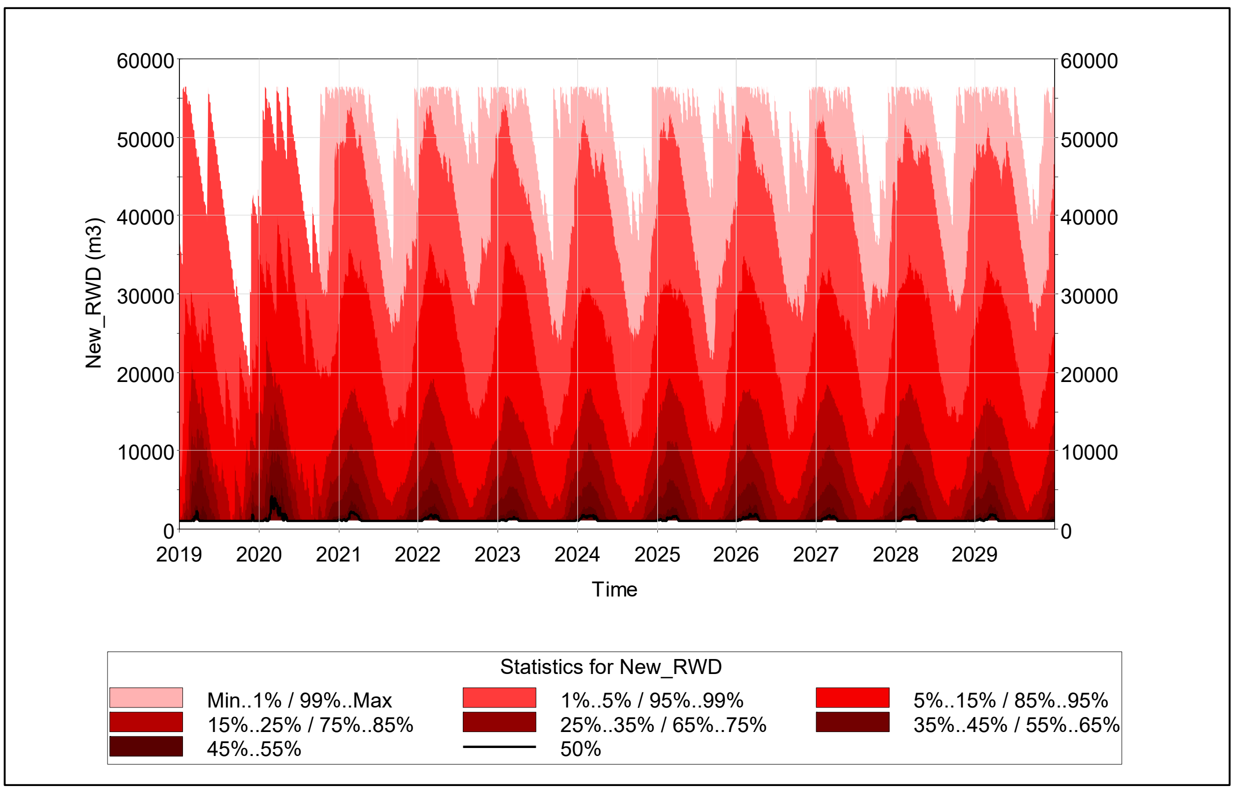

Figure 8: Envelope of simulated water volume stored - New RWD

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objectives of the project were to conceptualise the operation of the stormwater management of the iMpunzi Venture Dump, model the runoff from the various areas in relation to the dump and to determine the position and size of the stormwater measures, to separate clean and dirty stormwater given the 1:50 year 24-hour storm event. The objective also included modelling the operation of the stormwater management of the dump to estimate the required size of a pollution control dam with a spillage frequency of 1 in 50 years.

The conceptual stormwater layout and operation of the stormwater management infrastructure for the iMpunzi Venture Dump has been completed and is discussed in Section 4 of the report. In summary the following recommendations are made with regards to the design and operation of the stormwater management system for the iMpunzi Venture dump co-disposal facility:

- A barge pump (with a maximum pumping capacity of 250 m^3/day) to be installed to route runoff and operational slurry return water from the slurry pool to the perimeter channels, the channels route the water to the new RWD.
- A new 56 000 m^3 RWD to be constructed to receive runoff from the discard dump side slopes as well as the slurry return water and runoff from the dump top (embankment crest, dry beach, wet beach and slurry pool) routed through the barge pump system and diverted to the new RWD through the trapezoidal stormwater channel.
- The final detailed design and construction of stormwater channels to be done on the basis of the preliminarily design channels described in Section 4 of the report.

It is further proposed that the model and the report be reviewed and revised following the outcome of the review of Protocol 14 version 2.0, the CDA and latest Golder TSF design requirements conducted by the geotechnical specialist team.

6.0 REFERENCES

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Signature Page

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APPENDIX A

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APPENDIX B

Specialist Declaration

SPECIALIST DECLARATION

As required under Appendix 6 of the Environmental Impact Assessment Regulations, 2014 (as amended), I, **Eugeshin Naidoo**, 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 expertise in conducting the specialist report relevant to this application, including knowledge of Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with all applicable Acts and Regulations in compiling this report;
- I have not, and will not engage in conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing:
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signature of the specialist:

Golder Associates Africa (Pty) Ltd

Name of company (if applicable):

27 March 2020

Date:

golder.com

APPENDIX L

Other Specialist Studies

REPORT

Ecological Screening Study for the Proposed Haul Road at the iMpunzi Complex Mine

Glencore iMpunzi Complex

Submitted to:

Tebogo Chauke

Submitted by:

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March 2020

Distribution List

1 x eCopy to Glencore iMpunzi Complex

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Executive Summary

Glencore Operations South Africa's (GOSA) iMpunzi Complex has appointed Golder Associates Africa (Pty) Ltd (Golder) as an independent Environmental Assessment Practitioners (EAP) to undertake the Environmental Authorisation (EA) application process associated with the expansion of an existing haul road in order to enable the transportation of discard from the ATCOM discard dumps to the ATC plant, using haul trucks.

The proposed road expansion crosses a wetland and will involve clearance of vegetation and as a result, GOSA has appointed Golder to undertake an ecological screening study of the proposed road expansion route.

The iMpunzi Complex is located 27 km south-east of eMalahleni, in the Mpumalanga Province. Nearby town include Ogies and Kriel. The complex forms part of both the eMalahleni and Steve Tshwete Local Municipalities of the Nkangala District Municipality. The proposed haul road expansion is located along the R547 arterial road, within the iMpunzi Complex Mining Right Area (MRA).

The study area for the wetland and terrestrial ecology assessment was defined as the route of the proposed haul expansion plus a 500 m buffer zone around the proposed infrastructure to account for potential direct and indirect impacts within the regulated zone of a watercourse, as required by the National Water Act.

An unchanneled valley bottom wetland system with adjacent hillslope seepages occurs within the study area. This wetland's health (present ecological status – PES), ecological importance and sensitivity (EIS) and functionality (ecosystem services provision – WET Ecoservices) was assessed. Both the unchanneled valley bottom and the hillslope seepage wetland have an overall PES category of E which means that the wetland is seriously modified. While the overall EIS for both systems is of low/marginal category meaning the wetland is not ecologically important or sensitive on a local scale. The main ecological services rendered by both wetlands include erosion control, sediment trapping, phosphate trapping, nitrate removal and toxicant removal.

The proposed road expansion will not have any significant residual impact on the current environmental setting, provided that the recommended mitigation measures are implemented during construction and operation. It should be noted that the road crosses a wetland and as such constitutes a water use in terms of the National Water Act – requiring a Water Use License. In particular, the development and implementation of a construction method statement for wetland crossings with follow up monitoring will be critical in ensuring that no significant residual impacts on wetlands as a result of construction occur.

However, the severity of this impacts on the environment can be mitigated through the implementation of the recommended mitigation measures. Special attention must be given to the wetland that is crossed by the proposed road expansion during construction to ensure that impacts on wetland habitat are avoided and minimised.

Acronym List

Acronyms	
BODATSA	Biodiversity Data South Africa
AIS	Alien Invasive Species
CARA	Conservation of Agricultural Resources Act
DWAF	Department of Water and Forestry
DWS	Department of Water and Sanitation
EIS	Ecological Importance and Sensitivity
GOSA	Glencore Operations South Africa
HGM	Hydro-geomorphic
NEMBA	National Environmental Management: Biodiversity Act
PES	Present Ecological Status
POSA	Plants of South Africa
SANBI	South African National Biodiversity Institute
ToPS	Threatened or Protected species
UCVB	Unchanneled Valley Bottom

Table of Contents

TABLES

FIGURES

APPENDICES

APPENDIX A
Document Limitations

APPENDUIX B
Site Photographs

APPENDIX C
Specialist Declaration

1.0 INTRODUCTION

Glencore Operations South Africa's (GOSA) iMpunzi Complex has appointed Golder Associates Africa (Pty) Ltd (Golder) as an independent Environmental Assessment Practitioners (EAP) to undertake the Environmental Authorisation (EA) application process associated with the expansion of an existing haul road in order to enable the transportation of discard from the ATCOM discard dumps to the ATC plant, using haul trucks.

The proposed road expansion crosses a wetland and will involve clearance of vegetation and as a result, GOSA has appointed Golder to undertake an ecological screening study of the proposed road expansion route.

2.0 STUDY AREA

The iMpunzi Complex is located 27 km south-east of eMalahleni, in the Mpumalanga Province. Nearby town include Ogies and Kriel. The complex forms part of both the eMalahleni and Steve Tshwete Local Municipalities of the Nkangala District Municipality. The proposed haul road expansion is located along the R547 arterial road, within the iMpunzi Complex Mining Right Area (MRA) (Figure 1).

The study area for the wetland and terrestrial ecology assessment was defined as the route of the proposed haul road expansion plus a 500 m buffer zone around the proposed infrastructure to account for potential direct and indirect impacts within the regulated zone of a watercourse, as required by the National Water Act.

2.1 Project description

The proposed haul road will be located within an existing haul road. The proposed haul road will be an extension of the current haul road and will be approximately 6 m wide and approximately 2 km long. The road will connect to an existing railway to the north, towards the ATC plant. The road is located within an area of rehabilitated land, with rehabilitated tailings to the south and two slurry lagoons on both side of the haul road. Furthermore, towards the western direction of the road, there is a conveyor belt, transporting coal from one of iMpunzi Complex Mines. (Figure 2).

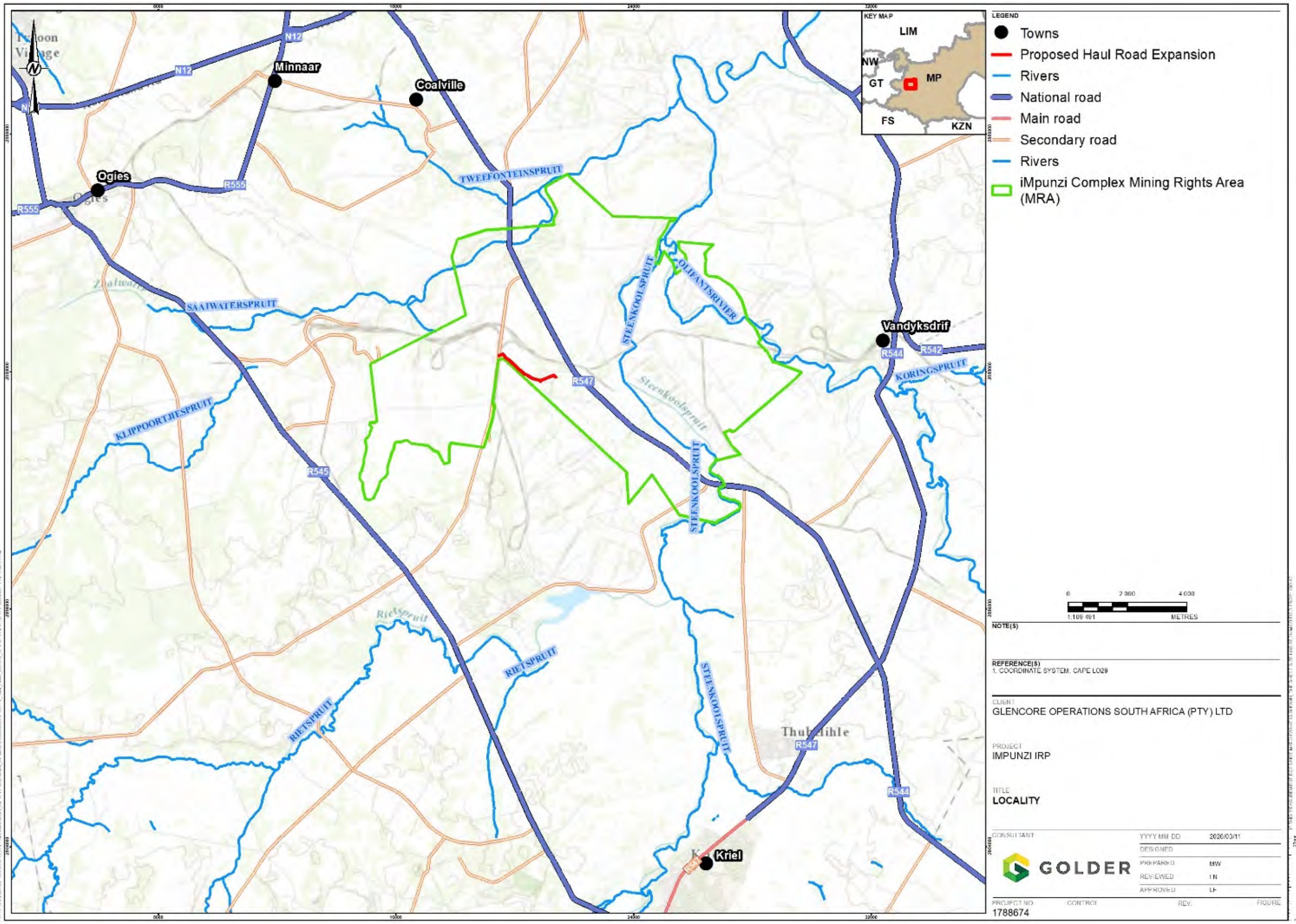

Figure 1: Location of the proposed road expansion

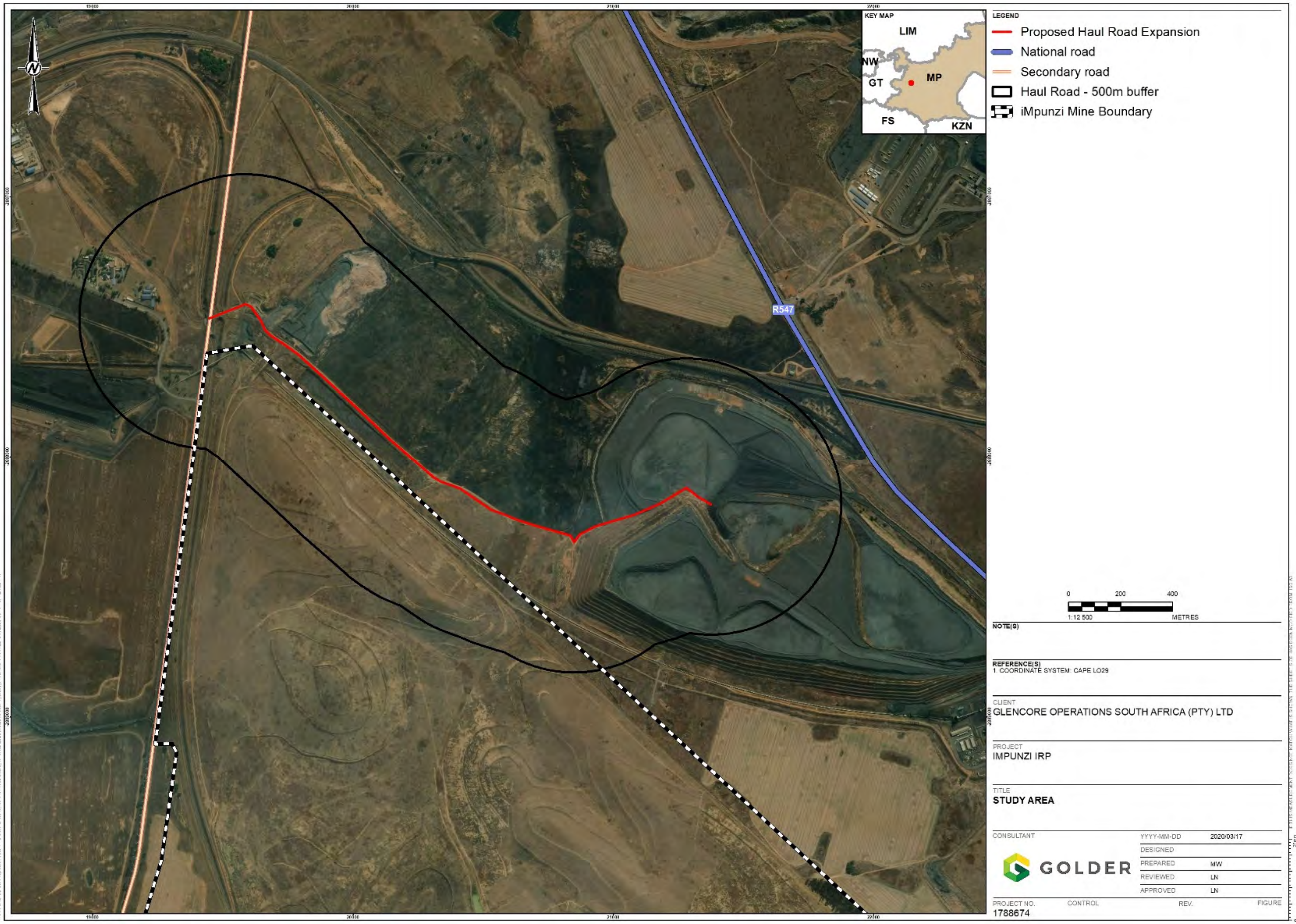

Figure 2: Study Area

3.0 STUDY METHODOLOGY

The ecology screening study included a literature review and a field survey, focusing on both terrestrial ecology and wetland habitats. The field survey was undertaken on the 06th of March 2020. The tasks undertaken as part of the scope of work are described in the sections below.

3.1 Terrestrial Ecology

3.1.1 Literature review

3.1.1.1 Flora

- The national vegetation community description relevant to the broader study area was obtained from Mucina and Rutherford (2006);
- The formal conservation context of the study area at a provincial and national level was determined based on the Mpumalanga Biodiversity Sector Plan (2013) and the National List of Threatened Ecosystems (NEMBA Threatened Ecosystems, 2011) respectively;
- A preliminary habitat/vegetation mapping exercise was undertaken at a desktop level using available satellite imagery, supported by land cover classification (GEOTERRA Image (GTI) 2014); and
- A list of flora species likely to occur in the area was obtained from SANBI[1]'s online database 'Plants of South Africa' (SANBI, 2020) and the Biodiversity Management Plan for the iMpunzi Complex (Clean Stream, 2019).

3.1.1.2 Fauna

- Lists of mammals, birds herpetofauna (reptiles and amphibians) likely to occur in the area were compiled from existing reports, available literature and online databases including:
  - Mammals: Stuart and Stuart (2007);
  - Birds: South African Bird Atlas Project 2 (ADU- SABAP2, 2011);
  - Reptiles: Bates et al. (2014);
  - Amphibians: Du Preez and Carruthers (2009);
  - Fauna (general): FitzPatrick Institute of African Ornithology's (2019) - Virtual Museum database (i.e. MammalMAP, ReptileMAP, FrogMAP); and
  - The Biodiversity Management Plan for the iMpunzi Complex (Clean Stream, 2019).
- Faunal species lists were cross-referenced against provincial and national threatened and protected species databases to determine species of conservation concern (refer to section 3.1.1.3); and
- A habitat suitability assessment for fauna of conservation concern potentially occurring in the study area to determine a 'probability of occurrence' (refer to section 4.1).

3.1.1.3 Screening of Species of Concern

Threatened and protected species of flora and fauna

The conservation status determination for floral and faunal species occurring or potentially occurring in the study area was based on:

[1] South African National Biodiversity Institute

- Regional/National Red List Status, as per:
  - Red List of South African Plants Version (SANBI, 2017);
  - Red List of Mammals of South Africa, Lesotho and Swaziland *EWT, 2016);
  - Regional Red List for Birds of South Africa, Lesotho and Swaziland (Birdlife South Africa, 2015); and
  - Atlas and Red List of the Reptiles of South Africa, Lesotho and Swaziland *Bates *et al.,* 2014).
- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004) - Threatened or Protected Species List (Notice 389 of 2013) (Draft NEMBA ToPS List, 2015); and
- Mpumalanga Nature Conservation Act (No. 10 of 1998).

Alien invasive species

Alien invasive plant species recorded on-site were categorised according to the following listings:

- Conservation of Agricultural Resources Act (CARA) (Act No. 43 of 1983); and/or
- National Environmental Management: Biodiversity Act (NEMBA) (Act No. 10 of 2004) - 2016 listing.

3.1.1.4 Fauna Habitat Suitability Assessment

Based on the lists of faunal species of conservation concern potentially occurring in the study area, a '*probability of occurrence*' for each species was determined by assessing habitat suitability and reviewing the results of previous faunal assessments documented in the Impunzi Biodiversity Management Plan (Clean Stream, 2019). Based on aerial imagery and general observations made during the field survey, the following parameters were used to guide the assessments:

- **Habitat requirements:** Most threatened and endemic species have very specific habitat requirements. The presence of these habitats in the study area was evaluated;
- **Habitat status:** The status or ecological condition of available habitat in the area was assessed. Often a high level of habitat degradation will negate the potential presence of sensitive species; and
- **Habitat linkage:** Dispersal and movement between natural areas for breeding and feeding are important population-level processes. Habitat connectivity within the study area and to surrounding natural habitat and corridors was evaluated to determine the likely persistence of species of concern in the study area.

Probability of occurrence is presented in three categories, namely:

- **High**: The species is likely to occur on the site due to suitable habitat and resources being present on or nearby the site;
- **Moderate**: The species may occasionally occur on the site, or move through the site (in the case of mobile species), due to potential habitat and/or resources; or
- **Low**: The species will not likely occur on the site due to lack of suitable habitat and resources.

3.1.2 Field Survey

The site of the proposed road expansion is located in a highly fragmented and modified landscape, dominated by various mine infrastructure. It was expected that most undeveloped areas would comprise disturbed, secondary habitat. In this context, the terrestrial ecology fieldwork focused on ground-truthing the ecological setting of the road expansion footprint to determine the general character and composition of potentially affected vegetation communities occurring along the proposed road expansion, and identifying any species or sites/habitats of ecological importance or sensitivity.

A one-day field survey was conducted on the 6th of March 2020. The field survey comprised a walk-down of the proposed road expansion route, during which data were recorded on the following:

- General habitat character, i.e. type and structure, landscape context, and disturbances;
- General flora composition;
- Opportunistic observations of fauna and the recording of evidence of their presence (e.g. tracks, scats, burrows, etc.); and
- A catalogue of photographs was also collected, which were used to supplement field notes.

3.2 Wetland Ecology

A review of Golder's existing wetland data holdings for Glencore was conducted to generate a desktop wetland delineation and classification map of the Study Area for confirmation in the field. The most recent assessments of wetland PES and EIS for wetland units occurring within the Study Area was reviewed with a view to confirming/updating the assessment during the site visit.

A one-day field survey was undertaken on the 06th of March 2020 to ground-truth the boundary of the wetlands in the Study Area, confirm their classification and update their PES and EIS scores. The methods used for each assessment are described in the following sections.

3.2.1 Wetland Delineation and Classification

Wetland Delineation

According to the National Water Act, 1998 (Act 36 of 1998), wetlands are defined as:

"land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or land that is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typical of life in saturated soil".

Furthermore, wetlands have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation;
- The presence, at least occasionally, of water loving plants (hydrophytes); and
- A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 50 cm of the soil (DWAF, 2005).

The boundary of wetlands previously delineated as part of iMpunzi's wetland offset strategy (WCS,2019).

Wetland Classification

Wetland types are classified based on their hydro-geomorphic (HGM) characteristics i.e. on the position of the wetland in the landscape, as well as the way in which surface water and/or groundwater moves into, through and out of the wetland systems. Six major inland HGM types are recognised for the purposes of classification (Table 1).

Table 1: Wetland hydro-geomorphic units (after Kotze *et al*., 2008)

Wetland Hydro-geomorphic type	Description	Source of water maintaining the wetland[1]	
		Surface	Sub-surface
Floodplain	Valley bottom areas with a well-defined stream channel, gently sloped and characterised by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*
Channelled valley bottom	Valley bottom areas with a well-defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterised by the net accumulation of alluvial deposits or may have steeper slopes and be characterised by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.	***	*/***
Unchanneled valley bottom	Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterised by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.	***	*/***
Hillslope seepage with channelled outflow	Slopes on hillsides, which are characterised by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well-defined stream channel connecting the area directly to a stream channel.	*	***
Hillslope seepage without channelled outflow	Slopes on hillsides, which are characterised by the colluvial movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a stream channel.	*	***
Depression (includes pans)	A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent, and therefore this type is usually isolated from the stream channel network.	*/***	*/***

[1] Precipitation is an important water source and evapotranspiration an important output in all of the above settings.

Water source: Contribution usually small *** Contribution usually large */ *** Contribution may be small or important depending on the local circumstances.*

3.2.2 Present Ecological State

WET-Health (Macfarlane *et al*., 2008) provides an appropriate framework for undertaking an assessment to indicate the ecological integrity of each of the wetland systems being assessed. The outcome of the assessment also highlights specific impacts, therefore highlighting issues that should be addressed through mitigation and rehabilitation interventions. The WET-Health approach assesses wetlands using three characteristics, namely hydrology, geomorphology and vegetation. Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have an impact on wetland functioning or condition.

The individual scores for the hydrology, geomorphology and vegetation modules are integrated based on a weighted average ratio of 3:2:2 (given that hydrology is considered to have the greatest contribution to health), to give an overall Present Ecological State (PES) score, enabling the placement of the wetland unit into a present state category. The impact categories, scores, and associated present state categories are summarised in Table 2.

Table 2: Impact scores and categories of Present Ecological State used by WET-Health for describing the integrity of wetlands (Macfarlane *et al*., 2008)

Impact Category	Description	Impact Score Range	Present State Category
None	Unmodified, or approximates natural condition	0 – 0.9	**A**
Small	Largely natural with few modifications, but with some loss of natural habitats	1 – 1.9	**B**
Moderate	Moderately modified, but with some loss of natural habitats	2 – 3.9	**C**
Large	Largely modified. A large loss of natural habitat and basic ecosystem function has occurred	4 – 5.9	**D**
Serious	Seriously modified. The losses of natural habitat and ecosystem functions are extensive	6 – 7.9	**E**
Critical	Critically modified. Modification has reached a critical level and the system has been modified completely with almost complete loss of natural habitat	8 – 10.0	**F**

3.2.3 Ecological Importance and Sensitivity

The EIS of each HGM unit is determined using the methodology developed by Rountree *et al.* (2013). It is a rapid scoring system to evaluate:

- Ecological Importance and Sensitivity;
- Hydrological Functions; and
- Direct Human Benefits.

The scoring assessment incorporates three components:

- EIS score derived using aspects of the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999);

- Hydro-function importance score derived from the WET-EcoServices tool for the assessment of wetland ecosystem services Kotze *et. al*. (2009); and
- Direct human benefits score derived from the WET-EcoServices tool for the assessment of wetland ecosystem services Kotze *et. al*. (2009).

Using the Rountree *et. al.* method (2013), the highest score of the three component scores (each with range 0 – 4) is then used to indicate the overall importance category of the wetland (Table 3).

Table 3: Ecological Importance and Sensitivity categories

Ecological Importance and Sensitivity Category Description	Range of EIS score
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and ≤4
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and ≤3
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and ≤2
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and ≤1

3.2.4 Wetland Ecosystem Services

Wetlands are specialised systems that perform ecological functions vital for human welfare and environmental sustainability. The WET – EcoServices tool (Kotze *et al*., 2007), a technique for rapidly assessing ecosystem services supplied by wetlands, is used to determine the key ecological services provided by each wetland in the Study Area. The rapid field assessment (Level 2) approach was applied, and the following services were examined and rated:

- Flood attenuation;
- Stream flow regulation;
- Sediment trapping;
- Phosphate trapping;
- Nitrate removal;
- Toxicant removal;
- Erosion control;
- Carbon storage;

- Maintenance of biodiversity;
- Water supply for human use;
- Natural resources;
- Cultivated foods;
- Cultural significance;
- Tourism and recreation; and
- Education and research.

Each of the above-listed services are scored according to the following general level of service provided:

Table 4: Level of service scores

Score	Level of Service Provision
0	Low
1	Moderately Low
2	Intermediate
3	Moderately High
4	High

3.3 Impact Assessment

The significance of identified impacts was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Table 5: Impact classification for impact assessment

Occurrence		Severity	
Probability	Duration	Scale/extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the following ranking scales are used (Table 6):

Table 6: Ranking scales

Probability	Duration
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8 - 15 years)
2 - Low probability	2 - Short-term (0 - 7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 - Immediate

0 - None	
Scale	**Magnitude**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

After ranking these factors for each impact, the significance of the two aspects, occurrence and severity, was assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance was then rated as per Table 7.

Table 7: Categories describing environmental consequence

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management, and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

Although not explicitly included in the criteria tables, there is uncertainty associated with the information and methods used in this impact assessment because of its predictive nature. The certainty with which an impact analysis can be completed depends on a number of factors including:

- Understanding of natural/ecological and socio-economic processes at work now and in the future; and
- Understanding of present and future properties of the affected resource.

The level of prediction confidence for an impact analysis will be discussed when there are questions about the factors reviewed above. Where the level of prediction confidence makes a prediction of the impact problematic, a subjective assessment is made based on the available information, the applicability of information on surrogates and on professional opinion.

The level of prediction confidence is sufficiently low in some cases that an estimate of environmental consequence cannot be made with a sufficient degree of confidence. Undetermined ratings are accompanied by recommendations for research or monitoring to provide more data in the future.

3.4 Mitigation and monitoring

Recommendations for control and/or mitigation measures were made in response to the impacts identified.

3.5 Study Assumptions and Limitations

- The scope of the current study was limited to terrestrial and wetland systems; No aquatic ecosystem assessment was conducted for the purposes of this study since no riparian systems occurred within the Study Area; and
- No small mammal trapping or dedicated bird surveys were conducted given the highly disturbed nature of the Study Area, and the outcomes and management recommendations of the recent BMP (Clean Stream, 2019).

4.0 BASELINE ASSESSMENT

4.1 Terrestrial Ecology

4.1.1 Regional ecological setting

The project site falls within the Mesic Highveld Grassland Bioregion that forms part of the Grassland Biome of South Africa. The dominant vegetation type found in this bioregion is Eastern Highveld Grassland (Mucina and Rutherford, 2006).

A brief description of this vegetation type is provided below, with the regional delineation shown in Figure 3:

Vegetation and Landscape Features

Eastern Highveld Grassland occurs on slightly to moderately undulating plains, including some low hills and pan depressions. The vegetation is short dense grassland dominated by the usual Highveld grass composition (*Aristida, Digitaria, Eragrostis, Themeda, Tristachya,* etc.) with small, scattered rocky outcrops with wiry, sour grasses and some woody species (*Senegalia caffra, Celtis africana, Diospyros lycioides* subsp *lycioides, Parinari capensis, Protea caffra, P. welwitschii* and *Rhus magalismontanum*) (Mucina and Rutherford, 2006).

Important Plant Taxa

Based on Mucina and Rutherford (2006) vegetation classification, important plant taxa are those species that have a high abundance, a frequent occurrence (not being particularly abundant) or are prominent in the landscape within a particular vegetation type. Mucina and Rutherford (2006) recognised the following species as important taxa in Eastern Highveld Grassland:

Graminoids: *Aristida aequiglumis, A. congesta, A. junciformis* subsp*. galpinii, Brachiaria serrata, Cynodon dactylon, Digitaria monodactyla, D. tricholaenoides, Elionurus muticus, Eragrostis chloromelas, E. curvula, E. plana, E. racemosa, E. sclerantha, Heteropogon contortus, Loudetia simplex, Microchloa caffra, Monocymbium ceresiiforme, Setaria sphacelata, Sporobolus africanus, S. pectinatus, Themeda triandra, Trachypogon spicatus, Tristachya leucothrix, T. rehmannii, Alloteropsis semialata* subsp*. eckloniana, Andropogon appendiculatus, A. schirensis, Bewsia biflora, Ctenium concinnum, Diheteropogon amplectens, Eragrostis capensis, E. gummiflua, E. patentissima, Harpochloa falx, Panicum natalense, Rendlia altera, Schizachyrium sanguineum, Setaria nigrirostris* and *Urelytrum agropyroides.*

Herbs: *Berkheya setifera, Haplocarpha scaposa, Justicia anagalloides, Pelargonium luridum, Acalypha angustata, Chamaecrista mimosoides, Dicoma anomala, Euryops gilfillanii, E. transvaalensis subsp. setilobus, Helichrysum aureonitens, H. caespititium, H. callicomum, H. oreophilum, H. rugulosum, Ipomoea crassipes, Pentanisia prunelloides subsp. latifolia, Selago densiflora, Senecio coronatus, Vernonia oligocephala* and*Wahlenbergia undulata.*

Geophytic Herbs: *Gladiolus crassifolius, Haemanthus humilis subsp. hirsutus, Hypoxis rigidula* var. *pilosissima* and*, Ledebouria ovatifolia.*

Succulent Herb: *Aloe ecklonis.*

Low Shrubs: *Anthospermum rigidum* subsp. *pumilum* and *Seriphium plumosum*

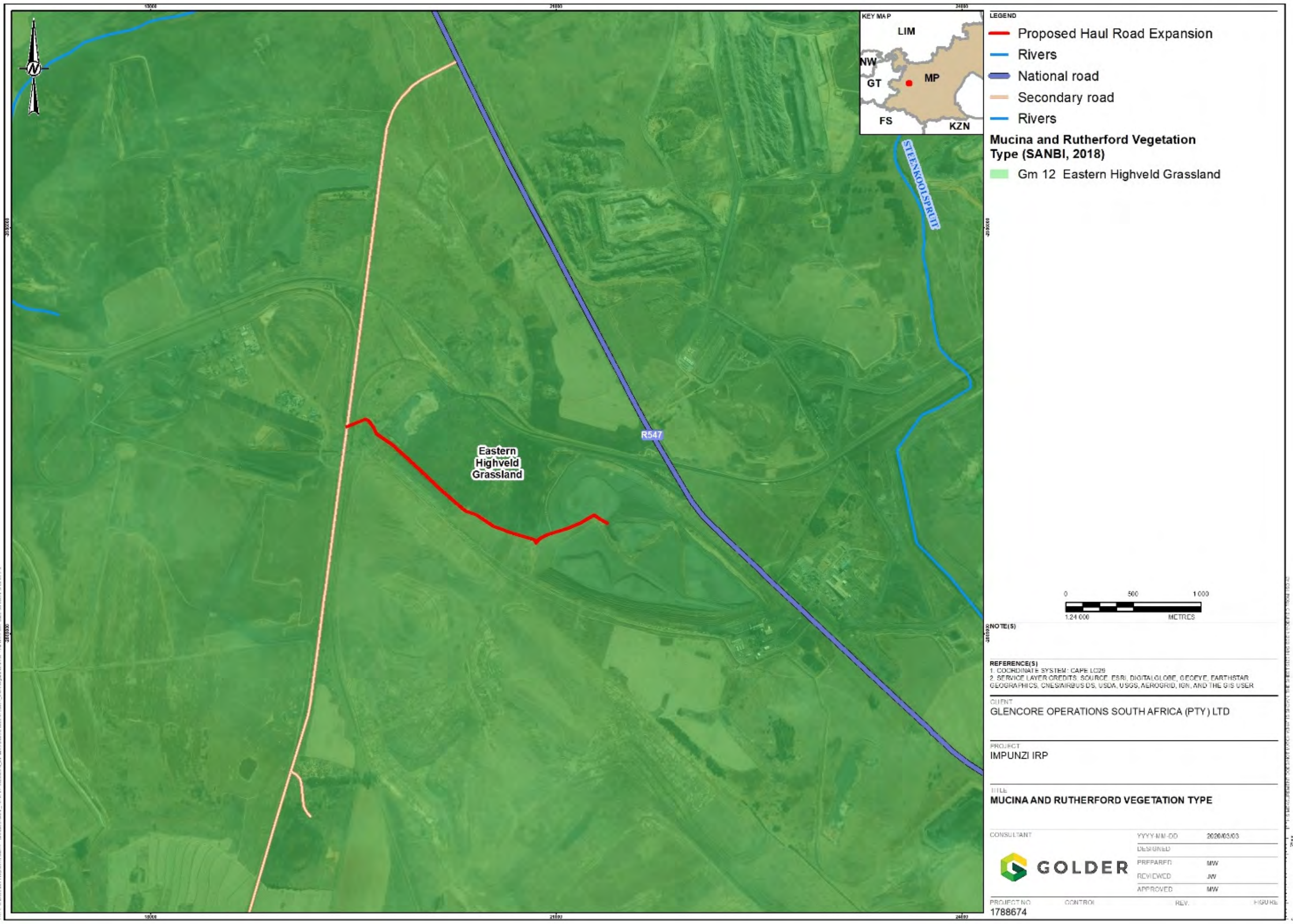

Figure 3: Proposed road expansion in relation to Mucina and Rutherford's (2006) regional vegetation types

4.1.2 National and Provincial Conservation Context

At a national level the proposed road expansion is located in an area mapped as a Vulnerable ecosystem based on data from 2009 (Figure 4). Vulnerable ecosystems are considered at high risk of undergoing significant degradation of ecological structure, function or composition as a result of human intervention (Clean Stream, 2019). Recent aerial imagery suggests that the information presented in Figure 4 is most likely outdated, as habitat degradation and transformation due to mining has occurred in the region in the interim.

4.1.2.1 Mpumalanga Biodiversity Sector Plan

According to the Mpumalanga Biodiversity Sector Plan (MBCP) (2013) the study area consists of three of the province's biodiversity categories. Based on Figure 5, the land considered as "other natural areas" is observed to the be the area that crosses a wetland system. While the area that has been "modified" is one observed to have tailings stockpiles and old slurry lagoons. These are listed and summarised in Table 8 and their distribution shown in Figure 5.

Table 8: Categories of the Mpumalanga Biodiversity Sector Plan (2013).

Category	Description and Motivation
Modified	Modified areas are those that have undergone a significant and often irreparable degree of transformation that has led to a near-complete loss of biodiversity and ecological functioning. Common agents of modification include mining, arable agriculture and infrastructure development.
Modified – Old lands	This sub-category of Modified relates to areas that have been altered by cultivation and other activities within the last 80 years and subsequently abandoned. The biodiversity and ecological functioning in such areas is compromised but may still play a role in the provision of ecosystem services.
Other natural areas	These are areas that have not been selected to meet biodiversity conservation targets, yet they are likely to provide habitat for flora and fauna species and a range of ecosystem services.
Critical Biodiversity Area (CBA) - Optimal	CBA – Optimal are areas selected to optimally meet biodiversity targets. Although these areas have a lower irreplaceability value than the CBA – Irreplaceable category, collectively they reflect the smallest area required to meet biodiversity conservation targets.

4.1.3 Landscape Context and Land Cover

The proposed road expansion is approximately 2 km long and 16 m wide. The proposed road expansion is located within the iMpunzi Complex Mine site in an area that was historically mined and rehabilitated. As shown in Figure 6, the proposed road transverses different land cover classes including grassland, mine and quarries, cultivated land, wetlands and waterbodies.

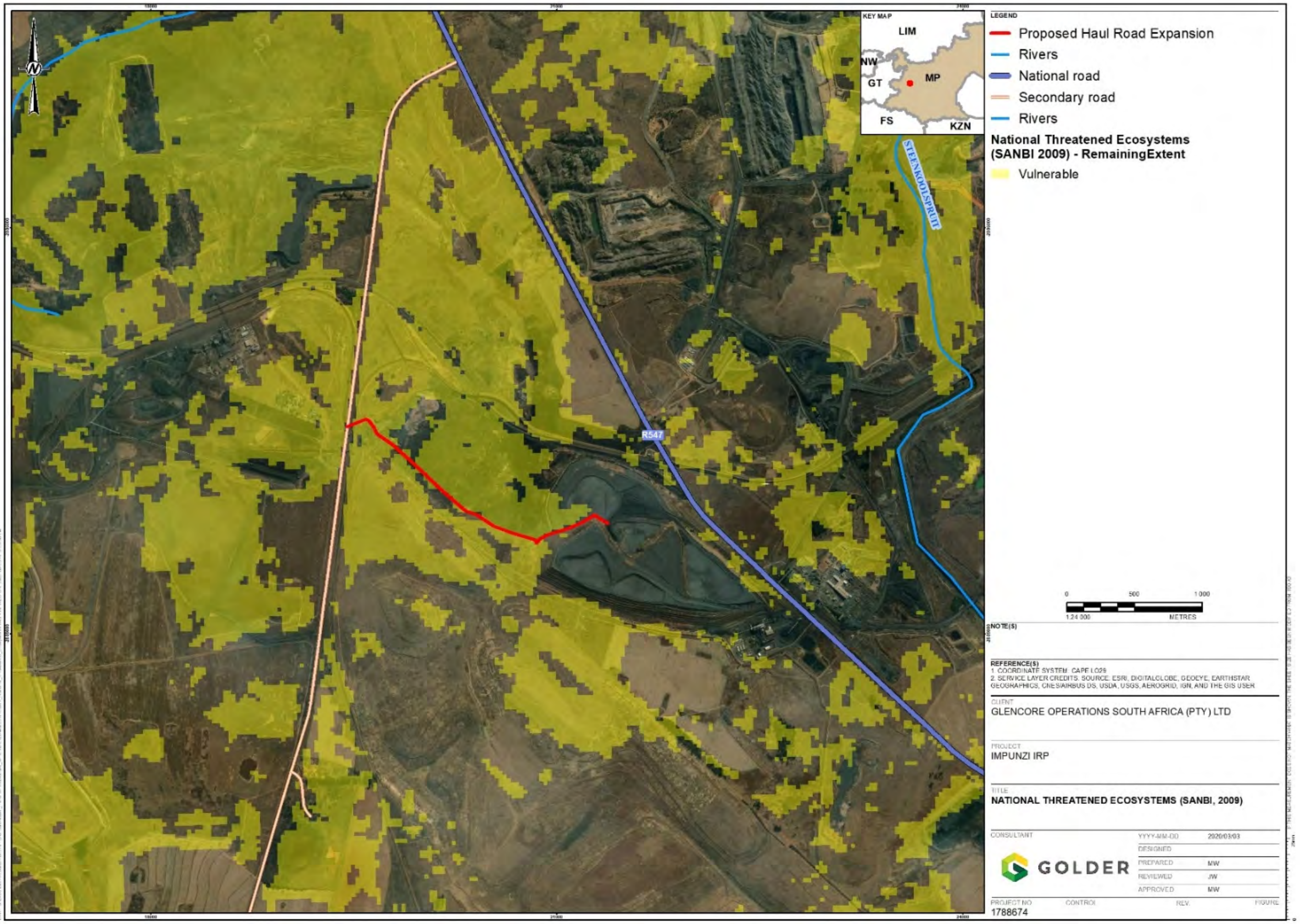

Figure 4: Delineation of Nationally Threatened Ecosystems (2009)

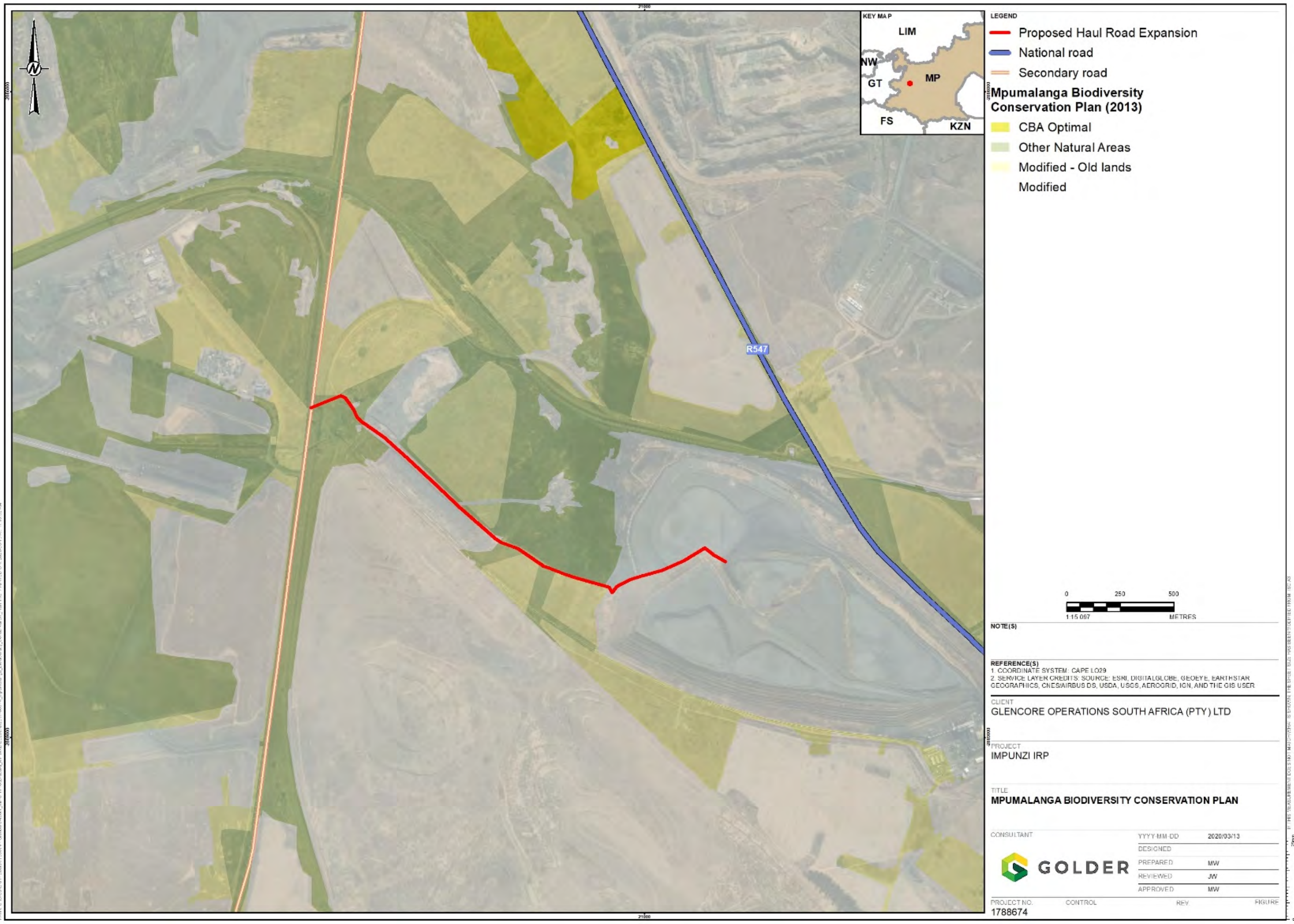

Figure 5: Proposed road expansion in relation to the Mpumalanga Conservation Plan

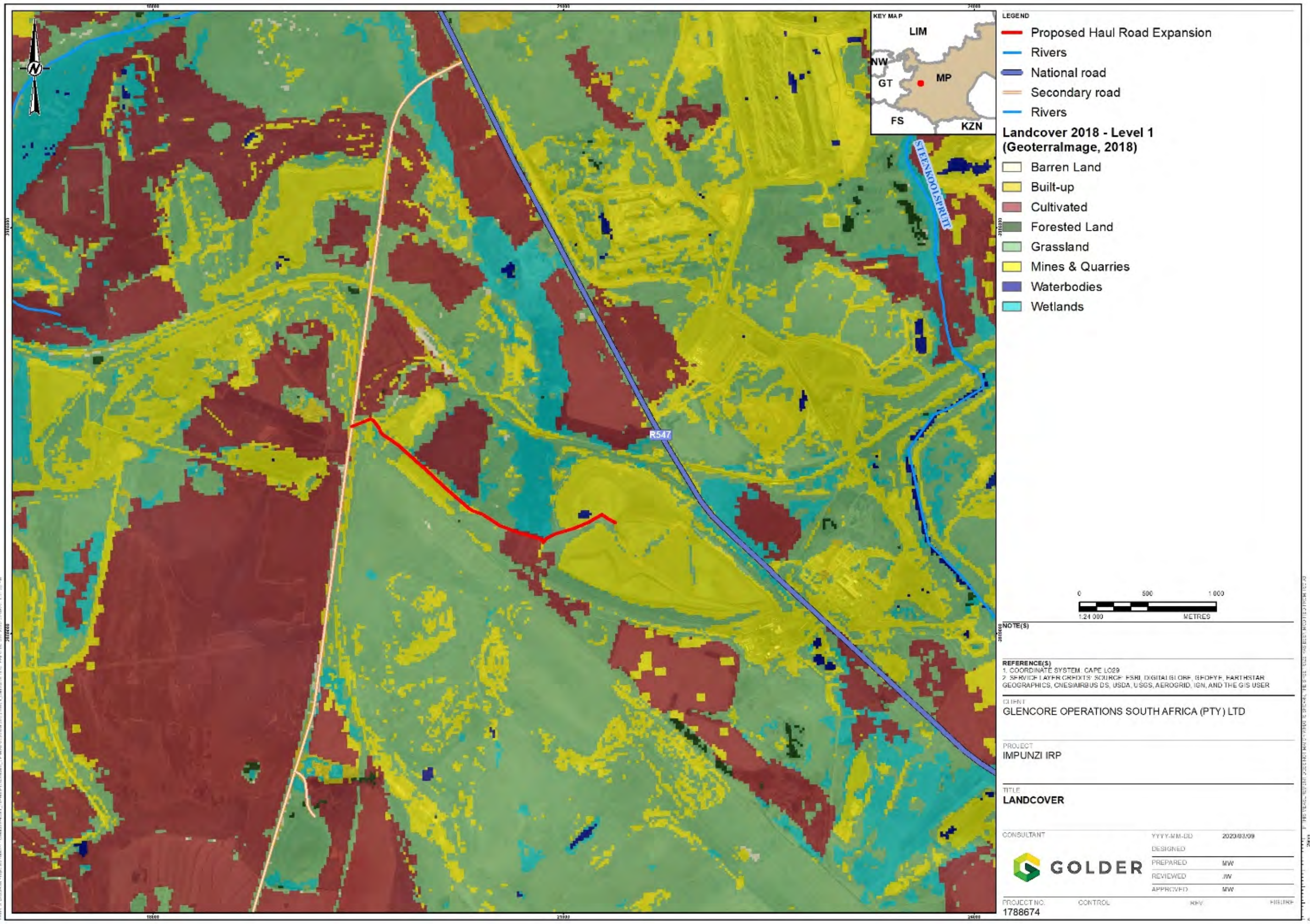

Figure 6: Land cover along the proposed road expansion (Geoterraimage, 2018)

Note: *This map is based on available existing Geographic Information System (GIS) data sets of the area, some variability on the ground may be expected.*

4.2 Flora Assessment

4.2.1 Habitat Units

As seen in Figure 15, the proposed haul expansion is located within a rehabilitated mine area with stockpiling Figure 17-Figure 19 and an existing road Figure 14. Based on the field observations, the majority of the vegetation identified along the undeveloped shoulders of proposed road expansion is disturbed and characterised by two main habitat types, namely rehabilitated/secondary grassland and moist grassland (wetland). A habitat map is presented in Figure 7.

Rehabilitation/secondary grassland dominates most of the land on either side of the proposed road expansion route. The most common grass species recorded were *Cynodon dactylon, Paspalum dilatatum, Hyparrhenia hirta, Themeda triandra,* and various *Eragrostis* species.

Weedy forbs were also abundant, with species such as *Bidens pilosa, Verbena bonariensis, Gomphocarpus physocarpus, Datura stramonium* and *Tagetes minuta* particularly common. These species are indicative of areas that have been physically disturbed (shown in Figure 12 and Figure 18). In addition to these species, *Melinis repens, Pseudognaphalium luteo-album, Chamaecrista mimosoides, Pollichia campestris* were also recorded.

In terms of woody shrubs taxa, multi-stemmed species such as *Asparagus laricinus, Solanum mauritianum, Seriphium plumosum, and Gomphocarpus fruticosus* were recorded along the proposed haul road. Of these shrub species, *Seriphium plumosum* shrub is considered problematic within the Grassland biome as it aggressively encroaches grasses found within this biome (Synman, 2012), while *Solanum mauritianum* encroaches the forest margins, plantations, roadsides, urban spaces and also sparsely forested riverine protected areas (ARC, 2014).

A stand of alien *Acacia* trees (*Acacia mearnsii/dealbata*) is present towards the western end of the road expansion footprint, and *Prunus persica* recorded adjacent the haul road. Herbaceous species recorded included *Cosmos bipinnatus* and *Nesaea schinzii,* which were abundant towards the northern end of the road expansion, and *Helichrysum cephaloideum* which was widespread within the moist grassland.

The proposed road expansion bisects an area of moist grassland Common plant species in this habitat includes *Juncus effuses, Ascolepis capensis, Bulbostylis hispidula, Carex glomerabilis, Fimbristylis dichotoma, Paspalum urvillei, Andropogon huilensis, Eragrostis gummiflua, Dichanthium annulatum, Plantago major* and *Imperata cylindrica*; the tall reed *Phragmites australis, Hemarthria altissima, Leersia hexandra, Persicaria amplexicaulis* and the rush *Typha capensis* (Figure 13) were recorded. These species are indicative of typical wetland species.

Alien invasive species noted within the area of moist grassland included *Campuloclinium macrocephalum,* and *Verbena bonariensis* – both are listed alien invasive species. Refer to section 4.4 for more detail on the wetland system.

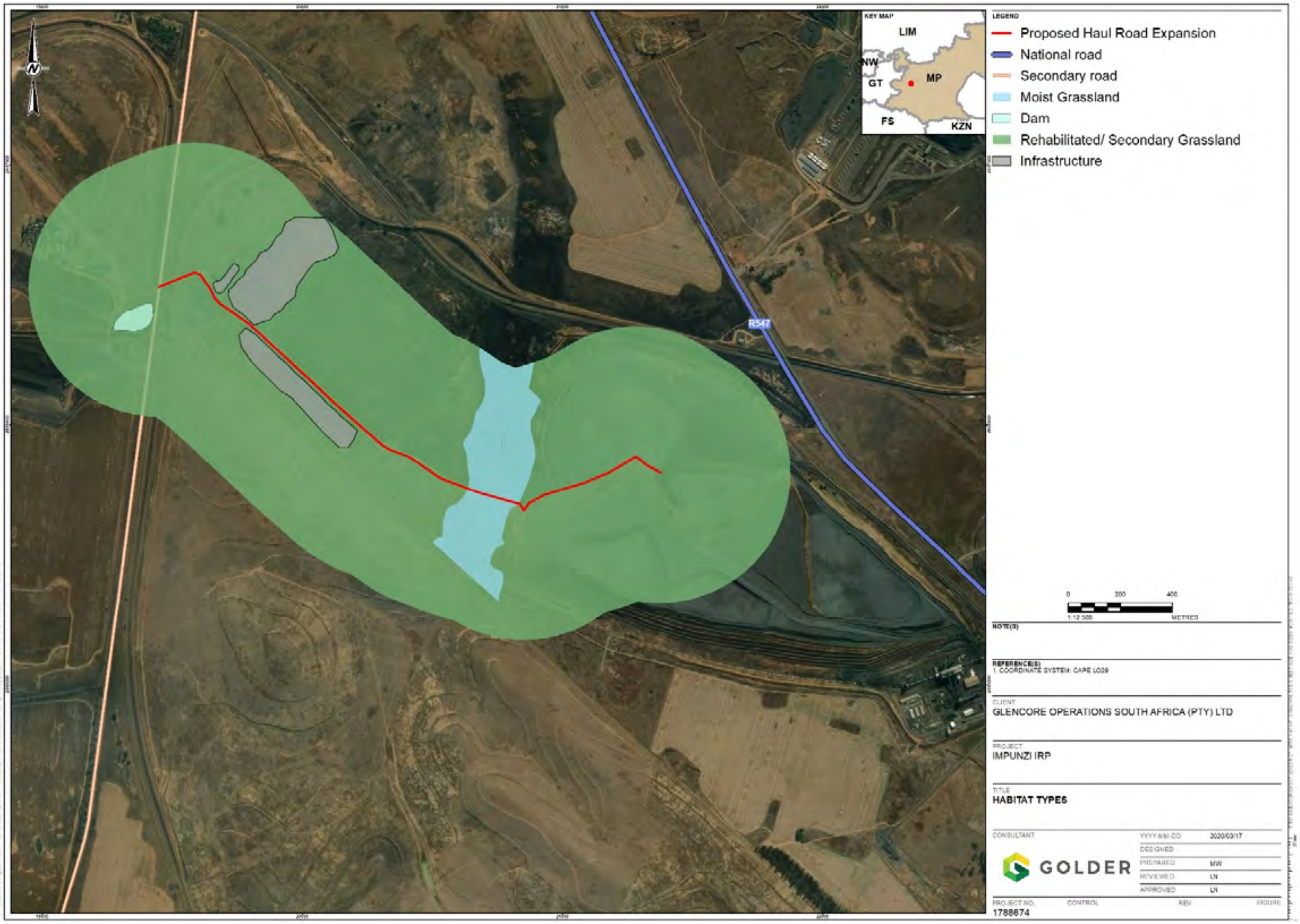

Figure 7: Habitats along the proposed road expansion

4.2.2 Threatened and Protected Plant Species

No plant species of conservation concern were recorded on-site during the field survey.

Although two plant species that are listed on the South African Red List have been previously recorded within the iMpunzi Complex Mine boundary (Clean Stream 2019) (Critically Endangered *Brachycorythis conica* subsp. *transvaalensis*; and Vulnerable *Khadia carolinensis)* these were recorded in primary grassland, shrubland and herb land BMUs in the Impunzi complex (Clean Stream, 2019) and are therefore not expected to occur in rehabilitated areas such as the secondary grasslands of the Study Area.

Other noteworthy plant species that have been documented at iMpunzi and are listed as Declining on the South African Red List include *Crinum bulbispermum, Hypoxis hemerocallidea* and *Boophone disticha (*Clean Stream, 2019*)*. Although these species are typically associated with wetland habitat, none were observed in the wetland habitat within the Study Area during the current survey.

4.2.3 Plants of Medicinal Value

Five plant species recorded during the field survey have recognised medicinal value. These are listed in Table 9, accompanied by a description of their purported use, as per Van Wyk *et al.*, (2009).

Table 9: Plants of medicinal value recorded during the site visit

Scientific Name	Growth Form
Asparagus laricinus	Treats tuberculosis, kidney aliments and rheumatism.
Datura stramonium	Relieves asthma and acts to reduce pain. Weak infusions are used as an aphrodisiac.
Typha capensis	Decoctions used to treat venereal disease, as well as diarrhoea, dysentery and enhance male libido.
Plantago major	Seed infusions used to treat diarrhoea (especially children); leaf as poultice for wounds and sores

4.2.4 Alien Invasive Species

Five plant species recorded in the study area during the field visit are listed as alien invasive species under either the NEMBA or CARA. These, along with their category are listed in (Table 10).

Table 10: CARA and NEMBA listed alien invasive flora species recorded during the field visit

Scientific Name	Common Name (English)	CARA Category	NEMBA Category
Acacia mearnsii/dealbata	Black/silver wattle	1/2	2
Campuloclinium macrocephalum	Pompom weed	1	1b
Cortaderia selloana	Pampas grass	1	1b
Datura stramonium	Common thorn apple	1	1b
Solanum sisymbriifolium	Wild tomato	2	1b
Solanum mauritianum	Bug weed	1	1b
Verbena bonariensis	Wild verbena	-	1b

4.3 Fauna Assessment

A full review of fauna diversity at Impunzi Complex was conducted as part of the BMP (Clean Stream, 2019). This study focussed on the likelihood of occurrence of species of conservation importance occurring in the Study Area for the proposed road expansion.

4.3.1 Mammals

During the field survey only the tracks of Water mongoose (*Atilax paludinosus*) were observed along the proposed road expansion route (Figure 8). This species has a widespread distribution and is abundant throughout its range. It is listed as Least Concern on the South African Mammal Red List.

According to the Biodiversity Management Plan (Clean Stream 2019), 32 mammal species have been recorded within the iMpunzi Complex, of these 13 are of conservation concern while two are endemic to South Africa (Highveld golden mole (*Amblysomus septentrionalis)* and Common molerat (*Cryptomys hottentotus).* Out of the 13 species of conservation concern, six have been confirmed within the iMpunzi Complex. These along with a probability of occurrence are presented in Table 11.

Figure 8: Water mongoose spoor observed within the wetland

Table 11: Mammals of conservation concern potentially occurring in the study area.

Scientific name	Common name	Conservation Status			Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	Mpumalanga Protected Species (1998)	
Amblysomus septentrionalis	Highveld golden mole	Near Threatened	-	-	Low
Dasymys incomtus	Water rat	Near Threatened	-	-	Confirmed *
Vulpes chama	Cape fox	Least Concern	Protected	-	Low
Aonyx capensis	Cape-clawless otter	Near Threatened	-	Protected	Confirmed *
Leptailurus serval	Serval	Near Threatened	Protected	-	Confirmed *

Scientific name	Common name	Conservation Status			Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	Mpumalanga Protected Species (1998)	
Mellivora capensis	Honey badger	Least Concern	-	Protected	Low
Ourebia ourebi	Oribi	Endangered	Endangered	Protected	Low
Hydrictis maculicollis	Spotted-necked otter	Vulnerable	-	Protected	Confirmed *
Felis nigripes	Black-footed cat	Vulnerable	Protected		Moderate
Atelerix frontalis	South African hedgehog	Near Threatened	-	Protected	High
Otomys auratus	Vlei Rat	Near Threatened	-	-	Confirmed *
Parahyaena brunnea	Brown hyaena	Near Threatened	-	-	Confirmed*
Mystromys albicaudatus	White-tailed mouse	Vulnerable	-	-	Moderate

**Recorded in the Biodiversity Management Plan for Glencore iMpunzi Complex (Clean Stream 2019)*

4.3.2 Birds

The SABAP2 database lists 139 bird species for the 2600_2910 pentad in which the study area is located. Of these, 29 are of conservation concern. While the Biodiversity Management Plan (Clean Stream 2019) lists 119 bird species that have been observed within the iMpunzi Complex. Of these, 16 are of conservation importance

Of the bird species expected to occur within the iMpunzi Complex and those observed during a biodiversity survey, 16 are of conservation importance, while three of these are endemic to South Africa (*Eupodotis caerulescens, Lamprotornis bicolor and Geronticus calvus*).These, along with their conservation status and probability of occurrence in close proximity to the proposed road expansion, are detailed in Table 12.

Table 12: Birds of conservation concern potentially occurring in the study area.

Scientific name	Common name	Status		Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	
Anthropoides paradiseus	Blue crane	Near Threatened	Protected	Low
Eupodotis senegalensis	White-bellied korhaan	Vulnerable	-	Low
Eupodotis caerulescens	Blue bustard	Near Threatened	-	Low

Scientific name	Common name	Status		Probability of occurrence
		Red List (2016)	NEMBA TOPS List (2015)	
Charadrius pallidus	Chestnut-banded plover	Near Threatened	-	Low
Glareola nordmanni	Black-winged pratincole	Near Threatened	-	Low
Oxyura maccoa	Maccoa Duck	Near Threatened	-	Confirmed*
Alcedo semitorquata	Half-collared kingfisher	Near Threatened	-	Low
Circus ranivorus	African marsh harrier	Endangered	-	Confirmed*
Tyto capensis	African grass owl	Vulnerable	-	Confirmed*
Lamprotornis bicolor	Pied Starling	Least concern	-	Confirmed*
Geronticus calvus	Southern bald ibis	Vulnerable	Vulnerable	Moderate
Phoeniconaias minor	Lesser Flamingo	Near Threatened	-	Low
Phoenicopterus roseus	Greater flamingo	Near Threatened	-	Low
Mycteria ibis	Yellow-billed stork	Endangered	-	Low
Ciconia nigra	Black stork	Vulnerable	-	Low
Sagittarius serpentarius	Secretarybird	Vulnerable	-	Moderate

4.3.3 Herpetofauna (Reptiles and Amphibians)

No reptiles were observed on-site during the field survey. According to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998), all species of reptile excluding both monitor species (*Varanus albigularis albigularis* and *V. niloticus*) and all snakes, are listed as Protected. According to the Biodiversity Management Plan (Clean Stream. 2019), 36 species are expected to occur in the area, of these species, nine have been recorded, while seven are considered endemic to South Africa. Additional listed reptiles that potentially occur in the study area according to the distribution maps in Bates *et al*. (2014) include Striped Harlequin Snake (*Homoroselaps dorsalis*) – Near Threatened (NT) and Breyer's Long-tailed Seps (*Tetradactylus breyeri*) – Vulnerable (VU). Considering the disturbed nature of habitat, both species have a low probability of being present.

Giant Bullfrog (*Pyxicephalus adspersus*) is the only protected amphibian species of the 13 species that have been recorded within the iMpunzi Complex (Clean Stream, 2019). According to Schedule 2 of the Mpumalanga Nature Conservation Act (No 10 of 1998) this species is protected. The Giant Bullfrog used to be listed as Near Threatened on the NEMBA ToPS List. The probability of this species occurring in the wetland is considered low.

4.4 Wetland Ecology

A description of the wetlands within the study area in terms of their classification, and the assessment of their health (PES), level of ecosystem service provision, and ecological importance and sensitivity (EIS), are outlined in the sections that follow.

4.4.1 Wetland Delineation and Classification

The proposed project intends to expand an existing haul road that crosses an Unchanneled Valley Bottom (UCVB) wetland and a Hillslope seepage to the south and is located within 500m of a dam to the north west of the proposed haul road (Figure 9). These wetland systems were assessed as part of this assessment (Figure 10).

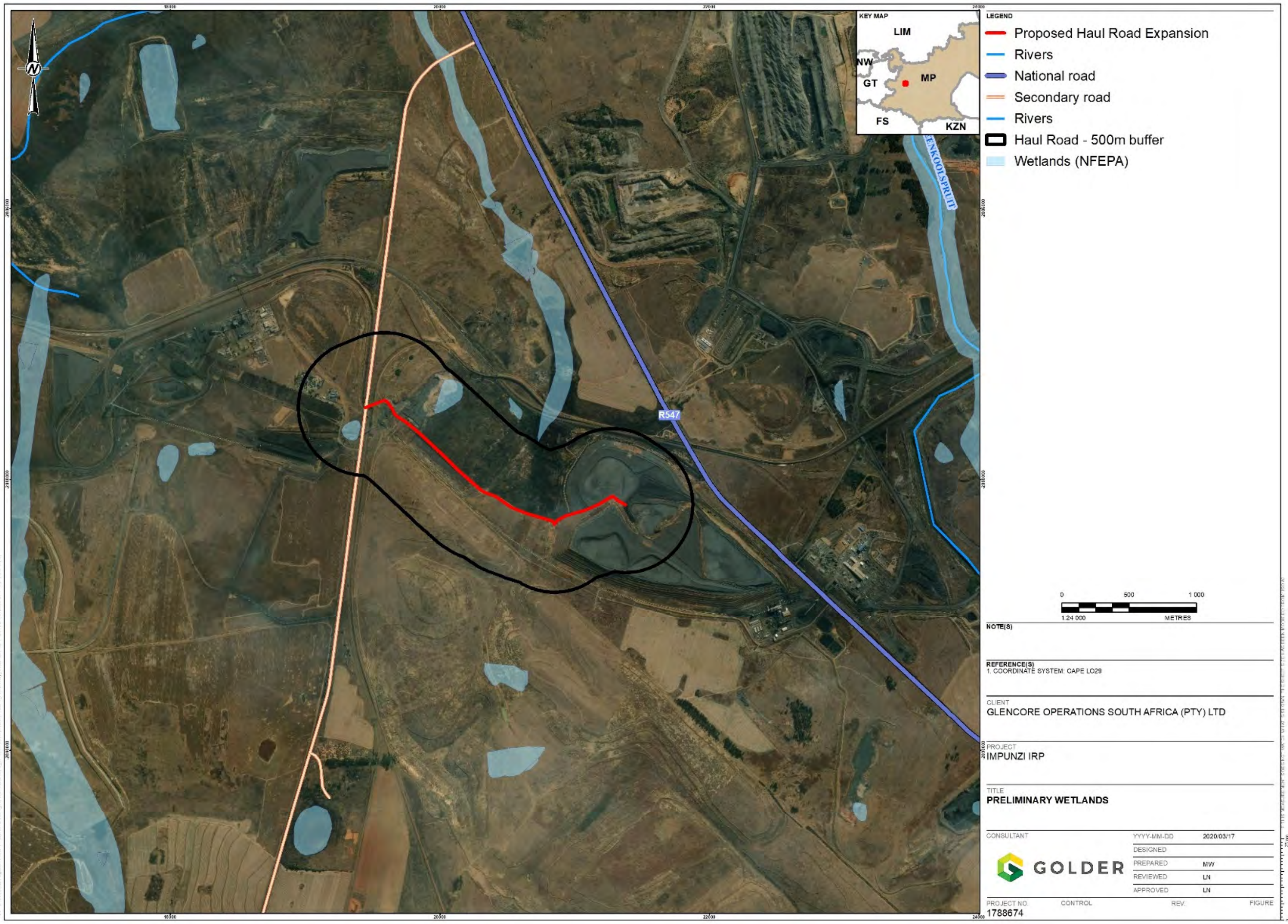

Figure 9: Preliminary desktop delineation of suspected wetlands within 500 m of the proposed road expansion.

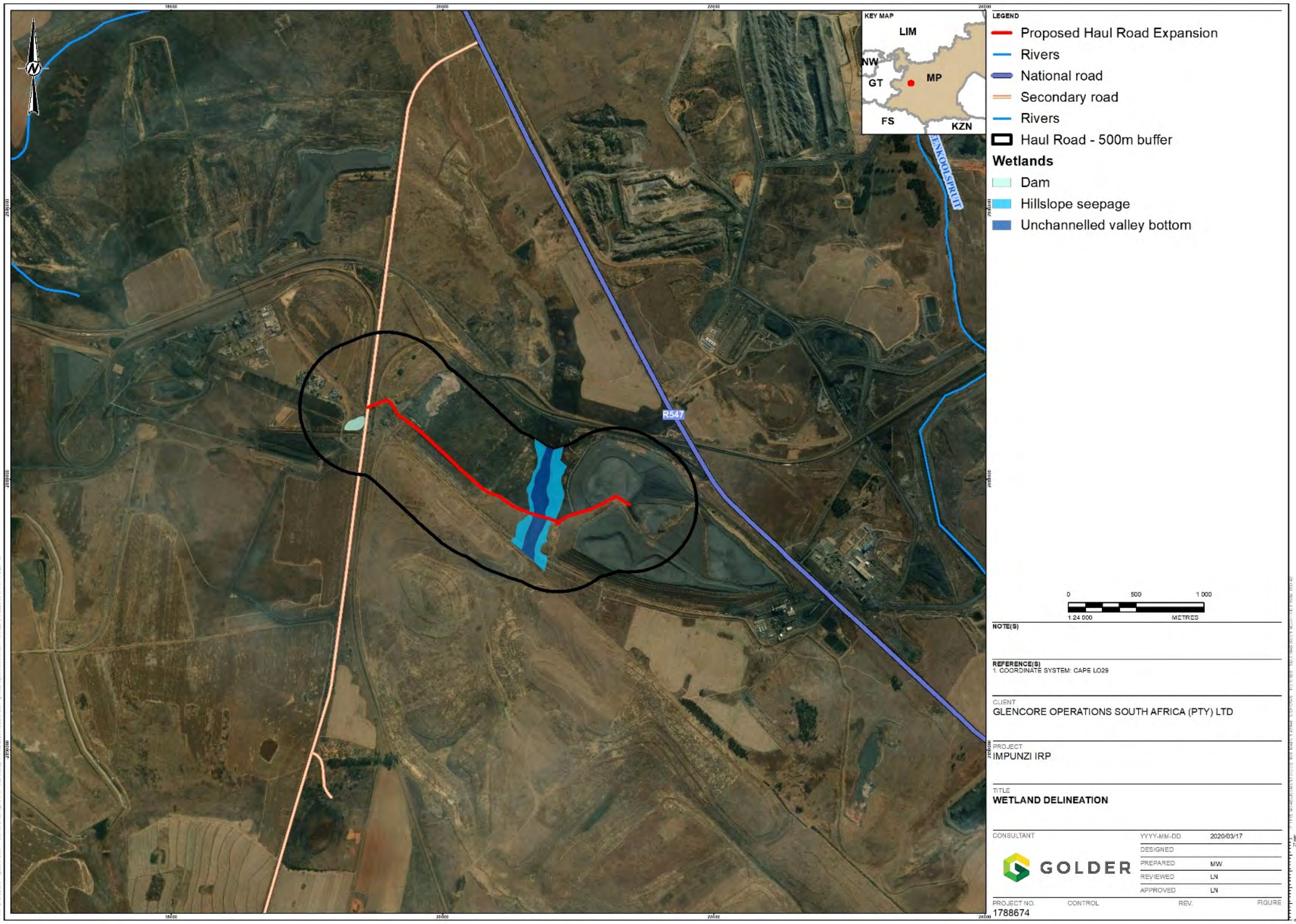

Figure 10: Wetland delineated within the study area

4.4.2 Present Ecological State

The PES of the identified UCVB wetland was determined to be Seriously modified, with a PES category of E. Impacts on wetland health including dams, trenches (**Figure 20**), vegetation removal (Figure 18) and establishment of alien invasive species (Figure 17) within the wetland HGM units, as well as increased water inflow into the wetland and pressures from catchment land use (mining) (Figure 15 and Figure 19) were recorded.

4.4.3 Ecological Importance and Sensitivity

The ecological importance and sensitivity of the wetlands within the study area was assessed as low/marginal, that is wetlands that are not ecologically important and sensitive at any scale. The wetlands of the study area are considered seriously modified (ref. section 4.4.2) and as such their capacity to support biodiversity and provide ecosystem services is reduced. The biodiversity of these wetlands is considered ubiquitous and not sensitive to flow and habitat modifications.

4.4.4 Wetland Ecosystem Services

The WetEcoservices assessment focussed on the unchanneled valley bottom within the Study Area and highlighted functionality of the wetland system and the ecoservices provided. As seen in Figure 11 the wetland provides services including erosion control, sediment trapping, phosphate trapping, nitrate removal and toxicant removal. Based on the robust vegetation within the system, it is able to attenuate floods and regulate flow on a local basis. This wetland does not provide any direct human benefit to the community as it is located within a mine boundary with limited access.

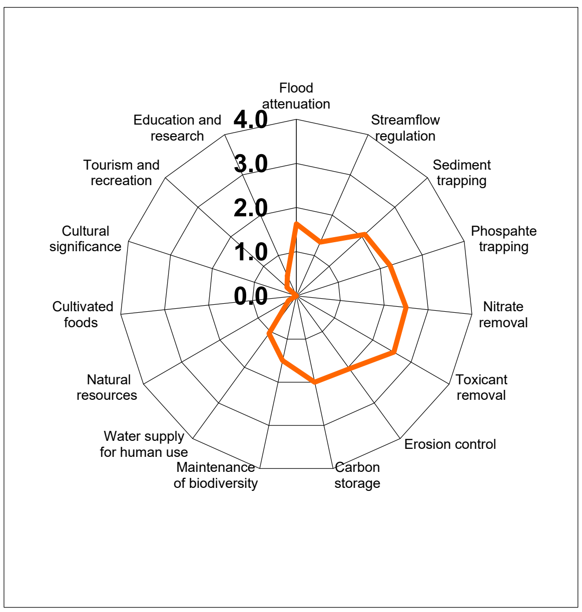

Figure 11: Study Area wetland – level of ecosystem service provision

5.0 IMPACT ASSESSMENT

The proposed project activities consist of the construction and operation of a haul road, which will be used by haul trucks for the transportation of discard from the ATCOM discard dumps to the ATC plant. As mentioned above, the proposed haul road will be 16 m wide and approximately 2 km long. The following sections describe the impacts that are expected to occur during the various phases of the project.

Table 13: Impact Assessment

Impacts	Phase	Rating before mitigation						Rating after mitigation					
		Magnitude	Duration	Scale	Probability	Significance points	Significance	Magnitude	Duration	Scale	Probability	Significance points	Significance
Loss and disturbance of rehabilitated/secondary grassland: Disturbance of vegetation may also result in other/secondary impacts, such as soil erosion and the establishment of alien invasive plants.	Construction	4	2	1	4	28	Low	2	2	1	3	15	low
Alien invasive species establishment: Alien invasive plant species are abundant and widespread in the area. Additional disturbances to natural vegetation during construction are likely to facilitate the colonisation and spread of alien invasive plant species. Alien invasive species may continue to colonise the areas disturbed by haul road construction activities during the operational phase. Alien invasive species may establish due to the introduction of foreign material such as soils and vegetation for rehabilitation purposes.	Construction Operation Decommissioning	8	2	1	3	33	Moderate	4	2	1	2	14	Low
Interruption of wetland hydrology: Soil disturbance and vegetation removal during construction could lead to breaches in subsurface soil profiles, altering the subsurface flows, potentially leading to flow concentration and subsequent erosion.	Construction	6	2	2	3	30	Moderate	4	2	1	2	14	Low
Interruption of wetland hydrology: Hardened surfaces associated with the compaction of soil will result in surface runoff and decreased infiltration into soils. This could result in decreased interflow recharge and decreased flow into the wetlands, while increased surface runoff could result in erosion of the adjacent wetlands.	Operation	6	3	2	3	33	Moderate	4	3	1	2	16	Low
Deterioration in wetland water quality: During the construction phase, the water quality in the wetland may deteriorate as a consequence of vegetation removal and increased risk of eroded soils and sediments being transported after rainfall events. Contaminants from machinery and materials (e.g. transported discards) could enter the wetland and contribute to water quality changes during construction and operation.	Construction Operation	8	2	2	3	36	Moderate	4	2	1	2	14	Low

6.0 RECOMMENDED MITIGATION AND BEST PRACTICE MEASURES

Recommended mitigation measures for the impacts identified in Table 13 are presented in Table 14.

Table 14: Recommended mitigation measures

Potential Impacts	Mitigation Measures
Loss and disturbance of natural habitat.	***Minimisation*** ■ As far as practical, vehicle access tracks and lay-down areas should be located in already disturbed areas. Where this is not possible, the disturbance footprints should also be kept to a minimum; ■ The approved area for construction should be demarcated to prevent construction vehicles entering areas of the wetland that will not be affected by the proposed road expansion, enabling construction contractors to avoid these areas; ■ Construction activities should be undertaken during the dry season insofar as possible; and ■ An Environmental Control Officer (ECO) should oversee the vegetation clearing process. ***Rehabilitation*** ■ Any areas cleared of vegetation during construction should be stabilised and revegetated using indigenous grass species.
Establishment and spread of alien invasive species.	***Minimisation*** ■ Actively control all alien invasive species (AIS) that colonise areas that have been disturbed during the construction phase. Control should include: ▪ Annual treatments along the entire length of the road and all sites disturbed during construction (e.g. vehicle access tracks and lay-down areas); ▪ A combined approach using both chemical and mechanical control methods; and ▪ Periodic follow-up treatments, with a regularity informed by annual monitoring. ■ AIS control should continue through all phases of the proposed project until such a time as monitoring indicates AIS are no longer actively establishing; and ■ Periodic follow-up treatments, informed by the findings of regular monitoring should be conducted for at least the first three years following decommissioning, or until such a time as monitoring indicates AIS are no longer actively establishing.
Interruption of wetland hydrology	***Minimisation*** ■ Vegetation clearing should be restricted to the footprint area to be disturbed by the road expansion; ■ The approved area for construction should be demarcated to prevent construction vehicles entering areas of the wetland that will not be

Potential Impacts	Mitigation Measures
	affected by the proposed road expansion, enabling construction contractors to avoid these areas; ■ Driving within the wetland areas should be kept to an absolute minimum. Clearly defined access routes should be used only; ■ A construction method statement should be developed for road construction across the wetland prior to construction, and provided to the contractor for implementation on site, overseen by the Environmental Control Officer (ECO); and ■ Appropriately engineered designs for the wetland crossing must be implemented to ensure that diffused flow regime is maintained upstream and downstream of the road crossing, and no impoundment upstream or erosion downstream of the road occurs.
Deterioration in wetland water quality	***Minimisation*** ■ Appropriate erosion protection and sediment control measures should be implemented during both construction and operation to prevent discharge of sediments to the valley bottom wetland; ■ Any waste from the construction process should be removed from the construction site; ■ Keep sufficient quantities of spill clean-up materials on site and/or on the construction vehicles to manage any incidental spills; and ■ Maintenance of construction vehicles is to be undertaken offsite and all vehicles used on site are to be in good working order without leakage of any oils, greases etc.

7.0 CONCLUSIONS

The proposed haul road expansion is located in an area that was previously mined and has since been rehabilitated. The vegetation of the study area consists of secondary grassland characterised by hardy grass species typically used in mine rehabilitation, and various alien invasive plant species.

Previous mining and rehabilitation activities have caused significant habitat disturbance and fragmentation of the landscape surrounding the proposed road expansion route. In this context, it is considered probable that faunal abundance and diversity in the area is low, and that land adjacent to the proposed road expansion is unlikely form important life-cycle habitats for fauna. 30 species (Mammals, Birds and Herpetofauna) of concern are considered likely to occur within the study area.

An unchanneled valley bottom wetland system with adjacent hillslope seepages occurs within the study area. This wetland's health (present ecological status – PES), ecological importance and sensitivity (EIS) and functionality (ecosystem services provision – WET Ecoservices) was assessed. Both the unchanneled valley bottom and the hillslope seepage wetland have an overall PES category of E which means that the wetland is seriously modified. While the overall EIS for both systems is of low/marginal category meaning the wetland is not ecologically important or sensitive on a local scale. The main ecological services rendered by both wetlands include erosion control, sediment trapping, phosphate trapping, nitrate removal and toxicant removal.

The proposed road expansion will not have any significant residual impact on the current environmental setting, provided that the recommended mitigation measures are implemented during construction and operation.

It should be noted that the road crosses a wetland and as such constitutes a water use in terms of the National Water Act – requiring a Water Use License. In particular, the development and implementation of a construction method statement for wetland crossings with follow up monitoring will be critical in ensuring that no significant residual impacts on wetlands as a result of construction occur.

However, the severity of this impacts on the environment can be mitigated through the implementation of the recommended mitigation measures. Special attention must be given to the wetland that is crossed by the proposed road expansion during construction to ensure that impacts on wetland habitat are avoided and minimised.

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Signature Page

Golder Associates Africa (Pty) Ltd.

Lufuno Nemakhavhani
Environmental consultant

Aisling Dower
Biodiversity specialist

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Reg. No. 2002/007104/07
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APPENDIX A

Document Limitations

APPENDIX B

Site Photographs

Figure 12: Vegetation fringing the existing road is often characterised by alien invasive weeds, such as *Tagetes minuta* (shown in foreground) and indigenous ruderal grasses such as *Hyparrhenia hirta*

Figure 13: Common plant species growing in the wetland included *Typha capensis* and *Phragmites australis,* and the alien invasive weed, *Verbena bonariensis*

Figure 14: Existing road traversing an area of wetland

Figure 15: Rehabilitated tailings located to the south of the proposed haul road expansion

Figure 16: Area of pooled rain water in rehabilitated mining area to west of road

Figure 17: Stockpiling on the eastern side of the road representing evidence of the disturbed environment caused by mining activities

Figure 18: Open, highly degraded land on the eastern side of the road dominated by alien species such as *Tagetes minuta* and *Bidens pilosa*

Figure 19: Stockpiling located adjacent to the proposed road expansion footprint

Figure 20: A trench within the wetland system, altering hydrological flows

APPENDIX C

SPECIALIST DECLARATION

SPECIALIST DECLARATION

As required under Appendix 6 of the Environmental Impact Assessment Regulations, 2014 (as amended), I, , **Aisling Dower** 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 expertise in conducting the specialist report relevant to this application, including knowledge of Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with all applicable Acts and Regulations in compiling this report;
- I have not, and will not engage in conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing:
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Aisling Dower

Signature of the specialist:

Golder Associates Africa (Pty) Ltd

Name of company (if applicable):

27 March 2020

Date:

GOLDER

golder.com

Wetland Specialist Report
Glencore iMpunzi Complex: Venture Dump Expansion and Proposed South Pit Dump

For:

Golder Associates Africa
Justin Walls
JuWalls@golder.co.za

By:

Wetland Consulting Services (Pty) Ltd

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Reference: 1316-2018

DOCUMENT SUMMARY DATA

PROJECT:	**Wetland Specialist Report Glencore iMpunzi Complex: Venture Dump Expansion and Proposed South Pit Dump**
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CONSULTANT:	**Wetland Consulting Services, (Pty) Ltd.**
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TABLE OF CONTENTS

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and Wetland Consulting Services (Pty.) Ltd. and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although Wetland Consulting Services (Pty.) Ltd. exercises due care and diligence in rendering services and preparing documents, Wetland Consulting Services (Pty.) Ltd. accepts no liability, and the client, by receiving this document, indemnifies Wetland Consulting Services (Pty.) Ltd. and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by Wetland Consulting Services (Pty.) Ltd. and by the use of the information contained in this document.

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

1. INTRODUCTION AND TERMS OF REFERENCE

Wetland Consulting Services (Pty.) Ltd. (WCS) was appointed by Golder Associates Africa to undertake the specialist wetland assessment study required for the proposed expansion of the Venture Dump and the proposed establishment of the South Pit Dump, both located at the Glencore iMpunzi Complex. Although both dumps are located within the footprints of previously opencast mined land, wetland habitat occurs within the immediate proximity of both proposed dump footprints, triggering the need for this wetland study.

The aim of the study was to provide a detailed baseline assessment of the wetlands within the project area and immediate zone of influence, to identify and assess likely impacts of the proposed activities, and to provide detailed recommendations on the mitigation and management measures within the framework of the mitigation hierarchy, to ensure minimisation of impacts to wetlands.

The terms of reference for the current study were defined as follows:

- Review and collation of existing wetland information (previous specialist reports) and published data (e.g. NFEPA, Mpumalanga Highveld Wetlands etc);
- Site visits to identify and delineate all wetlands on site using the DWAF 2005 wetland and riparian delineation guidelines;
- Should wetlands be found to occur:
  - Undertake wetland functional assessments of the wetlands affected by the proposed activities using the WET-EcoServices tool;
  - Determine the present ecological state (PES) of the wetlands affected by the proposed activities using the WET-Health Level 1 assessment methodology;
  - Determine the ecological importance and sensitivity (EIS) of the wetlands affected by the proposed activities using the widely accepted Rountree et al. (2013) methodology;
- Compilation of maps and shapefiles to accompany the wetland specialist report;
- Review of the proposed development plans and activities;
- Identification and assessment of expected impacts to wetlands, riparian areas and watercourses;
- Compilation of suitable mitigation and management measures to reduce project impacts;
- Completion of the GN509 Water Use Risk Assessment matrix; and
- Compilation of a detailed wetland delineation and assessment report.

2. SPECIALIST REPORT REQUIREMENTS

This report has been compiled to comply with the requirements for specialist technical reports as detailed in Government Notice 267 (24 March 2017) which details regulations and procedural requirements for water use license applications and appeals, as well as in compliance with the requirements of Appendix 6 of GN302 (Amendments to the Environmental Impact Assessment Regulations 2014) as published in Government Gazette 40772 of 7 April 2017 which details the requirements for specialist reports. The sections below detail the respective requirements in table format and reference the relevant sections of this report where the required information can be located.

2.1 WATER USE LICENCE APPLICATION REQUIREMENTS

No.	Requirement	Section in report
6	**Wetland Delineation Report**	
1	Introduction	1
2	Terms of Reference	1
3	Knowledge Gaps	6
4	Study Area	7 (7.1)
5	Expertise of Specialist	3 (3.2)
6	Aims and Objectives	5.1
7	**Methodology**	
7.1	Wetland identification and mapping	5.2.2
7.2	Wetland delineation	5.2.2
7.3	Wetland functional assessment	5.2.3
7.4	Determining the ecological integrity of wetlands	5.2.4
7.5	Determining the Present Ecological State of wetlands	5.2.4
7.6	Determining the Ecological Importance and Sensitivity of wetlands	5.2.5
7.7	Ecological classification and description	5.2.4 & 5.2.5
8	**Results**	
8.1	Wetland delineation	7 (7.2 & 7.3)
8.2	Wetland unit identification	7 (7.2 & 7.3)
8.3	Wetland unit setting	7 (7.2 & 7.3)
8.4	Wetland soils	7 (7.2 & 7.3)
8.5	Description of wetland type	7 (7.2 & 7.3)
8.6	General functional description of wetland types	7 (7.2 & 7.3)
8.7	Wetland ecological functional assessment	7 (7.2.2 & 7.3.2)
8.8	The ecological health assessment of the study area	7 (7.2.1 & 7.3.1)
8.9	The PES assessment of the remaining wetland areas	7 (7.2.1 & 7.3.1)
8.10	The EIS assessment of the remaining wetland areas	7 (7.2.3 & 7.3.3)
9	Impact Assessment Discussions	8
10	Conclusions & Recommendations	9
11	References	10

2.2 NEMA EIA REGULATION 982 REQUIREMENTS

No.	Requirement	Section in report
1	A specialist report prepared in terms NEMA EIA Regulation 982 must contain:	
a)	Details of -	
(i)	The specialist who prepared the report	3.1
(ii)	The expertise of that specialist to compile a specialist report including a curriculum vitae	3.2
b)	A declaration that the specialist is independent	4
c)	An indication of the scope of, and the purpose for which, the report was prepared	5.1
cA)	An indication of the quality and age of base data used for the specialist report	5.2.1
cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change	7 & 8
d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment	5.2.1
e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used	5.2
f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a site plan identifying site alternatives	7
g)	An identification of any areas to be avoided, including buffers	7 & 8
h)	A map superimposing the activity including the associated structure and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers	8
i)	A description of any assumption made and any uncertainties or gaps in knowledge	6
j)	A description the findings and potential implication\s of such findings on the impact of the proposed activity, including identified alternatives on the environment or activities	7
k)	Any mitigation measures for inclusion in the EMPr	8
l)	Any conditions for inclusion in the environmental authorisation	8
m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation	8
n)	A reasoned opinion -	9
(i)	As to whether the proposed activity, activities or portions thereof should be authorised	9
(iA)	Regarding the acceptability of the proposed activity or activities	8 & 9
(ii)	If the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan	8
o)	A description of any consultation process that was undertaken during the course of preparing the specialist report	Not applicable
p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
q)	Any other information requested by the competent authority	Not applicable

3. DETAILS OF SPECIALIST

3.1 DETAILS OF THE SPECIALIST WHO PREPARED THE REPORT

Table 1. Details of the Specialist

Project Consultancy	Wetland Consulting Services
Company Registration	1998/17216/07
Professional Affiliation	South African Council for Natural Scientific Professions (SACNASP) 400254/14
Contact Person	Mr Dieter Kassier
Physical Address	Room S153, Building 33, CSIR, Meiring Naude Road, Brummeria, 0184
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Telephone Number	+27 12 349 2699
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3.2 EXPERTISE OF THE SPECIALIST

2.2.1 Qualifications of the Specialist

Dieter Kassier holds the following degrees:

- B.Sc. from UNISA (2007) Environmental Management (Zoology Stream).
- B.Sc. (Hons) from the NWU Potchefstroom Campus (2012) in Environmental Science: Aquatic Ecosystem Health.

Dieter Kassier holds a Professional Registration with SACNASP since 2014 – 400254/14. He is registered in two fields:

- Environmental Science
- Ecological Science

2.2.2 Past Experience of the Specialist

Dieter Kassier, Wetland Ecologist, Holds a B.Sc. degree in Environmental Management (with specialisation in Zoology) from the University of South Africa (UNISA) as well as a BSc Honours degree in Environmental Science (Aquatic Ecosystem Health) from the University of the North West (Potchefstroom Campus). After 5 years working within the field of nature conservation and tourism in the Limpopo Lowveld and a short stint as an environmental consultant, Dieter joined Wetland Consulting Services in 2007 and is based in Pretoria. Over the past ten years he has gained extensive experience in the delineation and assessment of wetlands and riparian zones and the development of mitigation and management measures for the purposes of Environmental Impact Assessments in a wide range of projects, with special emphasis on coal mining in the Mpumalanga Coalfields and infrastructure developments within the greater Gauteng region. In addition, his work has entailed the GIS mapping and classification of wetlands for various Environmental Management Frameworks (EMF's) and the City of Johannesburg wetland management plan. Dieter has also been involved in the compilation of several Biodiversity Action Plans and Biodiversity Assessments where in addition to the specialist wetland work, he has provided input for faunal studies and has undertaken avifauna surveys. Dieter is a Registered Natural Scientist (SACNASP) (Environmental & Ecological Science), and a member of the South African Wetland Society.

3.3 CV OF THE SPECIALIST

A summarised CV of the Specialist is attached as APPENDIX A to this report.

4. DECLARATION OF INDEPENDENCE

I, **Dieter Kassier,** as the appointed specialist hereby declare/affirm the correctness of the information provided as part of the application, and that:

- I act as the 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 expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- am aware that it is an offence in terms of Regulation 48 to provide incorrect or misleading information and that a person convicted of such an offence is liable to the penalties as contemplated in section 49B(2) of the National Environmental Management Act, 1998 (Act 107 of 1998).

Signature of the specialist

Wetland Consulting Services (Pty) Ltd

Name of company

5 April 2019

Date

5. SCOPE, PURPOSE, APPROACH AND METHODOLOGY

5.1 SCOPE AND PURPOSE

The purpose of this report is to provide a detailed summary of the current conditions of the wetlands within the project area from an ecological perspective, focussing on the following key considerations:

- Presence and extent of wetlands;
- Wetland type (hydro-geomorphic classification);
- Functional importance of wetlands;
- Present ecological status of the wetlands on site; and
- Ecological importance and sensitivity of the wetlands on site.

Using the baseline information collected as part of this study, the next step was to identify and assess likely impacts of the proposed activities on the wetlands, and to provide detailed recommendations on the mitigation and management measures required, within the framework of the mitigation hierarchy, to ensure the avoidance and minimisation of the impact to wetlands.

5.2 APPROACH, METHODLOGY AND ACTIONS PERFORMED

5.2.1 Collation of existing information & field surveys

The Wetland Consulting Services Group of Companies has undertaken numerous wetland assessment studies for the Glencore iMpunzi Complex over the years that formed the basis for this current study. Relevant reports included:

- *WCS, 2017. Onsite Wetland Mitigation Strategy for the Proposed Glencore Impunzi East Opencast Coal Mining Project, Mpumalanga Province. Report reference 1241-2017*
- *WCS, 2016. iMpunzi East Block - Dewatering Pipeline Post-Construction Wetland Rehabilitation Monitoring. Report reference 1202-2016*
- *WCS, 2016. Wetland Delineation & Impact Assessment for the Proposed Office and Phoenix Opencast Pits, Glencore iMpunzi, Mpumalanga. Report reference 1190-2016*
- *WCS, 2014. Wetland Management Plan: Glencore iMpunzi Division. Report reference 1061-2014.*
- *WCS, 2014. Glencore Coal Mining Complexes South Africa Wetland Management Strategy. August 2014.*
- *WCS, 2013. Wetland Impact Assessment Report for the Proposed Impunzi Opencast Mining Areas, Mpumalanga. Report reference 1025-2013*

As part of the current study two further site visit were undertaken on the 26th July 2018 (winter dry season) and the 12th March 2019 (summer wet season).

5.2.2 Wetland Identification, Delineation & Typing

The National Water Act, Act 36 of 1998, defines wetlands as follows:

> *"Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil."*

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics; i.e. on the position of the wetland in the landscape, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in the figure below.

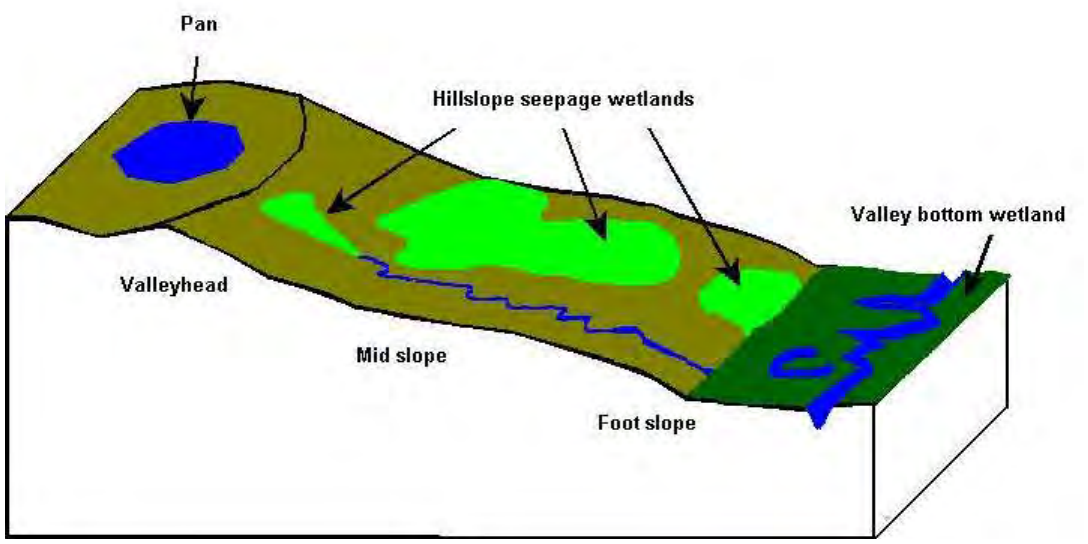


Figure 1. Diagram illustrating the position of the various wetland types within the landscape.

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcMap 9.0. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps. All identified areas suspected to be wetlands were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as described by DWAF (2005) and Kotze and Marneweck (1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use is made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within 50cm of the soil surface for an area to be classified as a wetland (*A practical field procedure for identification and delineation of wetlands and riparian areas*, DWAF).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and most recently modified for use in South African conditions by Ollis *et al*. (2013).

5.2.3 Functional Assessment

A functional assessment of the wetlands on site was undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze et al., 2008). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

5.2.4 Present Ecological State Assessment

Present ecological state (PES) assessments were undertaken for every natural wetland unit identified and delineated within project study areas. This was done in order to establish a baseline of the current state of the wetlands.

For the purpose of this study the Level 1 assessment as described by the WET-Health manual (Macfarlane et al., 2008), was applied for the determination of the PES. Wetlands were assessed using indicators based on hydrology, geomorphology and vegetation, with each module assessed individually and scored on a scale of 0 (natural) to 10 (complete loss of natural habitat and biota) as detailed in Table 2. A combined present ecological state score was obtained through combining the 3 module scores as follows:

PES = ((Hydrology score) x 3 + (Geomorphology score) x 2 + (Vegetation score) x 2) ÷ 7

Table 2. Table showing the rating scale used for the PES assessment (from Macfarlane et al., 2007).

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

Despite its value as a wetland assessment tool, WET-Health is not an applicable tool for assessing the PES of pans or depressions. As such it could not be applied to this study and the PES scores for the depression/pan wetlands were thus derived from a new assessment method developed by WCS, modified from the scoring system as described in the document "Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems" (DWAF, 1999).

5.2.5 Importance and Sensitivity (IS) Assessment

Use was made of the Importance and Sensitivity (IS) assessment tool developed by Rountree, Malan and Weston (2013). The tool allows the categories to be determined for each of the following criteria:

- Ecological Importance and Sensitivity (EIS) – considers the presence of Red Data species, populations of unique species, importance for migration, breeding and feeding sites for species, the protection status of the wetland and vegetation type/s present, the diversity of habitat types, the regional context of ecological integrity of the wetland, and the sensitivity of the wetland to changes in hydrology and water quality;
- Hydro-functional importance – considers the ecosystem services the wetland provides in terms of flood attenuation, stream-flow regulation water quality enhancement, sediment trapping, phosphate, nitrate and toxicant assimilation, erosion control, and carbon storage; and
- Direct human benefit importance - considers the subsistence uses and cultural benefits of the wetland system.

On the basis of this assessment, each of the criteria above were scored and categorized on a scale from 0 to 4 and assigned a category, according to that indicated in Table 3. The overall IS of the wetland was derived from the highest of the three main criteria (EIS, hydro-functional importance or direct human benefit importance).

Table 3. Scoring System Used for the IS Assessment (modified from DWAF, 1999 and used in Rountree et al., 2013).

Wetland Importance and Sensitivity Categories	Range of IS Scores
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2
Low/marginal	>0 and <=1

Wetland Importance and Sensitivity Categories	Range of IS Scores
Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	

5.2.6 *Impact Assessment*

The impact assessment is divided into three parts:

- **Issue identification** - each specialist will be asked to evaluate the 'aspects' arising from the project description and ensure that all issues in their area of expertise have been identified;
- **Impact definition** - positive and negative impacts associated with these issues (and any others not included) then need to be defined – the definition statement should include the activity (source of impact), aspect and receptor as well as whether the impact is direct, indirect or cumulative. Fatal flaws should also be identified at this stage.
- **Impact evaluation** – this is not a purely objective and quantitative exercise. It has a subjective element, often using judgment and values as much as science-based criteria and standards. The need therefore exists to clearly explain how impacts have been interpreted so that others can see the weight attached to different factors and can understand the rationale of the assessment.

The significance of identified impacts was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Table 4. Impact assessment factors

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude of impact

To assess these factors for each impact, the following four ranking scales are used:

Table 5. Impact assessment scoring methodology

Magnitude	Duration
10- Very high/ unknown	5- Permanent (>10 years)
8- High	4- Long term (7-10 years, impact ceases after site closure has been obtained)
6- Moderate	3- Medium-term (3 months- 7 years, impact ceases after the operational life of the activity)
4- Low	2- Short-term (0-3 months, impact ceases after the construction phase)
2- Minor	1- Immediate
Scale	**Probability**

5- International	5- Definite/Unknown
4- National	4- Highly Probable
3- Regional	3- Medium Probability
2- Local	2- Low Probability
1- Site Only	1- Improbable
0- None	0- None

Significance Points= (Magnitude + Duration + Scale) x Probability

Table 6. Significance of impact based on point allocation

Points	Significance	Description
SP>60	High environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30-60	Moderate environmental significance	An impact or benefit which is sufficiently important to require management and which could have an influence on the decision unless it is mitigated.
SP<30	Low environmental significance	Impacts with little real effect and which will not have an influence on or require modification of the project design.
+	Positive impact	An impact that is likely to result in positive consequences/effects.

For the methodology outlined above, the following definitions were used:

- Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are to be used as a measure of the level of impact;
- Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;
- Duration refers to the length of time over which an environmental impact may occur: i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent; and
- Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

6. ASSUMPTIONS, UNCERTAINTIES AND KNOWLEDGE GAPS

6.1 ASSUMPTIONS & LIMITATIONS

Wetland systems reflect the ecological boundary where there is a close relation and interaction between water content and soil particles in the first 50 centimetres of the soil profile. The soil-water interaction in response influences the plant communities and soil properties, i.e. causing mottling and gleying in the soil. The wetland boundary, based on vegetation species compositions and soil properties, can vary depending on historical rainfall conditions and introduce a degree of variability in the wetland boundary between years as well as sampling period.

A number of wetland systems were identified that have established on previously mined land. These wetland areas show clear vegetation indicators and often also clear signs of surface ponding of water. However, in most cases, no soil wetness indicators could be observed within the disturbed, rehabilitated soil profiles. Wetland habitat located on rehabilitated mine land was therefore delineated purely by the presence of vegetation indicator species.

The scale of the remote imagery used (1:10 000 aerial photographs and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineated wetlands in the field, result in the delineated wetland boundaries being accurate to about 10-20m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

Groundtruthing and field verification of wetland boundaries as part of this project was limited to the study area (Figure 3 and Figure 4) and a 500m buffer around the study area. Wetlands falling outside the 500m buffer area were not delineated in the field as part of the current study, and are based on existing information from previous studies.

This impact assessment was based on the project description and proposed development and activity descriptions as detailed and illustrated in this report.

6.2 UNCERTAINTIES

Reference conditions are unknown. This limits the confidence with which the present ecological state (PES) is assigned.

6.3 KNOWLEDGE GAPS

No hydrological flow modelling or hydro-pedological assessments of the wetlands were undertaken as part of this study. However, given the nature of the proposed project and the distance from adjacent wetlands, this is not considered a significant short-coming and sufficient wetland information is available to inform the study and decision making.

7. CURRENT ENVIRONMENTAL CONDITIONS

7.1 REGIONAL CHARACTERISTICS

7.1.1 Study Area

The study area for this project has been defined as the proposed footprints of both the venture Dump expansion and the proposed South Pit Dump, together with a 500m buffer around both footprints. The location of the project study area is illustrated in **Figure 2**.

The Glencore iMpunzi Complex is located along the R547 to the south of eMalahleni in the Mpumalanga Province. The Steenkoolspruit and Olifants Rivers both fall within the iMpunzi Complex mining rights area, with the confluence of the rivers located in the extreme north of the mining rights area.

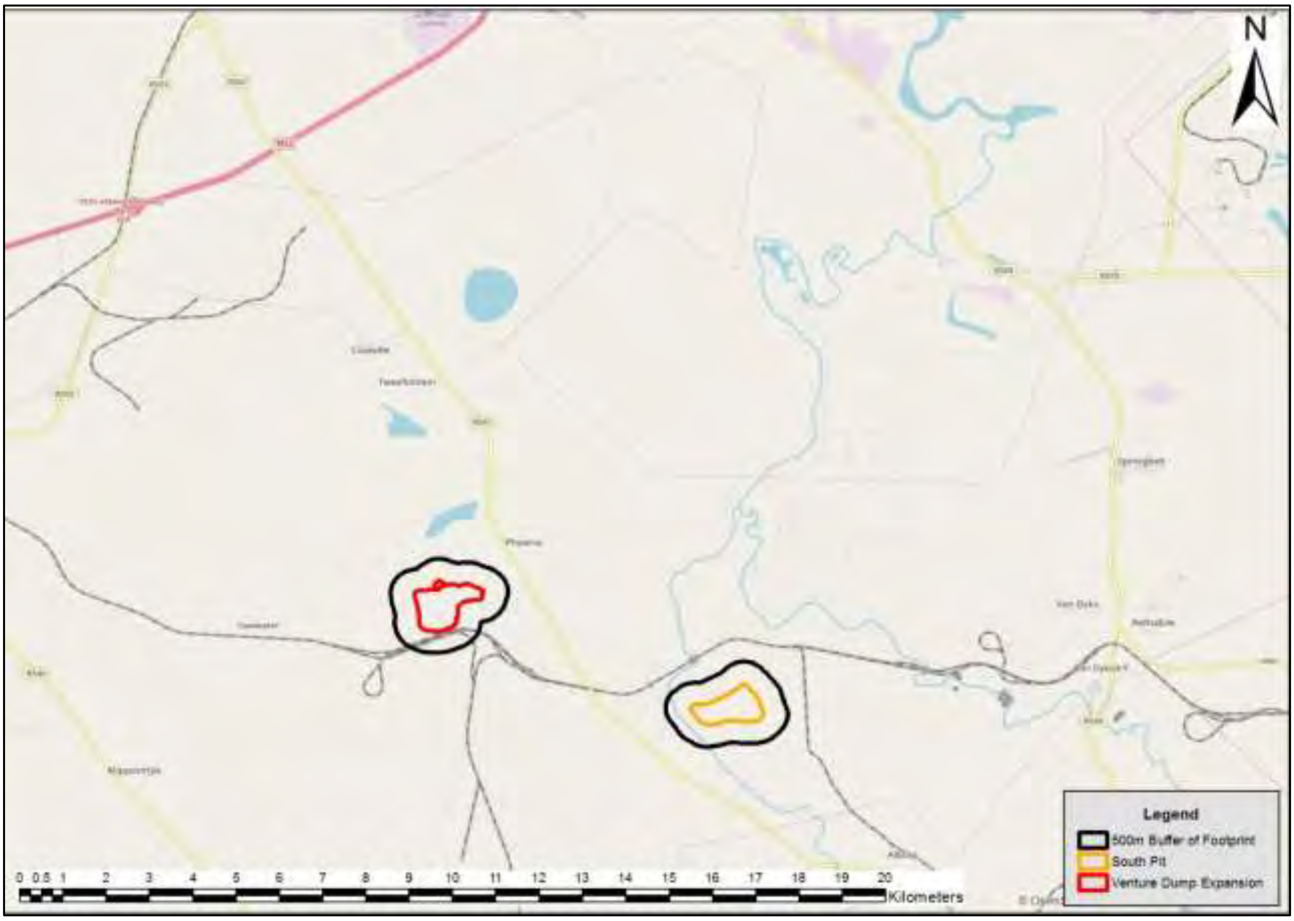


Figure 2. Map showing the regional location of the project study areas.

The Existing Venture Dump is located west of the R547 road and just to the south of the Klippoortjiespruit/Saaiwaterspruit[1]. The Glencore ATC Plant is located just to the south of the Venture Dump.

It is proposed that the existing Venture Dump be expanded in a westerly and northerly direction, as illustrated in **Figure 3** below. The entire proposed expansion footprint falls on a rehabilitated opencast mining footprint.

Figure 3. Map showing the iMpunzi South Pit study area overlain on aerial imagery.

The proposed South Pit Dump will be located on an opencast mine footprint located to the east of the R547 road and to the east of the Steenkoolspruit River diversion. The railway line is located just to the north of the proposed development footprint. The location and extent of the proposed South Pit Dump is shown in **Figure 4**.

[1] A discrepancy exists in the naming of the Klippoortjiespruit/Saaiwaterspruit river, with the DWS 1:50 000 Rivers database labelling the river as Klipoortjiespruit, but the 1:50 000 topographical maps labelling the river as Saaiwaterspruit.

Figure 4. Map showing the iMpunzi Venture Dump Extension study area overlain on aerial imagery.

7.1.2 Catchments

The proposed South Pit Dump and Venture Dump extension are both located within the Primary Catchment B. More specifically, the South Pit is within quaternary catchment B11E, and the Venture Dump extension within quaternary catchment B11F. Catchment B11E is drained by the Steenkoolspruit River and its tributaries the Rietspruit and Blesbokspruit. Catchment B11F is drained by the Olifants River and its tributaries the Tweefonteinspruit and Klippoortjiespruit/Saaiwaterspruit. Information regarding mean annual rainfall, runoff and evaporation potential per quaternary catchment is provided in the table below (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990). Figure 5 indicates the position of the project study areas in relation to the affected quaternary catchments.

Table 7. Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990).

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Precipitation (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as percentage of MAP
B11E	42 160	682.4	32.2	4.7 %
B11F	38 643	691.6	34.3	5%

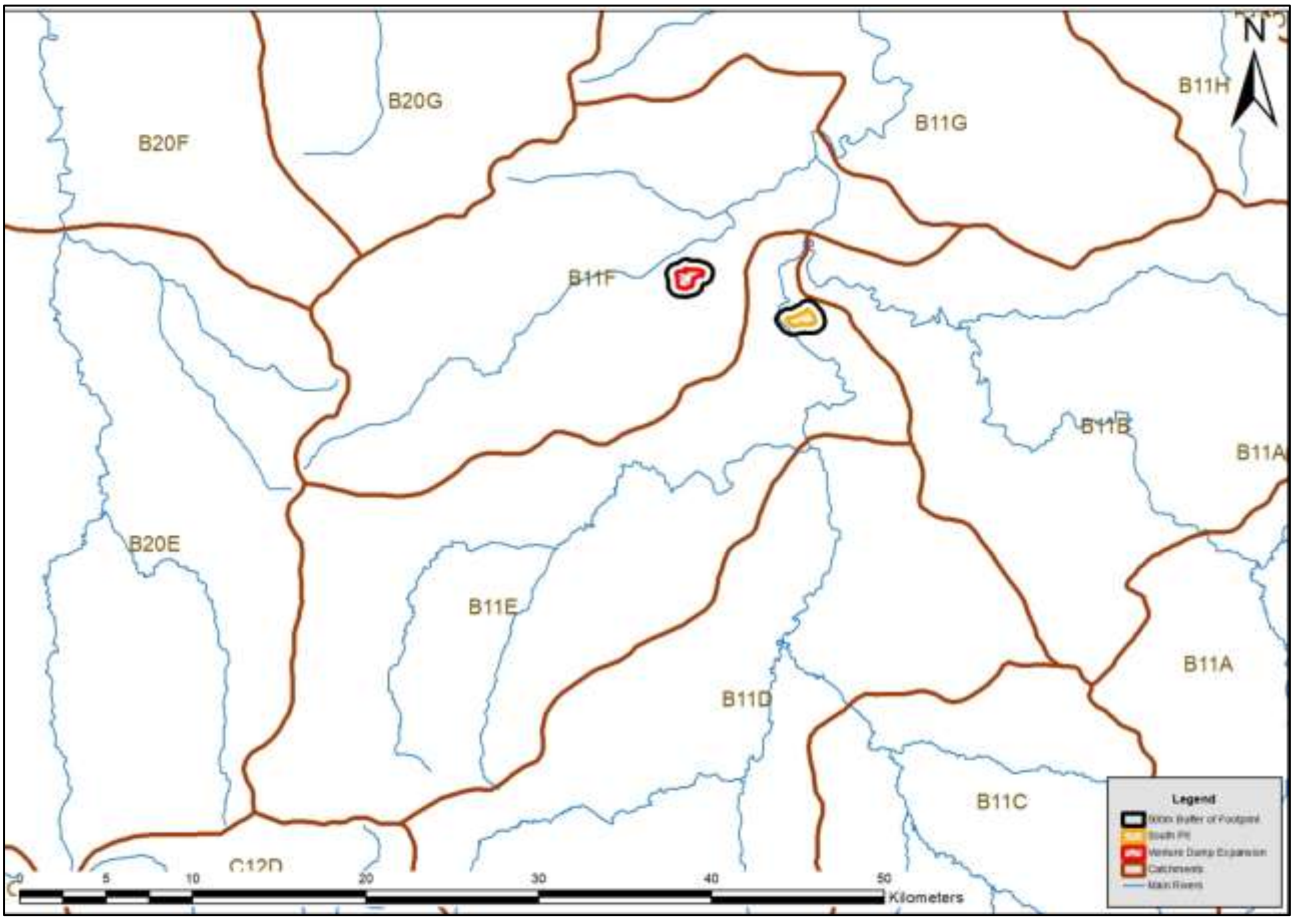


Figure 5. Map showing the study area in relation to the quaternary catchments.

7.1.3 Vegetation

According to the Vegetation Map of South Africa, Lesotho and Swaziland (Mucina and Rutherford, 2006), the study area falls within the Grassland Biome and the Mesic Highveld Grassland Bioregion. The dominant vegetation type found on site is Eastern Highveld Grassland (Gm12).

Under the National List of Ecosystems that are Threatened and in Need of Protection (GN1002 of 2011), the vegetation type is considered ***Vulnerable***.

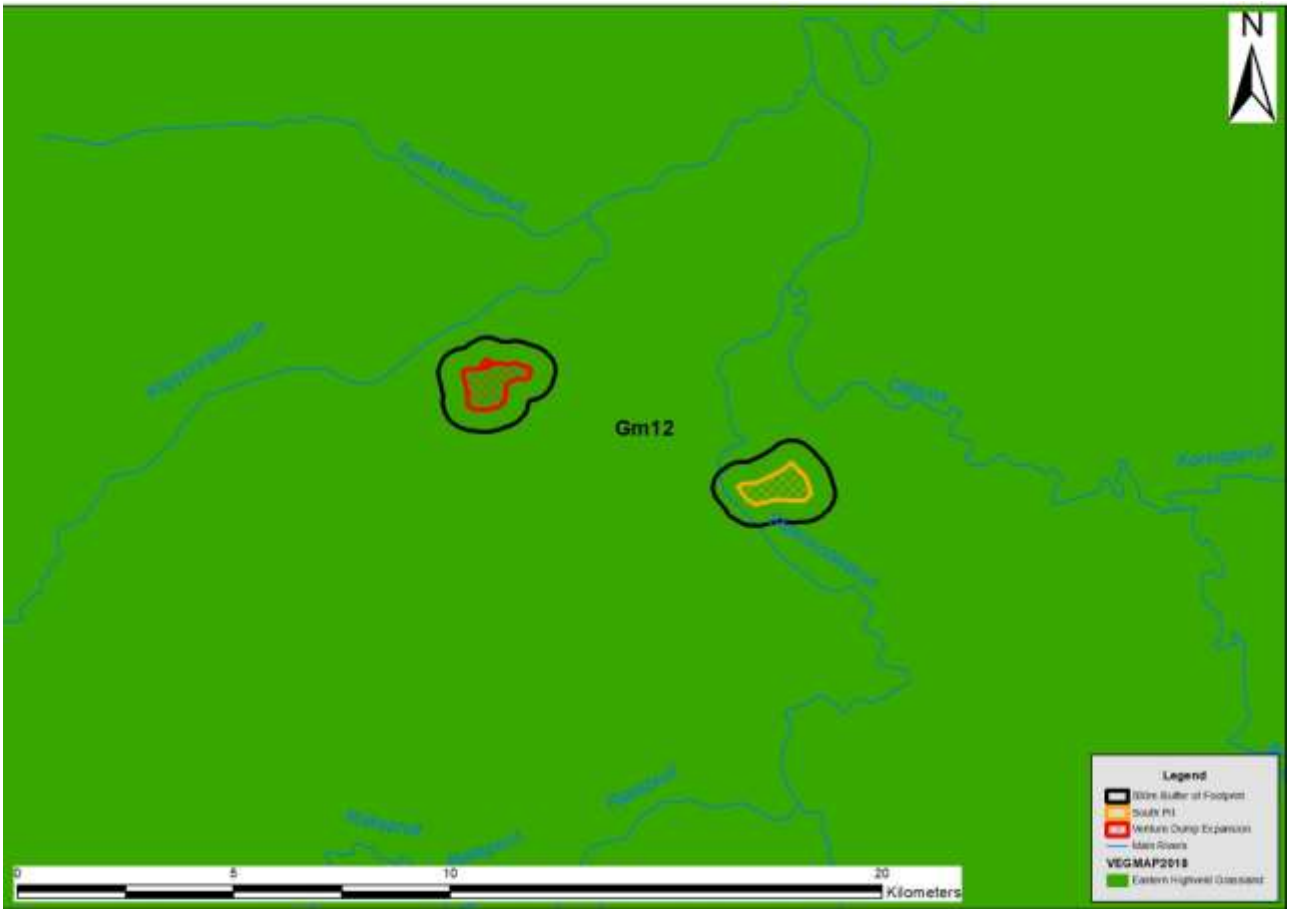


Figure 6. Map showing the vegetation types of the study area.

7.1.4 Freshwater Ecosystem Priority Areas

The Atlas of Freshwater Ecosystem Priority Areas (FEPA) in South Africa (Nel *et al*, 2011) (The Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, SAIAB and SANParks, provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. FEPA's were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. A recently completed WRC funded project (Mbona *et al*., 2015), updated the NFEPA wetland mapping for the Mpumalanga Highveld as well as the classification of FEPA wetlands. **Figure 7** provides and extract of the Mpumalanga Highveld Wetlands (MPHG) dataset from the Mbona *et al* (2015) study and indicates identified FEPA wetlands in the vicinity of the project study areas.

Although no wetland FEPA's are located within the project study areas, a number of wetlands are indicated as occurring in the general area of the proposed development footprints.

Figure 7. Map showing wetlands and wetland FEPA's within the study area and surroundings as per Mbona *et al*. (2015).

The wetlands on site fall within the Mesic Highveld Grassland Group 4 wetland vegetation type, with determined vegetation threat categories for all wetland vegetation types indicated in **Table 8**.

Table 8. Wetland ecosystem type, and its assigned threat status category (Mbona et al., 2015), occurring on site.

Wetland Ecosystem Type	Threat Status
Mesic Highveld Grassland Group 4	Least Threatened

7.1.5 Provincial Conservation Plans

An extract of the Mpumalanga Biodiversity Sector Plan 2013 terrestrial biodiversity assessment is illustrated in **Figure 8** below.

- The entire footprint of the proposed South Pit Dump is indicated as "Heavily Modified", which is consistent with the opencast mining and extensive cultivation that has taken place in the area.

- The footprint of the Venture Dump extension is indicated as “Heavily Modified” and “Other Natural Areas”, which is again consistent with the existing Venture Dump and rehabilitated opencast areas falling within the proposed footprint.
  - To the north of the proposed Venture Dump development footprint and area associated with the Klippoortjiespruit/Saaiwaterspruit has been classified as ***Critical Biodiversity Area Irreplaceable*** (CBA Irreplaceable) and ***Critical Biodiversity Area Optimal*** (CBA Optimal). These areas are associated with natural grassland and wetland habitat.

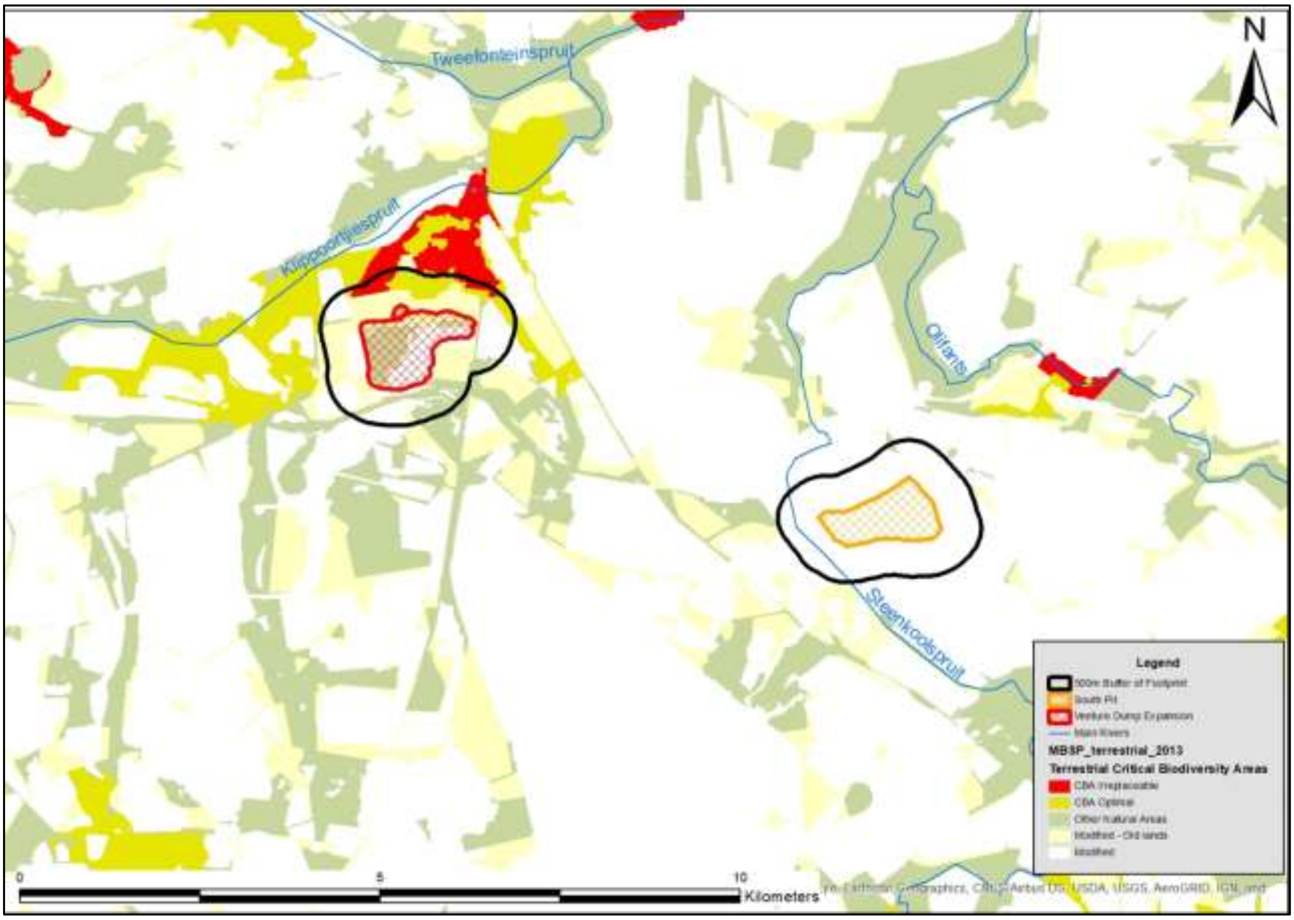


Figure 8. Extract from the Mpumalanga Biodiversity Sector Plan 2013 terrestrial biodiversity assessment.

7.2 SOUTH PIT SITE SPECIFIC ASSESSMENT

The South Pit study area is located within the footprint of an existing opencast pit to the east of the Steenkoolspruit. The proposed footprint of the South Pit is characterised by a backfilled opencast pit of which the western end nearest the Steenkoolspruit has been rehabilitated and revegetated. ***No wetlands were found to occur within the direct footprint of the proposed South Pit study area (refer to Figure 9 below)***.

Figure 9. Map of delineated wetlands within and adjacent to the South Pit study area. No wetlands were found to occur in the direct footprint of the proposed development footprint.

Within a 500m buffer around the South Pit study area a number of water resources were however observed (refer to Figure 9):

1 - The Steenkoolspruit River Diversion. Historically the Steenkoolspruit River would have extended across the area now occupied by the large South Pit opencast mine. To allow for mining the Steenkoolspruit was diverted along the western boundary of the pit to its current location. The Steenkoolspruit Diversion exists as a large, deep, cliff-sided river (see photos in Figure 10) with little lateral connectivity.

2 & 3 – Two water-filled voids exist at points 2 and 3 indicated on Figure 9. These voids are remnants of the opencast mining activity that took place within the South Pit. The water within the voids reflects groundwater levels in the opencast pit. No surface connectivity exists between these voids and any surrounding water resource.

4 – A small wetland feature ("Rehab wet area") has formed on the rehabilitated opencast surface at point 4. This can be considered a man-made feature as it has formed through accumulation of surface water on the rehabilitated surface. The haul road to the north forms a berm that leads to impoundment of flow. Augering of the soil profile within this wetland feature reveals replaced red soils that do not show typical mottling and gleying of wetland soils, confirming the recent nature of this wetland feature forming. However, wetland vegetation is present within this area (refer to Figure 11).

5 – A natural Seep wetland occurs to the north of the South Pit study area (Figure 12) which drains in a westerly direction to the Steenkoolspruit. This wetland is maintained by direct rainfall and interflow from the wetland catchment. An excavated dam occurs in the lowest portion of the wetland, while the northern edge of the wetland is flanked by stockpiles. An old railway servitude crosses the upper reach of the wetland as a raised berm. ***The bulk of this wetland falls within the footprint of an approved future opencast pit.***

Figure 10. Photographs of the Steenkoolspruit River diversion to the west of the South Pit study area.

Figure 11. Photographs of the wetland feature ("Rehab wet area") at point 4.

Figure 12. Photographs of the natural Seep wetland to the north of the South Pit study area.

7.2.1 Present Ecological State (PES) Assessment

A PES assessment was undertaken for all natural wetlands within a 500m radius of the proposed South Pit Dump footprint. The PES assessment provides a comparison between the current state or condition of a wetland compared to the reference or natural state of a wetland and assesses the departure from the reference state on a scale of A – Natural/Pristine to F – Critically Modified, with C denoting a Moderately Modified state. It was therefore not possible to undertake a PES assessment for man-made or artificial wetland systems (i.e. the wetland systems labelled as "Rehab wet areas" or "Void waterbodies" in Figure 9 and Figure 13) as such wetlands do not have a reference or natural state against which the current state can be compared.

The results of the PES assessment are illustrated in Figure 13. Only the Seep wetland in the north of the study area was assessed and found to be in a Moderately Modified condition (PES category C), though ongoing opencast mining activity (already authorised) will result in degradation and eventual loss of most of the wetland as the pit extends through the Seep wetland. Impacts resulting in the moderately modified state of the wetland include several linear infrastructure crossings through the wetland (haul roads and railway), mining adjacent to the wetland (though mostly downslope of the wetland), stockpiles adjacent and upslope of the wetland, excavation of a dam within the wetland and past cultivation within the wetland catchment.

The Steenkoolspruit River Diversion was also excluded from the PES assessment as this was considered a river and not a wetland habitat, preventing use of the WET-Health assessment methodology to determine PES. Reference is however made to the DWS (2014) National River PES[2] which indicates the Steenkoolspruit to be Largely Modified (PES category D).

Figure 13. Map showing the results of the PES assessment for the South Pit study area.

7.2.2 Wetland Functional Assessment

A functional assessment was undertaken as per the WET-EcoServices methodology (Kotze et al., 2008) with results illustrated in Figure 14.

The assessment highlighted a number of water quality related ecosystem services, specifically sediment trapping, phosphate trapping, nitrate removal and toxicant removal as likely being of

[2] Department of Water and Sanitation. 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: [W5 (for example)]. Compiled by RQIS-RDM:https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx accessed on [15 July 2019].

significance. Given the water quality concerns within the rivers of the area and the Olifants River in general, these functions are of importance. Sediments are trapped by the slowing down and spreading out of flows in the wetland, with the surface roughness provided by the vegetation and the unchannelled nature of the wetland being important in this regard. Due to upslope sediment sources, e.g. cultivated fields, unsurfaced roads and stockpiles, the wetland is well placed to contribute to this function. Associated with sediment trapping is phosphate trapping through adsorption to sediment particles. Phosphate sources within the catchment are likely to be associated with cultivated fields and the application of fertilizers to these fields. Nitrate removal occurs through the reduction of nitrate (and sulphate) as flows seep through the organic rich sediments of the Seep wetlands.

Maintenance of biodiversity is a further function highlighted by the assessment with a score of over 3 obtained. The importance of the wetland in this regard is elevated by the degree of transformation in the surrounding landscape caused by mining and agriculture, with wetland areas representing the bulk of remaining natural vegetation in the area.

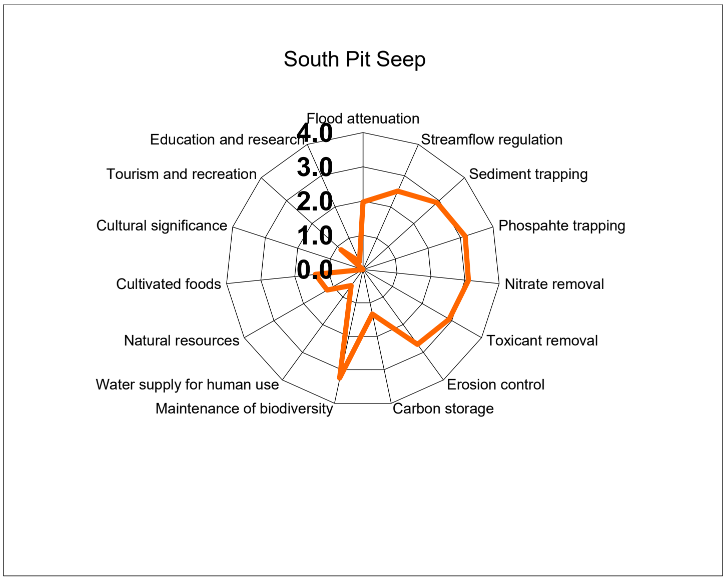


Figure 14. Results of the WET-EcoServices assessment for the Seep wetland north of the proposed South Pit Dump.

7.2.3 Wetland Importance and Sensitivity (IS)

The wetlands within the study area form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality and quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all remaining wetlands and rivers within the catchment that have as yet not been seriously modified and which can contribute to ecosystem services that aid in the maintenance of water quality, streamflow and biodiversity. Within this context a Wetland IS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the IS assessment include:

- The location of the study area within a vegetation type (Eastern Highveld Grassland) considered extensively transformed and threatened, having been classed as ***Vulnerable***.
- The wetland vegetation type of the area, Mesic Highveld Grassland Group 4, which is considered to be ***Least Threatened*** and ***Not Protected***.
- The fragmented and isolated nature of many of the wetland habitats located within a heavily modified agricultural and mining landscape.
- The generally largely modified state of the wetlands and watercourse within the study area and surroundings.

It is these considerations that have informed the scoring of the systems in terms of their importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands are illustrated in Figure 15, while an explanation of the scoring system is presented in Table 3.

The Steenkoolspruit River is considered by the DWS (2014) as being of ***Moderate*** environmental importance and ***High*** environmental sensitivity.

Figure 15. Results of the Importance and Sensitivity assessment.

7.3 VENTURE DUMP SITE SPECIFIC ASSESSMENT

The Venture Dump is an existing Discard Dump located to the north of the Glencore ATC Plant and Offices. The Tweefonteinspruit flows past roughly 1.3 km to the north of the Venture Dump.

The existing venture Dump, as well as the full footprint of the proposed expansion, will be located on rehabilitated mining land, with mining of the area having been completed prior to 2003. Disposal of discard into the void commenced between 2003 and 2006, as is visible from historical Google Earth imagery. ***No natural wetland habitat was found to occur within the proposed Venture Dump Expansion footprint.***

However, a number of wetland features, labelled “Rehab wet areas” in Figure 16 below, were found to occur within the expansion footprint, while a number of natural wetland systems occur within the 500m buffer around the proposed expansion footprint.

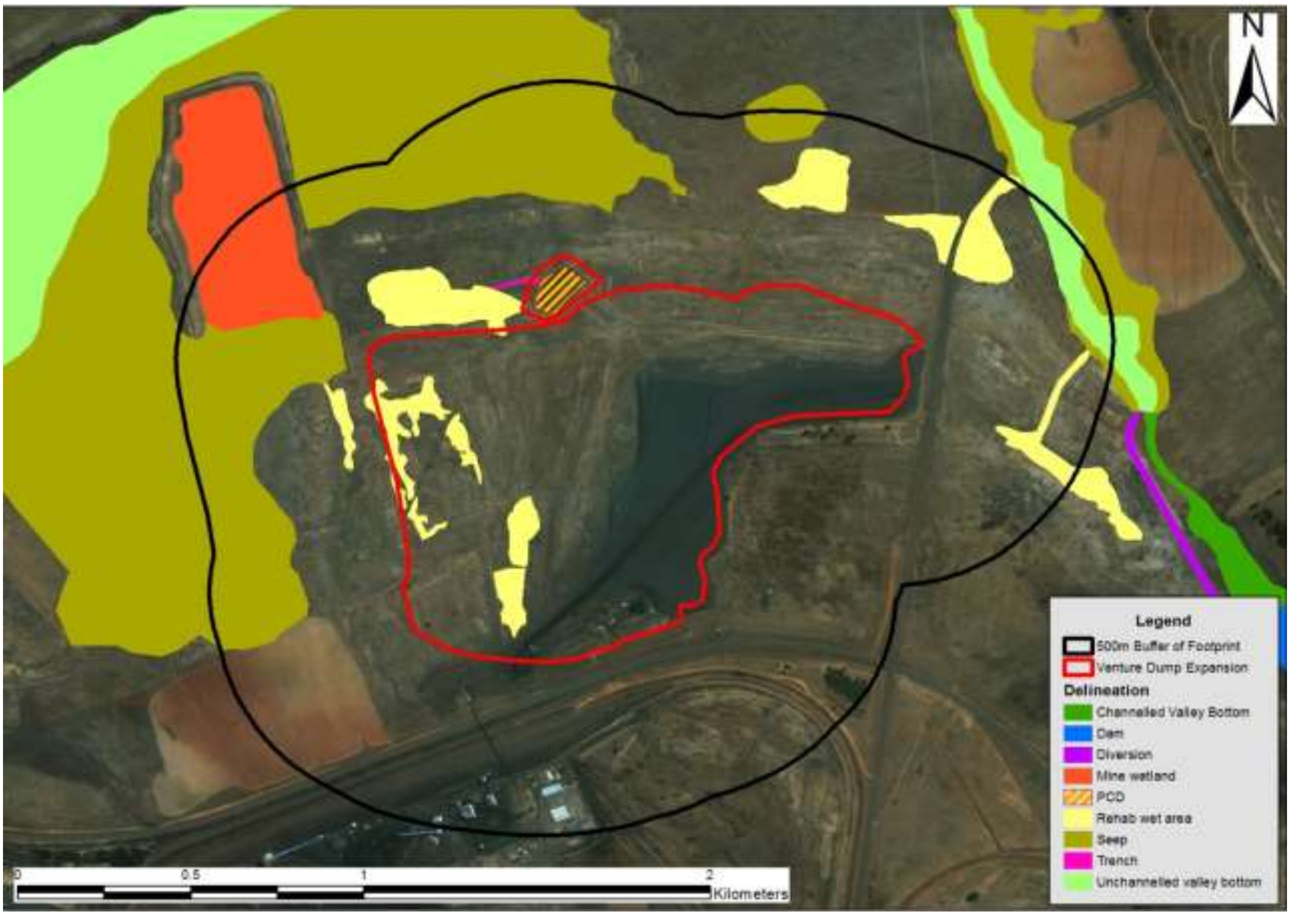


Figure 16. Map of delineated wetland habitat within and adjacent to the proposed Venture Dump Expansion footprint.

The “Rehab wet areas” can be considered man-made or artificial wetlands in the sense that they have reformed on rehabilitated mining land. Figure 14 below shows the extent of historical mining disturbance in relation to the delineated wetlands currently occurring on site. “Rehab wet areas” have formed as a result of water accumulation in lower lying areas, typically shallow depressions that are linked via trenches to spill towards the Seep wetland to the north. The largest of these "Rehab wet areas" also receives overflow from the existing Venture Dump PCD, while the southernmost of the "Rehab wet areas" appears to have historically also received flow discharges of an unknown source, but evidenced on site by a series of small, low dams to control flow. The main flow driver of these "Rehab wet areas" is considered to be direct rainfall and surface runoff from upslope areas accumulating in these low points. No interflow is expected to occur on the rehabilitated mining areas.

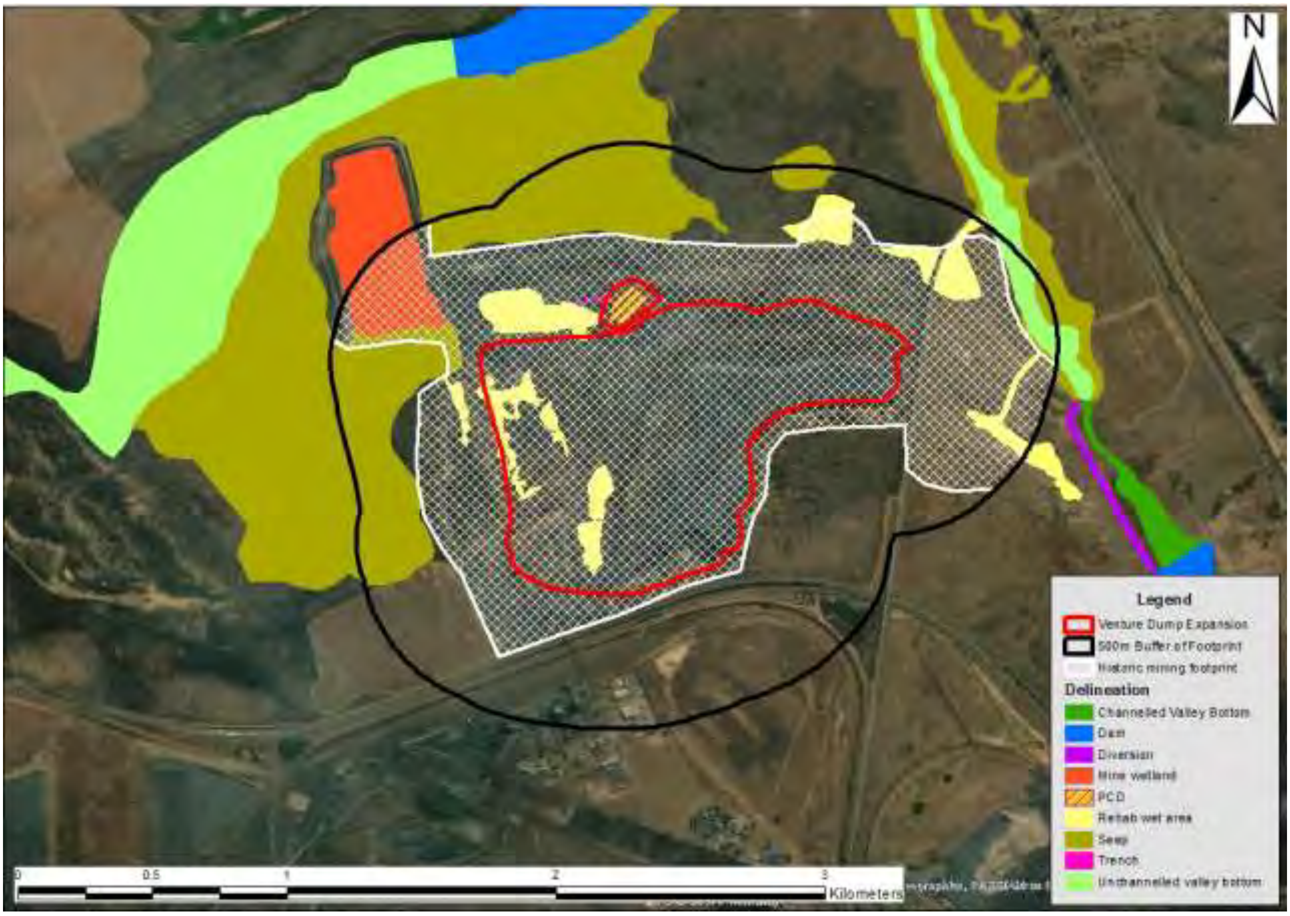


Figure 17. Map showing the extent of historical mining disturbance within the study area in relation to delineated wetlands.

A large Seep wetland (Figure 19) occurs to the west and north of the Venture Dump. This Seep wetland drains into the Tweefonteinspruit. The wetland is comprised of a mosaic of seasonal to temporary wet areas dominated by grass and sedge species and extends up to the edge of historical mining disturbance. To the north west of the Venture Dump, mining disturbance extends far into the Seep wetland in the form of a large rectangular berm that encloses an artificial wetland area dominated by *Phragmites australis* (labelled as "Mine wetland" in Figures 13 and 14). The main flow drivers of the Hillsope Seepage wetland are likely to have been modified somewhat by historical mining, with current wetland habitat being maintained by a combination of direct rainfall, surface runoff from the rehabilitated mining area and some interflow.

To the east of the Venture Dump an Unchannelled Valley Bottom wetland flows from south to north; this system is known as the Gilfillan Stream (Figure 20). A part of this wetland has been mined through in the past (Figure 17) and a stream diversion is in place just upstream of the Venture Dump study area. Downstream towards the confluence with the Tweefonteinspruit some channel incision has occurred within the wetland. Seep wetlands occur as narrow bands along either side of the valley bottom. The Gilfillan Stream was earmarked for rehabilitation as part of the iMpunzi Onsite Wetland Mitigation Strategy. The current status of this strategy is however not known.

Figure 18. Photographs of the "Rehab wet areas" observed on site. Top row shows summer images, bottom row shows winter images.

Figure 19. Photographs of typical wetland habitat observed within the Seep wetland north and west of the Venture Dump.

Figure 20. Photographs of the Valley Bottom and Seep wetland habitat associated with the Gilfillan Stream.

7.3.1 Present Ecological State (PES) Assessment

A PES assessment was undertaken for all natural wetlands within a 500m radius of the proposed Venture Dump footprint. The PES assessment provides a comparison between the current state or condition of a wetland compared to the reference or natural state of a wetland and assesses the departure from the reference state on a scale of A – Natural/Pristine to F – Critically Modified, with C denoting a Moderately Modified state. It was therefore not possible to undertake a PES assessment for man-made or artificial wetland systems (i.e. the wetland systems labelled as “Rehab wet areas” or “Void waterbodies” in Figure 16) as such wetlands do not have a reference or natural state against which the current state can be compared.

The results of the PES assessment are illustrated in Figure 21. The large Seep that extends to the north and west of the study area was assessed and found to be in a Largely Modified condition (PES category D), mostly due to the impacts of historical mining activity that extends into the wetland as well as changes in supporting hydrology resulting from the rehabilitated mining area. The Gilfillan Stream wetland system to the east of the study area was also found to be mostly in PES category D, indicating a Largely Modified wetland system. This wetland is also affected by historical mining activity, including the presence of a stream diversion along the system, the presence of two large coal discard dumps adjacent to its upper reaches, as well as a dam and several linear infrastructure crossings.

The Tweefonteinspruit wetland systems that flows past to the north of the study area was not included in this PES assessment. Reference is however made to the DWS (2014) National River PES which indicates the Steenkoolspruit to be Largely Modified (PES category D).

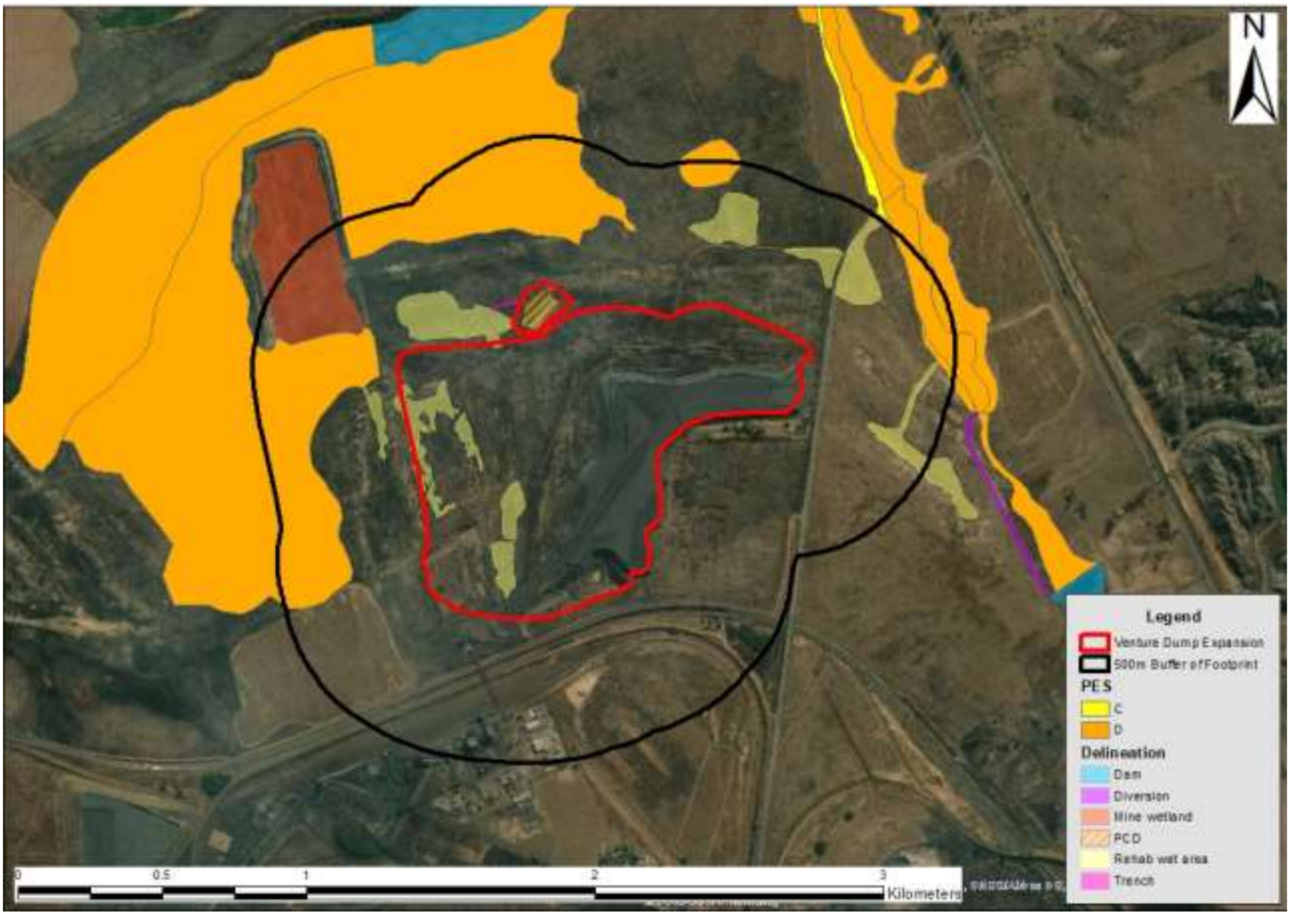


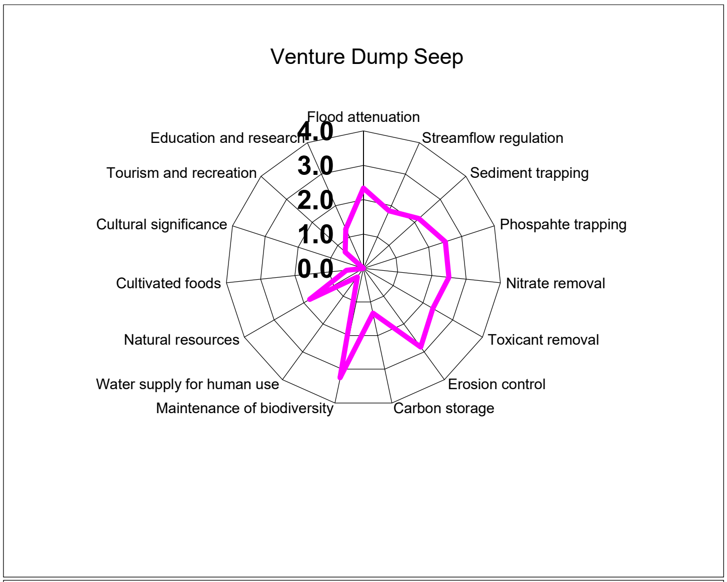
Figure 21. Map showing the results of the PES assessment.

7.3.2 Wetland Functional Assessment

A functional assessment was undertaken as per the WET-EcoServices methodology (Kotze et al., 2008) with results illustrated in Figure 22.

The assessment highlighted a number of water quality related ecosystem services, specifically sediment trapping, phosphate trapping, nitrate removal and toxicant removal as likely being of significance in especially the Valley Bottom wetland, but also the Seep. These functions are enhanced by the near permanent saturation of the Valley Bottom wetland and more robust vegetation growth when compared to the Seep wetland. Given the water quality concerns within the rivers of the area and the Olifants River in general, these functions are of importance. Sediments are trapped by the slowing down and spreading out of flows in the wetland, with the surface roughness provided by the vegetation and the unchannelled nature of the wetland being important in this regard. Due to upslope sediment sources, e.g. cultivated fields, unsurfaced roads and stockpiles, the wetland is well placed to contribute to this function. Associated with sediment trapping is phosphate trapping through adsorption to sediment particles. Phosphate sources within the catchment are likely to be associated with cultivated fields and the application of fertilizers to these fields. Nitrate removal occurs through the reduction of nitrate (and sulphate) as flows seep through the organic rich sediments of the Seep wetlands.

Maintenance of biodiversity is a function highlighted for both wetland systems assessed, with a scores of over 3 obtained. The importance of the wetlands in this regard is elevated by the degree of transformation in the surrounding landscape caused by mining and agriculture, with wetland areas representing the bulk of remaining natural vegetation in the area. The linear nature of Valley Bottom wetlands also makes them important as movement corridors for wildlife through a transformed landscape.



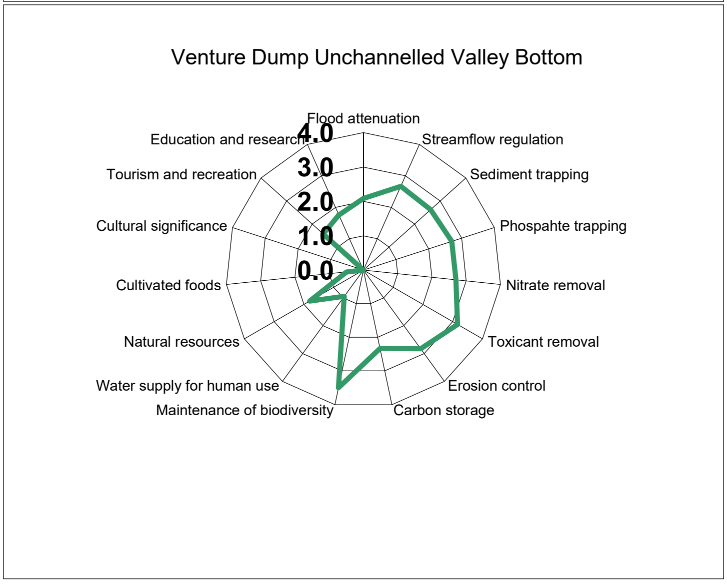


Figure 22. Results of the WET-EcoServices assessment for the Venture Dump wetlands.

7.3.3 Wetland Importance and Sensitivity (IS)

The wetlands within the study area form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality and quantity concerns have been raised within the sub-catchment. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all remaining wetlands and rivers within the catchment that have as yet not been seriously modified and which can contribute to ecosystem services that aid in the maintenance of water quality, streamflow and biodiversity. Within this context a Wetland IS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the IS assessment include:

- The location of the study area within a vegetation type (Eastern Highveld Grassland) considered extensively transformed and threatened, having been classed as ***Vulnerable***.
- The wetland vegetation type of the area, Mesic Highveld Grassland Group 4, which is considered to be ***Least Threatened*** and ***Not Protected***.
- The fragmented and isolated nature of many of the wetland habitats located within a heavily modified agricultural and mining landscape.
- The generally largely modified state of the wetlands and watercourse within the study area and surroundings.

It is these considerations that have informed the scoring of the systems in terms of their importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands are illustrated in Figure 23, while an explanation of the scoring system is presented in Table 3.

The Tweefonteinspruit is considered by the DWS (2014) as being of ***Moderate*** environmental importance and ***High*** environmental sensitivity.

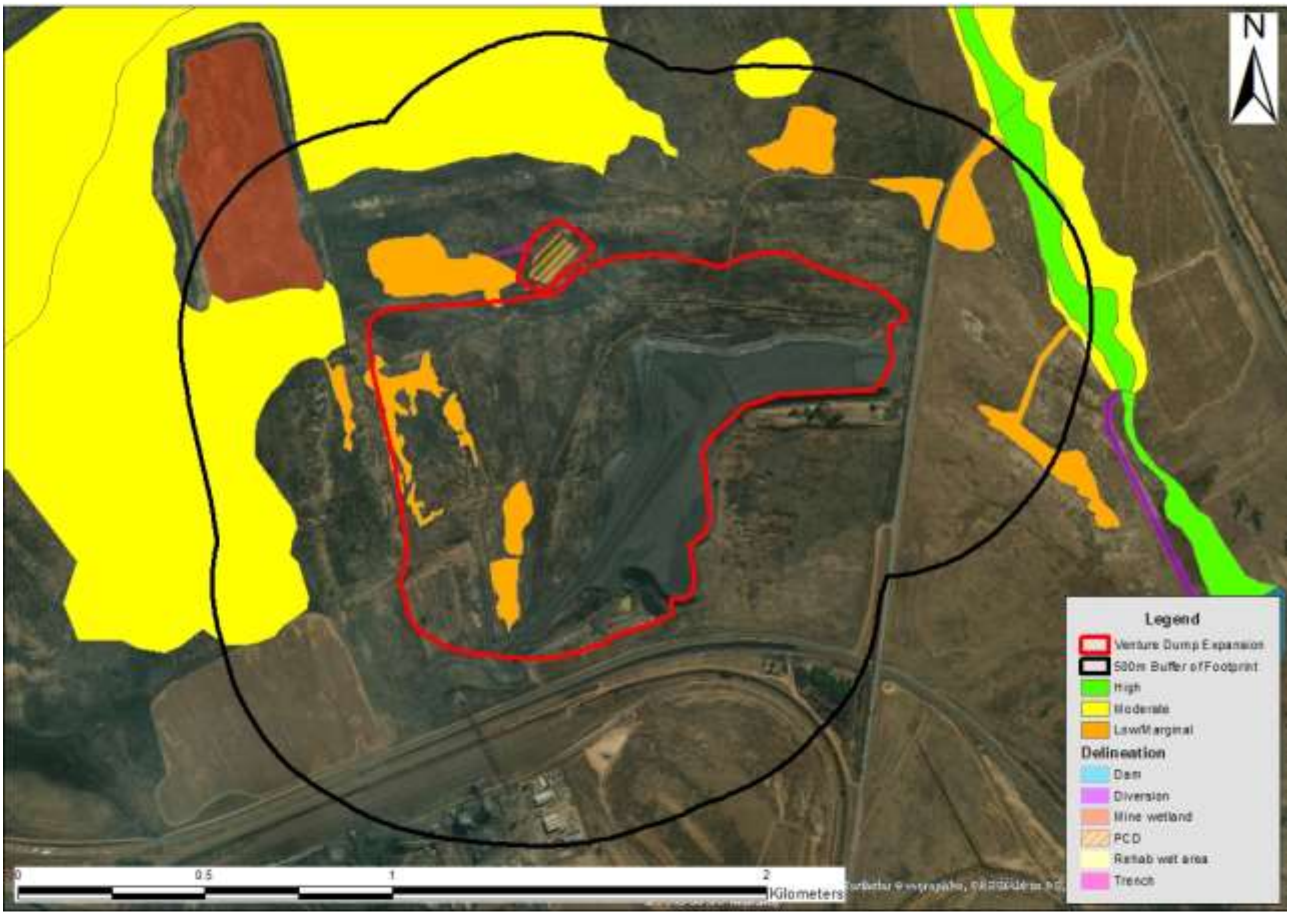


Figure 23. Results of the Importance and Sensitivity assessment.

8. IMPACT ASSESSMENT

8.1 ALTERNATIVES CONSIDERED

The reader is referred to the overall environmental authorisation application as compiled by Golder for details on any project alternatives considered. No alternative sites were considered as part of this assessment.

8.2 IMPACT ASSESSMENT

8.2.1 Project Description

The reader is referred to the overall environmental authorisation application as compiled by Golder for a detailed project description.

It is proposed that the existing Venture Dump be extended in a west and northerly direction to a total area of almost 100 hectares (Figure 24). ***The proposed extension will not directly affected any natural wetland systems as the entire extension footprint falls on rehabilitated mine***

land. The extension will however extend across a number of small artificial wetland areas, termed "Rehab wet area" that have formed on the rehabilitated mining land due to accumulation of surface water in shallow depressions and low-lying areas. The Venture Dump, including the extension, will form part of a dirty water area excluded and isolated from the surrounding catchment. An existing PCD will be utilised for this purpose.

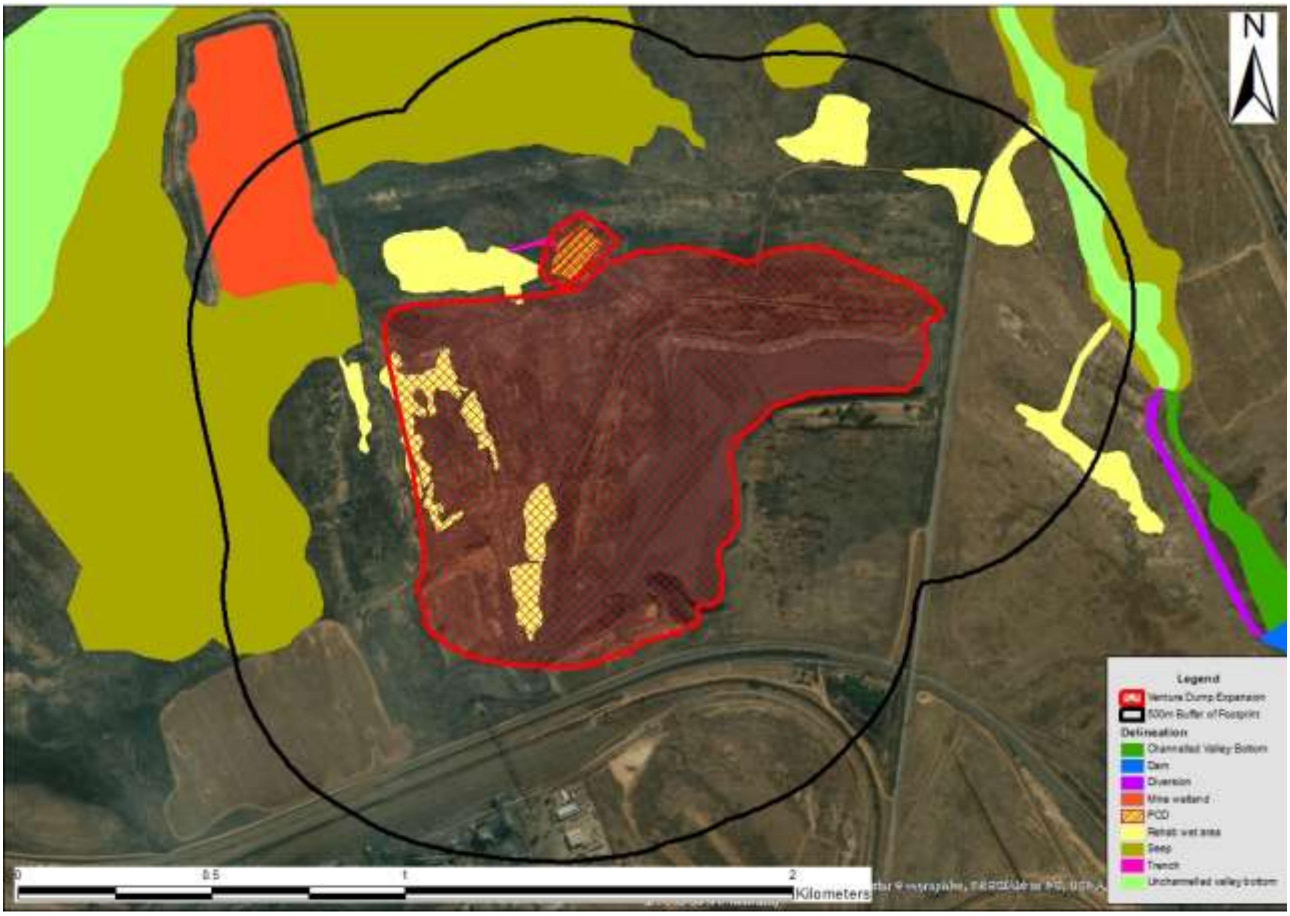


Figure 24. Map of the proposed Venture Dump extension in relation to delineated wetland habitat.

The South Pit Dump will entail the establishment of a new discard dump within the footprint of the South Pit opencast mining areas (Figure 25). It is understood that discard disposal will take place on the rehabilitated surface of the South Pit rather than within the open void of the pit. The proposed South Pit footprint will cover in the region of 85 hectares. As for the Venture Dump, the establishment of the South Pit Dump ***will not directly affected any natural wetland systems as the entire extension footprint falls on previously opencast mined land.*** The South Pit Dump, including the extension, will form part of a dirty water area excluded and isolated from the surrounding catchment.

Figure 25. Map of the proposed South Pit Dump extension in relation to delineated wetland habitat.

Although the Venture Dump and South Pit Dump are two separate activities in separate locations, the impacts to wetlands associated with the two proposed dumps are considered to be largely similar:

- No direct impacts to any natural wetlands from either dump;
- Both dumps are located on previously opencast mined land;
- Design and operation of the two dumps is understood to be largely the same; and
- Impacts to adjacent wetlands are likely to result only from indirect impacts (i.e. seepage from the dumps, runoff from the construction footprint etc).

For this reason only a single impact assessment was undertaken. Where difference between the two dumps and associated impacts are likely, such differences are however highlighted.

Expected impacts include:

Construction Phase:

1. Loss and disturbance of artificial wetland habitat – all artificial wetland habitat ("Rehab wet areas") falling within the proposed Venture Dump extension footprint will be lost. No such habitat occurs within the South Pit Dump footprint. Adjacent wetlands could be disturbed during the construction process and might be impacted by altered flow characteristics due

to catchment isolation. In the case of South Pit, the adjacent Seep will be lost to ongoing mining activities in future and is also located upslope of the proposed South Pit Dump footprint, so should be largely unimpacted.

2. Increased sedimentation within the wetlands due to sediment rich runoff from the construction site - Construction activities will involve the clearing of large areas of soil, as well as the movement of soil and subsequent stockpiling. This will expose large areas and large volumes of soil to erosion by wind and water, which will likely be aggravated by an increase in surface runoff from bare soil areas and concentration of flows. Sediment could be transported downslope via surface runoff to the adjacent wetland areas, leading to increased turbidity with resultant impacts on aquatic habitats, including loss of sensitive species, as well as increased sediment deposition in wetlands, leading to habitat degradation as these areas become colonised by alien and pioneer species. Severe sedimentation could also impact of flow distribution within the wetlands. In the case of South Pit, the adjacent Seep will be lost to ongoing mining activities in future and is also located upslope of the proposed South Pit Dump footprint, so should be largely unimpacted.
3. Increased turbidity and water quality degradation in adjacent wetlands - During the construction phase, as activities are taking place adjacent to wetlands, there is a possibility that water quantity and quality can be impaired through contaminated surface runoff entering the wetlands. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment within the wetlands. It is possible that hydrocarbons will be temporarily stored and used on site, as well as cement and other potential pollutants. In the case of South Pit, the adjacent Seep will be lost to ongoing mining activities in future and is also located upslope of the proposed South Pit Dump footprint, so should be largely unimpacted.

Operational Phase:

4. Decreased flows within adjacent wetlands due to catchment exclusion – the discard dumps will form isolated dirty water areas with all rain falling on the dumps captured within the dirty water management system and not contributing to the catchment flows of downslope wetland.
5. Water quality deterioration due to seepage out of the discard dumps – the proposed discard dumps will not be lined, though dirty water interception and isolation infrastructure will be put in place. It is expected that seepage out of the discard dumps will enter the underlying rehabilitated opencast pits and be managed as part of the overall water management of the mine. However, if the underlying rehabilitated opencast pits are allowed to fill with water and decant, there is a risk of contaminated seepage entering adjacent wetland areas as well as the Tweefonteinspruit (Venture Dump) or Steenkoolspruit (South Pit). Seepage is likely to be acidic as well as metal and sulphate rich, resulting in significant risk to receiving wetlands. The risk of contaminated, acidic seepage from the co-disposal facility entering the adjacent wetlands is thus high if left unmitigated.

Decommissioning and Closure Phase:

6. Sediment movement into wetlands –Rehabilitation of the discard dumps will involve the capping and placement of a topsoil layer on the dump, followed by the re-vegetation of the

dump. The steeper side slopes of the dump and sparse vegetation cover could provide a significant sediment source to adjacent wetlands. Sediments entering adjacent wetlands via surface runoff will likely deposit in the wetlands, with deposition areas providing an opportunity for the establishment of pioneer and weedy species within the wetlands, leading to habitat degradation.

7. Establishment of alien vegetation – The replaced topsoil on the rehabilitated dump slopes could provide opportunity for the establishment of alien vegetation, with such alien vegetation providing a source of seeds to spread into adjacent wetland areas.
8. Increased flow velocities within wetlands - Once rehabilitated, runoff from the dump will be considered clean water and released back into the environment. The steep side slopes of the dump will encourage high velocity flows that could lead to erosion within adjacent wetland areas, which are mostly hillslope seepage wetlands typically maintained by diffuse sub-surface flows. The shallow soils of hillslope seepage wetlands makes them very susceptible to erosion.
9. Water quality deterioration - Oxidation and leaching of pyritic material within the co-disposal facility will result in the seepage of low pH, high metal and sulphate rich water out of the dump and into the underlying rehabilitated opencast pits, which will be managed as part of the overall water management of the mine. However, if the underlying rehabilitated opencast pits are allowed to fill with water and decant, there is a risk of contaminated seepage entering adjacent wetland areas as well as the Tweefonteinspruit (Venture Dump) or Steenkoolspruit (South Pit). Seepage is likely to be acidic as well as metal and sulphate rich, resulting in significant risk to receiving wetlands. The risk of contaminated, acidic seepage from the co-disposal facility entering the adjacent wetlands is thus high if left unmitigated.

Table 9. Summary of expected impacts to wetlands and impact significance.

Impact		Magnitude	Duration	Scale	Probability	Score	Significance
Construction	Loss and disturbance of wetland habitat	Low (4)	Permanent (5)	Local (2)	Definite (5)	55	**Moderate**
	Increased sedimentation within the wetlands due to sediment rich runoff from the construction site	Moderate (6)	Medium-term (3)	Local (2)	Highly Probable (4)	44	**Moderate**
	Increased turbidity and water quality degradation in adjacent wetlands	Moderate (6)	Medium-term (3)	Local (2)	Highly Probable (4)	44	**Moderate**
Operation	Decreased flows within adjacent wetlands due to catchment exclusion	Low (2)	Permanent (5)	Local (2)	Definite (5)	45	**Moderate**
	Water quality deterioration	High (8)	Permanent (5)	Regional (3)	Definite (5)	80	**High**

Impact		Magnitude	Duration	Scale	Probability	Score	Significance
	due to seepage out of the Dumps						
Decommissioning	Sediment movement into wetlands	Moderate (6)	Medium-term (3)	Local (2)	Highly Probable (4)	44	**Moderate**
	Establishment of alien vegetation	Moderate (6)	Permanent (5)	Local (2)	Medium Probability (3)	42	**Moderate**
	Water quality deterioration	High (8)	Permanent (5)	Regional (3)	Definite (5)	80	**High**
	Increased flow velocities within wetlands	Moderate (6)	Permanent (5)	Local (2)	Medium Probability (3)	42	**Moderate**

8.3 MITIGATION, MANAGEMENT & REHABILITATION

A number of mitigation measures are recommended for implementation during the various project phases.

Construction Phase

- All construction areas should be fenced off/clearly demarcated prior to commencement of vegetation clearing activities on site so as to prevent access to adjacent wetlands and their associated buffer zones by construction machinery and personnel. In addition, all wetland areas should be clearly demarcated as such to alert construction staff on site. All construction staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process.
- Develop and implement a construction stormwater management plan prior to the commencement of site clearing activities. Such a plan should aim to minimise the transport of sediment off site. Sediment traps and sediment barriers should be installed where necessary, and stormwater discharge points should be protected against erosion and incorporate energy dissipaters.
  - Erosion within the construction site must be minimised through the following:
    - Limiting the area of disturbance and vegetation clearing to as small an area as possible;
    - Where possible, undertaking construction during the dry season;
    - Phasing vegetation clearing activities and limiting the time that any one area of bare soil is exposed to erosion;
    - Control of stormwater flowing onto and through the site. Where required, stormwater from upslope should be diverted around the construction site;
    - Prompt stabilisation and re-vegetation of soils after disturbance and construction activities in an area are complete; and
    - Protection of slopes. Where steeper slopes occur, these should be stabilised using geotextiles or any other suitable product designed for the purpose.
  - Sediment transport off the site must be minimised through the following:

  - Establishing perimeter sediment controls. This can be achieved through the installation of sediment fences along downslope verges of the borrow pit site where surface flows leave the site. Where channelled or concentrated flow occurs, reinforced sediment fences or other sediment barriers such as sediment basins should be used (refer to US EPA guidelines on Stormwater Pollution Prevention);
  - Discharge of stormwater from the construction site into adjacent grassland. Discharged flows must be slow and diffuse; and
  - Regular inspection and maintenance of sediment controls
- Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 200m from a wetland or water course. No abstraction of water from the wetlands or pans should be allowed unless expressly authorized in the IWULA.
- In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.
- Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the Environmental Co-coordinator and the relevant authorities (DWS) immediately, with specialists appointed to oversee the clean-up operations.

Operation Phase

- Develop and implement a water management plan that will ensure effective clean and dirty water separation;
- Implement and maintain dirty water infrastructure around all sources of potential dirty water. Regular inspections of all water management infrastructures must be undertaken and detailed records of such inspections maintained;
- Minimise extent of dirty water areas;
- Ensure all clean water is diverted around dirty water areas and allowed to re-enter the environment;
- Clean water diversion canals must be constructed as vegetated swales rather than cement lined canals wherever possible;
- Implement dust suppression within areas where carbonaceous dust may be generated and areas of heavy vehicle traffic. Implement dust suppression on haul trucks;
- Implement water quality and biomonitoring strategy;
- Compile an emergency response procedure for clean-up of any major spillages.

Key focus should be on mitigating the impact of water quality deterioration which was identified as the impact of highest significance from a wetland perspective. The recommendations from the surface water and groundwater specialist should be fully implemented to ensure containment of pollution plumes and prevent migration of contaminants into adjacent wetlands and river systems. The proposed discard dumps and the contaminated water derived from these dumps must be fully accommodated in the mine's water management strategy. Where contaminated water from the dumps is expected to seep into the underlying rehabilitated opencast pits, water levels within the opencast pits must be managed to prevent decant. The mine water management strategy must include allowance for treatment of contaminated water.

Decommissioning and Closure Phase

- Dump to be rehabilitated in whaleback fashion with as low slopes as possible;
- Dump to be topsoiled and vegetated with indigenous grass cover;
- Dump to be designated clean water area following completion of rehabilitation;
- Implement measures to manage stormwater runoff from the steep slopes of the rehabilitated dump;
- Safely introduce runoff into adjacent areas at flow velocities that will not result in erosion and scour of receiving wetland systems;
- Migration of groundwater pollution plume away from the dump to be managed as per recommendations in the groundwater specialist report;
- The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed;
- All disturbed and transformed areas should be landscaped to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off where possible;
- Compacted soils should be ripped and scarified;
- The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion;
- Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately;
- The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation; and
- Sediment traps should be placed in rehabilitated areas to avoid sedimentation

Table 10. Summary of expected impacts to wetlands and impact significance after implementation of recommended mitigation and management measures.

Impact		Magnitude	Duration	Scale	Probability	Score	Significance
Construction	Loss and disturbance of wetland habitat	Minor (2)	Permanent (5)	Site Only (1)	Definite (5)	40	**Moderate**
	Increased sedimentation within the wetlands due to sediment rich runoff from the construction site	Minor (2)	Medium-term (3)	Site Only (1)	Highly Probable (4)	24	**Low**
	Increased turbidity and water quality	Minor (2)	Medium-term (3)	Site Only (1)	Highly Probable (4)	24	**Low**

	Impact	Magnitude	Duration	Scale	Probability	Score	Significance
	degradation in adjacent wetlands						
Operation	Decreased flows within adjacent wetlands due to catchment exclusion	Low (2)	Permanent (5)	Local (2)	Definite (5)	45	**Moderate**
	Water quality deterioration due to seepage out of the Dumps	Moderate (6)	Permanent (5)	Local (2)	Highly Probable (4)	52	**Moderate**
Decommissioning	Sediment movement into wetlands	Minor (2)	Medium-term (3)	Site Only (1)	Highly Probable (4)	24	**Low**
	Establishment of alien vegetation	Minor (2)	Medium-term (3)	Site Only (1)	Medium Probability (3)	18	**Low**
	Water quality deterioration	Moderate (6)	Permanent (5)	Local (2)	Highly Probable (4)	52	**Moderate**
	Increased flow velocities within wetlands	Minor (2)	Permanent (5)	Site only (1)	Medium Probability (3)	24	**Moderate**

8.4 MONITORING

No specific wetland monitoring is recommended. However, the two proposed dumps should be included in the mine's water quality (surface and groundwater) and biomonitoring strategies, as per the recommendations of the respective specialists.

9. CONCLUSION & RECOMMENDATIONS

Wetland Consulting Services (Pty.) Ltd. (WCS) was appointed by Golder Associates Africa to undertake the specialist wetland assessment study required for the proposed expansion of the Venture Dump and the proposed establishment of the South Pit Dump, both located at the Glencore iMpunzi Complex. Although both dumps are located within the footprints of previously opencast mined land, wetland habitat occurs within the immediate proximity of both proposed dump footprints, triggering the need for this wetland study.

The aim of the study was to provide a detailed baseline assessment of the wetlands within the project area and immediate zone of influence, to identify and assess likely impacts of the proposed activities, and to provide detailed recommendations on the mitigation and management measures within the framework of the mitigation hierarchy, to ensure minimisation of impacts to wetlands.

The study area for this project has been defined as the proposed footprints of both the Venture Dump expansion and the proposed South Pit Dump, together with a 500m buffer around both footprints (**Figure 2**). Both sites are located within Primary Catchment B, and more specifically, the South Pit is within quaternary catchment B11E, and the Venture Dump extension within quaternary catchment B11F. Catchment B11E is drained by the Steenkoolspruit River and its tributaries the Rietspruit and Blesbokspruit. Catchment B11F is drained by the Olifants River and its tributaries the Tweefonteinspruit and Klippoortjiespruit/Saaiwaterspruit.

The South Pit study area is located within the footprint of an existing opencast pit to the east of the Steenkoolspruit. The proposed footprint of the South Pit is characterised by a backfilled opencast pit of which the western end nearest the Steenkoolspruit has been rehabilitated and revegetated. ***No wetlands were found to occur within the direct footprint of the proposed South Pit study area (Figure 9)***.

The Venture Dump is an existing Discard Dump located to the north of the Glencore ATC Plant and Offices. The Tweefonteinspruit flows past roughly 1.3 km to the north of the Venture Dump. The existing venture Dump, as well as the full footprint of the proposed expansion, will be located on rehabilitated mining land, with mining of the area having been completed prior to 2003. Disposal of discard into the void commenced between 2003 and 2006, as is visible from historical Google Earth imagery. ***No natural wetland habitat was found to occur within the proposed Venture Dump Expansion footprint.***

Impacts to wetlands are expected to be indirect as no wetlands fall within the proposed development footprints but wetland habitat occurs within the 500m area surrounding the development footprints. Expected impacts include:

1. Loss and disturbance of artificial wetland habitat.
2. Increased sedimentation within the wetlands due to sediment rich runoff from the construction site.
3. Increased turbidity and water quality degradation in adjacent wetlands.
4. Decreased flows within adjacent wetlands due to catchment exclusion.
5. Water quality deterioration due to seepage out of the discard dumps.
6. Sediment movement into wetlands during rehabilitation.
7. Establishment of alien vegetation.
8. Increased flow velocities within wetlands.
9. Post-closure water quality deterioration due to seepage out of the discard dumps.

Mitigation measures are recommended to reduce the significance of the identified impacts. ***Key focus should be on the impact of water quality deterioration which was identified as the impact of highest significance from a wetland perspective***. The recommendations from the surface water and groundwater specialist should be fully implemented to ensure containment of pollution plumes and prevent migration of contaminants into adjacent wetlands and river systems. The proposed discard dumps and the contaminated water derived from these dumps must be fully accommodated in the mine's water management strategy. Where contaminated water from the dumps is expected to seep into the underlying rehabilitated opencast pits, water levels within the opencast pits must be managed to prevent decant. The mine water management strategy must include allowance for treatment of contaminated water.

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APPENDIX A

CV of the Specialist

Dieter Oscar Kassier

Summarised *Curriculum Vitae*

Date of Birth:	1981-09-15	**Profession:**	Wetland Ecologist
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Academic History:	2012 – Honours B.Sc Environmental Science (Aquatic Ecosystem Health) (Distinction) - NWU 2006 – B.Sc Environmental Management (Zoology Stream) – UNISA 1999 – Matriculated from Hermannsburg School (IEB Exam)
Professional Affiliations:	SACNASP: Environmental Science (400254/14) South African Wetland Society (Reg. number R87XH0HU)
Additional Training:	2009 - Soil classification and wetland delineation (Terra Soil Science) 2009 – Rehabilitation of Mine Impacted Land (African Landuse Training) 2008 – Bringing data into ArcGIS (GIMS) 2007 – Wetland Delineation and Rehabilitation Course (University of Pretoria) 2004 – FGASA Level 1 and Trails Guide (FGASA)
Employment record:	2007 – Present day: Wetland Ecologist: Wetland Consulting Services (Pty.) Ltd. 2006 – 2007: Junior Environmental Consultant: WSP Environmental 2001 – 2006: Field Guid/Game Ranger: Makutsi Safari Farm, Karongwe Game Reserve
Publications:	

Wetland Rehabilitation in Mining Landscapes: An Introductory Guide. 2016. Macfarlane, D., Dlamini, B., Marneweck, G., Kassier D., Campbell, J., Young, A., Dini, J.A., Holness, S.D., de Klerk, A.R., Oberholster, P.J. and Ginsburg, A. WRC Report TT 658/16

Summarised project experience over the past 5 years

2016 Consulting Projects:

1. Olifants Letaba Reserve Project – Review of existing information, gap analysis, field verification of wetlands, prioritisation of wetlands and compilation of management recommendations and eco-specs for wetlands
2. Impumelelo Mine – Wetland baseline surveys (delineation and ecological assessment) for mine expansion activities over an area of over 8 000ha
3. Klipfontein Wetland Mitigation Strategy – compilation of a wetland mitigation and rehabilitation strategy in terms of the wetland offset guidelines
4. Leeuwpan Monitoring – Water Use License compliance monitoring for wetlands surrounding the Leeuwpan Mine
5. Riverfields – wetland delineation and ecological assessment as part of environmental authorisation processes for three sites in the Ekurhuleni Metropolitan Municipality

2015 Consulting Projects:

1. Kendal Offset study – compilation of a wetland offset strategy for the Kendal 30-year ash dam
2. Crown Mines Golf Course – wetland delineation and assessment study for proposed developments on the Crown Mine Golf Course
3. SANBI Guideline for Wetland Rehabilitation in Mining Landscapes – co-author
4. Greenside Thadeka Shaft – wetland delineation and impact assessment to support the various environmental authorisation applications required in terms of the MPRDA, NEMA and NWA
5. Compilation of a wetland management plan for the Stuart South Mine

2014 Consulting Projects:

1. Glencore Witbank Complex Wetland Management Strategy – Compilation of a wetland management strategy for the Glencore Witbank group of mines, Mpumalanga Province
2. Wetland Management and Rehabilitation Plan for the Glencore iMpunzi Division
3. De Wittekrans Coal Mine – Wetland delineation and assessment for the proposed De Wittekrans Coal Mine near Hendrina, Mpumalanga Province
4. Sishen Ramp-Up Project – wetland delineation and water use risk assessment for the proposed relocation of a 275kV powerline near Sishen in the Northern Cape
5. Clearwater Estates – wetland delineation and impact assessment for a proposed residential development along the Clearwater Pan in Ekurhuleni, Gauteng Province

2013 Consulting Projects:

1. Kusile 60-year Ash Dam – Wetland delineation assessment and site selection as part of the EIA/EMP and IWULA for the proposed Kusile 60-year Ash Dam
2. Mooifontein Uranium – Wetland assessment as part of the EIA/EMP and IWULA for a proposed uranium mine in the southern Free State Province
3. Lydenburg Golf Course Phase 1 and 2 – Wetland assessments as part of the environmental authorisation applications for proposed residential developments near Lydenburg, Mpumalanga
4. Du Toits Pan Kimberley – Wetland delineation and ecological assessment of the Du Toits Pan, Kimberley Mines, Northern Cape
5. Kendal Continuous Ashing Project – Wetland delineation and assessment for the Kendal Continuous Ashing Project

2012 Consulting Projects:

1. Ariesfontein Concentrated Solar Power Plant – Wetland Assessment as part of the EIA/EMP for a CSP solar power facility near Danielskuil, Northern Cape
2. Kriel Beneficiation Plant – Wetland Assessment as part of the EIA/EMP and IWULA for the Kriel Colliery Beneficiation Plant
3. Tweefonteinspruit Clean-up Project – Ecological assessment to inform the proposed clean-up of the Tweefonteinspruit near Witbank
4. Two Rivers Platinum Mine – Wetland and Riparian assessment as part of the EIA/EMP and IWULA for a new tailings storage facility near Steelpoort
6. Braam Fischerville – Wetland delineation and assessment as part of the EIA for a proposed commercial development in Soweto

REPORT

Surface Water Specialist Report - iMpunzi Venture Dump - Rev1

GLENCORE SOUTH AFRICA

Submitted to:

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Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Venture Dump at the iMpunzi Mining Complex (iMpunzi) of Glencore South Africa (Glencore) is an operational coarse coal discard dump expanding rapidly. During the last couple of years, the stormwater measures around the dump (albeit temporary) were improved with dedicated stormwater routing berms, a silt trap and an associated lined pollution control dam.

Discussions with the mine personnel indicated that that Venture Dump was growing faster than anticipated and was likely to exceed its originally planned footprint area. Additionally, the area earmarked for dump footprint expansion has surface subsidence. To mitigate the risk identified by a recent dedicated risk assessment with regards to surface subsidence and the expansion of the dump, Golder Associates Africa (Golder) was requested to revisit and update the latest engineering designs for the dump. Subsequent to the abovementioned discussions with the mine, it was also decided that the coarse coal discard dump would be retrofitted to become a co-disposal facility.

This document summarises the baseline surface water environment, water balance for the site and the conceptual design of Venture Dump stormwater management plan by describing the design approach and design standards.

2.0 PROJECT OBJECTIVES

The project objectives, as they relate to the stormwater management and water balance of Venture Dump, are summarised as follows:

- Formulation and preliminary design of the stormwater management at the iMpunzi Venture Dump.
- Model the runoff from the various areas in relation to the Venture Dump.
- Estimate the position and size of the stormwater measures, to separate clean and dirty stormwater for the 1:50 year 24-hour storm event (GN704).
- Model the proposed stormwater management of the Venture Dump to estimate the required size of a pollution control dam with a spillage frequency of less than 1 in 50 years.

3.0 SITE DATA

3.1 Location

The iMpunzi Mine Complex is located within the eMalahleni Municipal Area (Nkangala District Municipality), 25 km south of eMalahleni and 15 km south east of the town of Ogies.

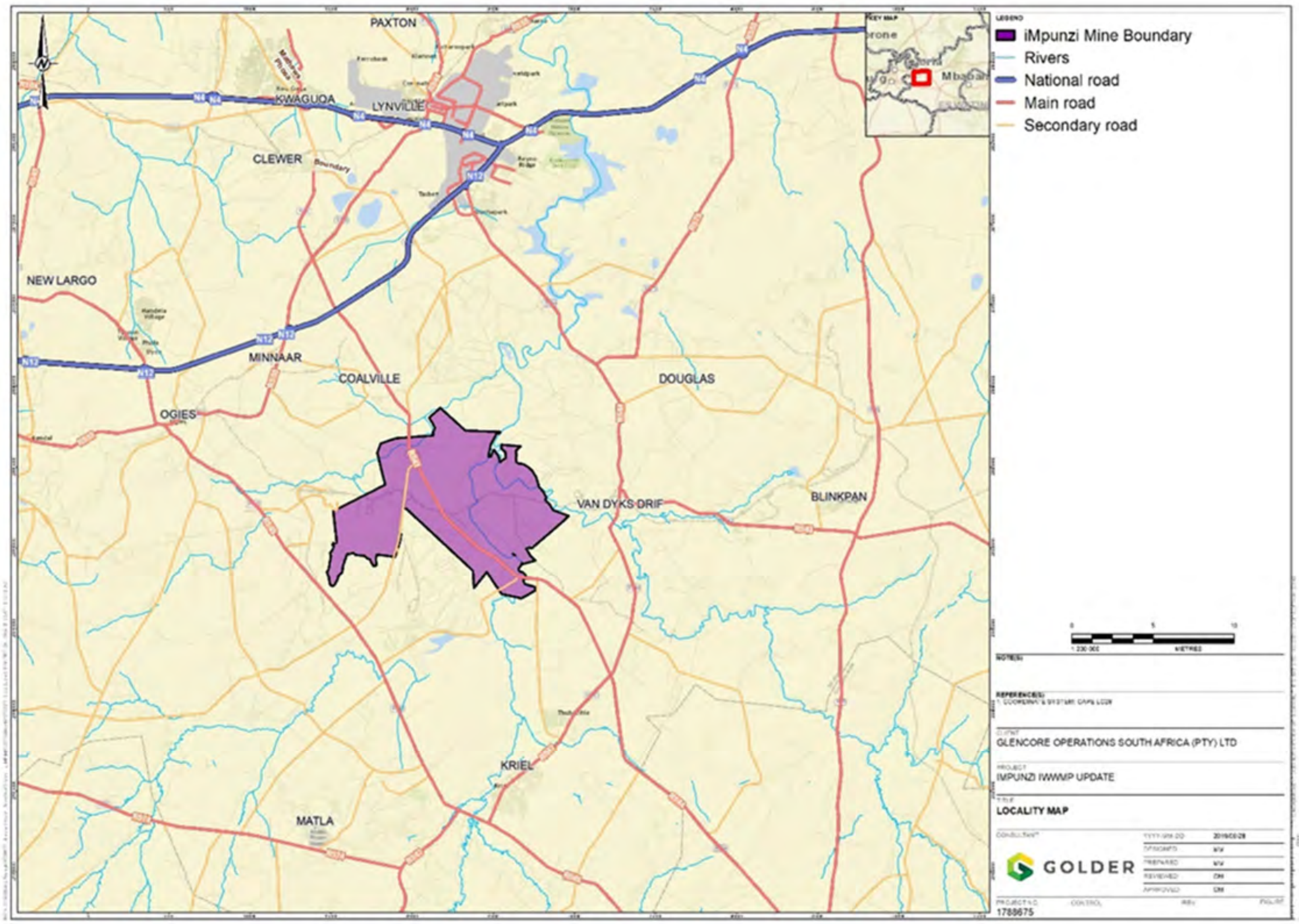

Figure 1: iMpunzi Mine Complex locality

3.2 Climate Data

3.2.1 Rainfall

The conceptual design reflected in this report includes the surface runoff regime related to the reconfigured co-disposal dump.

The daily rainfall data for the stormwater analysis for the above purpose was obtained from six rainfall gauges using the proprietary Daily Rainfall Data Extraction (Kunz, 2004). The details of the rain gauges are given in Table 1. The 24-hour rainfall depths were obtained for the rain gauges by utilizing the Design Rainfall Estimation programme.

Table 1: Rain gauge details and records

Station Name	SAWS Number	Distance to site (km)	Record (years)	Latitude	Longitude	MAP (mm)
Waterpan	0515270_W	9.7	42	26°0'	29°9'	695
Vandyksdrift	0478546_W	14.5	70	26°6'	29°19'	679
Ogies	0478093_W	14.8	92	26°3'	29°3'	745
Clydesdale	0515266_W	16.6	36	25°56'	29°9'	768
Cologne	0478008_W	18.4	74	26°7'	29°1'	683
Bombardie Estate	0478039_W	18.5	40	26°10'	29°2'	665

TR102 report on South African Storm Rainfall (Department of Environment Affairs, 1983) was also reviewed to obtain the storm rainfall depths for the recurrence intervals. In order to size the surface water collection infrastructure for the Venture Dump, the 24-hour design storm return period data set out in Table 2 was utilised.

Table 2: Return period data for 24-hour design storm

Return Period	Depth (mm)
1:2	55
1:5	74
1:10	89
1:20	104
1:50	126
1:100	145
1:200	165

In order to have a first order sizing of the Return Water Dam (RWD), the daily rainfall records were utilised. Rainfall data was collected from 0478093_W (Ogies) rainfall station. This data is patched data from the Ogies rainfall station. The record runs from January 1920 to December 2000, totalling 80 years of rainfall data (Figure 2).

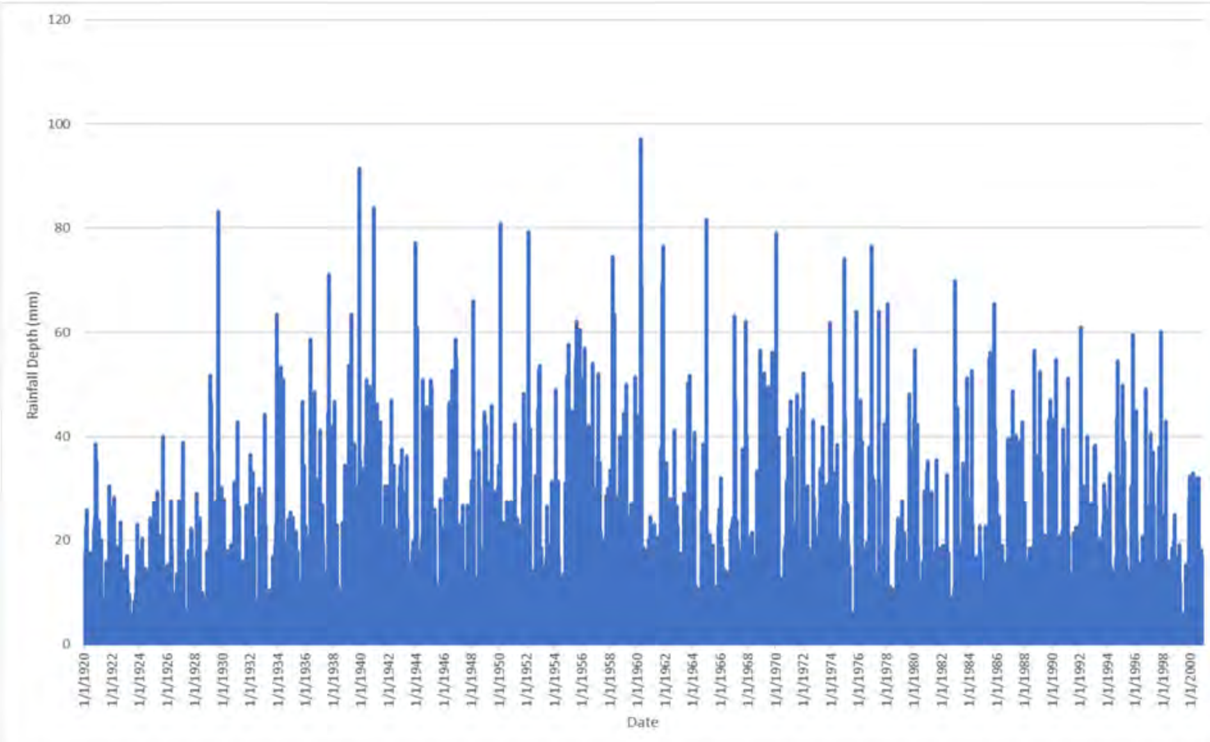

Figure 2: Ogies historical rainfall

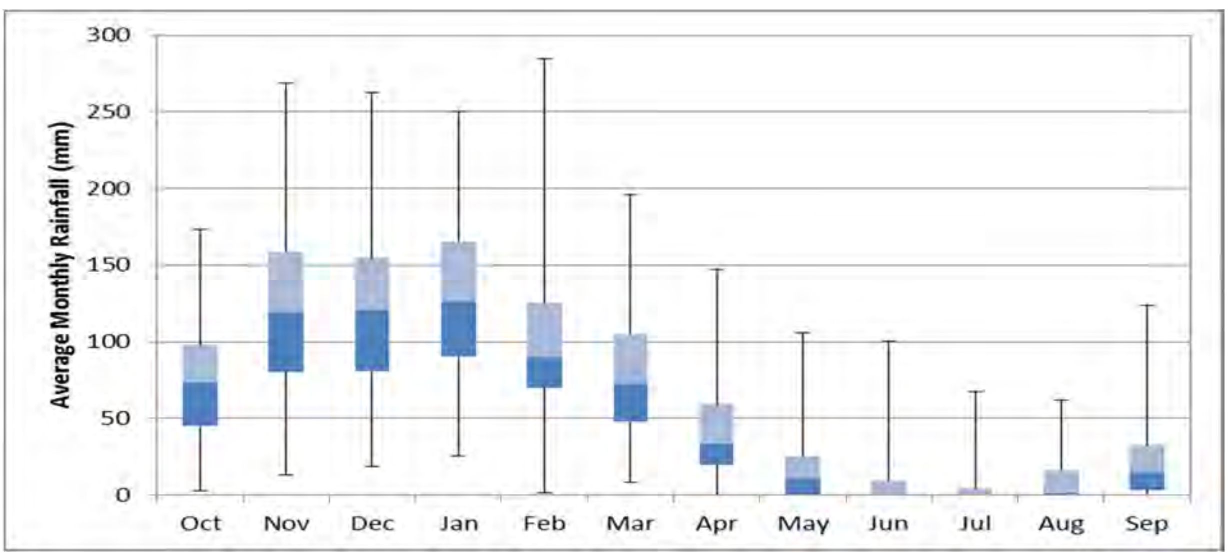

Figure 3: Ogies Monthly Rainfall Statistics

3.1 Evaporation

The mean annual S-class pan evaporation in the vicinity of the mine is 1 345 mm. Mean monthly evaporation is presented in Figure 4. The mean annual evaporation is higher than the rainfall throughout the year.

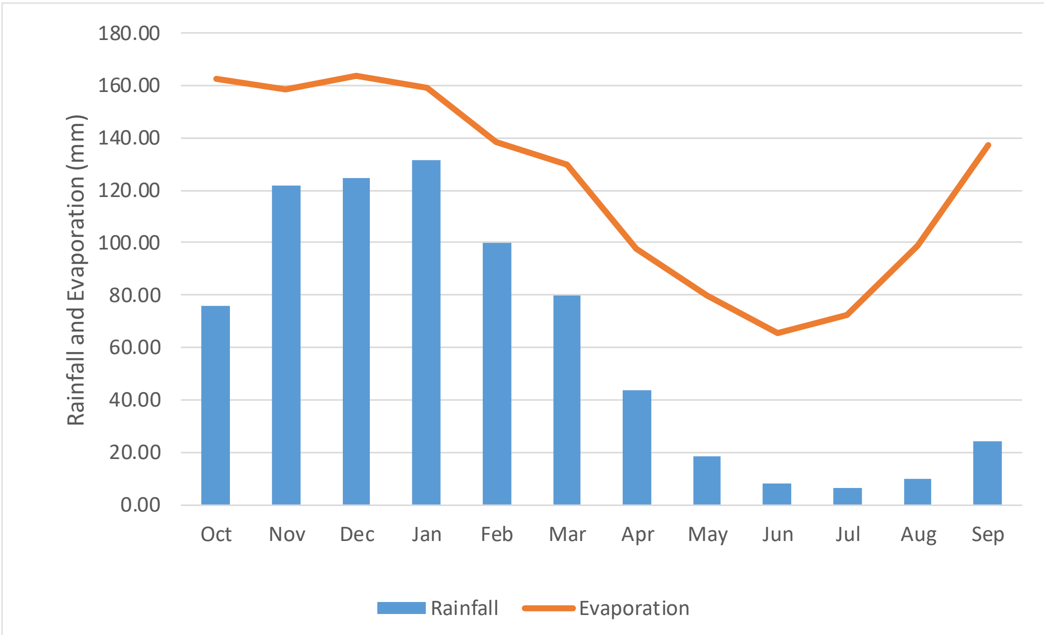

Figure 4: Average monthly evaporation and rainfall measurements for the Ogies weather station

3.2 Site-wide water management

The water reticulation at iMpunzi mine is presented in Figure 5. Where possible, the reuse of mine impacted water is prioritised. Potable water is sourced from the Olifants River Pumps Station and treated at the ATC or ATCOM potable water treatment plants.

The ATC plant processes re-mined coal from old discard facilities. The plant sources most of its makeup water from the ATC 2-seam workings and additional water is sourced from Venture 2-seam workings. Additional water is sourced from ATC 2-Seam Underground Storage and ATCOM Underground Lake. Discard is deposited on the Venture discard dump and slurry is currently disposed of into the 2-seam underground workings. With the Venture Dump Expansion project, both slurry and discard will be deposited on Venture Dump. The ATC plant has a backup water line for Olifants River water.

The ATCOM plant processes coal from the open cast mining pits. Water is sourced from the ATCOM Lake underground workings and additional water sourced from the Phoenix Lake underground workings. The lakes receive water from the pits and South Pit Discard Dump.

Excess water generated at the mine is treated at the Tweefontein Water Treatment Facility.

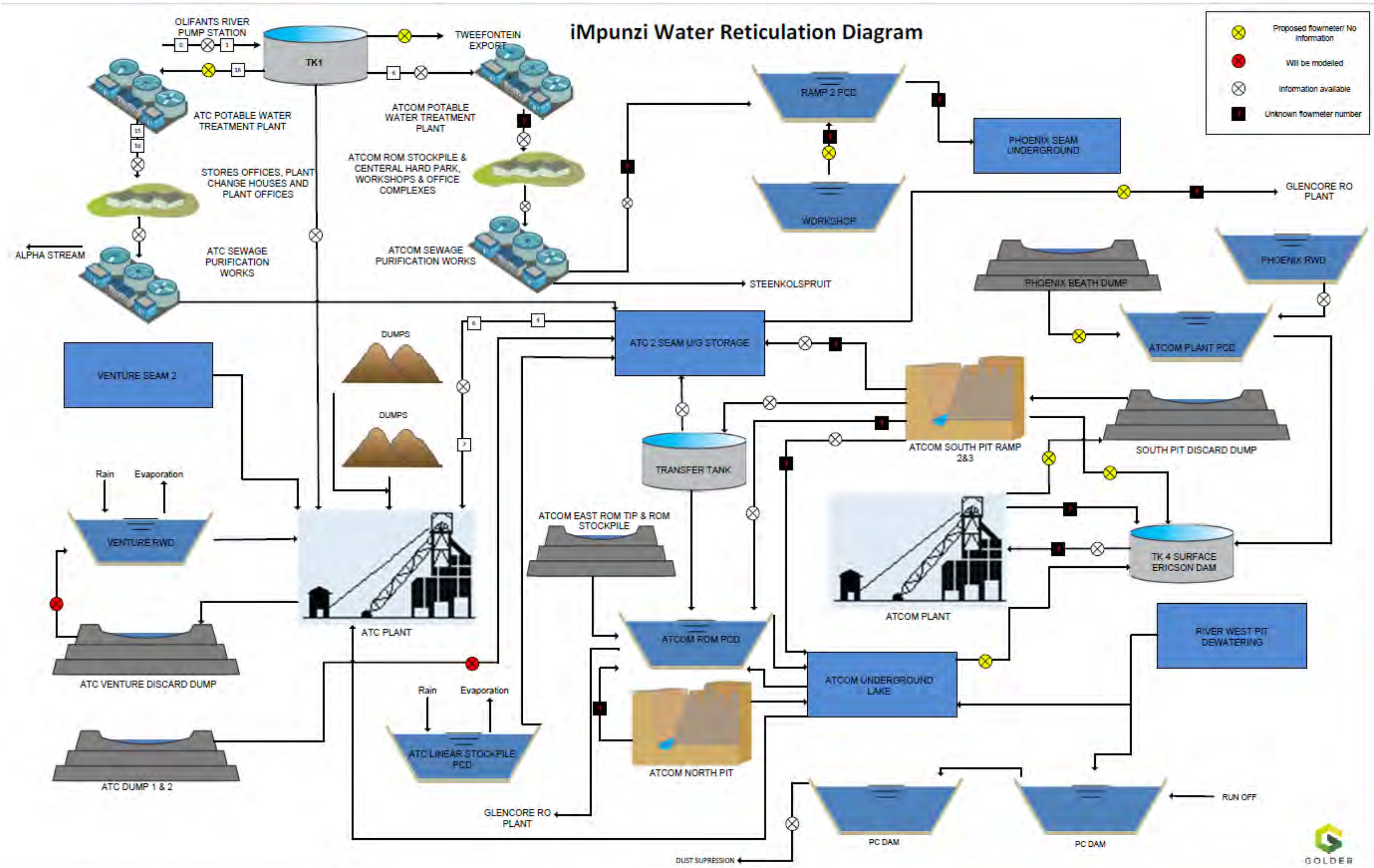

Figure 5: Water reticulation diagram for iMpunzi Mine

4.0 STORMWATER MANAGEMENT PLAN

The Venture Dump is currently being operated as a discard facility. Golder has designed a co-disposal facility as part of the discard-dump expansion project. The current silt trap, drainage corridors and stormwater dam were all designed as temporary measures, as the dump at the time had a limited remaining operational life. When the dump is finally rehabilitated with an appropriate engineered cover, runoff from the dump, will be clean and can drain into the receiving catchment.

In the interim, while the dump is operated as the newly designed co-disposal facility, the contaminated runoff from the dump will be routed to a newly constructed RWD, and water abstracted from the dam pumped to the iMpunzi operations for the use as process water. As evident from the stormwater analysis the capacity of the current stormwater dam is not adequate to receive the runoff from the extended discard dump and newly proposed co-disposal facility, without spilling more than once in a 50-year period. The basis of design and analysis methodology is discussed in the following sections.

The PCSWMM® (refer www.chiwater.com) commercial software package, developed by Computational Hydraulics International (CHI) was used as the analysis tool. PCSWMM® is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity. The runoff component of SWMM operates on a collection of sub-catchment areas that receive precipitation and simulate runoff overland and underground through a system of pipes, channels, storage and treatment devices, pumps, and regulators.

PCSWMM tracks the quantity of runoff generated within each sub-catchment, and the flow rate, flow depth and quality of water in each pipe and channel during a simulation period comprised of multiple time steps.

4.1 Storm Water Management Plan

A Stormwater Management Plan (SWMP) is a statutory requirement for mining and related activities in South Africa and is defined by General Notice 704 of the National Water Act (Act 36 of 1988). No water use licences in terms of this act will be granted without an approved SWMP. The purpose of a SWMP is to prevent the pollution of water resources in and around mining areas, or areas where mining related activity occurs. Regulations define a methodological approach to preventing and/or containing pollution on mining sites, set design standards and specify measures that must be taken to monitor and evaluate the efficacy of pollution control measures that are implemented.

The basic principles of a SWMP include:

- Separation of clean and dirty water - clean water should, as far as possible, be kept separate from dirty water. Water from clean water areas should be diverted away from dirty water areas and should be allowed to pass through to downstream users. Dirty water must be contained and captured on site. Spillage of dirty water is not allowed except during extreme flood events that are, on average, exceeded no more than once in 50 years.
- Containment of dirty water - reasonable measures must be taken to ensure that dirty water is contained. All dirty water must be captured and transported in lined channels (capable of containing 1:50-year design floods) to prevent the seepage of contaminated water into groundwater resources. Dirty water runoff must be stored in a Pollution Control Dam (PCD) or a Return Water Dam (RWD), where reasonable precautions are taken to prevent leaks or seepage. PCDs and RWDs may not spill more than (on average) once in 50 years. Design storage volumes are a function of peak storage requirements that often correspond to abnormally wet conditions that continue for an extended period of time, and not to a specific flood event.
- Reuse and recycling of dirty water - regulations stipulate a clear hierarchy of water use. First reuse any captured dirty water. Recycle as much water as possible. Minimise the import and use of clean water

resources. Excess water released from a dirty water area must be treated to a standard agreed to by the regulator and any plan to treat and release excess water must be approved and licensed.

- Preventing the pollution of water resources - exposure between water and potential pollutants should be reduced to a minimum. Special precautions may be required to prevent the transport of pollutants in water. Oil traps should be specified below workshops, fuel depots and vehicle wash-bays to prevent the flow of hydrocarbons into PCDs. Silt traps may be constructed where surface runoff is likely to lead to the transport of suspended sediments and the like. Under similar circumstances, wash-water should be separated from conventional water-borne sewage and treated separately.

4.1 Proposed Storm Water Management Plan

The site-wide framework for the SWMP is to separate the clean and dirty catchments. The clean water runoff being generated from the upslope clean water catchments will be diverted away from the area producing dirty water. The dirty water runoff generated from the site infrastructure will be contained for reuse or treatment. The proposed storm water management plan is detailed below and should be read in conjunction with Figure 1:

- The general gradient of the site is from the southeast to the northwest at an average slope of 0.5 %. To the south of the dump is a railway line with box culverts conveying runoff from the south under the railway towards the Venture Dump area. These areas (sub-catchments S1 and S2) were classified as clean water catchments. The clean surface water runoff generated from these catchments will be collected in unlined trapezoidal clean water cut-off channels (C1 and C2, located adjacent to the railway) and diverted for discharge (OF1) into the environment (located west of the site). North of the railway line an additional clean water catchment was identified (S5), this water will also be collected in the C2 unlined channel for discharge into the environment.
- Clean water catchments (S3 and S4) were identified south east to the existing dump. The clean surface water runoff generated from this catchment will be collected in an unlined trapezoidal clean water cut-off channel (C3) and diverted for discharge (OF3) into the environment located east of the site.
- Clean water catchment S8 was identified south of the proposed dump extension. The clean surface water runoff generated from this catchment will be collected in an unlined trapezoidal clean water cut-off channel (C4) and diverted for discharge (OF2) into the environment located west of the site.
- The existing dump as well as the proposed extension are considered dirty water catchments (S7-S14). The surface water run-off generated from these catchments will be captured by concrete lined perimeter channels (C5-C10), the water will be diverted to a proposed new RWD (HDPE lined). The capacity of the existing RWD is not adequate to receive the runoff and operational slurry return water from the newly proposed co-disposal facility. A new RWD will be constructed, inclusive of a new silt trap, and the old RWD will become redundant. A silt trap will be required to remove sediment from the water to ensure that the RWD does not fill up with sediment generated from the captured surface water runoff.
- The catchment immediately south of the dump extension was also identified as a dirty water catchment (S6). This catchment drains towards the east where the old adit is located. Currently water pools in this adit as it is the lowest point in the catchment. The catchment is relatively small generating approximately 2360 m3 of surface runoff during the 1 in 50-year event. It is therefore recommended that the surface water runoff collected in the adit be pumped to the dirty water perimeter channel C5 where it will be diverted to the new RWD. The surface water collected in the adit should be pumped immediately to channel C5 ensure to ensure that no water is being stored in the adit void.

- The slurry pool level will be regulated using a barge-pump system. The barge-pump system will route all slurry water inflow and runoff (maintaining the pool level below the pre-defined maximum water level), to the perimeter dirty stormwater channels from where it will be routed to the new RWD.

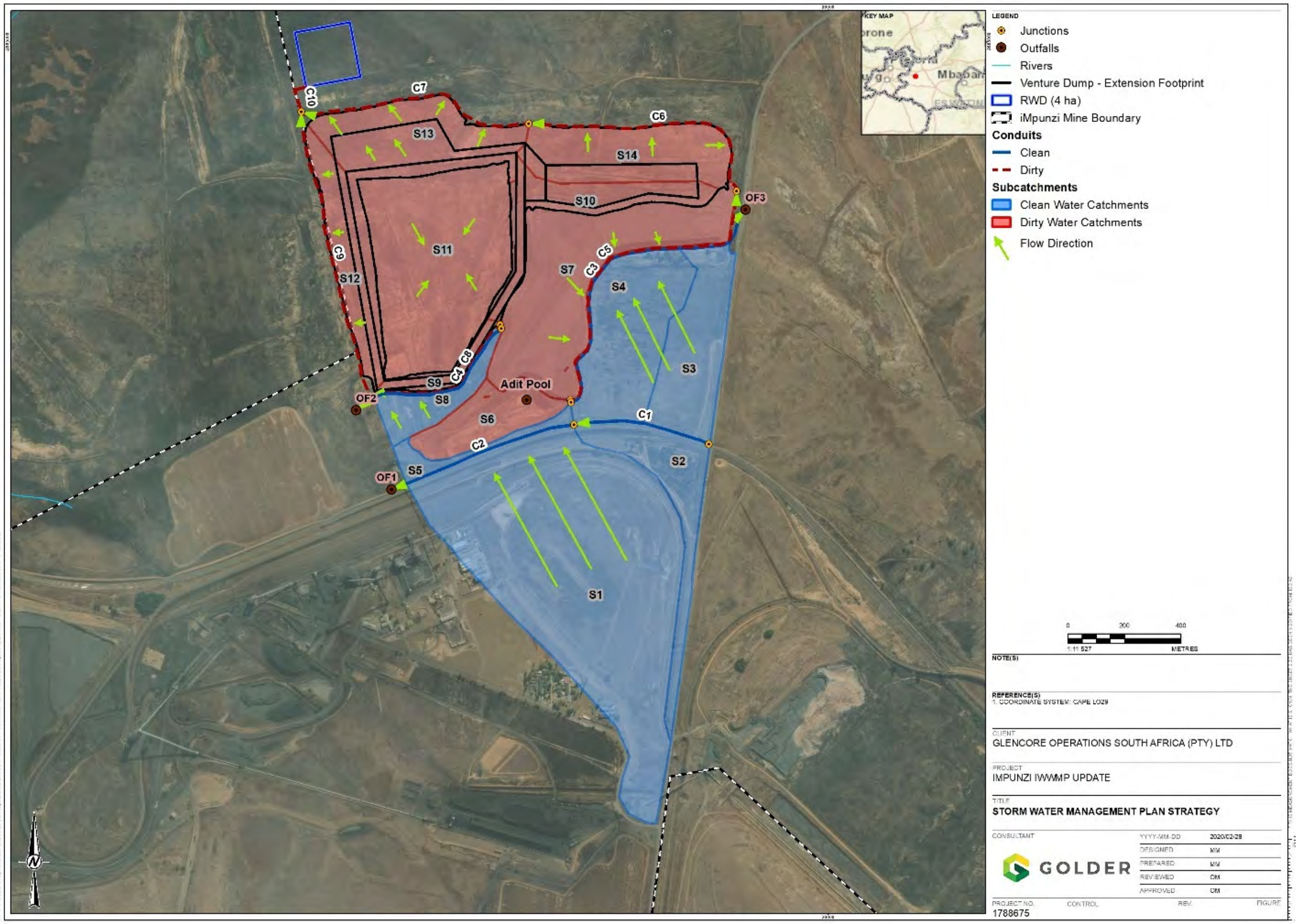

Figure 6: Storm Water Management Plan

4.1.1 Delineation of Clean and Dirty Water Catchments

Discretisation into sub-catchments is based on the topography of the study area. The designation of the clean and dirty water catchments was based on the land usage. The layout and extent of the clean and dirty water catchments is shown in Figure 7. The parameters used to model the overland flow are listed in Table 3. Manning's 'n' coefficient used in the model for the impervious areas and pervious areas were 0.015 (float finish, concrete) and 0.15 (veld type vegetation), respectively (McCuen, 1996).

The soils were identified as being in the sandy loam group (WR2012). The model uses these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The sandy loam group resulted in a Suction Head of 110.1 mm, a Hydraulic Conductivity of 21.8 mm/hr and an Initial Deficit of 0.25 being used in the modelling. Simulated runoff volumes are summarised in Table 3 for the 50-year recurrence interval storm event.

Table 3: Catchment parameters used in the modelling of the overall SWMP and results

Name	Description	Area (ha)	Flow Length (m)	Slope (%)	Runoff Volume (m^3)	Peak Runoff (m^3/s)
S1	Clean	67	1 122	1.22	5 200	1.72
S2	Clean	11	409	1.7	1 770	0.76
S3	Clean	13	554	1.78	1 880	0.75
S4	Clean	18	540	1.81	2 640	1.06
S5	Clean	3	91	2.23	840	0.62
S6	Dirty	8	291	1.5	2 360	1.73
S7	Dirty	26	300	20	12 490	13.22
S8	Clean	6	122	1.75	1 510	0.98
S9	Dirty	2	47	20	780	1.16
S10	Dirty	8	141	20	3 160	4.45
S11	Dirty	37	285	2	11 680	9.17
S12	Dirty	8	101	20	3 180	4.59
S13	Dirty	13	222	20	4 960	6.56
S14	Dirty	14	178	20	5 460	7.49

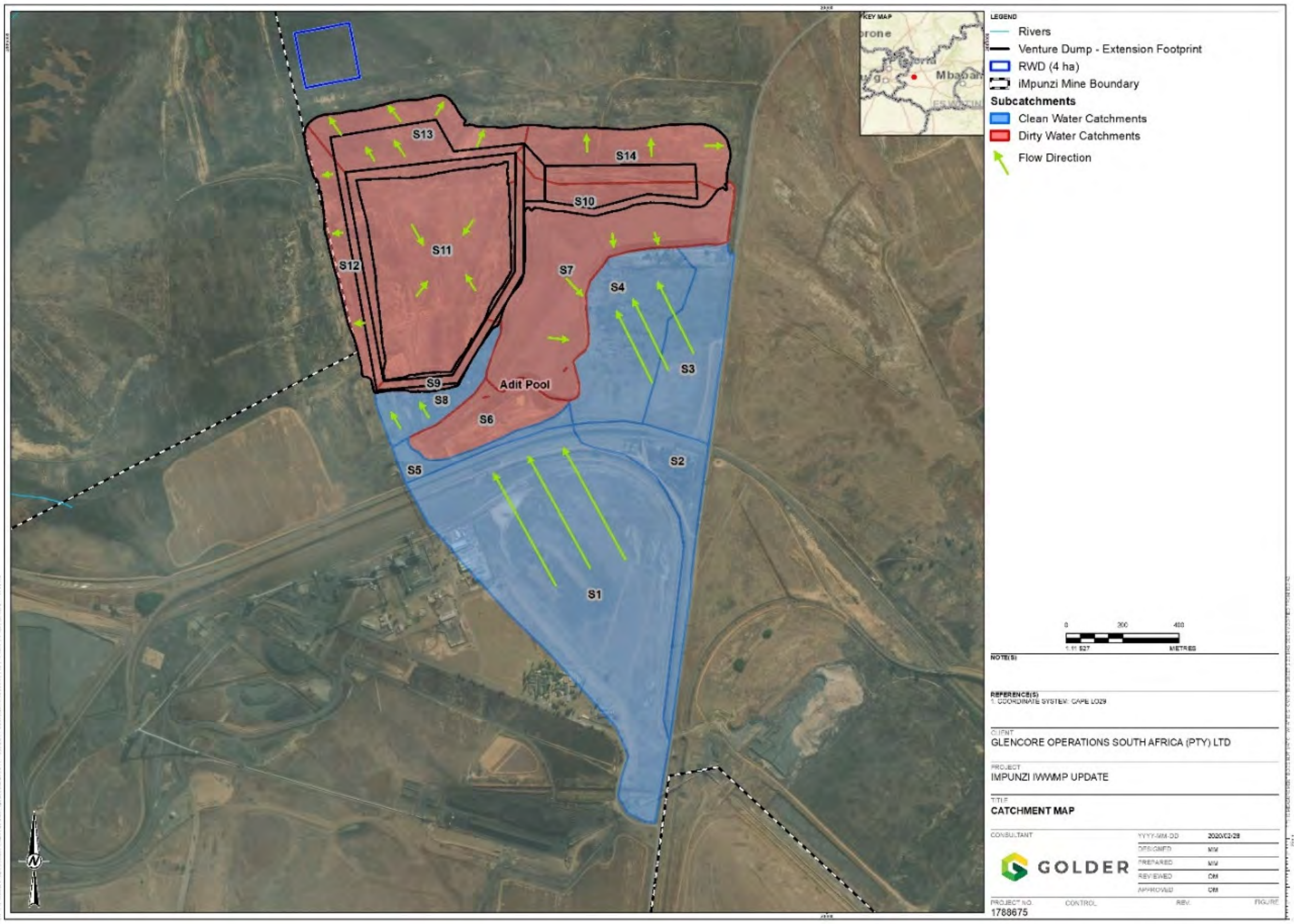

Figure 7: Layout and extent of clean and dirty water catchments

4.1.2 Channel Sizing

The diversion channels have been sized to divert the clean and dirty water runoff for the 50-year return period flood peak, as per GN704 (shown in Table 4). The proposed conceptual clean and dirty water diversion channel layout can be seen in Figure 8. The Manning's roughness assumed for the channels was 0.035 (vegetation-lined channels) and 0.02 (Concrete lined channel) (Hicks et al., 1998). Freeboard was included in the sizing calculations using the Guidelines for the design of canals and related structures (DWA, 1980). The equations utilised are shown below:

$$f = 0.2Y_n + \frac{v^2}{2g}$$ Sub-critical flow

$$f = 0.35\sqrt{1.2Y_n}$$ Super-critical flow

Where:

- f is the freeboard depth (m).
- Y_n is the normal depth in the channel (m).
- V is the velocity in the channel (m/s).
- g is gravity (m/s^2).

The results show that channels C5-C10 (dump perimeter channels) have maximum flow velocities greater than 4 m/s. The high velocities are due to the catchment gradients present on the site. The channels will be concrete lined and as such the velocities should not create any issues with the concrete lining.

Table 4: Channel characteristics and results

Name	Description	Length (m)	Roughness	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (1:H)	Right Slope (1:H)	Slope (m/m)	Max. |Flow| (m^3/s)	Max. |Velocity| (m/s)
C1	Clean	490	0.035	TRAPEZOIDAL	1	1	2	2	0.007	0.7	1.01
C2	Clean	689	0.035	TRAPEZOIDAL	1	1	2	2	0.013	2.8	1.81
C3	Clean	1 131	0.035	TRAPEZOIDAL	1	1	2	2	0.003	1.5	1.31
C4	Clean	646	0.035	TRAPEZOIDAL	1	1	2	2	0.003	0.8	0.98
C5	Dirty	1 179	0.015	TRAPEZOIDAL	1	1.5	2	2	0.009	12.0	4.62
C6	Dirty	925	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.010	16.2	4.86
C7	Dirty	860	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.006	28.5	4.73
C8	Dirty	584	0.015	TRAPEZOIDAL	1	1	2	2	0.004	0.9	1.9
C9	Dirty	1 040	0.015	TRAPEZOIDAL	1.5	1.5	2	2	0.014	4.5	4.15
C10	Dirty	120	0.015	TRAPEZOIDAL	1.8	2	2	2	0.007	32.3	4.76

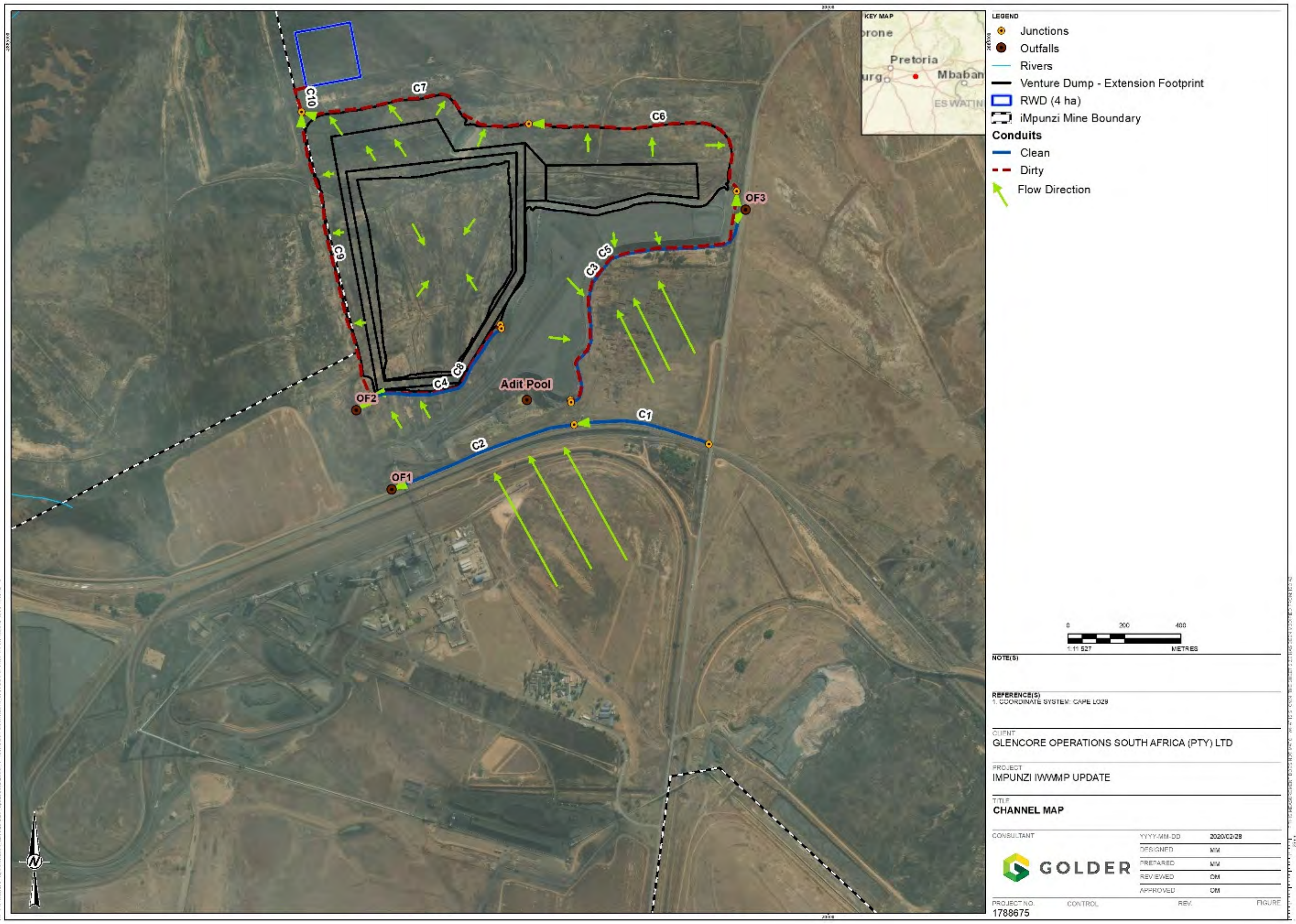

Figure 8: Layout and extent of the clean and dirty water diversion channels

5.0 WATER BALANCE

The mine has a site-wide water balance which is updated weekly. Water management on site is discussed in section 3.2 of the report. A daily timestep dynamic water balance was set up in order to assess the capacity of the return water dam required for the Venture Dump Co-disposal Facility.

5.1 Return Water Dam and Slurry Pool

5.1.1 Existing Pollution Control Dam

The existing pollution control dam capacity is not adequate to receive the total runoff and slurry return water from the Venture Dump co-disposal facility without spilling more than once in a 50-year period.

In addition to this, the new proposed footprint, encroaches on the current facility.

For this reason, it is envisaged that the existing PCD will not form part of the stormwater management of the newly proposed co-disposal facility.

5.1.2 New Return Water Dam

Based on the hydrological inputs from the stormwater runoff model constructed in PCSWWM, the geometrical inputs from the conceptual Venture Dump co-disposal facility and the assumptions and calculations made on the slurry pool operation, a daily time step simulation model was set up to determine the required size of the new RWD.

A stochastic rainfall generator was coded and calibrated within the simulation model, based on the Ogies historical dataset. This allows the model to generate random sequences of rainfall with similar statistical characteristics as the original data (Boughton, 1999).

The monthly mean evaporation measured at the Witbank evaporation station (B1E001) was used in this model. The selection was based on the station being close to the site (approximately 24 km away) with a reasonably long and reliable data set (1963-2008).

A number of simulations were carried out with various RWD capacities and abstraction rates in order to determine the capacity required to ensure that the RWD will not spill more than once in 50 years. A 1,000 different realizations were run and various RWD sizes were tested until a spillage frequency of 1 in 50 years was obtained. A new RWD size of 56 000 m^3 was found to be adequate.

The model was run with the following assumptions:

- A fixed abstraction of water of 450 m^3/day from the new RWD, pumped to the pumped to the Venture 2-seam for reuse at the ATC plant. This assumption will be verified and updated in the final design report.
- The projected slurry and discard volumes used in the slurry pool simulation are shown in Table 5. The slurry Moisture Content (MC) was assumed to be 75%, with a specific gravity (SG) of 1.47. Based on these assumptions, the water present in the slurry contributes on average 304 m^3/d to the slurry pool.

Table 5: Plant discard volumes (million tonnes)

	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Plant feed	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	21.60
Clean coal	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	1.13	10.15

	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Discard	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	1.03	9.29
Slurry	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	2.16

- The slurry pool stage-storage curve used in the analysis is shown in Figure 9 below. The slurry pond has a max depth of 2.3 m with a maximum capacity of 535 021 m^3. A freeboard requirement of 1 m was included in the analysis, resulting in a maximum operation pool depth of 1.3 m.

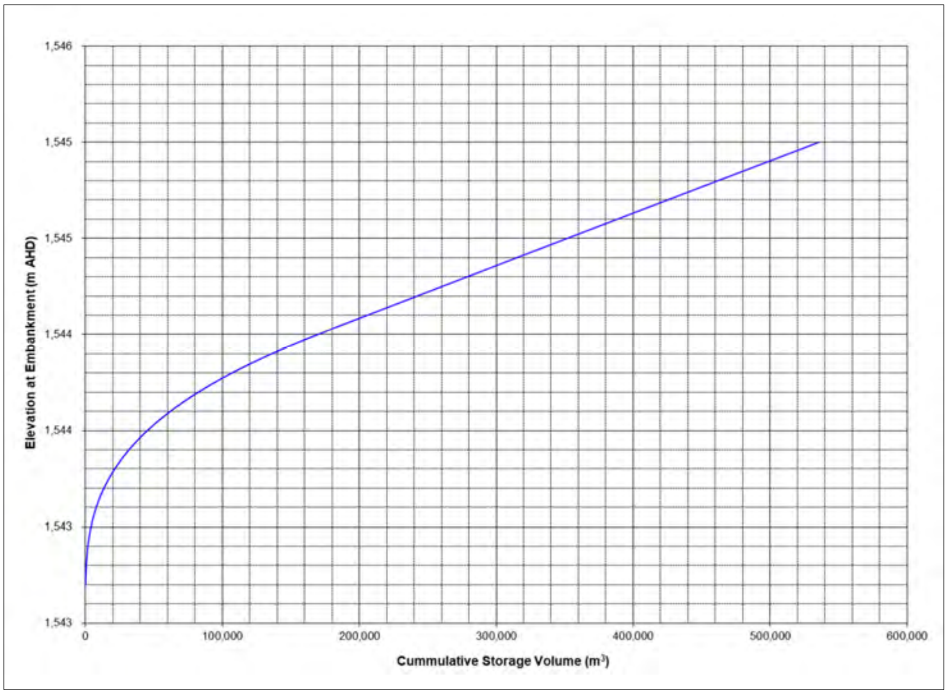

Figure 9: Slurry pool stage storage curve

The envelope of simulated water depth of the slurry pool for the entire operational duration (9 Years) of the Venture Dump is shown in Figure 10. The slurry pool does not exceed the maximum operation pool depth (1.3 m) throughout the simulation when the barge pump has a maximum pumping capacity of 250 m^3/d.

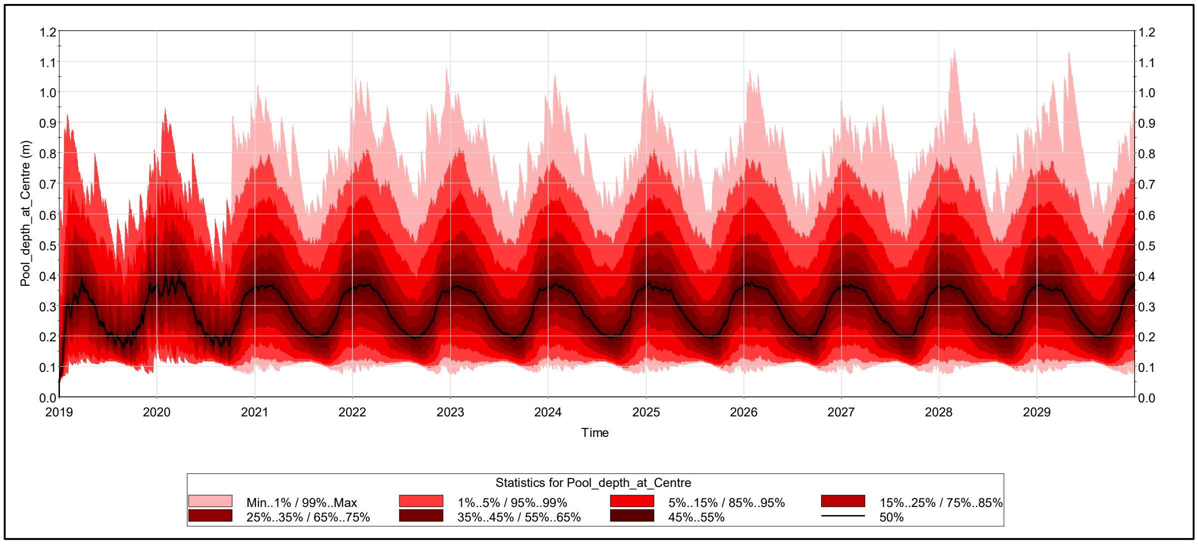

Figure 10: Envelope of simulated water depth - Slurry pool

The envelope of simulated water volume stored in the new RWD over the entire operational period is shown in Figure 11.

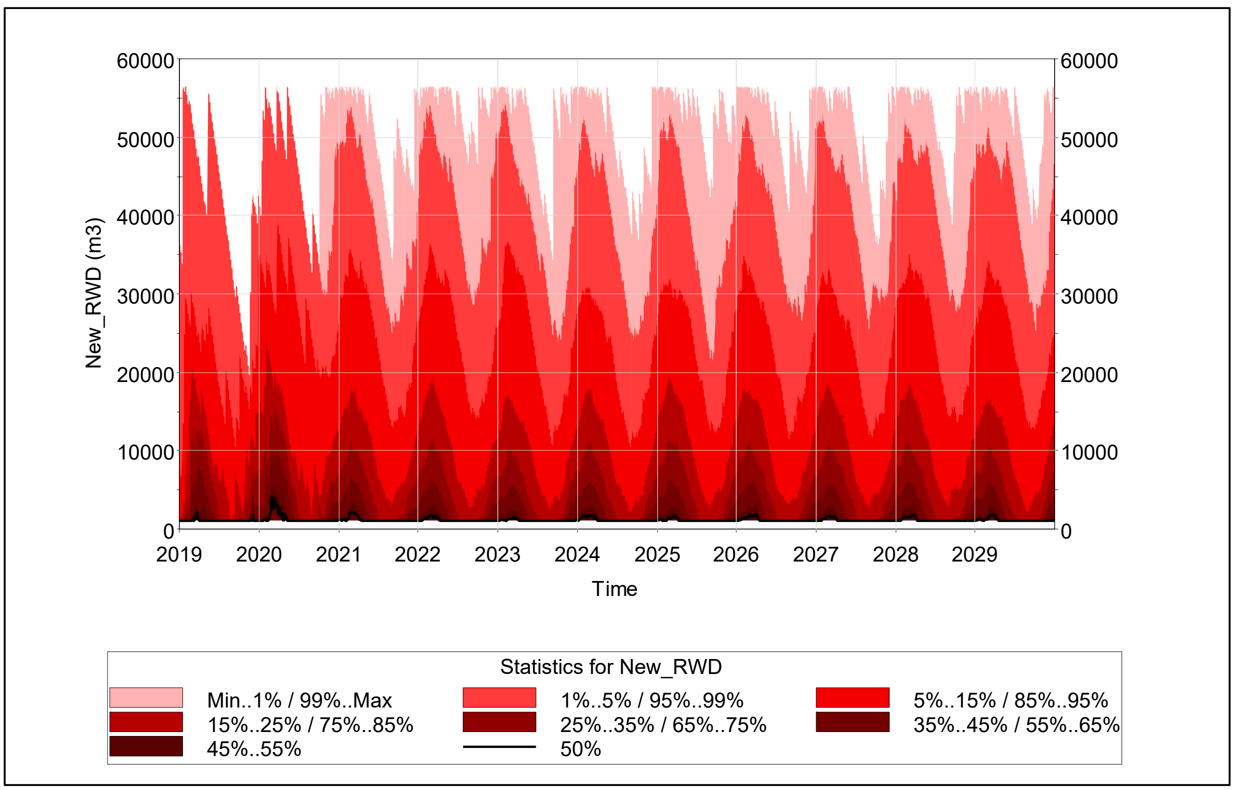

Figure 11: Envelope of simulated water volume stored - New RWD

6.0 SURFACE WATER IMPACT ASSESSMENT

The surface water impact assessment conducted was based on the operational development of the discard facility to final expanded area and height as well as cover application, rehabilitation, and final closure of the discard facility.

6.1 Major areas of concern for surface water impacts

The major activities of concern relating to the discard facility expansion on catchment water resources are identified in relation to the phases of the project development, which include:

- Preparation / Construction Phase.
- Operational Phase: Discard Facility development. This phase relates to activities that relate to the development of the discard facility to the expanded footprint and height.
- Closure Phase. This phase relates to the rehabilitation, closure and post-closure of the expanded discard facility.

The activities and associated impacts are described below.

6.1.1 Preparation / Construction Phase

- Construction of the required storm water management infrastructure around the extension discard area and existing facility.

6.1.2 Operational Phase: Discard Facility development

- Storm water management control to ensure adequate clean and dirty water separation.
- Decant management control by pumping from the pit and treating to prevent decant.
- Stockpiling of capping material and cover material (topsoil).
- Grading of discard area to ensure long-term drainage conditions.
- Soil placement, capping and revegetation of project site.

  Potential impacts

  - Increased erosion and runoff volumes due to increased discard facility footprint.
  - Impact on the capacity of the Return Water Dam to contain additional runoff and seepage generated.
  - Increased recharge and potential contamination of groundwater and resulting impact on surface water resources due to decant and plume migration.
  - Sedimentation in drainage systems.
  - Mixing of clean and dirty water due to inadequate provisions for storm water management.
  - Contaminated runoff from discard area on the receiving surface water environment.

6.1.3 Closure Phase

- Natural occurrence of rainfall resulting on discard facility expansion resulting in increased recharge.
- Ongoing monitoring and maintenance of water quality.
- Monitoring and maintenance of groundwater levels.

  Potential impacts

  - Decant of post closure water.
  - Increased recharge rates and potential contamination of water resources.

- Sedimentation in drainage streams.
- Inadequacy of selected post-closure water management control to treat seepage, i.e. passive/semi-passive and hence impacts on surface water resources related to poor quality discharges.

6.2 Impact Assessment Methodology

The significance of each identified impact was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude (severity) of impact

To assess each of these factors for each impact, the following four ranking scales are used:

Probability	Duration
5 - Definite/don't know	5 - Permanent
4 - Highly probable	4 - Long-term
3 - Medium probability	3 - Medium-term (8 - 15 years)
2 - Low probability	2 - Short-term (0 - 7 years) (impact ceases after the operational life of the activity)
1 - Improbable	1 – Immediate
0 - None	
Scale	**Magnitude**
5 - International	10 - Very high/don't know
4 - National	8 - High
3 - Regional	6 - Moderate
2 - Local	4 - Low
1 - Site only	2 - Minor
0 - None	

Definitions

Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely recognised standards are to be used as a measure of the level of impact.

Scale/ Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international.

Duration refers to the length of time over which an environmental impact may occur *i.e*. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent.

Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

Once these factors are ranked for each impact, the significance of the two aspects, occurrence and severity, is assessed using the following formula:

SP (significance points) = (magnitude + duration + scale) x probability

The maximum value is 100 significance points (SP). The impact significance will then be rated as follows:

SP >75	Indicates high environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30 – 75	Indicates moderate environmental significance	An impact or benefit which is sufficiently important to require management, and which could have an influence on the decision unless it is mitigated.
SP <30	Indicates low environmental significance	Impacts with little real effect and which should not have an influence on or require modification of the project design.
+	Positive impact	An impact that constitutes an improvement over pre-project conditions

Surface Water Impacts

The surface water impact assessment is presented in Table 16. The following conclusions can be drawn from the outcome of the impact assessment:

- Storm water management can be considered the most ‘important’ activity with the most significant impact that requires intervention during all three phases of the project. It has moderate significance for each of the phases but is reduced to low with the necessary mitigation. The storm water management across all phases requires separation of clean storm water from potentially contaminated storm water, as well construction of the necessary storm water channels, drainage structures, collection systems and diversion berms to limit impacts. These are easily achievable to mitigate impacts. Management of the impacts also requires that potentially contaminated storm water be treated, if necessary, prior to release to the environment.
- Increased erosion and sedimentation load are a recurring impact associated with many activities within the operational and closure phases of the project. Although generally rated as low significance, if not

adequately managed it will impact on the local water resources as well as on the storm water management system. In addition, it could potentially result in loss of cover material for the rehabilitation of the discard facility. Frequent maintenance of the diversion channels is recommended. Management will require maintenance of the storm water management system around the development area, drainage control berms, sediment traps and other means. as necessary.

  - Maintenance will include excavation of sediments, reinstatement of channels eroded during storms, removal of washed down vegetation and litter.
  - The clean water conveyance trench south of the discard disposal facility will be traversing dirty areas and special attention will need to be given to ensure that the channel remains clean.
  - Erosion protection in the form of riprap lining is recommended for all channels as the velocities are above 0.75 m/s.
  - Erosion protection in the form of scour aprons with energy dissipation must be provided at the discharge points of each channel; and
  - Scour aprons with stilling basins are required at the outlet of pipe chutes.

- Impacts related to potential contamination of water resources, *i.e.* seepage and decant of post closure water are also of importance in terms of the receiving surface water environment. These impacts are rated as moderate to high significance pre-mitigation. Management of decant water by required treatment must comply with the discharge standards. Implementation of the necessary rehabilitation and cover design option will also ensure reduced volumes of recharge and thus lower decant water volumes to be handled. Achievement of compliance would reduce the impacts to a low significance.
- The activities concerned with the rehabilitation of the discard facility relating to the management of the topsoil, capping material, grading, cover material, soil availability, revegetation and transportation and heavy machinery have impacts of low significance, however these activities have the potential to impact on the surface water environment and site decommissioning. If not adequately achieved or managed, the desired rehabilitation and post closure management objectives will not be met. Mitigation measures that include erosion control, proper onsite management of cover material, optimal design of cover, proper transportation and grading will ensure that impacts are at very low to negligible significance.

Table 6: Potential Surface Water Impacts Associated with the Venture Dump Expansion Project

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
CONSTRUCTION PHASE															
Construction of the required additional operational "dirty" storm water management infrastructure around the extension discard area and existing facility.	Preparation work may result in increased erosion and sediment loads.	Receiving water course	4	2	2	3	**24**	**Low**	Mitigation measures should include installation of drainage control berms to limit erosion and sedimentation. The construction activity should be maintained as small as possible. Mitigation will reduce the impact to **very low**.	4	2	2	2	**16**	**Low**
OPERATIONAL PHASE: DISCARD FACILITY DEVELOPMENT															
Discard placement on discard facility	Increased erosion and runoff from the discard material resulting in increased sedimentation and potential contaminated runoff reporting to surface water environment.	Receiving water course	4	2	2	3	**24**	**Low**	Protect spoils area from erosion by utilising applicable erosion procedures. Ensure adequate compaction of discard material and concurrent rehabilitation. Ensure that the storm water controls are in compliance with GN704 for the discard facility. Mitigation will reduce the impact to **negligible**.	4	2	2	2	**16**	**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
Loading of rehabilitation cover material onto truck for transportation to the discard facility	Hydrocarbon spills may result from discard vehicles and equipment during loading.	Receiving water course	6	2	2	3	**30**	**Moderate**	Clean up spillages immediately and dispose of contaminated materials to a permitted waste site.	4	2	2	3	**24**	**Low**
Storm water management control	Mixing of dirty and clean water, resulting in prevention of clean surface water reporting to downstream catchment		8	2	3	3	**36**	**Moderate**	Design stormwater management facilities for the discard facility is to comply with regulation GN 704 so that clean water is diverted away from the mining operations to the water resources.	4	2	2	3	**24**	**Low**
	Discharge from dirty storm water sump due to an extreme rainfall period.		8	2	2	2	**24**	**Low**	Ensure regular maintenance of the diversion channels. Channels that have been eroded during storms are to be maintained, including excavation of sediments, reinstatement of channels, removal of washed down vegetation and litter. Provide erosion protection for the clean water conveyance trench. ■ Erosion protection in the form of scour aprons with	6	2	2	2	**20**	**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
									energy dissipation must be provided at the discharge points of each channel and scour aprons with stilling basins are required at the outlet of pipe chutes.						
Soil placement, capping and revegetation of discard site sections	Soil handling to convey soil and capping from stockpiles for surface rehabilitation activities may result in erosion and sedimentation. Contamination of soil by handling of soil with contaminated earth moving machinery (machinery previously used for handling discard material).	Receiving water course	6	2	2	3	**30**	**Moderate**	Revegetate as quickly as possible to limit erosion and sedimentation in downstream water resources. Manage use of earth moving machinery	4	2	2	3	**24**	**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
Insufficient capping material with the appropriate soil characteristics as assumed in the capping design.	The desired lower recharge rates will not be achieved resulting in increased seepage, higher decant volumes and potential contamination of water resources.	Surface and groundwater water resources	8	3	3	4	**52**	**Moderate**	Implement the required cover design option to ensure optimal recharge rates. Ensure adequate overburden and topsoil material as required to meet the optimal capping make-up to limit seepage to groundwater resources. Comply to rehabilitation and closure plan.	4	2	2	3	**24**	**Low**
POST CLOSURE PHASE															
Capping material properties inadequate to sustain vegetation growth.	Increase in erosion of discard facility and mobilisation of sedimentation. Increase in recharge rates and decant volumes and subsequent impact of receiving environment.	Surface and groundwater water resources	8	3	3	4	**52**	**Moderate**	Ensure adequate overburden and topsoil material as required to meet the optimal capping make-up to limit seepage to groundwater resources. Comply to rehabilitation and closure plan and EMPR requirements.	4	2	2	3	**24**	**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
Decant of post closure water	Contamination of receiving water environment (surface and groundwater) due to decant acidic pit water (AMD).	Surface and groundwater water resources	10	4	3	5	**85**	**High**	Implementation of water management options to pump and treat water to the required specifications to achieve desired discharge water qualities as per the recommendation made in Golder, 2019d.	4	2	2	3	**24**	**Low**
Higher volumes of decant at post closure than predicted.	Inefficiency of water treatment plant to treat required volumes and quality of water.	Receiving water course	8	3	3	3	**52**	**Moderate**	Finalise the integrated water balance for all three mines to determine excess water required to be managed. Continue with level measurements and metering in order to improve calibration of models. Monitor the performance of the treatment plant on an ongoing basis. Maintenance activities to be scheduled during dry seasons. Conduct ongoing rehabilitation performance monitoring and assessment.	4	2	2	3	**24**	**Low**
Inadequate rehabilitation of the	Higher recharge rates will occur, resulting in increased	Receiving water course (non-perennial	8	4	3	4	**60**	**Moderate**	Implement the optimal cover design option and depth to	4	2	2	3	**24**	**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
discard facility (inadequate cover)	seepage and consequently higher decant water volumes. This will impact on the treatment volumes and quality (impact on capacity of treatment plant), which could result in contamination of water resources if not treated.	stream) and groundwater resource							ensure the lower recharge rates are achieved.						
Stormwater management control	Inadequate stormwater control measures on decommissioning may result in mixing of dirty and clean water. This could result in prevention of clean water surface water reporting to	Receiving water course (non-perennial stream) and groundwater resource	8	4	3	4	**60**	**Moderate**	Ensure that the storm water controls are in compliance with GN704 or the necessary GN-704 exemption has been applied for, and that clean water is separated enabling runoff into catchment. Implement monitoring programme to regular monitor water quality or more frequently during the rainy season to get an understanding of the potential						**Low**

Activity	Potential Impact	Aspect Affected	M	D	S	P	SP	Rating	Proposed Mitigation	M	D	S	P	SP	Rating
	downstream catchment and potential contamination of receiving water resources by dirty water.								contaminants of concern and adequacy of control measures.						

7.0 CONCLUSIONS AND RECOMMENDATIONS

The objectives of the project were to conceptualise the operation of the water management of iMpunzi Venture Dump, model the runoff from the various areas in relation to the dump and to determine the position and size of the stormwater measures, to separate clean and dirty stormwater given the 1:50 year 24-hour storm event. The objective also included modelling the operation of the water management of the dump to estimate the required size of a pollution control dam with a spillage frequency of 1 in 50 years.

The conceptual stormwater layout and operation of the stormwater management infrastructure for iMpunzi Venture Dump has been completed and is discussed in Section 4 of the report. In summary the following recommendations are made with regards to the design and operation of the water management system for iMpunzi Venture Dump co-disposal facility:

- A barge pump (with a maximum pumping capacity of 250 m^3/day) to be installed to route runoff and operational slurry return water from the slurry pool to the perimeter channels, the channels route the water to the new RWD.
- Frequent maintenance of the diversion channels is recommended. Maintenance will include excavation of sediments, reinstatement of channels eroded out during storms, removal of washed down vegetation, refuse, etc.
- Erosion protection in the form of scour aprons with energy dissipation must be provided at the discharge points of each channel.
- A new 56 000 m^3 RWD to be constructed to receive runoff from the discard dump side slopes as well as the slurry return water and runoff from the dump top (embankment crest, dry beach, wet beach and slurry pool) routed through the barge pump system and diverted to the new RWD through the trapezoidal stormwater channel.
- The final detailed design and construction of stormwater channels to be done on the basis of the preliminarily design channels described in Section 4 of the report.
- Rehabilitation of the discard facility should be conducted based on industry best practices. Rehabilitation should ensure adequate sloping and landform development to prevent ponding and pooling and allow for the drainage of clean runoff from the site.
- A total capping cover depth (topsoil and barrier layer) of 600 mm is recommended which must consist of between 250 mm and 300 mm of a topsoil layer with the remainder being material of some impermeable nature creating a barrier layer.
- The activities concerned with the rehabilitation of the discard facility relating to the management of the topsoil, capping material, grading, cover material, soil availability, revegetation and transportation should be properly planned and executed to prevent impacts to the environment. Mitigation measures will include erosion control, proper onsite management of cover material, optimal design of cover, proper transportation and grading will ensure that impacts are at very low to negligible significance.
- It is further proposed that the model and the report be reviewed and revised following the outcome of the review of Protocol 14 version 2.0, the CDA and latest Golder TSF design requirements conducted by the geotechnical specialist team.

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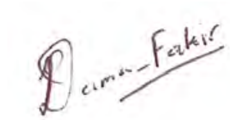

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APPENDIX A

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TECHNICAL MEMORANDUM

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SPECIALIST STUDIES ASSOCIATED WITH THE PROPOSED EXPANSION OF THE IMPUNZI PADDOCKS AND VENTURE DISPOSAL FACILITIES – SOIL AND LAND CAPABILITY ASSESSMENT

1.0 INTRODUCTION

Glencore Operations South Africa (Pty) Ltd. (GOSA) proposes to expand two of the current disposal facilities at their iMpunzi operation, namely the Venture discard facility and the ATCOM South Paddocks co-disposal facility.

These proposed extension projects require Environmental Authorisation in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA), the National Water Act (Act 36 of 1998), and the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA).

As part of the specialist studies identified for the above-mentioned authorizations, an assessment of the existing soil conditions and land capability was conducted for land identified by Glencore as available for soil harvesting. The soil assessment focused on determining the available soil volumes and capability for use as cover material. This technical memorandum details the approach and findings for the soil and land capability of the survey area at Glencore's IMpunzi operation.

2.0 OBJECTIVES

The objectives of the study were as follows:

- Conduct a detailed soils assessment on the proposed borrow areas;
- Classify and map the observed soils per the South African Taxonomic Soil Classification System, 1991;
- Determine the land capability for the proposed borrow area; and
- Estimate the volume of soil material available for future rehabilitation actions.

3.0 METHODOLOGY

3.1 Desktop study

The desktop study included a review of the historic and recent aerial imagery, evaluating topographic, land cover, land use, land type maps and memoirs, and geological maps of the study area. Review of previous soil reports and soil surveys of the project area were also done. This background information was used to plan and design the field survey.

3.2 Field Survey and Soil Classification

The field survey plan is provided in APPENDIX A.

The soil survey was conducted per the standard soil survey techniques. During the field survey the project area was delineated (into map units) and the natural resources, terrain form, soil type and land use of the project area, were recorded. The soil profile observations were evaluated along transects, evaluating the soil at the crest, scarp, midslope, footslope and valley bottom positions of the main geological groups, land types and terrain units of the project area. The shapefiles of the project boundary, existing and proposed infrastructure, surface water features, terrain, geology, landtype, existing land capability and land use were superimposed on google earth imagery and 1:50 000 topographic map sheet/s to create field maps for the survey. The geographical positions of the observation points were loaded onto a hand-held Global Positioning System (GPS) to aid in field traversing of the positions.

At each observation point, the soil was either augered to a depth of 120 cm (unless an impenetrable layer was encountered restricting sampling depth) using a bucket auger or, where possible, a test pit was excavated. The relevant and distinct soil and landscape features were recorded at each observation point. These included characteristics such as soil colour, texture, depth, stoniness, drainage class, parent material, signs of erosion, vegetation cover, micro-topography, aspect and fauna.

The soil characteristics were used to classify the soils according to the Taxonomic Soil Classification System for South Africa (Soil Classification Working Group, 1991). The procedure used in the identification of the soil types using the Taxonomic Soil Classification System involved the following:

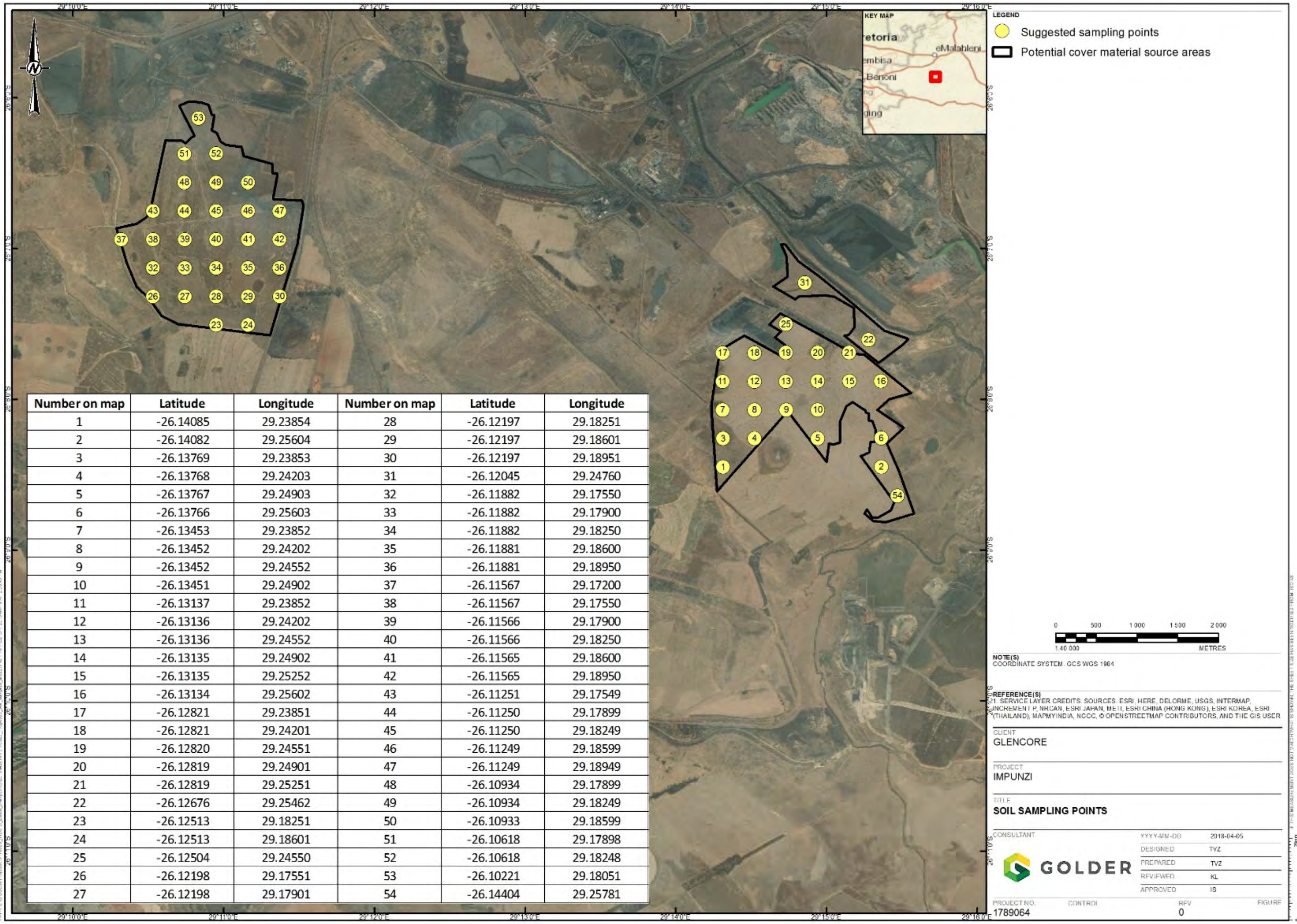
1. Demarcating the master horizons present in the profile
2. Identifying diagnostic horizons or materials
3. Establishing the soil form using the Key in the Classification Book
4. Identifying family criteria
5. Establishing the soil family
6. Determining the texture class of the A horizon, which was then added to the code of the soil family.

For this study, a set of **54** profiles within the survey area were described in detail and soil samples of the diagnostic topsoil and subsoil horizons were collected (locations of observation points for the transect walks are presented in Figure 1).

3.3 Soil Sampling and Analysis

The soil samples were only collected from distinctively different modal profiles comprising of A and B horizons or saprolite and were submitted for laboratory analysis to Eco Analytica laboratory, at the Northwest University in Potchefstroom. The analysis was conducted according to methods set out in the Handbook of Standard Testing for Advisory purposes (Soil Science Society of South Africa, 1990). Soil samples were analysed for the following parameters:

- Three (3) fraction particle size (sand, silt and clay) analysis
- Ammonium acetate (at pH 7) extractable cations (Ca, Mg, K and Na)
- Walkley- Black Organic Carbon
- Bray-1 Phosphorus
- pH and EC.



Number on map	Latitude	Longitude	Number on map	Latitude	Longitude
1	-26.14085	29.23854	28	-26.12197	29.18251
2	-26.14082	29.25604	29	-26.12197	29.18601
3	-26.13769	29.23853	30	-26.12197	29.18951
4	-26.13768	29.24203	31	-26.12045	29.24760
5	-26.13767	29.24903	32	-26.11882	29.17550
6	-26.13766	29.25603	33	-26.11882	29.17900
7	-26.13453	29.23852	34	-26.11882	29.18250
8	-26.13452	29.24202	35	-26.11881	29.18600
9	-26.13452	29.24552	36	-26.11881	29.18950
10	-26.13451	29.24902	37	-26.11567	29.17200
11	-26.13137	29.23852	38	-26.11567	29.17550
12	-26.13136	29.24202	39	-26.11566	29.17900
13	-26.13136	29.24552	40	-26.11566	29.18250
14	-26.13135	29.24902	41	-26.11565	29.18600
15	-26.13135	29.25252	42	-26.11565	29.18950
16	-26.13134	29.25602	43	-26.11251	29.17549
17	-26.12821	29.23851	44	-26.11250	29.17899
18	-26.12821	29.24201	45	-26.11250	29.18249
19	-26.12820	29.24551	46	-26.11249	29.18599
20	-26.12819	29.24901	47	-26.11249	29.18949
21	-26.12819	29.25251	48	-26.10934	29.17899
22	-26.12676	29.25462	49	-26.10934	29.18249
23	-26.12513	29.18251	50	-26.10933	29.18599
24	-26.12513	29.18601	51	-26.10618	29.17898
25	-26.12504	29.24550	52	-26.10618	29.18248
26	-26.12198	29.17551	53	-26.10221	29.18051
27	-26.12198	29.17901	54	-26.14404	29.25781

Figure 1: Locations of soil sampling and observation points

4.0 LAND EVALUATION

4.1 National Land Capability Classification

The land capability of the survey area was compared to the National Land Capability which was refined in 2014-2016. The National Land Capability methodology is based on a spatial evaluation modelling approach and a raster spatial data layer consisting of fifteen (15) land capability evaluation values (Table 1), usable on a scale of 1:50 000 – 1:100 000 (DAFF, 2017). The previous system is based on a classification approach, with 8 classes (Table 2).

Table 1: National Land Capability Values (DAFF, 2017)

Land Capability Evaluation Value	Land Capability Description
1	Very Low
2	
3	Very Low to Low
4	
5	**Low**
6	Low to Moderate
7	
8	**Moderate**
9	Moderate to High
10	
11	**High**
12	High to Very High
13	
14	Very High
15	

4.2 Site Specific Land Capability Classification

The land capability of the survey area was assessed in accordance with the definitions and system outlined by Scotney et al (1987) and updated for South African soils by the Agricultural Research Council (Schoeman, 2000). The criteria used as general guidelines to place soil and land into capability classes are indicated below. This system is based on the Land Capability Classification system of the United States Department of Agriculture (USDA) Soil Conservation Service by Klingelbiel and Montgomery (1961). The soils were classified into eight (**8**) capability classes (Table 2) based on varying limitations (restrictions for rain-fed cropping) of the following soil parameters:

- Effective Depth (D);

- Soil Texture (T).
- Flood Hazard (F);
- Erosion Hazard (E);
- Internal Drainage (W); and
- Mechanical limitations (M).

Table 2: Definition of land capability classes (after Scotney et al. 1987)

Class	General Description
ARABLE LAND SUITABILITY CLASSES	
I	Land has little permanent limitations that restrict the use thereof and has a high potential for intensive crop production.
II	Land has some permanent limitations that lower the degree of intensity of crop production but is still of a high potential.
III	Land has serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production and is of a moderate potential.
IV	Land has very serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production to a great extent.
NON-ARABLE LAND SUITABILITY CLASSES	
V	Land is not suitable for the production of annual crops, but has a slight erosion hazard under natural veld, permanent pastures, forestry or special crops (crops which give sufficient cover and which, with special conservation measures will keep soil losses at an acceptable level).
VI	Land has permanent limitations which make it unsuitable for cultivation and restrict the use of natural veld, forestry and nature life.
VII	Land has such serious limitations that it is unsuitable for cultivation and intensification and the use of the land is therefore limited to natural veld, forestry and nature life.
VIII	Land has permanent limitations that exclude it from commercial plant production and the use thereof is limited to nature life, recreation, water provision and aesthetic qualities.

4.3 Chamber of Mines Land Capability Classification

The land capability of rehabilitated surveyed areas were classified according to the Chamber of Mines Land Capability Classification System. The system recognises four land capability classes, these are:

- Class I - Wetland
- Class II - Arable land
- Class III - Grazing land, and
- Class IV - Wilderness land.

5.0 RESULTS

5.1 Regional soils

A reconnaissance landtype survey on a scale of 1:250 000 was conducted in the early 1970`s to compile inventories of the natural resources of South Africa in terms of soil, climate and terrain. The survey highlights the dominant soils in each landtype and their respective percentages. This information is however not a substitute for a detailed soil map but gives a very good indication of where certain soil types occur.

The landtype memoirs and associated maps of 2628 Pretoria and 2628 East Rand, (Landtype Survey Staff, 1976-2006) indicated that the study area comprises of landtype Bb 4.

The Bb 4 landtype comprises at least 30% Avalon, 6-10% of Hutton, Glencoe and, Mispah forms, with the Westleigh, Glenrosa, Longlands, Arcardia, Rensburg, Escourt, Katspruit and Kroonstad forms representing between 0.3 -5% of the landtype unit.

Landtype unit Bb represents "*a catena that in its perfect form is represented by (in order from highest to lowest in the upland landscape) Hutton, Bainsvlei, Avalon and Longlands forms. The valley bottom is occupied by one or other gley soil (e.g. Rensburg, Willowbrook, Katspruit, Champagne forms).*"

5.2 Field Survey and Soil Classification

The soils observed during the survey were classified according to the Taxonomic Soil system for South Africa (Soil Classification Working Group, 1991). Four different soil forms were identified within the project area and a detailed legend of the observed soil forms is presented in Table 3. The distribution of the soil forms within the surveyed area is shown in Figure 2.

Table 3: Soil Map Legend

Soil Map Unit	dAv1100LmSa	mBd1100LmSa	mBv1100LmSa	dCv1100Sa	sDr1000LmSa	mGc1100Sa	dHu1100SiCl	dHu1200LmSa	mLo1000Sa	sWb1000SaLm	dWe1000Sa	sWe1000Sa	sWe2000LmSa
Soil form	Avalon	Bloemdal	Bainsvlei	Clovelly	Dresden	Glencoe	Hutton	Hutton	Longlands	Witabank	Westleigh	Westleigh	Westleigh
Texture (A-horizon)	Loamy sand	Loamy sand	Loamy sand	Sand	Loamy sand	Sand	Silty clay	Loamy sand	Sand	Sandy loam	Sand	Sand	Loamy sand/ sand
Average topsoil depth (cm)	35	60	30	30	30	30	25	35	25		20	30	30
Average subsoil depth (cm)	60	60	55	65	85	45	95	75	55		80	35	40
Effective depth (cm)	95	120	120	120	30	30	120	120	75		100	65	70
Summarised soil description	Plinthic, soft-xanthic, dystrophic, haplic, fine loamy sand	Oxidic, rhodic-hydromorphic, dystrophic, haplic fine loamy sand	Oxidic, soft-rhodic, plinthic dystrophic, haplic, fine loamy sand	Oxidic, xanthic, dystrophic, haplic, fine sand	Plinthic, hard-chromic, fine loamy sand	Plinthic, hard-xanthic, dystrohphic, haplic, fine sand	Oxidic, rhodic, dystrophic, luvic, fine silty clay	Oxidic, rhodic, dystrophic, haplic, fine loamy sand	Plinthic, soft-eluvic, haplic, dystric, fine sand.	Anthropic, technic, fine sandy loam	Plinthic, soft-xanthic, dystrohphic, luvic, fine loamy sand	Plinthic, soft-xanthic, dystrohphic, luvic, fine loamy sand	Plinthic, soft-xanthic, dystrohphic, haplic, fine loamy sand
Coverage (ha)	52.6	31.9	25.0	81.4	73.6	68.1	24.7	49.6	29.6	45.0	28.0	70.4	48.0
Coverage Area (%)	8%	5%	4%	13%	12%	11%	4%	8%	5%	7%	4%	11%	8%
Estimated soil volumes - topsoil	184176	191445	75145	244123	220755	204287	61776	173701	74068		56030	211103	144000
Estimated soil volumes - subsoil	315730	191445	137766	528934	625473	306430	234748	372216	162951		224121	246287	192000

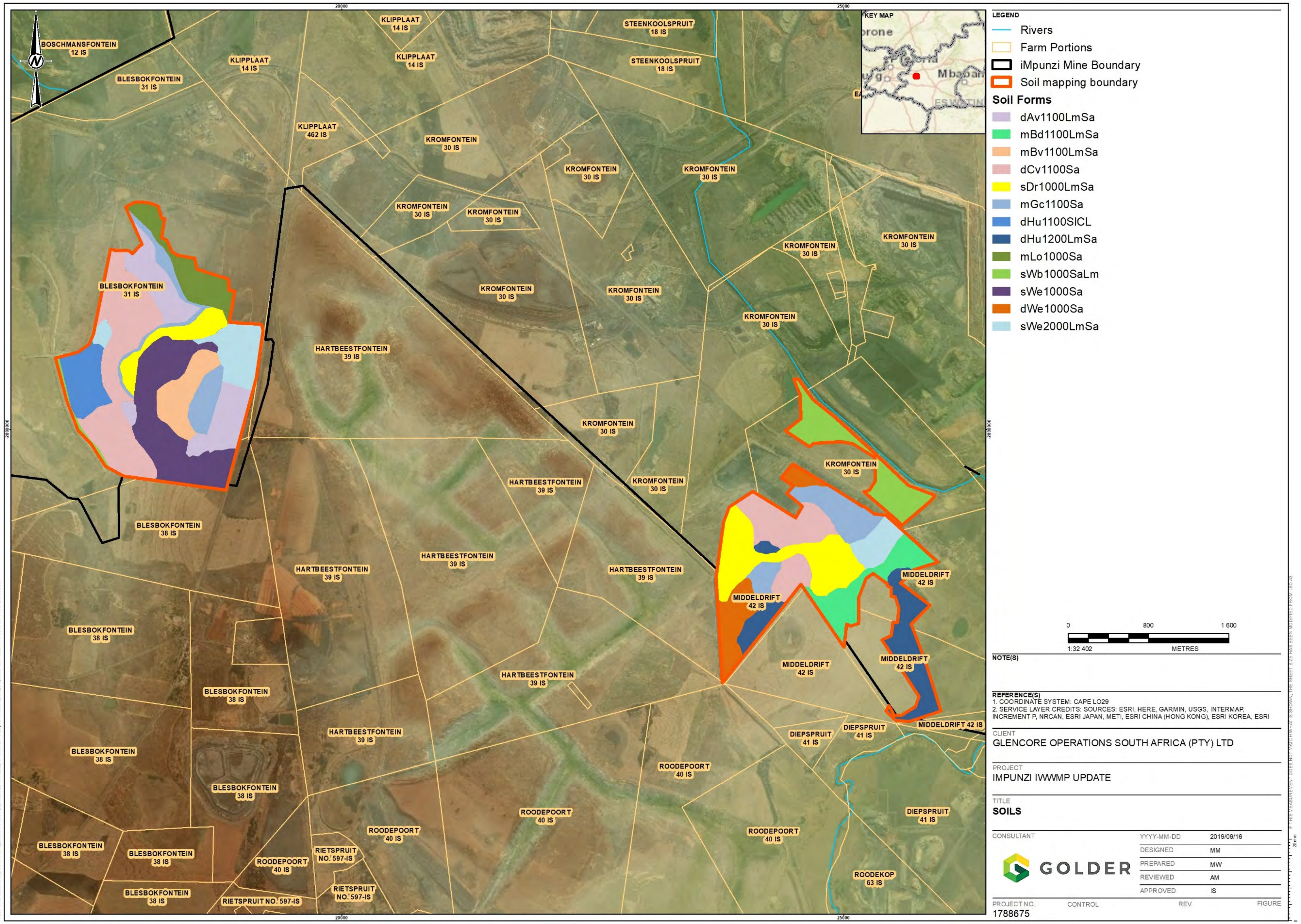


Figure 2: Distribution of soil forms

5.3 National Land Capability

The land capability classification was undertaken at a national scale, using the landtype data on a scale of 1:250 000 (Schoeman et. al. 2000). The land capability for the project area, as defined in the National Land Capability for South Africa, is presented in Table 4. The distribution of the various capability classes in shown in Figure 3.

Table 4: Breakdown of National Land Capability of Project area

National Land Capability	Area (%)
Class 6 & 7 – Low - Moderate	1%
Class 8 - Moderate	6%
Class 9 & 10 - Moderate – High	93%

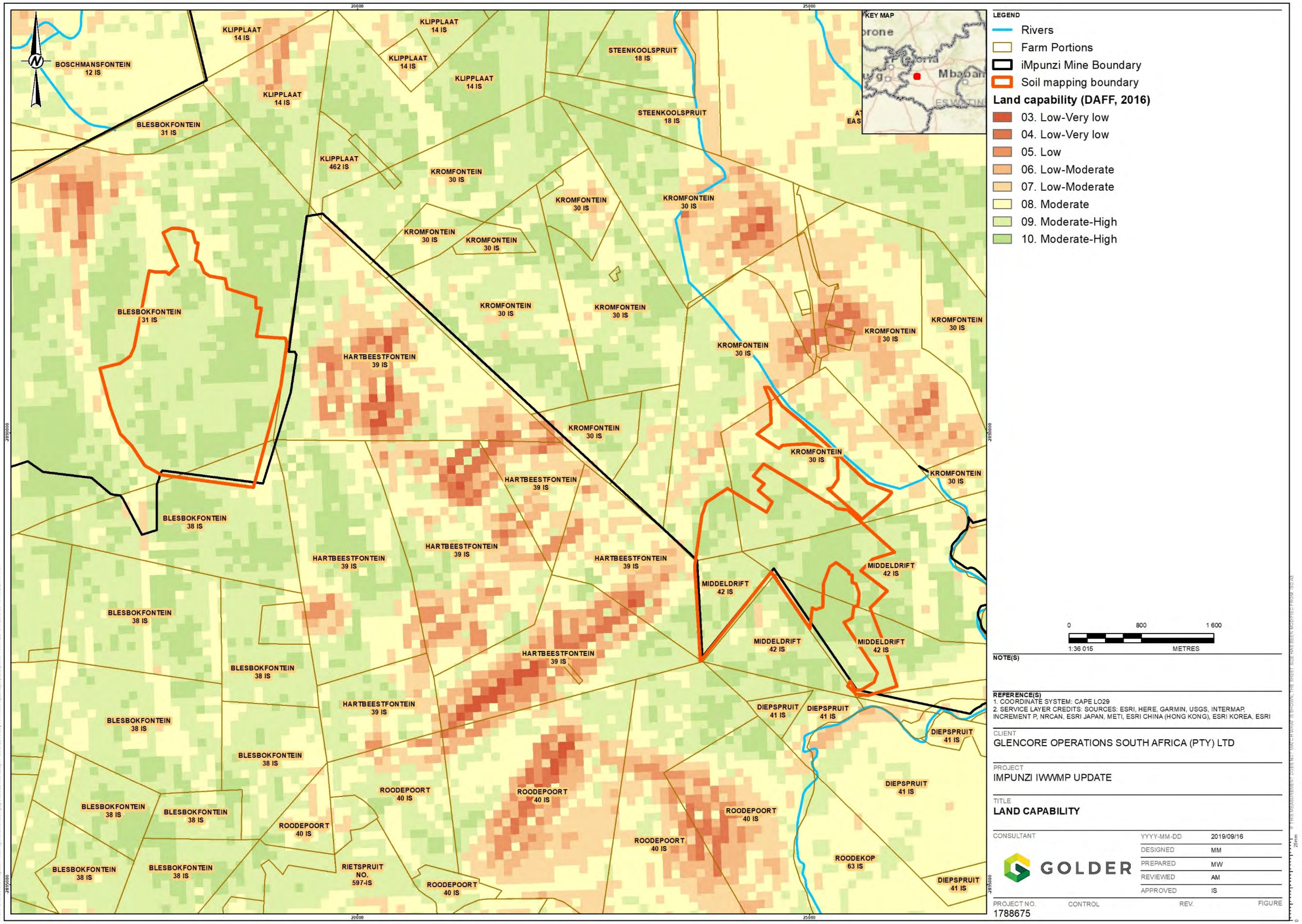


Figure 3: National Land Capability for survey area

5.4 Site Specific Land Capability Classification (USDA)

The land capabilities present in the survey area were assessed in accordance to the methodology outlined in Section 4.1. The results from the field observations and the soil properties were compared to the land capability criteria. The soil capability and land capability classification are presented in Table 6.

The soil capability classes are derived from the evaluation of terrain (field observations) and soil factors (soil properties). For the land capability, the evaluation of the climatic factors alongside the soil capability is required (note: Land capability considers the restrictions for rain-fed cropping and thus needs to consider the climatic factors which may limit for rain-fed crop production).

The site specific land capability of the project is Class III (58%) and Class IV (42%). The characteristics of the classes are summarised in Table 5.

Table 5: Characteristics of Land capability classes

Class III	Class IV
■ Moderately steep slopes. ■ High susceptibility to water or wind erosion or severe adverse effects of past erosion. ■ Frequent flooding accompanied by some crop damage. ■ Very slow permeability of the subsoil. ■ Wetness or some continuing waterlogging after drainage. ■ Shallow soil depth to bedrock, hardpan, fragipan or claypan that limit the rooting zone and the water storage. ■ Low water-holding capacity. ■ Low fertility not easily corrected. ■ Moderate salinity or sodicity.	■ Steep slopes. ■ Severe susceptibility to water or wind erosion or severe effects of past erosion. ■ Shallow soils. ■ Low water-holding capacity. ■ Frequent flooding accompanied by severe crop damage ■ Excessive wetness with continuing hazard of waterlogging after drainage. ■ Severe salinity or sodicity

5.5 Chamber of Mines Land Capability

The surveyed area comprises 58% arable land (Class II) and 42% grazing land (Class III). The distribution of the capability classes as per the Chamber of Mines classification system is shown in Figure 5.

Table 6: Site Specific Land Capability Classification

Soil Map Unit	dAv1100LmSa	mBd1100LmSa	mBv1100LmSa	dCv1100Sa	sDr1000LmSa	mGc1100Sa	dHu1200SiCl	dHu1200LmSa	mLo1000Sa	sWb1000SaLm	dWe1000Sa	sWe1000Sa	sWe2000LmSa
Soil form	Avalon	Bloemdal	Bainsvlei	Clovelly	Dresden	Glencoe	Hutton	Hutton	Longlands	Witabank	Westleigh	Westleigh	Westleigh
Summarised soil description	Plinthic, soft-xanthic, dystrophic, haplic, fine loamy sand	Oxidic, rhodic-hydromorphic, dystrophic, haplic fine loamy sand	Oxidic, soft-rhodic, plinthic dystrophic, haplic, fine loamy sand	Oxidic, xanthic, dystrophic, haplic, fine sand	Plinthic, hard-chromic, fine loamy sand	Plinthic, hard-xanthic, dystrohphic, haplic, fine sand	Oxidic, rhodic, dystrophic, luvic, fine silty clay	Oxidic, rhodic, dystrophic, haplic, fine loamy sand	Plinthic, soft-eluvic, haplic, dystric, fine sand.	Anthropic, technic, fine sandy loam	Plinthic, soft-xanthic, dystrohphic, luvic, fine sand	Plinthic, soft-xanthic, dystrohphic, luvic, fine loamy sand	Plinthic, soft-xanthic, dystrohphic, haplic, fine loamy sand
Texture (A-horizon)	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3
Erosion hazard	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1	E1
Flood Hazard	F1	F1	F1	F1	F1	F1	F1	F1	F3	F1	F1	F1	F1
Effective soil depth	D1	D1	D1	D1	D4	D2	D1	D1	D2	D4	D1	D4	D4
Internal drainage	W3	W3	W3	W1	W3	W3	W1	W1	W4	W1	W3	W3	W3
Mechanical Limitations	MB0	MB0	MB0	MB0	MB0	MB0	MB0	MB0	MB0	MB3	MB0	MB0	MB0
Soil class	S3	S3	S3	S3	S4	S3	S3	S3	S4	S4	S3	S4	S4
Climate class	C3	C3	C3	C3	C3	C3	C3	C3	C3	C3	C3	C3	C3
USDA Land Capability Class	III	III	III	III	IV	III	III	III	IV	IV	III	IV	IV
Chamber of Mines Land Capability Class	Arable	Arable	Arable	Arable	Grazing	Arable	Arable	Arable	Arable	Grazing	Grazing	Grazing	Grazing

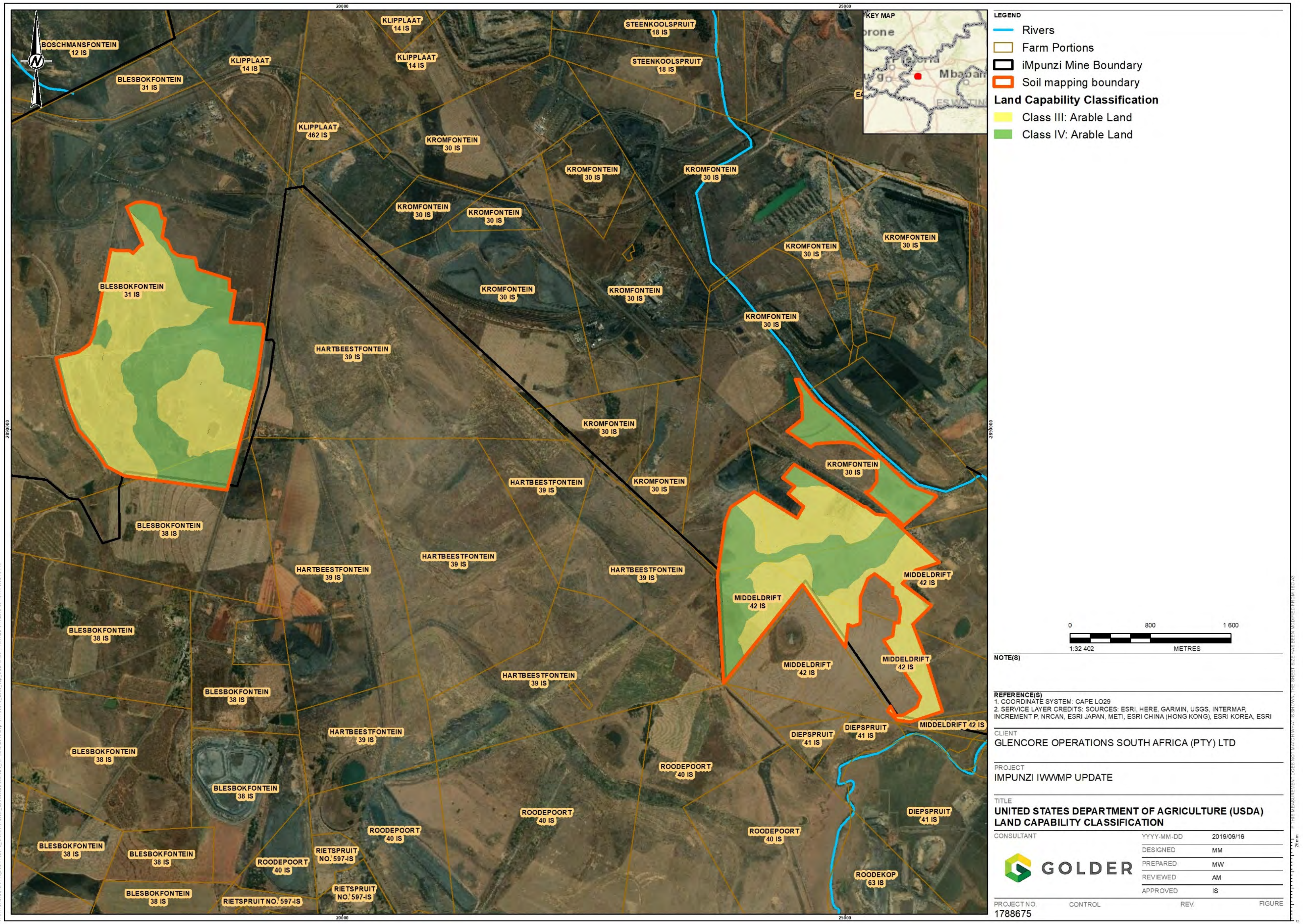


Figure 4: Site Specific USDA Land Capability Classification for surveyed area

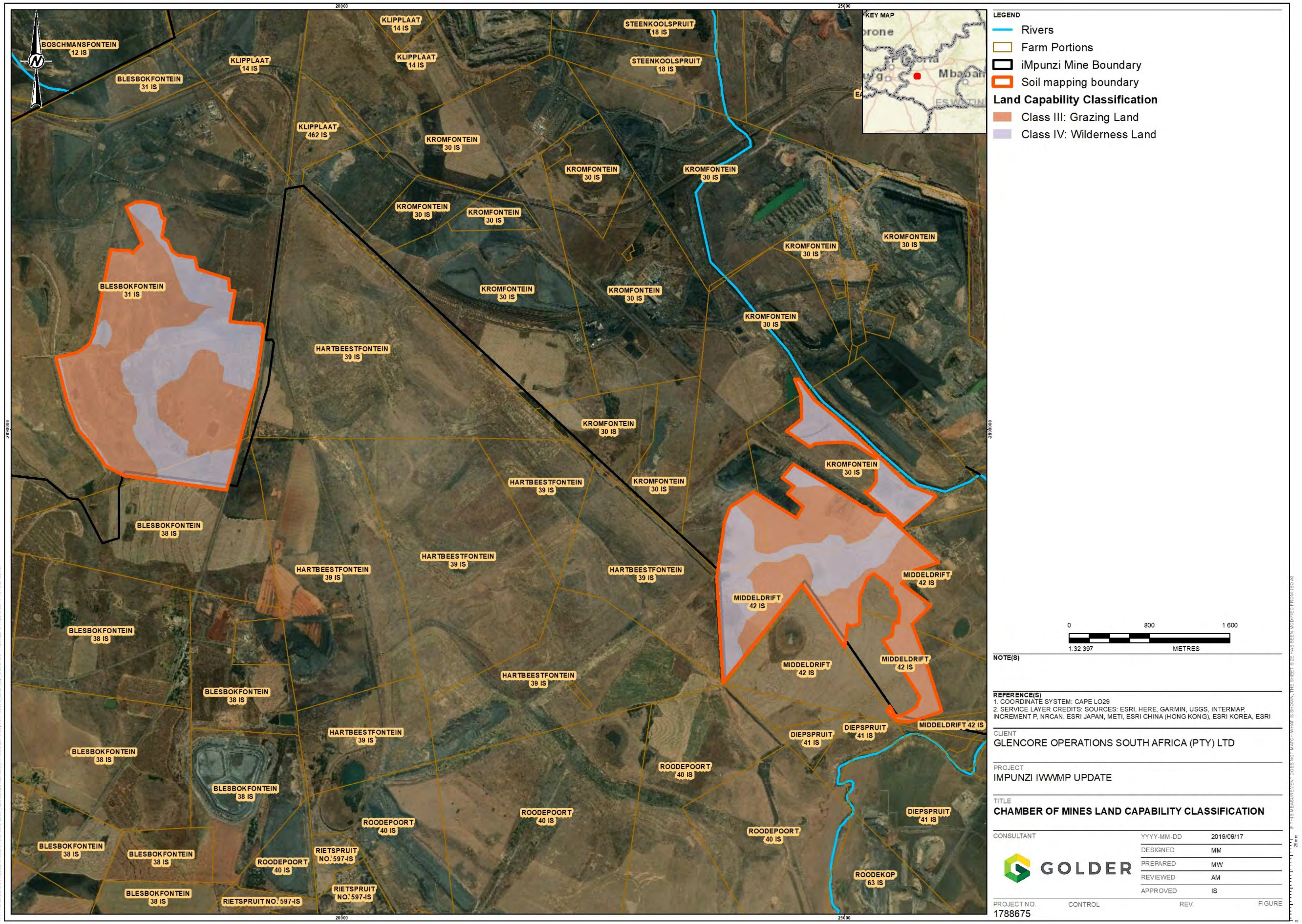


Figure 5: Chamber of Mines Land Capability Classification for surveyed area

5.6 Estimated soil availability for rehabilitation actions

Based on the soil classification, soil map and average horizon thickness recorded in field, the volume of topsoil and subsoil was estimated as 1 840 610 m^3 and 3 538 101 m^3 respectively (see Table 3). The calculation is based on the survey area (as shown in the soil map, Figure 2).

6.0 CONCLUSION

- The project area consists of 23 % Westleigh, 13 %, Clovelly, 12 % Hutton, 12% Dresden, 11 % Glencoe 8% Avalon, 7% Witbank, 5% Bloemdal, 5% Longlands and 4% Bainsvlei soil forms.
- The soil textures of representative soil forms are predominantly loamy sand to sand with an effective depth of at least 30 -120 cm. The estimated volumes of topsoil material for the surveyed area is 1 840 610 m^3 for top soil and 3 538 101 m^3 for the subsoil.
- In terms of land capability, 58% of the project area fall within Class III (arable, land has serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production and is of a moderate potential) and 42% in Class IV (arable, land has very serious permanent limitations that restrict the choice of alternative crops or the intensity of crop production to a great extent) based on the USDA classification system. The Chamber of Mines land capability classification for the surveyed area is 58% arable (Class II) and 42% grazing (Class III) capability.

7.0 REFERENCES

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SIGNATURES

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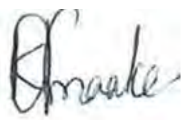

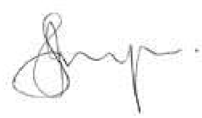

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APPENDIX A

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APPENDIX B

Specialist Declaration

SPECIALIST DECLARATION

As required under Appendix 6 of the Environmental Impact Assessment Regulations, 2014 (as amended), I, **Elize Herselman**, 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 expertise in conducting the specialist report relevant to this application, including knowledge of Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with all applicable Acts and Regulations in compiling this report;
- I have not, and will not engage in conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing:
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signature of the specialist:

Golder Associates Africa (Pty) Ltd

Name of company (if applicable):

27 March 2020

Date:

APPENDIX C

Field Survey Plan

APPENDIX D

Laboratory certificates

GOLDER

REPORT

Social Baseline - iMpunzi Update

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February 2020

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Table of Contents

TABLES

FIGURES

APPENDIX A
Document Limitations

ABBREVIATION/ACRONYMS

Acronym or Abbreviation	Full Term
ANC	African National Congress
DA	Democratic Alliance
CBD	Central Business District
ELM	eMalahleni Local Municipality
GDP	Gross Domestic Product
GVA	Gross Value Added
IDP	Integrated Development Plan
MCC	Members of the Mayoral Committee
MP	Mpumalanga Province
NDM	Nkangala District Municipality
STLM	Steve Tshwete Local Municipality
WSA	Water Service Authority
WSP	Water Service Provider

1.0 SOCIAL BASELINE

This social baseline covers the description of the social environment of the host communities areas in which the iMpunzi Complex and the proposed disposal facilities will be located viz., eMalahleni Local Municipality (herein after referred to ELM) and Steve Tshwete Local Municipality (herein after referred to as STLM) in the jurisdictional area of Nkangala District Municipality (herein after referred to as NDM) in Mpumalanga Province (MP), South Africa.

1.1 Demographics

1.1.1 Geographical location

The NDM comprises the western parts of MP and represents one of three district municipalities in the province. The district is approximately 17 000 km^2 and consists of about 165 towns and villages, with eMalahleni and Middelburg being the primary towns. The ELM is located to the North-west of the MP, and it covers an area of about 2677.67 square kilometres while the STLM is situated at the central of MP, covering a geographic area of approximately 3,976 square kilometres. Figure 1 shows the location of NDM and STLM within MP.

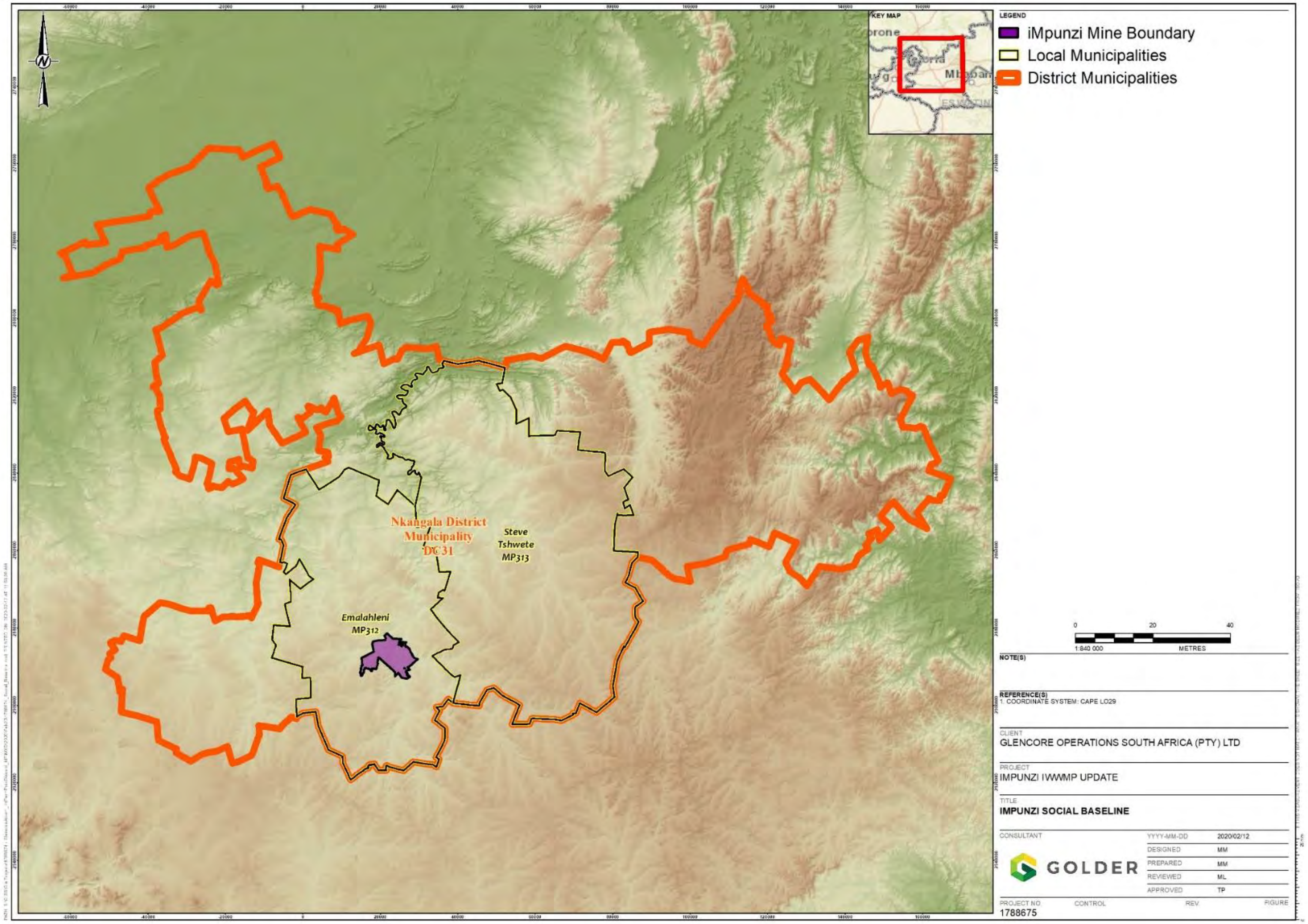

Figure 1: Locality Map

According to the eMalahleni Local Economic Development Strategic document (2011-2016), the following settlements are within the ELM:

- KwaMthunzi Vilakazi, which is a predominantly mining community with some agricultural holdings to the west. The Evraz Highveld Steel and Vanadium industrial complex is situated a few kilometres to the north thereof.
- The Wilge residential area which is privately owned and was formerly part of the Wilge Power Station.
- The Phola residential area, the western part of the local municipality is situated immediately to the north of the N12. This town also has a very limited economic base.
- The town of Ogies which is about the third largest centre of activity in the eMalahleni municipal area and which mainly exists as a result of the railway network converging in the town. Although it has a relatively small residential component, Ogies holds a fairly large number of economic activities.
- Rietspruit which is a former mining town comprising approximately 900 residential units and which has a small retail node in the central part of the town.
- The town of Ga-Nala, which is the southernmost town in the eMalahleni Local Municipal area and mainly exists because of the Matla and Ga-Nala Power Stations, both of which are situated a few kilometres to the west of Ga-Nala. Apart from the town of Witbank, this is the town with the strongest economic base in ELM.
- The Thubelihle residential settlement which is situated about two kilometres to the north of Ga-Nala and which was historically developed as the black town of Ga-Nala.
- The TNC, Clydesdale, Van Dyksdrift, Douglas, Springbok and Wolwekrans complex of settlements, related to mining and railway activity, in the south-eastern part of the area.
- Balmoral situated on the N4 on the western edge of the jurisdictional area comprising a railway station and a few houses.
- Witbank which remains the highest order settlement in the eMalahleni area, both in terms of population and function. Approximately 90% of the population of eMalahleni resides here, with only 10% of the population residing in the rural areas.

STLM comprises two main urban areas, namely Middelburg/ Mhluzi which is the primary commercial and administrative centre; and the much smaller Hendrina/ Kwazamokuhle situated near the south-eastern border of the municipality. Several smaller settlements are dispersed throughout the municipal area, primarily to the south of the N4 freeway.

1.1.2 Governance structure

All municipalities in South Africa are made up of a political structure and an administration structure. The political structure is responsible for governance, public participation, and ensuring that the communities' needs and priorities are realised. The governance structure of the ELM and STLM on the political side is headed by Council, which elects the Executive Mayor. The Executive Mayor, in turn, appoints six full-time councillors who are the Members of the Mayoral Committee (MMC). The MMCs assist the Executive Mayor, and the Executive Mayor may delegate certain function to the MMCs. Council also elects the Speaker of Council who presides at meetings of Council. Council also elects the Whip of Council who plays the role of ensuring good behaviour amongst councillors.

1.1.3 Population

In 2016, NDM had a population density of 84.9 per square kilometre, and it ranked highest amongst its peers. In terms of growth, NDM had an average annual growth in its population density of 2.16% per square kilometre per annum. It was also the region that had the highest average annual growth rate.

ELM and STLM account for the largest population within the NDM, with an estimate of 455 228 and 278 749 people respectively reported in the 2016 community survey. Table 1 shows the population trends of ELM and STLM from 2011 to 2016 and the 2030 projected population. From 2011 to 2016, the population of ELM has increased by 3.2%, and the population of STLM also increased by 4.4% from 2011 to 2016.

Table 1: Population trends of ELM and STLM

Area	Population growth rate% (2001 - 2011)		Average annual population growth	Projected
	2011 Census	2016 (community survey)	2011-2016	2030
ELM	395 466	455 228	3.2%	707 530
STLM	229 831	278 749	4.4%	509 355

Source: Stats SA 2011 and 2016

The increase in population in ELM and STLM might be due to the availability of mining industries and businesses around the area, which results in the following negative implications:

- Informal settlements and back rooms;
- Strain on water, sanitation, electricity and roads resulting in quality and capacity problems; and
- Increase in unemployment, particularly amongst youth and unskilled which might impact on issues of crime, prostitution, drug abuse.

In 2016, the NDM comprised of 404 000 households. The growth rate equates to an average annual rate of 2.88% in the number of households from 2006 to 2016. The total number of households in ELM and STLM has increased over the years. In 2011, a total of 119 874 and 64 971 households were respectively reported in ELM and STLM. In 2016, the number of households had respectively increased to 150 420 and 86 713 in ELM and STLM.

1.1.4 Gender and age distribution

The age and gender structure of the population is a key determinant of population change and dynamics. The male gender in ELM and STLM constitutes approximately 53% and 64.6% respectively of the total population, as indicated in Table 2. This trend can often be observed in mining towns where the mining industry is predominantly male orientated. Most people in ELM (43.1%) and STLM (40.7%) are in the 15-34 age group, as shown in Table 3.

Table 2: Gender distribution

Municipality	Males	Females
ELM	52.79%	47.21%
STLM	64.6%	35.4%

Table 3: Age distribution

Municipality	0-14		15-34		35-64		65+	
	Number	%	Number	%	Number	%	Number	%
ELM	111380	24,5	196255	43,1	133769	29,4	13824	3,0
STLM	66 601	23.9	113525	40.7	118314	31.7	10 308	3.7

1.1.5 Ethnicity and language

The African population group represents 89.2% of the NDM's total population. The population distribution of the ELM and STLM composes of all racial groups with the majority of the population belong to the Black African group, and the most spoken language is isiZulu and Southern Ndebele. The dominant home language in the ELM was isiZulu (42.4%), followed by Afrikaans (14.6%), Sepedi (12.5%) and isiNdebele (10%). In the STLM, the dominant home languages were isiNdebele (17%) and isiZulu (36%), followed by Afrikaans (15%). On a district level, isiNdebele (31.3%) was the most dominant home language, followed by isiZulu (22.8%) and Sepedi (15.8%). The home language indicates the cultural makeup of the area.

1.1.6 Education

Within NDM, the number of people without any schooling decreased from 2006 to 2016 with an average annual rate of -2.85%, while the number of people within the 'matric only' category increased from 161,000 to 271,000. The number of people with 'matric and a certificate/diploma' increased with an average annual rate of 5.38%, with the number of people with a 'matric and a Bachelor's' degree increasing with an average annual rate of 7.55%. Overall improvement in the level of education is visible with an increase in the number of people with 'matric' or higher education.

According to the 2016 community survey of Stats SA, the population in ELM aged 20+ completed grade 12, increased from 117 021 in 2011 to 146 952 (an increase of 29 931) in 2016, an increase of 25.6% in the relevant period.

The STLM 2016 community survey shows that 6% of the population had no schooling or did not complete primary school. Of this number 13236 are illiterate, and therefore future meaningful employment prospects are virtually impossible. A further 77.6% of the population did not complete the schooling curriculum and therefore, did not reach the level of matric. The status of teacher and pupil ratio in the township schools is slowly creating a problem for public education in the area.

1.1.7 Employment

From 2006 to 2016, the NDM had an average annual employment growth of 3.05%. According to Stats SA (2011), ELM was employed either by the formal and informal sector. Figure 2 shows the unemployment rate of ELM and STLM and according to the 2011 census and 2016 HIS global insight figures. STLM economy is one of the biggest economic areas, and it is therefore expected that a significant number of employment opportunities are being provided in the area. Mining, trade and manufacturing are the major leading employment drivers in STLM.

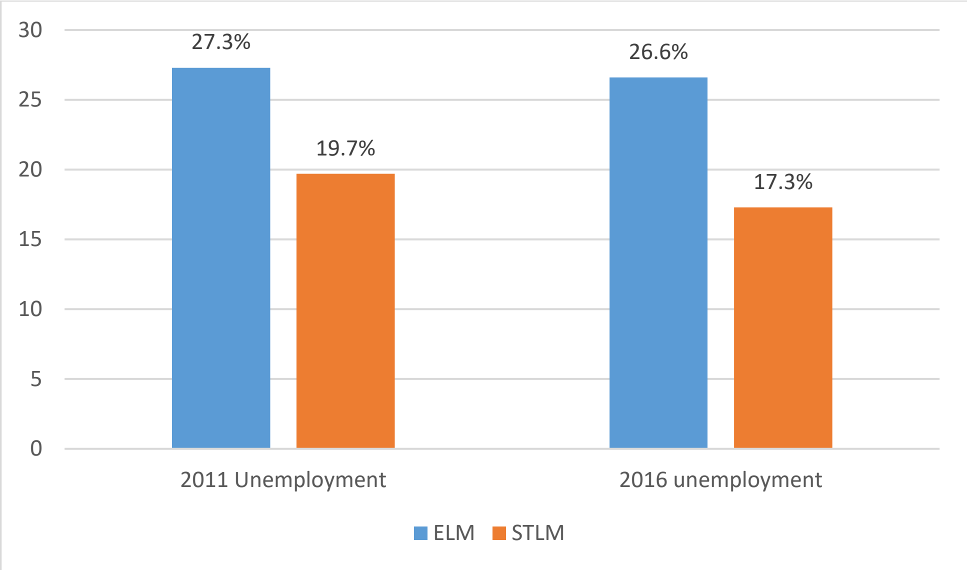

Figure 2: 2011 and 2016 unemployment rate in the municipalities (NDM Final IDP 2017/18-2021/22)

Apart from the formal and informal sector as the channels for sourcing income, other sources of income within the NDM include social services grants. Table 4 shows the grant types received by residents in ELM and STLM.

Table 4: Social services grant types in ELM and STLM (SASSA, 2017/2018)

Grant type	ELM	STLM
Old age	15 967	8 994
War veteran	0	0
Disability	5944	2 595
Foster child	2382	1 675
Care dependency	932	376
Child support	65 968	33 495
Grant in aid	650	56

In a growing economy among which production factors are increasing, most of the household incomes in NDM are spent on purchasing goods and services. Therefore, the measuring of the income and expenditure of households is a major indicator of several economic trends. It was estimated that in 2016 17.42% of all the households in the NDM, were living on R30, 000 or less per annum.

1.1.8 Key economic activities

The NDM's economy is made up of various industries. In 2016, the mining sector was reported to be the largest within NDM accounting for R 41.1 billion (37.3%) of the total Gross Value Added[1] in the district municipality's economy. The sector that contributes the second most to the GVA of the NDM is the manufacturing sector at

[1] The GRA provides a sector breakdown, where each sector is measured in terms of its value added produced in the local economy

12.0%, followed by the community services sector with 11.4%. The sector that contributes the least to the economy of NDM is the agriculture sector with a contribution of R 2.18 billion or 1.98% of the total GVA. Figure 3 shows the 2011 and 2016 industry contribution to the GDP at basic prices.

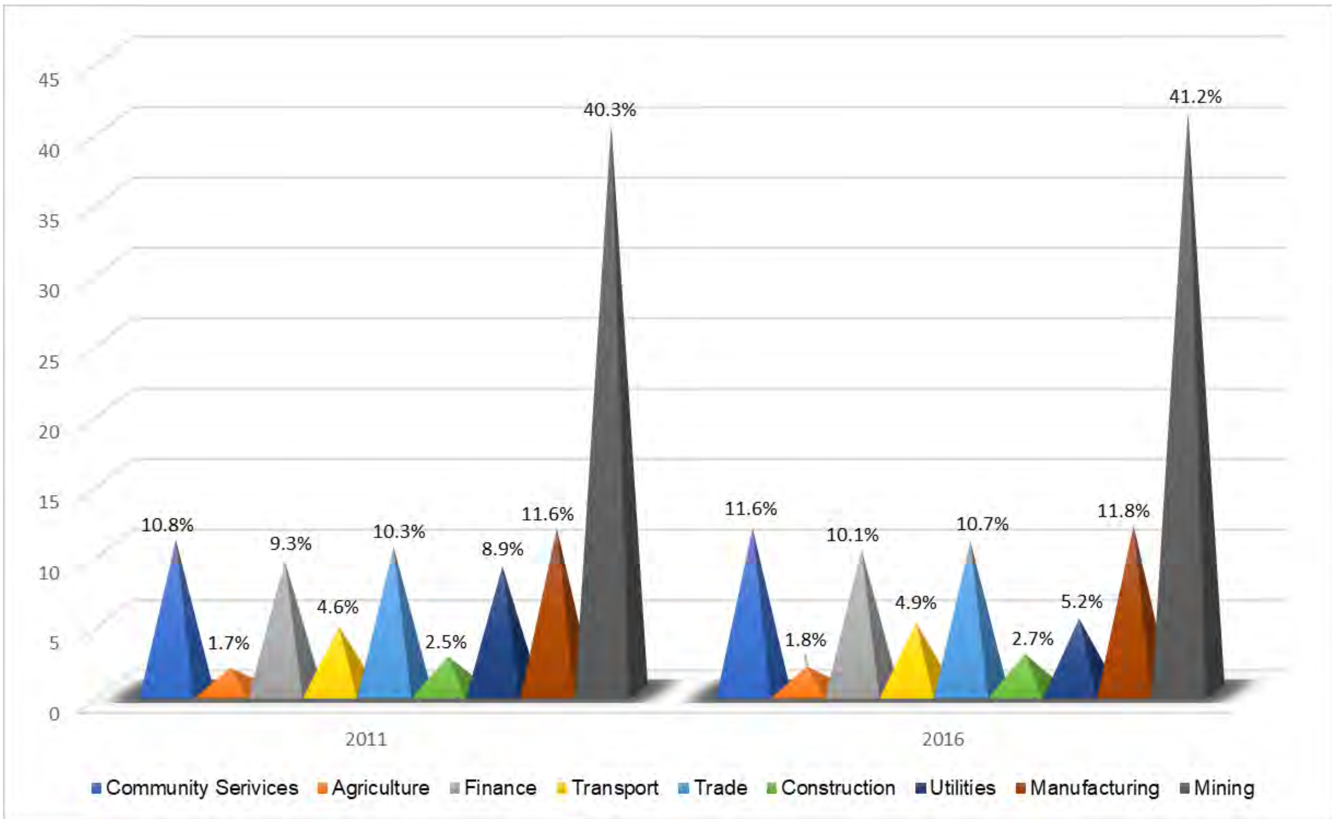

Figure 3: Industry contribution to GDP at basic prices in NDM, 2011 and 2016.

In 2015, the ELM contributed 20.9% to the MP economy while the STLM only contributed 13.4%. From 1996 to 2015, ELM demonstrated an average annual economic growth of 2.4% and STLM had an annual economic growth of 2.7%. The local economy in STLM is relatively diversified with the largest sector, in terms of output as well as proportional contribution being the trade sector. The sectors contributing to the economic activities in the ELM and STLM, consequently contributing to the economy of NDM, are highlighted further in the next sections:

1.1.8.1 Agriculture

Agriculture in ELM is limited to low-level subsistence farming, producing enough maize for personal use, traditional livestock farming and sorghum production, which is formalised and produced for the market (ECSECC, 2017). Wool production is one of the upcoming sources of income in the area for emerging communal farmers.

Most of the land within STLM is occupied by a range of agricultural activities, including grazing land and cultivated land as the two largest contributors. The north-eastern and southern extents of the municipal area are largely under cultivation with the main commodities being maize, soybeans, sorghum and potatoes. The mountainous north-western region predominantly provides for game farming while cattle farming occurs extensively throughout the area. It is also evident that there is a cluster of irrigated land (a very valuable resource) between Komati and Pullenshope and between Pullenshope and the N4 freeway, respectively. The latter area also holds several poultry farms and the Kanheim feedlot. Deciduous fruits and horticulture are clustered to the north thereof from the N4 towards KwaMakalane and even up to Doornkop.

1.1.8.2 Mining

Mining is a very significant economic sector in the ELM area, but it has also become a major form of development constraint due to shallow undermining - especially in the central, northern and southern portions of Witbank town. This shallow undermining has major implications in terms of correcting the distorted spatial pattern of Witbank town itself. There is a conflict between the mining operations and settlement development, especially in terms of the hazards associated with past mining operations, such as underground fires in old mines, seepage from mines and communities mining coal from remaining coal pillars and old coal dumps. Coal mining has also out-performed agriculture in terms of land-use within the municipal area; thereby causing a major challenge on agriculture development.

In STLM, mining activities are concentrated mainly on coal. The main mining areas are around Delmas in the centre of the municipal area, and in the far north-eastern corner of the municipal area. In ELM, mining is a very significant economic sector in the eMalahleni area, but it has also become a major form of development constraint due to shallow undermining - especially in the central, northern and southern portions of Witbank town.

1.1.8.3 Industries

Industrial areas in the ELM, most of which are situated within or around Witbank town. Middelburg town hosts the bulk of industrial activity in the municipal area, with Columbus Stainless Steel being the major industrial anchor located in the STLM. Many of the industries in Middelburg Town serve the mines in surrounding areas.

1.1.8.4 Business activities

The business activities in the STLM are closely related to the hierarchy of settlements. The Middelburg Central Business District and Hendrina Central Business District are the primary economic activity nodes within the municipal area. Both comprise a combination of retail, wholesale trade, financial services, offices, and government and municipal buildings. Convenience goods and services, as well as very basic social services and facilities, are provided in the various smaller villages and settlements.

1.1.8.5 Tourism

ELM and STLM are the point of entry into MP from Gauteng. The province of Mpumalanga comprises of unique scenery. It is also home to many world-renowned attractions, including the famous Kruger National Park. Also, Mpumalanga is the only province of South Africa to border two provinces of Mozambique and border all four districts of Swaziland.

STLM is strategically located in terms of the regional road network in that the N4, N12 and N11 freeways provide links from Gauteng to the major tourism centres in Mpumalanga, specifically the Kruger National Park to the east, Pilgrim's Rest, Graskop, Lydenburg and Hoedspruit to the north-east, as well as the Loskop Valley/ Olifants Gorge to the northwest. Subsequently, many tourists travel through the municipal area to surrounding tourism destinations.

Eco-tourism activities in the form of game farms are primarily consolidated in the mountainous north-western and northern extents of the LM where abundant grazing land and water from the Olifants River are available, while the major tourism destination within the municipal area is the Loskop Dam and surrounds.

1.1.9 Cultural heritage

The archaeological record begins with the stone age. In southern Africa, this comprises three broad phases viz., the earlier stone age, middle stone age and late stone age. These phases have been determined according to the stone tools and the material culture produced by the various hominid species through time. Figure 1 shows the broad timeframes of the major periods of the past in MP.

Table 5: Archaeological periods in Mpumalanga (Esterhuysen and Smith, 2007)

Period	Phase and timeframe	
The stone age	Earlier stone age	2 million years ago (mya) to 250 thousand years ago (kya)
	Middle stone age	250 kya to 20 kya
	Later stone age	20 kya to 500 CE (common era[2])
There appears to be a gap in the record in MP between approximately 7000 and 2000 BCE		
Farming communities	Early farming communities (EFC)	500 to 1400 CE
	Late farming communities (LFC)	1100 to 1800 CE
Historic period	-	1500 CE to 1850 (Behrens & Swanepoel, 2008)

The middle stone age dates from approximately 300 kya to 20 kya and is characterised by the use of good-quality raw material (Clark, 1982; Deacon & Deacon, 1999). Early middle stone age lithic industries are characterised by high proportions of blades, which are created using the Levallois technique and are minimally modified. Beads, bone tools, ochre and pendants also appear during the middle stone age.

The Late Stone Age dates from 40 kya to the historical period. The lithics characterising this period are highly specialised, where specific tools were created for specific purposes (Mitchell, 2002). Diagnostic tools include scrapers and segments and bone tools are also included in Late Stone Age assemblages. In southern Africa, the Late Stone Age is closely associated with hunter-gatherers, which may include San groups, such as the Basarwa and Bathwa (Makhura, 2007). These peoples are commonly regarded as being the first inhabitants of Mpumalanga. The late stone age is further defined by evidence of ritual practices and complex societies (Deacon & Deacon, 1999). In Mpumalanga, three rock art traditions occur, namely fine-line paintings associated with the late stone age hunter-gatherer groups, finger paintings associated with the later arrival of pastoralists and finger paintings associated with much later communities, possibly historical or farming communities.

The Farming Community period correlates with the movements of Bantu-speaking agropastoral moving into southern Africa. The period is divided into the EFC and the LFC. Only the LFC is represented in the regional study area. The LFC is represented by stonewalling or other tangible surface indicators including ceramics and evidence of domesticated animals (e.g. faunal remains or dung deposits). Stonewalling is categorised into several types based on the construction technique, coursing, height, internal divisions and shape of the structures (Huffman, 2007). Several types occur within the regional study area, including Bokoni or Badfontein walling (16th Century), KwaMaza (1700 to 1840 CE) and Type V (19th Century) walling. Table 6 shows the ceramics (ceramic facies) in MP.

[2] Common Era (CE) refers to the same period as Anno Domini ("In the year of our Lord", referred to as AD): i.e. the time after the accepted year of the birth of Jesus Christ and which forms the basis of the Julian and Gregorian calendars. Years before this time are referred to as 'Before Christ' (BC) or, here, BCE (Before Common Era).

Table 6: Ceramic facies commonly represented in MP, after Huffman (2007)

Facies	Key Characteristics	Period
Uitkomst	Stamped arcades, appliqué and blocks of parallel incisions, stamping and chord impressions.	1650 CE- 1820 CE
Rooiberg	Stamped rim band, a mixture of stamped and incised bands, arcades and triangles in the neck.	1650 CE- 1750 CE
Icon	Multiple incised bands separated by colour and lip decorations on bowls.	1300CE- 1500 CE
Madikwe	Multiple bands of cord impressions, incisions, stabs and punctuates separated by colour.	1500 CE- 1700 CE
Letaba	Hatched bands on the shoulder, below black and red triangles.	1600 CE- 1840 CE
Klingbeil	Triangles in neck bordered with slashes, punctuates on the shoulder.	1000 CE- 1200 CE

In MP, the predominant heritage resources demonstrate affiliations with 62.6% of burial grounds and graves and 30.3% of the historic built environment, as shown in Figure 4. Additionally, MP is underlain by valuable geological formations, in terms of both mineral and fossil wealth (Johnson, et al., 2006; Groenewald & Groenewald, 2014). These formations include:

- The Karoo Supergroup;
- The Bushveld Complex; and
- The Transvaal Supergroup.

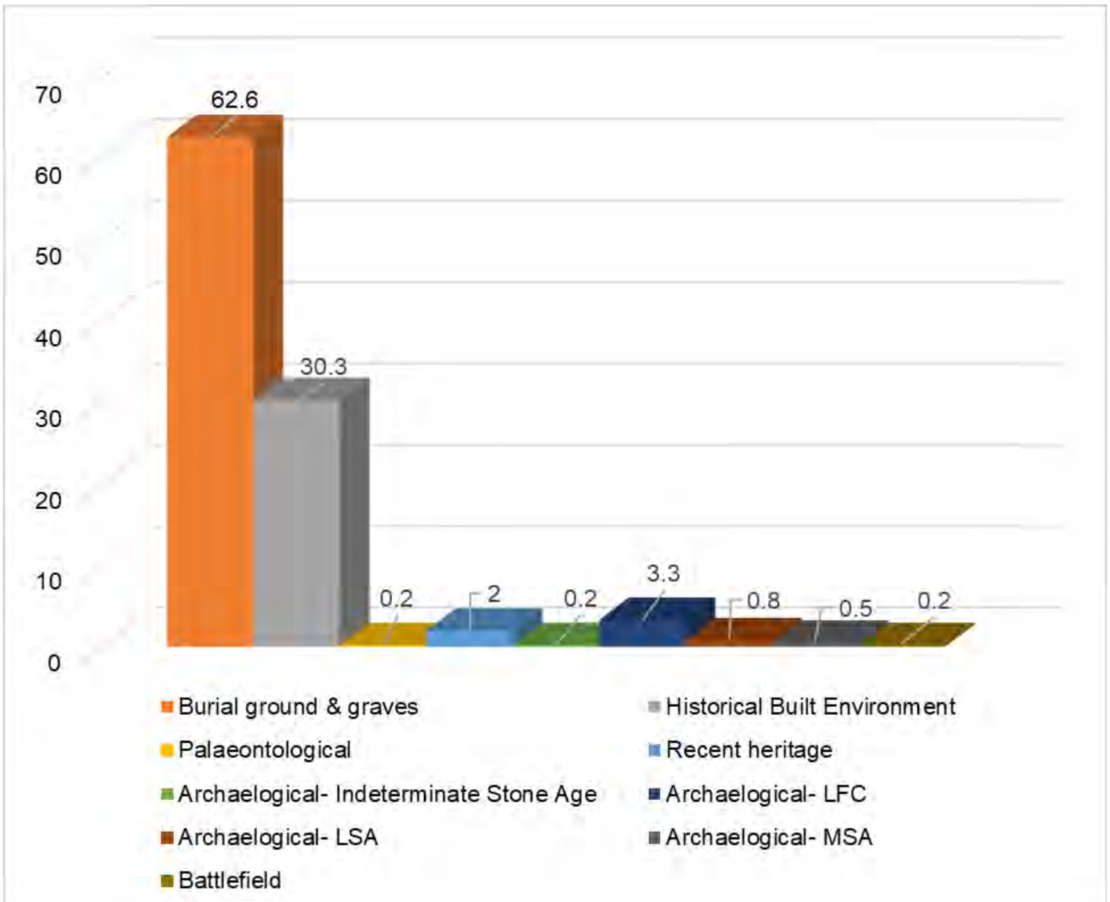

Figure 4: Heritage resources identified within the greater study area

1.2 Social and physical infrastructure

1.2.1 Housing

In 2016, the NDM had a total number of 147 000 (36.37% of total households) with very formal dwelling units, a total of 190 000 (47.03% of total households) formal dwelling units and a total number of 53 400 (13.23% of total households) informal dwelling units.

In terms of dwelling types, STLM and ELM have different dwellings types as shown in Table 7, the material used ranges from brick/concrete, traditional, flat, cluster, townhouses, informal and caravan. ELM has the highest number of very formal dwelling units with the NDM while STLM has an increased number of informal dwellings. STLM recognises that high migration and urbanisation rates mean that informal settlements in the municipality are likely to remain. However, the municipality is committed to ensuring that all households, including those located in informal settlements, have access to basic services and community amenities.

Table 7: The number of dwelling unit type, 2016.

Municipality	Very formal	Formal	Informal	Traditional	Other dwelling type
ELM	74000	33500	27600	3240	816
STLM	46 100	21 000	10 300	1 890	635

Source: Statistics South Africa- Census 2016

1.2.2 *Water*

The NDM had a total number of 155 000 (or 38.44%) households with piped water inside the dwelling, a total of 169 000 (41.80%) households had piped water inside the yard and a total number of 31 700 (7.86%) households had no formal piped water. ELM has been reported as having the highest number of households with piped water inside the dwelling. Figure 5 shows that the increase in population puts pressure on water resources, the households without access to water in ELM increased while in STLM decreased from 2011 to 2016.

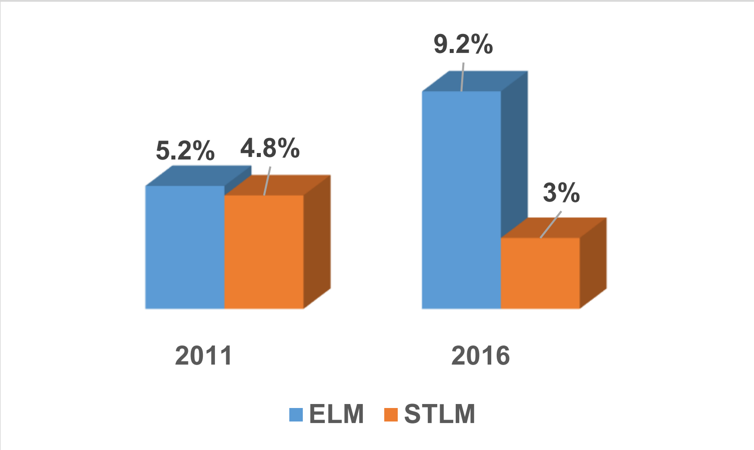

Figure 5: Households without water access in ELM and STLM in 2011 compared to 2016

The ELM functions as Water Service Authority (WSA) and Water Service Provider (WSP). The department is responsible for the provision of portable water and supply raw water to all industrial areas within the municipality. The water network has 950km of pipelines, of which a large component is still asbestos pipes. There is very limited use of ground water resources available within the area of the municipality mainly due to the seeping of acid mine water into sub-surface aquifers. Most existing boreholes are privately owned and mainly located in the agricultural small holdings.

Even though access to water and sanitation remains high in STLM, due to households increase between 2011 and 2016, the percentage of households with water and sanitation has decreased. The 2016 community survey reveals that 81.9 of households had access to potable water (household connections and communal stands) and 85.4% had flush and chemical toilets. In 2014, the Blue Drop Certified Systems awarded STLM a blue drop score of 97.1% (ranked 1st in the province), noting that the municipality continues to manage drinking water within their area of jurisdiction. The STLM was ranked second in terms of wastewater services in the Green Drop Report, which was at 61.9%.

1.2.3 *Sanitation*

NDM was reported in 2016 to have a total number of 221 000 flush toilets (54.65% of total households), 56 400 Ventilation Improved Pit (VIP) (13.96% of total households) and 114 000 (28.16%) of total household's pit toilets. ELM was reported to be the municipality with the highest number of flush toilets within the NDM (Table 8).

Table 8: Sanitation facilities in ELM and STLM

Municipality	Flush toilet	Ventilation improved pit (VIP)	Pit toilet	Bucket system	No toilet
ELM	101 000	6790	27 300	509	3130
STLM	67 600	5 200	4 100	1 660	1 410

1.2.4 Waste management

The NDM was reported to have a total number of 199 000 (49.33%) households which had their refuse removed weekly by the authority, a total of 8 890 (2.20%) households had their refuse removed less often than weekly by the authority and a total number of 152 000 (37.70%) households which had to remove their refuse personally (own dump). Within NDM, the municipality with the highest number of households where the refuse is removed weekly by the authority is ELM with 93 400 (46.93%) of the households where the refuse is removed weekly by the authority. There is a waste management unit in ELM which is currently servicing 95 114 formal households and over 100 businesses with skip collection. The sewer network in ELM has 1700km of pipelines with 27 pump stations within the network, some components of old townships establishment are of Clay Pipes.

1.2.5 *Electricity*

In 2016, the NDM had a total number of 34 800 (8.63%) households with electricity for lighting only, a total of 322 000 (79.77%) households had electricity for lighting and other purposes and a total number of 46 800 (11.60%) households did not use electricity. STLM is licensed to supply Middelburg, Hendrina, Kwaza, Doornkop, Komati, Blinkpan and Koornfontein with electricity and comprises with a small consumer, distribution and planning and bulk connection. The provision of electricity within the municipality continued to decrease by 0.7% between 2011 and 2016 (Figure 6).

The ELM is a licensed distributor of electricity with exception to the mines as issued by National Energy Regulator of South Africa. Unfortunately, there are various challenges experience by the municipality such as old infrastructure, increased demand as results of expansions and illegal connections which causes the electricity infrastructure to be overloaded and explode.

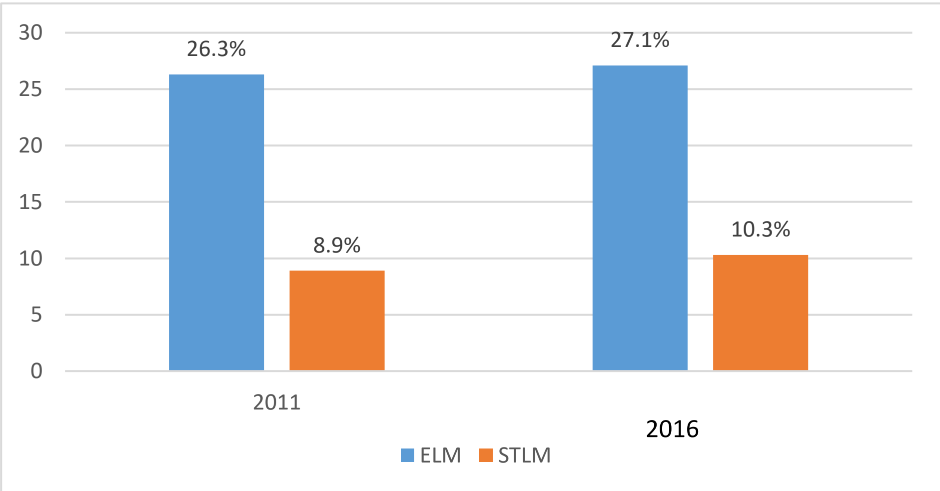

Figure 6: Households without electrical connection in ELM and STLM in 2011 and 2016

1.2.6 *Crime*

The highest frequency of crimes reported in MP[3] between 2010 and 2011 are contact crimes which include crimes such as murder, assault, robbery and sexual crimes. In contrast, the 2016 community survey revealed that the frequently experienced crime type in the province was housebreaking/ burglary. It is important to mention that crime is evident in NDM, specifically in both ELM and STLM, and it is on the increase. Contact crime has shown an increase together with violent crimes in the two municipalities. Drug abuse has also been

[3] The crime statistics for the SAPS are not group according to municipalities, but according to SAPS regions.

identified as a concern and a contributing factor to crime. Vandalism and "strip"-mining of metals and copper are also creating concerns within the municipalities. Sectors have formed neighbourhood watch groups to curb crime, which assist the police in crime prevention as the police is understaffed and under equipped.

1.2.7 *Roads*

Various national, provincial and municipal roads run through the STLM, with many regional routes converging at Delmas which lends it a strategic significance. Consequently, the municipality features a well-developed regional road and rail infrastructure. The N12 national toll road that links Johannesburg with Nelspruit runs from east to west through the northern part of the municipality. This road also links the Municipality with the Maputo Development Corridor.

The freeways that converge eMalahleni town include the N4, N11 and the N12, the N12 starts at eMalahleni and then the N4 proceeds to Nelspruit and Maputo. Running parallel to the N4 is a rail line that connects Gauteng through eMalahleni to Maputo. This significant rail and road infrastructure have been identified as part a Southern African initiative to connect Walvis Bay (on the west coast of Africa), and Maputo (on the east coast of Africa) called the Maputo Corridor.

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Signature Page

Golder Associates Africa (Pty) Ltd.

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Project Co-ordinator

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Technical Director

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APPENDIX A

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REPORT

Groundwater and Geochemistry Impact Assessment Report for the Proposed iMpunzi South Pit Coarse Discard Dump and Venture Co-disposal Facility Project

Glencore Operations South Africa (Pty) Ltd

Submitted to:

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Executive Summary

Glencore Operations South Africa's (GOSA) iMpunzi Mine Complex is located 27 km south-east of eMalahleni in the Mpumalanga Province, near the towns of Ogies and Kriel. The complex consists of four (4) sections, namely: Arthur Taylor Colliery (ATC), Phoenix (decommissioned), Arthur Taylor Colliery Opencast Mine (ATCOM), and ATCOM East. GOSA has appointed Golder Associates Africa (Pty) Ltd (Golder) as an independent environmental assessment practitioner (EAP) to undertake the regulatory application process for the proposed the expansion of the South Pit and Venture Dump discard facilities at their iMpunzi Mining Complex. The proposed South Pit Discard Dump will receive course discard from the ATCOM Central Plant. The South Pit is a previously mined-out area and has been partially rehabilitated. The existing Venture Discard Dump footprint will be expanded, and the facility will be modified into a co-disposal facility to accommodate both coarse and fine (slurry) discard. A new return water dam (RWD) will be constructed as part of the development of the Venture Co-disposal Facility. The co-disposal facility will receive coarse discard and slurry from the ATC Plant, which sources coal from opencast workings and from discard dump reprocessing. As part of the proposed discard expansion project, an existing haul road from the ATCOM Discard Dumps to the ATC Coal Processing Plant will be widened. The above activities require authorisation in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) (as amended), the National Water Act, 1998 (Act 36 of 1998) (NWA), and the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA) (as amended). The application process must be supported by an environmental impact assessment (EIA) in terms of the 2014 EIA Regulations, as amended in April 2017, to be submitted to the competent authority, the Department of Mineral Resources and Energy (DMRE). As part of the EIA process, a groundwater and geochemistry impact assessment are required.

The main findings of this study are:

- Seepage from the slurry and discard is considered to have a high magnitude because of the acid-generating nature of the discard and the elevated concentrations of calcium, aluminium and sulphate in the leachate. The impact is regional due to close proximity to rivers and is long-term due to the normal duration of acid-generation of Highveld coal discards (although kinetic testing of iMpunzi discard could determine the likely duration more accurately). This results in a high significance without mitigation.
- Prevention of decant results in reduction in baseflow to Steenkoolspruit and Saaiwaterspruit, which has been modelled to be a decrease in water quantity during Operations and post-closure phases, with a low magnitude, local impact, whose significance is moderate without mitigation.

The main required interventions are:

- Cover: a soil cover consisting of a 300 mm silty clay cover with established grassland vegetation over the discard facilities is required in order to reduce infiltration, thereby decreasing mass loads to the groundwater system (by 80 - 90%) and reducing the environmental impact. This reduction in infiltration is also required to decrease the volume of dirty water generated from rainfall, which is a gain in terms of water use efficiency.
- Prevention of decant through abstraction boreholes in Venture and ATCOM South Pits during operations and post-closure, which will:
  - Reduce the environmental impact of mine affected water and protect future uses of water resources in the area by preventing decant to surface water systems during the polluting period of the source;

  - Address water use efficiency requirements as the mine-affected water is abstracted for treatment and reuse, rather than leaving it as wasted dirty water.

The main recommendations of this study are:

- Implementation of the intervention contained in the environmental management programme;
- Pumping yields would need to be confirmed by means of pumping test after borehole construction at the various pits - this, together with an independent estimation of recharge rates for backfilled areas, will allow development of a pit calibrated groundwater model to improve evaluations of decant rates and abstraction rates for both pits;
- Kinetic testing of the spoils, discard and slurry material is needed to better predict post closure water quality - the results of kinetic testing allow for simulation of long-term leachate qualities post-closure, and resolve uncertainties in the available data which were used in this study;
- When pit decant rates have been refined based upon pump test data, and long-term seepage chemistry refined using kinetic testing, a predicted 95th percentile concentration scenario can be developed for each pit and used to indicate potential variability in feed concentrations to higher levels, which is essential for water treatment plant design.
- Nearer the end of life of mine, the abstraction volumes and treatment requirements required for post-closure decant management should be remodelled.

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION AND BACKGROUND

1.1 Background

Glencore Operations South Africa's (GOSA) iMpunzi Mine Complex is located 27 km south-east of eMalahleni in the Mpumalanga Province, near the towns of Ogies and Kriel. The complex consists of four (4) sections, namely: Arthur Taylor Colliery (ATC), Phoenix (decommissioned), Arthur Taylor Colliery Opencast Mine (ATCOM), and ATCOM East. GOSA has appointed Golder Associates Africa (Pty) Ltd (Golder) as an independent environmental assessment practitioner (EAP) to undertake the regulatory application process for the proposed the expansion of the South Pit and Venture Dump discard facilities at their iMpunzi Mining Complex. The proposed South Pit Discard Dump will receive course discard from the ATCOM Central Plant. The South Pit is a previously mined-out area and has been partially rehabilitated. The existing Venture Discard Dump footprint will be expanded, and the facility will be modified into a co-disposal facility to accommodate both coarse and fine (slurry) discard. A new return water dam (RWD) will be constructed as part of the development of the Venture Co-disposal Facility. The co-disposal facility will receive coarse discard and slurry from the ATC Plant, which sources coal from opencast workings and from discard dump reprocessing. As part of the proposed discard expansion project, an existing haul road from the ATCOM Discard Dumps to the ATC Coal Processing Plant will be widened. The above activities require authorisation in terms of the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA) (as amended), the National Water Act, 1998 (Act 36 of 1998) (NWA), and the National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEMWA) (as amended). The application process must be supported by an environmental impact assessment (EIA) in terms of the 2014 EIA Regulations, as amended in April 2017, to be submitted to the competent authority, the Department of Mineral Resources and Energy (DMRE). As part of the EIA process, a groundwater and geochemistry impact assessment is required.

1.2 Objectives

The key objective of this investigation is to develop a geochemical source-term set and a numerical groundwater flow and transport model which suitably represents current site conditions and which can be used to predict/forecast the impacts on the groundwater regime and how to mitigate these, including:

- Determining the likely areas of impact associated with the expansion of the two disposal facilities (Venture Co-disposal Facility and South Pit Discard Dump) and establish if any receptors are likely to become impacted; and
- Formulating appropriate mitigation measures.

2.0 BASELINE

2.1 Location

The iMpunzi Mining Complex (Figure 1) is a coal mining operation located 23 km south-east of eMalahleni in the Mpumalanga Province, South Africa. The iMpunzi Mine complex comprises of the ATC Colliery, ATCOM Colliery and Phoenix Colliery. The area has been intensively mined by open-cast and underground coal mining operations. The surface area comprises opencast pits which are mined, partially mined, backfilled or as yet unmined areas planned for future opencast mining. Operations at ATC traditionally consisted of underground workings but also included the now rehabilitated opencast pit called the Butterfly Pit. Current mining activities at ATCOM comprise of opencast mining of the North Pit, River West Pit and South Pit.

The study area has been mined extensively by both underground and opencast coal mining operations which have been in operation since 1936. Figure 2 presents the site characterisation of the study area including rehabilitated areas, opencast mine and future mining areas.

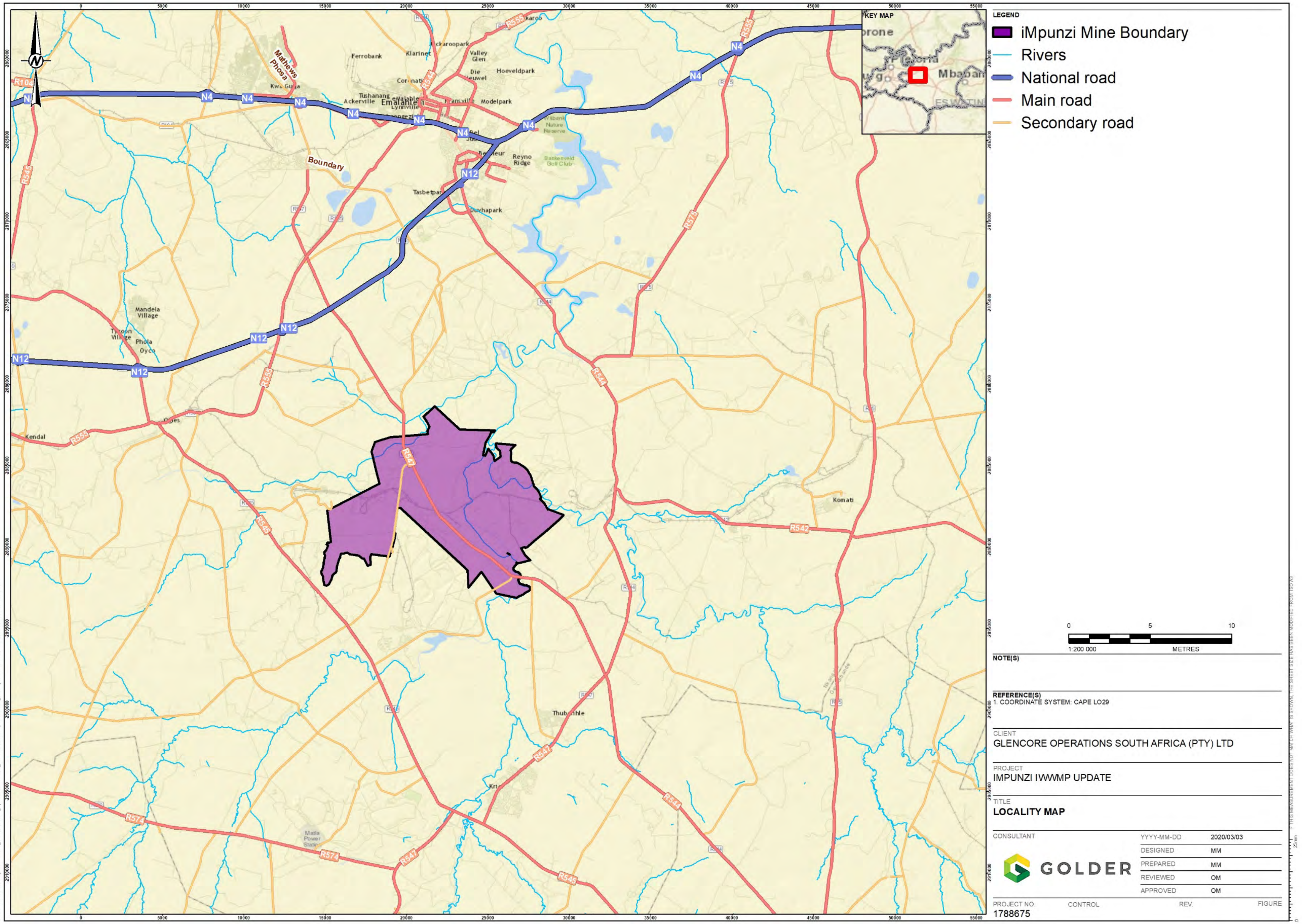


Figure 1: iMpunzi Locality Map

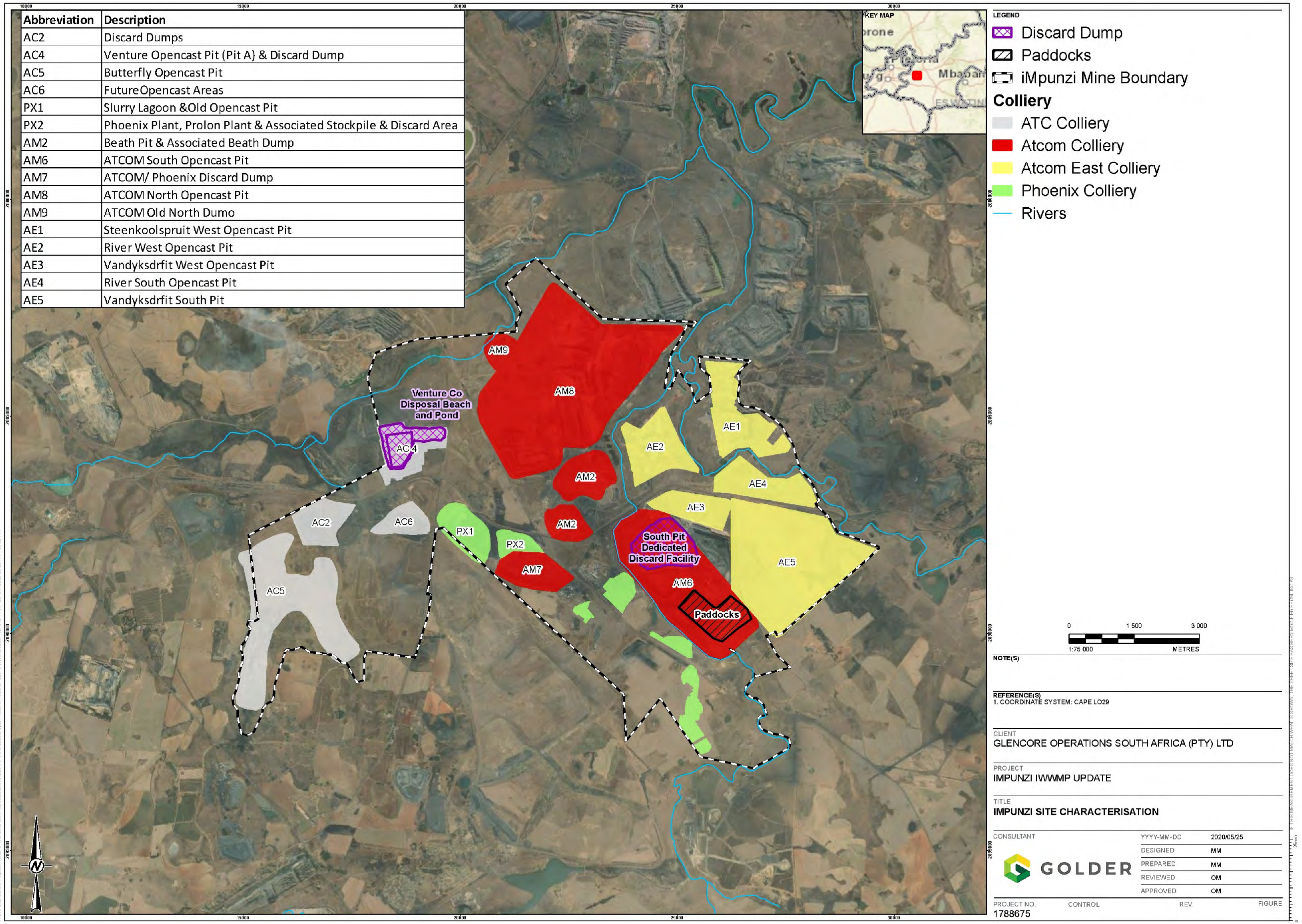


Figure 2: iMpunzi Mine Site Characterisation

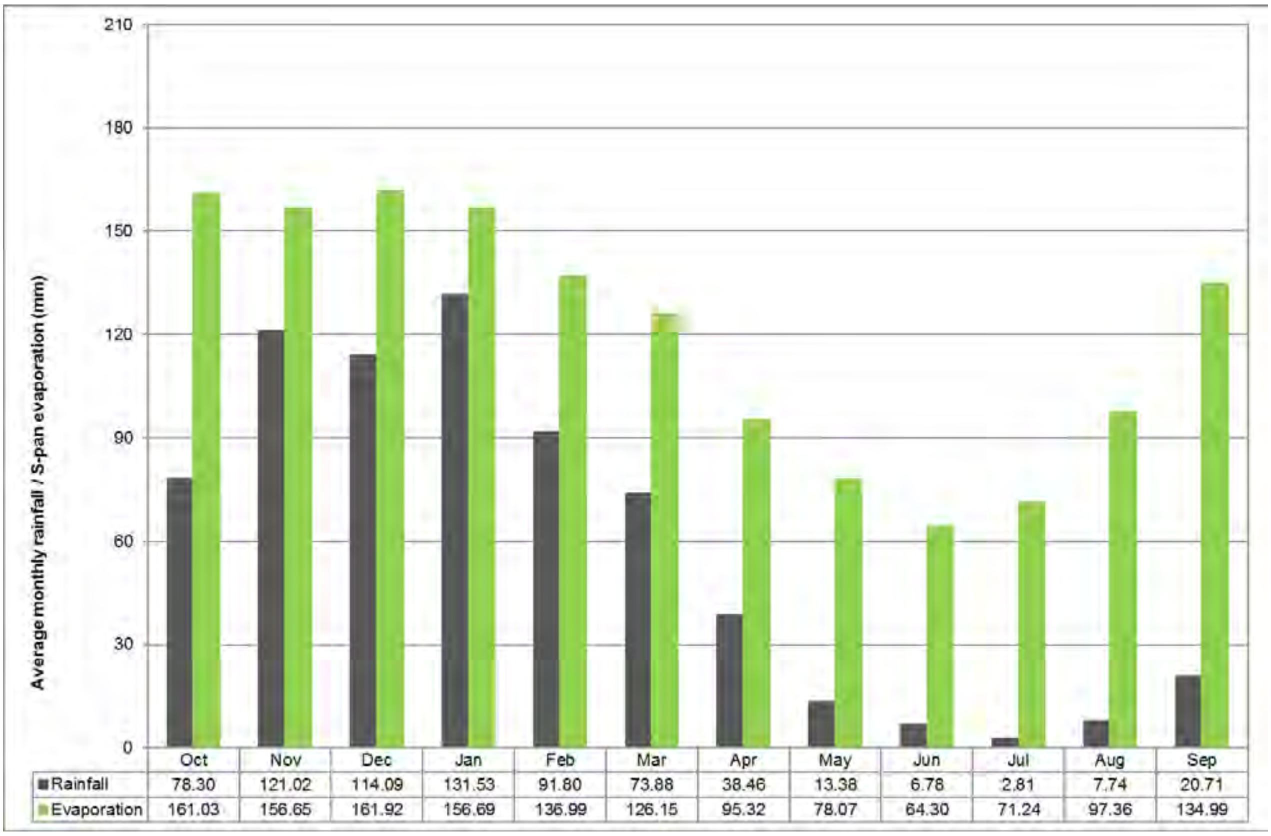
2.2 Topography and Drainage

iMpunzi mine complex is located within the Upper-Olifants River catchment. The main quaternary drainage regions are B11F, for the northern section and B11E for the southern section. The B11E catchment is drained by the Steenkoolspruit and B11B quaternary catchment drains towards Olifants River. The topography and drainage of the study area is illustrated in Figure 5, which typifying the undulating Highveld topography, which has been altered by past and current mining activities.

The two main rivers traversing the mine area are: Steenkoolspruit and Olifants River. The Steenkoolspruit flows north and is diverted around the South Pit. Steenkoolspruit joins the Olifants River on the eastern boundary of the mine area, upstream of the confluence with the Tweefonteinspruit. The Olifants Rivers flows east into the Witbank Dam.

2.3 Climate

The study area receives approximately 711.4 mm of rainfall per year according to the daily rainfall data obtained from the Department of Water and Sanitation (DWS) website. Station B1E001, which is situated 23 km to the north of Impunzi, was used to represent the climate at Impunzi. Rainfall and evaporation data were measured at the station from March 1964 to March 2009. The mean annual precipitation (MAP) for this period is 711.4 mm/a and the mean annual evaporation (MAE) is 1462.4 mm/a for a sunken pan. Figure 3 shows the average monthly rainfall and pan evaporation and Figure 4 shows the annual variation in rainfall and evaporation per hydrologic year.



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Rainfall	78.30	121.02	114.09	131.53	91.80	73.88	38.46	13.38	6.78	2.81	7.74	20.71
Evaporation	161.03	156.65	161.92	156.69	136.99	126.15	95.32	78.07	64.30	71.24	97.36	134.99

Figure 3: Average monthly rainfall and pan evaporation

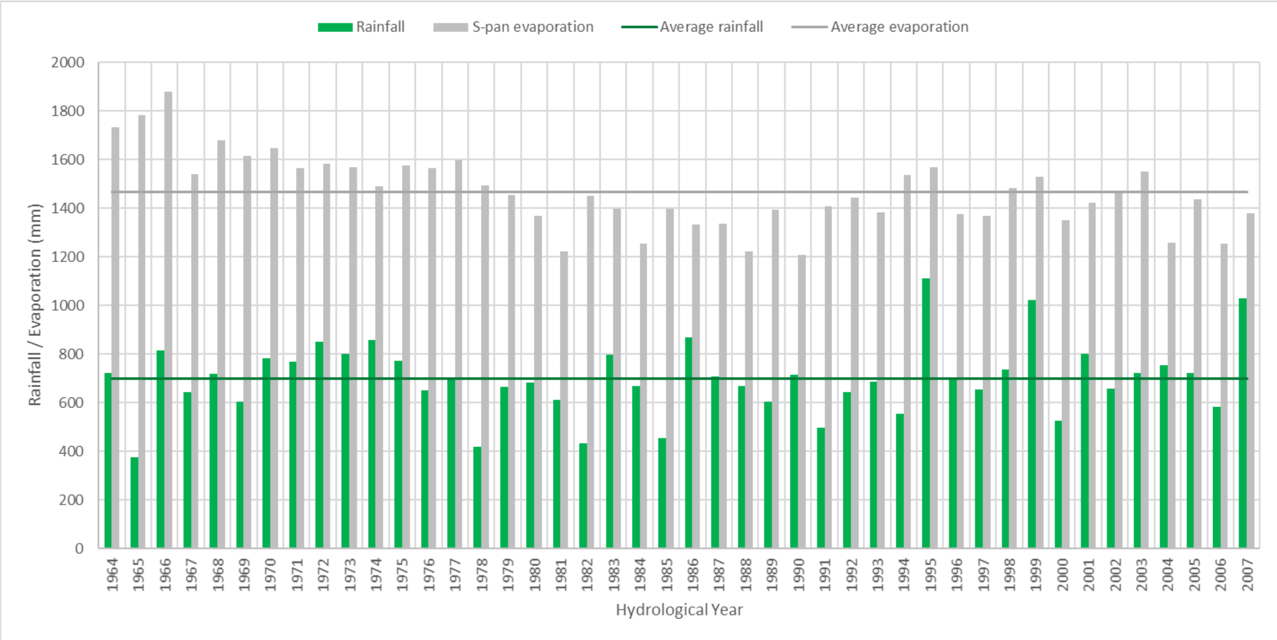


Figure 4: Annual rainfall and pan evaporation measured at Station B1E001

2.4 Geology

The regional geology in the study area is underlain by sediments of the Karoo Supergroup. The Karoo Supergroup comprise of the older Dwyka Formation at the base, which is overlain by the Ecca, Beaufort and Lebombo Groups.

The local geology in the study area comprises shale, carbonaceous shale, sandstone, and coal layers of the Ecca Group. The Vryheid Formation of the Ecca Subgroup is about 55 m thick and consists of shale and sandstone interbedded with five major coal seams, numbered 1 to 5 from the base, of varying thickness (1.5m - 9.0 m). The surface geology of the study area is presented in Figure 6.The iMpunzi Complex mines coal in the central-southern part of the Witbank Coalfield from the No. 2 and No. 4 Coal Seams.

A simplified geological stratigraphy for the iMpunzi area is presented in Table 1 the underlying geology has an apparent dip angle of 20° towards the south.

Table 1: Simplified Stratigraphy (Golder, 2015)

<table>
<tr><th>Period</th><th>Supergroup</th><th>Group</th><th>Formation</th><th>Lithology</th></tr>
<tr><td>Quaternary</td><td>-</td><td>-</td><td>-</td><td>Alluvium</td></tr>
<tr><td></td><td>-</td><td>-</td><td>-</td><td>Aeolian sand</td></tr>
<tr><td>Jurassic</td><td>-</td><td>-</td><td>-</td><td>Dolerite</td></tr>
<tr><td>Permian</td><td rowspan="3">Karoo</td><td rowspan="2">Ecca</td><td>Volkrust</td><td>Shale, subordinate sandstone</td></tr>
<tr><td rowspan="2">Carboniferous</td><td>Vryheid</td><td>Sandstone, Shale, Coal beds</td></tr>
<tr><td>-</td><td>Dwyka</td><td>Diamictite, shale</td></tr>
</table>

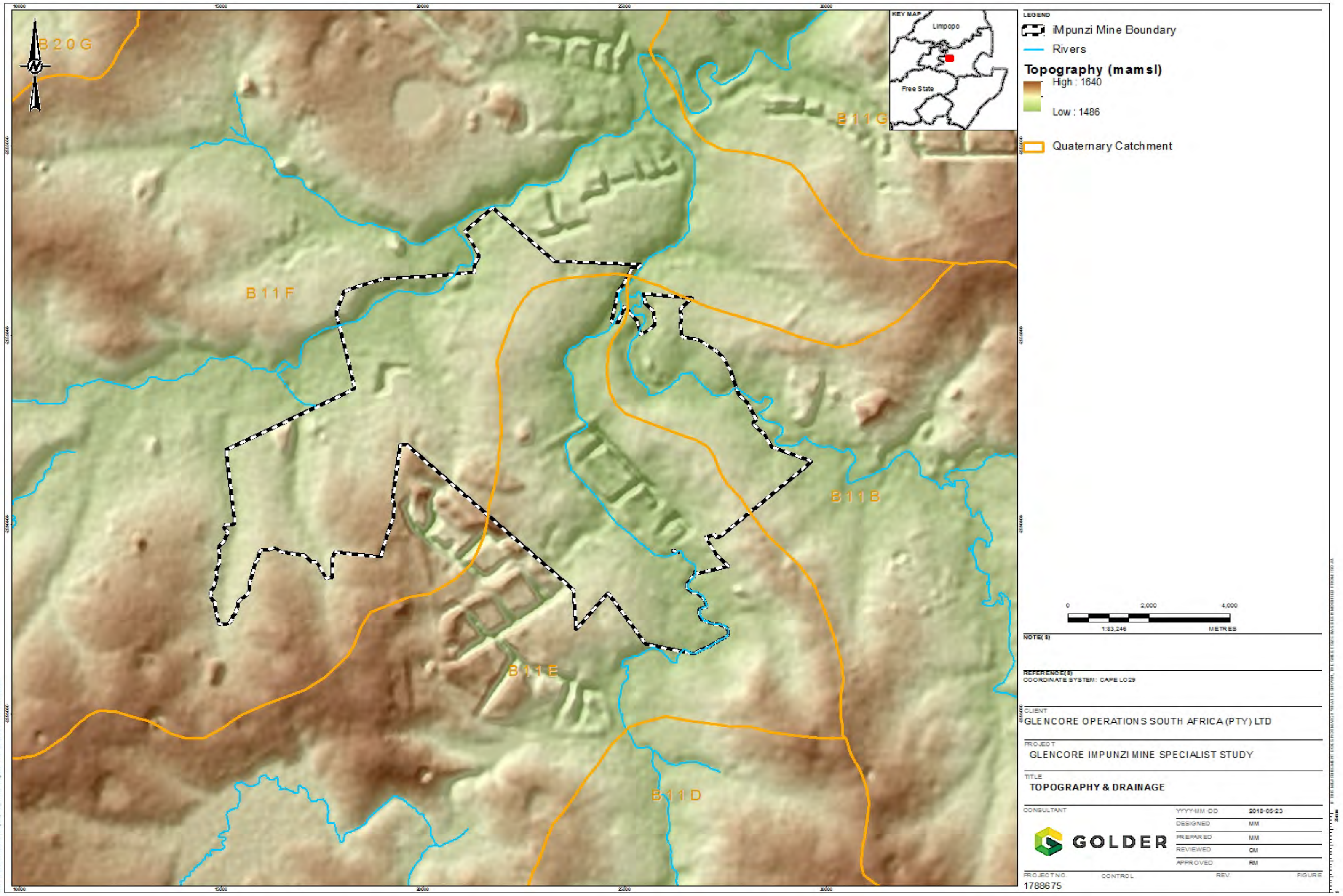


Figure 5: Topography and Drainage

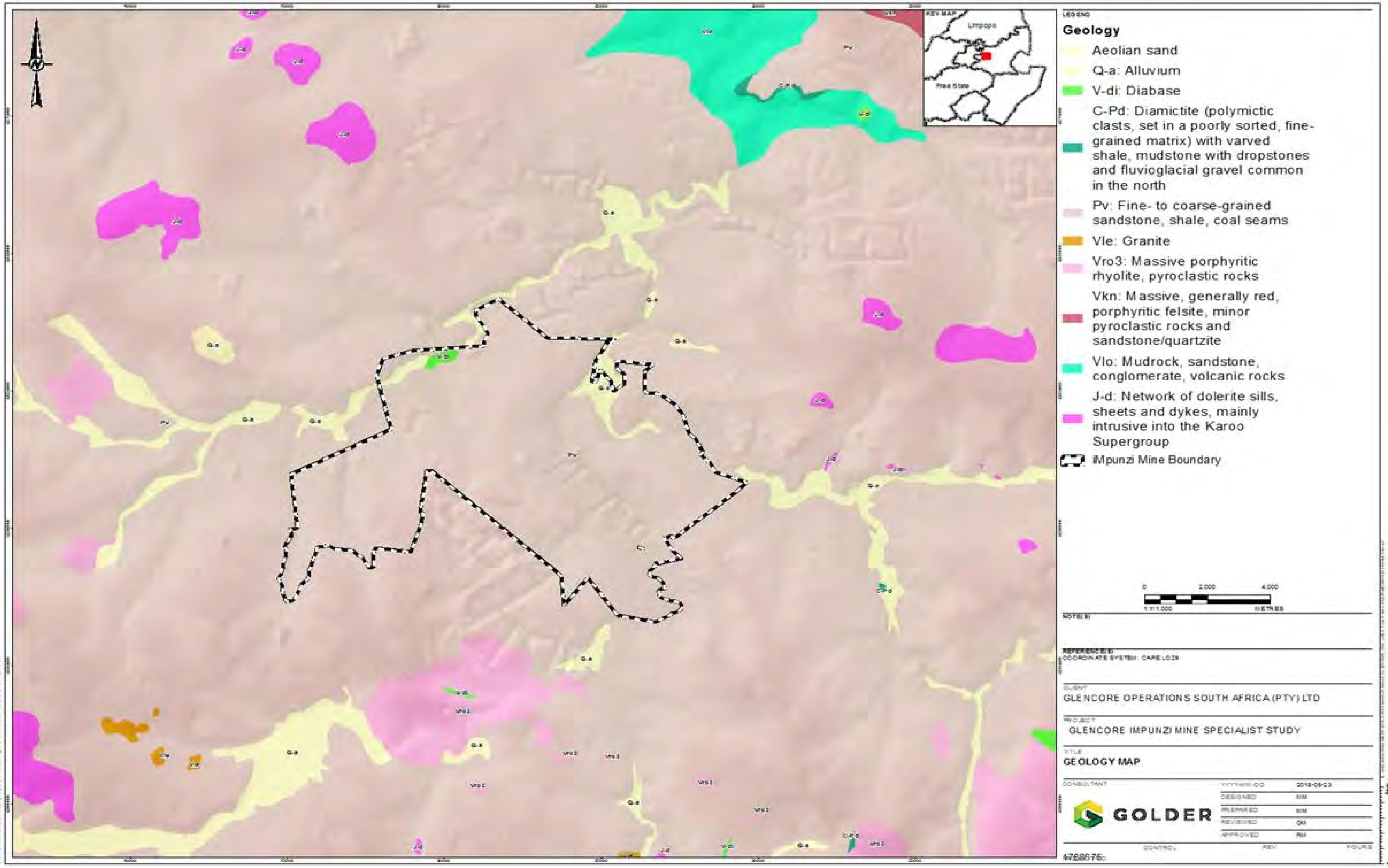


Figure 6: Geology of the study area

2.5 Hydrogeology

2.5.1 Current Groundwater Monitoring Boreholes

The current groundwater monitoring network at iMpunzi is illustrated in Figure 7 and the site name and coordinates are presented in Table 2.

Table 2: Current Groundwater Monitoring Sites locations

Site Name	Latitude	Longitude	Elevation (mamsl)
ACGF-1	-26.0826	29.2071	1562.6
ACGF-11	-26.0910	29.2249	1558.5
ACGF-12	-26.0996	29.2292	1550.3
ACGF-13	-26.0978	29.2216	1572.4
ACGF-4	-26.1098	29.2338	1543.0
ACGF-5	-26.0989	29.2578	1585.1
ACGF-7	-26.1230	29.2366	1546.1
ACGF-8	-26.1210	29.2297	1567.1
ACGF-9	-26.1194	29.2683	1549.8
ACGM-1	-26.1009	29.2336	1525.9
ACGM-1 Bottom	-26.1009	29.2336	1525.9
ACGM-2	-26.0735	29.2366	1547.5
ACGM-3	-26.1216	29.2528	1537.5
ACGM-3 Bottom	-26.1216	29.2528	1537.5
ACGM-4	-26.1191	29.2561	1529.6
ACGM-4 Bottom	-26.1191	29.2561	1529.6
ACGM-5	-26.0987	29.2188	1573.1
ACGM-5 Bottom	-26.0987	29.2188	1573.1
ACGM-6	-26.0986	29.2188	1567.1
ACGW-10	-26.1084	29.2086	1575.2
ACGW-11	-26.1052	29.2086	1560.3
ACGW-12	-26.1021	29.2095	1567.4
ACGW-13	-26.1140	29.2302	1572.1
ACGW-14	-26.1028	29.2155	1575.2
ACGW-15	-26.0821	29.2155	1539.9
ACGW-16	-26.1060	29.2232	1574.1
ACGW-17	-26.1060	29.2232	1574.1
ACGW-2	-26.0963	29.2189	1577.1
ACGW-25	-26.1110	29.2324	1575.0
ACGW-25s	-26.1107	29.2352	1543.6
ACGW-26	-26.1108	29.2354	1545.8

Site Name	Latitude	Longitude	Elevation (mamsl)
ACGW-26s	-26.1108	29.2354	1568.6
ACGW-27	-26.0987	29.2188	1578.4
ACGW-28	-26.0910	29.2249	1558.5
ACGW-30	-26.0996	29.2293	1546.8
ACGW-33	-26.0954	29.2417	1529.3
ACGW-35	-26.0976	29.2384	1529.9
ACGW-37	-26.0952	29.2440	1533.6
ACGW-5	-26.0927	29.2439	1531.4
ACGW-6	-26.1245	29.2426	1549.7
ACGW-7	-26.1224	29.2425	1538.3
ACGW-9	-26.1121	29.2227	1579.0
AEGM-1	-26.0938	29.2479	1542.0
AEGM-1 Bottom	-26.0938	29.2479	1542.0
AEGM-2	-26.0930	29.2563	1559.6
AEGM-3	-26.0882	29.2611	1531.0
AEGM-3 Bottom	-26.0882	29.2611	1531.0
AEGM-4	-26.1048	29.2694	1566.3
AEGM-5	-26.1106	29.2747	1566.6
AEGM-5 Bottom	-26.1106	29.2747	1566.6
AEGM-6 Bottom	-26.1153	29.2692	1542.3
AEGM-6 Top	-26.1153	29.2692	1550.2
AEGM-7	-26.1115	29.2668	1547.3
AEGM-7 Bottom	-26.1115	29.2668	1547.3
ATGF-2	-26.1123	29.1927	1590.4
ATGF-4	-26.0957	29.2020	1565.9
ATGF-5	-26.0995	29.1926	1579.0
ATGF-6	-26.1095	29.1520	1543.0
ATGF-7	-26.0992	29.1926	1575.9
ATGF-8	-26.0992	29.1926	1575.9
ATGM-1	-26.1115	29.1916	1594.8
ATGM-4	-26.1032	29.1667	1547.2
ATGM-4 Bottom	-26.1032	29.1667	1547.2
ATGM-5	-26.0921	29.2052	1553.3
ATGM-5 Bottom	-26.0921	29.2052	1553.3
ATGM-6	-26.0932	29.1699	1534.3

Site Name	Latitude	Longitude	Elevation (mamsl)
ATGM-6 Bottom	-26.0932	29.1699	1534.3
ATGO-1	-26.0817	29.1991	1550.2
ATGO-2	-26.0833	29.2013	1546.0
ATGO-3	-26.0832	29.2038	1544.9
ATGO-4	-26.0791	29.1922	1542.7
ATGO-5	-26.0784	29.1850	1534.7
ATGO-6	-26.0812	29.1861	1545.8
ATGO-7	-26.0859	29.1862	1545.5
ATGW-1	-26.0999	29.1843	1597.4
ATGW-10	-26.0989	29.1963	1581.0
ATGW-11	-26.0942	29.1744	1549.1
ATGW-12	-26.1001	29.1681	1539.7
ATGW-13	-26.0915	29.1872	1569.4
ATGW-13s	-26.0915	29.1872	1569.4
ATGW-14	-26.0914	29.1867	1564.2
ATGW-14s	-26.0914	29.1867	1564.2
ATGW-15	-26.0945	29.1859	1566.3
ATGW-2	-26.0935	29.1680	1542.5
ATGW-3	-26.0933	29.1704	1538.7
ATGW-4	-26.0977	29.1739	1550.1
ATGW-6	-26.0767	29.1914	1539.0
ATGW-7	-26.0769	29.1815	1543.1
ATGW-8	-26.0802	29.2028	1543.8
ATGW-9	-26.0799	29.2001	1539.6
BH07	26.1053	29.1837	-
BH08	26.1284	29.1728	-
BH09	26.1235	29.2246	-
BH12	-26.1216	29.2235	1572.6
BH13	-26.1235	29.2243	1570.9
BH14	-26.1236	29.2246	1568.2
DS06	-26.0868	29.2379	-
DS08	-26.0882	29.2611	-
DS09	-26.0938	29.2479	-
NB09	-26.0982	29.2765	-
NB11	-26.1295	29.2547	-

Site Name	Latitude	Longitude	Elevation (mamsl)
NB13	-26.1142	29.1696	-
PH BD-3	-25.7885	28.2932	1430.5
PH BS-3	-25.7883	28.2933	1411.0
PHGF-1	-26.0876	29.2036	1554.7
PHGF-2	-26.0982	29.2146	1574.1
PHGM-1	-26.1030	29.2192	1569.3
PHGM-1s	-26.1021	29.2110	1571.8
PHGM-3	-26.1345	29.2446	1572.4
PHGM-3	-26.1345	29.2446	1566.0
PHGM-3 Bottom	-26.1345	29.2446	1566.0
PHGM-4	-26.1469	29.2684	1538.8
PHGW-1	-25.7885	28.2933	1401.4
PHGW-2	-26.0635	29.2092	1529.5
PHGW-3	-26.1007	29.2055	1561.9
PHGW-4	-26.0970	29.2326	1545.7
PHGW-5	-26.0640	29.2058	1524.1
PHGW-6	-25.7883	28.2933	1411.0
PHGW-8	-26.1277	29.2517	1558.2
PHGW-8s	-26.1277	29.2517	1558.2
PHGW-9	-26.1021	29.2095	1565.3

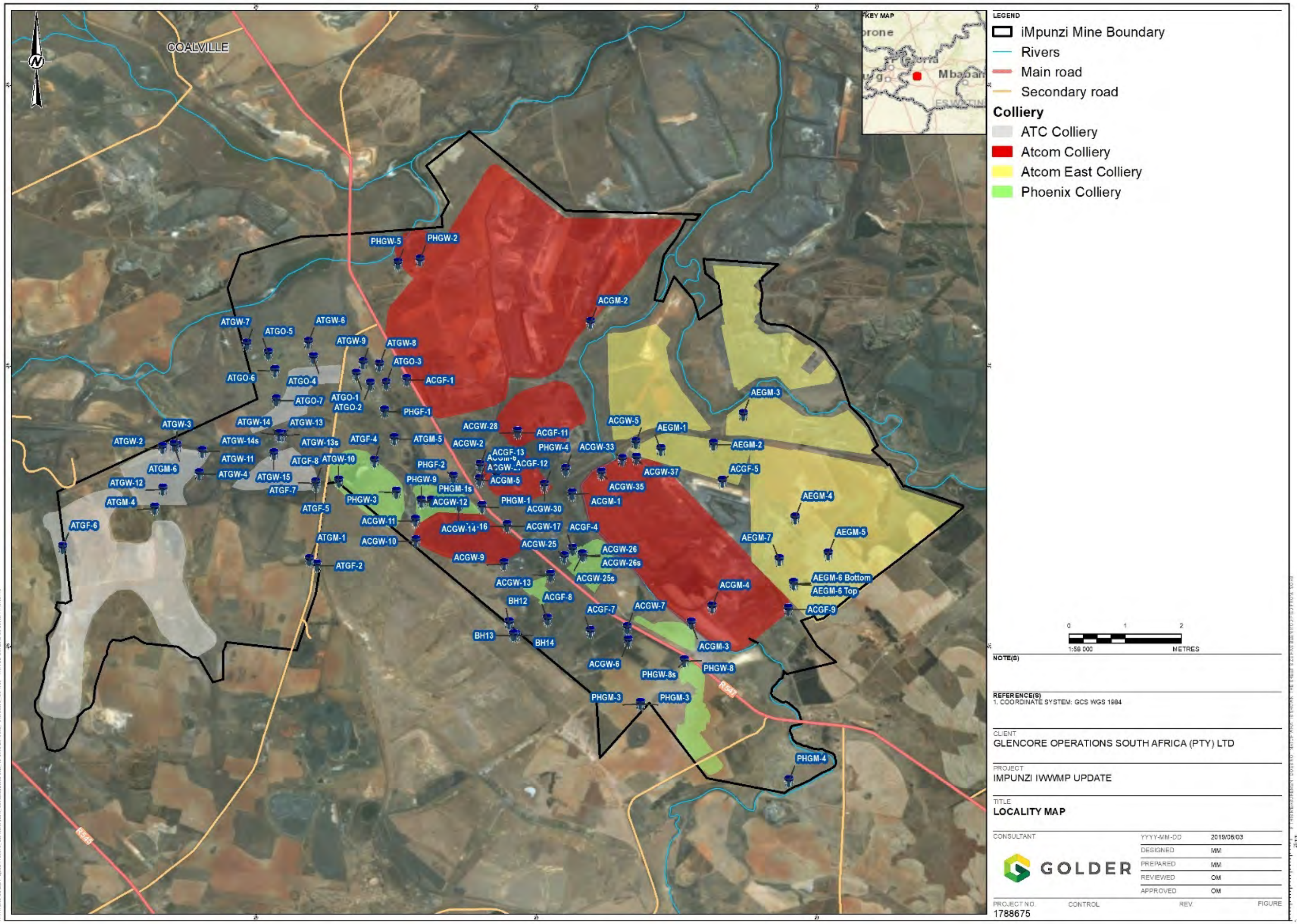


Figure 7: Current groundwater monitoring sites locations.

2.5.2 Previous Studies – Hydrogeology

Golder has previously undertaken Hydrogeological studies at iMpunzi including:

- Golder (2016) Groundwater Specialist Assessment at iMpunzi Office and Phoenix Pits (Report No.: 1538558-299322-2)
- Golder (2015) Phase I Groundwater Draft Report - ATCOM North Pan (Report no.: 13614989-13464-1)
- Golder (2015) Phase II & III Groundwater Draft Report -ATCOM North Pan (Report no.13614989-13464-1)
- Golder (2015) Phase III - Numerical Groundwater Flow Model to investigate Key Environmental Impacts (Report No.: 1772953-317054-1)
- Golder (2011) Groundwater Study at Xstrata ATCOM Operations, XSTRATA ATCOM South Pit and Beath Dump (Report No.: 12593-10317-8)

The data available in the previous studies undertaken by Golder is discussed in the following sections:

Golder (2016) Groundwater Specialist Assessment at iMpunzi Office and Phoenix Pits (Report No.: 1538558)

The above-mentioned study was undertaken as a requirement of the Environmental Impact Assessment (EIA) and Water Use License Application (WULA) associated with the proposed opencast mining operations at the Office and Phoenix Pits areas.

This study relied on the extensive groundwater level and groundwater quality database available for the site and field testing that was undertaken during previous studies. No additional field data was collected during the site visit.

- 2015 Water levels at 65 monitoring boreholes was made available.
- 2015 water quality data was made available for 69 sites.
- Slug test data of 7 boreholes, tested in 2011, were presented in this report.

  ACGF-11, ACGF-12, ACGF-13, ACGW-27, ACGW-28, ACGW-29 and ACGW-30

Golder (2015) Phase I Groundwater Draft Report - ATCOM North Pan (Report no.: 13614989-13464-1)

Golder undertook a hydrogeological study as part of a basic assessment and water use licenses application for the expansion of mining into the IMpunzi North Pan Area. Data used in this study is listed below.

- The 1:50,000 scale topographical sheets 2629AA and 2629AB;
- The 1:250,000 scale geological map sheet 2628 East Rand illustrating the geology of the site;
- The 1:500,000 scale hydrogeological map sheet 2526 Johannesburg illustrating the hydrogeology in the area of the site;
- Borehole data obtained from the Department of Water Affairs and Forestry, National Groundwater Data Base (NGDB); and
- Various groundwater quality chemical data sets as provided by the Client.

Golder (2015) Phase II & III Groundwater Draft Report - ATCOM North Pan (Report no.: 13614989-13464-1)

On completion of the baseline assessment, described above, Golder undertook a field program to further characterise the hydrogeological parameters of the site. The work undertaken is summarised below:

- Two pairs of monitoring boreholes (deep and shallow) were constructed by Ubuntu Rock Drilling Pty Ltd in close proximity to the North Pan. The drilling program started on 19th June 2015 and was completed on 20th June 2015. (IMP-BH1D & 1S and IMP BH2D and 2S);
- Water level measurements of the newly drilled boreholes;
- Slug testing of Imp-BH1S and IMP-BH2S. The tested conductivities were 0.054 m/d and 0.078 m/d respectively; and
- Based on client data and the field data undertaken, a conceptual model was developed which in turn was translated to a numerical model to aid in determining the inflows and impacts associated with mining the northern pit.

Golder (2011) Groundwater Study at Xstrata ATCOM Operations, ATCOM South Pit and Beath Dump (Report No.: 12593-10317-8)

In 2011 Golder undertook a characterisation study in vicinity of the ATCOM South Pit and Beath Dump for Xstrata Coal. The objectives of the work were to determine the depth of weathering along the northern boundary of the South Pit, and to establish the extent of groundwater quality impact from Beath Dump.

The following field program was followed as part of this study:

- A geophysical resistivity survey along the northern boundary of South Pit;
- Drilling of boreholes: Seven boreholes along the geophysical traverse at South Pit and Nine boreholes around Beath Dump;
  - Slug testing of seven boreholes to assess aquifer parameters (ACGF-11, ACGF-12, ACGF-13, ACGW-27, ACGW-28, ACGW-29 and ACGW-30); and
- Groundwater sampling of three boreholes at South Pit and nine boreholes at Beath Dump

In summary Golder has undertaken the following data collection between 2011 -2017:

- Drilled boreholes
  - 2017: Eight Boreholes drilled (One is reflective of rehabbed areas but it is presently combusting) and the remainder are representative of undisturbed sandstone, shale and coal.
  - 2015: Four boreholes (Two shallow and two deep) the boreholes were drilled into undisturbed shale prior to the mining of north pit.
  - ▪2011: 15 boreholes were drilled in vicinity of the Beath dump and South Pit.
- Aquifer Testing - Based on the reviewed reports Golder has not undertaken any pumping tests at the IMpunzi site.
  - **2017**: Slug testing of two boreholes representative of unmined shale and coal (Low permeability: 6e-8 m/d – 6e-5 m/d)
  - **2015**: Slug testing of two boreholes (Imp-BH1S and IMP-BH2S. The tested conductivities were 0.054 m/d and 0.078 m/d respectively).

- **2011**: Testing of seven boreholes (ACGF-11, ACGF-12, ACGF-13, ACGW-27, ACGW-28, ACGW-29 and ACGW-30). The boreholes were drilled in areas underlain by underground mine workings.

2.6 Mining Activities

The iMpunzi complex has undergone much underground and opencast mining since 1936, as well as rehabilitation in some areas. The historical mining activities considered for the groundwater flow and transport model are illustrated in Figure 8 – Figure 10 for underground and opencast mining for Seams 1, 2 and 4.

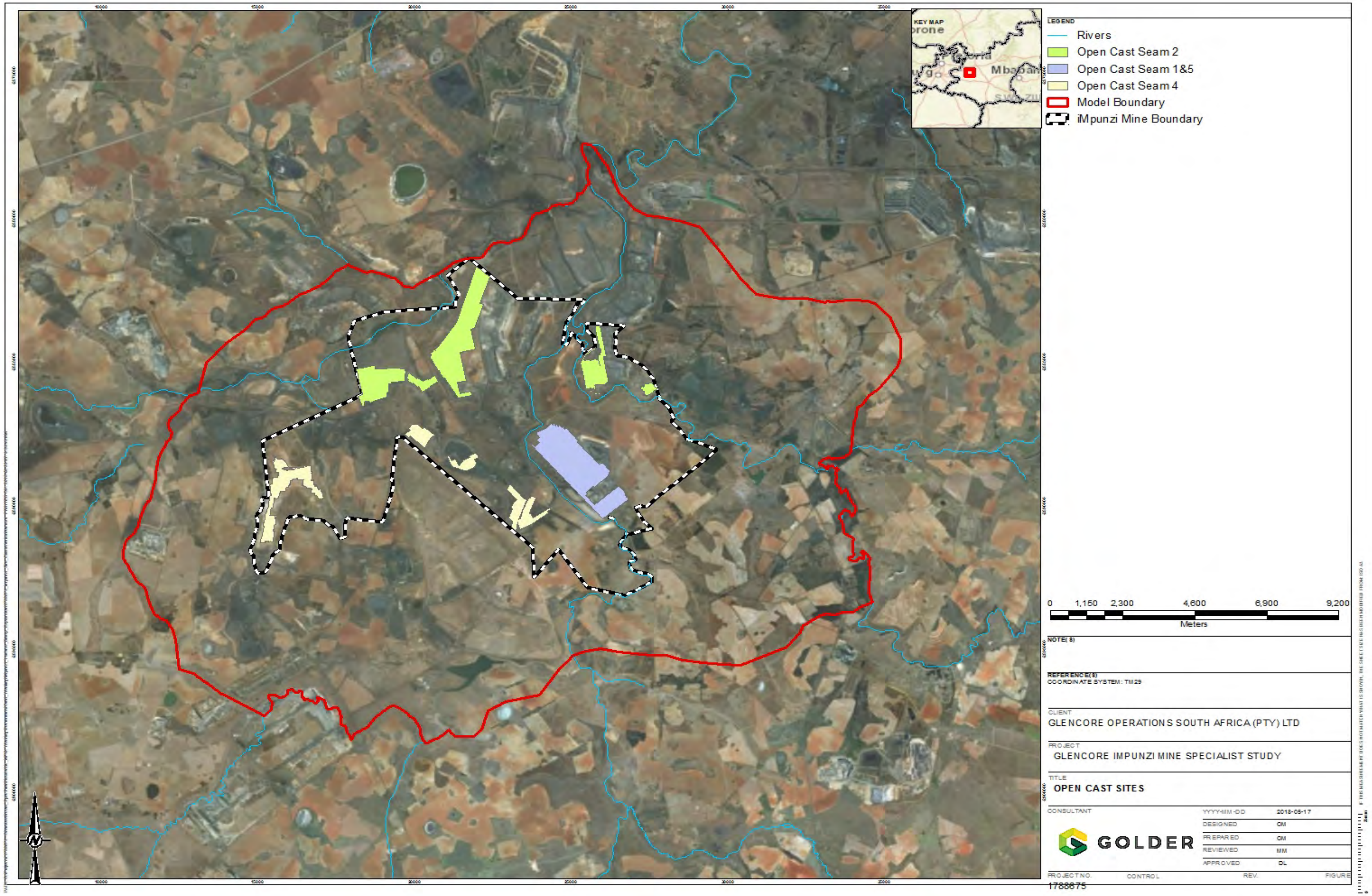


Figure 8: Open Cast Sites, iMpunzi mine area

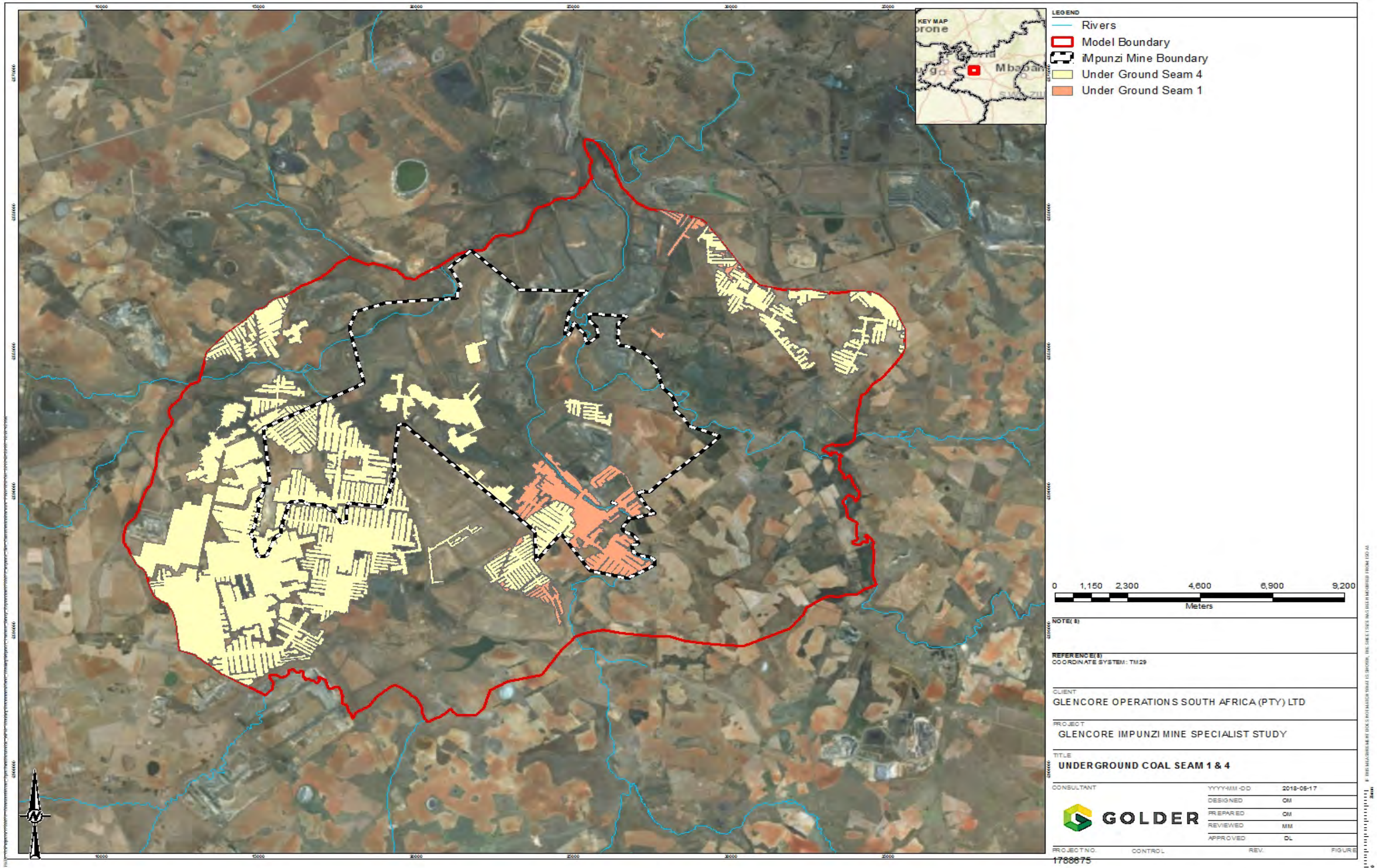


Figure 9: iMpunzi area underground workings Seam 1 and 4

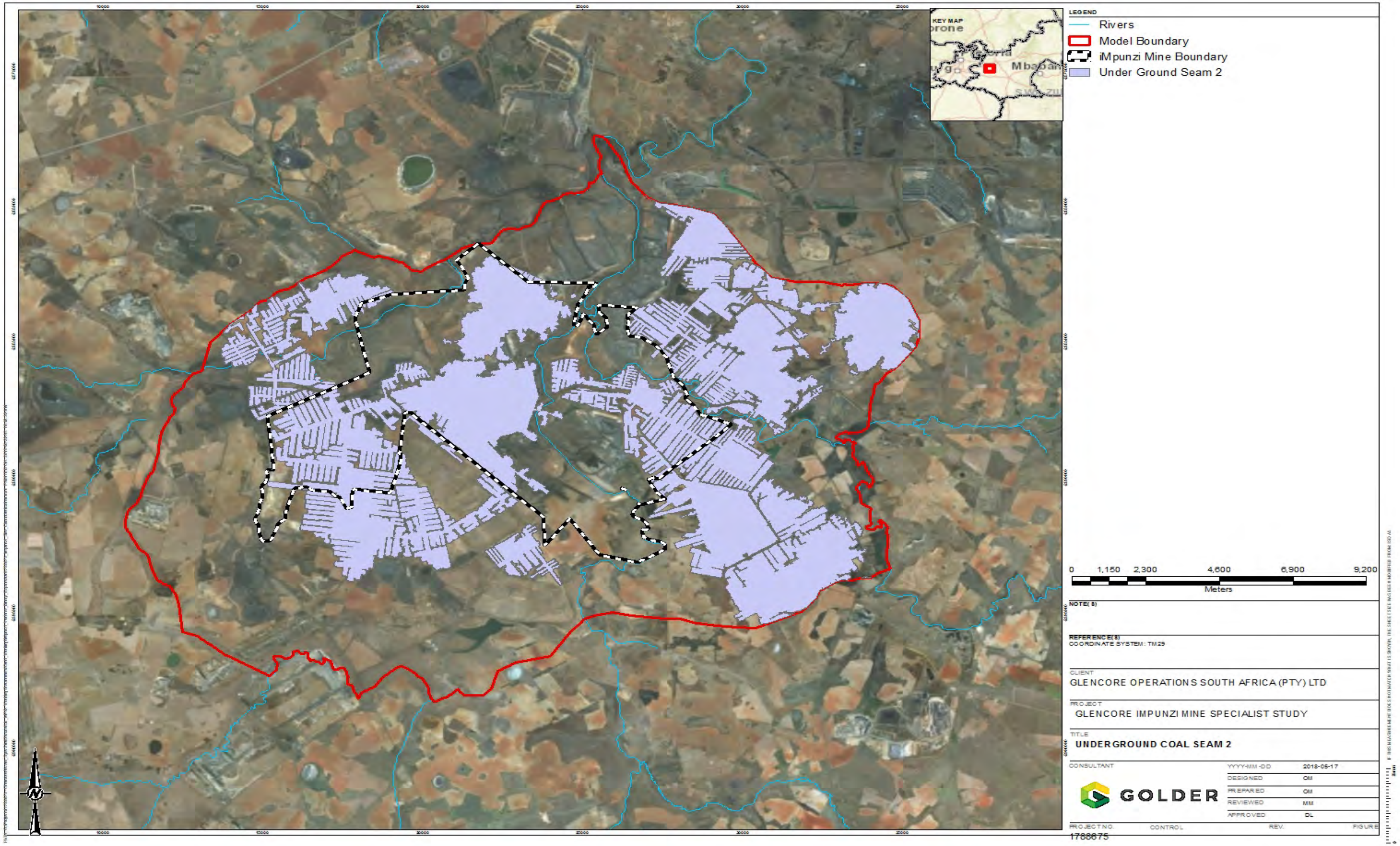


Figure 10: iMpunzi area underground workings Seam 2

2.7 Previous Studies – Geochemistry

Golder has previously undertaken Hydrogeological studies at iMpunzi including:

Golder (2014) iMpunzi Fines Paddocks: Geochemistry Specialist Study (Report no.: 13615344)

Golder undertook a study at iMpunzi Mining Complex in 2014 to assess the geochemical risks and the potential water quality impacts of the mine waste to be used in the construction of the paddocks (coarse discard) or dumped in the paddocks (coal fines), and thus guide the development of waste and water management mitigation measures for the paddocks and the ATCOM South Pit.

Sampling and characterisation of the discard and coal fines was undertaken and it was concluded that the discard material has a potential to be acid-generating in the long-term and the coal fines has an uncertain potential to generate an acidic drainage in the long-term. The constituents of concern that can be produced by the leaching of this material under the prosed site conditions includes total dissolved solids, ammonia, arsenic, boron, calcium, fluoride, magnesium, manganese, molybdenum, selenium and sulphate.

Golder (2018) Geochemistry Study in terms of the iMpunzi Water Use Licences Preliminary Report (Report no.: 1772953-316626-1)

Golder undertook a geochemistry study at iMpunzi Mining Complex in 2018 covering numerous dumps and other sources, including ATC Dump, North Dump, Venture Void Dump, Linear Stockpile and Fringe Lagoons. It was determined that the discard is acid generating and is likely to produce seepage with elevated levels in calcium, total dissolved solids, electrical conductivity, sulphate, manganese, aluminium and iron. Slurry has low acid-generating potential and is likely to produce seepage with elevated levels in electrical conductivity, sulphate, calcium, manganese and aluminium.

2.8 Mining Residues Geochemical Properties

The management of mine residues (stockpiles and waste deposits) is governed by regulations under the National Environmental Management: Waste Act (Act no. 59 of 2008): ***Regulations Regarding the Planning and Management of Residue Stockpiles and Residue Deposits from a Prospecting, Mining, Exploration or Production Operation*** (GN R. 632 of 2015), which provide for the characterisation of mine residues (all forms of mine waste and stockpiles) as the basis for a risk assessment.

Golder's approach to characterisation of mine residues incorporates:

- Waste characterisation in terms of GN R. 632 of 2015, summarised in Figure 8;
- Waste assessment in term of GN R. 635 of 2013, since this approach, while no longer the driver of pollution control barrier design, provides a useful reference point for engagement with the regulator as well as for the development of a "compliant design", should this prove desirable; and
- Waste classification in terms of GN R. 634 of 2013, since all waste generators must ensure that their waste is within 180 days of generation and re-classified every 5 years and the classification is required in terms of SANS10234 (based on the Global Harmonised System) for the transport of waste materials.

The waste characterisation is discussed in this section. The waste assessment and classification are discussed in the NEM:WA Mineral Residue Risk Assessment Report.

2.8.1 Sample Record

Geochemical sampling of mine waste and coal samples was carried in 2017 by Golder, this included sampling of coarse discard and slurry as described in Table 3. Discrete grab samples were collected with a plastic hand shovel from accessible positions on old and new coarse and fine discard disposal facilities as well as coal stockpiles.

Table 3: Geochemistry Study Sample List

Sample ID	Site Name	South	East	Comment	Material type
F2-S	Fringe 2	26˚07.626'	029˚14.680'	Fringe 2 stockpile of slurry being mined from pond. Collected a number of scoops around the positions.	Slurry
		26˚07.537'	029˚14.536'		
F3-S	Fringe 3	26˚05.893'	029˚11.749'	Collected a number of scoops from a pile to the immediate west of Fringe 3.	Slurry
		26˚05.916'	029˚11.761'		
EV-S	E-Void	26˚05.849'	029˚11.829'	Void was not accessible. Collected a number of scoops from piles on Fringe 3 of slurry mined from the void.	Slurry
		26˚05.853'	029˚11.861'		
A2-D	ATC 2	26˚06.086'	029˚09.975'	Collected fine to gravel sized particles of recently exposed discard on bench that was being mined	Discard
		26˚06.902'	029˚09.934'		
		26˚05.899'	029˚09.914'		
		26˚05.884'	029˚10.021'		
		26˚05.920'	029˚10.022'		
		26˚05.980'	029˚10.027'		
VV-D	Venture void	26˚05.305'	029˚11.143'	Fine to gravel sized particles of discard	Discard
		26˚05.181'	029˚11.395'		
		26˚05.152'	029˚11.402'		
		26˚05.110'	029˚11.316'		
		26˚05.128'	029˚11.309'		
		26˚05.116'	029˚11.393'		
AS-S	ATCOM South	26˚07.089'	029˚15.168'	Collected recent slurry from the southern ATCOM paddock.	Slurry
AS-D	ATCOM	26°06.887'	029°14.789'	Collected fine to gravel sized discard from paddock wall.	Discard
		26°06.886'	029°14.800'		
		26°07.072'	029°15.086'		
		26°07.084'	029°15.073'		
		26°07.091'	029°15.084'		

Sample ID	Site Name	South	East	Comment	Material type
		26°07.098'	029°15.102'		
ND-D	North Dump	26°03.734'	029°12.549'	Collected fine to gravel sized discard	Discard
		26°03.676'	029°12.607'		
		26°03.650'	029°12.629'		

2.8.2 Environmental Mineralogy

The mineralogical results of discard and slurry samples collected from various sources at iMpunzi are summarised in Figure 11 -detailed results are provided in APPENDIX C. The mineralogical analysis was aimed at identifying minerals that have a potential of generating acidity (sulphides and sulphates) and neutralisation potential (including carbonate and silicate minerals). It should be noted that the carbonaceous phases (organic matter or macerals) is represented by the phase "Organic C" in all the samples (Figure 11).

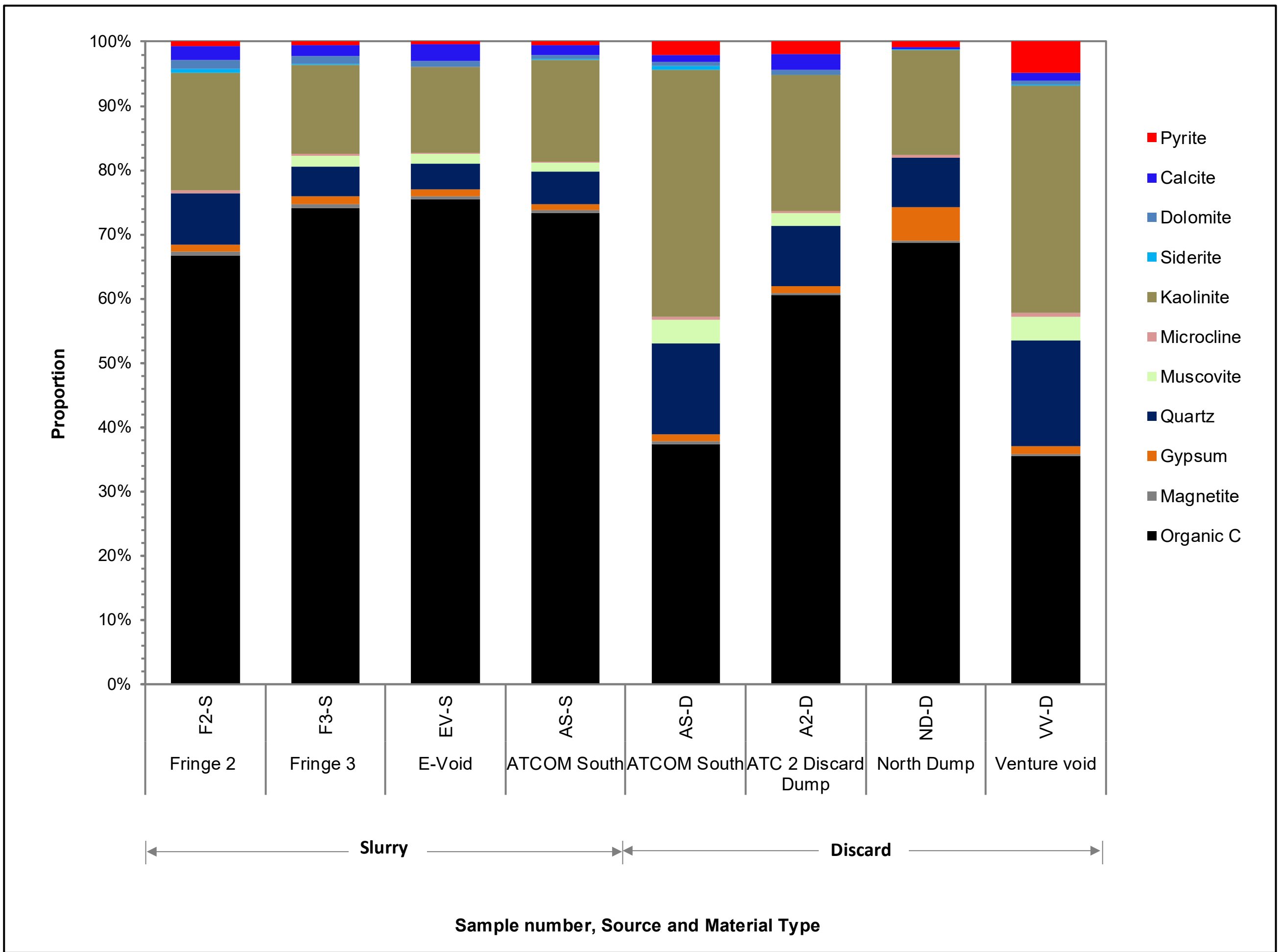


Figure 11: Mineralogical composition of iMpunzi discard, slurry, spoils and coal samples

Pyrite (0.42-0.68 wt.%) occurred as a rare[1] phase in slurry samples and was a rare to minor phase in discard samples (0.9-4.8 wt.%). The sulphide proportion was relatively low in washed coal from Linear stockpile (0.46 wt.%) compared to raw coal from the different pits (0.87-2.7 wt. %).

Carbonate minerals calcite (0.18-2.5 wt.%) and dolomite (0.09-1.3 wt.%) were detected as rare to minor phases in slurry and discard samples; and siderite (0.03-0.56 wt. %) was a rare phase in all samples except one slurry sample from E-Void where it was not detected. Silicate minerals kaolinite (13-39 wt. %), muscovite (not detected to 3.7 wt.%) and microcline (0.18-0.62 wt. %) were also present in the discard and slurry samples (Figure 11).

Secondary minerals magnetite (Fe_2O_3) and gypsum ($Ca(SO_4).2H_2O$), a hydrate sulphate mineral, were present as rare to minor phases in all discard and slurry samples indicating oxidation of pyrite in the different materials.

The bulk of the neutralisation capacity in the discard and slurry materials is expected to be provided by carbonates (dolomite and calcite), which are fast-reacting (dissolving) buffering minerals. Although siderite is a carbonate mineral, it does not have a net neutralisation capacity under aerobic conditions due to the oxidation and hydrolysis of iron, which produces equivalent acidity to that consumed by carbonates (MEND, 2009). Additional neutralisation is expected to be provided by silicate minerals albeit at a slow rate as the detected silicate minerals are slow to very slow weathering.

2.8.3 Acid Base Accounting

The acid base accounting results of discard and slurry from the different mine waste facilities are provided in Table 4.

The total Sulphur content of discard (1.6%-3.8%) and slurry (0.59%-0.74%) was generally high. The sulphide content was also high in discard (0.62%-3.6%) and slurry (0.28%-0.47%). Sulphate content was very low (0.05%-0.071%) except for the discard sample from North dump; and the content of other Sulphur species varied from 0.12%-0.51%, with relatively high content being recorded for discard samples from North dump and ATC 2 discard dump.

Bulk neutralization potential (Bulk NP) was generally high in the slurry (43-54 kg $CaCO_3$ eqv t^{-1}) and discard (39-53 kg $CaCO_3$ eqv t^{-1}), except the sample from North dump, which had nil neutralization potential. The carbonate neutralization potential (CaNP) for all samples (58-1068 kg $CaCO_3$ eqv t^{-1}) was higher than Bulk NP indicating that siderite represented a significant proportion of total carbonates in the samples of all materials. As already noted, siderite have limited neutralising capacity under oxidising field conditions as ferrous iron is an extra source of acidity due to the strong hydrolysis of the ferrous iron in solution (MEND, 2009).

The near-neutral paste pH (6.7-7.6) recorded for all spoils and three discard samples indicates sufficient reactive NP to buffer acidity generated by the initial oxidation of sulphides during the testing procedure in the discard materials from ATCOM South paddock walls, ATC2 dump and Venture void; and slurry residue facilities. The discard materials from the North dump had an acidic pH (5.0) confirming insufficient reactive NP to buffer acidity generated by the initial oxidation of sulphides during the testing procedure. There is generally excess buffering capacity in the slurry materials, with Bulk NP exceeding acid potential (AP) in all samples. The discard materials generally have insufficient buffering capacity with AP exceeding Bulk NP in all samples.

Classification of acid rock drainage (ARD) potential show that all the discard samples are potentially acid generating (PAG) per the guidelines of Morin and Hutt (2007) and MEND (2009). All slurry samples classify as not potentially acid generating (Non-PAG) - Figure 12. Classification using the guidelines of Price et al. (1997) and Soregaloli and Lawrence (1997) shows that all discard samples are likely to generate ARD and all slurry samples have a low ARD generation potential (Figure 13).

[1] Semi-quantitative classification of mineral phases: dominant (>40% of the mineral fraction), major (10-40%), minor (2-10%), accessory (1-2%) and rare (<1%)

In summary, slurry samples have a low risk of acid-generation, whereas coarse discard have moderate to high risk of acid-generation, with the highest risk from North Dump discard.

Either sulphide sulphur or total sulphur content can be used to estimate AP and classify ARD potential. The overall classification of samples' AP was based on total sulphur content, since this is conservative[2]. However, there was no major difference in classification of the slurry and discard samples based on sulphide sulphur and total sulphur-based AP (Table 4).

[2] If the sulphates present in the samples are secondary minerals (ARD products), then using sulphide sulphur content could under-estimate ARD potential. On the other, if substantial amounts of organic sulphur are present, then use of total sulphur content could over-estimate ARD potential.

Table 4: Acid Base Accounting results for discard and slurry

Sample ID	Source	Material Type	Paste pH	Total Sulphur	Sulphide Sulphur	Sulphate Sulphur	Sulphur (Other)	Total Carbon	Organic Carbon	Inorganic Carbon	[1]Bulk NP	[1]CaNP	[2]SAP	[2]TAP	[3]SNNP	[3]TNNP	[4]SNPR	[4]TNPR	Classification	
			s.u	%							kg $CaCO_3$/T						no units		Based on SNPR	Based on TNPR
F2-S	Fringe 2	Slurry	7.6	0.74	0.47	0.046	0.22	51	49	2.3	54	192	15	23	40	31	3.7	2.4	Non-PAG	Non-PAG
F3-S	Fringe 3	Slurry	7.4	0.59	0.31	0.007	0.27	58	55	3.3	47	275	10	18	37	28	4.8	2.5	Non-PAG	Non-PAG
EV-S	E-Void	Slurry	7.7	0.69	0.28	0.053	0.36	58	56	2.3	47	192	8.6	21	38	25	5.4	2.2	Non-PAG	Non-PAG
AS-S	ATCOM South	Slurry	7.6	0.70	0.35	0.065	0.28	59	46	13	43	1068	11	22	32	22	3.9	2.0	Non-PAG	Non-PAG
AS-D		Discard	6.9	1.8	1.7	0.011	0.09	26	24	2.2	39	183	53	56	-14	-17	0.73	0.69	PAG	PAG
A2-D	ATC 2 Discard Dump	Discard	7.1	1.9	1.6	0.036	0.30	47	38	8.2	53	684	49	60	3.4	-7.2	1.1	0.88	Uncertain	PAG
VV-D	Venture void	Discard	6.7	3.8	3.6	0.071	0.18	25	23	1.5	44	125	111	119	-68	-76	0.39	0.37	PAG	PAG
ND-D	North Dump	Discard	5.0	1.6	0.62	0.511	0.51	54	49	4.4	0	367	19	51	-19	-51	0.01	0.01	PAG	PAG

Notes

[1]Bulk NP is NP measured by Sobek titration. CaNP is NP calculated on the basis of inorganic carbon LECO analysis. Measured NP is used for the NPR calculation

[2]SAP - acid potential based on sulphide sulphur; TAP - acid potential based on the total sulphur content

[3]SNNP - the difference between bulk NP and SAP; TNNP - the difference between bulk NP and TAP

[4]SNPR - Ratio of SAP and bulk NP; TNPR - Ratio of TAP and bulk NP

PAG – Potentially acid generating; Non-PAG – not potentially acid generating

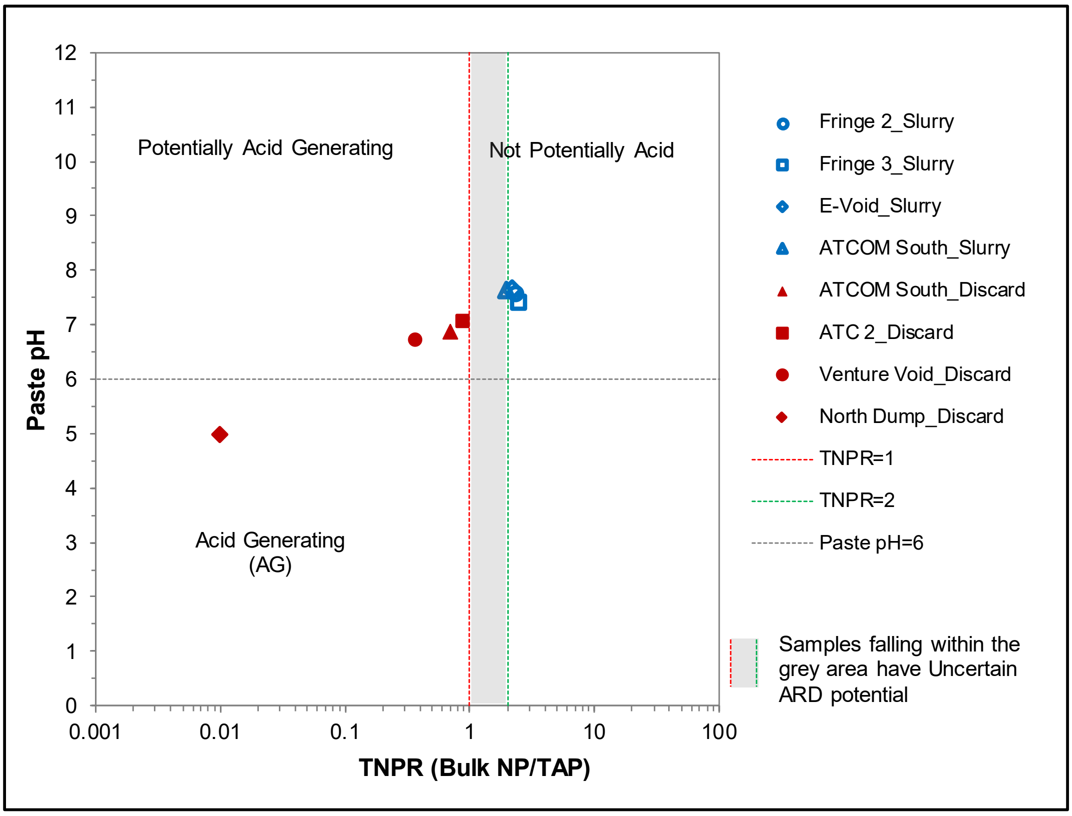


Figure 12: Paste pH versus total sulphur NPR (TNPR) of discard and slurry samples

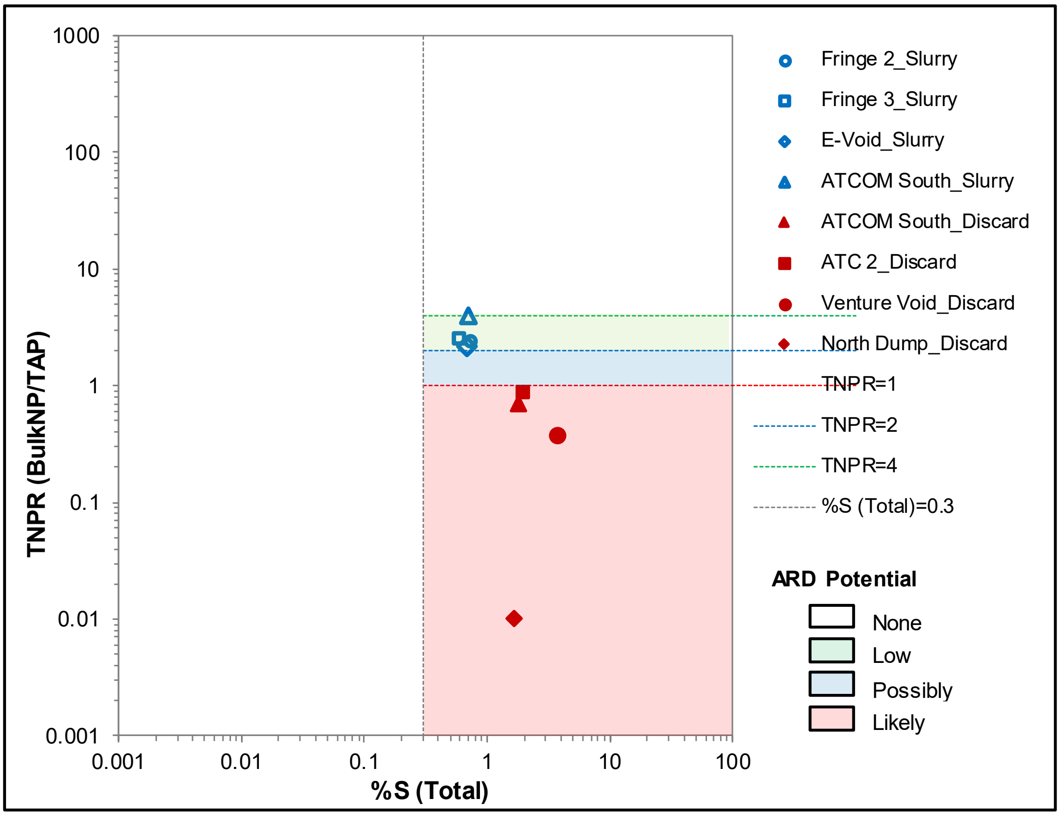


Figure 13: Plot of net potential ratio (TNPR) versus total sulphur content (%S) of discard and slurry samples

2.8.4 Whole Rock

The extent of elemental enrichment in the discard and slurry samples was assessed using the geochemical abundance index (GAI). GAI compares the measured concentration of an element with the estimated median crustal abundance after Fortescue (1992) and Price (1997), using the equation:

$$GAI = log_2[Cn/1.5 \times Bn]$$

where Cn is the concentration of the element in the sample and Bn is the crustal abundance of that element.

The GAI is expressed in integer increments from 0 through to 6, where a GAI of 0 indicates the element is present at a concentration similar to or less than the crustal abundances; GAI of 3 corresponds to a 12-fold; and so forth, up to a GAI of 6, which indicates a 96-fold or greater enrichment above the median crustal abundances.

The elements that were found to be enriched in at least one sample of the different mine residue materials are provided in Table 5. The GAI values are presented in APPENDIX C.

Table 5: Geochemical Abundance Index for discard and slurry samples

Sample ID	Material Type	Source	Elements with GAI > 0 *(Elements with GAI > 3 are highlighted in bold)*
F2-S	Slurry	Fringe 2	As, B, **Bi, C,** Li, **Se, Te**
F3-S		Fringe 3	B, **Bi, C,** Li, **S, Se, Te,** W
EV-S		E-Void	B, **Bi, C, S, Se, Te**
AS-S		ATCOM South	As, B, **Bi, C,** Ge, Li, P, **S, Se, Te**
AS-D	Discard	ATCOM South	Ag, As, **Au,** B, Ba, **Bi, C,** Hg, **Li**, Mo, P, Pb, **S,** Sb, **Se**, Sn, **Te,** W
A2-D		ATC 2 Discard Dump	As, B, **Bi, C,** Hg, Li, Mo, P, **S, Se, Te, W**
VV-D		Venture void	As, Au, B, **Bi, C**, Hg, Li, Mo, **S**, Sb, **Te**
ND-D		North Dump	As, B, **Bi, C,** Hg, Li, Mo, **S,** Sb, **Se**, **Te**

The discard and slurry materials at iMpunzi are enriched (in decreasing order) in carbon, bismuth, sulphur, selenium, tellurium, tungsten, lithium, arsenic, boron, molybdenum, phosphorus and mercury. Sulphur, selenium, arsenic, boron, mercury and molybdenum are environmentally significant as they are associated with sulphides, which are fast weathering minerals. Thus, these elements are potential constituents of concern (PCOCs) from the different discard and slurry stockpiles at iMpunzi. The other enriched elements, e.g. tungsten and bismuth, are mainly insoluble and therefore not environmentally significant.

2.8.5 Short Term Leach

Australian standard leaching procedure (ASLP) leach tests were carried out on discard and slurry samples, in order to obtain indications of the potential drainage quality and PCOC from the mine residue dumps at iMpunzi. These short-term leach tests measure readily soluble components of geological materials but do not predict long term water quality. Water-rock interactions often develop over periods of time that are much greater than can be represented in an 18 to 24-hour extraction test (INAP, 2010).

The results of leach tests are summarized and compared with DWAF (1996) water quality guidelines in Table 6 where exceedances of guidelines are highlighted. The leach tests results are also illustrated in Figure 14 and Figure 15.

2.8.5.1 Discard Dumps drainage

The discard materials from ATCOM south paddock walls, ATC 2 dump and Venture void are likely to produce predominantly near-neutral, low-metal drainage upon exposure to rainfall whilst drainage from the North Dump is likely to near-neutral to acid rock drainage with low metal content (Figure 14 and Figure 15). The following elements are likely to exceed water quality guidelines in drainage from the discard materials as per Table 6:

- North dump: The pH and levels of total dissolved solids, electrical conductivity (EC), sulphate, calcium and manganese are likely to exceed at least one DWAF (1996) water quality guidelines;
- Venture dump: The levels of electrical conductivity and manganese are likely to exceed domestic and irrigation water quality guidelines; and sulphate, aluminium and calcium are likely to exceed domestic water quality guidelines;
- ATCOM South paddock discard: The levels of calcium and iron are likely to exceed domestic use water quality guideline whilst manganese is likely to exceed irrigation water quality guideline; and
- ATC 2 discard: Calcium is likely to exceed domestic use water quality guidelines.

2.8.5.2 Slurry facilities drainage

The slurry materials from all the sampled sources are likely to produce near-neutral, low-metal drainage upon exposure to rainfall (Figure 14 and Figure 15). The following elements are likely to exceed water quality guidelines in drainage from the slurry facilities as per Table 6.

- ATCOM South paddock slurry: The level of electrical conductivity is likely to exceed DWAF (1996) irrigation water use quality guideline, whilst sulphate and calcium are likely to exceed domestic use water quality guidelines;
- E-Void slurry: The levels of aluminium and calcium are likely to exceed domestic use water quality guidelines;
- Fringe 3 slurry: The levels of calcium and sulphate are likely to exceed domestic use water quality guidelines whilst manganese is likely to exceed irrigation water quality guideline.
- Fringe 2 slurry: The levels of calcium are likely to exceed domestic use water quality guideline.

Table 6: ASLP leach testing (1:20 solid: liquid) results compared to water quality standards

*Potential Constituent of Concern	Units	South African DWAF (1996)			Slurry				Discard			
		Domestic Use	Livestock	Irrigation	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
pH	s.u	6-9	ng	6.5-8.4	7.4	7.2	7.4	7.3	7.6	7.3	7.4	*5.8*
TDS	mg/L	450	1000	ng	232	278	246	330	184	266	382	*1202*
EC	mS/m	ng	ng	40	31	38	35	46	28	37	53	134
SO_4^{2-}	mg/L	200	1000	ng	139	201	165	255	102	186	276	704
Cl^-	mg/L	100	1500	ng	<0.25	<0.25	0.301	1.671	<0.25	<0.25	<0.25	<0.25
F^-	mg/L	1	2	2	0.24	0.16	0.29	0.2	0.21	0.17	0.18	<0.1
M Alk.	mg/L	ng	ng	ng	21	17	17	17	40	24	45	3
NO_2^-	mg/L	ng	ng	ng	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NO_3^- as N	mg/L	ng	100	ng	0.58	0.64	0.7	0.59	0.74	0.63	0.7	0.07
Al	mg/L	0.15	5	5	0.066	0.032	0.19	0.049	0.062	0.031	0.65	0.13
As	mg/L	0.01	1	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
B	mg/L	ng	5	0.5	0.028	0.086	0.053	0.03	0.032	0	0.049	0.039
Be	mg/L	ng	0.1	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bi	mg/L	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/L	32	1000	ng	48	63	48	64	42	58	90	296
Cd	mg/L	5	10	10	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Co	mg/L	ng	1	0.05	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	0.008
Cr^{6+}	mg/L	0.05	1	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cu	mg/L	1	0.5	0.2	0.001	0.015	0.006	<0.001	0.009	0.01	0.006	0.003
Fe	mg/L	0.1	10	5	0.005	0.019	0.009	0	0.14	0.003	0.023	0.064
Hg	mg/L	0.001	0.001	ng	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/L	50	ng	ng	0.28	1.2	0.31	1.2	1.4	0.01	1.3	0.18
Li	mg/L	ng	ng	2.5	0.003	0.008	0.003	0.007	0.01	<0.001	0.008	0.008
Mg	mg/L	30	500	ng	9.6	10	16	19	8.8	12	15	9
Mn	mg/L	0.05	10	0.02	0.013	0.051	0.01	0.02	0.035	0.008	0.062	0.42
Mo	mg/L	ng	0.01	0.01	0.002	0.004	0.002	0.006	0.005	<0.001	0.003	<0.001
Na	mg/L	100	2000	70	1.1	1.9	2	6.8	2.3	1.7	1.9	0.9
Ni	mg/L	ng	1	0.2	0.002	0.005	0.002	0.003	0.005	0.001	0.003	0.018
Pb	mg/L	0.01	0.1	0.2	0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Se	mg/L	0.02	50	0.02	0.014	<0.001	0.013	0.006	0.013	<0.001	<0.001	<0.001
U	mg/L	ng	ng	0.01	0.0007	0.0004	0.0001	0.0002	0.0005	<0.0001	0.0006	<0.0001
V	mg/L	0.1	1	0.1	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	<0.001
Zn	mg/L	3	20	1	0.063	0.19	0.047	0.039	0.11	0.26	0.062	0.18

Notes

Highlight exceeds domestic use guideline highlight exceed livestock guideline highlight exceed irrigation guideline *italics* exceed at least two guidelines

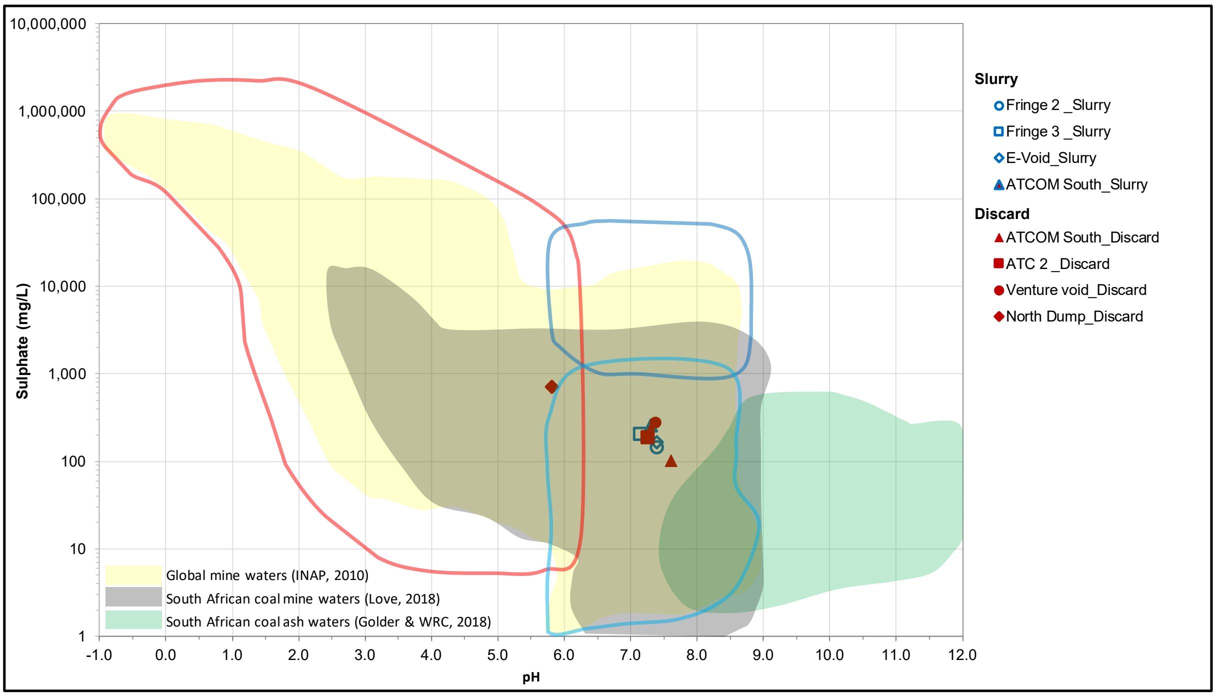


Figure 14: Classification of leachate from iMpunzi discard and slurry samples (modified after INAP, 2010)

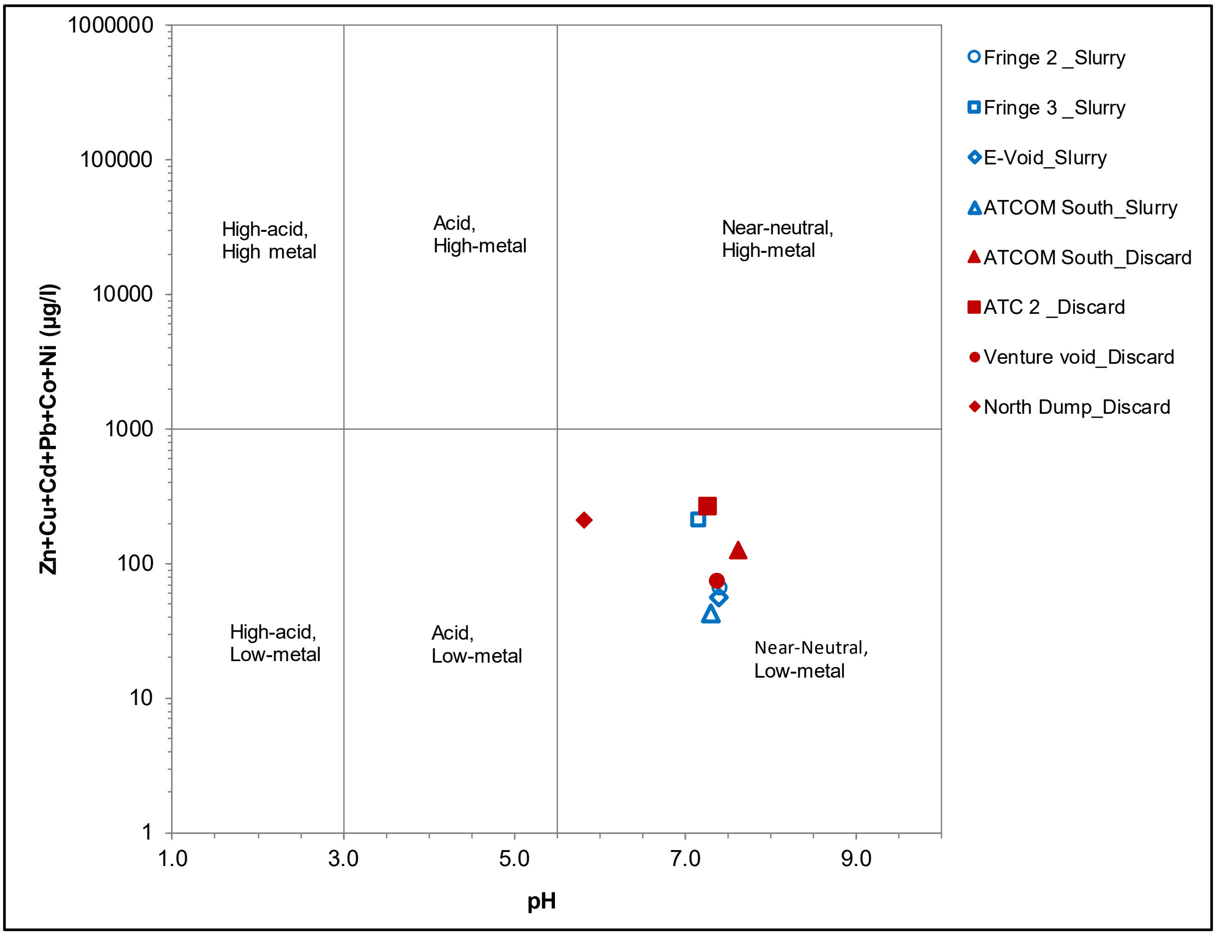


Figure 15: Ficklin diagram showing composition of leachate from iMpunzi discard and slurry samples

2.8.6 Waste Assessment

Analysis results for the waste assessment are summarised in Table 7 and Table 8. Detailed results are presented in APPENDIX C.

- Discard: The total concentrations of barium exceeded the TCT0 levels in samples from all the sampled discard dumps; arsenic and lead exceeded TCT0 levels in discard samples from the ATCOM South paddock wall, North dump and Venture void (arsenic). The leachable concentrations of all analytes were less than LCT0 in all the samples except for TDS and sulphate, which exceeded the LCT0 in the discard sample from the North dump; and sulphate, which exceeded LCT0 in discard sample from Venture void.

  The discard material from North dump and Venture void are type 3 waste whilst the materials from ATCOM South paddock wall and ATC 2 dump is not Type 4 waste as at least one parameter exceed TCT0, but it does not meet the definition of Type 3 waste due to low risk from leachate (all parameters LC≤LCT0).

- Slurry: The total concentrations of barium exceeded the TCT0 levels in samples from all the sampled slurry disposal facilities; and lead exceeded TCT0 levels in the slurry sample from Fringe 2 facility. The leachable concentrations of all analytes were less than LCT0 levels in the slurry samples except for sulphate which exceeded LCT0 levels in slurry from ATCOM South paddock

  The slurry material from ATCOM South paddock is type 3 waste whilst slurry material from Fringe 2, Fringe 3 and E-Void is not Type 4 waste as at least one parameter exceeds TCT0, but it does not meet the definition of Type 3 waste due to low risk from leachate (all parameters LC≤LCT0).

Table 7: Classification of composite samples based on total concentrations (whole rock chemistry data)

Constituent of Concern	Units	GN R.635 levels of thresholds for total concentrations			Slurry				Discard			
		TCT0	TCT1	TCT2	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Al	mg/kg	ng	ng	ng	42897	36352	35285	38045	101663	57162	96144	43475
As	mg/kg	5.8	500	2000	5.0	2.8	3.4	5.2	8.2	5.4	11	13
B	mg/kg	150	15000	60000	44	53	45	42	47	46	53	46
Ba	mg/kg	62.5	6250	25000	452	436	389	493	876	423	319	279
Ca	mg/kg	ng	ng	ng	22032	16149	15095	14562	14359	17493	14608	9715
Cd	mg/kg	7.5	260	1040	0.13	0.094	0.11	0.15	0.25	0.10	0.12	0.085
Co	mg/kg	50	5000	20000	7.5	14	11	8.7	6.5	11	6.9	7.8
Cr	mg/kg	46000	800000	N/A	71	43	45	59	92	42	74	54
Cu	mg/kg	16	19500	78000	20	21	15	19	26	17	21	21
Fe	mg/kg	ng	ng	ng	12744	8809	8748	9952	22775	20241	40095	24270
Hg	mg/kg	0.93	160	640	0.10	0.11	0.11	0.14	0.29	0.25	0.42	0.43
K	mg/kg	ng	ng	ng	2148	1412	1528	2210	4542	2798	4956	1321
Li	mg/kg	ng	ng	ng	56	68	37	57	154	95	127	51
Mg	mg/kg	ng	ng	ng	3215	3494	3666	2719	3116	2899	2898	920
Mn	mg/kg	1000	25000	100000	159	166	157	136	123	148	106	70
Mo	mg/kg	40	1000	4000	2.0	1.3	1.9	2.1	3.4	2.6	3.5	3.7
Na	mg/kg	ng	ng	ng	400	313	357	465	371	375	708	231
Ni	mg/kg	91	10600	42400	19	27	16	24	27	22	27	30
P	mg/kg	ng	ng	ng	1868	1735	1880	2535	6417	3083	1600	975
Pb	mg/kg	20	1900	7600	21	12	14	19	34	14	17	24
S	mg/kg	ng	ng	ng	7400	5900	6900	7000	18000	19200	38200	16400
Sb	mg/kg	10	75	300	0.25	0.36	0.22	0.36	0.50	0.36	0.55	0.53
Se	mg/kg	10	50	200	0.70	0.95	0.88	0.68	0.49	2.2	0.00	0.70
Si	mg/kg	ng	ng	ng	80275	56551	55143	60892	158450	94348	159105	74818
U	mg/kg	ng	ng	ng	3.1	2.3	2.5	3.4	4.7	2.7	3.6	2.7
V	mg/kg	150	2680	10720	58	43	45	54	67	38	56	39
Zn	mg/kg	240	160000	640000	21	38	16	22	34	14	27	24

Table 8: Classification of composite samples based on leachable concentrations (ASLP data)

Constituent of Concern	Unit	GN R.635 levels of thresholds for leachable concentrations				Slurry				Discard			
		LCT0	LCT1	LCT2	LCT3	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
						F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Al	mg/l	ng	ng	ng	ng	0.066	0.032	0.19	0.049	0.062	0.031	0.65	0.13
As	mg/l	0.01	0.5	1	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
B	mg/l	0.5	25	50	200	0.028	0.086	0.053	0.030	0.032	0.000	0.049	0.039
Ba	mg/l	0.7	35	70	280	0.10	0.24	0.11	0.12	0.19	0.000	0.095	0.084
Ca	mg/l	ng	ng	ng	ng	48	63	48	64	42	58	90	296
Cd	mg/l	0.003	0.15	0.3	1.2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Co	mg/l	0.5	25	50	200	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	0.008
Cr	mg/l	0.1	5	10	40	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001
Cr 6+	mg/l	0.05	2.5	5	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cu	mg/l	2	100	200	800	0.001	0.015	0.006	<0.001	0.009	0.010	0.006	0.003
Fe	mg/l	ng	ng	ng	ng	0.005	0.019	0.009	0.000	0.140	0.003	0.023	0.064

Constituent of Concern	Unit	GN R.635 levels of thresholds for leachable concentrations				Slurry				Discard			
		LCT0	LCT1	LCT2	LCT3	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
						F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Hg	mg/l	0.006	0.3	0.6	2.4	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
K	mg/l	ng	ng	ng	ng	0.28	1.2	0.31	1.2	1.5	0.01	1.3	0.18
Mg	mg/l	ng	ng	ng	ng	9.6	10.5	16	19	8.82	12	16	9.0
Mn	mg/l	0.5	25	50	200	0.013	0.051	0.010	0.02	0.035	0.008	0.062	0.43
Mo	mg/l	0.07	3.5	7	28	0.002	0.004	0.002	0.006	0.005	<0.001	0.003	<0.001
Na	mg/l	ng	ng	ng	ng	1.1	1.9	2.0	6.8	2.3	1.7	1.9	0.9
Ni	mg/l	0.07	3.5	7	28	0.002	0.005	0.002	0.003	0.005	0.001	0.003	0.018
Pb	mg/l	0.01	0.5	1	4	0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Sb	mg/l	0.02	1	2	8	<0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001
Se	mg/l	0.01	0.5	1	4	0.014	<0.001	0.013	0.006	0.013	<0.001	<0.001	<0.001
U	mg/l	ng	ng	ng	ng	0.0007	0.0004	0.0001	0.0002	0.0005	<0.0001	0.0006	<0.0001
V	mg/l	0.2	10	20	80	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	<0.001
Zn	mg/l	5	250	500	2000	0.063	0.19	0.047	0.039	0.11	0.26	0.062	0.18
pH	pH units	ng	ng	ng	ng	7.4	7.2	7.4	7.3	7.6	7.3	7.4	5.8
TDS	mg/l	1000	12500	25000	100000	232	278	246	330	184	266	382	1202
EC	mS/m	ng	ng	ng	ng	31	38	35	46	28	37	53	134
M Alk.	mg/l	ng	ng	ng	ng	21	17	17	17	40	24	45	3
F^-	mg/l	1.5	75	150	600	0.24	0.16	0.29	0.20	0.21	0.17	0.18	<0.1
Cl^-	mg/l	300	15000	30000	120000	<0.25	<0.25	0.301	1.7	<0.25	<0.25	<0.25	<0.25
NO_2^-	mg/l	ng	ng	ng	ng	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NO_3^- as N	mg/l	11	550	1100	4400	0.58	0.64	0.70	0.59	0.74	0.63	0.70	0.07
PO_4^{3-}	mg/l	ng	ng	ng	ng	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
SO_4^{2-}	mg/l	250	12,500	25,000	100,000	139	201	165	255	102	186	276	704

2.8.7 Summary of the Mining Residue

The following are the findings of the geochemistry study:

- Discard Dumps:
  - The discard materials from all the sampled dumps contain pyrite and carbonates in appreciable quantities.
  - The materials are enriched in environmentally significant elements sulphur, arsenic, boron, and selenium.
  - The discard materials from all dumps are potentially acid generating
  - The discard material from North dump and Venture void are type 3 waste whilst the materials from ATCOM South paddock wall and ATC 2 dump is not Type 4 waste as at least one parameter exceed TCT0, but it does not meet the definition of Type 3 waste due to low risk from leachate (all parameters LC≤LCT0).t in the discard materials.
  - The discard materials are likely to produce predominantly near-neutral, low-metal drainage upon exposure to rainfall. The levels of calcium, total dissolved solids, electrical conductivity, sulphate, manganese, aluminium and iron are likely to be elevated and exceed at least one DWAF (1996) water quality guideline in drainage from at least one discard dump.
  - The drainage from the ATC discard dumps and North dumps have a significant impact on the quality of Saaiwaterspruit and one of its tributaries, whilst drainage from the ATCOM South Paddock walls do not seem to have a significant impact on the Steenkoolspruit.
- Slurry Facilities:
  - Pyrite was rare, and carbonates present as accessory to minor phases in the slurry material.
  - The materials are enriched in environmentally significant elements sulphur, arsenic, boron, molybdenum, selenium and mercury.
  - The slurry materials from all sampled dumps have a very low acid generating potential.
  - The slurry material from ATCOM South paddock is type 3 waste whilst slurry material from Fringe 2, Fringe 3 and E-Void is not Type 4 waste as at least one parameter exceeds TCT0, but it does not meet the definition of Type 3 waste due to low risk from leachate (all parameters LC≤LCT0).
  - The slurry materials from all the sampled sources are likely to produce near-neutral, low-metal drainage upon exposure to rainfall. The levels of electrical conductivity, sulphate, calcium, manganese and aluminium are likely to exceed water quality guidelines in drainage from at least one of the sampled slurry facilities.

2.9 Quality and age of base data used for the specialist report

This statement is prepared in terms of Section 1 (cA) of Regulation 1 of Appendix 6 (Specialist Reports) of GN R. 326 of 2017 (EIA Regulations).

Table 9: Base Data Statement

Data	Age	Comment
Water levels	2009 –2018	mainly complete, more recent water level data 2018-2020 outstanding.
Water quality	2013-2020	Water quality data is complete for Groundwater and Surface water
Geochemical data	2013 and 2017	Static tests are complete on discard, slurry, spoils and coal material but no kinetic tests have been carried out

3.0 DESCRIPTION OF EXISTING IMPACTS ON THE SITE

3.1 Introduction

This statement is prepared in terms of Section 1 (cB) of Regulation 1 of Appendix 6 (Specialist Reports) of GN R. 326 of 2017 (EIA Regulations).

3.2 Impact Status of Groundwater

3.2.1 Historic Groundwater Quality

Groundwater water quality of iMpunzi have been documented by Golder (2015 and 2018) which covered all the monitoring borehole within the vicinity of the mine.

In 2015 Golder drilled two shallow and deep boreholes in close proximity to the North Pan ,the quality of the groundwater in both the shallow boreholes met the DWA (SABS, 2011) groundwater quality criteria for domestic use, however the groundwater quality sampled in IMP-BH1D did not comply with the drinking water quality guidelines, exceeding the water standard for domestic use with respect to major ion sulphate (SO_4) (783 mg/lL) and sodium (Na) (230 mg/L). The groundwater quality of the study area was described as been affected by mining activities and was classified in a 2016 report by Golder as moderate to poor.

Golder documented more water quality of the boreholes around the entire vicinity of the mine. This was based on groundwater monitoring results from the year 2017. Sulphate concentrations and total dissolved solids (TDS) are used as parameters to identify groundwater contamination. The presence of these parameters have been shown to increase steadily with time and excessive concentrations are caused by anthropogenic activities. Results exceeding the 1 000 mg/l for SO_4 can be seen to be more dominant in the Western region of the study area where opencast mining activities took place. A similar trend for the TDS results exceeding 3 400 mg/l is identified in the western region of the study.

Sulphate$^-$ and TDS concentrations in 2018 water quality data were used to identify groundwater contamination. Sulphate is a good indicator of contamination resulting from mining activities (acid mine drainage from coal) whereas TDS refers to the total mass of dissolved constituents in water. The presence of these parameters has been shown to increase steadily with time and excessive concentrations are caused by anthropogenic activities.

The analysed groundwater results from the monitoring boreholes were compared to the South African Water Quality Guidelines (SAWQG). The results plotted in red in Figure 16 and Figure 17 SAWQG limit for sulphate$^-$ and TDS.

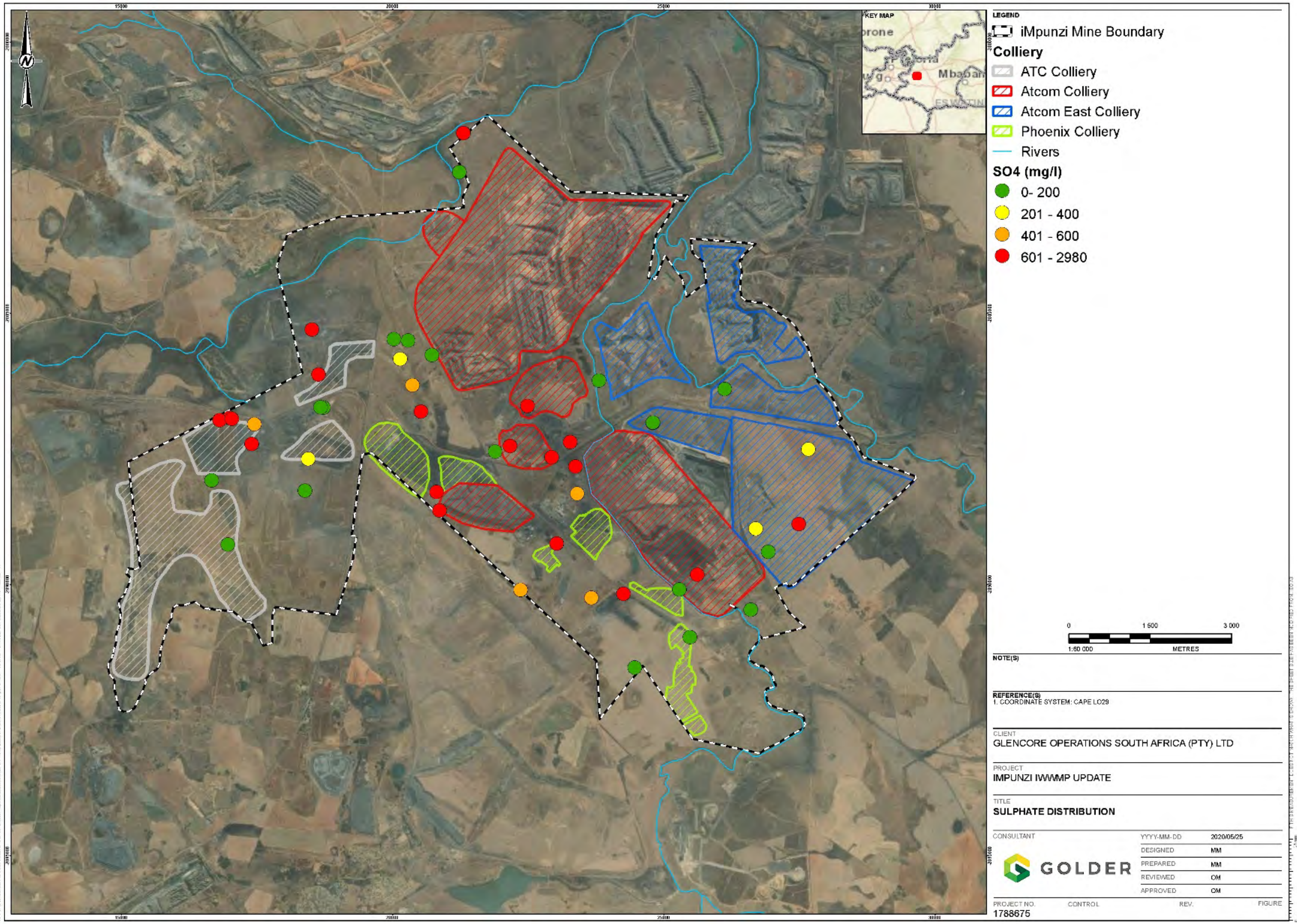


Figure 16: SO_4^{2-} levels in groundwater, March 2018

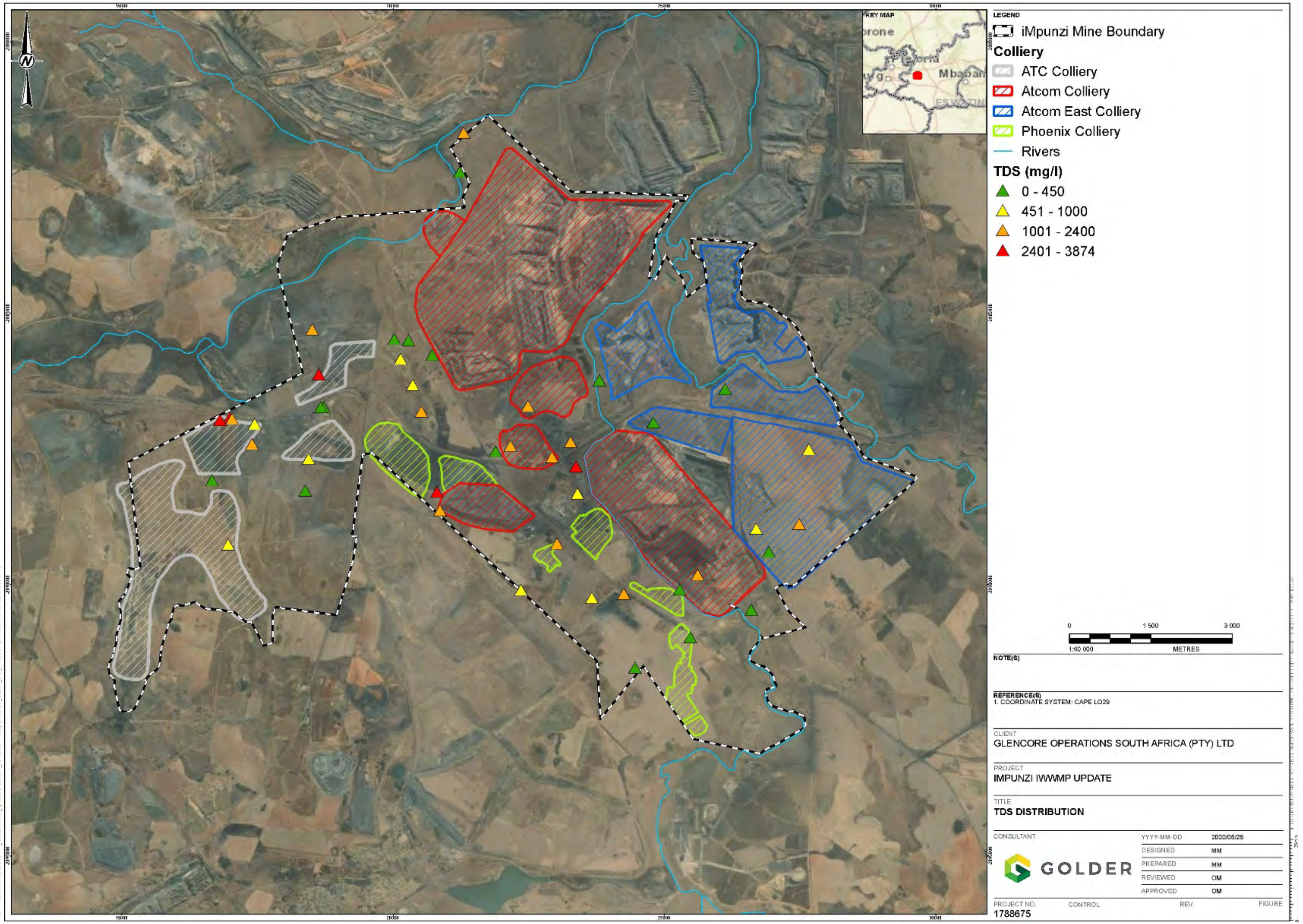


Figure 17: TDS levels in groundwater, March 2018

3.2.2 Current Groundwater Quality

The water quality data based on recent 2019 to 2020 groundwater monitoring data from the study area. SO_4^{2-} concentrations and TDS are used as parameters to identify groundwater contamination. Sulphate is a good indicator of contamination resulting from mining activities (acid mine drainage from coal) whereas TDS refers to the total mass of dissolved constituents in water. The presence of these parameters have been shown to increase steadily with time and excessive concentrations are caused by anthropogenic activities.

The analysed groundwater results from the monitoring boreholes were compared to the South African Water Quality Guidelines (SAWQG). The results in Table 10 for Venture discard facility and ATCOM South shows the SAWQG limit for SO_4^{2-} and TDS during 2019-2020 period. Both parameters show a similar trend throughout the various sites. The Venture discard facility footprint and the ATCOM South discard facility is impacted by activities in this part of the iMpunzi mine area and parts are rehabilitated land. SO_4^{2-} and TDS exceed the maximum allowable limit for Class 2 and Class 3 of the SAWQG limits for four boreholes that are located closest to the areas of interest.

3.2.3 Groundwater Classification

The groundwater quality of the recently sampled monitoring boreholes is visually represented on a Piper Diagram to distinguish between the different water types. The cation-anion balance is an important validation for groundwater analysis and the percentage error should be less than 5%. If the percentage is greater than 5%, the analysis does not pass the validation check. The error in cation-anion can be written as:

$$\% \text{ balance error} = \frac{\sum cations - \sum anions}{\sum cations + \sum anions} \times 100$$

Where the ions are expressed in meq/l.

A piper diagram illustrates the different hydrochemical compositions of the groundwater encountered in the boreholes drilled in the proposed iMpunzi North Pan mining area in 2015. The shallow groundwater encountered is of a distinctly different composition than the deeper groundwater encountered. The nature of the change of the groundwater quality encountered in the deeper borehole is typically encountered near or at coal mining sites where the oxidation of sulphide minerals, present in the ore and host rocks, releases dissolved sulphate, sodium and other dissolved ions into the affected hydrosphere.

Based on the major cation and anion, two predominant water types are found in the study area based on 2017 groundwater monitoring data. These are $Mg\text{-}HCO_3$ and $Mg\text{-}SO_4$. The chemical groundwater types of the study area are distinguished and grouped by their position on a Piper diagram. $Mg\text{-}HCO_3$ type water is characterised by recently recharged water rich in magnesium. $Mg\text{-}SO_4$ type water is typically characterised as water impacted by oxidation of pyrite.

Based on the hydrogeochemical compositions, the groundwater monitoring data from 2019-2020 shows boreholes ACGM-1 Bottom (flooded coal seam), ACGM-4 Bottom (flooded coal seam), ATGO-7 (ATC Rehab Pit A) and ATGO-12 calcium/ magnesium sulphate field type water which is typically characterised as water impacted by oxidation of pyrite. The rest of the boreholes plotted in the calcium/ magnesium bicarbonate field, which is typical of shallow, fresh groundwater (Figure 18).

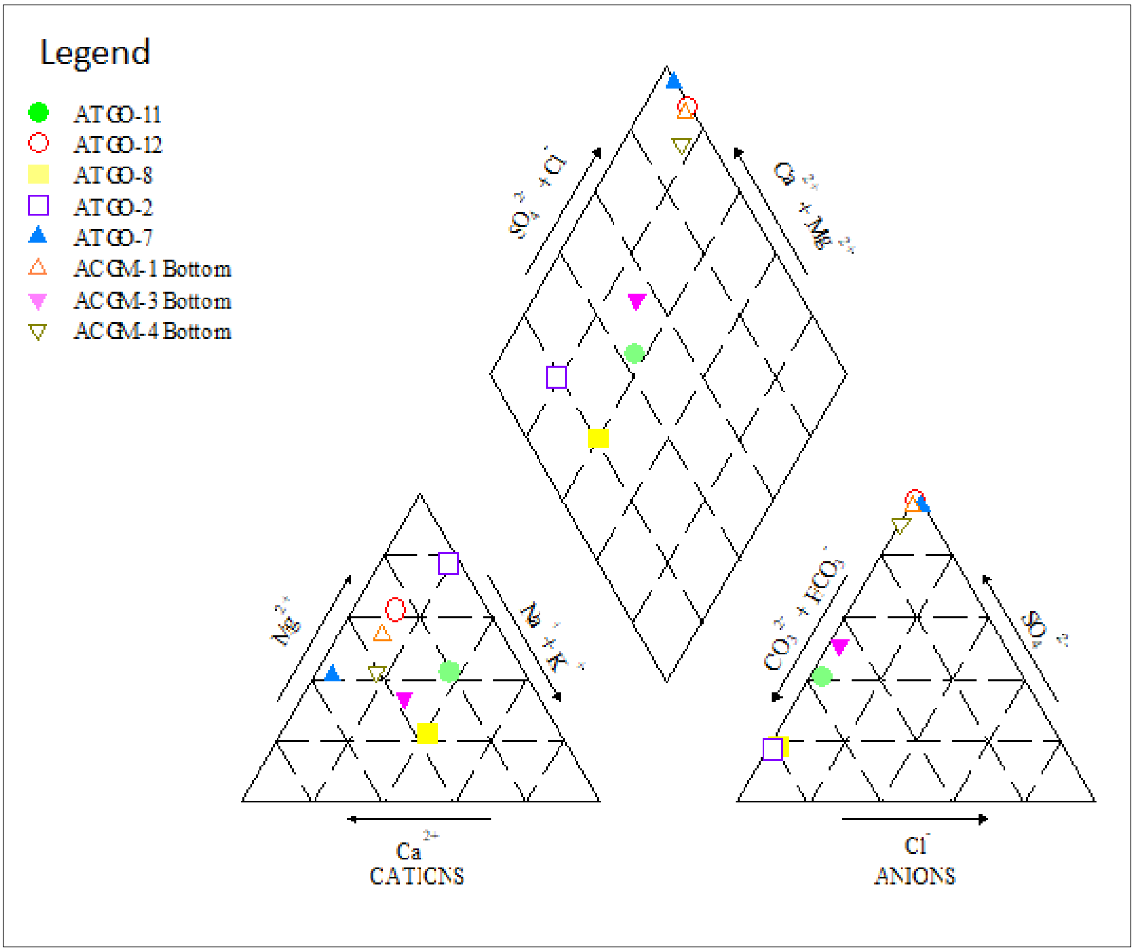


Figure 18: Groundwater piper diagram (2019-2020)

Table 10: Groundwater Quality 2019-2020

Borehole	Physical Determinants			Chemical Determinants											
Number	pH	EC (mS/m)	TDS (mg/l)	MALK (mg/l)	Ca (mg/l)	K (mg/l)	Mg (mg/l)	Na (mg/l)	Cl^- (mg/l)	NO_3^- as N (mg/l)	SO_4^{2-} (mg/l)	Al (mg/l)	F^- (mg/l)	Fe (mg/l)	Mn (mg/l)
ATGO-11	8.4	57	352	166	25	5.3	31	49	6.4	<0.459	117	<0.005	0.81	<0.009	0.14
ATGO-12	6.7	340	3100	33	255	26	377	124	11	<0.459	2307	0.009	<0.466	<0.009	0.55
ATGO-8	8.0	22	180	89	16	2.8	6.0	19	2.0	0.54	19	<0.005	<0.466	<0.009	<0.001
ATGO-2	8.9	95	610	536	7.53	21	113	42	7.6	4.1	105	0.103	<0.466	<0.009	0.051
ATGO-7	6.1	249	2238	16	377	17	177	28	35	<0.459	1655	0.015	0.766	6.0	7.4
ACGM-1 Bottom	5.89	309	3052	66.7	288	16.7	280	113	21.6	1.53	2241	0.015	<0.466	<0.009	6.31
ACGM-3 Bottom	8.4	50	256	114	35	4.0	19	29.25	5.9	<0.459	118	<0.005	0.595	<0.009	0.001
ACGM-4 Bottom	7.3	407	3778	243	472	13	288	214	18	1.8	2377	0.093	<0.466	0.033	1.2
Class 0 Max. Allowable Limit	9.5	<70	<450	-	<80	<25	<70	<100	<100	<6	<200	-	<0.7	<0.01	<0.1
Class 1 Max. Allowable Limit	10	150	1000	-	150	50	100	200	200	10	400	-	0.7-1.0	0.01-0.2	0.1-0.4
Class 2 Max. Allowable Limit	10.5	370	2400	-	300	100	200	400	600	20	600	-	1.0-1.5	0.2-2.0	1.0-4.0
Class 3 Max. Allowable Limit	11	520	3400	-	>300	500	400	1000	1200	40	1000	-	1.5-3.5	2.0-10.0	4.0-10.0

3.3 Impact of Existing Mineral Residue Facilities

3.3.1 Introduction

The impacts of sources sampled in the site-wide geochemistry study (Golder, 2018b) on watercourses was assessed by comparing the long-term water quality data at the upstream and downstream monitoring sites. The assessment was done for a tributary of the Saaiwaterspruit, which drains between the ATC discard dumps, the Saaiwaterspruit, which drains past the North dump and the Steenkoolspruit, which drains the ATCOM South pit and surrounding coal stockpiles. No watercourses were found to drain past the sampled slurry facilities, linear stockpile and venture void discard dump.

Constituents that exceeded at least one of the DWAF (1996) water quality guidelines in ASLP leachate from the facility were selected and time series graphs of these same constituents in the upstream and downstream surface water sampling points were plotted. The significance of the variations observed in levels of constituents between the upstream and downstream sites was statistically assessed using the t-Test. The t-Test is a parametric test that is used to compared average concentrations of two samples and determine whether the difference between the average concentrations presumably show an actual change in the population from which the samples were collected. The concentrations of upstream downstream sites were statistically analysed using excel Data Analysis Tool and the results are presented in Appendix C (Table C6, Table C7 and Table C8).

3.3.2 ATC Discard dumps

The time series graphs for an unnamed Saaiwaterspruit tributary that drains between the ATC 1 and ATC 2 discard show a consistent increase in levels of total dissolved solids, sulphate and calcium at the downstream site (ATSR-3) compared to the upstream (ATSR-4) surface water monitoring site. Figure 20

The levels of concentrations of total dissolved solids, sulphate and calcium are statistically significantly higher than the upstream site indicating that the discard dumps are impacting the watercourse.

3.3.3 North Discard Dump

The levels of total dissolved solids, sulphate and calcium are consistently and statistically significantly higher downstream (ACSR-1) relative to the upstream (ACSR-7) surface water monitoring site indicating that the North discard dump is impacting the water quality of the Saaiwaterspruit (Figure 21). The manganese and pH do not show definite trends.

3.3.4 ATCOM South Paddocks

The levels of sulphate, total dissolved solids and calcium are similar and not statistically significantly different at the upstream site (PHSR-3) and immediate downstream of the paddocks (site ACSR-8) suggesting that the paddocks do not have a significant impact on the Steenkoolspruit (Figure 22). The levels of these constituents are consistently and statistically significantly higher at monitoring site ACSR-4 (downstream of ATCOM South pit) indicating possible impact of ATCOM South pit or Beath Dump on the Steenkoolspruit – as any seepage from either ATCOM South or Beath would report to the same stretch of the river, affecting the water quality between ACSR8 and ACSR4.

3.3.5 Beath Dump

This discard dump has seepage with very low pH (average 2.4) and high TDS (average 24,392 mg/l, see Figure 23). As mentioned in the previous section, the Steenkoolspruit is impacted between ACSR8 and ACSR4 and Beath is one of the two possible sources.

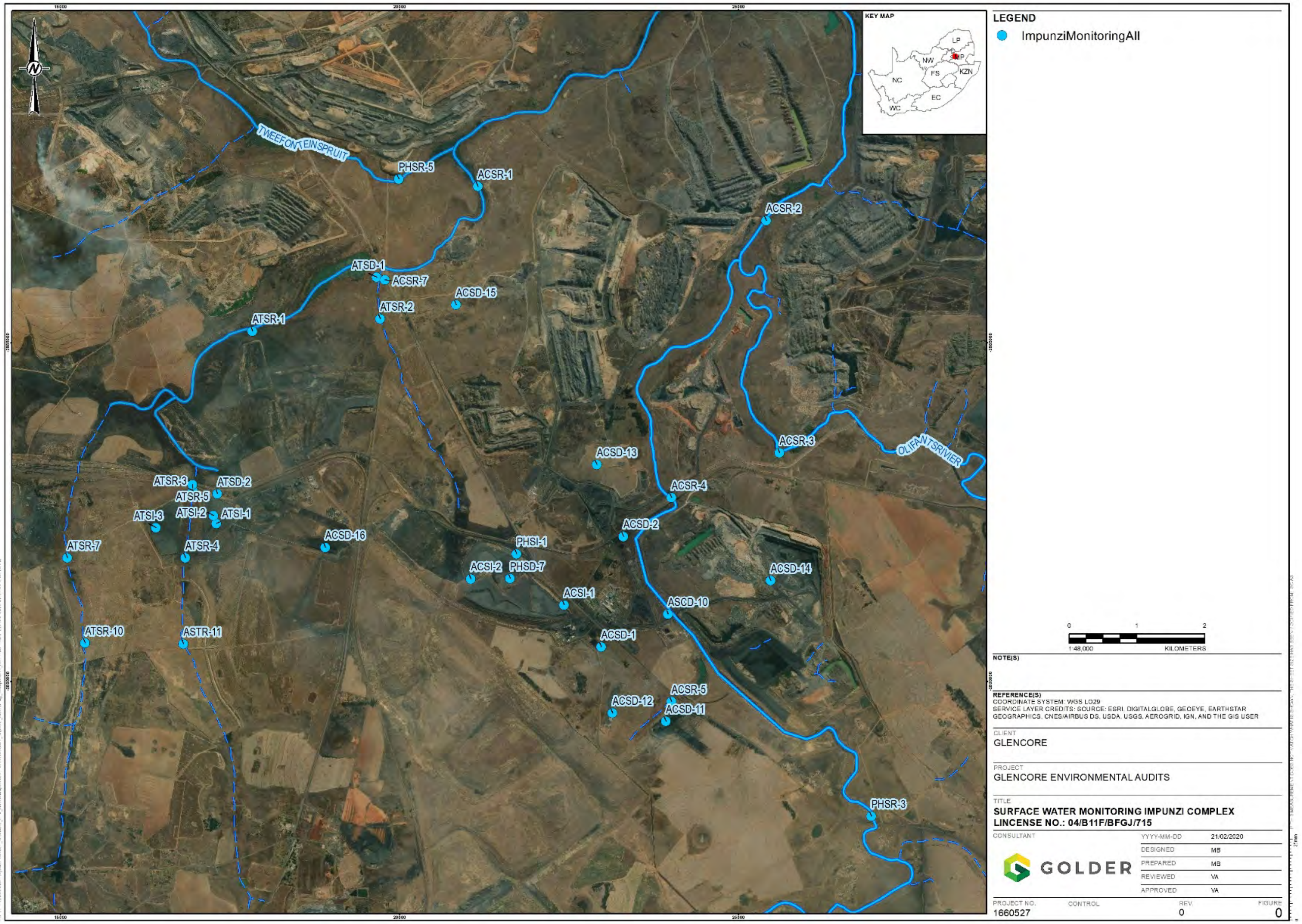


Figure 19: Location of iMpunzi surface water monitoring sites used in this assessment

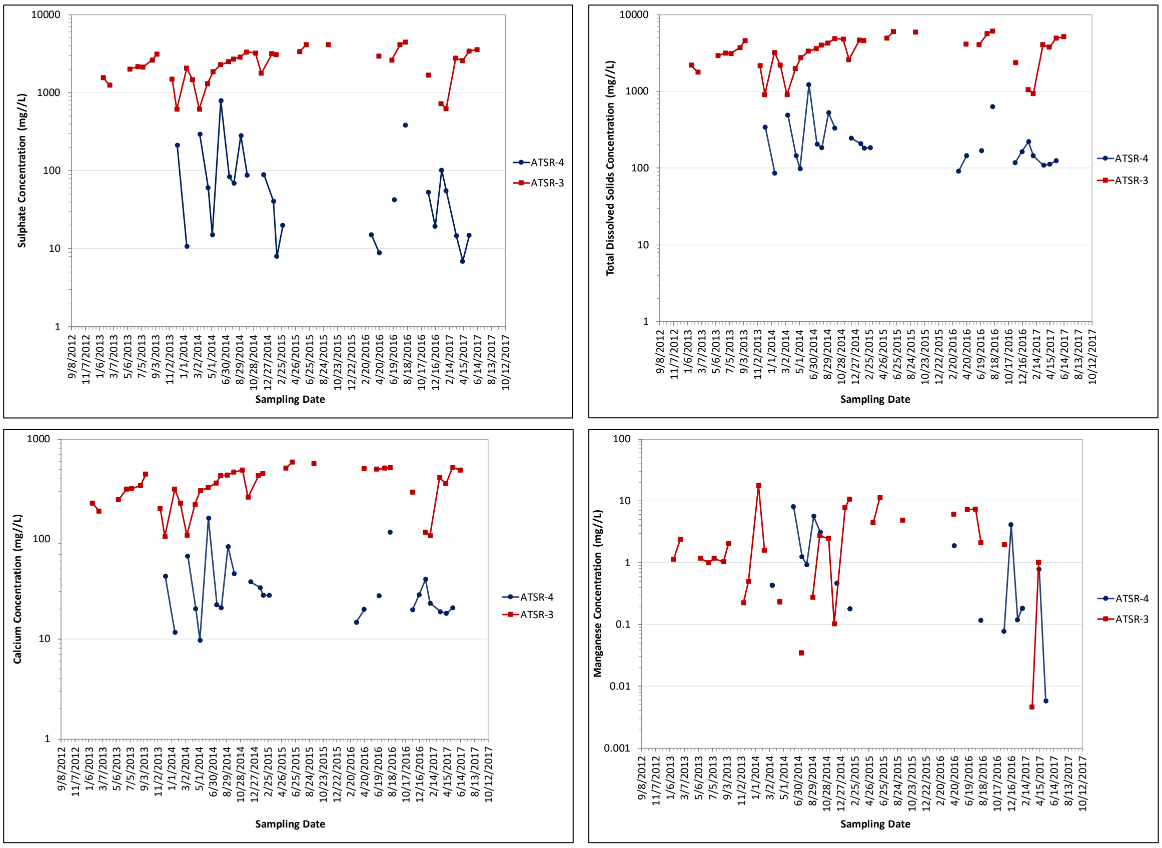


Figure 20: Time series graphs for upstream (ATSR-4) and downstream (ATSR-3) of ATC discard dumps

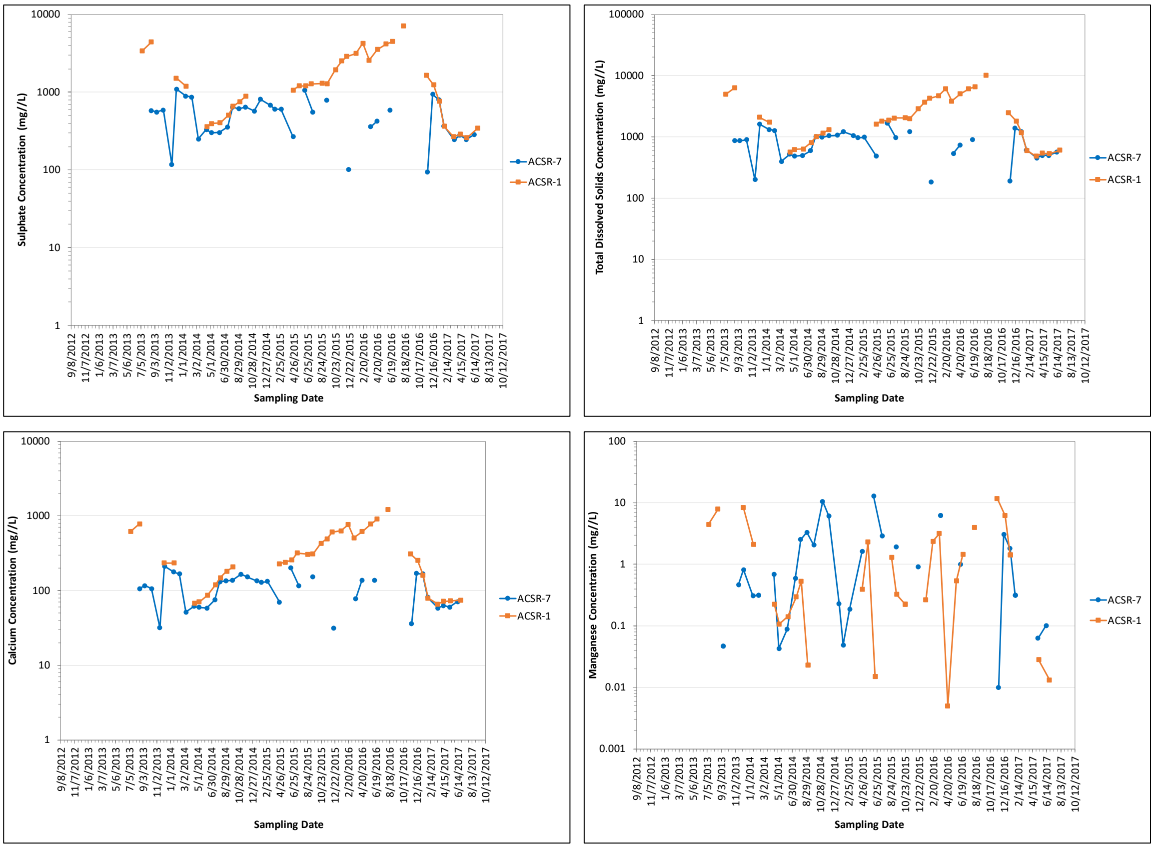


Figure 21: Time series graphs for upstream (ACSR-7) and downstream (ACSR-1) of North discard dump.

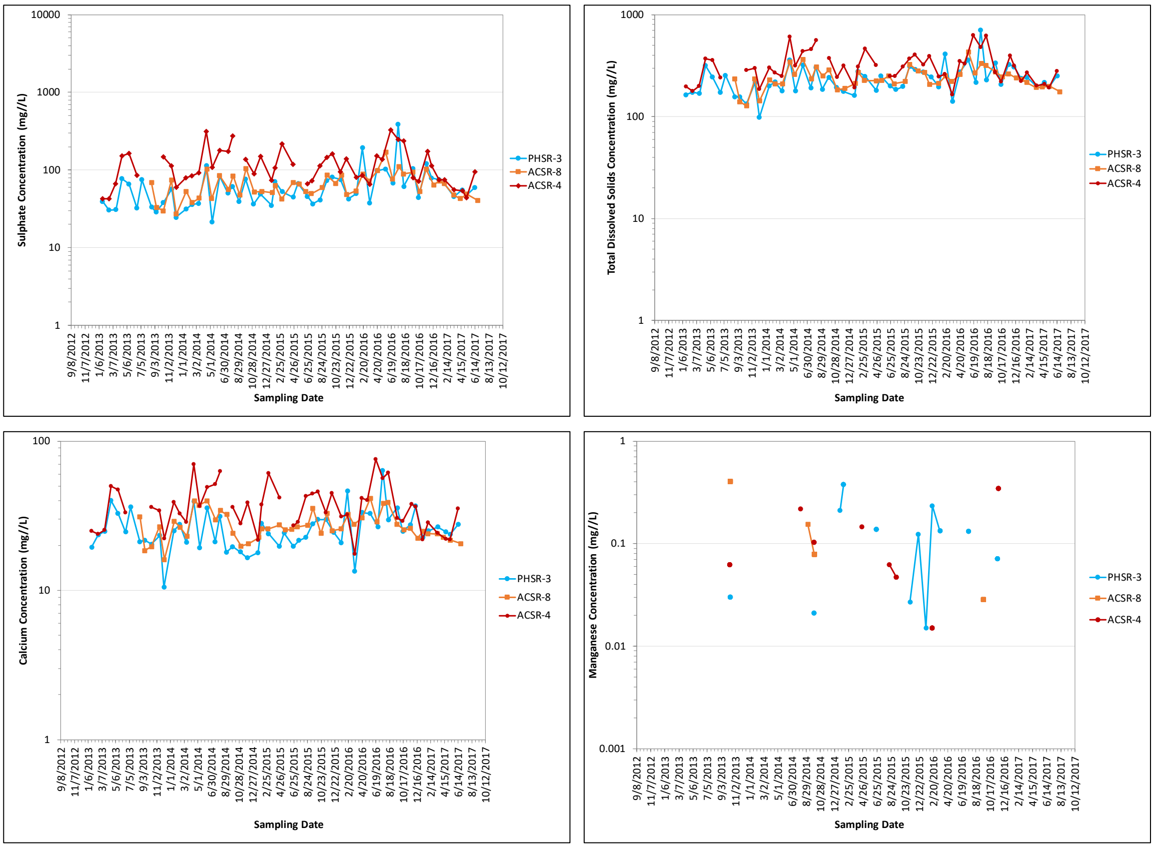


Figure 22:Time series graphs for upstream (PHSR-3), after paddocks (ACSR-8), and downstream of ATCOM South pit (ACSR-4)

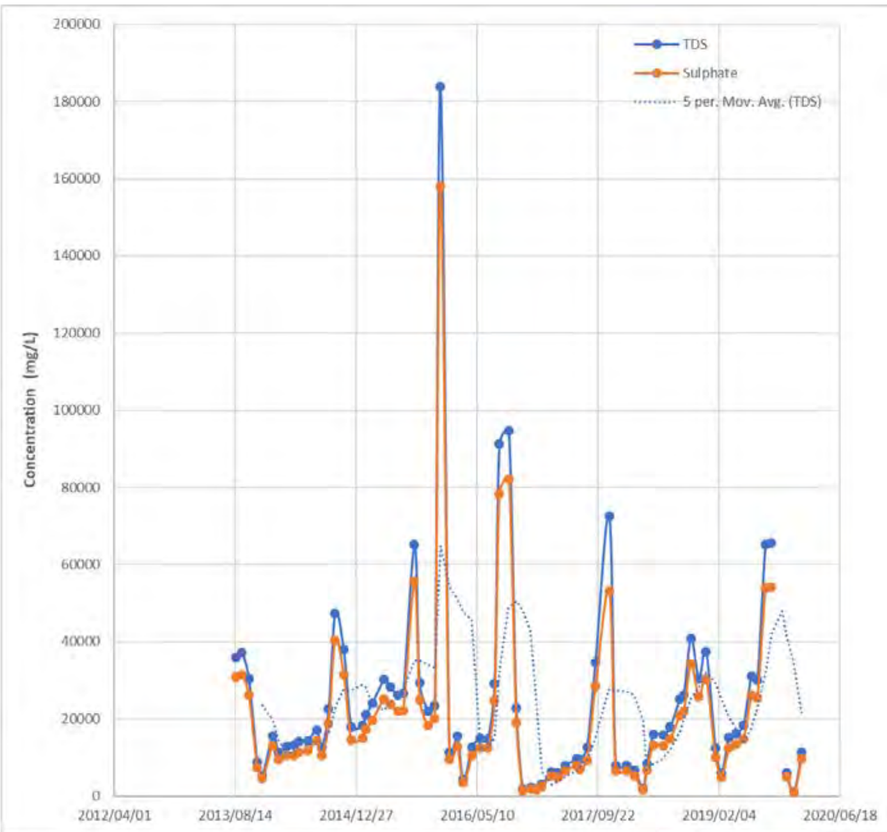


Figure 23: Time series graphs for Beath Dump (ASCD-13)

4.0 SOURCE-TERM MODELLING

4.1 Introduction

The objective of the geochemistry study was to use the existing information to derive source concentrations that will be used as input for the areas of concern in the groundwater contaminant transport model. The groundwater flow and mass transport model will aid in the groundwater impact assessment of the proposed Venture co-discard facility and the new ATCOM South pit coarse discard facility. A pollution source term characterisation was required to support the groundwater mass transport model. The potential contaminant sources that required source terms are presented in Figure 2.

4.2 Available Information

The available information on potential contaminant sources that was used to derive source-terms consists of:

- iMpunzi surface water and groundwater monitoring database for the period from 2008 to 2018.
- May 2010 integrated waste and water management plan (IWWMP) by Jones and Wagener.
- August 2014 integrated waste and water management plan (IWWMP) by Jones and Wagener
- Results of deionised water short-term leach tests on coarse discard, fine discard and spoils collected from disposal facilities as part of geochemistry study in terms of the IMpunzi Water use licence by Golder (2018b).
- Results of pit water samples and deionised water short-term leach tests on coarse discard and fine discard collected as part of geochemistry study for iMpunzi Paddocks by Golder (2014).
- Golder (2010) groundwater study report for Xstrata ATCOM operations.
- Golder (2014) groundwater assessment report for iMpunzi colliery.

4.3 Approach and Assumptions

The available information was used to estimate concentrations of concern in seepage from the identified sources as follows:

- There are pH, EC, TDS and sulphate values for most sources. For sources with no TDS data, the value was estimated from EC and summation of measured constituents. It should be noted that the TDS values obtained by summation are underestimated as calcium analyses were missing.
- For sources with surface water and groundwater monitoring data, average values were calculated for the CoC. It was assumed that the available data for the period from 2008 to 2018 is representative of the quality of water from the sources.
- For spoils, it was assumed that measurement of ramp water quality represented seepage from spoils, but it should be noted that this may have been diluted by inflowing groundwater and therefore be an underestimate – better understanding of spoils geochemistry is still needed.
- In the absence of measured data, the preferred source of data for the prediction of long-term seepage chemistry is the humidity cell test (Maest and Nordstrom, 2017), which provides quantitative estimates of the full chemistry of mine residue leachate – however, such data was not available for any of the sources at iMpunzi.
- The next-most reliable source of data is deionised water short-term leach tests. These are semi-quantitative tests, performed at a single moment in time and provide a standardised indication of the more important constituents of concern (CoC) in mine drainage (Hageman *et al*. 2015).

- The short-term leach tests data was not scaled up where it was used for operations source water quality. It has been noted that short term leach tests measure readily soluble components of geological materials but do not predict long term water quality. Water-rock interactions often develop over periods of time that are much greater than can be represented in an 18 to 24-hour extraction test (INAP, 2010). Thus, the concentrations determined from deionised water leach test data are considered orders of magnitude estimates.
- For sites with more than one data set, the most conservative value was selected, and measured values were preferred to short-term leach data.
- Where data was not available, data for sources with similar materials was used. It was assumed that the materials would have similar geochemical characteristics.
- For the post-closure source-terms, concentrations were scaled to 137 % of the respective operations phase concentrations – this scaling is based on the maximum acceptable error at 95% confidence level from the determination of total sulphur representivity in the sample set (Golder, 2014b). In the absence of kinetic testing data for discard, slurry and spoils, the concentrations from the different facilities were assumed to remain constant over time. This is a conservative approach, which will over-estimate the tonnage of TDS released over time, but the rate of decrease in load cannot be determined without kinetic testing.

4.4 Results

The sulphate, pH and total dissolved concentrations for the operational and closure sources are provided in Table 11.

For the post-closure period, the quality of feed from the ATCOM South pit and Venture pit will be a result of mixing of seepage from in-pit spoils, discard and slurry materials. The quality of seepage from the different sources was assumed to be represented by:

- Venture pit spoils: average of water quality monitoring data (67 samples) for three boreholes drilled into the opencast spoils before in-pit disposal of discard and slurry
- Coarse discard: Upscaled average of two samples of seepage collected from toe of a coarse discard dump in 2014,
- Slurry: Upscaled results of a slurry water sample collected in 2014.
- ATCOM south pit spoils: Upscaled average of two water samples collected from pit voids in 2014, before disposal of discard and slurry on the paddocks.

The quality of seepage from each source, and the data it was derived from, is presented in Table 12.

Table 11: Operational source terms

Site name	Site ID	Site Description	Type	Comment	pH	TDS (mg/l)	SO_4^{2-} (mg/l)
ATC Colliery	AC4	Venture opencast pit (Pit A) and Discard dump	Opencast pit water quality downgradient of discard dump	Average of GW monitoring points ATGO-4 (2013-2017), ATGO-6 (2013-2017) and ATGO-7 (2013-2019) water quality monitoring data. Boreholes are drilled in, NW and W of Venture Void/Dump in Rehab. Area (Downstream of discard dump). Assumed to be the quality of water at the time the co-disposal dump will be constructed	7.3	2 973	2 161
		Proposed Co-disposal facility	Coarse discard	Assumed to be quality of seepage from coarse discard dump embankments. Average of ATC Dump 1 and Dump 2 water quality monitoring data (2013-2019).	6.6	4 451	3 109
			Slurry	Assumed to be quality of seepage from slurry. Average of ATCOM/Phoenix dump East and west Toe drains water quality monitoring data (2013-2019) for points ACSI-1 and ACSI-2.	7.7	3 903	2 730
ATCOM South Pit	AM6	ATCOM South Opencast Pit	Opencast Spoils	Backfilled opencast pit with no discard facilities. Ramp water quality measured in 2013 (Golder, 2014)	7.8	4 869	3 341
			Existing Co-disposal facility coarse discard embankment and new coarse discard facility	Seepage from Discard Dump 2. Average of toe drain seepage quality monitoring data (2013-2020) for monitoring point ATSI-2.	6.0	5 050	3 648
			Existing Co-disposal facility Slurry	Slurry seepage. Measured value of ATCOM Co-disposal dump discharge from penstock to silt trap (Golder, 2014)	8.3	5 222	3 719

Table 12: Quality of seepage from different sources

Description	Units	Venture Pit Spoil	Venture /ATCOM South pit Slurry	Venture /ATCOM South pit Coarse Discard	ATCOM South pit Spoils
pH	s.u	7.4	8.2	7.4	7.6
TDS	mg/L	4074	7154	6382	6671
Alkalinity	mg/L	139	247	312	326
Cl^-	mg/L	29	26	26	23
F^-	mg/L	0.44	1.4	1.2	1.3
SO_4^{2-}	mg/L	2961	5095	4337	4576
NO_3^-	mg/L	0.095	2.4	0.61	1.52
NO_2^-	mg/L	nd	0.59	0.29	1.8
Ca	mg/L	339	793	747	650
Mg	mg/L	549	692	586	691
K	mg/L	32	28	27	34
Na	mg/L	72	192	190	168
Ag	mg/L	0.010	0.010	0.010	0.010
Al	mg/L	0.01	0.010	0.010	0.010
As	mg/L	0.01	0.010	0.010	0.010
B	mg/L	0.088	0.43	0.24	0.58
Ba	mg/L	nd	0.06	0.05	0.05
Be	mg/L	nd	0.01	0.01	0.01
Cd	mg/L	0.01	0.010	0.010	0.010
Co	mg/L	0.01	0.030	0.030	0.040
Cr	mg/L	0.01	0.010	0.010	0.010
Cu	mg/L	0.0027	0.020	0.020	0.020
Fe	mg/L	3.2	0.030	0.080	0.25
Li	mg/L	nd	0.45	0.21	0.86
Mn	mg/L	5.1	1.4	1.7	4.6
Mo	mg/L	nd	0.010	0.010	0.010
Ni	mg/L	0.01	0.070	0.110	0.080
Pb	mg/L	0.01	0.010	0.010	0.010
Sb	mg/L	0.010	0.010	0.010	0.010
Se	mg/L	0.01	0.010	0.010	0.010
Sn	mg/L	0.010	0.010	0.010	0.010

Description	Units	Venture Pit Spoil	Venture /ATCOM South pit Slurry	Venture /ATCOM South pit Coarse Discard	ATCOM South pit Spoils
Sr	mg/L	2.2	0.010	0.010	0.010
Tl	mg/L	0.010	0.010	0.010	0.010
U	mg/L	0.010	0.010	0.010	0.010
V	mg/L	0.010	0.010	0.010	0.010
Zn	mg/L	0.01	0.01	0.04	0.06

5.0 GROUNDWATER MODELLING

5.1 Conceptual model

Based on various hydrogeological studies undertaken in the area by Golder between 2011 and 2019 (see section 2.5.2 above) and Golders conceptual understanding of the site, the Karoo aquifer systems within the study area can be differentiated as a shallow weathered aquifer and deeper fractured aquifer. No additional investigative hydrogeology or groundwater testing work was undertaken as part of the current project.

5.1.1 Weathered aquifer

The weathered aquifer hosts confined or semi-unconfined shallow weathered Karoo aquifer extending to approximately 12 m weathering depth. Water levels are typically shallow receiving direct recharge from rainfall. Localised perched aquifers may occur on clay layers or lenses at shallow depth.

5.1.2 Fractured aquifer

The fractured aquifer underlies the weathered aquifer. This upper fractured aquifer is semi-confined to confined in which fracture flow dominates.

The study area is within Vryheid formation of the Ecca subgroup, which is approximately 55 m thick and consists of carbonaceous shale and sandstone interbedded with five coal seams varying in thickness between 1.5 m and 9.0 m. Below the Vryheid formation is the Dwyka formation consisting of Diamictite.

5.2 Recharge of Sources: Opencast Domains

Enhanced recharge in the study area is inferred to be a consequence of mining (mine dumps and spoils, etc.). Surface voids created by mining and backfilled opencast mines destroy in situ aquifer structures and can be regarded as areas of high transmissivity and storativity. Recharge into backfilled opencast pits is estimated between 15 – 30% MAP. Table 13 present the suggested average rainfall recharge percentage in the various opencast mining environments and in underground mine workings.

Table 13: Percentage rainfall in opencast (Hodgson and Lukas, 2006)

Water Source	Water into opencast (% rainfall)	Suggested average value (% rainfall)
Rainfall onto ramps and voids	20 - 100	70
Rain onto un-rehabilitated spoils	30 - 80	60
Rain onto levelled spoils (run-off)	3 - 7	5
Rain onto levelled spoils (Seepage)	15 - 30	20
Rain onto rehabilitated spoils (run-off)	5 - 15	10
Rain onto rehabilitated spoils	5 - 10	8

5.3 Cover Design – Seepage Modelling

Conceptual level seepage modelling of a 300 mm thick soil cover for both iMpunzi Venture co-disposal facility and Atcom South coarse discard facility was performed using the one-dimensional soil atmospheric modelling software HYDRUS-1D. The soil cover aims to limit erosion and seepage into the discard facilities and therefore reducing the mass loads to the water treatment facility.

It should be noted that the purpose of the 300 mm thick soil cover is for managing infiltration for pollution control (decreasing mass loads to the groundwater system) and water use efficiency (decreasing the volume of dirty water generated). Additional soil might be required for a growth medium, depending upon the final land use (e.g. grass vs shrubs). The final cover thickness would need to be confirmed as part of design (see for example the 500 mm thick cover as growth medium proposed for the Coarse Discard Dump in Golder, 2018c), but 300 mm silty clay is required as a minimum for pollution control and water use efficiency purposes.

The objective was to evaluate whether a 300 mm soil cover on each of the two discard facilities would reduce seepage. It is assumed that available soils will be used for cover material. Silty clay was not dominant, but present in smaller portions of the surveyed area: around 24 ha was identified in the soil survey. The dominant soil was loamy sand, but this did not yield favourable results to limiting ingress of water (Golder, 2020). The available volume of silty clay topsoil allows for a soil cover thickness of 300 mm for both facilities. For the conceptual level assessment, default silty clay properties in HYDRUS-1D were used. The saturated hydraulic conductivity for normal density (1.3 g/cm^3) silty clay (3.624 cm/day) was applied. Sand texture material properties were used to represent the discard material.

Figure 24 presents the simulated average net Infiltration for a 300 mm soil cover made of silty clay at normal density (1.3 g/cm^3). The average simulated net infiltration is 2.32 cm/yr, which equates to 3.3 % of the Mean Annual Precipitation.

Site specific parameters were not used in the model simulations. Site specific data is integral in assessing the recharge assessment through cover material. To progress from conceptual to pre-feasibility (that is from a 30% confidence level to a 60% confidence level), the use of site specific properties such as soil water characteristic curve, in-situ hydraulic conductivity testing, and particle size distribution for the cover borrow material on site as well as the backfill material is recommended. It is important to note that the simulated performance of the store and release vegetated cover is premised on optimal performance of the vegetation cover, which requires that the soil substrate be suitable for deep rooting and that the soils are fertile and uncompacted so that vigorous plant growth will maximise the leaf area for evapotranspiration.

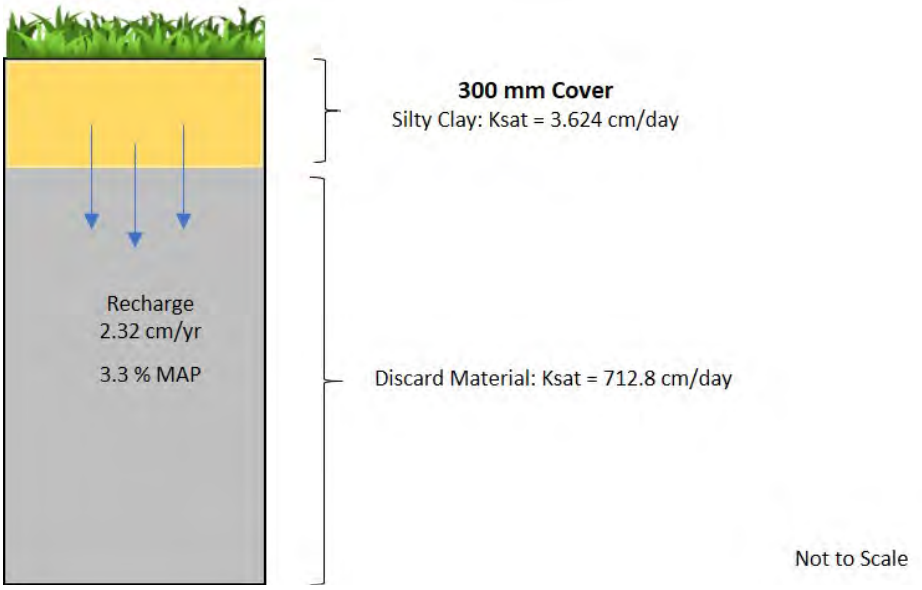


Figure 24: Simulated Conceptual Cover

5.4 Numerical model development

5.4.1 Groundwater Flow Equation

A steady state groundwater flow model for the study area was constructed to simulate groundwater flow conditions in 2018. These conditions serve as starting heads for the transient simulations of groundwater flow and mass transport. A dynamic flow model using the modelling package FEFLOW (Diersch, 1979) was constructed for the study area. The simulation model (FEFLOW) used in this modelling study is based on three-dimensional groundwater flow and may be described by the following equation:

$$\frac{\partial}{\partial x}(K_x\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(K_y\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(K_z\frac{\partial h}{\partial z})\pm W=S\frac{\partial h}{\partial t} \qquad (1)$$

Where,

h = hydraulic head [L]

K_x,K_y,K_z = Hydraulic Conductivity [L/T]

S = storage coefficient

t = time [T]

W = source (recharge) or sink (pumping) per unit area [L/T]

x,y,z = spatial co-ordinates [L]

For steady state conditions the groundwater flow equation (1) reduces to the following equation:

$$\frac{\partial}{\partial x}(Kx\frac{\partial h}{\partial x})+\frac{\partial}{\partial y}(Ky\frac{\partial h}{\partial y})+\frac{\partial}{\partial z}(kz\frac{\partial h}{\partial z})\pm W=0 \qquad (2)$$

According to the conceptual model for the system the calculated hydraulic head distribution (hx,hy,hz) is dependent upon the recharge from rainfall, hydraulic conductivity and boundary conditions. For a given hydraulic conductivity value (transmissivity value) and a set of boundary conditions, the head distribution across the aquifer can be obtained for a specific recharge value.

5.5 Model Domain

The model domain covers a surface area of about 321 km^2. The modelling area was selected based on a combination of both topographical i.e. along surface catchment boundaries and hydrogeological controls. The model was delineated to coincide with rivers and assumed groundwater divides. This is a reasonable approach since a fair correlation exists between groundwater level elevation and surface topography (for the shallow boreholes). The model domain was chosen large enough to ensure that the solute transport simulation is unaffected by assigned boundary conditions.

The model was set up as a three-dimensional groundwater flow model. The model domain is dissected into multiple layers corresponding with the conceptual model development. The mesh was designed to incorporate iMpunzi operations. The finite element mesh generated by FEFLOW used the triangular prism mesh made up of 598 136 elements and 344 312 nodes. Figure 25 illustrates the model domain for the study area.

The mesh quality is regarded suitable based on the following criterion:

- Interior holes: 0
- Obtuse angled triangles: 0.0% > 120°, 4.1% > 90º
- Delaunay-violating triangles: 0.3%

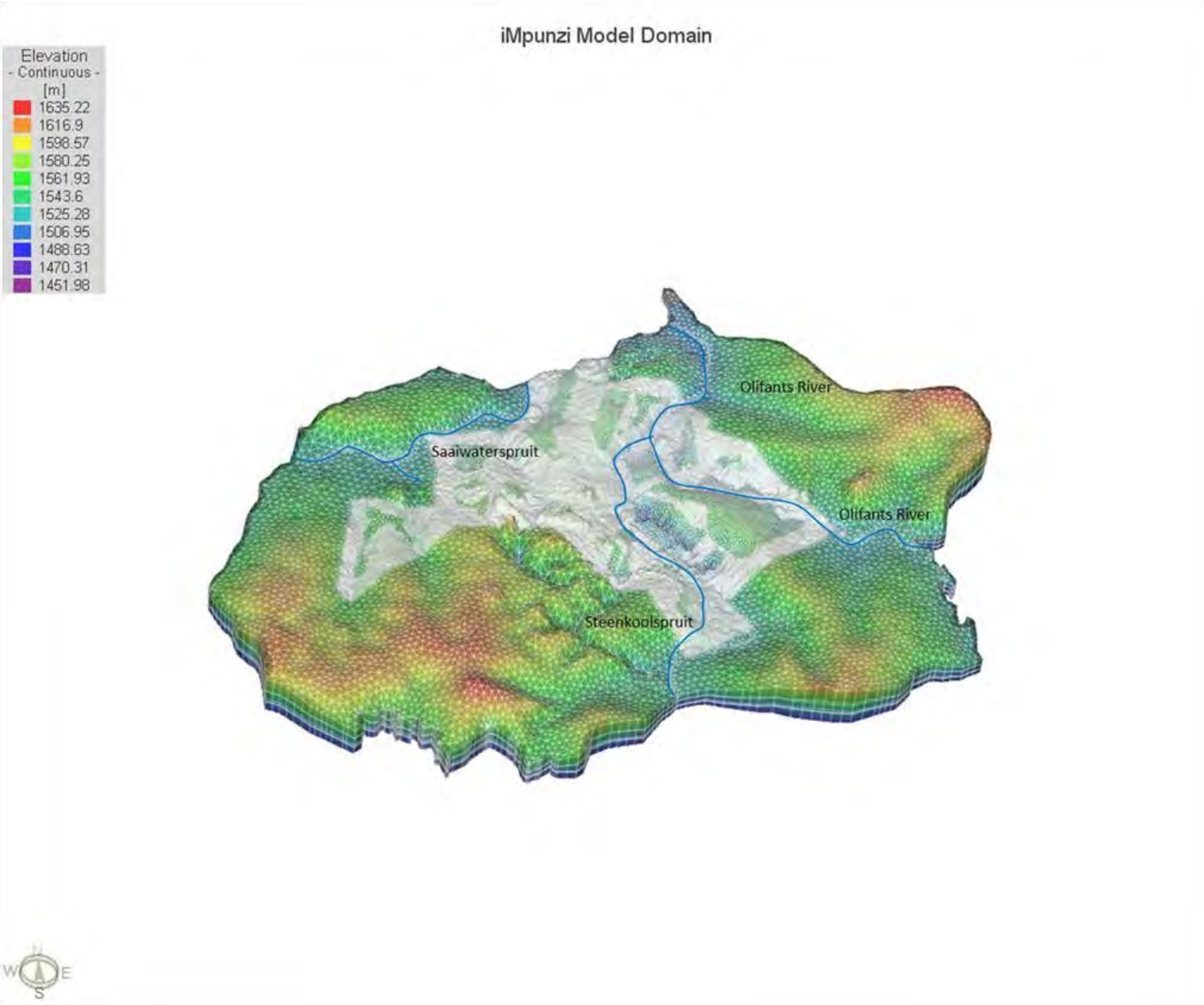


Figure 25: Model Domain

5.6 Model Limitations and Assumptions

The following limitations and associated assumptions have been identified:

- K values derived from slug test data are significantly low and results can be attributed to represent local conditions. Consequently, recognised literature values for the Karoo sedimentary units are also used in the calibration of the model for K and storativity (S) parameters.
- Coal seam elevations have been interpolated in places where no data was available to fit the model boundary and some accuracy may be reduced as a result.
- Contaminant transport modelling was carried out from 2018, life of mine plan provided is assigned from 2018 -2036.
- Seam No. 2 upper and lower seams are merged into seam 2 and No. 4 upper and lower seams are merged into seam 4 to avoid pinching out in places and to ensure model layers are continuous.
- The underground mined out seam workings are assumed be in steady state.
- Old underground mine seam workings are connected to backfilled open cast working in places and hence to the underground workings.

- A higher rainfall recharge to groundwater of 15% is applied to rehabilitated opencast pit areas.
- The mass transport simulations consider the current conditions (2018-2020). Historic groundwater contamination prior to 2018 have not been accounted for.
- Model flow directions are calibrated for steady state.
- No sources terms were applied to the LOM plans, conceptually the mass loads would be pumped out with dewatering during operations
- Rivers in the model domain were specified as seepage face boundary conditions. The river elevations were interpolated from surface elevation data.
- Post closure simulations assume all mining operations within the model domain have ceased.
- Post closure source terms are applied to Venture Pit and Venture co-disposal facility and ATCOM South Pit and ATCOM south coarse discard facility to simulate the impact of cover and no cover scenarios on the groundwater system.
- Recharge is assumed to be 100% of MAP on the slurry footprint areas during operations.
- Post closure simulations assume that slurry material has dried out.
- A constant source term is applied for mass transport simulations.

5.7 Model Boundary Conditions

Boundary conditions express the way the considered domain interacts with its environment. Specifically, they express the conditions of known water flux, such as piezometric head. Boundary conditions in the groundwater flow model were specified either as:

- Dirichlet Type (or constant head) boundary conditions;
- Neumann Type (or specified flux) boundary conditions; or
- Combination of Neuman type and Dirichlet.

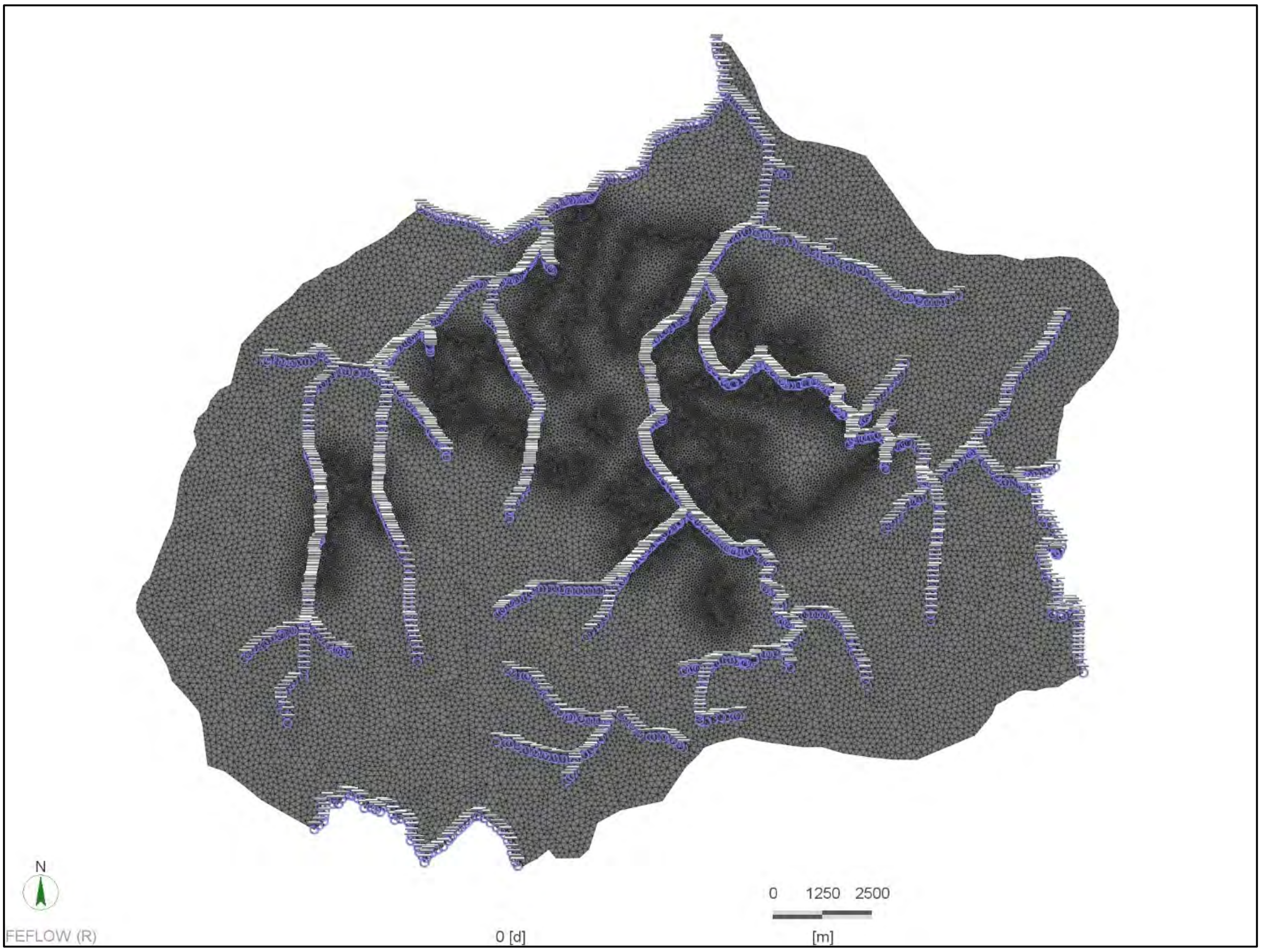


Figure 26: Boundary conditions on slice 1 in the model

5.7.1 Internal Boundary Conditions

Locally groundwater in both the shallow and deep aquifers flows from the high to low elevations, towards the rivers or drainages and follow topography. Seepage face boundary conditions were specified along the river drainages which are known to receive base flow from groundwater. The seepage face boundaries of the numerical model are shown in Figure 26.

5.8 Model Layers

The study area is represented by a 7-layered model based on existing data and a simplified geological section. The model domain was assumed to extend vertically to encompass the following coal seams: Seam 4, Seam 2 and Seam 1. It is assumed that the base of the model is impermeable. Table 14 presents the model layers and average thickness. Layer 2, 4 and 6 represents the coal seams. Figure 27 is a cross-sectional view of the model layers and assigned conductivity values, extracted from FEFLOW.

Table 14: Model layers

Model Layer	Layer No.	Average Thickness (m)
Weathered zone	1	6
Coal seam 4	2	4
Sandstone/Mudstone including Seam 3	3	32

Model Layer	Layer No.	Average Thickness (m)
Coal seam 2	4	3
Sandstone	5	5
Coal seam 1	6	3
Basement	7	9

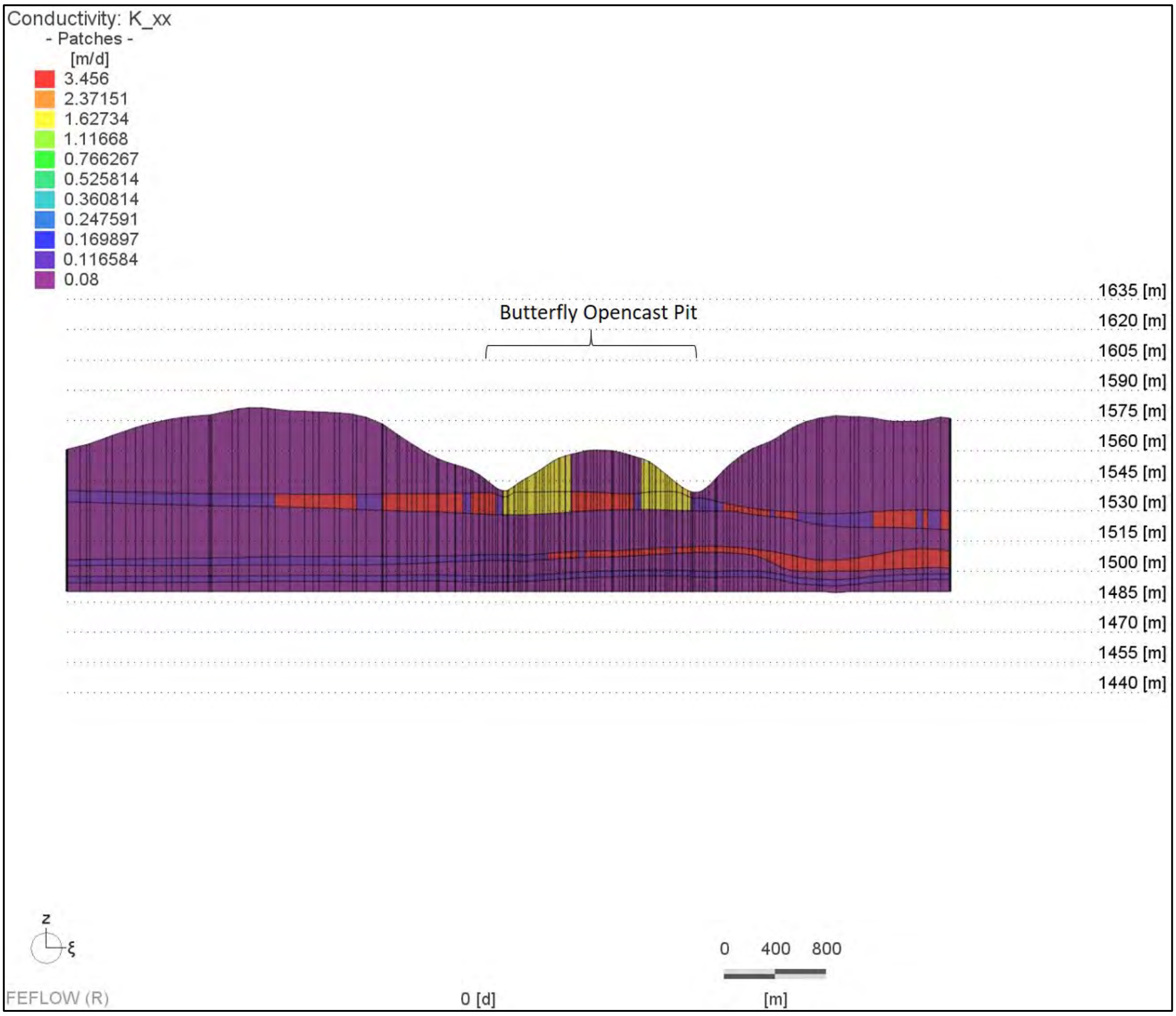


Figure 27: Example of a cross section of the model layers

5.9 Porosity and Dispersivity

Dispersion of contaminants in groundwater is important in terms of contaminant transport. Dispersive transport is caused by tortuous nature of pores in different flow velocity distributions within an aquifer. Longitudinal dispersivity is one component of dispersion and is scale depended. This parameter has significant uncertainty due to the difficulty in obtaining field measurements. A porosity value of 0.5% is assigned for the undisturbed aquifer and 15% for the opencast mined out pits. Longitudinal and transverse dispersivity of 5m and 0.5m respectively was specified for the simulations.

5.10 Storativity

For the steady state model, storativity is not required. For transient state simulations, a specific storage value of 1×10^{-4}/m was assumed throughout the model domain.

5.11 Model Hydraulic Properties

5.11.1 Hydraulic Conductivity and Transmissivity

The major hydrogeological units built into the model consist of the major aquifer zones and lithologies. Initial estimates of the K values are from representative Karoo aquifers and values recognised to be representative for sandstones/shale/siltstone sedimentary sequences of the Vryheid Formation. The aquifer K value is based on the conceptual understanding of the study area and Golder's experience with the Witbank coal fields. Generally accepted and recognised K values for sandstones/shale/ siltstone and sedimentary sequences of the Vryheid Formation vary between 0.01 m/day and 0.1 m/day**.** Table 15 presents the input aquifer parameter values used for model calibration.

Table 15: Model hydraulic properties

Geology	Layer	Kx	Ky	Kz	% of MAP	Recharge (mm/year)
Weathered zone	1	0.08	0.08	0.008	0.9	7
Coal seam 4	2	0.1	0.1	0.01	0	0
Sandstone/Mudstone	3	0.08	0.08	0.008	0	0
Coal seam 2	4	0.1	0.1	0.01	0	0
Sandstone	5	0.08	0.08	0.008	0	0
Coal seam 1	6	0.1	0.1	0.01	0	0
Basement	7	0.08	0.08	0.008	0	0
Backfilled opencast areas	1,2,3,4,5,6	1.728	1.728	1.728	15	107
Underground mined out areas	2,4,6	3.456	3.456	3.456	0	0

5.12 Model Calibration

5.12.1 Steady State Calibration Approach

Steady State calibration was accomplished by using aquifer K values based on the conceptual understanding of the study area and generally accepted and recognised K values for sandstones/shale/ siltstone and sedimentary sequences of the Vryheid Formation. The field conditions are not in steady state yet and are still influenced by mining operations. Groundwater water level contours were calibrated to match current groundwater level contours. Figure 28 illustrates the simulated hydraulic head contours which correspond to the observed hydraulic contours.

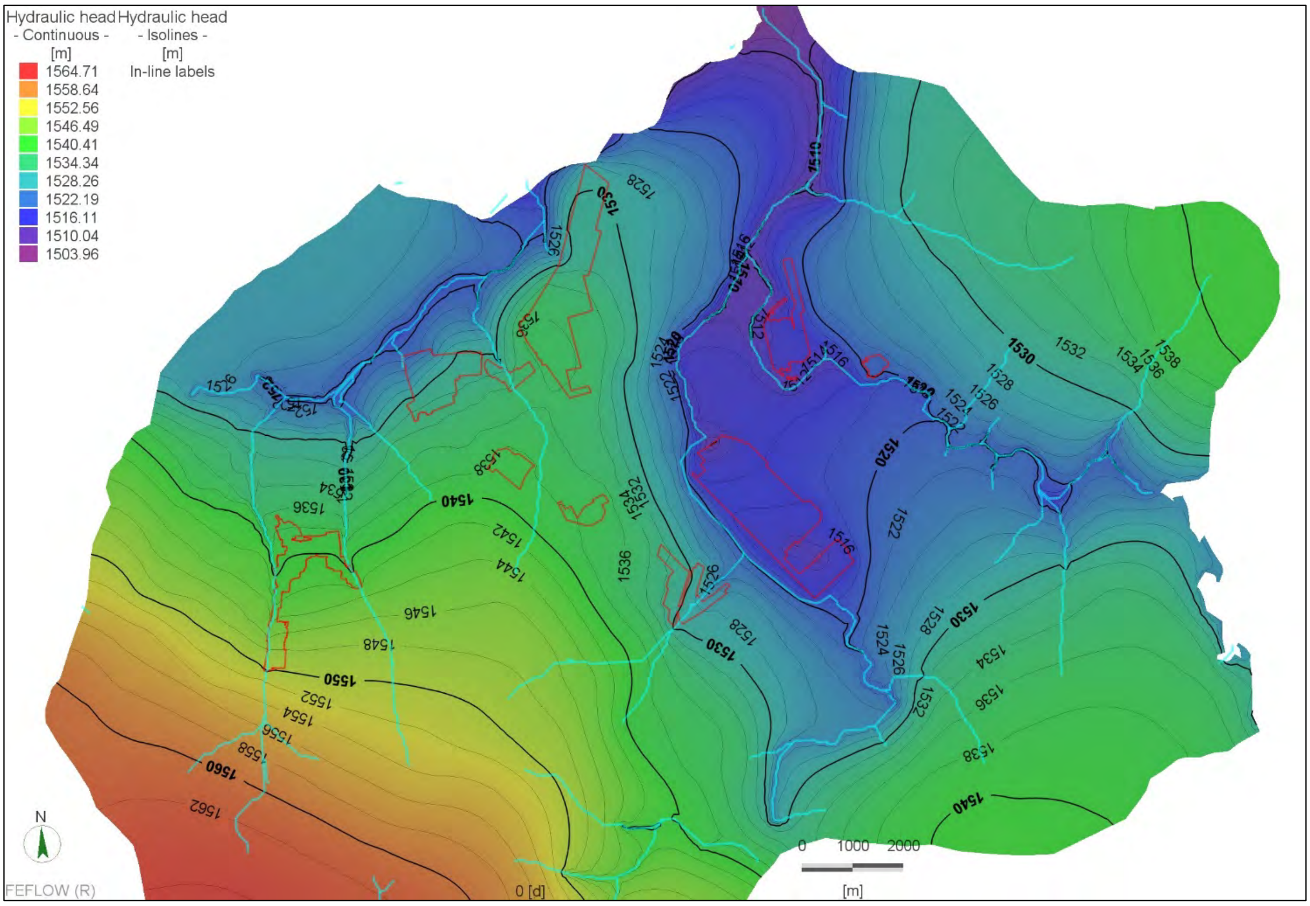


Figure 28: Steady State Simulated Hydraulic Heads

5.13 Mass Transport Model Development

5.13.1 Introduction

One of the main objectives of this study is the development of a mass transport model for iMpunzi Mine. For the solute transport model, the contaminants of concern modelled is TDS. The processes controlling contaminant migration in groundwater is briefly discussed in the following sections.

5.13.2 Process Controlling Contaminant Transport Migration

Transport through a porous medium is mainly controlled by advection and dispersion.

Advection is the component of contaminant movement described by Darcy's Law. If uniform flow at a velocity *V* takes place in the aquifer, Darcy's law calculates the distance (*x*) over which a labelled water particle migrates over a time period t as $x = Vt$.

Hydrodynamic dispersion comprises two processes: (1) mechanical dispersion and (2) molecular diffusion.

Mechanical dispersion is the process whereby the initially close group of labelled particles is spread in a longitudinal as well as in a transverse direction. This is caused by the velocity distribution (as a result of varying microscopic streamlines) that develops at the microscopic level of flow around the grain particles of the porous medium. Although this spreading is both in the longitudinal and transversal direction of flow, it is primarily in the former direction. Very little spreading can be caused in the transversal direction by velocity variations alone.

Molecular diffusion mainly causes transversal spreading, by the movement of the molecules in the fluid from higher contaminant concentrations to lower ones. It is thus clear that if $V = 0$, the contaminant is transported by molecular diffusion only or in other words the higher the velocity of the groundwater the less the relative effect of molecular diffusion on the transportation of a labelled particle.

5.14 Mass Balance Equation

The mass balance equation (Bear and Verruijt, 1992) (equation of *hydrodynamic dispersion* or the *advection-dispersion* equation) of a pollutant (contaminant) is expressed as:

$$\frac{\delta nc}{\delta t} = -\Delta \bullet q_{c,total} - f + n\rho\Gamma - P_c + R_c \quad (2)$$

where:

nc = mass of pollutant per unit volume of porous medium;

n = porosity of saturated zone;

c = concentration of pollutant (mass of pollutant per unit volume of liquid (water));

$\Delta \bullet q_{c,total}$ = excess of inflow of a considered pollutant over outflow, per unit volume of porous medium, per unit time;

f = quantity of pollutant leaving the water (through adsorption, ion exchange etc.);

$n\rho\Gamma$ = mass of pollutant added to the water (or leaving it) as a result of chemical interactions among species inside the water, or by various decay phenomena;

Γ = rate at which the mass of a pollutant is added to the water per unit mass of fluid;

p = density of pollutant;

P_c = total quantity of pollutant withdrawn (pumped) per unit volume of porous medium per unit time;

R_c = total quantity of pollutant added (artificial recharge) per unit volume of porous medium per unit time.

In the case of this investigation it is assumed that no decay or retardation of contaminants is taking place in the aquifer. Contaminant migration is therefore attributable only to advection and hydrodynamic dispersion. This will provide a worst-case scenario in terms of travel distance of contaminants.

5.15 Numerical Mass Transport Model – Data Input

FEFLOW software was used to approximate the advection and dispersion equation and to provide numerical solutions for the concentration values in the aquifer in time and space. Input required in the software is:

- input concentrations of contaminants;
- hydraulic conductivities in the x- and y- directions;
- porosity values for the saturated portion of the aquifer;
- longitudinal dispersivity;
- transversal dispersivity.

5.16 Input Sources and Concentration of Contaminants

The source terms are specified as mass flux boundary in the Feflow model. The mass flux boundary is specified as follows:

Source term specified in model = Seepage rate (m/day) × Concentration of seepage (mg/l) = Mass load into the aquifer (g/day) per square metre of source surface area.

Table 16 presents the various source terms applied to the model. Initial TDS concentration in the model domain is set to 1E-35 mg/l. This is done to reduce numerical instability.

Table 16: Operations source terms for various sites

Site	Recharge mm/a	Recharge m/day	TDS Concentration (mg/l)	Mass Flux (g/m2/d)
AC2 Discard Dumps	107	0.000292	5 050	1.48
AC4 Venture O/C pit	107	0.000292	2 973	0.87
Venture Corse Discard (Beach)	427	0.001169	4 451	5.21
Venture Slurry (Supernatant pond)	711	0.001949	3 903	7.61
AC5 Butterfly O/C Pit	57	0.000156	1 328	0.21
AC6 Future O/C Pits (Office Pit)	107	0.000292	1 851	0.54
PX1 Old O/C Pits	107	0.000292	1 650	0.48
AM2 Beath Dump	427	0.001169	24 392	28.52
AM6 ATCOM South O/C Pit	107	0.000292	4 869	1.42
South Pit Coarse discard facility	427	0.001169	5050	5.91
Paddocks Slurry	711	0.001949	5 222	10.18
AM9 ATCOM old North Dump	107	0.000292	1 202	0.35
AM8 ATCOM North O/C Pit	107	0.000292	4 902	1.43
AE1 Steenkoolspruit West O/C Pits	107	0.000292	3 434	1.00

5.17 Mass Transport Predictive Simulations

Mass transport simulations are carried out site wide for operations phase. Mass transport for post mine closure was carried out only for Venture and ATCOM South Facilities. The contaminant sources for post closure are shown in Figure 29. The post closure simulations are used to estimate the impact the two discard facilities will have on the groundwater system when: (a) a cover system is constructed over the discard facilities and; (b) no cover system is employed over the discard facilities.

The predicted plume development due to unmitigated conditions for iMpunzi Mine is conservative because of the water levels still recovering across the study area. The TDS contaminant plume is shown with a threshold value of 450 mg/L (Class 0 Drinking Water SANS 241 Standard) (Figure 30). The major contributor of mass load to the groundwater system during operations is Beath dump and its plume gets drawn to the open cast mining activities at ATCOM East.

During life of mine (2018 – 2036) Beath dump exhibits TDS plumes with substantial concentrations reaching the Steenkoolspruit. Contaminant plumes migrate from ATCOM old North Dump and Venture Co-disposal Facility into the Saaiwaterspruit. ATCOM South Coarse discard facility contaminants migrate into the Steenkoolspruit.

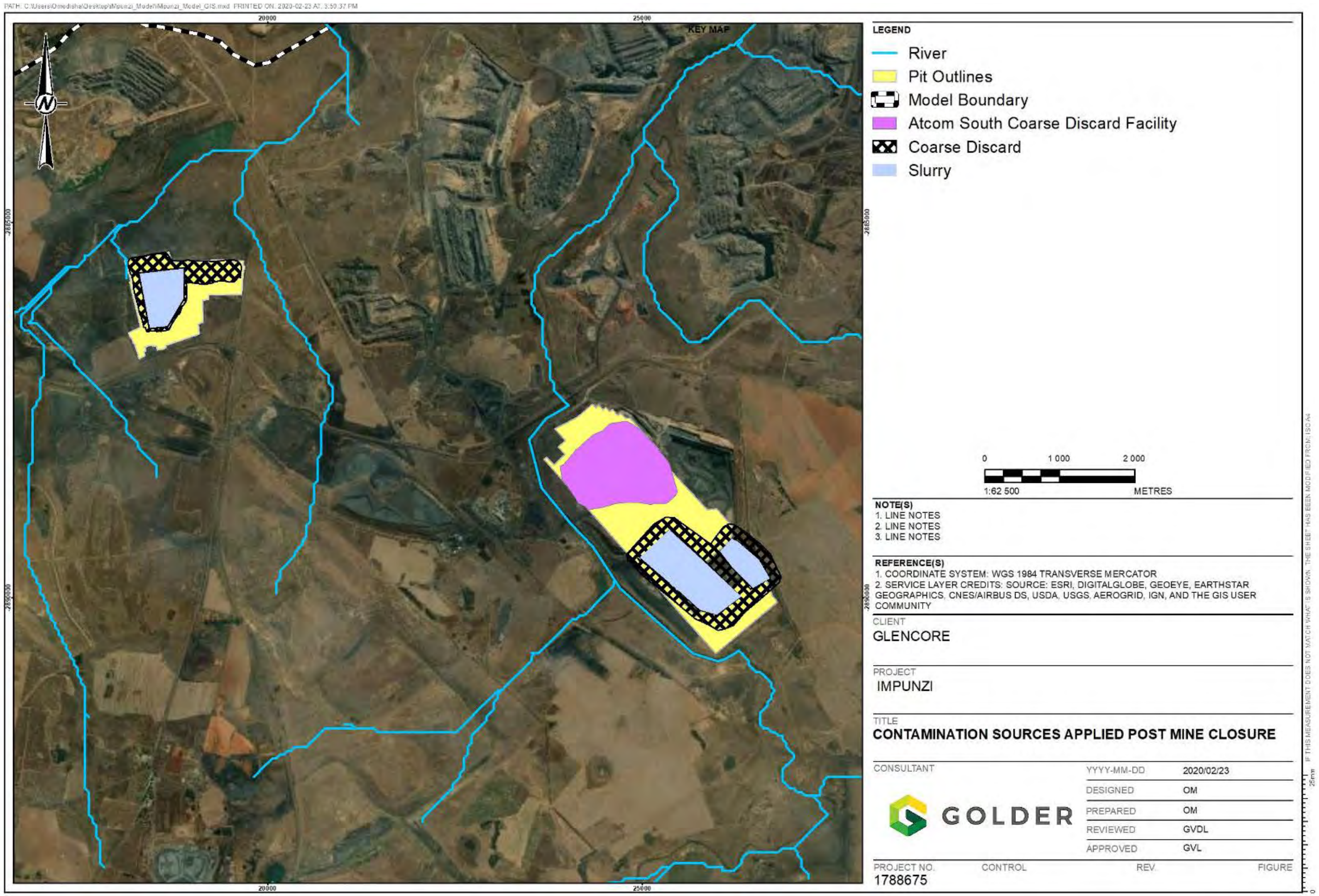


Figure 29: Contaminant sources for post closure simulations

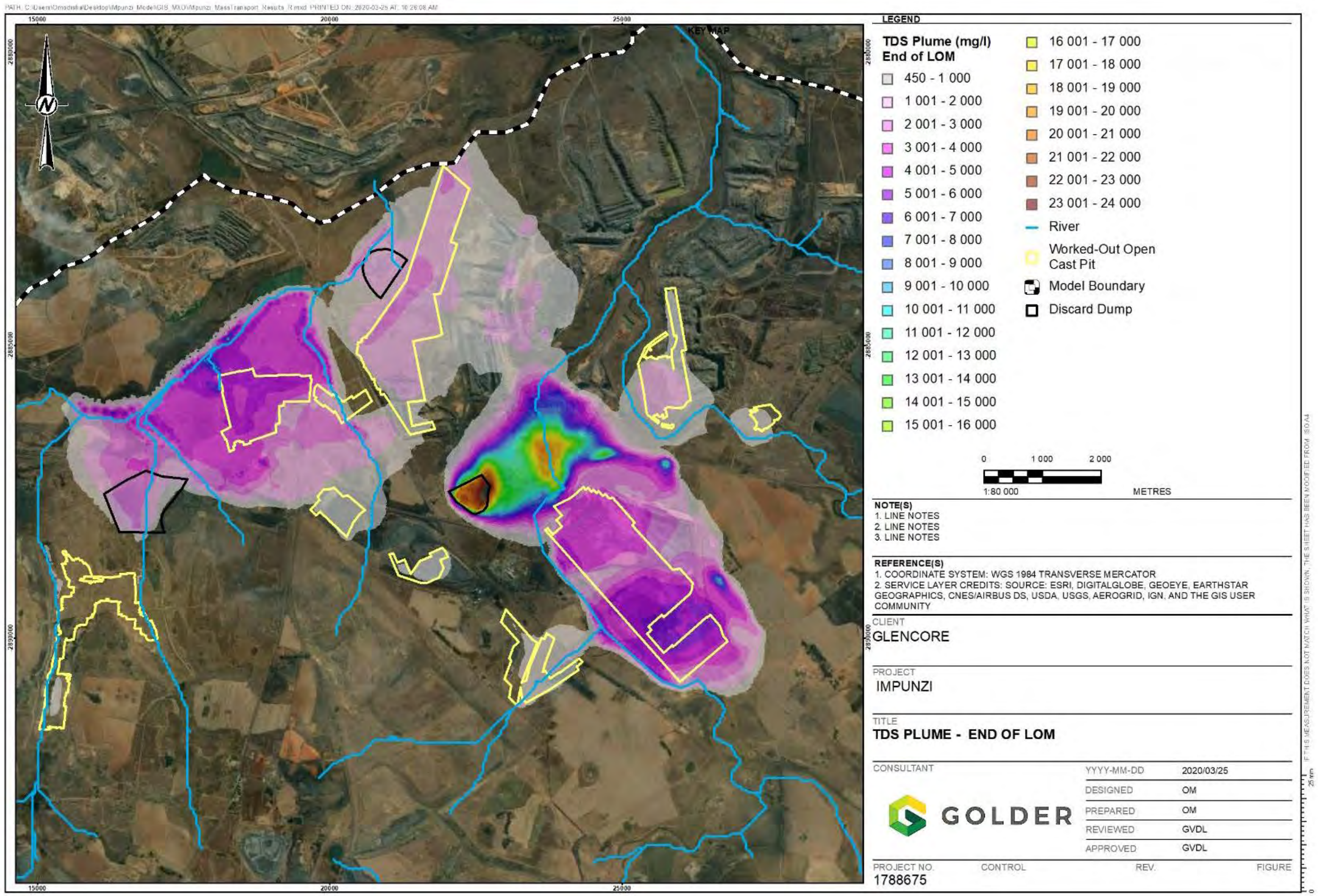


Figure 30: TDS plume end of life of mine (2036)

5.17.1 Post Closure Mass Transport

Post closure mass transport was simulated for 50 years' post closure for Venture Co-disposal Facility and South Pit Coarse discard facility. It is assumed the mining would have ceased and that the slurry facilities at both Venture and ATCOM South Pit would have dried out. Table 17 presents the recharge and mass flux applied for the post closure no cover scenario. Figure 31 illustrates the simulated TDS plume for post closure for no cover scenario. The highest TDS concentrations are located within the pits and a portion of the mass load migrates towards the decant locations and then further towards the surface drainages at Saaiwaterspruit for Venture Pit and Steenkoolspruit for ATCOM South pit.

Table 17: Post closure source terms - No Cover Scenario

Site	MAP Recharge % No Cover	TDS Concentration (mg/l)	Mass Flux (g/m^2/d)
Venture O/CPit AC4	15%	4074	1.19
Venture Coarse Discard	60%	6 382	7.46
Venture Slurry	2%	7 154	0.28
ATCOM South O/C Pit AM6	15%	6671	1.96
ATCOM South Coarse Discard Facility	60%	6 382	7.46
Paddocks Coarse Discard	60%	6 382	7.46
Paddocks Slurry	2%	7 154	0.28

For the post closure cover scenarios, it is assumed that the Venture pit and ATCOM South Pit would be rehabilitated and therefore a recharge of 8% MAP is applied to these pits. The discard is to be covered with a 300 mm thick layer of silty clay, see section 5.3 above. The recharge rates for this cover were modelled using Hydrus, and the Cover recharge rates are provided in Table 18.

Table 18: Post closure source terms - Cover Scenario

Site	MAP Recharge % with Cover	TDS Concentration (mg/l)	Mass Flux (g/m2/d)
Venture O/C Pit AC4	8%	4074	0.64
Venture Coarse Discard	3.3%	6 382	0.41
Venture Slurry	0.5%	7 154	0.07
ATCOM South O/C Pit AM6	8%	6671	1.04
ATCOM South Coarse Discard Facility	3.3%	6 382	0.41
Paddocks Coarse Discard	3.3%	6 382	0.41
Paddocks Slurry	0.5%	7 154	0.07

Figure 32 present the simulated TDS plume for post closure cover scenario. The TDS contaminant plume is shown with a threshold value of 450 mg/L (Class 0 Drinking Water SANS 241 Standard). There is a smaller footprint of high concentration TDS plume outside the pit boundaries compared to the no cover scenario. TDS concentrations at decant locations are of a lower concentration compared to the no cover scenario.

Figure 33 and Figure 34 show the cover and no cover cumulative mass flux to and from groundwater and mass reporting to surrounding receptors at ATCOM South Facilities and Venture facilities respectively. Receptors in this instance are identified as Saaiwaterspruit, Steenkoolspruit and Diversion around South Pit. On a cumulative basis 67,050 t (tonne) of TDS will be released over the period 2037-2087 for no cover and 8,264 t for cover scenarios resulting in a reduction of 58,786 t of TDS (87%) to the groundwater at Venture co-disposal facility and pit. Similarly, on a cumulative basis some 358,694 t of TDS will be released over the same period at ATCOM South Coarse discard facility and pit for the no cover scenario and 38,083 iT for the cover scenario resulting in a reduction of 320,612 t cumulative TDS mass load (89%).

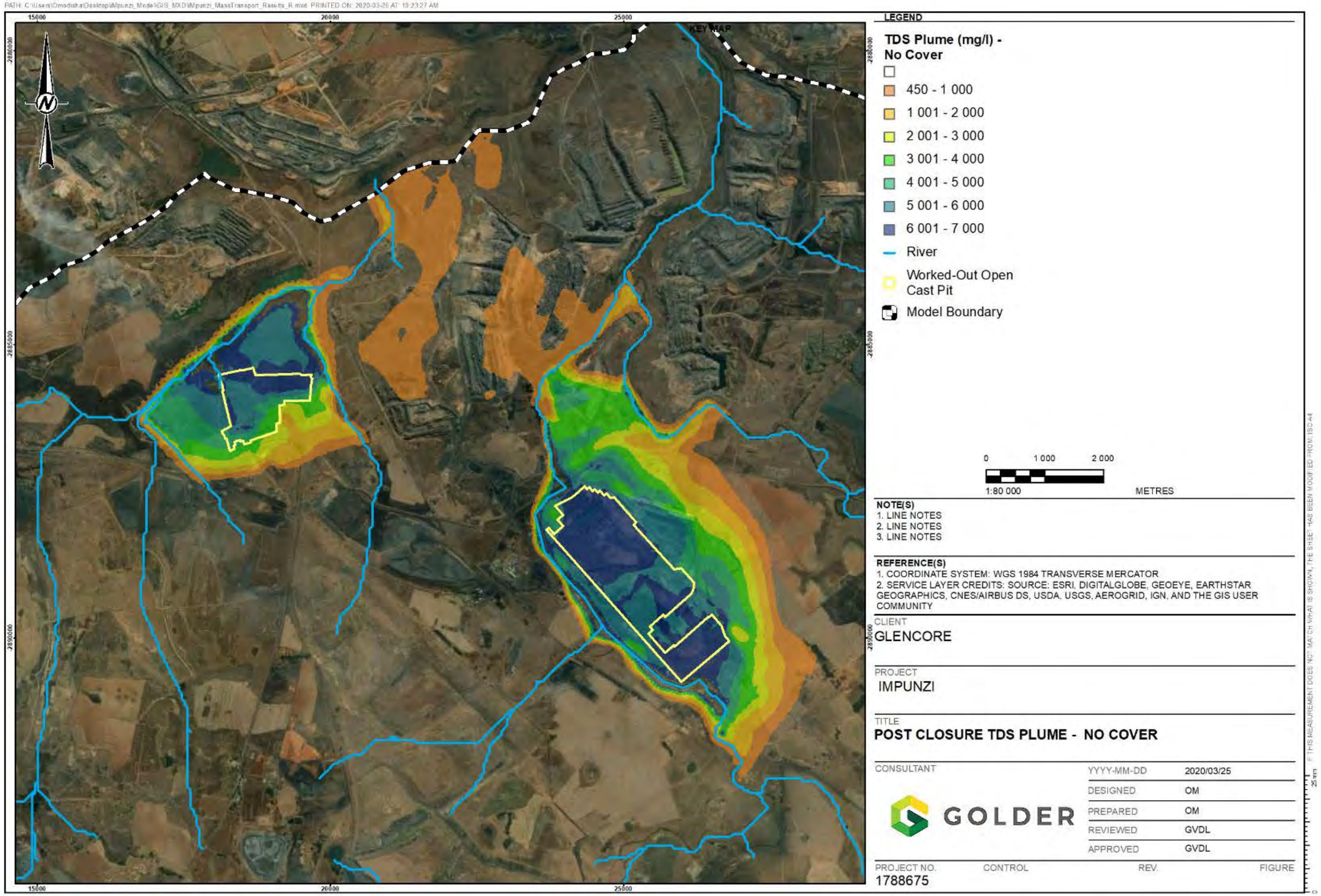


Figure 31: Post Closure Simulated TDS Plume - No Cover

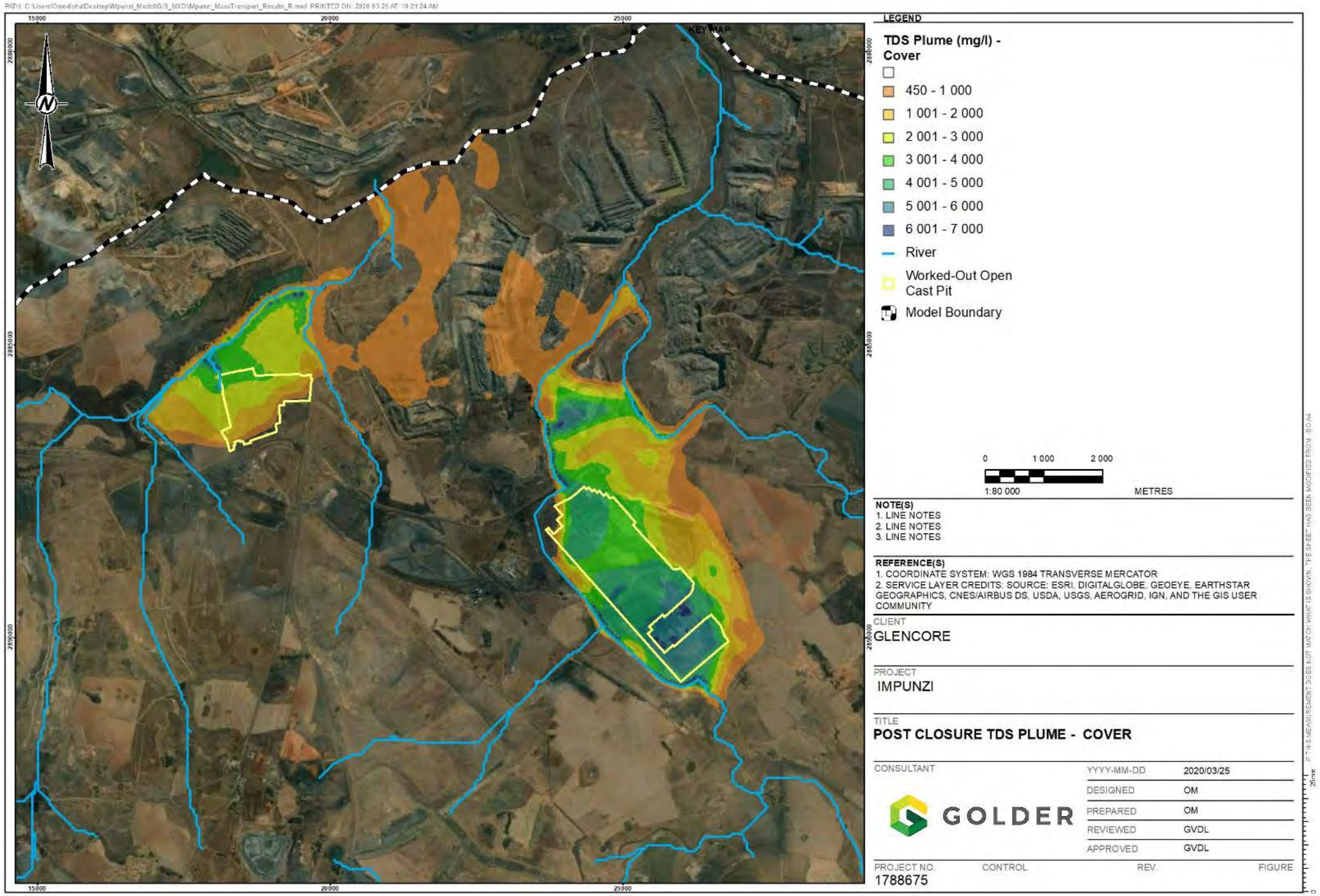


Figure 32: Post Closure Simulated TDS Plume - Cover

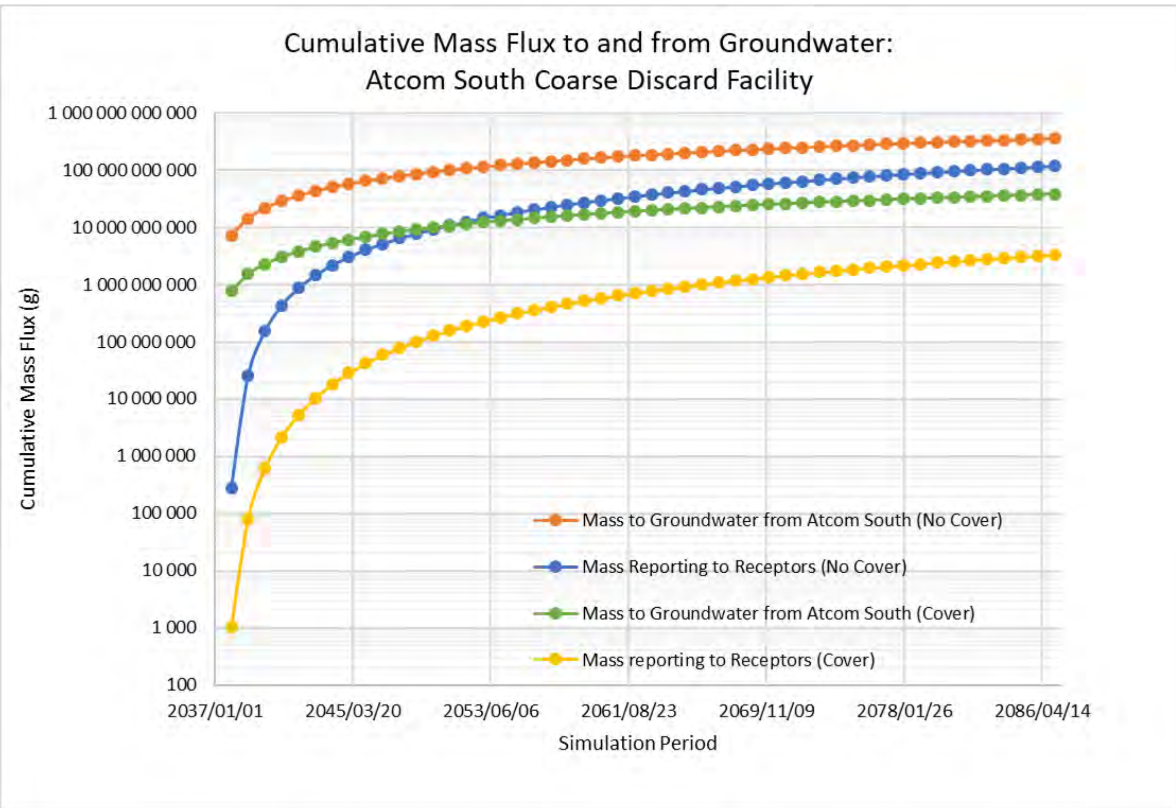


Figure 33: Cumulative mass flux to and from groundwater from ATCOM South Coarse discard facility and Pit

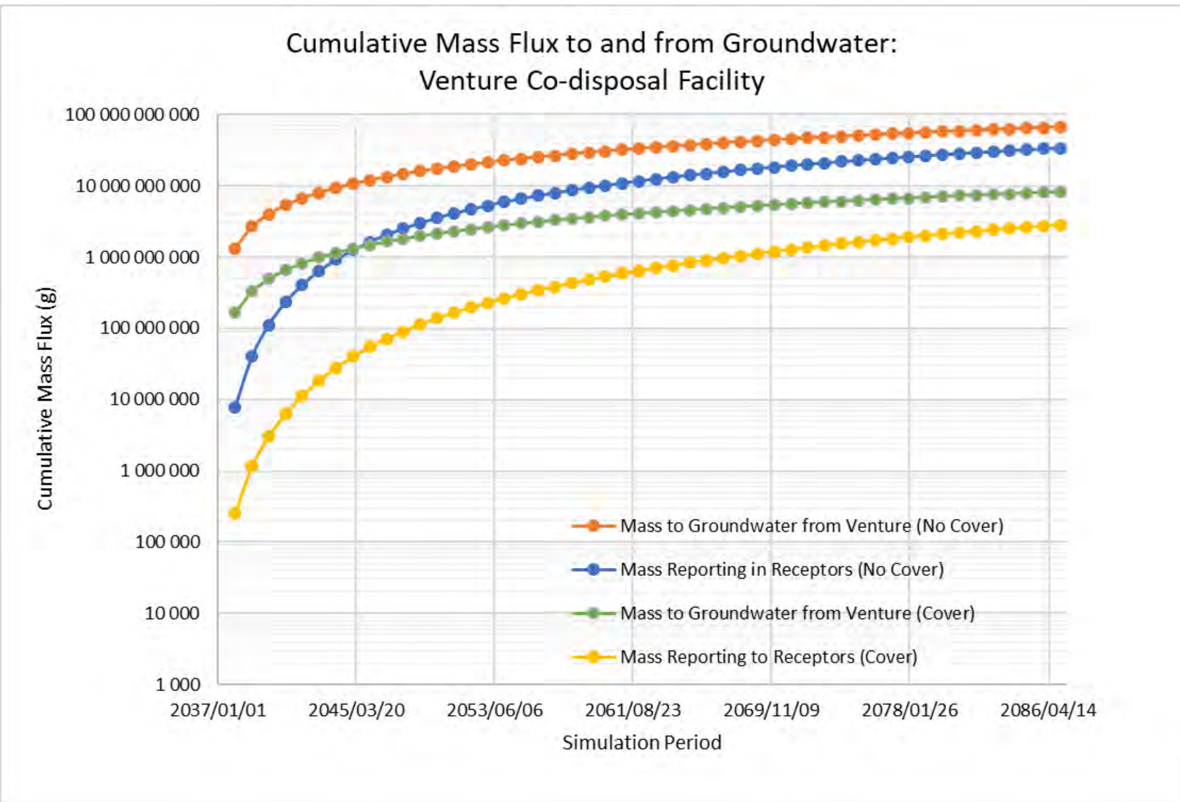


Figure 34: Cumulative mass flux to and from groundwater from Venture co-disposal facility and pit

5.17.2 Operations Decant Mitigation Abstraction

During operations, decant was simulated at Venture pit and ATCOM South Pit. The decant locations at ATCOM South pit are later affected by mine dewatering at the ATCOM East during operations which draws down the water table and reduces decant slightly at ATCOM South Pit.

Mitigation abstraction is simulated to observe the possible reduction of water levels to within the pit so that there is a possible reduction in impacts to the environment. The positions of the six abstraction boreholes at Venture Pit and eight abstraction boreholes at ATCOM South pit are depicted in Figure 35. The boreholes were assigned along the pit outlines were possible decant would occur. The effectiveness of abstraction is a function of the transmissivity of the fill material in the pit. A hydraulic conductivity of 1.728 m/d was assumed in the model. Boreholes at Venture pit are each pumped at 4l/s for a total abstraction of 24 l/s. Boreholes at ATCOM South pit are each pumped at 6.9 l/s for a total abstraction of 55 l/s. Actual boreholes yields would need to be verified and confirmed on site upon construction of abstraction boreholes.

5.17.3 Post Closure Decant Mitigation Abstraction

Mitigation abstraction for post closure cover and no cover scenarios is simulated to observe the possible reduction of water levels to within the pit to verify that there is a possible reduction in impacts to the environment. The six abstraction boreholes at Venture Pit with a total abstraction rate of 24 l/s for both cover and no cover scenario will be sufficient to maintain the water level to within the pit post closure. The eight abstraction boreholes at ATCOM South pit are each pumped at 6.9 l/s for a total abstraction of 55 l/s for the cover scenario. Whereas for the no cover scenario an additional abstraction borehole at ATCOM South Pit will be required bringing the total abstraction boreholes to nine. The nine boreholes will each be pumped at 6.9 l/s for a total abstraction of 62.10 l/s for the no cover scenario. Borehole yields would need to be confirmed on site upon final construction of abstraction boreholes.

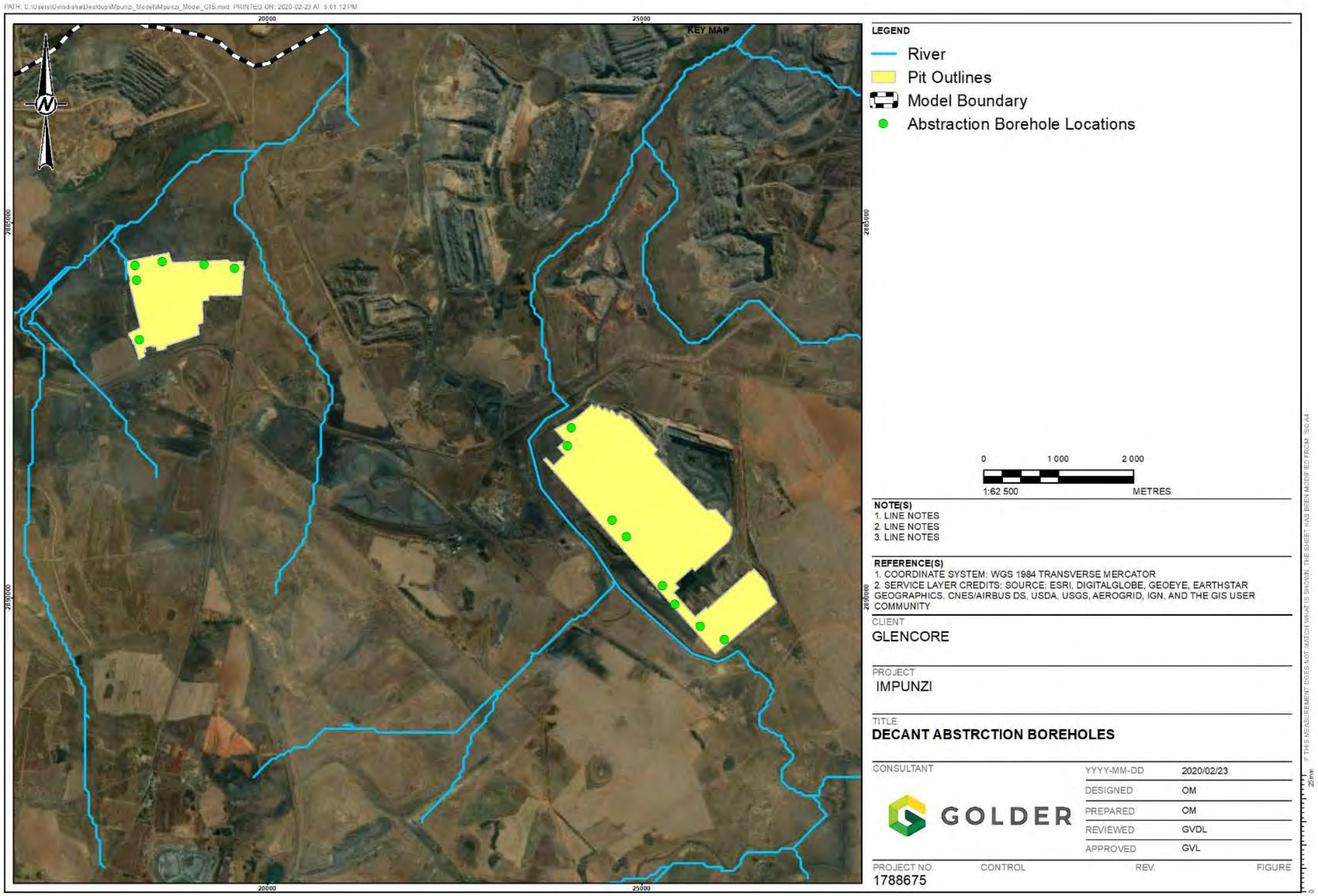


Figure 35: Abstraction Borehole Locations (assigned along the pit outlines were possible decant would occur)

5.18 Recommendations to Improve Model

In order to improve the confidence of the model the following steps should be undertaken:

- Independent estimation of recharge rates for backfilled pit areas.
- Confirmation of abstraction borehole yields, by means of test pumping, upon final construction.
- Pit calibrated groundwater model to improve evaluations of decant rates and abstraction rates for Venture and ATCOM South Pits as opposed to a site wide calibration.
- Update of water level and water quality chemistry data from 2018 to 2020.
- Kinetic test to generate decaying post closure source terms.

6.0 WATER TREATMENT IMPLICATIONS

6.1 Introduction

With the proposed development of the new coarse discard facility on ATCOM South Pit and the extension of the Venture Void disposal facility to a co-disposal facility, it is likely that the mine water quality from both pits will change over time. As water from both of these pits is / will be pumped to the Tweefontein water reclamation plant, keeping the water level in the pits low enough to prevent surface or subsurface decant, the principal water quality impact of these developments will be the change in water quality of the WTP feed. It is therefore necessary to investigate the water treatment implications

6.2 Predicted Quality of feed from South Pit and Venture Pit

6.2.1 Geochemical Mixing Model Code

Geochemical code PHREEQC, a computer program for simulating chemical reactions and mass- transfer in natural or contaminated water (Parkhurst and Appelo, 1999) was used to carry out the geochemical modelling of quality of feed from ATCOM South pit and Venture pit. PHREEQC can simulate the pertinent processes occurring in aqueous systems such as mixing of multiple solutions, precipitation/dissolution of selected mineral phases, redox reactions and adsorption of metals. The minteq. v4 geochemical database was used as it contains equilibrium constants for most elements that were measured in the mine water samples.

6.2.2 Assumptions and limitations

Use of geochemical modelling to predict speciation and geochemical controls essentially requires use of assumptions due to the general inability to explicitly define the physical and geochemical characteristics of the complex systems being modelled. The following assumptions were made during modelling of quality of plant feed from ATCOM South pit and Venture pit.

- The input data used in the modelling is representative of modelled system water quality – please see section 4.3 above for the assumptions involved in developing the source terms which were used as input data.
- The PHREEQC model appropriately simulates chemical reactions and contains the appropriate thermodynamic constants.
- Dissolved phase metals concentrations were modelled: It was assumed that the concentration data that was used as input data for geochemical modelling was for dissolved metals and semi-metals, which represents the geochemically-reactive fraction.
- The modelled water from the different sources has uniform density and temperature.

- The water in the pits would be open to atmospheric oxygen and carbon-dioxide. Thus oxic conditions were modelled.
- Constituent concentrations below detectable limits were assumed equal to half the detection limit.

6.2.3 Modelling Scenarios

For each pit, annual volumes of recharge from discard, slurry and spoils were estimated from surface areas and recharge rates provided in Section 5.17.1 for no cover scenario and 300 mm cover scenario. The recharge volumes that were used to calculate mixing ratios for each scenario are presented in Table 19, and the input data is presented in Table 12.

Table 19 Annual recharge volumes used to calculate mixing ratios for different scenarios.

Source	Total_Area_m^2	No cover scenario	Cover scenario
		Infiltration (L/a)	Infiltration (L/a)
Venture Slurry Area	369 240	5 191 514	1 297 879
Venture Coarse Discard Area	457 360	192 914 448	10 610 295
Venture Pit Spoils	1 302 047	137 300 856	73 227 123
ATCOM South Coarse Discard Facility	1 261 039	531 906 250	29 254 844
ATCOM South Pit Spoils	3 650 537	384 949 127	205 306 201
ATCOM South Paddocks - slurry	1 250 000	17 575 000	4 393 750
ATCOM South Paddocks - discard	510 000	215 118 000	11 831 490

6.2.4 Modelling Approach

The proportion of seepage volume from each source was calculated by dividing the estimated annual recharge volume by the total volume of recharge for each modelled scenario. The different proportions were used as ratios for seepage from each source as per scenarios.

The geochemical modelling included an evaluation of saturation indices for mineral phases to determine minerals that are likely to dissolve or precipitate in the mixed water. Supersaturated mineral phases were identified and assessed for their likelihood to precipitate from the mixed water. After equilibration with the selected solid phases, the mixed water quality was determined anew.

6.2.5 Modelling Results

The predicted water chemistry for both pits is circum-neutral, saline mine drainage, dominated by calcium, magnesium, sodium and sulphate – see Table 20. Gypsum, Calcite, Barite, Hematite, Aragonite, Birnessite, pyrolusite and Diaspore are in equilibrium with the water from both pits, and could precipitate, as could Malachite in ATCOM South Pit.

Table 20: Modelled post-closure pit water qualities

Potential Constituent of Concern	Venture Pit		ATCOM South Pit	
	No Cover scenario	Cover scenario	No Cover scenario	Cover scenario
Chemistry				
pH [s.u]	7.9	7.9	7.9	7.9
TDS [mg/L]	5049	4241	5489	5749
Alkalinity [mg/L $CaCO_3$]	30	33	31	32
Chloride [mg/L]	27	29	25	24
Fluoride [mg/L]	0.91	0.55	1.3	1.3
Sulphate [mg/L]	3766	3165	4125	4343
Nitrate [mg/L]	2.7	1.1	7.7	13
Al [mg/L]	0.00026	0.00029	0.00027	0.00028
Ag [mg/L]	0.0069	0.0069	0.010	0.010
As [mg/L]	0.0069	0.0069	0.010	0.010
B [mg/L]	0.18	0.11	0.36	0.52
Ba [mg/L]	0.0035	0.0038	0.0033	0.0032
Be [mg/L]	0.0041	0.0010	0.010	0.010
Ca [mg/L]	491	350	476	470
Cd [mg/L]	0.0069	0.0069	0.010	0.010
Co [mg/L]	0.019	0.010	0.033	0.038
Cu [mg/L]	0.014	0.0053	0.019	0.018
Cr [mg/L]	0.0069	0.0069	0.010	0.010
Fe [mg/L]	0.00	0.00	0.00	0.00
K [mg/L]	29	31	29	33
Li [mg/L]	0.13	0.03	0.43	0.75
Mg [mg/L]	572	556	623	674
Mn [mg/L]	0.00	0.00	0.00	0.00
Mo [mg/L]	0.0041	0.0010	0.010	0.010
N [mg/L]	0.60	0.24	1.7	2.9
Na [mg/L]	142	89	182	172
Ni [mg/L]	0.067	0.021	0.099	0.085
Pb [mg/L]	0.0069	0.0069	0.010	0.010
Sb [mg/L]	0.0069	0.0069	0.010	0.010
Se [mg/L]	0.0069	0.0069	0.010	0.010
Sn [mg/L]	0.0069	0.0069	0.010	0.010
Sr [mg/L]	0.90	1.9	0.010	0.010

Potential Constituent of Concern	Venture Pit		ATCOM South Pit	
	No Cover scenario	Cover scenario	No Cover scenario	Cover scenario
Tl [mg/L]	0.0069	0.0069	0.010	0.010
U [mg/L]	0.0069	0.0069	0.010	0.010
V [mg/L]	0.0069	0.0069	0.010	0.010
Zn [mg/L]	0.027	0.011	0.046	0.056
Equilibrium phases (may precipitate)				
Hematite [Fe_2O_3]	✓	✓	✓	✓
Aragonite [$CaCO_3$]	✓	✓	✓	✓
Birnessite [MnO_2]	✓	✓	✓	✓
Diaspore [AlOOH]	✓	✓	✓	✓
Gypsum [$CaSO_4{:}2H_2O$]	✓	✓	✓	✓
Calcite [$CaCO_3$]	✓	✓	✓	✓
Barite [$BaSO_4$]	✓	✓	✓	✓
Malachite [$Cu_2(OH)_2CO_3$]			✓	✓
Pyrolusite [MnO_2]	✓	✓	✓	✓
Saturated phases (will likely precipitate)				
None	-	-	-	-

6.3 Predicted Quantity of feed from South Pit and Venture Pit

At Venture pit it is proposed that each of six boreholes be pumped at 4 l/s for a total abstraction of 24 l/s. At ATCOM South pit, each of eight boreholes are to be pumped at 6.9 l/s for a total abstraction of 55 l/s. Boreholes yields would need to be confirmed on site following construction of the abstraction boreholes.

6.4 Opinion on Suitability of Existing Water Treatment Plant

6.4.1 Methodology

Original design information was obtained from the Prentec (2017: section 2.1 Tables 1 and 2). This report reflected both original and revised design feed water qualities for three cases, namely:

- 50th percentile;
- 95th percentile and
- Design

The revised design data represent the proposed installed facility final design ranges.

A new expected feed water quality was developed as per section 6.2 above. The referred data ("predicted feed quality, revised analysis") is however only based on average values and does not consider ranges, e.g. 95th percentile values which are essential in water treatment plant design.

In order to compare the two sets of data, a number of assumptions had to be made to accommodate for these variances between the two sets of data. The main assumptions are as follows:

- The level of variances between the final design ranges specified and the ranges experienced in the new design will be similar. In other words, if the new average analysis is equal to or less than the revised design average, the 95th percentile will also be within the proposed design range. This assumption could be risky if different mining methodologies used, could result in significantly larger water composition excursions than in the previous evaluation.
- For metals and semimetals it is assumed that the exceedances can be addressed by the proposed green sands filters prior to downstream treatment processes and hence does not require any downstream expansion of the treatment system. Again, this assumption does pose some risks, since components such as manganese can cause severe damage to downstream membranes if not adequately removed.

6.4.2 Comparative Values

Scenarios were developed for both the Venture Pit as well as the ATCOM South Pit, based on a limited number of sample analyses (coarse discard and ATCOM spoils 2 samples each and slurry 1 sample). Each pit was again divided in 2 cases, namely no cover and cover. The values for these scenarios were assumed to be average values. The simulations indicated that Iron and Manganese will precipitate prior to entering the treatment plant and should thus be absent from the stream. The values listed in Table 21 are for components where the value for the scenario with the highest predicted concentration, are equal to or less than that of the original design 50th percentile. For purposes of this comparison it was assumed that, for components where the new average concentration is less than the design 50th percentile, the maximum would also be within the original design range.

Table 21: Components with 50th percentile within the original design specification

Water Quality Variable	Units	Revised Analysis	Original Design 50th percentile
Alkalinity as $CaCO_3$	mg/L	30 – 33	240
Chloride	mg/L	24 – 29	42.3
Aluminium	µg/L	0.26 – 0.29	70
Barium	µg/L	3.2 – 3.8	20
Calcium	mg/L	350 – 491	565
Iron	mg/L	0	0.07
Manganese	mg/L	0	0.57
Silica	mg/L	Not measured	5.95
Strontium	mg/L	0.01 – 1.9	4.67

In the first analyses provided, which were based on different source water ratios, the metals listed on average exceeded the design 50th percentile concentrations. In the revised analyses as received on 24 Feb and 06 Apr 2020, all metals were within the design 50th percentile.

Ionic components listed in Table 22 exceed the 50th percentile of the design case. This may result in increased scaling risk to the membranes requiring expansion of the membrane treatment section of the facility.

Table 22: Ionic components that exceed the original 50th percentile concentration

Water Quality Variable	Units	Revised Analysis	Original Design 50th percentile	Original Design Specification	Comment
Sulphate	mg/L	3 165 – 4 343	2 883	3 722	All values for ATCOM South Pit exceed the design 50th percentile value. The Venture Pit Cover scenario is within the design specification value, but all other values exceed it.
Fluoride	mg/L	0.55 – 1.3	0.35	0.90	All values exceed the design 50th percentile value. The Venture Pit Cover scenario is within the design specification value, but all other values exceed it.
Potassium	mg/L	29 – 33	20.4	29.7	All values exceed the design 50th percentile value. The three No Cover cases are within the design specification value, but the Cover cases exceed it.
Magnesium	mg/L	556 - 674	372	517	All values exceed the design 50th percentile value as well as the design specification value.
Nitrate & Nitrite	mg/L	1.3 – 16	0.52	1.53	All values exceed the design 50th percentile value. The Venture Pit Cover scenario is within the design specification value, but all other scenarios exceed it.
Sodium	mg/L	89 - 182	142	222	All values for ATCOM South Pit exceed the design 50th percentile value and the design specification value.
TDS	mg/L	4 241 – 5 749	4 008	5 148	All values exceed the design 50th percentile value. The Venture Pit Cover scenario is within the design specification value, but all other scenarios exceed it.

The impact of blending the two streams and utilizing the lower concentrations from the venture pit to dilute the feed from ATCOM South Pit was also evaluated. The venture pit contributes approximately 30% of the blended feed during operation and post-closure it reduces to 27% for the no cover scenario, but remains 30% for the cover scenario. Even after blending, the blended stream compositions still exceed the design case 50th percentile and mostly also the design specification value as per Table 23 below.

Table 23: Blended Ionic components that exceed the original 50th percentile concentration

Water Quality Variable	Units	Revised Analysis	Original Design 50th percentile	Original Design Specification	Comment
Sulphate	mg/L	3 985 – 4 025	2 883	3 722	All values still exceed the design 50th percentile value and the design specification value.
Fluoride	mg/L	1.07 – 1.19	0.35	0.90	All values exceed the design 50th percentile and design specification value.
Potassium	mg/L	29 – 32	20.4	29.7	All values exceed the design 50th percentile value. The No Cover scenario is within the design specification value, but not the Cover scenario.
Magnesium	mg/L	608 - 638	372	517	All values exceed the design 50th percentile and design specification value.
Nitrate & Nitrite	mg/L	7.5 – 11.5	0.52	1.53	All values exceed the design 50th percentile and design specification value.
Sodium	mg/L	147 - 171	142	222	All values exceed the design 50th percentile value, but are within the design specification value.
TDS	mg/L	5 290 – 5 366	4 008	5 148	All values exceed the design 50th percentile and design specification value.

The predicted flow from Venture Pit is 2 ML/day and that from ATCOM South Pit is 4.7 ML/day. The combined flow rate is 6.7 ML/day during the operation phase. Post closure, the flow from the ATCOM South Pit in the no cover scenario will increase to 5.4 ML/day resulting in a combined flow rate of 7.4 ML/day. The excess water will be pumped to underground storage lakes on the mine for reuse at the ATC Plant and ATCOM Plant. Impunzi pumps treats excess water generated at the mine at the Tweefontein Water Reclamation facility. The facility has a capacity of 14.1 ML/day and is currently treating approximately 11 ML/day.

6.4.3 Discussion and Conclusions

The predicted volumetric flow rates provided are within the design ranges of Phase 1 of the treatment plant design. However, since the treatment plant also receives water from Tweefontein and GGV, the anticipated flows from these units should also be considered before a final conclusion can be made.

In the original analyses provided, some of the metallic ions exceeded the current design criteria, but in the revised composition, metallic ions are within the design ranges and hence the Greensands filters should not be overloaded.

However, a number of ionic species are shown to, at average predicted concentrations, significantly exceed the maximum design range specified for the water treatment works. This could impact the capacity of the RO membranes to achieve the predicted recoveries and these units may need to be re-rated to reflect the impact of higher ionic concentrations.

It is recommended to also include the following:

1) Develop a predicted 95th percentile concentration scenario, to indicate potential variability in feed concentrations to even higher levels than currently indicated in the average scenarios;

2) Run RO simulations to ascertain the impact of the higher ionic concentrations in the feed on the % water recovery that can be achieved. Some components associated with scale formation, e.g. Calcium still seems to be within range, but the overall TDS increase impact on recovery needs to be quantified;

3) Since the treatment plant was designed for modular expansion, some expansions may need to be considered.

4) Verify revised flow rates from GGV and Tweefontein to the treatment plant to confirm that treatment capacity is not exceeded.

7.0 GROUNDWATER IMPACT ASSESSMENT

7.1 Scoping

The following potential impacts were identified during the scoping phase:

- Potential negative impact on pit water quality due to the additional acid-generating discard that will be placed on top of old infilled pits;
- Chemical leaks/spills from construction vehicles and machinery during construction may result in water quality deterioration;
- Potential negative impact on the quality of downstream water resources resulting from potential seepage or spillage of contaminated storm water runoff emanating from the discard facilities; and
- Potential impact on the volume of contaminated mine affected water requiring management/treatment in the post-closure phase of the mine.

7.2 Methodology

The significance of identified impacts was determined using the approach outlined below (terminology from the Department of Environmental Affairs and Tourism Guideline document on EIA Regulations, April 1998). This approach incorporates two aspects for assessing the potential significance of impacts, namely occurrence and severity, which are further sub-divided as follows:

Table 24: Impact assessment factors

Occurrence		Severity	
Probability of occurrence	Duration of occurrence	Scale/extent of impact	Magnitude of impact

To assess these factors for each impact, the following four ranking scales are used:

Table 25: Impact assessment scoring methodology

Magnitude	Duration
10- Very high/ unknown	5- Permanent (>10 years)
8- High	4- Long term (7-10 years, impact ceases after site closure has been obtained)
6- Moderate	3- Medium-term (3 months- 7 years, impact ceases after the operational life of the activity)
4- Low	2- Short-term (0-3 months, impact ceases after the construction phase)
2- Minor	1- Immediate
Scale	**Probability**
5- International	5- Definite/Unknown
4- National	4- Highly Probable
3- Regional	3- Medium Probability
2- Local	2- Low Probability
1- Site Only	1- Improbable
0- None	0- None

Significance Points= (Magnitude + Duration + Scale) x Probability

Table 26: Significance of impact based on point allocation

Points	Significance	Description
SP>60	High environmental significance	An impact which could influence the decision about whether or not to proceed with the project regardless of any possible mitigation.
SP 30-60	Moderate environmental significance	An impact or benefit which is sufficiently important to require
		management and which could have an influence on the decision unless it is mitigated.

Points	Significance	Description
SP<30	Low environmental significance	Impacts with little real effect and which will not have an influence on or require modification of the project design.
+	Positive impact	An impact that is likely to result in positive consequences/effects.

For the methodology outlined above, the following definitions were used:

- Magnitude is a measure of the degree of change in a measurement or analysis (e.g., the area of pasture, or the concentration of a metal in water compared to the water quality guideline value for the metal), and is classified as none/negligible, low, moderate or high. The categorization of the impact magnitude may be based on a set of criteria (e.g. health risk levels, ecological concepts and/or professional judgment) pertinent to each of the discipline areas and key questions analysed. The specialist study must attempt to quantify the magnitude and outline the rationale used. Appropriate, widely-recognised standards are to be used as a measure of the level of impact;
- Scale/Geographic extent refers to the area that could be affected by the impact and is classified as site, local, regional, national, or international;
- Duration refers to the length of time over which an environmental impact may occur i.e. immediate/transient, short-term (0 to 7 years), medium term (8 to 15 years), long-term (greater than 15 years with impact ceasing after closure of the project), or permanent; and
- Probability of occurrence is a description of the probability of the impact actually occurring as improbable (less than 5% chance), low probability (5% to 40% chance), medium probability (40% to 60% chance), highly probable (most likely, 60% to 90% chance) or definite (impact will definitely occur).

7.3 Impact Assessment

Seepage from the slurry and discard is considered to have a high magnitude because of the acid-generating nature of the discard and the elevated concentrations of calcium, aluminium and sulphate in the leachate. The impact is regional due to close proximity to rivers and is long-term due to the normal duration of acid-generation of Highveld coal discards (although kinetic testing of iMpunzi discard could determine the likely duration more accurately). This results in a high significance without mitigation.

The groundwater modelling shows that prevention of decant results in reduction in baseflow to Steenkoolspruit and Saaiwaterspruit, a decrease in water quantity during Operations and post-closure phases, with a low magnitude, local impact, whose significance is moderate without mitigation.

Mitigation of the impact on groundwater is through decreasing the recharge using a cover and abstracting dirty water from the pit to prevent decant. This decreases the magnitude to minor and the scale to site only, resulting in a moderate significance with mitigation.

ACTIVITY *whether listed or not listed.*	POTENTIAL IMPACT	ASPECTS AFFECTED	PHASE In which impact is anticipated *(e.g. Construction, commissioning, operational Decommissioning, closure, post-closure)*	Size and Scale of Disturbance *(volumes, tonnages, and hectares, or m²)*	Magnitude	Duration	Scale	Probability	Significance	Significance without Mitigation	Magnitude	Duration	Scale	Probability	Significance	Significance with Mitigation	Detailed Mitigation Measures	Mitigation Type (Modify, remedy, control or stop)	Time period for implementation	Standards to be Achieved *(Impact avoided, noise levels, dust levels, rehabilitation standards, end use objectives etc*	Compliance with Standards	Responsible person
Groundwater																						
Use of construction vehicles	Chemical leaks and spills from contruction vehicles	water quality	Construction phase	Site only	2	1	1	2	8	Low	2	1	1	1	4	Low	Maintenance, use of drip trays	Modify	Construction phase	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Haulage of coarse discard	Discard spills, chemical and oil spills	water quality	Operations phase	Site only	2	1	1	2	8	Low	2	1	1	1	4	Low	Correct loading SOP, maintenance, use of drip trays	Modify	Operations phase	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Deposition of slurry in Venture Co-Disposal Facility	Seepage of process water from slurry	water quantity and water quality	Operations phase	Regional	8	5	3	5	80	High	2	5	1	5	40	Moderate	Removal of process water, abstraction of dirty water from pit	Control decant through pit levels	Operations phase	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Deposition of slurry in Venture Co-Disposal Facility	Seepage from dried slurry	water quality	Post-closure phase	Regional	8	5	3	5	80	High	2	5	1	5	40	Moderate	Decrease in recharge by means of a cover, abstraction of dirty water from pit to prevent decant	Prevent decant through control of water levels in pit. Remedy recharge through rehabilitation	Post-closure phase	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Deposition of coarse discard in Venture Co-Disposal Facility embankments	Seepage from coarse discard	water quality	Operations and post-closure phases	Regional	8	5	3	5	80	High	2	5	1	5	40	Moderate	Decrease in recharge by means of a cover, abstraction of dirty water from pit to prevent decant	Prevent decant through control of water levels in pit. Remedy recharge through rehabilitation	Operations and post-closure phases	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Deposition of coarse discard in South Pit Coarse Discard Dump	Seepage from coarse discard	water quality	Operations and post-closure phases	Regional	8	5	3	5	80	High	2	5	1	5	40	Moderate	Decrease in recharge by means of a cover, abstraction of dirty water from pit to prevent decant	Prevent decant through control of water levels in pit. Remedy recharge through rehabilitation	Operations and post-closure phases	Measured water quality parameters in the river and shallow groundwater are compliant	Water use license water quality specifications for the resource	Environmental Manager; iMpunzi Site Manager; ECO
Prevention of decant	Reduction in baseflow to Steenkools pruit and Saaiwaters pruit	water quantity	Operations and post-closure phases	Local	4	5	2	3	33	Moderate	2	5	2	3	27	Low	Abstraction of dirty water from pits should be the minimum required to avoid flow towards the river	Prevent decant through control of water levels in pit.	Operations and post-closure phases	No streamflow reduction activity		Environmental Manager; iMpunzi Site Manager; ECO

8.0 ENVIRONMENTAL MANAGEMENT PROGRAMME

8.1 Cover

A soil cover consisting of a 300 mm silty clay cover with established grassland vegetation over the discard facilities is required in order to reduce infiltration thereby decreasing mass loads to the groundwater system (by 80 - 90%) and reducing the environmental impact.

It should be noted that the purpose of the 300 mm thick soil cover is for managing infiltration for pollution control and water use efficiency. Additional soil might be required for a growth medium, depending upon the final land use (e.g. grass vs shrubs). The final cover thickness would need to be confirmed as part of design. The performance of the store and release vegetated cover is premised on optimal performance of the vegetation cover which requires that the soil substrate be suitable for deep rooting and that the soils are fertile and uncompacted so that vigorous plant growth will maximise the leaf area for evapotranspiration.

The reduction in infiltration is also required in order to decrease the volume of dirty water – by reducing infiltration into the waste mass, the cover decreases the volume of dirty water generated from rainfall, which is thus a gain in terms of water use efficiency.

8.2 Prevention of Decant

Abstraction boreholes in Venture and ATCOM South Pits would need to be installed during mining operations to keep water levels within pit level and therefore preventing decant during operations and post-closure. This will:

- Reduce the environmental impact of mine affected water and protect future uses of water resources in the area by preventing decant to surface water systems during the polluting period of the source;
- Address water use efficiency requirements as the mine-affected water is abstracted for treatment and reuse, rather than leaving it as wasted dirty water.

8.3 Monitoring requirements

- Existing groundwater level monitoring network for the study area should continue to be utilised
- Boreholes downgradient of backfilled or rehabilitated pits should be monitored for rising water levels, and potential decant of these pits
- Groundwater levels should continue to be monitored monthly.
- The current groundwater monitoring network is deemed adequate and should continue to be utilised. Yearly audits of the monitoring network will need to be reviewed to access where new boreholes may need to be located where boreholes have either been demolished or blocked.

8.4 Studies Required to Refine Management Interventions and Reduce Uncertainty

8.4.1 Pumping Borehole Yields

The site wide groundwater model simulated total abstraction rates of 24 l/s for Venture pit and 55.2 l/s for ATCOM South Pit. The pumping yields would need to be confirmed by means of pumping test after borehole construction at the various pits. This, together with an independent estimation of recharge rates for backfilled areas, will allow development of a pit calibrated groundwater model to improve evaluations of decant rates and abstraction rates for both pits.

8.4.2 Kinetic Testing and Post-Closure Water Quality Prediction

Kinetic testing of the spoils, discard and slurry material is needed to better predict post closure water quality. Discard, spoil and slurry samples with a net acid generating potential will be subjected to kinetic tests. Kinetic test is defined as a group of test work procedure wherein acid generation and metal mobilization from a sample is measured over time, during accelerated weathering in a humidity cell. The results of kinetic testing allow for simulation of long-term leachate qualities post-closure, and resolve uncertainties in the available data which were used in this study.

This will allow for a more accurate determination of the pit water qualities for Venture and ATCOM South, including the slurry, coarse discard and spoils seepage, which will in turn allow for the development of a predicted 95th percentile concentration scenario for each pit. This can be used to indicate potential variability in feed concentrations to higher levels than currently indicated in the average scenarios, which is essential for water treatment plant design.

8.4.3 Post-Closure Water Management

Nearer the end of life of mine, the abstraction volumes required for post-closure decant management should be remodelled.

Based on predicted post-closure water qualities for iMpunzi (see section 6.4.3), as well as for GGV and Tweefontein, run RO simulations to ascertain the impact of the higher ionic concentrations in the feed on the % water recovery that can be achieved. Some components associated with scale formation, e.g. Calcium still seems to be within range, but the overall TDS increase impact on recovery needs to be quantified;

Verify or develop post-closure flow rates from GGV and Tweefontein to the treatment plant to confirm that treatment capacity is not exceeded.

9.0 CONCLUDING REMARKS

This report incorporates reviews by Gerhard van der Linde (Associate Hydrogeologist), David Love (Technical Director: Geochemistry) and Priyal Dama-Fakir (Senior Environmental Engineer). Please direct any queries to the undersigned.

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Signature Page

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APPENDIX A

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APPENDIX B

Details of specialist and declaration of interest

SPECIALIST DECLARATION

As required under Appendix 6 of the Environmental Impact Assessment Regulations, 2014 (as amended), I, **Gerhard van der Linde**, 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 expertise in conducting the specialist report relevant to this application, including knowledge of Acts, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with all applicable Acts and Regulations in compiling this report;
- I have not, and will not engage in conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing:
  - any decision to be taken with respect to the application by the competent authority; and
  - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this declaration are true and correct.

Signature of the specialist:

Golder Associates Africa (Pty) Ltd

Name of company (if applicable):

Date: **3 June 2020**

APPENDIX C

Detailed Results

Detailed Mineralogical Results

Table C1: Mineralogy of iMpunzi discard and slurry samples

Weathering Rate (After Bowell, 2000	Mineral	Chemical formula	Slurry				Discard			
			Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	North Dump	Venture void
			F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	ND-D	VV-D
Acid Forming Minerals			**Proportion (%)**							
Fast Weathering	Pyrite	FeS_2	0.68	0.57	0.45	0.54	2.1	1.9	0.9	4.8
Neutralising Minerals			**Proportion (%)**							
Dissolving	Calcite	$Ca(CO_3)$	2.2	1.7	2.5	1.5	1.0	2.5	0.18	1.3
	Dolomite	$CaMg(CO_3)_2$	1.3	1.3	1.1	0.64	0.68	0.78	0.09	0.62
Fast Weathering	Siderite	$FeCO_3$	0.56	0.04	0	0.07	0.49	0.06	0.08	0.03
Slow Weathering	Kaolinite	$Al_2Si_2O_5(OH)_4$	18	14	13	16	39	21	16	35
Very Slow Weathering	Muscovite	$KAl_2(Si_3AlO_{10})(OH)_2$	0	1.7	1.5	1.3	3.7	2.1	0	3.7
	Microcline	$K(AlSi_3O_8)$	0.38	0.27	0.18	0.21	0.37	0.24	0.38	0.62
Inert	Quartz	SiO_2	8.0	4.6	4.1	5.2	14	9.4	7.7	16
Secondary Minerals	Gypsum	$Ca(SO_4) \cdot 2H_2O$	1.05	1.26	0.98	0.9	1	1.08	5.19	1.22
	Magnetite	Fe_2O_3	0.72	0.59	0.53	0.52	0.4	0.26	0.32	0.41
Organic Matter			67	74	76	73	37	61	69	36

Detailed Whole rock Geochemistry Results

Table C2: Geochemical abundance indices for iMpunzi mine discard and coal

Sample ID	F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
PCOC /Source	Slurry				Discard			
	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
	GAI	GAI	GAI	GAI	GAI	GAI	GAI	GAI
Al	0	0	0	0	0	0	0	0
Ag	0	0	0	0	1	0	0	0
As	1	0	0	1	2	1	2	2
Au	0	0	0	0	3	0	1	0
B	2	2	2	2	2	2	2	2
Ba	0	0	0	0	1	0	0	0
Be	0	0	0	0	0	0	0	0
Bi	6	5	5	6	6	6	6	5
C	6	6	6	6	6	6	6	6
Ca	0	0	0	0	0	0	0	0
Cd	0	0	0	0	0	0	0	0
Ce	0	0	0	0	0	0	0	0
Co	0	0	0	0	0	0	0	0
Cr	0	0	0	0	0	0	0	0
Cs	0	0	0	0	0	0	0	0
Cu	0	0	0	0	0	0	0	0
Fe	0	0	0	0	0	0	0	0
Ga	0	0	0	0	0	0	0	0
Ge	0	0	0	1	0	0	0	0
Hf	0	0	0	0	0	0	0	0
Hg	0	0	0	0	1	1	2	2
K	0	0	0	0	0	0	0	0
La	0	0	0	0	0	0	0	0
Li	1	1	0	1	3	2	2	1
Mg	0	0	0	0	0	0	0	0
Mn	0	0	0	0	0	0	0	0
Mo	0	0	0	0	1	1	1	1
Na	0	0	0	0	0	0	0	0
Nb	0	0	0	0	0	0	0	0

Sample ID	F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
PCOC /Source	Slurry				Discard			
	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
	GAI	GAI	GAI	GAI	GAI	GAI	GAI	GAI
Nd	0	0	0	0	0	0	0	0
Ni	0	0	0	0	0	0	0	0
P	0	0	0	1	2	1	0	0
Pb	0	0	0	0	1	0	0	0
Pt	5	5	5	5	6	5	5	5
Rb	0	0	0	0	0	0	0	0
S	4	4	4	4	5	5	6	5
Sb	0	0	0	0	1	0	1	1
Sc	0	0	0	0	0	0	0	0
Se	3	4	4	3	3	5	0	3
Si	0	0	0	0	0	0	0	0
Sn	0	0	0	0	1	0	0	0
Sr	0	0	0	0	0	0	0	0
Ta	0	0	0	0	0	0	0	0
Te	4	4	3	4	5	4	4	4
Th	0	0	0	0	0	0	0	0
Ti	0	0	0	0	0	0	0	0
Tl	0	0	0	0	0	0	0	0
U	0	0	0	0	0	0	0	0
V	0	0	0	0	0	0	0	0
W	0	4	0	0	1	3	0	0
Y	0	0	0	0	0	0	0	0
Zn	0	0	0	0	0	0	0	0
Zr	0	0	0	0	0	0	0	0

Acid Base Accounting Results

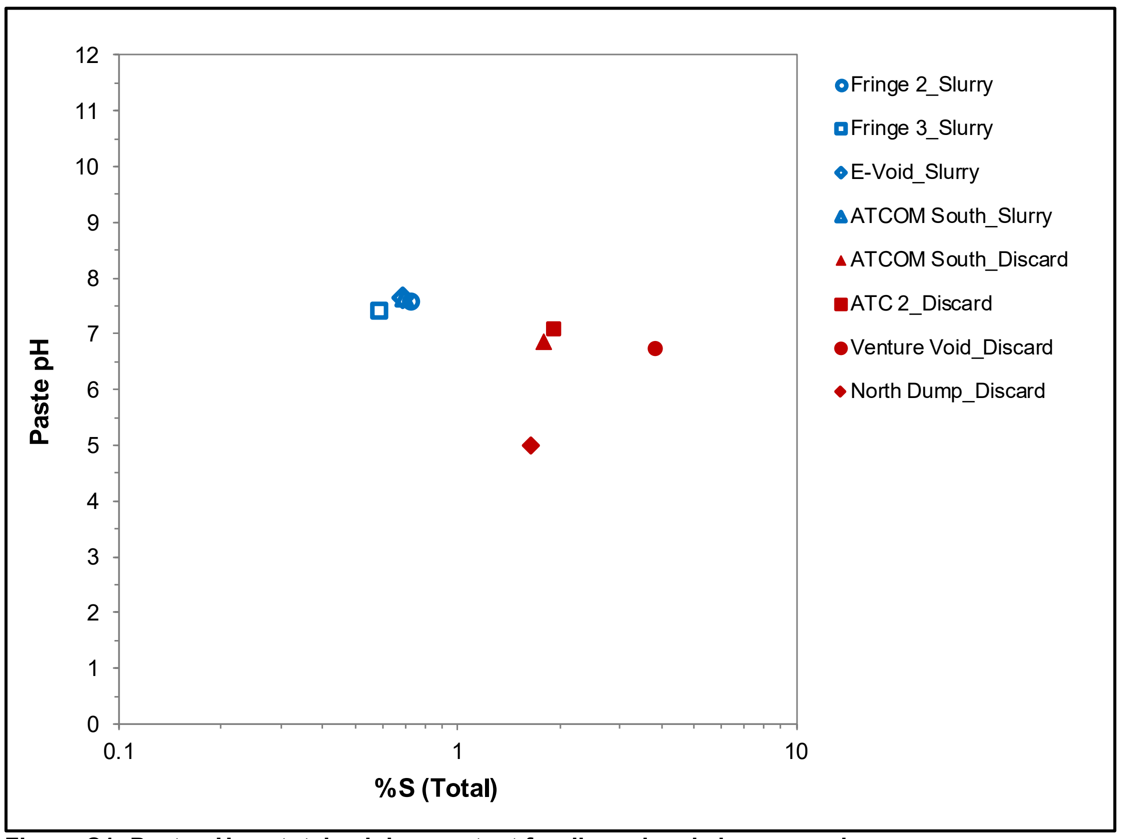

Figure C1: Paste pH vs. total sulphur content for discard and slurry samples

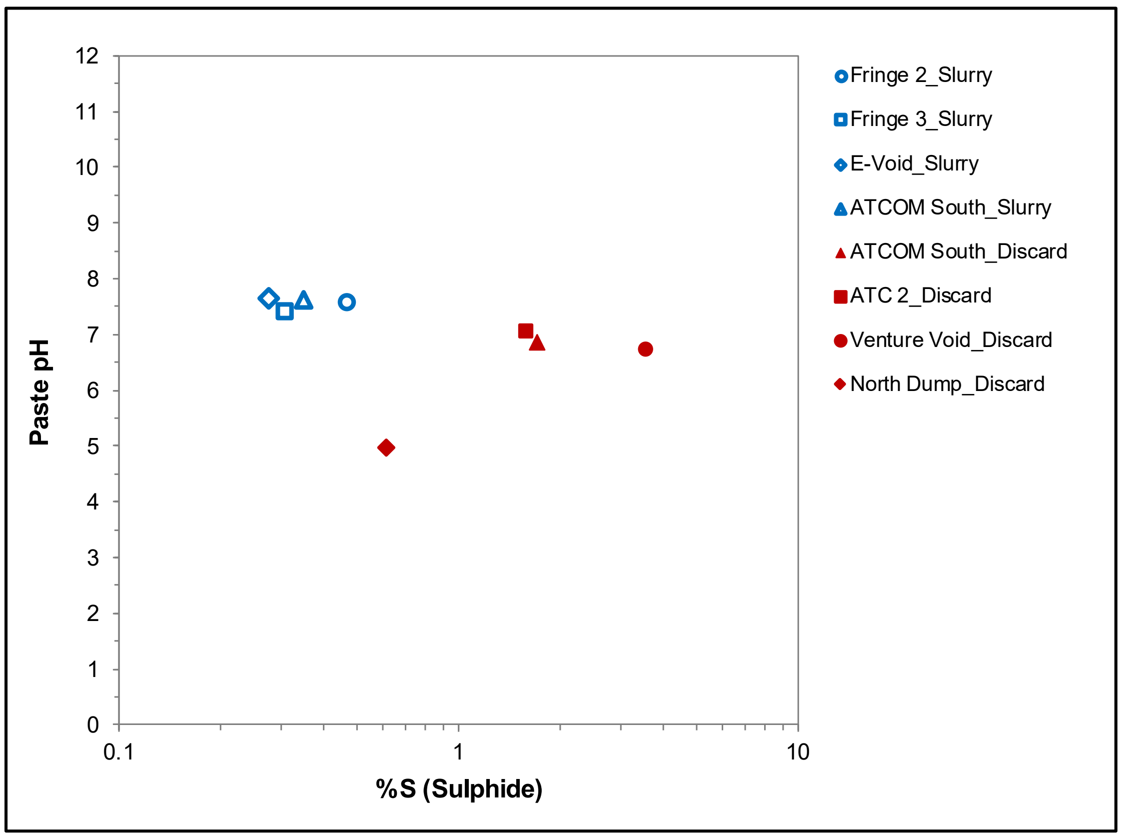

Figure C2: Paste pH vs. sulphide sulphur content for discard and slurry samples

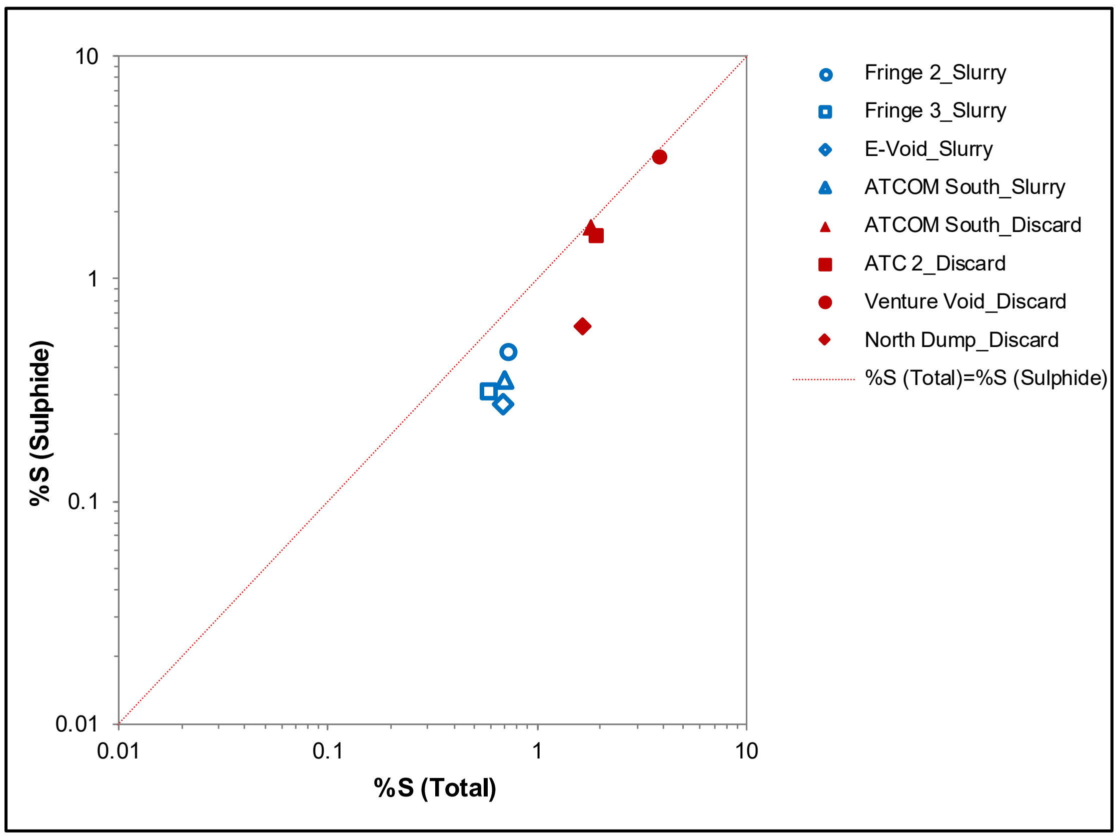

Figure C3: Sulphide sulphur vs. Total sulphur content for discard and slurry samples

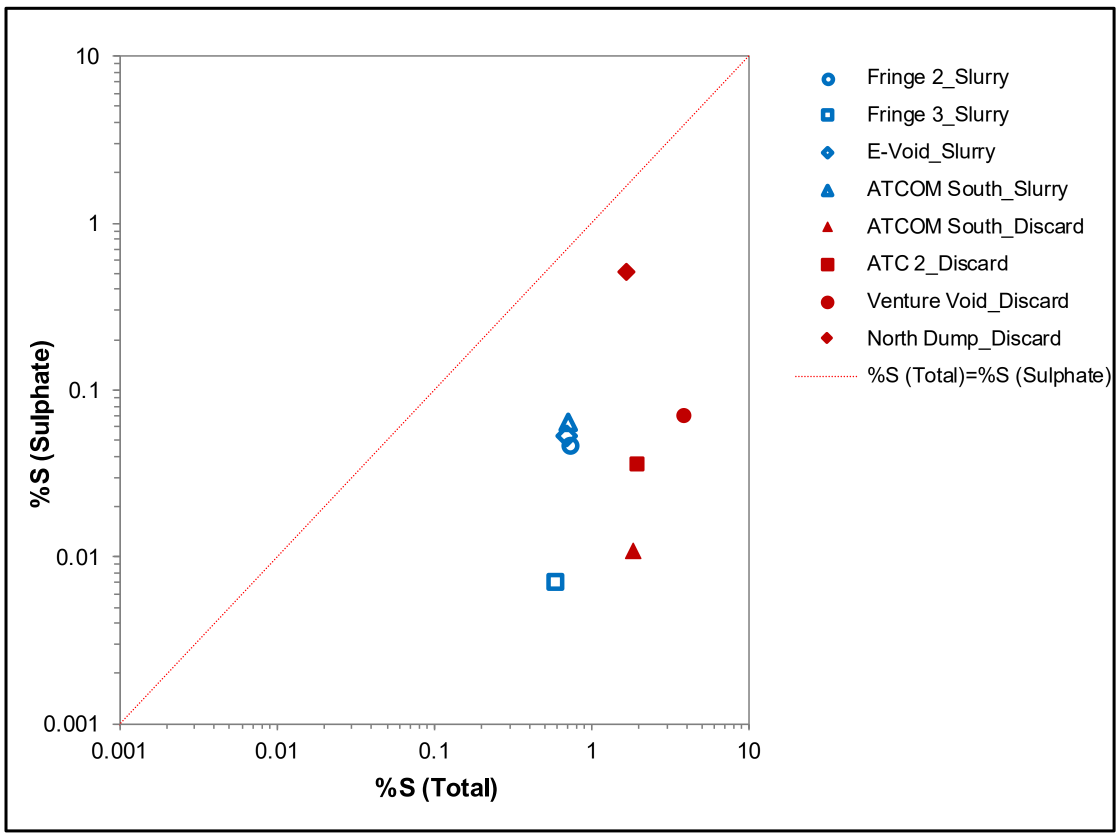

Figure C4: Sulphate sulphur vs. Total sulphur content for discard and slurry samples

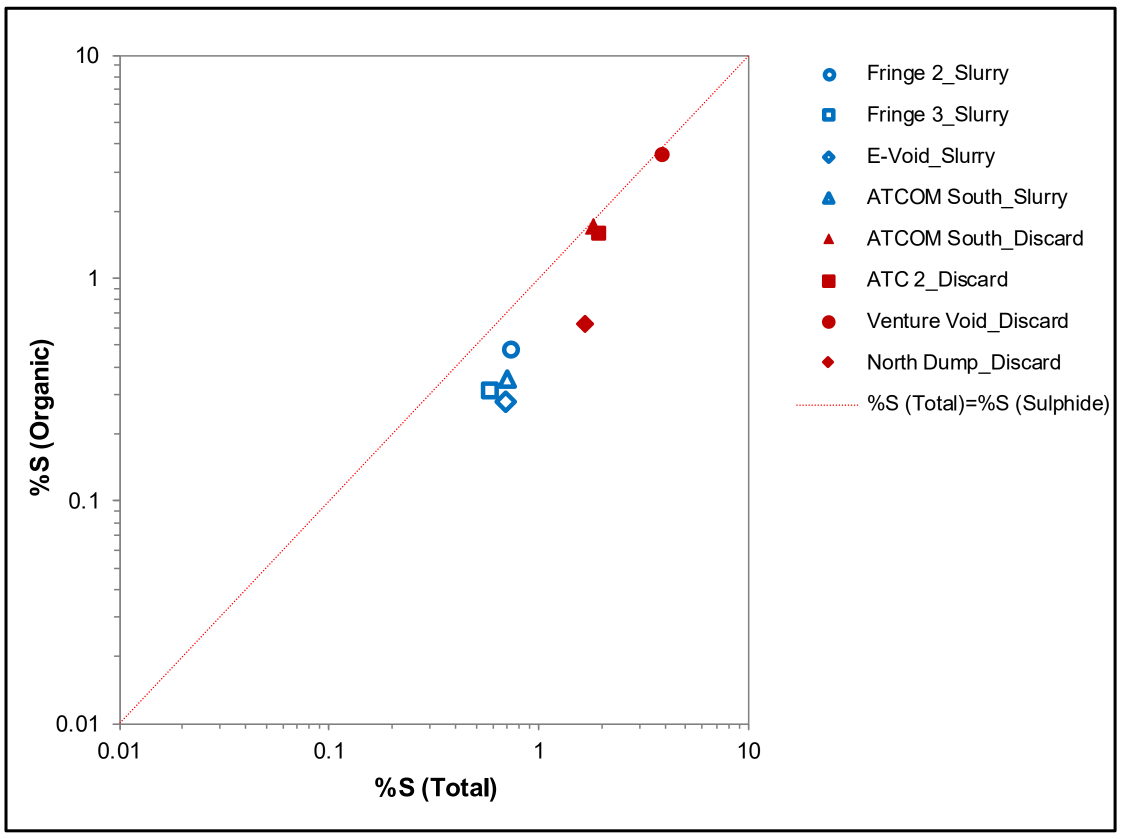

Figure C5: Organic sulphur vs. Total sulphur content for discard and slurry samples

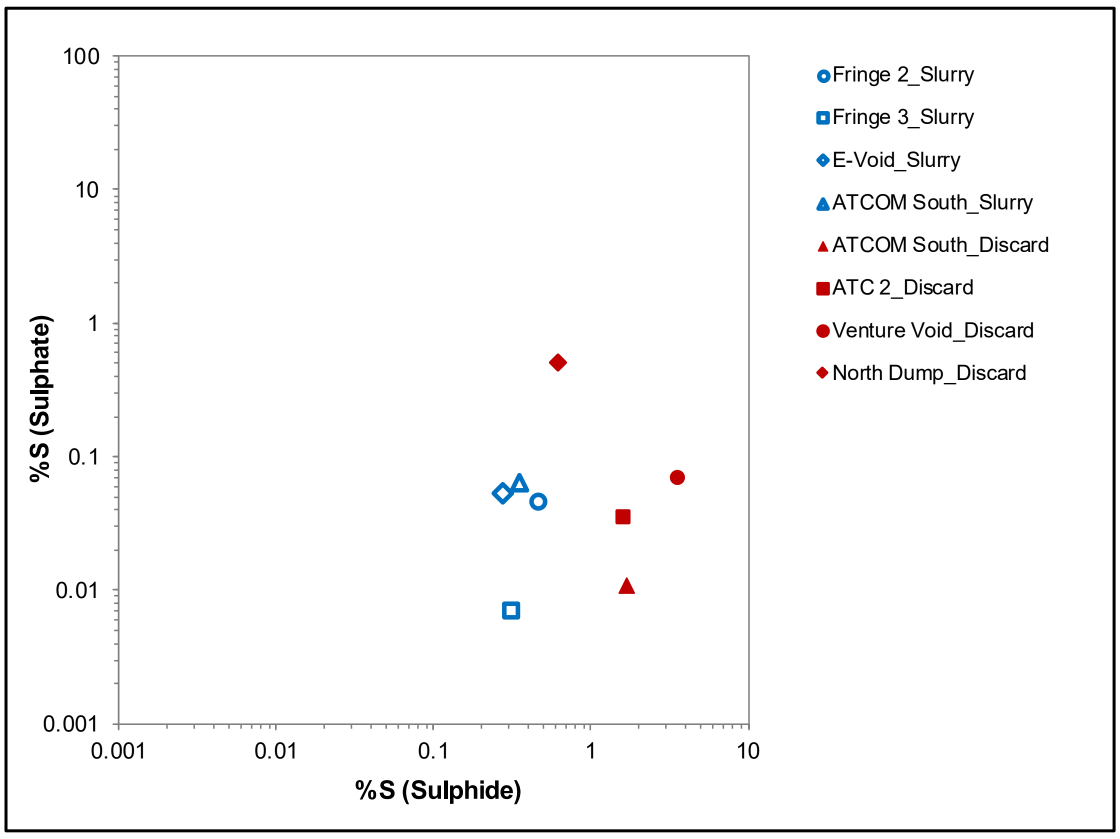

Figure C6: Sulphate sulphur vs. Sulphide sulphur content for discard and slurry samples

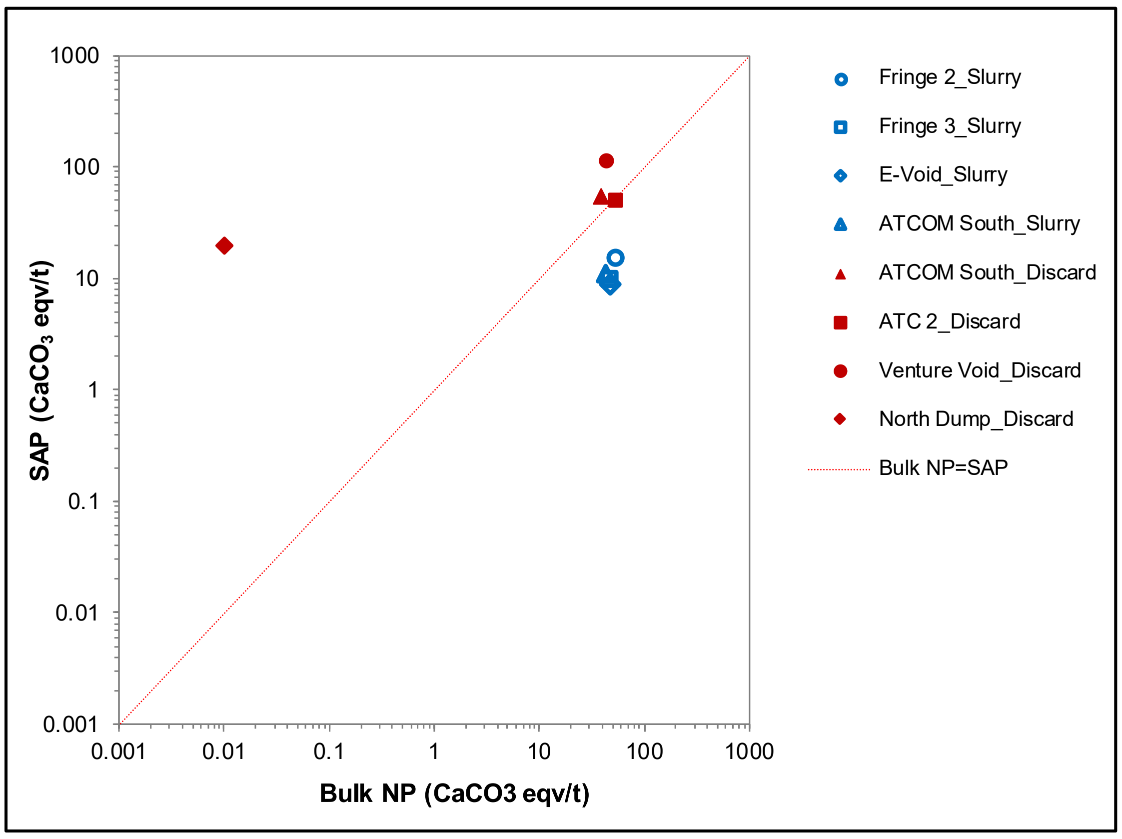

Figure C7: Sulphide sulphur based AP vs. Bulk NP for discard and slurry samples

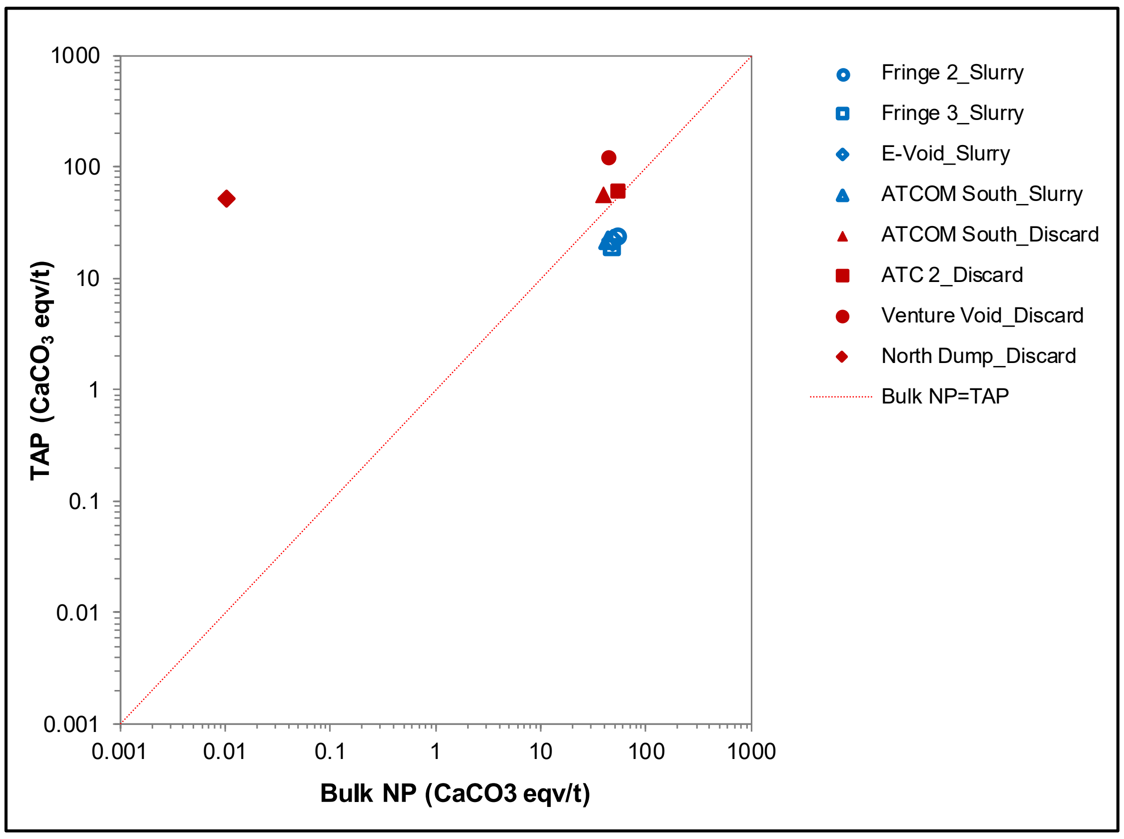

Figure C8: Total Sulphur based AP vs. BulkNP for discard and slurry samples

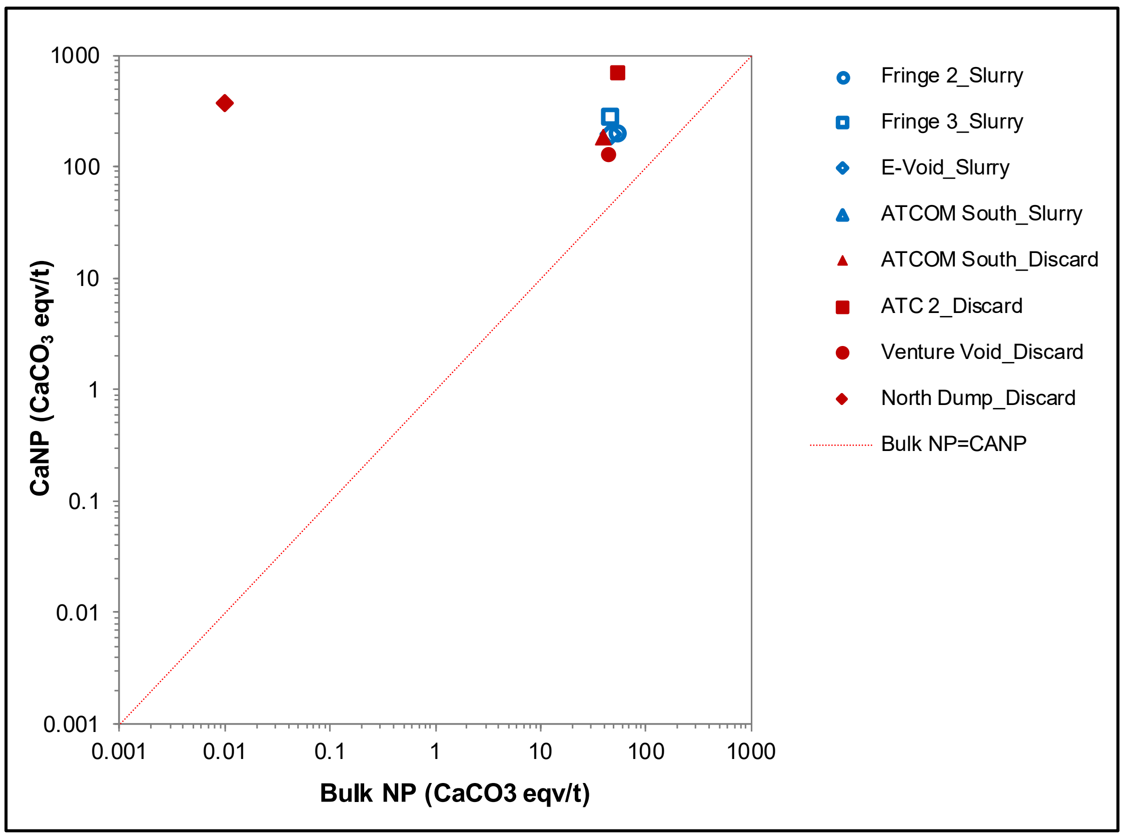

Figure C9: Carbonate NP vs. BulkNP for discard and slurry samples

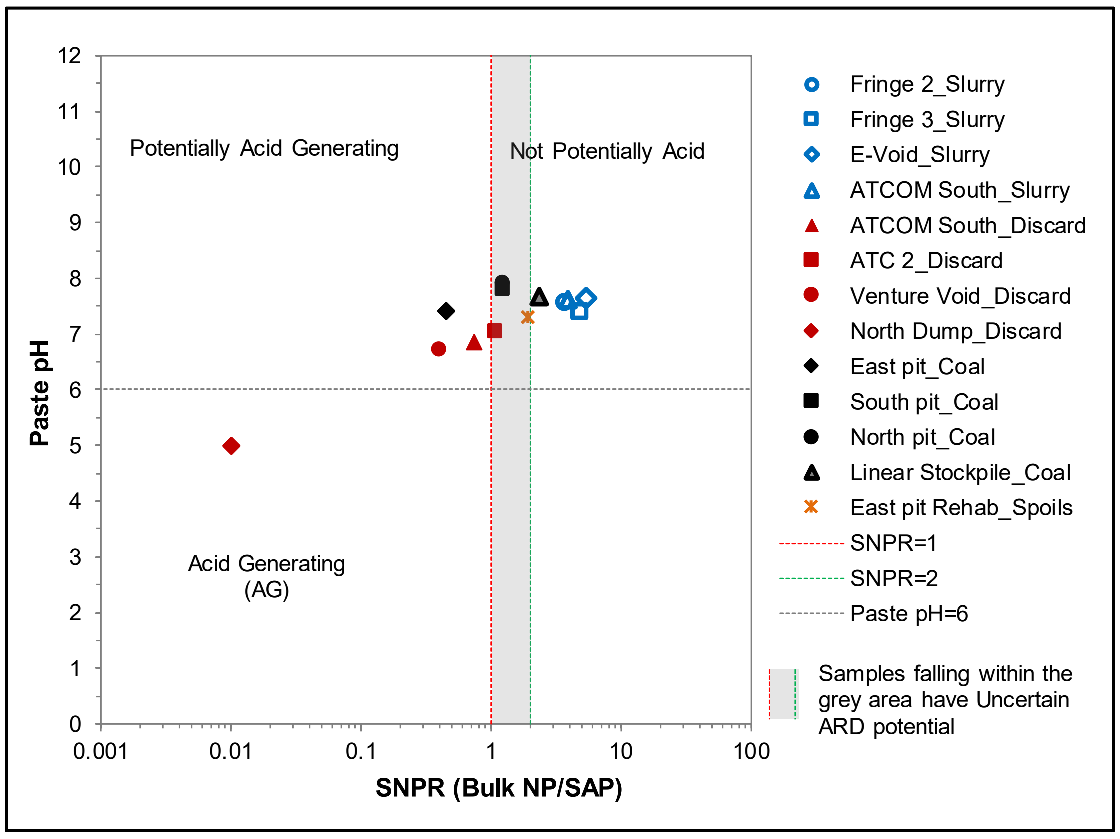

Figure C10: paste pH vs Sulphide sulphur-based NPR for discard, slurry, spoils and coal samples

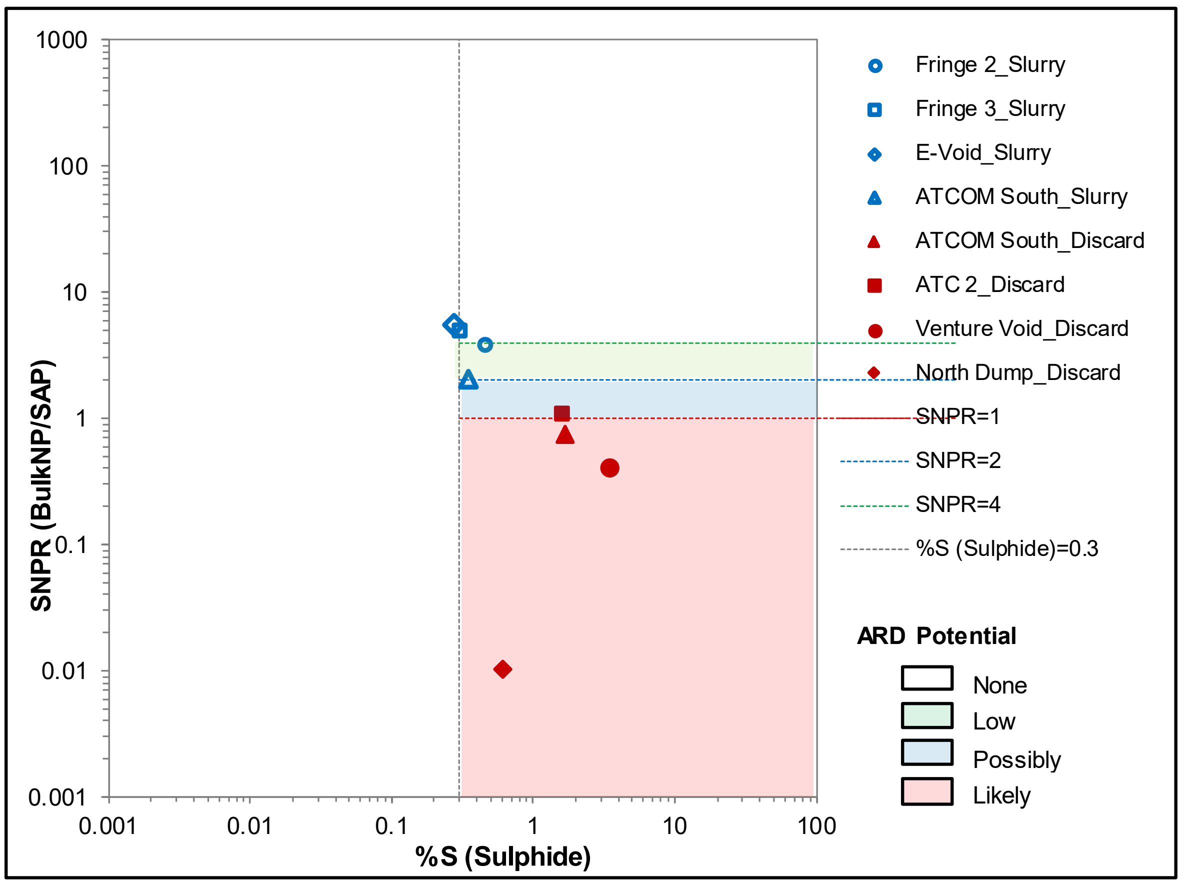

Figure C11: sulphide sulphur-based NPR Sulphide sulphur content of discard and slurry samples

Detailed Waste Assessment Results

Table C3 Classification of discard and slurry samples based on total concentrations (whole rock chemistry data)

PCOC	Units	GN R.635 levels of thresholds for total concentrations			Slurry				Discard			
		TCT0	TCT1	TCT2	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Al	mg/kg	ng	ng	ng	42897	36352	35285	38045	101663	57162	96144	43475
Ag	mg/kg	ng	ng	ng	0.12	0.11	0.11	0.14	0.22	0.12	0.12	0.11
As	mg/kg	5.8	500	2000	5.0	2.8	3.4	5.2	8.2	5.4	11	13
Au	mg/kg	ng	ng	ng	0.0040	0.0037	0.0016	0.0012	0.039	0.006	0.014	0.004
B	mg/kg	150	15000	60000	44	53	45	42	47	46	53	46
Ba	mg/kg	62.5	6250	25000	452	436	389	493	876	423	319	279
Be	mg/kg	ng	ng	ng	2.0	1.6	1.7	2.6	3.1	1.9	2.0	1.7
Bi	mg/kg	ng	ng	ng	0.60	0.51	0.48	0.69	0.94	0.61	0.58	0.52
C	mg/kg	ng	ng	ng	511000	578000	582000	586000	257000	466000	245000	537000
Ca	mg/kg	ng	ng	ng	22032	16149	15095	14562	14359	17493	14608	9715
Cd	mg/kg	7.5	260	1040	0.13	0.094	0.11	0.15	0.25	0.10	0.12	0.085
Ce	mg/kg	ng	ng	ng	97	100	40	92	14	65	18	33
Co	mg/kg	50	5000	20000	7.5	14	11	8.7	6.5	11	6.9	7.8
Cr	mg/kg	46000	800000	N/A	71	43	45	59	92	42	74	54
Cs	mg/kg	ng	ng	ng	3.0	2.6	1.4	2.6	1.1	2.0	0.82	1.2
Cu	mg/kg	16	19500	78000	20	21	15	19	26	17	21	21
Fe	mg/kg	ng	ng	ng	12744	8809	8748	9952	22775	20241	40095	24270
Ga	mg/kg	ng	ng	ng	15	14	14	16	31	15	22	16
Ge	mg/kg	ng	ng	ng	2.9	2.9	1.3	3.8	1.9	1.7	1.5	3.1
Hf	mg/kg	ng	ng	ng	3.3	2.7	2.9	3.1	5.6	2.9	3.2	2.7
Hg	mg/kg	0.93	160	640	0.10	0.11	0.11	0.14	0.29	0.25	0.42	0.43
K	mg/kg	ng	ng	ng	2148	1412	1528	2210	4542	2798	4956	1321
Li	mg/kg	ng	ng	ng	56	68	37	57	154	95	127	51
Mg	mg/kg	ng	ng	ng	3215	3494	3666	2719	3116	2899	2898	920
Mn	mg/kg	1000	25000	100000	159	166	157	136	123	148	106	70
Mo	mg/kg	40	1000	4000	2.0	1.3	1.9	2.1	3.4	2.6	3.5	3.7
Na	mg/kg	ng	ng	ng	400	313	357	465	371	375	708	231
Nb	mg/kg	ng	ng	ng	14	11	11	14	31	14	22	14
Nd	mg/kg	ng	ng	ng	8.2	10	1.5	7.4	0.79	5.9	0.93	2.0
Ni	mg/kg	91	10600	42400	19	27	16	24	27	22	27	30
P	mg/kg	ng	ng	ng	1868	1735	1880	2535	6417	3083	1600	975
Pb	mg/kg	20	1900	7600	21	12	14	19	34	14	17	24
Pt	mg/kg	ng	ng	ng	0.028	0.020	0.024	0.033	0.062	0.027	0.028	0.030
Rb	mg/kg	ng	ng	ng	28	14	12	28	9.7	11	25	14
S	mg/kg	ng	ng	ng	7400	5900	6900	7000	18000	19200	38200	16400
Sb	mg/kg	10	75	300	0.25	0.36	0.22	0.36	0.50	0.36	0.55	0.53
Sc	mg/kg	ng	ng	ng	14	10	9.2	11	22	14	23	11
Se	mg/kg	10	50	200	0.70	0.95	0.88	0.68	0.49	2.2	0.00	0.70
Si	mg/kg	ng	ng	ng	80275	56551	55143	60892	158450	94348	159105	74818
Sn	mg/kg	ng	ng	ng	3.4	3.2	2.2	3.5	6.5	2.8	4.1	3.4
Sr	mg/kg	ng	ng	ng	357	421	351	345	789	453	280	188
Ta	mg/kg	ng	ng	ng	0.92	0.74	0.69	0.87	2.0	0.97	1.4	0.95
Te	mg/kg	ng	ng	ng	0.07	0.11	0.05	0.11	0.15	0.10	0.13	0.12

PCOC	Units	GN R.635 levels of thresholds for total concentrations			Slurry				Discard			
		TCT0	TCT1	TCT2	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Th	mg/kg	ng	ng	ng	12	13	4.8	9.7	5.7	13	3.4	7.2
Ti	mg/kg	ng	ng	ng	3065	2276	2277	2653	6032	2966	4385	2972
Tl	mg/kg	ng	ng	ng	0.27	0.15	0.22	0.35	0.69	0.52	0.75	0.89
U	mg/kg	ng	ng	ng	3.1	2.3	2.5	3.4	4.7	2.7	3.6	2.7
V	mg/kg	150	2680	10720	58	43	45	54	67	38	56	39
W	mg/kg	ng	ng	ng	2.1	20.7	1.6	1.9	4.2	12.6	2.5	2.2
Y	mg/kg	ng	ng	ng	22	28	4.5	20	2.2	16	1.8	5.3
Zn	mg/kg	240	160000	640000	21	38	16	22	34	14	27	24
Zr	mg/kg	ng	ng	ng	307	60	81	125	33	130	66	86

Table C4 Classification of discard and slurry samples based on leachable concentrations (ASLP leach testing data)

PCoC	Unit	GN R.635 levels of thresholds for leachable concentrations				Slurry	Slurry	Slurry	Slurry	Discard	Discard	Discard	Discard
						Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
		LCT0	LCT1	LCT2	LCT3	F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Ag	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Al	mg/l	ng	ng	ng	ng	0.066	0.032	0.193	0.049	0.062	0.031	0.654	0.130
As	mg/l	0.01	0.5	1	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Au	mg/l	ng	ng	ng	ng	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	0.001
B	mg/l	0.5	25	50	200	0.028	0.086	0.053	0.030	0.032	0.000	0.049	0.039
Ba	mg/l	0.7	35	70	280	0.103	0.240	0.109	0.123	0.191	0.000	0.095	0.084
Be	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bi	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca	mg/l	ng	ng	ng	ng	48.3	62.8	48.11	64.3	41.9	57.90	90.2	295.7
Cd	mg/l	0.003	0.15	0.3	1.2	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Ce	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Co	mg/l	0.5	25	50	200	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	0.008
Cr	mg/l	0.1	5	10	40	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001
Cr^{6+}	mg/l	0.05	2.5	5	20	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cs	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu	mg/l	2	100	200	800	0.001	0.015	0.006	<0.001	0.009	0.010	0.006	0.003
Fe	mg/l	ng	ng	ng	ng	0.005	0.019	0.009	0.000	0.140	0.003	0.023	0.064
Ga	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ge	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hf	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg	mg/l	0.006	0.3	0.6	2.4	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ho	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ir	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
K	mg/l	ng	ng	ng	ng	0.28	1.19	0.31	1.18	1.45	0.01	1.25	0.18
La	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Li	mg/l	ng	ng	ng	ng	0.003	0.008	0.003	0.007	0.010	<0.001	0.008	0.008
Mg	mg/l	ng	ng	ng	ng	9.63	10.46	15.68	18.71	8.82	11.78	15.5	9.01
Mn	mg/l	0.5	25	50	200	0.013	0.051	0.010	0.02	0.035	0.008	0.062	0.43
Mo	mg/l	0.07	3.5	7	28	0.002	0.004	0.002	0.006	0.005	<0.001	0.003	<0.001

PCoC	Unit	GN R.635 levels of thresholds for leachable concentrations				Slurry	Slurry	Slurry	Slurry	Discard	Discard	Discard	Discard
						Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
		LCT0	LCT1	LCT2	LCT3	F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Na	mg/l	ng	ng	ng	ng	1.1	1.9	2.0	6.8	2.3	1.7	1.9	0.9
Nb	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nd	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Ni	mg/l	0.07	3.5	7	28	0.002	0.005	0.002	0.003	0.005	0.001	0.003	0.018
Pb	mg/l	0.01	0.5	1	4	0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Pt	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rb	mg/l	ng	ng	ng	ng	0.001	0.003	0.001	0.003	0.004	<0.001	0.003	0.001
Sb	mg/l	0.02	1	2	8	<0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001
Sc	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se	mg/l	0.01	0.5	1	4	0.014	<0.001	0.013	0.006	0.013	<0.001	<0.001	<0.001
Si	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	0.68	0.04	0.40	0.66
Sn	mg/l	ng	ng	ng	ng	0.008	0.005	0.004	0.004	0.003	0.003	0.003	<0.001
Sr	mg/l	ng	ng	ng	ng	0.408	1.104	0.526	0.563	0.393	<0.001	1.084	1.039
Ta	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Te	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Th	mg/l	ng	ng	ng	ng	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ti	mg/l	ng	ng	ng	ng	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U	mg/l	ng	ng	ng	ng	0.0007	0.0004	0.0001	0.0002	0.0005	<0.0001	0.0006	<0.0001
V	mg/l	0.2	10	20	80	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	<0.001
W	mg/l	ng	ng	ng	ng	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Y	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Zn	mg/l	5	250	500	2 000	0.063	0.193	0.047	0.039	0.110	0.259	0.062	0.182
Zr	mg/l	ng	ng	ng	ng	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001
pH	pH units	ng	ng	ng	ng	7.4	7.1	7.4	7.3	7.6	7.3	7.4	5.8
TDS	mg/l	1 000	12 500	25 000	100 000	232	278	246	330	184	266	382	**1 202**
EC	mS/m	ng	ng	ng	ng	31	38	35	46	28	37	53	134
P Alk.	mg/l	ng	ng	ng	ng	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
M Alk.	mg/l	ng	ng	ng	ng	21	17	17	17	40	24	45	3
F^-	mg/l	1.5	75	150	600	0.24	0.16	0.29	0.20	0.21	0.17	0.18	<0.1
Cl^-	mg/l	300	15 000	30 000	120 000	<0.25	<0.25	0.301	1.671	<0.25	<0.25	<0.25	<0.25
NO_2^-	mg/l	ng	ng	ng	ng	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NO_3 as N	mg/l	11	550	1 100	4 400	0.58	0.64	0.70	0.59	0.74	0.63	0.70	0.07
PO_4^{3-}	mg/l	ng	ng	ng	ng	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
SO_4^{2-}	mg/l	250	12 500	25 000	100 000	139	201	165	255	102	186	276	704

Detailed Leach Testing Results

Table C5: ASLP leach testing results (1:20 S: L ratio) compared to water quality standards

Potential Constituent of Concern	Unit	South African DWAF (1996) drinking water quality guidelines			Slurry				Discard			
		Domestic Use	Livestock	Irrigation	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
pH		6-9	ng	6.5-8.4	7.4	7.2	7.4	7.3	7.6	7.3	7.4	*5.8*
TDS		450	1000	ng	232	278	246	330	184	266	382	1 202
EC		ng	ng	40	31	38	35	46	28	37	53	134
SO_4^{2-}		200	1000	ng	139	201	165	255	102	186	276	704
Cl^-		100	1500	ng	<0.25	<0.25	0.301	1.671	<0.25	<0.25	<0.25	<0.25
F^-		1	2	2	0.24	0.16	0.29	0.20	0.21	0.17	0.18	<0.1
M Alk.		ng	ng	ng	21	17	17	17	40	24	45	3
P Alk.		ng	ng	ng	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6	<0.6
NO_2^-		ng	ng	ng	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NO_3^- as N		6	ng	ng	0.58	0.64	0.70	0.59	0.74	0.63	0.70	0.07
PO_4^{3-}		ng	ng	ng	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8	<0.8
Al		0.15	5	5	0.066	0.032	0.19	0.049	0.062	0.031	0.65	0.13
Ag		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
As		0.01	1	0.1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001
Au		ng	ng	ng	0.001	0.001	0.001	0.001	<0.001	<0.001	0.001	0.001
B		ng	5	0.5	0.028	0.086	0.053	0.030	0.032	0.000	0.049	0.039
Ba		ng	ng	ng	0.103	0.240	0.109	0.123	0.191	0.000	0.095	0.084
Be		ng	0.1	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Bi		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ca		32	1000	ng	48	63	48	64	42	58	90	296
Cd		5	10	10	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0002
Ce		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Co		ng	1	0.05	0.001	0.001	0.001	0.001	0.001	<0.001	0.001	0.008
Cr		ng	ng	ng	0.001	0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001
Cr^{6+}		0.05	1	0.1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Cs		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cu		1	0.5	0.2	0.001	0.015	0.006	<0.001	0.009	0.010	0.006	0.003
Fe		0.1	10	5	0.005	0.019	0.009	0.000	0.14	0.003	0.023	0.064
Ga		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ge		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hf		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Hg		0.001	0.001	ng	<0.0001	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ho		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Ir		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
K		50	ng	ng	0.28	1.2	0.31	1.2	1.4	0.01	1.3	0.18
La		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Li		ng	ng	2.5	0.003	0.008	0.003	0.007	0.010	<0.001	0.008	0.008
Mg		30	500	ng	9.6	10	16	19	8.8	12	15	9.0
Mn		0.05	10	0.02	0.013	0.051	0.010	0.02	0.035	0.008	*0.062*	*0.43*
Mo		ng	0.01	0.01	0.002	0.004	0.002	0.006	0.005	<0.001	0.003	<0.001
Na		100	2000	70	1.1	1.9	2.0	6.8	2.3	1.7	1.9	0.9
Nb		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nd		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001

Potential Constituent of Concern	Unit	South African DWAF (1996) drinking water quality guidelines			Slurry				Discard			
		Domestic Use	Livestock	Irrigation	Fringe 2	Fringe 3	E-Void	ATCOM South	ATCOM South	ATC 2 Discard Dump	Venture void	North Dump
					F2-S	F3-S	EV-S	AS-S	AS-D	A2-D	VV-D	ND-D
Ni		ng	1	0.2	0.002	0.005	0.002	0.003	0.005	0.001	0.003	0.018
Pb		0.01	0.1	0.2	0.001	<0.001	<0.001	<0.001	0.001	0.001	<0.001	<0.001
Pt		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Rb		ng	ng	ng	0.001	0.003	0.001	0.003	0.004	<0.001	0.003	0.001
Sb		ng	ng	ng	<0.001	0.001	0.001	0.001	0.001	<0.001	0.001	<0.001
Sc		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Se		0.02	50	0.02	0.014	<0.001	0.013	0.006	0.013	<0.001	<0.001	<0.001
Si		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	0.682	0.04	0.40	0.66
Sn		ng	ng	ng	0.008	0.005	0.004	0.004	0.003	0.003	0.003	<0.001
Sr		ng	ng	ng	0.41	1.1	0.53	0.56	0.39	<0.001	1.1	1.0
Ta		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Te		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Th		ng	ng	ng	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Ti		ng	ng	ng	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tl		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
U		ng	ng	0.01	0.0007	0.0004	0.0001	0.0002	0.0005	<0.0001	0.0006	<0.0001
V		0.1	1	0.1	<0.001	0.001	0.001	<0.001	0.002	0.001	<0.001	<0.001
W		ng	ng	ng	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Y		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Zn		3	20	1	0.063	0.193	0.047	0.039	0.110	0.259	0.062	0.182
Zr		ng	ng	ng	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001

Notes

Highlight exceeds domestic use guideline highlight exceed livestock guideline highlight exceed irrigation guideline *italics* exceed at least two guidelines

Detailed Statistical analysis Results

Table C6: t-Test: Sample ATSR-4 and ATSR-3 Assuming Unequal Variances

Constituent of Concern	Monitoring Site	Watercourse	Mean	Variance	Observations	Hypothesized Mean Difference	degrees of freedom	t Stat	P(T<=t) one-tail	t Critical one-tail	P(T<=t) two-tail	t Critical two-tail
Sulphate	ATSR-4	Saaiwaterspruit tributary draining between ATC1 and ATC2 Discard Dumps	111	30168	25	0	39	-13.29	2.31E-16	1.684875	4.61E-16	2.022691
	ATSR-3		2432	1084616	37							
TDS	ATSR-4		260	61308	25	0	39	-13.20	2.89E-16	1.684875	5.79E-16	2.022691
	ATSR-3		3552	2212994	37							
Manganese	ATSR-4		1. 1	4.2	25	0	57	-2.10	0.020199	1.672029	0.040397	2.002465
	ATSR-3		2.7	16	37							
Calcium	ATSR-4		38	1240	25	0	43	-13.28	4.13E-17	1.681071	8.25E-17	2.016692
	ATSR-3		358	19581	37							

Table C7: t-Test: Sample ACSR-7 and ACSR-1 Assuming Unequal Variances

Constituent of Concern	Monitoring Site	Watercourse	Mean	Variance	Observations	Hypothesized Mean Difference	degrees of freedom	t Stat	P(T<=t) one-tail	t Critical one-tail	P(T<=t) two-tail	t Critical two-tail
Sulphate	ACSR-7	Saaiwaterspruit before and after North discard dump	522	71925	36	0	36	-4.67	2E-05	1.6883	4E-05	2.0281
	ACSR-1		1820	2633800	35							
TDS	ACSR-7		834	152501	36	0	36	-4.687	2E-05	1.6883	4E-05	2.0281
	ACSR-1		2695	5366027	35							
Manganese	ACSR-7		1.7	8.6	36	0	69	-0.018	0.4927	1.6672	0.9854	1.9949
	ACSR-1		1.7	8.1	35							
Calcium	ACSR-7		116	2382	28	0	36	-4.833	1E-05	1.6883	3E-05	2.0281
	ACSR-1		355	82691	35							

Table C8: t-Test: Sample PHSR-3 and ACSR-8; and PHSR-3 and ACSR-4 Assuming Unequal Variances

Constituent of Concern	Monitoring Site	Water Course	Mean	Variance	Observations	Hypothesized Mean Difference	df	t Stat	P(T<=t) one-tail	t Critical one-tail	P(T<=t) two-tail	t Critical two-tail
Sulphate	PHSR-3	Steenkoolspruit draining past ATCOM South pit	66	2888	54	0	79	-0.125	0.4504	1.6644	0.9007	1.9905
	ACSR-8		67	691	47							
TDS	PHSR-3		238	8395	54	0	91	-0.275	0.3918	1.6618	0.7837	1.9864
	ACSR-8		242	3341	47							
Manganese	PHSR-3		0.0269	0.0053	54	0	99	1.0477	0.1487	1.6604	0.2973	1.9842
	ACSR-8		0.0127	0.0040	47							
Calcium	PHSR-3		26	75	54	0	95	-0.816	0.2082	1.6611	0.4163	1.9853
	ACSR-8		28	37	47							
Sulphate	PHSR-3		66	2888	54	0	91	-4.741	4E-06	1.6618	8E-06	1.9864
	ACSR-4		123	4635	49							
TDS	PHSR-3		238	8395	54	0	91	-3.928	8E-05	1.6618	0.0002	1.9864
	ACSR-4		320	13514	49							
Manganese	PHSR-3		0.027	0.0053	54	0	101	0.5831	0.2805	1.6601	0.5611	1.9837
	ACSR-4		0.019	0.0039	49							
Calcium	PHSR-3		26	75	54	0	81	-5.05	1E-06	1.6639	3E-06	1.9897
	ACSR-4		38	176	49							

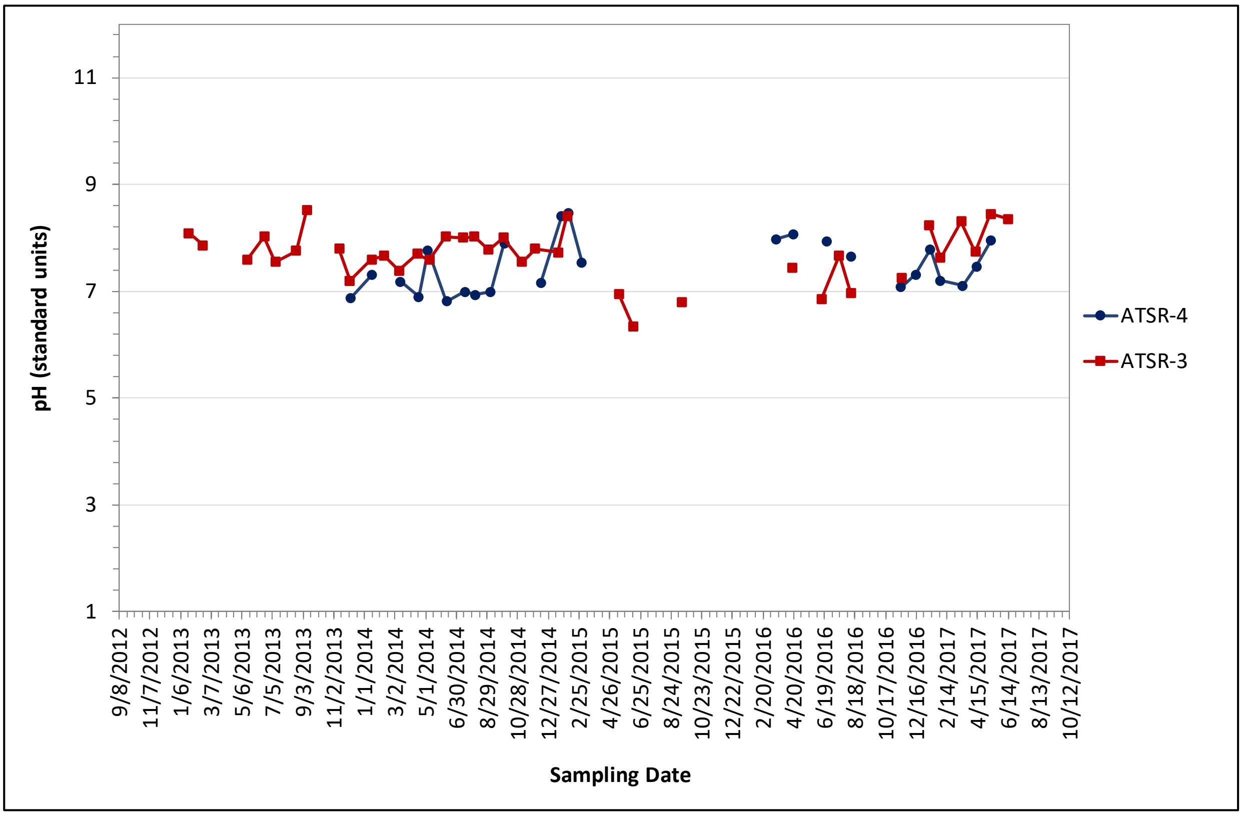

Figure C12: Variation of pH upstream and downstream of Saaiwaterspruit tributary draining ATC discard dumps

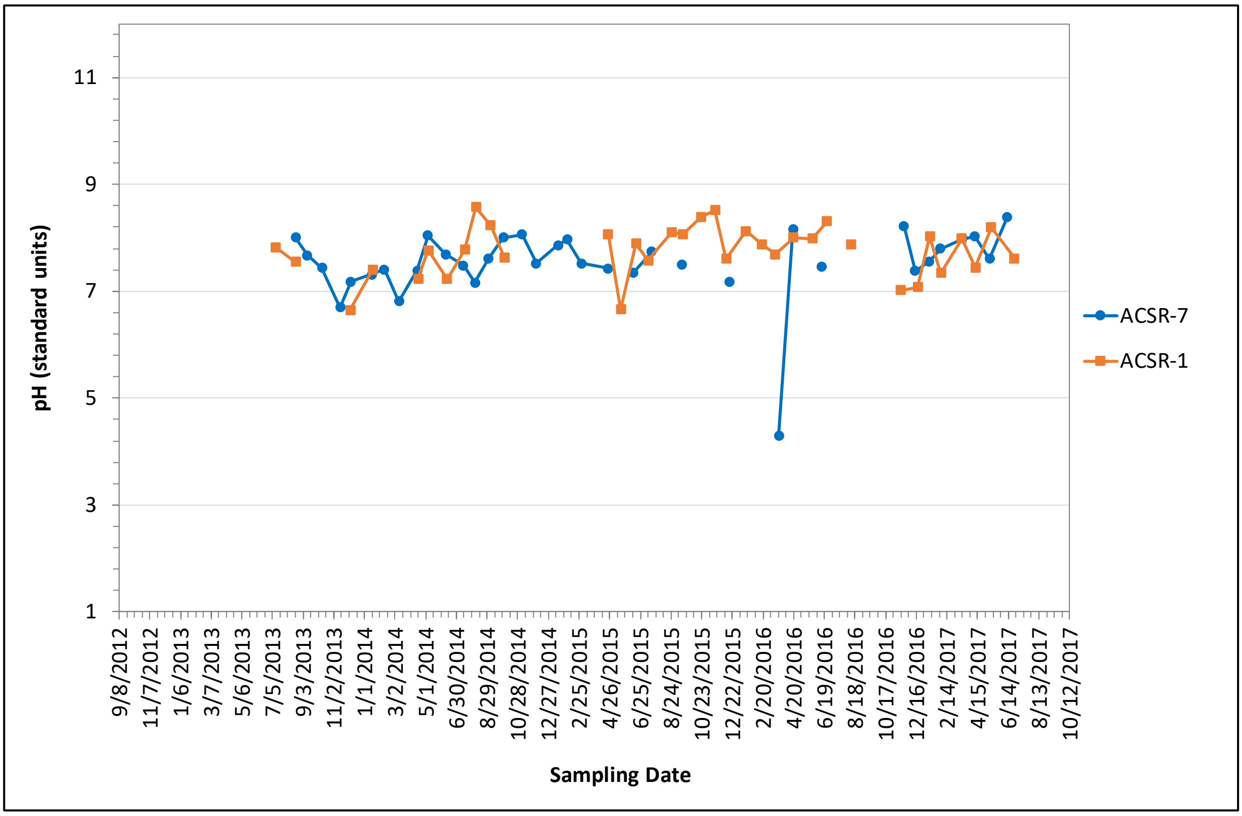

Figure C13: Variation of Saaiwaterspruit pH upstream and downstream of North dump

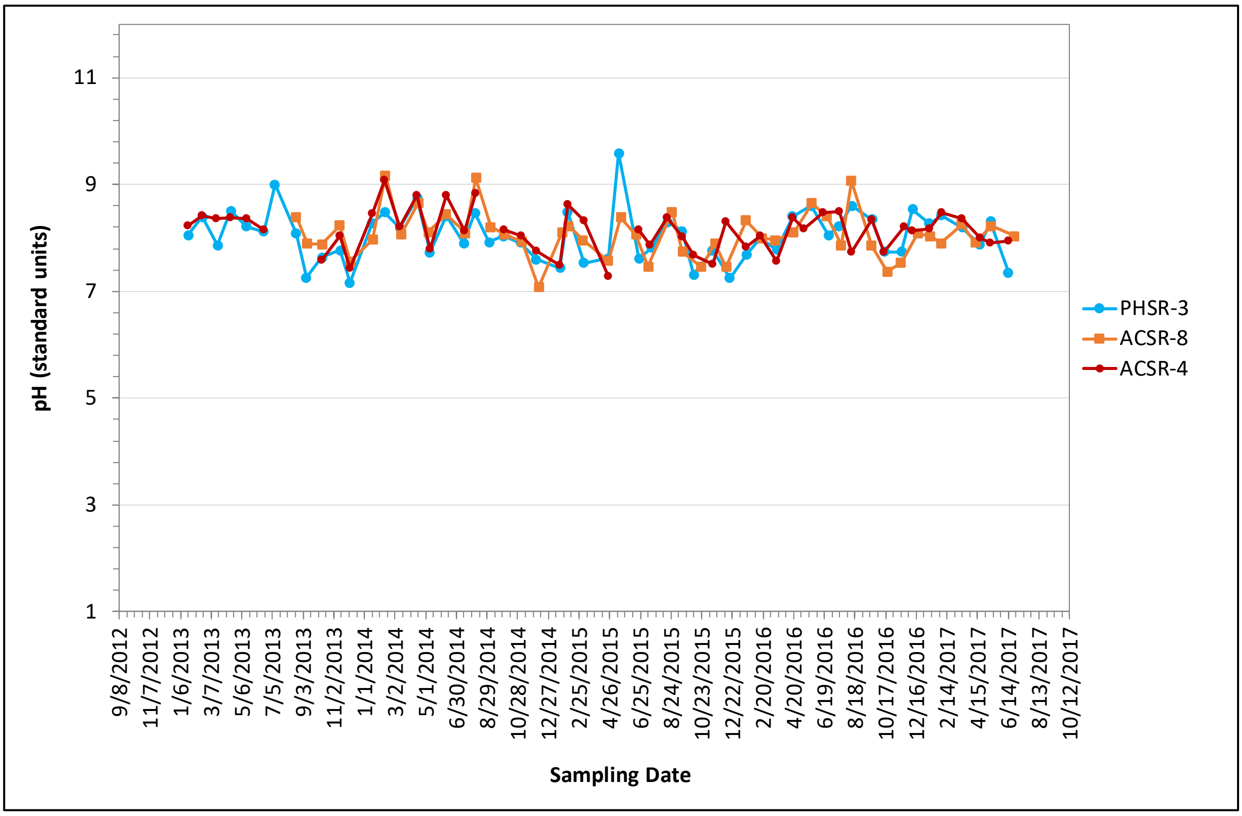

Figure C14: Variation of Steenkoolspruit pH upstream and downstream of ATCOM South pit

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REPORT

Rehabilitation and Closure Plan and Related Costs for the Coarse Discard Dump and the Venture Co-disposal Facility at iMpunzi Complex

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Terms	
Care and maintenance	This involves the maintenance and corrective action conducted on rehabilitated areas, and the inspection and monitoring required to demonstrate that the closure measures implemented have successfully achieved their intended purpose
Closure	This involves the application for a closure certificate and initiation of the transfer of ongoing care and maintenance to third parties
Contingencies	This allows for making reasonable provision for possible oversights/omissions and possible work not foreseen at the time of compilation of the closure costs. Allowance of between 10 percent and 20 percent would usually be made based on the accuracy of the estimations. The South African Department of Minerals and Energy Guideline (January 2005) requires an allowance of 10 percent
Decommissioning	This relates to the situation after cessation of operations involving the deconstruction/removal and/or transfer of surface infrastructure and the initiation of general site rehabilitation
Post-closure	The period of on-going care and maintenance, as per arrangement with third parties
Preliminary and Generals (P&Gs)	This is a key cost item that is directly related to whether or not third-party contractors are used for site rehabilitation. This cost item comprises both fixed and time-related charges. The former makes allowance for the establishment (and de-establishment) of contractors on site, as well as covering their operational requirements (electricity/water/communications) for their offices, workshops, etc. Time-related items make allowance for the running costs of the fixed charged items for the contract period. An allowance of 25% has been made for P&Gs
Remediation	Work done to assist in the rehabilitation process by enhancing the quality of an area through specific actions to improve especially bio-physical site conditions
Rehabilitation	The return of a disturbed area to its original state, or as close as possible to this state
Scheduled closure	Cessation of operations that happens at the planned closure date and/or time horizon
Site relinquishment	Handover of the site to a third party for commencement of the next land use, and on-going care and maintenance, if required. Site relinquishment occurs after receipt of a closure certificate

Abbreviations	
AMD	Acid mine drainage
ARP	Annual rehabilitation plan
DMR	Department of Mineral Resources
DWA	Department of Water Affairs
DWS	Department of Water and Sanitation
EIA	Environmental impact assessment
EMPr	Environmental management programme
ERA	Environmental risk assessment
MPRDA	Mineral and petroleum resources development act
MRA	Mining rights area
NEMA	National environmental management act
RoM	Run off mine

Units of measurement	
ha	Hectares
m^2	Square metres
m^3	Cubic metres

Table of Contents

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

Golder Associates (Golder) was appointed by Glencore South Africa (Pty) Ltd (Glencore) to compile a closure plan and associated closure costs for the rehabilitation and closure of the coarse discard dump that will be developed over the infilled Atcom South Pit, and co-disposal facility that is currently being developed over the infilled Venture Pit at iMpunzi Mine Complex (iMpunzi). The closure plan and associated closure costs are in support of an Environmental Impact Assessment (EIA) and associated licensing application process. The contents of this document are aligned with the requirements of the Financial Provision Regulations, 2015 (GN R.1147 of 20 November 2015) (as amended), published under the National Environmental Management Act (Act 107 of 1998) (NEMA), and although this piece of legislation will likely to be superseded by the Financial Provision Regulations, 2019, it is unlikely that the amendment will require significant changes to the contents of the different report/plans.

iMpunzi Complex consists of four collieries or sub-sections, namely: ATC, Phoenix Colliery, ATCOM, and ATCOM East. Coal mining within the complex was initiated at the Phoenix Colliery in 1936 (Figure 1). Operations at all four collieries have historically been underground. However, all underground operations ceased in 2008, and all remaining operations are opencast.

All opencast mining is undertaken using the strip-mining method using draglines, and truck and shovel at the smaller open pits. All hard overburden (shale/sandstone) and coal are blasted using bulk explosives (heavy ammonium nitrate and fuel oil emulsion). The coal is transported by a fleet of trucks to the crushing and pillar screening plant (Golder, 2016).

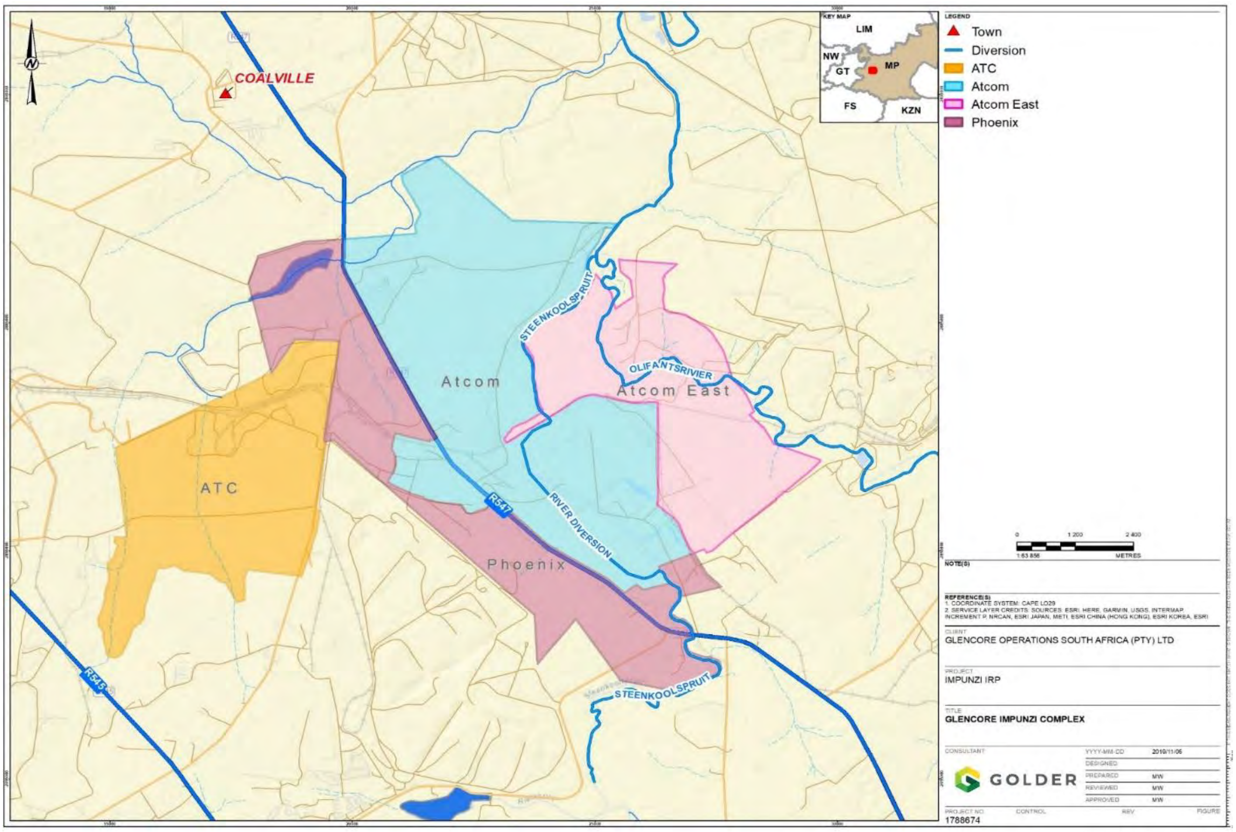

Figure 1: iMpunzi Complex and associated sub-sections

1.1 Atcom

The ATCOM area consists of both opencast and underground coal mining operations. Operations at the ATCOM area commenced in 1991, and the extent of the South Pit covered the original course of the Steenkoolspruit.

A permanent river diversion was constructed to divert the Steenkoolspruit around the South Pit (Jones & Wagener, 2014).

Current mining activities at ATCOM comprise of opencast mining of the North Pit, South Pit and River West Pit (all through pillar extraction from old underground workings). Mining at ATCOM is expected to cease in 2025. The coal mined at ATCOM is transported to the ATCOM Central Plant where it is washed and conveyed to the linear stockpile at ATC. From there, it is conveyed to a rapid load-out silo situated at ATC, from where it is transported via rail to Richards Bay for export (Jones & Wagener, 2014).

1.1.1 South Pit Discard Dump

The proposed South Pit Discard Dump (discard dump) will be located on an area which was historically opencast mined (South Pit) and then filled with spoils that have been shaped and levelled to various states towards rehabilitation (see Figure 3). The discard dump will receive coarse discard from the ATCOM Central Plant.The discard dump was planned to not extend south of the existing haul road that connects to the Triangle Pit with the ROM pad and plant.

The discard dump will occupy a total footprint area of 128.5 ha, providing a total placement capacity to 2035 of approximately 83 995 000 m^3. It was established in the prefeasibility study (Golder, 2018) that the available footprint and height restriction of 30 m from the immediate surrounding ground elevation, allows side slopes of 1v:7h. This means that the slope will be flat enough to also function as a stable landform and not require any further shaping at closure, and that only shaping of the top surface of the discard dump will be required.

Although the EMPr compiled by Digby Wells Environmental (2014) recommends placement of a 300 mm deep soil cover ,supported by the Groundwater and Geochemistry impacts assessment compiled by Golder (2020) and the Conceptual level of unsaturated flow modelling which has shown that a minimum cover thickness of 300 mm of selected fine grained materials should suffice in terms of the infiltration rate; it is however envisioned that a more realistic evaporative cover thickness should be 600 mm to take account of vegetation rooting depth requirement, possible erosion rates and possible salination of the soil. The cover thickness allowed for in this report and closure costs is consequently 600 mm.

At closure, the temporary cut-off berm that would have been constructed to separate the dirty run-off from the clean area until the side slope has been vegetated, will need to be removed, as the catchment area on the dump will be considered clean due to successful vegetation establishment. Runoff from the eastern side slope will drain into a new clean water drainage line that will be established during rehabilitation of the Triangle Pit as presented in Figure 2 below. Therefore, at closure, there will be no need to construct toe paddocks or establishment of drainage lines.

The low-lying areas located south of the discard dump (Figure 2) need to be infilled at closure to ensure that clean water can be free draining post-mining as per general mine closure requirements. This will also provide for a possible route to the Steenkoolspruit to drain the run-off from the southern side slopes and the borehole can also be decommissioned.

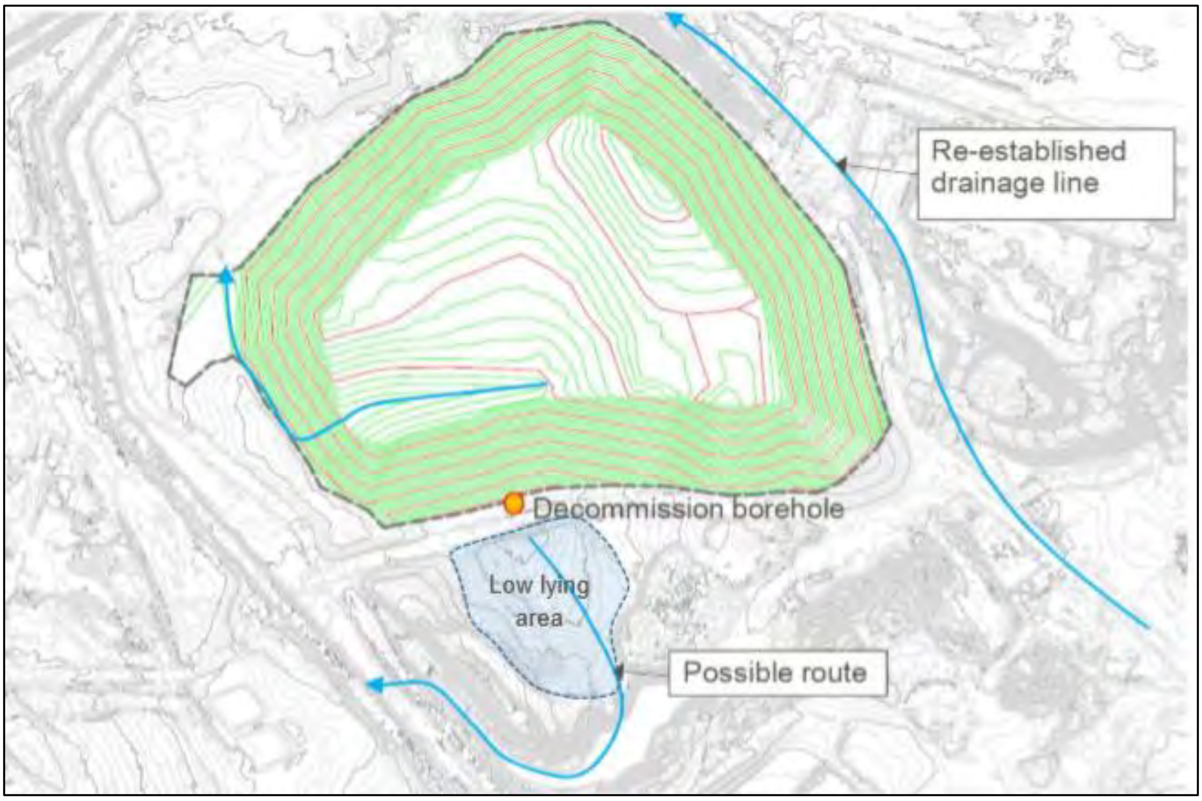

Figure 2: Coarse disposal final closure layout and drainage

1.1.2 Venture Co-Disposal

The existing Venture Discard Dump is used for the disposal of coal discard which originates from the processing of coal at the ATC Plant. The facility is located on the mined-out ATC Venture Pit. The Venture Discard Dump is to be expanded to accommodate additional volumes of discard and be modified into a co-disposal facility (co-disposal) to also accommodate fine discard (slurry).

The expanded co-disposal will have a remaining lifespan of approximately 13 years and will be limited to the remainder of the backfilled historic ATC Venture Pit footprint area. The co-disposal will receive coarse discard and slurry from the ATC Plant, which sources coal from opencast workings and from discard dump reprocessing. The slurry will be piped from the ATC Plant to the co-disposal via pipeline to be constructed (see Figure 5).

As per the design study developed by Golder (2020) for the co-disposal, the side slopes are to be engineered at a slope of 1v:5h with a maximum height of 20 m. This means that the slopes will be flat enough to also function as a stable landform, and thus not require any further shaping at closure. The co-disposal will have a storage capacity of 5 821 353 m^3 for the coarse discard and 2 320 981 m^3 for the coal fines, amounting a total storage capacity of 8 142 334 m^3 predicted and will occupy a total footprint area of 82.66 ha.

The EMPr compiled by Digby Wells Environmental (2014) recommends placement of a 300 mm deep soil cover ,supported by the Groundwater and Geochemistry impacts assessment compiled by Golder (2020) and the Conceptual level of unsaturated flow modelling which has shown that a minimum cover thickness of 300 mm of selected fine grained materials should suffice in terms of the infiltration rate. Similar to the discard dump, it is however envisioned that a more realistic evaporative cover thickness should be 600 mm to take account of vegetation rooting depth requirement, possible erosion rates and possible salination of the soil, thus the cover thickness allowed for in this report and closure costs is consequently 600 mm.

As part of the co-disposal, a new return water dam (RWD) will be constructed to manage the surface water from around the perimeter of the facility and supernatant decant water from the slurry portion of the co-disposal facility. In order to enable the transportation of the discard from the dumps to the ATC Plant (via haul trucks), the existing haul road from the ATCOM discard dumps to the ATC coal processing plant will also be widened (refer to Figure 5).

2.0 APPROACH TO CLOSURE PLAN AND COST DETERMINATION

The approach followed in compiling the closure plan and closure costs for the discard dump and co-disposal at iMpunzi was as follows:

- Conduct discussions with specialists and review engineering design and specialist reports
- Compile a screening level closure risk assessment to ensure that the discard dump and co-disposal rehabilitation is considered within the broader site wide closure context and
- Determine the Total scheduled closure costs the discard dump and co-disposal facilities, as per the requirements of GN R.1147 by:
  - Obtaining the discard dump, co-disposal and related support infrastructure quantities based on the engineering designs
  - Verify unit rates for infrastructure dismantling and demolition as well as associated rehabilitation of disturbed areas, taking account of the latest demolition equipment available
  - Apply the above unit rates and associated quantities in the latest Golder costing model to determine the closure costs as at February 2020
  - Calculate the scheduled closure costs, by including the confirmed closure measures in Golder's costing model (including demolition of the support infrastructure, general surface rehabilitation, and post-closure monitoring and
  - Documenting the outcomes of the above in the closure plan and associated closure costs report

3.0 AVAILABLE INFORMATION

The information summarised in Table 1, was used to inform the closure plan and closure costs.

Table 1: Key supporting information used to inform the closure plan and closure costs

Title/Description	Author	Date
Consolidated Tavistock EIA and EMPr Amendment	Digby Wells	April 2014
Conceptualisation of the Coarse Discard Dump configuration over infilled Atcom South open pit as part of integrated pit closure	Golder Associates	April 2018
Final Scoping Report for the Proposed iMpunzi South Pit Discard Dump and Venture Co-disposal	Golder Associates	January 2020
iMpunzi Beath Dump cover-seepage modelling	Golder Associates	July 2019
Proposed haul road.kmz	Golder Associates	February 2020
South Pit Discard dump footprint.kmz	Golder Associates	February 2020
Venture discard dump footprint.kmz	Golder Associates	February 2020
Updated Pipelines.kmz	Golder Associates	February 2020
Groundwater and Geochemistry Impact Assessment Report for the Proposed iMpunzi South Pit Coarse Discard Dump and Venture Co-disposal Facility Project	Golder Associates	April 2020

MINE SITE CONTEXT

4.0 LOCALITY OF THE OVERALL MINE SITE

The mine site is located approximately 27 km south-east of eMalahleni, near the towns of Ogies and Kriel, within the greater Nkangala District Municipality, in the eMalahleni and Steve Tshwete Local Municipalities in the Mpumalanga Province, South Africa. The extent of the discard dump and co-disposal facilities are indicated within the iMpunzi Complex Boundary.

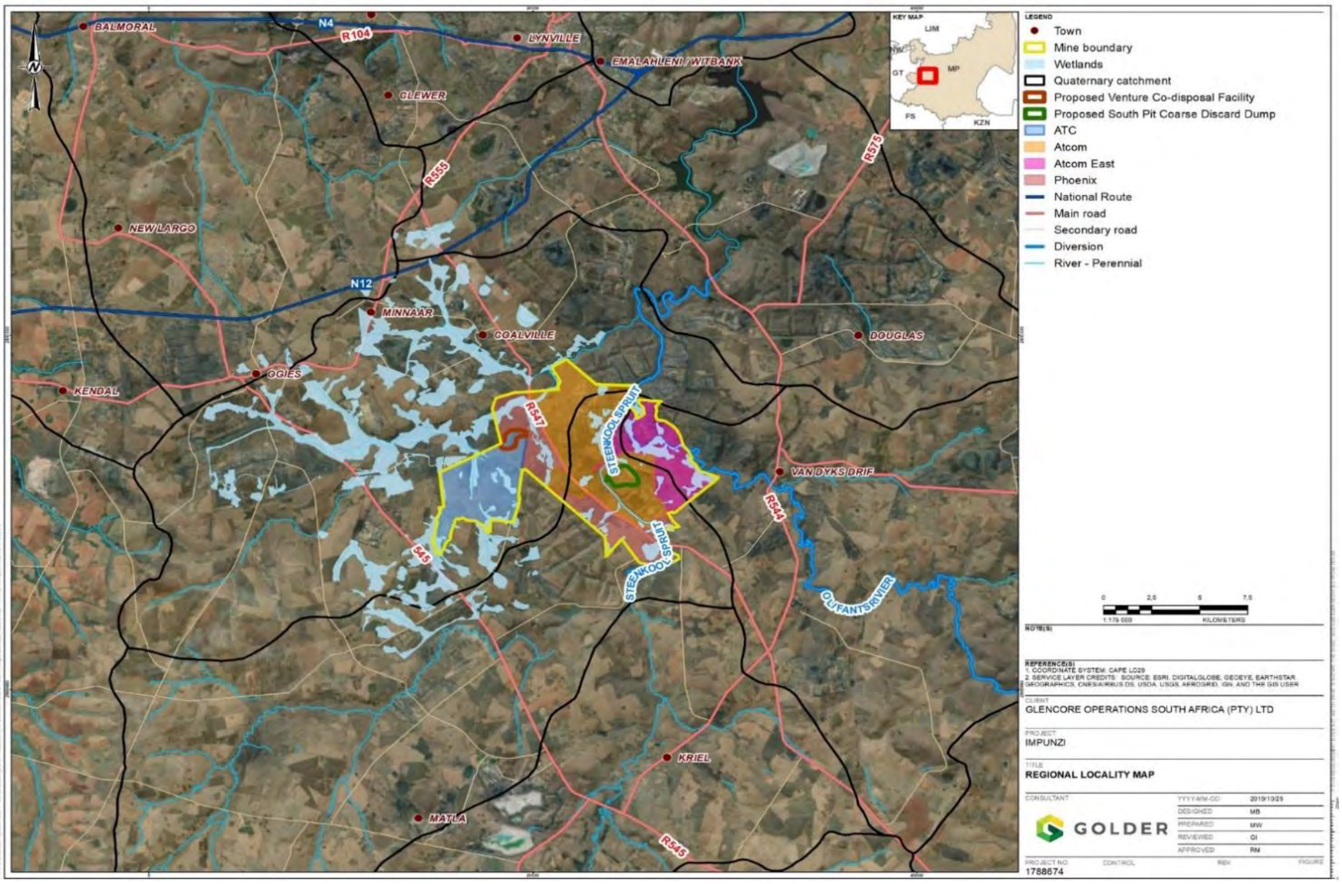

Figure 3: Location and extent of the iMpunzi Complex, the discard dump and co-disposal facilities

5.0 LEGAL STATUS OF THE MINE

The Mineral Rights holder for iMpunzi is Glencore South Africa (Pty) Ltd. The mine operates under the consolidated Tavistock Amended EIA and EMP compiled by Digby Wells Environmental (2014) approved under section 39 of the Minerals Act (Act 50 of 1991).

6.0 BATTERY LIMITS

The specific battery limits for this closure plan and associated closure costing refer to the discard dump over the infilled South Pit (Figure 4) and the co-disposal over the infilled Venture Pit of iMpunzi(Figure 5). All other infrastructure and mining waste residues are excluded from this assessment as they are included in the site-wide closure costs. The long-term costs for pumping and treating extraneous groundwater have not been determined in this assessment as it is assumed that these are already included in the iMpunzi side-wide closure costs.

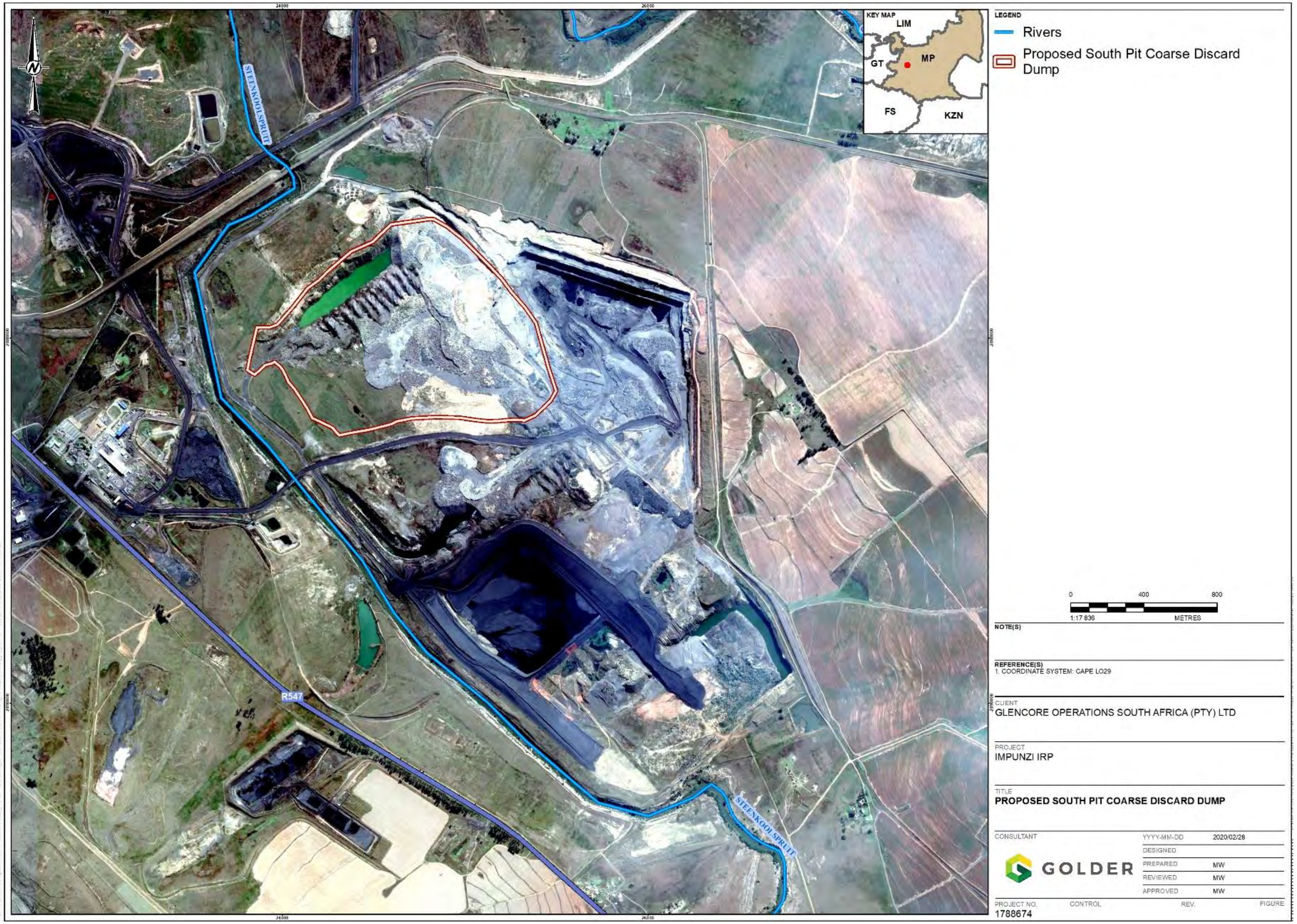

Figure 4: Location of the discard dump over the infilled South Pit of iMpunzi

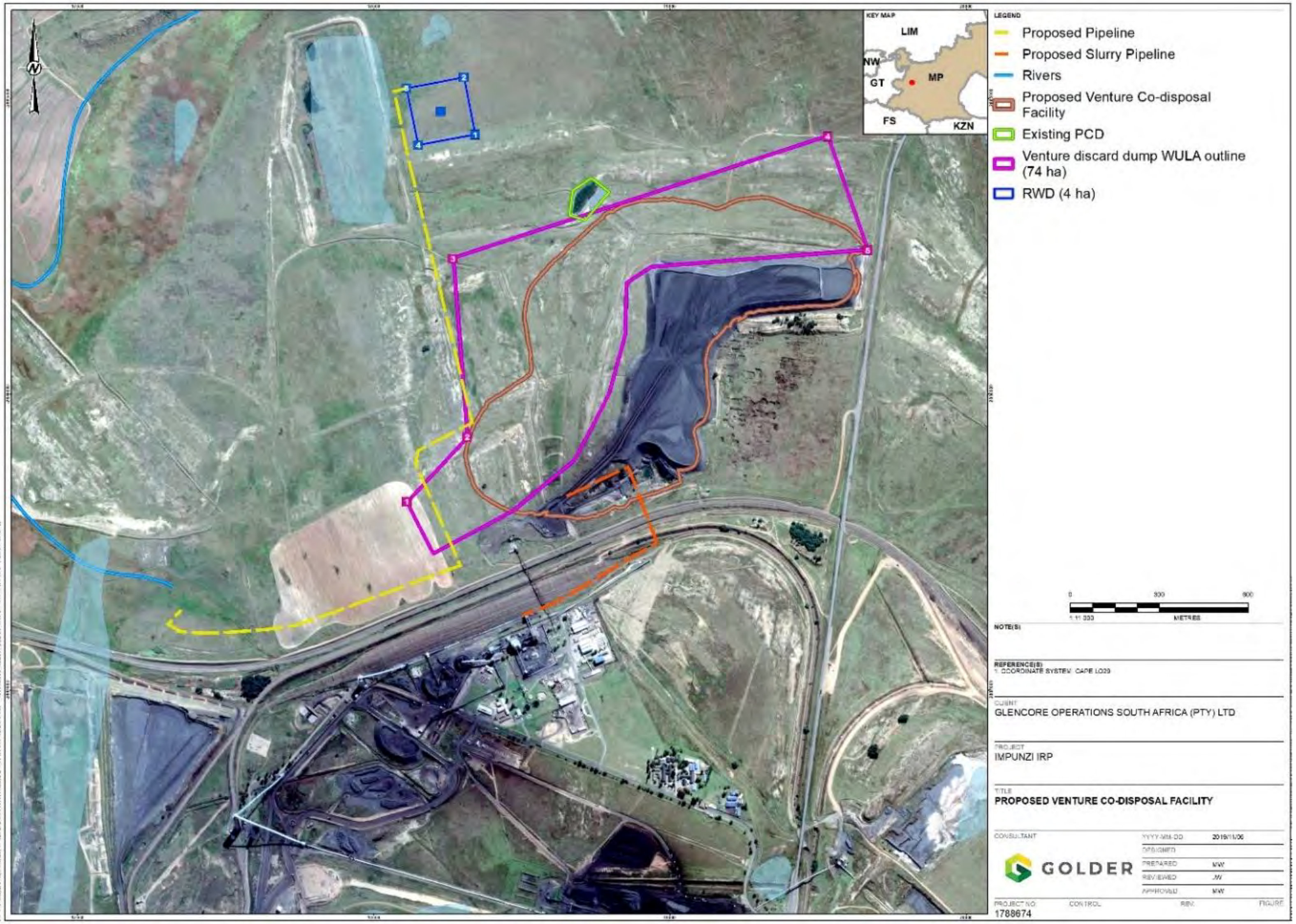

Figure 5: Location of the co-disposal over the infilled Venture Pit of iMpunzi

7.0 OBJECTIVES

The purpose of this assessment is to determine the rehabilitation and closure costs the discard dump, the co-disposal (Figure 4 and Figure 5), and the related support infrastructure namely:

- Venture return water dam
- Pump station
- Slurry and return water pipelines
- Temporary concrete lined channels/trenches
- Haul road; and
- Temporary co-disposal borehole.

CLOSURE PLANNING

The scheduled closure costs are reflected as the costs to implement the rehabilitation measures once the discard dump and co-disposal reach capacity. Site-wide post closure water treatment costs are indicated separately.

8.0 SCREENING LEVEL RISK ASSESSMENT

8.1 Methodology

To ensure that the discard dump and co-disposal rehabilitation are considered within the site wide context, a screening level risk assessment (SLRA) was undertaken as part of this closure cost assessment. The SLRA is qualitative in nature and compiled through the identification of risks, risk drivers and the resulting impacts. The following definitions apply:

- Aspect – typical broad categories utilised for closure objective setting
- Driver/root cause - fact, activity or event giving rise to a potential risk of not achieving the closure objectives (relates mainly to the implementation/lack of implementation of specific closure measure in terms of the respective categories and subcategories below); and
- Resultant impacts - manner in which an undesirable event harms closure objective in terms of the respective receptors.

Table 2: Screening level risk assessment

Aspect	Risk Driver	Consequence/Unwanted Event	Mitigation
End land use	Land use and land capability targets not met	▪ Post mining landform gradients too steep ▪ Rehabilitated areas not free draining into the natural catchment ▪ Insufficient soil cover quantity; and ▪ Insufficient revegetation due to poor rehabilitated soil quality (heavy compaction).	▪ Compile a detailed next land use plan as part of the iMpunzi complex wide closure plan development in terms of GN R.1147 ▪ Develop clear rehabilitation objectives for each area along with implementation plans ▪ Compile and maintain a Life of Mine topsoil balance for iMpunzi complex ▪ Develop a site-wide post mining landform model informed by suitable storm water runoff and erosion modelling ▪ Ensure that all interested and affected parties are engaged and buy-in is reached regarding the desired closure state, so that expectations can be managed throughout the operational period; and ▪ Make sure rehabilitation is done according to industry good practice and internal policies and rehabilitation standard procedures are implemented.
	Failure to manage the land use practices after closure	▪ Destruction of vegetation cover, resulting in increased erosion and general failure of rehabilitation measures.	▪ Clearly define the post mining land use for the rehabilitated discard dump and co-disposal including specific management measures to ensure the long-term success of the rehabilitation; and ▪ Negotiate and conclude post mining land use agreements with third parties as required.

Aspect	Risk Driver	Consequence/Unwanted Event	Mitigation
Landscape viability	Discard dump and co-disposal rehabilitated in isolation	■ The rehabilitated discard dump and co-disposal are not part of a coherent overarching rehabilitation and closure plan for the whole mine; and ■ Non-alignment with mine wide closure goals and objectives.	■ Compile the detailed closure plan and annual rehabilitation plan aligned with GN R.1147 and incorporate the proposed discard dump and co-disposal into the comprehensive risk-based approach to ensure a coherent approach to setting and achieving closure objectives.
	Unsustainable vegetation covers on the final landform	■ Compaction and decline in topsoil structure during stripping, stockpiling and topsoil re-placement ■ Ineffective soil amelioration resulting in poor vegetation establishment ■ Loss of topsoil through erosion at stockpiles, pit edges and rehabilitated areas ■ Lack of rehabilitation-related post closure monitoring to support site relinquishment; and ■ Extensive unvegetated areas, resulting in excessive dust generation (nuisance dust) with unwanted impacts on surrounding environment, agriculture, and neighbours.	■ Make sure rehabilitation is done according to industry good practice and internal policies and rehabilitation standard procedures are implemented, including but not limited to: ▪ Proper stripping and placement methodologies to limit compaction ▪ Compaction alleviation through effective ripping and scarifying ▪ Implement site specific soil amelioration based on dedicated sampling, analysis and interpretation of results and ▪ Implement a monitoring programme designed to identify short comings and address them timeously.
	Topsoil contamination with hydrocarbons and chemical compounds from mechanical equipment	■ Soil contamination resulting in reduced soil fertility and land capability and potential contamination of surface water runoff.	■ Define no-go areas to limit activity to the affected footprint ■ Ensure good practice in terms of servicing and rotating mass earth works equipment is implemented; and

Aspect	Risk Driver	Consequence/Unwanted Event	Mitigation
			■ Make sure rehabilitation is done according to industry good practice and internal policies and rehabilitation standard procedures are implemented.
Biodiversity	Insufficient control of alien invasive species on rehabilitated land	■ Loss of biodiversity due to proliferation of alien invasive species.	■ Implement the revegetation measures as soon as possible following topsoil placement ■ Implement monitoring and maintenance of all rehabilitated areas; and ■ Implement and actively update the site wide Biodiversity Action Plan (BAP) and actively remove alien invasive species and manage regrowth.
Groundwater contamination	AMD or metal leaching/ contaminated seepage from discard dump and rehabilitated pit	■ Surface and groundwater contamination and associated health and safety concerns for groundwater users (surrounding communities).	■ Pump and treat affected water for beneficial reuse or discharge back into the catchment via a dedicated treatment system (assumed to be addressed as part of site-wide closure planning).
Surface water contamination	Soil contamination due to surface water runoff from dirty areas	■ Reduced soil quality and fertility	■ Implement storm water management measures as per the storm water management plan for the project ■ Ensure concurrent rehabilitation is implemented during the life of the mine to methodically achieve the closure objectives over time; and ■ Ensure that the mine water balance is regularly updated.

9.0 ASSUMPTIONS APPLIED IN THE CLOSURE PLAN

This closure plan primarily addresses the requirement to rehabilitate the proposed discard dump and co-disposal, decommission and demolish the related infrastructure at their estimated End of life.

The following assumptions have been made in the compilation of this closure plan:

- The plan has been compiled without input from external stakeholders. Stakeholder consultation will be undertaken by the mine during operations to obtain stakeholder views and opinions, and these will be considered and incorporated in future versions of the overall mine closure plan
- The closure plan is based on available information supplied by the mine along with other updated specialist studies conducted by Golder. It is however important that closure-related knowledge gaps be addressed based on priority, during the operational life of the mine
- Successful closure of the discard dump and co-disposal will require buy-in from, and collaboration with, district municipalities, regulators, mine employees and surrounding landowners and communities. This closure plan assumes that the working relationship required with these stakeholders for successful closure will be well established at the onset of closure
- Decommissioning and rehabilitation activities will follow directly on the cessation of operational life of the discard dump and co-disposal; and
- Closure planning will be a progressive/iterative process where new information, as it becomes available, will be assimilated and incorporated into the closure planning to achieve an appropriate, up-to-date and implementable closure plan at the time of actual closure.

10.0 EMPR REHABILITATION CRITERIA AND OBJECTIVES

The following general rehabilitation and closure criteria pertaining to the discard dump and co-disposal have been extracted from the Digby Wells Environmental (2014) EMPr:

- Ensure that water draining off the surface of the dumps is clean and channelled into the clean water systems
- Contain seepage from the discard dump areas in a dirty water management system and allow evaporation to take place, where possible
- Ensure that runoff is not kept on the discard dumps, but allowed to discharge as quickly as possible (free draining)
- Rehabilitate the discard dumps so that they do not cause surface water, groundwater or air pollution that is unacceptable to nearby or downstream users and to ensure structural stability
- Cover the discard dumps with a layer of soil that will be able to support plant growth under a normal level of farm management
- Divert all surface water, which is considered to be clean water after vegetation has established itself, past the dirty water management system
- Re-vegetate all areas, including the discard dumps and water control structures and to maintain these areas in the normal way for a period of three to five years after decommissioning activities have ceased; and
- Monitor groundwater, surface water and vegetation for a three-year period after operations cease or until the residual risk with the facility is understood.

11.0 CLOSURE SCENARIO

To guide the determination of scheduled closure costs, the likely closure scenario has been defined in terms of the closure period and beyond, where the mine has been handed over to the closure contractors (s) to implement the closure measures and related engineering work in terms of the final closure plan and the general rehabilitation and closure criteria.

The closure scenario, as seen in Table 3 below, is based on the end of the operational life of the discard dump and co-disposal and their related support infrastructure for closure, focusing specifically on the following key aspects:

- Infrastructure area
- Processing residues
- Dirty water impoundment
- Waste and contaminated land
- General surface rehabilitation and
- Water management.

Table 3: Closure scenario for the discard dump, co-disposal and related infrastructure

Aspect	Closure scenario
Infrastructure	
■ Return water dam pump station ■ Haul roads ■ Concrete channels and ■ Pipelines.	■ Dismantling, removal and demolition would be undertaken with scrap steel prepared for salvage. Concrete will be safely disposed of at a licensed disposal site in eMalahleni ■ Surface contamination due to the removal of surface infrastructure will be collected and removed for safe disposal ■ Haul roads will be rehabilitated as aligned to the post mining land use; and ■ Disturbed footprint areas will be suitably rehabilitated and vegetated to achieve a succession trajectory that will eventually result in the agreed post mining land use and desired ecological state.
Processing residues	
■ Venture co-disposal ■ ATCOM South Pit coarse discard dump; and ■ Low lying area south of the coarse discard dump.	■ The processing residue will be rehabilitated in-situ by shaping the top surfaces, capping with suitable soil cover depth and vegetated on both the top surface and side slopes; and ■ Low lying area will be infilled with the available soil and vegetated to achieve a succession trajectory that will eventually result in the agreed post mining land use and desired ecological state.
Dirty water impoundments	
■ Return water dam.	■ Any potential spillages or contamination from the impoundment will be cleaned-up by removing sediment from the basin and disposing of this onto the respective co-disposal facility prior to final rehabilitation

Aspect	Closure scenario
	■ Remaining liner system will be cleaned and removed for safe disposal, followed by remediation of contaminated soils; and ■ The dam basin will be backfilled and shaped to be free draining, soil will be ripped and ameliorated according to dedicated soil analysis, and vegetation will be re-established using a suitable seed mix.
Waste and contaminated land	
■ Pipelines; and ■ Roads,	■ Remaining steel and related wastes that can be salvaged will be sold and moved off-site ■ Transport contaminated demolishing waste to a registered hazardous waste facility for safe disposal (Holfontein); and ■ If there are any asphalt surfaces; these will be crushed and stockpiled in a central location on site for re-sale to third parties.
General surface rehabilitation	
■ All disturbed areas.	■ Monitoring will continue to identify any possible sinkhole and subsidence development ■ Final shaping and levelling of areas from which infrastructure was removed and/or disturbed during operations will be undertaken ■ The above shaping and levelling will be in accordance with the agreed post-closure surface drainage regime and aligned to the post mining land use ■ Shaped and levelled areas will be ripped to alleviate compaction, and in situ soils ameliorated and vegetated towards achieving the desired post mining land use ■ Corrective action over already rehabilitated areas will be undertaken as required; and ■ Ongoing eradication of exotic vegetation will be undertaken post-closure.
Water management	
	■ Site drainage lines will be reinstated/developed on the rehabilitated surface areas ■ Surface water and groundwater monitoring will continue to be conducted for 5 years post closure to demonstrate success of implemented closure measures; and ■ Water treatment will continue post-closure for an agreed upon period as reflected in the final closure plan.

12.0 CURRENT LAND USE

The current land use of the iMpunzi complex and adjacent area is dominated by cultivated land, grassland and mining activities as displayed in Figure 6.

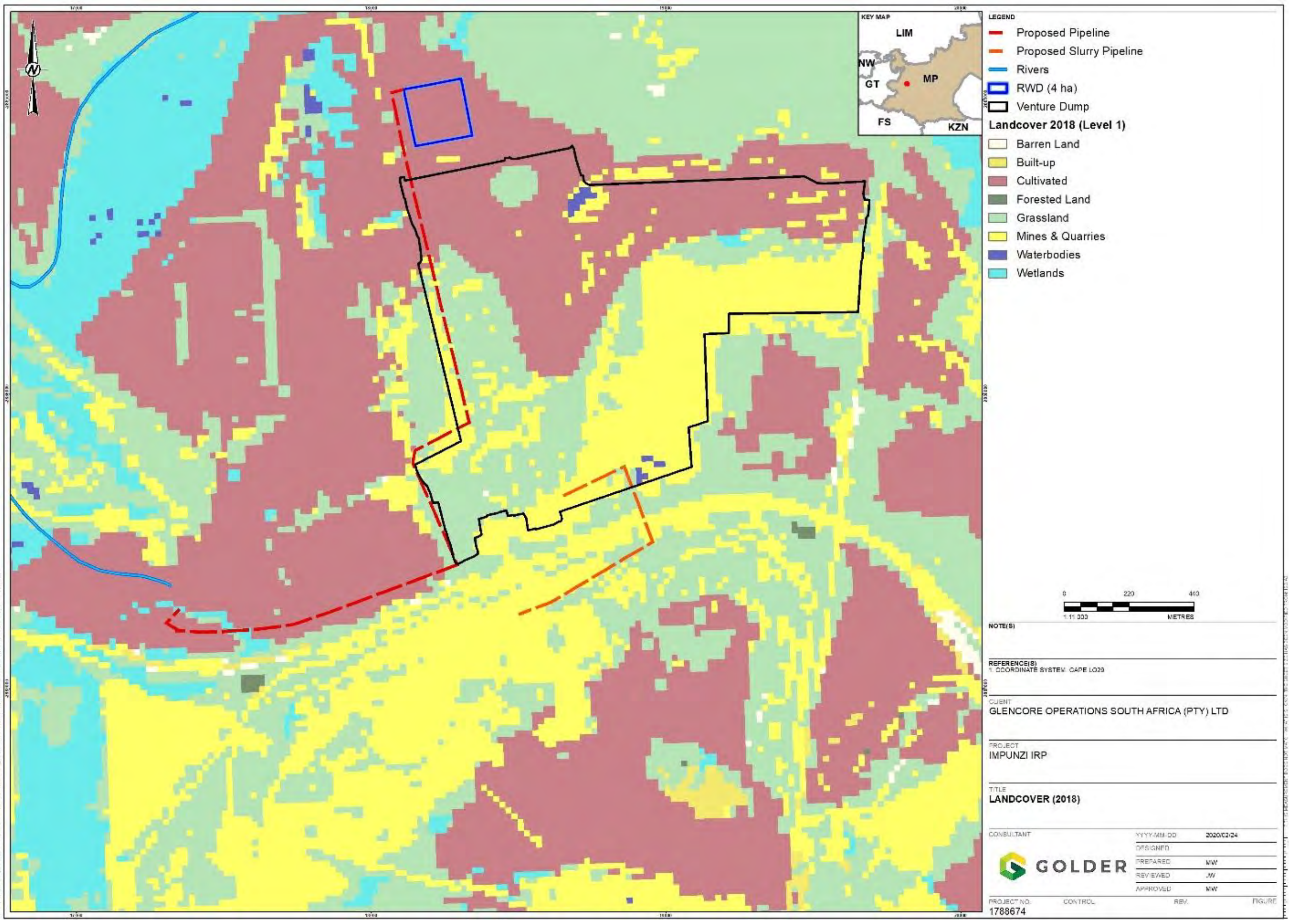

Figure 6: The current land use of iMpunzi complex and the adjacent area

13.0 POST MINING LAND USE

The post mining land use is a key driver of the rehabilitation process and implementation strategy, so the latter should be geared to achieving the post closure land use objectives systematically over the operational life. The EIA/EMPr by Digby Wells Environmental (2014) indicates that post mining the land will be returned to a grazing land capacity.

CLOSURE COST DETERMINATION

14.0 CLOSURE COSTING

14.1 Unit rates

The unit rates for general rehabilitation and closure measures and activities were obtained from Golder's existing database in consultation with demolition and earthworks contractors, as well as with rehabilitation practitioners. Golder undertakes a thorough review of its unit rate database, as follows:

- Minor unit rates are adjusted with standard inflation, with confirmation generally occurring annually
- Key rates for the dismantling of infrastructure are benchmarked by a specialised demolition contractor, to ensure that it remains market-related and take account of the latest dismantling and demolition techniques
- Earthworks rates are benchmarked against recent tenders available to Golder as well as benchmarking in discussions with contractors; and
- Aggregated rates dependent on base infrastructure or earthworks related rates are recalculated given the latest base rates.

The unit rates applied in the closure cost estimate were last updated in March 2019, and were escalated to February 2020, using 3.1% escalation, as informed by CPI data from StatsSA.

14.2 Closure cost assessment

The closure measures as per the GN R.1147 Regulations, where applicable, are reflected in Table 4.

Table 4: Closure measures as per the GN R 1147 regulation (where applicable)

Aspect	Closure Measures
Infrastructural areas	
Steel structures, reinforced concrete structures, buildings and related structures and infrastructure	**Return water pump station and concrete channels** ■ Dismantle surface infrastructure ■ Demolish and dispose of concrete material ■ Replace topsoil – 300 mm deep topsoil shall be placed under the entire area of the demolished structure ■ Rip top alleviate compaction; and ■ Ameliorate soils based on dedicated soil fertility sampling and establish vegetation by applying suitable seed mix. **Pipelines** ■ Dismantle pipelines and demolish concrete footings ■ Sell-off salvageable material (steel, rubber belts, etc.) to identified third party ■ Ameliorate soils based on dedicated soil fertility sampling, rip and shape footprint area to be free-draining, aligned to site-wide routing; and ■ Ameliorate soils based on dedicated soil fertility sampling and establish vegetation by applying suitable seed mix.

Aspect	Closure Measures
Roads	**Haul road** ■ Ameliorate soils based on dedicated soil fertility sampling, rip and shape footprint area to be free-draining, aligned to site-wide routing; and ■ Ameliorate soils based on dedicated soil fertility sampling and establish vegetation by applying suitable seed mix.
Fences	■ Not applicable.
Demolishing waste	
Disposal of demolition waste	**General** ■ Allowance for sorting and screening of demolition waste. **Concrete demolition waste** ■ Transport concrete to a licensed disposal facility in eMalahleni. **Steel** ■ Recycle waste that can be recycled/salvaged (e.g. steel) after decontamination. **Hazardous waste** ■ Transport hazardous waste to Holfontein hazardous waste disposal facility.
Mining areas	
Rehabilitation of final voids and ramps	■ Not applicable.
Sealing of shafts, adits and inclines	■ Not applicable.
Rehabilitation of processing waste deposits and evaporation ponds (polluting potential)	**Discard dump** ■ Shape the top surface to be free draining ■ Apply soil cover/capping material to a depth of 600 mm; and ■ Vegetate entire surface of landform. **Co-disposal** ■ Shape the top surface to be free draining ■ Apply soil cover/capping material to a depth of 600 mm; and ■ Vegetate entire surface of landform.
Rehabilitation of dirty water impoundments	**Return water dam** ■ Remove the contaminated sediment and dispose of in the co-disposal ■ Remove HDPE liner, shred and dispose of in in the co-disposal ■ Backfill dam basin and shape area to be free draining ■ Topsoil placement to 300 mm over rehabilitated area ■ Rip to alleviate compaction and

Aspect	Closure Measures
	■ Ameliorate soils based on dedicated soil fertility sampling and establish vegetation by applying suitable seed mix.
General surface rehabilitation	
General surface rehabilitation	**Rehabilitated and reshaped areas** ■ Restore land to the agreed land capability by reinstating a free-draining surface topography and placing sufficient soil/growth medium and revegetate. **Vegetation** ■ Establish vegetation by applying suitable seed mix; and continue with alien plant eradication programme by cutting and/or use of herbicides.
Water management	
Re-instatement of drainage lines	■ No measures applied as it has been assumed general surface rehabilitation shaping will account for the drainage lines and free draining.
River diversion	■ Not applicable (assumed included in site-wide closure plan and costs).
Post-closure aspects	
Surface water and groundwater monitoring	■ Monitor groundwater for a period of 5 years post-closure (or until site relinquishment criteria have been met) and ■ Monitor surface water for a period of 5 years post-closure (or until site relinquishment criteria have been met).
Rehabilitation monitoring	■ Conduct rehabilitation monitoring for a period of 5 years post-closure (or until site relinquishment criteria have been met).
Care and maintenance	Undertake maintenance and aftercare for 5 years after mine production has ceased, by: ■ Applying fertilizer annually over rehabilitated areas ■ Undertaking monitoring of surface and groundwater quality ■ Controlling alien plants and ■ Undertaking general maintenance, including rehabilitation of cracks and subsidence.
Additional allowances	
Preliminary and general	■ Additional allowance of 25% P&Gs and 10% contingencies were applied to Subtotal 1.

14.3 Closure cost assumptions and qualifications

The following section describes key assumptions that guided the scheduled closure costs for discard dump and co-disposal at iMpunzi. Focus was placed on site-specific and newly resolved matters.

14.3.1 Closure costs classification

- Based on the information used, the accuracy of this assessment can be classified to be at a -30% to +50% accuracy.

14.3.2 General costing assumptions

- The closure costs comprise a number of cost components. This report only addressed the decommissioning and rehabilitation costs, equating to an outside (third party) contractor establishing on-site and conducting the outstanding rehabilitation-related work on discard dump and co-disposal
- Based on the above, dedicated contractors would be commissioned to conduct the demolition and rehabilitation work on the site. This would, inter alia, require establishment costs for the contractors and hence, the allowance for preliminary and general (P&Gs) in the cost estimate
- It was assumed that all metal and steel waste would have been salvaged, although it is expected to be minimal. No allowance was made to offset the salvage value of the scrap metal against the demolition costs
- Allowance was made for third party contractors and consultants to conduct care and maintenance work, as well as compliance monitoring, following the rehabilitation of outstanding items and
- Detailed measures and assumptions were described for the scheduled closure scenario only for the discard dump and co-disposal

14.3.3 General support infrastructure assumptions

- Although the planned support infrastructure could have salvage or resale value at closure, no cost off-sets due to possible salvage values were considered as part of this costing
- The haul road would be rehabilitated, deep-ripped, profiled and vegetated and
- Final rehabilitation measures applicable to support infrastructure areas were described under general rehabilitation

14.3.4 Dirty water impoundments

The return water dam will receive dirty water from the plant and co-disposal and thus the following approach was applied to rehabilitate this dam:

- Collection, transport and disposal of the contaminated sediment into the co-disposal
- Removal of HDPE synthetic liner, shredding of this and safe disposal or recycling
- Backfilling the dam basin via dozing and cut to fill as required
- Shape and level the area to be align with the site wide surface water drainage framework
- Place 300 mm topsoil over the shaped area and rip to alleviate compaction; and
- Establishment of a suitable vegetation cover

14.3.5 Demolition Waste

- It has been assumed that all inert demolition waste will be transported and disposed of at a licensed disposal facility in eMalahleni
- A 40 km load and haul for demolition waste has been applied for the above disposal: and

- If there are any asphalt surfaces, these would be crushed and appropriately stockpiled for sale to a third party for beneficial re-use.

14.3.6 Discard dump

- This will remain at closure and the side slopes of this facility will be shaped operationally
- At closure, only the top surface will require shaping
- Place 600 mm cover/capping soil over the side slopes and top surface and rip to alleviate compaction and
- Establishment of a suitable vegetation cover

14.3.7 Co-disposal

- This will remain at closure and the side slopes of this facility will be shaped operationally
- At closure, only the top surface will require shaping
- Place 600 mm cover/capping soil over the side slopes and top surface and rip to alleviate compaction and
- Establishment of a suitable vegetation cover

14.3.8 General rehabilitation

- All areas where infrastructure has been removed will be backfilled with 300 mm topsoil; and
- Ripping to alleviate compaction to facilitate effective revegetation has been allowed for across all disturbed areas where topsoil will be replaced.

14.3.9 Post-closure monitoring and maintenance and additional allowances

- An allowance for rehabilitation monitoring and care and maintenance over all rehabilitated areas has been included for a period of 5 years post-closure; and
- Surface and groundwater quality monitoring will be conducted for a minimum period of 5 years, to assess success of the implemented rehabilitation and closure measures.

14.3.10 P&Gs and Contingencies

- P&Gs are applied at 25% and contingencies at 10%.

14.4 Rehabilitation and closure costs

The scheduled closure costs for the discard dump and co-disposal, as at February 2020, amount to approximately **R 194 million** (including P&Gs and contingencies, and excluding VAT), as summarised in Table 5. The detailed costing spreadsheet is provided in APPENDIX A.

Table 5: Scheduled closure costs summary for the discard dump, co-disposal and associated support infrastructure at iMpunzi

1788675 iMpunzi Complex Closure Costs, as at February 2020			
Closure components		**Scheduled Closure**	
1	Infrastructural aspects	R	12,962,916
2	Mining aspects	R	111,587,407
3	General surface rehabilitation	R	10,164,050
	Sub-Total 1	**R**	**134,714,373**
5	**Post-Closure Aspects**		
5.1	Surface water monitoring	R	1,762,780
5.2	Groundwater monitoring	R	784,532
5.3	Rehabilitation monitoring	R	605,649
5.4	Care and maintenance	R	8,711,380
	Sub-Total 2	**R**	**11,864,341**
6	**Additional Allowances**		
6.1	Preliminary and general	R	33,678,593
6.2	Contingencies	R	13,471,437
	Sub-Total 3	**R**	**47,150,031**
	Grand Total **Excl. VAT. (Sub-total 1 +2 +3)**	**R**	**193,728,745**

14.4.1 Post-closure water treatment costs

The long-term costs for pumping and treating extraneous groundwater have not been determined in this assessment as it is assumed that these have been included in the iMpunzi site-wide closure costs.

15.0 ACTIONS REQUIRED

The following actions are required to improve the resolution of the closure planning and costing:

- Compile a topsoil balance for all areas of the iMpunzi complex and related mine residue facilities indicating the topsoil volume (and quality) requirements for rehabilitation and closure, topsoil volumes available and their location (in-situ ahead of mining and stockpiled) and the shortfall or surplus
- Identify and quantify potential topsoil sources to address any shortfalls
- Review and update the site wide closure planning and costing to align with GN R.1147 in the next 12 months and include the specific cover depth for the dump
- Update the proposed land preparation, soil amelioration and hydroseeding rates based on site specific soil sampling and analysis and

- Incorporate the planned discard dump and co-disposal into the mine wide closure planning and costing to ensure the alignment of end land use planning and closure objectives

16.0 REFERENCE LIST

DigbyWells, 2014. *Consolidated Tavistock EIA and EMPr Amendment,* s.l.: s.n.

Golder, 2018. *Conceptualisation of the Coarse Discard Dump configuration over infilled Atcom South open pit as part of integrated pit closure,* Halfway House: s.n.

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APPENDIX A

Detailed Closure Costs

Ref.	Closure Component	Cash flowed costs expensed method	Applicable	Quantity	Unit	Unit rate code	Unit rate	Total cost	Notes
	1788675 iMpunzi Complex Closure Costs, as at February 2020								
	iMpunzi								
	Select View		Scheduled Closure						
	iMpunzi								
1	**Infrastructural Areas**								
1.1	**Dismantling of processing plant and related structures**								
1.1.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Dismantling of processing plant and related structures	S-curve						**R 0.00**	
1.2	**Demolition of steel buildings**								
1.2.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Demolition of steel buildings	S-curve						**R 0.00**	
1.3	**Demolition of other buildings and structures**								
1.3.1	Return water dam pumpstation								
	Steel building	S-curve	Yes	49	/m²	B1.2	R 739.99	R 36 259.51	Assume light to medium structure
	Concrete base	S-curve	Yes	49	/m2	A2.3	R 278.12	R 13 627.88	Assume 300 mm thick concrete
	Shaping and profiling disturbed areas to ensure they are free draining	S-curve	Yes	0.005	/ha	G1.1	R 83 212.71	R 407.74	
	Topsoil placement	S-curve	Yes	0.005	/ha	G1.4	R 133 848.00	R 655.86	Assum e 300 mm thick topsoil
	Sub-total for Demolition of other buildings and structures	0.00						**R 50 950.99**	
1.4	**Rehabilitation of roads and paved surfaces**								
1.4.1	Haul roads								
	Clean up coal contaminated material	S-curve	Yes	31621	/m3	H1.5	R 50.34	R 1 591 817.25	Assume contaminated material up to a thickness of 300 mm
	Dispose of coal contaminated material	S-curve	Yes	31621	/m3	H2.1.1	R 37.29	R 1 179 159.02	Dispose on the co-disposal facility. Assume 1 km distance
	Rehabilitation of road	S-curve	Yes	105404	/m2	E2	R 29.07	R 3 064 105.91	Assume 45 m width
	Sub-total for Rehabilitation of roads and paved surfaces	S-curve						**R 5 835 082.18**	
1.5	**Demolition and rehabilitation of railway lines**								
1.5.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Demolition and rehabilitation of railway lines	S-curve						**R 0.00**	
1.6	**Other linear Infrastructure**								
1.6.1	Concrete channels	S-curve	Yes	4816	/m3	A1.3	R 794.62	R 3 826 691.27	Around the Venture co-disposal facility .Assume 250 mm thick concrete
	Topsoil placement	S-curve	Yes	2	/ha	G1.4	R 133 848.00	R 257 831.40	Assum e 300 mm thick topsoil
1.6.2	Slurry pipelines	S-curve	Yes	1021.46	/m	D3.3	R 151.24	R 154 485.61	Assume overland steel pipelines from the plant to the co-disposal facility with a diameter of 500 mm
1.6.3	Returm water pipelines	S-curve	Yes	2917.88	/m	D3.3	R 151.24	R 441 300.17	Assume overland steel pipelines from the RWD to the underground with a diameter of 500 mm
	Sub-total for Other linear Infrastructure	S-curve						**R 4 680 308.45**	
1.7	**Disposal of demolition waste**								
1.7.1	Establish salvage yard	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
1.7.2	Construct decontamination bay	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
1.7.3	Sorting and screening of demolition waste	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
1.7.4	Concrete demolition waste								
	Decontamination of concrete	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Crushing of concrete demolition waste	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Transport of concrete demolition waste	S-curve	Yes	4830	/m3	M5	R 326.41	R 1 576 707.18	Transport demolishing waste to dedicated waste disposal site in Emalahleni (assume 20 km away)
	Disposal of demolition waste	S-curve	Yes	4830	/m3	G5.1.1	R 160.74	R 776 446.53	Cost for disposal at waste disposal site
1.7.5	Steel demolition waste								
	Decontamination of steel	S-curve	Yes	1	/sum	L2	R 36 259.51	R 36 259.51	Steel pipelines
	Transport of steel demolition waste	S-curve	Yes	15	/m3	M5	R 326.41	R 4 798.23	Transport demolishing waste to dedicated waste disposal site in Emalahleni (assume 40 km away)
	Disposal of demolition waste	S-curve	Yes	15	/m3	G5.1.1	R 160.74	R 2 362.88	Cost for disposal at waste disposal site
1.7.6	General demolition waste								
	Transport of waste to dedicated demolition waste disposal site	S-curve	Yes	0	/m3	M5	R 326.41	R 0.00	Transport demolishing waste to dedicated waste disposal site in Emalahleni (assume 20 km away)
	Disposal of demolition waste	S-curve	Yes	0	/m3	G5.1.1	R 160.74	R 0.00	Cost for disposal at waste disposal site
1.7.7	Hazardous waste								
	Transport of demolition hazardous waste	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Disposal of demolition hazardous waste	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Disposal of demolition waste	S-curve						**R 2 396 574.33**	
1.8	**Making good of infrastructure**								
1.8.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Making good of infrastructure	S-curve						**R 0.00**	
	Sub-total for Infrastructural Areas							**R 12 962 915.95**	
2	**Mining Areas**								
2.1	**Open pit rehabilitation including final voids and ramps**								
2.1.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Open pit rehabilitation including final voids and ramps	S-curve						**R 0.00**	
2.2	**Sealing of shafts, adits and inclines**								
2.2.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
	Sub-total for Sealing of shafts, adits and inclines	S-curve						**R 0.00**	
2.3	**Rehabilitation of stockpiles and processing residues**								
2.3.1	**Venture co-disposal facility**								
	Shape the top surface	S-curve	Yes	78	/ha	G1.3	R 195 195.00	R 15 149 162.03	Assume the side slope to be shaped operationally.
	Compact the top surface	S-curve	Yes	194026	/m3	H5.1	R 28.14	R 5 459 891.64	Assume 250 mm compaction
	Placement of a soil layer to cap the facility	S-curve	Yes	515249	/m3	H2.1.1	R 37.29	R 19 213 636.70	Assume dump height of 20 m from the top to toe, and a perimeter length = 4132m. Assume placement of 600 mm thick soil layer on the top surface and side slopes
2.3.1	**Atcom South Pit Coarse discard dump**								
	Shape the top surface	S-curve	Yes	128.5	/ha	G1.3	R 195 195.00	R 25 082 557.50	Assume the side slope to be shaped operationally
	Compact the top surface	S-curve	Yes	321250	/m3	H5.1	R 28.14	R 9 039 975.00	Assume 250 mm compaction
	Placement of a soil layer to cap the facility	S-curve	Yes	848784	/m3	H2.1.1	R 37.29	R 31 651 159.83	Assume dump height of 30 m from the top to toe, and a perimeter length = 4321 m. Assume placement of 600 mm thick soil layer on the top surface and side slopes
	Decommission borehole	S-curve	Yes	1	sum	G3.6.2	R 17 031.17	R 17 031.17	Assume full depth plug(approximately 35 m deep)
2.3.2	**Low lying area south of the Atcom South Pit Coarse discard dump**								
	In-fill the low lying areas	S-curve	Yes	59271	/m3	H2.2.1	R 29.91	R 1 772 795.61	Assume L& H distance of 1km
	Shape to be free draining	S-curve	Yes	59271	/m3	G1.6	R 12.57	R 745 036.47	

1788675 iMpunzi Complex Closure Costs, as at February 2020										
iMpunzi										
Ref.		Closure Component (Select View)	Cash flowed costs expensed method	Scheduled Closure						
				Applicable	Quantity	Unit	Unit rate code	Unit rate	Total cost	Notes
		Sub-total for Rehabilitation of stockpiles and processing residues	0.00						R 108 131 245.95	
	2.4	**Rehabilitation of clean water empoundments**								
	2.4.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-total for Rehabilitation of clean water empoundments	S-curve						R 0.00	
	2.5	**Rehabilitation of dirty water empoundments**								
	2.5.1	**Venture co-disposal return water dam**	S-curve							
		Clean up of contaminated sediments	S-curve	Yes	12000	/m3	H1.5	R 50.34	R 604 080.00	Contaminated sediments up to a depth of 300 mm
		Clean up of contaminated soils	S-curve	Yes	12000	/m3	H1.5	R 50.34	R 604 080.00	Contaminated soils up to a depth of 300 mm
		Dispose contaminated material	S-curve	Yes	12000	/m3	H2.1.1	R 37.29	R 447 480.00	Dispose on the co-disposal facility. Assume 1 km distance
		Remove HDPE liner	S-curve	Yes	40000	/m2	F2.2	R 7.82	R 312 800.00	Removal and disposal of the HDPE liner
		Breach dam wall	S-curve	Yes	788	/m	G1.8	R 786.11	R 619 478.26	Assume perimeter length = 788 m
		Topsoil placement	S-curve	Yes	4	/ha	G1.4	R 133 848.00	R 535 392.00	Assum e 300 mm thick topsoil
		Shaping and profiling disturbed areas to ensure they are free draining	S-curve	Yes	4	/ha	G1.1	R 83 212.71	R 332 850.84	
		Sub-total for Rehabilitation of dirty water empoundments	S-curve						R 3 456 161.10	
	2.6	**Rehabilitation of subsided areas**								
	2.6.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-total for Rehabilitation of subsided areas	S-curve						R 0.00	
		Sub-total for Mining Areas							R 111 587 407.06	
	3	**General Surface Rehabilitation**								
	3.1	**Infrastructural Areas**								
	3.1.1	**Venture co-disposal facility**								
		Ripping to alleviate compaction	S-curve	Yes	86	/ha	H3.3	R 3 609.32	R 309 949.78	Side slopes and top surface
		Establish vegetation on the top surface and side slopes	S-curve	Yes	86	/ha	G2.2.5	R 43 192.01	R 3 709 106.95	Side slopes and top surface
	3.1.2	**Atcom South Pit Coarse discard dump**								
		Ripping to alleviate compaction	S-curve	Yes	141	/ha	H3.3	R 3 609.32	R 510 588.92	Side slopes and top surface
		Establish vegetation on the top surface and side slopes	S-curve	Yes	141	/ha	G2.1.5	R 37 558.27	R 5 313 143.86	Side slopes and top surface
	3.1.3	**Low lying area south of the Atcom South Pit Coarse discard dump**								
		Ripping to alleviate compaction	S-curve	Yes	0.13	/ha	H3.3	R 3 609.32	R 462.71	
		Establish vegetation	S-curve	Yes	0.13	/ha	G2.1.1	R 49 418.78	R 6 335.49	
	3.1.4	**Return water dam pumpstation**								
		Ripping to alleviate compaction	S-curve	Yes	0.005	/ha	H3.3	R 3 609.32	R 17.69	
		Establish vegetation over rehabilitated areas	S-curve	Yes	0.005	/ha	G2.1	R 37 558.27	R 184.04	
	3.1.5	**Concrete channels**								
		Ripping to alleviate compaction	S-curve	Yes	2	/ha	H3.3	R 3 609.32	R 6 952.63	
		Establish vegetation	S-curve	Yes	2	/ha	G2.1.1	R 49 418.78	R 95 195.40	
	3.1.6	**Venture co-disposal return water dam**								
		Ripping to alleviate compaction	S-curve	Yes	4	/ha	H3.3	R 3 609.32	R 14 437.28	
		Establish vegetation	S-curve	Yes	4	/ha	G2.1.1	R 49 418.78	R 197 675.12	
		Sub-total for Infrastructural Areas	0.00						R 10 164 049.85	
	3.2	**Other surface disturbances**								
	3.2.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-total for Other surface disturbances	S-curve						R 0.00	
		Sub-total for General Surface Rehabilitation							R 10 164 049.85	
	4	**Surface Water Reinstatement**								
	4.1	**River diversions and watercourse reinstatement**								
	4.1.1	Not applicable	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-total for River diversions and watercourse reinstatement	S-curve						R 0.00	
	4.2	**Reinstatement of drainage lines**								
	4.2.1	Drainage lines	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-total for Reinstatement of drainage lines	S-curve						R 0.00	
		Sub-total for Surface Water Reinstatement							R 0.00	
		Sub-Total 1 (for infrastructure and related aspects)							R 134 714 372.86	
	5	**P&Gs, Contingencies and Additional Allowances**								
	5.1	Preliminaries and general	S-curve	Yes	25	/sum	L2	R 33 678 593.21	R 33 678 593.21	Assumed 25 % of Sub-total 1
	5.2	Contingencies	S-curve	Yes	10	/sum	L2	R 13 471 437.29	R 13 471 437.29	Assumed 10 % of Sub-total 1
	5.3	Additional studies	S-curve	No	0	N/A	L1	R 0.00	R 0.00	
		Sub-Total 2 (for Additional Allowances)	S-curve						R 47 150 030.50	
	6	**Pre-site Relinquishment Monitoring and Aftercare**								
	6.1	Surface water quality monitoring	S-curve	Yes	5	/yr	K1	R 352 556.06	R 1 762 780.30	
	6.2	Groundwater quality monitoring	S-curve	Yes	5	/yr	K2	R 156 906.45	R 784 532.25	
	6.3	Rehabilitation monitoring of rehabilitated areas	S-curve	Yes	244	ha/5yrs	J1	R 2 482.79	R 605 648.56	
	6.4	Care and maintenance of rehabilitated areas	S-curve	Yes	244	ha/5yrs	J2	R 35 711.35	R 8 711 380.29	
	6.5	Contingencies for post-closure aspects	S-curve	No	0	/sum	L2	R 1 186 434.14	R 0.00	
		Sub-Total 3 (for Post-Closure aspects)	S-curve						R 11 864 341.41	
		Grand Total Excl. VAT. (for Sub-total 1 +2 +3)							R 193 728 744.77	

APPENDIX B

Document Limitations

DOCUMENT LIMITATIONS

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i) This Document has been prepared for the particular purpose outlined in Golder's proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

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APPENDIX M

DEA Environmental Screening Tool

SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION OR FOR A PART TWO AMENDMENT OF AN ENVIRONMENTAL AUTHORISATION AS REQUIRED BY THE 2014 EIA REGULATIONS – PROPOSED SITE ENVIRONMENTAL SENSITIVITY

EIA Reference number: MP30/5/1/2/3/2/1/ (375) EM

Project name: iMpunzi Complex IRP

Project title: Proposed iMpunzi Haul Road

Date screening report generated: 07/11/2019 13:17:39

Applicant: Glencore Operations South Africa (Pty) Ltd

Compiler: Golder Associates Africa (Pty) Ltd

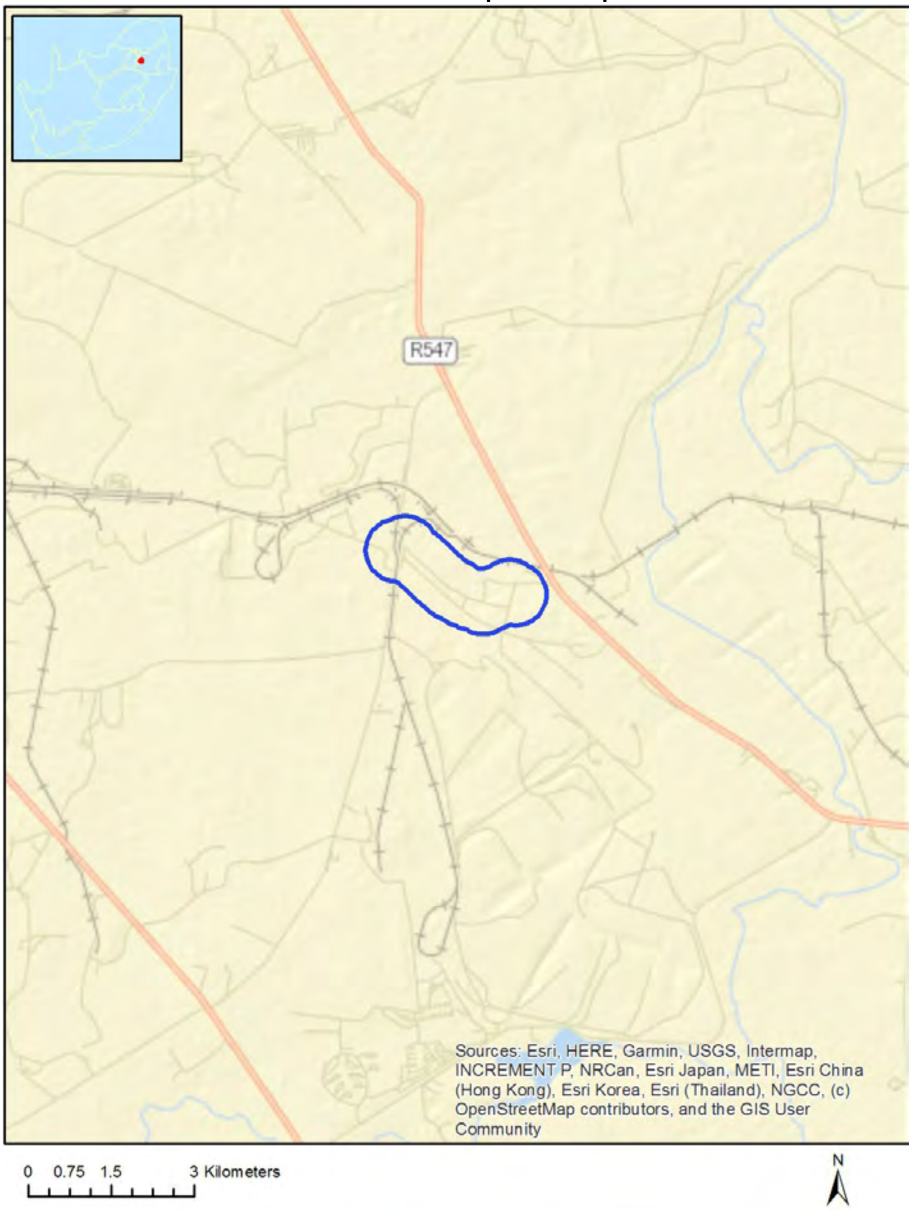
Compiler signature: ……………………………………………………………………………………………

Table of Contents

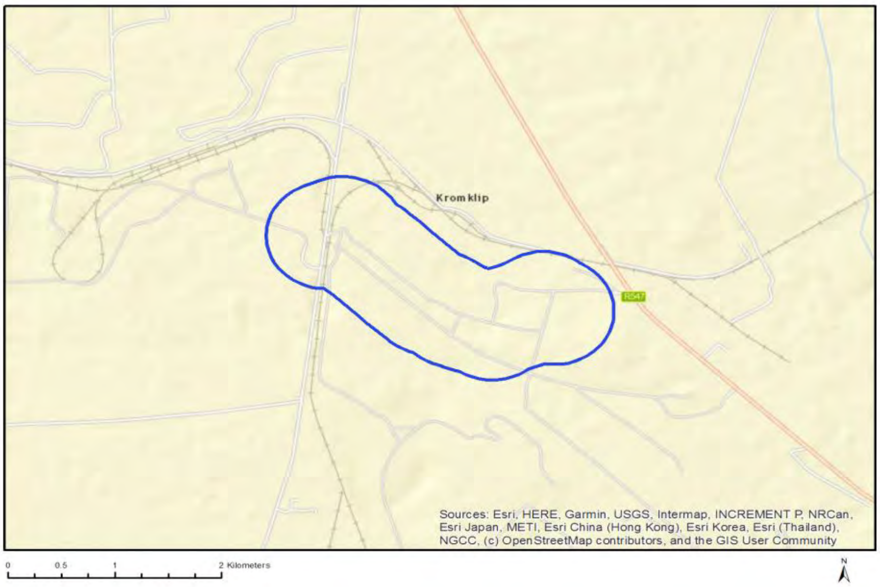
Proposed Project Location

Orientation map 1: General location

General Orientation: iMpunzi Complex IRP



Map of proposed site and relevant area(s)



Cadastral details of the proposed site

Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	KLIPPLAAT	462	0	26°5'37.89S	29°11'51.06E	Farm
2	KROMFONTEIN	30	0	26°6'37.26S	29°14'21.01E	Farm
3	KLIPPLAAT	14	0	26°3'51.92S	29°12'5.58E	Farm
4	BLESBOKFONTEIN	31	0	26°6'47.58S	29°9'51.06E	Farm
5	HARTBEESTFONTEIN	39	0	26°7'49.29S	29°12'37.05E	Farm
6	KROMFONTEIN	30	36	26°6'0.73S	29°13'1.42E	Farm Portion
7	KROMFONTEIN	30	1	26°5'37.53S	29°12'58.35E	Farm Portion
8	KROMFONTEIN	30	19	26°6'5.85S	29°12'53.95E	Farm Portion
9	KROMFONTEIN	30	32	26°5'49.69S	29°12'20.75E	Farm Portion
10	KROMFONTEIN	30	5	26°6'35.49S	29°13'3.54E	Farm Portion
11	KLIPPLAAT	462	0	26°5'37.89S	29°11'51.06E	Farm Portion
12	HARTBEESTFONTEIN	39	0	26°6'49.79S	29°12'9.15E	Farm Portion
13	KROMFONTEIN	30	11	26°6'5.37S	29°12'26.18E	Farm Portion
14	KROMFONTEIN	30	37	26°5'54.81S	29°12'31.09E	Farm Portion
15	KLIPPLAAT	14	14	26°5'14.59S	29°11'29.21E	Farm Portion
16	BLESBOKFONTEIN	31	0	26°6'49.82S	29°9'49.65E	Farm Portion

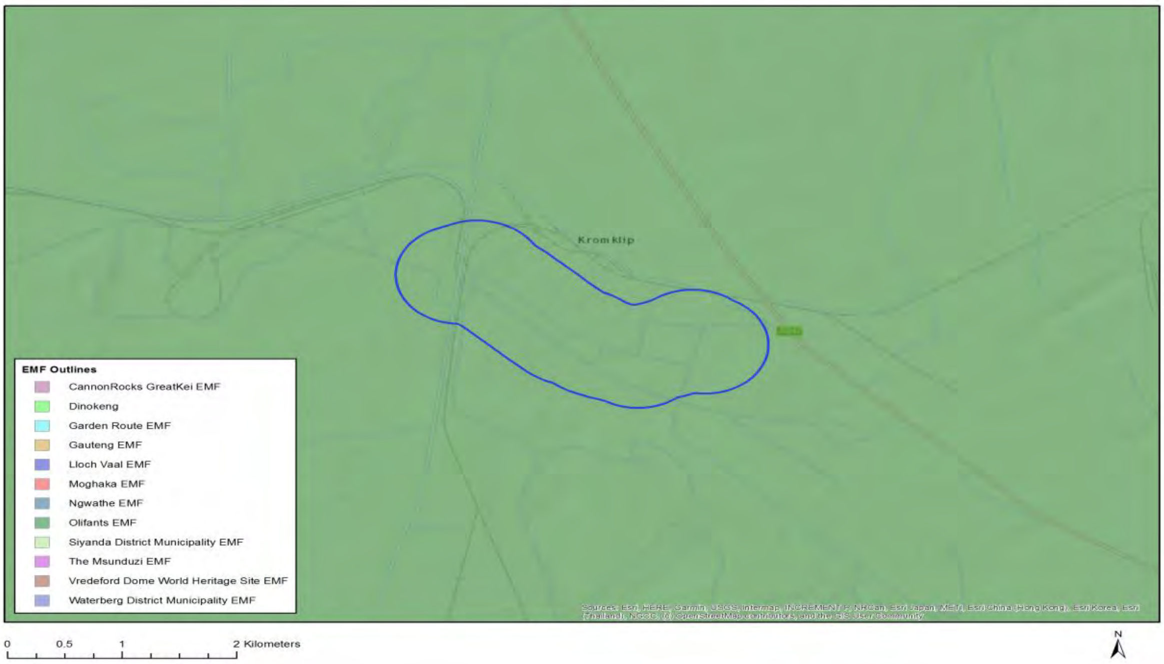
Development footprint[1] vertices:
No development footprint(s) specified.

[1] "development footprint", means the area within the site on which the development will take place and incudes all ancillary developments for example roads, power lines, boundary walls, paving etc. which require vegetation clearance or which will be disturbed and for which the application has been submitted.

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	14/12/16/3/3/2/759	Solar PV	Approved	20.7

Environmental Management Frameworks relevant to the application



Environmental Management Framework	LINK
Olifants EMF	https://screening.environment.gov.za/ScreeningDownloads/EMF/Zone_46,_67,_78,_80,_92,_103,_122,_129.pdf

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development site as well as the most environmental sensitive features on the site based on the site sensitivity screening results for the application classification that was selected. The application classification selected for this report is: Mining|Mining Right|Mining - Mining Right.

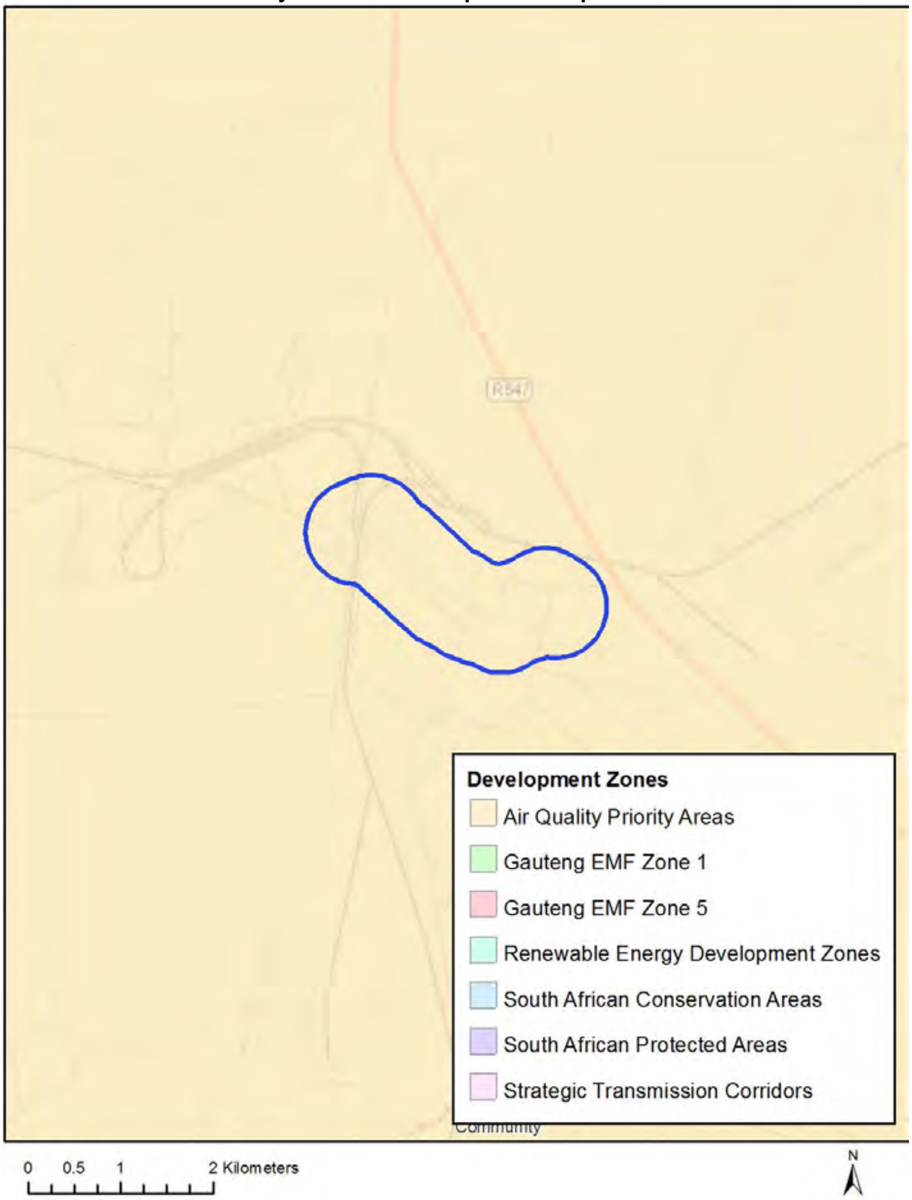
Relevant development incentives, restrictions, exclusions or prohibitions

The following development incentives, restrictions, exclusions or prohibitions and their implications that apply to this site are indicated below.

Incentive, restriction or prohibition	Implication
Strategic Transmission Corridor-International corridor	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/GNR_350_of_13_April_2017.pdf
Air Quality-Highveld Priority Area	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/HIGHVELD_PRIORITY_AREA_AQMP.pdf

Map indicating proposed development footprint within applicable development incentive, restriction, exclusion or prohibition zones

Project Location: iMpunzi Complex IRP



Proposed Development Area Environmental Sensitivity

The following summary of the development site environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme		X		
Aquatic Biodiversity Theme				X

Archaeological and Cultural Heritage Theme		X		
Civil Aviation Theme		X		
Plant Species Theme			X	
Defence Theme				X
Terrestrial Biodiversity Theme	X			

Specialist assessments identified

Based on the selected classification, and the environmental sensitivities of the proposed development footprint, the following list of specialist assessments have been identified for inclusion in the assessment report. It is the responsibility of the EAP to confirm this list and to motivate in the assessment report, the reason for not including any of the identified specialist study including the provision of photographic evidence of the site situation.

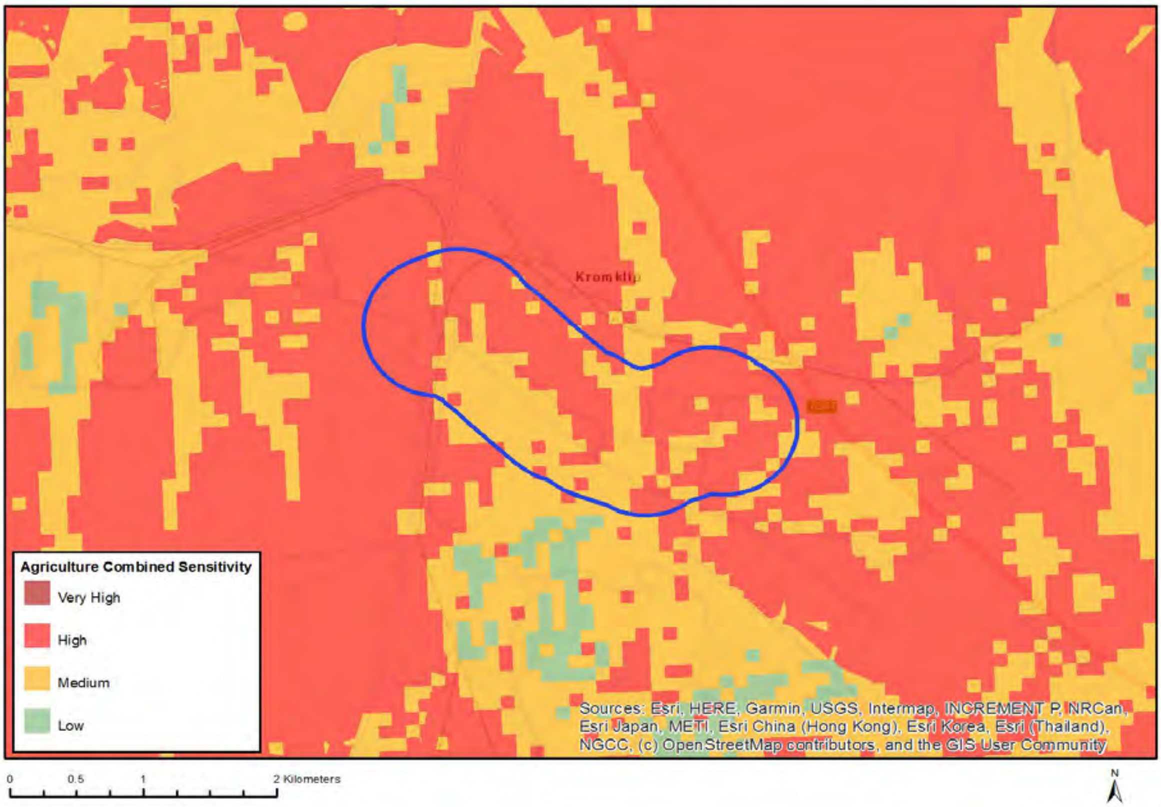
No	Specialist assessment	Assessment Protocol
1	Agricultural Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Agriculture_Assessment_Protocols.pdf
2	Landscape/Visual Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
3	Archaeological and Cultural Heritage Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
4	Palaeontology Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
5	Terrestrial Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Terrestrial_Biodiversity_Assessment_Protocols.pdf
6	Aquatic Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Aquatic_Biodiversity_Assessment.pdf
7	Hydrology Assessm	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf

	ent	
8	Noise Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Noise_Impacts_Assessment_Protocols.pdf
9	Radioactivity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
10	Traffic Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
11	Geotechnical Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
12	Climate Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
13	Health Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
14	Socio-Economic Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
15	Ambient Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
16	Seismicity Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
17	Plant Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
18	Animal Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf

Results of the environmental sensitivity of the proposed area.

The following section represents the results of the screening for environmental sensitivity of the proposed site for relevant environmental themes associated with the project classification. It is the duty of the EAP to ensure that the environmental themes provided by the screening tool are comprehensive and complete for the project. Refer to the disclaimer.

MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY

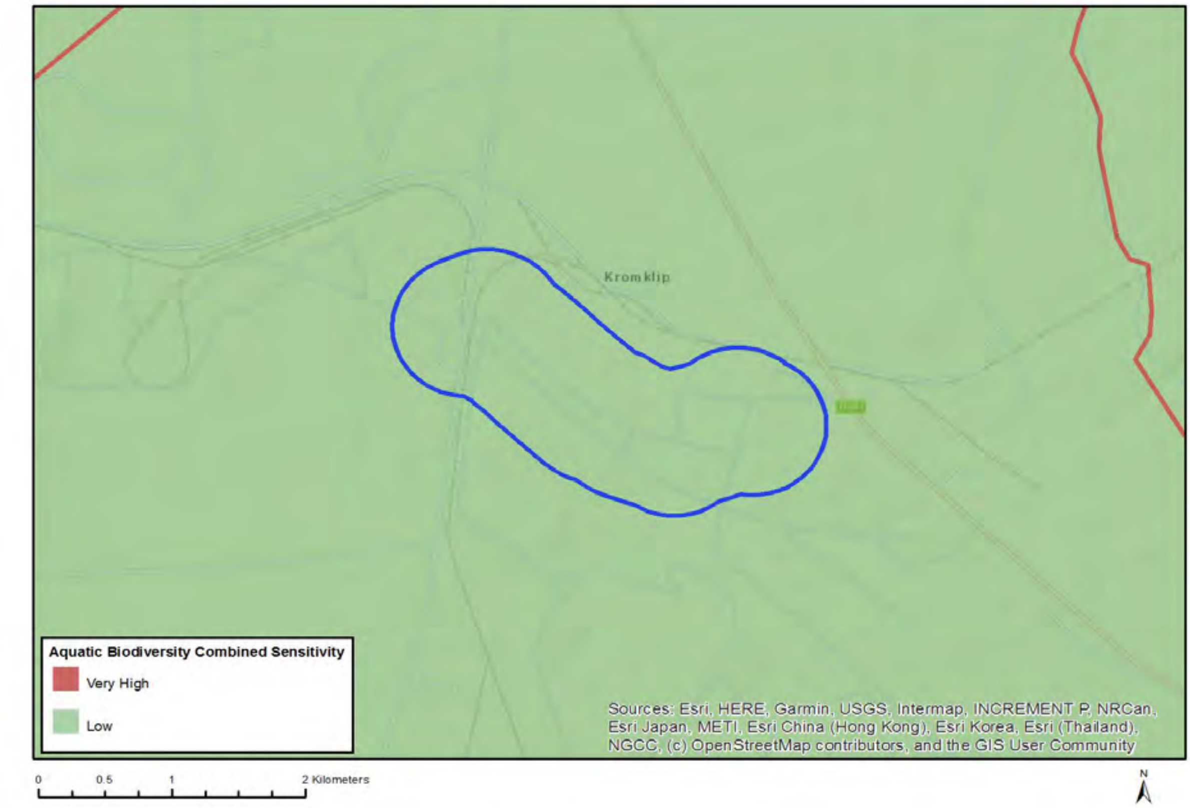


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Land capability;09. Moderate-High/10. Moderate-High
High	Old Fields;Land capability;09. Moderate-High/10. Moderate-High
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY



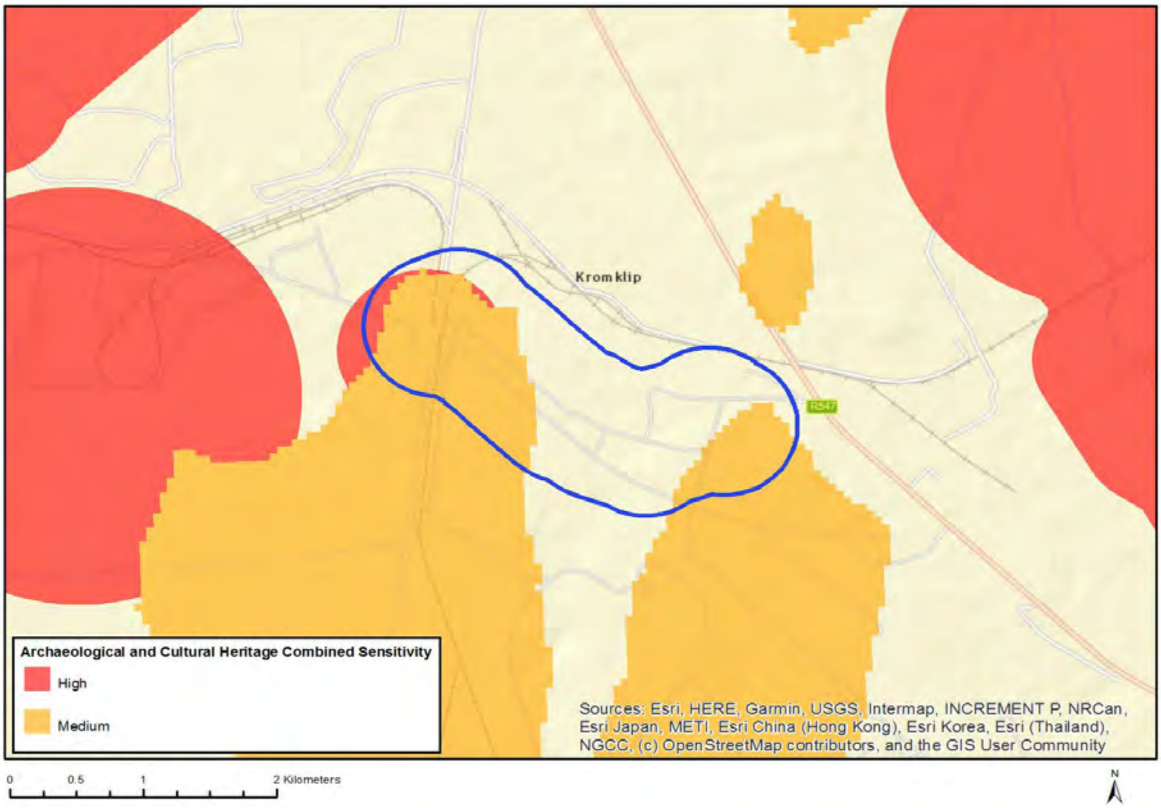
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity Areas

07/11/2019

MAP OF RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY

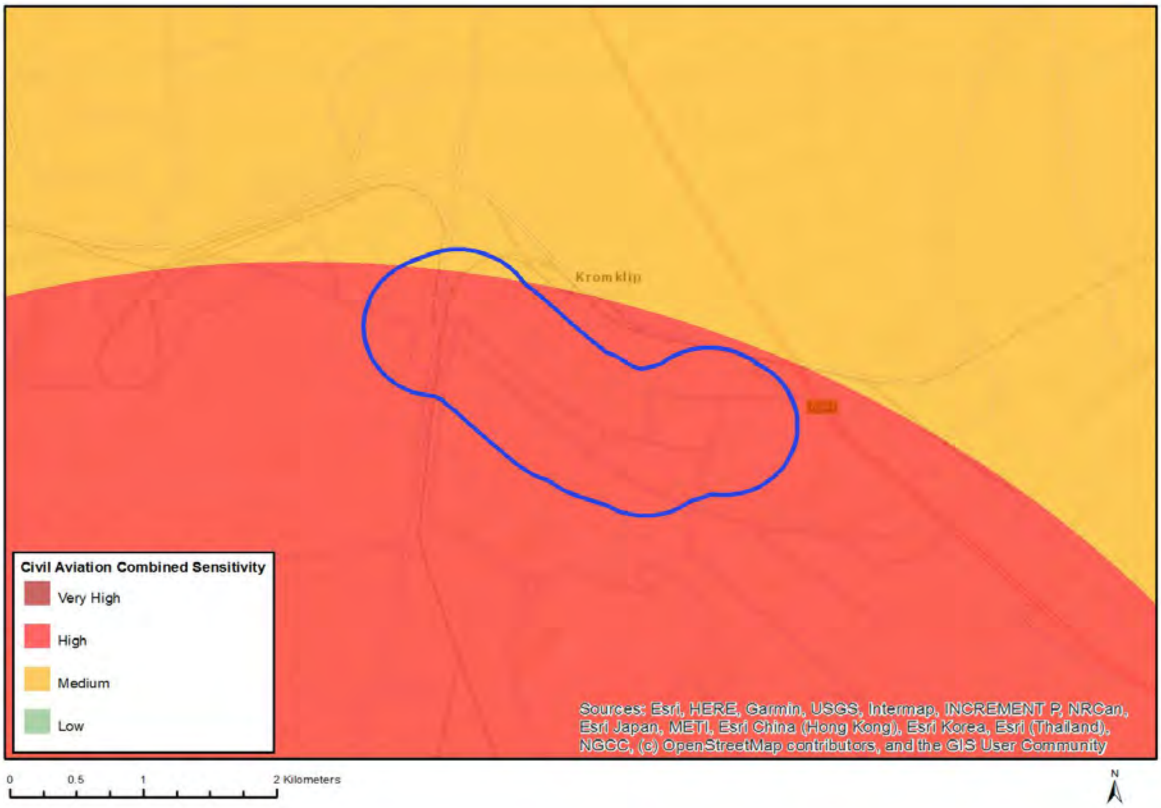


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Within an important wetland
High	Within 500 m of an important wetland
Medium	Mountain or ridge

MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY

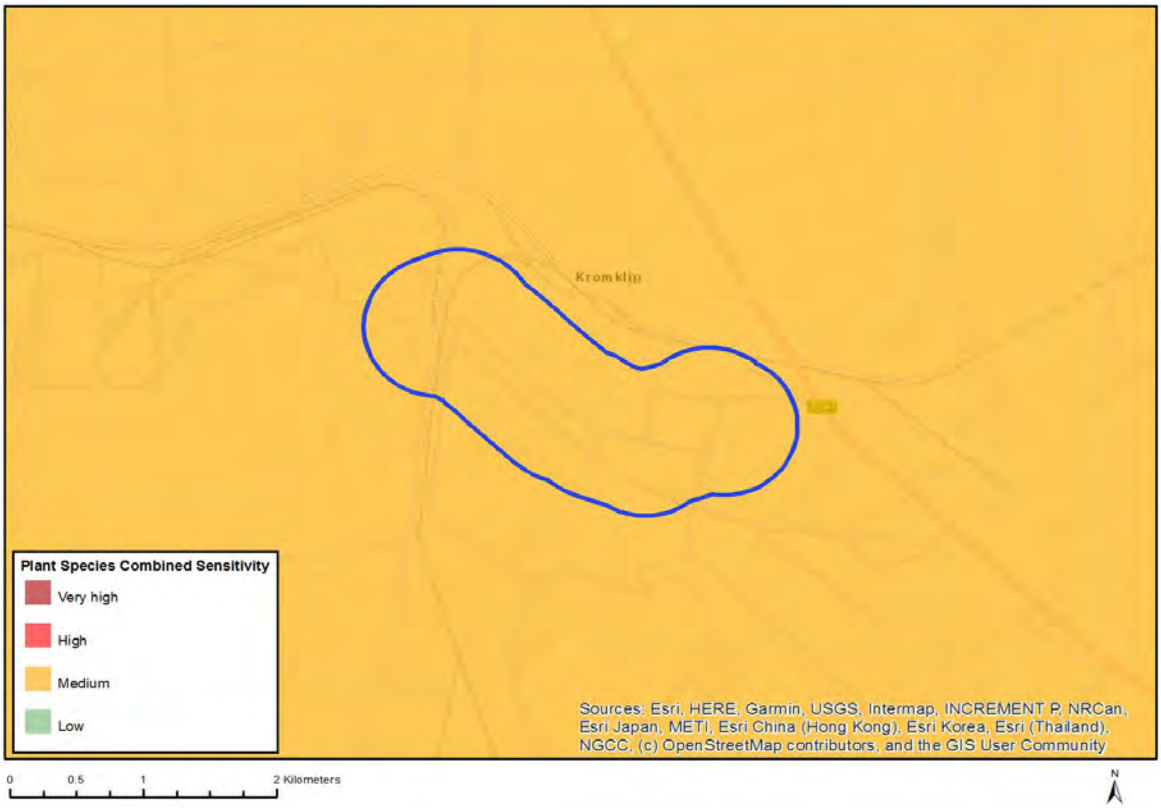


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Within 8 km of other civil aviation aerodrome
Medium	Between 8 and 15 km of other civil aviation aerodrome

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY

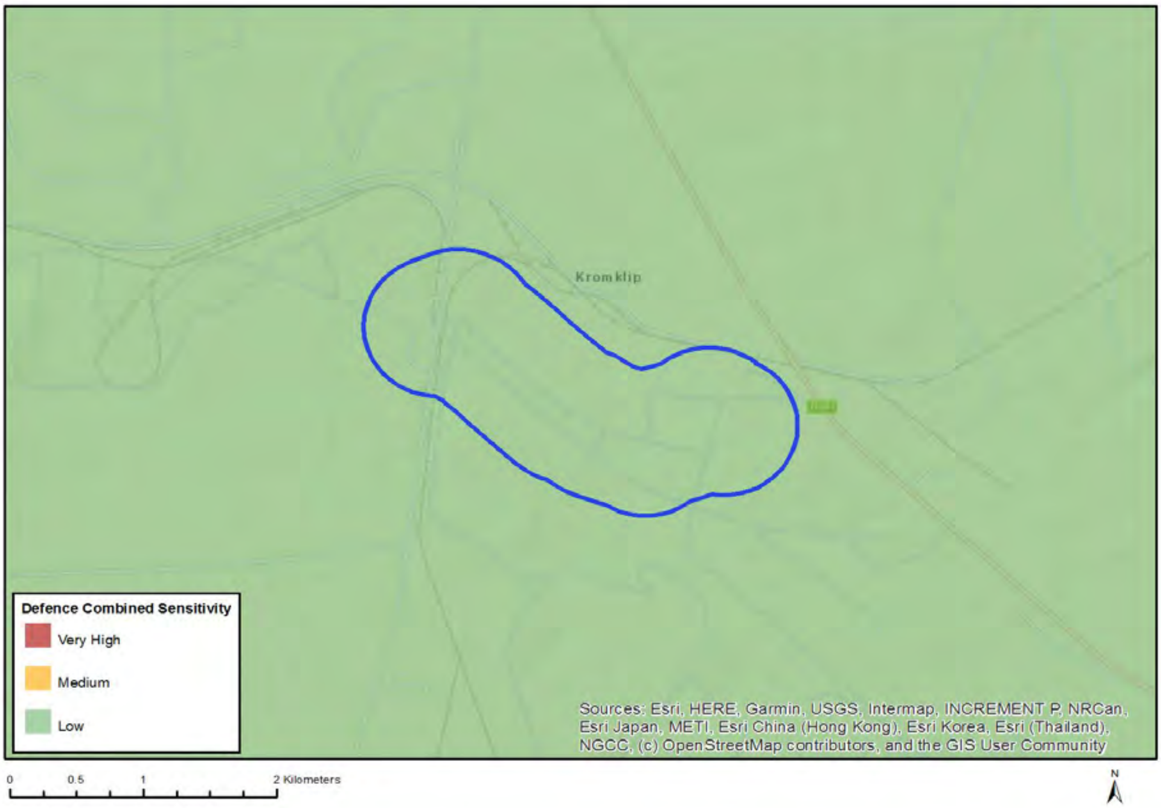


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Sensitive species 411
Medium	Sensitive species 455
Medium	Sensitive species 647
Medium	Pachycarpus suaveolens
Medium	Brachycorythis conica subsp. transvaalensis

MAP OF RELATIVE DEFENCE THEME SENSITIVITY

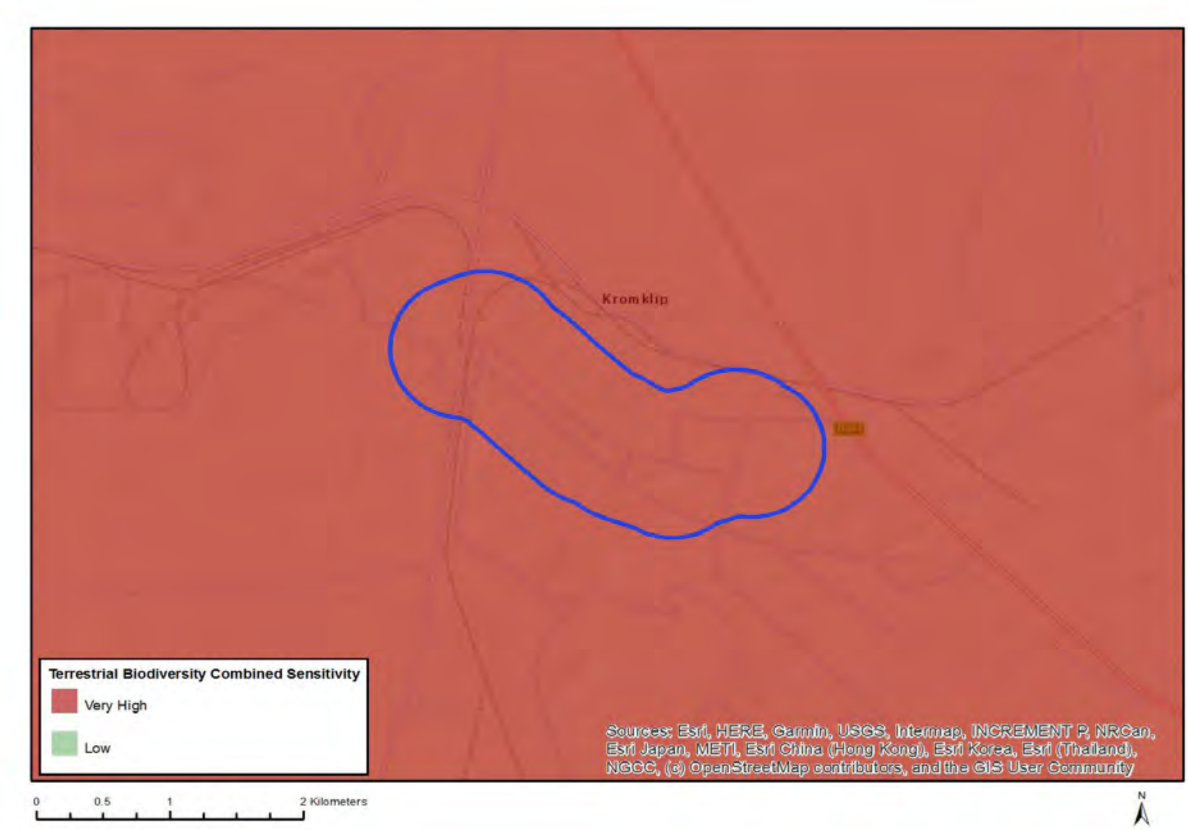


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Very High	Vulnerable ecosystem

SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION OR FOR A PART TWO AMENDMENT OF AN ENVIRONMENTAL AUTHORISATION AS REQUIRED BY THE 2014 EIA REGULATIONS – PROPOSED DEVELOPMENT FOOTPRINT ENVIRONMENTAL SENSITIVITY

EIA Reference number: MP30/5/1/2/3/2/1/ (375)EM

Project name: iMpunzi Complex IRP

Project title: Proposed iMpunzi South Pit Coarse Discard Facility

Date screening report generated: 23/10/2019 11:29:06

Applicant: Glencore Operations South Africa (Pty) Ltd

Compiler: Golder Associates Africa (Pty) Ltd

Compiler signature: ....

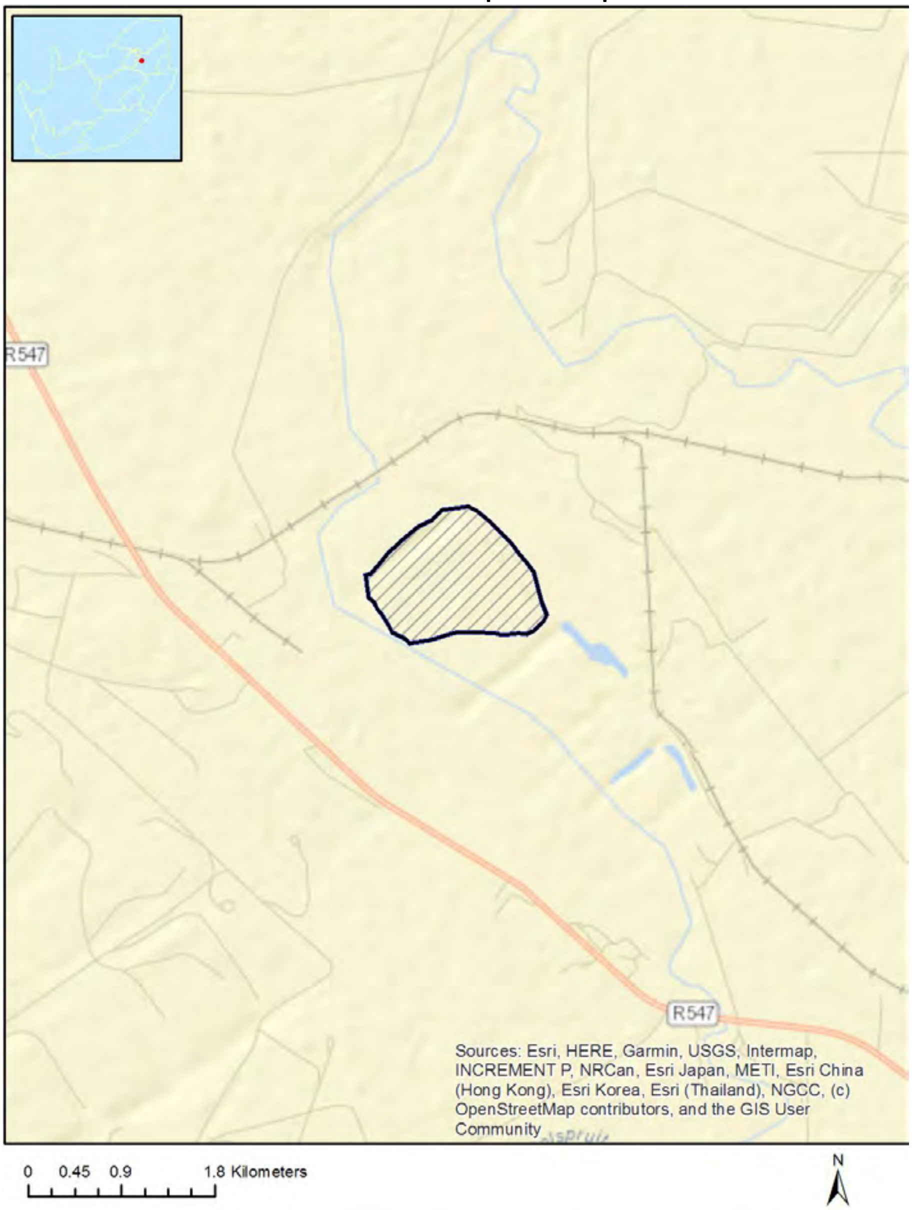
Mariëtte Weideman
Environmental Consultant
GOLDER

Table of Contents

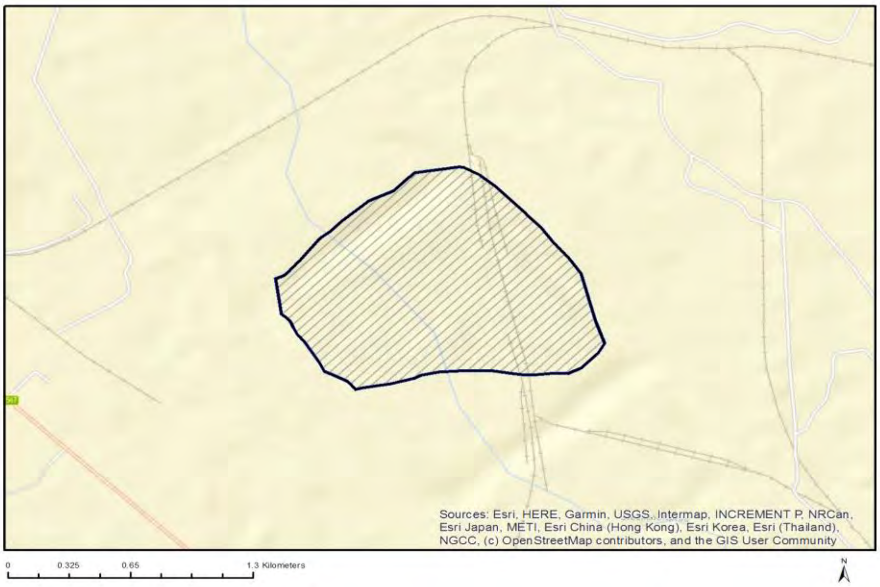
Proposed Project Location

Orientation map 1: General location

General Orientation: iMpunzi Complex IRP



Map of proposed site and relevant area(s)



Cadastral details of the proposed site

Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	KROMFONTEIN	30	0	26°6'37.26S	29°14'21.01E	Farm
2	KROMFONTEIN	30	23	26°6'8.35S	29°15'0.13E	Farm Portion
3	KROMFONTEIN	30	2	26°6'39.91S	29°15'32.26E	Farm Portion
4	KROMFONTEIN	30	12	26°6'26.84S	29°14'57.21E	Farm Portion
5	KROMFONTEIN	30	28	26°7'3.73S	29°14'26.16E	Farm Portion
6	KROMFONTEIN	30	3	26°5'52.46S	29°15'2.6E	Farm Portion
7	KROMFONTEIN	30	22	26°6'22.27S	29°15'10.64E	Farm Portion
8	KROMFONTEIN	30	14	26°6'26.03S	29°15'2.7E	Farm Portion
9	KROMFONTEIN	30	20	26°5'55.1S	29°14'55.65E	Farm Portion
10	KROMFONTEIN	30	2	26°6'22.81S	29°14'52.25E	Farm Portion
11	KROMFONTEIN	30	3	26°6'0.19S	29°14'19.15E	Farm Portion

Development footprint[1] vertices:

Footprint	Latitude	Longitude
1	26°6'16.03S	29°14'21.11E
1	26°6'9.92S	29°14'20.2E
1	26°6'9.33S	29°14'21.73E
1	26°6'6.52S	29°14'24.49E
1	26°6'2.9S	29°14'27.71E
1	26°6'1.59S	29°14'29.72E
1	26°5'59.73S	29°14'31.77E
1	26°5'56.4S	29°14'36.14E

[1] "development footprint", means the area within the site on which the development will take place and incudes all ancillary developments for example roads, power lines, boundary walls, paving etc. which require vegetation clearance or which will be disturbed and for which the application has been submitted.

1	26°5'54.62S	29°14'40.5E
1	26°5'53.01S	29°14'42.28E
1	26°5'51.55S	29°14'44.03E
1	26°5'50.59S	29°14'51.49E
1	26°5'50.61S	29°14'51.94E
1	26°5'50.64S	29°14'52.49E
1	26°5'51.92S	29°14'55.06E
1	26°5'54.08S	29°14'58.1E
1	26°5'58.71S	29°15'3.22E
1	26°6'1.2S	29°15'5.82E
1	26°6'3.54S	29°15'7.77E
1	26°6'6.33S	29°15'10.49E
1	26°6'9.04S	29°15'12.59E
1	26°6'17.15S	29°15'15.1E
1	26°6'21.12S	29°15'16.59E
1	26°6'22.87S	29°15'15.47E
1	26°6'25.46S	29°15'12.47E
1	26°6'26.35S	29°15'10.38E
1	26°6'26.27S	29°15'8.63E
1	26°6'26.28S	29°15'7.25E
1	26°6'26.48S	29°15'5.16E
1	26°6'26.55S	29°15'3.12E
1	26°6'26.29S	29°15'0.81E
1	26°6'25.87S	29°14'57.61E
1	26°6'25.81S	29°14'53.1E
1	26°6'26.03S	29°14'48.22E
1	26°6'26.6S	29°14'45.22E
1	26°6'27.12S	29°14'44.02E
1	26°6'28.06S	29°14'39.88E
1	26°6'28.54S	29°14'36.83E
1	26°6'28.83S	29°14'35.07E
1	26°6'29.06S	29°14'33.91E
1	26°6'27.73S	29°14'32.55E
1	26°6'26.7S	29°14'30.28E
1	26°6'25.98S	29°14'28.59E
1	26°6'24.29S	29°14'27.6E
1	26°6'22.59S	29°14'26.34E
1	26°6'20.82S	29°14'25.06E
1	26°6'19.61S	29°14'23.89E
1	26°6'18.45S	29°14'23.25E
1	26°6'17.37S	29°14'22.69E
1	26°6'16.73S	29°14'22.08E
1	26°6'16.41S	29°14'21.64E
1	26°6'16.03S	29°14'21.11E

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	14/12/16/3/3/2/759	Solar PV	Approved	18.6

Environmental Management Frameworks relevant to the application

Environmental Management Framework	LINK
Olifants EMF	https://screening.environment.gov.za/ScreeningDownloads/EMF/Zone_46,_67,_78,_80,_92,_103,_122,_129.pdf

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development footprint as well as the most environmental sensitive features on the footprint based on the footprint sensitivity screening results for the application classification that was selected. The application classification selected for this report is:
Mining|Mining|Beneficiation|Hydrocarbon|Beneficiation - Hydrocarbon.

Relevant development incentives, restrictions, exclusions or prohibitions

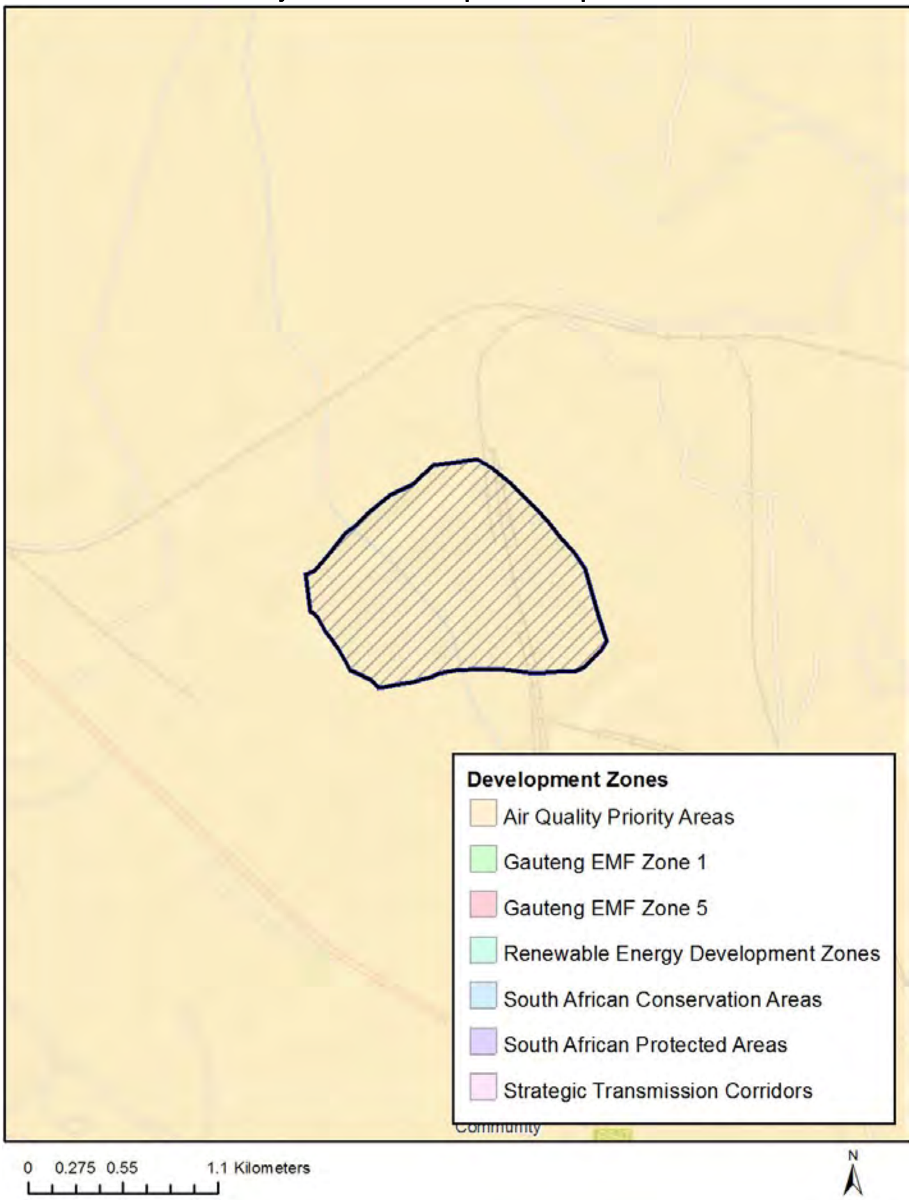
The following development incentives, restrictions, exclusions or prohibitions and their implications that apply to this footprint are indicated below.

Incentive, restriction or prohibi	Implication

tion	
Strategic Transmission Corridor-International corridor	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/GNR_350_of_13_April_2017.pdf
Air Quality-Highveld Priority Area	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/HIGHVELD_PRIORITY_AREA_AQMP.pdf

Map indicating proposed development footprint within applicable development incentive, restriction, exclusion or prohibition zones

Project Location: iMpunzi Complex IRP



Proposed Development Area Environmental Sensitivity

The following summary of the development footprint environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme		X		
Aquatic Biodiversity Theme	X			
Archaeological and Cultural Heritage Theme		X		
Civil Aviation Theme			X	
Plant Species Theme			X	
Defence Theme				X
Terrestrial Biodiversity Theme	X			

Specialist assessments identified

Based on the selected classification, and the environmental sensitivities of the proposed development footprint, the following list of specialist assessments have been identified for inclusion in the assessment report. It is the responsibility of the EAP to confirm this list and to motivate in the assessment report, the reason for not including any of the identified specialist study including the provision of photographic evidence of the footprint situation.

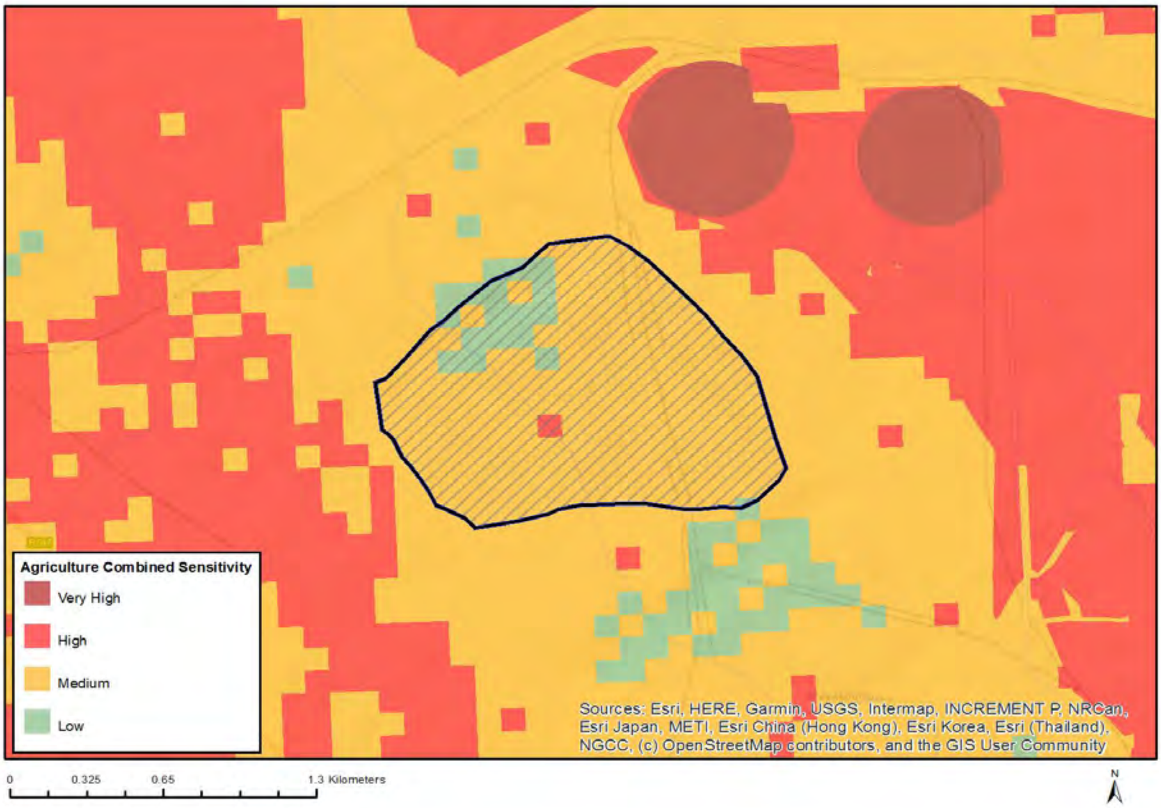
No	Specialist assessment	Assessment Protocol
1	Agricultural Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Agriculture_Assessment_Protocols.pdf
2	Archaeological and Cultural Heritage Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
3	Palaeontology Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
4	Terrestrial Biodiv	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Terrestrial_Biodiversity_Assessment_Protocols.pdf

	ersity Impact Assessment	
5	Aquatic Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Aquatic_Biodiversity_Assessment.pdf
6	Hydrology Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
7	Noise Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Noise_Impacts_Assessment_Protocols.pdf
8	Traffic Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
9	Geotechnical Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
10	Climate Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
11	Health Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
12	Socio-Economic Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
13	Ambient Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
14	Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/Assessment/General/Appendix6.pdf
15	Plant Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
16	Animal Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf

Results of the environmental sensitivity of the proposed area.

The following section represents the results of the screening for environmental sensitivity of the proposed footprint for relevant environmental themes associated with the project classification. It is the duty of the EAP to ensure that the environmental themes provided by the screening tool are comprehensive and complete for the project. Refer to the disclaimer.

MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY

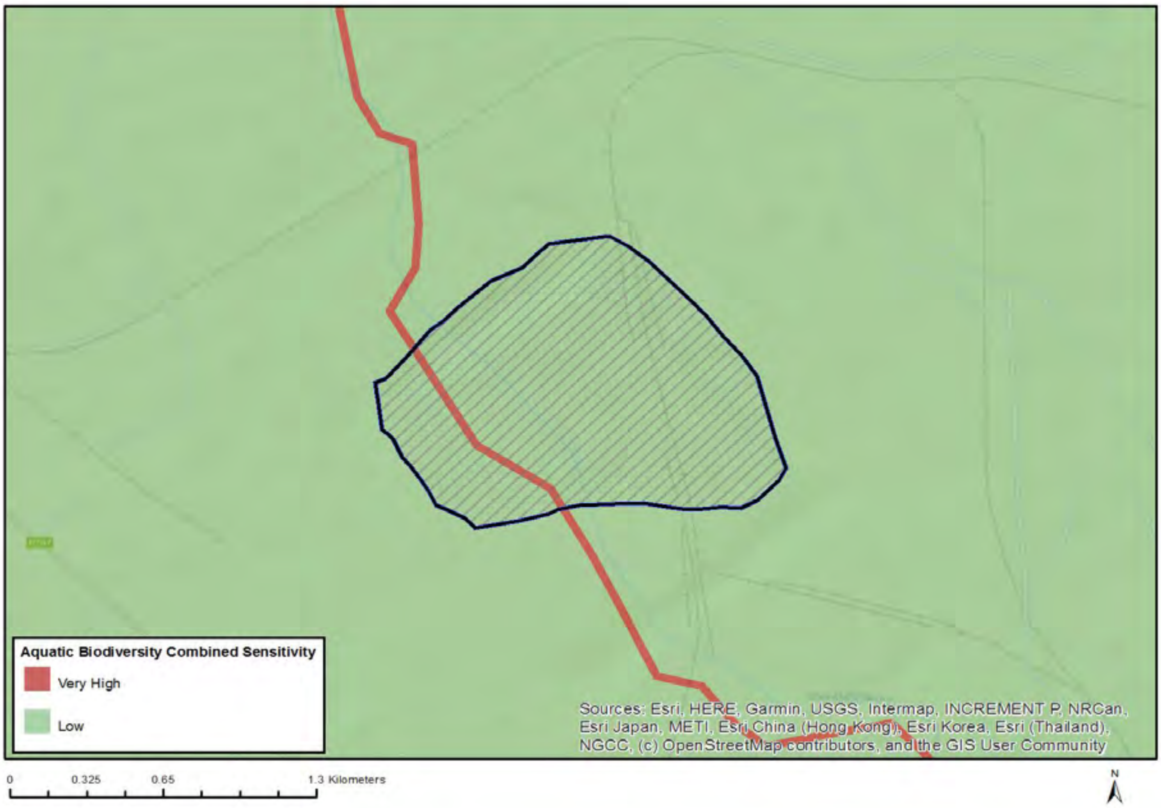


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Land capability;09. Moderate-High/10. Moderate-High
Low	Land capability;01. Very low/02. Very low/03. Low-Very low/04. Low-Very low/05. Low
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY



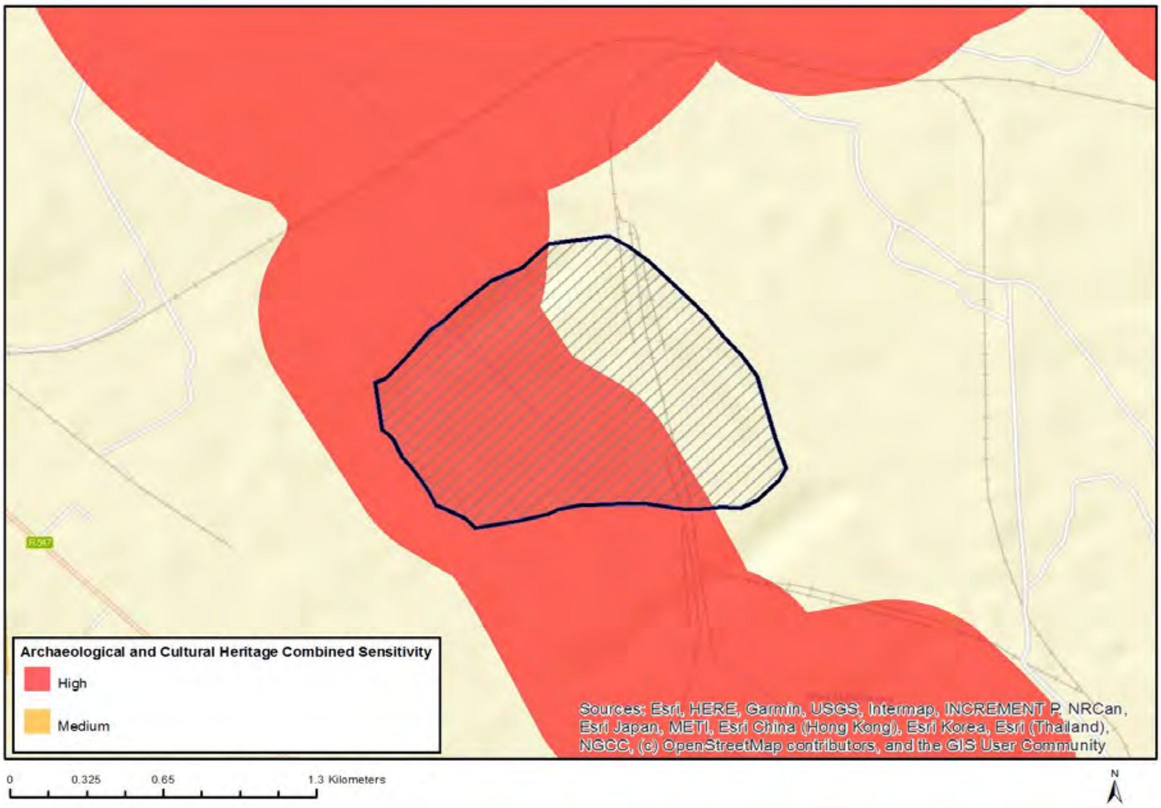
Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity Areas
Very High	CBA,River,Steenkoolspruit

23/10/2019

MAP OF RELATIVE ARCHAEOLOGICAL AND CULTURAL HERITAGE THEME SENSITIVITY

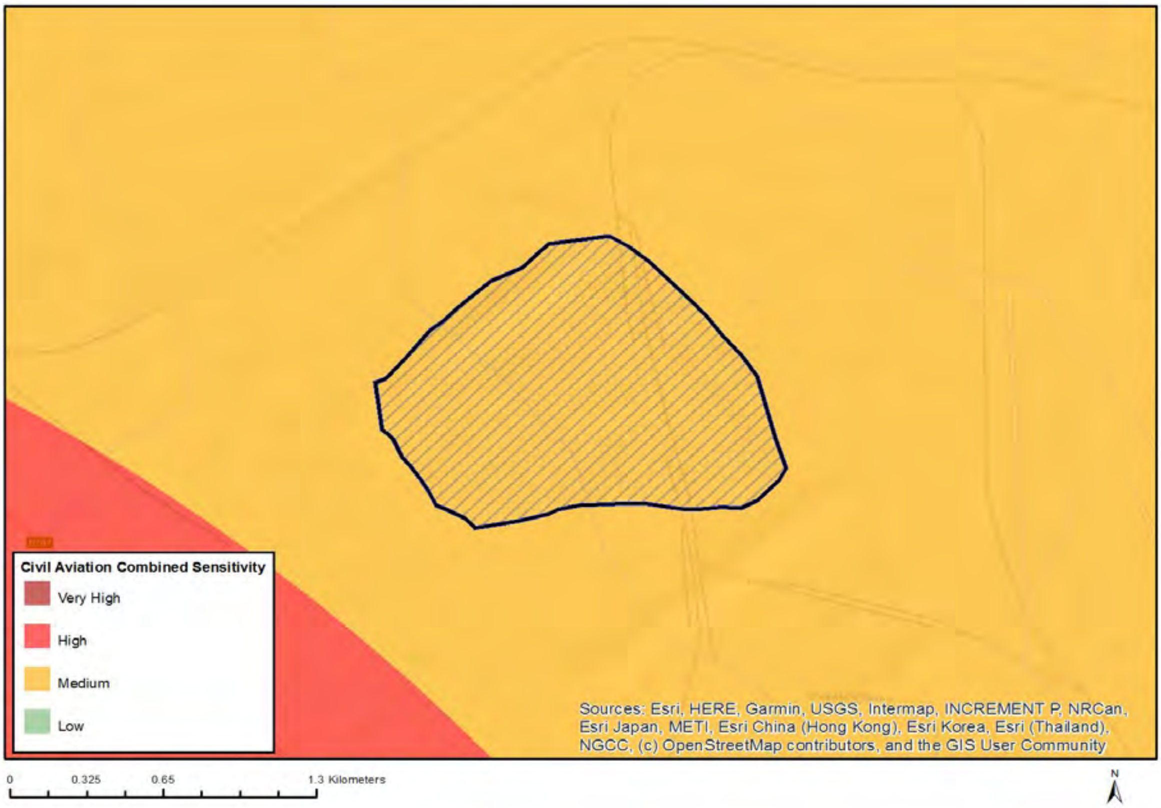


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Within 500 m of an important river

MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY

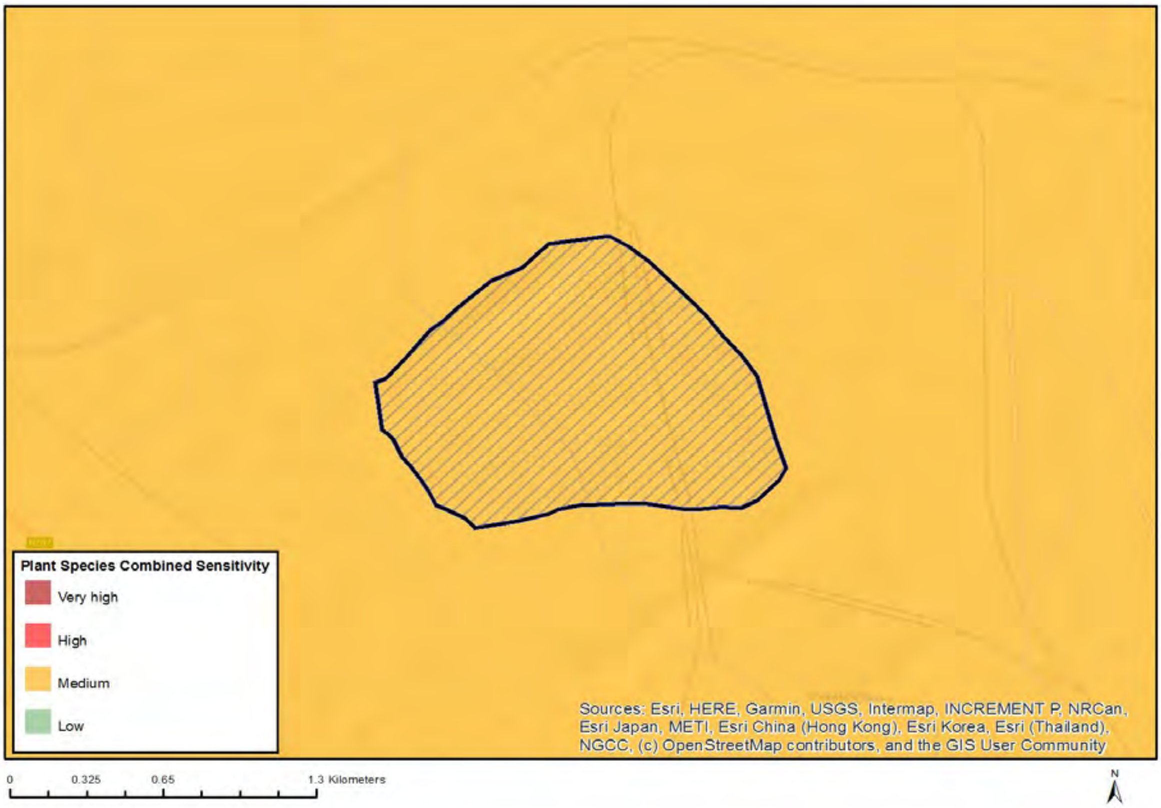


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Between 8 and 15 km of other civil aviation aerodrome

MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY

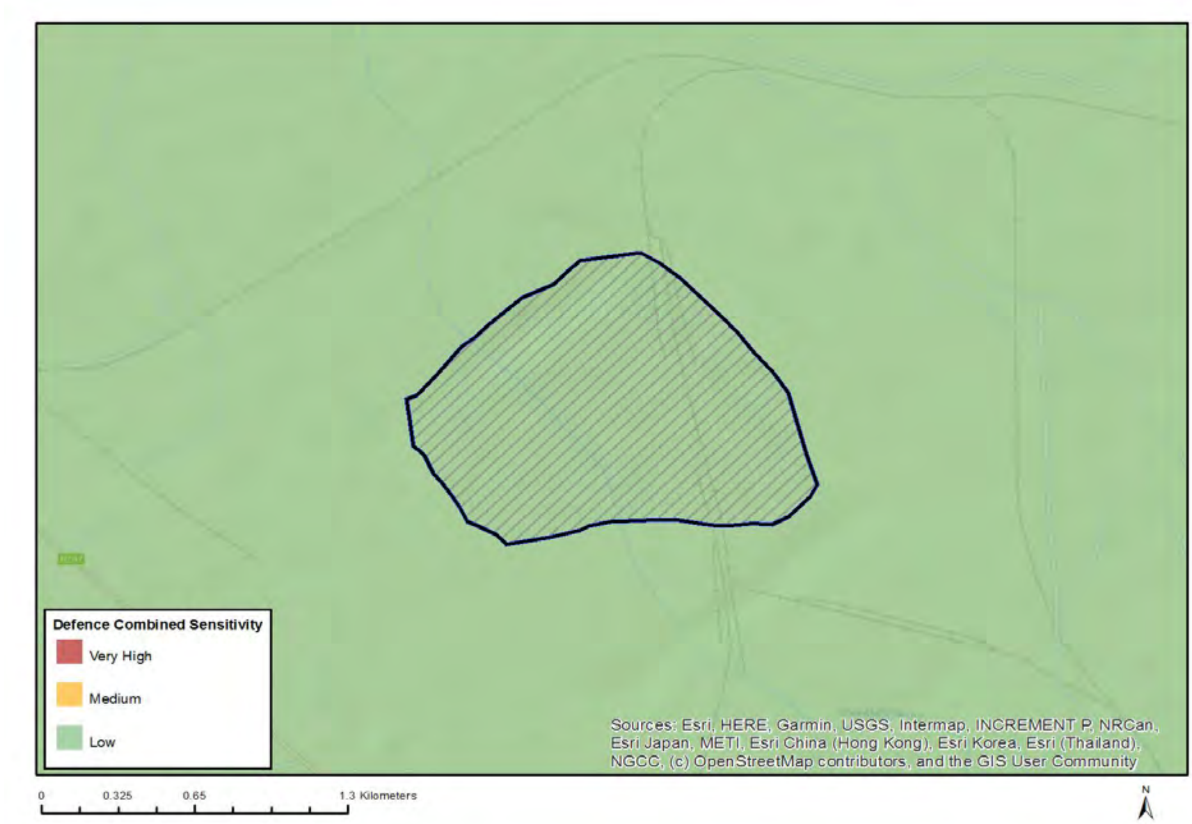


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Sensitive species 411
Medium	Sensitive species 455
Medium	Sensitive species 647
Medium	Pachycarpus suaveolens
Medium	Brachycorythis conica subsp. transvaalensis

MAP OF RELATIVE DEFENCE THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

23/10/2019

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Very High	Vulnerable ecosystem

23/10/2019

SCREENING REPORT FOR AN ENVIRONMENTAL AUTHORIZATION OR FOR A PART TWO AMENDMENT OF AN ENVIRONMENTAL AUTHORISATION AS REQUIRED BY THE 2014 EIA REGULATIONS – PROPOSED DEVELOPMENT FOOTPRINT ENVIRONMENTAL SENSITIVITY

EIA Reference number: MP30/5/1/2/3/2/1/ (375)EM

Project name: iMpunzi Complex IRP

Project title: Proposed iMpunzi Venture co-disposal facility

Date screening report generated: 23/10/2019 10:57:17

Applicant: Glencore Operations South Africa (Pty) Ltd

Compiler: Golder Associates Africa (Pty) Ltd

Compiler signature: ....

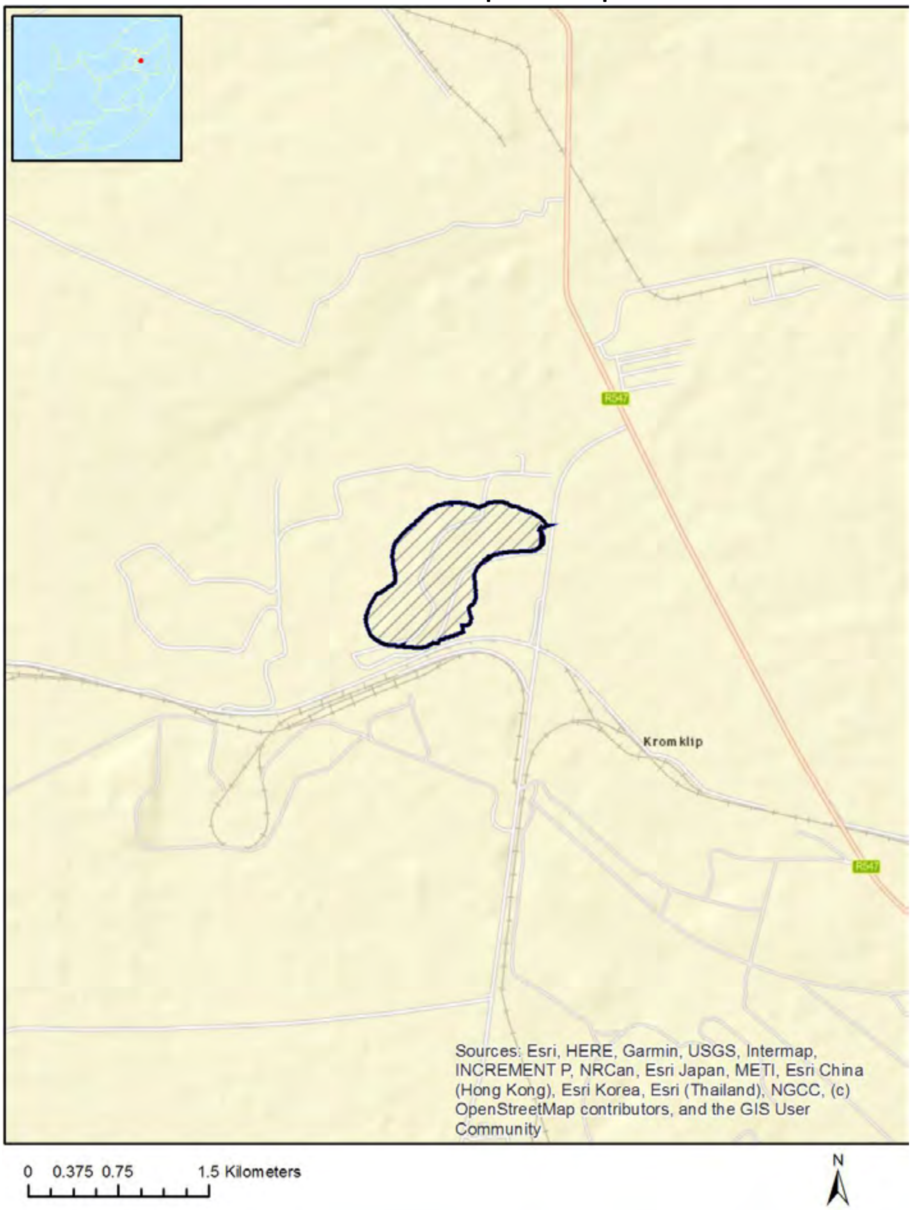
Mariëtte Weideman
Environmental Consultant
GOLDER

Table of Contents

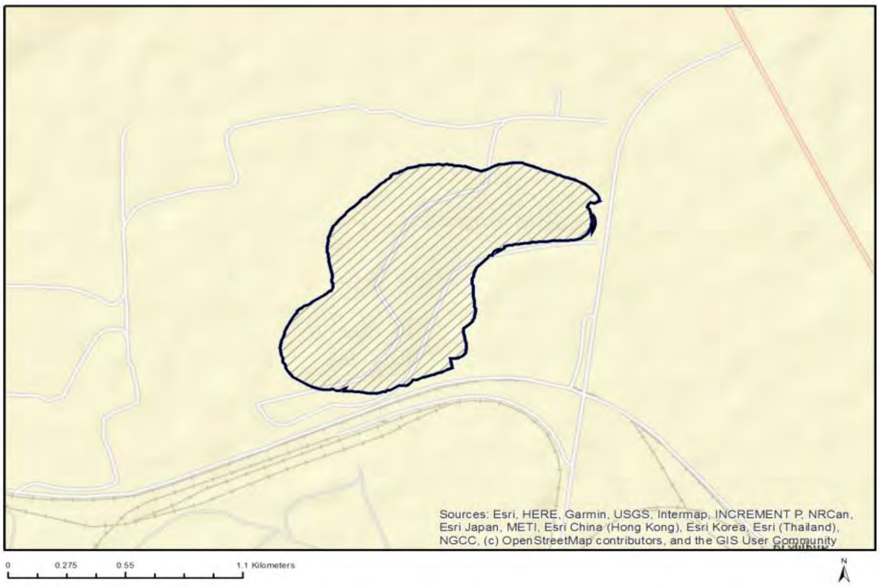
Proposed Project Location

Orientation map 1: General location

General Orientation: iMpunzi Complex IRP



Map of proposed site and relevant area(s)



Cadastral details of the proposed site

Property details:

No	Farm Name	Farm/ Erf No	Portion	Latitude	Longitude	Property Type
1	KLIPPLAAT	14	0	26°3'51.92S	29°12'5.58E	Farm
2	BLESBOKFONTEIN	31	0	26°6'47.58S	29°9'51.06E	Farm
3	BLESBOKFONTEIN	31	2	26°5'24.47S	29°10'43.17E	Farm Portion
4	KLIPPLAAT	14	14	26°5'14.59S	29°11'29.21E	Farm Portion
5	KLIPPLAAT	14	1	26°4'17.02S	29°11'17.32E	Farm Portion

Development footprint[1] vertices:

Footprint	Latitude	Longitude
1	26°4'43.42S	29°11'35.37E
1	26°4'43.44S	29°11'35.63E
1	26°4'43.53S	29°11'35.89E
1	26°4'43.61S	29°11'36.2E
1	26°4'43.78S	29°11'36.68E
1	26°4'43.88S	29°11'36.98E
1	26°4'43.97S	29°11'37.27E
1	26°4'44.13S	29°11'37.66E
1	26°4'44.31S	29°11'38.13E
1	26°4'44.5S	29°11'38.57E
1	26°4'44.57S	29°11'38.91E
1	26°4'44.64S	29°11'39.1E
1	26°4'44.71S	29°11'39.57E

[1] "development footprint", means the area within the site on which the development will take place and incudes all ancillary developments for example roads, power lines, boundary walls, paving etc. which require vegetation clearance or which will be disturbed and for which the application has been submitted.

1	26°4'44.81S	29°11'39.88E
1	26°4'44.99S	29°11'40.37E
1	26°4'45.18S	29°11'40.83E
1	26°4'45.31S	29°11'41.27E
1	26°4'45.42S	29°11'41.58E
1	26°4'45.6S	29°11'42.05E
1	26°4'45.68S	29°11'42.53E
1	26°4'45.88S	29°11'42.94E
1	26°4'45.94S	29°11'43.41E
1	26°4'46.14S	29°11'43.87E
1	26°4'46.4S	29°11'44.31E
1	26°4'46.55S	29°11'44.79E
1	26°4'46.72S	29°11'45.09E
1	26°4'46.98S	29°11'45.51E
1	26°4'47.15S	29°11'45.72E
1	26°4'47.4S	29°11'45.98E
1	26°4'47.75S	29°11'46.32E
1	26°4'48.03S	29°11'46.66E
1	26°4'48.37S	29°11'46.92E
1	26°4'48.64S	29°11'47.15E
1	26°4'49.11S	29°11'47.21E
1	26°4'49.19S	29°11'47.3E
1	26°4'49.57S	29°11'46.43E
1	26°4'49.45S	29°11'45.92E
1	26°4'49.74S	29°11'45.6E
1	26°4'50.16S	29°11'45.37E
1	26°4'50.38S	29°11'45.68E
1	26°4'50.82S	29°11'45.84E
1	26°4'51.28S	29°11'45.92E
1	26°4'51.76S	29°11'46.01E
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1	26°4'52.7S	29°11'46.57E
1	26°4'53.01S	29°11'46.54E
1	26°4'53.3S	29°11'46.46E
1	26°4'53.6S	29°11'46.36E
1	26°4'53.88S	29°11'46.22E
1	26°4'53.42S	29°11'46.16E
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1	26°4'54.65S	29°11'44.83E
1	26°4'54.89S	29°11'44.4E
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1	26°4'55.18S	29°11'43.54E
1	26°4'55.24S	29°11'43.06E
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1	26°4'55.35S	29°11'39.91E

1	26°4'55.42S	29°11'39.44E
1	26°4'55.47S	29°11'38.95E
1	26°4'55.48S	29°11'38.44E
1	26°4'55.51S	29°11'37.93E
1	26°4'55.56S	29°11'37.52E
1	26°4'55.49S	29°11'37.14E
1	26°4'55.67S	29°11'36.66E
1	26°4'55.68S	29°11'36.18E
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1	26°5'1.55S	29°11'27.94E
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1	26°5'2.23S	29°11'28.1E
1	26°5'2.56S	29°11'28.11E
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1	26°5'5.47S	29°11'28.32E
1	26°5'5.8S	29°11'28.43E
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1	26°5'8.28S	29°11'27.23E
1	26°5'8.57S	29°11'26.83E
1	26°5'8.76S	29°11'26.66E
1	26°5'9.11S	29°11'26.54E
1	26°5'9.53S	29°11'26.62E
1	26°5'9.85S	29°11'26.73E
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1	26°5'10.68S	29°11'26.92E
1	26°5'11.13S	29°11'27.06E

23/10/2019

1	26°5'11.59S	29°11'27.09E
1	26°5'12.02S	29°11'27E
1	26°5'12.48S	29°11'26.88E
1	26°5'12.88S	29°11'26.58E
1	26°5'13.13S	29°11'26.12E
1	26°5'13.3S	29°11'25.65E
1	26°5'13.34S	29°11'25.18E
1	26°5'13.32S	29°11'24.65E
1	26°5'13.41S	29°11'24.67E
1	26°5'14.74S	29°11'24.93E
1	26°5'14.93S	29°11'24.46E
1	26°5'15.08S	29°11'23.99E
1	26°5'15.29S	29°11'23.55E
1	26°5'15.47S	29°11'23.1E
1	26°5'15.55S	29°11'22.67E
1	26°5'15.8S	29°11'22.22E
1	26°5'15.88S	29°11'21.72E
1	26°5'16S	29°11'21.26E
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1	26°5'16.27S	29°11'20.26E
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1	26°5'16.61S	29°11'19.34E
1	26°5'16.67S	29°11'18.86E
1	26°5'17.04S	29°11'18.59E
1	26°5'17.37S	29°11'18.26E
1	26°5'17.5S	29°11'17.93E
1	26°5'17.5S	29°11'17.4E
1	26°5'17.39S	29°11'16.9E
1	26°5'17.66S	29°11'16.46E
1	26°5'17.88S	29°11'16.02E
1	26°5'18.11S	29°11'15.56E
1	26°5'18.22S	29°11'15.05E
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1	26°5'18.62S	29°11'12.91E
1	26°5'18.7S	29°11'12.38E
1	26°5'18.6S	29°11'11.89E
1	26°5'18.5S	29°11'11.42E
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1	26°5'18.41S	29°11'10.39E
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1	26°5'18.33S	29°11'8.52E
1	26°5'17.9S	29°11'8.74E
1	26°5'18.03S	29°11'8.29E
1	26°5'18.25S	29°11'7.86E
1	26°5'18.24S	29°11'7.34E
1	26°5'18.03S	29°11'6.93E
1	26°5'18.05S	29°11'6.5E
1	26°5'18.11S	29°11'6.1E
1	26°5'18.11S	29°11'5.59E
1	26°5'18.04S	29°11'5.17E
1	26°5'17.92S	29°11'4.65E
1	26°5'17.82S	29°11'4.18E
1	26°5'17.72S	29°11'3.85E
1	26°5'17.53S	29°11'3.44E
1	26°5'17.37S	29°11'3.03E

1	26°5'17.17S	29°11'2.62E
1	26°5'16.94S	29°11'2.21E
1	26°5'16.73S	29°11'1.77E
1	26°5'16.46S	29°11'1.34E
1	26°5'16.21S	29°11'0.91E
1	26°5'15.92S	29°11'0.59E
1	26°5'15.58S	29°11'0.22E
1	26°5'15.55S	29°11'0.19E
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1	26°5'14.12S	29°10'59.48E
1	26°5'13.88S	29°10'59.29E
1	26°5'13.53S	29°10'59.24E
1	26°5'13.08S	29°10'59.12E
1	26°5'12.75S	29°10'59.02E
1	26°5'12.31S	29°10'58.9E
1	26°5'11.87S	29°10'58.82E
1	26°5'11.51S	29°10'58.82E
1	26°5'11.04S	29°10'58.94E
1	26°5'10.7S	29°10'59.01E
1	26°5'10.47S	29°10'59.1E
1	26°5'10.09S	29°10'59.29E
1	26°5'9.64S	29°10'59.4E
1	26°5'9.18S	29°10'59.53E
1	26°5'8.76S	29°10'59.74E
1	26°5'8.32S	29°10'59.91E
1	26°5'7.9S	29°11'0.17E
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1	26°5'4.36S	29°11'4.22E
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1	26°4'58.16S	29°11'6.2E

1	26°4'57.87S	29°11'6.17E
1	26°4'57.43S	29°11'6.11E
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1	26°4'55.55S	29°11'6.05E
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1	26°4'54.79S	29°11'6.15E
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1	26°4'52.54S	29°11'7.38E
1	26°4'52.27S	29°11'7.65E
1	26°4'51.91S	29°11'7.99E
1	26°4'51.63S	29°11'8.28E
1	26°4'51.29S	29°11'8.64E
1	26°4'50.98S	29°11'8.88E
1	26°4'50.71S	29°11'9.2E
1	26°4'50.4S	29°11'9.51E
1	26°4'50.13S	29°11'9.88E
1	26°4'49.83S	29°11'10.29E
1	26°4'49.5S	29°11'10.67E
1	26°4'49.2S	29°11'10.98E
1	26°4'48.76S	29°11'11.43E
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1	26°4'48.25S	29°11'12.16E
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1	26°4'47.48S	29°11'13.1E
1	26°4'47.27S	29°11'13.39E
1	26°4'46.94S	29°11'13.76E
1	26°4'46.5S	29°11'14.28E
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1	26°4'45.9S	29°11'15.05E
1	26°4'45.68S	29°11'15.43E
1	26°4'45.27S	29°11'15.66E
1	26°4'45.07S	29°11'16.01E
1	26°4'44.96S	29°11'16.36E
1	26°4'45S	29°11'16.74E
1	26°4'44.76S	29°11'16.98E
1	26°4'44.57S	29°11'17.4E
1	26°4'44.31S	29°11'17.85E
1	26°4'44.24S	29°11'18.21E
1	26°4'44.13S	29°11'18.58E
1	26°4'44.02S	29°11'19.06E
1	26°4'43.92S	29°11'19.48E
1	26°4'43.8S	29°11'19.89E
1	26°4'43.77S	29°11'20.42E
1	26°4'43.72S	29°11'20.91E
1	26°4'43.7S	29°11'21.14E
1	26°4'43.74S	29°11'21.78E
1	26°4'43.72S	29°11'21.9E
1	26°4'43.65S	29°11'22.44E
1	26°4'43.61S	29°11'22.81E
1	26°4'43.63S	29°11'23.14E
1	26°4'43.69S	29°11'23.44E
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1	26°4'43.58S	29°11'24.06E
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1	26°4'44.24S	29°11'27.89E
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1	26°4'44.67S	29°11'29.21E
1	26°4'44.58S	29°11'29.57E
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1	26°4'44.1S	29°11'30.85E
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1	26°4'43.84S	29°11'31.52E
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1	26°4'43.61S	29°11'32.41E
1	26°4'43.53S	29°11'32.93E
1	26°4'43.51S	29°11'33.36E
1	26°4'43.45S	29°11'33.85E
1	26°4'43.43S	29°11'34.29E
1	26°4'43.4S	29°11'34.62E
1	26°4'43.39S	29°11'34.95E
1	26°4'43.42S	29°11'35.37E

Wind and Solar developments with an approved Environmental Authorisation or applications under consideration within 30 km of the proposed area

No	EIA Reference No	Classification	Status of application	Distance from proposed area (km)
1	14/12/16/3/3/2/759	Solar PV	Approved	20.2

23/10/2019

Environmental Management Frameworks relevant to the application

Environmental Management Framework	LINK
Olifants EMF	https://screening.environment.gov.za/ScreeningDownloads/EMF/Zone_46,_67,_78_,_80,_92,_103,_122,_129.pdf

Environmental screening results and assessment outcomes

The following sections contain a summary of any development incentives, restrictions, exclusions or prohibitions that apply to the proposed development footprint as well as the most environmental sensitive features on the footprint based on the footprint sensitivity screening results for the application classification that was selected. The application classification selected for this report is:
Mining|Beneficiation|Hydrocarbon|Beneficiation - Hydrocarbon.

Relevant development incentives, restrictions, exclusions or prohibitions

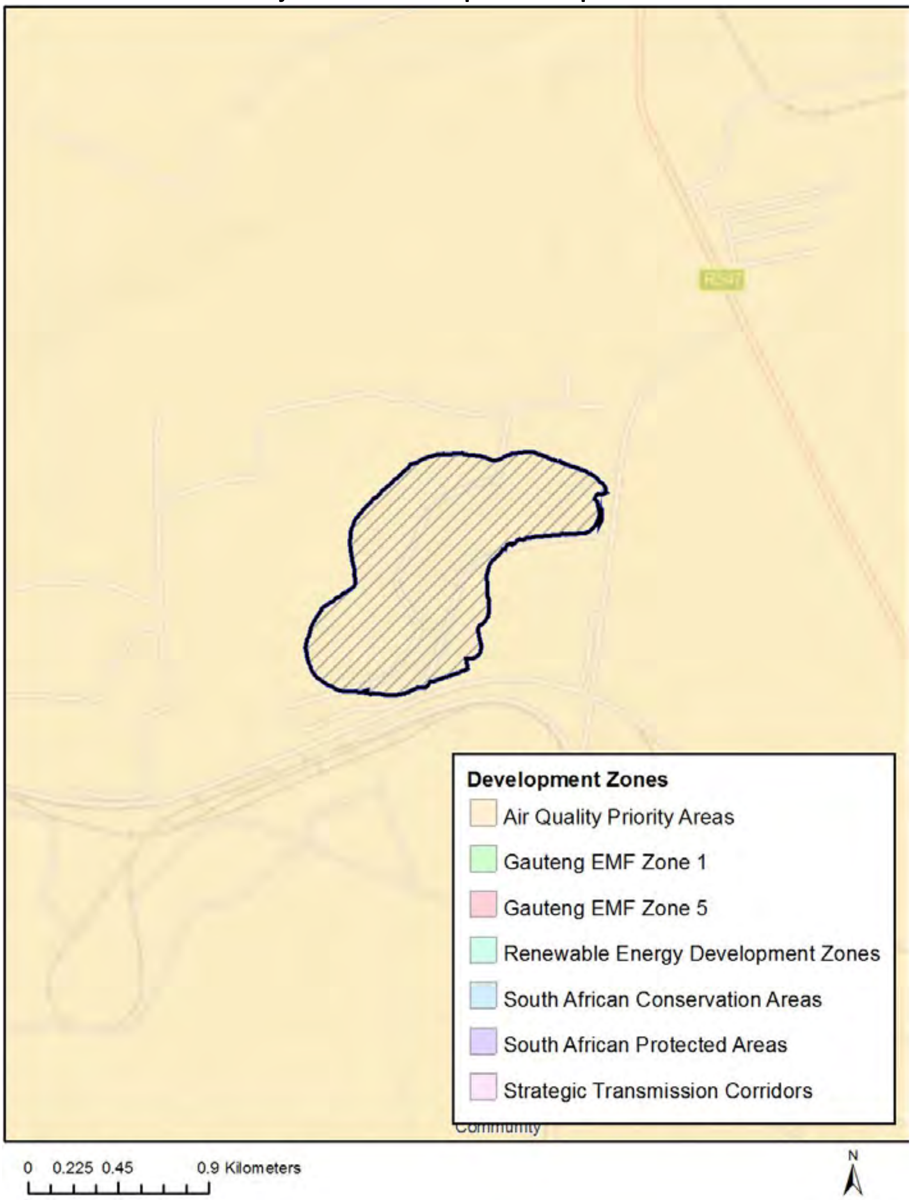
The following development incentives, restrictions, exclusions or prohibitions and their implications that apply to this footprint are indicated below.

Incentive, restriction or prohibi	Implication

tion	
Strategic Transmission Corridor-International corridor	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/GNR_350_of_13_April_2017.pdf
Air Quality-Highveld Priority Area	https://screening.environment.gov.za/ScreeningDownloads/DevelopmentZones/HIGHVELD_PRIORITY_AREA_AQMP.pdf

Map indicating proposed development footprint within applicable development incentive, restriction, exclusion or prohibition zones

Project Location: iMpunzi Complex IRP



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Proposed Development Area Environmental Sensitivity

The following summary of the development footprint environmental sensitivities is identified. Only the highest environmental sensitivity is indicated. The footprint environmental sensitivities for the proposed development footprint as identified, are indicative only and must be verified on site by a suitably qualified person before the specialist assessments identified below can be confirmed.

Theme	Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
Agriculture Theme		X		
Aquatic Biodiversity Theme				X
Civil Aviation Theme			X	
Plant Species Theme			X	
Defence Theme				X
Terrestrial Biodiversity Theme	X			

Specialist assessments identified

Based on the selected classification, and the environmental sensitivities of the proposed development footprint, the following list of specialist assessments have been identified for inclusion in the assessment report. It is the responsibility of the EAP to confirm this list and to motivate in the assessment report, the reason for not including any of the identified specialist study including the provision of photographic evidence of the footprint situation.

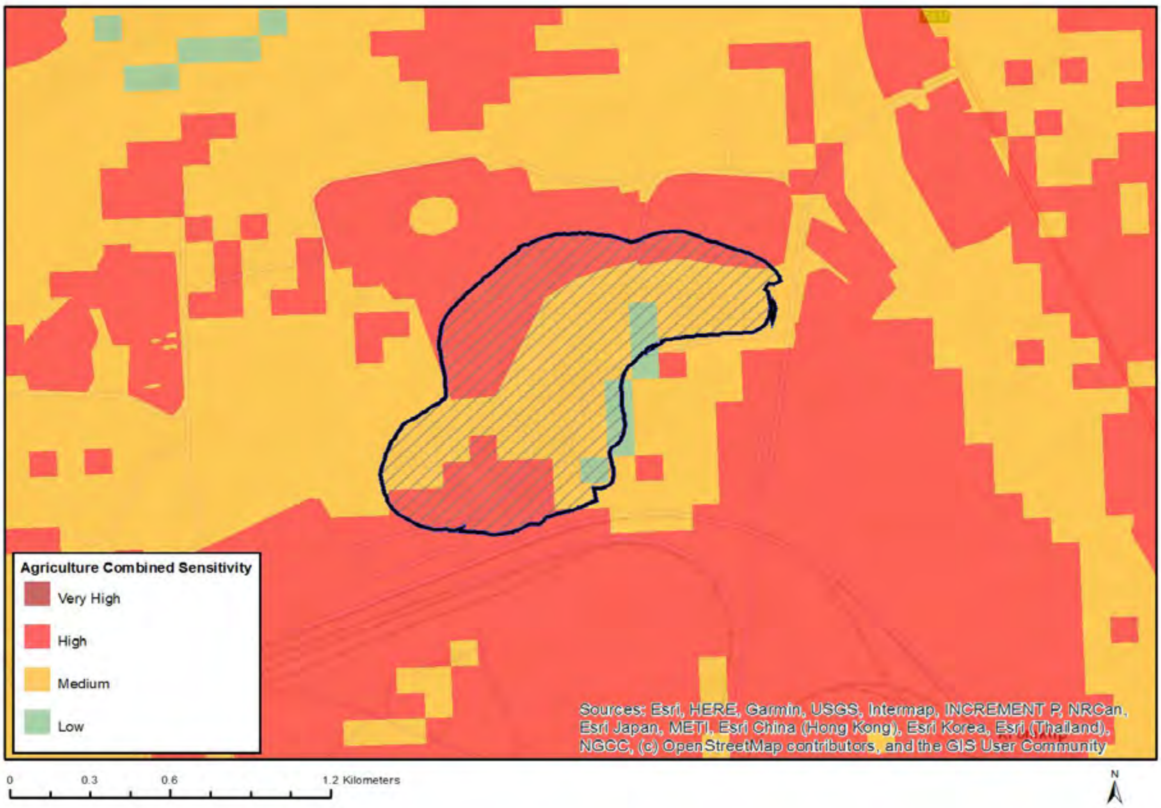
No	Specialist assessment	Assessment Protocol
1	Agricultural Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Agriculture_Assessment_Protocols.pdf
2	Archaeological and Cultural Heritage Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
3	Palaeontology Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
4	Terrestrial Biodiv	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Terrestrial_Biodiversity_Assessment_Protocols.pdf

	ersity Impact Assessment	
5	Aquatic Biodiversity Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Aquatic_Biodiversity_Assessment.pdf
6	Hydrology Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
7	Noise Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_Noise_Impacts_Assessment_Protocols.pdf
8	Traffic Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
9	Geotechnical Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
10	Climate Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
11	Health Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
12	Socio-Economic Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
13	Ambient Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
14	Air Quality Impact Assessment	https://screening.environment.gov.za/ScreeningDownloads/Assessment/General/Appendix6.pdf
15	Plant Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf
16	Animal Species Assessment	https://screening.environment.gov.za/ScreeningDownloads/AssessmentProtocols/DraftGazetted_General_Requirement_Assessment_Protocols.pdf

Results of the environmental sensitivity of the proposed area.

The following section represents the results of the screening for environmental sensitivity of the proposed footprint for relevant environmental themes associated with the project classification. It is the duty of the EAP to ensure that the environmental themes provided by the screening tool are comprehensive and complete for the project. Refer to the disclaimer.

MAP OF RELATIVE AGRICULTURE THEME SENSITIVITY

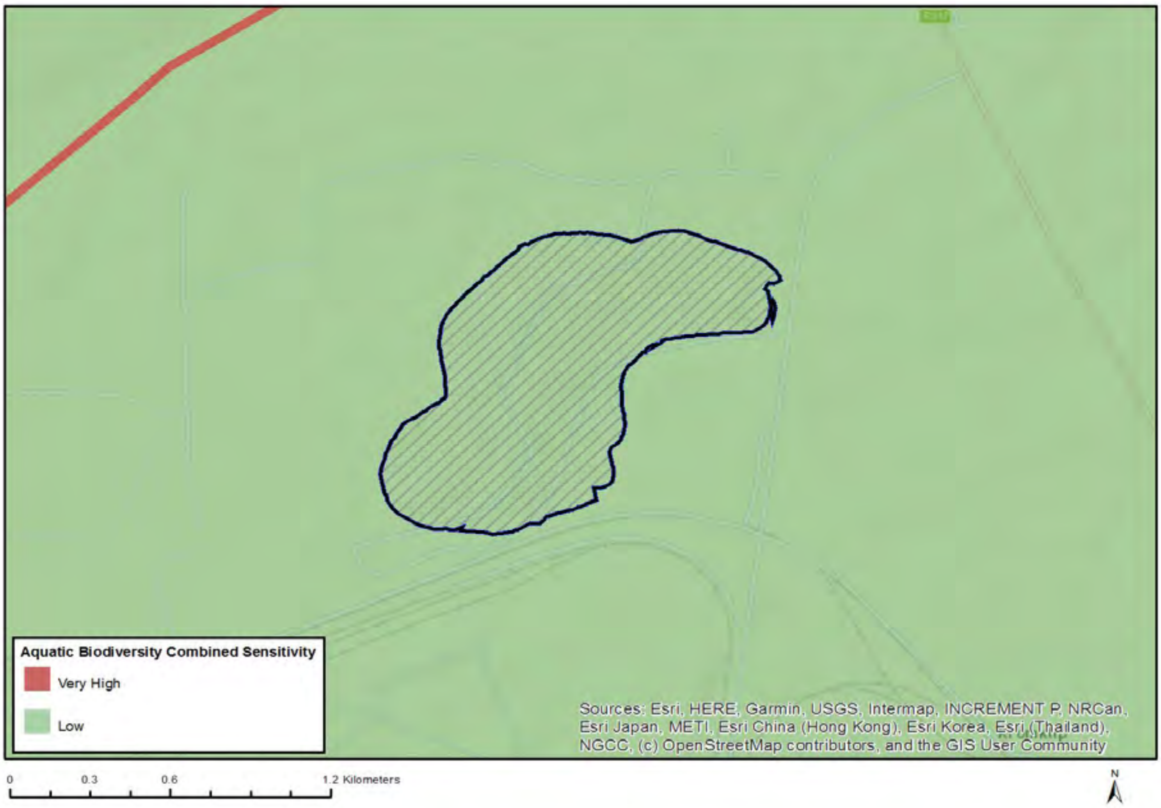


Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
	X		

Sensitivity Features:

Sensitivity	Feature(s)
High	Land capability;09. Moderate-High/10. Moderate-High
High	Old Fields;Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate
Low	Land capability;01. Very low/02. Very low/03. Low-Very low/04. Low-Very low/05. Low
Medium	Land capability;06. Low-Moderate/07. Low-Moderate/08. Moderate

MAP OF RELATIVE AQUATIC BIODIVERSITY THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low Sensitivity Areas

MAP OF RELATIVE CIVIL AVIATION THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Between 8 and 15 km of other civil aviation aerodrome

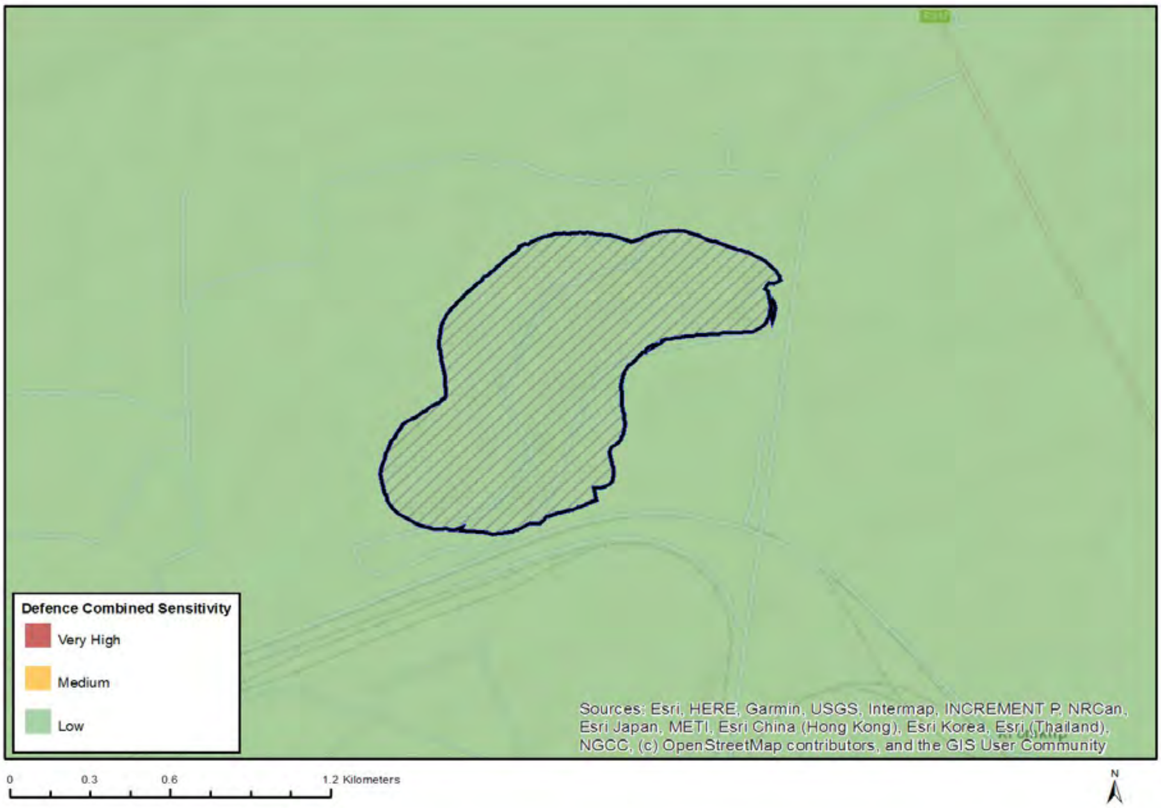
MAP OF RELATIVE PLANT SPECIES THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
		X	

Sensitivity Features:

Sensitivity	Feature(s)
Medium	Sensitive species 411
Medium	Sensitive species 455
Medium	Sensitive species 647
Medium	Pachycarpus suaveolens
Medium	Brachycorythis conica subsp. transvaalensis

MAP OF RELATIVE DEFENCE THEME SENSITIVITY



Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
			X

Sensitivity Features:

Sensitivity	Feature(s)
Low	Low sensitivity

MAP OF RELATIVE TERRESTRIAL BIODIVERSITY THEME SENSITIVITY

Very High sensitivity	High sensitivity	Medium sensitivity	Low sensitivity
X			

Sensitivity Features:

Sensitivity	Feature(s)
Very High	Vulnerable ecosystem