# FLOOD-LINE ASSESSMENT FOR THE WEST WITS MINING OPERATION

**Version 1**

**02 APRIL 2026**

**PROJECT NO. EIM-021**

**HYDROLOGIC CONSULTING**
Email: info@hydrologic.consulting | Phone: +27 72 239 0974

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*Prepared For*

**EIMS (PTY) LTD**

*Prepared By*

**HYDROLOGIC CONSULTING (PTY) LTD**

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# 1 INTRODUCTION

Hydrologic Consulting has been appointed by Environmental Impact Management Services (EIMS) to undertake a hydrological flood-line assessment for the proposed Golden Core Trade and Invest (Pty) Ltd and Harmony Gold Mining Company Limited (the applicant's) West Wits and Mponeng Operations (hereafter referred to as the site), located approximately 8km south-west of the town of Carletonville, in the Gauteng Province of South Africa.

This report outlines the flood-line assessment for the mining operation.

## 1.1 SCOPE OF WORK

The scope of work included in this study is as follows:

- Baseline Assessment – sourcing of baseline climatic and hydrological data. This included the interrogation of rainfall data, site-specific design rainfall (depth/duration/frequency), evaporation, soils, and land use, as well as a regional and local hydrological assessment.
- Site Examination – a site was conducted by Hydrologic Consulting on the 4th and 5th of February 2026;
- Flood Modelling – to define the 1:50 and 1:100 maximum flood events, a PCSWMM model (hydrology) and a 2D HEC-RAS (hydraulic) flood model were developed;
- A technical report detailing the achieved scope of work (this report).

The above scope of work is based on the onsite hydrological conditions, which included site details and culvert dimensions obtained from a site visit (culvert inspection undertaken on the 4th and 5th of February 2026).

## 1.2 PROJECT DESCRIPTION

The following project description outlines the proposed works.

*The applicant owns and operates numerous Gold Mines and Plants in the West Wits region in the Gauteng Province. The Savuka Plant currently deposits tailings onto the Savuka 7a & 7b Tailings Storage Facilities (TSFs).*

*The TSFs are constructed and operated through a drywall paddock system; however, it is proposed to change the deposition method to cycloning. This will lengthen the deposition timeframe up to the current approved height, with cyclone deposition continuing into the height extension. No additional infrastructure is proposed as part of the height extension over and above the conversion to cyclone deposition.*

*Furthermore,[1] Harmony is in the pre-feasibility stage of assessing and designing for the West Wits region's future deposition capacity needs (current reclamation, run-of-mine, and future projects) and requires the necessary environmental and specialist studies to apply for the required authorisation and permits to execute the desired option(s).*

[1] *Harmony Gold Mining Company Limited. (2025, March 20). West Wits Reclamation and Deposition (Pre-feasibility and Feasibility): Scope of work – WWR Project Environmental Authorisation (Revision 0) [Internal company report]. Executive Projects, Central Projects Function.*

*One specific option to commence at the Feasibility level is to license and authorise the construction of the future Deelkraal 2 TSF receiving residue from Kusasalethu and Mponeng plants and to reclaim the existing Deelkraal 1 TSF and Kusasalethu TSF for processing at the Kusasalethu plant.*

*An EIA application is required for the new Deelkraal 2 TSF as well as the associated pipelines, as indicated on the same figure. There will also be some upgrades to the existing Kusasalethu plant. The old Savuka TSF and DF5 footprints would also need to be looked at as alternative sites; however, these are existing TSF footprints.*

## 1.3 REGIONAL SETTING AND LAYOUT

West Wits and Mponeng (hereafter also referred to as the 'site') is located at 26° 26' 34" S and 27° 20' 17" E. The regional setting is illustrated in **Figure 1-1,** while the layout of the site is presented in **Figure 1-2**.

The site encompasses the Savuka, Mponeng, Deelkraal I, Proposed Deelkraal II, and Kusasalethu TSFs and includes the following associated infrastructure:

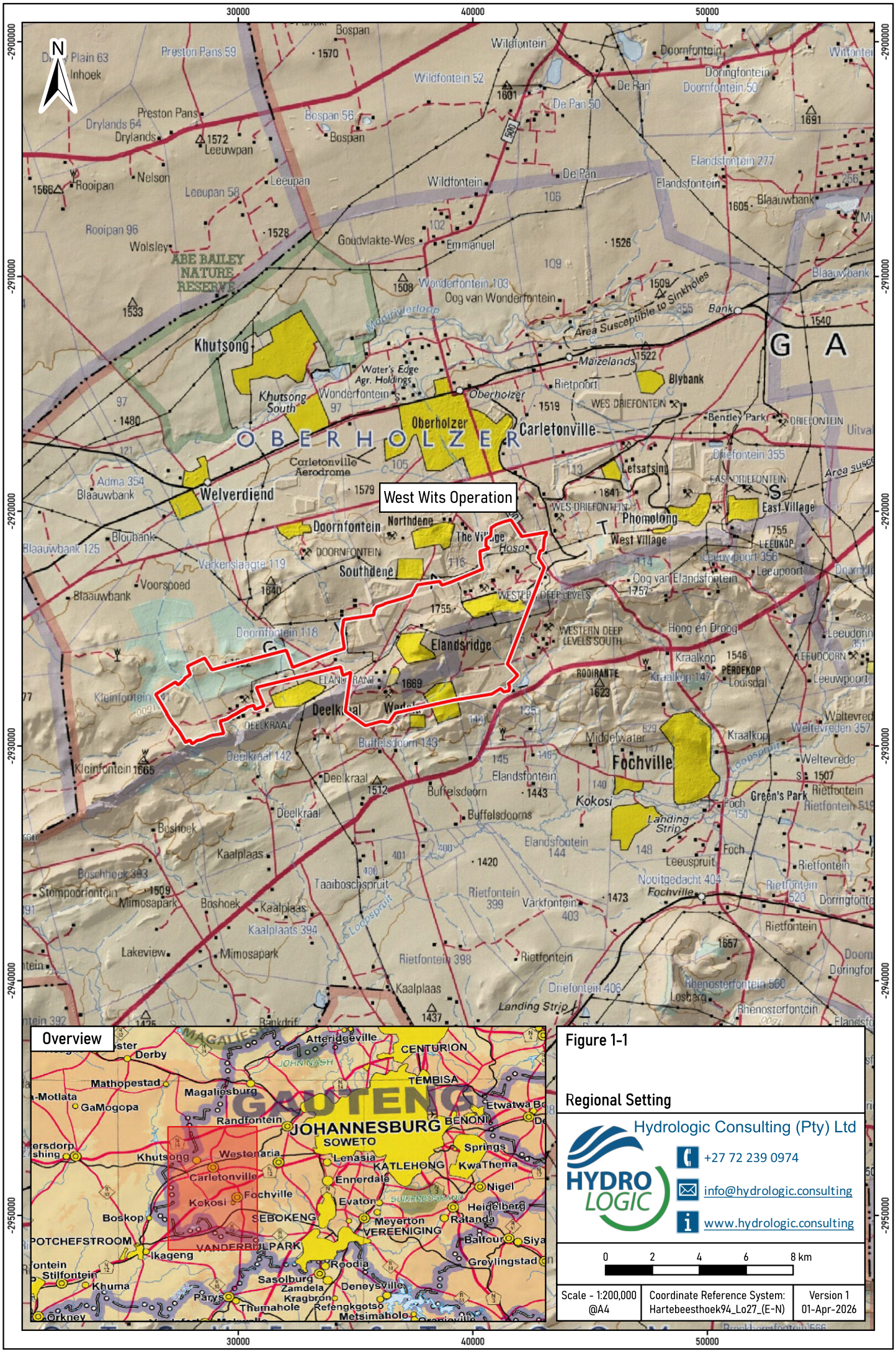
- TSF related:
    - Penstock Pipelines; and
    - Cyclone Embankment.
    - Toe Paddocks
    - Toe Rings
    - Return Water Dam (RWD);
    - Topsoil Stockpile;
    - Silt Trap; and
    - Stormwater Diversion (Bund and Trench).
- Pipeline related:
    - Concrete Slab Foundation
    - Concrete Apron
    - Pump Station

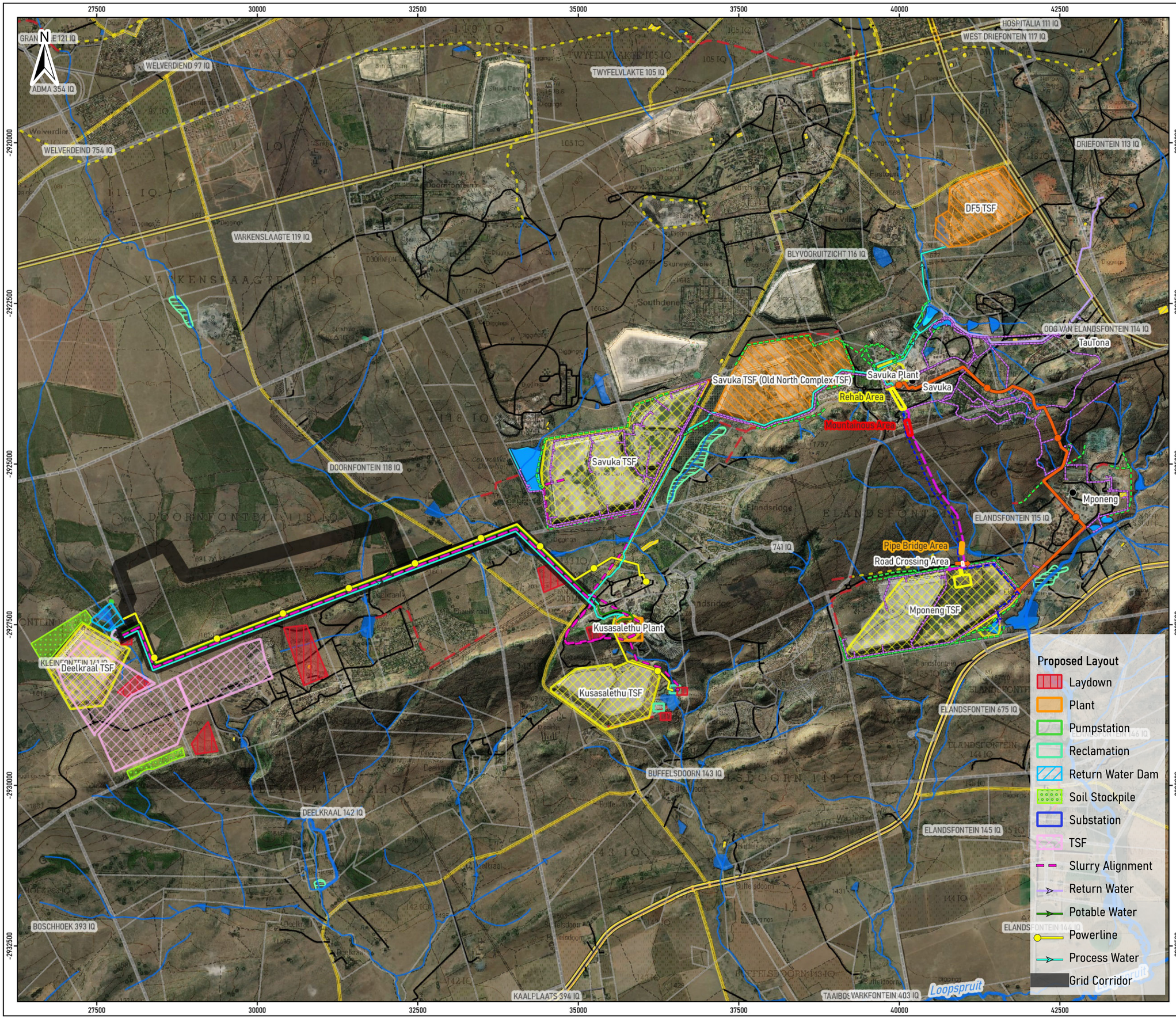
The associated infrastructure references both existing and proposed infrastructure for the existing and conceptual layout plans.

### 1.3.1 EXPERTISE OF PRIMARY AUTHOR AND DECLARATION OF INDEPENDENCE

As the lead consultant for this assessment, Mark Bollaert brings over 17 years of specialised hydrological experience across the UK and South Africa. After completing his Master's in Hydrology at the University of KwaZulu-Natal, he achieved several professional charters, including Pr.Sci.Nat (South Africa), and CSci, CEnv, and C.WEM (UK), reflecting a commitment to ongoing professional development.

To ensure impartiality, both Hydrologic Consulting and Mr. Bollaert declare full independence. Their involvement is limited to providing objective, expert analysis, free from any conflicting financial or personal interests in the project's outcome.


30000
40000
50000
-2900000
-2910000
-2920000
-2930000
-2940000
-2950000
N
West Wits Operation
Overview
Khutsong
Welverdiend
Carletonville
Oberholzer
Doornfontein
Southdene
Elandsridge
Deelkraal
Fochville
Kokosi
Khutsong South
Wonderfontein
Blybank
Phomolong
East Village
West Village
Area Susceptible to Sinkholes
ABE BAILEY NATURE RESERVE
Carletonville Aerodrome
Water's Edge Agr. Holdings
Landing Strip
GAUTENG
JOHANNESBURG
CENTURION
TEMBISA
SOWETO
KATLEHONG
SEBOKENG
VEREENIGING
VANDERBIJLPARK
Mathopestad
Magaliesburg
GaMogopa
Randfontein
Westonaria
Lenasia
Ennerdale
Springs
KwaThema
Nigel
Heidelberg
Ratanda
Balfour
Greylingstad
Roodia
Sasolburg
Zamdela
Deneysville
Kragbron
Parys
Thumahole
Refengkgotso
Metsimahole
Orkney
Khuma
Stilfontein
Ikageng
POTCHEFSTROOM
Boskop
Derby
Atteridgeville
Figure 1-1
Regional Setting
Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting
0 2 4 6 8 km
Scale - 1:200,000 @A4
Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N)
Version 1 01-Apr-2026




## Legend

**Reclamation Areas**

- Existing
- Existing (Trade-off)

**Proposed Layout (Mponeng)**

- Pipelines Alternative Route (Propos
- Return Water Alignment (Proposed)
- Slurry Alignment (Proposed)
- Mponeng Culvert (Proposed)
- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Shafts (Mponeng)

**Rivers**

- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)

**Roads**

- Main Road (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)

**Dams**

- Dam (50K Topo)
- Non-perennial pan (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Parent Farm
- Farm Portion

Figure 1-2

Layout

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0 1 2 3 km

| Scale - 1:55,000 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

# 2 BASELINE ENVIRONMENT

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

## 2.1 RAINFALL

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

South African Weather Services (SAWS) and Department of Water and Sanitation (DWS) stations are located near the site. SAWS data requires purchasing, and alternative sources of average monthly site-specific data were instead utilised, sourced from Pegram (2016). **Table 2-1** presents the summary of the site-specific average monthly rainfall distribution, while **Figure 2-1** illustrates the variation in rainfall in the region.

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

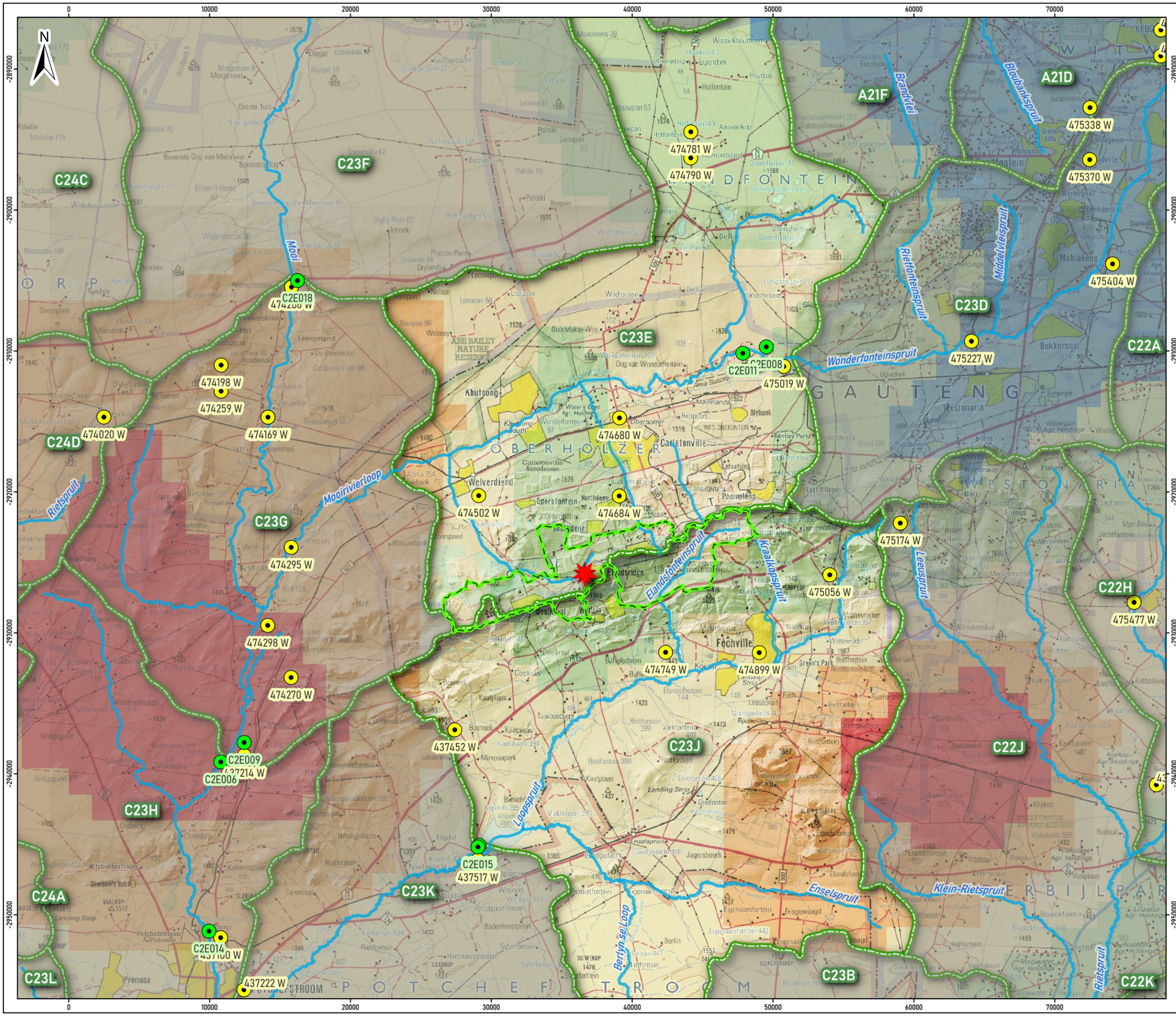
| West-Wits | |
|---|---|
| **Month** | **Rainfall (mm)** |
| Jan | 113 |
| Feb | 91 |
| Mar | 83 |
| Apr | 44 |
| May | 19 |
| Jun | 7 |
| Jul | 6 |
| Aug | 8 |
| Sep | 19 |
| Oct | 59 |
| Nov | 88 |
| Dec | 101 |
| **Total** | **640** |

**Estimates were sourced at the centre of the site.*

## 2.2 1-DAY DESIGN RAINFALL DEPTHS

For the development of a stormwater management plan and assessment of flooding, design rainfall is the most important rainfall variable to consider, as it is the driver behind peak flows.

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




## Legend

- Quaternary Catchment
- Area of Hydrological Relevance
- Project Site Central Point
- SAWS
- DWS
- Rivers (500K Topo)

**Mean Annual Precipitation (mm)**

- <= 550
- 550 - 585
- 585 - 620
- 620 - 655
- > 655

Figure 2-1

Mean Annual Precipitation


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0 4 8 12 km

| Scale - 1:250,000 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

**TABLE 2-2: 24-HOUR STORM DEPTH**

| Recurrence Interval (Years) | Rainfall Depth (24-hour) (mm) |
|---|---|
| **2** | 62.2 |
| **5** | 83 |
| **10** | 96.9 |
| **20** | 110.4 |
| **50** | 128.1 |
| **100** | 141.5 |
| **200** | 154.9 |

* Estimates were sourced for the area of hydrological relevance.

## 2.3 EVAPORATION

Evaporation data was sourced from the South African Atlas of Climatology and Agrohydrology (Schulze and Lynch, 2006) in the form of A-Pan equivalent potential evaporation[2]. The average monthly evaporation distribution is presented in **Table 2-3** and shows that the sites have an annual potential evaporation of 2,246 mm.

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

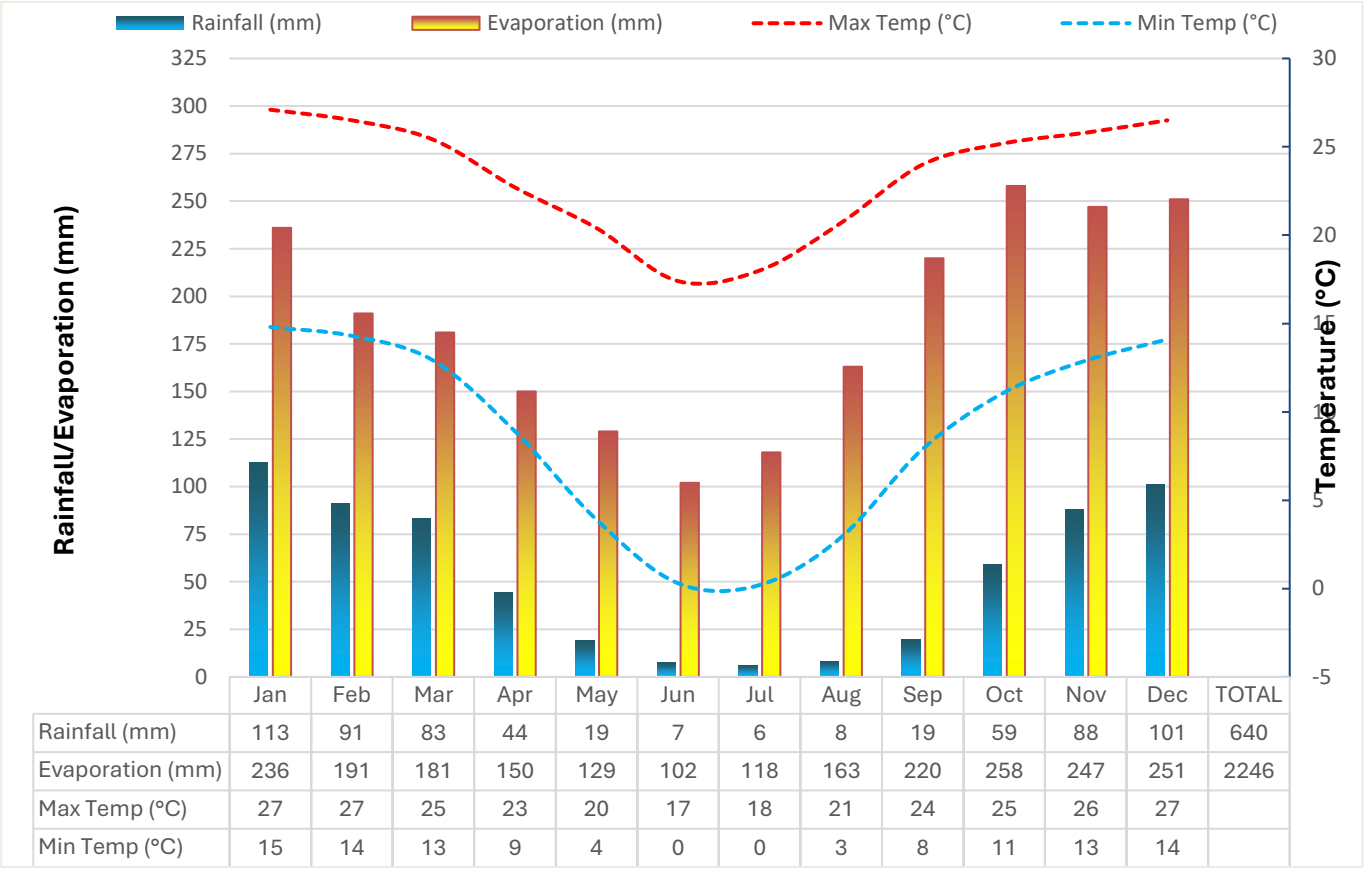
| Month | Evaporation (mm) |
|---|---|
| Jan | 236 |
| Feb | 191 |
| Mar | 181 |
| Apr | 150 |
| May | 129 |
| Jun | 102 |
| Jul | 118 |
| Aug | 163 |
| Sep | 220 |
| Oct | 258 |
| Nov | 247 |
| Dec | 251 |
| **Total** | **2,246** |

**Estimates were sourced at the centre of the site.*

## 2.4 AVERAGE CLIMATE

The average climate for the site is presented in **Figure 2-2** using the outcome of the investigation into rainfall and evaporation for the site. The combination of rainfall (Pegram, 2016) and evaporation and temperature (Schulze and Lynch, 2006) results in a temperate climate with dry winters and warm, wet summers according to the Köppen-Geiger climate classification[3].

[2] *Schulze* and *Lynch (2006) is the latest available dataset (Atlas, 2006) providing mean A-Pan Evaporation and Temperature data (1950-1999). The regional grids provide data that is not supplanted by newer remote sensed data.*
[3] *http://stepsa.org/climate_koppen_geiger.html*




| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainfall (mm) | 113 | 91 | 83 | 44 | 19 | 7 | 6 | 8 | 19 | 59 | 88 | 101 | 640 |
| Evaporation (mm) | 236 | 191 | 181 | 150 | 129 | 102 | 118 | 163 | 220 | 258 | 247 | 251 | 2246 |
| Max Temp (°C) | 27 | 27 | 25 | 23 | 20 | 17 | 18 | 21 | 24 | 25 | 26 | 27 | |
| Min Temp (°C) | 15 | 14 | 13 | 9 | 4 | 0 | 0 | 3 | 8 | 11 | 13 | 14 | |

**FIGURE 2-2: AVERAGE MONTHLY CLIMATE FOR THE SITE (WEST-WITS)**

## 2.5 TERRAIN

Two terrain datasets were used to assess the terrain of the site and its surrounds, namely:

1. A 0.5 m digital terrain model (DTM) derived from the client-provided 2023 LiDAR point cloud dataset;
2. A 1 m digital terrain model (DTM) derived from the client-provided 2023 LiDAR point cloud dataset;
3. A 30 m DSM global digital surface model (DSM)[4]; and
4. National Geospatial Institute (NGI) 5 m contours.

**Figure 2-3** illustrates the elevation datasets utilised.

High-resolution terrain data were reviewed for all facilities, including the Kusasalethu TSF, for which the client supplied 2023, 2024, and 2025 LiDAR datasets. Although the 2025 dataset supersedes the 2024 survey in both date of capture and quality, neither the 2024 nor the 2025 dataset provided full spatial coverage of the TSF or the surrounding areas required for hydrological assessment. In contrast, the 2023 LiDAR dataset offers complete coverage across all relevant sites, including the Kusasalethu TSF, and aligns with the datasets available for the other components of the study area. To maintain internal consistency, ensure comparability, and avoid partial or mismatched topographic surfaces, the 2023 LiDAR dataset was adopted as the primary terrain source for all modelling and spatial analyses. The newer datasets were nevertheless reviewed to confirm that no substantial geomorphic changes had occurred that would materially affect the hydrological interpretation. It is important to

[4] *https://www.eorc.jaxa.jp/*

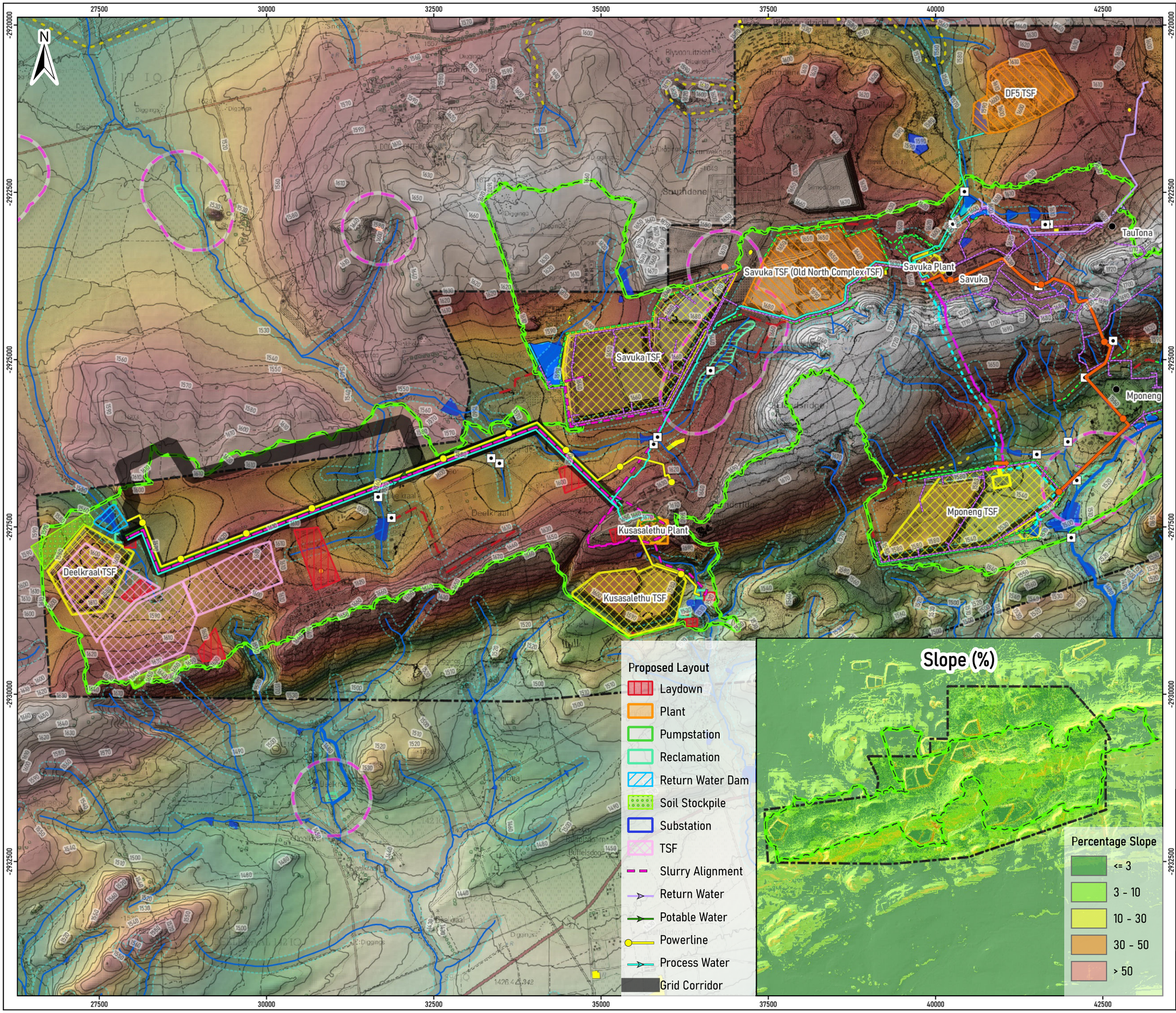
note that the site is an operational mine; thus, certain areas of the terrain did not correlate with the aerial imagery and site observations, and these are discussed in the assumptions and limitations in Appendix A.

Terrain detail on the site is highly detailed due to the use of the 0.5 m and 1 m datasets. The LiDAR-derived terrain datasets were selected as the primary source of elevation information due to the spatial resolution and coverage of the study area. The 1 m LiDAR DTM was used for the delineation of sub-catchments and the determination of the area of hydrological relevance in the hydrological model. For detailed hydraulic modelling and mapping, the 0.5 m LiDAR DTM was employed and supplemented by the low-resolution 30 m DSM where required.

The DTM is preferred as it represents the 'bare-earth' surface, with vegetation and buildings removed, whereas a digital surface model (DSM) includes surface features such as vegetation and buildings. For this study, the use of a coarse 30 m DSM was primarily used for mapping and had a limited influence on the flood model. The NGI's 5 m contours provide a generalised understanding of the terrain of the site and its surroundings.

Ground elevations on the West-Wits site are approximately 1,500 m to 1,711 m AMSL.

**Figure 2-3** also includes a calculation of slope with the site predominantly exhibiting slopes below 10%; however, the areas with existing TSFs are generally more undulating, with some slopes here falling between 10-30%.




## Legend

- Area of Hydrological Relevance

**Reclamation Areas**

- Existing
- Existing (Trade-off)

**Proposed Layout (Mponeng)**

- Pipelines Alternative Route (Propos
- Return Water Alignment (Proposed)
- Slurry Alignment (Proposed)
- Culvert (Proposed)
- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Shafts (Mponeng)
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- Dam (50K Topo)
- Non-perennial pan (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- 100m Watercourse Buffer (DWS)
- 500m Vlei/Pan Buffer (DWS)
- Culverts (Modelled)

**Elevation (m AMSL)**

1 711

1 500

- 0.5m Survey Extent
- 10m Contour (0.5m DTM Derived)

Figure 2-3

Terrain and Hydrology

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0 0.8 1.6 2.4 km

| Scale - 1:52,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

## 2.6 HYDROLOGY

**Figure 2-3** also illustrates the hydrological setting of the site, while **Figure 2-1** presents the river network of the greater region. The Mooirivierloop is a perennial river situated north-east of the site in quaternary catchment C23E, which approximates 850 km$^2$ in area. The Loopspruit River is also perennial; it is situated to the south of the site in quaternary catchment C23J.

The site is positioned primarily within quaternary catchments C23E and C23J; however, the area of hydrological relevance (AHR) encroaches on catchment C23G and is approximately 79.65 km$^2$.

The nearest rivers are the Mooirivierloop River to the north-east of the site, and the Loopspruit River situated to the south. According to the NGI's 1:50,000 topographical map data, water drains from the site to both rivers through stormwater channels and non-perennial rivers. The NGI's 1:50,000 topographical map data illustrates numerous non-perennial river systems to the north and south, both of which converge to the southwest of the site into the Mooirivier.

The northern system is associated with multiple vleis along the Mooirivierloop channel to the north and dams both north and south of the site. There are furrows directing runoff from part of the greater Mponeng Operation (south of the Old North Complex TSF) and along the Mponeng TSF trenches draining to the non-perennial rivers to the west. The southern system is characterised by two larger dams, one of which is listed as the proposed return water dam for the Mponeng TSF. There are two dams to the west, one that connects to the Mooirivierloop network and is the proposed alternative location for the Return Water Dam to the south of the proposed Deelkraal TSF. This proposed return water dam sits at the headwaters of the non-perennial tributary connecting to the Loopspruit river.

All hydrological features have been presented according to the NGI's 1:50,000 topographical map data, and this report does not intend to alter their classification.

To refine the representation of available flow paths and verify the accuracy of mapped channel positions, high-resolution 2023 aerial imagery and 0.5 m LiDAR-derived terrain data were incorporated into the hydrological assessment. These datasets provided improved delineation of channel alignments, floodplain extents, and anthropogenic modifications not captured in the 1:50,000 topographical maps. Subtle shifts in drainage lines, the presence of diversion features, and updated dam and vlei extents were identified, some of which influence local flow routing and river reach connectivity. While the NGI mapping remains the formal source of hydrological feature classification, the LiDAR and imagery datasets were used to inform flood model development.

In considering the intended flood modelling, TSFs and associated RWDs were assumed to be self-contained such that they would not contribute to flooding. **Figure 2-3** consequently illustrates this along with the AHR defined for the study. The AHR is the area from which rainfall and subsequent runoff generate simulated flooding within the northern and southern river systems of interest.

This report also does not delineate or comment on the significance of any wetlands/vleis – consideration of this would require a wetland specialist. The NGI's 1:50,000 vleis are used for indicative purposes.

## 2.7 SOILS, VEGETATION, AND LAND-COVER

In considering the Soil Conservation Service for South Africa (SCS-SA) dataset of the area of hydrological relevance, soils are classified as being in hydrological soil group C (moderately high runoff potential). The TSFs have, however, covered the site's original soil. TSF soil conditions are expected to have high runoff potential.

The natural vegetation of the site is classified as Gauteng Shale Mountain Bushveld (according to SANBI, 2018). 'Grassland' is predominant over the area of hydrological relevance, followed by 'Forested Land', and 'Mines and Quarries', with most occurring in the study area according to the Department of Forestry, Fisheries and the Environment (DFFE's) 2022 land-cover dataset. 'Forested Land' and 'Built-up' are secondary land-covers surrounding the study area infrastructure.

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

30000 35000 40000 45000

-2920000 -2925000 -2930000 -2935000

C23E C23G C23J C23K

Kraalkoopspruit Loopspruit

SCS Soils

## Legend

- Quaternary Catchment
- Area of Hydrological Relevance
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)

**SANBI Vegetation Atlas (2018)**

- Andesite Mountain Bushveld
- Carletonville Dolomite Grassland
- Gauteng Shale Mountain Bushveld
- Rand Highveld Grassland

**SCS Soils Runoff Potential**

- B/C - Moderately Low to Moderately High Runoff Potential
- C - Moderately High Runoff Potential

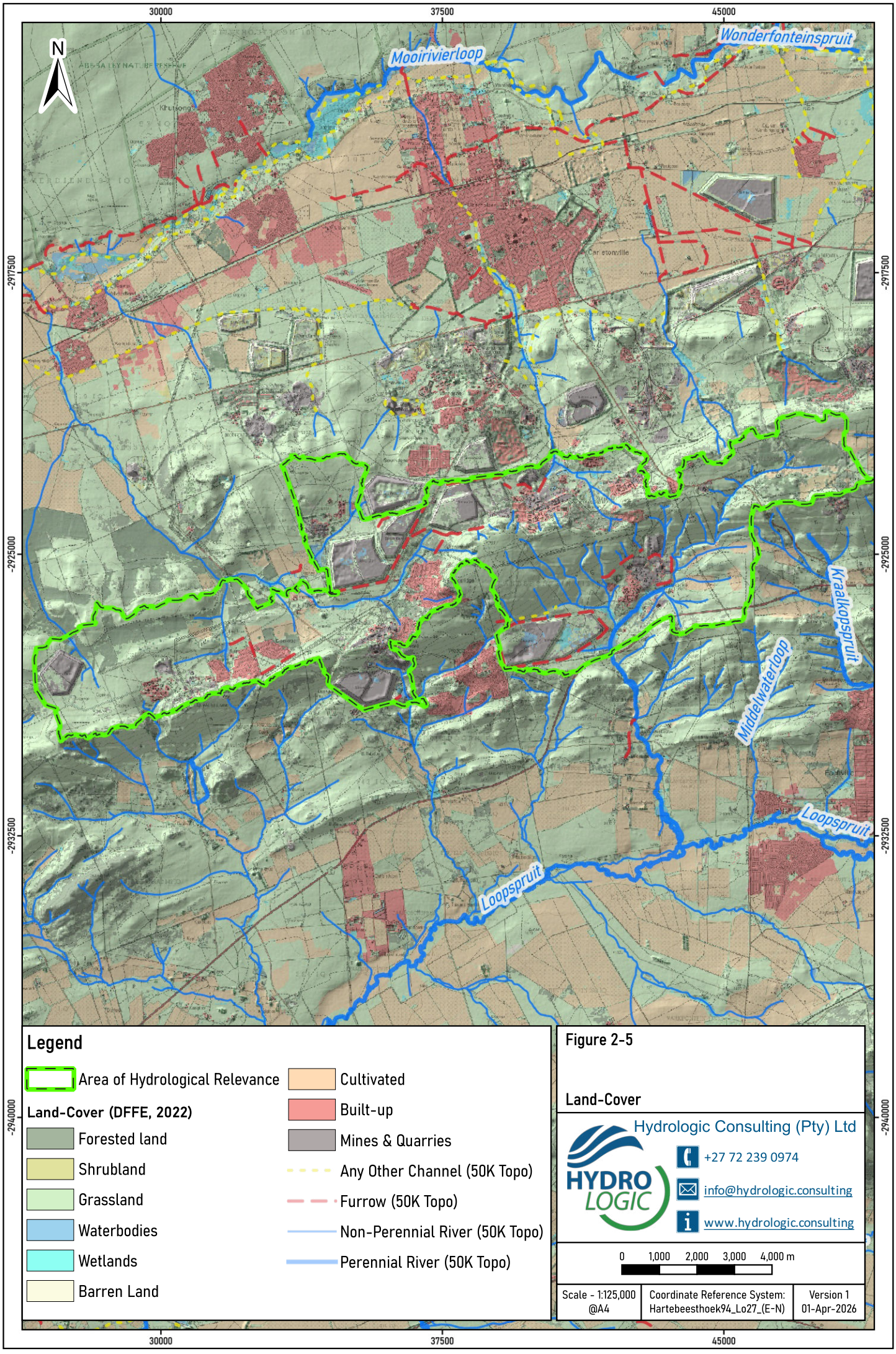
**Figure 2-4**

**Vegetation and Soil Runoff Potential**

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+27 72 239 0974
info@hydrologic.consulting
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0 1 2 3 km

| Scale - 1:70,000 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|


30000
37500
45000
-2917500
-2925000
-2932500
-2940000
N
Mooirivierloop
Wonderfonteinspruit
Kraalkopspruit
Middelwaterloop
Loopspruit
Loopspruit
Legend
Area of Hydrological Relevance
Land-Cover (DFFE, 2022)
Forested land
Shrubland
Grassland
Waterbodies
Wetlands
Barren Land
Cultivated
Built-up
Mines & Quarries
Any Other Channel (50K Topo)
Furrow (50K Topo)
Non-Perennial River (50K Topo)
Perennial River (50K Topo)
Figure 2-5
Land-Cover
Hydrologic Consulting (Pty) Ltd
HYDRO LOGIC
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting
0 1,000 2,000 3,000 4,000 m
Scale - 1:125,000 @A4
Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N)
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# 3 FLOODING ASSESSMENT

The details of the flood modelling for the site are presented in **Appendix A**. Since the modelling of flooding is (as undertaken), an approximation of reality, various assumptions and limitations are relevant when considering the status quo (baseline flooding) model results. These have been highlighted at various places in this report and are also outlined in Appendix A.

## 3.1 RELEVANT GUIDANCE

The following guidance informs the need for flood-lines; in particular, the 1:100-year RI flood-line.

### 3.1.1 DEPARTMENT OF WATER AND SANITATION NOTICE 4167 OF 2023

DWS Notice 4167 of 2023 "General Authorisation in Terms of Section 39 of the National Water Act 36 of 1998 for Water Uses as defined in Section 21(c) or Section 21(i)" includes the following:

- **Regulated area of a watercourse** – for section 21(c) or (i) of the Act, water uses in terms of this Notice means:

(a) The outer edge of the 1 in 100-year flood line or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, dams, and lakes;

(b) In the absence of a determined 1 in 100-year flood line or riparian area as contemplated in (a) above the area within 100m distance from the edge of a watercourse where the edge of the watercourse (excluding flood plains) is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the National Water Act 36 of 1998);

(c) In respect of a wetland: a 500 m radius around the delineated boundary (extent) of any wetland (including pans);

Where the applicable Section 21 water uses per the above are as follows:

- ***Section 21 (c)*** – impeding or diverting the flow of water in a watercourse;

***Section 21 (i)*** – altering the bed, banks, course, or characteristics of a watercourse

### 3.1.2 GOVERNMENT NOTICE 704

The Department of Water Affairs and Forestry (now the Department of Water and Sanitation) established GN 704 to provide regulations on the use of water for mining and related activities aimed at the protection of water resources. There are important definitions in the regulation that require understanding.

The principal condition of GN 704 applicable to the mine concerning flooding is summarised as follows:

- *Condition 4* defines the area in which mine workings or associated structures may be located with regard to a watercourse and its associated flooding. The 50-year flood-line and 100-year flood-line are used for defining suitable locations for mine workings (prospecting, underground mining, or excavations) and associated structures, respectively. Where the flood-line is less than 100 metres away from the

watercourse, then a minimum watercourse buffer distance of 100 metres is required for both mine workings and associated structures.

## 3.2 RIVER REACHES OF RELEVANCE

The operational area contains multiple non-perennial drainage features, including non-perennial streams and furrows. These drainage lines occur within, adjacent to, and around the mining footprint and the associated infrastructure. Multiple river reaches were delineated and modelled. These reaches include non-perennial channels that intersect the mining footprint, as well as those located immediately upstream and downstream of mining-related infrastructure. Per the 100 m buffer (of the 1:50,000 topographical map rivers), the southern (Loopspruit) river is within greater proximity to the operational footprint than the northern (Mooirivierloop) river.

## 3.3 HYDRAULIC MODEL CHOICE

HEC-RAS 6.7 was selected to model flood hydrology and hydraulics using a 2D model approach. HEC-RAS is designed to perform one-dimensional and two-dimensional calculations for a full network of natural and constructed channels. The software is used worldwide, and the 1D component of the model has undergone thorough testing through numerous case studies. The 2D component to the HEC-RAS model is a recent addition, having been released in 2015, although robust benchmarking (USACE, 2016) and verification and validation tests (USACE, 2018) have been performed to prove that the 2D component of the model works as intended.

## 3.4 FLOOD APPROACH

The defined 1:50,000 topographical map, rivers within and around the mining footprint, and the associated infrastructure were selected (for flood modelling). The modification to the proposed layout resulted in the development of two flood models: the greater West-Wits and Mponeng model and the updated Savuka model, which reflected the latest proposed layout. The Mponeng results are excluded from this report and can be found in a secondary flood study report. The position of the culverts is illustrated in **Figure 2-3.**

**Greater Harmony West-Wits and Mponeng**

Flood modelling utilised the 1 m DSM for the development of the hydrological (PCSWMM) model and 0.5 m for the hydraulic (HEC-RAS) model.

The PCSWMM model utilised 253 subcatchments for flood assessment connected by hypothetical channels. Each subcatchment had its hydrological parameters informed by site-specific datasets. Due to the operational footprint, subcatchments for the TSFs were defined as self-contained where applicable, such that runoff generated within the TSF footprint and associated operational areas is retained and managed internally, without interaction with surrounding clean water catchments.

The delineation process was informed by high-resolution 1 m terrain data and aerial imagery. The output of PCSWMM was 34 1:100 RI, 24-hour design hydrographs that were applied to the multiple non-perennial rivers, and visible channels in places that deviated from the 50K river channels due to observed terrain changes. This division of the inflow hydrographs was based on the individual river reaches, approximating 1 km, which assists in improving the accuracy of the modelling by distributing flows rather than 'lumping' flows together.

The availability of a continuous 0.5 m DTM and 30 m DSM allowed for the adoption of a 2D flood model approach using HEC-RAS. Unlike a 1D approach (using cross-sections), which samples the DSM at set cross-section

locations, a 2D model approach uses a continuous model grid. The advantage of a 2D model is consequently its ability to account for more variation in the topographic data since no gaps are present in the model geometry (as is the case with cross-sections).

The use of the 0.5 m DTM (2023) resulted in minor terrain modifications. The dataset is LiDAR-derived, and LiDAR cannot penetrate water. This, along with the high degree of vegetation noted over the dam (per aerial imagery), results in a poorly interpolated DTM surface water elevation. The storage potential of the dam and its attenuating influence on the flood surge are consequently not well represented. This would require a bathymetric survey of the dam for an accurate depth determination. A high-level approximation of the dams was undertaken to modify the terrain to improve the interpolated water surface elevation. The modified dam elevations were used to set initial conditions in the HEC-RAS model; these initial conditions are considered to provide a realistic antecedent storage and tailwater state for assessing fluvial flood behaviour and associated downstream impacts.

A 30 m DSM was applied in the model, where the available 0.5 m terrain data was insufficient. Along the interface between the 30 m and 0.5 m datasets, targeted terrain modifications were implemented to improve surface interpolation and, consequently, the reliability of the simulated flood extents and depths. The 0.5 m survey extent mapped in the flood results in **Section 3.5** illustrates the interface between the two datasets.

The 1:50,000 topographical mapping provided an initial indication of river alignment and surface water flow paths. During the site visit, however, field observations and review of the available terrain data showed that the actual low-flow channel and overland flow direction differ from the mapped topographical rivers in the village and golf course North of the Savuka Plant. This resulted in the management of water through a stormwater management plan, grass channels, and culverts. For the purposes of the flood modelling, the hydrographs were applied to the current drainage configuration defined in accordance with the observed terrain controls and site evidence, rather than strictly following the 1:50,000 topographical river layer.

**Savuka**

The existing Savuka TSF model (Project No. EIM-019, 14 November 2025) was refined to include a larger downstream area, and the previously excluded upstream area was included due to the updated proposed layout. The exclusion of this area is not considered to materially affect the flood behaviour at the study location, provided that the assumptions and design criteria of the earlier study remain applicable. Within this river reach, seven hydrographs and three culverts are relevant, all of which are located along the defined watercourse. Harmony provided the details of these culverts.

Flood modelling utilised the 1 m DTM for the development of the hydrological (PCSWMM) model and 0.5 m for the hydraulic (HEC-RAS) model.

The PCSWMM model utilised 19 subcatchments connected by hypothetical channels. Each subcatchment had its hydrological parameters informed by site-specific datasets. The output of PCSWMM was seven 1:100 RI, 24-hour design hydrographs that were applied to the non-perennial river at various locations.

## 3.5 FLOOD MODELLING RESULTS

The overall results of the status quo flood modelling are presented in **Figures A-3**, **A-4**, and **A-5**, which illustrate the 1:100-year and 1:50-year flood-lines for the West, Central, and East of West-Wits. The flood-lines are plotted together as the results are nearly coincident. A 100 m watercourse buffer (defined according to the NGI's 1:50,000 topographical map dataset) is also presented in the flood-line figures**. Figures 3-1**, **3-2**, and **3-3** present the maximum depth associated with the 1:100 RI flood event for the West, Central, and East, respectively, while **Figures A-9**, **A-10**, and **A-11** illustrate the maximum flood velocity for the 1:100-year flood event. The 1:50-year depth and velocity results are represented in **Figures A-6**, **A-7**, **A-8**, **A-12**, **A-13**, and **A-14** for the West, Central, and East West-Wits. The following discusses flooding based on the status quo results. Proposed works will alter the status quo.

**Deelkraal (DS1)**

The flood modeling results for the Deelkraal area indicate that both the 1:50 and 1:100-year flood events do not intersect or inundate the existing TSF (Tailings Storage Facility) toe paddocks. However, the flood-lines intersect the proposed reclamation laydown area and the proposed reclamation area. The proposed Deelkraal I TSF expansion will also intersect with the delineated flood-lines.

The proposed pump station and high-tension (HT) substation are located outside the identified flood-lines. Similarly, the proposed soil stockpile is not affected by flood impacts; however, a separation distance of only approximately 2 metres exists between the 1:100-year flood-line and the stockpile.

The proposed Deelkraal Reclamation Construction Laydown area is situated within both the 1:50 and 1:100-year flood-lines. Most of the flood-line lies within the 100 m regulated watercourse buffer zone; however, two portions of the flood-line extend beyond this buffer. The most notable exceedance occurs along the eastern bank of the river, where the proposed pipelines and grid corridor are located. The depths in this area are primarily less than 0.25 m. The flood velocity exceeding 1m/s is noted in the channel centre line, with velocities exceeding 2 m/s, where depths do not exceed 1 m.

**East of Deelkraal (DS3)**

The flood modeling results indicate that the 1:50-year and 1:100-year flood events are predominantly contained within the 100 m regulated watercourse buffer. Limited exceedance of the buffer occurs in three key areas: at the large dam within the main river channel, within the downstream floodplain, and in the lower reaches of the river channel.

The proposed grid corridor and associated pipelines intersect both the 100 m buffer and the modeled flood-lines, as these services traverse areas connected to the 1:50,000 topographically mapped rivers. The proposed laydown area is also situated within, and partially intercepts, the delineated flood-lines, river channel, and buffer zone.

**Figure A-9** illustrates velocities that exceed 2 m/s in some places, largely associated with the centre of the river. The proposed pipelines and grid corridor are illustrated as being located within an area of velocities exceeding 2 m/s.

Overall, while the majority of the flood extents remain contained within the recommended buffer limits, localised encroachments have been identified.

**West of Savuka (DS4)**

The 1:50 and 1:100-year design floods are predominantly contained within the delineated 100 m river buffer, indicating that the existing corridor accommodates most overbank flows for these events. Localised exceedance of the buffer is, however, observed along the secondary road where shallow overtopping and lateral spill of floodwaters occur. In the downstream floodplain, inundation widens notably as flow velocities decrease and water spreads across the low-lying areas, resulting in broader but generally shallower flooding.

Along the secondary road, out-of-buffer flooding is associated with local topographic lows and constrained conveyance at road embankments and crossings, which cause ponding and overtopping on the road surface. This suggests a need for improved drainage provisions or upgraded crossing structures to safely pass the 1:50 and 1:100 year events without compromising access. In contrast, the downstream floodplain functions as a natural storage and attenuation zone, where floodwaters disperse over a wider area, reducing peak flow but increasing the extent of inundated land.

**Figure 3-3** indicates that depths in this reach do not exceed 1 m, which is noted upstream, and the maximum flood depth of the floodplain is less than 0.25 m. The velocities in this area are primarily below 2 m/s, with higher velocities associated with the channel centreline.

These results highlight that, while the 100 m buffer is largely effective in containing flood extents for the analysed events, targeted interventions are required at the secondary road and within the downstream floodplain to manage residual flood risk and protect infrastructure and land use in these locations.

**Kusasalethu (DS5)**

The flood-lines are primarily contained within the delineated 100 m river buffer, indicating that the buffer generally accommodates the modeled flood extents for the assessed events. Noticeable flooding does, however, occur upstream of the modeled dam, where inundation clearly exceeds the 100 m buffer and extends laterally beyond the immediate river corridor. From the aerial imagery, this upstream flooding is concentrated within the cascading vegetated dam compartments, illustrating that these features actively store and convey floodwater during high-flow conditions. The floodwaters are noted overtopping the road deck north of the dam.

Upstream of the dam, the proposed pipelines, as well as the reclamation and laydown areas, are situated within the mapped flood-lines and are therefore exposed to inundation during the design flood events. In addition, the pipelines and powerlines intersect the river channel at two locations, placing these linear infrastructures directly within the flood-prone zone at the crossing points.

**Figure 3-7** indicates flood depths exceeding 2 m; however, this is associated with the return water dam. The flood depths remain below 0.5 m in the river channel. Despite these limited depths, the corresponding flood velocity results show relatively high flow velocities, frequently exceeding 2 m/s within the channel. The elevated velocities are attributed to the confined nature and longitudinal gradient of the drainage channel, which concentrate and accelerate the flow towards the dam.

These results highlight the need to consider flood-resilient design, protection, or potential realignment of the pipelines, powerlines, and associated surface infrastructure in the upstream area to reduce flood risk and operational vulnerability.

**Mponeng (DS6)**

Whilst there are formalised furrows along the northern perimeter of the TSF, floodwater is observed to enter the lower compartment of the TSF, indicating that the current drainage measures do not fully prevent inundation of this

facility. There is noticeable flooding along the eastern perimeter of the TSF where water extends beyond the 100 m buffer, further demonstrating local exceedance of the designated flood corridor. The culvert downstream of the dam is noted to convey most of the flow; however, ponding and overtopping occur upstream of the structure, with water overtopping the road deck during the design events.

To the north of the plant, there has been an effort to divert runoff along the roadside, but the channel does not fully contain the flow, and flooding of the plant area is evident (not originally represented as a plant platform in the model). A portion of this flow is observed to re-enter the downstream drainage system, joining the river channel and draining towards the modelled dam.

**Figure 3-3** indicates shallow flooding over the modelled reaches. Concentrated depths are noted in the main channel and the dam downstream of the TSF. The flood depths of the TSF Lower Compartment do not exceed 0.5 m. The flood velocity is illustrated exceeding 2 m/s in some areas, large;y associated with the centre of the river channel and the spillway downstream of the dam.

The proposed pipelines intersect the mapped flood-lines where they cross the river channels, confirming that these crossings are located within active flood zones and should be treated as critical points for flood-resilient design and protection.

**North of Savuka Plant (DS7)**

There are several locations where flooding clearly exceeds the 100 m buffer, particularly in the upstream reaches and local low-lying areas. The dam, its associated channel, and the downstream culvert effectively contain floodwater, and most of the water in the downstream floodplain remains within the 100 m buffer as intended.

In the upstream modelled reaches, substantial volumes of water are seen leaving the 100 m buffer; however, this area was not represented strictly according to the 1:50,000 river alignment, owing to the observed stormwater management measures and diversion of flows. Ponding in the far eastern area, where no culvert is present, and local topography promotes water accumulation, was anticipated based on the terrain and existing drainage configuration. Additional ponding is also evident along the roadside, with overtopping of the road deck where effective drainage structures are absent or not well defined.

**Figures 3-3** and **A-11** illustrate the flood depths and velocities. The depths exceeding 2 m are associated with the North Boundary Dam. The depths exceeding 1 m are associated with the centre of the channel and the ponding in the far eastern area. The velocities remain primarily less than 2 m/s, and velocities at or exceeding 2 m/s are associated with the centre of the channel.

The proposed pipelines are located within the mapped flood-lines at the points where they intersect the river channels, confirming that these crossings fall inside active flood zones and will require appropriate design and protection to manage flood risk.

**Savuka**

The 1:50 and 1:100-year flood events are primarily contained within the delineated 100 m river buffer, confirming that the designated corridor generally accommodates these design floods. The buffer does, however, intersect the TSF (Old North Complex), and model results indicate inundation within portions of the TSF footprint, demonstrating that this facility is exposed to flooding under both return periods.

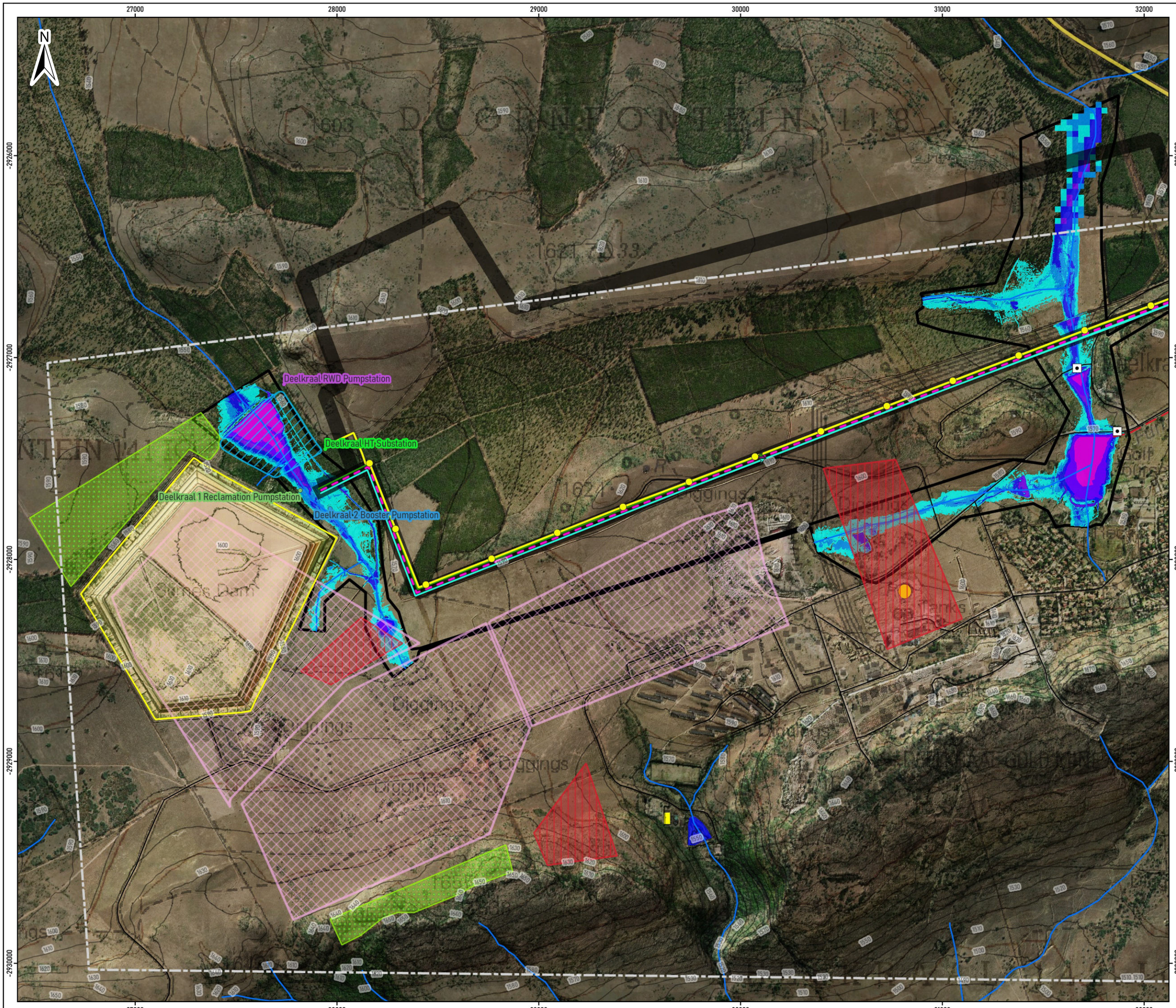
Flooding is also observed where the proposed pipelines intersect the 100 m buffer at multiple locations as they cross the river channel. In these areas, the pipelines are consequently situated within the mapped flood-lines for

the 1:50 and 1:100 year events. This indicates a potential risk to pipeline integrity and operability during flood conditions and may necessitate design refinement, protection measures, or alignment adjustments to reduce exposure to flood-related impacts.

**Figure 3-1** illustrates depths in the channel centreline exceeding 1 m; the depths associated with the 1:50-year event indicate shallow flooding spreading further, whereas the results of the 1:100-year event indicate greater depths concentrated in the channel. These results correlate with the flood velocity. The velocity tends to remain below 2 m/s for the 1:100-year event and coincides with the greater flood depths.

Inaccuracies in the flood modelling due to both general limitations in modelling and data limitations are discussed in **Section A.2.8.** Dimensional errors, such as additional freeboard, should be factored into the interpretation of the results.

This study, however, has evaluated up to the 1:100 RI event. Larger flood events, including the potential increases in flooding caused by climate change, would exacerbate the simulated flooding.




## Legend

**Proposed Layout**

- Laydown
- Return Water Dam
- Soil Stockpile
- TSF
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor

- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Depth (m)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure 3-1**

**Maximum Flood Depth (1:100 RI) West West-Wits**

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info@hydrologic.consulting
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0 200 400 600 800 m

| Scale - 1:17,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|




## Legend

**Proposed Layout**

- Laydown
- Plant
- Reclamation
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Trenches (Mponeng)
- Tailings and Process Water Pipelines (Existing)
- Pollution Dams (Mponeng)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Depth (m)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

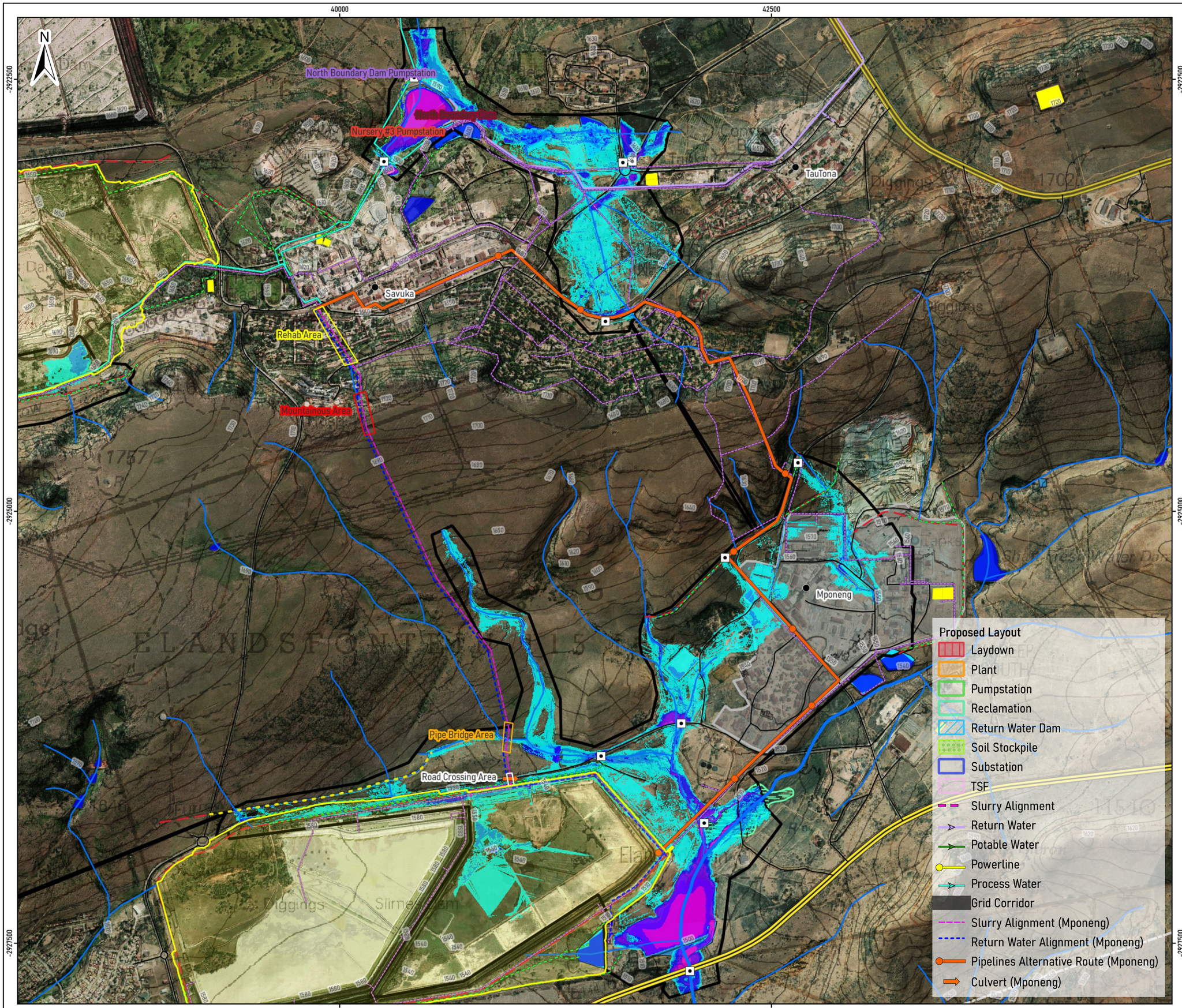
Figure 3-2

Maximum Flood Depth (1:100 RI) Central West-Wits


Hydrologic Consulting (Pty) Ltd
HYDRO LOGIC
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting


0 200 400 600 800 m

| Scale - 1:18,250 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|




## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Mponeng Shafts
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Main Road (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- Self-contained
- Mponeng Plant (Not Modelled)
- Culverts (Modelled)

**Maximum Flood Depth (m)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure 3-3**

**Maximum Flood Depth (1:100 RI) East West-Wits**

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info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:20,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

# 4 CONCLUSION AND RECOMMENDATIONS

This report presents a hydrological flood-line assessment for the Harmony West Wits and Mponeng Mining Compound, inclusive of Savuka, prompted by a directive from the Department of Water and Sanitation. The study modelled the 1:50-year and the 1:100-year recurrence interval (RI) flood lines for the non-perennial river systems located to the north and south of the TSFs using a 2D HEC-RAS hydraulic model.

**Recommendations**

The reader is referred to **Section 3.5** flood maps for the basis of the recommendations. The following actions are recommended to mitigate the identified flood risk to the status quo model. It is important to note that recommendations are based on current conditions and landuse.

- Based upon site observations, the maintenance of culverts and channels (i.e., removal of vegetation) to ensure water is adequately conveyed.
- Ensure distinction between clean and dirty water diversions with sufficient berms between channels to prevent channel erosion and overtopping of channel banks.

**Deelkraal**

- **Berm Reinforcement**: The RWD spills in two locations (both left and right), resulting in not all floodwater being routed through the spillway, which is a serious safety concern. The earthen berm at the foot of the Deelkraal RWD should be raised and reinforced, particularly at the low point where overtopping occurs.
- **Prevent RWD Inflow**: In consideration of the status quo conditions, the clean water diversion channel of the RWD is not sufficient to convey the 1:50 and 1:100 RI flood events. Ensure distinction between clean and dirty water diversions with sufficient berms between channels to prevent channel erosion and overtopping of channel banks.
- The channel and RWD capacity concerns are relative to the status quo results; however, should the proposed layout be constructed, the majority of the upstream catchment is expected to be removed, therefore reducing the downstream containment requirements.

**Mponeng**

- **Reinforce perimeter berms:** Raise and strengthen the earthen berm surrounding the Mponeng TSF, focusing on sections where overtopping occurs along the enforced furrow centreline, to ensure that all floodwaters are safely contained and routed away from the compartments.
- **Prevent TSF and plant inflow:** Reconfigure and upgrade diversion and drainage infrastructure so that no floodwater enters the TSF compartments or plant area, with clearly separated clean and dirty water channels and sufficient berms to prevent erosion, bank overtopping, and site run-on, particularly north of the Mponeng plant, where additional channel capacity is required to convey flows downstream.

**Savuka**

- **Berm Reinforcement**: The earthen berm surrounding the Savuka TSF (Old North Complex) should be raised and reinforced to prevent flood inflow. The primary goal of these engineering works should be to contain the floodwaters where possible to reduce the risk of a flood-induced spill. Furthermore, enforced distinction between clean and dirty water channels to prevent cross-contamination and flooding of channels.

Consider the location of the proposed pipelines where they traverse the mapped flood-lines, and ensure the final design adequately accounts for flood exposure. Ensure that construction occurs with consideration of a GN-704-compliant stormwater management plan where applicable. Furthermore, consider the proposed location of reclamataion and laydown areas, where poor alignment is proposed along/within active floodplains. Revised routing/placement or additional protection measures should be evaluated for this section.

This study evaluated events up to the 1:100-year RI. Larger floods and the potential effects of climate change could further exacerbate flooding, underscoring the need for robust, conservative engineering solutions.





Mckennah Harrower
BAHons Geography and Environmental Studies
Author/Reviewer

Mark Bollaert
MSc, CSci, CEnv, C.WEM, PrSciNat
Author/Project Manager/Reviewer

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# APPENDIX A: FLOOD MODELLING

## A.1 HYDROLOGICAL MODEL

A hydrological model was required to be first developed for the area of hydrological relevance to the two rivers.

### A.1.1 HYDROLOGICAL MODEL CHOICE

PCSWMM is a model package that makes use of the USEPA Storm Water Management Model (SWMM), which is a computer program that computes dynamic rainfall-runoff from developed urban and undeveloped or rural areas (Rossman, 2008).

The SWMM model suited the application to this study since it could account for:

- Time-varying rainfall;
- Rainfall interception in depression storage;
- Infiltration of rainfall into unsaturated soil layers;
- Routing of overland flow;
- Dynamic wave flow routing of flood waters; and
- Capture and retention of rainfall/runoff.

The hydrological modelling, as it pertains to the development of storm water management plans and flooding assessments using SWMM, has been undertaken for many thousands of studies throughout the world (Rossman, 2008), including South Africa, and was well-suited to deriving the upstream inflows and effective rainfall as input into the hydraulic component of this study.

### A.1.2 HYDROLOGICAL MODEL DOMAIN

The 1 m DTM formed the basis of the hydrological model domain, informing the partitioning of subcatchments, the accumulation of flow, and some parameterisation of the model (e.g., subcatchment slope). The 30 m DSM provided the supplementary subcatchments required for the hydrological model domain. A delineation was conducted, and the 30 m DSM-derived subcatchments were incorporated into the 1 m DTM-derived model where required. Subcatchments of interest were derived through geoprocessing of the available elevation data. Sequential computations of flow direction, flow accumulation, and stream definition based upon a contributing area of 20ha were then used to delineate the Harmony West-Wits and Mponeng subcatchments, with a total subcatchment area of 86.39km$^2$ being modelled, and a contributing area of 50ha was used to delineate the Savuka subcatchments, with a total subcatchment area of 11.85 km$^2$ (Savuka).

### A.1.3 SUBCATCHMENT DELINEATION

Subcatchment delineation for the flood assessment was applied to define contributing upstream catchments and to assess the influence of the TSFs. The ability to define self-contained subcatchments was based on high-resolution 1 m terrain data and aerial imagery. The approach prioritised the identification of drainage controls such as embankments, toe paddocks, channels, and return water dams, while recognising that data resolution and site conditions influence the clarity of drainage boundaries. Where terrain or imagery did not distinguish operational

areas from surrounding clean water environments, conservative, site-specific assumptions were applied to avoid overstating the extent of self-contained subcatchments.

TSF-Specific Delineation Decisions:

**Deelkraal (DS1)**

The Return Water Dam was not included within the self-contained subcatchment. Imagery and terrain data indicate that clean water flows toward the Return Water Dam from outside the TSF area. As such, the self-contained area was defined to include the TSF-footprint only, excluding the dirty area channel and downstream features.

**Savuka**

The upper compartments of the TSF were delineated as self-contained. However, the side slopes and peripheral areas were not considered self-contained due to evident drainage pathways directing runoff away from the TSF into surrounding catchments.

**Kusasalethu (DS5)**

The return water dam was excluded from the self-contained subcatchment. The delineation includes the TSF footprint and toe paddocks only, as drainage pathways indicate that the Return Water Dam receives flows from clean water areas external to the TSF.

**Mponeng (DS6)**

The TSF and the associated Return Water Dam were included within a single self-contained subcatchment. Although furrowed channels are present around the TSF, imagery suggests these features divert runoff toward the perennial river rather than toward the Return Water Dam. The TSF- dam system was therefore assessed as hydraulically self-contained for this study.

**North of Mponeng (DS7)**

The TSF is decommissioned (confirm). Depression storage associated with the TSF is assumed to form part of the self-contained area. This delineation extends beyond the immediate TSF footprint to include downstream operational areas influenced by the depression storage, representing a conservative assumption for flood assessment purposes.

### A.1.4 SUBCATCHMENT PARAMETERISATION

Land cover parameters were estimated according to the SCS-SA soil for the area of interest, DEA land-cover, the 0.5 m DTM, and imagery, for each of the 282 subcatchments (cumulative of two models). These were used to populate model attributes relating to depression storage, surface roughness, infiltration loss, slope, and impervious areas.

### A.1.5 DESIGN RAINFALL

In assessing flooding, it was necessary to define the associated rainfall that would cause this flooding. A hypothetical storm consequently needed to be developed, which utilised the depth-duration-frequency (DDF) data provided by DRESSA (see Section 2.2). This hypothetical storm is the design rainfall that will produce the highest degree of flooding at each location, independent of catchment response time (which is the index of the rate at which stormflow moves through a catchment). To calculate the hypothetical storm, the DRESSA 1:50 and 1:100 year RI rainfall depths for various durations (e.g., 5 minutes, 30 minutes, and 2 hours) were transformed into a

synthetic rainfall distribution or design hyetograph. The DRESSA estimates used were those relevant to the flooding component of the study.

When considering the catchment area upstream, it was not necessary to include an areal reduction factor that considers the difference between the design rainfall estimate for a point versus that over a large catchment (since larger catchments are less likely to experience high-intensity storms over the full catchment area).

### A.1.6 DESIGN HYDROGRAPHS

The 1:100-year RI design hydrographs were extracted from the PCSWMM model at 34 locations (Harmony and Mponeng) and 7 locations (Savuka) (for application on the river reaches to be modelled). A comparison of the downstream modelled hydrographs estimated using PCSWMM to the Standard Design Flood (SDF).

Differences between the regional SDF method and site-specific PCSWMM estimates are expected; however, **Figure A-1** illustrates these differences. The SDF method produced a high peak flow; as such, the PCSWMM model was adjusted to produce higher flows (than those produced from the original model), given the outcome of the SDF method.

It is, however, also the specific hydrological characteristics of the subcatchments making up the PCSWMM model that lead to one of the most significant uncertainties concerning the flood modelling undertaken. The parameterisation of these subcatchments has utilised site-specific datasets; however, some inaccuracies are expected, with the potential for peak flows and design hydrographs to differ in reality. The lack of calibration due to the absence of observed flows means the PCSWMM model results couldn't be verified.

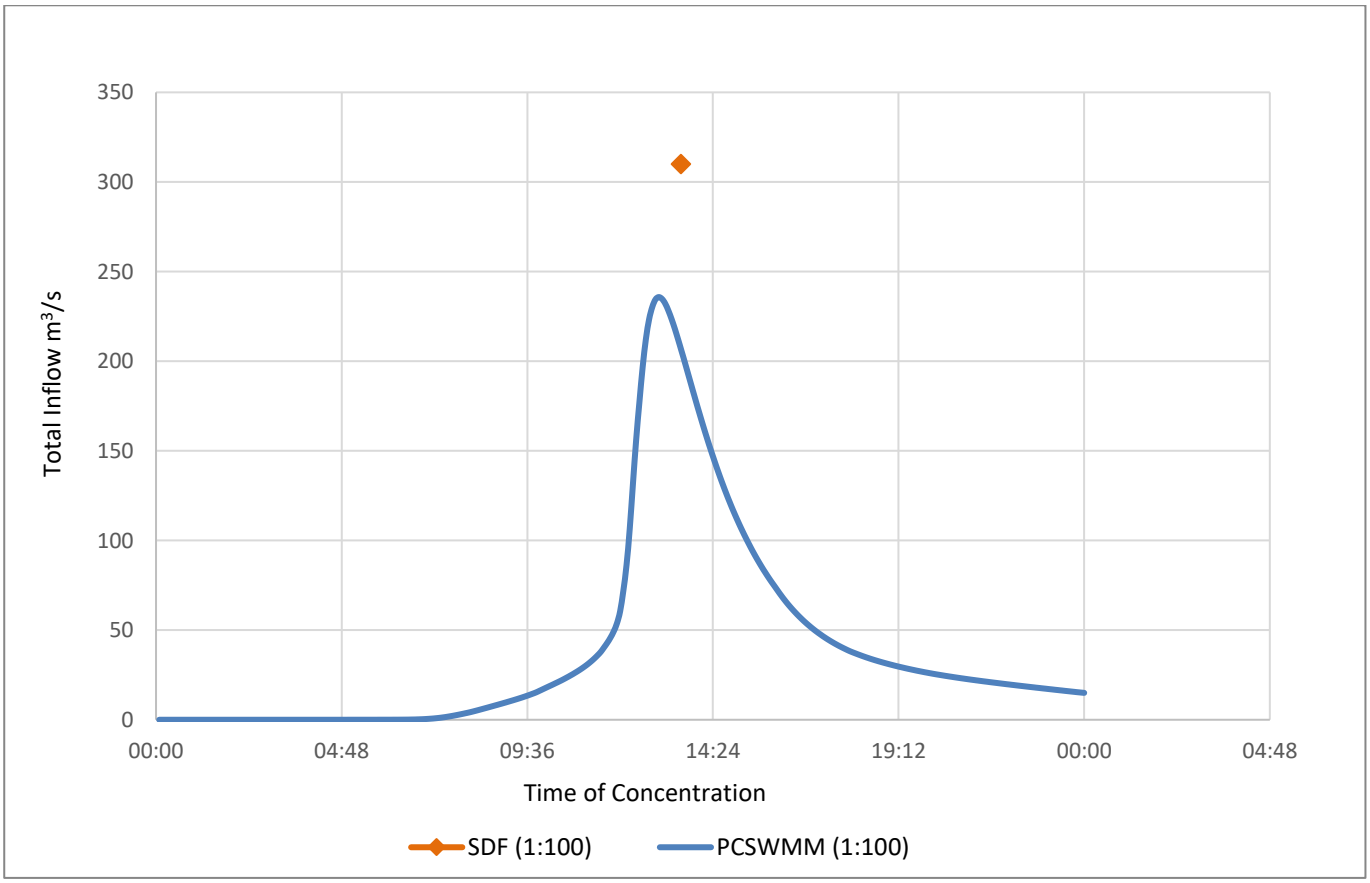



**FIGURE A-1: 1:100-YEAR RI HYDROGRAPH AND COMPARATIVE PEAK FLOWS**

## A.2 HYDRAULIC (FLOOD) MODELLING

The hydraulic model developed for modelling 1:100-year RI flood-lines utilised available terrain data in the form of the 0.5 m DTM and 30 m DSM.

### A.2.1 HYDRAULIC MODEL CHOICE

HEC-RAS 6.7 was selected to model the hydraulic flooding on the two rivers of interest. HEC-RAS is designed to perform one-dimensional and two-dimensional hydraulic calculations for a full network of natural and constructed channels. The software is used worldwide, and the 1D component of the model has been thoroughly tested through numerous case studies. The 2D component to the HEC-RAS model is a more recent addition, having been released in 2015, although robust benchmarking (USACE, 2016) and verification and validation tests (USACE, 2018) have been performed to prove that the 2D component of the model works as intended.

### A.2.2 TOPOGRAPHIC DATA

The 0.5 m DTM and the 30 m DSM data (detailed in Section 2.3) provided the available terrain data for the hydraulic model build. The 0.5 m terrain data was of higher accuracy but did not cover the full model extent and was supplemented by the 30 m DSM data, which has poorer accuracy (mostly associated with either thick vegetation or water).

### A.2.3 COMPUTATIONAL MODEL MESH

In developing a 2D HEC-RAS model, it was necessary to first delineate the model boundary. The model boundary was then used to define the model grid, with a 5 m model mesh spacing selected to maximise spatial detail while limiting unnecessary model complexity.

The computational model mesh is the primary element making up the HEC-RAS 2D model. This mesh contains the data about the terrain of the underlying elevation data, the presence of linear features, and surface roughness.

One of HEC-RAS's major advances in hydraulic modelling has been the addition of a subgrid. The subgrid extracts the detail available in the underlying terrain (i.e., the 0.5x0.5m DEM) into a hydraulic properties table for each cell and cell face in the model mesh. This includes variables such as the elevation/volume relationship per cell and the cross-section, elevation/area, and wetted perimeter for each cell face. This results in HEC-RAS models being able to use a larger cell size while still representing much of the underlying terrain, thereby producing an improved model result.

Aside from added hydraulic detail, the visual benefit from HEC-RAS using a subgrid is that a more representative result of the expected flooding is possible since HEC-RAS will show only partial flooding for a mesh cell (where applicable).

### A.2.4 BOUNDARY CONDITIONS AND BREAKLINES

Upstream and downstream boundaries were defined for the model using a normal depth slope. This 'normal depth' is estimated according to the river bed slope.

The 40 inflow hydrographs (Savuka and West-Wits) were applied to the upstream ends of the relevant river reaches within the hydraulic model, despite being representative of the accumulated flows at the downstream end of the

respective reach. This is common practice, whereby the design hydrographs for a point at the end of a modelled river reach are applied to a point upstream, resulting in some conservatism (where more flooding is conservative).

Breaklines were used to represent linear features that may otherwise have been missed by the application of a consistent model mesh (e.g., 5 m mesh).

### A.2.5 ROUGHNESS VALUES

A Manning's 'n' value shapefile was developed for the site based upon a review of aerial imagery. Values ranged between 0.015 (concrete channel) to 1.0 (building). Manning's 'n' values are approximate only and assume uniformity in areas (where some localised variation is expected).

### A.2.7 MODEL RUN

More accurate full momentum equations were used in the running of the model.

27500 30000 32500 35000 37500 40000 42500

-2922500 -2925000 -2927500 -2930000 -2932500

N

## Legend

- Initial Conditions (Dams)
- Culverts (Modelled)
- Breaklines
- Boundary Conditions
- 2D Model Boundary (Savuka)
- 2D Model Boundary (Harmony)
- Proposed 'To Model'
- 0.5m Survey Extent
- Dam (50K Topo)
- Non-perennial pan (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)

Elevation (m AMSL)

1 711

1 500

Figure A-2

Hydraulic Model Setup

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0 0.8 1.6 2.4 km

| Scale - 1:50,000 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

### A.2.8 ASSUMPTIONS AND LIMITATIONS

Various assumptions were required in the development of the hydraulic model, with resultant limitations in the accuracy of the modelled flooding. They included the following:

- *Rainfall distribution* – the rainfall distribution used is hypothetical, with a symmetrical S-curve approach adopted (centred at the 12-hour mark). Extreme rainfall may occur differently with greater spatial variability from this, which may affect predicted volumes.
- *Rainfall depth* – DRESSA rainfall depths are assumed to be accurate, with normal DRESSA values applied to this study. DRESSA also includes upper values representative of upper confidence limits. In addition, rainfall duration up to the 24-hour event has been considered. Longer event rainfall could exacerbate flooding; however, this may be limited due to the balance of infiltration loss compared to longer-duration rainfall.
- *Equivalence in recurrence interval* – the design rainfall event applied to the flood model is assumed to result in the equivalent design flood event (i.e., the 1:100 RI storm produces the 1:100 RI flood).
- *Climate Change* – Climate change was not considered in this study. A risk analysis using the expected life of a structure or process will indicate the relevance of considering climate change (i.e., as the expected life increases, the influence of climate change increases). Climate change is expected to exacerbate any flooding due to a likely increase in rainfall intensities.

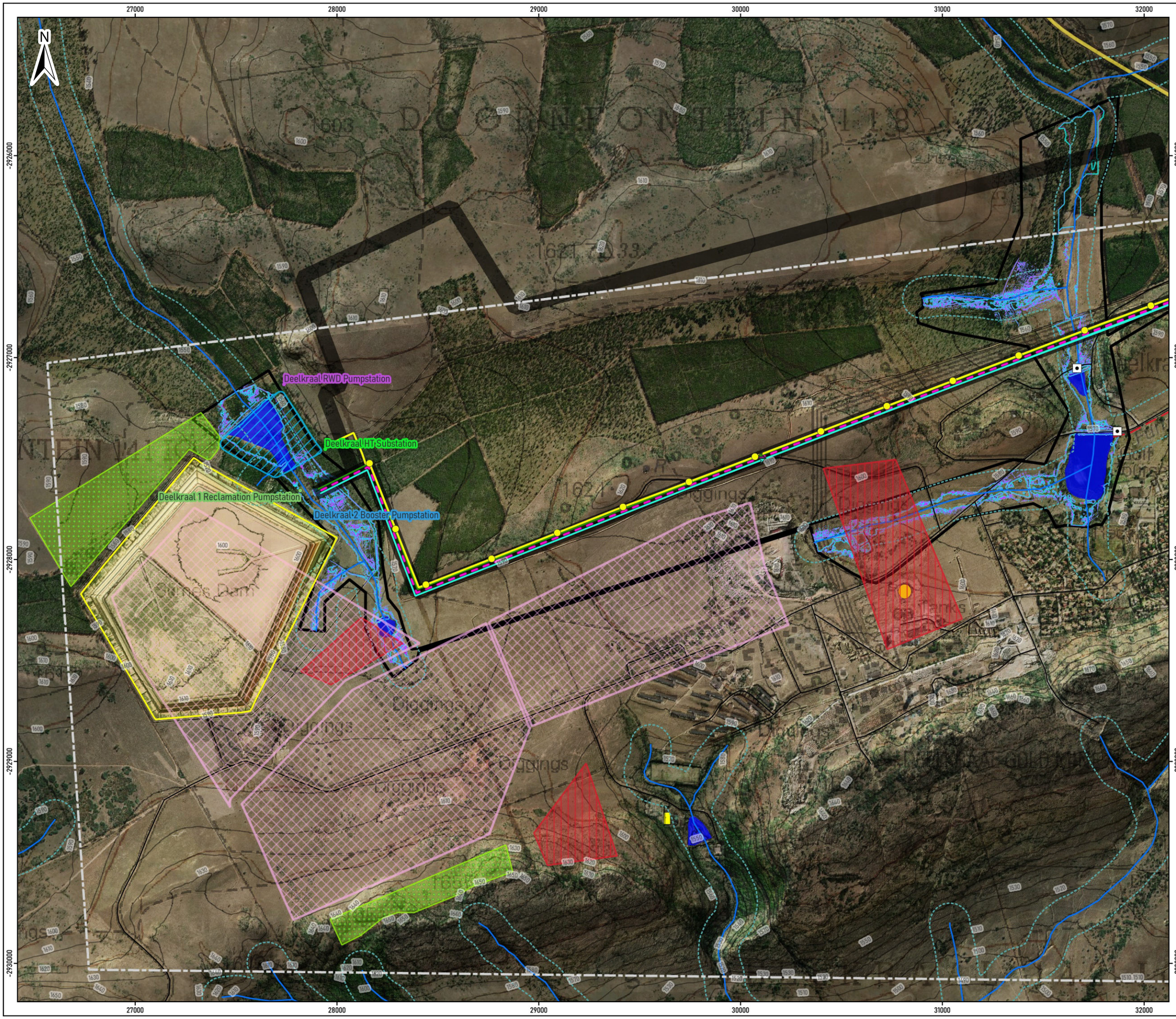
**Hydrological (PCSWMM)**

- *PCSWMM parameterisation* – Design hydrographs estimated using PCSWMM are accurate, given the potential for large deviations in their estimation to significantly influence resulting flooding.
- *Potential error in the parameterisation of the model* – this included the soils and land-cover classification used, which may not accurately represent the site and surrounding area. Infiltration losses are significant to this study. These losses have only been considered using a generalised approach to infiltration and are not based on measured data. Soils are parameterised as the Hydrological Soil Group C, consistent with pre-activity conditions; however, variations due to anthropogenic activity could affect runoff predictions.
- *TSF Representation and Self-Contained Areas* – Selected Tailings Storage Facilities (TSFs) were represented as self-contained only where containment could be clearly defined. For some TSFs, this was limited to areas up to the clearly defined toe paddocks, while other TSFs were partially or fully included in the model where containment could not be confidently demonstrated. For rehabilitated mine TSFs, only the upper TSF surfaces where localised depression storage occurs were treated as self-contained. Under extreme rainfall events or where containment performance varies spatially, actual runoff pathways may differ from those represented in the model.
- *Drainage Representation* – Flow paths and flow lengths were defined based on the conceptual location of sumps and drainage channels, informed by available spatial datasets including the 1:50,000 Rivers dataset. Due to the scale of the dataset and site-specific drainage alterations associated with mining activities, some mapped drainage pathways were found to be inconsistent with current conditions and were manually refined, using NGI and high-resolution aerial imagery, by adjusting subcatchment boundaries and drainage paths. The model may not fully represent actual surface flow routing or runoff response at a local scale, particularly where drainage has been modified or where generalised infiltration losses have been applied in the absence of site-specific measured data.

- *Dam Representation and Assumed Operating Conditions* – Only dams with capacities greater than 10,000 $m^3$ were included in the model, with assumed initial storage levels (e.g., 100% full) applied where data were unavailable. In line with guidance, actual operating conditions may differ, and operational controls, freeboard, and spillway performance are not explicitly modelled; results are indicative only and not suitable for dam safety assessment.
- *Catchment delineation* – a containing catchment has been used for modelling. This catchment has been defined using geoprocessing of the available terrain data. This geoprocessing is based upon an 8-point pour model, with the lowest neighbouring cell assumed to receive all the flow from the cell upstream of it. As such, there is no consideration of the flow rate and the potential for an upstream cell to feed into more than one downstream cell. This has potential implications for the final containing catchment extent.
- *Terrain accuracy* – the development of a flood model has relied primarily on the detail and accuracy of 0.5 m and 1 m DTM. The flood model cannot improve on the accuracy of the parent data (i.e., the terrain data used). The use of the 2023 LiDAR data introduced inaccuracies due to changes in terrain not captured by the low-resolution 30 m DSM and the 2023 0.5 m DTM. Features not captured by the terrain may result in under-representation, affecting derived slopes and drainage channels.
- *Terrain representation* – The terrain can only be expected to represent the terrain at the time of data capture. Changes in terrain, including changes in the morphology of any flow paths or river channel morphology, can alter the results of this assessment.

**Hydraulic (HEC-RAS)**

- *Breaklines* – To compensate for mesh detail, linear features (and ridges in particular) were digitised as breaklines and then applied to the model mesh. The application of breaklines is assumed adequate.
- *Roughness values* – the absence of depth-varying roughness in HEC-RAS, as this time meant that a concentrated channel mannings approach needed to be adopted. There are consequently limitations to this approach as depths of flooding do vary during flooding, with surface roughness likewise varying (according to depth).
- *Mesh detail* – the default mesh utilised a 5 m mesh size. While one of HEC-RAS's major strengths is the use of a subgrid, the obstructing or routing influence of linear features that are smaller than the mesh resolution will not be well defined.
- *Model calibration* – no calibration of the model was undertaken as there is no observed data for calibration purposes.
- *Software Performance* – The software and methods utilised are assumed accurate with regard to their utilisation of input data and the processes they simulate.
- *Culverts and Road Crossings* – culverts are assumed to be accurate based on the site observations and terrain data. Culvert representation incorporates local terrain modifications at road crossings, where embankments and inverts were adjusted to maintain realistic flow conveyance. Culverts are modelled as either conveying flow (open) or no conveyance (blocked). Culverts with no conveyance are excluded from the model, and it is further assumed that, where culverts are not blocked, any accumulated debris would be mobilised and cleared under a large flood event.




## Legend

**Proposed Layout**

- Laydown
- Return Water Dam
- Soil Stockpile
- TSF
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- 100m Watercourse Buffer (DWS)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Maximum Flood-Line (1:100 RI)
- Maximum Flood-Line (1:50 RI)
- 10m Contour (0.5m DTM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained

Figure A-3

Maximum Flood-Lines (1:50 RI & 1:100 RI)
West West-Wits

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0 200 400 600 800 m

| Scale - 1:17,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

35000

37500

-2925000

-2927500

N

Slimes Dam

Slimes Dam

Proposed Layout
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Culverts (Modelled)
- 100m Watercourse Buffer (DWS)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Pollution Dams (Mponeng)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- Maximum Flood-Line (1:100 RI)
- Maximum Flood-Line (1:50 RI)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained

Figure A-4

Maximum Flood-Lines (1:50 RI & 1:100 RI)
Central West-Wits

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0 200 400 600 800 m

| Scale - 1:18,250 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

40000 42500

-2922500 -2925000 -2927500

N

North Boundary Dam Pumpstation

Nursery #3 Pumpstation

Savuka

TauTona

Rehab Area

Mountainous Area

Pipe Bridge Area

Road Crossing Area

Mponeng

Proposed Layout
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Mponeng Shafts
- Culverts (Modelled)
- 100m Watercourse Buffer (DWS)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- Maximum Flood-Line (1:100 RI)
- Maximum Flood-Line (1:50 RI)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- Self-contained
- Mponeng Plant (Not Modelled)

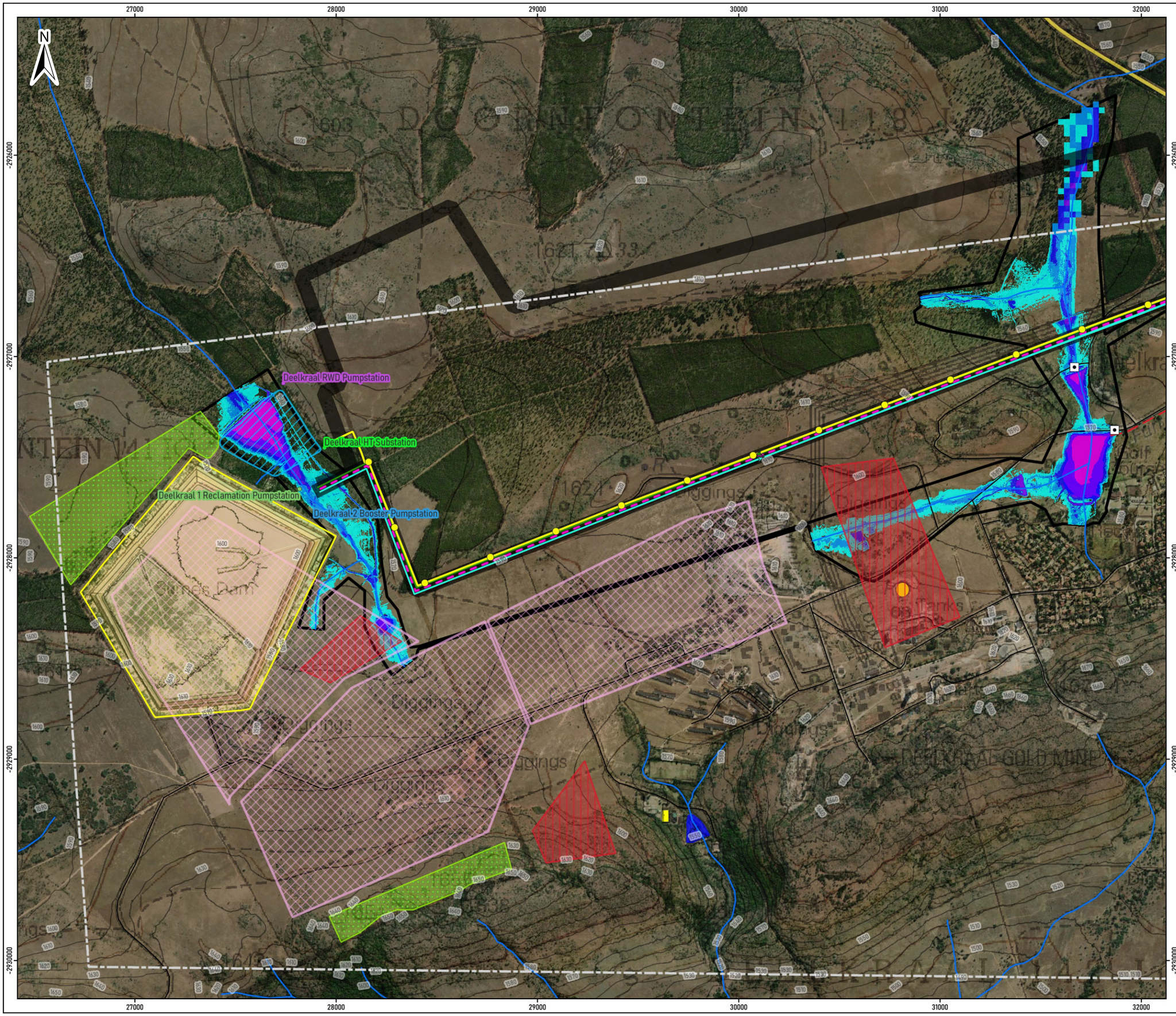
**Figure A-5**

**Maximum Flood-Lines (1:50 RI & 1:100 RI)**
**East West-Wits**

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0 200 400 600 800 m

| Scale - 1:20,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|




## Legend

**Proposed Layout**

- Laydown
- Return Water Dam
- Soil Stockpile
- TSF
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor

- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Depth (m)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-6**

**Maximum Flood Depth (1:50 RI) West West-Wits**

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0 200 400 600 800 m

| Scale - 1:17,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

35000

37500

-2925000

-2927500

N

Slimes Dam

Slimes Dam

Diggings

Sandridge

Proposed Layout
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Pollution Dams (Mponeng)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Depth (m)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-7**

**Maximum Flood Depth (1:50 RI) Central West-Wits**

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0 200 400 600 800 m

| Scale - 1:18,250 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

40000 42500

-2922500 -2925000 -2927500

N

North Boundary Dam Pumpstation
Nursery #3 Pumpstation
TauTona
Savuka
Rehab Area
Mountainous Area
Mponeng
Pipe Bridge Area
Road Crossing Area

**Proposed Layout**
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Mponeng Shafts
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Main Road (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- Self-contained
- Mponeng Plant (Not Modelled)
- Culverts (Modelled)

**Maximum Flood Depth (m)**
- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

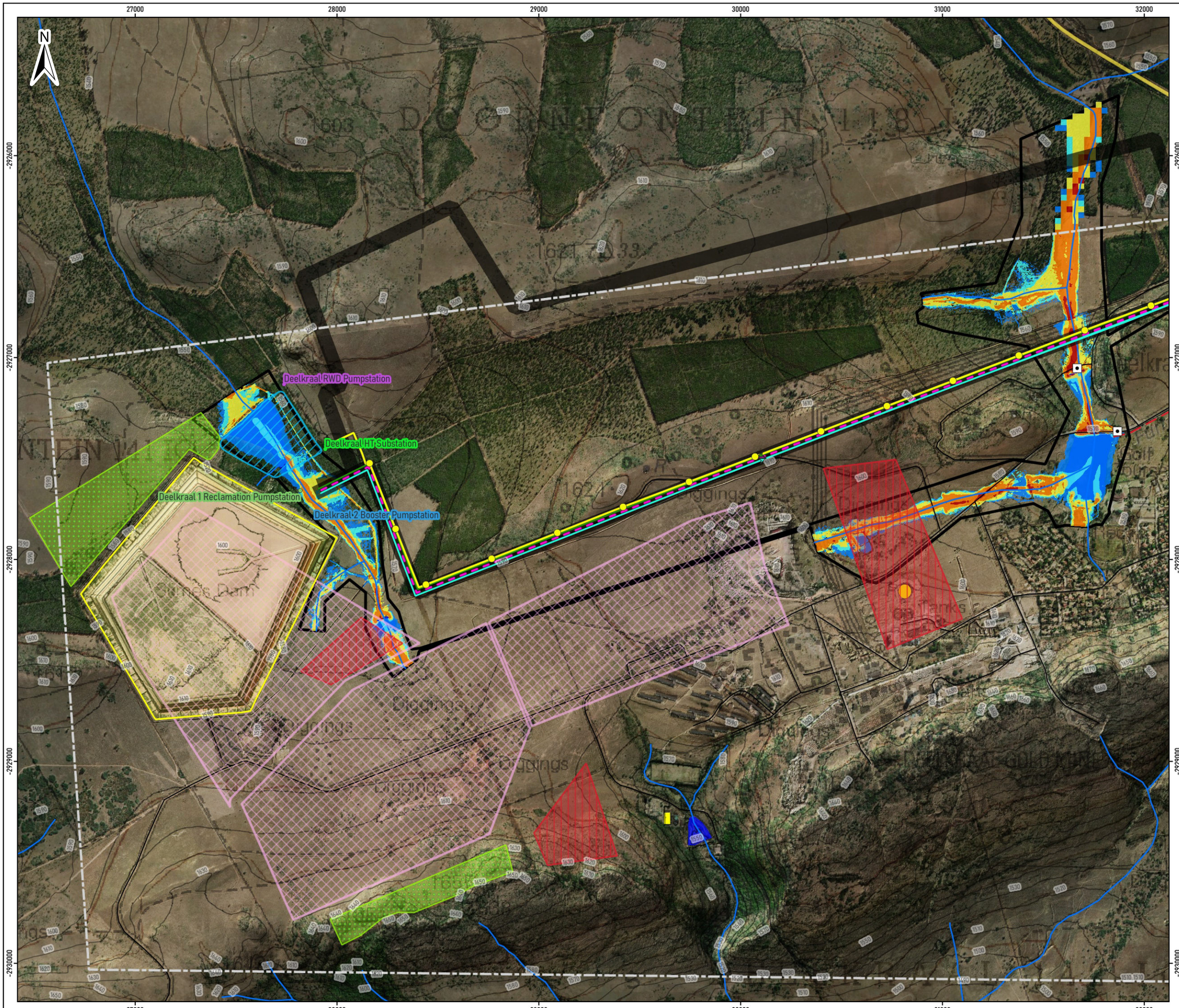
**Figure A-8**

**Maximum Flood Depth (1:50 RI) East West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:20,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|




## Legend

**Proposed Layout**

- Laydown
- Return Water Dam
- Soil Stockpile
- TSF
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-9**

**Maximum Flood Velocity (1:100 RI) West West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:17,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

35000

37500

-2925000

-2927500

N

Slimes Dam

Slimes Dam

Proposed Layout
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Pollution Dams (Mponeng)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**
- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-10**

**Maximum Flood Velocity (1:100 RI) Central West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:18,250 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

40000 42500

-2922500 -2925000 -2927500

North Boundary Dam Pumpstation
Nursery #3 Pumpstation
Savuka
TauTona
Rehab Area
Mountainous Area
Pipe Bridge Area
Road Crossing Area
Mponeng

**Proposed Layout**
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Mponeng Shafts
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Main Road (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- Self-contained
- Mponeng Plant (Not Modelled)
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**
- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

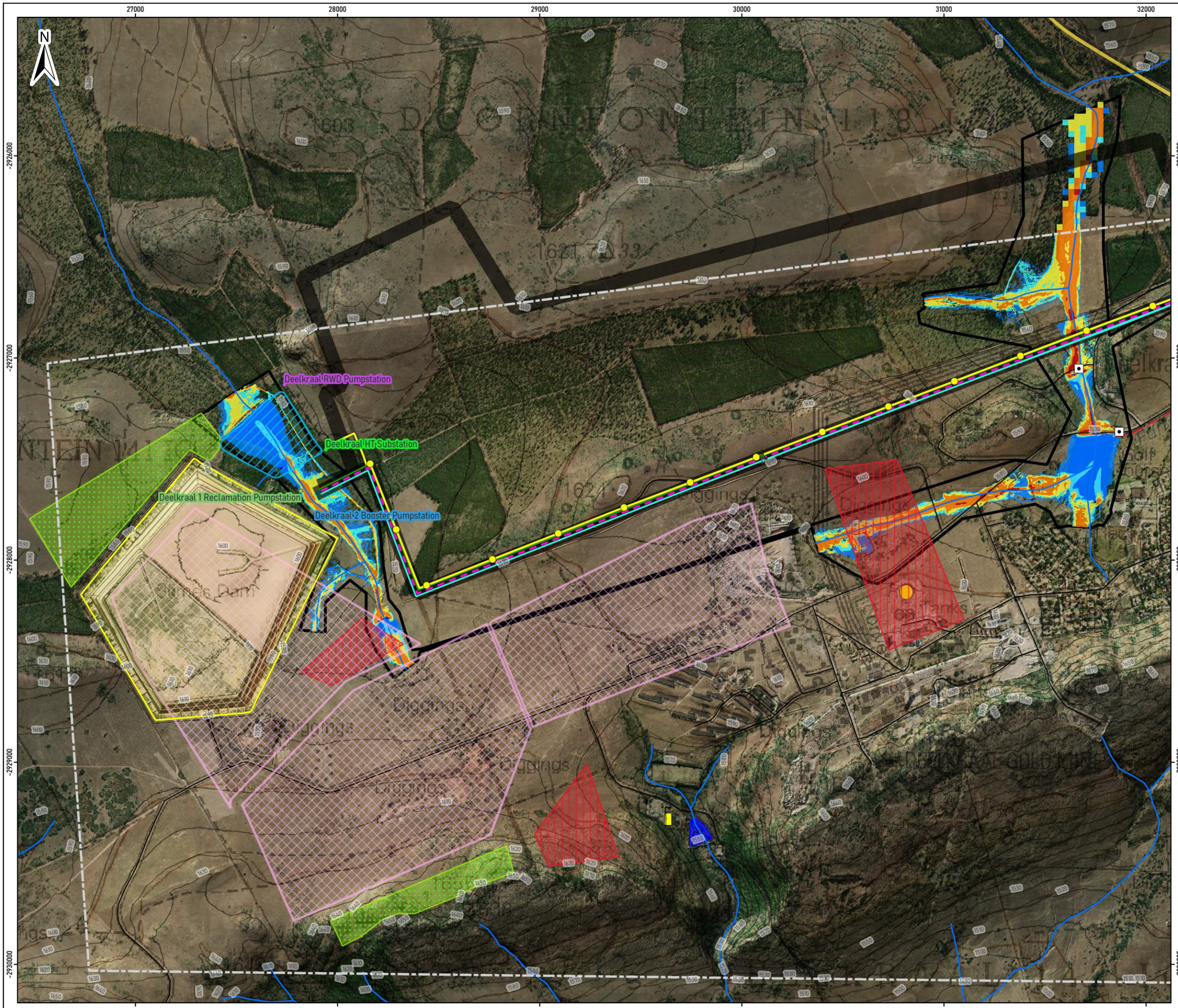
**Figure A-11**

**Maximum Flood Velocity (1:100 RI) East West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:20,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|




## Legend

**Proposed Layout**

- Laydown
- Return Water Dam
- Soil Stockpile
- TSF
- Slurry Alignment
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**

- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-12**

**Maximum Flood Velocity (1:50 RI) West West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
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www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:17,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

35000

37500

-2925000

-2927500

N

Slimes Dam

Slimes Dam

Proposed Layout
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Pollution Dams (Mponeng)
- Other Road (50K Topo)
- Secondary Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- 0.5m Survey Extent
- Self-contained
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**
- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-13**

**Maximum Flood Velocity (1:50 RI) Central West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:18,250 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|

40000 42500

-2922500 -2925000 -2927500

North Boundary Dam Pumpstation
North Boundary Dam
Nursery #3 Pumpstation
TauTona
Savuka
Rehab Area
Mountainous Area
Mponeng
Pipe Bridge Area
Road Crossing Area

**Proposed Layout**
- Laydown
- Plant
- Pumpstation
- Reclamation
- Return Water Dam
- Soil Stockpile
- Substation
- TSF
- Slurry Alignment
- Return Water
- Potable Water
- Powerline
- Process Water
- Grid Corridor
- Slurry Alignment (Mponeng)
- Return Water Alignment (Mponeng)
- Pipelines Alternative Route (Mponeng)
- Culvert (Mponeng)

## Legend

- Tailings and Process Water Pipelines (Existing)
- Trenches (Mponeng)
- Mponeng Shafts
- Any Other Channel (50K Topo)
- Furrow (50K Topo)
- Non-Perennial River (50K Topo)
- Perennial River (50K Topo)
- Dam (50K Topo)
- Open Reservoir (50K Topo)
- Vlei (50K Topo)
- Dams (Mponeng)
- Pollution Dams (Mponeng)
- Main Road (50K Topo)
- National Road (50K Topo)
- Other Road (50K Topo)
- 10m Contour (0.5m DTM Derived)
- 10m Contour (30m DSM Derived)
- 2D Model Boundary
- Self-contained
- Mponeng Plant (Not Modelled)
- Culverts (Modelled)

**Maximum Flood Velocity (m/s)**
- <= 0.25
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 2.00
- > 2.00

**Figure A-14**

**Maximum Flood Velocity (1:50 RI) East West-Wits**

Hydrologic Consulting (Pty) Ltd
+27 72 239 0974
info@hydrologic.consulting
www.hydrologic.consulting

0 200 400 600 800 m

| Scale - 1:20,500 @A3 | Coordinate Reference System: Hartebeesthoek94_Lo27_(E-N) | Version 1 01-Apr-2026 |
|---|---|---|