

**Annexure E:     Specialist Studies**

Annexure E1    Wetland Biodiversity Assessment and Aquatic Site Sensitivity Verification Report



# Reinstating the Low-Level Dam Spillway

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Wetland Biodiversity Assessment and  
Aquatic Site Sensitivity Verification  
Report

June 2025

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2025.08.08

Date

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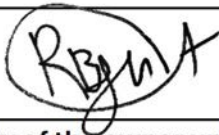
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| <b>Project name:</b> Reinstating the Low-Level Dam Spillway   Wetland Biodiversity Assessment   June 2025                                                                                    |                           |                                                                                                                                                |                         |
| <b>Nature of Signoff</b>                                                                                                                                                                     | <b>Responsible Person</b> | <b>Role/Responsibility</b>                                                                                                                     | <b>Qualifications</b>   |
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| <b>Document number</b>                                                                                                                                                                       | <b>Checked by:</b>        | <b>Electronic Signature:</b>                                                                                                                   | <b>Date</b>             |
| <b>Client review</b>                                                                                                                                                                         |                           |                                                                                                                                                |                         |
| <b>Final Report</b>                                                                                                                                                                          | Rudi Bezuidenhoudt        |                                                             | 2025.08.08              |
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## EXECUTIVE SUMMARY

Limosella Consulting (Pty) Ltd has been appointed by Shangoni Management Services (Pty) Ltd to provide specialist wetland input in support of the proposed reinstatement of the Low-Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station, located near eMalahleni in Mpumalanga Province. This report forms part of the environmental authorisation process and is intended to inform the necessary approvals in terms of relevant environmental legislation. This report incorporates a Site Sensitivity Verification component that precedes and informs the aquatic impact assessment. The site sensitivity verification was undertaken by a suitably qualified aquatic specialist and environmental assessment practitioner through a combination of desktop analysis, a preliminary site inspection, and the review of available and relevant information, as required by Section 2 of Government Notice No. 320.

Fieldwork was conducted on 9 June 2025.

The terms of reference for this assessment were as follows:

- Determine the presence/absence of natural wetlands within the proposed working area, if natural wetlands occur:
- Delineate the wetland and riparian areas.
- Classify the watercourse according to the system proposed in the national wetlands inventory, if relevant.
- Undertake functional and integrity assessment of wetlands areas within the area assessed, as specified in General Notice 267 of 24 March 2017.
- Undertake an impact assessment as specified in the NEMA 2014 regulations (as amended).
- Undertake a risk assessment as specified in Revised GA 4167 of 8 December 2023.
- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, and the buffer zone guidelines (Macfarlane & Bredin, 2017)
- Discuss appropriate mitigation and management procedures relevant to the conserving of watercourse areas on, and downstream of, the site.
- Based on the findings during the desktop and field assessments, a detailed risk assessment of all identified significant risks shall be done, including cumulative impacts on watercourse assemblages in the region.
- Recommendations shall be provided on management and mitigation measures (including opportunities and constraints) with regards to the development/operation of the proposed development to improve, manage and mitigate impacts (positive and negative) on the watercourse ecology of the area.
- To undertake a site sensitivity verification for aquatic and riparian features associated with the proposed low-level dam spillway reinstatement and weir construction, in accordance with the requirements of Government Notice No. 320 of 20 March 2020, and to use the verified sensitivities to inform the aquatic biodiversity assessment, impact assessment, and mitigation measures.

The study area consists of artificial wetland-like systems, including a seepage wetland, a canal, a breached dividing berm, and a wetland formed over historical diggings. These features exhibit saturated soils and



hydrophytic vegetation but are not natural wetlands, having formed through dam seepage or excavation. Historical imagery confirms their absence in earlier decades. The only natural aquatic feature in the area is an unchannelled valley-bottom wetland located approximately 320 metres north of the proposed works, well beyond the calculated (44 m) and conservative (100 m) buffer zones. The natural wetlands are confirmed to be highly sensitive as indicated in the screening report, the artificial wetlands are less sensitive but does contribute to some extent to ecosystem services.

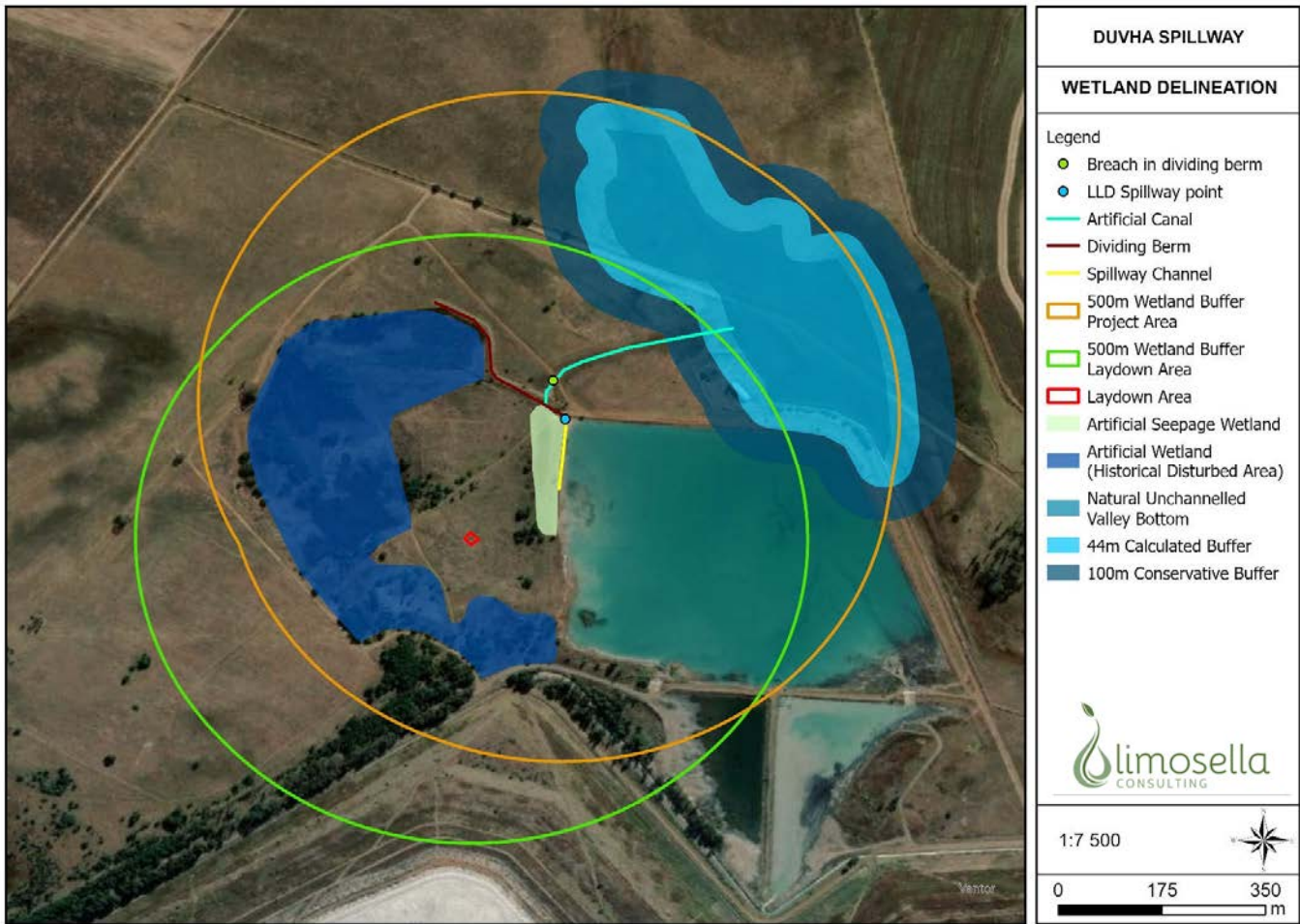
A WET-EcoServices assessment was conducted for the artificial wetland areas and confirmed very low functional value across all ecosystem services. No WET-Health or REC assessment was applied, as these tools are not suited to artificial systems. An Ecological Importance and Sensitivity (EIS) rating was completed to support the interpretation of functional relevance, while a precautionary DWS Risk Assessment Matrix (RAM) was included despite the limited applicability under Section 21(c) and (i) of the National Water Act.

All impacts associated with the proposed development are considered localised, temporary, and readily mitigatable. No work will take place within or directly impact any natural wetland. Construction-phase risks such as erosion, sedimentation, and invasive species spread will be managed through standard mitigation and rehabilitation measures. Operationally, the project is expected to reduce long-term hydrological risk and improve controlled overflow conditions, thereby enhancing downstream protection. The important factors relevant to Environmental Authorisation for the project, are summarised in the table below:

|                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Quaternary Catchment and WMA areas</b>                                     | B11G<br>Limpopo-Olifants (LOCMA)<br>#2 - Olifants: Major rivers include Elands, Wilge, Steelpoort, Olifants and Letaba Rivers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Watercourse</b>                                                            | The primary watercourse feature is the Low Level Dam (LLD), an artificial off-channel ash return dam. Although mapped as a wetland in the NFEPA and NBA2018 datasets, it does not represent a natural wetland system but rather an engineered containment structure with wetland-like characteristics.<br><br>Downstream of the LLD, the spillway channel connects to a valley-bottom wetland associated with a non-perennial river. This wetland drains into the Witbak Dam. <ul style="list-style-type: none"> <li>NBA (2018) list the watercourses as <b>Vulnerable</b></li> <li>NFEPA (2011) list the watercourses as <b>Vulnerable</b></li> </ul> |
| <b>Classification (SANBI, 2013)</b>                                           | Artificial Wetland Areas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>WetEcoServices</b>                                                         | Very Low for all metrics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>EIS (Kotze, et al., 2020)</b>                                              | <b>Low Category</b> - Wetlands that are 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 in major rivers                                                                                                                                                                                                                                                                                                                                                   |
| <b>Coj Generic Buffer and Calculated Buffer Zone (Macfarlane et al, 2015)</b> | <b>Calculated Buffer Zone: 44 m</b><br><b>Conservative Buffer: 100 m</b><br><b>Artificial Wetland Areas: No Buffer</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>DWS 2024 Risk Assessment</b>                                               | Risk scores fall in the <b>Low category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |



|                                         |                                                                                                                                                      |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>National Screening Tool Findings</b> | This study confirms that the natural wetlands are highly sensitive as indicated on the screening report, the artificial wetlands are less sensitive. |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|



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## 1 Introduction

Limosella Consulting (Pty) Ltd has been appointed by Shangoni Management Services (Pty) Ltd to provide specialist wetland input in support of the proposed reinstatement of the Low Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station, located near eMalahleni in Mpumalanga Province. This report forms part of the environmental authorisation process and is intended to inform the necessary approvals in terms of relevant environmental legislation. This report incorporates a Site Sensitivity Verification component that precedes and informs the aquatic impact assessment. The site sensitivity verification was undertaken by a suitably qualified aquatic specialist and environmental assessment practitioner through a combination of desktop analysis, a preliminary site inspection, and the review of available and relevant information, as required by Section 2 of Government Notice No. 320.

Fieldwork was conducted on 9 June 2025.

### 1.1 Description of the Project:

The proposed project entails the reinstatement and upgrading of the Low-Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station ([Figure 1](#)). The LLD is an off-channel storage facility used for the containment of ash return water and contaminated stormwater from the station and its surrounding areas. The dam is located approximately 1.2 km southeast of the Witbank Dam and has a spillway level capacity of 811,240 m<sup>3</sup>.

In 2013, an earth berm was constructed along the LLD spillway, significantly reducing its width and creating non-compliance in terms of the Dam Safety Regulations. In 2019, the dam experienced overtopping risk when water levels reached 7.7 m, leaving a freeboard of only 300 mm. This triggered the need to remove the berm and restore the spillway to meet regulatory discharge capacity standards.

The scope of the proposed works includes the following:

- **Spillway Reinstatement:** Removal of the earth berm and widening of the spillway to 62 m to accommodate a peak flow of approximately 130 m<sup>3</sup>/s, in line with the Safety Evaluation Discharge (SED) for a Category II dam. A reinforced concrete sill and an elevated brick masonry headwall will be constructed.
- **Concrete Weir Construction:** A new weir structure will be installed at a breach in the dividing berm (between the dirty and clean water sections) to manage high-flow events and prevent erosion. Retaining walls and erosion protection measures such as *Armorflex* and Reno mattresses will be incorporated.
- **LLD Crest Raising:** Due to observed settlement along the dam crest ( $\pm 3\%$ ), the crest will be levelled and compacted with G3–G4 gravel material to restore freeboard and prevent ponding.
- **Temporary Laydown Area** – A small laydown area of 217m<sup>2</sup> will be located adjacent to an access road.



All construction activities will be undertaken in accordance with engineering standards and applicable environmental management requirements. The upgrades are designed to ensure dam safety compliance, improve operational capacity, and reduce the risk of uncontrolled overflow events.



Figure 1: Water extraction proposal

## 1.2 Terms of Reference

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

- Determine the presence/absence of natural wetlands within the proposed working area
- Delineate the wetland and riparian areas.
- Classify the watercourse according to the system proposed in the national wetlands inventory, if relevant.
- Undertake functional and integrity assessment of wetlands areas within the area assessed, as specified in General Notice 267 of 24 March 2017.
- Undertake an impact assessment as specified in the NEMA 2014 regulations (as amended).
- Undertake a risk assessment as specified in Revised GA 4167 of 8 December 2023.



- Recommend suitable buffer zones as specified in General Notice 267 of 24 March 2017, and the buffer zone guidelines (Macfarlane & Bredin, 2017)
- Discuss appropriate mitigation and management procedures relevant to the conserving of watercourse areas on, and downstream of, the site.
- Based on the findings during the desktop and field assessments, a detailed risk assessment of all identified significant risks shall be done, including cumulative impacts on watercourse assemblages in the region.
- Recommendations shall be provided on management and mitigation measures (including opportunities and constraints) with regards to the development/operation of the proposed development to improve, manage and mitigate impacts (positive and negative) on the watercourse ecology of the area.
- To undertake a site sensitivity verification for aquatic and riparian features associated with the proposed low-level dam spillway reinstatement and weir construction, in accordance with the requirements of Government Notice No. 320 of 20 March 2020, and to use the verified sensitivities to inform the aquatic biodiversity assessment, impact assessment, and mitigation measures.

## 1.7.3 Assumptions and Limitations

- All wetlands within 500 m of any developmental activities should be identified as per the DWS authorisation regulations, as well as 100 m from any river. Watercourses that fall outside of the site, but that fall within 100/500 m of the proposed activities were delineated based on desktop analysis of vegetation gradients visible from aerial imagery.
- Deriving a 100% factual report based on field collecting and observations can only be done over several years and seasons to account for fluctuating environmental conditions and migrations. Since environmental impact studies deal with dynamic natural systems additional information may come to light at a later stage.
- The specialist responsible for this study reserves the right to amend this report, recommendations and/or conclusions at any stage should any additional or otherwise significant information come to light.
- Floodline calculations fall outside the scope of the current assessment.
- A Red Data scan, fauna and flora, were not included in the current study.
- Species composition described for landscape units aimed at depicting characteristic species and did not include a survey for cryptic or rare species.
- The recreation grade GPS used for wetland and riparian delineations is accurate to within five meters.
- Watercourses delineation plotted digitally may be offset by at least five meters to either side. Furthermore, it is important to note that, while converting spatial data to final drawings, several steps in the process may affect the accuracy of areas delineated in the current report. The scale at which maps and drawings are presented in the current report may become distorted should they be reproduced by for example photocopying and printing.



- Determination of permissible abstraction rates, volumes, or thresholds was not included in the scope of this study. This information must be compiled separately by a suitably qualified hydrologist or water resource specialist in support of the Section 21(a) water use application.
- It is acknowledged that new or unforeseen environmental impacts, natural events, or human interventions may alter the state of the watercourses and surrounding landscape after this assessment is completed. As such, this report reflects conditions at the time of the site visit and desktop review.



## 2 Definitions and Legal Framework

### 2.1 Wetlands and Riparian Areas

The **National Water Act, 1998 (Act No. 36 of 1998) [NWA]** establishes the legal basis for water resource management in South Africa, ensuring pollution prevention, ecological conservation, and sustainable utilisation. Under this Act, all water resources are state property and regulated by the Department of Water and Sanitation (DWS). The NWA outlines principles for water use decisions that may significantly affect water resources, defining a water resource to include watercourses, surface water, estuaries, and aquifers. A watercourse encompasses rivers, springs, natural channels with intermittent or regular water flow, wetlands, lakes, pans, dams, and any water collection declared as such by the Minister, along with their beds and banks. The NWA defines a wetland as land transitioning between terrestrial and aquatic systems, with the water table usually near the surface or covered periodically by shallow water, supporting vegetation adapted to saturated soil conditions.

Riparian habitats are vital for ecological and hydrological functions, similar to wetlands, and serve as indicators for delineating river footprints. The NWA defines riparian habitat as areas associated with watercourses, characterised by alluvial soils, and inundated or flooded to support distinct vegetation compared to adjacent lands.

### 2.2 Authorisations for Water Use Activities

Water use authorisations, outlined in Section 21 of the NWA, apply to activities related to watercourses, specifically (**Table 1**):



**Table 1: Water uses associated with the project/**

|                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Section 21(c):<br/>Impeding or<br/>diverting water<br/>flow in a<br/>watercourse</b></p>                                                                                                                                                                                                                                                                                   | <ul style="list-style-type: none"> <li>• Construction of a new concrete weir structure at the breach in the dividing berm. This structure will regulate overflow from the LLD into adjacent water pathways and is specifically designed to manage high-flow stormwater events (<math>\geq 1:50</math>-year floods). While engineered to improve control and minimise downstream erosion, it alters the existing hydrology and introduces a permanent impeding feature within the watercourse.</li> <li>• Reinstatement of the spillway, which includes the removal of the earth berm and excavation along a 62 m section of the original spillway alignment. Although the removal of the berm restores capacity, it also changes the current flow regime temporarily during construction, and permanently by reconfiguring flow volume and velocity.</li> <li>• Installation of Reno mattresses and <i>Armorflex</i>-type protection downstream of the spillway and weir. These erosion protection measures modify flow paths and reduce energy, which constitutes a deliberate intervention in the natural hydraulic regime.</li> </ul> |
| <p><b>Section 21(i):<br/>Altering the bed,<br/>banks, course, or<br/>characteristics of a<br/>watercourse</b></p>                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>• Excavation of in-situ material to reinstate the spillway channel and construct the concrete sill, weir, and retaining structures. These activities will physically alter the shape, gradient, and composition of the watercourse bed and banks.</li> <li>• Raising and shaping of the LLD crest, which will adjust the embankment and runoff characteristics into the surrounding area, including potential overland flow paths during high rainfall events.</li> <li>• Backfilling and compacting activities associated with spillway, weir, and berm reshaping. These modify not only the topography but also the infiltration capacity and hydraulic behaviour of the area.</li> <li>• Use of materials such as concrete, terrablocks, and rip-rap to line and reinforce sections of the flow path alters the natural substrate and bank composition, thereby modifying the watercourse's physical characteristics.</li> </ul>                                                                                                                                                               |
| <p>Spills from the Low-Level Dam into the natural wetland downstream are not included within the scope of this application. As such, Section 21(f) (discharge of waste or water containing waste into a water resource) and Section 21(g) (disposal of waste in a manner which may impact a water resource) of the National Water Act are not applicable to this assessment.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

Government Notice 4167 of 8 December 2023 replaced Government Notice 509 of 2016 and regulates these activities under Section 21(c) and (i). This notice provides General Authorisation (GA) for low-risk activities as determined by the Risk Assessment matrix. Medium or high-risk activities require a Water Use Licence (WUL) from the DWS.

Conditions for activities impacting watercourses include site selection criteria to avoid bends, high gradient areas, unstable slopes, actively eroding banks, interflow zones, springs, and seeps.





## 2.3 Additional Legislation and Frameworks

Compliance with the following national legislation, conventions, and regulations is required for wetlands, riparian zones and other aquatic areas (**Table 2**).

**Table 2: Legislation/Regulation and Relevance to the WULA and Proposed Development**

| Legislation                                                                              | Relevance to Proposed Development                                                                                                                              |
|------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Ramsar Convention and the South African Wetlands Conservation Programme (SAWCP)</b>   | Ensures the protection of wetland ecosystems that may be affected by site preparation, water use, or drainage activities.                                      |
| <b>National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998)</b>          | Provides overarching principles for sustainable development and environmental management, applicable to all phases of development.                             |
| <b>National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004)</b>    | Protects biodiversity, requiring mitigation of impacts on habitats, species, and ecosystems affected by development activities.                                |
| <b>National Environmental Management: Protected Areas Act, 2003 (Act No. 57 of 2003)</b> | Regulates activities in or near protected areas, which may overlap or border proposed sites.                                                                   |
| <b>NEMA Regulations GN R.982, R.983, R.984, and R.985 of 2014</b>                        | Outlines the need for Environmental Impact Assessments (EIAs) and the listing of activities that require environmental authorisation for sewer projects.       |
| <b>Regulations and Guidelines on Water Use under the NWA</b>                             | Ensures compliance with water use authorisations for construction and operation, including abstraction for panel cleaning or other operational needs.          |
| <b>South African Water Quality Guidelines under the NWA</b>                              | Guides the quality of water discharged or used onsite to ensure minimal contamination of surrounding water resources.                                          |
| <b>DWS General Notice 267 of 24 March 2017</b>                                           | Provides specific requirements for activities near wetlands and watercourses, relevant for compliance during site selection and development.                   |
| <b>Revised General Authorisation (GA) 4167 of 8 December 2023</b>                        | Updates general authorisation requirements for water use activities, including those associated with sewer construction and maintenance.                       |
| <b>National Water Act (NWA), 1998 (Act No. 36 of 1998)</b>                               | Governs the use, management, and protection of water resources, critical for managing water abstraction and discharge during sewer construction and operation. |
| <b>Hazardous Substances Act, 1973 (Act No. 15 of 1973)</b>                               | Regulates the handling and storage of hazardous substances, such as batteries used in Battery Energy Storage Systems (BESS).                                   |
| <b>Electricity Regulation Act, 2006 (Act No. 4 of 2006)</b>                              | Governs the licensing and regulation of electricity production, including renewable energy facilities.                                                         |

This legal framework ensures that the environmental impacts of activities related to aquatic and wetland resources are properly assessed and managed, promoting sustainable development and conservation.



### 3 Locality of the study site

The study site is located within the boundaries of Duvha Power Station, situated approximately 15 km east of eMalahleni in the Mpumalanga Province of South Africa. The power station falls under the jurisdiction of the Emalahleni Local Municipality within the Nkangala District Municipality. The specific focus of the proposed works is the Low-Level Dam (LLD) and associated infrastructure, which lies approximately 1.2 km southeast of the Witbank Dam and approximately 1.7 km from the Ash Dam complex. The LLD is an off-channel facility used for the containment of return water and contaminated stormwater associated with ash handling and operational activities at the power station. (Figure 2).

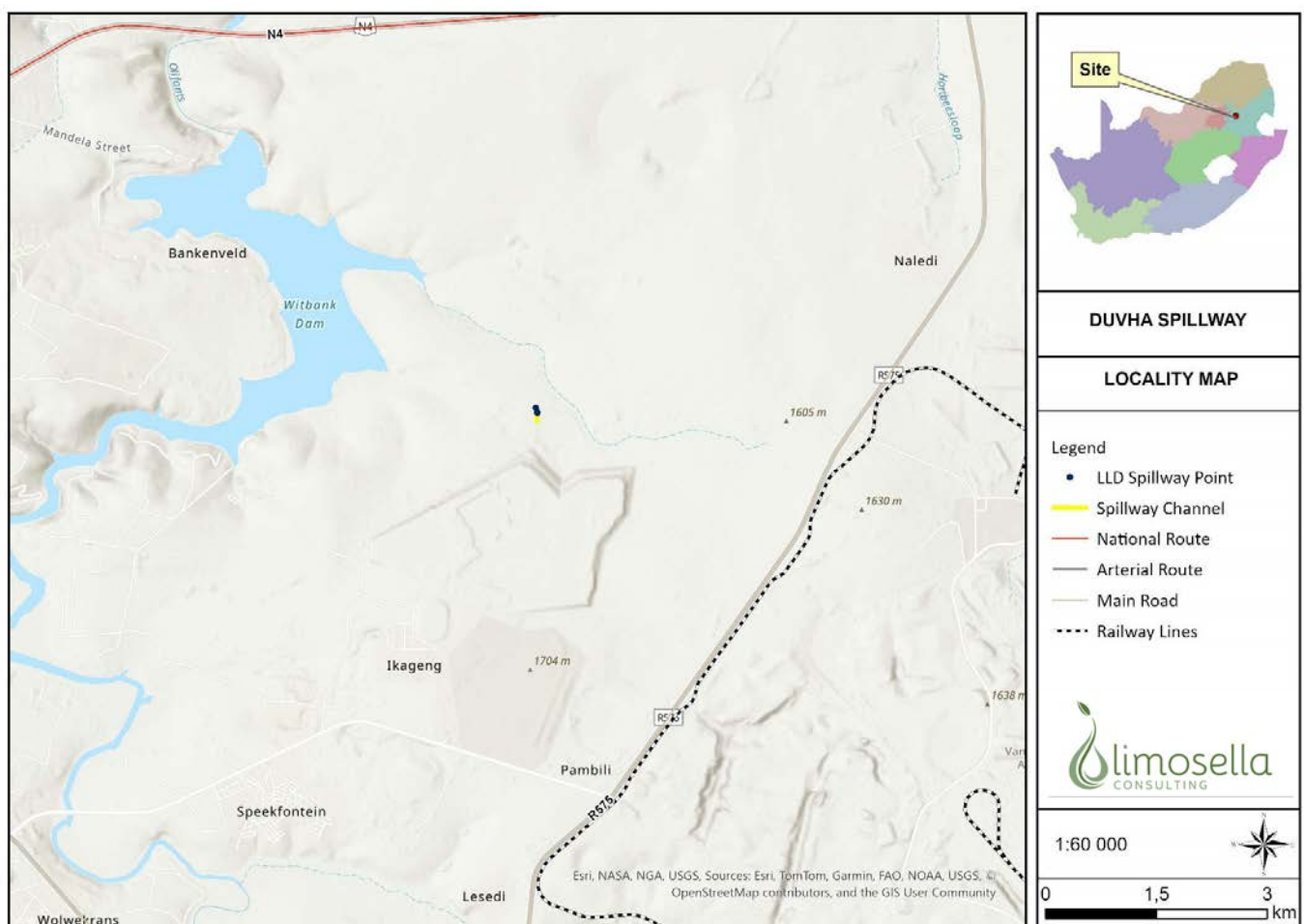


Figure 2: Locality Map



## 4 Description of the Receiving Environment

A review of available literature and spatial data formed the basis for the characterisation of the biophysical environment in its theoretically undisturbed state, and consequently an analysis of the degree of impact to the ecology of the study site in its current state. **Table 1** below provides a summary of the important aspects.



**Table 3: A summary of relevant site information obtained from a review of available spatial data.**

| National Screening Tool ( <a href="https://screening.environment.gov.za/screeningtool">https://screening.environment.gov.za/screeningtool</a> )                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                 | <p>The spillway is located on an area classified as having Low Aquatic Sensitivity, however, the wetlands in the north and east is classified as having <b>Very High Aquatic Sensitivity</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| General Description (Mucina & Rutherford , 2006))                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Broad Vegetation Units (Figure 3)</b>                                                                                                                                         | <b>Gm 12 - Eastern Highveld Grassland</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Conservation Status</b>                                                                                                                                                       | <b>Endangered</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Topography</b>                                                                                                                                                                | Slightly to moderately undulating plains, including some low hills and pan depressions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Climate</b>                                                                                                                                                                   | Summer rainfall with very dry winters. MAP between about 600 and 700 mm. Frost fairly frequent in winter. Strongly seasonal summer rainfall, with very dry winters. MAP 650–900 mm (overall average: 726 mm), MAP relatively uniform across most of this unit, but increases significantly in the extreme southeast. The coefficient of variation in MAP is 25% across most of the unit, but drops to 21% in the east and southeast. Incidence of frost from 13–42 days, but higher at higher elevations.                                                                                                                                                       |
| Hydrology and National Freshwater Ecosystem Priority Area (NFEPA, 2011) (NBA, 2018) Database                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Important Rivers (Figure 4) National Freshwater Ecosystem Priority Areas (NFEPA) (Driver, et al., 2012) and National Biodiversity Assessment (NBA) (SANBI, 2018) Wetlands</b> | <p>The primary watercourse feature is the Low Level Dam (LLD), an artificial off-channel ash return dam. Although mapped as a wetland in the NFEPA and NBA2018 datasets, it does not represent a natural wetland system but rather an engineered containment structure with wetland-like characteristics.</p> <p>Downstream of the LLD, the spillway channel connects to a valley-bottom wetland associated with a non-perennial river. This wetland drains into the Witbak Dam.</p> <ul style="list-style-type: none"> <li>NBA (2018) list the watercourses as <b>Vulnerable</b>.</li> <li>NFEPA (2011) list the watercourses as <b>Vulnerable</b>.</li> </ul> |
| <b>Quaternary Catchment</b>                                                                                                                                                      | B11G                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Catchment Management Areas (CMA) Invalid source specified</b>                                                                                                                 | Limpopo-Olifants (LOCMA)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Water Management Areas (WMA) (Government Gazette, 16 September 2016)</b>                                                                                                      | #2 - Olifants: Major rivers include Elands, Wilge, Steelpoort, Olifants and Letaba Rivers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |



|                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Wetland Ecosystem Type</b> (Ollis, et al., 2013)                                                                 | Mesic Highveld Grassland Group 4<br><b>Ecosystem Threat Status:</b> <b>Critically Endangered</b><br><b>Protection Level:</b> <b>Not Protected</b>                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Eco-Region Level 2</b> (DWS, 2024)                                                                               | Highveld 11.02                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) Model</b> (DWA, 2024) | The Present Ecological State (PES), Ecological Importance (EI) and Ecological Sensitivity (ES) were determined per Sub-Quaternary Reaches (SQR) for Secondary Catchments in South Africa. The SQRs of the study site is: <ul style="list-style-type: none"> <li>1155(PES=D)(EI=High)(ES=High)</li> </ul>                                                                                                                                                                                                                                         |
| <b>Surface Strategic Water Source (GSWS)</b> (Driver, et al., 2014)                                                 | Not located on a SWSA                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Geology and soil</b>                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Geology</b>                                                                                                      | Rhyolite is a fine-grained, silica-rich volcanic rock that is typically light in colour. It is the extrusive equivalent of granite and is formed from high-viscosity lava that cools quickly at or near the Earth's surface. Rhyolite often contains small crystals of quartz and feldspar and may exhibit banding or flow textures due to its viscous nature. In terms of hydrology, rhyolite tends to be impermeable, contributing to surface runoff and limited infiltration, which can promote the formation of wetlands or seeps downslope. |
| <b>Soil</b> (ENPAT, 2024)                                                                                           | Ba4 - Plinthic catena: dystrophic and/or mesotrophic; red soils widespread, upland duplex and marginal soils rare                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Biodiversity Sector Plan</b>                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Critical Aquatic Biodiversity Areas</b> (Figure 5)                                                               | According to the Mpumalanga Biodiversity Sector Plan (MBSP), The proposed construction footprint (spillway and weir) is also surrounded by Moderately Modified and Heavily Modified areas associated with historical land use, ash disposal, and infrastructure. While the development is largely constrained to disturbed zones, care must be taken to avoid further encroachment into the intact CBA area, and any unavoidable impacts should be accompanied by appropriate mitigation measures.                                               |





Figure 3: Vegetation of the study site





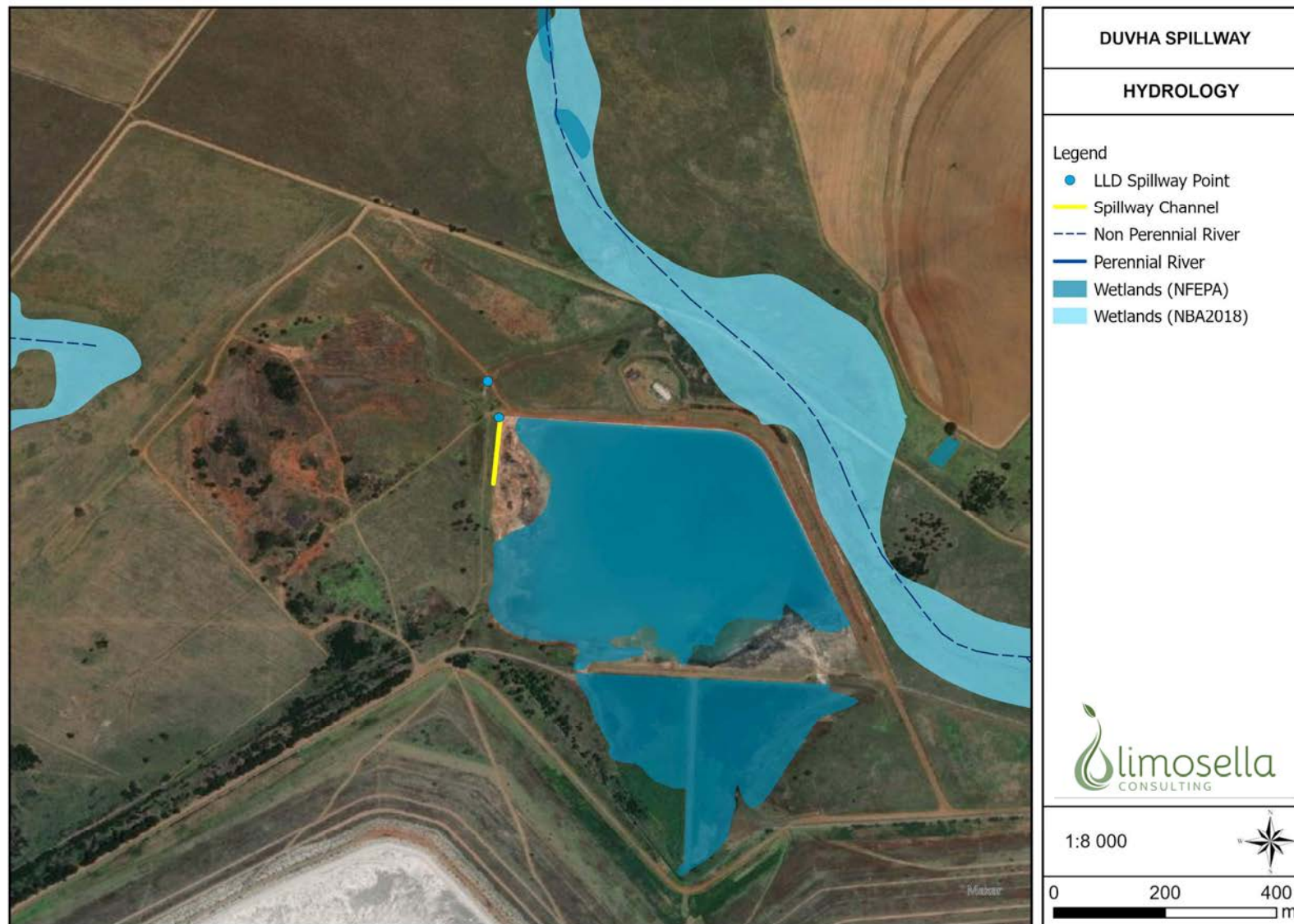


Figure 4: Regional hydrology relative to the study site?





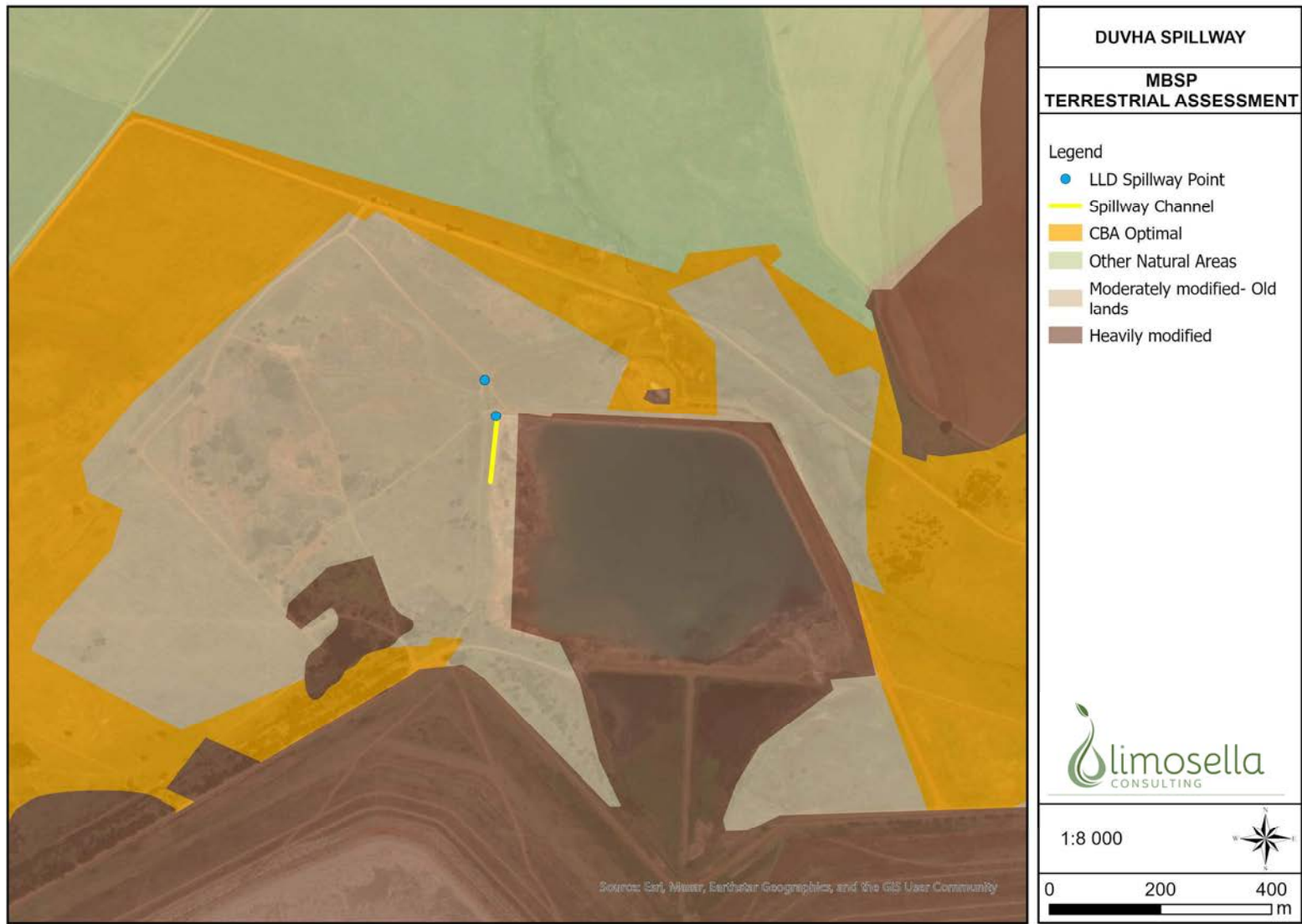


Figure 5: Critical Biodiversity Areas relevant to the study site



## 5 Methodology

The delineation method documented by the DWS in their document “**Updated manual for identification and delineation of wetlands and riparian areas**” (DWAF, 2008), as well as the **Classification System for Wetlands and other Aquatic Ecosystems in South Africa** (User Manual: Inland Systems (Ollis, et al., 2013) was followed throughout the field survey.

These guidelines describe the use of indicators to determine the outer edge of the wetland and riparian areas such as soil and vegetation forms, as well as the terrain unit indicator.

A smartphone was used to capture GPS co-ordinates in the field. 1:50 000 cadastral maps and available GIS data were used as reference material for the mapping of the preliminary watercourse boundaries. These were converted to digital image backdrops, and delineation lines and boundaries were imposed accordingly after the field survey. Applications used on the smartphone includes GPX Viewer Pro and Google Earth.

Following a desktop assessment highlighting wetland area to be groundtruthed in the field, soil and vegetation sampling on site informed a fine-scale delineation. In the current study, the wetland area was assessed using Wet-Health (Macfarlane, et al., 2020), EIS and WetEcoServices, (Kotze, et al., 2020). The assessment of potential impacts follows the 2014 NEMA regulations (as amended) and the DWS 2023 Risk Assessment.

In order to ease the legibility of the report, details regarding the methods used in each phase of the watercourse assessment are presented in a separate document, attached to this report as Appendix C, entitled (Bezuidenhoudt, 2024): R.Bezuidenhoudt (2024) . Appendix C: Aquatic Methodology. Limosella Consulting. Pretoria.



## 6 Results

The aquatic features (**Figure 6**) adjacent to the LLD spillway consist of a mixture of artificial and natural systems, shaped primarily by dam operations and historical land use. Directly west of the spillway, a seepage wetland has formed, likely as a result of sustained seepage from the dam wall (Green Polygon). Although it displays wetland characteristics such as saturated soils and hydrophytic vegetation, its artificial origin is suggested by its alignment with the dam wall and its absence from historical imagery.

To the north of the spillway, a man-made canal has been constructed (Red Line), where a breach in the dividing berm now allows water to flow toward a natural unchannelled valley-bottom wetland. This canal does not appear in the 1962 imagery, indicating it is a relatively recent intervention, likely to divert or manage overflow from the dam. The dividing berm itself (Blue Line) redirects flow westward into a large artificial wetland (Yellow Polygon), which overlays what appears to be an area of historical disturbance or excavation (possibly diggings). This wetland-like area is also not present in the 1962 imagery, confirming its artificial and operational nature.

Although the natural unchannelled valley-bottom wetland lies approximately 320 metres north of the LLD spillway, it is situated well beyond both the calculated 44 metre buffer and the more conservative 100 metre buffer applied in this assessment. As such, no direct impacts on this natural wetland are anticipated from the proposed construction activities, which are confined to the disturbed footprint of the LLD, spillway, and dividing berm. Furthermore, the project does not include any new or intensified discharges toward the natural system, and all spill-related events fall outside the scope of this assessment. While downstream impacts from future spill events may warrant separate operational consideration, they are not addressed herein. The current activities, focused on infrastructure reinstatement, are therefore unlikely to pose a risk to the ecological integrity of the natural wetland.





Figure 6: Characteristics of the Aquatic Environment

## 6.1 Historical Land Use, Cover and Aquatic Ecological State

The historical imagery from 1962 (Figure 7 - Top) shows that the area surrounding the current Low-Level Dam (LLD) was largely rural and undeveloped, characterised by natural grasslands interspersed with limited patches of cultivated land. No evidence of dam infrastructure or major earthworks is visible in the imagery, indicating that the LLD and ash disposal facilities did not yet exist. The natural drainage patterns were intact, with well-defined valley-bottom wetland features present to the west and northwest of the current dam footprint. These wetlands appear to have been hydrologically connected and functioning within a largely unmodified landscape, suggesting that the aquatic ecological state at the time was predominantly unaltered, with good hydrological and ecological integrity.

In contrast, the 2025 imagery (Figure 7 - Bottom) reveals significant landscape transformation. The construction of the LLD, along with extensive ash disposal facilities and associated roads, has introduced a high degree of surface disturbance. The LLD occupies the centre of the image, with clearly defined embankments and altered hydrological connectivity. Although the artificial dam is now mapped as a wetland in some datasets due to its standing water and surrounding vegetation, it is not a natural system. Some valley-bottom wetlands remain





visible to the north and west of the LLD, and while these appear structurally intact, they are likely subject to altered flow regimes due to upstream containment and runoff control infrastructure.



**Figure 7: Historical aerial imagery (1962) (CDNGI, 2024) compared to recent aerial imagery (2025) (GoogleEarth, 2024) comparing the land-use changes**

Notes on Artificial Wetlands

6.2 The National Climate Change Adaptation Strategy

South Africa’s policy framework for climate resilience is guided by the **National Climate Change Adaptation Strategy (NCCAS)** and more recently formalised through the **Climate Change Act, 2024 (Act No. 22 of 2024)**. These frameworks aim to ensure that development projects account for climate-related risks, strengthen ecological resilience, and promote sustainable water resource management. In the context of this assessment, which involves the reinstatement of dam spillway infrastructure adjacent to regulated watercourses and wetland systems, alignment with climate adaptation objectives is essential to reduce vulnerability to extreme weather events and safeguard ecological infrastructure. The table below outlines key objectives from each policy and their relevance to the proposed abstraction activity (**Table 4**).

**Table 4: Climate Change Adaptation Strategies and relation to the development.**

| Policy / Strategy                                   | Relevant Objective / Requirement                                   | Relevance to Proposed Project                                                                                                                                                                                                      |
|-----------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| National Climate Change Adaptation Strategy (NCCAS) | • Enhance adaptive capacity.                                       | The project takes place within a regulated watercourse environment prone to hydrological variability. Infrastructure upgrades such as spillway reinstatement reduce flood risk and increase resilience to intense rainfall events. |
|                                                     | • Protect water resources                                          |                                                                                                                                                                                                                                    |
|                                                     | • Strengthen climate-resilient infrastructure                      |                                                                                                                                                                                                                                    |
| Climate Change Act, 2024 (Act No. 22 of 2024)       | • Institutionalise climate governance                              | The Act mandates that infrastructure projects consider potential climate risks and demonstrate how adaptation has been integrated into design and implementation.                                                                  |
|                                                     | • Require climate risk consideration in development authorisations |                                                                                                                                                                                                                                    |
|                                                     | • Promote ecosystem-based adaptation                               |                                                                                                                                                                                                                                    |





## 6.3 Buffer Zones

In line with national regulatory requirements and best-practice guidelines, all delineated wetlands and watercourses within and adjacent to the proposed development footprint have been assessed to determine appropriate buffer zones and whether the project triggers environmental authorisation thresholds under the National Environmental Management Act (NEMA) and the National Water Act (NWA).

The “regulated area of a watercourse” 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).

Buffer zones are typically applied to natural wetlands and riparian areas to safeguard ecological functioning and reduce the risk of disturbance from adjacent activities. In this case, no buffer zones have been applied to the artificial wetlands identified near the LLD spillway, including the seepage wetland, canal, and the wetland overlying the historical diggings. These features are all of anthropogenic origin and do not qualify for formal buffer delineation under wetland policy guidelines.

For the natural unchannelled valley-bottom wetland located approximately 320 m north of the spillway, a buffer zone was calculated using the (Macfarlane & Bredin, 2017) methodology, In accordance with the requirements of GN509 of 2016 (and the revised GN4167 of 2022), yielding a site-specific buffer of 44 m. However, to ensure a conservative approach, a 100 m buffer was applied. The proposed construction activities occur well outside this buffer, and as discussed in the results section, no direct or indirect impacts are anticipated to the natural wetland.

Regarding the DWS 500 m regulated area, this radius is generally applied around natural wetlands to determine the need for a Water Use Licence in terms of Section 21(c) and (i) of the National Water Act. In this case, no natural wetlands occur within or adjacent to the LLD spillway footprint. Since the nearest natural wetland is more than 300 m away and the other water features are artificial, it is not appropriate or feasible to establish a 500 m regulated area around the project footprint for the purpose of licensing. The assessment thus focuses on activities directly associated with the spillway and dam wall, where regulatory triggers are based on proximity to and alteration of artificial and engineered watercourses.



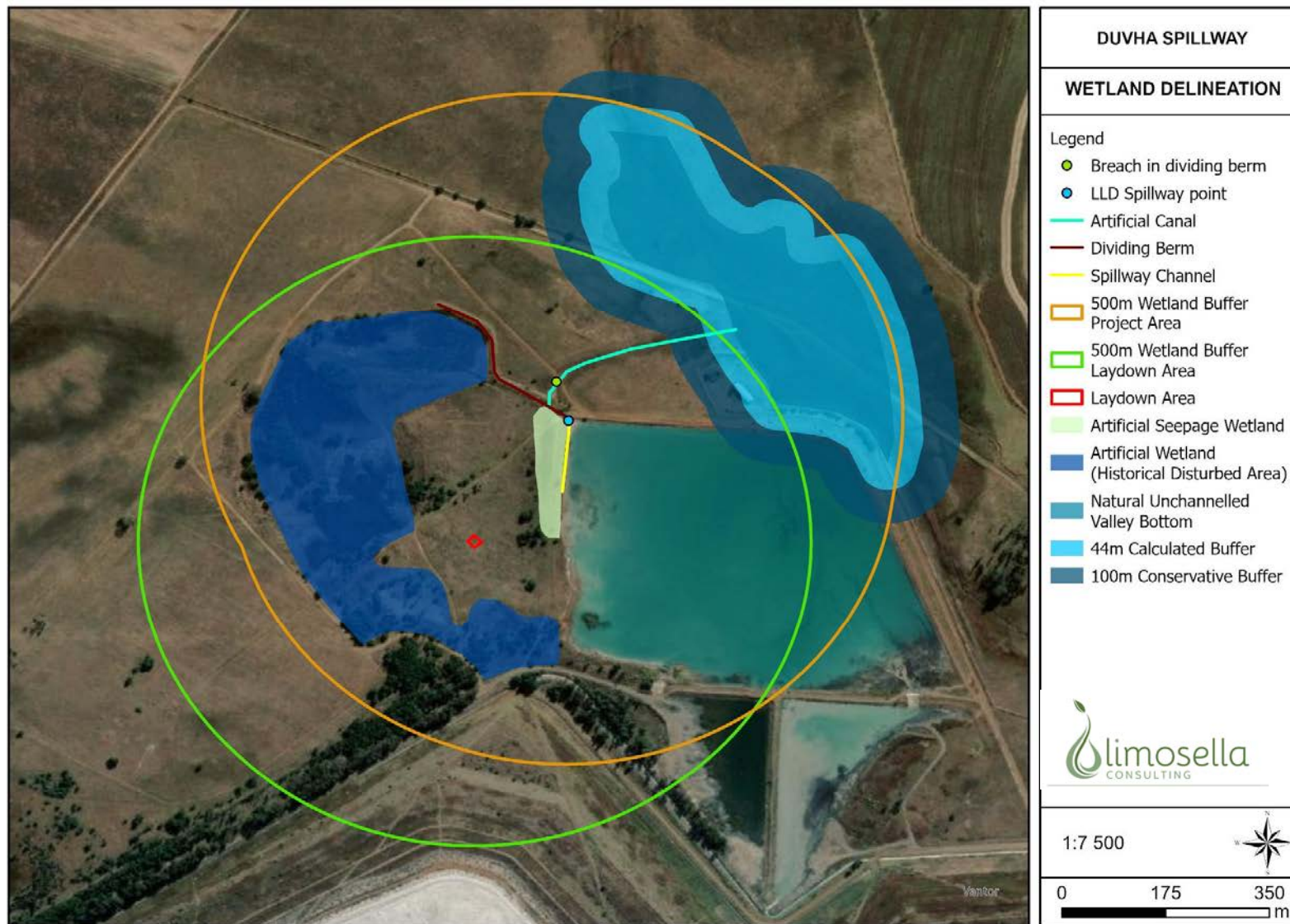


Figure 8: The watercourse delineation with calculated buffer zones?



## 6.3.1 Wetland/Riparian Delineation

The Classification System for Wetlands and Other Aquatic Ecosystems (Ollis, et al., 2013) in South Africa is a hierarchical framework designed to standardise the identification and categorisation of aquatic ecosystems. The following table (**Table 5**) provides a detailed classification of the watercourse based on the six-tiered framework for aquatic ecosystem description. This framework considers biophysical, geomorphological, and hydrological factors, as well as specific site descriptors. The classification is essential for understanding the ecological character, functioning, and sensitivity of the system, and it informs appropriate management and mitigation measures related to the proposed dam wall rehabilitation activities.

**Table 5: Classification System for Wetlands and Other Aquatic Ecosystems in South Africa (Ollis, et al., 2013)**

| Level | Name                       | Description                                                                                                                                   | Purpose                                                                                          |
|-------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| 1     | System                     | Broadly categorises ecosystems as marine, estuarine, inland, or artificial systems.                                                           | Defines the overarching environment where the aquatic ecosystem is located.                      |
| 2     | Regional Setting           | Places the system within a bioregional context (e.g., ecoregions, climatic zones).                                                            | Provides insight into the climatic and geographical influences shaping the ecosystem.            |
| 3     | Landscape Unit             | Defines the geomorphological context (e.g., valleys, plateaus, floodplains).                                                                  | Establishes how the landscape influences hydrology and ecosystem structure.                      |
| 4     | Hydrogeomorphic (HGM) Unit | Categorises ecosystems based on hydrology, geomorphology, and water sources.                                                                  | Differentiates systems like rivers, floodplains, depressions, or seepage wetlands.               |
| 5     | Hydrological Regime        | Focuses on the hydrology, including:                                                                                                          | Provides detailed understanding of water movement and its influence on ecosystems.               |
|       |                            | - 5A: Inundation Period - Frequency and duration of surface water presence.                                                                   |                                                                                                  |
|       |                            | - 5B: Saturation Period - Duration of soil saturation without surface water.                                                                  |                                                                                                  |
| 6     | Descriptors                | Adds specific characteristics, such as:<br>- Natural vs. Artificial systems<br>- Salinity, pH, substratum type, vegetation cover, and geology | Offers detailed descriptions of physical and ecological attributes for site-specific management. |

The watercourse is classified (Ollis, et al., 2013) from level 1 to 4 (**Table 6**)

**Table 6: Summary of the result of the study area with application of Levels 1 to 4 of the Classification System for Wetlands and Other Aquatic Ecosystems in South Africa (Ollis, et al., 2013)**

| Level 1 | Level 2                          | Level 3                 | Level 4: HGM unit                                  |
|---------|----------------------------------|-------------------------|----------------------------------------------------|
| System  | NFEPA Wetland Vegetation Group   | Landscape Unit          | Level 4A                                           |
| Inland  | Mesic Highveld Grassland Group 4 | Slope and Valley Bottom | Artificial wetlands and Unchannelled Valley Bottom |



### 6.2.4 Difficult to Delineate Wetlands

The guidance provided by Job (2009) is directly relevant to the current study area (Table 7), as the spillway surroundings include several artificial wetland-like features, namely the seepage wetland, the canal leading to the natural wetland, and the artificial wetland overlying the historical diggings. These areas display typical wetland indicators such as hydrophytic vegetation, saturated soils, and signs of surface water retention, yet they are clearly non-natural in origin, having formed due to dam seepage, excavation, or engineered water diversion.

Table 7: List of types of sites that are difficult to delineate. (Jobs, 2009)

| Type of “difficult site”                                                                                | Approach                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Relevance to the Study Site and findings                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Some or all, wetland indicators are present but is a non-natural wetland (e.g. some dams, road islands) | <ul style="list-style-type: none"><li>Decide on the relative permanence of the change and whether the area can now be said to be functioning as a wetland.</li><li>Time field observations during the wet season, when natural hydrology is at its peak, to help to differentiate between naturally occurring versus human-induced wetland.</li><li>Decide appropriate policy/management i.e. can certain land uses be allowed due to “low” wetland functional value, or does the wetland perform key functions despite being artificial.</li></ul> | <ul style="list-style-type: none"><li>The relative permanence of these artificial wetlands suggests that although they now function as wetland systems, their origin and hydrology are entirely anthropogenic. They lack natural catchment processes and geomorphic setting.</li><li>Field observations, including current site verification, support the conclusion that these features formed post-construction and are not present in historical imagery (e.g., 1962). Therefore, their classification as natural wetlands is not supported.</li><li>From a management and policy perspective, these artificial wetlands are considered to have low ecological functional value. While they may perform limited roles such as water storage or vegetation support, they do not warrant the same level of regulatory protection as natural wetlands. Land use and infrastructure reinstatement within or near these features can proceed with appropriate mitigation, without invoking formal wetland buffers or DWS 500 m regulated areas.</li></ul> |



## 6.5 Wetland Soil and Vegetation

### 6.5.1 Artificial Seepage Wetland

The artificial seepage wetland adjacent to the LLD spillway is characterised by soils that are persistently moist but do not display redoximorphic features, such as mottling or gleying, which are typical indicators of prolonged anaerobic conditions in natural wetlands. Instead, the soils are uniformly red (Figure 9), suggesting a well-drained origin not typically associated with naturally hydromorphic conditions.

Despite the soil limitations, the vegetation is distinctly hydrophytic, with species such as *Juncus rigidus* dominating the permanent (central) zone of the wetland. The edge and temporary zones support a mix of facultative and upland species, including *Cyperus longus*, *Andropogon eucomus*, *Andropogon huilensis*, *Eragrostis gummiflua*, *Haplocarpha scaposa*, *Imperata cylindrica*, *Helichrysum mundtii*, and *Sporobolus africanus*. These species indicate temporary to seasonal saturation and are consistent with wetland fringe vegetation.

Several Alien invasive species (AIS) were recorded both within and adjacent to the wetland. Invasive woody species such as *Acacia mearnsii* and *Eucalyptus* sp. were noted throughout the wetland and surrounding areas. Other AIS included *Pennisetum clandestinum* (kikuyu), *Datura ferox*, and scattered individuals in adjacent upland areas. Terrestrial edge species observed outside the wetland included *Asclepias fruticosa* and *Seriphium plumosum*, indicating a transition into more typical grassland or old-field vegetation types. Figure 9 gives a general overview of the vegetation and substrate composition.







Figure 9: General Vegetation and substrate composition of the artificial seepage wetland?

## 6.5.2 Artificial Wetland – Previously Disturbed Area

The artificial wetland situated within the area of historical diggings is characterised by permanent standing water, with depths sufficient to submerge woody alien invasive species (AIS) such as *Eucalyptus* spp. and *Acacia mearnsii*. These species, which are not naturally adapted to prolonged inundation, are growing within the central zone of the wetland, indicating that the current water regime is likely more recent and not aligned with their ecological preferences. Despite this, hydrophytic species such as *Persicaria lapathifolia* thrive in these deeper areas, suggesting colonisation by wetland-adapted flora.

In the shallower margins, species such as *Phragmites australis* dominate, forming dense stands. The edges of the wetland include additional AIS such as *Cortaderia selloana* (pampas grass), which is known for its aggressive spread and habitat alteration. Other wetland species present in this artificial system are consistent with those found in the adjacent seepage wetland, including facultative hydrophytes that tolerate seasonal saturation.

The presence of standing water, wetland vegetation, and invasive species confirms that the area has developed wetland characteristics due to artificial modification of hydrology, likely through excavation and water diversion. However, as with the seepage wetland, its origin is clearly anthropogenic, and its functional value is considered limited in terms of natural wetland processes or biodiversity conservation.







**Figure 10: General Vegetation and substrate composition of the artificial wetland -Previously Disturbed**

### **6.5.3 Artificial Canal and Dividing Berm**

The artificial canal and dividing berm, including the breached area, exhibit clear signs of anthropogenic origin. The canal is straight and engineered, with banks dominated by terrestrial vegetation, including grasses and scattered alien invasive species (AIS). Standing water was observed in both the canal and breached section during the site visit, likely the result of recent rainfall or a spill event. Hydrophytic vegetation was limited within the canal channel itself, with only sparse wetland species present until the point where the canal discharges into the natural unchannelled valley-bottom wetland. At this interface, the vegetation shifts noticeably, with indigenous wetland species such as *Typha capensis* becoming dominant.

The dividing berm was vegetated primarily by grasses and invasive species, similar in composition to the adjacent seepage wetland, and showed signs of trampling by livestock or wildlife, particularly in areas where water had pooled. The soil within the canal channel was dark red and clay-rich, consistent with the soils observed in the artificial seepage wetland, and lacked redoximorphic indicators typically associated with prolonged natural saturation.





These features further support the classification of the canal and berm as artificial and disturbed, functioning primarily as flow diversion structures rather than natural wetland systems. Their ecological integrity is low, although connectivity to the downstream natural wetland warrants attention for broader management purposes.



**Figure 11: General Vegetation and substrate composition of the artificial canal and Dividing beam – including breached area**

A summary of the dominant vegetation and soil characteristics for a level 6 assessment are described in the table below (**Table 8**).

**Table 8: Summary of the Level 6 dominant soil and vegetation characteristics of the wetlands on the study site.**

| Dominant Descriptor Categories (Level 6) |                                   |                        |                    |
|------------------------------------------|-----------------------------------|------------------------|--------------------|
| 6A: Natural vs Artificial                | Vegetation Cover, Form and Status |                        |                    |
|                                          | 6A: Veg Cover                     | 6B, C & D Primary Form | 6E: Veg Conditions |
| Artificial                               | Vegetated                         | AIS and Grasses        | Largely AIS        |



## 7 Watercourse Functional Assessment

In order to reflect a comprehensive suite of assessments appropriate for the watercourse type and characteristics, the following assessments are discussed in the sections below (**Given the** artificial nature of the wetland features associated with the LLD spillway, namely the seepage wetland, the historical diggings area, the artificial canal, and the dividing berm, a full WET-Health assessment is not appropriate. These systems have no natural reference condition, as they originated from anthropogenic activities such as dam seepage, excavation, or flow diversion. Applying WET-Health in this context would yield artificially low Present Ecological State (PES) scores and misrepresent their functional capacity.

Instead, the WET-EcoServices tool (Kotze et al., 2020) was applied to evaluate the combined functional value of these artificial wetlands. This approach focuses on the ecosystem services currently provided—such as flood attenuation, sediment trapping, and limited habitat provision—regardless of the wetland's origin. Grouping the artificial areas into a single functional unit for assessment reflects their shared hydrological influence and degraded, non-natural character.

In addition to EcoServices, the Ecological Importance and Sensitivity (EIS) framework was used to support interpretation of management value. While these systems may not be natural, some may perform limited regulatory or supporting functions in the broader landscape and could inform land-use decisions, particularly where erosion control or water retention is evident.

The Recommended Ecological Category (REC) (Rountree et al., 2013), however, was not applied to these artificial systems, as it is specifically intended for natural wetlands with a defined reference state. Applying the REC to anthropogenic systems would be inappropriate and potentially misleading. Instead, REC is only considered for the natural unchannelled valley-bottom wetland located approximately 320 m downstream of the LLD, which is of natural origin, visible in historical imagery, and ecologically intact enough to warrant formal assessment should future work include it.

**Table 9).** Given the artificial nature of the wetland features associated with the LLD spillway, namely the seepage wetland, the historical diggings area, the artificial canal, and the dividing berm, a full WET-Health assessment is not appropriate. These systems have no natural reference condition, as they originated from anthropogenic activities such as dam seepage, excavation, or flow diversion. Applying WET-Health in this context would yield artificially low Present Ecological State (PES) scores and misrepresent their functional capacity.

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**Table 9: Assessments undertaken in the current assessment**

| Watercourse Type         | Assessment Method                                                                                                                                                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Artificial Wetland Areas | <ul style="list-style-type: none"><li>• <b>Ecosystem Services:</b> WetEcosystem Services V2 (ES) (Kotze <i>et al.</i>, 2020).</li><li>• <b>Ecological Importance and Sensitivity (EIS)</b> - (Kotze <i>et al.</i>, 2020) and.</li></ul> |





## 7.2.1 WetEcoServices Kotze et al. (2020)

The total absence of Moderate or High importance scores confirms that these artificial systems are functionally limited, with no significant ecological, social, or economic value in their current state. While they may retain saturated conditions and support opportunistic wetland vegetation, they do not meaningfully contribute to biodiversity support, hydrological regulation, or ecosystem services typically expected from natural wetland systems (Table 10).

**Table 10: Summary of the Ecosystem Services provided by the Artificial Wetlands**

|                                    |                          | Present State |        |                  |            |
|------------------------------------|--------------------------|---------------|--------|------------------|------------|
| ECOSYSTEM SERVICE                  |                          | Supply        | Demand | Importance Score | Importance |
| REGULATING AND SUPPORTING SERVICES | Flood attenuation        | 0.0           | 0.3    | 0.0              | Very Low   |
|                                    | Stream flow regulation   | 0.0           | 0.3    | 0.0              | Very Low   |
|                                    | Sediment trapping        | 1.0           | 0.5    | 0.0              | Very Low   |
|                                    | Erosion control          | 0.5           | 1.0    | 0.0              | Very Low   |
|                                    | Phosphate assimilation   | 0.8           | 0.8    | 0.0              | Very Low   |
|                                    | Nitrate assimilation     | 0.5           | 0.8    | 0.0              | Very Low   |
|                                    | Toxicant assimilation    | 0.8           | 0.8    | 0.0              | Very Low   |
|                                    | Carbon storage           | 1.6           | 0.0    | 0.1              | Very Low   |
|                                    | Biodiversity maintenance | 0.3           | 1.0    | 0.0              | Very Low   |
| PROVISIONING SERVICES              | Water for human use      | 0.0           | 1.3    | 0.0              | Very Low   |
|                                    | Harvestable resources    | 2.0           | 0.3    | 0.7              | Very Low   |
|                                    | Food for livestock       | 1.5           | 0.7    | 0.3              | Very Low   |
|                                    | Cultivated foods         | 1.4           | 0.0    | 0.0              | Very Low   |
| CULTURAL SERVICES                  | Tourism and Recreation   | 0.3           | 0.0    | 0.0              | Very Low   |
|                                    | Education and Research   | 0.3           | 0.0    | 0.0              | Very Low   |
|                                    | Cultural and Spiritual   | 2.0           | 0.0    | 0.5              | Very Low   |



## 7.2 Ecological Importance and Sensitivity (EIS) (Rountree, et al., 2013)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Importance and Sensitivity scoring system which also addresses hydrological importance and direct human benefits. Both EC and EIS form part of a larger reserve determination process documented by the Department of Water and Sanitation.

Ecological importance is an expression of a wetland’s importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity refers to the system’s ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (Rountree, et al., 2013). This classification of water resources allows for an appropriate management class to be allocated to the water resource and includes the following:

- Ecological Importance in terms of ecosystems and biodiversity such as species diversity and abundance.
- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors.
- Basic human needs including subsistence farming and water use.

The highest EIS score of 2.6 **falls in the Low Category**. Wetlands that are 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 in major rivers.

- **Biodiversity maintenance importance: 0.7 (Very Low)**
- **Regulating services importance: 0.1 (Very Low)**
- **Provisioning and cultural services importance: 0.5 (Very Low)**

## 7.3 Summary of Findings

The Following table (Table 11) is a summary of the functional assessment for the wetlands within the study site.

Table 11: Summary of wetland functionality.

|                          |                                                                                                                                                                                                                                                                                                       |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Classification           | Artificial Wetland Areas                                                                                                                                                                                                                                                                              |
| WetEcoServices           | Very Low for all metrics                                                                                                                                                                                                                                                                              |
| EIS (Kotze et al., 2020) | <b>Low Category</b> - Wetlands that are 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 in major rivers. |



## 8 General Principles of Watercourse Protection (SANBI & DWS, 2016)

1. **Avoid/Prevent:** This is the highest priority in the hierarchy and involves avoiding or preventing impacts to watercourses altogether. It focuses on identifying and selecting alternative actions or locations that do not pose a risk to watercourses. This may involve changing the design or selecting a different site altogether to avoid potential negative impacts.
2. **Minimise:** If avoidance is not possible, the next step is to minimize the potential impacts on watercourses. This involves employing measures and techniques to reduce the extent, magnitude, duration, or intensity of the impacts. Examples include implementing erosion and sediment control measures, using best management practices for stormwater management, and adopting sustainable water use practices.
3. **Rehabilitate:** If impacts occur despite avoidance and minimisation efforts, the next step is to rehabilitate or restore the affected watercourses. This involves taking actions to improve the ecological, hydrological, and geomorphological functions of the impacted areas. It may include restoring natural vegetation, improving water quality, stabilising banks, and enhancing habitat for aquatic species.
4. **Offset:** If complete avoidance, minimisation, or rehabilitation is not feasible or insufficient to mitigate the impacts, offsetting measures can be considered. Offset measures aim to compensate for the residual impacts by restoring or creating new watercourse features elsewhere. This may involve creating or enhancing watercourses, establishing buffer zones, or implementing other habitat restoration projects to achieve a net benefit for watercourses and their associated ecosystems. This should be discussed with the relevant authorities, and if deemed necessary an offset plan should be developed and approved.



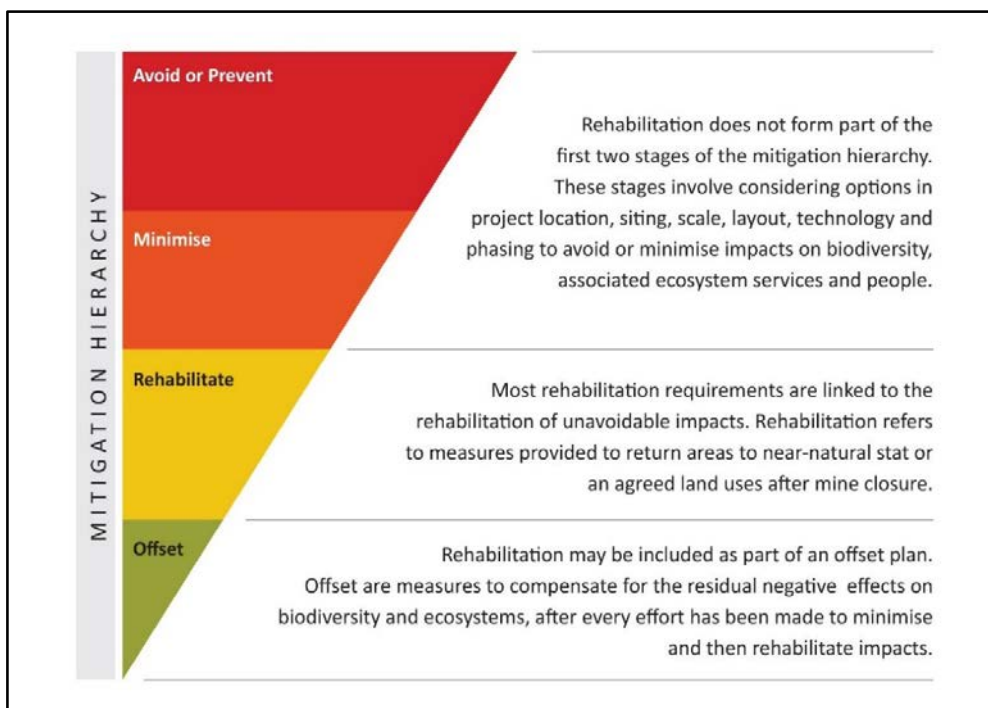


Figure 12: Mitigation Hierarchy (SANBI, 2016)

In terms of this project, which involves the reinstatement of the Low Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station, the development aligns with the mitigation hierarchy as follows:

### 8.1 Avoidance

Where possible, the project has been designed to avoid direct impact on any natural wetland systems. All construction activities are restricted to a highly disturbed and artificial footprint, including the LLD spillway, canal, berm, and seepage wetland. The only natural wetland in proximity, the unchannelled valley-bottom wetland located  $\pm 320$  m from the activity zone, falls outside the 100 m buffer and is not physically or hydrologically altered by the proposed works. No new infrastructure is placed within or directly adjacent to this natural feature.

### 8.2 Minimisation

Impacts within the artificial wetland areas should be limited through standard construction-phase controls, such as:

- Timing construction during the dry season to reduce soil disturbance and erosion risk;
- Stabilising exposed surfaces and stockpiles;
- Installing erosion protection (e.g., *Armorflex*, Reno mattresses) to reduce downstream sedimentation;
- Ensuring machinery remains within designated areas to prevent unnecessary trampling or vegetation removal.



The engineered design also improves the dam's resilience to high rainfall events, reducing the risk of uncontrolled spills that could affect downstream ecosystems.

### **8.23 Rehabilitation**

Post-construction, any temporarily disturbed areas (e.g. berm realignments, access tracks) will be stabilised and re-vegetated using appropriate, preferably indigenous, grass species to reduce erosion risk. While the artificial wetlands themselves are not targeted for ecological rehabilitation, the surrounding disturbed soils will be shaped and compacted to promote stability and passive recovery.

### **8.24 Offsetting**

No residual impact on natural aquatic ecosystems is anticipated; therefore, no biodiversity offsets are required. All construction occurs within artificial or heavily modified environments with very low ecological value, as confirmed by the WET-EcoServices assessment.





## 9 Impacts

The reinstatement of the Low Level Dam (LLD) spillway and associated infrastructure has the potential to result in several impacts on the surrounding environment if no mitigation measures are applied. While the development footprint is confined to disturbed and artificial areas, the nature of the works, particularly involving excavation, concrete placement, and vegetation clearance

### 9.1 Site Specific Impacts

The anticipated operational and construction impacts of the proposed project on watercourses are summarised in the table below (Table 12).

**Table 12: Anticipated Construction and Operational Phase Impacts.**

| Impact                                 | Description                                                                                | Phase                            | Consequence                                                           |
|----------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------|-----------------------------------------------------------------------|
| Soil disturbance and erosion           | Excavation may expose soil, leading to erosion and sedimentation in adjacent wetlands      | Construction                     | Increased sediment load, downstream siltation, and habitat smothering |
| Vegetation loss                        | Clearance of wetland and berm vegetation, including hydrophytes and terrestrial species    | Construction                     | Loss of limited habitat and reduction in ecosystem services           |
| Water quality degradation              | Runoff may carry sediment, concrete residues, and hydrocarbons into surface water          | Construction                     | Temporary deterioration in water quality affecting aquatic biota      |
| Disturbance to wetland fauna           | Noise, vibration, and habitat removal may displace amphibians, birds, or invertebrates     | Construction                     | Temporary faunal displacement from artificial wetlands                |
| Flow disruption during works           | Incomplete or blocked spillway may alter flow paths during rain or overflow events         | Construction                     | Increased risk of uncontrolled discharge into natural wetland         |
| Spread of alien invasive species (AIS) | Soil disturbance may promote regrowth or spread of invasive species in and around the site | Construction & Post-construction | Increased AIS density, competition with indigenous vegetation         |



## 10 Opportunities and Constraints

The reinstatement of the LLD spillway and associated infrastructure presents both opportunities and limitations within the broader environmental and operational context. While the site is highly disturbed and largely artificial in nature, providing flexibility for construction without affecting natural wetlands, there are still ecological and operational considerations that must guide project planning. The table below outlines key aspects, associated opportunities, and constraints identified during the assessment (**Table 13**):

**Table 13: Opportunities and Constraints**

| Aspect                              | Opportunities                                                                                          | Constraints                                                                                |
|-------------------------------------|--------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|
| <b>Site condition</b>               | Existing disturbance and artificial wetlands minimise ecological sensitivity of the construction area  | Limited ecological value may lead to misunderstanding of functional roles of some features |
| <b>Wetland origin</b>               | Artificial nature allows flexibility in design and management without contravening wetland regulations | Cannot be treated as natural systems for offset or rehabilitation obligations              |
| <b>Proximity to natural wetland</b> | Natural wetland is located ~320 m away, outside the buffer—avoiding direct impact                      | Indirect impacts from future spills must still be carefully managed                        |
| <b>Hydrology</b>                    | Opportunity to restore spillway function and manage flood risk through controlled discharge            | Temporary risk of flow disruption or erosion during construction                           |
| <b>Alien invasive species (AIS)</b> | Invasive vegetation can be cleared and managed as part of rehabilitation                               | High existing AIS load may promote re-establishment without follow-up management           |
| <b>Ecological service provision</b> | Potential to enhance ecosystem services (e.g. erosion control) through design improvements             | Current wetland services are very low—limited baseline for functional gain                 |

## 11 Cumulative Impacts

As required by the Department of Forestry, Fisheries and the Environment (DFFE) under the **National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998)** and its associated EIA Regulations (as amended), all proposed developments must consider not only direct project-specific impacts, but also cumulative impacts that may arise when added to other past, present, or reasonably foreseeable future activities in the area. The table below identifies key cumulative impacts relevant to this project, their potential ecological consequences, and mitigation strategies to ensure compliance with DFFE's cumulative assessment expectations. (**Table 14**).

The verified environmental sensitivities, including the distinction between highly sensitive natural wetlands and medium-sensitivity artificial wetland features, were used to spatially contextualise cumulative pressures within the broader catchment and downstream environment. Identified cumulative pressures such as hydrological alteration, sediment mobilisation, alien invasive species proliferation, and habitat fragmentation were evaluated against the ecological condition and sensitivity of these aquatic systems.



The specialist-recommended mitigation measures, including maintenance of controlled flow regimes, retention of buffer zones around natural wetlands, erosion and sediment control, and alien invasive species management, were then applied to the cumulative impact pathways to assess their effectiveness in limiting incremental degradation. These mitigation measures directly informed the post-mitigation cumulative impact significance ratings reflected in the risk assessment tables.

The conclusions drawn in the cumulative impact assessment therefore do not rely on generic assumptions, but are directly derived from verified site sensitivities, specialist impact findings, and the feasibility of mitigation within an already modified operational landscape.

### 11.1 Cumulative Impact Significance and Influence on Need and Desirability

The cumulative impact assessment indicates that, without mitigation, continued hydrological modification and physical disturbance would contribute incrementally to the degradation of downstream wetland functioning and ecosystem service delivery. However, when the specialist mitigation measures are implemented, cumulative impacts are assessed as low to moderate in significance, given that:

- The proposed works occur largely within an existing, modified aquatic and infrastructural footprint.
- No additional transformation of intact, highly sensitive natural wetlands is proposed.
- The development includes measures that stabilise flows and reduce uncontrolled erosion and sediment input relative to the existing condition.

As such, the post-mitigation cumulative impact significance does not preclude the proposed development and supports the need and desirability of the project, particularly where the intervention contributes to infrastructure safety, operational efficiency, and improved management of hydrological processes within an already transformed system.

### 11.2 Cumulative Impact Environmental Statement

Based on the cumulative impact assessment undertaken, and taking into account the verified environmental sensitivities, specialist recommendations, and proposed mitigation measures, it is concluded that the proposed development may proceed, provided that:

- No further encroachment into natural, highly sensitive wetland areas occurs;
- Specialist-recommended mitigation measures are fully implemented and maintained; and
- Ongoing monitoring is undertaken to identify and respond to cumulative downstream effects over time.

Under these conditions, the proposed development is not expected to result in unacceptable cumulative environmental impacts and is considered environmentally justifiable within the context of the existing modified landscape



**Table 14: The cumulative impacts of the proposed development\***

| Cumulative Impact                               | Description of Impact                                                                    | Cumulative Effect                                                                         | Potential Result                                                        | Mitigation                                                                                    |
|-------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>Continued modification of hydrology</b>      | Ongoing dam operations, spillway modification, and artificial canals alter flow patterns | Incremental loss of natural hydrological function downstream                              | Degradation of downstream wetland functioning and ecological integrity  | Maintain controlled flow regimes; monitor downstream impacts; avoid further channelisation    |
| <b>Increase in alien invasive species</b>       | Construction disturbance adds to existing AIS presence in berms and wetlands             | Spread and dominance of invasive species across the broader wetland and grassland matrix  | Loss of indigenous biodiversity; reduced habitat quality                | Implement AIS control plan during and post-construction                                       |
| <b>Sediment and nutrient input</b>              | Combined runoff from infrastructure and spillways contributes to sediment/nutrient load  | Long-term sedimentation and eutrophication in downstream systems                          | Decline in water quality; encroachment of aggressive wetland vegetation | Install erosion and sediment controls; maintain vegetation cover                              |
| <b>Habitat simplification and fragmentation</b> | Ongoing development fragments aquatic and terrestrial habitat                            | Cumulative reduction in faunal movement and habitat heterogeneity                         | Reduced ecological resilience and species richness                      | Retain buffer zones around natural wetlands; minimise further encroachment                    |
| <b>Reduced ecosystem service delivery</b>       | Repeated alteration of natural features reduces wetland capacity for service provision   | Decline in regional flood attenuation, water quality regulation, and biodiversity support | Increased vulnerability to climate extremes and land degradation        | Restore functionality in natural systems where possible; prioritise no further transformation |

\*Notes

1. The cumulative impacts are based on activities within a 30 km radius, aligned with DFFE requirements



## 12 Mitigation Measures

Mitigation measures are essential to reduce or eliminate potential negative environmental impacts during the planning, construction, and operational phases of the proposed LLD spillway reinstatement. These measures are aligned with the principles of the mitigation hierarchy and aim to preserve downstream ecosystem integrity, manage erosion and invasive species, and ensure that artificial wetlands are not further degraded during the course of the project. The table below outlines the key objectives and corresponding measures for each project phase (**Table 15**):

**Table 15: Mitigation plan.**

| Project Phase            | Mitigation Objective                       | Mitigation Measures                                                                                                                                                                                                      |
|--------------------------|--------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pre-construction</b>  | Minimise impact through effective planning | <ul style="list-style-type: none"> <li>• Demarcate the construction footprint to avoid unnecessary disturbance</li> <li>• Clearly map artificial vs natural features- Prepare AIS control and monitoring plan</li> </ul> |
| <b>Construction</b>      | Prevent soil erosion and sedimentation     | <ul style="list-style-type: none"> <li>• Apply erosion controls (e.g., silt fences, straw bales)</li> <li>• Stabilise exposed soils promptly</li> <li>• Avoid working during heavy rainfall periods</li> </ul>           |
|                          | Maintain water quality                     | <ul style="list-style-type: none"> <li>• Store fuels and chemicals in bunded areas</li> <li>• Prevent concrete runoff from entering wet areas</li> <li>• Regularly inspect vehicles for leaks</li> </ul>                 |
|                          | Minimise vegetation and habitat loss       | <ul style="list-style-type: none"> <li>• Restrict machinery to defined access routes</li> <li>• Stockpile and re-use topsoil where feasible</li> <li>• Re-vegetate disturbed areas post-construction</li> </ul>          |
|                          | Control spread of alien invasive species   | <ul style="list-style-type: none"> <li>• Remove AIS manually or with approved herbicide methods-</li> <li>• Avoid transporting contaminated soil/materials between sites</li> </ul>                                      |
|                          | Avoid indirect impact on natural wetland   | <ul style="list-style-type: none"> <li>• Maintain 100 m buffer from natural wetland</li> <li>• Prevent unregulated water release during works</li> </ul>                                                                 |
| <b>Post-construction</b> | Restore stability and vegetation           | <ul style="list-style-type: none"> <li>• Shape and compact disturbed areas</li> <li>• Seed with indigenous grass species</li> <li>• Monitor erosion-prone areas</li> </ul>                                               |
| <b>Operational</b>       | Long-term prevention of AIS resurgence     | <ul style="list-style-type: none"> <li>• Implement regular follow-up AIS control</li> <li>• Conduct inspections after seasonal rains</li> <li>• Include AIS monitoring in operational management plans</li> </ul>        |

## 13 Rehabilitation

Rehabilitation in this document refers to the reinstatement of disturbed areas affected by the construction or due to construction and operational related activities, to a state that resemble the conditions prior to the disturbances. It therefore does not address the rehabilitation of the wetlands and riparian areas downstream of the study site from example a management category E to a D (Kleynhans, et al., 2007). The following table describes the rehabilitation suggested for the proposed abstraction (**Table 16**). Rehabilitation aims to restore the stability, functionality, and visual integrity of areas disturbed during construction. Given the project's location within artificial and already modified environments, rehabilitation will focus primarily on stabilising soils, preventing erosion, and managing alien invasive species (AIS). Ecological restoration is not required for the artificial wetlands, but basic functional rehabilitation will ensure that no further degradation occurs and that the area blends into the surrounding landscape post-construction.





**Table 16: Rehabilitation plan.**

| Impact                                   | Rehabilitation                                                                                                                  | Time Frame                                                            |
|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| <b>Disturbed soils and embankments</b>   | Reshape and compact berms and spillway banks; apply erosion control (e.g., mulch, geo-fabric)                                   | Immediate (within 2 weeks post-construction)                          |
| <b>Vegetation clearance</b>              | Re-vegetate using indigenous grass species suited to disturbed soils (e.g., <i>Eragrostis</i> spp.)                             | Planting during the first suitable rainfall window after construction |
| <b>Loss of topsoil</b>                   | Replace stockpiled topsoil in disturbed zones; scarify and seed                                                                 | Concurrent with re-vegetation                                         |
| <b>AIS colonisation post-disturbance</b> | Remove regrowth of <i>Acacia mearnsii</i> , <i>Eucalyptus</i> , <i>Cortaderia selloana</i> , and <i>Pennisetum clandestinum</i> | Ongoing; first follow-up within 3 months, then seasonally for 2 years |
| <b>Trampled or compacted areas</b>       | Loosen compacted soils and re-seed; restrict future access                                                                      | Immediate; monitor quarterly until vegetation establishes             |
| <b>Visual and landscape impact</b>       | Blend reshaped surfaces with surrounding topography and vegetation cover                                                        | Within 1 month post-construction                                      |



## 14 GN320 Impacts on the Aquatic Environment

A discussion on impacts to the aquatic environment (as required in GN320 of March 2020) is summarised in **Table 17**. The numbers (e.g., 2,5,3) refer to specific impact categories outlined in GN320 of March 2020, which guides the assessment of impacts on watercourses. These numbers correspond to predefined sections in the Government Notice that categorise different types of ecological impacts. In this context, they indicate that the impact assessment addresses:

- (2) Impacts on hydrological processes, including changes to flood regimes, floodplain connectivity, and groundwater interactions.
- (5) Impacts on ecosystem functioning and resilience, particularly how the proposed development may alter wetland or riparian dynamics.
- (3) Impacts related to sediment transport, erosion control, and other geomorphological changes.

**Table 17: Impacts as per GN320 of March 2020.**

| Number | Impact question                                                                                                                                                                                                                                              | Expected impact                                                                                                                                                                                                                                                                                                    | Mitigation Measures                                                                                                                                                                                                                                  |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2,5,3  | How will the development impact on fixed and dynamic ecological processes that operate within or across the site?                                                                                                                                            |                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                      |
|        | a) Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding, or destruction of floodplain processes); | The development is located within an artificial, off-channel dam system and will not significantly alter the broader landscape-scale hydrological regime. However, during construction, temporary disruption of controlled overflow pathways could occur, potentially affecting downstream hydrology if unmanaged. | <ul style="list-style-type: none"> <li>• Ensure controlled discharge remains operational during construction.</li> <li>• Schedule works outside peak rainfall season.</li> <li>• Monitor downstream flows to prevent unseasonal releases.</li> </ul> |
|        | b) Change in the sediment regime (e.g. sand movement, meandering river mouth /estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub -catchment;                                                                         | Minimal long-term change is expected. Short-term increased sedimentation risk may arise from excavation of the spillway and berm removal. Sediment could be transported to artificial wetlands or, in extreme events, reach downstream natural wetlands.                                                           | <p>Apply erosion control measures (e.g., silt fences, hay bales).</p> <ul style="list-style-type: none"> <li>- Stabilise excavated areas promptly.</li> <li>- Monitor turbidity during and after rain events.</li> </ul>                             |



| Number | Impact question                                                                                                                                                                                                                                                    | Expected impact                                                                                                                                                                                                                                                                        | Mitigation Measures                                                                                                                                                                                                     |
|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | c) The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary, seasonal, permanent zone, of a wetland, in the riparian zone, or within the channel of a watercourse, etc.). | All modifications are confined to artificial systems— seepage wetland, canal, berm, and diggings area. No work occurs within the natural wetland or its seasonal/permanent zones. Thus, the extent of modification is limited to degraded/artificial areas.                            | Maintain a 100 m buffer to the natural wetland.<br>- Clearly demarcate construction zones.<br>- Avoid any direct runoff pathways to the natural system.                                                                 |
|        | d) The extent to which the risk associated with water uses and related activities change.                                                                                                                                                                          | There is a temporary increase in risk during construction due to possible sedimentation, uncontrolled spills, and pollutant mobilisation. However, the completed project will likely reduce long-term risk by restoring spillway capacity and preventing uncontrolled overflow events. | Maintain on-site environmental control measures.<br>- Supervise handling of fuels, cement, and waste.<br>- Ensure post-construction erosion protection (e.g., Reno mattresses, Armorfex) is implemented and maintained. |
| 2,5,4  | How will the proposed development impact on the functioning of the aquatic feature?<br><br>This must include:                                                                                                                                                      |                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                         |
|        | a) Base flows (e.g. too little/ too much water in terms of characteristics and requirements of system)                                                                                                                                                             | Negligible impact expected. The project does not alter the natural flow regime of any river or stream. The LLD is an artificial off-channel system, and the reinstatement of the spillway will maintain existing baseflow conditions.                                                  | N/A                                                                                                                                                                                                                     |
|        | b) Quantity of water, including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or offstream impoundment of a wetland or river)                         | The reinstatement of the spillway is expected to restore controlled overflow and reduce risk of unregulated discharge. There is no change in hydroperiod or water abstraction proposed.                                                                                                | N/A                                                                                                                                                                                                                     |



| Number | Impact question                                                                                                                                                                                                         | Expected impact                                                                                                                                                                                                                                                              | Mitigation Measures                                                                                                                                                                           |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|        | c) Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland)                                                         | No change in HGM type will occur. All work is within artificial features; the downstream natural wetland remains unaltered. The artificial canal will continue to discharge into the unchannelled valley-bottom wetland.                                                     | N/A                                                                                                                                                                                           |
|        | d) Quality of water (e.g. due to increased sediment load, contamination by chemical and /or organic effluent, and/ or eutrophication)                                                                                   | Temporary deterioration in water quality may occur during construction due to sediment release or accidental pollution. Long-term, the restored spillway will reduce uncontrolled erosion                                                                                    | Implement best practice erosion and pollution controls during construction (e.g., banded storage, silt fencing).<br>- Prevent construction runoff from entering the canal or seepage wetland. |
|        | e) Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal)                                                                                              | No additional fragmentation will occur. The site is already artificial and hydrologically modified. No new roads or linear infrastructure intersect natural features.                                                                                                        | N/A                                                                                                                                                                                           |
|        | f) The loss or degradation of all or part of any unique or important features (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.) associated with or within the aquatic ecosystem | No unique or important aquatic features (e.g. springs, peat, oxbows) are present within the construction area. The natural wetland is not modified and lies >300 m from the activity footprint.                                                                              | N/A                                                                                                                                                                                           |
| 2,5,5, | How will the proposed development impact on key ecosystem regulating and supporting services? In particular:                                                                                                            |                                                                                                                                                                                                                                                                              |                                                                                                                                                                                               |
|        | a) Flood attenuation                                                                                                                                                                                                    | Neutral to positive. The reinstatement of the spillway will restore controlled overflow capacity, reducing the risk of unregulated overtopping. While the artificial wetlands provide minimal attenuation value, the project may slightly improve upstream flood management. | N/A                                                                                                                                                                                           |
|        | b) Stream flow regulation                                                                                                                                                                                               | Negligible impact. The project does not influence stream baseflow, nor does it intersect a perennial or ephemeral                                                                                                                                                            | N/A                                                                                                                                                                                           |



| Number | Impact question                             | Expected impact                                                                                                                                                                                                                     | Mitigation Measures                                                                                                   |
|--------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
|        |                                             | river. The artificial wetlands are not connected to long-term streamflow regulation processes.                                                                                                                                      |                                                                                                                       |
|        | c) Sediment trapping and g) Erosion Control | Short-term negative, long-term neutral to positive. Earthworks may mobilise sediments temporarily, but installation of erosion protection (Armorflex, Reno mattresses) will stabilise key areas, especially downstream of the weir. | Apply sediment and erosion control measures during construction.<br>- Maintain vegetation on berms post-construction. |
|        | d) Phosphate assimilation                   | Negligible to very low impact. Artificial wetlands currently show very limited capacity for nutrient assimilation. The development will not alter nutrient inputs or improve wetland function significantly                         | N/A                                                                                                                   |
|        | e) Nitrate assimilation                     |                                                                                                                                                                                                                                     |                                                                                                                       |
|        | f) Toxin assimilation                       |                                                                                                                                                                                                                                     |                                                                                                                       |
|        | h) Carbon Storage                           | Negligible change. The project may temporarily disturb vegetated areas, but the biomass loss is minimal. The artificial wetlands have very low carbon storage capacity.                                                             | N/A                                                                                                                   |





## 15 Government Notices (GN) 1150 of 2020 and 3717 of 2023

Additionally, the report was conducted in terms of the Government Notices (GN) 1150 of 2020 and 3717 of 2023 which outlines the protocols for specialist assessments and minimum report content requirements for environmental impacts on aquatic animal species in South Africa.

- GN 1150 of 2020: This notice establishes the initial protocols for conducting specialist assessments concerning aquatic animal species. It specifies the necessary qualifications for specialists, the methodologies to be employed during assessments, and the essential content that must be included in environmental reports. The aim is to ensure that assessments are thorough, standardized, and provide sufficient information for decision-making processes.
- GN 3717 of 2023: This notice serves as an amendment to the original protocols established in GN 1150 of 2020. The amendments may include updates to assessment methodologies, reporting requirements, or other relevant procedures to reflect current best practices and scientific understanding.

The following table indicated the impacts as per GN1150 of 2020 and GN3717 of 2023 (**Table 18**).



**Table 18: Impacts as per GN1150 of 2020 and GN3717 of 2023**

| Number | Impact Question                                                                  | Expected Impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Mitigation Measures                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------|----------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2,5,3  | <b>How will the development impact aquatic animal species and their habitat?</b> | The proposed development is confined to artificial aquatic systems—including the seepage wetland, canal, and historical diggings area—which have limited habitat value for aquatic fauna. These systems are largely disturbed, dominated by alien vegetation, and lack the structural complexity typical of natural wetland habitats. As such, the loss or alteration of habitat during construction is expected to have negligible ecological consequence. The natural unchannelled valley-bottom wetland, which could support a more diverse aquatic community, lies over 300 m away and will not be physically impacted by the project.                                             | <p>To minimise even these low-level impacts:</p> <ul style="list-style-type: none"> <li>• Vegetation clearing should be phased and preceded by a brief inspection for nesting birds, amphibians, or large invertebrate aggregations;</li> <li>• Where feasible, shallow pools with vegetation can be retained or reinstated post-construction;</li> <li>• Ensure construction runoff does not degrade water quality in adjacent areas that may serve as refuge habitat.</li> </ul> |
| 2,5,4  | <b>How will the development impact aquatic animal species directly?</b>          | <p>Direct impacts to aquatic fauna—such as amphibians, aquatic invertebrates, and opportunistic wetland birds—are likely to be minimal and temporary, limited to:</p> <ul style="list-style-type: none"> <li>• Disturbance from noise and human activity;</li> <li>• Temporary loss of shallow water zones within the artificial wetlands during excavation;</li> <li>• Possible trampling or displacement of fauna during vegetation clearing.</li> </ul> <p>Given the degraded nature of the artificial systems, the fauna present are expected to be common, disturbance-tolerant species with high mobility or resilience.</p> <ul style="list-style-type: none"> <li>•</li> </ul> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |



## 16 Site Sensitivity Verification and Minimum Report Content Requirements

In accordance with the requirements of Government Notice No. 320 of 20 March 2020, a site sensitivity verification was undertaken prior to, and in support of, the aquatic specialist assessment. The purpose of this process was to verify the current land use and environmental sensitivities identified by the national environmental screening tool and to ensure that the specialist assessment is informed by confirmed site conditions. The site sensitivity verification process and outcomes are summarised in **Table 19** below.

**Table 19: Site Sensitivity Verification in accordance with GN 320 (20 March 2020)**

| GN 320 Requirement                                                                                                                                                                                                                                            | Compliance Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Requirement: Prior to commencing with a specialist assessment, the current use of the land and the environmental sensitivity of the site identified by the screening tool must be confirmed by undertaking a site sensitivity verification<sup>2</sup></b> | A site sensitivity verification was undertaken prior to the aquatic biodiversity and wetland assessment to verify the land use and aquatic sensitivities identified by the environmental screening tool. The verification focused on aquatic features associated with the existing low-level dam, spillway, downstream channel, and associated wetland areas within the development footprint.                                                                                                                                                               |
| <b>2<sup>21</sup> The site sensitivity verification must be undertaken by an environmental assessment practitioner or a specialist<sup>2</sup></b>                                                                                                            | The site sensitivity verification was undertaken by a suitably qualified aquatic specialist registered with the South African Council for Natural Scientific Professions (SACNASP), with demonstrated experience in aquatic biodiversity assessments, wetland delineation, and regulatory compliance.                                                                                                                                                                                                                                                        |
| <b>2<sup>22</sup>(a) Desktop analysis using satellite imagery<sup>2</sup></b>                                                                                                                                                                                 | A desktop verification was conducted using recent and historical aerial and satellite imagery, topographical mapping, and available spatial datasets. This analysis verified the spatial extent of natural wetland areas, artificial or modified wetland features associated with historical infrastructure, and the surrounding land use context.                                                                                                                                                                                                           |
| <b>2<sup>22</sup>(b) Preliminary on-site inspection<sup>2</sup></b>                                                                                                                                                                                           | A preliminary site inspection was undertaken to ground-truth the desktop findings and confirm current site conditions. The inspection verified the presence, condition, and degree of modification of both natural wetland areas and artificial wetland features, as well as the extent of instream and riparian disturbance associated with existing infrastructure.                                                                                                                                                                                        |
| <b>2<sup>22</sup>(c) Other available and relevant information<sup>2</sup></b>                                                                                                                                                                                 | Additional relevant information reviewed included existing specialist studies, project documentation, regulatory guidance, and photographic records. These sources were used to contextualise the origin, function, and condition of natural versus artificial wetland components within the study area.                                                                                                                                                                                                                                                     |
| <b>2<sup>23</sup>(a) Confirmation or dispute of current land use and environmental sensitivity identified by the screening tool<sup>2</sup></b>                                                                                                               | The site sensitivity verification confirmed the presence of both natural and artificial wetland components within the study area. Natural wetland and their buffer areas were verified as highly sensitive due to their ecological functioning, hydrological connectivity, and biodiversity value. Artificial or engineered wetland areas associated with historical infrastructure were verified as having a medium sensitivity, reflecting their modified origin, reduced ecological integrity, and partial reliance on anthropogenic hydrological inputs. |
| <b>2<sup>23</sup>(b) Motivation and evidence (e.g. photographs) supporting the verified or revised sensitivity<sup>2</sup></b>                                                                                                                                | The differentiation in sensitivity is supported by site observations, photographic evidence, and interpretation of satellite imagery, which collectively demonstrate intact hydrological and vegetative characteristics in natural wetland areas, contrasted with structural modification, altered flow regimes, and simplified vegetation assemblages in artificial wetland features.                                                                                                                                                                       |
| <b>2<sup>23</sup>(c) Submission together with the relevant assessment report in accordance with the EIA Regulations<sup>2</sup></b>                                                                                                                           | This site sensitivity verification is documented as part of the aquatic specialist assessment report and is submitted in support of the Basic Assessment Report in accordance with the Environmental Impact Assessment Regulations, 2014 (as amended). The verified sensitivity classifications directly inform the impact assessment and mitigation measures presented in subsequent sections of this report.                                                                                                                                               |



## 17 Shangoni Risk Assessment Criteria (Revision 2)

Table 20 indicates the impact scores for the potential impacts relevant to the proposed activities. These impacts include aspects of the aquatic environment as specified in GN350 of March 2022. The laydown area is not located close to any natural wetland and is thus unlikely to have an impact on any watercourse.



**Table 20: Shangoni Risk Assessment for the proposed development.**

| No. | Aspect affected                                       | Activity           | Potential Impact                                                                                                                                                                                                                                                        | Reversibility | Irreplaceable loss | Phase                     | Size and scale of disturbance | Significance pre-mitigation |           |              | Mitigation Type | Significance post-mitigation |           |              |
|-----|-------------------------------------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|---------------------------|-------------------------------|-----------------------------|-----------|--------------|-----------------|------------------------------|-----------|--------------|
|     |                                                       |                    |                                                                                                                                                                                                                                                                         |               |                    |                           |                               | Probability                 | Magnitude | Significance |                 | Probability                  | Magnitude | Significance |
| 1   | Impacts to hydrological function at a landscape level | Operational phase. | The sources of this impact include the compaction of soil, the removal of vegetation, surface water redirection, changes to watercourse morphology or input of high energy surface water which could occur during construction and operation of the mining development. | Reversible    | Low Degree         | Construction, Operational | Local and Downstream          | 2                           | 2         | Low          | Preventative,   | 1                            | 1         | Low          |





| No | Aspect affected | Activity       | Potential Impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Reversibility | Irreplaceable loss | Phase                        | Size and scale of disturbance | Significance pre-mitigation |           |              | Mitigation Type | Significance post-mitigation |           |              |
|----|-----------------|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|------------------------------|-------------------------------|-----------------------------|-----------|--------------|-----------------|------------------------------|-----------|--------------|
|    |                 |                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |               |                    |                              |                               | Probability                 | Magnitude | Significance |                 | Probability                  | Magnitude | Significance |
| 2  | Sedimentation   | All Activities | <p>Construction and maintenance activities will result in earthworks and soil disturbance as well as the disturbance of natural vegetation. This could result in the loss of topsoil, sedimentation of the watercourses and pan and increase the turbidity of the water. Possible sources of the impacts include:</p> <ul style="list-style-type: none"> <li>• Earthwork activities during construction</li> <li>• Clearing of surface vegetation will expose the soils, which in rainy events would wash through the watercourse, causing sedimentation. In addition, indigenous vegetation communities are unlikely to colonise eroded soils successfully and seeds from proximate alien invasive trees can spread easily into these eroded soil.</li> <li>• Disturbance of soil surface</li> <li>• Disturbance of slopes through creation of roads and tracks adjacent to the watercourse</li> <li>• Erosion (e.g. gully formation, bank collapse)</li> </ul> | Reversible    | Low Degree         | Construction and Operational | Local and Downstream          | 2                           | 2         | Low          | Preventative    | 1                            | 1         | Low          |

| No | Aspect affected                                                    | Activity                               | Potential Impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Reversibility | Irreplaceable loss | Phase                        | Size and scale of disturbance | Significance pre-mitigation |           |              | Mitigation Type | Significance post-mitigation |           |              |
|----|--------------------------------------------------------------------|----------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|------------------------------|-------------------------------|-----------------------------|-----------|--------------|-----------------|------------------------------|-----------|--------------|
|    |                                                                    |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |               |                    |                              |                               | Probability                 | Magnitude | Significance |                 | Probability                  | Magnitude | Significance |
| 3  | Introduction and spread of alien vegetation.                       | All Activities                         | The moving of soil and vegetation resulting in opportunistic invasions after disturbance and the introduction of seed in building materials and on vehicles. Invasions of alien plants can impact on hydrology, by reducing the quantity of water entering a watercourse, and outcompete natural vegetation, decreasing the natural biodiversity. Once in a system alien invasive plants can spread through the catchment. If allowed to seed before control measures are implemented alien plants can easily colonise and impact on downstream users. | Reversible    | Low Degree         | Construction and Operational | Local Area                    | 2                           | 2         | Low          | Preventative    | 1                            | 1         | Low          |
| 4  | Loss and disturbance of watercourse habitat and fringe vegetation. | Operational and maintenance activities | Loss and disturbance of watercourse habitat and fringe vegetation due to direct development on the watercourse as well as changes in management, fire regime and habitat fragmentation                                                                                                                                                                                                                                                                                                                                                                 | Reversible    | Low Degree         | Construction and Operational | Local Area                    | 2                           | 2         | Low          | Preventative,   | 1                            | 1         | Low          |



| No. | Aspect affected          | Activity                               | Potential Impact                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Reversibility | Irreplaceable loss | Phase | Size and scale of disturbance | Significance pre-mitigation |           |              | Mitigation Type | Significance post-mitigation |           |              |
|-----|--------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|-------|-------------------------------|-----------------------------|-----------|--------------|-----------------|------------------------------|-----------|--------------|
|     |                          |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |               |                    |       |                               | Probability                 | Magnitude | Significance |                 | Probability                  | Magnitude | Significance |
| 5   | Changes in water quality | Operational and maintenance activities | Changes in water quality due to input of foreign materials e.g. due to increased sediment load, contamination by chemical and /or organic effluent, and /or eutrophication. Construction and operational activities may result in the discharge of solvents and other industrial chemicals, leakage of fuel/oil from vehicles and the disposal of sewage resulting in the loss of sensitive biota in the wetlands/rivers and a reduction in watercourse function. | Reversible    | Low Degree         |       | Local and Downstream          | 2                           | 2         | Low          | Preventative    | 1                            | 1         | Low          |



| No.      | Aspect affected       | Activity                               | Potential Impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Reversibility | Irreplaceable loss | Phase                        | Size and scale of disturbance                                                                        | Significance pre-mitigation |           |              | Mitigation Type            | Significance post-mitigation |           |              |
|----------|-----------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|--------------------|------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------|-----------|--------------|----------------------------|------------------------------|-----------|--------------|
|          |                       |                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |               |                    |                              |                                                                                                      | Probability                 | Magnitude | Significance |                            | Probability                  | Magnitude | Significance |
| 6        | Loss of aquatic biota | Operational and maintenance activities | Loss of instream habitat, deposition of wind-blown sand, loss of fringing vegetation and erosion, alteration in base flow, natural fire regimes and subsequent loss of non-marginal and marginal vegetation. Increase in invasive species due to disturbance. Change in water quality. Changes in flow Loss and disturbance of biota due to direct development on the watercourse as well as changes in habitat including water quality, the water column, increased sediment, increased alien vegetation fire regime and habitat fragmentation | Reversible    | Low Degree         | Construction and Operational | Local and Downstream                                                                                 | 2                           | 2         | Low          | Preventative and Reduction | 1                            | 1         | Low          |
| Table 14 | Cumulative Impacts    | Operational and maintenance activities | Continued modification of flow regimes through dam operations, spillway infrastructure, and artificial channels contributes incrementally to the loss of natural hydrological functioning downstream, with associated degradation of wetland ecological integrity.                                                                                                                                                                                                                                                                              | Reversible    | Low Degree         | Construction and Operational | The cumulative impacts are based on activities within a 30 km radius, aligned with DFFE requirements | 2                           | 2         | Low          | Preventative and Reduction | 1                            | 1         | Low          |



## 18 DWS (2024) Risk Assessment

In accordance with the requirements of Government Notice 509 of 2016, as amended by GN 509 of 2023, a Risk Assessment Matrix (RAM) was completed to evaluate the level of risk associated with the proposed water use activities under Section 21 (a), (c) and (i) of the National Water Act, 1998 (Act No. 36 of 1998). The RAM assesses both the construction, operational, and decommissioning phases of the proposed abstraction infrastructure, including riverbed excavation, berm construction, pump installation, and the abstraction of water from the Hex River (Table 21). Although the proposed development is confined to artificial and highly disturbed aquatic features and lies more than 300 metres from any natural wetland, the DWS Risk Assessment Matrix (RAM) has been completed as a precautionary measure to support transparent decision-making and regulatory alignment. Strictly speaking, the DWS RAM is not required for artificial systems that do not constitute natural watercourses under the National Water Act (Act 36 of 1998).

**Low Risk category:** The risk and impact on watercourses are acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.

**Table 21: The severity score derived from the DWS (2023) risk assessment matrix for the proposed development**

| Phase              | Activity                                                                                                     | Impact                                                         | Potentially affected watercourses |     |                                |
|--------------------|--------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-----------------------------------|-----|--------------------------------|
|                    |                                                                                                              |                                                                | Name/s                            | PES | Overall Watercourse Importance |
| CONSTRUCTION       | Earthworks and vegetation clearance (includes excavation of berm, spillway reshaping, and canal/breach work) | Soil disturbance and erosion                                   | Artificial Wetland                | F   | Low / Very low                 |
|                    |                                                                                                              | Loss of vegetation and associated wetland habitat              | Artificial Wetland                | F   | Low / Very low                 |
|                    |                                                                                                              | Temporary sedimentation in artificial wetlands                 | Artificial Wetland                | F   | Low / Very low                 |
|                    | Construction and installation of infrastructure (includes concrete works, weir, erosion control)             | Localised water quality deterioration (e.g. cement residue)    | Artificial Wetland                | F   | Low / Very low                 |
|                    |                                                                                                              | Alteration of wetland-like habitats                            | Artificial Wetland                | F   | Low / Very low                 |
|                    |                                                                                                              | Disturbance to opportunistic aquatic fauna                     | Artificial Wetland                | F   | Low / Very low                 |
| OPERATIONAL        | Functioning of the reinstated spillway and weir                                                              | Improved control of overflow, reducing uncontrolled discharges | Artificial Wetland                | F   | Low / Very low                 |
|                    | Maintenance and access post-construction                                                                     | Periodic disturbance from vehicles or machinery                | Artificial Wetland                | F   | Low / Very low                 |
|                    |                                                                                                              | Possible regrowth of AIS if unmanaged                          | Artificial Wetland                | F   | Low / Very low                 |
| Cumulative Impacts | Cumulative Impacts                                                                                           | Cumulative Impacts as per table 14                             | Artificial Wetland                | F   | Low / Very low                 |

| Intensity of Impact on Resource Quality |               |          |                   |       | Overall Intensity<br>(max = 10) | Spatial scale<br>(max = 5) | Duration<br>(max = 5) | Severity<br>(max = 20) | Importance rating<br>(max = 5) | Consequence (max = 100) | Likelihood<br>(Probability)<br>of Impact | Significance<br>(max = 100) | Risk Rating | Confidence<br>level |
|-----------------------------------------|---------------|----------|-------------------|-------|---------------------------------|----------------------------|-----------------------|------------------------|--------------------------------|-------------------------|------------------------------------------|-----------------------------|-------------|---------------------|
| Abiotic Habitat (Drivers)               |               |          | Biota (Responses) |       |                                 |                            |                       |                        |                                |                         |                                          |                             |             |                     |
| Hydrology                               | Water Quality | Geomorph | Vegetation        | Fauna |                                 |                            |                       |                        |                                |                         |                                          |                             |             |                     |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 80%                                      | 8                           | L           | Medium              |
|                                         |               |          |                   |       |                                 |                            |                       |                        |                                |                         |                                          |                             |             |                     |
| -2                                      | -2            | 0        | -1                | -2    | 0                               | 1                          | 2                     | 3                      | 2                              | 6                       | 60%                                      | 3.6                         | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 60%                                      | 6                           | L           | Medium              |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 60%                                      | 6                           | L           | Medium              |
|                                         |               |          |                   |       |                                 |                            |                       |                        |                                |                         |                                          |                             |             |                     |
| 1                                       | 1             | 1        | 1                 | 1     | 2                               | 1                          | 2                     | 5                      | 2                              | 10                      | 40%                                      | 4                           | L           | Medium              |





## 19 Conclusion

The proposed reinstatement of the Low Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station is a necessary intervention to restore safe discharge capacity, ensure compliance with dam safety regulations, and reduce the long-term risk of uncontrolled overflow. The development footprint is entirely confined to artificial or heavily modified features, including the seepage wetland, canal, dividing berm, and the disturbed wetland overlying historical diggings. These features, while exhibiting wetland-like characteristics, are of anthropogenic origin and were confirmed to have very low ecological and functional value based on the WET-EcoServices assessment.

No direct impacts on natural wetlands or watercourses are anticipated. The nearest natural unchannelled valley-bottom wetland lies approximately 320 m from the activity footprint and remains outside both the calculated and conservative buffer zones. As such, no triggers under Section 21(f) or (g) of the National Water Act apply, and Section 21(c) and (i) are considered only as a precaution due to the proximity of engineered water features. The natural wetlands are confirmed to be highly sensitive as indicated in the screening report, the artificial wetlands are less sensitive but does contribute to some extent to ecosystem services.

All potential impacts are limited, localised, and temporary, and can be effectively mitigated through standard best-practice construction and rehabilitation measures. Long-term, the project is expected to reduce operational risk, enhance flow control, and prevent further degradation of surrounding artificial wetlands. As such, the development is considered environmentally acceptable and aligned with national policies on sustainable water resource management and climate adaptation. The important factors, relevant to Environmental Authorisation for the proposed project, are summarised in **Table 22** below:

**Table 22: Summary of the findings.**

|                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Quaternary Catchment and WMA areas</b>                                     | B11G<br>Limpopo-Olifants (LOCMA)<br>#2 - Olifants: Major rivers include Elands, Wilge, Steelpoort, Olifants and Letaba Rivers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Watercourse</b>                                                            | <p>The primary watercourse feature is the Low Level Dam (LLD), an artificial off-channel ash return dam. Although mapped as a wetland in the NFEPA and NBA2018 datasets, it does not represent a natural wetland system but rather an engineered containment structure with wetland-like characteristics.</p> <p>Downstream of the LLD, the spillway channel connects to a valley-bottom wetland associated with a non-perennial river. This wetland drains into the Witbak Dam.</p> <ul style="list-style-type: none"> <li>NBA (2018) list the watercourses as <b>Vulnerable</b></li> <li>NFEPA (2011) list the watercourses as <b>Vulnerable</b></li> </ul> |
| <b>Classification (SANBI, 2013)</b>                                           | Artificial Wetland Areas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>WetEcoServices</b>                                                         | Very Low for all metrics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>EIS (Kotze, et al., 2020)</b>                                              | <b>Low Category</b> - Wetlands that are 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 in major rivers                                                                                                                                                                                                                                                                                                                                                          |
| <b>Coj Generic Buffer and Calculated Buffer Zone (Macfarlane et al, 2015)</b> | <p><b>Calculated Buffer Zone: 44 m</b></p> <p><b>Conservative Buffer: 100 m</b></p> <p><b>Artificial Wetland Areas: No Buffer</b></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>DWS 2024 Risk Assessment</b>                                               | Risk scores fall in the <b>Low category</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>National Screening Tool Findings</b>                                       | This study confirms that the natural wetlands are highly sensitive as indicated on the screening report, the artificial wetlands are less sensitive.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## APPENDIX A: Requirements for Aquatic Biodiversity Assessments

The NEMA regulations of 2014 (as amended) specify required information to be included in specialist reports. **Table 23** presents a summary of these requirements, in accordance with GNR982, as amended by GN326. In March 2020, the Department of Environmental Affairs issued General Notice 320 which set out requirements of the EIA Screening Tool Protocols for the Assessment and Reporting of Environmental Themes, including Aquatic Biodiversity. These specifications overlap somewhat with the 2014 EIA regulations, as amended (GN 982 as amended by GN326). **Table 24** presents a summary of the requirements of this protocol, with notes on sections of this report applicable to each aspect. Additionally, Protocols to Follow as per GN 1150 of 2020, as Amended by GN 3717 of 2023 is indicated in **Table 25**.

**Table 23: Legislative report requirements GNR982**

| GNR982 as amended by GN326                                                                                                                              | Report Section                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|
| (1) A specialist report prepared in terms of these Regulations must contain—                                                                            |                                              |
| (a) details of—                                                                                                                                         |                                              |
| (i) the specialist who prepared the report; and                                                                                                         | Page 3                                       |
| (ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;                                                      | Appendix B                                   |
| (b) a declaration that the specialist is independent in a form as may be specified by the competent authority;                                          | Page 1                                       |
| (c) an indication of the scope of, and the purpose for which, the report was prepared;                                                                  | Section 1                                    |
| (cA) an indication of the quality and age of base data used for the specialist report;                                                                  | <b>Table 3</b>                               |
| (cB) a description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;                     | Section 8                                    |
| (d) the duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;                           | Section 1                                    |
| (e) a description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used; | Section 2 and Appendix E (Separate Document) |

|                                                                                                                                                                                                                                          |                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| (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; | Figure 8       |
| (g) an identification of any areas to be avoided, including buffers;                                                                                                                                                                     | Figure 8       |
| (h) a map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;                                             | Figure 8       |
| (i) a description of any assumptions made and any uncertainties or gaps in knowledge;                                                                                                                                                    | Section 1.3    |
| j) a description of the findings and potential implications of such findings on the impact of the proposed activity or activities;                                                                                                       | Section 8      |
| (k) any mitigation measures for inclusion in the EMPr;                                                                                                                                                                                   | Section 8      |
| (l) any conditions for inclusion in the environmental authorisation;                                                                                                                                                                     | Section 8      |
| (m) any monitoring requirements for inclusion in the EMPr or environmental authorisation;                                                                                                                                                | Section 8      |
| (n) a reasoned opinion—                                                                                                                                                                                                                  |                |
| (i) whether the proposed activity, activities or portions thereof should be authorised;                                                                                                                                                  | Conclusion     |
| (iA) regarding the acceptability of the proposed activity or activities; and                                                                                                                                                             | Conclusion     |
| (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;   | Conclusion     |
| (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 |
| (2) Where a government notice gazetted by the Minister provides for any protocol or minimum information requirement to be applied to a specialist report, the requirements as indicated in such notice will apply.                       | Not Applicable |



**Table 24: Content of Specialist report GN320**

| Requirement                                                                                                                                                                                                                                                                                                                                                                                                                                      | Section                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| 2.3.1. a description of the aquatic biodiversity and ecosystems on the site, including;<br><br>(a) aquatic ecosystem types; and<br><br>(b) presence of aquatic species, and composition of aquatic species communities, their habitat, distribution and movement patterns;                                                                                                                                                                       | Section 6.3                                                      |
| 2.3.2. the threat status of the ecosystem and species as identified by the screening tool;                                                                                                                                                                                                                                                                                                                                                       | Table 3                                                          |
| 2.3.3. an indication of the national and provincial priority status of the aquatic ecosystem, including a description of the criteria for the given status (i.e. if the site includes a wetland or a river freshwater ecosystem priority area or sub catchment, a strategic water source area, a priority estuary, whether or not they are free-flowing rivers, wetland clusters, a critical biodiversity or ecologically sensitivity area); and | Table 3                                                          |
| 2.3.4. a description of the ecological importance and sensitivity of the aquatic ecosystem including:                                                                                                                                                                                                                                                                                                                                            | Table 3                                                          |
| (a) the description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); and                                                                                                                                                                           | Figure 8                                                         |
| (b) the historic ecological condition (reference) as well as present ecological state of rivers (in- stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel and flow regime (surface and groundwater).                                                                                                                                                                                  | Figure 7                                                         |
| 2.4. The assessment must identify alternative development footprints within the preferred site which would be of a "low" sensitivity as identified by the screening tool and verified through the site sensitivity verification and which were not considered appropriate.                                                                                                                                                                       | No alternatives were available during the writing of the report. |
| 2.5. Related to impacts, a detailed assessment of the potential impacts of the proposed development on the following aspects must be undertaken to answer the following questions:                                                                                                                                                                                                                                                               | Section 8                                                        |



|                                                                                                                                                                                                                                                                                      |           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 2.5.1. Is the proposed development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?                                                                                                                                 | Section 8 |
| 2.5.2. is the proposed development consistent with maintaining the resource quality objectives for the aquatic ecosystems present?                                                                                                                                                   | Section 8 |
| 2.5.3. how will the proposed development impact on fixed and dynamic ecological processes that operate within or across the site? This must include:                                                                                                                                 | Section 8 |
| (a) impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g., suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes);                        | Section 8 |
| (b) will the proposed development change the sediment regime of the aquatic ecosystem and its sub -catchment (e.g. sand movement, meandering river mouth or estuary, flooding or sedimentation patterns);                                                                            | Section 8 |
| (c) what will the extent of the modification in relation to the overall aquatic ecosystem be (e.g. at the source, upstream or downstream portion, in the temporary   seasonal   permanent zone of a wetland, in the riparian zone or within the channel of a watercourse, etc.); and | Section 8 |
| (d) to what extent will the risks associated with water uses and related activities change;                                                                                                                                                                                          | Section 8 |
| 2.5.4. how will the proposed development impact on the functioning of the aquatic feature? This must include:                                                                                                                                                                        | Section 8 |
| (a) base flows (e.g., too little or too much water in terms of characteristics and requirements of the system);                                                                                                                                                                      | Section 8 |
| (b) quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g., seasonal to temporary or permanent; impact of over -abstraction or instream or off stream impoundment of a wetland or river);                                       | Section 8 |
| (c) change in the hydrogeomorphic typing of the aquatic ecosystem (e.g., change from an unchannelled valley-bottom wetland to a channelled valley-bottom wetland);                                                                                                                   | Section 8 |
| (d) quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication);                                                                                                                                                | Section 8 |





|                                                                                                                                                                                                                                                                                                                                                                                                                              |                |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|
| (e) fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and                                                                                                                                                                                                                                                                                             | Section 8      |
| (f) the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.);                                                                                                                                                                                                    | Section 8      |
| 2.5.5. how will the proposed development impact on key ecosystems regulating and supporting services especially:<br><br>(a) flood attenuation;<br>(b) streamflow regulation;<br>(c) sediment trapping;<br>(d) phosphate assimilation;<br>(e) nitrate assimilation;<br>(f) toxicant assimilation;<br>(g) erosion control; and<br>(h) carbon storage?                                                                          | Section 8      |
| 2.5.6. how will the proposed development impact community composition (numbers and density of species) and integrity (condition, viability, predator - prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?                                                                                                                                                                     | Section 8      |
| 2.6. In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to:<br><br>(a) size of the estuary;<br>(b) availability of sediment;<br>(c) wave action in the mouth;<br>(d) protection of the mouth;<br>(e) beach slope;<br>(f) volume of mean annual runoff; and<br>(g) extent of saline intrusion (especially relevant to permanently open systems). | Not applicable |



**Table 25: Protocols to Follow as per GN 1150 of 2020, as Amended by GN 3717 of 2023**

| Protocol Requirement    | Details                                                                                                               | Report Section                         |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------|----------------------------------------|
| Specialist Requirements | The assessment must be conducted by a qualified aquatic ecologist or aquatic biodiversity specialist.                 | Page 3                                 |
|                         | The specialist must have proven expertise in South African aquatic ecosystems and species identification.             |                                        |
|                         | The specialist should hold a postgraduate qualification in aquatic ecology, conservation biology, or a related field. |                                        |
|                         | Field experience in freshwater, estuarine, or marine ecology is required.                                             |                                        |
| Assessment Methodology  | Desktop Study: Review of existing aquatic biodiversity databases, including SANBI, NFEPA, and National Wetland Map.   | Table 3                                |
|                         | Historical data analysis on species occurrences, water quality, and habitat conditions.                               | Section 6.1                            |
|                         | Identification of threatened, endemic, or indicator species.                                                          | Not recorded                           |
|                         | Field Surveys: Aquatic species sampling using standardised methodologies.                                             | No flowing water to conduct these test |
|                         | Use of SASS 5 protocol for macroinvertebrates.                                                                        |                                        |
|                         | Electrofishing, seine netting, or fyke netting for fish species.                                                      |                                        |
|                         | Dip-netting and visual observation for amphibians.                                                                    |                                        |
|                         | Habitat assessment including water quality, aquatic habitat integrity, and flow conditions.                           |                                        |
|                         | Impact Assessment: Evaluation of direct and indirect impacts on aquatic habitats and species.                         | Section 8.1                            |



| Protocol Requirement   | Details                                                                                                              | Report Section                   |
|------------------------|----------------------------------------------------------------------------------------------------------------------|----------------------------------|
|                        | Assessment of potential risks from habitat loss, fragmentation, water quality degradation, and hydrological changes. | <b>Table 17</b>                  |
|                        | Cumulative impact assessment within 30 km radius.                                                                    | Section 12.1                     |
| Minimum Report Content | Introduction & Background: Project description and objectives.                                                       | Section 1                        |
|                        | Legal & Policy Framework: Compliance with NEMA, NWA, Biodiversity Acts.                                              | Section 2.2 and 2.3              |
|                        | Study Area Description: Hydrological, geomorphological, and ecological features of aquatic ecosystems.               | <b>Table 3</b>                   |
|                        | Survey Methodology: Description of sampling techniques and site selection.                                           | Appendix E and separate document |
|                        | Findings & Discussion: Presence and status of threatened, protected, or endemic aquatic species.                     | Section 6                        |
|                        | Ecological Importance and Sensitivity (EIS) scores.                                                                  | <b>Section 6.4.2</b>             |
|                        | Present Ecological State (PES) of watercourses.                                                                      | <b>Section 6.4.2</b>             |
|                        | Water quality and hydrological changes.                                                                              | <b>Section 9</b>                 |
|                        | Impact Assessment: Impacts during pre-construction, construction, and operation phases.                              | Section 16 and 17                |
|                        | Cumulative impacts with other developments.                                                                          |                                  |
|                        | Mitigation & Management Measures: Avoidance, minimisation, rehabilitation, and offset strategies.                    | Table 15                         |
|                        | Buffer zones, erosion control, stormwater management, and pollution prevention.                                      | Table 15                         |
|                        | Monitoring & Compliance: Long-term monitoring plan for aquatic species and habitats.                                 | N/a                              |



| Protocol Requirement  | Details                                                                         | Report Section                |
|-----------------------|---------------------------------------------------------------------------------|-------------------------------|
|                       | Adaptive management strategies for ongoing ecological changes.                  | <b>Table 14</b>               |
| Compliance & Approval | The report must be submitted to DFFE, DWS, and relevant provincial authorities. | Responsibility of the client. |
|                       | The assessment should be peer-reviewed before submission.                       |                               |
|                       | Findings must be incorporated into the EIA and WULA.                            |                               |



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## Appendix A: CVs of Specialists



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 ECOLOGIST

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- SACNASP** (South African Council for Natural Scientific Professions) (Professional Natural Scientist Reg. No. 008867)
- SAWS** (South African Wetland Society) Founding member
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**PERSONAL INTERESTS**  
Active CrossFit Member  
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**ABOUT ME**

I am a skilled Scientific Professional with more than 10 years experience in various ecological fields with a specialisation in aquatic ecology and anthropogenic interactions.

**EDUCATIONAL QUALIFICATIONS**

**FORMAL QUALIFICATIONS**

- B.Sc. (Botany & Zoology)**, University of South Africa (2008 - 2012)
- B.Sc. (Hons) Botany**, University of South Africa (2014 - 2016)

**OTHER QUALIFICATIONS**

- Introduction to wetlands**, Gauteng Wetland Forum (2010)
- Biomimicry and Constructed Wetlands**, Golder Associates and Water Research Commission (2011)
- Tools for Wetland Assessment**, Rhodes University (2011)
- Understanding Environmental Impact Assessment**, WESSA (2011)
- Wetland Seminar**, ARC-ISCW & IMCG (2011)
- SASS 5**, Groundtruth (2012)
- Wetland Rehabilitation Principles**, University of the Free State (2012)
- Wetland Legislation**, University of Free-State (2013)
- Wetland Plant Identification Course**, SANBI (2015)
- Wetland Operations and Diversity Management Master Class**, Secolo Consulting Training Services (2015)
- Tree Identification**, Braam van Wyk - University of Pretoria (2015)
- Wetland Buffer Legislation** - Eco-Pulse & Water Research Commission (2015)
- Venomous Snake Handling Course** - African Reptiles and Venom (2015)
- Invasive Species Training**, SAGIC (2016)
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- Green Entrepreneurship** - United Nations Development Programme (2022)
- Fundamentals on Reducing emissions from deforestation and forest degradation** - United Nations Development Programme (2022)
- Using Spatial Data for Biodiversity** - United Nations Development Programme (2022)
- Communicating the Value of Biodiversity** - United Nations Development Programme (2022)
- Protected Areas and Sustainable Development** - United Nations Development Programme (2022)
- Applying Resilience Thinking to National Biodiversity Plans** - United Nations Development Programme (2022)
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- New Zealand Landscape as Culture: Motu (Island)**, EDx & Victoria University of Wellington (2022)
- New Zealand Landscape as Culture: Maunga (Mountains)**, EDx & Victoria University of Wellington (2022)
- Exploring Volcanoes and their hazards: Iceland and New Zealand**, EDx & University of Catenbury.



APPENDIX B: GLOSSARY OF TERMS

|                     |                                                                                                                                                                                                                                                                                                                                                                                    |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Buffer              | A strip of land surrounding a wetland or riparian area in which activities are controlled or restricted, in order to reduce the impact of adjacent land uses on the wetland or riparian area.                                                                                                                                                                                      |
| Hydrophyte          | Any plant that grows in water, or on a substratum, that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.                                                                                                                                                                                           |
| Hydromorphic soil   | Soil that, in its undrained condition, is saturated or flooded long enough during the growing season to develop anaerobic conditions, favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).                                                                                                                           |
| Seepage             | A type of wetland occurring on slopes, usually characterised by diffuse (i.e. unchannelled, and often subsurface) flows.                                                                                                                                                                                                                                                           |
| Sedges              | Grass-like plants belonging to the family Cyperaceae, sometimes referred to as nutgrasses. Papyrus is a member of this family.                                                                                                                                                                                                                                                     |
| Soil profile        | The vertically-sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).                                                                                                                                                                                                                                    |
| Wetland             | <i>“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.”</i> (National Water Act; Act 36 of 1998)                         |
| Wetland delineation | The determination and marking of the boundary of a wetland on a map using the DWAF (2005) methodology. This assessment includes identification of suggested buffer zones and is usually done in conjunction with a wetland functional assessment. The impact of the proposed development, together with appropriate mitigation measures, are included in impact assessment tables. |







# forestry, fisheries & the environment

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Forestry, Fisheries and the Environment  
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## **SPECIALIST DECLARATION FORM – AUGUST 2023**

Specialist Declaration form for assessments undertaken for application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

### **REPORT TITLE**

Reinstating the Low-Level Dam Spillway

Wetland Biodiversity Assessment and Aquatic Site Sensitivity Verification Report

### **Kindly note the following:**

1. This form must always be used for assessment that are in support of applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting, where this Department is the Competent Authority.
2. This form is current as of August 2023. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at <https://www.dffe.gov.za/documents/forms>.
3. An electronic copy of the signed declaration form must be appended to all Draft and Final Reports submitted to the department for consideration.
4. The specialist must be aware of and comply with 'the Procedures for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the act, when applying for environmental authorisation - GN 320/2020', where applicable.

### **1. SPECIALIST INFORMATION**

|                                        |                                       |
|----------------------------------------|---------------------------------------|
| Title of Specialist Assessment         | Mr                                    |
| Specialist Company Name                | Limosella Consulting                  |
| Specialist Name                        | Rudi Bezuidenhout                     |
| Specialist Identity Number             | 8808315038081                         |
| Specialist Qualifications:             | Msc Environmental Engineering         |
| Professional affiliation/registration: | SACNASP 008867                        |
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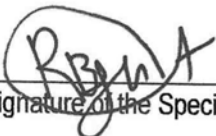
## SPECIALIST DECLARATION FORM – AUGUST 2023

---

### 2. DECLARATION BY THE SPECIALIST

I, Rudi Bezuidenhout declare that –

- I act as the independent specialist in this application;
- I am aware of the procedures and requirements for the assessment and minimum criteria for reporting on identified environmental themes in terms of sections 24(5)(a) and (h) and 44 of the National Environmental Management Act (NEMA), 1998, as amended, when applying for environmental authorisation which were promulgated in Government Notice No. 320 of 20 March 2020 (i.e. "the Protocols") and in Government Notice No. 1150 of 30 October 2020.
- 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
- I realise that a false declaration is an offence in terms of Regulation 48 and is punishable in terms of section 24F of the NEMA Act.

  
Signature of the Specialist

Limosella Consulting

Name of Company:

14 Jan 2026

Date



## SPECIALIST DECLARATION FORM – AUGUST 2023

---

### 3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Rudi Bezuidenhoudt, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

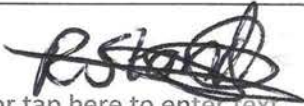
  
Signature of the Specialist

Limosella Consulting

Name of Company

2026.01.14

Date

  
Click or tap here to enter text.

Signature of the Commissioner of Oaths

14/11/2026

Click or tap to enter a date.

Date

**Roschenka Stander CA(SA) - 08112251**  
Commissioner of Oaths (RSA)  
2 Leslie Road, Irene, Pretoria



## Appendix E: Aquatic Methodology

---

**Limosella Consulting Pty Ltd**

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**Cell: +27 71 602 2994**

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# 1 Wetland and Riparian Delineation

Wetlands are delineated based on scientifically sound methods and utilizes a tool from the DWS 'A practical field procedure for identification and delineation of wetlands and riparian areas' (DWAF, 2005) as well as the "Updated manual for identification and delineation of wetlands and riparian areas" (DWAF, 2008) The delineation of the watercourses presented in this report is based on both desktop delineation and groundtruthing.

## 1.1 Desktop Delineation

A desktop assessment was conducted with wetland and riparian units potentially affected by the proposed activities identified using a range of tools, including:

- 1: 50 000 topographical maps.
- Recent, relevant aerial and satellite imagery, including Google Earth.
- NFEPA wetlands and Rivers (CDNGI, 2024)
- Municipal and DWS spatial datasets.

All areas suspected of being wetland and riparian habitat based on the visual signatures on the digital base maps were mapped using google earth.

## 1.2 Ground Truthing

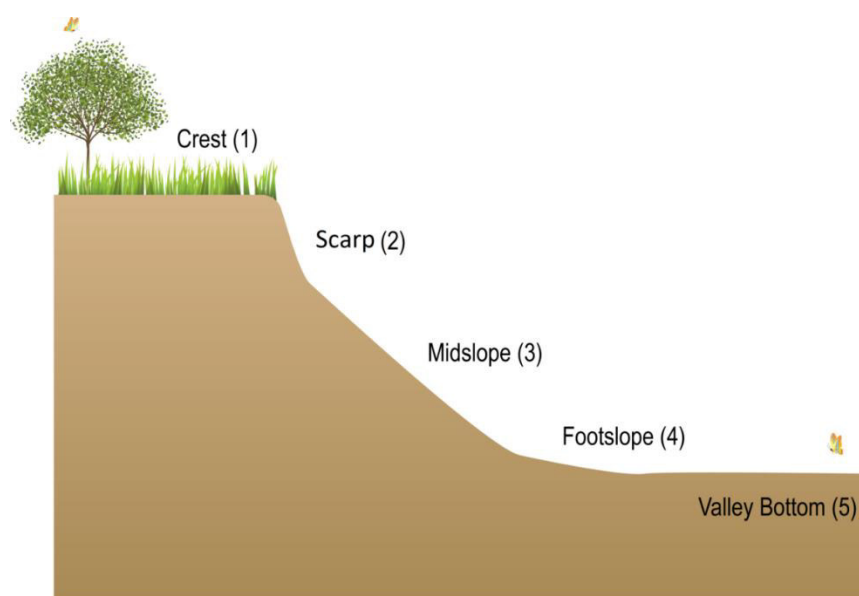
Field investigations confirmed fine-scale wetland and riparian boundaries where possible, Scenarios exist where some areas are inaccessible due to unforeseen circumstances. Extrapolation together with high resolution aerial imagery will be used here.

## 1.3 Wetland Indicators

Wetlands were identified based on one or more of the following characteristic attributes (DWAF, 2005):

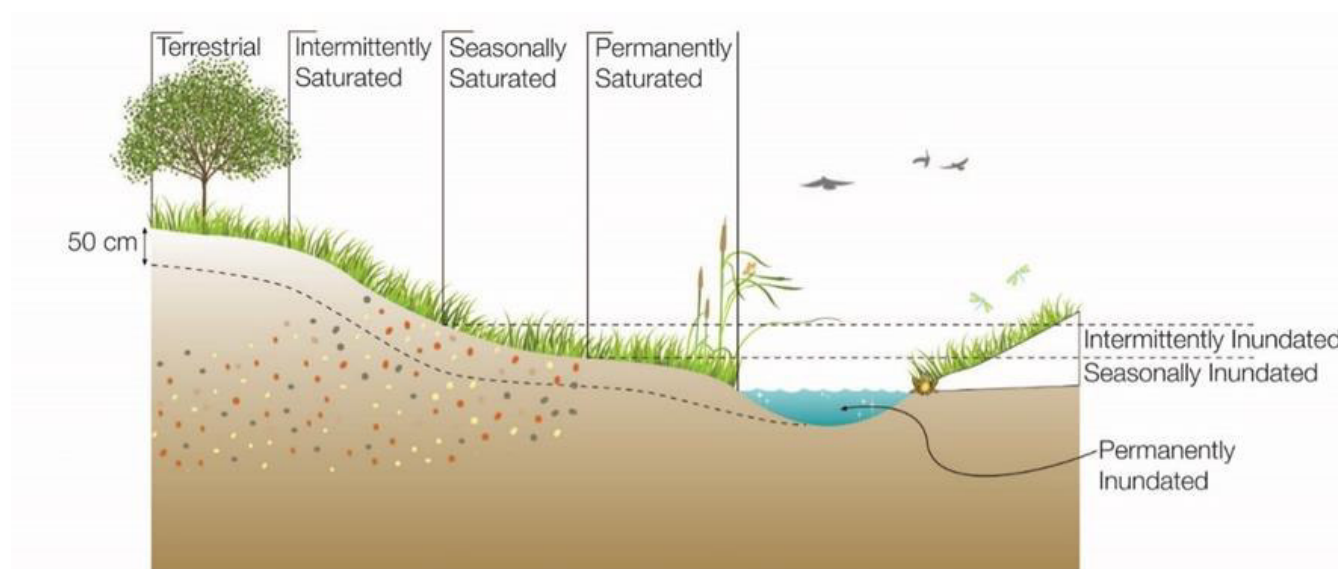
- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur (Figure 1).
- The presence of plants adapted to or tolerant of saturated soils (hydrophytes).
- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation; and
- A high-water table that results in saturation at or near the surface, leading to anaerobic conditions developing within 50cm of the soil surface (Figure 2).





Wetlands qualify as a (unit 5) or units 1(5), 3(5), 4(5)

**Figure 1: Terrain units (DWAF, 2005) (© Artist rendition done by Limosella)**



**Figure 2: Typical cross section of a wetland (Ollis, et al., 2013) (© Artist rendition done by Limosella)**

### 1.3.1 Terrain Unit Indicator

The terrain unit indicator is an important guide for identifying the parts of the landscape where wetlands might possibly occur and is relevant to the hydropedological setting of a wetland. For example, some wetlands occur on slopes higher up in the catchment where groundwater discharge is taking place through seeps. The type of wetland which occurs on a specific topographical area in the landscape is described using the Hydrogeomorphic classification which separates wetlands into 'HGM' units. The classification of (Ollis, et al., 2013) is used, where wetlands are classified on Level 4 as either Rivers, Floodplain wetlands, Valley-bottom wetlands, Depressions, Seeps, or Flats (Figure 3).

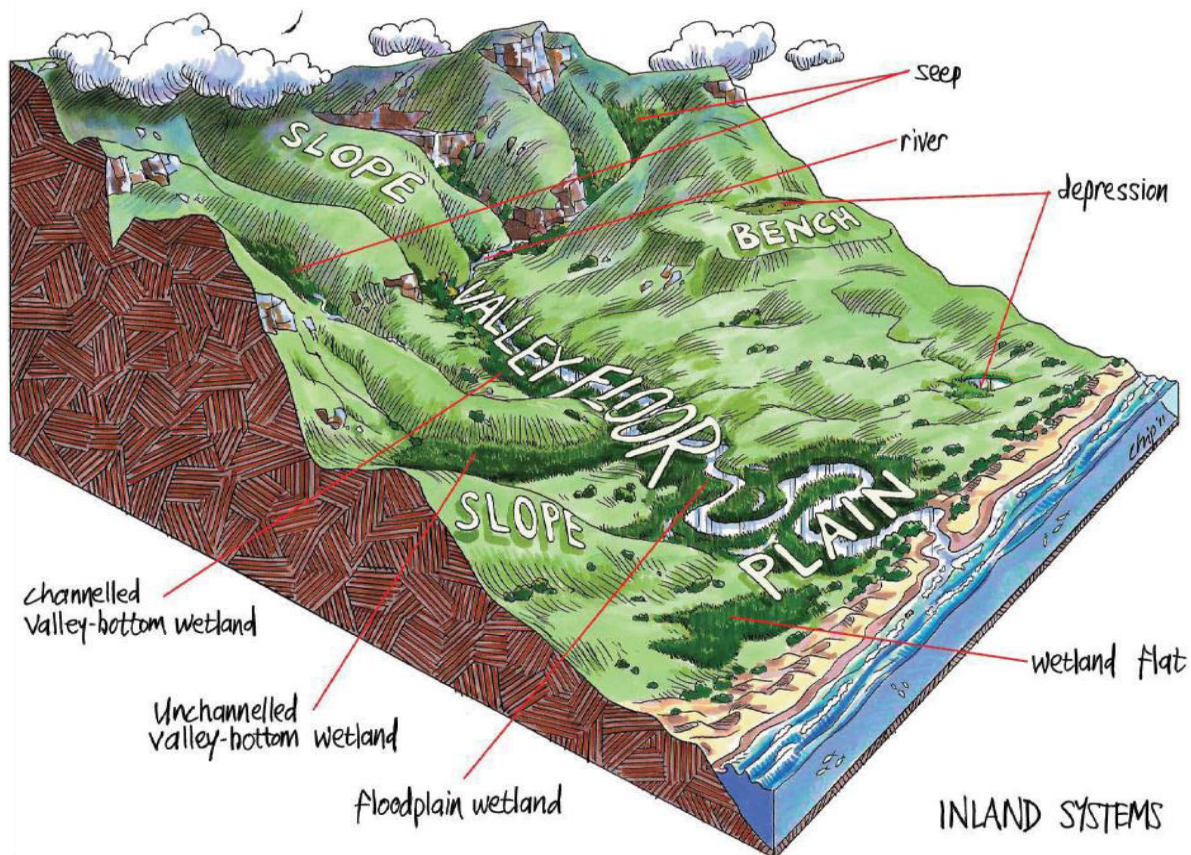


Figure 3: Terrain units (Ollis, et al., 2013) (Artwork copyright – Clip Snaddon).

### 1.3.2 Hydromorphic Soils (DWAF, 2008)

- Mottling – Formation of clumps of iron oxide within the soil matrix in the form of orange, yellow, black, or reddish-brown speckling. Mottling occurs in most soils and reaches maximum density in the centre of the seasonal zone with sparse mottling in the temporary zone and no mottling in the permanent zone.
- Gleying – Shift in soil colour from the terrestrial baseline towards a blue, green, or grey colour and an overall reduction in soil chroma. This phenomenon is normally difficult to identify in the temporary zone, noticeable in the seasonal zone and most significant in the permanent zone.
- Organic Surface Layers – surface layers with very high organic content that typically occur in the wetland seasonal and permanent zones.
- Organic Streaking – Streaks of organic matter within the soil column which may be present in all zones, but particularly the temporary and seasonal zones.

### 1.3.3 Hydrophytic Vegetation (Ginkel & Cilliers, 2017)

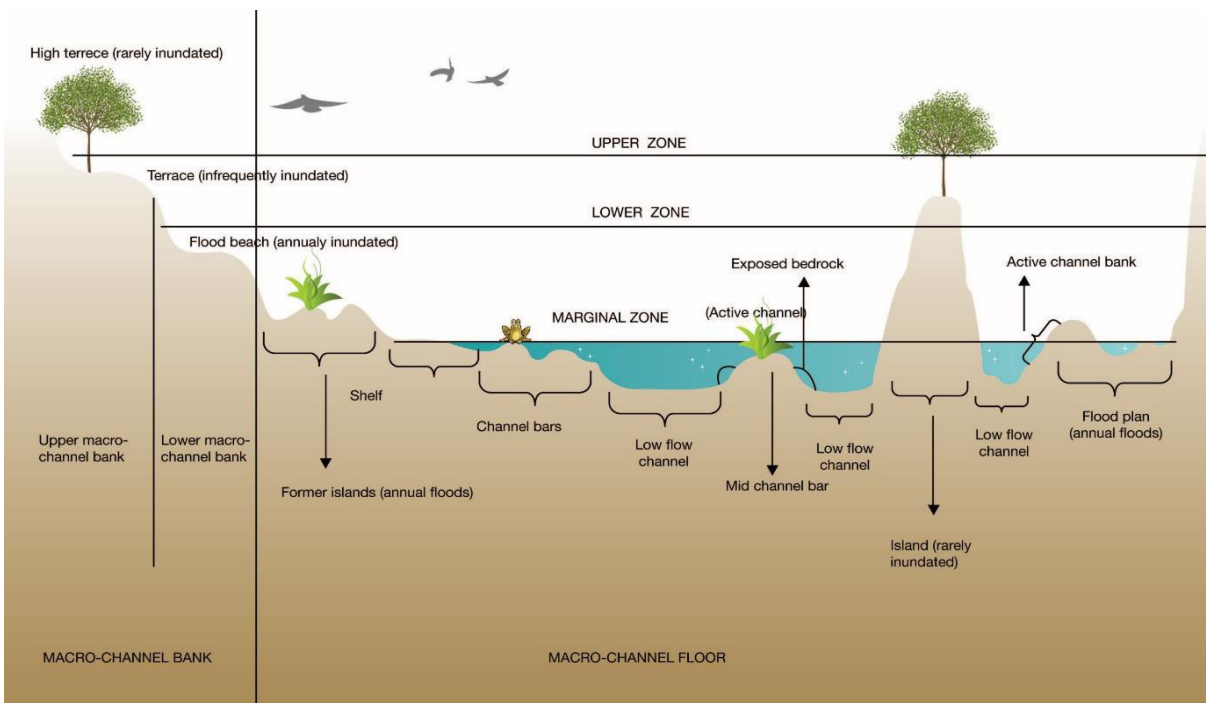
- Obligate Species: These species occur in wetlands more than 99% of the time, usually found in the permanent or seasonal zones.
- Facultative Positive Species: These species have 67 to 99% of their population occurring within wetlands, typically in the seasonal and temporary zones, with the remaining 1 to 33% found in the adjacent area on the wetland periphery.
- Facultative Species: These species have 33 to 67% of their population occurring within wetlands, usually in seasonal or temporary zones, with the remaining 33 to 67% found in the adjacent area on the wetland periphery.
- Facultative Negative Species: These species have 1 to 33% of their population occurring within wetlands, usually in the temporary zone, with the remaining 67 to 99% found in the adjacent area on the wetland periphery.
- Wetland Cosmopolitan Species: These species have no specific affinity for wetlands and colonise both wetland and terrestrial areas.

## 1.4 Riparian Indicators

A riparian area can be defined as a linear fluvial, eroded landform which carries channelized flow on a permanent, seasonal, or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The “river” includes both the active channel (the portion which carries the water) as well as the riparian zone (Kleynhans, et al., 2007)

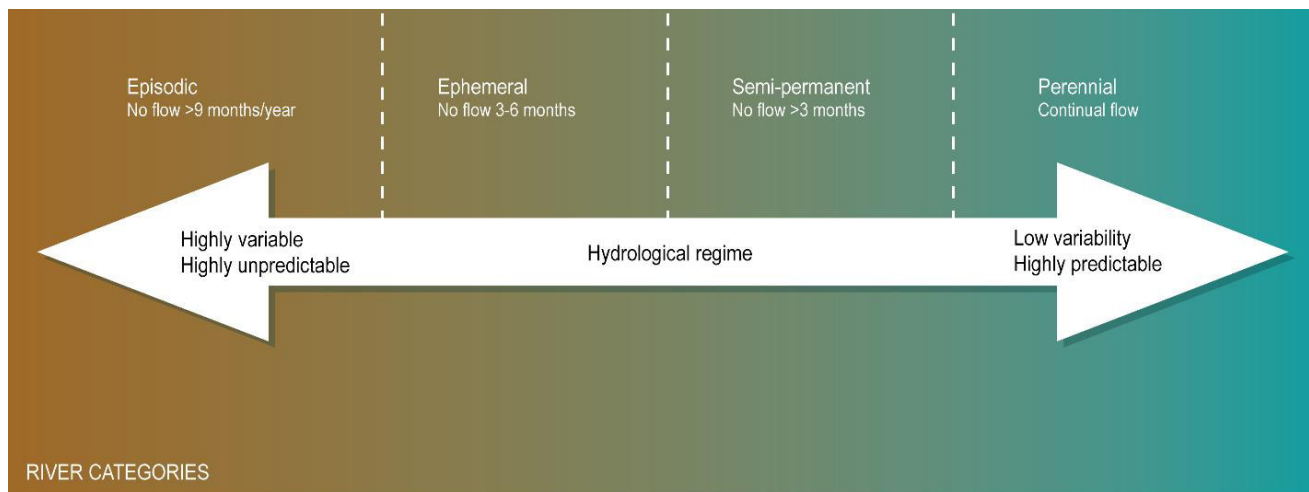
Riparian habitat is classified primarily by identifying riparian vegetation along the edge of the macro stream channel. The macro stream channel is defined as the outer bank of a compound channel and should not be confused with the active riverbank. The macro channel bank often represents a dramatic change in the energy with which water passes through the system. Rich alluvial soils deposit nutrients making the riparian area a highly productive zone. This causes a very distinct change in vegetation structure and composition along the edges of the riparian area (DWAF, 2008). The marginal zone includes the area from the water level at low flow, to those

features that are hydrologically activated for the greater part of the year. The non-marginal zone is the combination of the upper and lower zones (Figure 4).



**Figure 4: Schematic diagram illustrating an example of where the 3 zones would be placed relative to geomorphic diversity (Kleynhans et al., 2007) (© Artist rendition done by Limosella)**

Riparian areas can be grouped into different categories based on their inundation period per year. Perennial rivers are rivers with continuous surface water flow, intermittent rivers are rivers where surface flow disappears, but some surface flow remains, temporary rivers are rivers where surface flow disappears for most of the channel Figure 5. Two types of temporary rivers are recognized, namely “ephemeral” rivers that flow for less time than they are dry and support a series of pools in parts of the channel, and “episodic” rivers that only flow in response to extreme rainfall events, usually high in their catchments (Seaman, et al., 2010)



**Figure 5: The four categories associated with rivers and the hydrological continuum. Dashed lines indicate that boundaries are not fixed (Seaman, et al., 2010). (© Artist rendition done by Limosella)**

## 2 Wetland/Riparian Classification

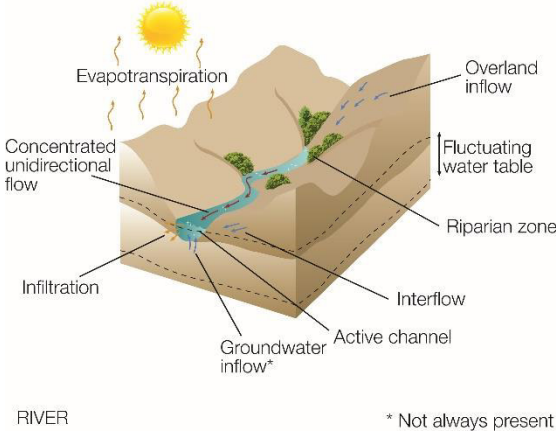
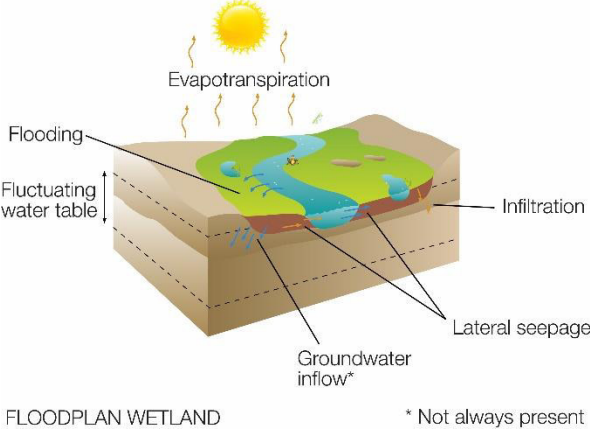
The classification system developed for the National Wetlands Inventory is based on the principles of the hydro-geomorphic (HGM) approach to wetland classification. The current watercourse assessment follows the same approach by classifying watercourses in terms of a functional unit recognised in the classification system proposed in (Ollis, et al., 2013). HGM units take into consideration factors that determine the nature of water movement into, through and out of the watercourse system. In general, HGM units encompass three key elements (Kotze, et al., 2020)

- Geomorphic setting - This refers to the landform, its position in the landscape and how it evolved (e.g. through the deposition of river borne sediment).
- Water source - There are usually several sources, although their relative contributions will vary amongst wetlands, including precipitation, groundwater flow, stream flow, etc.; and
- Hydrodynamics - This refers to how water moves through the wetland.

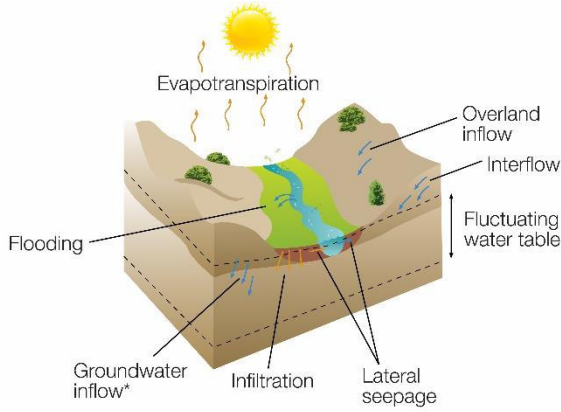
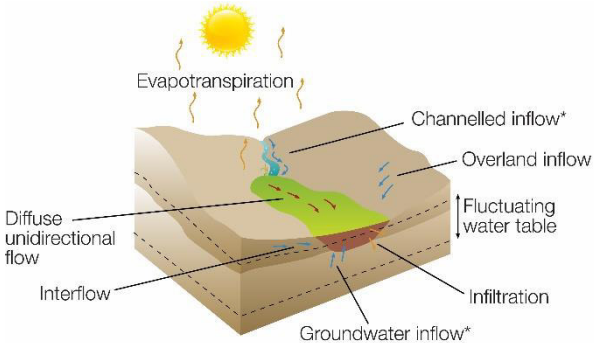
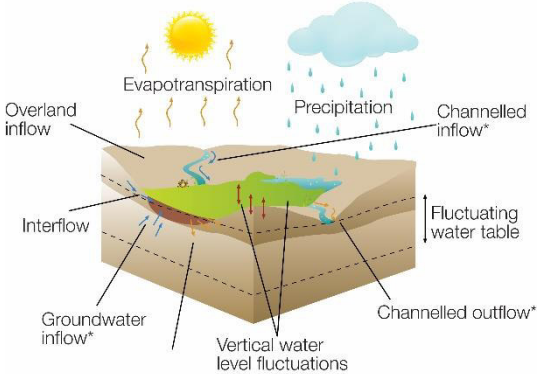
The classification of watercourse areas found within the study site and/or within 500 m of the study site are as follows (Table 1).

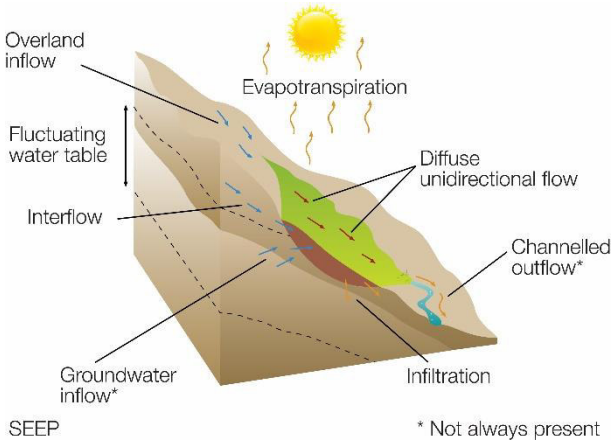
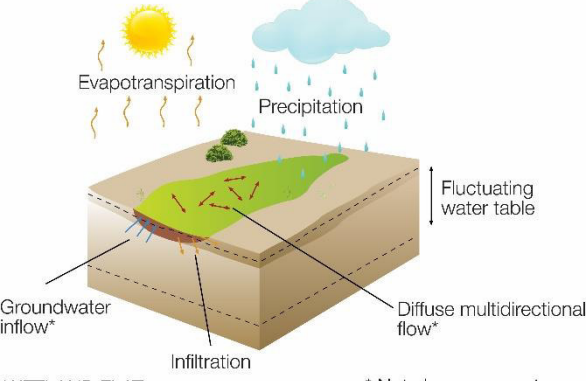


Table 1: Watercourse Types and descriptions (Ollis, et al., 2013). (© Artist rendition done by Limosella)

| Hydro-geomorphic types                                                                                                                                                        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Riparian habitat</i></p>  <p>RIVER</p> <p>* Not always present</p>                     | <p>Linear fluvial, eroded landforms which carry channelized flow on a permanent, seasonal, or ephemeral/episodic basis. The river channel flows within a confined valley (gorge) or within an incised macro-channel. The “river” includes both the active channel (the portion which carries the water) as well as the riparian zone.</p>                                                                                                                                                                                                                                                                                                                                                                                                           |
| <p><i>Meandering Floodplain</i></p>  <p>FLOODPLAIN WETLAND</p> <p>* Not always present</p> | <p>Linear fluvial, net depositional valley bottom surfaces which have a meandering channel which develop upstream of a local (e.g. resistant dyke) base level, or close to the mouth of the river (upstream of the ultimate base level, the sea). The meandering channel flows within an unconfined depositional valley, and oxbows or cut-off meanders evidence of meandering – are usually visible at the 1:10 000 scale (i.e. observable from 1:10 000 orthomaps).</p> <p>The floodplain surface usually slopes away from the channel margins due to preferential sediment deposition along the channel edges and areas closest to the channel. This can result in the formation of backwater swamps at the edges of the floodplain margins.</p> |



| Hydro-geomorphic types                                                                                                                                                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><i>Valley bottom with a channel</i></p>  <p>CHANNELLED VALLEY-BOTTOM WETLAND * Not always present</p>       | <p>Linear fluvial, net depositional valley bottom surfaces which have a straight channel with flow on a permanent or seasonal basis. Episodic flow is thought to be unlikely in this wetland setting. The straight channel tends to flow parallel with the direction of the valley (i.e. there is no meandering), and no oxbows or cut-off meanders are present in these wetland systems. The valley floor is, however, a depositional environment such that the channel flows through fluvially-deposited sediment. These systems tend to be found in the upper catchment areas.</p> |
| <p><i>Valley bottom without a channel</i></p>  <p>UNCHANNELLED VALLEY-BOTTOM WETLAND * Not always present</p> | <p>Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas, or at tributary junctions where the sediment from the tributary smothers the main drainage line.</p>                                                                                                                                                                                                                         |
| <p><i>Depressional pans</i></p>  <p>DEPRESSION * Not always present</p>                                      | <p>Small (deflationary) depressions which are circular or oval in shape; usually found on the crest positions in the landscape. The topographic catchment area can usually be well-defined (i.e. a small catchment area following the surrounding watershed). Although often apparently endorheic (inward draining), many pans are “leaky” in the sense that they are hydrologically connected to adjacent valley bottoms through subsurface diffuse flow paths.</p>                                                                                                                  |

| Hydro-geomorphic types                                                                                                                                                                                                                                                                                                                                                 | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Seepage Wetlands</b></p>  <p>Overland inflow</p> <p>Fluctuating water table</p> <p>Interflow</p> <p>Groundwater inflow*</p> <p>SEEP</p> <p>Evapotranspiration</p> <p>Diffuse unidirectional flow</p> <p>Channelled outflow*</p> <p>Infiltration</p> <p>* Not always present</p> | <p>Seepage wetlands are the most common type of wetland (in number), but probably also the most overlooked. These wetlands can be located on the mid- and footslopes of hillsides; either as isolated systems or connected to downslope valley bottom wetlands. They may also occur fringing depressional pans. Seepages occur where springs are decanting into the soil profile near the surface, causing hydric conditions to develop; or where through flow in the soil profile is forced close to the surface due to impervious layers (such as plinthite layers; or where large outcrops of impervious rock force subsurface water to the surface).</p> |
| <p><b>Flat Wetland</b></p>  <p>Evapotranspiration</p> <p>Precipitation</p> <p>Fluctuating water table</p> <p>Groundwater inflow*</p> <p>WETLAND FLAT</p> <p>Infiltration</p> <p>Diffuse multidirectional flow*</p> <p>* Not always present</p>                                       | <p>In areas with weakly developed drainage patterns and flat topography, rainfall may not drain off the landscape very quickly, if at all, due to the low relief. In such areas (commonly characterized by aeolian deposits or recent sea floor exposures) the wet season water table may rise close to, or above, the soil surface, creating extensive areas of shallow inundation or saturated soils. In these circumstances the seasonal or permanently high groundwater table creates the conditions for wetland formation.</p>                                                                                                                          |

### 3 Buffer Zones and Regulated Areas

A buffer zone is defined as a strip of land surrounding a wetland or riparian area in which activities are controlled or restricted (DWAF, 2005). A development has several impacts on the surrounding environment and on a watercourse. The development changes habitats, the ecological environment, infiltration rate, amount of runoff and runoff intensity of the site, and therefore the water regime of the entire site. An increased volume of stormwater runoff, peak discharges, and frequency and severity of flooding is, therefore, often characteristic of

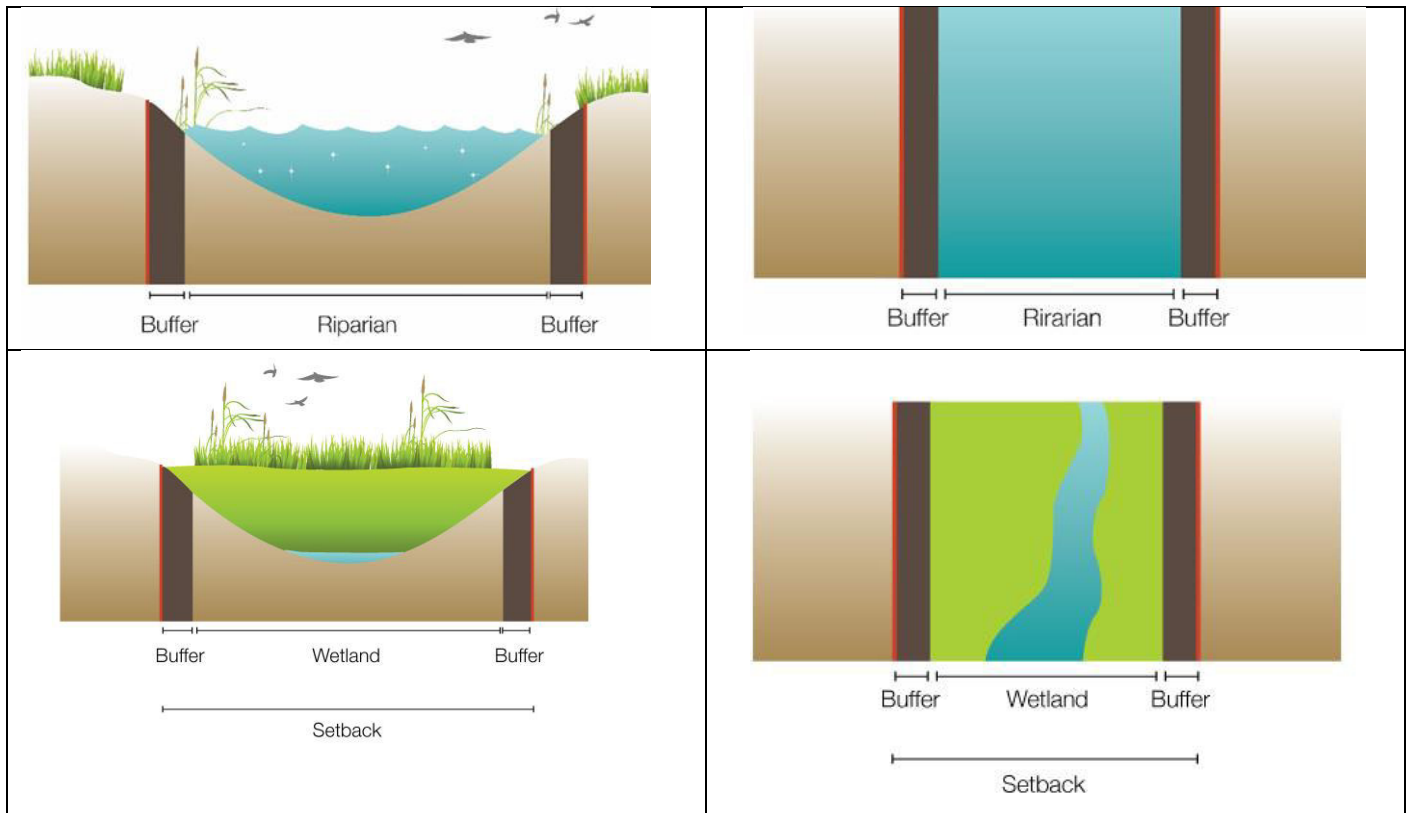
transformed catchments. The buffer zone identified in this report serves to highlight an ecologically sensitive area in which activities should be conducted with this sensitivity in mind.

Buffer zones have been shown to perform a wide range of functions and have therefore been widely proposed as a standard measure to protect water resources and their associated biodiversity. These include (i) maintaining basic hydrological processes; (ii) reducing impacts on water resources from upstream activities and adjoining landuses; (iii) providing habitat for various aspects of biodiversity. Buffer zones are therefore proposed as a standard mitigation measure to reduce impacts of land uses / activities planned adjacent to water resources. Although buffer zones can be effective in addressing diffuse source pollution in storm water run-off, they should typically be seen as part of a treatment train designed to address storm water impacts.

Authorisation from the DWS requires calculation of a site-specific buffer zone (GN267 of 24 March 2017), following (Macfarlane, et al., 2010). This Excel-based tool calculates the best suited buffer for each wetland or section of a wetland based on numerous on-site observations. The resulting buffer zone can thus have large differences depending on the current state of the wetland as well as the nature of the proposed development. Developments with a high-risk factor such as mining are likely to have a larger buffer area compared to a residential development with a lower risk factor. Figure 6 represents the buffer zone setback for the watercourse types discussed in this report.

*It should be noted that the buffer calculation tool does not take into account the effects of climate change or cumulative impacts to floodflows resulting from transformed catchments. Therefore, a conservative approach to the application of buffer zones is encouraged.*

Regulated areas are zones within which authorisation is required. The DWS specifies a 500 m regulated area around all wetlands and 100 m around all riparian zones within which development must be authorised from their department (unless a fine scale riparian delineation has been done in which case the calculated buffer zone is used as the regulated area). Development within 32 m of the edge of the watercourse triggers the requirement for authorisation under the National Environmental Management Act (NEMA): Environmental Impact Assessment (EIA) Regulations of 2014 (GN326) as amended.



**Figure 6: A represent the buffer zone setback for the watercourse discussed in the accompanying report. (© Artist rendition done by Limosella).**

## 4 Watercourse Functionality, Status and Sensitivity

Watercourse functionality is defined as a measure of the deviation of structure and function from its natural reference condition. The natural reference condition is based on a theoretical undisturbed state extrapolated from an understanding of undisturbed regional vegetation and hydrological conditions.

The allocations of scores in the functional and integrity assessment are somewhat subjective and are thus vulnerable to the interpretation of the specialist. With the exception of the assessment of water quality and invertebrates, collection of empirical data is precluded at this level of investigation due to project constraints including time and budget. Water quality values, species richness and abundance indices, surface and groundwater volumes, amongst others, should ideally be used rather than a subjective scoring system such as is presented here.

The functional assessment methodologies presented below take into consideration subjective recorded impacts to determine the scores attributed to each functional Hydrogeomorphic (HGM) unit. Following the calculation of PES and EC scores, a Recommended Ecological Category can be obtained. This score reflects an auditable management or rehabilitation target to be achieved by the proposed project. The sections below provide a brief description of each method.

#### 4.1 Present Ecological Status (PES) – WET-Health (Macfarlane , et al., 2020)

A summary of the four components of the WET-Health (2.0) namely Hydrological; Geomorphological, water quality and Vegetation Health assessment for the wetlands found on site is described in **Table 2**. For this assessment, WET-Health Version 2.0 was used. This method builds on the WET-Health Version 2.0 (Macfarlane , et al., 2020). The WET-Health Version 2 considers four (4) components to assess the PES of wetland ecosystems. Geology, climate, and topographic position determines the ecological setting of a wetland. Three (3) core interrelated drivers broadly influence all wetlands, namely Hydrology, Geomorphology and Water Quality (i.e. physico-chemical attributes). Wetland biology, and more specifically vegetation, responds to the changes in these drivers and to the surrounding environment.

**Table 2: The three levels of assessment to cater for application of the WET-Health Version 2 Tool across different spatial scales and for different purposes (Macfarlane , et al., 2020).**

| Level of Assessment | Spatial Scale                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------|--------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Level 1A            | Desktop-based, low resolution  | Entirely desktop-based and only uses pre-existing landcover data. Landcover types within a buffer / “pseudo catchment” around a wetland is used to determine the impacts on the wetland arising from the upslope catchment. Impacts arising from within individual wetlands are inferred from landcover types occurring within desktop-delineated wetlands.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Level 1B            | Desktop-based, high resolution | Largely desktop-based using pre-existing landcover data but makes a few finer distinctions than Level 1A in terms of landcover types and usually requires “heads-up” interpretation of the best available aerial imagery to do so. Upslope catchment of each wetland can be individually delineated at this level, and landcover in this area is used as a proxy of the impacts on a wetland arising from its upslope catchment. Impacts arising from within individual wetlands are inferred from landcover types occurring within desktop-delineated wetlands. In terms of water quality PES, the option is provided to factor in point-source pollution inputs in a Level 1B assessment.                                                                                                                                                                                                            |
| Level 2             | Rapid field-based assessment   | Strongly informed by desktop landcover mapping; refined by assessing a range of catchment and wetland-related indicators known to affect wetland condition. Impacts arising from the upslope catchment of a wetland are inferred from landcover mapping but are refined based on additional information. Landcover types occurring within the wetland are used as the starting point for assessing human impacts arising from within the wetland but are refined through the assessment of additional indicators as part of a rapid field-based assessment. This involves sub-dividing the wetland into relatively homogenous “disturbance units” and assessing a suite of site-based wetland questions that provide a more direct assessment of change. Determination of water quality PES in a Level 2 assessment requires the identification and characterisation of point-source pollution inputs. |

A summary of the change class, description and symbols used to evaluate wetland health are summarised in Table 3. The trajectory of change is summarised in Table 4.

**Table 3: Health categories used by WET-Health for describing the integrity of wetlands** (Macfarlane , et al., 2020)

| Ecological Category | Description                                                                                                                                                                                 | Impact Score | PES Score (%) |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|---------------|
| A                   | Unmodified, natural                                                                                                                                                                         | 0 to 0.9     | 90-100        |
| B                   | Largely Natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.                          | 1.0 to 1.9   | 80-89         |
| C                   | Moderately Modified. A moderate change in ecosystem processes and loss of natural habitats has taken place, but the natural habitat remains predominantly intact.                           | 2.0 to 3.9   | 60-79         |
| D                   | Largely Modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.                                                                                 | 4.0 to 5.9   | 40-59         |
| E                   | Seriously Modified. The change in ecosystem processes and loss of natural habitat and biota is great, but some remaining natural habitat features are still recognizable.                   | 6.0 to 7.9   | 20-39         |
| F                   | Critical Modification. The modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota. | 8.0 to 10    | 0-19          |

**Table 4: Trajectory class, change scores and symbols used to evaluate Trajectory of Change to wetland health** (Macfarlane , et al., 2020)

| Change Class        | Description                                                              | Symbol |
|---------------------|--------------------------------------------------------------------------|--------|
| Improve             | Condition is likely to improve over the over the next 5 years            | (↑)    |
| Remain stable       | Condition is likely to remain stable over the next 5 years               | (→)    |
| Slowly deteriorate  | Condition is likely to deteriorate slightly over the next 5 years        | (↓)    |
| Rapidly deteriorate | Substantial deterioration of condition is expected over the next 5 years | (↓↓)   |



## 4.2 Ecological Importance and Sensitivity (EIS) (Rountree, et al., 2013)

The Ecological Importance and Sensitivity (EIS) score forms part of a larger assessment called the Wetland Importance and Sensitivity scoring system which also addresses hydrological importance and direct human benefits relevant to a HGM unit. Both PES and EIS form part of a larger reserve determination process documented by the Department of Water and Sanitation.

Ecological importance is an expression of a wetland's importance to the maintenance of ecological diversity and functioning on local and wider spatial scales. Ecological sensitivity refers to the system's ability to tolerate disturbance and its capacity to recover from disturbance once it has occurred (Rountree, et al., 2013). This classification of water resources allows for an appropriate management class to be allocated to the water resource and includes the following:

- Ecological Importance in terms of ecosystems and biodiversity such as species diversity and abundance.
- Ecological functions including groundwater recharge, provision of specialised habitat and dispersal corridors.
- Basic human needs including subsistence farming and water use.

The Ecological Importance and Sensitivity of the wetlands is represented are described in the results section. Explanations of the scores are given in Table 5.

**Table 5: Environmental Importance and Sensitivity rating scale used for the estimation of EIS scores** (Rountree, et al., 2013)

| Ecological Importance and Sensitivity Categories                                                                                                                                                                                                                                                                             | Rating    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| <p>Very High</p> <p>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 in major rivers.</p> | >3 and ≤4 |
| <p>High</p> <p>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.</p>                                                         | >2 and ≤3 |
| <p>Moderate</p> <p>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 in major rivers.</p>        | >1 and ≤2 |
| <p>Low/Marginal</p> <p>Wetlands that are 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 in major rivers.</p>                   | >0 and ≤1 |

### 4.3 Ecosystem Services (ES)

The Department of Water and Sanitation authorisations related to wetlands are regulated by Government Notice 267 published in the Government Gazette 40713 of 24 March 2017 regarding Section 21(c) and (i). Page 196 of this notice provides a detailed terms of reference for wetland assessment reports and includes the requirement that the ecological integrity and function of wetlands be addressed.

WET-EcoServices Version 2 (Kotze, et al., 2020) includes 16 different ecosystem services, which were selected for their specific relevance to the South African situation:

- Flood attenuation.
- Streamflow regulation.
- Sediment trapping.
- Phosphate assimilation.
- Nitrate assimilation.
- Toxicant assimilation.
- Erosion control.
- Carbon storage.
- Biodiversity maintenance.
- Provision of water for human use.
- Provision of harvestable resources.
- Food for livestock.
- Provision of cultivated foods.
- Cultural and spiritual experience.
- Tourism and recreation.
- Education and research.

Table 5 and Table 6 describe the categories for integrating scores for supply and demand of ecosystem services and their overall importance.

**Table 6: Integrating the scores for ecosystem supply and demand into an overall importance score.**

| Integrating scores for supply & demand to obtain an overall importance score |   |          |     |          |      |           |
|------------------------------------------------------------------------------|---|----------|-----|----------|------|-----------|
|                                                                              |   | Supply   |     |          |      |           |
|                                                                              |   | Very Low | Low | Moderate | High | Very High |
| Demand                                                                       |   | 0        | 1   | 2        | 3    | 4         |
| Very Low                                                                     | 0 | 0.0      | 0.0 | 0.5      | 1.5  | 2.5       |
| Low                                                                          | 1 | 0.0      | 0.0 | 1.0      | 2.0  | 3.0       |
| Moderate                                                                     | 2 | 0.0      | 0.5 | 1.5      | 2.5  | 3.5       |
| High                                                                         | 3 | 0.0      | 1.0 | 2.0      | 3.0  | 4.0       |
| Very High                                                                    | 4 | 0.5      | 1.5 | 2.5      | 3.5  | 4.0       |

**Table 7: Categories used for reporting the overall importance of ecosystem services.**

| Importance Category |            | Description                                                                                         |
|---------------------|------------|-----------------------------------------------------------------------------------------------------|
| Very Low            | 0-0.79     | The importance of services supplied is very low relative to that supplied by other wetlands.        |
| Low                 | 0.8 – 1.29 | The importance of services supplied is low relative to that supplied by other wetlands.             |
| Moderately Low      | 1.3 – 1.69 | The importance of services supplied is moderately-low relative to that supplied by other wetlands.  |
| Moderate            | 1.7 – 2.29 | The importance of services supplied is moderate relative to that supplied by other wetlands.        |
| Moderately High     | 2.3 – 2.69 | The importance of services supplied is moderately-high relative to that supplied by other wetlands. |
| High                | 2.7 – 3.19 | The importance of services supplied is high relative to that supplied by other wetlands.            |
| Very High           | 3.2 - 4.0  | The importance of services supplied is very high relative to that supplied by other wetlands.       |

#### 4.4 Use of WET-EcoServices for assessing the Ecological Importance and Sensitivity (EIS) of wetlands.

The term Ecological Importance and Sensitivity (EIS) is well entrenched in water resource management in South Africa. Ecological Importance (EI) is the expression of the importance of wetlands and rivers in terms of the maintenance of biological diversity and ecological functioning at a local and landscape level. Ecological Sensitivity (S) refers to ecosystem fragility or the ability to resist or recover from disturbance (Rountree, et al., 2013) (Kotze, et al., 2020). The purpose of assessing ecological importance and sensitivity of water resources like wetlands, and rivers is to be able to identify those systems that provide valuable biodiversity support functions, regulating ecosystem services, or are especially sensitive to impacts. Knowing what ecosystems are valuable enables the appropriate setting of management objectives (i.e. recommended ecological category - REC) and the prioritization of management actions and interventions to promote effective water resource management.

The tool currently used for assessing wetland EIS (Rountree, et al., 2013) (Kotze, et al., 2020) is somewhat outdated but is typically informed by a WET-EcoServices assessment. The implication is that practitioners involved in wetland assessments typically have to complete both a WET-EcoServices assessment and a stand-alone EIS assessment to inform decision-making processes. Recommendations to refine the wetland EIS tool have been documented (Macfarlane, et al., 2020) and includes the need to revise and update the wetland EIS assessment framework to simply integrate the key outputs of the WET-EcoServices tool to produce an overall ecological importance (EI) score.

Specific recommendations for integrating the WET-EcoServices outputs into the wetland EIS assessment have also been documented. These include grouping of ecosystem service scores into broad categories which would then be integrated into an overall ecological importance (EI) score:

- **Biodiversity maintenance importance:** This is the importance score derived from the biodiversity maintenance component of WET-EcoServices.
- **Regulating services importance:** This would be calculated as the maximum score of all the importance scores for regulating services considered in WET-EcoServices.
- **Provisioning and cultural services importance:** This would be calculated as the maximum score of all the importance scores for provisioning and cultural services considered in WET-EcoServices.

The EI would be simply derived based on the maximum of these scores and could then be integrated with the ecological sensitivity (ES) score to produce an overall EIS score. A simple schematic of the proposed Wetland EIS framework is shown in Figure 7 below.

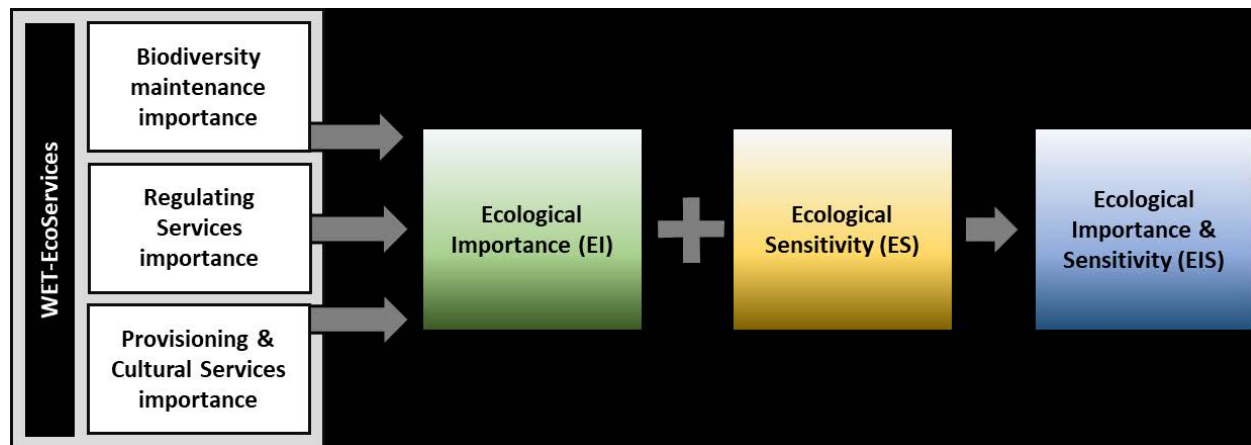


Figure 7: Schematic of the recommended Wetland EIS framework.

## 4.5 Present Ecological Category (EC): Riparian

In the current study, the Ecological Category of the riparian areas was assessed using a level 3 VEGRAI (Riparian Vegetation Response Assessment Index) (Kleynhans, et al., 2007) (**Table 8**).

**Table 8: Generic ecological categories for EcoStatus components** (Kleynhans, et al., 2007).

| ECOLOGICAL CATEGORY | DESCRIPTION                                                                                                                                                                                                                                                                             | SCORE (% OF TOTAL) |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| A                   | Unmodified, natural.                                                                                                                                                                                                                                                                    | 90-100             |
| B                   | Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.                                                                                                                        | 80-89              |
| C                   | Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.                                                                                                                                   | 60-79              |
| D                   | Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.                                                                                                                                                                                    | 40-59              |
| E                   | Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.                                                                                                                                                                                      | 20-39              |
| F                   | Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible | 0-19               |

## 4.6 Physical Habitat Assessment: Integrated Habitat Assessment System (IHAS) method.

The quality of the instream and riparian habitat has a direct influence on the aquatic community. Evaluating the structure and functioning of an aquatic ecosystem must therefore take into account the physical habitat to assess the ecological integrity. The IHAS sampling protocol, of which version 2 is currently used, was developed by (McMillan, 1998) for use in conjunction with the SASS5 protocol to determine which habitats are present for aquatic macroinvertebrates.

IHAS consists of a scoring sheet that assists to determine the extent of each of the instream habitats, together with the physical parameter of the stream. For example, the proportion of stones in current and stones out of current will be compared with the presence of instream vegetation. This sampling protocol assists with the interpretation of the SASS5 data.



Data recorded during the site visit concerning sampling habitat and stream condition is uploaded into an excel spreadsheet. The results are then interpreted according to the categories supplied by (McMillan, 1998) (Table 9).

**Table 9: IHAS score interpretation table.**

| <b>IHAS Score</b> | <b>Interpretation</b>                                                        |
|-------------------|------------------------------------------------------------------------------|
| <65%              | Insufficient for supporting a diverse aquatic macro invertebrate community   |
| 65%-75%           | Acceptable for supporting a diverse aquatic macroinvertebrate community      |
| 75%               | Highly suitable for supporting a diverse aquatic macroinvertebrate community |

## 4.7 SASS5

SASS5 is a rapid bioassessment method used to identify changes in species composition of aquatic invertebrates to indicate relative water quality (Dickens & Graham, 2002). SASS5 requires the identification of invertebrates to a family level in the field.

SASS5 is based on the principle that some invertebrate taxa are more sensitive than others to alterations in ecological drivers such as pollutants or flooding events. Macroinvertebrate assemblages are good indicators of localized conditions in rivers. Many macroinvertebrates have limited migration patterns or are not free moving, which makes them well-suited for assessing site specific impacts with upstream/downstream studies. Benthic macroinvertebrates are abundant in most streams. Even small streams (1st and 2nd order) which may have a limited fish population will support a diverse macroinvertebrate fauna. These groups of species constitute a broad range of trophic levels and pollution tolerances. Thus, SASS5 is a useful method for interpreting the cumulative effects of impacts on aquatic environments.

Using a 'kick net', the SASS5 sampling method entails prescribed time-periods and spatial areas for the kicking of in-current and out-current stones and bedrock; sweeping of in-current and out-current marginal and aquatic vegetation, as well as of gravel, stones, and mud (GSM); followed by visual observations and hand-picking. The results of each biotope are kept separate, until all observations are noted. The entire sample is then returned to the river, retained alive, or preserved for further identification.

In SASS5 analysis, species abundance is recorded on an SASS5 data sheet which weighs the different taxons common to South African rivers from 1 (pollutant tolerant) to 15 (pollution sensitive). The SASS5 score will be high at a particular site if the taxa are pollution sensitive and low if they are mostly pollution tolerant.

The SASS5 Score, the number of taxa observed, and the average score per taxon (ASPT) are calculated for all the biotopes combined. Dallas (2007) used available SASS5 Score and ASPT values for each eco-region in South Africa to generate biological bands on standardised graphs that are used as a guideline for interpreting any data obtained during the study. The meaning of each SASS5 Ecological Category is as follows Table 10.

**Table 10: SASS categories** (Dallas, 2007).

| EC       | Ecological Category | Description                            |
|----------|---------------------|----------------------------------------|
| <b>A</b> | Natural             | Unmodified natural                     |
| <b>B</b> | Good                | Largely natural with few modifications |
| <b>C</b> | Fair                | Moderately modified                    |
| <b>D</b> | Poor                | Largely modified                       |
| <b>E</b> | Seriously modified  | Seriously modified                     |
| <b>F</b> | Critically modified | Critically or extremely modified       |

#### 4.8 Physical properties of water

The physical properties of water are based on the temperature, Electrical Conductivity (EC), pH, and oxygen content of the water- using physical methods. The physical properties of water influence the aesthetical – as well as the chemical qualities of water. Relevance of the indicators of the physical properties of water include pH, which affects the corrosiveness of water, and EC, an indication of the “freshness” of water (indicates the presence of dissolved salts and other dissolved particles). Included in the physical properties of water is the suspendoids’ effects on water quality. This includes turbidity, and total suspended solids. Turbidity is measured in Nephelometric Turbidity Units (NTU’s) and is the indication of the ability of light to pass through water. See Table 11 for a list of physical properties of water and comparative results.

**Table 11: Table for comparative results of physical properties of water.**

| <b>pH Values</b>                                                |                                                                                                                                |
|-----------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| pH > 8.5                                                        | Alkaline                                                                                                                       |
| pH 6.0-8.5                                                      | Circumneutral                                                                                                                  |
| pH < 6.0                                                        | Acidic                                                                                                                         |
| <b>Total Hardness (in mg CaCO<sub>3</sub>/l)</b>                |                                                                                                                                |
| Hardness < 50 mg/l                                              | Soft                                                                                                                           |
| Hardness 50-100 mg/l                                            | Moderately soft                                                                                                                |
| Hardness 100- 150 mg/l                                          | Slightly hard                                                                                                                  |
| Hardness 150-200 mg/l                                           | Moderately hard                                                                                                                |
| Hardness 200-300 mg/l                                           | Hard                                                                                                                           |
| Hardness 300-600 mg/l                                           | Very hard                                                                                                                      |
| <b>Total Dissolved Solids as indicator of salinity of water</b> |                                                                                                                                |
| TDS <450 mg/l                                                   | Non saline                                                                                                                     |
| TDS 450-1000 mg/l                                               | Saline                                                                                                                         |
| TDS 1000-2400 mg/l                                              | Very saline                                                                                                                    |
| TDS 2400-3400 mg/l                                              | Extremely saline                                                                                                               |
| <b>Total suspended solids (TSS)</b>                             |                                                                                                                                |
| Background TSS concentrations are < 100 mg/l                    | Any increase in TSS concentrations must be limited to < 10 % of the background TSS concentrations at a specific site and time. |

## 4.9 Recommended Ecological Category (REC).

The REC is determined by the Present Ecological State of the water resource and the importance and/or sensitivity of the water resource. Water resources which have Present Ecological State categories in an E or F ecological category are deemed unsustainable by the DWS. In such cases the REC must automatically be increased to a D.

Where the PES is in the A, B, C, D or E the EIS components must be checked to determine if any of the aspects of importance and sensitivity (Ecological Importance; Hydrological Functions and Direct Human Benefits) are high or very high. If this is the case, the feasibility of increasing the PES (particularly if the PES is in a low C or D category) should be evaluated. This is recommended to enable important and/or sensitive wetland water resources to maintain their functionality and continue to provide the goods and services for the environment and society (Table 12).

If:

- PES is in an E or F category:  
The REC should be set at at least a D, since E and F EC's are considered unsustainable.
  - The PES category is in a A, B, C or D category, AND the EIS criteria are low or moderate OR the EIS criteria are high or even very high, but it is not feasible or practicable for the PES to be improved:
- The REC is set at the current PES.
  - The PES category is in a B, C or D category, AND the EIS criteria are high or very high AND it is feasible or practicable for the PES to be improved:
- The REC is set at least one Ecological Category higher than the current PES.” (Rountree, et al., 2013)

**Table 12: Generic Matrix for the determination of REC and (Recommended Management Objective) RMO for water resources**

|     |     |                  | EIS           |                |                 |                 |
|-----|-----|------------------|---------------|----------------|-----------------|-----------------|
|     |     |                  | Very high     | High           | Moderate        | Low             |
| PES | A   | Pristine/Natural | A<br>Maintain | A<br>Maintain  | A<br>Maintain   | A<br>Maintain   |
|     | B   | Largely Natural  | A<br>Improve  | A/B<br>Improve | B<br>Maintain   | B<br>Maintain   |
|     | C   | Good - Fair      | B<br>Improve  | B/C<br>Improve | C<br>Maintain   | C<br>Maintain   |
|     | D   | Poor             | C<br>Improve  | C/D<br>Improve | D<br>Maintain   | D<br>Maintain   |
|     | E/F | Very Poor        | D<br>Improve  | E/F<br>Improve | E/F<br>Maintain | E/F<br>Maintain |

## 5 Impact Assessments

### 5.1 DWS (2023) Risk Ratings

Risk-based management has value in providing an indication of the potential for delegating certain categories of water use “risks” to DWS regional offices (RO) or Catchment Management Agencies (CMA). Risk categories obtained through this assessment serve as a guideline to establish the appropriate channel of authorisation of these water uses.

The DWS has therefore developed a risk assessment matrix to assist in quantifying expected impacts. The scores obtained in this assessment are useful in evaluating how the proposed activities should be authorised.

The formula used to derive a risk score is as follows:

$$\text{RISK} = \text{CONSEQUENCE} \times \text{LIKELIHOOD}$$

$$\text{CONSEQUENCE} = \text{SEVERITY} + \text{SPATIAL SCALE} + \text{DURATION}$$

$$\text{LIKELIHOOD} = \text{FREQUENCY OF THE ACTIVITY} + \text{FREQUENCY OF THE IMPACT} + \text{LEGAL ISSUES} + \text{DETECTION}$$

Table 13 below provides a description of the classes into which scores are sorted, and their implication for authorisation.

**Table 13: An extract from DWS (2023) indicating the risk scores and classes as well as the implication for the appropriate authorization process.**

| RATING   | CLASS                                                       | MANAGEMENT DESCRIPTION                                                                                                                                          |
|----------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 – 29   | (L) Low Risk<br>OR<br>(+) Positive<br>(+ +) Highly positive | Acceptable as is or with proposed mitigation measures. Impact to watercourses and resource quality small and easily mitigated, or positive.                     |
| 30 – 60  | (M) Moderate Risk                                           | Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required. |
| 61 – 100 | (H) High Risk                                               | Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.             |

## 5.2 NEMA (2014) Impact Ratings with reference to aquatic aspects specified in GN320 of March 2020

As required by the 2014 NEMA regulations (as amended), impact assessment should provide quantified scores indicating the expected impact, including the cumulative impact of a proposed activity. Specific aspects of the aquatic environment that should be assessed are set out in GN 320. These are listed in Appendix A. The impact assessment should follow the format presented below (Table 14, Table 15 and Table 16). Impact scores are calculated using the following parameters:

**Table 14: Step 1: Determine the PROBABILITY of the impact by calculating the average between the Frequency of the Aspect, the Availability of a pathway to the receptor and the availability of the receptor (thus: Sum of the three column scores below ÷ 3)**

| Frequency of Aspect / Unwanted Event         | Score | Availability of pathway from the source to the receptor               | Score | Availability of receptor                | Score |
|----------------------------------------------|-------|-----------------------------------------------------------------------|-------|-----------------------------------------|-------|
| Never known to have happened, but may happen | 1     | A pathway to allow for the impact to occur is never available         | 1     | The receptor is never available         | 1     |
| Known to happen in industry                  | 2     | A pathway to allow for the impact to occur is almost never available  | 2     | The receptor is almost never available  | 2     |
| < once a year                                | 3     | A pathway to allow for the impact to occur is sometimes available     | 3     | The receptor is sometimes available     | 3     |
| Once per year to up to once per month        | 4     | A pathway to allow for the impact to occur is almost always available | 4     | The receptor is almost always available | 4     |
| Once a month - Continuous                    | 5     | A pathway to allow for the impact to occur is always available        | 5     | The receptor is always available        | 5     |



**Table 15: Step 2: Determine the MAGNITUDE of the impact by calculating the average of the factors below (thus: Sum of all six column ratings below ÷ 6)**

| Source                                  |       |                                                                                 |       |                                                                             |       | Receptor                                                                                                         |       |                                                                                                                            |       |                                                                                                                                                                        |       |
|-----------------------------------------|-------|---------------------------------------------------------------------------------|-------|-----------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------|-------|----------------------------------------------------------------------------------------------------------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Duration of impact                      | Score | Extent                                                                          | Score | Volume / Quantity / Intensity                                               | Score | Toxicity / Destruction Effect                                                                                    | Score | Reversibility                                                                                                              | Score | Sensitivity of environmental component                                                                                                                                 | Score |
| Lasting days to a month                 | 1     | Effect limited to the site. (metres);                                           | 1     | Very small quantities / volumes / intensity (e.g. < 50L or < 1Ha)           | 1     | Non toxic (e.g. water) / Very low potential to create damage or destruction to the environment                   | 1     | Bio-physical and/or social functions and/or processes will remain unaltered.                                               | 1     | Current environmental component(s) are largely disturbed from the natural state.<br><br>Receptor of low significance / sensitivity                                     | 1     |
| Lasting 1 month to 1 year               | 2     | Effect limited to the activity and its immediate surroundings. (tens of metres) | 2     | Small quantities / volumes / intensity (e.g. 50L to 210L or 1Ha to 5Ha)     | 2     | Slightly toxic / Harmful (e.g. diluted brine) / Low potential to create damage or destruction to the environment | 2     | Bio-physical and/or social functions and/or processes might be negligibly altered or enhanced / Still reversible           | 2     | Current environmental component(s) are moderately disturbed from the natural state.<br><br>No environmentally sensitive components.                                    | 2     |
| Lasting 1 – 5 years                     | 3     | Impacts on extended area beyond site boundary (hundreds of metres)              | 3     | Moderate quantities / volumes / intensity (e.g. > 210 L < 5000L or 5 – 8Ha) | 3     | Moderately toxic (e.g. slimes) Potential to create damage or destruction to the environment                      | 3     | Bio-physical and/or social functions and/or processes might be notably altered or enhanced / Partially reversible          | 3     | Current environmental component(s) are a mix of disturbed and undisturbed areas.<br><br>Area with some environmental sensitivity (scarce / valuable environment etc.). | 3     |
| Lasting 5 years to Life of Organisation | 4     | Impact on local scale / adjacent sites (km's)                                   | 4     | Very large quantities / volumes / intensity (e.g. 5000 L – 10 000L)         | 4     | Toxic (e.g. diesel & Sodium Hydroxide)                                                                           | 4     | Bio-physical and/or social functions and/or processes might be considerably altered or enhanced / potentially irreversible | 4     | Current environmental component(s) are in a natural state.<br><br>Environmentally sensitive environment / receptor (endangered)                                        | 4     |

| Source                                                          |   |                                                  |   |                                                                                                        |   |                                             |   | Receptor                                                                                                                                       |   |                                                                                                                                                                                           |   |
|-----------------------------------------------------------------|---|--------------------------------------------------|---|--------------------------------------------------------------------------------------------------------|---|---------------------------------------------|---|------------------------------------------------------------------------------------------------------------------------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
|                                                                 |   |                                                  |   | or 8Ha–<br>12Ha)                                                                                       |   |                                             |   |                                                                                                                                                |   | species /<br>habitats etc.).                                                                                                                                                              |   |
| Beyond life<br>of<br>Organizatio<br>n /<br>Permanent<br>impacts | 5 | Extends<br>widely<br>(nationally<br>or globally) | 5 | Very<br>large<br>quantitie<br>s /<br>volumes<br>/<br>intensity<br>(e.g. ><br>10 000 L<br>or ><br>12Ha) | 5 | Highly<br>toxic (e.g.<br>arsenic or<br>TCE) | 5 | Bio-physical and/or<br>social functions<br>and/or processes<br>might be<br>severely/substantia<br>lly altered or<br>enhanced /<br>Irreversible | 5 | Current<br>environmental<br>component(s)<br>are in a<br>pristine<br>natural state.<br><br>Highly<br>Sensitive area<br>(endangered<br>species,<br>wetlands,<br>protected<br>habitats etc.) | 5 |

**Table 16: Step 3: Determine the SEVERITY of the impact by plotting the averages that were obtained above for Probability and Magnitude in the table below.**

| ENVIRONMENTAL IMPACT RATING / PRIORITY |            |          |             |           |            |
|----------------------------------------|------------|----------|-------------|-----------|------------|
|                                        | MAGNITUDE  |          |             |           |            |
| PROBABILITY                            | 1<br>Minor | 2<br>Low | 3<br>Medium | 4<br>High | 5<br>Major |
| 5<br>Almost Certain                    | Low        | Medium   | High        | High      | High       |
| 4<br>Likely                            | Low        | Medium   | High        | High      | High       |
| 3<br>Possible                          | Low        | Medium   | Medium      | High      | High       |
| 2<br>Unlikely                          | Low        | Low      | Medium      | Medium    | High       |
| 1<br>Rare                              | Low        | Low      | Low         | Medium    | Medium     |

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## Appendix E2: Technical Design Report



**REPORT:** DUVHA POWER STATION LOW LEVEL ASH WATER RETURN DAM  
SPILLWAY UPGRADING DESIGN REPORT

**DATE:** 04 MAY 2020

**REPORT NUMBER:** P047-R0030

SAWE / PG CONSULTING

BUILDING 24, SUNNUNGHILL OFFICE PARK, 20 PELTIER ROAD, SUNNINGHILL,  
JOHANNESBURG, 2157



**REPORT NUMBER:** P047-R0030

**REPORT TITLE:** DUVHA POWER STATION LOW LEVEL ASH WATER RETURN DAM  
SPILLWAY UPGRADING DESIGN REPORT

**REPORT VERSION:** V3

**CONTRACT NUMBER:** 4600064796

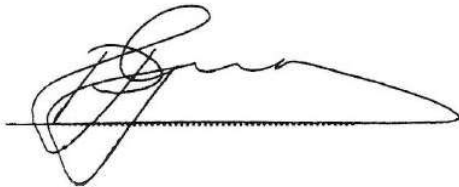
**CLIENT:** DUVHA POWER STATION

**DEPARTMENT:** AUXILIARY ENGINEERING

**SYSTEMS ENGINEER/ PROJECT MANAGER:** TAKALANI NETHSIA

**REPORT AUTHORS:** FRANCOIS JOUBERT, Pr Tech Eng

**AUTHORISED BY:**

A handwritten signature in black ink, appearing to read 'Pieter Gouws', written over a horizontal line.

PIETER GOUWS, Pr Eng (Civil), APP

**DATE:** 04 MAY 2020

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## LIST OF ABBREVIATIONS

|         |                                                |
|---------|------------------------------------------------|
| APP     | Approved Professional Person                   |
| CL      | Contour Level                                  |
| DEA     | Department of Environmental Affairs            |
| DWS     | Department of Water and Sanitation             |
| EPP     | Emergency Preparedness Plan                    |
| EWB     | Ecological Water Reserve                       |
| FSL     | Full Supply Level                              |
| HRU     | Hydrological Research Unit                     |
| IFR     | Instream Flow Requirements                     |
| Ke      | Regional coefficient                           |
| MAP     | Mean annual precipitation                      |
| MAR     | Mean sea run-off                               |
| masl    | Meters above sea level                         |
| NOC     | Non-overspill crest                            |
| NWA     | National Water Act                             |
| OMM     | Operation and maintenance manual               |
| PMF     | Probable maximum flood                         |
| PMP     | Probable maximum precipitation                 |
| RDD     | Recommended design discharge                   |
| RDF     | Recommended design flood                       |
| RI      | Recurrence interval                            |
| RL      | Relative level                                 |
| RMF     | Regional maximum flood                         |
| SANCOLD | South African National Committee on Large Dams |
| SCS     | Soil Conservation Service                      |
| SED     | Safety evaluation discharge                    |
| SEF     | Safety evaluation flood                        |

## LIST OF REFERENCES

| Document Title                                                                       | Preparer / Author             | Document Number             | Revision or Date of Issue |
|--------------------------------------------------------------------------------------|-------------------------------|-----------------------------|---------------------------|
| <b>1. Legislative Requirements</b>                                                   |                               |                             |                           |
| [1] The National Water Act                                                           | NWA                           | Act of 36                   | 1998                      |
| [2] The National Environmental Management Act                                        | NEMA                          | Act of 107                  | 1998                      |
| [3] Regulation Gazette No. 20119<br><i>Mining and Related Activities Regulations</i> | NWA                           | Government Notice (GN) R704 | 1999                      |
| [4] Regulation Gazette No. 35062<br><i>Dam Safety Regulations</i>                    | NWA                           | Government Notice (GN) R139 | 2012                      |
| <b>2. National Standards and Information</b>                                         |                               |                             |                           |
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| [6] GIS information: WRC2012                                                         | WRC                           |                             | 2012                      |
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| <b>3. Technical Guidelines</b>                                                       |                               |                             |                           |
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| [10] Best Practice Guideline A4 Pollution Control Dams                               | DWAF                          | BPG 1                       | 2007                      |
| <b>4. Other Documentation and Information</b>                                        |                               |                             |                           |
| [11] Lidar Survey Data & Settlement Beacons and Piezometer Positions Report          | SAWE / PGC                    | P047-R0012                  | 2019                      |
| [12] First Dam Safety Evaluation Report                                              | Darling De Lange & Van Tonder |                             | 2006                      |
| [13] Ash Dam Operations and Maintenance Manual                                       | ESKOM                         | ENM0003                     | 2018                      |

## 1. INTRODUCTION

### 1.1 Background

At an inspection on 11 December 2020, an instruction was given by Mr. Pieter Gouws, the Approved Professional Person, to breach the berm that had been constructed downstream of the Low-Level Ash Water Return Dam (LLAWRD) to prevent imminent overtopping of the LLAWRD. The berm had been constructed to mitigate the risk of spilling water to the clean natural water system that leads into Witbank Dam. This breach led to a spill into the clean natural water system.

SAWE Engineering Solutions (Pty) Ltd was appointed by Eskom Holdings SOC Ltd to re-evaluate the current situation at the Low-Level Ash Water Return Dam (LLAWRD) in respect of the following:

1. Operating level and spillway capacity,
2. Formalizing of the spillway design.

The LLAWRD is situated at the Eskom Duvha Power Station just north of the Ash tailings facility, about 13 kilometres south-east of Emalahleni in the Nkangala District, Mpumalanga Province. The centre co-ordinates (WGS 84) for the LLAWR Dam are latitude 25° 55' 37.31" S and longitude 29° 20' 40.96" E.

The location is illustrated in Figure 1 below.



Figure 1: Google Earth Image showing the dam position

## **1.2 Scope of Work**

The scope of work can be summarised as follows.

- a) Estimate the current LLAWR Dam's spillway capacity, before overtopping of the dam wall crest will occur (as reduced by an earth berm placed by Eskom within the original spillway channel).
- b) Reinstate spillway capacity to comply with acceptable dam safety standards.
- c) Address the man-made breached section in the dividing berm and propose a more formalised structure which will allow for spillage into the clean water system only during a flood storm which exceeds a 1:50-year recurrence interval.
- d) Calculate the wetland potential storage capacity, which is located within the dirty water area, to the western side of the LLAWR Dam.
- e) Re-evaluate the optimum operating level within the LLAWR Dam in order to allow for enough buffer capacity to safely accommodate the 1:100-year 24-hour flood storm volume (as recommended in the Ash Dam Operations and Maintenance Manual, ENM003-2018).
- f) Provide a specification for gravel topping on the dam wall crest.

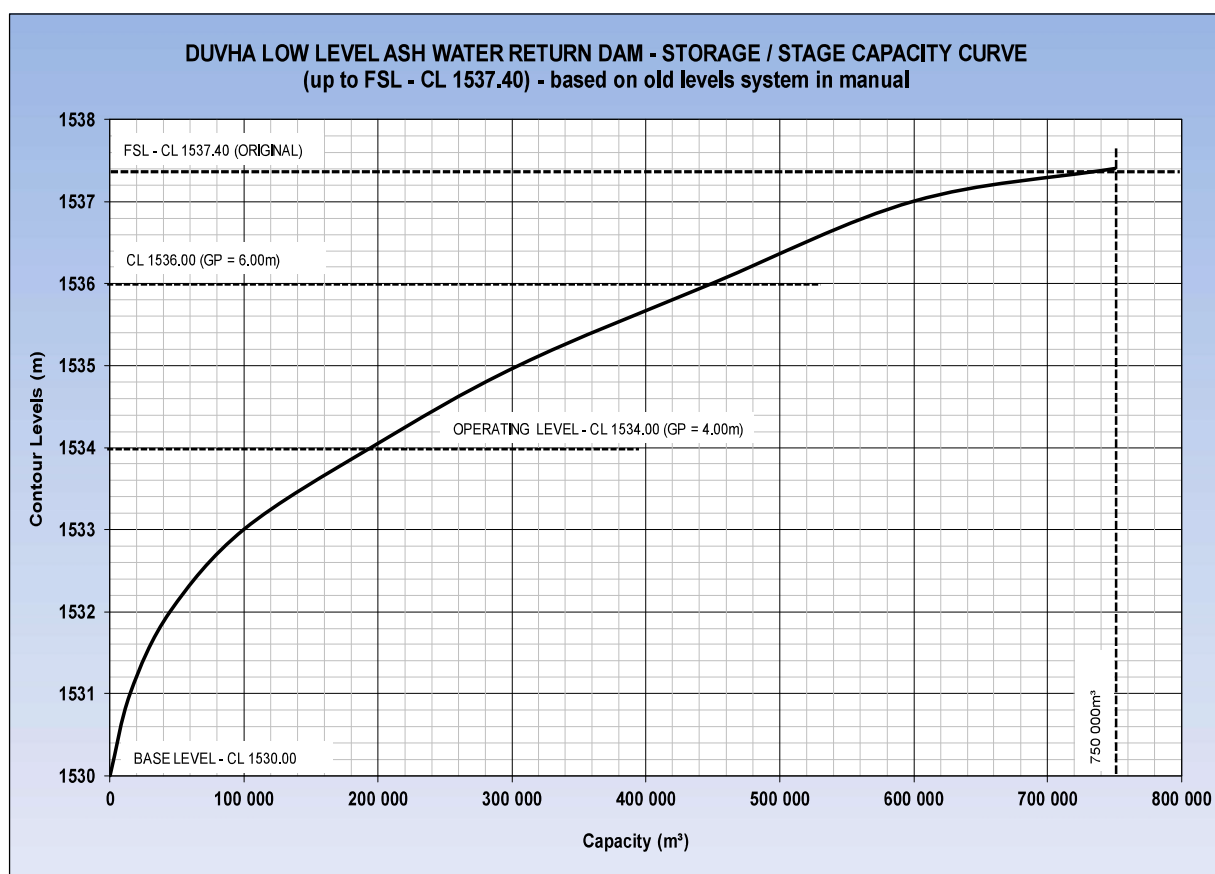


## 2. OPERATION OF LOW-LEVEL ASH WATER RETURN DAM

With reference to the Ash Dam Operations and Maintenance Manual, page 59 (ENM0003 – 2018), the LLAWR Dam is to be operated within a water level range of between 1354 and 1352 masl. The levels shown in this graph is based on the old level system, before the Lidar and RTK surveys were conducted during 2019, which provides a more accurate elevation.

***The higher limit is to ensure adequate storage capacity during any major storm, including a 1:100-year 24-hour storm. The lower limit is to prevent cavitation on the pumps.***

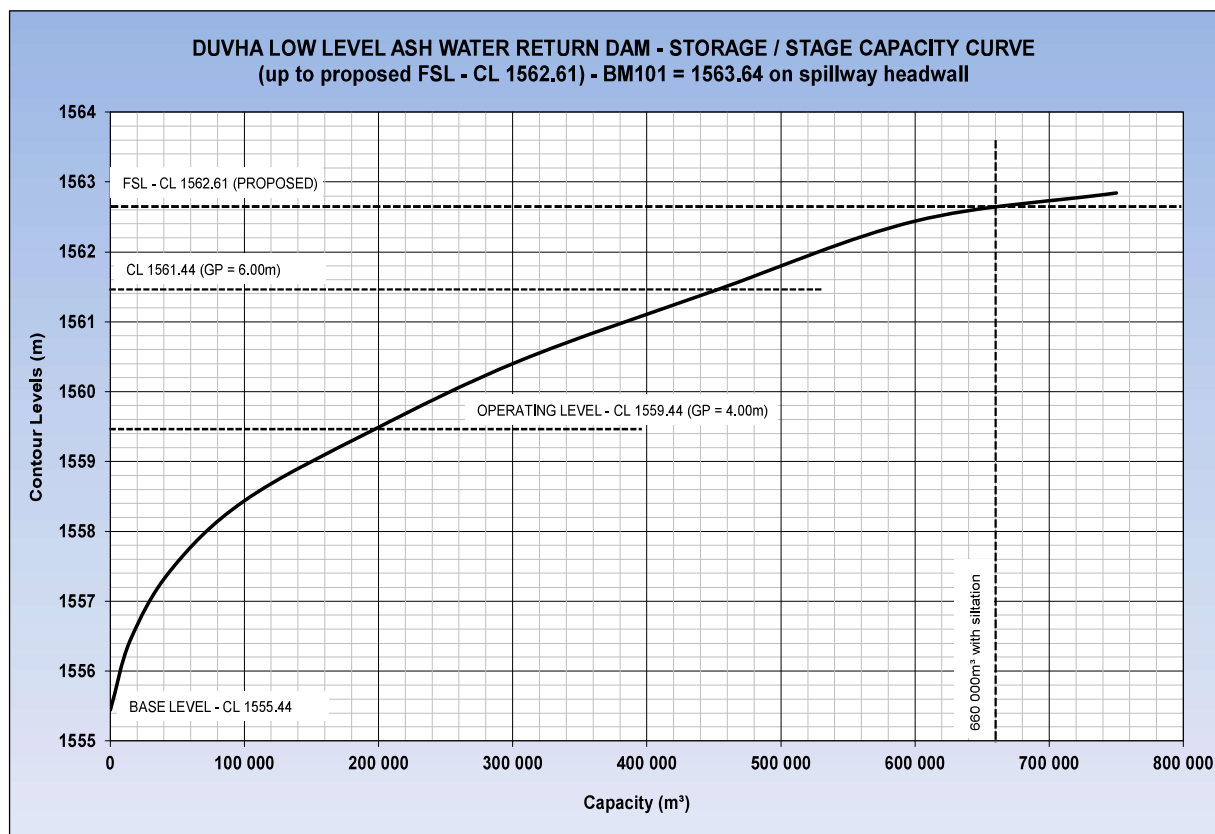
With the above in mind, the maximum operation level should not exceed 1354m (which equals the 4m level marker). Unfortunately, it was found that in recent times, the dam was operated at 1356m and even higher (6m+ level marker). The graph in Figure 2 below illustrates these operating parameters.



**Figure 2: Storage / stage capacity curve (based on old levels system)**

The graph in Figure 3 below, although like the graph above, gives the adjusted levels (meters above mean sea level) based on the Lidar and RTK surveys conducted during 2019. In future, this level set will be used as the reference points. The Operations and Maintenance Manual must be updated to reflect this change.

The graph below in Figure 3 below provides the above in the revised survey parameters.



**Figure 3: Storage / stage capacity curve (based on new levels system)**

The LLAWRD also receives both stormwater and process water from the power station terrace. This is directed to the LLAWRD through the stormwater channels and the solution trench that emanate from the power station and surround the ash tailings facility.

**NOTE:** The above storage / stage capacity curves are based on the graph given in the Ash Dam Operations and Maintenance Manual which differs from the initial as-build graph. See Figure 4 below for comparison based on old levels system. As such it is recommended to conduct a new dam basin survey (bathometric survey) on the LLAWRD to establish the exact present storage capability (with new graph), since the dam has recently been desilted.

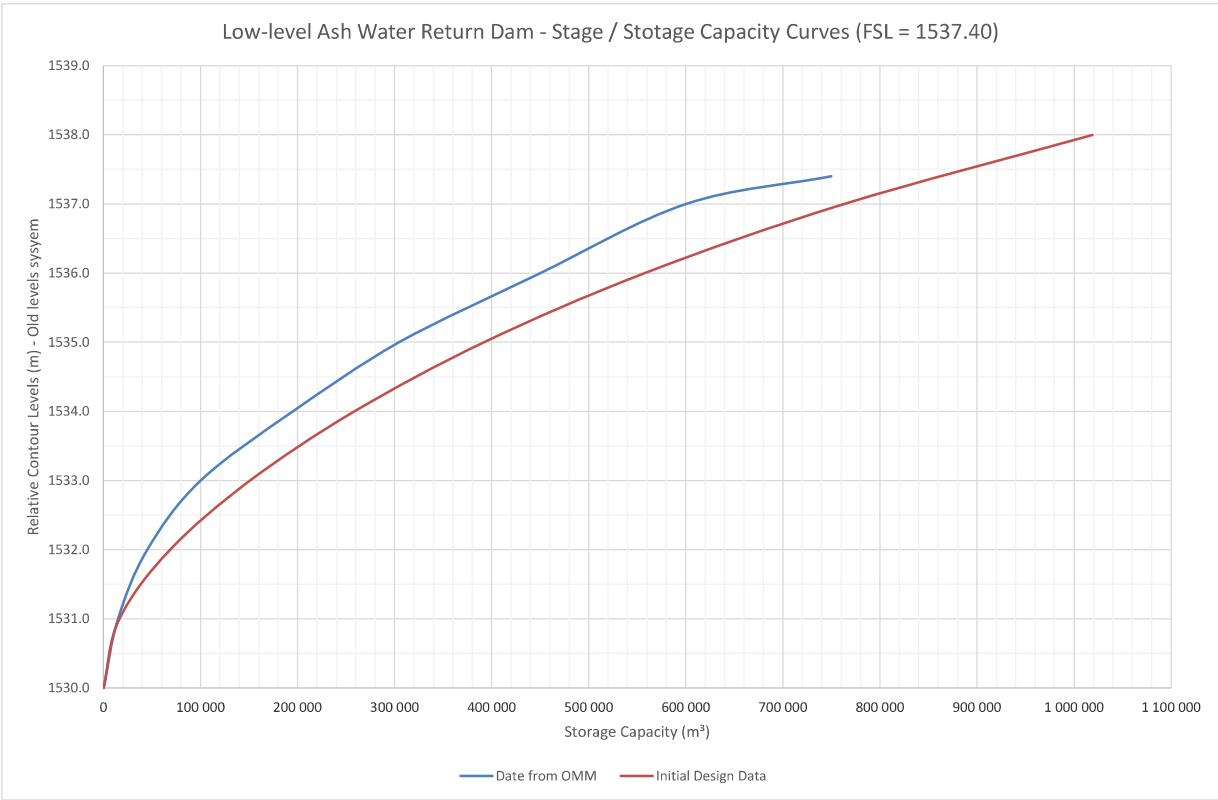


Figure 4: Storage / stage capacity curves comparison

### 3. LEGISLATION REQUIREMENTS

#### 3.1 Government Notice (GN139) – Dam Safety Regulations

In regulating dams, the government has developed a legislative framework that is set out in Chapter 12 Sections 117-123 of the National Water Act (Act 36 of 1998). Dam Safety regulations are set out in Government Notice 139 (GN 139) and this indicates the criteria that are required to be considered when classifying a dam. Furthermore, Government Notice 704 (GN 704) provides additional criteria for clean and dirty water systems, which would be applicable in this case.

A dam with a maximum wall height of more than 5 (five) meters and a capacity which exceeds 50 000 cubic meters, is defined as a dam with a safety hazard. Such a dam must be formally classified and registered for dam safety purposes with the Department of Water and Sanitation (Dam Safety Office - Pretoria). In addition, the regulations also prescribe the following relevant information, which is to be read in conjunction with the that stipulated by SANCOLD, namely:

1. Dam use,
2. Flood spillway hydraulic capabilities;
3. Flood attenuation capabilities;
4. The need to undertake periodic dam safety assessments, and for,
5. Oversight of an Approved Professional Person to provide guidance on the operation of the dam.

**NOTE:** In view of the above, the LLAWR Dam was classified on 8 June 2006 as a **small size, Category II-dam** with a **significant hazard potential** rating and was formally registered on 22 June 2006. DSO reference number 12/2/B102/83. Refer to Dam Safety Registration Certificate attached as **Appendix C**.

The SANCOLD guidelines provide more specific requirements.

#### 3.2 Guidelines on Safety in Relation to Floods (SANCOLD Report N0. 4 – 1991)

Based on the SANCOLD Guidelines (1991), for a Category II-dam, with a significant hazard potential, the flood spillway design needs to safely allow for a discharge of a 1:100-year flood with adequate safety “dry” freeboard applied. In addition to this, the spillways with no safety freeboards, should also allow for the recommended SEF before overtopping of the NOC (embankment crest) occur.

The Guidelines state that the SEF shall be set equal to the routed RMF-Δ flood peak.

#### 3.3 Government Notice (GN704) – Regulations on Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources

Section 6 of GN 704 states the following in relation to capacity requirements of clean and dirty water systems, namely (relevant sections quoted):

*d) design, construct, maintain and operate any dirty water system at the mine or activity so that it is not likely to spill into any clean water system more than once in 50 years; and;*

*e) design, construct, maintain and operate any dam or tailings dam that forms part of a dirty water system to have a minimum freeboard of 0.8 m above full supply level, unless otherwise specified in terms of Chapter 12 of the Act.*

It basically states that any dirty water system (i.e. dam) must be designed, constructed, and maintained in such a way that it is not likely to spill into any clean water system more than once in 50 years. Subsequently, the flood volume of the 1:50-year flood storm must be contained within the defined dirty water area. Flood water in excess of the 1:50-year may spill into the clean water system.

Currently the dam does not adhere to the above requirements as it being operated in a manner that is above the set operational level, with less free-board. In Section 8 in this report we review and optimise the operating level.

## 4. FLOOD HYDROLOGY

### 4.1 Calculation Methodology

Methods which were adopted and applied to calculate the expected run-off peaks with variance in the return periods are summarised below.

- a) **Rational Method Implementation #1** – Based on the regional DDF-equations representing the HRU 1/78 DDF-relationships (“Op ten Noort & Stephenson” -1982),
- b) **Rational Method Implementation #2** – Based on the DDF-tables of TR102 for an n-day storm depths in Southern Africa (“Adamson” -1981),
- c) **Empirical Method (TR137)** – Regional maximum floods based on “Francou-Rodier” K-values (“Kovacs” – 1988) – Commonly used by DWS. However, this method tends to give over conservative values for catchments >10km<sup>2</sup> but had to be applied in order to obtain the RMF value.

### 4.2 Catchment Parameters

The catchments identified and delineated for the dam forms part of quaternary catchment **B11G**. (Refer to Google image below, Figure 5).

The mean annual rainfall of the catchment, based on the nearest rainfall station (0515382W), is given as **773 mm**. The Mean Annual Precipitation (MAP) for the quaternary catchment is given as **693 mm**. Rainfall data and design rainfall depths from the table below (highlighted) were incorporated in the hydrology calculations.

|                                                               |                           |
|---------------------------------------------------------------|---------------------------|
| Ash Dam Complex catchment area (km <sup>2</sup> )             | <b>5.38km<sup>2</sup></b> |
| Duvha Power Station terrace catchment area (km <sup>2</sup> ) | <b>1.22km<sup>2</sup></b> |
| Total catchment area (km <sup>2</sup> )                       | <b>6.60km<sup>2</sup></b> |
| Flow length of longest watercourse (km)                       | <b>5.0km</b>              |
| Vertical difference in catchment (m)                          | <b>90m</b>                |
| Average watercourse / river slope (10/85)                     | <b>1.80%</b>              |
| Time of concentration (Tc)                                    | <b>1.08 hour</b>          |

## DESIGN RAINFALL DEPTHS AT SELECTED STATIONS IN SOUTH AFRICA

| SAWB<br>NUMBER | Station Name         | Latitude<br>(°) (') | Longitude<br>(°) (') | MAP<br>(mm) | Altitude<br>(m) | Years<br>(days) | Return Period (years) |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|----------------|----------------------|---------------------|----------------------|-------------|-----------------|-----------------|-----------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                |                      |                     |                      |             |                 |                 | 2                     |     |     | 5   |     |     | 10  |     |     | 20  |     |     | 50  |     |     | 100 |     |     | 200 |     |     |     |
|                |                      |                     |                      |             |                 |                 | L                     | D   | U   | L   | D   | U   | L   | D   | U   | L   | D   | U   | L   | D   | U   | L   | D   | U   | L   | D   | U   |     |
| 0515382AW      | WITBANK-1            | 25 52               | 29 13                | 773         | 1583            | 42              | 1                     | 52  | 52  | 52  | 69  | 69  | 70  | 81  | 81  | 82  | 92  | 93  | 95  | 108 | 110 | 112 | 120 | 123 | 127 | 132 | 137 | 143 |
|                |                      |                     |                      |             |                 |                 | 2                     | 71  | 71  | 71  | 92  | 92  | 93  | 106 | 107 | 107 | 120 | 121 | 122 | 137 | 140 | 142 | 151 | 154 | 157 | 165 | 168 | 174 |
|                |                      |                     |                      |             |                 |                 | 3                     | 79  | 79  | 80  | 102 | 102 | 103 | 117 | 118 | 118 | 132 | 133 | 133 | 151 | 152 | 153 | 165 | 167 | 168 | 180 | 181 | 183 |
|                |                      |                     |                      |             |                 |                 | 4                     | 87  | 88  | 88  | 113 | 113 | 114 | 129 | 130 | 131 | 145 | 146 | 147 | 165 | 167 | 168 | 179 | 181 | 185 | 194 | 197 | 201 |
|                |                      |                     |                      |             |                 |                 | 5                     | 95  | 96  | 96  | 123 | 123 | 124 | 140 | 141 | 142 | 157 | 159 | 160 | 178 | 181 | 183 | 193 | 197 | 201 | 208 | 213 | 219 |
|                |                      |                     |                      |             |                 |                 | 6                     | 101 | 102 | 102 | 130 | 131 | 131 | 148 | 149 | 150 | 165 | 167 | 169 | 186 | 189 | 192 | 201 | 205 | 209 | 215 | 221 | 228 |
|                |                      |                     |                      |             |                 |                 | 7                     | 107 | 108 | 108 | 137 | 138 | 139 | 157 | 157 | 158 | 174 | 176 | 177 | 196 | 199 | 201 | 212 | 215 | 219 | 227 | 232 | 236 |
| 0515382 W      | WITBANK - MAG        | 25 52               | 29 13                | 773         | 1583            | 62              | 1                     | 52  | 53  | 53  | 69  | 70  | 70  | 81  | 82  | 83  | 93  | 94  | 95  | 109 | 111 | 113 | 121 | 124 | 128 | 133 | 138 | 144 |
|                |                      |                     |                      |             |                 |                 | 2                     | 66  | 67  | 67  | 86  | 87  | 87  | 100 | 100 | 101 | 113 | 114 | 115 | 129 | 131 | 133 | 142 | 145 | 148 | 155 | 158 | 163 |
|                |                      |                     |                      |             |                 |                 | 3                     | 75  | 75  | 76  | 97  | 97  | 98  | 112 | 112 | 113 | 126 | 126 | 127 | 144 | 145 | 146 | 157 | 159 | 160 | 171 | 172 | 174 |
|                |                      |                     |                      |             |                 |                 | 4                     | 82  | 82  | 83  | 106 | 106 | 107 | 122 | 122 | 123 | 136 | 137 | 138 | 155 | 157 | 158 | 168 | 171 | 174 | 182 | 185 | 189 |
|                |                      |                     |                      |             |                 |                 | 5                     | 88  | 88  | 88  | 113 | 113 | 114 | 129 | 130 | 131 | 145 | 146 | 147 | 164 | 166 | 169 | 178 | 181 | 185 | 192 | 196 | 202 |
|                |                      |                     |                      |             |                 |                 | 6                     | 93  | 93  | 94  | 119 | 119 | 120 | 135 | 136 | 137 | 151 | 152 | 154 | 170 | 173 | 175 | 184 | 187 | 191 | 197 | 202 | 208 |
|                |                      |                     |                      |             |                 |                 | 7                     | 97  | 98  | 98  | 125 | 126 | 126 | 143 | 143 | 144 | 159 | 160 | 161 | 179 | 181 | 183 | 193 | 196 | 199 | 207 | 211 | 215 |
| 0515383 W      | WITBANK (POW)        | 25 53               | 29 13                | 729         | 1598            | 44              | 1                     | 48  | 48  | 48  | 64  | 64  | 65  | 75  | 76  | 77  | 86  | 88  | 90  | 101 | 105 | 108 | 113 | 118 | 123 | 126 | 132 | 139 |
|                |                      |                     |                      |             |                 |                 | 2                     | 62  | 62  | 62  | 82  | 82  | 82  | 96  | 96  | 97  | 109 | 110 | 111 | 128 | 129 | 131 | 142 | 144 | 146 | 157 | 160 | 163 |
|                |                      |                     |                      |             |                 |                 | 3                     | 71  | 71  | 72  | 93  | 94  | 94  | 108 | 110 | 111 | 123 | 125 | 127 | 142 | 146 | 150 | 156 | 162 | 169 | 171 | 179 | 189 |
|                |                      |                     |                      |             |                 |                 | 4                     | 78  | 78  | 79  | 102 | 103 | 103 | 118 | 120 | 121 | 134 | 136 | 139 | 154 | 159 | 163 | 169 | 176 | 183 | 185 | 194 | 204 |
|                |                      |                     |                      |             |                 |                 | 5                     | 85  | 85  | 85  | 110 | 111 | 112 | 128 | 129 | 130 | 144 | 146 | 148 | 166 | 169 | 173 | 182 | 187 | 193 | 197 | 205 | 213 |
|                |                      |                     |                      |             |                 |                 | 6                     | 90  | 90  | 91  | 117 | 117 | 118 | 135 | 136 | 136 | 153 | 153 | 154 | 175 | 177 | 179 | 193 | 195 | 198 | 210 | 214 | 217 |
|                |                      |                     |                      |             |                 |                 | 7                     | 95  | 95  | 95  | 122 | 123 | 123 | 141 | 142 | 142 | 158 | 160 | 161 | 181 | 184 | 186 | 198 | 202 | 205 | 215 | 220 | 225 |
| 0515412 W      | WITBANK (MUN)        | 25 52               | 29 14                | 698         | 1610            | 43              | 1                     | 51  | 52  | 52  | 69  | 69  | 70  | 81  | 82  | 83  | 93  | 95  | 97  | 109 | 113 | 116 | 122 | 127 | 133 | 135 | 142 | 150 |
|                |                      |                     |                      |             |                 |                 | 2                     | 64  | 65  | 65  | 85  | 86  | 86  | 100 | 100 | 101 | 114 | 115 | 116 | 133 | 135 | 136 | 148 | 150 | 153 | 164 | 166 | 170 |
|                |                      |                     |                      |             |                 |                 | 3                     | 72  | 73  | 73  | 95  | 96  | 96  | 111 | 112 | 113 | 126 | 128 | 130 | 145 | 149 | 154 | 160 | 166 | 173 | 174 | 183 | 193 |
|                |                      |                     |                      |             |                 |                 | 4                     | 80  | 80  | 81  | 104 | 105 | 106 | 121 | 122 | 124 | 137 | 139 | 142 | 158 | 162 | 167 | 173 | 180 | 187 | 189 | 198 | 208 |
|                |                      |                     |                      |             |                 |                 | 5                     | 87  | 88  | 88  | 114 | 114 | 115 | 131 | 132 | 133 | 148 | 150 | 152 | 170 | 174 | 178 | 187 | 192 | 198 | 203 | 211 | 219 |
|                |                      |                     |                      |             |                 |                 | 6                     | 91  | 92  | 92  | 118 | 119 | 119 | 137 | 137 | 138 | 155 | 156 | 157 | 178 | 180 | 181 | 195 | 198 | 200 | 213 | 216 | 220 |
|                |                      |                     |                      |             |                 |                 | 7                     | 98  | 98  | 98  | 126 | 127 | 127 | 146 | 146 | 147 | 164 | 165 | 166 | 187 | 190 | 192 | 204 | 208 | 212 | 222 | 227 | 232 |
| 0515528 W      | OLIFANTSRIVIER (SAR) | 25 48               | 29 18                | 656         | 1410            | 72              | 1                     | 51  | 51  | 51  | 68  | 69  | 69  | 80  | 81  | 82  | 92  | 94  | 95  | 108 | 111 | 115 | 120 | 125 | 131 | 134 | 140 | 148 |
|                |                      |                     |                      |             |                 |                 | 2                     | 63  | 63  | 64  | 84  | 84  | 84  | 98  | 98  | 99  | 112 | 113 | 113 | 131 | 132 | 134 | 146 | 148 | 150 | 161 | 163 | 166 |
|                |                      |                     |                      |             |                 |                 | 3                     | 72  | 72  | 72  | 94  | 95  | 95  | 109 | 111 | 112 | 124 | 126 | 129 | 143 | 147 | 152 | 158 | 164 | 170 | 172 | 181 | 190 |
|                |                      |                     |                      |             |                 |                 | 4                     | 79  | 79  | 80  | 104 | 104 | 105 | 120 | 121 | 123 | 136 | 138 | 141 | 156 | 161 | 165 | 172 | 178 | 185 | 187 | 197 | 207 |
|                |                      |                     |                      |             |                 |                 | 5                     | 85  | 86  | 86  | 111 | 112 | 112 | 128 | 129 | 131 | 145 | 147 | 149 | 167 | 170 | 174 | 183 | 188 | 194 | 199 | 206 | 215 |
|                |                      |                     |                      |             |                 |                 | 6                     | 89  | 90  | 90  | 116 | 117 | 117 | 134 | 135 | 135 | 151 | 152 | 153 | 174 | 176 | 177 | 191 | 194 | 196 | 209 | 212 | 215 |
|                |                      |                     |                      |             |                 |                 | 7                     | 95  | 96  | 96  | 123 | 124 | 124 | 142 | 143 | 143 | 160 | 161 | 162 | 182 | 185 | 187 | 199 | 203 | 207 | 216 | 221 | 226 |
| 0515732 W      | BOTSABELO (SKL)      | 25 42               | 29 24                | 697         | 1410            | 67              | 1                     | 54  | 54  | 54  | 71  | 72  | 72  | 83  | 84  | 85  | 96  | 97  | 98  | 112 | 114 | 116 | 124 | 128 | 132 | 137 | 142 | 148 |
|                |                      |                     |                      |             |                 |                 | 2                     | 68  | 68  | 69  | 89  | 89  | 89  | 102 | 103 | 103 | 115 | 116 | 118 | 133 | 135 | 137 | 145 | 148 | 151 | 159 | 162 | 167 |
|                |                      |                     |                      |             |                 |                 | 3                     | 76  | 76  | 77  | 98  | 99  | 99  | 113 | 114 | 114 | 128 | 128 | 129 | 146 | 147 | 148 | 160 | 161 | 162 | 173 | 175 | 177 |
|                |                      |                     |                      |             |                 |                 | 4                     | 85  | 85  | 85  | 109 | 110 | 110 | 125 | 126 | 127 | 140 | 142 | 143 | 160 | 162 | 163 | 174 | 176 | 179 | 188 | 191 | 195 |
|                |                      |                     |                      |             |                 |                 | 5                     | 90  | 91  | 91  | 117 | 117 | 118 | 133 | 134 | 135 | 149 | 151 | 152 | 169 | 172 | 174 | 184 | 187 | 191 | 198 | 203 | 208 |
|                |                      |                     |                      |             |                 |                 | 6                     | 95  | 96  | 96  | 122 | 123 | 123 | 139 | 140 | 141 | 155 | 157 | 158 | 175 | 178 | 180 | 189 | 193 | 197 | 202 | 207 | 214 |
|                |                      |                     |                      |             |                 |                 | 7                     | 101 | 101 | 102 | 129 | 130 | 131 | 148 | 148 | 149 | 164 | 165 | 167 | 185 | 187 | 190 | 199 | 203 | 206 | 214 | 218 | 223 |
| 0515826 W      | MIDDELBURG (TNK)     | 25 46               | 29 28                | 689         | 1459            | 96              | 1                     | 44  | 44  | 45  | 59  | 60  | 60  | 69  | 70  | 71  | 80  | 81  | 83  | 94  | 97  | 100 | 105 | 109 | 114 | 116 | 122 | 129 |
|                |                      |                     |                      |             |                 |                 | 2                     | 59  | 59  | 59  | 78  | 78  | 79  | 91  | 92  | 92  | 104 | 105 | 106 | 122 | 123 | 124 | 135 | 137 | 139 | 149 | 152 | 155 |
|                |                      |                     |                      |             |                 |                 | 3                     | 66  | 67  | 67  | 87  | 88  | 88  | 101 | 103 | 104 | 115 | 117 | 119 | 133 | 137 | 141 | 146 | 152 | 158 | 160 | 168 | 177 |
|                |                      |                     |                      |             |                 |                 | 4                     | 73  | 74  | 74  | 96  | 96  | 97  | 111 | 112 | 113 | 126 | 128 | 130 | 144 | 149 | 153 | 159 | 165 | 172 | 173 | 182 | 191 |
|                |                      |                     |                      |             |                 |                 | 5                     | 79  | 80  | 80  | 104 | 104 | 105 | 120 | 121 | 122 | 135 | 137 | 139 | 155 | 159 | 162 | 170 | 175 | 181 | 185 | 192 | 200 |
|                |                      |                     |                      |             |                 |                 | 6                     | 85  | 85  | 85  | 110 | 110 | 111 | 127 | 127 | 128 | 143 | 144 | 145 | 165 | 166 | 168 | 181 | 183 | 186 | 198 | 201 | 204 |
|                |                      |                     |                      |             |                 |                 | 7                     | 90  | 90  | 91  | 116 | 117 | 117 | 134 | 135 | 135 | 151 | 152 | 153 | 172 | 174 | 177 | 188 | 191 | 195 | 204 | 209 | 213 |

188

L=lower 90% error bound (mm); D=design rainfall depth (mm); U=upper 90% error bound (mm)

Table 1: Design rainfall depths (Adamson 1981)



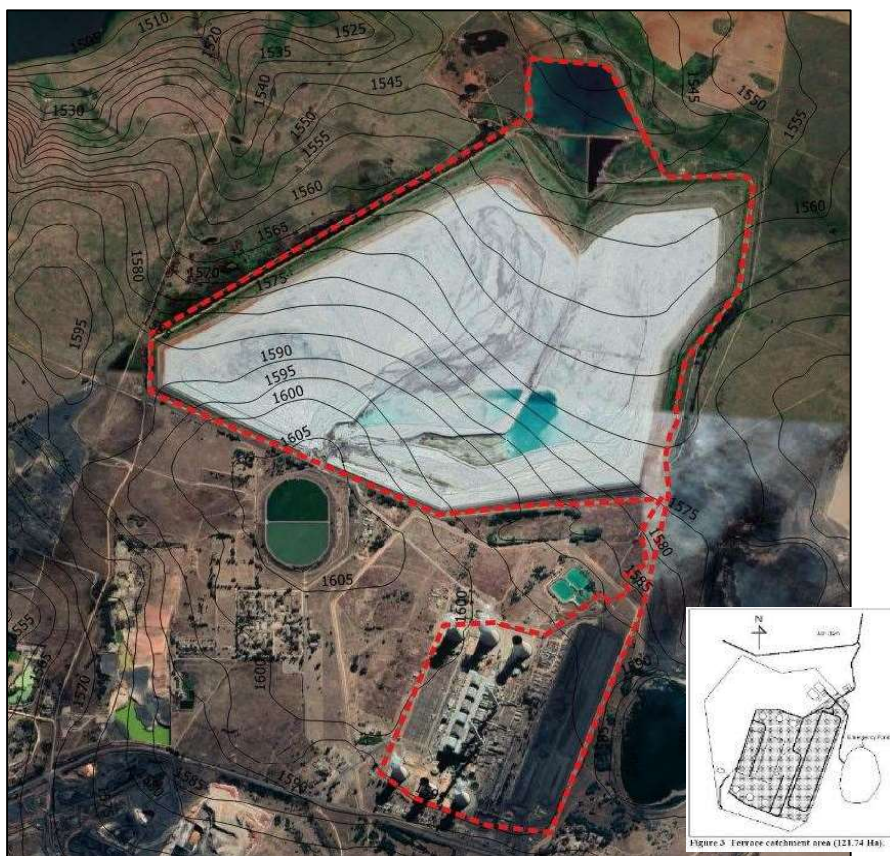


Figure 5: Google image showing LLAWR dam catchment

### 4.3 Summary of Hydrology

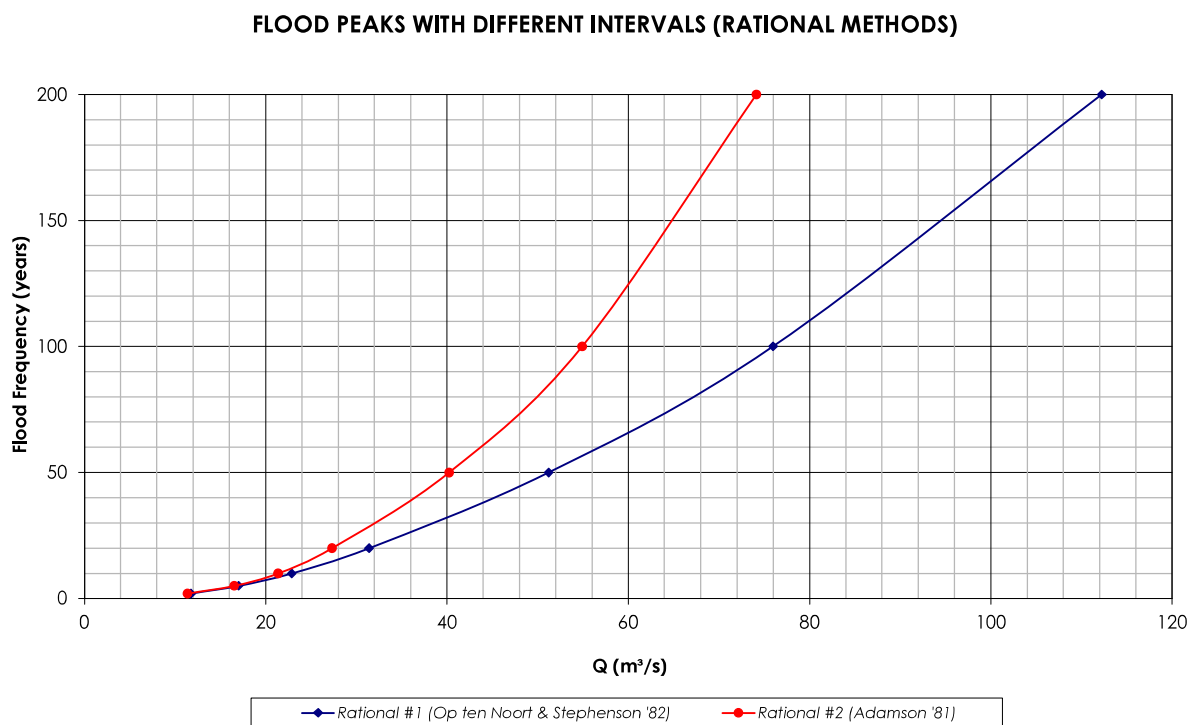
During the final hydrology calculations, following various considerations, it was decided to adopt the average flood values derived by the two deterministic Rational methods applied. This allows for the inclusion of specific conditions as the catchment size is  $<10\text{km}^2$ .

The values derived by the TR137 empirical method were found to be too conservative as it is based on general regional assumptions. However, because this is a Category II-dam, the method had to be applied in order to derive the RMF peak for SEF purposes. Refer to the flood graphs included below and calculation sheets **Appendix A**.

| Flood peaks derived                        |          |                 |           |
|--------------------------------------------|----------|-----------------|-----------|
| Values in $\text{m}^3/\text{s}$            | $Q_{50}$ | $Q_{100}$ (RDF) | $Q_{200}$ |
| Rational Method (Implementation #1)        | 51.2     | 76.0            | 112.2     |
| Rational Method (Implementation #2)        | 40.2     | 54.9            | 74.1      |
| Empirical TR137 Method ( $K_e$ region 5.2) | 85.2     | 107.3           | 128.8     |
| Average of two Rational Methods applied    | 45.7     | 65.5            | 93.2      |

Table 2: Summary of calculated flood peaks with three applied methods

|                                                                                |                           |
|--------------------------------------------------------------------------------|---------------------------|
| Regional maximum flood (RMF) – calculated for $K_e$ - region 4,6:              | 205 $\text{m}^3/\text{s}$ |
| Regional maximum flood (RMF- $\Delta$ ) – calculated for $K_e$ - region 4,0:   | 133 $\text{m}^3/\text{s}$ |
| Probable maximum flood (PMF) 1:10 000 years – $K_{e\text{ max}}$ – region 5,6: | 361 $\text{m}^3/\text{s}$ |



**Figure 6: Flood graphs derived by the two Rational Method implementations applied**

The re-evaluated flood peak values above compare favourably with the flood values presented in the First Dam Safety Evaluation Report (2006) compiled by Darling De Lange & Van Tonder. Refer to abstract in Figure 7 below.

| <b><u>SECTION 7: FLOOD ESTIMATES</u></b> |                                  |
|------------------------------------------|----------------------------------|
| <b>Catchment area:</b> .....             | 538 ha                           |
| <b>Catchment slope:</b> .....            | 0,5%                             |
| <b>Weather station:</b> .....            | Witbank 515382                   |
| <b>Mean annual rainfall:</b> .....       | 615 mm                           |
| <b>Combined run-off factor:</b> .....    | 0,38 to 0,57                     |
| <b>Time of concentration:</b> .....      | 1,13 hr                          |
| <b>Region:</b> .....                     | 4,6                              |
| <b><u>Flood estimates</u></b>            |                                  |
| <b>1:20 year:</b> .....                  | 26m³/s                           |
| <b>1:50 year:</b> .....                  | 39m³/s                           |
| <b>1:100 year:</b> .....                 | 52m³/s                           |
| <b>1:200 year:</b> .....                 | 57m³/s                           |
| <b>Regional maximum flood:</b> .....     | 190m³/s                          |
| <b>Recommended design flood:</b> ...     | 52m³/s                           |
| <b>Safety evaluation flood:</b> .....    | 124m³/s (RMF <sub>-delta</sub> ) |

**Figure 7: Hydrology summary abstract from the 1<sup>st</sup> Dam Safety Evaluation Report (2006)**

## 5. METHODOLOGY FOR SCOPE OF WORK

The following methodology was adopted to address the scope of work.

- a) To establish the current spillway discharge capacity, the Lidar survey data and RTK survey data from 2019 were used to compile a representative profile alignment at the spillway control section (i.e. where the earth berm was placed). A sectional spillway calculation was then applied. See calculation sheets attached as **Appendix A**.
- b) To reinstate the spillway capacity to prescribed standards, the SANCOLD Guidelines were consulted by applying acceptable spillway hydraulic calculations. See calculation sheets **Appendix A** and drawings **Appendix B** attached.
- c) In order to address the man-made breached section in the dividing berm and to propose a more formal structure to allow for spillage only at a recurrence interval of 1:50-years and larger, the detention capacity of the wetland within the dirty area, as well as the buffer retention capacity of the LLAWR Dam had to be established. This was then used to establish the overspill level of the proposed structure at the dividing berm. See drawings attached for illustration.
- d) With the re-evaluation of the optimum operating level in the LLAWR Dam, a re-evaluation of the flood hydrology was done in order to establish the expected 1:100-year 24-hour storm event runoff volume that needs to be retained. This was then balanced to an existing dam storage / stage curve to allow for sufficient buffer capacity during such a storm event.

## 6. RETENTION / DETENTION STORAGE CAPACITY CALCULATIONS

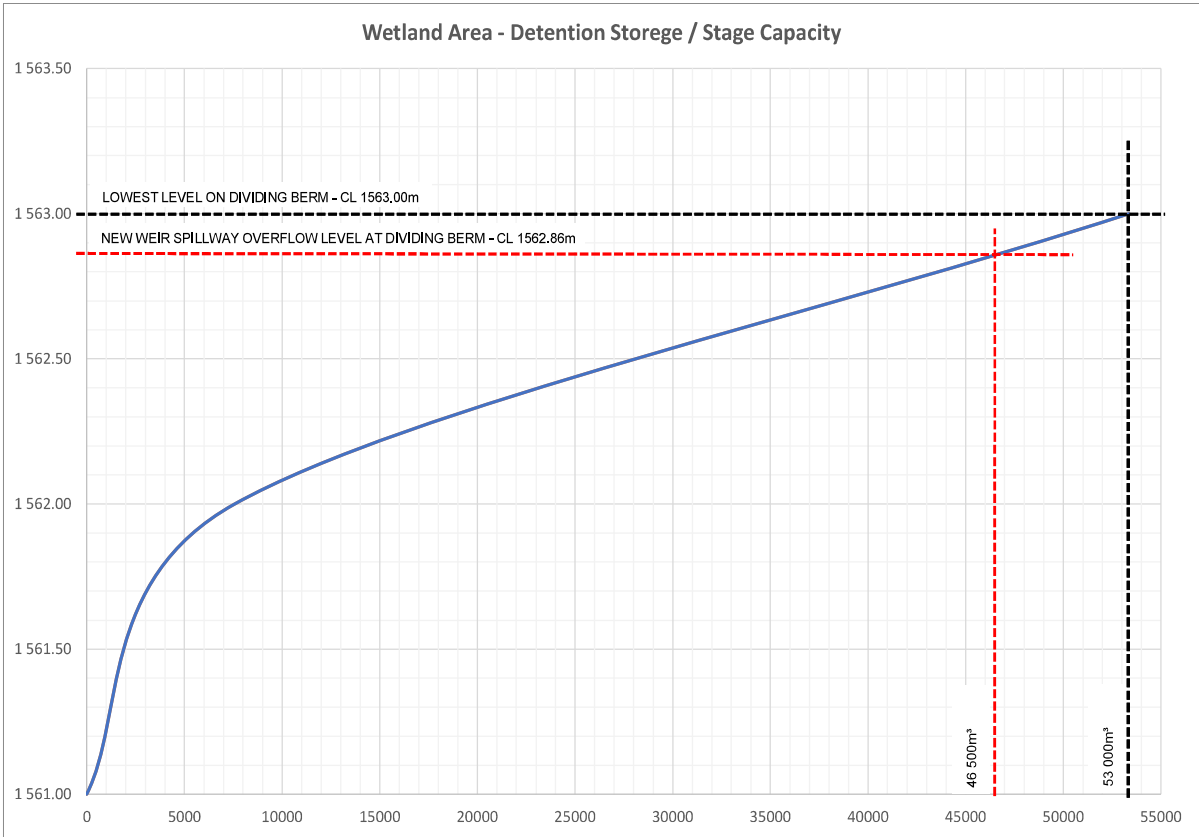
Based on the flood hydrology calculation under Section 4, the following Table 3, provides a summary and averages of the expected flood runoff volumes at the different flood recurrence intervals based on a 1:2 ratio flood hydrograph. Rational Method Implementation #1 gives the flood volume for a 1:100-year 24-hour flood storm as 441 254m<sup>3</sup> while Rational Method Implementation #2 gives it as 318 981m<sup>3</sup>. Subsequently, as with the flood peak values, the average was adopted which gives a more realistic volume of approximately **380 000m<sup>3</sup>** which is used for buffer capacity estimation. For the 1:50-year 24-hour flood storm the average is given as approximately **265 000m<sup>3</sup>**.

| DUVHA P/S LOW LEVEL ASH WATER RETURN DAM |               |               |               |                |                |                |                |                |                  |
|------------------------------------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|------------------|
| Rational (Implementation #1)             |               |               |               |                |                |                |                |                |                  |
| Flood Frequency (Years)                  |               | 2             | 5             | 10             | 20             | 50             | 100            | 200            | PM F             |
| V (m <sup>3</sup> )                      | 0.5 tc        | 108 922       | 157 721       | 211 830        | 291 219        | 474 902        | 704 426        | 1 040 700      | 4 067 407        |
|                                          | <b>1.0 tc</b> | <b>68 229</b> | <b>98 797</b> | <b>132 690</b> | <b>182 420</b> | <b>297 480</b> | <b>441 254</b> | <b>651 897</b> | <b>2 547 832</b> |
|                                          | 2.0 tc        | 40 089        | 58 049        | 77 964         | 107 183        | 174 787        | 259 263        | 383 029        | 1 497 006        |
|                                          | 3.0 tc        | 28 804        | 41 709        | 56 018         | 77 012         | 125 586        | 186 283        | 275 209        | 1 075 611        |
| Rational (Implementation #2)             |               |               |               |                |                |                |                |                |                  |
| Flood Frequency (Years)                  |               | 2             | 5             | 10             | 20             | 50             | 100            | 200            | PM F             |
| V (m <sup>3</sup> )                      | 0.5 tc        | 105 250       | 152 910       | 197 790        | 252 798        | 372 505        | 508 376        | 686 308        | 1 215 458        |
|                                          | <b>1.0 tc</b> | <b>66 039</b> | <b>95 944</b> | <b>124 104</b> | <b>158 618</b> | <b>233 728</b> | <b>318 981</b> | <b>430 625</b> | <b>762 640</b>   |
|                                          | 2.0 tc        | 38 953        | 56 592        | 73 202         | 93 560         | 137 863        | 188 149        | 254 001        | 449 839          |
|                                          | 3.0 tc        | 27 860        | 40 476        | 52 356         | 66 917         | 98 604         | 134 570        | 181 670        | 321 739          |
| Average                                  |               |               |               |                |                |                |                |                |                  |
| Flood Frequency (Years)                  |               | 2             | 5             | 10             | 20             | 50             | 100            | 200            | PM F             |
| V (m <sup>3</sup> )                      | 0.5 tc        | 107 086       | 155 315       | 204 810        | 272 008        | 423 704        | 606 401        | 863 504        | 2 641 432        |
|                                          | <b>1.0 tc</b> | <b>67 134</b> | <b>97 370</b> | <b>128 397</b> | <b>170 519</b> | <b>265 604</b> | <b>380 117</b> | <b>541 261</b> | <b>1 655 236</b> |
|                                          | 2.0 tc        | 39 521        | 57 320        | 75 583         | 100 371        | 156 325        | 223 706        | 318 515        | 973 422          |
|                                          | 3.0 tc        | 28 332        | 41 092        | 54 187         | 71 964         | 112 095        | 160 427        | 228 440        | 698 675          |

**Table 3: Summary of expected flood volumes at different recurrence intervals**

The detention storage capacity of the wetland area, located next to the dam on the western side, was also calculated based on the latest Lidar survey data of 2019. Calculations had revealed that the area has a possible storage capacity of approximately **53 000m<sup>3</sup>** up to the lowest section on the dividing berm, which is at 1563.00 masl. Refer to the graph in Figure 8 below.

Based on the proposed new concrete weir spillway design under Section 7, the weir will have an overflow spill level at CL 1562.86 masl. With reference to the graph, Figure 8, the corresponding storage capacity is given as approximately **46 500m<sup>3</sup>** at this level.



**Figure 8: Storage / stage capacity curve of wetland area next to the LLAWR Dam**

## 7. SPILLWAY UPGRADING (DESIGNS)

Because of an earth berm which was placed in the spillway channel control section of the LLAWR Dam, the flood discharge capacity and capability of the dam was drastically reduced. This led to non-compliance in terms of the Dam Safety Regulations which must be rectified. Initially the dam was constructed with a 110m-wide spillway channel with an 800mm freeboard, which was enough to accommodate the SEF as previously discussed. Below, in Figure 9, is a section through the spillway, as present, derived from the Lidar survey. The black line represents the lowest level on the dam wall crest.

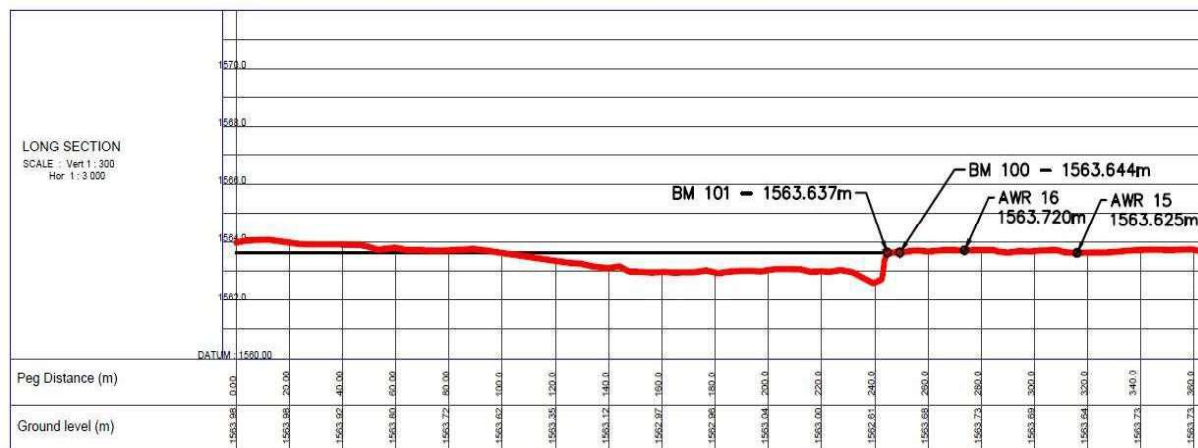


Figure 9: Image showing current spillway profile at the control section (dam wall on right)

Hydraulic calculations were performed on the flow section of the spillway channel which had revealed that the current spillway geometry is only capable of discharging approximately **44m<sup>3</sup>/s** before overtopping of the dam wall crest will occur. Refer to calculation sheets attached as **Appendix A**.

In order to rectify the non-compliance, it is proposed to remove the earth berm and to reshape the spillway channel. The proposed upgraded channel will have a control width of **60m-wide** and in addition, a freeboard of **1.25m** will be implemented. The freeboard will be achieved by excavating and forming the base of the spillway channel at CL 1562.61masl. In addition, a gravel topping will be placed on the existing dam wall crest section, as described under Section 9.

Note that with regard to the regulation of GN 704, which only allows flood water to spill into clean water systems every 50 years or above, provision for the 50-year storm volume subsequently will have to be contained within the dam basin, referred to as the “buffer” capacity (i.e. storage capacity between the operating level and the FSL). Fortunately, to augment this buffer capacity, it is recommended that the wetland area, also situated within the dirty water area, shall be utilized. An additional capacity of **46 500m<sup>3</sup>** is available, as described under Section 6.

Due to recent high-water levels within the LLAWRD it was necessary to breach a section within the dividing berm in order to prevent overtopping of the dam wall, and subsequent damage and inundation of the pump station. As part of the LLAWRD spillway upgrading, it



was also decided to design and construct a formal concrete weir spillway structure at the man-made breach section, for future spillage capability (>50-year flood peak). Refer to the image in Figure 10 below, for illustration purposes.



Figure 10: Google Image showing dam's spillway section and dividing berm

Calculations had revealed that by constructing a weir spillway with an overflow width of **24m** and a freeboard of **1m**, the discharge capacity will safely accommodate the “routed” 1:50-year flood peak before the berm will overtop. Refer to calculation sheets, **Appendix A** and concept design details on attached drawings, **Appendix B**. The overflow level of the weir spillway will be at CL 1562.86 (250mm higher than the LLAWRD FSL).

Note that some low sections on the existing dividing berm will also have to be raised and compacted with earth-fill in order to provide the 1m freeboard throughout. The earth berm material within the LLAWRD can be utilised for this purpose.

Images below, in Figures 11 and 12, show the earth berm placed in the existing spillway channel of the LLAWR Dam and the manmade bridge section within the dividing berm between the dirty and clean water systems.





**Figure 11: Image of earth berm placed within the original spillway channel**



**Figure 12: Image of manmade breached section at dividing berm which was necessitates because of high water levels in the LLAWRD (proposed weir position indicated with red line)**

## 8. OPTIMIZING OF OPERATING LEVEL

In view of the proposed and recommended designs and operational changes above, the initial recommended maximum operating level of the LLAWR Dam (i.e. level depth marker 4m) was revisited and re-evaluated accordingly.

With reference to the recommendation of the Ash Dam Operating and Maintenance Manual, stating that; “the maximum operating level is to ensure that adequate storage capacity is available during any major storm, including a **1:100-year 24-hour storm**”, the required buffer capacity was re-evaluated. It was found that a buffer capacity of approximately **380 000m<sup>3</sup>** is required (Section 6).

In view of the above, this capacity needs to be provided for especially during the summer months (during the rainfall season). For the winter months the required capacity can be based on the **1:50-year 24-hour storm** which requires a buffer capacity of approximately **265 000m<sup>3</sup>**. Subsequently the maximum operating level will fluctuate between two maximum allowable operation levels (i.e. summer and winter months).

This, in effect, means that there must be buffer capacity of 380 000 m<sup>3</sup> between the maximum operating level and the FSL of the dam during the summer months. This was applied, as can be seen on the graph in Figure 13 below, which results in a revised maximum operation level of **CL 1560.24 masl** which corresponds with level depth marker **4.80m**.

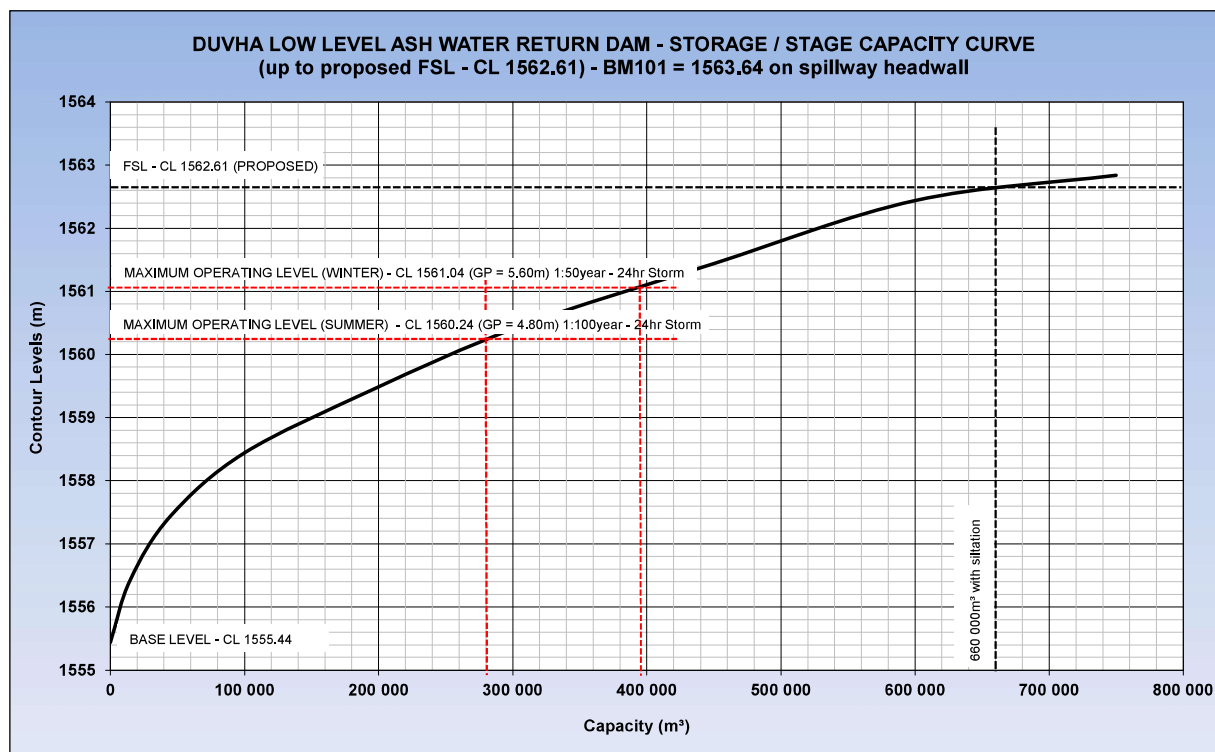


Figure 13: Storage / stage capacity curve with revised operating level

During the winter months there must be buffer capacity of 265 000 m<sup>3</sup> between the maximum operating level and the FSL of the dam. This was also applied, as can be seen on the graph in Figure 13, which results in a revised maximum operation level of **CL 1561.04 masl** which corresponds with level depth marker **5.60m**.

## 9. GRAVEL TOPPING ON DAM WALL CREST

Following the Lidar and RTK surveys during 2019, it was found that minor settlement had occurred on the embankment crest section. Another defect is the fact that the crest section, after rainfall, becomes very slippery and inaccessible for vehicle traffic.

Subsequently, it is recommended to apply a 300mm thick gravel topping on the entire crest section to correct both concerns. The gravel topping shall be compacted to at least 92% Mod AASHTO with a 2% crossfall towards the upstream (water) side, to prevent standing and ponding water on the crest, after rainfall. Refer to drawing 047/AWR/006 for detail, attached as **Appendix B**.

The dam safety settlement beacons, recently placed on the crest of the embankment, will have to be re-placed after the placement of the gravel topping and re-shaping of the crest.

## 10. CONCLUSIONS

Currently the Low-Level Ash Water Return Dam is being operated outside of the safe operations requirements prescribed for the dam. A number of factors have led to this, these being amongst others:

- a) The process water make from the power station operations is higher than expected and not in sync with the water withdrawn from the dam for lower level water services such as ashing.
- b) In the recent past, the dam / pan south of the coal stockyard has been removed from the power station water management system, resulting in more storm water being directed to the LLAWRD.
- c) The current status of the ash tailings facility makes it difficult to temporarily store water on the dam. This ability makes the operation of the LLAWRD acutely prone to potential spills.
- d) The current operational and maintenance status of the LLAWRD return pumps and the pipelines providing suction to these could potentially be causing the pumps to cavitate at lower LLAWRD operational level than designed.

In order to rectify non-compliance in terms of legal requirements, the following upgrading works need to be implemented at the Low-Level Ash Water Return Dam. The works as described in the report can be briefly summarised as follows.

- a) Remove earth berm in existing spillway channel and form and reshape channel to specifications. A concrete sill needs to be constructed as well to act as a definite control point.
- b) Construct new concrete weir spillway and spillway channel at dividing berm to allow for the 1:50-year flood storm to spill.
- c) Apply gravel topping to the existing dam wall crest section in order to provide sufficient freeboard and to prevent rainwater from accumulating on the crest during rain events.

A re-evaluation on the flood hydrology and maximum operating level of the dam was conducted, which needs to be instated and adhered to at all times. The revised maximum operating levels are subsequently set as CL 1560.24masl (GP = 4.80m) during the summer months and CL 1561.06masl (GP = 5.60m) during the winter months. The present level marker systems need to be repaired / upgraded so that the operator can easily read and manage levels accurately.

The old levels system had been adjusted to the current standards based on a Lidar survey conducted during 2019. The new level system needs to be updated in the Ash Dam Operations and Maintenance Manual. We recommend that the manual be revised accordingly.

The present standard and state of operation of the ash dam and low-level dam needs to be rectified as a matter of urgency. It is imperative that this is done whilst the current dry season we are going into is taken advantage of before the next rainy season. Other aspects that need to be addressed are:

- a) The water management process at the power station to ensure that the dirty water make is in sync with the operation of the LLAWRD.
- b) Review the storm water management on the power station in light of the capacities needed to comply to the various regulations in particular GN 704.
- c) Ensure the operations and maintenance of the return pumping facility is in good health to meet the requirements of the water management process at the power station.
- d) Conduct a new dam basin survey (bathometric survey) on the LLAWRD to establish the exact present storage capability, since the dam has recently been desilted.

It is our opinion that a concerted effort in terms of the repair, re-instatement, and upgrade of various infrastructure at the LLAWRD dam as well as implementing operational disciplines will ensure that the dam can be operated safely. Failing this, the dam is likely to be at high risk and will spill on any sustained rainfall event, even those within the design parameters for the dam.



**Appendix A – Hydrology and Spillway Calculation Sheets**

**Appendix B – Drawings x6**

**Appendix C – Dam Safety Registration Certificate**



**APPENDIX A**  
***Hydrology and Spillway Calculation Sheets***

## RATIONAL METHOD # 1

Based on the Regional DDF-Equations representing the HRU 1/78 DDF-relationships (Op ten Noort & Stephenson, 1982)

### PROJECT DUVHA P/S LOW LEVEL ASH WATER RETURN DAM

#### CATCHMENT CHARACTERISTICS

|                                        |           |       |           |                        |        |     |                               |       |      |
|----------------------------------------|-----------|-------|-----------|------------------------|--------|-----|-------------------------------|-------|------|
| Catchment Area                         | Total (A) | 6.600 | km²       | Effective (Ae)         | 6.6000 | km² | Longest Watercourse (L)       | 5.000 | km   |
| Areal Weighting Factors: x + y + z = 1 |           |       |           | Dolomitic (Ad)         |        | km² | Height Difference (H) "10/85" | 90    | m    |
| x (Rural)                              | y (Urban) |       | z (Lakes) | Ratio of Ad / A        |        | %   | Mean Slope (S)                | 1.80  | %    |
| 1.00                                   |           |       |           | Channelised Flow (Y/N) | Y      |     | Mean Annual Rainfall (MAP)    | 773   | mm   |
|                                        |           |       |           | Overland Flow (Y/N)    | N      |     | Time of Concentration (tc)    | 1.08  | hour |
|                                        |           |       |           |                        |        |     |                               | 64.5  | min  |

|               |   |
|---------------|---|
| Inland (Y/N)  | Y |
| Coastal (Y/N) | N |

| C1          |         |        |       |                   |                |        |      |                   |     |        |       |
|-------------|---------|--------|-------|-------------------|----------------|--------|------|-------------------|-----|--------|-------|
| Steepness % | %A      | Factor | Avg   | Soil Permeability | %A             | Factor | Avg  | Vegetation        | %A  | Factor | Avg   |
| 10/85 Slope | < 1     | 100    | 0.03  | 0.030             | Very Permeable |        |      | Forest Plantation |     |        |       |
|             | 1 - 3   |        |       |                   | Permeable      | 70     | 0.08 | Dense Bush, Wood  |     |        |       |
|             | 3 - 10  |        |       |                   | Semi-Permeable | 30     | 0.16 | Thin Bush         |     |        |       |
|             | 10 - 30 |        |       |                   | Impermeable    |        |      | Cultivated Land   |     |        |       |
|             | 30 - 50 |        |       |                   |                |        |      | Grassland         | 30  | 0.21   | 0.063 |
|             | > 50    |        |       |                   | Total %        | 100    | Cp   | Bare Surface      | 70  | 0.28   | 0.196 |
| Total %     | 100     | Cs     | 0.030 | Total C1 Value    | 0.393          |        |      | Total %           | 100 | Cv     | 0.259 |

| Urban for T < 21 Years |    |        |     | C2 | Urban for T 21 to 50 Years |    |        |     |
|------------------------|----|--------|-----|----|----------------------------|----|--------|-----|
| Occupation             | %A | Factor | Avg |    | Occupation                 | %A | Factor | Avg |
| Lawns, Parks           |    |        |     |    | Lawns                      |    |        |     |
| Sandy flat < 2%        |    |        |     |    | Other                      |    |        |     |
| Sandy 2 - 7%           |    |        |     |    | Total %                    |    |        |     |
| Sandy steep > 7%       |    |        |     |    | Urban for T > 50 Years     |    |        |     |
| Heavy soil flat < 2%   |    |        |     |    | All included               |    |        |     |
| Heavy soil 2 - 7%      |    |        |     |    | Total C2 for T < 21        |    |        |     |
| Heavy soil > 7%        |    |        |     |    | Total C2 for T 21 - 50     |    |        |     |
| Residential            |    |        |     |    | Total C2 for T > 50        |    |        |     |
| Single family area     |    |        |     |    |                            |    |        |     |
| Apartment dwelling     |    |        |     |    |                            |    |        |     |
| Industrial             |    |        |     |    |                            |    |        |     |
| Light areas            |    |        |     |    |                            |    |        |     |
| Heavy areas            |    |        |     |    |                            |    |        |     |
| Business               |    |        |     |    |                            |    |        |     |
| Downtown               |    |        |     |    |                            |    |        |     |
| Neighbourhood          |    |        |     |    |                            |    |        |     |
| Streets                |    |        |     |    |                            |    |        |     |
| Total %                |    |        |     |    |                            |    |        |     |

|                               |  |
|-------------------------------|--|
| Surface Condition Factor (r ) |  |
|-------------------------------|--|

Surface Condition Factor (r )

#### STORM RAINFALL

| Flood Frequency<br>in<br>Years | STORM DURATION (AS MULTIPLES OF tc) IN HOURS |       |          |              |       |          |              |       |          |              |       |          |
|--------------------------------|----------------------------------------------|-------|----------|--------------|-------|----------|--------------|-------|----------|--------------|-------|----------|
|                                | 0.5 tc (h) =                                 |       |          | 1.0 tc (h) = |       |          | 2.0 tc (h) = |       |          | 3.0 tc (h) = |       |          |
|                                | D (mm)                                       | ARF   | I (mm/h) | D (mm)       | ARF   | I (mm/h) | D (mm)       | ARF   | I (mm/h) | D (mm)       | ARF   | I (mm/h) |
| 2                              | 28                                           | 1.000 | 52.01    | 35           | 1.000 | 32.58    | 41           | 1.000 | 19.14    | 44           | 1.000 | 13.76    |
| 5                              | 37                                           | 1.000 | 68.47    | 46           | 1.000 | 42.89    | 54           | 1.000 | 25.20    | 58           | 1.000 | 18.11    |
| 10                             | 45                                           | 1.000 | 84.30    | 57           | 1.000 | 52.80    | 67           | 1.000 | 31.03    | 72           | 1.000 | 22.29    |
| 20                             | 56                                           | 1.000 | 103.78   | 70           | 1.000 | 65.01    | 82           | 1.000 | 38.20    | 89           | 1.000 | 27.45    |
| 50                             | 73                                           | 1.000 | 136.62   | 92           | 1.000 | 85.58    | 108          | 1.000 | 50.28    | 117          | 1.000 | 36.13    |
| 100                            | 90                                           | 1.000 | 168.20   | 113          | 1.000 | 105.36   | 133          | 1.000 | 61.90    | 144          | 1.000 | 44.48    |
| 200                            | 111                                          | 1.000 | 207.07   | 140          | 1.000 | 129.71   | 164          | 1.000 | 76.21    | 177          | 1.000 | 54.76    |
| PMF                            | 360                                          | 1.000 | 669.60   | 451          | 1.000 | 419.44   | 530          | 1.000 | 246.45   | 571          | 1.000 | 177.07   |

#### RUN-OFF COEFFICIENT

| Flood Frequency (Years) | 2     | 5     | 10    | 20    | 50    | 100          | 200   | PMF*  |
|-------------------------|-------|-------|-------|-------|-------|--------------|-------|-------|
| Rural C1                | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |
| Urban C2                |       |       |       |       |       |              |       |       |
| Combined C              | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |
| C1 adjusted for Ad      |       |       |       |       |       |              |       |       |
| Final adjusted C        | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |

\* PMF = Cs + Cp max + Cv max

#### PEAK DISCHARGE

| Flood Frequency (Years) | 2             | 5            | 10           | 20           | 50           | 100          | 200          | PMF*          |
|-------------------------|---------------|--------------|--------------|--------------|--------------|--------------|--------------|---------------|
| Q (m³/s)                | 0.5 tc        | 18.75        | 27.16        | 36.47        | 50.14        | 81.77        | 121.28       | 700.30        |
|                         | <b>1.0 tc</b> | <b>11.75</b> | <b>17.01</b> | <b>22.85</b> | <b>31.41</b> | <b>51.22</b> | <b>75.97</b> | <b>438.67</b> |
|                         | 2.0 tc        | 6.90         | 9.99         | 13.42        | 18.45        | 30.09        | 44.64        | 257.74        |
|                         | 3.0 tc        | 4.96         | 7.18         | 9.64         | 13.26        | 21.62        | 32.07        | 185.19        |

#### FLOOD VOLUMES

| Flood Frequency (Years) | 2             | 5             | 10            | 20             | 50             | 100            | 200            | PMF*             |
|-------------------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|------------------|
| V (m³)                  | 0.5 tc        | 108 922       | 157 721       | 211 830        | 291 219        | 474 902        | 704 426        | 4 067 407        |
|                         | <b>1.0 tc</b> | <b>68 229</b> | <b>98 797</b> | <b>132 690</b> | <b>182 420</b> | <b>297 480</b> | <b>441 254</b> | <b>2 547 832</b> |
|                         | 2.0 tc        | 40 089        | 58 049        | 77 964         | 107 183        | 174 787        | 259 263        | 1 497 006        |
|                         | 3.0 tc        | 28 804        | 41 709        | 56 018         | 77 012         | 125 586        | 186 283        | 1 075 611        |

## RATIONAL METHOD # 2

Based on the DDF-Tables of TR102 for an n-day storm depths in Southern Africa (Adamson, 1981)

### PROJECT DUVHA P/S LOW LEVEL ASH WATER RETURN DAM

#### CATCHMENT CHARACTERISTICS

|                                        |           |           |     |                        |        |     |                               |       |      |
|----------------------------------------|-----------|-----------|-----|------------------------|--------|-----|-------------------------------|-------|------|
| Catchment Area                         | Total (A) | 6.600     | km² | Effective (Ae)         | 6.6000 | km² | Longest Watercourse (L)       | 5.000 | km   |
| Areal Weighting Factors: x + y + z = 1 |           |           |     | Dolomitic (Ad)         |        | km² | Height Difference (H) "10/85" | 90    | m    |
| x (Rural)                              | y (Urban) | z (Lakes) |     | Ratio of Ad / A        |        | %   | Mean Slope (S)                | 1.80  | %    |
| 1.00                                   |           |           |     | Channelised Flow (Y/N) | Y      |     | Mean Annual Rainfall (MAP)    | 773   | mm   |
|                                        |           |           |     | Overland Flow (Y/N)    | N      |     | Time of Concentration (tc)    | 1.08  | hour |
|                                        |           |           |     |                        |        |     |                               | 64.5  | min  |

|                                                                                       |         |    |    |        |        |     |     |                 |   |
|---------------------------------------------------------------------------------------|---------|----|----|--------|--------|-----|-----|-----------------|---|
| Rainfall Station Name                                                                 | WITBANK |    |    | Number | 515382 |     |     | Rainfall Region |   |
| Recurrence Interval (Years)                                                           | 2       | 5  | 10 | 20     | 50     | 100 | 200 | Summer Rainfall | Y |
| 1-day Storm Depths (mm)                                                               | 53      | 70 | 83 | 95     | 113    | 128 | 144 | Winter Rainfall | N |
| 7-day Storm Depth for Recurrence Interval of 200 years (mm) - (* For PMF Calculation) | 211     |    |    |        |        |     |     |                 |   |

| C1          |         |        |       |                   |                |        |      |            |                   |        |       |
|-------------|---------|--------|-------|-------------------|----------------|--------|------|------------|-------------------|--------|-------|
| Steepness % | %A      | Factor | Avg   | Soil Permeability | %A             | Factor | Avg  | Vegetation | %A                | Factor | Avg   |
| 10/85 Slope | < 1     | 100    | 0.03  | 0.030             | Very Permeable | 70     | 0.08 | 0.056      | Forest Plantation | 30     | 0.21  |
|             | 1 - 3   |        |       |                   | Permeable      |        |      |            | Dense Bush, Wood  |        |       |
|             | 3 - 10  |        |       |                   | Semi-Permeable |        |      |            | Thin Bush         |        |       |
|             | 10 - 30 |        |       |                   | Impermeable    |        |      |            | Cultivated Land   |        |       |
|             | 30 - 50 |        |       |                   | Total %        |        |      |            | Grassland         |        |       |
|             | > 50    |        |       |                   |                | 100    | Cp   | 0.104      | Bare Surface      | 70     | 0.28  |
| Total %     | 100     | Cs     | 0.030 | Total C1 Value    | 0.393          |        |      | Total %    | 100               | Cv     | 0.259 |

| Urban for T < 21 Years |    |        |     | C2                     |    |        |     | Urban for T 21 to 50 Years |    |        |     |
|------------------------|----|--------|-----|------------------------|----|--------|-----|----------------------------|----|--------|-----|
| Occupation             | %A | Factor | Avg | Occupation             | %A | Factor | Avg | Occupation                 | %A | Factor | Avg |
| Lawns, Parks           |    |        |     | Lawns                  |    |        |     | Lawns                      |    |        |     |
| Sandy flat < 2%        |    |        |     | Other                  |    |        |     | Other                      |    |        |     |
| Sandy 2 - 7%           |    |        |     | Total %                |    |        |     | Total %                    |    |        |     |
| Sandy steep > 7%       |    |        |     | Urban for T > 50 Years |    |        |     |                            |    |        |     |
| Heavy soil flat < 2%   |    |        |     | All included           |    |        |     | All included               |    |        |     |
| Heavy soil 2 - 7%      |    |        |     | Total C2 for T < 21    |    |        |     | Total C2 for T < 21        |    |        |     |
| Heavy soil > 7%        |    |        |     | Total C2 for T 21 - 50 |    |        |     | Total C2 for T 21 - 50     |    |        |     |
| Residential            |    |        |     | Total C2 for T > 50    |    |        |     | Total C2 for T > 50        |    |        |     |
| Single family area     |    |        |     |                        |    |        |     |                            |    |        |     |
| Apartment dwelling     |    |        |     |                        |    |        |     |                            |    |        |     |
| Industrial             |    |        |     |                        |    |        |     |                            |    |        |     |
| Light areas            |    |        |     |                        |    |        |     |                            |    |        |     |
| Heavy areas            |    |        |     |                        |    |        |     |                            |    |        |     |
| Business               |    |        |     |                        |    |        |     |                            |    |        |     |
| Downtown               |    |        |     |                        |    |        |     |                            |    |        |     |
| Neighbourhood          |    |        |     |                        |    |        |     |                            |    |        |     |
| Streets                |    |        |     |                        |    |        |     |                            |    |        |     |
| Total %                |    |        |     |                        |    |        |     |                            |    |        |     |

Surface Condition Factor (r )

#### STORM RAINFALL

| Flood Frequency in Years | STORM DURATION (AS MULTIPLES OF tc) IN HOURS |       |          |                  |       |          |                  |       |          |                  |       |          |
|--------------------------|----------------------------------------------|-------|----------|------------------|-------|----------|------------------|-------|----------|------------------|-------|----------|
|                          | 0.5 tc (h) =                                 |       |          | 1.0 tc (h) =     |       |          | 2.0 tc (h) =     |       |          | 3.0 tc (h) =     |       |          |
|                          | Ratio from Graph                             |       |          | Ratio from Graph |       |          | Ratio from Graph |       |          | Ratio from Graph |       |          |
|                          | D (mm)                                       | ARF   | I (mm/h) | D (mm)           | ARF   | I (mm/h) | D (mm)           | ARF   | I (mm/h) | D (mm)           | ARF   | I (mm/h) |
| 2                        | 27                                           | 1.000 | 50.26    | 34               | 1.000 | 31.54    | 40               | 1.000 | 18.60    | 43               | 1.000 | 13.30    |
| 5                        | 36                                           | 1.000 | 66.38    | 45               | 1.000 | 41.65    | 53               | 1.000 | 24.57    | 57               | 1.000 | 17.57    |
| 10                       | 42                                           | 1.000 | 78.71    | 53               | 1.000 | 49.39    | 63               | 1.000 | 29.13    | 67               | 1.000 | 20.84    |
| 20                       | 48                                           | 1.000 | 90.09    | 61               | 1.000 | 56.53    | 72               | 1.000 | 33.34    | 77               | 1.000 | 23.85    |
| 50                       | 58                                           | 1.000 | 107.16   | 72               | 1.000 | 67.24    | 85               | 1.000 | 39.66    | 92               | 1.000 | 28.37    |
| 100                      | 65                                           | 1.000 | 121.39   | 82               | 1.000 | 76.16    | 97               | 1.000 | 44.92    | 104              | 1.000 | 32.13    |
| 200                      | 73                                           | 1.000 | 136.56   | 92               | 1.000 | 85.68    | 109              | 1.000 | 50.54    | 117              | 1.000 | 36.15    |
| PMF                      | 108                                          | 1.000 | 200.10   | 135              | 1.000 | 125.55   | 159              | 1.000 | 74.06    | 171              | 1.000 | 52.97    |

#### RUN-OFF COEFFICIENT

| Flood Frequency (Years) | 2     | 5     | 10    | 20    | 50    | 100          | 200   | PMF*  |
|-------------------------|-------|-------|-------|-------|-------|--------------|-------|-------|
| Rural C1                | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |
| Urban C2                |       |       |       |       |       |              |       |       |
| Combined C              | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |
| C1 adjusted for Ad      |       |       |       |       |       |              |       |       |
| Final adjusted C        | 0.197 | 0.216 | 0.236 | 0.263 | 0.326 | <b>0.393</b> | 0.472 | 0.570 |

#### PEAK DISCHARGE

| Flood Frequency (Years) | 2             | 5            | 10           | 20           | 50           | 100          | 200          | PMF*         |
|-------------------------|---------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Q (m³/s)                | 0.5 tc        | 18.12        | 26.33        | 34.05        | 43.52        | 64.14        | 87.53        | 118.16       |
|                         | <b>1.0 tc</b> | <b>11.37</b> | <b>16.52</b> | <b>21.37</b> | <b>27.31</b> | <b>40.24</b> | <b>54.92</b> | <b>74.14</b> |
|                         | 2.0 tc        | 6.71         | 9.74         | 12.60        | 16.11        | 23.74        | 32.39        | 43.73        |
|                         | 3.0 tc        | 4.80         | 6.97         | 9.01         | 11.52        | 16.98        | 23.17        | 31.28        |

#### FLOOD VOLUMES

| Flood Frequency (Years) | 2             | 5             | 10            | 20             | 50             | 100            | 200            | PMF*           |
|-------------------------|---------------|---------------|---------------|----------------|----------------|----------------|----------------|----------------|
| V (m³)                  | 0.5 tc        | 105 250       | 152 910       | 197 790        | 252 798        | 372 505        | 508 376        | 686 308        |
|                         | <b>1.0 tc</b> | <b>66 039</b> | <b>95 944</b> | <b>124 104</b> | <b>158 618</b> | <b>233 728</b> | <b>318 981</b> | <b>430 625</b> |
|                         | 2.0 tc        | 38 953        | 56 592        | 73 202         | 93 560         | 137 863        | 188 149        | 254 001        |
|                         | 3.0 tc        | 27 860        | 40 476        | 52 356         | 66 917         | 98 604         | 134 570        | 181 670        |

## Duvha P/S Low Level Ash Water Return Dam

### CALCULATION OF (RMF) REGIONAL MAXIMUM FLOOD AND THE RECOMMENDED (SEF) SAFETY EVALUATION FLOOD (TR 137 "DWAF" KOVACS - BASED ON THE FRANCOU-RODIER MODEL) EMPIRICAL METHOD

Size of dam (S/M/L)  
Hazard rating (L/S/H)  
Category (1/2/3)  
Ke - determined value if applicable  
Ke - envelope value  
Watersurface at FSL (ha.)  
Areal catchment area (sq. km.)  
Is the dam in the Southwest-Cape (Y/N) ?

|       |                                           |
|-------|-------------------------------------------|
| S     | Small / Medium / Large                    |
| S     | Low / Significant / High                  |
| 2     | Category                                  |
| 0.0   | Ke - value if determine otherwise "0"     |
| 4.6   | 2.8 / 3.4 / 4 / 4.6 / 5 / 5.2 / 5.4 / 5.6 |
| N/A   | In hectare                                |
| 6.600 | Smaller than 10 use other methods         |
| N     | Important for region 5                    |

Zone

**RMF**  
Q200  
Q100  
Q50  
Q20\*  
**RDF**  
\*\* RMF -  $\Delta$   
\*\* RMF +  $\Delta$

| Transition zone |
|-----------------|
| <b>204.8</b>    |
| 128.8           |
| 107.3           |
| 85.2            |
| 41.0            |
| <b>107.3</b>    |
| 133.0           |
| 256.9           |

**PMF (Grafic)**  
**PMF (K-max)**  
**PMF (Avg)**

Q175  
Q150  
Q125  
Q75  
Q25

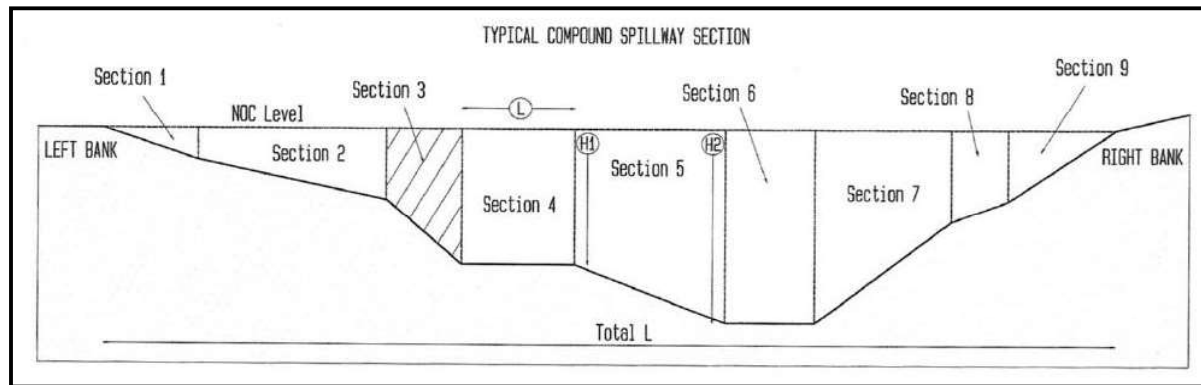
|              |
|--------------|
| <b>553.2</b> |
| <b>360.8</b> |
| <b>457.0</b> |
| 123.5        |
| 118.1        |
| 112.7        |
| 99.6         |
| 49.8         |

#### Recommended SEF

PMF based  
RMF based  
**Average SEF**  
SEF (Cat. I)  
< 10km<sup>2</sup> = Q175

|              |
|--------------|
| 228.5        |
| 133.0        |
| <b>180.7</b> |
| N/A          |

**CALCULATION OF THE MAXIMUM DISCHARGE CAPACITY  
OF DUVHA P/S LLAWR DAM (CURRENT) SPILLWAY DISCHARGE IN m<sup>3</sup>/s**



*equation applied:  $Q = C.L.H^{1.5}$*

*C = discharge coefficient    L = section length (m)    H = height (m)*

*A = cross-sectional area (m<sup>2</sup>)    V = discharge velocity (m/s)    Q = discharge capacity (m<sup>3</sup>/s)*

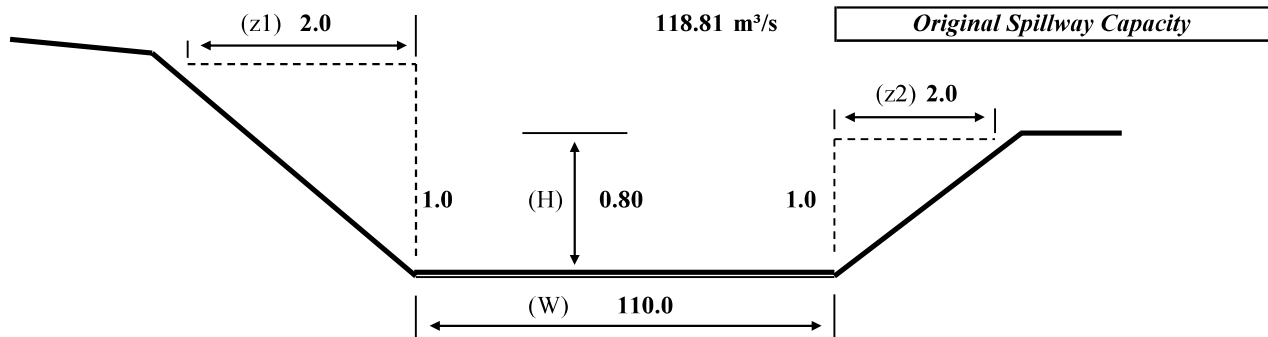
**Main Spillway**

| Section         | C    | L             | H1               | H2   | H           | Q                  | A     | V            |
|-----------------|------|---------------|------------------|------|-------------|--------------------|-------|--------------|
| (LB) 1          | 1.47 | 31.79         | -                | 0.41 | 0.21        | 4.34               | 13.03 | 0.33         |
| 2               | 1.47 | 36.69         | 0.41             | 0.42 | 0.42        | 14.42              | 15.23 | 0.95         |
| 3               | 1.47 | 18.62         | 0.42             | 0.33 | 0.38        | 6.29               | 6.98  | 0.90         |
| 4               | 1.47 | 24.13         | 0.33             | 0.37 | 0.35        | 7.34               | 8.45  | 0.87         |
| 5               | 1.47 | 12.35         | 0.37             | 0.82 | 0.60        | 8.33               | 7.35  | 1.13         |
| 6               | 1.47 | 3.13          | 0.82             | 0.68 | 0.75        | 2.99               | 2.35  | 1.27         |
| 7               | 1.47 | 2.01          | 0.68             |      | 0.34        | 0.59               | 0.68  | 0.86         |
| 8               |      |               |                  |      |             |                    |       |              |
| 9               |      |               |                  |      |             |                    |       |              |
| 10              |      |               |                  |      |             |                    |       |              |
| 11              |      |               |                  |      |             |                    |       |              |
| Total top width |      | <b>128.72</b> | Average velocity |      | <b>0.82</b> | Discharge capacity |       | <b>44.29</b> |
| Sectional area  |      | <b>54.07</b>  | Maximum depth    |      | <b>0.82</b> |                    |       |              |

**Emergency Spillway (if applicable)**

| Section         | C | L | H1               | H2 | H | Q                  | A | V |
|-----------------|---|---|------------------|----|---|--------------------|---|---|
| (LB) 1          |   |   | -                |    |   |                    |   |   |
| 2               |   |   |                  |    |   |                    |   |   |
| 3               |   |   |                  |    |   |                    |   |   |
| 4               |   |   |                  |    |   |                    |   |   |
| 5               |   |   |                  |    |   |                    |   |   |
| 6               |   |   |                  |    |   |                    |   |   |
| 7               |   |   |                  |    |   |                    |   |   |
| 8               |   |   |                  |    |   |                    |   |   |
| 9               |   |   |                  |    |   |                    |   |   |
| (RB) 10         |   |   |                  |    |   |                    |   |   |
| Total top width |   |   | Average velocity |    |   | Discharge capacity |   |   |
| Sectional area  |   |   | Maximum depth    |    |   | Combined capacity  |   |   |

**CALCULATION OF THE MAXIMUM DISCHARGE CAPACITY  
OF LLAWR DAM (ORIGINAL) SPILLWAY IN m³/s  
(USING THREE (3) METHODS)**



**MEASUREMENTS:**

z1 - side slope to 1  
 z2 - side slope to 1  
 H - total freeboard available (m)  
 W - width of spillway control point (m)

|             |
|-------------|
| 2.00        |
| 2.00        |
| <b>0.80</b> |
| 110.0       |

Section area (m²)  
 Velocity (m/s)

|             |
|-------------|
| 89.6        |
| <b>1.33</b> |

**Q - CALCULATIONS:**

equation:  $Q1 = 4.43k (h^{0.5}) (H - h) ((B + z (H - h)))$

where  $k = 0.90$

equation:  $h = (3 (2zH + B) - (16z^2 H^2 + 16zBH + 9B^2)^{0.5}) / 10z$

with: h (in meter) = 

|      |
|------|
| 0.26 |
|------|

with: **Q1** (in cub.m./sec.) = 

|               |
|---------------|
| <b>121.96</b> |
|---------------|

equation:  $Q2 = a.L.H^{1.5} + 1.35z.H^{2.5}$

where  $a = 1.47$

with: **Q2** (in cub.m./sec.) = 

|               |
|---------------|
| <b>117.25</b> |
|---------------|

equation:  $Q3 = C.Le.H^{1.5}$

where  $Le = L + 0.9zH$

and  $C = 1.47$

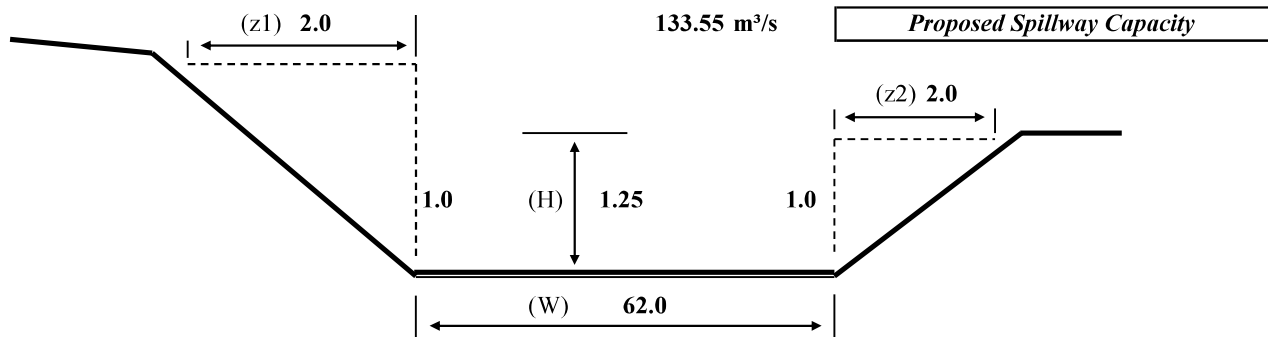
with: **Q3** (in cub.m./sec.) = 

|               |
|---------------|
| <b>117.22</b> |
|---------------|

**Average Q**  $((Q1+Q2+Q3)/3)$  in cub.m./sec. =

|               |
|---------------|
| <b>118.81</b> |
|---------------|

**CALCULATION OF THE MAXIMUM DISCHARGE CAPACITY  
OF LLAWR DAM (UPGRADED) SPILLWAY IN m<sup>3</sup>/s  
(USING THREE (3) METHODS)**



**MEASUREMENTS:**

z1 - side slope to 1  
 z2 - side slope to 1  
 H - total freeboard available (m)  
 W - width of spillway control point (m)

|      |
|------|
| 2.00 |
| 2.00 |
| 1.25 |
| 62.0 |

Section area (m<sup>2</sup>)  
 Velocity (m/s)

|      |
|------|
| 80.0 |
| 1.67 |

**Q - CALCULATIONS:**

equation:  $Q1 = 4.43k (h^{0.5}) (H - h) ((B + z (H - h)))$

where  $k = 0.90$

equation:  $h = (3 (2zH + B) - (16z^2 H^2 + 16zBH + 9B^2)^{0.5}) / 10z$

with: h (in meter) = 0.41

with: **Q1** (in cub.m./sec.) = 136.56

equation:  $Q2 = a.L.H^{1.5} + 1.35z.H^{2.5}$

where  $a = 1.47$

with: **Q2** (in cub.m./sec.) = 132.09

equation:  $Q3 = C.Le.H^{1.5}$

where  $Le = L + 0.9zH$

and  $C = 1.47$

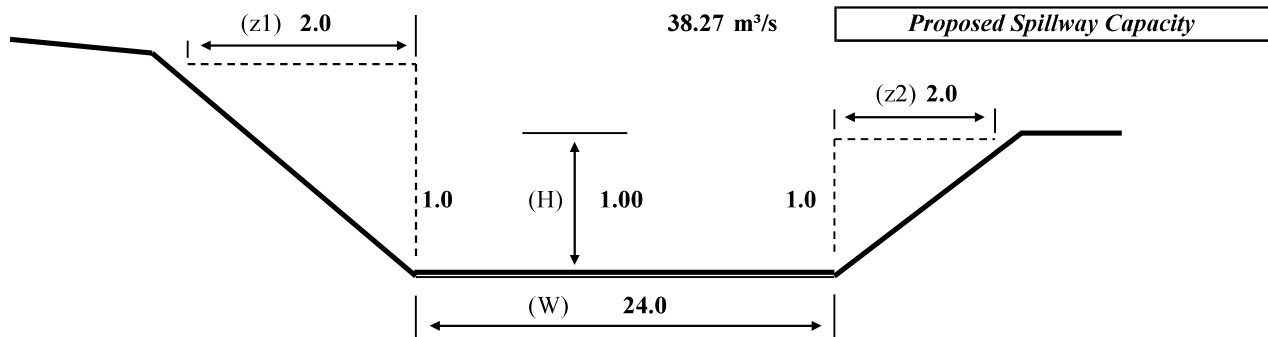
with: **Q3** (in cub.m./sec.) = 131.99

**Average Q**  $((Q1+Q2+Q3)/3)$  in cub.m./sec. =

|        |
|--------|
| 133.55 |
|--------|



# **CALCULATION OF THE MAXIMUM DISCHARGE CAPACITY OF DIVIDING BERM WEIR SPILLWAY IN m<sup>3</sup>/s (USING THREE (3) METHODS)**



## **MEASUREMENTS:**

z1 - side slope to 1  
z2 - side slope to 1  
H - total freeboard available (m)  
W - width of spillway control point (m)

2.00  
2.00  
**1.00**  
24.0

Section area (m<sup>2</sup>)  
Velocity (m/s)

26.0  
**1.47**

## **Q - CALCULATIONS:**

equation:  $Q1 = 4.43k (h^{0.5}) (H - h) ((B + z (H - h)))$

where  $k = 0.90$

equation:  $h = (3 (2zH + B) - (16z^2 H^2 + 16zBH + 9B^2)^{0.5}) / 10z$

with: h (in meter) = **0.32**

with: **Q1** (in cub.m./sec.) = **38.89**

equation:  $Q2 = a.L.H^{1.5} + 1.35z.H^{2.5}$

where  $a = 1.47$

with: **Q2** (in cub.m./sec.) = **37.98**

equation:  $Q3 = C.Le.H^{1.5}$

where  $Le = L + 0.9zH$

and  $C = 1.47$

with: **Q3** (in cub.m./sec.) = **37.93**

**Average Q**  $((Q1+Q2+Q3)/3)$  in cub.m./sec. = **38.27**

## **APPENDIX B**

### ***Drawings***



GOOGLE AREAL IMAGE - NOT TO SCALE

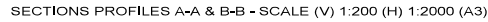
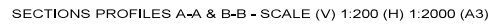
| CONCEPT DESIGN DRAWING                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| <table border="1"> <thead> <tr> <th colspan="2">AMENDMENTS</th> <th>NOTES</th> <th>CLIENT</th> <th>CONSULTANTS</th> <th>SURVEYED</th> <th>UDAR &amp; RTK 2019</th> <th>Project</th> </tr> </thead> <tbody> <tr> <td>NO.</td> <td>DATE</td> <td>APPROVED</td> <td>DESCRIPTION</td> <td> <p><b>GENERAL NOTES</b></p> <p>1. ALL NEW MUST COMPLY WITH THE BY-LAWS AND SPECIFICATIONS OF THE LOCAL AUTHORITY, NATIONAL BUILDING REGULATIONS AND SANS 104.</p> <p>2. ALL DIMENSIONS AND LEVELS SHALL BE CHECKED ON SITE BEFORE WORK COMMENCES AND ANY DISCREPANCIES SHOULD BE REPORTED TO THE ENGINEER IN WRITING.</p> <p>3. THE ENGINEER MUST ASSESS THE CONTRACTOR'S STAKING LINES WHERE AFTER THE CONTRACTOR SHALL TAKE OVER ALL SETTING OUT, STAKING, SURVEY BEACONS AND MAINTAIN THEM DURING THE CONSTRUCTION PERIOD.</p> </td> <td> <p><b>ESKOM GENERATION</b><br/><b>DUVHA POWER STATION</b></p> </td> <td> <p>Plot 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 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545, 546, 547, 5</p></td></tr></tbody></table> |      |                  |             | AMENDMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                               | NOTES                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                                                                                                                                                                               | CONSULTANTS | SURVEYED | UDAR & RTK 2019 | Project | NO. | DATE | APPROVED | DESCRIPTION | <p><b>GENERAL NOTES</b></p> <p>1. ALL NEW MUST COMPLY WITH THE BY-LAWS AND SPECIFICATIONS OF THE LOCAL AUTHORITY, NATIONAL BUILDING REGULATIONS AND SANS 104.</p> <p>2. ALL DIMENSIONS AND LEVELS SHALL BE CHECKED ON SITE BEFORE WORK COMMENCES AND ANY DISCREPANCIES SHOULD BE REPORTED TO THE ENGINEER IN WRITING.</p> <p>3. THE ENGINEER MUST ASSESS THE CONTRACTOR'S STAKING LINES WHERE AFTER THE CONTRACTOR SHALL TAKE OVER ALL SETTING OUT, STAKING, SURVEY BEACONS AND MAINTAIN THEM DURING THE CONSTRUCTION PERIOD.</p> | <p><b>ESKOM GENERATION</b><br/><b>DUVHA POWER STATION</b></p> | <p>Plot 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 823, 824, 825, 826, 827, 828, 829, 830, 831, 832, 833, 834, 835, 836, 837, 838, 839, 840, 841, 842, 843, 844, 845, 846, 847, 848, 849, 850, 851, 852, 853, 854, 855, 856, 857, 858, 859, 860, 861, 862, 863, 864, 865, 866, 867, 868, 869, 870, 871, 872, 873, 874, 875, 876, 877, 878, 879, 880, 881, 882, 883, 884, 885, 886, 887, 888, 889, 890, 891, 892, 893, 894, 895, 896, 897, 898, 899, 900, 901, 902, 903, 904, 905, 906, 907, 908, 909, 910, 911, 912, 913, 914, 915, 916, 917, 918, 919, 920, 921, 922, 923, 924, 925, 926, 927, 928, 929, 930, 931, 932, 933, 934, 935, 936, 937, 938, 939, 940, 941, 942, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 954, 955, 956, 957, 958, 959, 960, 961, 962, 963, 964, 965, 966, 967, 968, 969, 970, 971, 972, 973, 974, 975, 976, 977, 978, 979, 980, 981, 982, 983, 984, 985, 986, 987, 988, 989, 990, 991, 992, 993, 994, 995, 996, 997, 998, 999, 1000.</p> | <p>Plot 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 5</p> |
| AMENDMENTS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                                                                                                                                                                                       | SURVEYED                                                      | UDAR & RTK 2019                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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|                                                                                                 |                    |                                |  |
|-------------------------------------------------------------------------------------------------|--------------------|--------------------------------|--|
| Project                                                                                         |                    | LOW LEVEL ASH WATER RETURN DAM |  |
| Plan Description                                                                                | DATE<br>2020-04-28 | SCALE<br>AS SHOWN              |  |
| CONTOUR PLAN LAYOUT<br>DAM BASIN, SPILLWAY & WETLAND AREA                                       |                    | DRAWING NUMBER<br>047/AWR/002  |  |
|                                                                                                 |                    | REVISION NUMBER<br>0           |  |
| Copyright is vested in SHAW Engineering Solutions in terms of the<br>Copyright Act 1968 or 1978 |                    | PROJECT NUMBER<br>4600064796   |  |



## AS-BUILT SECTIONS DERIVED FROM LIDAR & RTK SURVETS









**APPENDIX C**  
***Dam Safety Registration Certificate***



## water & sanitation

Department:  
Water and Sanitation  
REPUBLIC OF SOUTH AFRICA

### Registration Details of a Dam Registered in terms of Dam Safety Legislation in terms of Chapter 12 of the National Water Act (Act 36 of 1998)

(Please note that registration for dam safety legislation is not an entitlement for water use in terms of Chapter 4 of the National Water Act)

|                                |                                                |        |
|--------------------------------|------------------------------------------------|--------|
| Enter No of dam                | B102/83                                        | Column |
| No of dam                      | B102/83                                        | 1      |
| WARMS Dam ID                   | 0                                              | 2      |
| Name of dam                    | DUVHA POWER STATION LOW LEVEL ASH WATER RETURN | 3      |
| Water management area          | 2                                              | 4      |
| Quaternary Drainage Area       | B11G                                           | 5      |
| Latitude deg                   | 25                                             | 6      |
| Lat min                        | 55                                             | 7      |
| Lat sec                        | 30                                             | 8      |
| Longitude deg                  | 29                                             | 9      |
| Long min                       | 20                                             | 10     |
| Long sec                       | 40                                             | 11     |
| Town nearest                   | WITBANK                                        | 12     |
| Distance from Town             | 10                                             | 13     |
| Name of farm                   | RHENOSTERFONTEIN 318 JS                        | 14     |
| District                       | WITBANK                                        | 15     |
| Province                       | MPUMALANGA                                     | 16     |
| DWS Provincial Office / Region | MPUMALANGA                                     | 17     |
| Completion date                | 1979                                           | 18     |
| Completion date raised         | 0                                              | 19     |
| River or Watercourse           | OFF-CHANNEL                                    | 20     |
| Wall type                      | EARTHFILL                                      | 21     |
| Wall height                    | 8                                              | 22     |
| Crest Length (m)               | 930                                            | 23     |
| Spillway Type                  | SIDE CANAL                                     | 24     |
| Capacity (1000 cub m)          | 850                                            | 25     |
| Surface area (ha)              | 25.25                                          | 26     |
| Catchment area (sq km))        | 5.38                                           | 27     |
| Purpose                        | ASH TRANSPORT                                  | 28     |
| Owner Name                     | ESKOM: DUVHA POWER STATION                     | 29     |
| Designer                       | OVE ARUP & PARTNERS                            | 30     |
| Contractor                     | UNKNOWN                                        | 31     |
| Registration date              | 2006/06/22                                     | 32     |
| Size                           | Small                                          | 33     |
| Hazard Potential               | Significant                                    | 34     |
| Category                       | 2                                              | 35     |
| Classification date            | 2006/06/08                                     | 36     |
| Sector                         | O                                              | 37     |
| Date Last DSE                  | 2012/08/14                                     | 38     |
| Number Last DSE                | 2                                              | 39     |
| Target date next DSE           | 2018/10/30                                     | 40     |

## Appendix E3: Motivation from engineers from assessing design and layout alternatives

|                                                                                   |                                                    |                     |                      |
|-----------------------------------------------------------------------------------|----------------------------------------------------|---------------------|----------------------|
|  | <b>EXEMPTION FROM DESIGN<br/>PHASE(S) TEMPLATE</b> | Template Identifier | 240-77476531 (Rev 5) |
|                                                                                   |                                                    | Document Identifier | xxx-xxx              |
|                                                                                   |                                                    | Document Revision   | x.x                  |
|                                                                                   |                                                    | Effective Date      | October 2017         |
|                                                                                   |                                                    | ENGINEERING         |                      |

|                               |                     |                 |     |
|-------------------------------|---------------------|-----------------|-----|
| STATION NAME:                 | Duvha Power Station |                 |     |
| ECN NO:                       | 25450210            | WBS/CC:         |     |
| REQUESTED BY:                 | Netshia Takalani    | PROJECT CODE:   |     |
| ENGINEERING DESIGN WORK LEAD: | Netshia Takalani    | CLASSIFICATION: | L2, |
| SYSTEM ENGINEER:              | Netshia Takalani    | PROJECT VALUE:  | R3M |

| PROJECT TITLE AND DESCRIPTION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Project title: Upgrading of LLD spillway system</b></p> <p><b>Description:</b><br/> The Low Level Dam (LLD) is an off-channel storage dam used to store ash water. The dam is also used to collect all contaminated storm water from the ash dam, station and the surrounding area. The LLD has a capacity of 811 240m<sup>3</sup> at the spillway level of 7.2m. The LLD spillway Currently have a width of 10m as opposed to the original design width of 110m, this is due to a berm constructed along the spillway in the past.</p> <p>In 2013 the station constructed another earth berm on the downstream of the LLD spillway as a preventative measure in an event where the LLD overflow and since then it has been Duvha Power Station's practice to contain ash water in a bund along the LLD spillway to prevent contamination of the natural stream.</p> <p>In 2019 Duvha had a risk of LLD overtopping when the level was at 7.7m and freeboard on the dam wall was approximately 300mm due to inadequate discharge capability caused by constructed berms. LLD is classified as a category II by The Department of Water and Sanitation as part of dam safety regulation dam and according to the same regulation it is a requirement that the dam should have adequate spillway system to prevent dam failures. In order to comply with the regulation Duvha need to remove the earth berm and reshape the spillway channel to its original capacity based on the SED (safety evaluation discharge) for a Category II-dam</p> <p>The original design of the spillway and the downstream path was all earthworks, it has been recommended by the Approved Professional Person (APP) that as part of reinstating process the area be upgraded and minor concrete works together with slope protection be constructed to prevent further scouring of the soil</p> |

| MOTIVATION                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>As part of Reinstating the LLD spillway to its original Design the APP has recommended that the station should install concrete beam, concrete weir and install Reno Mattress protection to prevent scouring soil downstream of the LLD spillway. The details of the above recommendation have been provided by the APP on the spillway reinstating scope of work together with detail drawing</p> <p>The request to the committee is to skip the Concept design and Basic design, to proceed into environmental studies then compile detail design after the recommendation from the Environmental studies.</p> <p>The proposed upgrade of the LLD spillway doesn't impact any operations of the current system but just improves the plant physics and prevent future environmental contravention. There will be no safety or cost impact that will be incurred by bypassing of theses phases.</p> |

#### CONTROLLED DISCLOSURE

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|                                                                                   |                                                   |                     |                      |
|-----------------------------------------------------------------------------------|---------------------------------------------------|---------------------|----------------------|
|  | <b>EXEMPTION FROM DESIGN<br/>PHASE(S)TEMPLATE</b> | Template Identifier | 240-77476531 (Rev 5) |
|                                                                                   |                                                   | Document Identifier | xxx-xxx              |
|                                                                                   |                                                   | Document Revision   | x.x                  |
|                                                                                   |                                                   | Effective Date      | October 2017         |
|                                                                                   |                                                   | ENGINEERING         |                      |

I declare that the exemption for not completing the phases above does not contravene compliance to the ECM Process, impact the safeguarding of the Design Base and that the relevant stakeholders have been consulted in making this decision.

|                                                                                                                                      | Date       | Signature                                                                            |
|--------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------------------------------------------------------------------------|
| Site Line Engineering Manager<br>Nelly Hlophe                                                                                        | 2021/02/19 |    |
| GMR2 Manager:<br>Maila Mamoleka<br><br><b>Note: Signing for confirmation that<br/>all present law requirements have<br/>been met</b> | 2021-02-23 |    |
| Site Change Control Committee<br>Chairperson (L1, L2, L3) :<br>Oloff Nel                                                             | 2021-02-23 |  |

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## Appendix E4: Site Sensitivity Verification Report





**Eskom Holdings SOC Ltd: Duvha Power Station**

**Site Sensitivity Verification Report for the Reinstatement of the low-level dam spillway at Duvha Power Station**

Date: 22 January 2026

Reference: ESK-DUV-23-11-01



**Stewards**



**Problem Solvers**



**Team Players**

*Influencing decisions since 2000 through identification, quantification and mitigation of environmental, safety, health and compliance risks*

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## Abbreviations

|                  |                                                                                         |
|------------------|-----------------------------------------------------------------------------------------|
| <b>CBA</b>       | Critical Biodiversity Areas                                                             |
| <b>DFFE</b>      | Department of Forestry, Fisheries, and the Environment                                  |
| <b>DWS</b>       | Department of Water and Sanitation                                                      |
| <b>EMPr</b>      | Environmental Management Programme Report                                               |
| <b>ESA</b>       | Ecological Support Area                                                                 |
| <b>EA</b>        | Environmental Authorisation                                                             |
| <b>GIS</b>       | Geographic Information Systems                                                          |
| <b>IDP</b>       | Integrated Development Plan                                                             |
| <b>I&amp;APs</b> | Interested and Affected Parties                                                         |
| <b>MAP</b>       | Mean Annual Precipitation                                                               |
| <b>MASL</b>      | meters above sea level                                                                  |
| <b>MDARDLEA</b>  | Mpumalanga Department of Agriculture, Rural Development, Land and Environmental Affairs |
| <b>MPHRA</b>     | Mpumalanga Heritage Resources Authority                                                 |
| <b>NDM</b>       | Nkangala District Municipality                                                          |
| <b>NDP</b>       | National Development Plan                                                               |
| <b>NEMA</b>      | National Environmental Management Act, 1998 (Act No. 107 of 1998)                       |
| <b>NEMWA</b>     | National Environmental Management: Waste Act, 2008 (Act No. 28 of 2008)                 |
| <b>NWA</b>       | National Water Act, 1998 (Act No. 36 of 1998)                                           |
| <b>SAHRA</b>     | South African Heritage Resources Association                                            |
| <b>TLM</b>       | Steve Tshwete Local Municipality                                                        |
| <b>WMA</b>       | Water Management Area                                                                   |
| <b>WUL</b>       | Water Use License                                                                       |
| <b>WULA</b>      | Water Use License Application                                                           |



# 1 Details of Project Applicant and Environmental Assessment Practitioner

## 1.1 Details of Project Applicant

Table 1: Details of the applicant

| Name of operation        | Eskom Holdings SOC Ltd: Duvha Power Station                                   |
|--------------------------|-------------------------------------------------------------------------------|
| Applicant                | Eskom Holdings SOC Ltd: Duvha Power Station                                   |
| Postal address           | Eskom Holdings SOC Ltd: Duvha Power station<br>PO Box 2199<br>Witbank<br>1035 |
| Responsible person       | Lourence Chauke                                                               |
| Telephone no.            | (013) 691 6300                                                                |
| e-mail address           | ChaukeTL@eskom.co.za                                                          |
| Company registration no. | 2002/015527/30                                                                |

## 1.1. Details and Expertise of Environmental Assessment Practitioner

Table 2: Details of the environmental assessment practitioner

| EAP            | Shangoni Management Services (Pty) Ltd.: Lee-Anne Fellowes |
|----------------|------------------------------------------------------------|
| Tel No         | (012) 807 7036                                             |
| Fax No         | (012) 807 1014                                             |
| e-mail Address | leeanne@shangoni.co.za                                     |

Table 3: Expertise of the environmental assessment practitioner

| Name and Surname  | Qualifications and summary of experience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lee-Anne Fellowes | Lee-Anne is a Principal Consultant who has a B-tech degree in Nature Conservation from the Tshwane University of Technology and holds a National Diploma in Nature Conservation. She gained valuable experience in the conservation and the environmental field through her employment at Gauteng's Department of Agriculture, Conservation and Environment for a period of 5 years. Her areas of expertise include alien invasive surveys, biodiversity action & conservation plans, Environmental Impact Assessments ("EIA"), Environmental Management Programmes ("EMP"), Section 24G Rectification |



| Name and Surname | Qualifications and summary of experience                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                  | <p>Applications, Basic Assessments, Water Use Licenses and Project Management. Lee-Anne has 19 years' experience at Shangoni.</p> <p>Lee-Anne has been registered as a Professional Natural Scientist in the field of Conservation Science Registration number: 115574 and is registered as an environmental impact assessment practitioner Registration number: 2019/850. Lee-Anne served on the Gauteng's Department of Agriculture and Rural Development Appeals Panel Committee for a period of 36 months (2020 – 2023) and gained valuable experience with the appeals procedure.</p> |

## 2 Introduction

### 2.1 Introduction and Background

Shangoni Management Services ("Shangoni") has been appointed by Eskom Holdings SOC Ltd: Duvha Power station ("Duvha Power Station") to conduct Basic Assessment ("BA") and General Authorisation ("GA") Processes as part of the application for the reinstatement of the low-level dam spillway at Duvha power station. As part of the project, Shangoni has reviewed available information to compile this screening report. This screening report has identified the following:

- Environmental sensitivities of the study area; and
- Licences / authorisations required for each activity / infrastructure.

The Duvha Power Station is located at approximately 15 km east of Witbank under the Jurisdiction of Emalahleni Local Municipality ("ELM") and the Nkangala District Municipality ("NDM") within the Mpumalanga Province. The Station has been operational for over 40 years and consists of six 600 MW units with a total installed capacity of 3,600 MW operating with a turbine Maximum Continuous Rating of 37.6%. The station is a twin sister to Tutuka Power Station. The Duvha Power Station produces wet ash which is pumped into an Ash Dam. The settled water is then decanted into the Low-Level Dam ("LLD") before it is pumped back to the station for reuse. The LLD is an off-channel storage dam used to store ash water. Additionally, the LLD is also used to collect all contaminated storm water from the ash dam, station and the surrounding area with a capacity of 811 240 m<sup>3</sup> at the spillway level of 7.2 m.

The LLD spillway currently has a width of 10 m as opposed to the design width of 110 m, this is due to a berm constructed along the spillway in the past. The spillway size needs to be reinstated to its original capacity which was based on the Safety Evaluation Discharge ("SED") for a Category II dam.





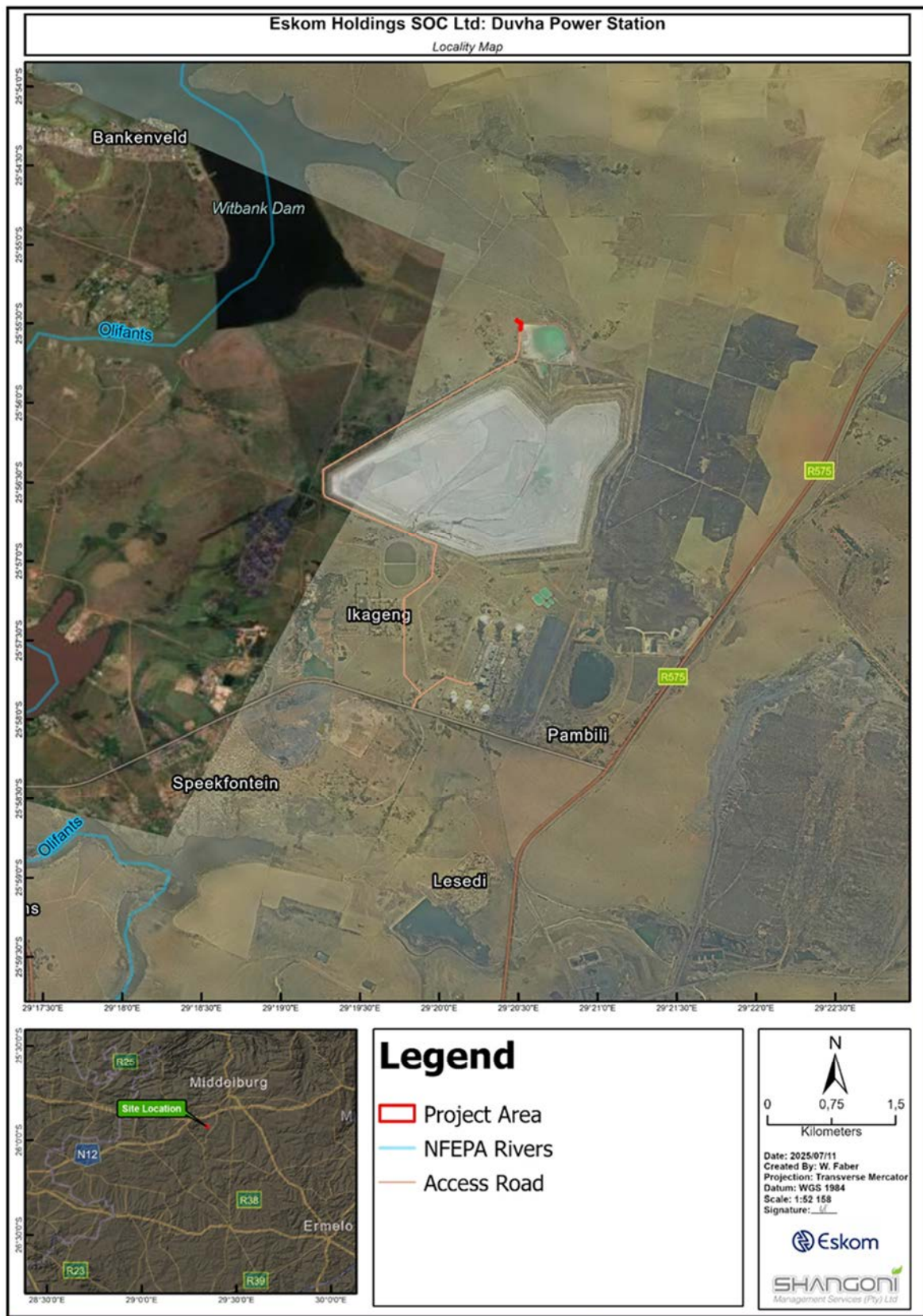


Figure 1: Locality Map

## 2.2 Assumptions and limitations

The following assumptions and limitations have bearing on this environmental screening report:

1. The environmental screening report is based on information provided by Eskom Holdings: Duvha Power Station.
2. The report includes environmental sensitivities identified using the Department of Forestry, Fisheries and Environment (“DFFE”) Screening Tool.
3. The DFFE Screening Tool was used specifically for the proposed reinstatement of the low-level dam spillway (as per the project area kmz file) at Duvha Power Station.
4. The site was screened to determine potential environmental authorisation and water use licence requirements that may be triggered by the proposed project.
5. The report includes the outcomes of the *Wetland Biodiversity Assessment and Aquatic Site Sensitivity Verification Report* dated June 2025 compiled by Limosella Consulting.

## 3 Project Description

The following activities will be undertaken as part of the reinstatement of the LLD spillway:

### 3.1.1.1 Construction of the weir structure:

A man-made breach section has been created at the diving berm (between dirty and clean water areas) to allow water to flow downstream in an event of a high storm. A concrete weir structure must be constructed at the position of man-made breach for proper management of flow when the dam spill in the event of floods >1:50-years and to prevent soil erosion by engaging in the following activities:

- Excavate the existing diving berm for a width of 34 m up to counter level 1561.86.
- Rip and compact the in-situ material to at least 95% Mod AASHTO to a depth of 150 mm.
- Construction of a new concrete weir structure.
- Construction of a new retaining walls for embankment protection using terra block or similar.
- Backfill all low sections of the dividing berm as indicated on long section using material excavated from the LLD spillway section.
- Install Reno mattress protection downstream of the weir structure for a width of 2 m.
- Shape the downstream channel of the weir structure by installing (laying) the Armoflex protection.

### 3.1.1.2 Re-instate the Spillway

The original spillway width was 110 m; however, an earth berm was constructed which reduced the size of the spillway to current width of 10 m. The design of the spillway has been optimized and upgraded and will now have a width of 62 m to accommodate a maximum capacity of approximately 130 m<sup>3</sup>/s which is equivalent to the SED:





- Excavate the berm up to invert level 1562.61 over a length of 62 m toward the southern direction referencing from the existing spillway headwall. The excavated material will be used as backfill for area on section 3.1.2 of the scope.
- Rip and compact the in-situ material to at least 95% Mod AASHTO to a depth of 150 mm.
- Cast in reinforced concrete sill up to a finish floor level (FFL) of 1562.61, The concrete sill should be 500 mm x 600 mm x 62 m.
- Raise the spillway headwall with brick masonry to contour level 1563.86. A double brick masonry (230 mm) wall – 3 layers of bricks built on top of existing headwall.

#### 3.1.1.3 LLD dam crest

*The LLD crest was surveyed and settlement of about 3% has occurred which is currently resulting in an uneven surface profile, reducing the dam's freeboard. In order to rectify the settlement and to reinstate adequate freeboard a new wearing course of approximately 300mm gravel topping must be applied. The layer must be compacted to at least 92% Mod AASHTO with a 2% cross fall towards the upstream (water) side, to prevent standing and ponding water on the crest, after rainfall, refer to drawing 047/AWR/006 for details. The lay out map below as indicated in*

Figure 2 below illustrate the proposed spillway and associated infrastructure.

#### 3.1.1.4 Temporary laydown area

A Temporary laydown area of 217 m<sup>2</sup> is required to store material for the re-instatement of the LLD Spillway. The temporary laydown area will be located west of the existing infrastructure and adjacent to an access road. The temporary laydown area is not located close to any natural wetland and is thus unlikely to have an impact on any watercourse.



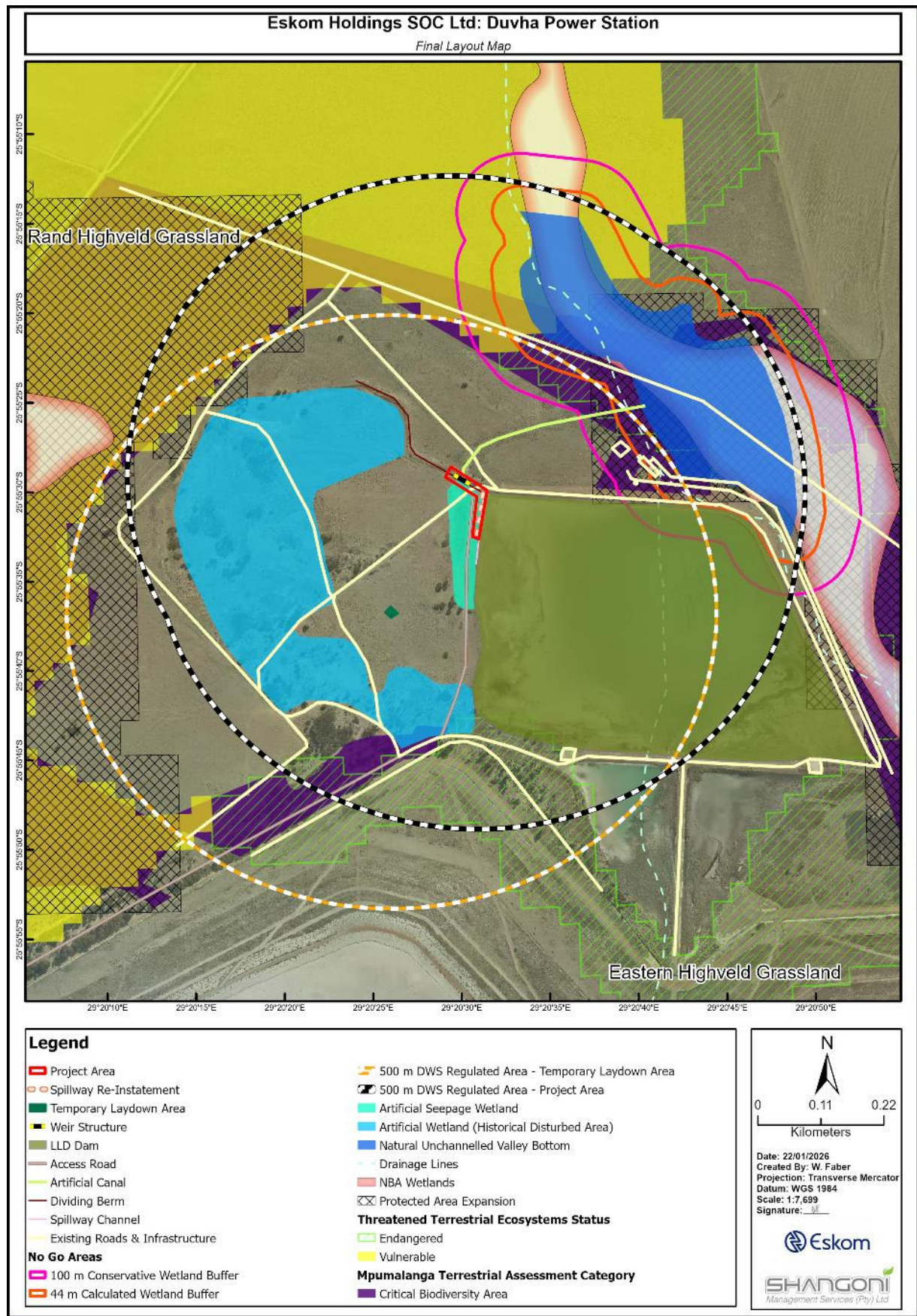


Figure 2: Layout map of the proposed Spillway

## 4 Basic Assessment Reporting Process

An Application for Environmental Authorisation in terms of the National Environmental Management Act (Act No. 107 of 1998) (NEMA) and the Environmental Impact Assessment (EIA) Regulations of 2014 (as amended) has been made for the proposed Project. In terms of the aforementioned Act, the lead decision-making authority for the environmental assessment is the Department of Forestry, Fisheries and the Environment (DFFE).

The process for seeking authorisation is being undertaken in accordance with Government Notice No. R. 982 of 4 December 2014 (as amended). Although the Project triggers activities listed in Listing Notice 1 a Basic Assessment Process is being undertaken.

Shangoni Management Services (Pty) Ltd was appointed by the Applicant as the Environmental Assessment Practitioner (EAP) to undertake the Basic Assessment Process for the proposed Project.

## 5 Site Sensitivity Verification Report

The Protocols for the Assessment and Minimum Criteria for Reporting on identified Environmental Themes ("the Protocols") were published in Government Gazette No. 43110 on 20 March 2020 and Government Gazette No. 43855 on 30 October 2020, in terms of Sections 24(5)(a) and (h) and 44 of the NEMA.

After 9 May 2020, compliance to the Protocols was mandatory for every new application for Environmental Authorisation submitted. According to the Protocols, the EAP must verify the current use of the site in question and potential environmental sensitivity as identified by the Screening Tool to determine the need for specialist inputs in relation to the themes included in the Protocols.

This document serves as the Site Sensitivity Verification Report for the proposed development for the specialist studies that were not undertaken or included in the application. Furthermore, this report complies with the Site Sensitivity Verification section within the Protocols.

### 5.1 Specialist Assessment Identified

Based on the selected classification, and the known impacts associated with the proposed development, 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.

Table 4: Specialist assessments identified and undertaken

| No | Specialist assessment              | Undertaken |
|----|------------------------------------|------------|
| 1  | Landscape/Visual Impact Assessment | No         |



| No | Specialist assessment                                  | Undertaken |
|----|--------------------------------------------------------|------------|
| 2  | Archaeological and Cultural Heritage Impact Assessment | No         |
| 3  | Palaeontology Impact Assessment                        | No         |
| 4  | Terrestrial Biodiversity Impact Assessment             | Yes        |
| 5  | Aquatic Biodiversity Impact Assessment                 | Yes        |
| 6  | Hydrology Assessment                                   | No         |
| 7  | Socio-Economic Assessment                              | No         |
| 8  | Plant Species Assessment                               | No         |
| 9  | Animal Species Assessment                              | No         |

## 6 Specialist Input Required

Based on the above, the following specialist input will be required for undertaking the licencing processes:

- Wetland Biodiversity Assessment – The site area has been highly transformed and disturbed due to ash dams, alien plant infestation and mining activities. According to the Mpumalanga. Biodiversity Conservation Plan, the proposed site area falls within the “Moderately modified - Old lands”.
- Wetland delineation Assessment - this study will provide recommendations on the placement of erosion protection, spillway infrastructure and wetland rehabilitation measures.





## 7 Outcomes of the Site Sensitivity Verification

The following information was extracted from the *Wetland Biodiversity Assessment and Aquatic Site Sensitivity Verification Report* dated June 2025 compiled by Limosella Consulting.

The proposed reinstatement of the Low-Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station is a necessary intervention to restore safe discharge capacity, ensure compliance with dam safety regulations, and reduce the long-term risk of uncontrolled overflow. The development footprint is entirely confined to artificial or heavily modified features, including the seepage wetland, canal, dividing berm, and the disturbed wetland overlying historical diggings. These features, while exhibiting wetland-like characteristics, are of anthropogenic origin and were confirmed to have very low ecological and functional value based on the WET-EcoServices assessment.

No direct impacts on natural wetlands or watercourses are anticipated. The nearest natural unchannelled valley-bottom wetland lies approximately 320 m from the activity footprint and remains outside both the calculated and conservative buffer zones. As such, no triggers under Section 21(f) or (g) of the National Water Act apply, and Section 21(c) and (i) are considered only as a precaution due to the proximity of engineered water features. The natural wetlands are confirmed to be highly sensitive as indicated in the screening report, the artificial wetlands are less sensitive but does contribute to some extent to ecosystem services.

All potential impacts are limited, localised, and temporary, and can be effectively mitigated through standard best-practice construction and rehabilitation measures. Long-term, the project is expected to reduce operational risk, enhance flow control, and prevent further degradation of surrounding artificial wetlands. As such, the development is considered environmentally acceptable and aligned with national policies on sustainable water resource management and climate adaptation. The important factors, relevant to Environmental Authorisation for the proposed project, are summarised in the table below:

|                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Quaternary Catchment and WMA areas</b> | <p>B11G</p> <p>Limpopo-Olifants (LOCMA)</p> <p>#2 - Olifants: Major rivers include Elands, Wilge, Steelpoort, Olifants and Letaba Rivers</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Watercourse</b>                        | <p>The primary watercourse feature is the Low-Level Dam (LLD), an artificial off-channel ash return dam. Although mapped as a wetland in the NFEPA and NBA2018 datasets, it does not represent a natural wetland system but rather an engineered containment structure with wetland-like characteristics.</p> <p>Downstream of the LLD, the spillway channel connects to a valley-bottom wetland associated with a non-perennial river. This wetland drains into the Witbank Dam.</p> <ul style="list-style-type: none"> <li>NBA (2018) list the watercourses as <b>Vulnerable</b>.</li> <li>NFEPA (2011) list the watercourses as <b>Vulnerable</b></li> </ul> |



|                                                                               |  |                                                                                                                                                                                                                                                                                                      |
|-------------------------------------------------------------------------------|--|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Quaternary Catchment and WMA areas</b>                                     |  | B11G<br>Limpopo-Olifants (LOCMA)<br>#2 - Olifants: Major rivers include Elands, Wilge, Steelpoort, Olifants and Letaba Rivers                                                                                                                                                                        |
| <b>Classification (SANBI, 2013)</b>                                           |  | Artificial Wetland Areas                                                                                                                                                                                                                                                                             |
| <b>WetEcoServices</b>                                                         |  | Very Low for all metrics                                                                                                                                                                                                                                                                             |
| <b>EIS (Kotze, et al., 2020)</b>                                              |  | <b>Low Category</b> - Wetlands that are 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 in major rivers |
| <b>Coj Generic Buffer and Calculated Buffer Zone (Macfarlane et al, 2015)</b> |  | <b>Calculated Buffer Zone: 44 m</b><br><b>Conservative Buffer: 100 m</b><br><b>Artificial Wetland Areas: No Buffer</b>                                                                                                                                                                               |
| <b>DWS 2024 Risk Assessment</b>                                               |  | Risk scores fall in the <b>Low category</b>                                                                                                                                                                                                                                                          |
| <b>National Screening Tool Findings</b>                                       |  | This study confirms that the natural wetlands are highly sensitive as indicated on the screening report, the artificial wetlands are less sensitive.                                                                                                                                                 |

In accordance with the requirements of Government Notice No. 320 of 20 March 2020, a site sensitivity verification was undertaken prior to, and in support of, the aquatic specialist assessment. The purpose of this process was to verify the current land use and environmental sensitivities identified by the national environmental screening tool and to ensure that the specialist assessment is informed by confirmed site conditions. The site sensitivity verification process and outcomes are summarised in Table 5 below.

Table 5: Site Sensitivity Verification in accordance with GN 320 (20 March 2020)

| GN 320 Requirement                                                                                                                                                                                                                                 | Compliance Response                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Requirement: Prior to commencing with a specialist assessment, the current use of the land and the environmental sensitivity of the site identified by the screening tool must be confirmed by undertaking a site sensitivity verification.</b> | A site sensitivity verification was undertaken prior to the aquatic biodiversity and wetland assessment to verify the land use and aquatic sensitivities identified by the environmental screening tool. The verification focused on aquatic features associated with the existing low-level dam, spillway, downstream channel, and associated wetland areas within the development footprint. |



| GN 320 Requirement                                                                                                                  | Compliance Response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>2.1 The site sensitivity verification must be undertaken by an environmental assessment practitioner or a specialist.</b></p> | <p>The site sensitivity verification was undertaken by a suitably qualified aquatic specialist registered with the South African Council for Natural Scientific Professions (SACNASP), with demonstrated experience in aquatic biodiversity assessments, wetland delineation, and regulatory compliance.</p>                                                                                                                                                                                                                                                                      |
| <p><b>2.2(a) Desktop analysis using satellite imagery.</b></p>                                                                      | <p>A desktop verification was conducted using recent and historical aerial and satellite imagery, topographical mapping, and available spatial datasets. This analysis verified the spatial extent of natural wetland areas, artificial or modified wetland features associated with historical infrastructure, and the surrounding land use context.</p>                                                                                                                                                                                                                         |
| <p><b>2.2(b) Preliminary on-site inspection.</b></p>                                                                                | <p>A preliminary site inspection was undertaken to ground-truth the desktop findings and confirm current site conditions. The inspection verified the presence, condition, and degree of modification of both natural wetland areas and artificial wetland features, as well as the extent of instream and riparian disturbance associated with existing infrastructure.</p>                                                                                                                                                                                                      |
| <p><b>2.2(c) Other available and relevant information.</b></p>                                                                      | <p>Additional relevant information reviewed included existing specialist studies, project documentation, regulatory guidance, and photographic records. These sources were used to contextualise the origin, function, and condition of natural versus artificial wetland components within the study area.</p>                                                                                                                                                                                                                                                                   |
| <p><b>2.3(a) Confirmation or dispute of current land use and environmental sensitivity identified by the screening tool.</b></p>    | <p>The site sensitivity verification confirmed the presence of both natural and artificial wetland components within the study area. Natural wetland and their buffer areas were verified as <b>highly sensitive</b> due to their ecological functioning, hydrological connectivity, and biodiversity value. Artificial or engineered wetland areas associated with historical infrastructure were verified as having a <b>medium sensitivity</b>, reflecting their modified origin, reduced ecological integrity, and partial reliance on anthropogenic hydrological inputs.</p> |
| <p><b>2.3(b) Motivation and evidence (e.g. photographs) supporting the verified or revised sensitivity.</b></p>                     | <p>The differentiation in sensitivity is supported by site observations, photographic evidence, and interpretation of satellite imagery, which collectively demonstrate intact hydrological and vegetative characteristics in natural wetland areas, contrasted with structural modification, altered flow regimes, and simplified vegetation assemblages in artificial wetland features.</p>                                                                                                                                                                                     |





| GN 320 Requirement                                                                                            | Compliance Response                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>2.3(c) Submission together with the relevant assessment report in accordance with the EIA Regulations.</b> | This site sensitivity verification is documented as part of the aquatic specialist assessment report and is submitted in support of the Basic Assessment Report in accordance with the Environmental Impact Assessment Regulations, 2014 (as amended). The verified sensitivity classifications directly inform the impact assessment and mitigation measures presented in subsequent sections of this report. |



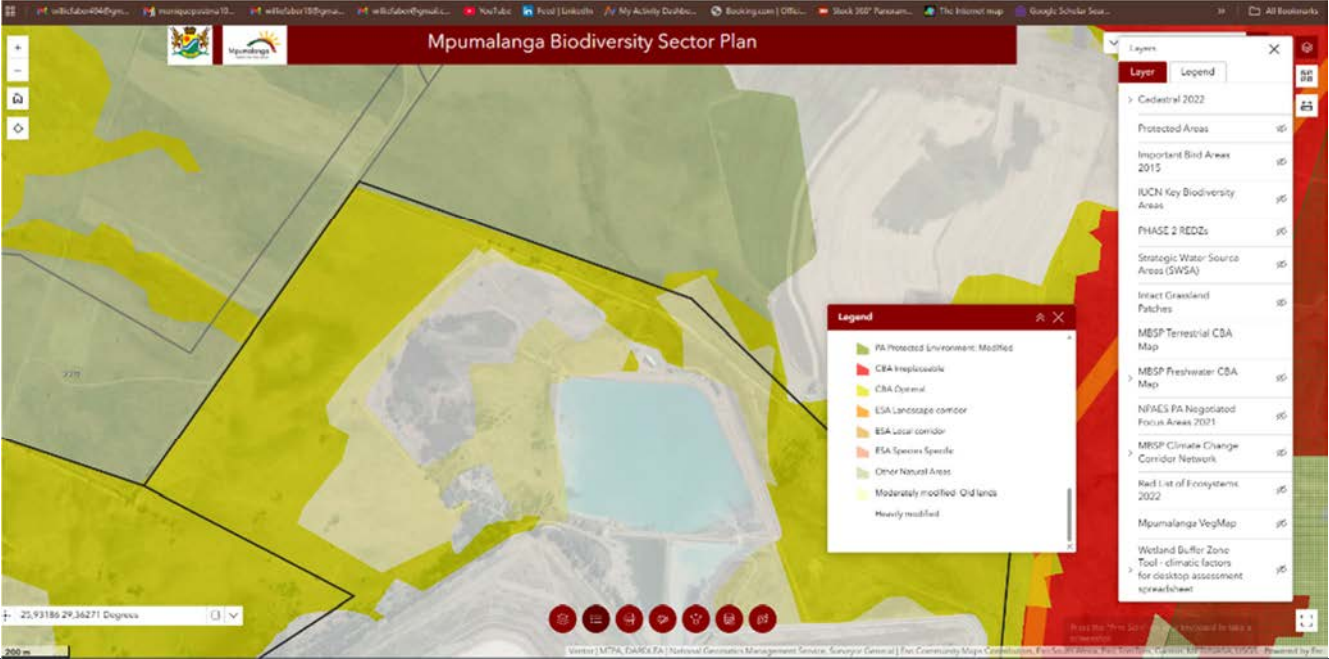
Table 6: List of identified themes for which specialist studies have not been undertaken

| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings                                                        | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Landscape/Visual Impact Assessment                        | Not applicable                                 | Existing infrastructure is not visible to outside receptors.                                               | <p>Not applicable. Screening tool results did not include Landscape/Visual.</p> <p>The existing Low-Level Dam Spillway is not visible to any surrounding receptors and is considered integral to the functioning of the Duvha Power Station.</p> <p>The power station has been operational for over 40 years and consists of six 600 MW units with a total installed capacity of 3,600 MW operating with a turbine Maximum Continuous Rating of 37.6%. Duvha Power Station produces wet ash which is pumped into an Ash Dam. The settled water is then decanted into the Low-Level Dam ("LLD") before it is pumped back to the station for reuse. The LLD is an off-channel storage dam used to store ash water. Additionally, the LLD is also used to collect all contaminated storm water from the ash dam, station and the surrounding area with a capacity of 811 240 m<sup>3</sup> at the spillway level of 7.2 m.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Archaeological and Cultural Heritage Impact Assessment    | Low                                            | Low, as the area is disturbed and modified by existing Low-Level Dam Spillway and existing infrastructure. | <p>The Low-Level Dam Spillway was constructed in the 1980's (1985) when the Ash Dump was created. The Low Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station was constructed to ensure safe discharge capacity, ensure compliance with dam safety regulations, and reduce the long-term risk of uncontrolled overflow.</p> <p>In 2013 the station constructed another earth berm on the downstream of the LLD spillway as a preventative measure in an event where the LLD overflow and since then it has been Duvha Power Station's practice to contain ash water in a bund along the LLD spillway to prevent contamination of the natural stream.</p> <p>In 2019 Duvha had a risk of LLD overtopping when the level was at 7.7 m and freeboard on the dam wall was approximately 300 mm due to inadequate discharge capability caused by constructed berms. LLD is classified as a category II by The Department of Water and Sanitation as part of dam safety regulation dam and according to the same regulation it is a requirement that the dam should have adequate spillway system to prevent dam failures. In order to comply with the regulation Duvha need to remove the earth berm and reshape the spillway channel to its original capacity based on the SED (safety evaluation discharge) for a Category II-dam.</p> <p>The original design of the spillway and the downstream path was all earthworks, it has been recommended by the Approved Professional Person (APP) that as part of reinstating process the area be upgraded and minor concrete works together with slope protection be constructed to prevent further scouring of the soil.</p> |



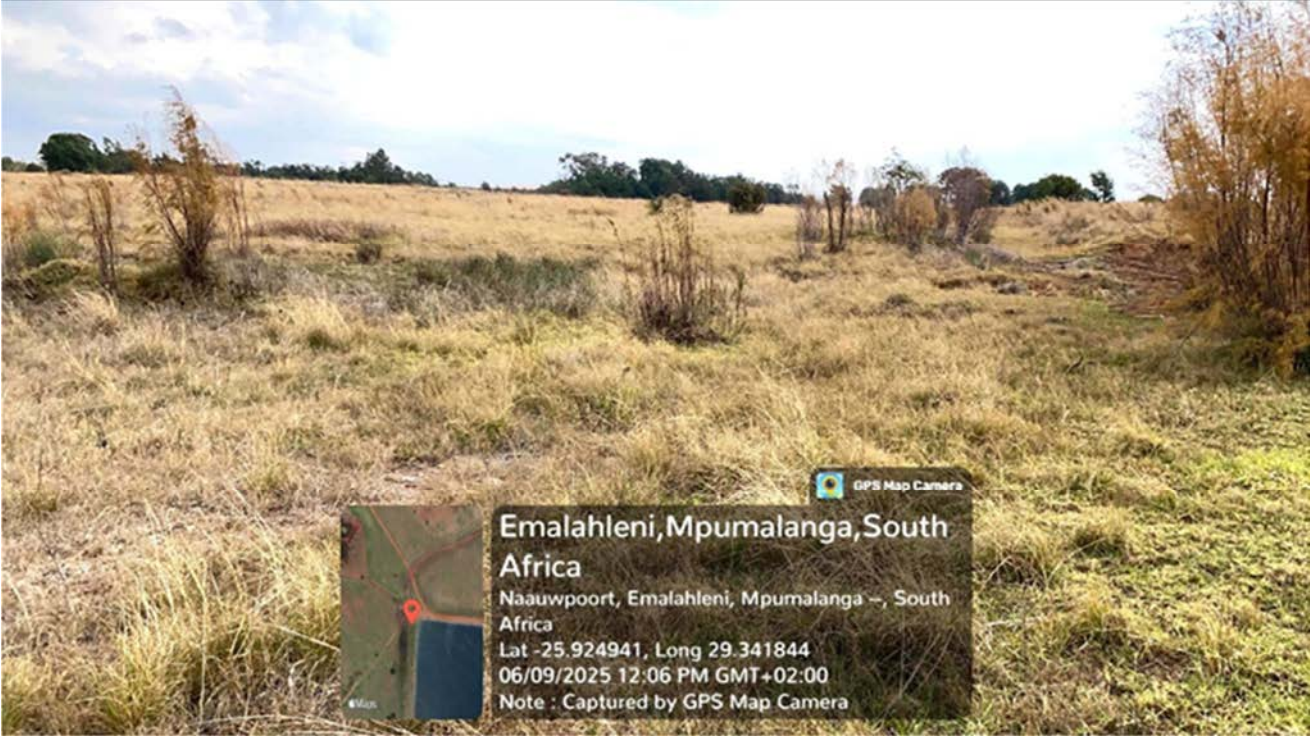
| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings  | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------|------------------------------------------------|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           |                                                |                                                      |                                                                                                                                                                                                                                                                                                                                                                                   |
| Palaeontology Impact Assessment                           | Medium                                         | Low as there will be no impact to the palaeontology. | The Low-Level Dam Spillway was constructed in the 1980's (1985) when the Ash Dump was created. The Low Level Dam (LLD) spillway and associated infrastructure at Duvha Power Station was constructed to ensure safe discharge capacity, ensure compliance with dam safety regulations, and reduce the long-term risk of uncontrolled overflow. As the activity has already taken place there will be no impact on the palaeontology for the reinstatement of the LLD. |

| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings                                                                                                                                                                                                                                                                                                                                                               | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study   |
|-----------------------------------------------------------|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|                                                           |                                                |                                                                                                                                                                                                                                                                                                                                                                                                                   |  |
| Hydrology Assessment                                      | Not applicable                                 | The <i>Wetland Biodiversity Assessment and Aquatic Site Sensitivity Verification Report</i> dated June 2025 compiled by Limosella Consulting found that no direct impacts on natural wetlands or watercourses are anticipated. The nearest natural unchannelled valley-bottom wetland lies approximately 320 m from the activity footprint and remains outside both the calculated and conservative buffer zones. | Not applicable. Screening tool results did not include Hydrology.                    |
| Socio-Economic Assessment                                 | Not applicable                                 | Duvha Power Station is one of the major contributors to local, provincial,                                                                                                                                                                                                                                                                                                                                        | Not applicable. Screening tool results did not Socio-Economic.                       |

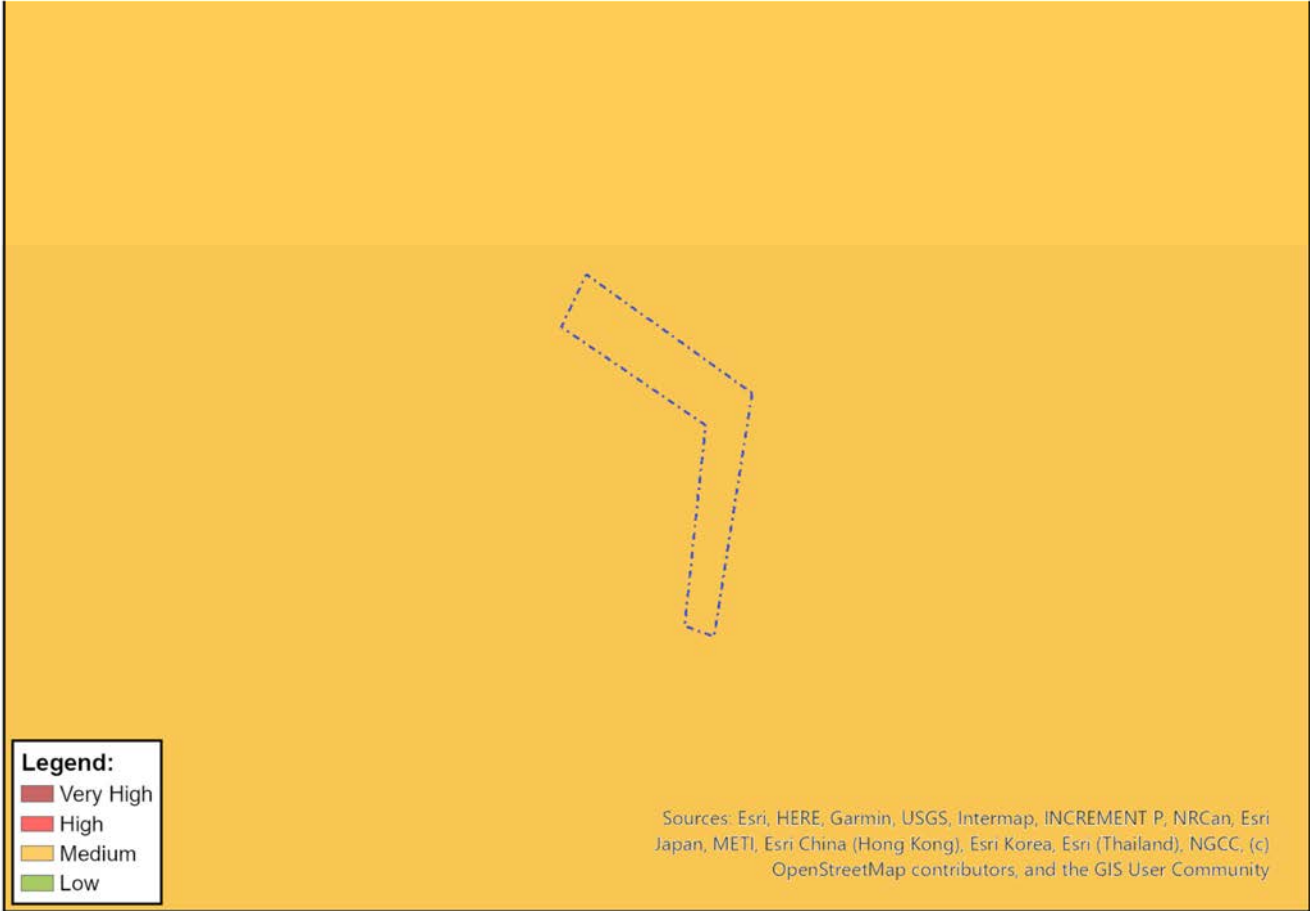
| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings                                                                                                                                                                                                                                                                          | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study                                                                                                                                                                                          |
|-----------------------------------------------------------|------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           |                                                | and national electricity supply. As such, the proposed project contributes to the local economic and energy security. The reinstatement of the spillway will prevent costly unplanned shutdowns that could disrupt national power generation and ensure a long-term stability for industries reliant on a stable power grid. |                                                                                                                                                                                                                                                                             |
| Plant Species Assessment                                  | Low                                            | Low as the area is disturbed and modified by existing Low-Level Dam Spillway.                                                                                                                                                                                                                                                | <p>According to the Mpumalanga Biodiversity Sector Plan the project area to be classified as Moderately modified old lands. The project area is not located within CBA 1 or ESA 1.</p>  |
| Animal Species Assessment                                 | Medium                                         | Low as the area is disturbed by existing Low-Level Dam Spillway.                                                                                                                                                                                                                                                             | <p>The site area has been highly transformed and disturbed due to ash dams, alien plant infestation and mining activities. According to the Mpumalanga. Biodiversity Conservation Plan, the proposed site area falls within the “Moderately modified - Old lands”.</p>      |





| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------|------------------------------------------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           |                                                |                                                     | <div></div> <p>The Terrestrial Ecological Assessment Report for the Proposed Duvha Ash Dam Seepage Interception Drains, compiled by Nemaï Consulting and dated July 2017 found that mammal species diversity was very low, and this could have been due to habitat transformation and mining activities. Mammals are naturally sensitive to disturbances. The following mammals were recorded:</p> <ul style="list-style-type: none"><li>• Common Duiker;</li><li>• Cape Porcupine;</li><li>• Blesbok;</li><li>• Plains zebra;</li><li>• Scrub hare;</li><li>• African Mole Rat; and</li><li>• Slender mongoose.</li></ul> <p>The likelihood of occurrence of Red Data Listed Mammal species for Southern African Hedgehog and Oribi is low (Skinner and Chimimba, 2005).</p> <p><u>The following species were identified by the Screening Tool:</u></p> <p>Aves – Hydroprogne caspia – Caspian Tern</p> <p>Mammalia – Crocidura maquassiensis – Makwassie musk shrew</p> <p>Mammalia – Hydricutis maculicollis – Spotted necked otter</p> <p>Mammalia – Ourebia ourebi ourebi - Oribi</p> |



| Theme/Specialist Study identified in the Screening Report | Sensitivity Rating as per the Screening report | Sensitivity Rating as per the Verification Findings | Reasons for Site Sensitivity Verification and not undertaking the Specialist Study                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------------------------------|------------------------------------------------|-----------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           |                                                |                                                     | <div>Reptilia – Kinixys lobatsiana - Lobatse hinge-back tortoise</div> <div>A site visit was conducted and with the information gathered during this process the following conclusions were made with regards to the probability of these species occurring on site refer to Appendix A). From the information contained in Table 1, it was determined that no terrestrial or avifaunal specialist studies were required during the assessment of the project site.</div> <div><div><div><b>Legend:</b><br/>Very High<br/>High<br/>Medium<br/>Low</div><div>Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community</div></div><div><div>00.030.070.13 Kilometers</div><div>N</div></div></div> |





## 8 Conclusion and Recommendations

This Site Verification Report for the proposed development for the specialist studies that were not undertaken or included in the application include:

- Landscape/Visual Impact Assessment;
- Archaeological and Cultural Heritage Impact Assessment;
- Palaeontology Impact Assessment;
- Hydrology Assessment;
- Socio-Economic Assessment;
- Plant Species Assessment; and
- Animal Species Assessment.

The project area is situated within the Duvha Power Station, an industrial area that has been significantly modified and disturbed by historical construction, power generation operations, and previous infrastructure upgrades. Based on the outcome of the above Site Verification Report, the following has been confirmed:

- No natural or sensitive ecosystems remain within the direct project footprint;
- Although the area falls within a high terrestrial biodiversity sensitivity, the area has been developed, has no remaining intact indigenous vegetation and is operationally managed.

Additionally, the spillway and berms were engineered structures originally constructed during the power station's development. The reinstatement of the spillway project will require Water Use Licence Application and Environmental Authorisation through a basic Assessment process.

## 9 Declaration of independence

Shangoni hereby declares that it is an independent consultant in that it has no business, financial, personal or other interest in this project in respect of which Shangoni is appointed. Furthermore, no circumstances exist that may compromise the objectivity of Shangoni, excluding fair remuneration for work performed in connection with this Site Sensitivity Verification report.

**Report**

**DRAFT FOR REVIEW**

**Report reviewed by:**

**DRAFT FOR REVIEW**

**compiled by:**

**Lee-Anne      Fellowes**

**Jan Nel**

**EAPASA No.2019/850**

**SACNASP No.115574**



Appendix A

The following species were identified by the Screening Tool:

- Aves – *Hydroprogne caspia* – Caspian Tern
- Mammalia – *Crocidura maquassiensis* – Makwassie musk shrew
- Mammalia – *Hydricutis maculicollis* – Spotted necked otter
- Mammalia – *Ourebia ourebi ourebi* - Oribi
- Reptilia – *Kinixys lobatsiana* - Lobatse hinge-back tortoise

A site visit was conducted and with the information gathered during this process the following conclusions were made with regards to the probability of these species occurring on site (Refer to Table 1). From the information contained in Table 1, it was determined that no terrestrial or avifaunal specialist studies were required during the assessment of the project site.

Table 7: Evaluation of the probability of occurrence of screening tool listed species

| Habitat  |                                |                                    |                                                                                                                                                                                                                                                                                                                                              | Observed | Probability     | Potential impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                |
|----------|--------------------------------|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Aves     | <i>Hydroprogne caspia</i>      | Caspian Tern                       | Coastal: Sheltered bays, estuaries, river mouths, mudflats, and beaches.<br><br>Inland: Large freshwater or saltwater bodies, including lakes, reservoirs, saline pans, and even sewage ponds.<br><br>Nesting Sites: Islands (offshore, artificial, or in pans/dams), sandy or pebbly shores, often near other colonial waterbirds.          | No       | Highly unlikely | This species has never been recorded within the study area according to the South African Bird Atlas Project. (Refer to Table 2 for the complete list of avian species recorded) Therefore there is no risk to be mitigated or potential impact (SABAP, 2026).                                                                                                                                                                                                                                                                                                                                                                                                                     | No specialist studies required |
| Mammalia | <i>Crocidura maquassiensis</i> | Makwassie musk shrew<br>Vulnerable | As of 2026, the species is generally listed as Least Concern on the IUCN Red List, but vulnerable regionally.<br><br>This species can be found patchily across South Africa (including Limpopo, Mpumalanga, KwaZulu-Natal, and Northwest provinces. Typically inhabits rocky areas and moist grasslands within savanna and grassland biomes. | No       | Highly unlikely | This species has a poor dispersal ability and prefers natural wetlands avoiding overgrazed or mowed areas. Areas with high compaction, such as roads and trampled soil make it difficult for them to burrow. This species is small, relatively rare and seldom caught in traps during sampling. The study area is very degraded through anthropogenic activities and human disturbances which makes it highly unlikely that it would occur in the study site. Current research states that this species are not easily trapped. With the status of the habitat in conjunction with the habits of this species there will be no risk to mitigate or potential impact (SANBI, 2026). | No specialist studies required |
| Mammalia | <i>Hydricutis maculicollis</i> | Spotted necked otter               | Prefers large, permanent, and continuous freshwater /unpolluted systems. It hunts by site and requires clear water with good visibility. Preferred vegetation is dense with large boulders along the shoreline. Its diet includes fish, frogs, crabs, and aquatic insects. (SANBI, 2026).                                                    | No       | Highly unlikely | The study site has no viable habitat for this species, therefore there will be no risk to be mitigated or potential impact.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No specialist studies required |



| Habitat  |                              |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Observed | Probability     | Potential impact                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                |
|----------|------------------------------|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| Mammalia | <i>Ourebia ourebi ourebi</i> | Oribi                       | Oribi inhabit savannah woodlands, floodplains and other open grasslands, from around sea level to about 2,200 (Mpumalanga Province). They reach their highest density on floodplains and moist tropical grasslands, especially in association with large grazers. They prefer open grassland in good condition containing a mosaic of both short grass for feeding and long grass for feeding and shelter (SANBI, 2026).                        | No       | Highly unlikely | <p>The study area consists of disturbed grassland, with anthropogenic disturbance, including access roads. The wetland is not a natural wetland, and the site is under pressure from several Alien Invasive Species (AIS).</p> <p><i>Acacia mearnsii</i> (Black Wattle) Eucalyptus species, <i>Pennisetum clandestinum</i> (Kikuyu) and <i>Datura ferox</i> (Thorn apple).</p> <p>The state of veld degradation, in conjunction with disturbances from anthropogenic activity, concludes that this area is not suitable for this species therefore there will be no risk to be mitigated or potential impact.</p> | No specialist studies required |
| Reptilia | <i>Kinixys lobatsiana</i>    | Lobatse hinge-back tortoise | The range of K. lobatsiana falls mainly within Limpopo Province of South Africa, for which 15% of land cover is considered developed or degraded (Limpopo Environmental Outlook Report 2016). Kinixys lobatsiana is a savanna species that inhabits rocky hillsides in habitats of mixed Acacia and Combretum woodland, tropical Bushveld and Thornveld where vegetation ranges from dense, short shrubland to open tree savanna (SANBI, 2026). | No       | Highly unlikely | <p>The study site has no viable habitat for this species, therefore there will be no risk to be mitigated or potential impact.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | No specialist studies required |



Table 8 Bird species list: [https://sabap2.birdmap.africa/coverage/pentad/2555\\_2920](https://sabap2.birdmap.africa/coverage/pentad/2555_2920)

| Ref | Common group | Common species  | Genus                | Species              |
|-----|--------------|-----------------|----------------------|----------------------|
| 72  |              | Hamerkop        | <i>Scopus</i>        | <i>umbretta</i>      |
| 637 |              | Neddicky        | <i>Cisticola</i>     | <i>fulvicapilla</i>  |
| 844 |              | Quailfinch      | <i>Ortygospiza</i>   | <i>atricollis</i>    |
| 256 |              | Ruff            | <i>Calidris</i>      | <i>pugnax</i>        |
| 439 | Barbet       | Crested         | <i>Trachyphonus</i>  | <i>vaillantii</i>    |
| 404 | Bee-eater    | European        | <i>Merops</i>        | <i>apiaster</i>      |
| 812 | Bishop       | Yellow-crowned  | <i>Euplectes</i>     | <i>afer</i>          |
| 545 | Bulbul       | Dark-capped [x] | <i>Pycnonotus</i>    | <i>tricolor</i>      |
| 154 | Buzzard      | Common          | <i>Buteo</i>         | <i>buteo</i>         |
| 860 | Canary       | Black-throated  | <i>Crithagra</i>     | <i>atroregularis</i> |
| 575 | Chat         | Ant-eating      | <i>Myrmecocichla</i> | <i>formicivora</i>   |
| 646 | Cisticola    | Levaillant's    | <i>Cisticola</i>     | <i>tinniens</i>      |
| 634 | Cisticola    | Wing-snapping   | <i>Cisticola</i>     | <i>ayresii</i>       |
| 629 | Cisticola    | Zitting         | <i>Cisticola</i>     | <i>juncidis</i>      |
| 212 | Coot         | Red-knobbed     | <i>Fulica</i>        | <i>cristata</i>      |
| 50  | Cormorant    | Reed            | <i>Microcarbo</i>    | <i>africanus</i>     |
| 47  | Cormorant    | White-breasted  | <i>Phalacrocorax</i> | <i>lucidus</i>       |
| 203 | Crake        | Black           | <i>Zaporina</i>      | <i>flavirostra</i>   |
| 522 | Crow         | Pied            | <i>Corvus</i>        | <i>albus</i>         |
| 352 | Cuckoo       | Diederik        | <i>Chrysococcyx</i>  | <i>caprius</i>       |
| 52  | Darter       | African         | <i>Anhinga</i>       | <i>rufa</i>          |
| 317 | Dove         | Laughing        | <i>Spilopelia</i>    | <i>senegalensis</i>  |
| 318 | Dove         | Namaqua         | <i>Oena</i>          | <i>capensis</i>      |
| 314 | Dove         | Red-eyed        | <i>Streptopelia</i>  | <i>semitorquata</i>  |
| 316 | Dove         | Ring-necked     | <i>Streptopelia</i>  | <i>capicola</i>      |
| 940 | Dove         | Rock            | <i>Columba</i>       | <i>livia</i>         |
| 103 | Duck         | Maccoa          | <i>Oxyura</i>        | <i>maccoa</i>        |



| Ref | Common group | Common species   | Genus                  | Species              |
|-----|--------------|------------------|------------------------|----------------------|
| 104 | Duck         | White-backed     | <i>Thalassornis</i>    | <i>leuconotus</i>    |
| 96  | Duck         | Yellow-billed    | <i>Anas</i>            | <i>undulata</i>      |
| 60  | Egret        | Intermediate [x] | <i>Ardea</i>           | <i>intermedia</i>    |
| 59  | Egret        | Little           | <i>Egretta</i>         | <i>garzetta</i>      |
| 61  | Egret        | Western Cattle   | <i>Bubulcus</i>        | <i>ibis</i>          |
| 707 | Fiscal       | Southern         | <i>Lanius</i>          | <i>collaris</i>      |
| 86  | Flamingo     | Greater          | <i>Phoenicopterus</i>  | <i>roseus</i>        |
| 87  | Flamingo     | Lesser           | <i>Phoeniconaias</i>   | <i>minor</i>         |
| 665 | Flycatcher   | Fiscal           | <i>Melaenornis</i>     | <i>silens</i>        |
| 89  | Goose        | Egyptian         | <i>Alopochen</i>       | <i>aegyptiaca</i>    |
| 88  | Goose        | Spur-winged      | <i>Plectropterus</i>   | <i>gambensis</i>     |
| 4   | Grebe        | Great Crested    | <i>Podiceps</i>        | <i>cristatus</i>     |
| 6   | Grebe        | Little           | <i>Tachybaptus</i>     | <i>ruficollis</i>    |
| 192 | Guineafowl   | Helmeted         | <i>Numida</i>          | <i>meleagris</i>     |
| 288 | Gull         | Grey-headed      | <i>Chroicocephalus</i> | <i>cirrocephalus</i> |
| 55  | Heron        | Black-headed     | <i>Ardea</i>           | <i>melanocephala</i> |
| 56  | Heron        | Goliath          | <i>Ardea</i>           | <i>goliath</i>       |
| 54  | Heron        | Grey             | <i>Ardea</i>           | <i>cinerea</i>       |
| 57  | Heron        | Purple           | <i>Ardea</i>           | <i>purpurea</i>      |
| 418 | Hoopoe       | African          | <i>Upupa</i>           | <i>africana</i>      |
| 81  | Ibis         | African Sacred   | <i>Threskiornis</i>    | <i>aethiopicus</i>   |
| 84  | Ibis         | Hadada           | <i>Bostrychia</i>      | <i>hagedash</i>      |
| 82  | Ibis         | Southern Bald    | <i>Geronticus</i>      | <i>calvus</i>        |
| 394 | Kingfisher   | Pied             | <i>Ceryle</i>          | <i>rudis</i>         |
| 130 | Kite         | Black-winged     | <i>Elanus</i>          | <i>caeruleus</i>     |
| 247 | Lapwing      | African Wattled  | <i>Vanellus</i>        | <i>senegallus</i>    |
| 245 | Lapwing      | Blacksmith       | <i>Vanellus</i>        | <i>armatus</i>       |
| 242 | Lapwing      | Crowned          | <i>Vanellus</i>        | <i>coronatus</i>     |



| Ref  | Common group | Common species       | Genus               | Species                |
|------|--------------|----------------------|---------------------|------------------------|
| 488  | Lark         | Red-capped           | <i>Calandrella</i>  | <i>cinerea</i>         |
| 458  | Lark         | Rufous-naped         | <i>Mirafra</i>      | <i>africana</i>        |
| 703  | Longclaw     | Cape                 | <i>Macronyx</i>     | <i>capensis</i>        |
| 509  | Martin       | Brown-throated       | <i>Riparia</i>      | <i>paludicola</i>      |
| 210  | Moorhen      | Common               | <i>Gallinula</i>    | <i>chloropus</i>       |
| 392  | Mousebird    | Red-faced            | <i>Urocolius</i>    | <i>indicus</i>         |
| 390  | Mousebird    | Speckled             | <i>Colius</i>       | <i>striatus</i>        |
| 734  | Myna         | Common               | <i>Acridotheres</i> | <i>tristis</i>         |
| 1    | Ostrich      | Common               | <i>Struthio</i>     | <i>camelus</i>         |
| 311  | Pigeon       | Speckled             | <i>Columba</i>      | <i>guinea</i>          |
| 692  | Pipit        | African              | <i>Anthus</i>       | <i>cinnamomeus</i>     |
| 695  | Pipit        | Buffy                | <i>Anthus</i>       | <i>vaalensis</i>       |
| 694  | Pipit        | Plain-backed         | <i>Anthus</i>       | <i>leucophrys</i>      |
| 1332 | Pochard      | Red-crested          | <i>Netta</i>        | <i>rufina</i>          |
| 102  | Pochard      | Southern             | <i>Netta</i>        | <i>erythrophthalma</i> |
| 650  | Prinia       | Black-chested        | <i>Prinia</i>       | <i>flavicans</i>       |
| 805  | Quelea       | Red-billed           | <i>Quelea</i>       | <i>quelea</i>          |
| 808  | Red Bishop   | Southern             | <i>Euplectes</i>    | <i>orix</i>            |
| 581  | Robin-Chat   | Cape                 | <i>Cossypha</i>     | <i>caffra</i>          |
| 258  | Sandpiper    | Common               | <i>Actitis</i>      | <i>hypoleucos</i>      |
| 94   | Shoveler     | Cape                 | <i>Anas</i>         | <i>smithii</i>         |
| 786  | Sparrow      | Cape                 | <i>Passer</i>       | <i>melanurus</i>       |
| 784  | Sparrow      | House                | <i>Passer</i>       | <i>domesticus</i>      |
| 4142 | Sparrow      | Southern Grey-headed | <i>Passer</i>       | <i>diffusus</i>        |
| 159  | Sparrowhawk  | Black                | <i>Accipiter</i>    | <i>melanoleucus</i>    |
| 85   | Spoonbill    | African              | <i>Platalea</i>     | <i>alba</i>            |
| 185  | Spurfowl     | Swainson's           | <i>Pternistis</i>   | <i>swainsonii</i>      |
| 746  | Starling     | Pied                 | <i>Lamprotornis</i> | <i>bicolor</i>         |



| Ref  | Common group | Common species      | Genus                | Species                 |
|------|--------------|---------------------|----------------------|-------------------------|
| 745  | Starling     | Red-winged          | <i>Onychognathus</i> | <i>morio</i>            |
| 253  | Stint        | Little              | <i>Calidris</i>      | <i>minuta</i>           |
| 576  | Stonechat    | African             | <i>Saxicola</i>      | <i>torquatus</i>        |
| 772  | Sunbird      | Amethyst            | <i>Chalcomitra</i>   | <i>amethystina</i>      |
| 493  | Swallow      | Barn                | <i>Hirundo</i>       | <i>rustica</i>          |
| 502  | Swallow      | Greater Striped     | <i>Cecropis</i>      | <i>cucullata</i>        |
| 504  | Swallow      | South African Cliff | <i>Petrochelidon</i> | <i>spilodera</i>        |
| 495  | Swallow      | White-throated      | <i>Hirundo</i>       | <i>albigularis</i>      |
| 208  | Swamphen     | African             | <i>Porphyrio</i>     | <i>madagascariensis</i> |
| 387  | Swift        | African Palm        | <i>Cypsiurus</i>     | <i>parvus</i>           |
| 385  | Swift        | Little              | <i>Apus</i>          | <i>affinis</i>          |
| 383  | Swift        | White-rumped        | <i>Apus</i>          | <i>caffer</i>           |
| 98   | Teal         | Cape                | <i>Anas</i>          | <i>capensis</i>         |
| 97   | Teal         | Red-billed          | <i>Anas</i>          | <i>erythrorhyncha</i>   |
| 305  | Tern         | Whiskered           | <i>Chlidonias</i>    | <i>hybrida</i>          |
| 275  | Thick-knee   | Spotted             | <i>Burhinus</i>      | <i>capensis</i>         |
| 1104 | Thrush       | Karoo               | <i>Turdus</i>        | <i>smithi</i>           |
| 686  | Wagtail      | Cape                | <i>Motacilla</i>     | <i>capensis</i>         |
| 606  | Warbler      | African Reed [x]    | <i>Acrocephalus</i>  | <i>baeticatus</i>       |
| 604  | Warbler      | Lesser Swamp        | <i>Acrocephalus</i>  | <i>gracilirostris</i>   |
| 609  | Warbler      | Little Rush         | <i>Bradypterus</i>   | <i>baboecala</i>        |
| 843  | Waxbill      | Common              | <i>Estrilda</i>      | <i>astrild</i>          |
| 838  | Waxbill      | Orange-breasted     | <i>Amandava</i>      | <i>subflava</i>         |
| 803  | Weaver       | Southern Masked     | <i>Ploceus</i>       | <i>velatus</i>          |
| 804  | Weaver       | Thick-billed        | <i>Amblyospiza</i>   | <i>albifrons</i>        |
| 568  | Wheatear     | Capped              | <i>Oenanthe</i>      | <i>pileata</i>          |
| 846  | Whydah       | Pin-tailed          | <i>Vidua</i>         | <i>macroura</i>         |
| 816  | Widowbird    | Fan-tailed          | <i>Euplectes</i>     | <i>axillaris</i>        |





| Ref | Common group | Common species | Genus            | Species           |
|-----|--------------|----------------|------------------|-------------------|
| 818 | Widowbird    | Long-tailed    | <i>Euplectes</i> | <i>progne</i>     |
| 453 | Wryneck      | Red-throated   | <i>Jynx</i>      | <i>ruficollis</i> |

