# Wetland Delineation & Impact Assessment for the Proposed Alexander Project near Kriel, Mpumalanga

***For:***

Synergistics
Marline Medallie
mmedallie@slrconsulting.co.za

***By:***

**Wetland Consulting Services (Pty) Ltd**

Wetland Consulting Services (Pty.) Ltd.
PO Box 72295
Lynnwood Ridge
Pretoria
0040

Tel: 012 349 2699
Fax: 012 349 2993
Email: info@wetcs.co.za

**Reference: ???**

# DOCUMENT SUMMARY DATA

| | |
|---|---|
| PROJECT: | **Wetland Delineation & Impact Assessment for the Proposed Alexander Project near Kriel, Mpumalanga** |
| CLIENT: | **Synergistics** |

CONTACT DETAILS:

**Marline Medallie**
**SLR Africa (Block 7)**
**Fourways Manor Office Park**
**2191, Cnr Roos and Macbeth Streets**
**Fourways, Johannesburg, 2060**
**South Africa**
**Email:** mmedallie@slrconsulting.co.za

CONSULTANT: **Wetland Consulting Services, (Pty) Ltd.**

CONTACT DETAILS:

**Dieter Kassier**
**PO Box 72295**
**Lynnwood Ridge**
**0040**
**Telephone number: (012) 349 2699**
**Fax number: (012) 349 2993**
**E-mail:** info@wetcs.co.za

# DECLARATION OF INDEPENDENCE

**Declaration**

**Independent Specialist Consultant**

I, Dieter Kassier, representing Wetland Consulting Services (Pty.) Ltd., declare that we:

- Act as independent specialist consultants, in this application, in the field of wetland and riparian ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of this specialist component of the Environmental Impact Assessment;
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of national or other applicable Regulations or Legislation; and
- Will provide the competent authority with access to all the information at our disposal regarding the application, whether such information is favourable to the applicant or not.

Wetland Consulting Services (Pty.) Ltd.
**Name of Company**

Dieter Kassier
**Name of Specialist Consultant**

**Signature of Specialist Consultant**

22 May 2016
**Date**

# TABLE OF CONTENTS

# TABLE OF FIGURES

# TABLE OF TABLES

# INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

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

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

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

# 1. INTRODUCTION

Wetland Consulting Services (Pty.) Ltd. was appointed by Synergistics (part of the SLR Group) to update the baseline wetland assessment study as part of the EIA/EMP being compiled for the proposed Anglo American Inyosi Coal Alexander Project near Kriel, Mpumalanga Province.

Wetland Consulting Services (Pty.) Ltd. (WCS) had previously undertaken a baseline wetland assessment study for the Alexander Project (WCS, 2014). This report needs to be updated and an impact assessment for the following main activities included:

- Underground mining
- Shaft infrastructure
- Conveyor (linking to the proposed Elders conveyor) – 2 alternatives

The requirement to establish the existence and/or extent of wetlands on the property is based on the legal requirements contained in the National Environmental Management Act (NEMA) and the National Water Act (NWA), as well as the Mineral and Petroleum Resources Development Act (MPRDA). Given the stringent legislation regarding developments within or near wetland areas, it is important that these areas are identified and developments planned sensitively around them to minimize any potential impacts.

## *1.1 Scope of Work*

The agreed upon scope of work for the project is as follows:

**Phase 1: Baseline Assessment**

- ⇒ Review of existing wetland information and published literature on wetlands of the area;
- ⇒ Conduct a desktop and field investigation of the wetlands within the study area;
- ⇒ Assess, classify, delineate and map the identified wetlands using the DWAF 2005 wetland delineation guidelines;
- ⇒ Identify and describe the functions of the wetlands on site using the WET-EcoServices methodology;
- ⇒ Determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the wetlands on site; and
- ⇒ Compilation of a specialist wetland delineation and assessment report.

**Phase 2: Impact Assessment**

- ⇒ Review of the proposed mine and development plans;
- ⇒ Identification and assessment of expected impacts;
- ⇒ Recommendations on suitable mitigation and management measures to avoid, minimise or mitigate expected impacts; and
- ⇒ Compilation of a specialist wetland impact assessment report.

## *1.2 Limitations & assumptions*

Some portions of the study area could not be accessed for field work as no permission from landowners had been granted to enter onto their properties, and in some cases landowner contact details were missing. No groundtruthing of wetland boundaries could thus be undertaken in these areas and the wetland delineation in these areas was based on desktop mapping as well as information available from previous studies. Figure 1 below indicates which portions of the study area that could not be accessed.

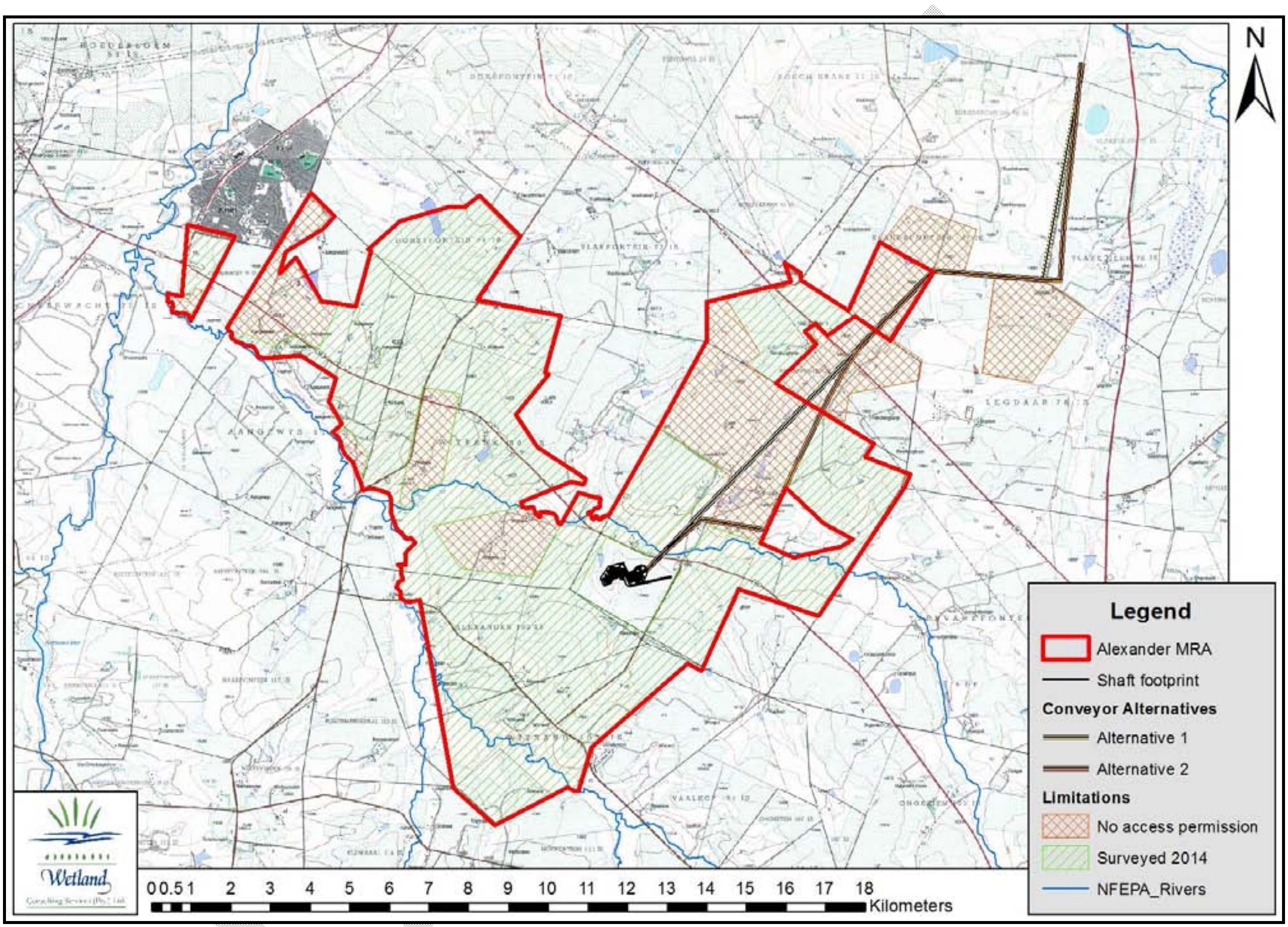


**Figure 1. Map of the study area showing farms within the study area which could not be accessed for wetland study field work.**

The alignment of conveyor Alternative 2 was only chosen after completion of field work. As such the wetlands along those sections of Alternative 2 that do not overlap with Alternative 1 were not visited in the field as part of the current survey

While an effort was made to visit every wetland within those farms to which access permission was obtained, not every wetland boundary was walked. Extensive cultivation along and within the wetland boundaries, which results in complete removal of wetland vegetation and disturbs the soil profile, also presented obstacles to accurate delineation of the wetland boundaries on site.

The scale of the remote imagery used (1:10 000 aerial photographs and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineated wetlands in the field, result in the delineated wetland boundaries being accurate to about 15m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

Groundtruthing and field verification of wetland boundaries was limited to the Alexander MRA (Mining Rights Area) and the conveyor route. Wetlands falling outside the Alexander MRA boundary were not delineated in the field but are based on desktop mapping.

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

For the purpose of the impact assessment, it is assumed that the shallow weathered aquifer will remain generally intact above the undermined areas. This assumption will however need to be verified against the findings of the groundwater specialist studies once such a study is complete, and this report updated if required.

### *1.2.1 Adequacy of predictive measures*

A number of generally accepted assessment methods were utilised within the current study for the assessment of the wetland and aquatic habitats on site:

- WET-Eco-Services (Kotze et al., 2009)
- WET-Health (Macfarlane et al., 2008) – used for all wetland types, excluding pans
- Wetland-IHI (Rountree *et al*., 2007) – used only for valley bottom and floodplain wetlands
- Adaptation of the RDM Method for Wetlands (DWAF, 1999) – used for hillslope seepage wetlands
- Modified version of the RDM Methods for Wetlands (DWAF, 1999), incorporating catchment characteristics (unpublished, WCS, 2013) – used for pan wetlands

Although there are limitations associated with each of these methods, the methods are generally accepted and widely applied within environmental impact assessments in South Africa and are deemed adequate for the purpose of this study.

## 2. LEGISLATION AND POLICY FRAMEWORK

The following legislation is of relevance to the wetland delineation and assessment study being undertaken for the Alexander Project:

- The Constitution of South Africa, Act 108 of 1996, as amended
- National Water Act (NWA) Act 36 of 1998

  - GNR 704 of 4 June 1999 – Regulations on use of water for mining and related activities aimed at the protection of water resources
  - GNR 1199 – General Authorisation for Water Uses 21 (c) and (i)
- National Environmental Management Act (NEMA) Act 107 of 1998
  - GNR 982 of 4 December 2014 – EIA Regulations
  - GNR 983 of 4 December 2014 – Listing Notice 1
  - GNR 984 of 4 December 2014 – Listing Notice 2
  - GNR 985 of 4 December 2014 – Listing Notice 3
- National Environmental Management: Biodiversity Act (NEMBA) Act 10 of 2004
- Conservation of Agricultural Resources Act (CARA) Act 43 of 1983

Additional guidelines utilised within the study include:

- DWAF wetland delineation guidelines, “A practical field procedure for identification and delineation of wetlands and riparian areas”, DWAF, 2005.
- Mpumalanga Minimum Requirements for Biodiversity Assessments

# 3. BACKGROUND INFORMATION

## *3.1 Study Area*

The Alexander Project area, approximately 10 978 hectares in size, is located to the south east of the town of Kriel and straddles the R545 Kriel to Bethal road. A number of gravel secondary roads cross the site, while the R544 also traverses the extreme north east section of the project area. The proposed conveyor route runs in a roughly northerly direction from the centre of the Alexander MRA to link up with the proposed Elders conveyor.

The study area is located within a region dominated by agricultural activities, including extensive cultivation for maize and soya, as well as livestock grazing. The Steenkoolspruit River drains across the middle of the site from east to west, before turning northwards and forming the western boundary of the site.

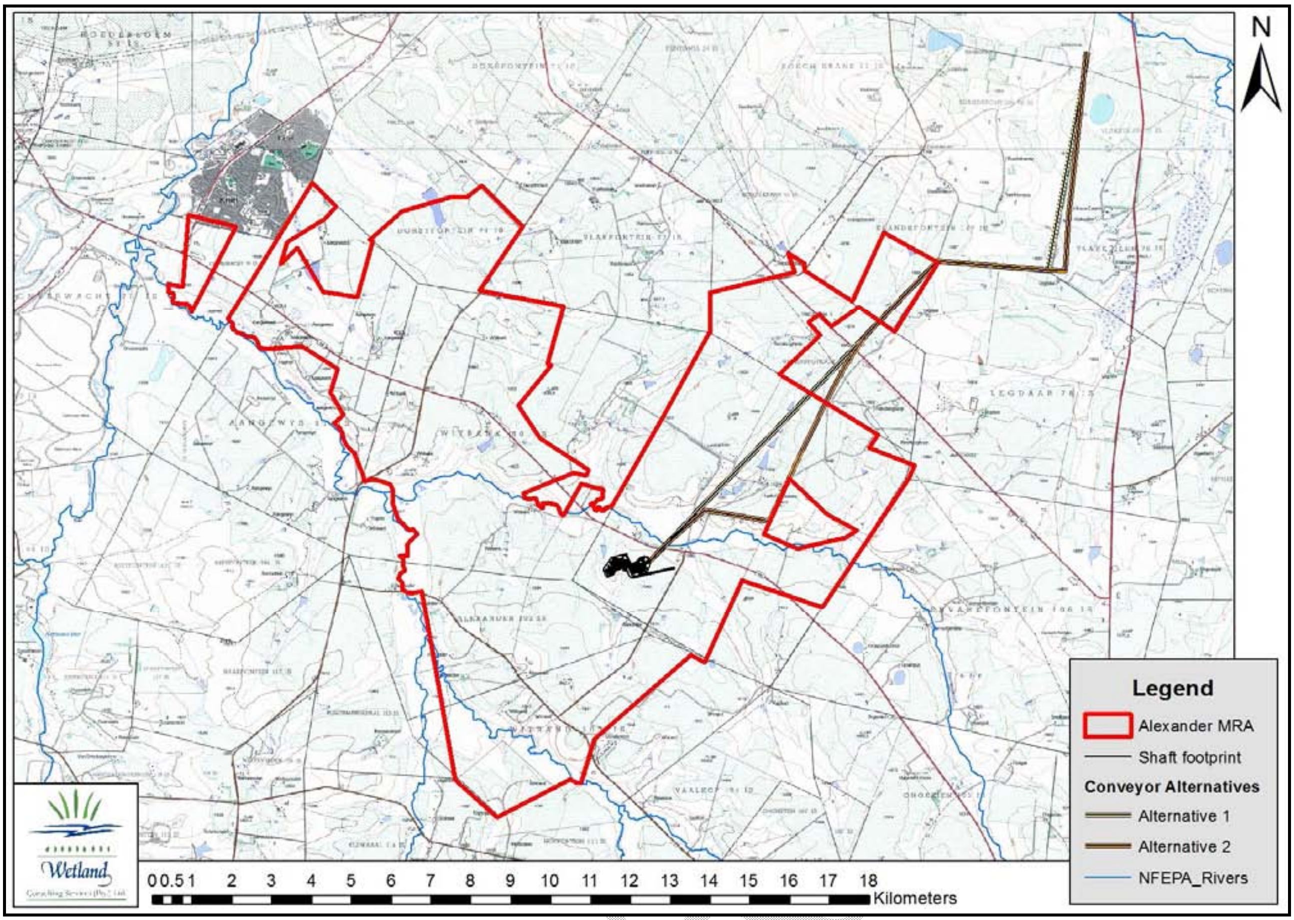


**Figure 2. Map showing the Alexander project area.**

## 3.2 Catchments

The study area is located within the Olifants River Catchment (Primary Catchment B) and, more specifically, mostly within the Steenkoolspruit sub-catchment of the Upper Olifants catchment. The quaternary catchment mainly affected by the proposed mining area is the B11C catchment, which is drained by the Steenkoolspruit and its tributaries the Debeerspruit and the Piekespruit. The project area also extends into quaternary catchments B11A, B11B and B11D.

Information regarding catchment size, mean annual rainfall and runoff for the quaternary catchment is provided in the table below (Macfarlane et al., 2009).

**Table 1. Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment.**

| Quaternary Catchment | Catchment Surface Area (km$^2$) | Mean Annual Rainfall (MAP) in mm | Mean Annual Run-off (MAR) in mm | MAR as a % of MAP | Potential Evaporation (PET) | Ratio of MAP to PET |
|---|---|---|---|---|---|---|
| B11A | 953 | 699 | 67.8 | 9.70 % | 1942.8 | 0.360 |
| B11B | 438 | 687 | 48.4 | 7.05 % | 2023.8 | 0.339 |
| B11C | 388 | 673.1 | 78.3 | 11.63 % | 2010.5 | 0.335 |
| B11D | 555 | 671.2 | 59.6 | 8.88 % | 2036.4 | 0.330 |

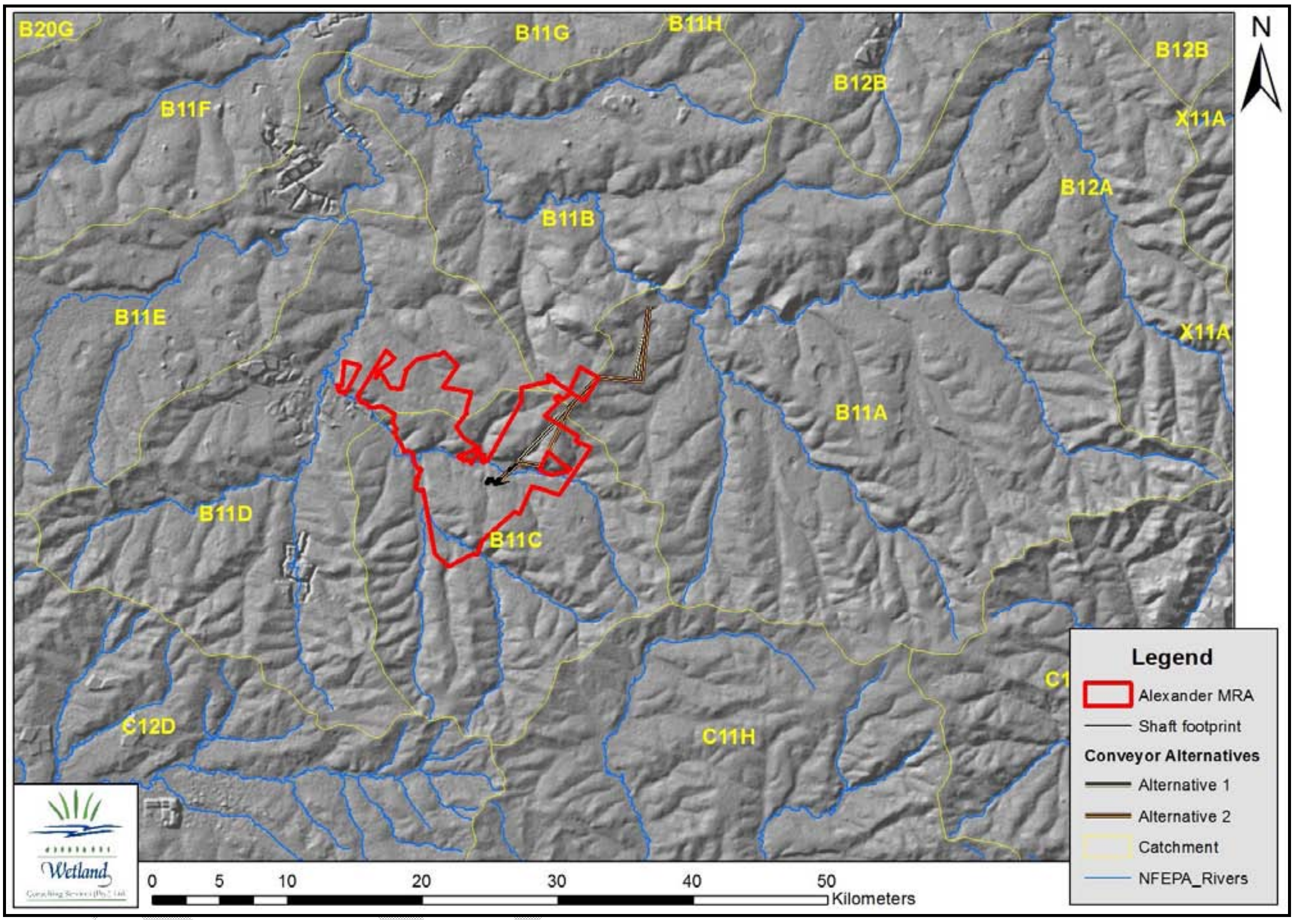


**Figure 3. Map showing the study area in relation to the quaternary catchment.**

The very low percentage of annual rainfall ending up as runoff out of the catchment, around 9.3 % on average for the 4 catchments, indicates that large volumes of water infiltrate the soil profile on site and is potentially available to support wetlands on site. Especially hillslope seepage wetlands are expected to be extensive on site.

## *3.3 Geology and Soils*

According to the 1:250 000 Geological Map Series map (2628 East Rand), the geology of the study area is dominated by sandstones of the Vryheid Formation, Ecca Group, Karoo Sequence. Significant alluvial deposits occur along the two large valley bottom wetland systems that traverse the study site, while numerous small outcrops of dolerite occur scattered through the study area, with a more significant outcrop in the north east of the study area.

Sandstones weather to form sandy soils that allow easy infiltration of rainwater into the soil and thus result in minimal runoff (less than 10 % of the rainfall within the catchments ends up as surface runoff). Typically these soils however have an aquitard[1] within the soil profile that prevents the deeper infiltration of rainwater into groundwater, resulting in shallow perched water tables across large portions of the landscape. Where this perched water table approaches the surface and results in the seasonal or permanent saturation of the top 50 cm of the soil profile, wetland conditions develop, typically in the form of large hillslope seepage wetlands that drain into valley bottom or pan wetlands. Within the study area, the aquitard usually occurs in the form of a hard or soft plinthic horizon.

Dolerites weather to form more clayey soils, typically occurring as dark Arcadia or Rensburg soil forms on the Highveld. These soils, which occur in the north east of the study area and associated with the large valley bottoms and floodplain wetlands, are less permeable than sandstones and result in higher volumes of surface runoff.

## *3.4 Vegetation*

A number of vegetation classification systems have been compiled for South Africa. According to the most recent vegetation classification of the country, "*The Vegetation of South Africa, Lesotho and Swaziland*" (Mucina and Rutherford, 2006), the study area falls within the Grassland Biome, Mesic Highveld Grassland Bioregion. At a finer level, the study area is classed as Eastern Highveld Grassland, though a small section in the south western corner of the study area is classified by Soweto Highveld Grassland.

*Eastern Highveld Grassland* is mostly confined to Mpumalanga and western Swaziland, occurring marginally as well into Gauteng. The conservation status of this vegetation type is considered **Endangered** by Mucina & Rutherford (2006), and whilst the conservation target is 24%, only a small fraction (<1%) is currently protected and 44% is considered to be transformed, mostly by cultivation, forestry, mines, dams and urbanisation. Typical species composition is as follows:

**Graminoids**: *Andropogon appendiculatus* (d), *Brachiaria serrata* (d), *Digitaria monodactyla* (d), *D. tricholaenoides* (d), *Elionurus muticus* (d), *Eragrostis capensis* (d), *E. chloromelas* (d), *E. plana* (d), *E. racemosa* (d), *Harpochloa falx* (d), *Heteropogon contortus* (d), *Microchloa caffra* (d), *Panicum natalense* (d), *Setaria nigrirostris* (d), *S. sphacelata* (d), *Themeda triandra* (d), *Trichoneura grandiglumis* (d), *Tristachya leucothrix* (d), *Abilgaardia ovata*, *Andropogon schirensis*, *Aristida bipartita*, *A. congesta*, *A. junciformis* subsp. *galpinii*, *A. stipittata* subsp. *graciliflora*, *Bulbostylis contexta*, *Chloris virgate, Cymbopogon caesius, C. pospischilii, Cynodon dactylon, Digitaria diagonalis, D. ternate, Diheteropogon amplectens, Eragrostis curvula, Koeleria capensis, Panicum coloratum*, and *Setaria incrassata*.

**Herbs**: *Berkheya setifera* (d), *Vernonia natalensis*, *V. oligocephala* (d), *Acalypha peduncularis, A. wilmsii, Berkheya insignis, B. pinnatifida, Crabbea acaulis,*

---

[1] Aquitard – a layer or horizon within the soil profile with low to no permeability, i.e. a layer which restricts the vertical movement of water through the soil profile. Typically a hard or soft plinthic layer on site.

*Cynoglossum hispidum, Dicoma anomala, Haplocarpha scaposa, Helichrysum caespititium, H. rugulosum, Hermannia coccocarpa, H. depressa, H. transvaalensis, Ipomoea crassipes, I. oblongata, Jamesbrittenia silenoides, Pelargonium luridum, Pentanisia prunelloides* subsp. *latifolia, Peucedanum magalismontanum, Pseudognaphalium luteo-album, Rhynchosia effusa, Salvia repens, Schistostephium crataegifolium, Sonchus nanus*, and *Wahlenbergia undulata*.

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

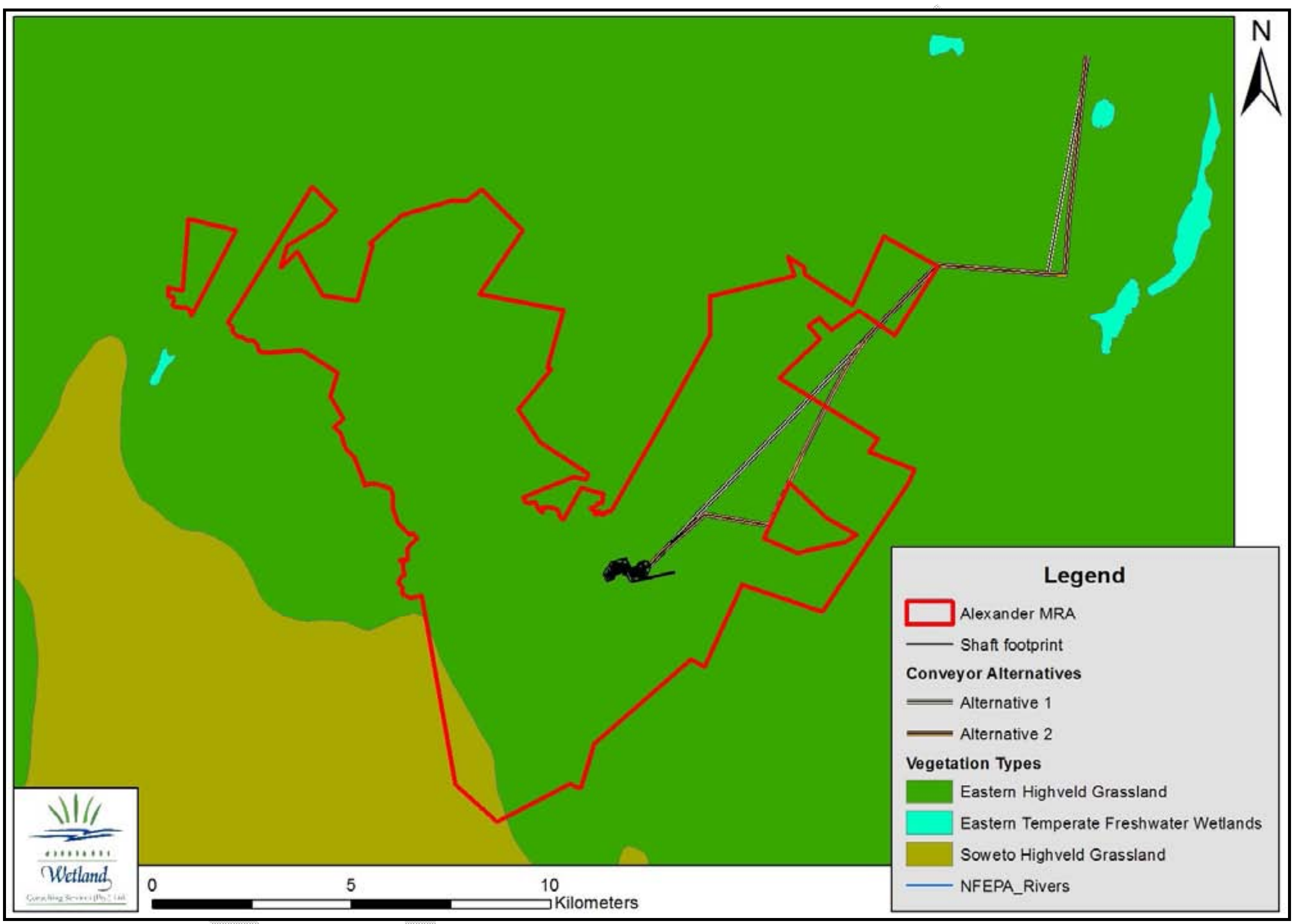


**Figure 4. Map showing the vegetation types of the project area.**

The Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011) identified 791 wetland ecosystem types in South Africa based on classification of surrounding vegetation (taken from Mucina and Rutherford, 2006) and hydro-geomorphic (HGM) wetland type; seven HGM wetland types are recognised and 133 wetland vegetation groups. Based on this classification, the following wetland vegetation types are indicated as occurring on site:

- Mesic Highveld Grassland Group 4_Channelled valley bottom wetland
- Mesic Highveld Grassland Group 4_Floodplain
- Mesic Highveld Grassland Group 4_Flat
- Mesic Highveld Grassland Group 4_Seep
- Mesic Highveld Grassland Group 4_Unchannelled valley bottom wetland

- Mesic Highveld Grassland Group 4_Depression

The National Biodiversity Assessment 2011: Freshwater Component (Nel et al., 2012) undertook an ecosystem threat status assessment for each of the 791 wetland ecosystem types where each wetland ecosystem type was assigned a threat status based on wetland type as well as on wetland vegetation group. A summary of the findings for the 6 wetland ecosystem types expected to occur on site is provided in Table 2 below.

**Table 2. Summarised findings of the wetland ecosystem threat status assessment as undertaken by the National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2012) and updated by Mbona et al (2015) for wetland ecosystems recorded on site.**

| Wetland Ecosystem Type | Wetland HGM Type | Wetland Vegetation Group | Protection Level | Threat Status |
|---|---|---|---|---|
| Mesic Highveld Grassland Group 4_Floodplain | Floodplain | Mesic Highveld Grassland | Not protected | EN |
| Mesic Highveld Grassland Group 4_Channelled valley bottom wetland | Channelled valley bottom | Mesic Highveld Grassland | Not protected | LT |
| Mesic Highveld Grassland Group 4_Flat | Flat | Mesic Highveld Grassland | Not protected | EN |
| Mesic Highveld Grassland Group 4_Seep | Seep | Mesic Highveld Grassland | Not protected | LT |
| Mesic Highveld Grassland Group 4_Unchannelled valley bottom wetland | Unchannelled valley bottom | Mesic Highveld Grassland | Moderately protected | LT |
| Mesic Highveld Grassland Group 4_Depression | Depression/Pan | Mesic Highveld Grassland | Not protected | EN |

CR = Critically Endangered, implying area of wetland ecosystem type in good (A or B) condition ≤ 20% of its original area
EN = indicates Endangered, area of wetland ecosystem type in good condition ≤ 35% of its original area

## *3.5 National Freshwater Ecosystem Priority Areas*

The Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011a) (The Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, SAIAB and SANParks, provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. Freshwater Ecosystem Priority Areas (FEPA's) were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as eco-region, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. The Atlas incorporates the National Wetland Inventory (SANBI, 2011) to provide information on the distribution and extent of wetland areas. An extract of the NFEPA database is illustrated in Figure 6 below. The map indicates extensive wetland areas on site, but only one of these (in the south western corner of the site) has been classified as a Freshwater Ecosystem Priority Area (FEPA).

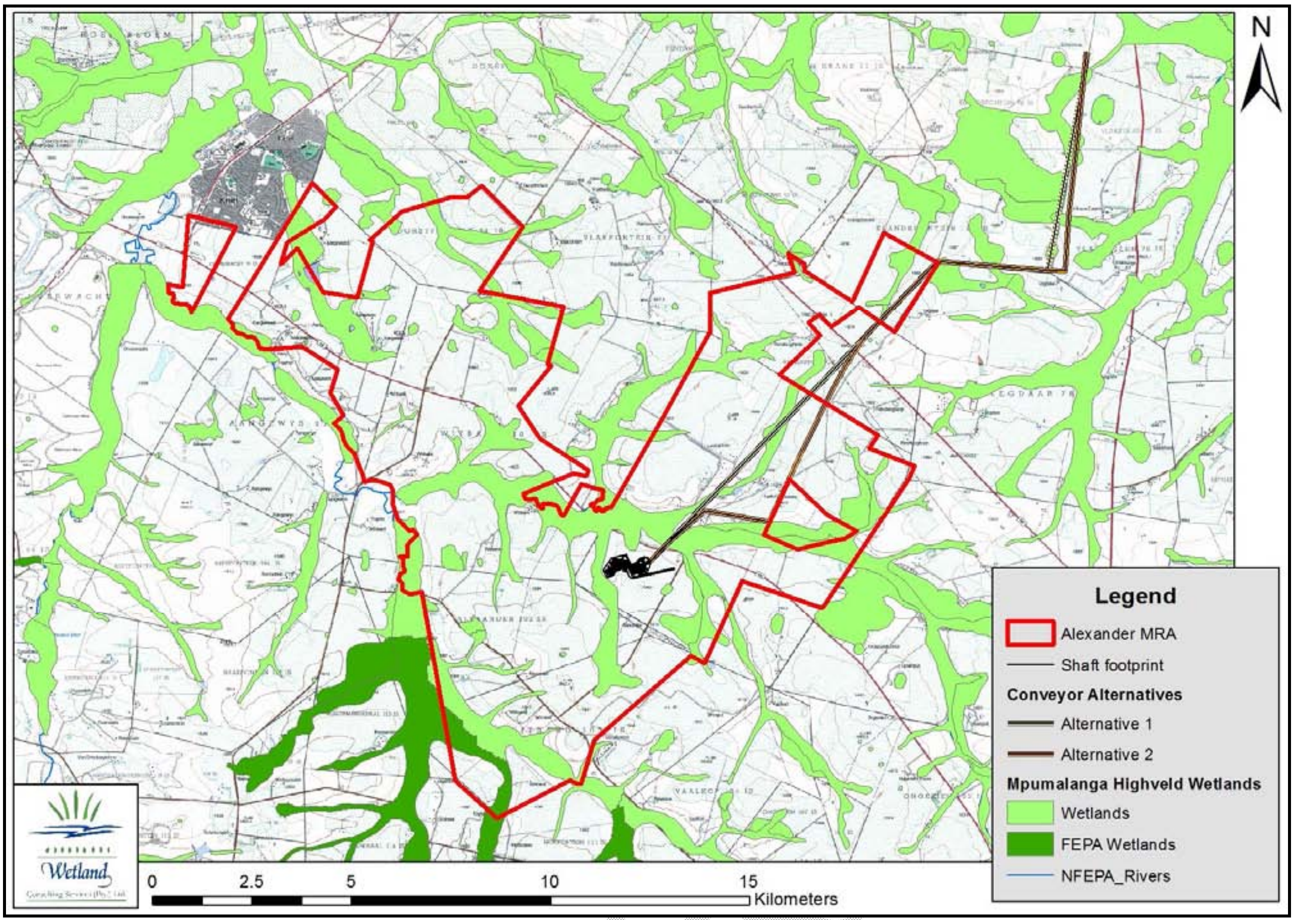


**Figure 5: Extract of the Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*., 2011).**

### *3.6 Mpumalanga Biodiversity Sector Plan 2013*

Agricultural activities have resulted in extensive transformation of the natural habitats within the study area, as portrayed in the Mpumalanga Biodiversity Sector Plan 2013 (MBSP 2013) terrestrial biodiversity assessment which classifies large parts of the study area as having no natural habitat remaining.

Significant portions of the study area have however been classified as Critical Biodiversity Areas (MBSP 2013). **It is striking to note how most of these Critical Biodiversity Areas are associated with the larger drainage lines of the area and consist mostly of the large floodplain wetlands associated with the Steenkoolspruit and its tributary the Piekespruit**.

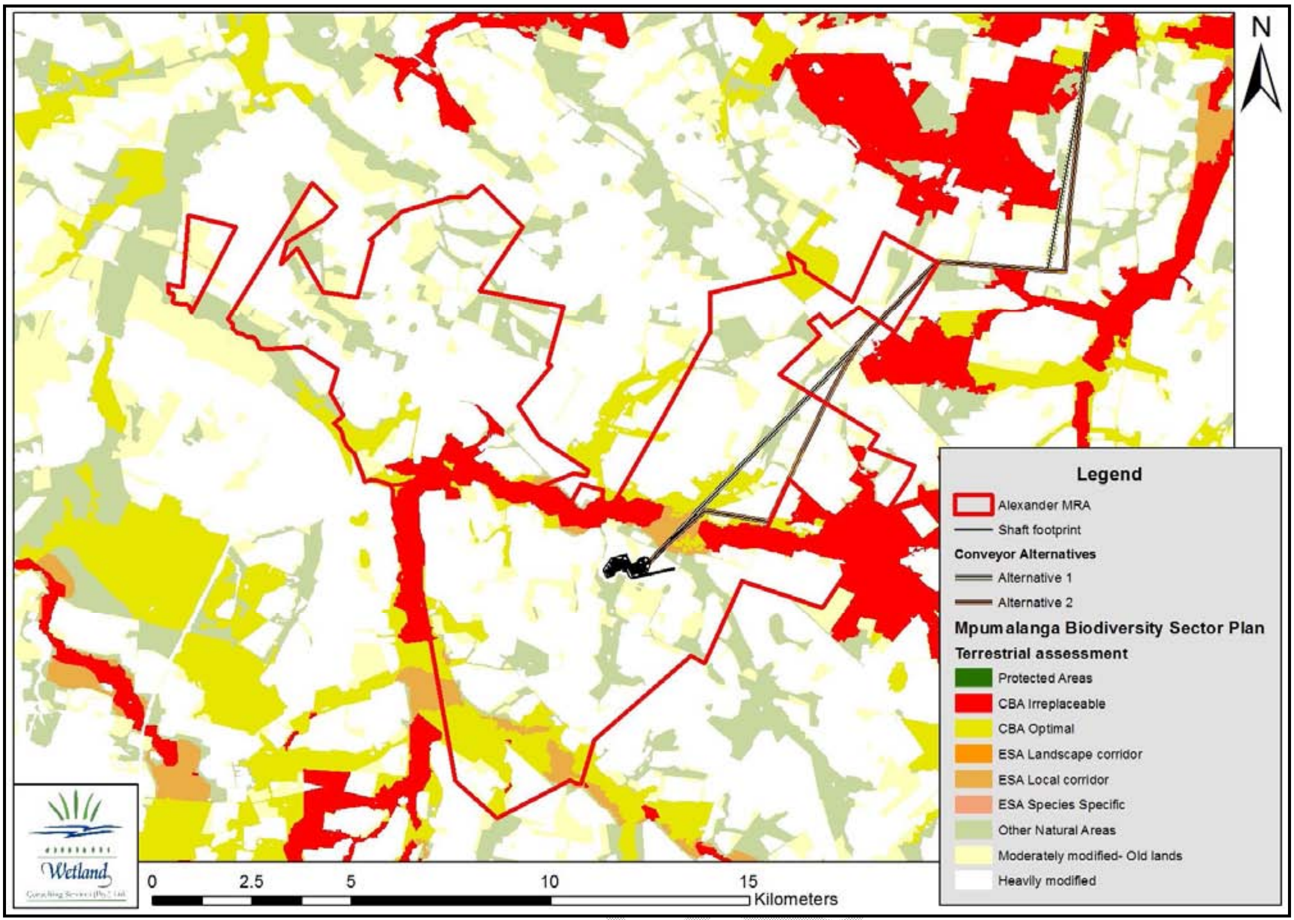


**Figure 6. Extract of the MBSP 2013 for the study area, indicating Critical Biodiversity Areas in red.**

# 4. METHODOLOGY

## *4.1 Wetland Delineation and Classification*

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

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

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

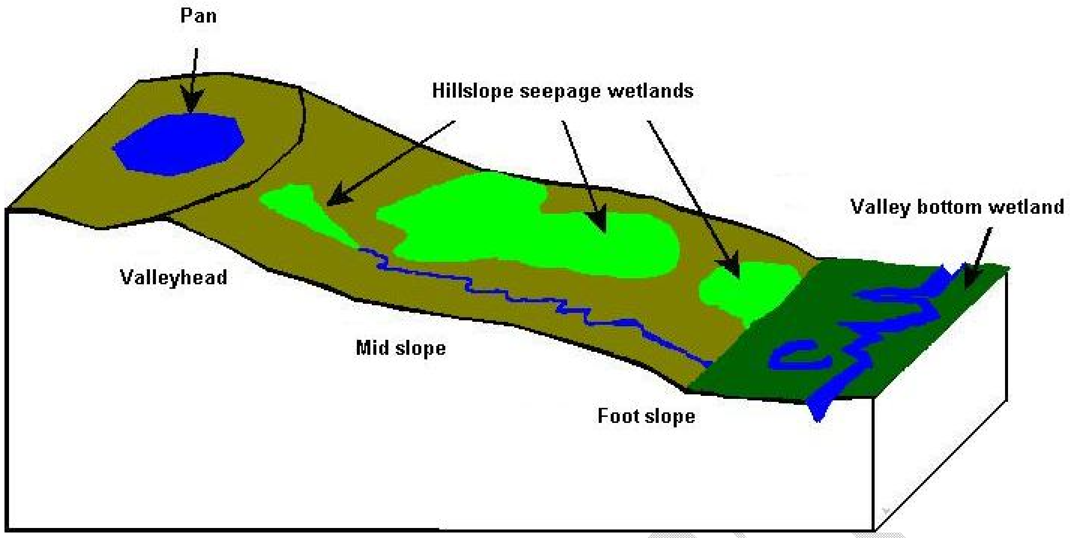


**Figure 7.** Diagram illustrating the position of the various wetland types within the landscape.

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

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

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

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and most recently modified for use in South African conditions by SANBI (2009).

## *4.2 Functional Assessment*

A functional assessment of the wetlands on site was undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze et al., 2007). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

### 4.3 Present Ecological State and Ecological Importance & Sensitivity

A present ecological state (PES) and ecological importance and sensitivity (EIS) assessment was conducted for every hydro-geomorphic wetland unit identified and delineated within the study area. This was done in order to establish a baseline of the current state of the wetlands and to provide an indication of the conservation value and sensitivity of the wetlands in the study area. For the purpose of this study the following methods were applied for the determination of the PES:

- Wetland-IHI (Rountree et al., 2007) – used for valley bottom and floodplain wetlands.
- Adaptation of the RDM Method for Wetlands (DWAF, 1999) – used mostly for hillslope seepage wetlands.
- Modified version of the RDM Methods for Wetlands (DWAF, 1999), incorporating catchment characteristics (unpublished, WCS, 2013) – used for pan wetlands.

# 5. FINDINGS

## *5.1 Wetland Delineation and Classification*

Site visits for the study were undertaken over twelve days during February to May 2014, by two specialists, and again for a further two days on 17 April 2016 and 19 May 2016. In total 28 man days were spent on site during the wetland survey.

During the course of the field work the wetlands within the study area were walked and assessed with a view to verifying the wetland boundaries and collecting the required data for the PES and EIS assessments. While an effort was made to visit every wetland within those farms to which access permission was obtained, it was not possible for every wetland boundary to be walked.

The total wetland extent within the Alexander MRA was found to equal approximately 4 060 hectares and covers just over 37 % of the surface area within the study site (Table 3). 5 different hydro-geomorphic wetland types were identified and classified according to the Ollis et al. (2013) wetland classification system. The wetland types identified are as follows:

- Channelled valley bottom wetlands;
- Floodplain wetlands;
- Unchannelled valley bottom wetlands;
- Depression/pan wetlands; and
- Hillslope seepage wetlands.

**Table 3. Table showing the extent of the various wetland types occurring on site.**

| | Wetland Type | Area (ha) | % of wetland area | % of study area |
|---|---|---|---|---|
| **Natural Wetlands** | Channelled Valley Bottom | 179.30 | 4.42% | 1.66% |
| | Floodplain | 953.61 | 23.49% | 8.83% |
| | Hillslope Seepage | 2 799.76 | 68.96% | 25.92% |
| | Depression/Pan | 27.17 | 0.67% | 0.25% |
| | Unchannelled Valley Bottom | 20.86 | 0.51% | 0.19% |
| **Artificial Wetlands** | Dam | 79.09 | 1.95% | 0.73% |
| | TOTAL | 4 059.79 | 100.00% | 37.59% |

**Table 4. Ollis et al. (2013) wetland classification system as applied to the study area.**

| Level 1: System | Level 2: Regional Setting | Level 3: Landscape Unit | Level 4A: Hydro-geomorphic Unit |
|---|---|---|---|
| Inland Systems | **DWAF Level 1 Ecoregion:** Highveld | Slope | Channelled valley bottom |
| | | | Seep/Hillslope Seepage |
| | | Bench | Depression/Pan |
| | | | Seep/Hillslope Seepage |
| | **NFEPA WetVeg:** Mesic Highveld Grassland Group 4 | Valley floor | River/Channel |
| | | | Channelled valley bottom |
| | | | Unchannelled valley bottom |
| | | | Floodplain |

Two large floodplain wetland systems occur on site, associated with the Steenkoolspruit which drains across the project area from east to west before turning north-westwards and forming the western boundary of the study, as well as with the Piekespruit, a tributary joining the Steenkoolspruit from the south. Both these wetland systems occupy broad, flat valley bottoms and are characterised by an incised, meandering channel. Some floodplain depressions and cut-off meanders occur. The lower reach of the Steenkoolspruit floodplain within the study area has been significantly impacted by opencast coal mining activities along its western bank outside the project area. A berm across the floodplain at the confluence between the Steenkoolspruit and the Piekespruit directs flows via a culvert onto the floodplain downstream of the berm which is bounded by a flood protection berm along its western edge and significantly reduced in size from its natural condition. Significant channel incision is expected to result in decreased channel overtopping and has led to some terrestrialisation of the floodplain. Lateral flows entering the floodplain, especially from hillslope seepage wetlands are expected to be important in maintaining saturation of the floodplain verges, especially during low flow periods.

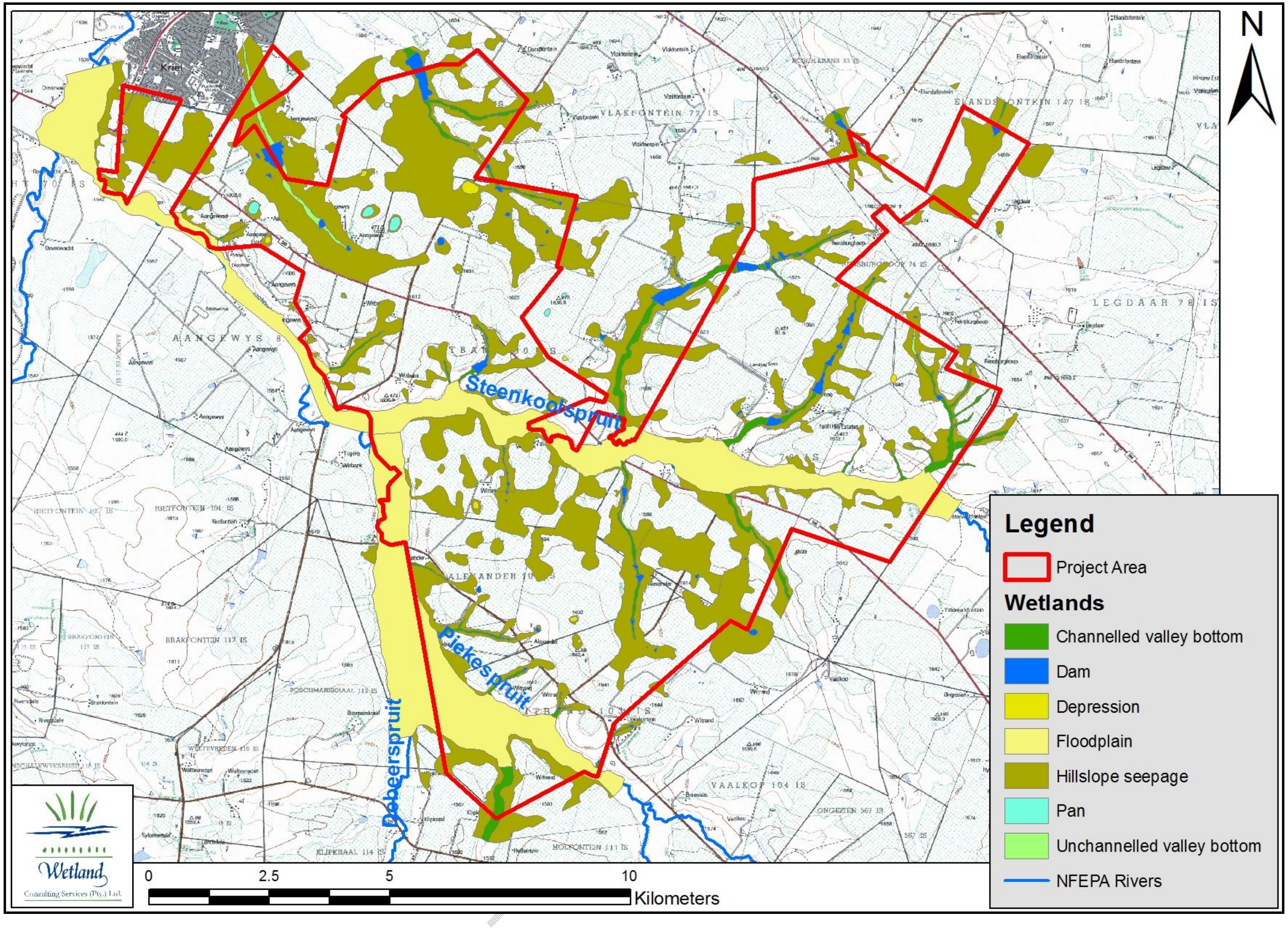


**Figure 8. Map of the delineated and classified wetlands within the study area.**

The most extensive wetland type recorded on site are the hillslope seepage wetlands, covering 26 % of the project area and making up more than 69 % of the wetland area on site. This is typical of the Mpumalanga Highveld, especially in areas underlain by sandstones and characterised by sandy soils. Rainfall easily infiltrates the sandy soils, limiting surface runoff and maximizing recharge to the shallow perched soil aquifer that supports the hillslope seepage wetlands. The deeper terrestrial soils on site, typically the areas that are cultivated, are considered to play a vital role in maintaining the hillslope seepage wetlands. The terrestrial soils are expected to act like underground reservoirs that receive water via infiltrated rainwater and then slowly supply water via shallow sub-surface seepage to the pans and valley bottom wetlands of the area, with hillslope seepage wetlands developing in those areas where the perched aquifer approaches the surface and results in saturation of the top 50cm of the soil profile on at least a temporary basis during the wet season.

The valley bottom wetlands, which make up only 4.9 % of the wetland area on site, vary between being channelled and unchannelled systems. It is thought that under natural conditions most of the valley bottom systems on site would have been classified as unchannelled. Under current conditions however, many of the valley bottom wetlands are significantly incised and severe erosion was observed in a number of valley bottom wetlands which have been eroded down to the underlying bedrock. Initially erosion is mostly vertical, until the bedrock is reached, where after lateral erosion of the channel banks commences via bank collapse. Changes in landuse and resultant changes in runoff characteristics, as well as changes in flow distribution within wetlands due to for example road crossings, are likely to have been the main reasons for channel incision. Channel incision experienced along the larger systems such as the Steenkoolspruit have also resulted in lowering the base level and causing head-cut erosion in tributaries as these try and adjust to the lowered base level. Long-term climate changes may however also have contributed in part to changes observed within the wetland systems.

Only 14 depression/pan wetlands were identified on site, with most of these being small systems, and all of them less than 6.5 ha in size. For the purpose of this report, a distinction has been made between “pan wetlands” and “depression wetlands” in order to provide more detail on the types of wetland systems present, as two distinct wetland groups occur on site:

- **Pans** – generally larger wetland systems with a clearly defined basin that is regularly characterised by open water. These systems typically have a closed elevation contour and no obvious surface linkage/outlet to nearby drainage systems.
- **Depressions** – wetland systems very variable in size that are characterised by a poorly defined, shallow depression that is well vegetated and seldom has open water for extended periods. These systems typically occur within hillslope seepage wetlands located at the extreme upper end of headwater systems. The depressions often have a direct link to adjacent drainage lines via surface outflows or shallow seepage.

### *5.1.1 Shaft Infrastructure Area*

Wetland habitat within the direct vicinity of the proposed shaft infrastructure (shown in Figures 9 and 10 below) is dominated by large hillslope seepage wetlands. All of these hillslope seepage wetlands have been impacted by cultivation to some degree, with extensive portions of hillslope seepage wetlands currently under cultivation. Large sections of the hillslope seepage wetlands are also characterised by secondary vegetation, pointing to historical cultivation.

Two large trenches were also observed within the hillslope seepage wetland to the south east of the proposed shaft footprint, one on either side of the hillslope seepage wetland. These trenches have presumably been excavated in an attempt to drain the wetland area.

A small channelled valley bottom wetland is located just to the west of the proposed shaft footprint draining south to north and forming a tributary to the Steenkoolspruit. Several dams occur along this valley bottom wetland both upstream and downstream of the proposed shaft footprint.

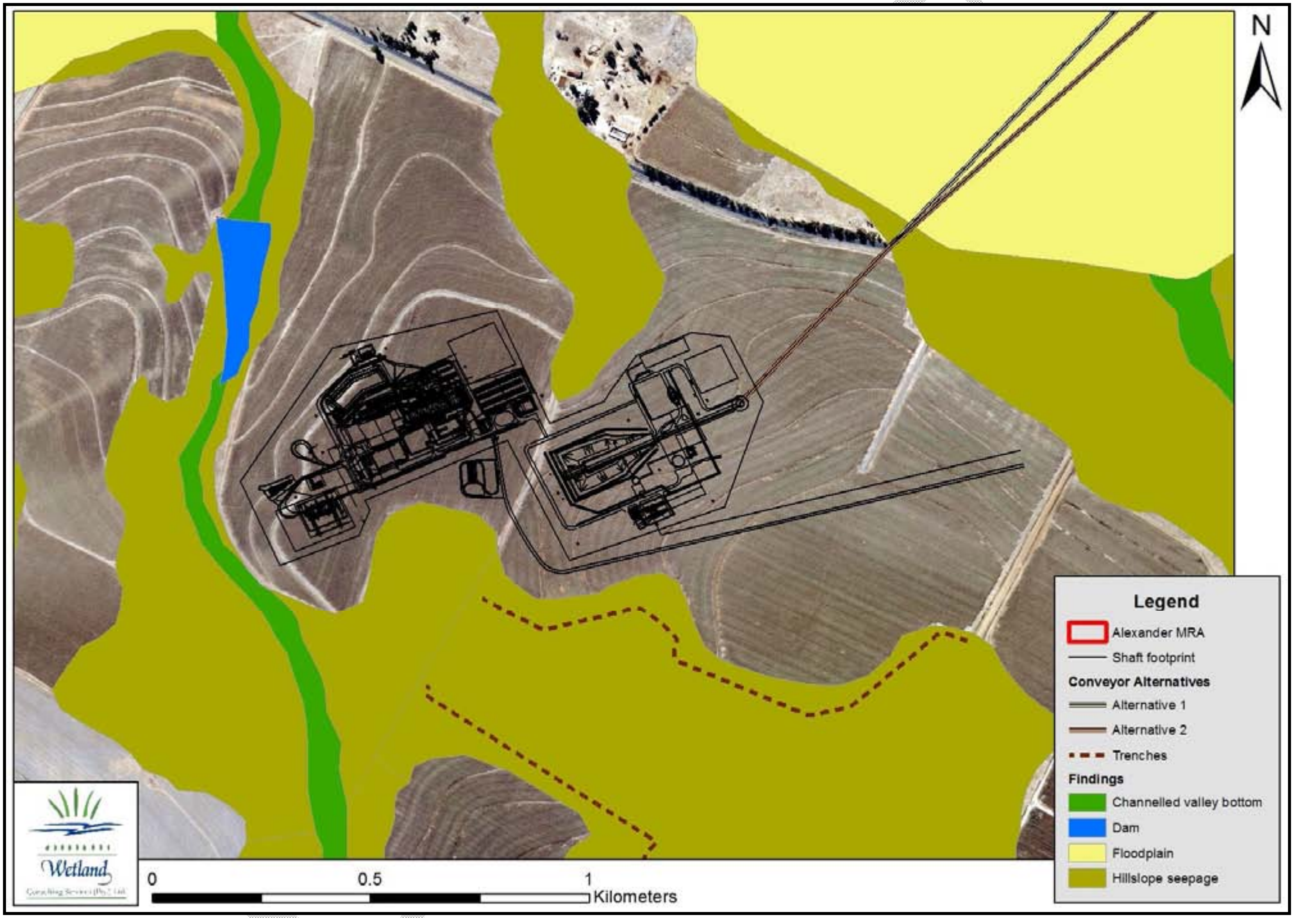


**Figure 9. Delineated wetland habitat within the direct vicinity of the proposed shaft infrastructure.**

**Table 5. Some of the dominant and more widespread plant species observed within the wetlands in close proximity to the shaft footprint.**

| Species Name | Species Name | Species Name |
|---|---|---|
| *Agrostis lachnantha* | *Cynodon dactylon* | *Paspalum urvillei* |
| **Bidens formosa* | **Cyperus esculentus* | *Phragmites australis* |
| **Bidens pilosa* | *Eragrostis curvula* | *Setaria pallide-fusca* |
| **Chenopodium album* | *Eragrostis chloromelas* | *Typha capensis* |
| **Cirsium vulgare* | *Imperata cylindrica* | |
| **Conyza albida* | *Hyparrhenia hirta* | |

**Figure 10. Photos of wetlands within the proposed shaft infrastructure footprint. Clockwise from top left: Hillslope seepage wetland north of the shaft footprint; large hillslope seepage wetland east of shaft footprint; one of two large trenches in hillslope seepage wetland east of shaft footprint; and view across the seepage wetland and valley bottom wetland (background) west of shaft footprint.**

### *5.1.2 Conveyor Route*

Two conveyor alternatives were assessed as part of this study:

Alternative 1 – 18 km
Alternative 2 – 19.3 km

The two alternative alignments roughly overlap for considerable sections of their lengths, though they differ in two sections. A number of wetland crossings were identified along both alternatives and are numbered 1 – 13 for alternative 1 (Figure 11). The same numbering is used for wetland crossings along Alternative 2 where the same wetland systems area crossed, with additional wetlands crossed only by Alternative 2 numbered A-D. These crossings are briefly described below.

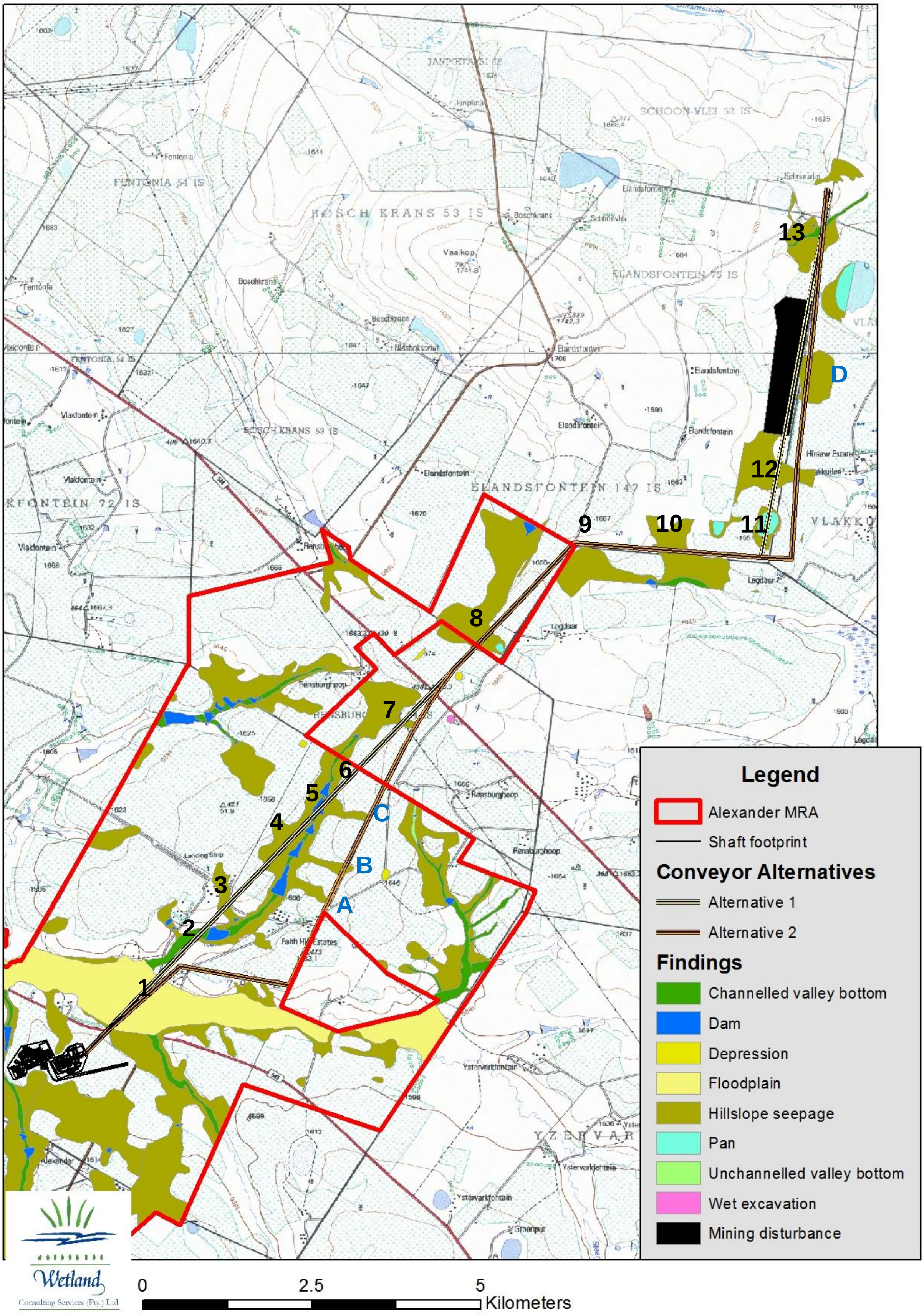


**Figure 11. Map of the delineated wetlands along the proposed conveyor route.**

**Figure 12. Photos of the proposed crossing point over the Steenkoolspruit floodplain.**

**Crossing 1** – Crossing of the Steenkoolspruit floodplain wetland and associated hillslope seepage wetland. Both alternatives cross the wetland at this point. At the proposed crossing point the Steenkoolspruit is deeply incised (in the region of 3-4m deep) (Photo in Figure 12), with the adjacent valley bottom wetland habitat showing significant terrestrialisation. Including the narrow band of hillslope seepage wetland, this crossing is over 1 000m in length.

**Crossing 2** – Crossing over a channelled valley bottom wetland and associated hillslope seepage wetland forming a tributary to the Steenkoolspruit. Crossing will be located just below a large farm dam across a severely incised reach of the valley bottom wetland. Crossing length will be approximately 250m. Only Alternative 1.

**Crossing 3** – Hillslope seepage wetland with a large erosion gully. Crossing length will be approximately 250m. Only Alternative 1.

**Crossing 4** – This will be a diagonal crossing across a large hillslope seepage wetland feeding into a channelled valley bottom wetland. Although this wetland could not be surveyed in the field, it appears to be characterised by secondary vegetation and shows signs of past cultivation in parts of the wetland. Crossing length will be approximately 1 030m. Only Alternative 1.

**Crossing 5** – Crossing over a channelled valley bottom wetland and associated farm dam. Based on aerial imagery the affected farm dam represents a permanent body of water and forms one of 5 dams located along a short reach of the valley bottom wetland. Crossing length across the dam will be approximately 150m, with a further 35m across the valley bottom wetland. Only Alternative 1.

**Crossing 6** – Similar to crossing 4, with this hillslope seepage wetland being located along the other side of the valley bottom wetland located at crossing 5. Crossing length will be approximately 250m. Only Alternative 1.

**Crossing 7** – Crossing over the upper reach of a hillslope seepage wetland which has been previously cultivated. Crossing length will be approximately 115m in the case of Alternative 1, and 69m in the case of Alternative 2.

**Crossing 8** - Crossing over the upper reach of a hillslope seepage wetland which has been previously cultivated. Crossing length will be approximately 350m. Both alternatives cross the wetland at this point.

**Crossing 9** – Not a crossing per se, but the proposed conveyor will run within a couple of meters of a hillslope seepage wetland and the servitude is likely to extend into the seepage wetland. Both alternatives cross the wetland at this point.

**Crossing 10** - Crossing over the upper reach of a hillslope seepage wetland showing temporary wetness. Wetland appears to support degraded primary vegetation. Crossing length will be approximately 470m. Both alternatives cross the wetland at this point.

**Crossing 11** – Crossing over a pan and associated hillslope seepage wetland. Crossing length will be approximately 620m. This is a seasonal pan, holding water for extended periods during high rainfall years but drying up on occasion. The Red Data listed Greater Flamingo was recorded from this pan during the wetland survey. Photos in Figure 13. **Only Alternative 1.**

**Figure 13. Photos of the pan that will be crossed by the proposed conveyor (Crossing 11 above) also showing Greater Flamingo recorded on site.**

**Crossing 12** - Crossing over the upper reach of a hillslope seepage wetland which has been previously cultivated. Crossing length will be approximately 425m for Alternative 1 and 190m for Alternative 2.

**Crossing 13** – Crossing over a narrow channelled valley bottom wetland and associated hillslope seepage wetlands. Valley bottom wetland is only marginally incised, though with head-cut present that could lead to further channel incision. Valley bottom wetland and seepage wetlands characterised by primary vegetation and displaying high diversity. Located downstream of partially rehabilitated opencast mining activities. Both alternatives cross the wetland at roughly the same point.

**Crossing A** – Crossing over extreme upper reach of a hillslope seepage wetland draining out of cultivated fields. Conveyor route follows existing farm road crossing. Crossing length will be approximately 79m. Only Alternative 2.

**Crossing B** - Crossing over extreme upper reach of a hillslope seepage wetland draining out of cultivated fields. Conveyor route follows existing farm road crossing. Crossing length will be approximately 183m. Only Alternative 2.

**Crossing C** - Crossing over extreme upper reach of a hillslope seepage wetland draining out of cultivated fields. Conveyor route follows existing farm road crossing. Crossing length will be approximately 50m. Only Alternative 2.

**Crossing D** – Crossing over a large, temporary hillslope seepage wetland characterised by secondary grassland and draining into a rehabilitated opencast area. Conveyor would run approximately 100m upslope of rehabilitated mining area. Crossing length will be approximately 700m. Only Alternative 2.

## 5.2 *Functional Assessment*

Numerous functions are typically attributed to wetlands, which include biodiversity support, nutrient removal (and more specifically nitrate removal), sediment trapping (and associated with this is the trapping of phosphates bound to iron as a component of the sediment), stream flow augmentation, flood attenuation, trapping of pollutants and erosion control. Many of these functions attributed to wetlands are wetland type specific and can be linked to the position of wetlands in the landscape as well as to the way in which water enters and flows through the wetland. Thus not all wetlands can be expected to perform all functions, or to perform these functions with the same efficiency. Despite this, certain assumptions on the functions supported by wetlands can be made, based on the hydro-geomorphic wetland classification system which classifies wetlands according to the way that water moves through the wetland as well as the position of the wetland within the landscape.

For the purpose of this study the Wet-EcoServices tool (Kotze, Marneweck, Batchelor, Lindley and Collins, 2004) was applied to the four different types of wetland systems occurring within the study area. This tool enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

### 5.2.1 *Valley bottom wetlands*

Valley bottom wetlands represent just over 4 % of the wetland area in the study site.

The linear nature of valley bottom wetlands within the landscape and their connectivity to the larger drainage system provides the opportunity for these wetlands to play an important role as an ecological corridor allowing the movement and migration of fauna and flora between remaining natural areas within the landscape. Although modified in certain respects, the wetlands still provide a natural refuge for biodiversity, and within the study area and surroundings, the valley bottom wetlands with associated footslope seepage wetlands represent the most significant extent of remaining natural vegetation, further enhancing their importance from a biodiversity support function.

Channelled valley bottom wetlands, through the erosion of a channel through the wetland, indicate that sediment trapping is not always an important function of these wetlands, except where regular overtopping of the channel occurs and flows spread across the full width of the wetland. Under low and medium flows, transport of sediment through, and out, of the system are more likely to be the dominant processes. Erosion may be both vertical and/or lateral and reflect the attempts of the stream to reach equilibrium with the imposed hydrology. A number of the valley bottom wetland systems show signs of erosion, presumably as a result of changes in landuse (conversion to cultivated fields) and altered hydrology due to farm road crossings and dams. As flows become more channel bound through vertical incision and lateral erosion of the channel, the ability of the wetlands to trap sediments decreases.

From a functional perspective channelled valley bottom wetlands can play a role in flood attenuation when flows over top the channel bank and spread out over a greater width, with the surface roughness provided by the vegetation further slowing down the flood flows. These wetlands are considered to play only a minor role in the improvement of water quality given the short contact period between the water and the soil and vegetation within the wetland.

Un-channelled valley bottom wetlands reflect conditions where surface flow velocities are such that they do not, under existing flow conditions, have sufficient energy to transport sediment to the extent that a channel is formed. In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through for example mineralisation of rain water. These wetlands could be seen to play an important role in nutrient removal, including ammonia, through adsorption onto clay particles. The large size of the unchannelled valley bottom wetland associated with the Bronkhorstspruit suggests that this wetland plays an important role in flood attenuation – the temporary storage of flood waters within the wetland.

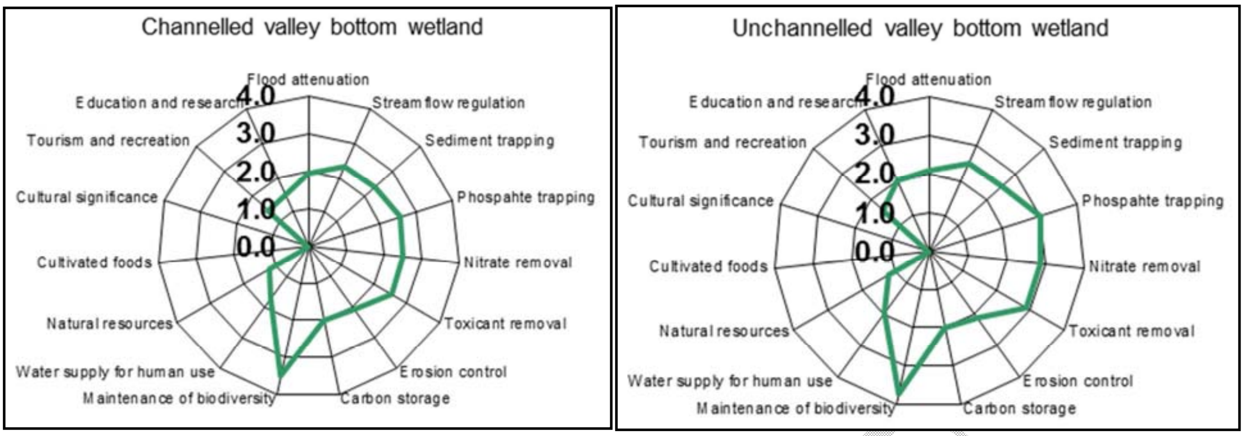


**Figure 14. Radial plots showing the results of the WET-EcoServices assessment.**

### *5.2.2 Hillslope seepage wetlands*

Hillslope seepage wetlands account for more than 60 % of the wetland area in the study site.

Hillslope seepage wetlands are mostly maintained by shallow sub-surface interflow, derived from rainwater. Rainfall infiltrates the soil profile, percolates through the soil until it reaches an impermeable layer (e.g. a plinthic horizon or the underlying sandstone), and then percolates laterally through the soil profile along the aquitard (resulting in the formation of a perched water table). Such a perched water table occurs across large areas of the Mpumalanga Highveld, not only within hillslope seepage wetlands, but also within terrestrial areas, only at greater depth. The hillslope seepage wetlands are merely the surface expression of this perched water table in those areas where a shallow soil profile results in the perched water table leading to saturation of the profile within 50cm of the soil surface. The importance of individual seepage wetlands in temporarily storing and then discharging flows to downslope wetlands (flow regulation) varies and depends on a number of factors. Generally, seepage wetlands associated with springs and located adjacent to terrestrial areas characterised by deep, well-drained soils are more likely to play an important role in flow regulation than seepage wetlands where the wetland and catchment are characterised by shallower soils. Such seepage wetlands are likely often maintained mostly by direct rainfall and lose most of their water to evapotranspiration, and surface run-off during large storm events.

Hillslope seeps can support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile, and are thus thought to contribute to water quality improvement and/or the provision of high quality water. The greatest importance of the hillslope seepage wetlands on site is thus taken to be the movement of clean water through the hillslope seepage wetlands and into the adjacent valley bottom wetlands, though the flow contribution from hillslope seepage wetlands to downslope wetlands was not quantified.

As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquitard, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). However, by retaining water in the landscape and then slowly releasing this water into adjacent valley bottom or floodplain wetlands, some hillslope seepage wetlands can contribute to stream flow augmentation, especially during the rainy season and early dry season. From an overall water yield perspective there is evidence that seepage wetlands contribute to water loss. The longer the water is retained on or near the surface the more likely it is to be lost through evapo-transpiration (McCartney, 2000). Hillslope seepage wetlands are not generally considered to play an important role in flood attenuation, though early in the season, when still dry, the seeps have some capacity to retain water and thus reduce surface run-off. Later in the rainy season when the wetland soils are typically saturated, infiltration will decrease and surface run-off increase. Further flood attenuation can be provided by the surface roughness of the wetland vegetation; the greater the surface roughness of a wetland, the greater is the frictional resistance offered to the flow of water and the more effective the wetland will be in attenuating floods (Reppert et al., 1979). In terms of the hillslope seepage wetlands on site, the surface roughness is taken to be moderately low, given that most of the seepage wetlands are either cultivated of characterised by typical grassland vegetation, thus offering only slight resistance to flow.

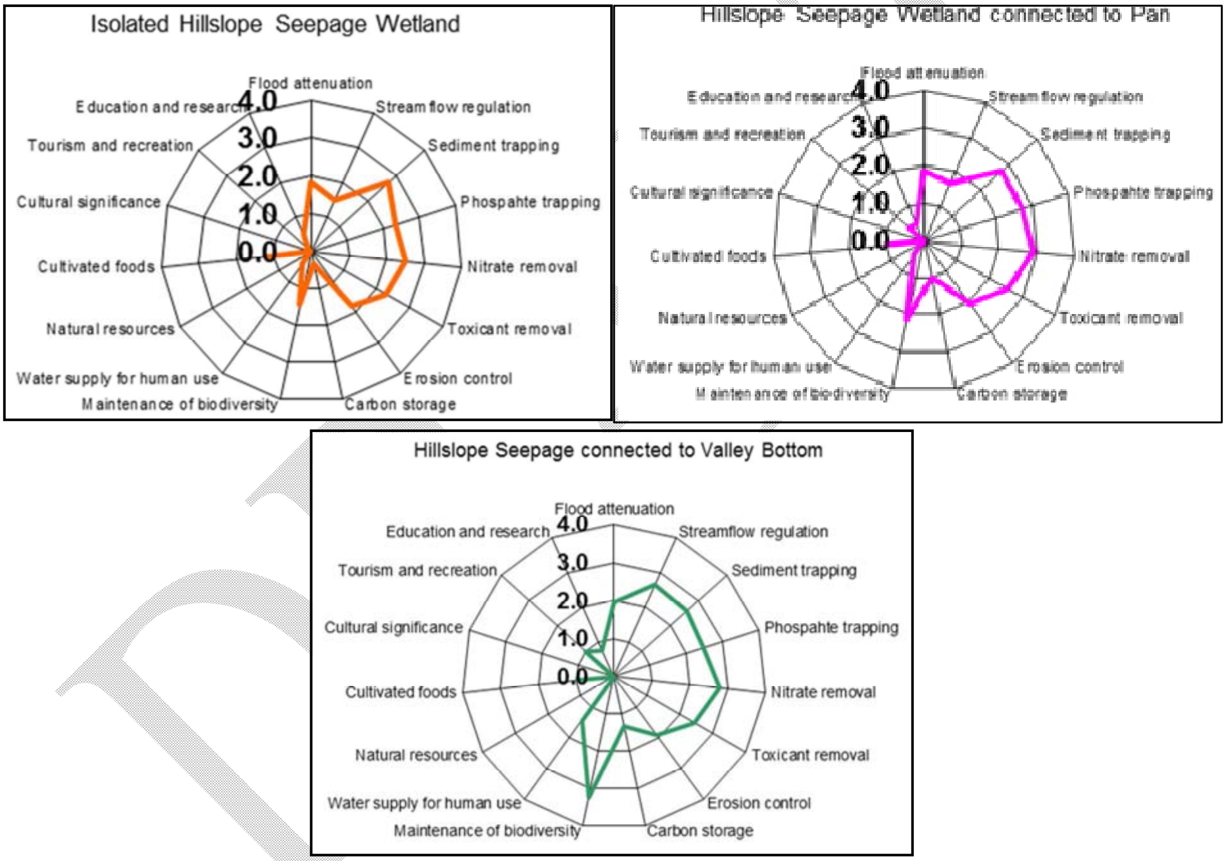


**Figure 15. Radial plots showing the results of the WET-EcoServices assessment.**

### *5.2.3 Pan/depression wetlands*

The hydrological benefits supported by the pans are generally limited, though this is to be expected given that most of the pans are not directly linked to the stream network and can thus only play a limited role in functions such as flood attenuation and/or streamflow regulation. Especially the saline pans tend to be isolated from the surrounding drainage systems, as indicated by their ability to concentrate salts. The function of water quality maintenance is also limited as the pans tend to concentrate salts over time through evaporation, as indicated by the salinity levels recorded within the pan. The concentration of bird life on the pans can also lead to increased nitrate levels in the pan.

The pans are expected to play an important role in supporting biodiversity and nutrient cycling. Endorheic pans tend to be naturally highly productive systems that play an important role in nutrient cycling. The highly saline nature of the pans means that only species that are adapted to high and extremely variable salinity and/or desiccation (in seasonal pans) can survive. In particular, bacteria, protozoans, algae, crustaceans and molluscs tend to be abundant, feeding on nutrient inputs from water birds and plants. The birds, in turn, feed on the planktonic organisms and invertebrates that they support. Although not sampled as part of the current study, a high number of crustaceans, including copepods, ostracods and cladocerans, are expected; these animals are an important food source for many water birds. Water birds likely to utilise the pan include the Greater and Lesser Flamingo.

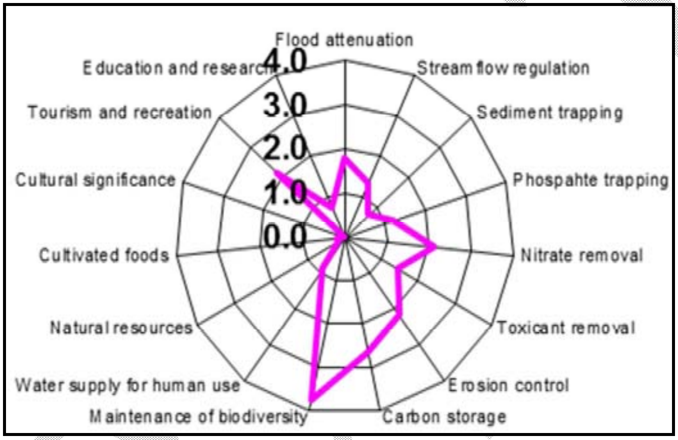


**Figure 16. Radial plot indicating the functions typically performed by the pans on site. Maintenance of biodiversity is highlighted as the most important function.**

### *5.2.4 Floodplain wetlands*

The processes operating on floodplains are dominated by surface hydrological forces. Water inputs are predominantly from upstream sources and enter the wetland via the channel. During high flows the channel capacity is regularly exceeded, resulting in overtopping of the channel and flood flows spreading across the width of the floodplain. This allows the wetland to play an important role in flood attenuation, as well as sediment trapping through the deposition of sediments on the floodplain as flows slow down. The presence of shallow, alluvial levees within the floodplain is evidence of sediment deposition.

Within the Alexander Project area, the floodplains and valley bottom wetlands have in many cases been subjected to significant erosion and channel incision. Erosion of the channel, both vertically and laterally, increases channel competency, resulting in less regular channel overtopping and reduced residence time within the wetland, thus reducing the importance of the wetlands in terms of flood attenuation, sediment trapping and water quality maintenance functions. Where erosion is severe, the wetlands can actually become sources of sediment, rather than sediment sinks. Channel incision and the resultant local drop in soil water table can also lead to the desiccation of wetland habitat and terrrestrialisation of the wetland vegetation.

The floodplain wetland also plays an important role in biodiversity support, as highlighted above. In this regard, the water inputs from adjacent hillslope seepage wetlands and small drainage lines play a very important role. Although the contribution from these sources does not normally significantly contribute to flooding under high flow conditions, under lower flow conditions contributions from these systems play a very important role in supporting the different habitats found within the floodplain; specifically the increased soil saturation often found near the edge of the floodplains is derived from these systems.

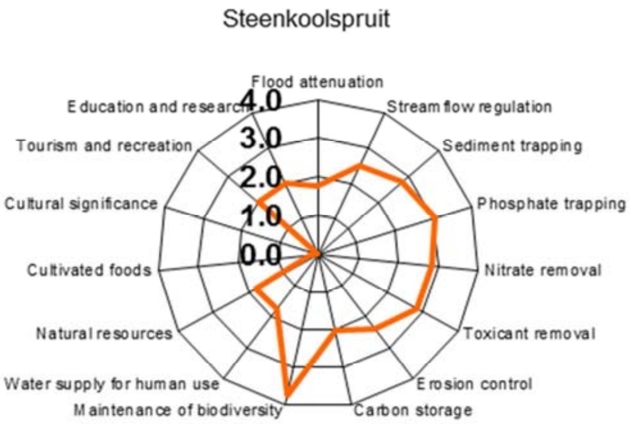


**Figure 17. WET-EcoServices assessment result for the Steenkoolspruit Floodplain.**

## *5.3 PES Assessment Results*

The dominant land use with the study area and surroundings is that of agriculture, which includes both extensive cultivation and livestock grazing. These activities have resulted in direct changes to wetland habitat where they intrude into wetland areas (e.g. cultivation of hillslope seepage wetlands), but also in indirect changes through impacting on the runoff characteristics of the landscape and the hydrology supporting the wetlands. A significant impact to the wetlands on site is that of erosion and channel incision, which in many of the valley bottom wetlands on site is severe.

Reduced vegetation cover due to cultivation and overgrazing, together with soil compaction in cultivated areas and especially on roads, has likely resulted in somewhat increased surface runoff volumes and velocities. Where flow concentration occurs due to poorly sited and/or designed farm roads, dam spillways, road culverts etc., channel incision and gully erosion has resulted within wetland areas. As a consequence, the local water table drops, leading to partial desiccation of the wetland habitat and terrestrialisation of the vegetation.

This is exacerbated by the numerous small farm dams within the project area and the catchment areas of the wetlands on site. 74 farm dams were identified within the project area. These dams impound flows, resulting in decreased flows within downstream wetlands, especially where dams are used to abstract water for irrigation purposes. Dams also trap sediments and at the same time concentrate flows through spillways, resulting in downstream erosion as sediment-hungry flows are released as point source discharges into downstream wetlands.

Extensive cultivation has also occurred within the hillslope seepage wetlands on site, leading to the complete transformation of wetland vegetation. Where wetlands are currently cultivated, no natural vegetation remains. Previously cultivated wetlands have either been converted to planted pastures (typically Eragrostis pastures on site) or have become dominated by pioneer and ruderal species, often dominated by dense stands of the alien cosmos flower, *Bidens Formosa*.

Further impacts observed include:

- Alien vegetation infestations, with alien tree stands such as *Populus canescens*, *Acacia mearnsii* and *Eucalyptus* being especially significant;
- Numerous road crossings, both from public roads and farm roads;
- Farm dams;
- Breached dam walls leading to flow concentration; and
- Heavy livestock grazing and trampling.

The majority of wetlands on site, 58 %, are Moderately Modified (PES category C), though a significant extent of wetland habitat, 29 %, is considered Largely Modified (PES category D). Only around 8 % of the wetlands on site are still considered to be in largely natural (PES category B) condition, and consist almost exclusively of hillslope seepage wetlands that have not been significantly cultivated and have not been affected by gully erosion.

Channelled valley bottom wetlands have in the most part been significantly impacted by erosion, channel incision and dam building, resulting in most of these wetlands being considered Largely to Seriously Modified.

Unchannelled valley bottom wetlands, although making up only a very small proportion of the wetland systems on site, were generally found to be the least impacted wetland type, with 80% of unchannelled valley bottom wetlands considered in Largely Natural condition.

48% of hillslope seepage wetlands were considered to be in Moderately Modified condition, while 36% were considered Largely Modified, mostly as a result of current and historic cultivation within these hillslope seepage wetlands.

Floodplain and pan wetlands were found to be generally Moderately Modified.

**Table 6. Results of the PES assessment.**

| Wetland Type | B | | C | | D | | E | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|
| | Area | % | Area | % | Area | % | Area | % | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Channelled Valley Bottom | 0.4 | 0.24% | 14.6 | 8.15% | 87.5 | 48.80% | 76.8 | 42.81% | 179.3 |
| Floodplain | 0.0 | 0.00% | 902.4 | 94.63% | 51.2 | 5.37% | 0.0 | 0.00% | 953.6 |
| Hillslope Seepage | 285.9 | 10.21% | 1348.7 | 48.17% | 997.7 | 35.63% | 167.5 | 5.98% | 2799.8 |
| Depression/Pan | 0.0 | 0.00% | 24.3 | 89.54% | 2.0 | 7.39% | 0.8 | 3.08% | 27.2 |
| Unchannelled Valley Bottom | 17.3 | 81.97% | 2.5 | 11.61% | 1.4 | 6.41% | 0.0 | 0.00% | 21.1 |
| **TOTAL** | **303.7** | | **2292.5** | | **1139.7** | | **245.1** | | **3980.9** |
| % of total wetland area | 7.63% | | 57.59% | | 28.63% | | 6.16% | | 100% |

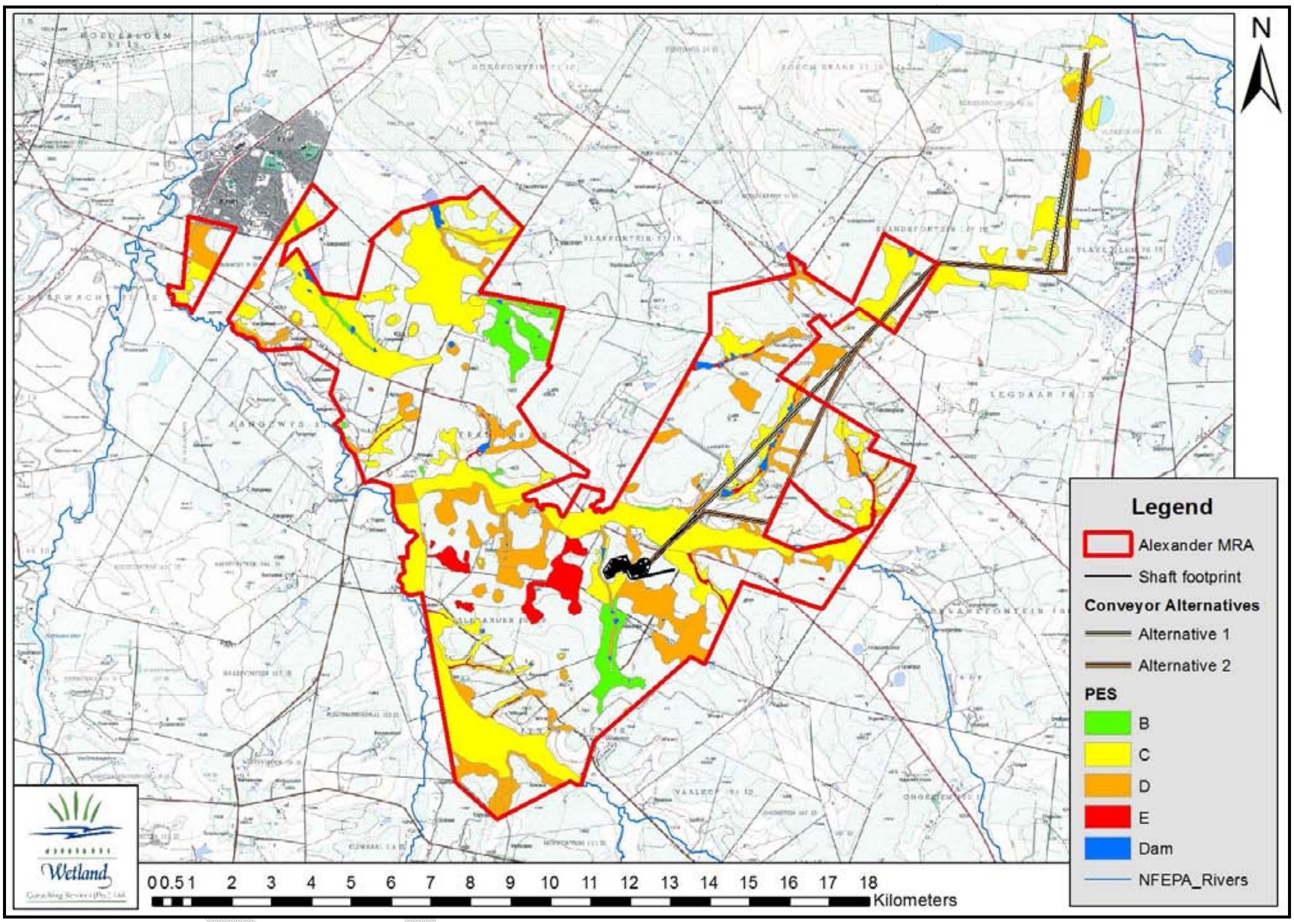


Figure 18. Map showing the results of the PES assessment.

## 5.4 EIS Assessment Results

"Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbances and its capability to recover from disturbance once it has occurred. In determining the EIS of a wetland, the following factors are considered:

- Biodiversity – i.e. the presence of rare and endangered species, populations of unique species, species richness, diversity of habitat types, and migration/breeding and feeding sites for wetland species.

- Hydrology – i.e. sensitivity to changes in the supporting hydrological regime and/or changes in water quality.
- Functionality – i.e. flood storage, energy dissipation and particulate/element removal.
- Ecological Integrity – taken from the result of the PES assessment

The wetlands within the study area all form part of the Olifants River Primary catchment which is a heavily utilised and economically important catchment. Wetlands and rivers within the Olifants River Catchment upstream of Loskop Dam have been greatly impacted upon by various activities, which include mining, power stations, water abstraction, urbanization, agriculture etc. As a result of these impacts serious water quality concerns and also water quantity concerns have been raised within the sub-catchment, also specifically within the Witbank Dam sub-catchment, which is fed by the Olifants River, with its most significant tributary upstream of the Witbank Dam being the Steenkoolspruit. Given this situation, and the fact that wetlands can support functions such as water purification and stream flow regulation, a high importance and conservation value is placed on all wetlands and rivers within the catchment that have as yet not been seriously modified. Within this context an EIS assessment was conducted for every hydro-geomorphic wetland unit identified within the study area. Further considerations that informed the EIS assessment include:

- The location of the study area within a vegetation type (Eastern Highveld Grassland) considered to be extensively transformed and threatened, and classed as ***Vulnerable.***
- The wetland ecosystem type of the area, Mesic Highveld Grassland Group 4 wetlands, is considered to be ***Critically Endangered.***
- The classification of a significant portion of the wetlands within the study area associated with the floodplain wetlands as Critical Biodiversity Areas: Irreplaceable 7 Optimal in the Mpumalanga Biodiversity Sector plan 2013.

It is these considerations that have informed the scoring of the systems in terms of their ecological importance and sensitivity. The results of the assessment and rankings based on our current understanding of the wetlands is illustrated in Figure 15 and summarised in Table 6.

**Table 7. Results of the updated EIS assessment.**

| **Wetland Type** | **High** | | **Moderate** | | **Low/Marginal** | | **TOTAL** |
|---|---|---|---|---|---|---|---|
| | **Area** | **%** | **Area** | **%** | **Area** | **%** | |
| Channelled Valley Bottom | 2.7 | 1.51% | 54.0 | 30.57% | 119.9 | 67.92% | 176.504 |
| Floodplain | 902.4 | 94.63% | 51.2 | 5.37% | 0.0 | 0.00% | 953.614 |
| Hillslope Seepage | 306.8 | 10.96% | 1505.9 | 53.79% | 987.1 | 35.26% | 2799.76 |
| Depression/Pan | 3.9 | 14.50% | 20.4 | 75.03% | 2.8 | 10.46% | 27.1701 |
| Unchannelled Valley Bottom | 0.0 | 0.00% | 20.9 | 100.00% | 0.0 | 0.00% | 20.8579 |
| **TOTAL** | **1215.80289** | | **1652.250553** | | **1109.851544** | | **3977.9** |
| % of total wetland area | 30.56% | | 41.54% | | 27.90% | | |

Based on the EIS assessment, around 30 % of the wetlands, consisting mostly of floodplain wetlands and hillslope seepage are considered of High ecological importance and sensitivity. This indicates wetlands which are ecologically important on a provincial or national scale and which play a role in moderating the quantity and quality of water of major rivers. The remaining wetlands were rated as being of Moderate (42%) or Low/Marginal (28%) ecological importance. The wetlands classed as being of low/marginal ecological importance consist mostly of hillslope seepage and valley bottom wetlands that have been seriously modified due to cultivation taking place within the wetlands, extensively modified by the construction of various impoundments, or have experienced severe erosion and channel incision.

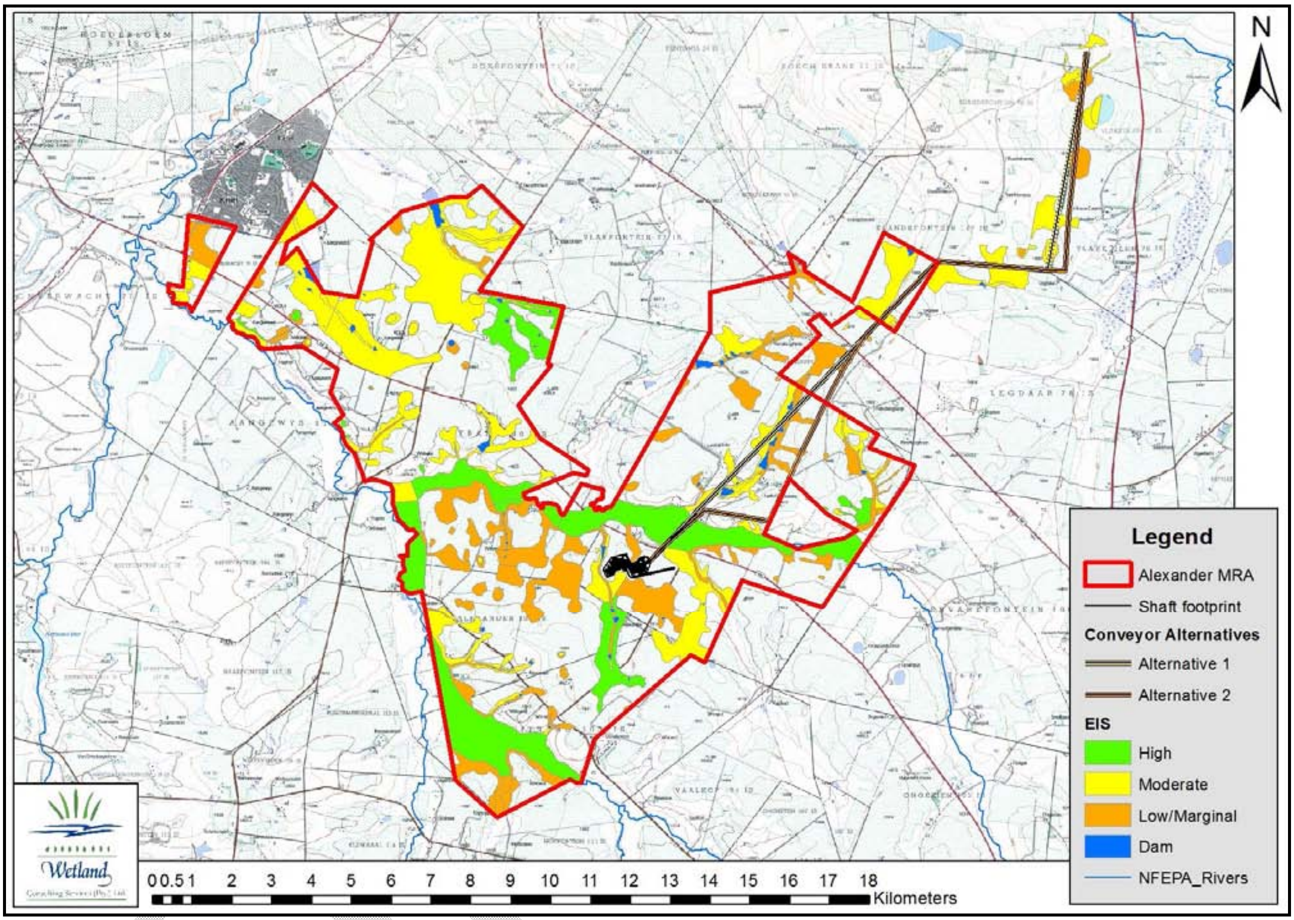


**Figure 19. Results of the updated EIS assessment.**

# 6. IMPACT ASSESSMENT

## *6.1 Project Description*

The following summarised project description has been extracted from the Scoping Report for the Proposed Alexander Project (March 2016) as compiled by Synergistics.

The proposed Alexander Project will involve the underground mining of coal on various farm properties located in the Ecca Group of the Karoo Basin. The proposed project will be constructed on land previously used for agriculture, with an estimated prospecting right area/proposed mining right area of 10,700ha, an estimated underground mine area of ~ 7,300ha, and a surface area of disturbance of 220ha (shaft complex ~ 120ha, and overland conveyor ~ 100ha). The life of mine (LOM) is approximately between 30 and 35 years.

Underground mining activities will be undertaken as part of the proposed Alexander Project which will be designed to process ~ 6 million tonnes per annum during steady state production. Although the No. 2, 3, 4 and 5 coal seams are all developed within the Alexander Project area, only the No. 4 seam is considered within this mining right application. The No. 4 seam is on average 4.90m thick and occurs at a depth of 63m below surface with the preferred quality situated in the lower two-thirds of the seam. Two shafts will be required for the proposed project, one incline shaft for material and coal extraction and one vertical shaft with ventilation fans for personnel and small material access. A conveyor belt system will be linked to the incline shaft in order to transport the ROM coal extracted underground to the surface. The mining method will be the traditional Bord and Pillar method with cutting of the coal through Continuous Miner technology. Bord and Pillar is a mining system in which the mined material is extracted across a horizontal level, creating horizontal rows of rooms and pillars. In the continuous mining technology, a Continuous Miner Machine will be utilised with a large rotating steel drum that is equipped with teeth to scrape coal from the seam. The coal then gets loaded directly onto a shuttle which transfers the coal to the conveyors for transportation to the surface. Dewatering activities will be required to allow for safe mining operations.

Shaft infrastructure will include the following:

- Fencing;
- Boxcut/portal;
- Incline shaft;
- Vertical shaft and ventilation fans;
- Overland conveyor and surge/surface ROM and stone dust silo;
- Topsoil stockpiles and berms;
- Overburden rock dump/ stockpile and berm;
- Main access road (sealed);
- Internal and maintenance access gravel roads;
- Water treatment plant;
- Sewage treatment plant;
- Sub-station (Eskom yard);
- Power lines;
- Change house;
- Water holding facilities (raw water tank, fire water tank, ground level potable water storage tank and
- elevated bulk process water storage tank);
- Stormwater management facilities (drains, berms and recycled water ponds/ pollution control dam);
- Potable water, process water and sewage effluent pipelines;
- Lighting masts;
- Fuel and oil storage facilities and refuelling bays;
- Waste/salvage yard;
- Administrative block (including mine offices, kitchen, canteen, training centre, mustering/gathering
- centre and clinic/emergency room);

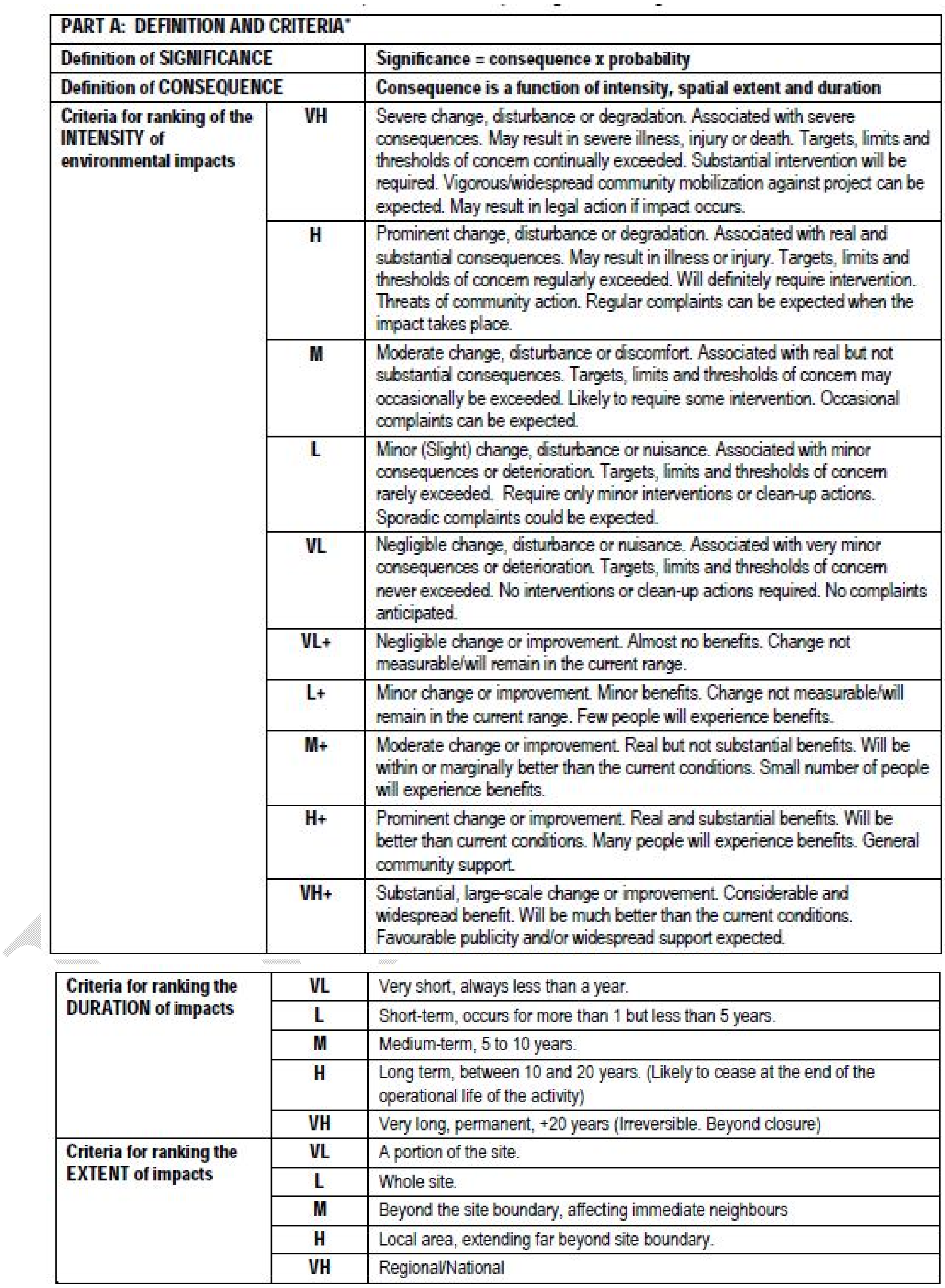
- Control room;
- Car park/ Bus stop and shelter;
- Security gate and office;
- Workshop and wash-bay/ cable yard repair workshop;
- Stores;
- Lamp rooms; and
- Flammable store.

**A processing plant will not be required** for the proposed Alexander Project, since all run-of-mine (ROM) production will be transported via the overland conveyor to Elders and then to the Goedehoop beneficiation plant.

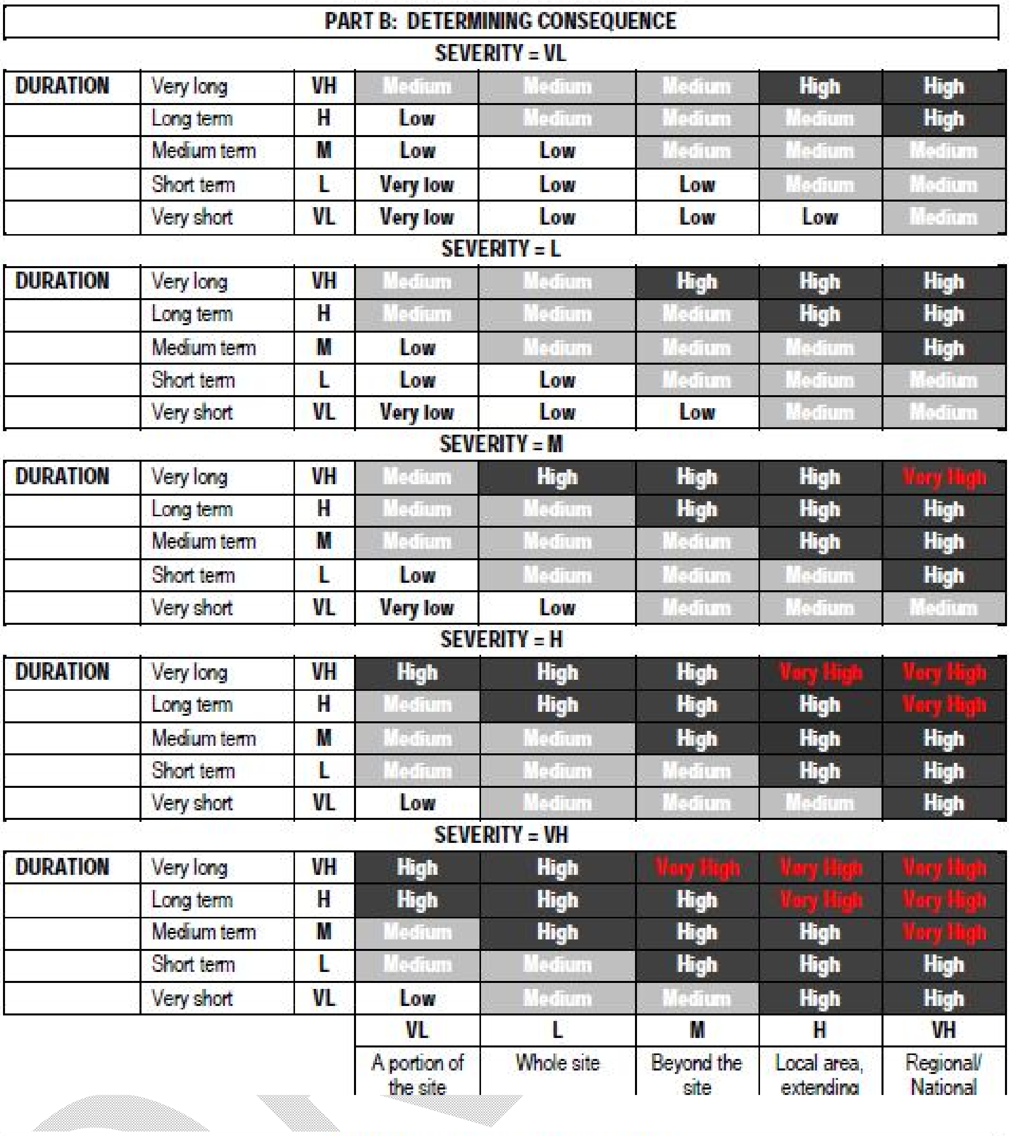
An overland conveyor with an associated service road will be constructed to transport run-of mine coal from the proposed Alexander incline shaft to the stockpile area at the Elders Colliery from where it will be transported via the Elders overland conveyor to Goedehoop Colliery for beneficiation purposes. The conveyor will be between 1.2m and 1.5m wide and ~ 18km in length, the associated servitude is ~ 55m wide.

## 6.2 Impact Assessment Methodology

The following impact assessment methodology was supplied by Synergistics.



| PART A: DEFINITION AND CRITERIA* | | |
|---|---|---|
| **Definition of SIGNIFICANCE** | | **Significance = consequence x probability** |
| **Definition of CONSEQUENCE** | | **Consequence is a function of intensity, spatial extent and duration** |
| **Criteria for ranking of the INTENSITY of environmental impacts** | **VH** | Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs. |
| | **H** | Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place. |
| | **M** | Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected. |
| | **L** | Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected. |
| | **VL** | Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated. |
| | **VL+** | Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range. |
| | **L+** | Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits. |
| | **M+** | Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits. |
| | **H+** | Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support. |
| | **VH+** | Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected. |
| **Criteria for ranking the DURATION of impacts** | **VL** | Very short, always less than a year. |
| | **L** | Short-term, occurs for more than 1 but less than 5 years. |
| | **M** | Medium-term, 5 to 10 years. |
| | **H** | Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity) |
| | **VH** | Very long, permanent, +20 years (Irreversible. Beyond closure) |
| **Criteria for ranking the EXTENT of impacts** | **VL** | A portion of the site. |
| | **L** | Whole site. |
| | **M** | Beyond the site boundary, affecting immediate neighbours |
| | **H** | Local area, extending far beyond site boundary. |
| | **VH** | Regional/National |



**PART B: DETERMINING CONSEQUENCE**

SEVERITY = VL

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DURATION | Very long | VH | Medium | Medium | Medium | High | High |
| | Long term | H | Low | Medium | Medium | Medium | High |
| | Medium term | M | Low | Low | Medium | Medium | Medium |
| | Short term | L | Very low | Low | Low | Medium | Medium |
| | Very short | VL | Very low | Low | Low | Low | Medium |

SEVERITY = L

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DURATION | Very long | VH | Medium | Medium | High | High | High |
| | Long term | H | Medium | Medium | Medium | High | High |
| | Medium term | M | Low | Medium | Medium | Medium | High |
| | Short term | L | Low | Low | Medium | Medium | Medium |
| | Very short | VL | Very low | Low | Low | Medium | Medium |

SEVERITY = M

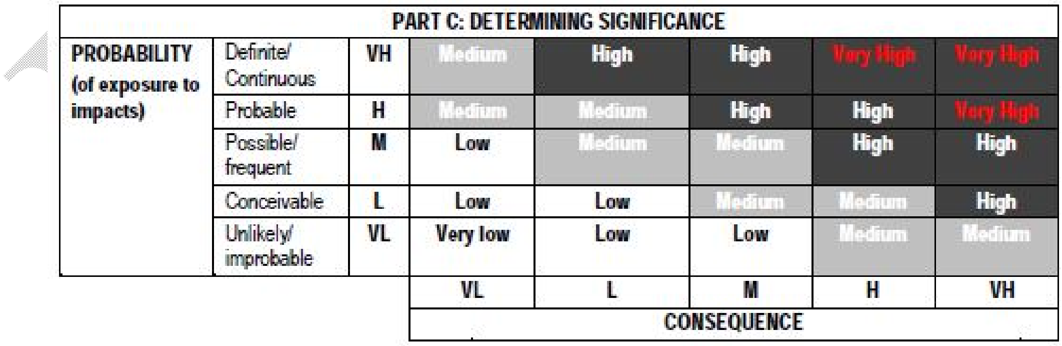
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DURATION | Very long | VH | Medium | High | High | High | Very High |
| | Long term | H | Medium | Medium | High | High | High |
| | Medium term | M | Medium | Medium | Medium | High | High |
| | Short term | L | Low | Medium | Medium | Medium | High |
| | Very short | VL | Very low | Low | Medium | Medium | Medium |

SEVERITY = H

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DURATION | Very long | VH | High | High | High | Very High | Very High |
| | Long term | H | Medium | High | High | High | Very High |
| | Medium term | M | Medium | Medium | High | High | High |
| | Short term | L | Medium | Medium | Medium | High | High |
| | Very short | VL | Low | Medium | Medium | Medium | High |

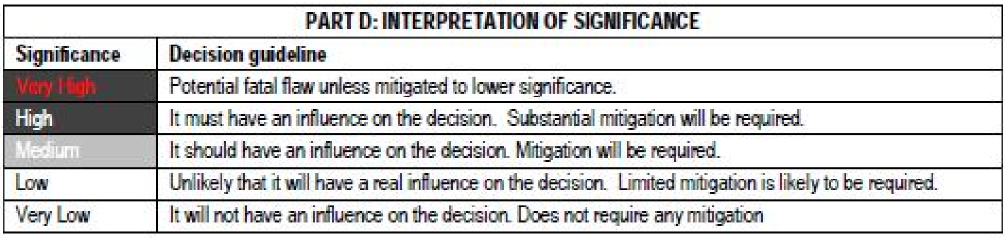
SEVERITY = VH

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DURATION | Very long | VH | High | High | Very High | Very High | Very High |
| | Long term | H | High | High | High | Very High | Very High |
| | Medium term | M | Medium | High | High | High | Very High |
| | Short term | L | Medium | Medium | High | High | High |
| | Very short | VL | Low | Medium | Medium | High | High |
| | | | VL | L | M | H | VH |
| | | | A portion of the site | Whole site | Beyond the site | Local area, extending | Regional/ National |



**PART C: DETERMINING SIGNIFICANCE**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PROBABILITY (of exposure to impacts) | Definite/ Continuous | VH | Medium | High | High | Very High | Very High |
| | Probable | H | Medium | Medium | High | High | Very High |
| | Possible/ frequent | M | Low | Medium | Medium | High | High |
| | Conceivable | L | Low | Low | Medium | Medium | High |
| | Unlikely/ improbable | VL | Very low | Low | Low | Medium | Medium |
| | | | VL | L | M | H | VH |
| | | | CONSEQUENCE | | | | |



**PART D: INTERPRETATION OF SIGNIFICANCE**

| Significance | Decision guideline |
|---|---|
| Very High | Potential fatal flaw unless mitigated to lower significance. |
| High | It must have an influence on the decision. Substantial mitigation will be required. |
| Medium | It should have an influence on the decision. Mitigation will be required. |
| Low | Unlikely that it will have a real influence on the decision. Limited mitigation is likely to be required. |
| Very Low | It will not have an influence on the decision. Does not require any mitigation |

*VH = very high, H = high, M= medium, L= low and VL= very low and + denotes a positive impact.

## 6.3 Impact Identification

### 6.3.1 Surface Infrastructure

The surface infrastructure required as part of the Alexander Project will be located on the Farms Kafferstad 79 IS and Witbank 576 IS, in an area just to the south east of the R545 crossing over the Steenkoolspruit.

The affected area is characterised by extensive cultivated areas and a number of hillslope seepage wetlands, though no wetlands will be directly affected. All surface infrastructure associated with the shaft complex will be located outside delineated wetland habitat as well as outside the 30m buffer associated with the wetlands.. The surrounding wetland habitat varies from moderately modified (PES category C) and of Moderate importance and sensitivity to largely modified (PES category D) and of low/marginal importance and sensitivity.

No direct wetland loss is expected as a result of the shaft infrastructure. Adjacent wetland habitat located downslope is however likely to be indirectly impacted through a reduction in flows, both in terms of surface flow (due to exclusion of part of the catchment as a dirty water area) and sub-surface flow (reduced recharge of interflow and lowering of the local groundwater table due to the boxcut).

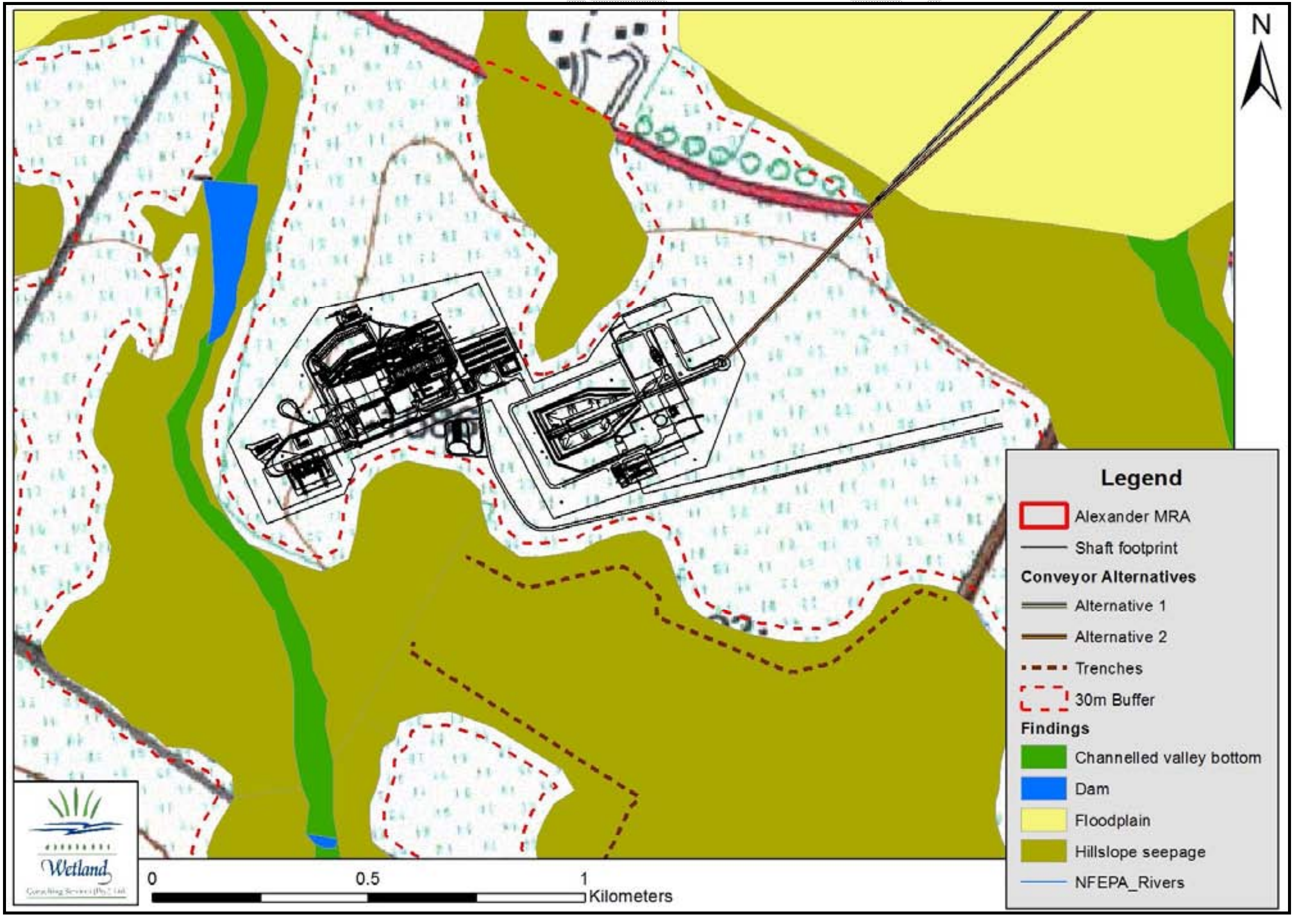


**Figure 20. Map of the proposed surface infrastructure in relation to the delineated wetlands.**

Expected impacts due to the proposed shaft infrastructure:

**Construction Phase:**
Loss and disturbance of wetland habitat
Increased sediment transport into wetlands
Water quality deterioration
Decreased flow inputs to adjacent wetlands

**Operational Phase:**
Water quality deterioration
Decreased flow inputs to adjacent wetlands
Discharge of stormwater into wetlands

**Decommissioning & Closure Phase:**
Water quality deterioration
Increased sediment transport into wetlands
Increased alien vegetation

### *6.3.2 Conveyor Servitude*

A conveyor servitude of roughly 18-19km in length will be required to connect the Alexander Project shaft area to the proposed Elders Colliery conveyor to the north east. Associated with the conveyor belt, and following the same servitude, will be a service road. This will entail a servitude approximately 55 m wide.

The conveyor servitude will be required to run in a north easterly direction from the surface infrastructure area to link up with the proposed Elders Colliery conveyor just to the south of the Olifants River. Two alternative alignments are assessed as part of this study:

**Alternative 1** – 18 km with two transfer stations
**Alternative 2** – 19.3 km with 4 transfer stations

Conveyor structures will be constructed above ground with structural steel gantries on reinforced concrete supports. At river crossings the gantries will be designed to span the river crossing and ensure a 1m freeboard above the 1:100 year flood level. The river bed and bank will be protected with gabions. No cut and fill will be required for the conveyor, though some fill material will be required for service road construction.

The two conveyor alternatives are illustrated in Figure 21. 13 wetland crossings have been identified along Alternative 1 and 11 wetland crossings along Alternative 2.

The most significant impacts associated with the proposed conveyor revolve around firstly the concentration of flows and subsequent erosion within the wetlands, and secondly around the fragmentation of habitat.

The shallow nature of the soils within hillslope seepage wetlands crossed by the conveyor servitude makes these soils especially susceptible to erosion. Shallow soils become quickly saturated, leading to increased surface runoff and increased risk of erosion. The service road is likely to represent the biggest risk in this regard as it is likely to be constructed on fill, whereas the conveyor will be raised above the ground surface on steel gantries.

Linear infrastructure is virtually always associated with habitat fragmentation, if the linear infrastructure presents a barrier to faunal movements. The Steenkoolspruit floodplain wetland, which represents a Critical Biodiversity Areas in terms of the Mpumalanga Biodiversity Sector Plan and which forms some of the most extensive natural habitat remaining on site is likely to be most impacted in this regard as the floodplain is considered to represent an important movement corridor for wildlife through a highly transformed agricultural landscape. However, it must be borne in mind that the Steenkoolspruit floodplain is already crossed by numerous roads and fences that play a role in restricting wildlife movements.

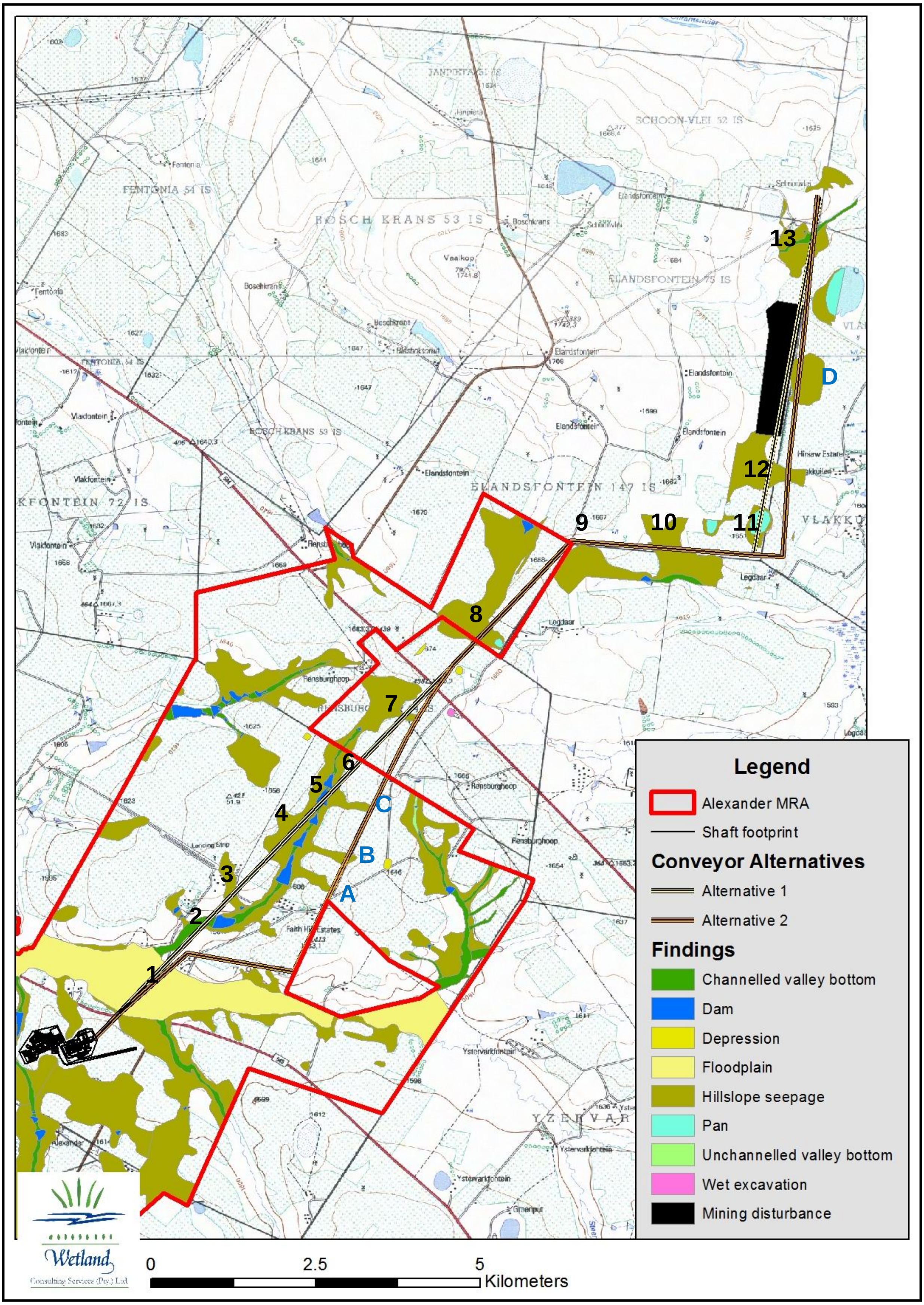


Figure 21. Map of the delineated wetlands along the proposed conveyor route.

**Table 8. Table comparing the length of wetland crossings between Alternative 1 and Alternative 2. Refer to Figure 21 for the numbering and locations of crossings.**

| Wetland Crossing | Length of Crossing | |
|---|---|---|
| | Conveyor Alternative 1 | Conveyor Alternative 2 |
| 1 | 1 051 m | 1 064 m |
| 2 | 250 m | N/A |
| 3 | 178 m | N/A |
| 4 | 1031 m | N/A |
| 5 | 186 m | N/A |
| 6 | 258 m | N/A |
| 7 | 118 m | 69 m |
| 8 | 359 m | 359 m |
| 9 | N/A | N/A |
| 10 | 472 m | 472 m |
| 11 | 614 m | N/A |
| 12 | 428 m | 192 m |
| 13 | 484 m | 463 m |
| A | N/A | 79 m |
| B | N/A | 183 m |
| C | N/A | 50 m |
| D | N/A | 701 m |
| **TOTAL** | **5 429 m** | **3 632 m** |

Expected impacts due to the proposed conveyor infrastructure:

**Construction Phase:**
Loss and disturbance of wetland habitat
Increased risk of erosion within wetlands
Increased sediment transport into wetlands
Water quality deterioration
Habitat fragmentation
Establishment and spread of alien species

**Operational Phase:**
Water quality deterioration
Disturbance of wetland habitat

**Decommissioning & Closure Phase:**
Disturbance of wetland habitat
Increased sedimentation in adjacent wetlands
Establishment and spread of alien species

### *6.3.3 Underground Mining*

The proposed mining of the No. 4 seam by underground bord-and-pillar mining methods will involve the undermining of over 2 274 ha of wetlands, consisting mostly of hillslope seepage wetlands (1 147 ha), but also including significant areas of floodplain and valley bottom wetlands. Roughly 50 % of the affected wetlands are in a PES category C, with about 30 % in a category D.

**Table 9. Summary of wetland types and extent to be undermined.**

| Wetland | Area (ha) | % of underground mining area | PES B | PES C | PES D | PES E |
|---|---|---|---|---|---|---|
| Channelled valley bottom | 87.9 | 1.4% | 0.0 | 4.8 | 54.9 | 28.1 |
| Floodplain | 499.3 | 7.7% | 0.0 | 497.9 | 1.4 | 0.0 |
| Hillslope seepage | 1616.7 | 25.0% | 213.4 | 625.4 | 613.5 | 164.5 |
| Pan | 18.3 | 0.3% | 0.0 | 17.8 | 0.5 | 0.0 |
| Unchannelled valley bottom | 2.1 | 0.0% | 1.3 | 0.9 | 0.0 | 0.0 |
| Dam | 50.1 | 0.8% | 0.0 | 0.0 | 0.0 | 0.0 |
| TOTAL | 2274.3 | 0.4 | 214.6 | 1146.8 | 670.3 | 192.6 |

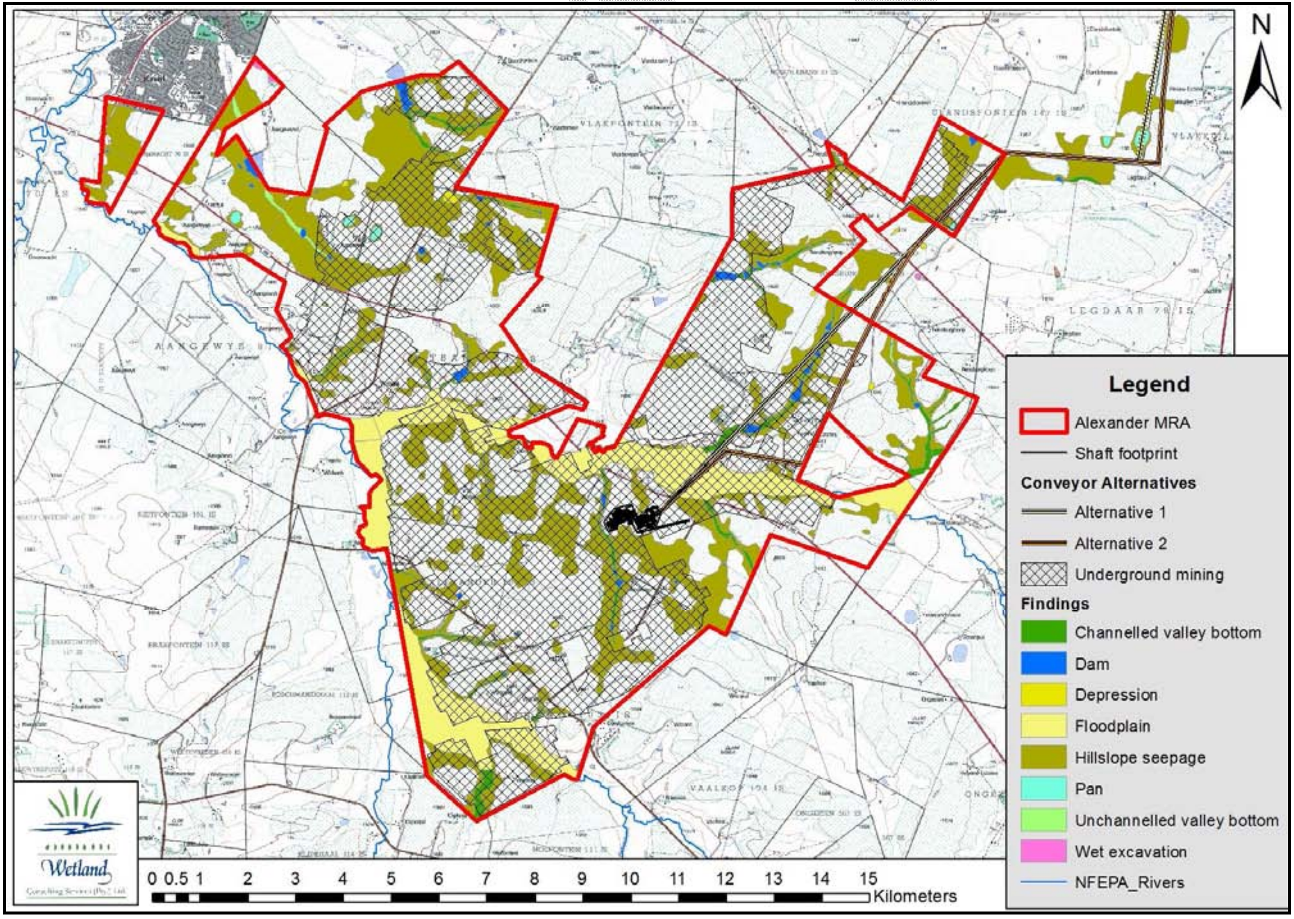


**Figure 22. Map of the proposed undermining area in relation to the delineated wetlands.**

The biggest concern from a wetland perspective regarding the proposed undermining is the potential loss of surface water and shallow groundwater supporting the wetland into the mined out voids underground. The proposed mining method (bord and pillar) seeks to ensure structural stability of the overlying rock strata and prevent any reduction in surface flow and shallow groundwater seepage; if this is achieved, the proposed underground mining is unlikely to significantly affect the wetlands. This is based on the assumption that deeper groundwater does not play a role in supporting the wetlands on site.

**For the purpose of this impact assessment, it is assumed that the shallow weathered aquifer will remain generally intact above the undermined areas. This assumption will however need to be verified against the findings of the groundwater specialist studies once such a study is complete.**

Expected impacts due to the proposed underground mining of coal:

**Construction Phase:**
Construction of the boxcut and shaft access to the underground mining area has been included under the assessment of impacts associated with the construction of the shaft complex. Underground mining of coal will only commence during the operational phase.

**Operational Phase:**
Subsidence and loss of surface water to groundwater
Decreased flow in wetlands due to loss of groundwater inputs

**Decommissioning & Closure Phase:**
Water quality deterioration due to decant
Establishment of acid seeps and loss of wetland habitat

## 6.4 Impact Assessment

### 6.4.1 Surface Infrastructure

#### 6.4.1.1 Construction Phase – Loss and disturbance of wetland habitat

As indicated above, no wetlands fall within the direct development footprint of the proposed shaft infrastructure, and a 30m buffer has been maintained around all wetlands. **No direct loss of wetland habitat is therefore expected**.

However, construction activities, if not strictly controlled, could also result in disturbances to the wetland vegetation and habitat adjacent to the development footprints through for example uncontrolled driving in the wetland area, fire, construction of associated infrastructures, or temporary stockpiling of material in the wetland area. Such disturbances can lead to increased erosion in the wetlands (e.g. preferential flow paths created by vehicle tracks), displacement of wetland fauna, changes in wetland vegetation and invasion by alien vegetation. Blasting activities are also likely to result in disturbance and possibly displacement to wetland fauna.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Loss and disturbance of wetland habitat | **M** | **L** | **VL** | **Low** | **Possible** | **Medium** |

*Mitigation*

The shaft footprint was adjusted to fall outside delineated wetland areas and an associated 30m buffer zone.

The following further mitigation measures are recommended:

- All construction areas should be fenced off prior to commencement of vegetation clearing activities on site so as to prevent access to adjacent wetlands and their associated buffer zone by construction machinery and personnel. In addition, all wetland areas should be clearly marked and demarcated as such to alert construction staff on site. All construction staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process.
- Develop and implement a construction stormwater management plan prior to the commencement of site clearing activities.
- No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located away from these areas, with a minimum buffer of 30m maintained from delineated wetland boundaries.
- Rehabilitate and re-vegetate all disturbed areas as soon as possible following disturbance.
- An alien vegetation management plan should be drawn up by the Environmental Co-ordinator and implemented. Regular removal of invasive alien species should be undertaken. This should extend right through to the decommissioning and closure phase of the project.

#### 6.4.1.2 Construction Phase – Increased sediment transport into wetlands

Stripping of vegetation will increase volumes and velocities of surface runoff generated from the affected areas, increasing erosion risk within downslope receiving wetlands. Soil compaction due to movement of machinery during construction will further increase runoff, while vehicle ruts and tracks resulting from construction activity could provide preferential flow paths that lead to flow concentration, again increasing erosion risk.

Increased sediment loads transported into adjacent wetlands from the sediment rich runoff generated on site will be deposited within the wetlands as flows slow down. Deposited sediments are likely to be colonised by pioneer and ruderal species, leading to deterioration of habitat quality.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sediment transport into wetlands | **L** | **L** | **M** | **Medium** | **Probable** | **High** |

*Mitigation*

A construction stormwater management plan must be developed and implemented prior to the commencement of large scale vegetation clearing activities or construction activities and be maintained until the end of the construction phase. Such a plan should aim to minimise the transport of sediment off site as well as prevent the discharge of high velocity flows into downslope wetlands. Sediment traps and sediment barriers should be installed where necessary, and discharge points should be protected against erosion and incorporate energy dissipaters.

Vegetation clearing, soil stripping and major earthmoving activities should be phased to minimise the extent of bare soils surfaces exposed at any one time. Vegetation clearing and soil stripping should also only be undertaken immediately preceding the onset of construction activities on site, i.e. ideally not more than 7 days before the onset of construction activities. A scenario of cleared areas lying bare and unused for weeks on end must be avoided.

To minimise the impact of increased runoff and sediment transport into adjacent wetlands, vegetation clearing and soil stripping should be concentrated in the dry season. Given the duration of construction activities as well as uncertainties around the commencement date, limiting all construction activities to the dry season are however likely to be impossible.

- Erosion within the construction site must be minimised through the following:
  - Limiting the area of disturbance and vegetation clearing to as small an area as possible;
  - Where possible, undertaking construction during the dry season;
  - Phasing vegetation clearing activities and limiting the time that any one area of bare soil is exposed to erosion;
  - Control of stormwater flowing onto and through the site. Where required, stormwater from upslope should be diverted around the construction site;
  - Prompt stabilisation and re-vegetation of soils after disturbance and construction activities in an area are complete; and
  - Protection of slopes. Where steeper slopes occur, these should be stabilised using geotextiles or any other suitable product designed for the purpose.
- Sediment transport off the site must be minimised through the following:
  - Establishing perimeter sediment controls. This can be achieved through the installation of sediment fences along downslope verges of the construction site. Where channelled or concentrated flow occurs, reinforced sediment fences or other sediment barriers such as sediment basins should be used (refer to US EPA guidelines on Stormwater Pollution Prevention);
  - Discharge of stormwater from the construction site into adjacent grassland rather than directly into wetland habitat. Discharged flows must be slow and diffuse; and
  - Regular inspection and maintenance of sediment controls

#### 6.4.1.3 Construction Phase - Water quality deterioration

During the construction phase, as activities are taking place in close proximity to wetlands, there is a possibility that water quality can be impaired. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment within the wetlands. It is likely that hydrocarbons will be stored and used on site, as well as cement and other potential pollutants.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **L** | **L** | **L** | **Low** | **Probable** | **Medium** |

*Mitigation*

Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 50m from a wetland or water course. No abstraction of water from the wetlands or dams should be allowed unless expressly authorized in the IWULA.

In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.

Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the Environmental Co-ordinator and the relevant authorities (DWA) immediately, with specialists appointed to oversee the clean-up operations.

#### 6.4.1.4 Construction Phase - Decreased flow inputs to adjacent wetlands

Construction of the shaft and associated surface infrastructure will result in decreased flow inputs to adjacent wetlands in two ways:

- Exclusion of the dirty water areas from the surrounding catchments, decreasing water yield to downslope wetlands; and
- The excavations associated with the shaft are likely to result in a drawdown of the local water table, potentially decreasing flows to adjacent wetlands that are in contact with the shallow weathered aquifer and fall within the drawdown cone.

Based on our understanding, the wetlands on site are likely to be maintained predominantly by surface flows and interflow within the soil profile, as well as in some cases the shallow weathered groundwater aquifer. It is considered unlikely that the deeper confined aquifer plays a role in supporting the wetlands on site. Proposed mining activities will impact on surface flows and interflow by excluding dirty water areas from draining into the adjacent downstream catchment. Surface water is likely to be captured in stormwater infrastructure and interflow will be intercepted by excavations and cut-off trenches.

The deeper excavations of the shaft will probably result in the formation of a drawdown cone around the shaft. This could have a significant impact on some of the wetlands where there is a link to the weathered aquifer that feeds the wetlands. The weathered aquifer is often in contact with wetland soils and is therefore the cause for keeping wetland soils saturated for certain periods mostly in summer. In many cases however wetlands are delinked from shallow groundwater in which case they are either solely rain fed or receive interflow typically from the soil-bedrock interface. This interflow typically reaches wetlands soils where the soil profile is relatively shallow or where water is forced to the surface.

The upper reaches of hillslope seepage wetlands affected by the proposed shaft area are considered unlikely to receive significant inputs from the shallow groundwater aquifer. However shallow groundwater is likely to play a role in supporting the adjacent valley bottom wetlands and also in encouraging interflow.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Decreased flow inputs to adjacent wetlands | **M** | **H** | **M** | **High** | **Possible** | **High** |

*Mitigation*

Dirty water areas should be kept as small as possible, while still ensuring the effective separation of clean and dirty water. All clean water from upslope of the dirty water areas should be diverted around the dirty water areas and discharged back into the environment:

- Clean water diversions should ideally take the form of grassed swales rather than simple excavated trenches that present an erosion risk.
- The clean water diversion discharge points should be protected against erosion and must incorporate energy dissipating structures to prevent erosion in receiving wetlands.
- Discharge points should be regularly inspected and maintained to ensure efficient functioning. Any observed erosion damage should be repaired immediately and the cause addressed.

There is little opportunity to mitigate against the impact of drawdown of shallow groundwater. The mitigation measures as detailed in the specialist groundwater report should be followed in this regard.

#### 6.4.1.5 Operational Phase - Water quality deterioration

As part of supporting activities for the underground mining activities, numerous hazardous and potentially polluting substances will be utilised and possibly temporarily stored on site, including for example diesel, oil, cement explosives etc. Spillages and leaks of these substances could result in the deterioration of water quality should they enter the adjacent wetland areas via surface runoff.

Stockpiling of any carbonaceous material or overburden could also result in contaminated runoff and/or seepage entering adjacent wetlands.

Water leaking or overflowing from any dirty water retention dams or PCD's on site could also lead to water quality deterioration.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **M** | **H** | **L** | **Medium** | **Probable** | **High** |

*Mitigation*

All hazardous substances should be stored on impervious surfaces, outside any wetland areas, that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the Environmental Co-ordinator. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site.

Any carbonaceous material stockpiled on site must be located within a dirty water area isolated from the surrounding catchment and all runoff and seepage from the stockpile contained. No discharge of such dirty water may take place on site.

All PCD's should be suitably lined and designed as per the required specifications and legislation to ensure that no overflow occurs at least up to the 1:50 year return event. Management of water levels within the PCD should be carefully controlled to ensure that the required storage capacity is always available. Water quality and biomonitoring plans should be implemented to monitor for water quality deterioration downslope of any dirty water areas, carbonaceous stockpiles, PCD's or any other potentially polluting activity.

#### 6.4.1.6 Operational Phase - Decreased flow inputs to adjacent wetlands

This impact is a continuation of the impact described under Section 6.4.1.4 above. The impact will commence in the construction phase and extend right through to the decommissioning phase.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Decreased flow inputs to adjacent wetlands | **M** | **H** | **M** | **High** | **Possible** | **High** |

*Mitigation*

Dirty water areas should be kept as small as possible, while still ensuring the effective separation of clean and dirty water. All clean water from upslope of the dirty water areas should be diverted around the dirty water areas and discharged back into the environment:

- Clean water diversions should ideally take the form of grassed swales rather than simple excavated trenches that present an erosion risk.
- The clean water diversion discharge points should be protected against erosion and must incorporate energy dissipating structures to prevent erosion in receiving wetlands.
- Discharge points should be regularly inspected and maintained to ensure efficient functioning. Any observed erosion damage should be repaired immediately and the cause addressed.

There is little opportunity to mitigate against the impact of drawdown of shallow groundwater. The mitigation measures as detailed in the specialist groundwater report should be followed in this regard.

#### 6.4.1.7 Operational Phase - Discharge of stormwater into wetlands

Impermeable surfaces and compacted soils associated with the shaft infrastructure (e.g. road surfaces) will result in increased volumes and velocities of run-off. It is anticipated that this run-off will be collected in the storm water system and conveyed to the valley bottoms. Release of the storm water through point source discharges increases the risk of erosion within the valley bottoms at the discharge point.

Storm water also typically contains various pollutants that could contribute to deteriorating the water quality in the wetlands where storm water is released into the valley bottoms.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Discharge of stormwater into wetlands | **L** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

- Clean and dirty storm water need to be separated.
- No contaminated water should be allowed to enter the clean storm water system.
- Dirty storm water may not be released into the wetlands and should be contained and treated on site, or used for dust suppression. Should contaminated water enter the wetlands due to spillages or other unforeseen circumstances a wetland/water quality expert should be consulted regarding implementation of suitable mitigation and/or rehabilitation measures.

- The volumes of storm water run-off should be minimised by limiting the area of impermeable surfaces and compacted soils.
- Where possible, storm water should be conveyed through grassed swales rather than concrete channels to aid infiltration and reduce run-off volumes.
- Where storm water and/or diverted clean water is discharged into wetlands, gabions should be constructed to contain erosion. This should be done in consultation with an appropriate wetland and storm water specialist. The gabion structure should also include measures to dissipate energy of flows and to disperse flows over a greater area. This could be achieved for example by a delta shaped apron radiating out from the point of discharge at 45 degrees, with energy dissipaters spaced across the apron.

#### 6.4.1.8 Decommissioning Phase - Water quality deterioration

Decommissioning activities that involve the removal of infrastructures within the dirty water areas or associated with dirty water management systems such as PCD's could potentially result in the mobilisation of pollutants potentially trapped in the soils underlying these areas.

Runoff water following rainfall events could potentially mobilise these sediments and pollutants and transport them into adjacent wetland areas.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **M** | **M** | **M** | **Medium** | **Possible** | **Medium** |

*Mitigation*

Clean and dirty water separation should be maintained until all contaminated materials have been removed from the dirty water areas. Soils suspected of being contaminated should be analysed and, if possible, remediated on site or, if this is not possible, should be removed and disposed of offsite in suitable waste disposal facilities.

All solid waste should be removed from site and suitably disposed of in approved waste disposal sites.

#### 6.4.1.9 Decommissioning Phase - Increased sediment transport into wetlands

The mine impacted areas undergoing rehabilitation during the decommissioning phase will be susceptible to erosion during and following rehabilitation, especially in areas that are sparsely vegetated or not vegetated at all. This will result in increased sediment loads in the downslope wetlands, leading to deteriorating water quality (increased turbidity and TSS) and changes in the aquatic fauna. Changes in wetland vegetation can also occur as sediment loving plants (e.g. *Phragmites australis*) become dominant.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sediment transport into wetlands | **M** | **L** | **M** | **Medium** | **Probable** | **High** |

*Mitigation*

All disturbed areas should be landscaped to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off. Compacted soils should be ripped and scarified. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation.

#### 6.4.1.10 Decommissioning Phase - Increased alien vegetation

Following the completion of decommissioning, the recently placed and disturbed soils will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased alien vegetation | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of ten years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

### *6.4.2 Conveyor Servitude – Alternative 1*

#### 6.4.2.1 Construction Phase – Loss and disturbance of wetland habitat

13 wetland crossings have been identified along the Alternative 1 conveyor servitude, consisting of a crossing over the Steenkoolspruit floodplain, two channelled valley bottom wetland crossings, several hillslope seepage wetland crossings and a crossing across a pan wetland. Approximately 30% of the conveyor route (5.4km of the total length of 18km) will fall within wetland habitat.

Wetland habitat falling within the footprint of the proposed linear infrastructure, especially the conveyor and the service road, will be disturbed during the construction process, and some wetland habitat is also likely to be lost.

In addition, construction vehicles accessing the route, turning, offloading materials on site etc. are also likely to contribute to disturbance and destruction of wetland habitat outside the servitude. Disturbance of the wetland vegetation is also likely to provide opportunity for invasion by alien vegetation and increase the risk of erosion.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Loss and disturbance of wetland habitat | **H** | **H** | **M** | **High** | **Definite** | **Very High** |

*Mitigation*

Given that the start and end points of the required conveyor are fixed, as well as the extent of wetlands in the area, the complete avoidance of wetlands is impossible. The required conveyor runs roughly from south to north, while the Steenkoolspruit floodplain runs east to west in close proximity to the shaft area – a crossing over the Steenkoolspruit floodplain is therefore inevitable. However, the current proposed crossing will cross the floodplain at it widest point. In addition the conveyor crosses a further valley bottom wetland diagonally across a farm dam (over 100m of the conveyor will be located within the dam basin) and also crosses through the middle of a pan wetland that is known to support Red Data bird species. The Alternative 1 conveyor route is considered to be significantly flawed from a wetland perspective. **It is therefore recommended that alternative conveyor alignments be investigated and that, as a minimum, the pan wetland be avoided**.

To further minimise the significance of impacts, the following mitigation measures should be strictly enforced:

- The extent of disturbance should be limited by limiting all construction activities to the servitude as far as practically possible.
- The servitude should be fenced off using a 5 strand cattle fence or other suitable fence prior to the commencement of vegetation clearing or earthmoving activities.
- No materials should be stockpiled within the wetland areas along the route and driving within the wetland areas should be kept to an absolute minimum. Clearly defined access routes should be used.
- As far as possible, the existing road and farm tracks should be used as the service road for the conveyor and to provide access during construction as this will reduce the extent of the disturbed area along the route.
- Where possible, the service road should utilise existing road/farm track crossings, even where this requires a deviation from the conveyor alignment. No service road crossing should be allowed to be constructed across the Steenkoolspruit or across the pan.
- The conveyor should span the entire width of the active channel in floodplain and valley bottom crossings. Conveyor footings within the wetlands should be kept to a minimum.

- Post construction all alien invasive vegetation should be removed from site. This will also require long-term follow up to ensure establishment of natural vegetation in all disturbed areas.
- Ideally construction activities within wetlands should take place in winter (during the dry season). Where summer construction is unavoidable, temporary diversions of the streams might be required.

#### 6.4.2.2 Construction Phase – Increased risk of erosion within wetlands

The soils within the hillslope seepage wetlands along the conveyor route are generally fairly shallow and underlain by a soft plinthic horizon. These soils are highly susceptible to erosion. The clearing of vegetation, together with the disturbance of the soil and the potential flow concentration within wetlands during the construction phase pose a significant erosion risk, with eroded sediment transported downstream and into the Steenkoolspruit, Vlakkuilenspruit and Olifants River respectively.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased risk of erosion in wetlands | **H** | **L** | **L** | **Medium** | **Probable** | **High** |

*Mitigation*

Minimise the construction footprint within the wetland area. Clearly demarcate the required construction servitude and maintain all activities within the demarcated area.

Make use of existing roads and tracks as far as possible. Where possible, existing wetland crossings should be utilised for the service road.

Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, placement of hay bales around the within wetland construction areas and re-vegetation of disturbed areas as soon as possible.

Maintain flow connectivity in valley bottom wetlands during the construction phase by temporarily diverting streams around the construction area.

No conveyor footings should be placed within the active channel of any valley bottom wetlands. The active channel should be spanned. Placement of conveyor footings within wetland areas should be minimised, but clear spanning wetland areas is not possible. Vegetation clearing activities should be limited to the footprints of the conveyor footings. Clearing of the entire area should be avoided.

Detailed method statements must be developed for all service road crossings over wetlands. Crossing structures must be designed to ensure flow connectivity across the wetland is maintained and that no impoundment or concentration of flow occurs that could lead to habitat degradation.

Where hillslope seepage wetlands are crossed parallel to the direction of flow (i.e. perpendicular to the contour), no means of conveying flow under the road is required. However, measures should be put in place to prevent the formation of preferential flow paths along the road verges. This should be achievable through the placement of regular low berms parallel to the contour along the road verges. Where hillslope seepage wetlands are crossed perpendicular to the direction of flow (i.e. parallel to the contour), provision will need to be made to allow flows to pass through underneath the road. Key here would be to prevent the concentration of flows as this would lead to erosion at the discharge point on the downslope side, as well as partial desiccation of the wetland area. Consideration should be given to installing subsurface drains under the road. This could be achieved through installing a coarse gravel pioneer layer at natural ground level (from just below natural ground level to just above) under the pavement layers of the road through which water could flow. To prevent water just flowing along the drain, impermeable plastic trench breakers should be installed within the coarse gravel layer across the road.

Locate all stockpiles, laydown areas and temporary construction infrastructure at least 50m from the edge of delineated wetlands.

#### 6.4.2.3 Construction Phase – Increased sediment transport into wetlands

Sediment washed off the bare soil areas associated with construction areas will be deposited in wetland areas and eventually enter the Olifants River. Sediment deposition in wetlands will lead to changes in wetland vegetation.

The soils within the wetlands along the conveyor servitude are generally fairly shallow and underlain by a ferricrete horizon. These soils are highly susceptible to erosion. The clearing of vegetation, together with the disturbance of the soil and the potential flow concentration within wetlands during the construction phase pose a significant erosion risk, with eroded sediment transported downstream.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sediment transport into wetlands | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

- Install erosion prevention measures and sediment barriers prior to the commencement of construction activities.
- Minimise the construction footprint within the wetland area. Clearly demarcate the required construction servitude and maintain all activities within the demarcated area
- Make use of existing roads and tracks as far as possible

- Limit cleared areas to as small an area as possible at any one time
- Re-vegetate and rehabilitate areas as soon as possible after completion of construction
- Locate all stockpiles, laydown areas and temporary construction infrastructure at least 50m from the edge of delineated wetlands.

#### 6.4.2.4 Construction Phase – Water quality deterioration

During construction, as activities are taking place adjacent to wetlands, there is a possibility that water quality can be impaired. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment within the wetlands. It is likely that hydrocarbons will be stored and used on site, as well as cement and other potential pollutants.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 50m from a wetland or water course. No abstraction of water from the wetlands or the Steenkoolspruit should be allowed unless expressly authorized in the IWULA.

In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.

Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the Environmental Officer and the relevant authorities (DWA) immediately, with specialists appointed to oversee the clean-up operations

#### 6.4.2.5 Construction Phase – Habitat fragmentation

Construction of linear infrastructure such as a conveyor across the wetlands is likely to lead to habitat fragmentation and to provide an obstacle to free movement of faunal species associated with the wetlands. This impact will start in the construction phase but will persist for the duration of the operational phase.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Habitat fragmentation | **M** | **H** | **L** | **Medium** | **Definite** | **High** |

*Mitigation*

The conveyor should be realigned to avoid the pan wetland.

The conveyor should be constructed in such a way that sufficient space remains underneath the conveyor to allow for free movement of faunal species such as small mammals (rodents) and herpetofauna. In addition, the fence surrounding the conveyor should be of such a nature so as not to hinder movement of small rodents and herpetofauna. A standard 5 strand cattle fence is recommended.

#### 6.4.2.1 Construction Phase – Establishment and spread of alien species

Areas disturbed during the construction process will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased alien vegetation | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

An alien vegetation management plan should be compiled by an ecologist during the construction/operational phase of the mine and should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

#### 6.4.2.1 Operational Phase - Water quality deterioration

Coal spillages and coal dust from the conveyor can lead to pollution of wetlands and other water resources along the conveyor route. However, coal spillages from coal transported via conveyor are generally considered to be less than spillages from coal trucks.

Transfer stations along the conveyor are likely to increase the risk of contamination. Only 2 transfer stations will be required along Alternative 1.

Of special concern is the spillage of coal and coal dust into the pan wetland. As pans are inwardly draining, there is limited opportunity for contaminants to be flushed out of the system. Even very low inputs of contaminants will therefore accumulate over time.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

The conveyor should be realigned to avoid the pan wetland.

The conveyor should be designed and operated to minimise the likelihood of spillages. Measures such as not loading the conveyor to full capacity should be implemented to minimise spillages. Dust suppression measures should also be used.

Gantries/decking should be installed at all wetland crossings to prevent spillages directly entering wetlands. Gantries/decking should be regularly inspected and cleaned to prevent built up of coal spillages.

Transfer stations are likely to be classed as dirty water areas and all contaminated water from these areas will need to be isolated from the surrounding catchment.

Should larger spillages occur due to malfunctioning of the conveyor or for any other reason, clean-up of the spillages should be undertaken as soon as possible following the event. In this regard regular inspection of the entire conveyor route should be undertaken.

#### 6.4.2.2 Operational Phase - Disturbance of wetland habitat

Regular maintenance activities along the conveyor servitude could lead to disturbances of the wetland systems crossed by the servitude.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **L** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

All wetlands along the conveyor servitude must be clearly demarcated as sensitive habitats and staff/contractors made aware of the location and sensitivity of these habitats. No temporary laydown or stockpiling of material required for maintenance activities may take place in wetland areas.

All vehicular and machinery movement along the servitude must be restricted to the service road. No off-road driving should be allowed.

The servitude must be fenced off with a 5 strand cattle fence to prevent vehicles and staff accessing wetlands outside the servitude area. A 5 strand cattle fence is preferred to a razor wire security fence as it allows for free movement of small mammals and reptiles under the fence. If electrification of the fence is required, the lowest electrical fence strand should be positioned to still allow for free movement of small mammals and reptiles under the fence

#### 6.4.2.1 Decommissioning Phase - Disturbance of wetland habitat

The decommissioning of the conveyor and associated service road could result in the disturbance and destruction of wetland habitat. In addition, vehicles accessing the route, turning, loading materials on site etc. could also contribute to disturbance and destruction of wetland habitat outside the 55m servitude. Disturbance of the wetland vegetation is also likely to provide opportunity for erosion and invasion by alien vegetation.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Disturbance of wetland habitat | **M** | **L** | **VL** | **Low** | **Possible** | **Medium** |

*Mitigation*

Limit disturbance to wetland habitat by limiting decommissioning activities to the actual disturbance footprint. No activities should take place outside the servitude. No access to wetland areas should be allowed unless infrastructure to be decommissioned is located within a wetland area. Only make use of existing roads and tracks to access the site during decommissioning phase. Implement an alien vegetation management plan to prevent establishment and spread of alien species.

#### 6.4.2.2 Decommissioning Phase - Increased sedimentation in adjacent wetlands

The rehabilitated areas will be susceptible to erosion following rehabilitation, especially in areas that are sparsely vegetated or not vegetated at all. This will result in increased sediment loads in the downslope wetlands, leading to deteriorating water quality (increased turbidity and TSS) and changes in the aquatic fauna. Changes in wetland vegetation can also occur as sediment loving plants (e.g. *Phragmites australis*) become dominant.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sedimentation in adjacent wetlands | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

All disturbed areas should be landscape to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off. Compacted soils should be ripped and scarified. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation.

#### 6.4.2.3 Decommissioning Phase - Establishment and spread of alien species

Following the completion of decommissioning, the recently placed and disturbed soils will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased alien vegetation | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

### *6.4.3 Conveyor Servitude – Alternative 2*

#### 6.4.3.1 Construction Phase – Loss and disturbance of wetland habitat

11 wetland crossings have been identified along the Alternative 2 servitude, consisting of a crossing over the Steenkoolspruit floodplain, one channelled valley bottom wetland crossing, and several hillslope seepage wetland crossings. Approximately 19% of the conveyor route (3.6km of the total length of 19.3km) will fall within wetland habitat.

Wetland habitat falling within the footprint of the proposed linear infrastructure, especially the conveyor and the service road, will be disturbed during the construction process, and some wetland habitat is also likely to be lost.

In addition, construction vehicles accessing the route, turning, offloading materials on site etc. are also likely to contribute to disturbance and destruction of wetland habitat outside the servitude.

Disturbance of the wetland vegetation is also likely to provide opportunity for invasion by alien vegetation and increase the risk of erosion.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Loss and disturbance of wetland habitat | **L** | **H** | **M** | **Medium** | **Definite** | **High** |

*Mitigation*

Given that the start and end points of the required conveyor are fixed, as well as the extent of wetlands in the area, the complete avoidance of wetlands is impossible. The required conveyor runs roughly from south to north, while the Steenkoolspruit floodplain runs east to west in close proximity to the shaft area – a crossing over the Steenkoolspruit floodplain is therefore inevitable. However, the current proposed crossing will cross the floodplain at it widest point.

The Alternative 2 conveyor was proposed by the EIA project team in an effort to reduce the number of wetland crossings and to avoid the most sensitive wetlands. **The total length of wetland crossings for Alternative 2 is approximately 1 800m less than for Alternative 1**. In addition two crossings over one channelled valley bottom wetland have been avoided (including the crossing over a farm dam) as well as *the crossing over the pan has been avoided*. Alternative 2 therefore represents an attempt to avoid and minimise wetland impacts, as required by the mitigation hierarchy.

To further minimise the significance of impacts, the following mitigation measures should be strictly enforced:

- The extent of disturbance should be limited by limiting all construction activities to the servitude as far as practically possible.
- The servitude should be fenced off using a 5 strand cattle fence or other suitable fence prior to the commencement of vegetation clearing or earthmoving activities.
- No materials should be stockpiled within the wetland areas along the route and driving within the wetland areas should be kept to an absolute minimum. Clearly defined access routes should be used.
- As far as possible, the existing road and farm tracks should be used as the service road for the conveyor and to provide access during construction as this will reduce the extent of the disturbed area along the route.
- Where possible, the service road should utilise existing road/farm track crossings, even where this requires a deviation from the conveyor alignment. No service road crossing should be allowed to be constructed across the active channel of the Steenkoolspruit.
- The conveyor should span the entire width of the active channel in floodplain and valley bottom crossings. Conveyor footings within the wetlands should be kept to a minimum.
- Post construction all alien invasive vegetation should be removed from site. This will also require long-term follow up to ensure establishment of natural vegetation in all disturbed areas.

- Ideally construction activities within wetlands should take place in winter (during the dry season). Where summer construction is unavoidable, temporary diversions of the streams might be required.

### 6.4.3.2 Construction Phase – Increased risk of erosion within wetlands

The soils within the hillslope seepage wetlands along the conveyor route are generally fairly shallow and underlain by a soft plinthic horizon. These soils are highly susceptible to erosion. The clearing of vegetation, together with the disturbance of the soil and the potential flow concentration within wetlands during the construction phase pose a significant erosion risk, with eroded sediment transported downstream and into the Steenkoolspruit, Vlakkuilenspruit and Olifants River respectively.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased risk of erosion in wetlands | **M** | **L** | **L** | **Medium** | **Probable** | **High** |

*Mitigation*

Minimise the construction footprint within the wetland area. Clearly demarcate the required construction servitude and maintain all activities within the demarcated area.

Make use of existing roads and tracks as far as possible. Where possible, existing wetland crossings should be utilised for the service road.

Install erosion prevention measures prior to the onset of construction activities. Measures should include low berms on approach and departure slopes to crossings to prevent flow concentration, sediment barriers along the lower edge of bare soil areas, placement of hay bales around the within wetland construction areas and re-vegetation of disturbed areas as soon as possible.

Maintain flow connectivity in valley bottom wetlands during the construction phase by temporarily diverting streams around the construction area.

No conveyor footings should be placed within the active channel of any valley bottom wetlands. The active channel should be spanned. Placement of conveyor footings within wetland areas should be minimised, but clear spanning wetland areas is not possible. Vegetation clearing activities should be limited to the footprints of the conveyor footings. Clearing of the entire area should be avoided.

Detailed method statements must be developed for all service road crossings over wetlands. Crossing structures must be designed to ensure flow connectivity across the wetland is maintained and that no impoundment or concentration of flow occurs that could lead to habitat degradation. Where hillslope seepage wetlands are crossed parallel to the direction of flow (i.e. perpendicular to the contour), no means of conveying flow under the road is required. However, measures should be put in place to prevent the formation of preferential flow paths along the road verges. This should be achievable through the placement of regular low berms parallel to the contour along the road verges. Where hillslope seepage wetlands are crossed perpendicular to the direction of flow (i.e. parallel to the contour), provision will need to be made to allow flows to pass through underneath the road. Key here would be to prevent the concentration of flows as this would lead to erosion at the discharge point on the downslope side, as well as partial desiccation of the wetland area. Consideration should be given to installing subsurface drains under the road. This could be achieved through installing a coarse gravel pioneer layer at natural ground level (from just below natural ground level to just above) under the pavement layers of the road through which water could flow. To prevent water just flowing along the drain, impermeable plastic trench breakers should be installed within the coarse gravel layer across the road.

Locate all stockpiles, laydown areas and temporary construction infrastructure at least 50m from the edge of delineated wetlands.

#### 6.4.3.3 Construction Phase – Increased sediment transport into wetlands

Sediment washed off the bare soil areas associated with construction areas will be deposited in wetland areas and eventually enter the Olifants River. Sediment deposition in wetlands will lead to changes in wetland vegetation.

The soils within the wetlands along the conveyor servitude are generally fairly shallow and underlain by a ferricrete horizon. These soils are highly susceptible to erosion. The clearing of vegetation, together with the disturbance of the soil and the potential flow concentration within wetlands during the construction phase pose a significant erosion risk, with eroded sediment transported downstream.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sediment transport into wetlands | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

- Install erosion prevention measures and sediment barriers prior to the commencement of construction activities.
- Minimise the construction footprint within the wetland area. Clearly demarcate the required construction servitude and maintain all activities within the demarcated area
- Make use of existing roads and tracks as far as possible
- Limit cleared areas to as small an area as possible at any one time
- Re-vegetate and rehabilitate areas as soon as possible after completion of construction
- Locate all stockpiles, laydown areas and temporary construction infrastructure at least 50m from the edge of delineated wetlands.

### 6.4.3.4 Construction Phase – Water quality deterioration

During construction, as activities are taking place adjacent to wetlands, there is a possibility that water quality can be impaired. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment within the wetlands. It is likely that hydrocarbons will be stored and used on site, as well as cement and other potential pollutants.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 50m from a wetland or water course. No abstraction of water from the wetlands or the Steenkoolspruit should be allowed unless expressly authorized in the IWULA.

In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.

Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the Environmental Officer and the relevant authorities (DWA) immediately, with specialists appointed to oversee the clean-up operations

### 6.4.3.5 Construction Phase – Habitat fragmentation

Construction of linear infrastructure such as a conveyor across the wetlands is likely to lead to habitat fragmentation and to provide an obstacle to free movement of faunal species associated with the wetlands. This impact will start in the construction phase but will persist for the duration of the operational phase.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Habitat fragmentation | **L** | **H** | **L** | **Medium** | **Definite** | **High** |

*Mitigation*

The conveyor should be constructed in such a way that sufficient space remains underneath the conveyor to allow for free movement of faunal species such as small mammals (rodents) and herpetofauna. In addition, the fence surrounding the conveyor should be of such a nature so as not to hinder movement of small rodents and herpetofauna. A standard 5 strand cattle fence is recommended.

#### 6.4.3.6 Construction Phase – Establishment and spread of alien species

Areas disturbed during the construction process will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased alien vegetation | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

An alien vegetation management plan should be compiled by an ecologist during the construction/operational phase of the mine and should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

#### 6.4.3.7 Operational Phase - Water quality deterioration

Coal spillages and coal dust from the conveyor can lead to pollution of wetlands and other water resources along the conveyor route. However, coal spillages from coal transported via conveyor are generally considered to be less than spillages from coal trucks.

Transfer stations along the conveyor are likely to increase the risk of contamination. 4 transfer stations will be required along Alternative 2.

Of special concern is the spillage of coal and coal dust into pan wetlands. As pans are inwardly draining, there is limited opportunity for contaminants to be flushed out of the system. Even very low inputs of contaminants will therefore accumulate over time.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **L** | **H** | **M** | **Medium** | **Possible** | **Medium** |

*Mitigation*

The conveyor should be designed and operated to minimise the likelihood of spillages. Measures such as not loading the conveyor to full capacity should be implemented to minimise spillages. Dust suppression measures should also be used.

Gantries/decking should be installed at all wetland crossings to prevent spillages directly entering wetlands. Gantries/decking should be regularly inspected and cleaned to prevent built up of coal spillages.

Transfer stations are likely to be classed as dirty water areas and all contaminated water from these areas will need to be isolated from the surrounding catchment.

Should larger spillages occur due to malfunctioning of the conveyor or for any other reason, clean-up of the spillages should be undertaken as soon as possible following the event. In this regard regular inspection of the entire conveyor route should be undertaken.

#### 6.4.3.8 Operational Phase - Disturbance of wetland habitat

Regular maintenance activities along the conveyor servitude could lead to disturbances of the wetland systems crossed by the servitude.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **L** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

All wetlands along the conveyor servitude must be clearly demarcated as sensitive habitats and staff/contractors made aware of the location and sensitivity of these habitats. No temporary laydown or stockpiling of material required for maintenance activities may take place in wetland areas.

All vehicular and machinery movement along the servitude must be restricted to the service road. No off-road driving should be allowed.

The servitude must be fenced off with a 5 strand cattle fence to prevent vehicles and staff accessing wetlands outside the servitude area. A 5 strand cattle fence is preferred to a razor wire security fence as it allows for free movement of small mammals and reptiles under the fence. If electrification of the fence is required, the lowest electrical fence strand should be positioned to still allow for free movement of small mammals and reptiles under the fence

### 6.4.3.9 Decommissioning Phase - Disturbance of wetland habitat

The decommissioning of the conveyor and associated service road could result in the disturbance and destruction of wetland habitat. In addition, vehicles accessing the route, turning, loading materials on site etc. could also contribute to disturbance and destruction of wetland habitat outside the 55m servitude. Disturbance of the wetland vegetation is also likely to provide opportunity for erosion and invasion by alien vegetation.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Disturbance of wetland habitat | **M** | **L** | **VL** | **Low** | **Possible** | **Medium** |

*Mitigation*

Limit disturbance to wetland habitat by limiting decommissioning activities to the actual disturbance footprint. No activities should take place outside the servitude. No access to wetland areas should be allowed unless infrastructure to be decommissioned is located within a wetland area. Only make use of existing roads and tracks to access the site during decommissioning phase. Implement an alien vegetation management plan to prevent establishment and spread of alien species.

### 6.4.3.10 Decommissioning Phase - Increased sedimentation in adjacent wetlands

The rehabilitated areas will be susceptible to erosion following rehabilitation, especially in areas that are sparsely vegetated or not vegetated at all. This will result in increased sediment loads in the downslope wetlands, leading to deteriorating water quality (increased turbidity and TSS) and changes in the aquatic fauna. Changes in wetland vegetation can also occur as sediment loving plants (e.g. *Phragmites australis*) become dominant.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased sedimentation in adjacent wetlands | **M** | **L** | **VL** | **Low** | **Probable** | **Medium** |

*Mitigation*

All disturbed areas should be landscape to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off. Compacted soils should be ripped and scarified. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation.

#### 6.4.3.11 Decommissioning Phase - Establishment and spread of alien species

Following the completion of decommissioning, the recently placed and disturbed soils will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Increased alien vegetation | **M** | **H** | **VL** | **Medium** | **Possible** | **Medium** |

*Mitigation*

The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of five years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

### *6.4.4 Comparison of conveyor alternatives*

Both conveyor alternatives have advantages and disadvantages from a wetland perspective. Alternative 1 is the overall shorter route, but has more and longer wetland crossings, and includes the crossing of a pan known to support Red Data bird species. **This pan crossing is a significant flaw** and, if Alternative 1 should be selected, then as a minimum this pan should be avoided.

Alternative 2 is the somewhat longer route, but has less and shorter wetland crossings, as well as completely avoiding the pan. However, in order to avoid the wetlands, Alternative 2 will require an additional 2 transfer stations along the conveyor route, increasing the risk of water quality deterioration somewhat.

**In our opinion from a purely wetland perspective, the preferred conveyor route would be Alternative 2**.

**Table 10. Brief comparison between conveyor alternatives from a wetland perspective. Preferred alternative for each criteria highlighted in gree.**

| **Criteria** | **Alternative 1** | **Alternative 2** |
|---|---|---|
| Length of conveyor | 18 km | 19.3 km |
| Number of wetland crossings | 13 | 11 |
| Total length of wetland crossings | 5 429 m | 3 632 m |
| Steenkoolspruit crossing | Yes | Yes |
| Pan crossing | Yes | No |
| Channelled valley bottom crossings | 2 | 1 |

| | | |
|---|---|---|
| Transfer stations | 2 | 4 |

### *6.4.5 Underground Mining*

#### 6.4.5.1 Operational Phase - Subsidence and loss of surface water to groundwater

2 274 hectares of wetlands are likely to be undermined, consisting of mostly hillslope seepage wetlands, but also including significant portions of the Steenkoolspruit and De Beerspruit floodplain wetlands. Within the study area, virtually all of the wetlands and their catchments are dominated by sandy soils and underlain by sandstones, with the exception of the floodplain wetlands that are characterized by more clayey soils.

Should subsidence occur in wetlands as a result of the undermining of the wetlands, there are a number of possible scenarios:

- Shallow subsidence in sandstones may result in localised interception of surface water and shallow perched groundwater and percolation into the shallow aquifer. Water may continue to flow horizontally within the shallow aquifer and is not lost to deeper groundwater, therefore being of low risk to wetlands;
- Shallow subsidence in cutanic or vertic soils that are driven by surface runoff are likely to result in shallow depressions that are self-sealing due to the clay content of the soil. In this scenario, water is retained at the surface and exposed to evapotranspiration. This may cause localised changes in vegetation but is considered low risk. This scenario could occur within the floodplain wetlands but is considered unlikely in hillslope seepage wetlands, given the sandy soils;
- Shallow subsidence which is connected to the underlying fractured zone may result in the loss of shallow perched groundwater and surface water to deeper groundwater, with concomitant desiccation of downslope wetlands which will be transformed into terrestrial habitat. The probability of this occurring depends on the permeability of the overburden and degree of fracturing. However, this scenario is only likely to result in spatially localised ingress that is unlikely to affect the water balance at a landscape level. If the gaps between the fractures of the rock are sufficiently large to allow the export of soil material from the surface, an open hole may develop, posing a physical threat to people and livestock.

A wetland is by definition a specific area of land where sufficient water occurs close enough to the soil surface for long enough periods to influence plant growth. This shallow saturation is often referred to as perched groundwater and is often linked to the shallow perched aquifer in the fractured Karoo sediments. For this assessment it is crucial to understand that perched groundwater exists throughout the entire study area but generally only gets close enough to the surface to be within the reach of plant roots in the wetland areas. The wetlands are therefore a product of primarily topography and soil depth which causes shallow groundwater to either reach the surface or get within close proximity of the surface.

The sources of water to hillslope seepages and valley bottom systems are therefore shallow perched groundwater as well as rainfall. Water inputs are mainly from subsurface flow in hillslope seepage wetlands and surface flow in valley bottom wetlands (with additional inputs via subsurface flow).

Where subsidence forms in sandy soils towards the top of hillslopes, there may be some localised loss of water where surface water is intercepted. Where this is underlain by a fractured sandstone aquifer there is a high risk of loss of shallow perched water to deeper groundwater. However this loss is likely to be localised within a landscape context. If the subsidence occurs in the catchment of a wetland, the impact on the wetland may or may not be felt depending on the remaining intact section of the catchment that is still contributing water to the wetland. In areas where sandy soils are prevalent and where hillslope seepage systems are extensive, as is the case within most of the study area, the risk of loss of surface water and shallow perched aquifer water to deeper groundwater when subsidence occurs is considered high, especially where subsidence occurs within wetlands.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Subsidence and loss of surface water to groundwater | **H** | **VH** | **M** | **High** | **Possible** | **High** |

*Mitigation*

Ideally, surface subsidence should be avoided. As a minimum, it is recommended that **no subsidence be allowed to take place within delineated wetland areas** and within a 100m buffer zone surrounding the wetlands. A suitable pillar safety factor must be implemented to ensure such subsidence is avoided.

#### 6.4.5.2 Operational Phase - Decreased flows in wetlands due to dewatering of groundwater aquifers

Operation of the underground mine will result in a drawdown of the local groundwater table. Typically two groundwater aquifers exist on the Highveld: a shallow weathered aquifer and a second deeper aquifer. The deeper aquifer is not thought to play a role in supporting the wetlands on site.

The majority of wetlands on site, specifically the hillslope seepage wetlands, are predominantly maintained by direct rainfall, shallow perched water tables (interflow) and the shallow weathered aquifer. For wetland units were these flow drivers remain intact during undermining, the wetlands are considered unlikely to be significantly affected by the dewatering. Some wetlands will however be impacted, with the impact likely to be most significant in the larger valley bottom and floodplain wetlands.

**For the purpose of this impact assessment, it is assumed that the shallow weathered aquifer will remain generally intact above the undermined areas. This assumption will**

**however need to be verified against the findings of the groundwater specialist studies once such a study is complete. Should the shallow weathered aquifer be significantly drawn down by mining activities, the impact significance will probably increase to Very High.**

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Decreased flow in wetlands due to dewatering | **H** | **VH** | **M** | **High** | **Probable** | **High** |

*Mitigation*

Little opportunity to mitigate as dewatering is required to allow mining to be undertaken safely.

Ideally, surface subsidence should be avoided. As a minimum, it is recommended that **no subsidence be allowed to take place within delineated wetland areas** and within a 100m buffer zone surrounding the wetlands. A suitable pillar safety factor must be implemented to ensure such subsidence is avoided.

Should flow losses be found to be significant, ecological flow releases back into the affected wetlands should be investigated.

### 6.4.5.1 Decommissioning Phase - Water quality deterioration

The mined out areas are likely to fill with water following the completion of mining activities. Once pumping of groundwater stops, groundwater levels will rebound and, if left unmanaged, will eventually start decanting. Decanting water is likely to be acidic as well as metal and sulphate rich. Given the location of the mine, decant is likely to enter into the Steenkoolspruit if left unmitigated.

| IMPACT RATING & SIGNIFICANCE | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **H** | **VH** | **H** | **Very High** | **Probable** | **Very High** |

*Mitigation*

The likelihood of decant, as well as its expected quality should be determined and measures put in place to ensure that no decant or discharge of contaminated water occurs, unless it meets the applicable resource quality objectives (RQO's). Where the RQO's are exceeded, contaminated water will need to be treated. In this regard it is recommended that a water treatment plant be established on site and that water levels within the mined out areas are actively managed post-mining to ensure decant is prevented and no contaminated water is discharged into the environment untreated. Opportunities for the passive treatment of mine water post closure should also be investigated to reduce maintenance costs and responsibilities of water treatment post closure.

### 6.4.5.2 Decommissioning Phase - Loss of wetland habitat/Establishment of acid seeps

Decant from the mined out areas is likely to occur within low-lying points in the landscape, typically in wetland areas, and take the form of acid seeps. Decanting water could become acidic as well as metal and sulphate rich, and will result in a die-off of the vegetation within the affected area. Such areas will then also be subject to erosion.

| **IMPACT RATING & SIGNIFICANCE** | | | | | | |
|---|---|---|---|---|---|---|
| Impact | Intensity | Duration | Extent | Consequence | Probability | Significance |
| Water quality deterioration | **H** | **VH** | **VL** | **High** | **Possible** | **High** |

*Mitigation*

Preventing decant through the management of water levels in the mined out areas will prevent the formation of acid seeps.

# 7. CONCLUSION

Wetland Consulting Services (Pty.) Ltd. was appointed by Synergistics (part of the SLR Group) to update the baseline wetland assessment study as part of the EIA/EMP being compiled for the proposed Anglo American Inyosi Coal Alexander Project near Kriel, Mpumalanga Province.

Wetland Consulting Services (Pty.) Ltd. (WCS) had previously undertaken a baseline wetland assessment study for the Alexander Project (WCS, 2014). This report needs to be updated and an impact assessment for the following main activities included:

- Underground mining
- Shaft infrastructure
- Conveyor (linking to the proposed Elders conveyor) – 2 Alternatives

The Alexander Project area, approximately 10 978 hectares in size, is located to the south east of the town of Kriel and straddles the R545 Kriel to Bethal road. The proposed conveyor route runs in a roughly northerly direction from the centre of the Alexander PRA to link up with the proposed Elders conveyor. The study area is located within a region dominated by agricultural activities, including extensive cultivation for maize and soya, as well as livestock grazing. The Steenkoolspruit River drains across the middle of the site from east to west, before turning northwards and forming the western boundary of the site.

The study area is located within the Olifants River Catchment (Primary Catchment B) and, more specifically, mostly within the Steenkoolspruit sub-catchment of the Upper Olifants catchment. The quaternary catchment mainly affected by the proposed mining area is the B11C catchment, which is drained by the Steenkoolspruit and its tributaries the Debeerspruit and the Piekespruit. The project area also extends into quaternary catchments B11A, B11B and B11D.

Site visits for the study were undertaken over twelve days during February to May 2014, by two specialists, and again for a further two days on 17 April 2016 and 19 May 2016. In total 28 man days were spent on site during the wetland survey. During the course of the field work the wetlands within the study area were walked and assessed with a view to verifying the wetland boundaries and collecting the required data for the PES and EIS assessments. While an effort was made to visit every wetland within those farms to which access permission was obtained, it was not possible for every wetland boundary to be walked and verified.

The total wetland extent within the Alexander PRA was found to equal approximately 4 060 hectares and covers just over 37 % of the surface area within the study site. 5 different hydro-geomorphic wetland types were identified and classified according to the Ollis et al. (2013) wetland classification system. The wetland types identified are as follows:

- Channelled valley bottom wetlands;
- Floodplain wetlands;
- Unchannelled valley bottom wetlands;
- Depression/pan wetlands; and
- Hillslope seepage wetlands.

The majority of wetlands on site, 58 %, are Moderately Modified (PES category C), though a significant extent of wetland habitat, 29 %, is considered Largely Modified (PES category D). Only around 8 % of the wetlands on site are still considered to be in largely natural (PES category B) condition, and consist almost exclusively of hillslope seepage wetlands that have not been significantly cultivated and have not been affected by gully erosion.

Based on the EIS assessment, around 30 % of the wetlands, consisting mostly of floodplain wetlands and hillslope seepage wetlands are considered of High ecological importance and sensitivity. This indicates wetlands which are ecologically important on a provincial or national scale and which play a role in moderating the quantity and quality of water of major rivers. The remaining wetlands were rated as being of Moderate (42%) or Low/Marginal (28%) ecological importance.

An impact assessment was undertaken for the proposed shaft infrastructure, the proposed conveyor and the planned underground mining. A brief summary of the key impacts is as follows:

- No wetlands fall within the direct shaft footprint or within the 30m buffer zone around delineated wetlands. Adjacent wetland habitat located downslope is however likely to be indirectly impacted through a reduction in flows, both in terms of surface flow (due to exclusion of part of the catchment as a dirty water area) and sub-surface flow (reduced recharge of interflow and lowering of the local groundwater table due to the boxcut).
- The proposed mining of the No. 4 seam by underground bord-and-pillar mining methods will involve the undermining of over 2 274 ha of wetlands, consisting mostly of hillslope seepage wetlands (1 147 ha), but also including significant areas of floodplain and valley bottom wetlands.
- 2 conveyor alternatives were assessed. Given that the start and end points of the required conveyor are fixed, as well as the extent of wetlands in the area, the complete avoidance of wetlands is impossible. The required conveyor runs roughly from south to north, while the Steenkoolspruit floodplain runs east to west in close proximity to the shaft area – a crossing over the Steenkoolspruit floodplain is therefore inevitable. However, the current proposed crossing will cross the floodplain at it widest point. Alternative 2 was selected as the preferred alternative from a purely wetland perspective based on having fewer wetland crossings, having shorter wetland crossings and most significantly, because Alternative 2 completely avoids the pan.

Key mitigation measures recommended in the report include:

- Implementation of a suitable pillar safety factor to ensure no subsidence underneath delineated wetland areas and, as a minimum, a 100m buffer around these wetlands.
- Implementation of a water management/treatment plan to ensure decant of contaminated water is prevented.
- **Re-alignment of the proposed conveyor route to avoid the pan wetland**. Should Alternative 2 be selected, the pan will not be impacted.

**For the purpose of this assessment it has been assumed that the shallow weathered aquifer will remain largely intact above underground mining activities and will continue to feed**

**wetlands**. Should the specialist groundwater study reveal that the shallow weathered aquifer will be significantly impacted, the assessment of the impact of underground mining on the wetlands of the study area will need to be revised.

**It is important to point out that any activity which is contemplated and which will impact the watercourses[2] on site by either impeding or diverting flow in a watercourse, or through altering the beds, banks, course or characteristics of the watercourse will be subject to authorisation in terms of water uses (c) and (i) as detailed under Section 21 of the National Water Act.**

---

[2] Based on the definition in the National Water Act, all wetlands constitute a watercourse.

# 8. REFERENCES

**Department of Water Affairs and Forestry. 1999a**. Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems Version 1.0, Pretoria.

**Department of Water Affairs and Forestry. 1999b**. Resource Directed Measures for Protection of Water Resources. Volume 1. River Ecosystems Version 1.0, Pretoria.

**Department of Water Affairs and Forestry, 2005**. A practical field procedure for identification and delineation of wetland and riparian areas. DWAF, Pretoria.

**Department of Water Affairs and Forestry, 2009**. INTEGRATED WATER RESOURCE MANAGEMENT PLAN FOR THE UPPER AND MIDDLE OLIFANTS CATCHMENT: Integrated Water Resource Management Plan. Report Number: P WMA 04/000/00/7007. DWAF, Pretoria

**Ferrar, A.A. and Lötter, M.C. 2006. Mpumalanga Biodiversity Conservation Plan Map. Mpumalanga Tourism and Parks Agency, Nelspruit.**

**Kleynhans, C.J. 1996**. A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River. Journal of Aquatic Ecosystem Health 5: 41 - 54.

**Kleynhans, C.J. 1999**. A procedure for the determination of the ecological reserve for the purposes of the national water balance model for South African Rivers. Institute for Water Quality Studies. Department of Water Affairs and Forestry, Pretoria.

**Kotze, D.C., Marneweck, G.C., Batchelor, A.L., Lindley, D.S. and Collins, N.B. 2007.** WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. Water Research Commission. WRC TT 339/09

**Kotze, D.C. and Marneweck, G.C. 1999.** Guidelines for delineating the boundaries of a wetland and the zones within a wetland in terms of the South African Water Act. Pretoria: Department of Water Affairs.

**Macfarlane, D.M., Kotze, D.C., Ellery, W. N., Walters, D., Koopman, V., Goodman, P. and Goge, C. 2009.** WET-Health: A technique for rapidly assessing wetland health. Water Research Commsision. Report No. TT340/09

**Midgley, D.C., Pitman, W.V. and Middelton, B.J. 1994**. Surface Water Resources of South Africa 1990 Book of Maps: Volume 1. Water Research Commission. WRC 298/1.2/94

**Mucina, L. and Rutherford, M.C. 2006**. The Vegetation of South Africa, Lesotho and Swaziland. Strelizia 19. SANBI, Pretoria.

**Nel, J.L., Driver, A., Strydom, W.F., Maherry, A., Petersen, C., Hill, L., Roux, D.J., Nienaber, S., van Deventer, H. Swartz, E. and Smith-Adao, L.B. 2011**. Atlas of Freshwater Ecosystem Priority Areas in South Africa: Maps to support sustainable development of water resources. Water Research Commission, Gezina. WRC Report No. TT 500/11

**OLLIS, D.J., SNADDON, C.D., JOB, N.M. & MBONA, N. 2013.** Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems. SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria.

**SANBI. 2009**. Further Development of a Proposed National Wetland Classification System for South Africa. Primary Project Report. Prepared by the Freshwater Consulting Group (FCG) for the South African National Biodiversity Institute (SANBI).

**South Africa. 1998.** National Water Act 38 of 1998. Pretoria: Government Printer