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A WETLAND DELINEATION AND IMPACT ASSESSMENT REPORT FOR THE DOORNHOEK FLUORSPAR MINING RIGHT APPLICATION IN THE NGAKA MODIRI MOLEMA DISTRICT, NORTH WEST PROVINCE

EOH

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Innovation in Sustainability

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WETLAND DELINEATION REPORT

July 2016

Conducted on behalf of:

SA Fluorite (Pty) Limited & Southern Palace 398 (Pty) Limited

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REPORT DISTRIBUTION LIST

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DECLARATION

I, Barend Johannes Henning, declare that -

- I act as the independent specialist;
- I will perform the work relating to the project in an objective manner, even if this results in views and findings that are not favourable to the project proponent;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this project, including knowledge of the National Environmental Management Act, 1998 (Act No. 107 of 1998; the Act), regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I will take into account, to the extent possible, the matters listed in Regulation 8;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the project proponent and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the project; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority or project proponent;
- All the particulars furnished by me in this document are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

____

SIGNATURE OF SPECIALIST

Company: Exigo Sustainability (Pty) Ltd.

DATE: JULY 2016

Notations and terms

Aerobic: having molecular oxygen (O_2) present.

Anaerobic: not having molecular oxygen (O_2) present.

Anthropogenic: of human creation

Aquic moisture regime: a reducing regime virtually free of dissolved oxygen because the soil is saturated. Some **soil horizons**, at times, are saturated with water while dissolved oxygen is present (as may occur if the water is moving). The required **soil saturation** duration is not known (and depends on site factors such as soil texture and temperature), but must be at least a few days (Soil Survey Staff, 1992).

Biota: living things; plants, animals, bacteria

Bog: a **mire** (i.e. a **peat** accumulating wetland) that is hydrologically isolated, meaning that it is only fed by water falling directly on it as rain or snow and does not receive any water from a surrounding catchment. Bogs have acidic waters and are often dominated by mosses (Mitsch and Gosselink, 1986). The term bog is frequently used much more broadly in South Africa to refer to high altitude wetlands that have organic-rich soils. Many of these wetlands would not be bogs in the correct sense.

Bottomland: the lowlands along streams and rivers, on alluvial (river deposited) soil.

Chroma: the relative purity of the spectral colour, which decreases with increasing greyness.

Connectivity: In this context, referring to either the upstream-downstream or lateral (between the channel and the adjacent floodplain) connectivity of a drainage line. Upstream-downstream connectivity is an important consideration for the movement of sediment as well as migratory aquatic biota. Lateral connectivity is important for the flooplain species dependent on the wetting and nutrients associated with overbank flooding

Delineation (of a wetland): to determine the boundary of a wetland based on soil, vegetation, and/or hydrological indicators (see definition of a wetland).

Endorheic: closed drainage e.g. a pan.

Fen: a mire (i.e. a peat accumulating wetland) that receives some drainage from mineral soil in the surrounding catchment.

Floristic: of flora (plants).

Floodplain: Wetland inundated when a river overtops its banks during flood events resulting in the wetland soils being saturated for extended periods of time.

Gley: soil material that has developed under anaerobic conditions as a result of prolonged saturation with water. Grey and sometimes blue or green colours predominate but **mottles** (yellow, red, brown and black) may be present and indicate localised areas of better aeration.

Groundwater: subsurface water in the zone in which permeable rocks, and often the overlying soil, are saturated under pressure equal to or greater than atmospheric.

Groundwater table: the upper limit of the groundwater.

Horizon: see soil horizons.

Hydric soil: soil that in its undrained condition is saturated or flooded long enough during the growing season to develop anaerobic conditions favouring the growth and regeneration of hydrophytic vegetation (vegetation adapted to living in anaerobic soils).

Hydrophyte: any plant that grows in water or on a substratum that is at least periodically deficient in oxygen as a result of soil saturation or flooding; plants typically found in wet habitats.

Hydro-geomorphic: Refers to the water source and geology forms.

Hydrology is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing (extrinsic), as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland, intrinsic factors.

Geomorphology is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).

Hue (of colour): the dominant spectral colour (e.g. red).

Infilling: dumping of soil or solid waste onto the wetland surface. Infilling generally has a very high and permanent impact on wetland functioning and is similar to drainage in that the upper soil layers are rendered less wet, usually so much so that the area no longer functions as a wetland.

Lacustrine: Lacustrine systems (e.g. lakes & dams) are wetlands that are situated in a topographic depression or a dammed river channel, have a total area greater than 8 ha and surface area coverage by mosses, lichens, trees, shrubs or persistent emergents of less than 30%.

Marsh. a wetland dominated by emergent herbaceous vegetation (usually taller than 1 m), such as the common reed (*Phragmites australis*) which may be seasonally wet but are usually permanently or semi-permanently wet.

Mire: a peat accumulating wetland, including both bogs and fens.

Mottles: soils with variegated colour patters are described as being mottled, with the "background colour" referred to as the matrix and the spots or blotches of colour referred to as mottles.

Munsell colour chart: A standardized colour chart which can be used to describe hue (i.e. its relation to red, yellow, green, blue, and purple), value (i.e. its lightness) and chroma (i.e. its purity). Munsell colour charts are available which show that portion commonly associated with soils, which is about one fifth of the entire range.

***n* Value:** the relationship between the percentage of water under field conditions and the percentage of inorganic clay and humus. It can be approximated in the field by a simple test of squeezing the soil in the hand. It is helpful in predicting the degree of subsidence that will occur after drainage (Pons and Zonneveld, 1965; Soil Survey Staff, 1992).

Organic soil material: soil material with a high abundance of undecomposed plant material and humus. According to the Soil Classification Working Group (1991) an organic soil horizon must have at least 10% organic carbon by weight throughout a vertical distance of 200 mm and be saturated for long periods in the year unless drained. According to the Soil Survey Staff (1975) definition, in order for a soil to be classed as organic it must have >12% organic carbon by weight if it is sandy and >18% if it is clay-rich.

Oxidised rhizospheres: Roots growing in saturated soil conditions may produce brightly coloured areas in the soil immediately surrounding them called oxidised rhizospheres. Roots need oxygen to survive and function, and under anaerobic conditions oxygen moves to the roots from the aerial parts of the plant. Leakage of this oxygen results in the iron in the soil surrounding the roots oxidising to form the bright orange/red colours. The presence of oxidised rhizospheres is therefore useful in confirming the presence of saturated conditions.

Palustrine (wetland): All non-tidal wetlands dominated by persistent emergent plants (e.g. reeds) emergent mosses or lichens, or shrubs or trees (see Cowardin *et al.*, 1979).

Peat: a brownish-black organic soil that is formed in acidic, anaerobic wetland conditions. It is composed mainly of partially-decomposed, loosely compacted organic matter with more than 50% carbon. The 50 % carbon content is mostly applicable for the sphagnum peat moss peat deposits in the Northern Hemisphere. The South African soil classification uses a >10 % carbon content as a guideline. Inorganic soil particles are blown or washed into peatlands and also form part of the peat.

Peraquic moisture regime: an aquic moisture regime where the where the ground water is always at or very close to the surface (Soil Survey Staff, 1992).

Perched water table: the upper limit of a zone of saturation in soil, separated by a relatively impermeable unsaturated zone from the main body of groundwater.

Permanently wet soil: soil which is flooded or waterlogged to the soil surface throughout the year, in most years.

Riparian: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as **riparian wetlands**. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).

Roughness coefficient: an index of the roughness of a surface; a reflection of the frictional resistance offered by the surface to water flow.

Runoff: total water yield from a catchment including surface and subsurface flow.

Seasonally wet soil: soil which is flooded or waterlogged to the soil surface for extended periods (>1 month) during the wet season, but is predominantly dry during the dry season.

Sedges: Grass-like plants belonging to the family *Cyperaceae*, sometimes referred to as nutgrasses. Papyrus is a member of this family.

Soil drainage classes: describe the soil moisture conditions as determined by the capacity of the soil and the site for removing excess water. The classes range from very well drained, where excess water is removed very quickly, to very poorly drained, where excess water is removed very slowly. Wetlands include all soils in the very poorly drained and poorly drained classes, and some soils in the somewhat poorly drained class. These three classes are roughly equivalent to the permanent, seasonal and temporary classes

Soil horizons: layers of soil that have fairly uniform characteristics and have developed through pedogenic processes; they are bound by air, hard rock or other horizons (i.e. soil material that has different characteristics).

Soil profile: the vertically sectioned sample through the soil mantle, usually consisting of two or three horizons (Soil Classification Working Group, 1991).

Soil saturation: the soil is considered saturated if the water table or **capillary fringe** reaches the soil surface (Soil Survey Staff, 1992).

Temporarily wet soil: The soil close to the soil surface (i.e. within 50 cm) is wet for periods > 2 weeks during the wet season in most years. However, it is seldom flooded or saturated at the surface for longer than a month.

Terrain unit classes: areas of the land surface with homogenous form and slope. Terrain may be seen as being made up of all or some of the following units: crest (1), scarp (2), midslope (3), footslope (4) and valley bottom

(5).

Transpiration: the transfer of water from plants into the atmosphere as water vapour

Unchannelled valley bottom: Linear fluvial, net depositional valley bottom surfaces which do not have a channel. The valley floor is a depositional environment composed of fluvial or colluvial deposited sediment. These systems tend to be found in the upper catchment areas.

Value (soil colour): the relative lightness or intensity of colour.

Vegetation is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite.

Vlei: a colloquial South African term for wetland.

Water regime: When and for how long the soil is flooded or saturated.

Water Quality largely self-explanatory and reflecting the changes in quality as a consequence of changes in land use or as a direct result of activities within the wetland itself that could lead to changes in the quality of the water flowing through and within the wetland

Waterlogged: soil or land saturated with water long enough for anaerobic conditions to develop.

Wetland: 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin *et al.*, 1979).

Wetland catchment: the area up-slope of the wetland from which water flows into the wetland and including the wetland itself.

Wetland delineation: the determination and marking of the boundary of a wetland on a map.

1 ASSIGNMENT

Exigo Sustainability was appointed by SA Fluorite / ENPRC to conduct a wetland delineation study and impact assessment as part of the EIA phase (Mining Right Application) for the proposed establishment of the Doornhoek Fluorspar Mine. The project involves the development of opencast mining sections, a processing plant as well as associated infrastructure (e.g. access roads, tailings storage facility, overburden dumps etc.). The proposed activities/infrastructure will be located on portions of the farms 306 JP, Knoflookfontein 310 JP and Rhenosterfontein 304 JP. The farms are currently zoned as agriculture. The project area is located in the Zeerust area, Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality, North West Province (see figure 1).

The main purpose was to compile a specialist report on the abovementioned aspects that will guide the future layout plans of the mine and indicate potential risks associated with the mining development on wetlands and riparian zones within the project area. This assessment is essential as it will contribute to meeting the requirements of the National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) in conjunction with Regulation 543 of 18 June 2010, promulgated in terms of Section 24 (5) of NEMA and Chapter 4 of the National Water Act, Act 36 of 1998.

The assignment is interpreted as follows: Compile a study on the wetlands of the site according to guidelines and criteria set by the Department of Water Affairs and the North West Department of Agriculture, Conservation, Environment & Rural Development (DACERD), North West Province and National Department of Environmental Affairs (DEA).

The study includes a wetland delineation and functionality assessment, with descriptions of the anticipated impacts (risks) associated with the proposed development activities and broad management guidelines to reduce impacts. In order to compile this, the following had to be done:

1.1 Information Sources

The following information sources were obtained for the study:

1. All relevant topographical maps, aerial photographs and information (previous studies and environmental databases) related to wetlands in the study area;
2. Requirements regarding the wetland survey as stipulated in the following guidelines:
    a. A practical field procedure for identification and delineation of wetlands and riparian areas (DWAF, 2006);
    b. National Wetland Classification System for South Africa (SANBI, 2009);
3. Guidelines regarding development in and around wetlands as stipulated by DWA and NWDACERD;

1.2 Regulations governing this report

1.2.1 National Environmental Management Act, 1998 (Act No. 107 of 1998) - Regulation No. R982

This report was prepared in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Gazette No. 38282 Government Notice R. 982. Appendix 6 – Specialist reports includes a list of requirements to be included in a specialist report:

1. A specialist report or a report prepared in terms of these regulations must contain:
    a. Details of
        i. The specialist who prepared the report; and
        ii. The expertise of that specialist to compile a specialist report, including a curriculum vitae;
    b. A declaration that the specialist is independent in a form as may be specified by the competent authority;
    c. An indication of the scope of, and purpose for which, the report was prepared;
    d. The date and season of the site investigation and the relevance of the season to the outcome of the assessment;
    e. A description of the methodology adopted in preparing the report or carrying out the specialized process;
    f. The specific identified sensitivity of the site related to the activity and its associated structures and infrastructure;
    g. An identification of any areas to be avoided, including buffers;
    h. A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;
    i. A description of any assumptions made and any uncertainties or gaps in knowledge;
    j. A description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives, on the environment;
    k. any mitigation measures for inclusion in the EMPr;
    l. any conditions for inclusion in the environmental authorisation;

m. any monitoring requirements for inclusion in the EMPr or environmental authorisation

n. a reasoned opinion –

  i. As to whether the proposed activity or portions thereof should be authorised and

  ii. If the opinion is that the proposed activity or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr and where applicable, the closure plan;

o. A description of any consultation process that was undertaken during the course of preparing the specialist report;

p. A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and

q. Any other information requested by the competent authority.

1.2.2 The National Water Act (Act No. 36 of 1998)

Chapter 4 of the National Water Act, Act 36 of 1998 specifies that:

"In general a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, is permissible under a general authorisation, or if a responsible authority waives the need for a licence. The Minister may limit the amount of water which a responsible authority may allocate. In making regulations the Minister may differentiate between different water resources, classes of water resources and geographical areas."

In section 21 of the NWA water uses are listed as:

a. Taking water from a water resource;

b. Storing water;

c. Impeding or diverting the flow of water in a watercourse;

d. Engaging in a stream flow reduction activity contemplated in section 36;

e. Engaging in a controlled activity identified as such in section 37(1) or declared under section 38(1);

f. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;

g. Disposing of waste in a manner which may detrimentally impact on a water resource;

h. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;

i. Altering the bed, banks, course or characteristics of a watercourse;

j. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and

k. Using water for recreational purposes.

1.2.3 Conservation of Agricultural Resources Act (Act No. 43 of 1983)

This Act controls the utilization and protection of wetlands, soil conservation and all matters relating thereto including prevention of veld fires, control of weeds and invader plants, prevention of water pollution resulting from farming practices and losses in biodiversity.

1.2.4 The National Environmental Management Act (NEMA) (Act No. 107 of 1998)

This Act embraces all three fields of environmental concern namely: resource conservation and exploitation; pollution control and waste management; and land-use planning and development. The environmental management principles include the duty of care for wetlands and special attention is given to management and planning procedures.

1.3 Terms of reference

1.3.1 The Doornhoek Project: Background information

The Doornhoek Project has the potential to contain in excess of 50 million tonnes of fluorspar and is believed to be one of the world's largest fluorspar deposits. The underground ore body has grades more than double that of the adjoining Sallies Witkop Mine and resources sufficient to justify an initial life of mine in excess of 20 years.

The Doornhoek Project is currently in exploration phase and based on a request from the Department of Mineral Resources to quantify the groundwater use and potential exploration impacts on the groundwater resources.

The planned infra-structure for the mining operations is as follows:

1. Opencast and underground mining to depths of 90m;
2. Overburden dumps;
3. Minerals processing plant;
4. Tailings facility;
5. Haul roads and offices;

6. Water supply pipelines;
7. Electrical reticulation and sub-stations.

1.3.2 Objectives

The project was done according to the following objectives:

- Conduct a desktop and field investigation to confirm the presence or absence of wetlands and riparian areas within the study area;
- Delineate and map the identified wetland areas on site;
- Classify wetlands according to their hydro-geomorphic characteristics;
- Determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of all wetlands and riparian areas on site;
- Determine the impacts associated with the proposed development on the wetlands;
- Specify mitigation measures and management plan for the wetlands on site;
- Compile a report with the findings and maps.

1.4 Limitations and assumptions

The large study area did not allow for the finer level of assessment that can be obtained in smaller study areas. Therefore, data collection in this study relied heavily on data from representative sections, as well as general observations and a desktop analysis.

2 STUDY AREA

2.1 LOCATION

The Doornhoek Fluorspar Mine is located in the North West Province of South Africa, approximately 15 km southeast of the town of Zeerust along the R510 provincial road to Koster and falls within the Ditsobotla Local Municipality, Ngaka Modiri Molema District Municipality (Figure 1). Due to poor international market conditions it will be necessary to gradually phase in the mining activities, and to divide the mining activities into two phases. The first phase will take place on portions of Rhenosterfontein 304 JP, and the second phase will take place on portions of the Farm 306 JP. The mine surface infrastructure is proposed to be located on the above farms. Additional mineral resources are also located on surrounding farms within the mining right area. The area is drained to the north by the Klein Marico River and a number of associated tributaries. The aerial image of the project area is included in figure 2, while the detailed layout map alternatives for the plant and TSF are indicated in Figure 4 to 7.

Physical mining will only begin in year 5 after mining license has been granted. Road and plant construction will take place in the years before this. Ore will be mined from year 5-10 from area shown in Figure 4 below, estimated to contain approximately 3.2Mt of ore. Year 10-15, 15-20 and 20-30 mining will take place on the farm 306JP owned by the company (Figure 3).

Labour will be sourced from the local community as far as possible, and is planned to be accommodated in the town of Zeerust.

Envisaged infrastructure will comprise of the following:

- Opencast mine development;
- Overburden and topsoil stockpiles;
- Concentrator (processing) plant and related infrastructure (a alternatives Figure 4-7);
- Haul, maintenance and access roads;
- Storm water management infrastructure (compliance GN704);
- Buildings (admin, offices, change house, stores, workshops etc);
- Diesel storage tanks;
- Water supply pipelines;
- Electricity supply High tension (HT) power lines;
- Tailings disposal facility; and
- Water reservoirs and settling ponds.

Doornhoek Fluorspar Mine Wetland Impact Assessment

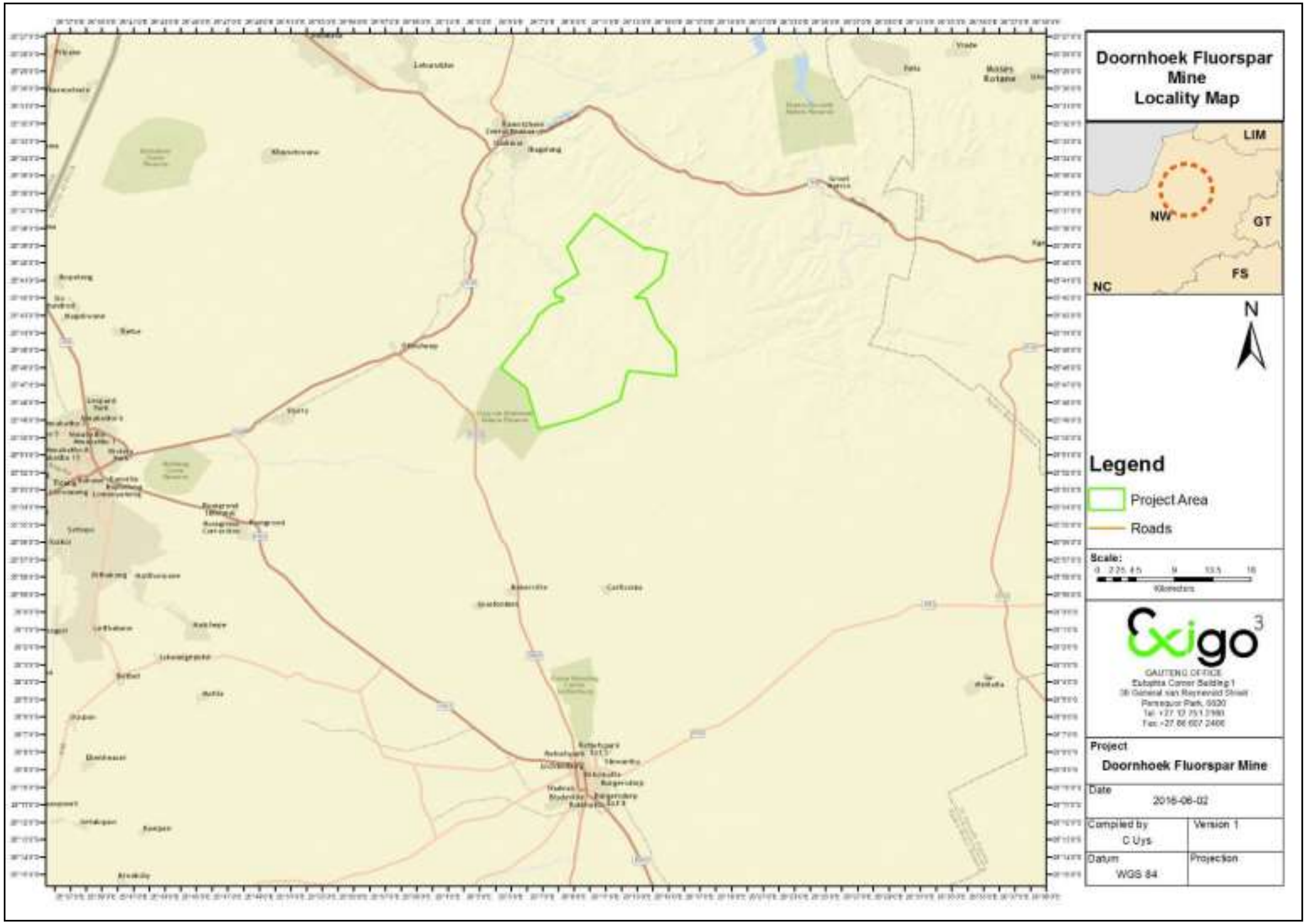


Figure 1. Regional Location Map

Doornhoek Fluorspar Mine Wetland Impact Assessment

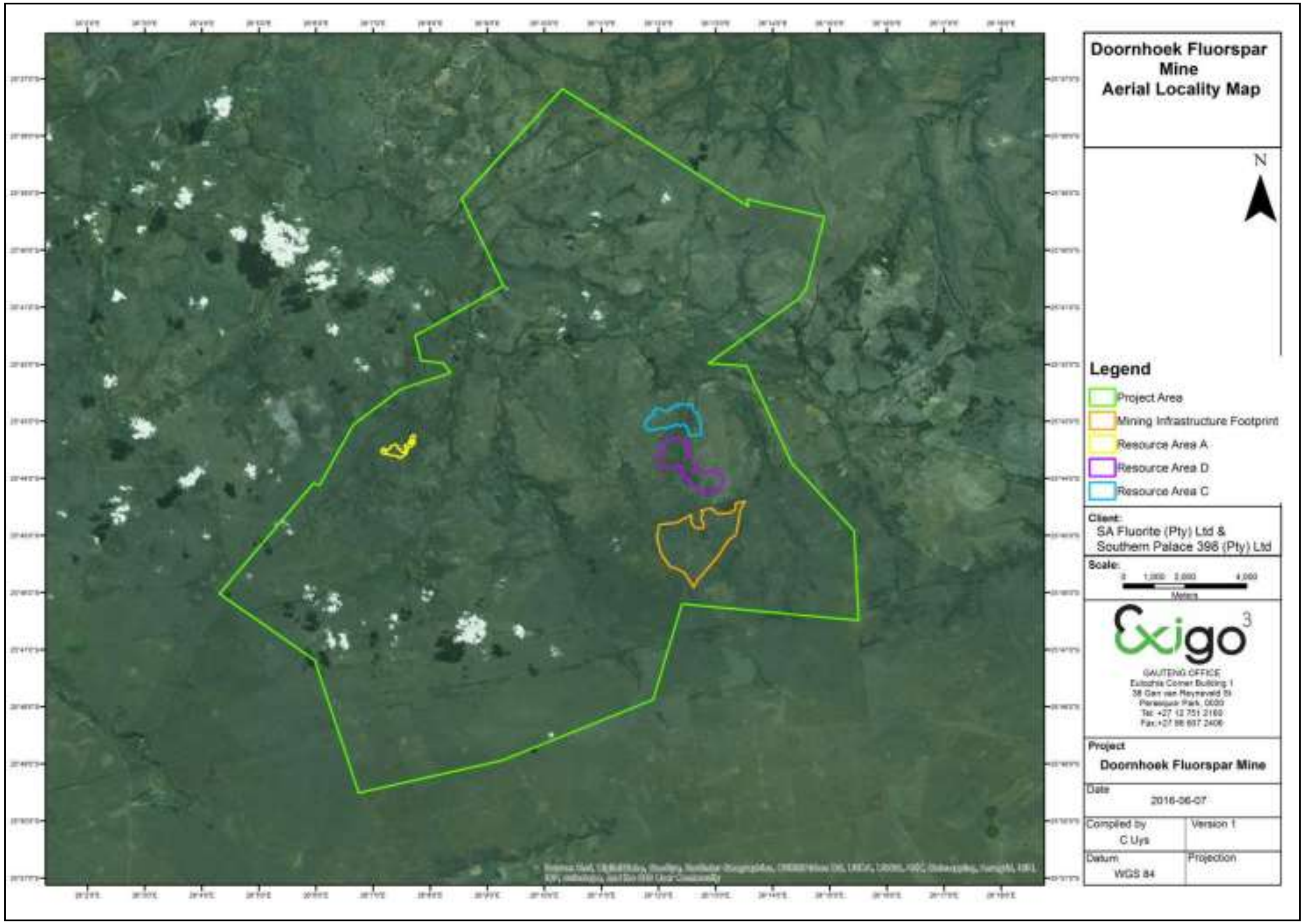


Figure 2. Satelite image showing the project area (Google Pro, 2010)

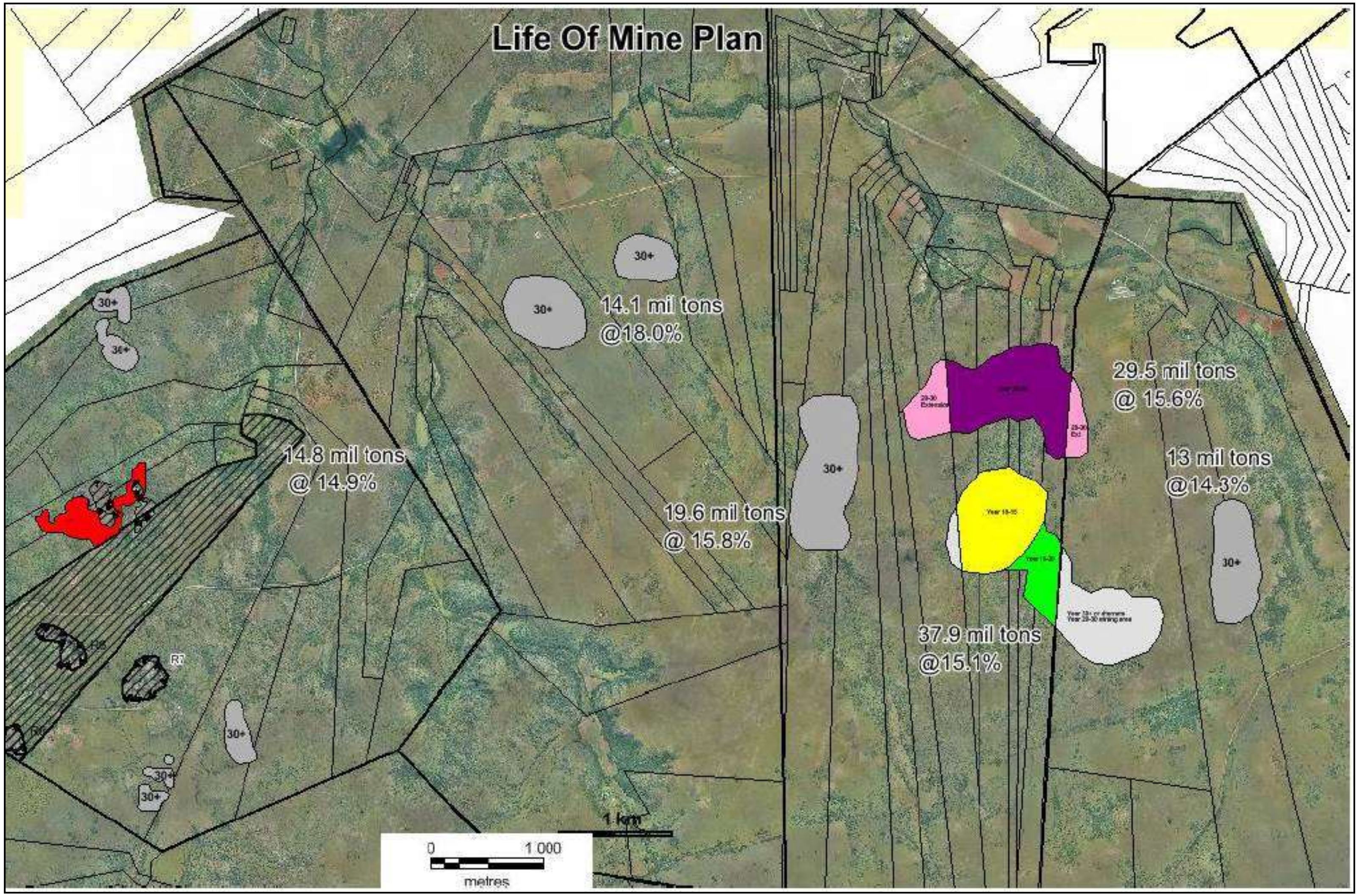


Figure 3. Open Pit Mining Schedule

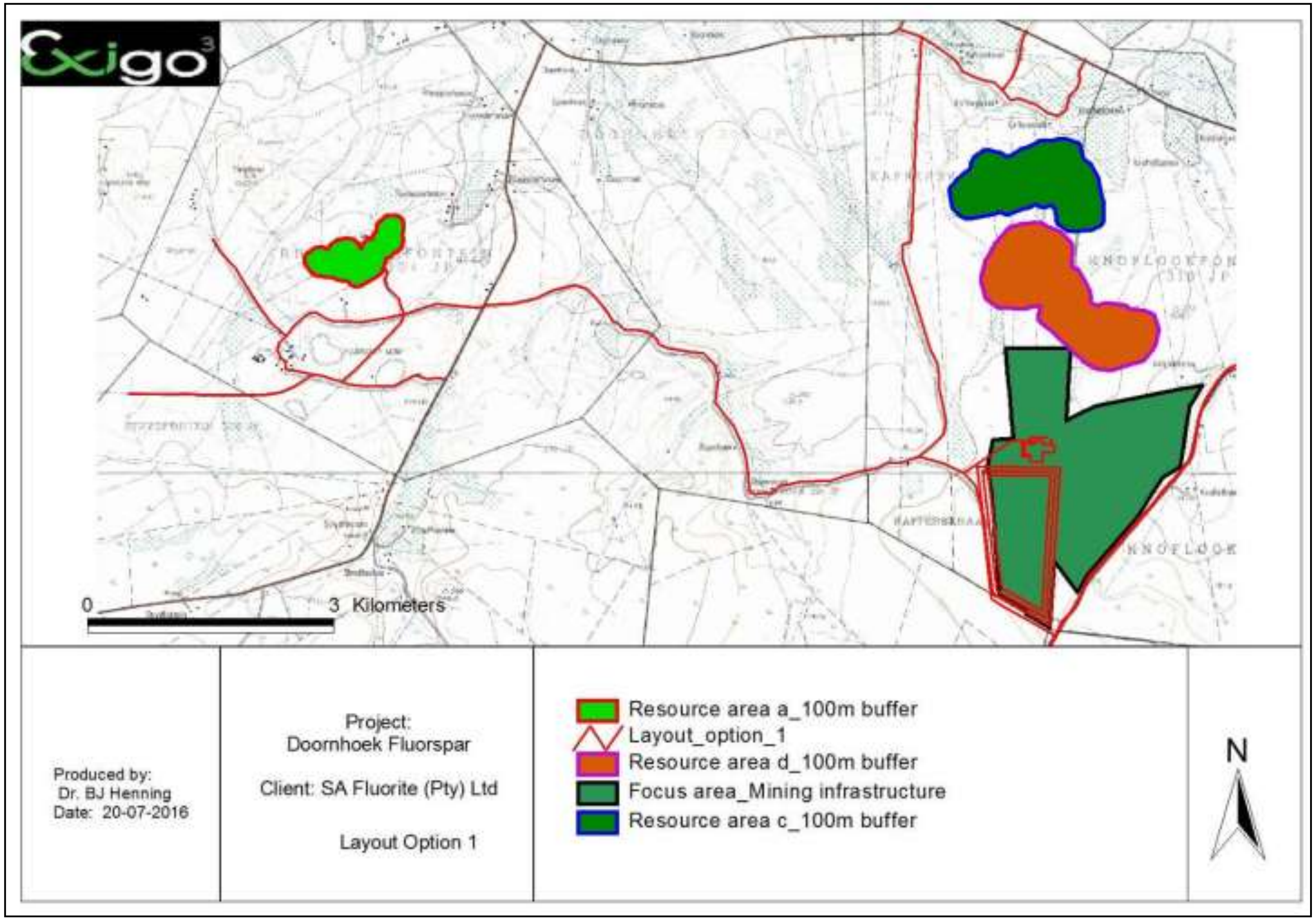


Figure 4.Layout option 1 for the mining infrastructure of the Doornhoek Fluorspar Mine

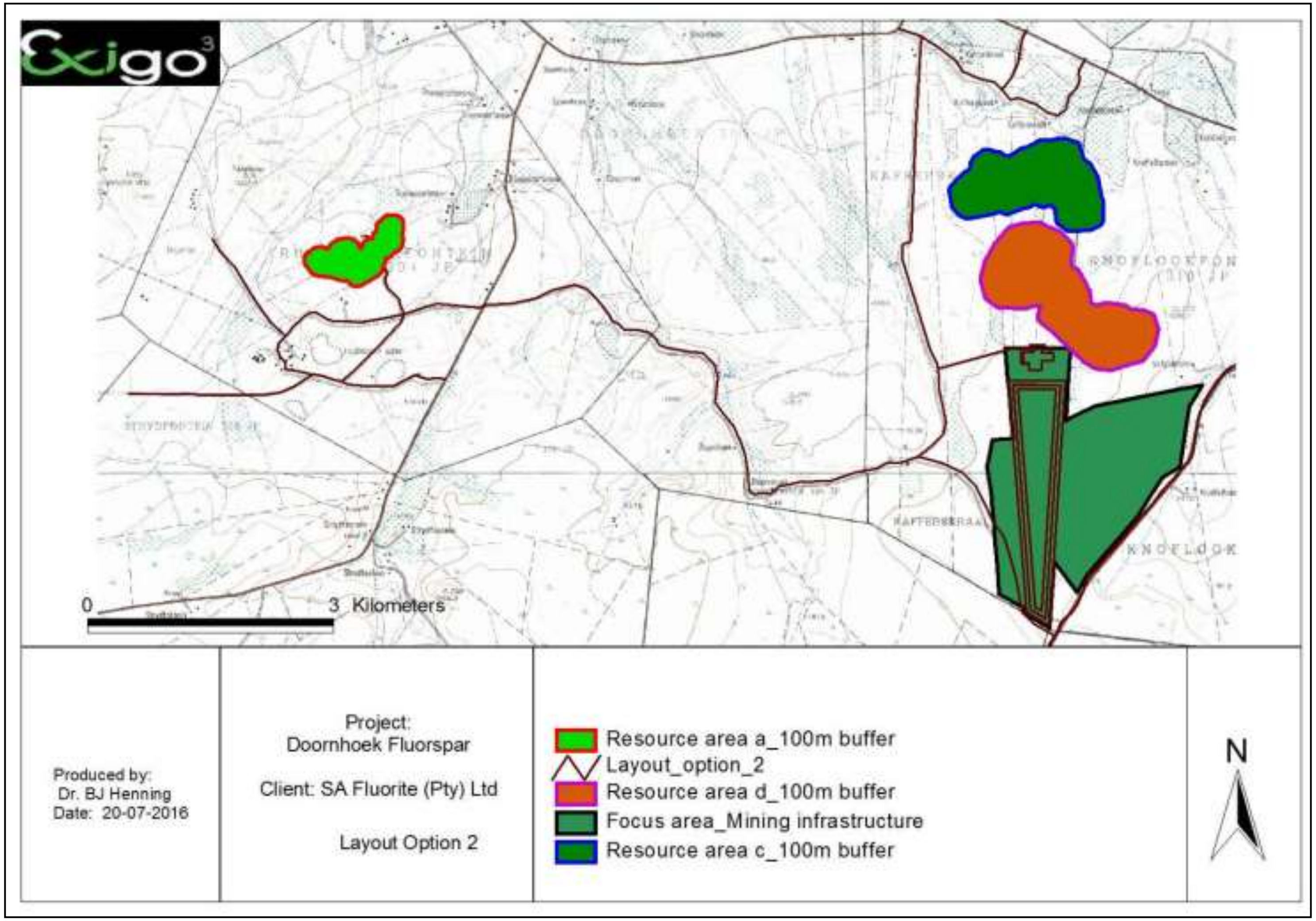


Figure 5. Layout option 2 for the mining infrastructure of the Doornhoek Fluorspar Mine

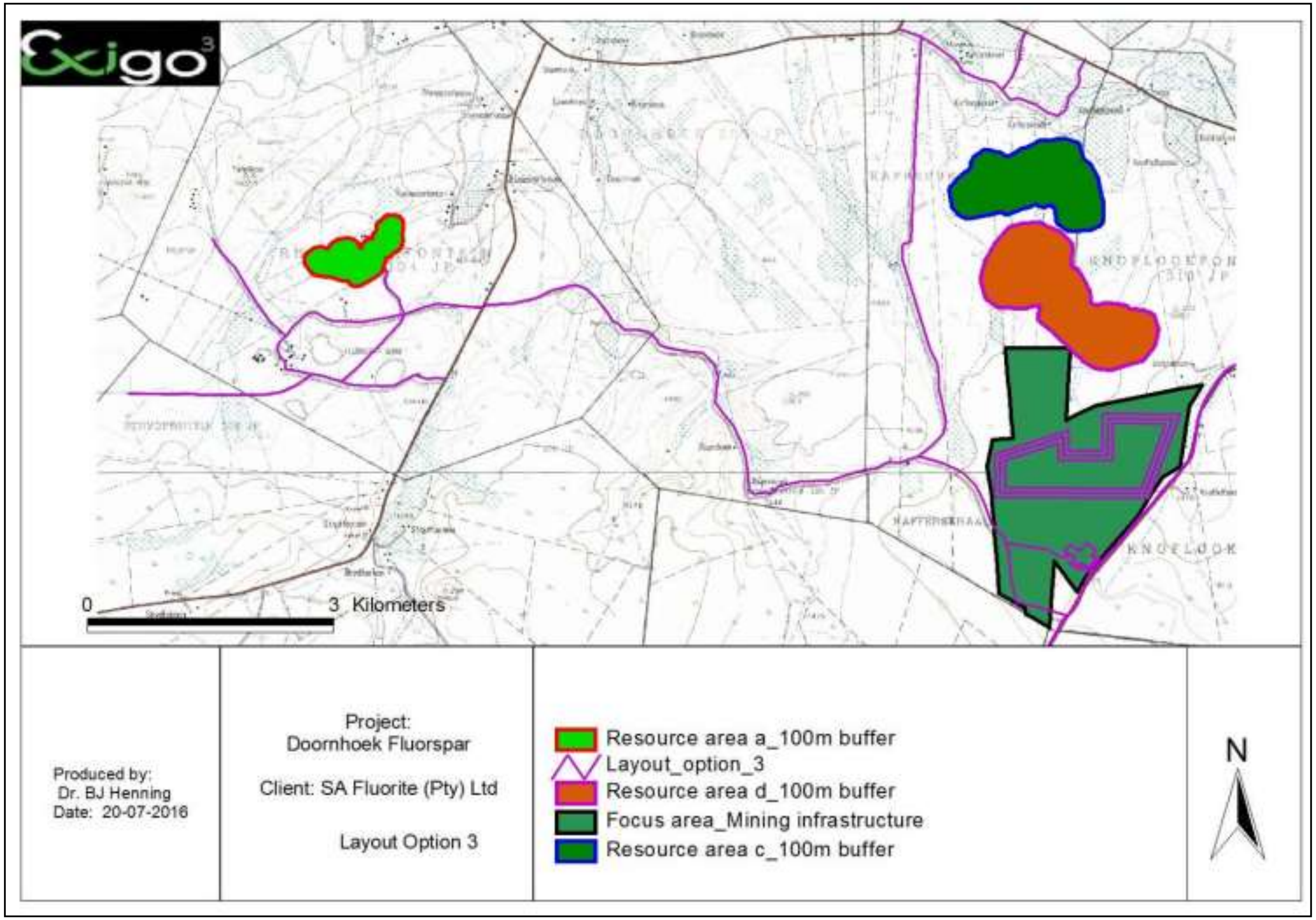


Figure 6. Layout option 3 for the mining infrastructure of the Doornhoek Fluorspar Mine

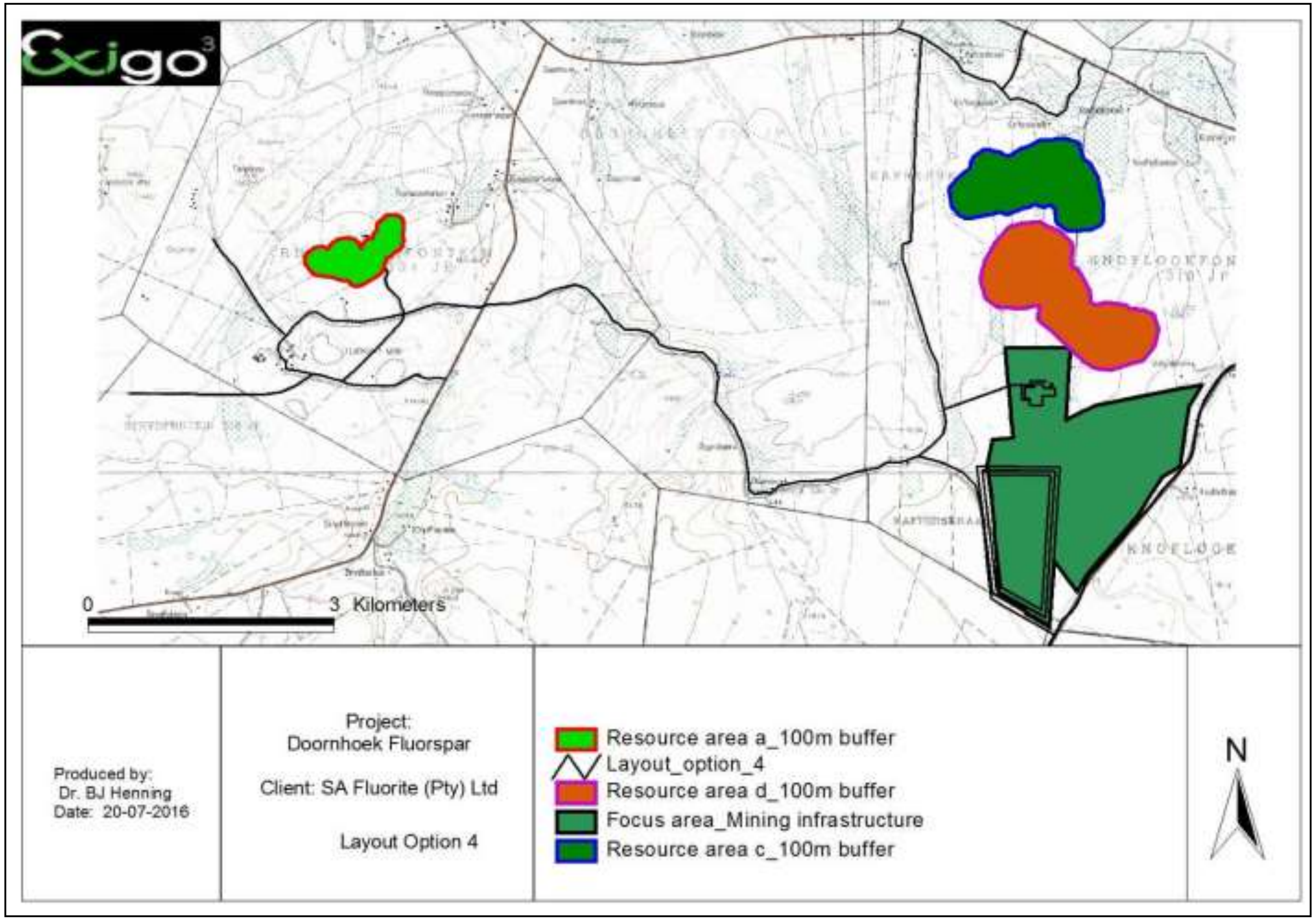


Figure 7. Layout option 4 for the mining infrastructure of the Doornhoek Fluorspar Mine

2.2 CLIMATE

Climate in the broad sense is a major determinant of the geographical distribution of species and vegetation types. However, on a smaller scale, the microclimate, which is greatly influenced by local topography, is also important. Within areas, the local conditions of temperature, light, humidity and moisture vary greatly and it is these factors which play an important role in the production and survival of plants (Tainton, 1981). The climate for the region can be described as warm-temperate.

In terrestrial environments, limitations related to water availability are always important to plants and plant communities. The spatial and temporal distribution of rainfall is very complex and has great effects on the productivity, distribution and life forms of the major terrestrial biomes (Barbour et al. 1987).

2.2.1 Rainfall & Temperature

In this report, climate refers to the summation of the daily, weekly and monthly changes of weather over a long period and it is influenced by latitude, altitude, direction and intensity of wind and the presence of large bodies of water such as the ocean, lakes, dams and rivers. The main climatic factors analysed for the site were long-term monthly average rainfall, temperature and relative humidity.

The area known as the Bankeveld, which occur in portions of Zeerust and Marico, can be separated from the Highveld region on the grounds of the differences shown in its climatic statistics. The project site has warm to hot summers and cool and dry to cold winters, with an average annual rainfall of 439mm. According to Groundwater Resource Directed Measures (GRDM) the Mean Annual Precipitation (MAP) is 566mm/a and the Mean Annual Runoff is 8mm/a for the entire catchment. The Mean Annual Evaporation (MAE) is 8mm/a.

The average maximum temperatures for the region have been recorded between November and January, with temperatures reaching a maximum of 31°C. The average minimum temperatures are reached during June and July with a minimum temperature of 1°C.

The rainfall pattern of Marico catchments is highly variable and unevenly distributed within the catchments. The intermittence of the rainfall results in frequent floods and local droughts.

As far as the temperatures are concerned it is noticeable that the daily average maximums are all more than 30.3ºC, while the minimum for Zeerust is below 0˚C. The absolute maximum temperature of Zeerust is in excess of 40.6ºC. The absolute minimums recorded varies between -3,3ºC and -7,8ºC.The days with temperatures below freezing is still in the order of 23 to 32, but days with temperatures of less than -2,5ºC are less than on the Highveld.

As far as precipitation is concerned it is noticeable that the averages are all in excess of 600mm. Zeerust receives on average 57.1 days with thunder and only 1,1 days with hail.

Figure 8 indicates the monthly climatic averages of the project area, while Table 1 indicate the temperature, precipitation and humidity levels for the Zeerust and Mafikeng weather stations :

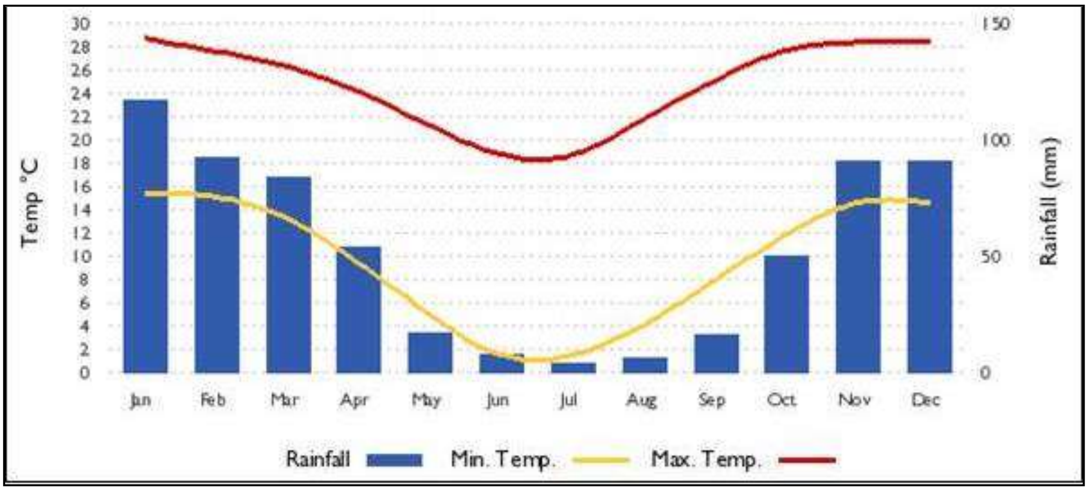


Figure 8. Monthly climatic averages for the project area

Table 1. Temperature, precipitation and humidity levels for the weather stations of the project area (Source: South African Weather Bureau)

STATIONS:	MEAN TEMPERATURES (ºC)		PRECIPITATION (mm)			MEAN RELATIVE HUMIDITY (%)	
	JAN	JUL	MEAN	HIGH	LOW	JAN	JUNE
MAFIKENG	30,4	3,0	553	868	265	65	35
ZEERUST	30,8	-0,8	600	1002	390	69	36

2.2.2 Wind

The long-term weather record indicates that wind speed, experienced in the project area from 0 to more than 10.0 ms-1. The maximum wind speed rarely rises beyond 10 ms-1. Figure 9 indicate the seasonal variations of the wind direction and speed.

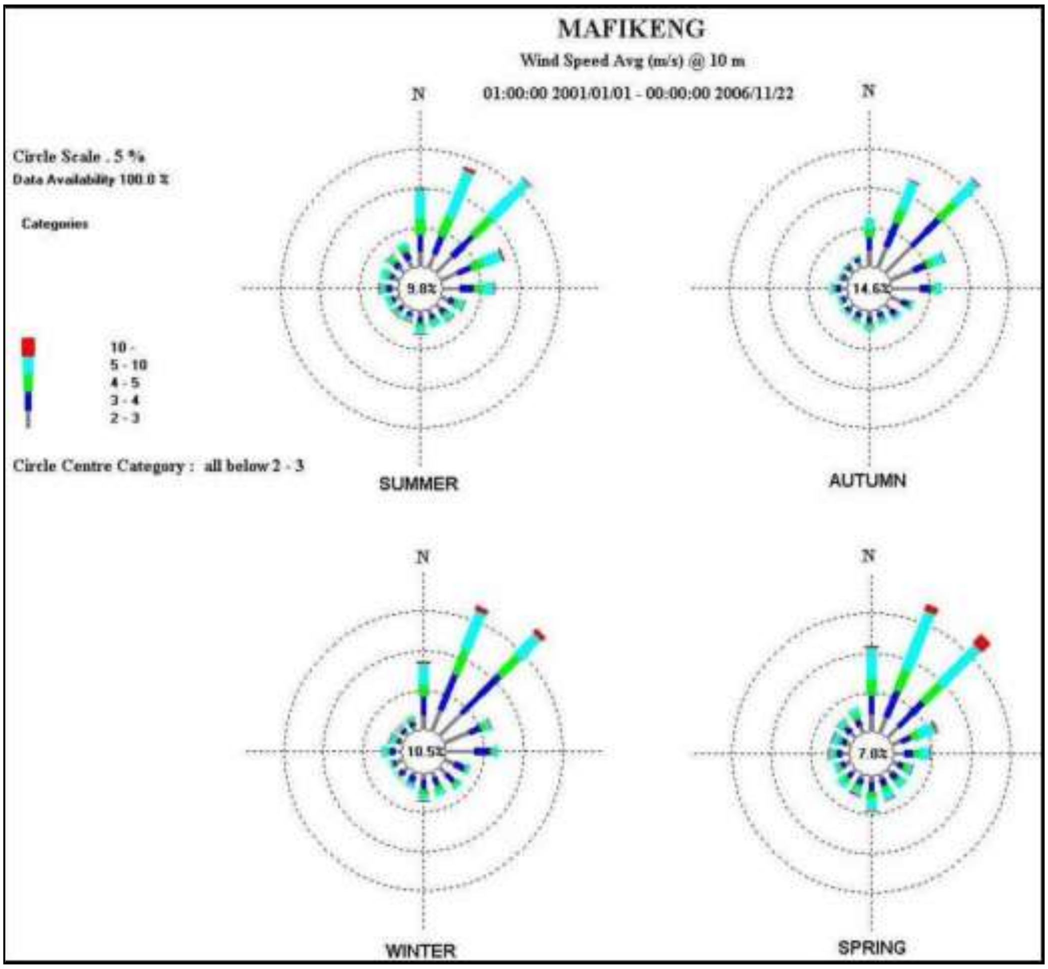


Figure 9. Wind roses for the different seasons of the project area as obtained from the Mafikeng weather station

2.3 GEOLOGY AND SOIL TYPES

Geology is directly related to soil types and plant communities that may occur in a specific area (Van Rooyen & Theron, 1996).

The area is situated close to the western termination of the Bushveld tectonic basin, consisting of the gently dipping sedimentary sequence of the Transvaal Supergroup, intruded by numerous basic sills. The main zone involved is the uppermost subdivision of the Malmani Subgroup or Frisco Formation, a 150 meter thick isolated limestone beds. The Frisco Formation is conformably overlain by banded chert of the Penge Fromation, which was strongly eroded prior to the deposition of the shale, quartzite and iron-formation of the Pretoria Group. The Malmani Subgroup is also known as the Chuniespoort Group. The soils covering the project area can be grouped into different land types. A Landtype unit is a unique combination of soil pattern, terrain and macroclimate, the classification of which is used to determine the potential agricultural value of soils in an area. The landtypes, geology and associated soil types is presented in Table 2 below as classified by the Environmental Potential Atlas, South Africa (ENPAT, 2000). However, it must be noted that soil types are mostly determined by position on the landscape. A landtype map (figure 11) indicates the location of the landtypes in the area.

Deeper sandy soils are associated with flat topography whilst shallow, rocky soils are associated with the undulating hills and rocky outcrops. Existing agricultural activities are limited to the flat areas of the project area. As a result of the irregular undulating rocky areas, fairly steep rocky slopes, shallow rocky nature of the soils and intensity of rainfall the project area is very susceptible to water erosion, especially on roads and areas denuded of vegetation with a poor herbaceous basal cover.

Table 2. Landtype, soils and geology of the project area

Landtype	Soil	Geology
Ae59	Red-yellow apedal, freely drained soils; red, high base status, > 300 mm deep (no dunes)	Shale, slate, siltstone and hornfels of the Strubenkop, Silverton and Timeball Hill Formations; quartzite of the Timeball Hill and Daspoort Formations; diabase sills present. Rocks possess regional dip of 7 degrees to the north and north-east.
Ac71	Red-yellow apedal, freely drained soils; red and yellow, dystrophic and/or mesotrophic	Shale, slate, siltstone and quartzite of the Rooihoogte and Timeball Hill Formations, with diabase sills in places. Dolomite and chert of the Chuniespoort Group in the south-west.

2.4 TOPOGRAPHY & DRAINAGE

When assessing the ecology of an area, it is important to know in which eco-region it is located. The project area forms part of the Highveld and Western Bankenveld Eco-regions. The project area is located at an altitude of approximately 1 342 metres above mean sea level (m amsl). The topography is relatively flat, dipping at a low angle in a north-westerly direction.

The project area is defined as hills and lowlands in the northern section, while the southern section is classified as escarpment (ENPAT, 2000). The topography of the area is a mixture of terrains, ranging from flat to moderately undulating plains, outcrops, bottomlands (drainage channels) and slightly undulating hills.

The Water Management Areas (WMA) as defined by the Department of Water Affairs within the project area is classified as the Crocodile (West) and Marico water management area. This WMA borders on Botswana to the north-west. Its main rivers, the Crocodile and Marico, give rise to the Limpopo River at their confluence.

The Marico and Crocodile Rivers form the headwaters of the Limpopo at their confluence. The flow in the Marico River is highly variable and intermittent. There are two major storage reservoirs that regulate the flow in the Marico River, namely the Marico Bosveld Dam in the upper catchment and the Molatedi Dam further down-stream. There are several other dams, such as the Klein Maricopoort and Sehujwane Dams, from which water is mainly used for irrigation along the Marico River, particularly downstream of Marico Bosveld Dam, are present.

A general orientation of the project area in relation to the WMA and subcatchments is given by Figure 10.

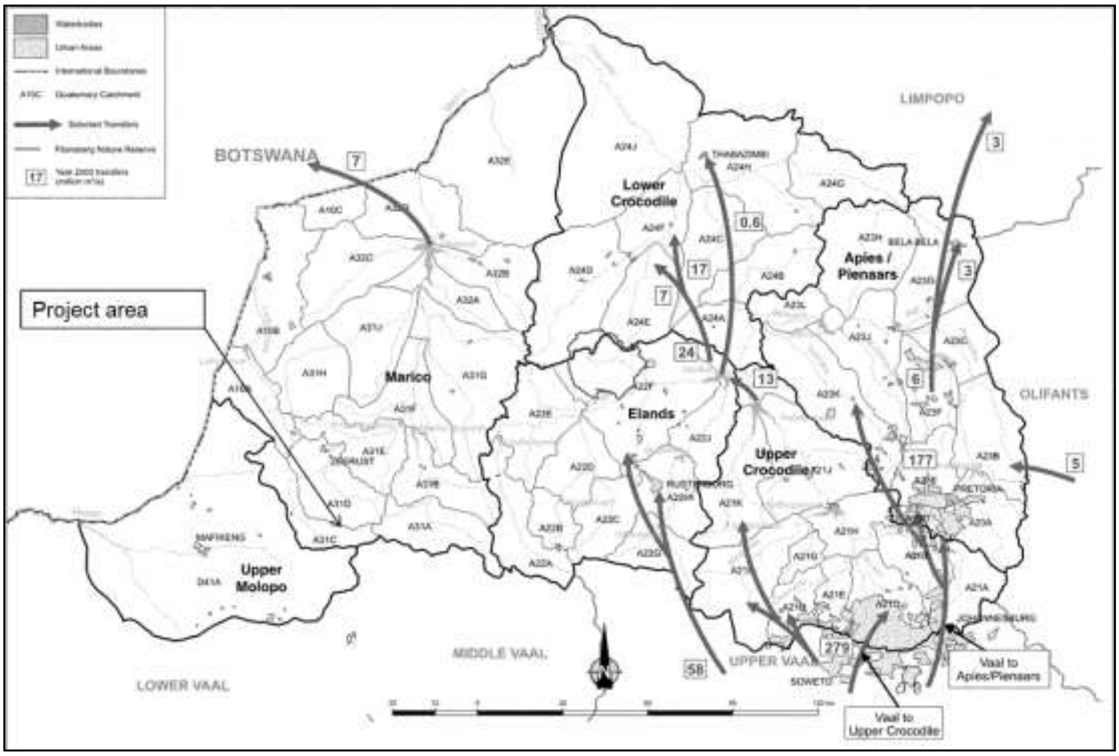


Figure 10. Project area in relation to the Crocodile (West) and Marico WMA

At a basin or sub-basin scale, particularly in semi-arid and arid areas, priority is often placed on monitoring and management of water quantity. Equally important, however, is the monitoring and management of water quality (DWAF 2004). Water quality is often characterised in terms of the concentration of different chemicals in the water (Hatfield 2008). What determines “good” or “bad” water quality depends on the purpose of the assessment - for example, water with naturally elevated concentrations of some metals may be unsafe to drink, but still suitable for industrial uses. Assessment involves comparing measured chemical concentrations with natural, background, or baseline concentrations, and with guidelines established to protect human health or ecological communities.

The Marico sub-management area corresponds to the catchment of the Marico River. Main tribuitaries of the Marico River include the Klein and Groot Marico rivers. This sub-area forms the western part of the WMA. The town of Zeerust is found in this The Groot Marico River is fed by a number of springs within the Groot Marico dolomitic aquifer compartment. These dolomitic eyes include the Molemane Eye and the Marico Eye. The upper reaches of this catchment are not densely populated.

The overall EcoStatus for the Klein Marico River study unit is FAIR and comprises the following indices:

- Instream Habitat Integrity is FAIR, this is primarily due to the presence of the Klein-Maricopoort and Kromellenboog dams. Both dams impact on the levels of water in the river and natural sedimentation patterns. Above the Klein-Maricopoort Dam habitat integrity is less impacted. The Riparian Zone Habitat Integrity is GOOD primarily because of the low levels of development in the area. At Oopgenoeg and Nahoek water abstraction has resulted in some wetlands drying up.
- The Riparian Vegetation Integrity is FAIR due to the presence of alien vegetation and the removal of some vegetation for agriculture.
- Fish Assemblage Integrity is POOR, only the most hardy of species are present due to reduced flows and localised poor water quality.
- The Macro-invertebrate Integrity is POOR due to the impact of the dams on water flow but primarily due to the impacts of reduced water quality especially near the town of Zeerust.
- The Water Quality in general is FAIR - flows have intermediate levels of nutrients and there is some evidence of organic pollution.
- Ecological Importance and Sensitivity (EI&S): EI&S is MARGINAL / LOW, overall diversity of habitat types is low. There are however some locally unique areas with noteworthy features such as abundant and often large, Wild Olive trees at Ottoshoop and Molemane Eye Game Reserve. The Molemane dolomitic eye and associated wetland represents a

unique, relatively undisturbed wetland ecosystem and is rich in invertebrate species with some unique and isolated fish populations.

The drainage channels provide breeding and foraging habitat for fauna. The state of the major rivers and streams in the quaternary catchments in the project area and surrounding areas is presented in Table 3. Although surface water in the area is not generally used for potable purposes the South African National Standards (SANS) provides a useful benchmark against the more stringent irrigation and the more relaxed livestock watering guidelines.

Table 3. State of major streams / rivers in the project area (DWA)

Name	Class	Quaternary drainage	Ecoregion II	State of river / streams	Category
Klein-Marico	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Unknown	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Rhenosterfontein	Perennial	A31D	Bushveld basin	Class C: Moderately Modified	Critically endangered
Rhenosterfontein	Perennial	A31D	Highveld	Class C: Moderately Modified	Critically endangered

The project area is located in the Quaternary Catchment Areas A31C and A31D . The storm water collects along roads and footpaths cutting through the area, to drain into the regionally channels indicated above. It must be noted that surface flow along these rivers generally only occurs in the period directly after precipitation events or a wet rainy season, and that these rivers may exhibit a large base-flow component with groundwater flow occurring within the sandy sediments lining its channel.

2.4.1 Vegetation types

Although the site is classified mainly as Moot Plains Bushveld, representations of the Carletonville Dolomite Grassland was also observed in the area and subsequently this vegetation type is included as part of the focus area. Figure 11 indicates the most recent vegetation map for the project area according to Sanbi (2012).

The vegetation and landscape features of the Carletonville Dolomite Grassland consist of slightly undulating plains dissected by prominent rocky chert ridges. Species-rich grasslands form a complex mosaic pattern dominated by many species. Prominent grasses are *Loudetia simplex, Hyparrhenia hirta, Brachiaria serrata* and *Heteropogon contortus*, as well as scattered shrubs including *Euclea undulata, Searsia magalismontanum, Zanthoxylum capense* and *Diospyros lycoides*. The conservation status is “Vulnerable”, with a small extent conserved. Almost a quarter of the Carletonville Dolomite Grassland Vegetation Type is already transformed for cultivation, by urban sprawl or by mining activity as well as the building of dams. Erosion is very low.

The vegetation and landscape features of the Moot Plains Bushveld consist of open to closed low, often thorny savannah dominated by various species of *Acacia* in the bottomlands as well as woodland of varying height and density on the lower hillsides. Herbaceous lyer is dominated by grasses. This vegetation functions as a transitional area between different habitats. This vegetation type has been large modified in the larger project area by agricultural activities. Moot Plains Bushveld has a vulnerable conservation status with 13% statutorily conserved and 28% transformed by means of cultivation and built-up areas.

An important aspect relating to the project area of the Doornhoek Project should be to protect and manage the biodiversity (structure and species composition) of the vegetation types represented on site. Future mining activities should aim to remove minimal vegetation and only vegetation on the footprint areas should be removed during development constructions. The unnecessary removal of tall indigenous tree species (>3m) and indigenous vegetation during construction should be avoided as far as possible.

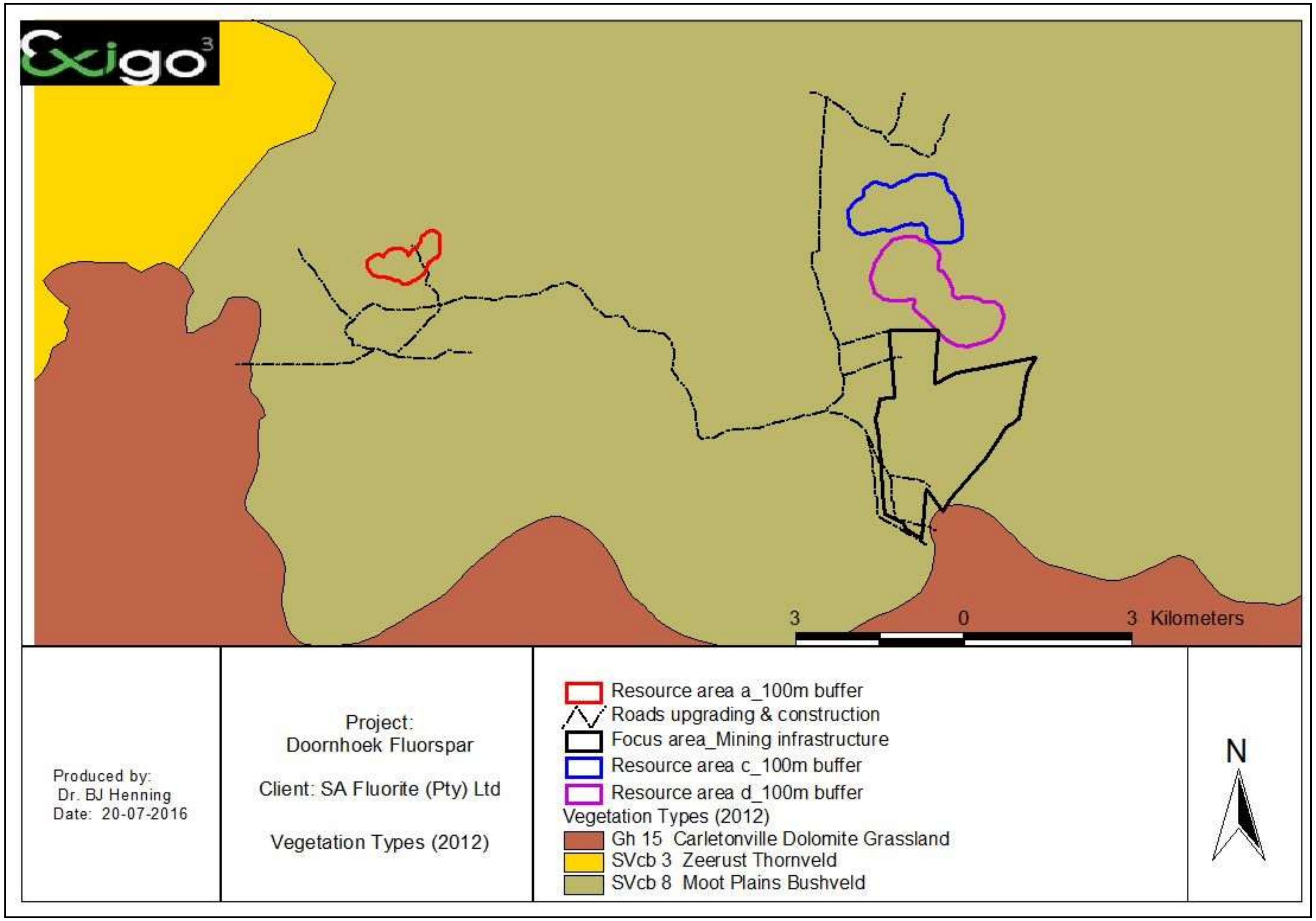


Figure 11. Vegetation Types of the project area according to the 2012 classification by Sanbi (2012)

3 APPROACH & METHODOLOGY

3.1 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."

Wetlands were delineated according to the delineation procedure given in "A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas" (DWAF, 2003).

Wetland indicators are divided into different unit indicators which need to be given consideration in the delineation of wetlands (Figure 7). The outer edge of the temporary zone requires the delineator to take the following specific indicators into account:

- The terrain unit indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by Macvicar (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

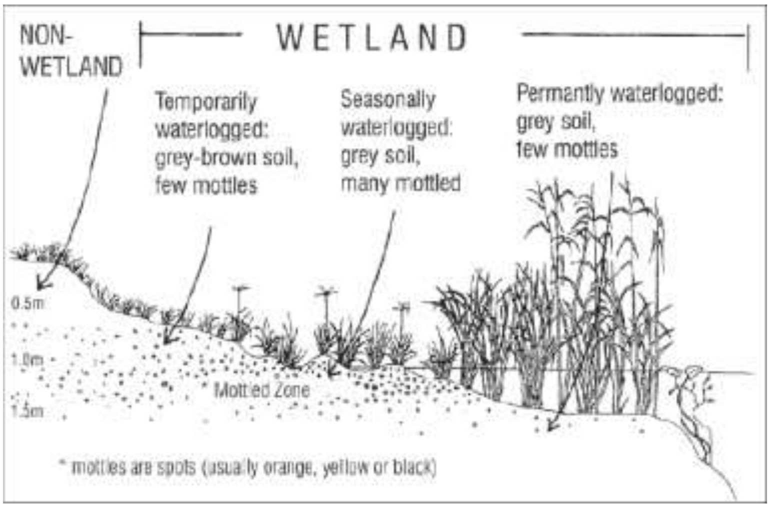


Figure 12. A cross section through a wetland showing how the soil form indicators and vegetation changes from the centre to the edge of the wetland (adapted from Kotze, 1996).

3.2 WETLAND CLASSIFICATION

The study area was sub-divided into transects and the soil profile was examined for signs of wetness within 50 cm of the surface using a hand auger along transects. The wetland boundaries were then determined by the positions of augered holes that showed signs of wetness as well as by the presence or absence of hydrophilic vegetation. The wetlands were subsequently classified according to their hydro-geomorphic setting based on the system proposed in the National Wetland Classification System (Table 4) (SANBI, 2009).

Furthermore, as a result of alluvial deposits being visible from the air, aerial photography was also used to assist in determining the extent of deposits, as well as the vegetation line indicating a difference in species composition or more vigorous growth. The aerial photographs were used to guide on-screen delineation of wetlands in ArcView GIS 3.3.

Table 4. Wetland Unit types based on hydrogeomorphic characteristics (Adapted from Kotze *et al.* 2005).

Hydro-geomorphic type	Code	Illustration	Description
Flood Plain	FP		Valley bottom areas with a well defined stream channel, gently sloped and characterized by floodplain features such as oxbow depressions and natural levees and the alluvial (by water) transport and deposition of sediment, usually leading to a net accumulation of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom with a Channel	VBC		Valley bottom areas with a well defined stream channel but lacking characteristic floodplain features. May be gently sloped and characterized by the net accumulation of alluvial deposits or may have steeper slopes and be characterized by the net loss of sediment. Water inputs from main channel (when channel banks overspill) and from adjacent slopes.
Valley Bottom Without a channel	VB		Valley bottom areas with no clearly defined stream channel, usually gently sloped and characterized by alluvial sediment deposition, generally leading to a net accumulation of sediment. Water inputs mainly from channel entering the wetland and also from adjacent slopes.
Channelled Hillslope Seepage feeding a Water course	CHSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow and outflow is usually via a well defined stream channel connecting the area directly to a watercourse.
Hillslope Seepage feeding a Water course	HSW		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs are mainly from sub-surface flow connecting the area directly to a watercourse.
Hillslope Seepage not feeding a water course	HS		Slopes on hillsides, which are characterized by the colluvial (transported by gravity) movement of materials. Water inputs mainly from sub-surface flow and outflow either very limited or through diffuse sub-surface and/or surface flow but with no direct surface water connection to a watercourse.
Depression	D		A basin shaped area with a closed elevation contour that allows for the accumulation of surface water (i.e. it is inward draining). It may also receive sub-surface water. An outlet is usually absent.

3.3 WETLAND INTEGRITY ASSESSMENTS

3.3.1 Present Ecological Status (PES) of wetlands

The Present Ecological State (PES) assessment of the wetlands within the study area was undertaken to determine the extent of departure of the wetlands from a natural state or reference condition. This method is based on the modified Habitat Integrity approach (Table 5) developed by Kleynhans (1999). Anthropogenic modification of the criteria and its attributes can have an impact on the ecological integrity of a wetland.

The PES was determined for the perennial or non-perennial drainage channels, and channelled valley bottom wetlands of the study area.

Table 5. Habitat integrity assessment criteria for wetlands (Adapted from DWAF, 2003)

Criteria and Attributes	*Relevance*
Hydrologic	
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to or from a wetland.
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.
Water Quality	
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Hydraulic/Geomorphic	
Canalization	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly in inundation patterns.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilization of Biota	Overgrazing, over fishing, etc.
Attributes above are rated and scored as one of the following: Natural/Unmodified 5; Largely Natural 4; Moderately Modified 3; Largely Modified 2; Seriously Modified 1; Critically Modified 0	

For the purpose of this study, the scoring system as described in the document "Resource Directed Measures for Protection of Water Resources, Volume 4. Wetland Ecosystems" (DWAF, 1999) was applied for the determination of the PES (Table 6).

Two tools have recently been developed to facilitate the derivation of scores to reflect the present ecological sate, namely the Index of Habitat Integrity (IHI) DWA, 2007, and Wet-Health, developed by Macfarlane et al., 2008. Both these tools have limitations in that they were developed primarily to assess conditions of floodplain and valley bottom wetlands and Hill slope seepage wetlands linked to drainage lines. The former tool was developed to provide a rapid assessment of the PES specifically for application in reserve studies, while the latter tool was developed to support the Working for Wetlands program. The objective of the latter tool was to provide a semi quantitative assessment of the state of wetland prior to rehabilitation, and one post rehabilitation to demonstrate "improvement". The intention in defining the health category (PES) of a wetland is to provide an indication of the current "condition" of a wetland in order to inform a management class. The latter provides the guidelines against that inform water quality and quantity required to maintain or improve the quality of the water resource.

The PES or health of wetlands has only been applied to the "natural" wetlands, i.e. those that have developed naturally as a consequence of the presence of water. Wetlands are rated on a scale of A to F, with A being a natural wetland and F being a completely modified and disturbed wetland (Table 6). The Wet-Health assesses the following four factors that influence the "health" or condition of wetlands and in this particular application floodplains and river channels associated with the site:

- Hydrology;
- Geomorphology;
- Vegetation, and ideally
- Water quality.

The Present Ecological Status Class (PESC) of the wetlands was based on the available information for each of the criteria listed in Table 5 and the mean score determined for each wetland (Table 6). This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the PESC (DWAF, 2003).

Table 6. Present Ecological Status Class Descriptions

CLASS	CLASS BOUNDARY	CLASS DESCRIPTION
A	>4	**Unmodified, natural;** • The resource base reserve has not been decreased; • The resource capability has not been exploited
B	>3 and <=4	**Largely natural with few modification**; • The resource base reserve has been decreased to a small extent; • A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.
C	>2 and <=3	**Moderately modified**; • The resource base reserve has been decreased to a moderate extent. • A change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.
D	2	**Largely modified**; • The resource base reserve has been decreased to a large extent. • Large changes in natural habitat, biota and basic ecosystem functions have occurred.
E	>0 and <2	**Seriously modified**; • The resource base reserve has been seriously decreased and regularly exceeds the resource base; • The loss of natural habitat, biota and basic ecosystem functions is extensive.
F	0	**Critically modified**; • The resource base reserve has been critically decreased and permanently exceeds the resource base; • Modifications have reached a critical level and the resource has been modified completely with an almost total loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.

3.3.2 Ecological Importance and Sensitivity (EIS)

The Ecological Importance and Sensitivity (EIS) assessment was conducted according to the guidelines as discussed by DWAF (1999). Here DWAF defines "ecological importance" of a water resource as an expression of its importance to the maintenance of ecological diversity and function on local and wider scales. "Ecological sensitivity", according to DWAF (1999), is the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred.

The EIS was determined for the perennial or non-perennial drainage channels and channelled valley bottom wetlands of the study area.

In the method outlined by DWAF a series of determinants for EIS are assessed for the wetlands on a scale of 0 to 4 (Table 7). The median of the determinants is used to determine the EIS of the wetland unit (Table 8).

Table 7. Criteria for assessing the Ecological Importance and Sensitivity of Wetlands

Determinant
PRIMARY DETERMINANTS
1. Rare & Endangered Species
2. Populations of Unique Species
3. Species/taxon Richness
4. Diversity of Habitat Types or Features
5. Migration route/breeding and feeding site for wetland species
6. Sensitivity to Changes in the Natural Hydrological Regime
7. Sensitivity to Water Quality Changes
8. Flood Storage, Energy Dissipation & Particulate/Element Removal
MODIFYING DETERMINANTS
9. Protected Status
10. Ecological Integrity

Score guideline	Very high = 4; High = 3, Moderate = 2; Marginal/Low = 1; None = 0
Confidence rating	Very high confidence = 4; High confidence = 3; Moderate confidence = 2; Marginal/low confidence = 1

Table 8. Ecological Importance and Sensitivity Classes

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

3.3.3 Wetland functional assessments (WET-Ecoservices)

Wetland functional assessments (ecosystem services delivery) were conducted for wetlands in the study area using the tool WET-Ecoservices (Kotze et al., 2005).

WET-Ecoservices provides guidelines for assessing the importance of a wetland in delivering different ecosystem services. A total of 15 ecosystem services are assessed including, flood attenuation, sediment trapping, phosphate trapping, nitrate removal, toxicant removal, erosion control, stream flow augmentation, carbon trapping, water for human use, harvestable natural resources, cultivated food and biodiversity maintenance. The potential of a wetland to deliver these services is also assessed based upon future changes in activities within the wetland and catchment. A Level 2 assessment was undertaken which examines and rates Natural and Human services.

The following natural services were assessed:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity.

Scores for each of the above natural service assessments were allocated a class based on the class boundaries shown in Table 9. These scores were then added to determine the overall level of natural services for the wetland unit using the classes shown in Table 10.

Table 9. Classes for service scores

Class Boundary	Class Score
0 - 0.99	1
1 - 1.99	2
2 - 2.99	3
3 - 4	4

Table 10. Classes for the overall level of natural services provided by a wetland unit

Class Boundaries	Class	Class Description
30 - 36	**Very High**	Unmodified or approximated natural condition.
24 - 29.9	**High**	Largely natural with few modifications, but with some loss of natural habitats.
18 - 23.9	**Moderate**	Moderately modified, but with some loss of natural habitats.
12 - 17.9	**Low**	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
6 - 11.9	**Very Low**	Seriously modified. The losses of natural habitats and basic ecosystem

Class Boundaries	Class	Class Description
		functions are extensive.
0 - 5.9	**Non Existent**	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

The following human services were assessed:

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

Scores for each of the above human service assessments were allocated a class based on the class boundaries shown in Table 9. These scores were then added to determine the overall level of human services for the wetland unit using the classes shown in Table 11.

Table 11. Classes for the overall level of human services provided by a wetland unit

Class Boundaries	Class	Class Description
20 - 24	**Very High**	Local people are extremely dependent on the wetland and benefit from it greatly.
16 - 19.9	**High**	Local people have a high level of dependence on the wetland and benefit from it considerably.
12 - 15.9	**Moderate**	Local people are moderately dependent on the wetland and benefit from it from occasionally.
8 - 11.9	**Low**	Local people have a low dependency on the wetland and seldom benefit from it.
4 - 7.9	**Very Low**	Local people rarely rely on the wetland and almost never benefit from it.
0 - 3.9	**Non Existent**	Local people have no interaction with the wetland and never receive any benefits from it.

3.4 Impact rating assessment

An impact can be defined as any change in the physical-chemical, biological, cultural and/or socio-economic environmental system that can be attributed to human activities related to alternatives under study for meeting a project need.

The significance of the impacts will be determined through a synthesis of the criteria below (Plomp, 2004):

Probability. This describes the likelihood of the impact actually occurring:

- Improbable: The possibility of the impact occurring is very low, due to the circumstances, design or experience.

- Probable: There is a probability that the impact will occur to the extent that provision must be made therefore.
- Highly Probable: It is most likely that the impact will occur at some stage of the development.
- Definite: The impact will take place regardless of any prevention plans, and there can only be relied on mitigation actions or contingency plans to contain the effect.

Duration. The lifetime of the impact

- Short term: The impact will either disappear with mitigation or will be mitigated through natural processes in a time span shorter than any of the phases.
- Medium term: The impact will last up to the end of the phases, where after it will be negated.
- Long term: The impact will last for the entire operational phase of the project but will be mitigated by direct human action or by natural processes thereafter.
- Permanent: Impact that will be non-transitory. Mitigation either by man or natural processes will not occur in such a way or in such a time span that the impact can be considered transient.

Scale. The physical and spatial size of the impact

- Local: The impacted area extends only as far as the activity, e.g. footprint.
- Site: The impact could affect the whole, or a measurable portion of the above mentioned properties.
- Regional: The impact could affect the area including the neighbouring areas.

Magnitude/ Severity. Does the impact destroy the environment, or alter its function.

- Low: The impact alters the affected environment in such a way that natural processes are not affected.
- Medium: The affected environment is altered, but functions and processes continue in a modified way.
- High: Function or process of the affected environment is disturbed to the extent where it temporarily or permanently ceases.

Significance. This is an indication of the importance of the impact in terms of both physical extent and time scale, and therefore indicates the level of mitigation required.

- Negligible: The impact is non-existent or unsubstantial and is of no or little importance to any stakeholder and can be ignored.
- Low: The impact is limited in extent, has low to medium intensity; whatever its probability of occurrence is, the impact will not have a material effect on the decision and is likely to require management intervention with increased costs.
- Moderate: The impact is of importance to one or more stakeholders, and its intensity will be medium or high; therefore, the impact may materially affect the decision, and management intervention will be required.
- High: The impact could render development options controversial or the project unacceptable if it cannot be reduced to acceptable levels; and/or the cost of management intervention will be a significant factor in mitigation.

The following weights will be assigned to each attribute (Table 4)

Table 12. Impact assessment matrix weights

Aspect	Description	Weight
Probability	Improbable	1
	Probable	2
	Highly Probable	4
	Definite	5
Duration	Short term	1
	Medium term	3
	Long term	4
	Permanent	5
Scale	Local	1
	Site	2
	Regional	3
Magnitude/Severity	Low	2
	Medium	6
	High	8
Significance	**Sum(Duration, Scale, Magnitude) x Probability**	
	Negligible	<20
	Low	<40
	Moderate	<60
	High	>60

The significance of each activity will be rated without mitigation measures and with mitigation measures for the development.

4 RESULTS

DWAF (2003) states that in order to classify an area as a wetland it must have one or more of the following attributes:

- Hydromorphic soils that exhibit features characteristic of prolonged saturation;
- The presence of hydrophytes (even if only infrequently);
- A shallow water table that results in saturation at or near the surface, leading to the development of anaerobic conditions in the top 50cm of the soil.

Three major wetland types were identified on site namely:

1. Floodplain wetland;
2. Hillslope seep wetlands;

The wetland areas are presented in figure 8. Wetland zone identification was done according to geology (Photograph 1), soil types (Photograph 2), soil wetness indicators (mottling in top 50 cm of soil, Photograph 3) topography of the landscape (photograph 4) and vegetation (plant species indicators, Photograph 5).

Photograph 1. Shallow ferricrete bedrock indicate perched water table conditions (seepage areas) in the northeastern section of the project area

Photograph 2. Typical soil profile associated with the floodplains of the Klein Marico River in the project area

Photograph 3. Typical mottling in the topsoil of wetland soils as observed during the surveys

Photograph 4. Typical landscape of the project area indicating wster course with riparian woodland

The non-perennial drainage channels on site are considered as water courses with developed riparian woodland. In some areas, the channels form floodplains along its banks (without any wetland characteristics therefore not wetlands) as indicated in the wetland / riparian map. The water courses identified on site are characterised as shallow sandy channels representing tributaries of the Klein Marico River.

The identification of the water courses was done according to the aerial photograph and a field survey where the topography of the landscape and vegetation were used to delineate the water course or riparian zone. The water courses and wetland delineation map are presented in the site (figure 13).

A buffer zone of 30 meter is needed around the larger drainage channels, floodplains and other wetlands. Where mining and road crossings will cause unavoidable impact on the wetlands and water courses on site, a Water Use Licence should be obtained from DWS.

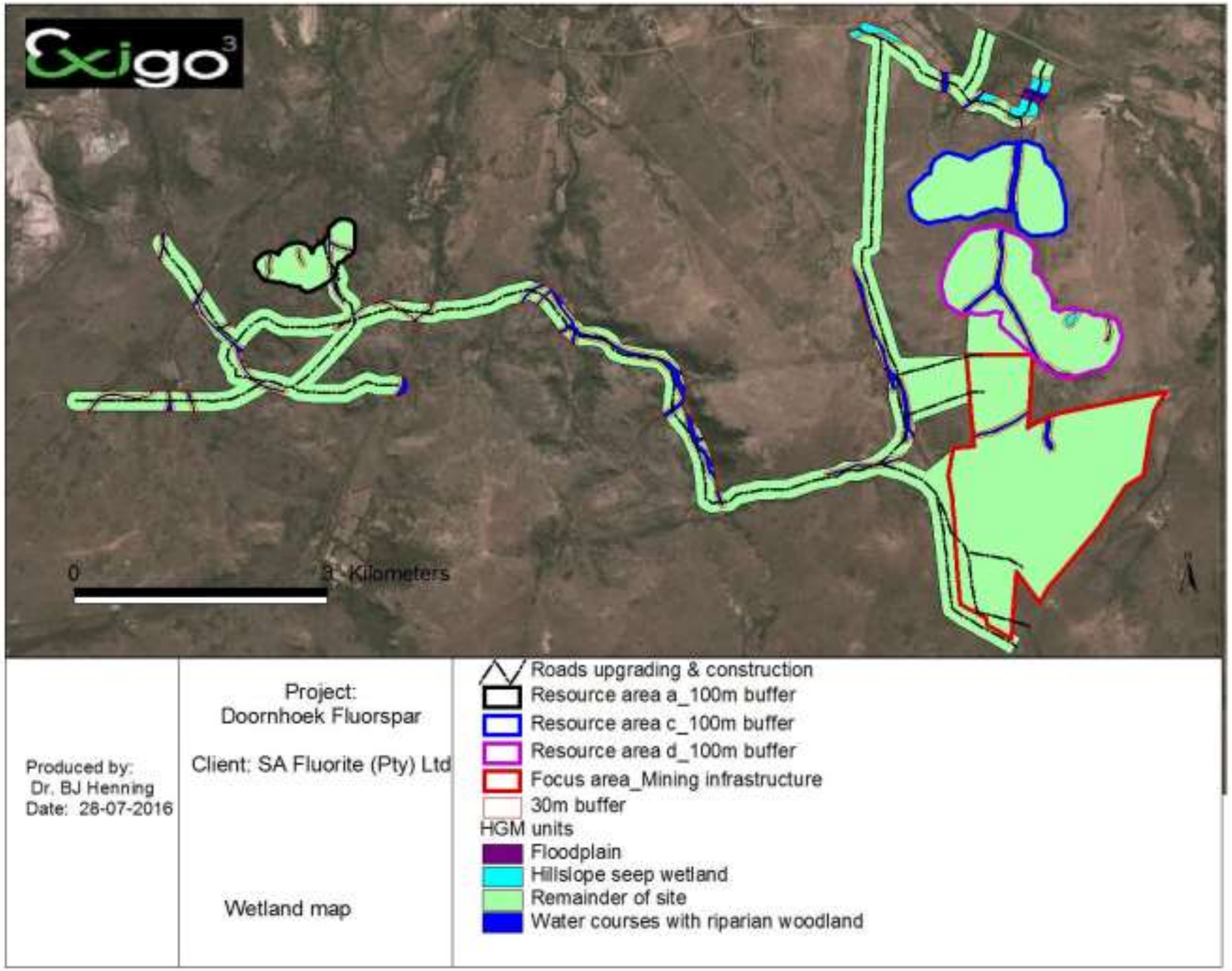


Figure 13. Wetland map for the proposed Doornhoek Fluorspar Mine project Area

4.1 WETLAND CLASSIFICATION

4.1.1 Floodplains wetland

The wetland classification system of the National Water Act classifies the HGM unit associated with the Klein Marico River as a floodplain wetland (Photograph 5). A floodplain, is a flat or nearly flat land adjacent a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (figure 10). It includes the floodway, which consists of the stream channel (in this case the Klein Marico River, Photograph 6) and adjacent areas (riparian woodland, hygrophilic grassland) that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current. In other words, a floodplain is an area near a river or a stream which floods easily.

Floodplains are made by a meander eroding sideways as it travels downstream. When a river breaks its banks and floods, it leaves behind layers of rock and mud. These gradually build up to create the floor of the flood plain. Floodplains generally contain unconsolidated sediments, often extending below the bed of the stream. These are accumulations of sand, gravel, loam, silt, and/or clay, and are often important aquifers, the water drawn from them being pre-filtered compared to the water in the river.

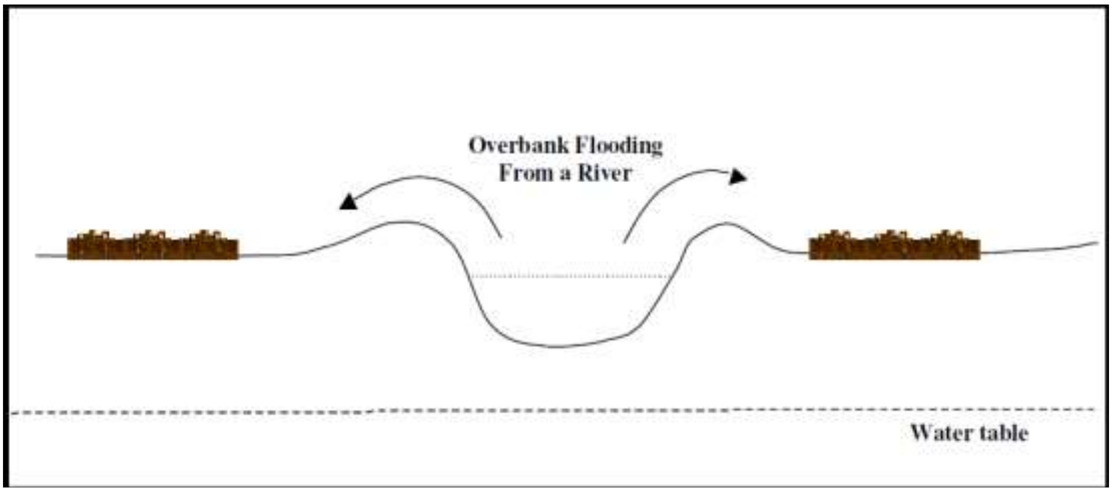


Figure 14. Cross section through a floodplain

Photograph 5. Floodplains and riparian woodland adjacent to the Klein Marico River in the project area

Photograph 6. Instream channel of the Klein Marico River

4.1.2 Hillslope seep wetlands

This vegetation unit represent the grassland areas classified as 'Hill slope Seep Wetlands' mostly adjacent to the water courses or floodplain wetlands (Photograph 7). The seep areas either feed the floodplains or valley-bottom wetland or occur isolated along a slope. A Hill slope seep is classified as a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Water inputs are primarily from precipitation that that enters the wetland from an up-slope direction in the form of subsurface flow. Water movement through the wetland is mainly in the form of interflow, with diffuse overland flow ('sheetwash') often being significant during and after rainfall events. In this hill slope seep the water leaves the 'Hill slope seep without channelled outflow', although it is directly connected to a water course (SANBI, 2009).

This wetland type has a unique nature due to its direct connectivity to the drainage valley-bottom as a result of the geological formation directly adjacent to the drainage channel that forms an impermeable layer of hard plinthite rock and very shallow soils. Hard plinthite is also called ferricrete and is a mineral conglomerate consisting of surficial sand and gravel cemented into a hard mass by iron oxide derived from the oxidation of percolating solutions of iron salts (Wikipedia, undated). The presence of ferricrete is indicative of a fluctuating water table. The fluctuations may have only occurred in the past but may be active at present. Ferricrete can be present as discrete nodules within the residual granitic soil or may be in the form of hardpan (Photograph 1). Where hardpan has developed (as is the case of the study area) a perched water table is often present. These characteristics encourage poor infiltration of surface flow and high surface run off. Hill Slope wetlands have several functions including supporting biological diversity, water storage, water exchange between surface water and underground water, surface water filtration.

The vegetation associated with the seep wetland varies according to various factors such as land-use and soils. The most common grass species associated with hillslope seep wetland is *Eragrostis gummiflua*. Where degradation such as overgrazing has occurred the dwarf shrub *Stoebe vulgaris* completely dominate the lower herbaceous stratum as observed on the seeps (Photograph 8). The overgrazing further caused sheet erosion along hillslope seeps of this area.

Photograph 7. A hillslope seep in the southern section of the project area dominated by *Eragrostis gummiflua*

4.2 WATER COURSES

The non-perennial channels that occur throughout the project area can be described as water courses or channels. (SANBI, 2009). The channels are mostly defined with riparian woodland along its edges dominated by species such as *Acacia karroo, Ziziphus mucronata* and *Searsia lancea* (Photograph 8). The more defined water courses are classified as channels. A Channel (river, including the banks) is classified as an open conduit with clearly defined margins that (i) continuously or periodically contains flowing water, or (ii) forms a connecting link between two water bodies. Dominant water sources include concentrated surface flow from upstream channels and tributaries, diffuse surface flow or interflow, and/or groundwater flow. Water moves through the system as concentrated flow and usually exits as such but can exit as diffuse surface flow because of a sudden change in gradient. Unidirectional channel-contained horizontal flow characterises the hydrodynamic nature of these units. As a result of the erosive forces associated with concentrated flow, channels characteristically have relatively obvious active channel banks.

4.2.1 Instream habitat / Channel Zone:

Section 1.1 (xi) of the National Water Act (1998) described “instream habitat'' as the area which includes the physical structure of a watercourse and the associated vegetation in relation to the bed of the watercourse (Photograph 8). The water course on the site is a perennial channel associated with the Klein Marico River. It forms a channel with clearly defined banks on the edge of the channel. The water input is from the upstream mountainous areas and water flows through the water courses in a northerly direction. The channel plays an important role as a source of water to various organisms throughout the year.

4.2.2 Riparian zone

Riparian Habitat are described by the National Water Act (1998) Section 1.1 (xxi) as follows: “riparian habitat'' includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas”.

In the case of the study area the floodplain adjacent to the Klein Marico River is clearly identified as riparian woodland due to the plant species composition (photograph 7). Small channels have formed on the floodplains where water “takes a short-cut” over the floodplain during flood events.

Riparian zones are particularly vulnerable to invasion by alien vegetation (because they are good dispersal routes for seeds) and this is becoming a huge ecological problem in South Africa. Large section of the riparian woodland next to the Klein Marico River has been invaded by various aliens such as *Populus alba, Salix babylonica*, *Melia azedarach* and *Pyracantha angustifolia*.

Alien vegetation is a problem because:

- It takes up more water than indigenous vegetation (which may impact on the river’s flow regime);
- It takes up habitat for indigenous vegetation (which support a greater variety of flora and fauna);
- It changes the aesthetic characteristics of the riparian zone; and
- It damages buffering capabilities of the riparian zone.

Although alien species have invaded large section of the riparian woodland it still plays many essential roles in the functioning of the ecosystem, including:

- Flow regulation: the riparian vegetation slows the flow of water, both by physically blocking the passage of water, and by absorbing the water into its root systems. This moderates the impacts of flooding on surrounding areas.
- Water quality regulation: the riparian vegetation acts as a buffer or filter between nutrients, sediments, contaminants, and bacteria from the surrounding land and air, and the river channel itself. The riparian vegetation therefore prevents soil, pesticides, fertilizers and oil from entering the river and impacting on in-stream communities.

- Habitat provision: The riparian zone is an important habitat for many plants and animals, because it is an area of transition between the land and the river. These relatively steep environmental gradients (moisture, temperature, topography, and soil) generally support higher levels of biodiversity than more homogeneous areas.

Corridor functions: because it follows the river, the riparian zone serves as a corridor, connecting two or more habitats that may otherwise be isolated by land transformation of areas in between. Many species of animals use corridors to disperse, and find food and mates.

Photograph 8. Small non-perennial water courses in the project area

5 WETLAND INTEGRITY ASSESSMENTS

For the purpose of this study only the most prominent wetlands that bisects the proposed development site was assessed namely the floodplains, channelled valley bottom wetlands and depressions. The hillslope seep wetlands and valleyhead seeps was not assessed due to the type of wetland not being suitable for the integrity assessments.

In determining the integrity of the wetlands the condition of the site and the indirect and direct disturbances is taken into account. The embankments, roads, alien invasive vegetation species, etc. was taken into account in determining the PES (Table 13) and EIS (Table 14) of these wetland units.

5.1 Present Ecological State

All of the wetlands within and around the study area have been impacted upon to some degree, causing changes in the natural flow regime.

Evidence was observed on site of transformation of the floristic characteristics of the site. Impacting activities which may have altered the expected floristic composition include overgrazing, impoundments, road crossings, mining and agricultural activities.

All of the wetlands on site have however been affected by livestock or game grazing, with overgrazing resulting in decreased diversity as well as decreased cover, increasing the risk of erosion, while cattle and game paths and trampling by cattle further create erosion nick points. Incorrect burning regimes and too frequent burning exacerbate the problems caused by cattle. Building of farm dams has also had a significant impact on the wetlands through changing the hydrological regime of the riparian zones and leading to flow concentration, resulting in erosion. All of the above impacts have resulted in the current condition of the wetlands on site departing significantly from the reference or unimpacted condition of the wetland. This is reflected in the results of the PES assessment which indicates that the Klein Marico River floodplains are in a moderately modified condition (PES C) mainly due to alien species invasion, erosion and sedimentation of the river ecosystem, while the tributaries of the Klein Marico is largely in a natural state.

The non-perennial water courses represent the most natural areas within the study area (PES score 4.0 – Class A: Largely Natural.

Only the wetlands that represent naturally functioning HGM units were analysed as a result of the artificial systems functioning in combination with these systems (Table 13).

Table 13. Present Ecological State Scores for the naturally functioning HGM units associated with the site

Wetland Type	PES	Ecological Management Class
Floodplains wetland	C: Moderately modified, but with some loss of natural habitats	Moderately sensitive systems. A moderate risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities. However, the impact of local and acute disturbances must at least partly be mitigated by the presence of sufficient refuge areas.
Water courses	B: Largely natural with few modifications, but with some loss of natural habitats.	Sensitive systems. Only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. Although the risk to the well-being and survival of especially intolerant biota (depending on the nature of the disturbance) at a very limited number of localities may be slightly higher than expected under natural conditions, the resilience and adaptability of biota must not be compromised. The impact of acute disturbances must be totally mitigated by the presence of sufficient refuge areas.

5.2 Ecological Importance and Sensitivity

The concept of Ecological importance and Sensitivity is derived from the Reserve process where a water resource such as a wetland is classified according to criteria listed in Table 7.

These values are then used to inform the Recommended Ecological Category, (REC) which takes into consideration the ecosystem services provided by the wetland. The overall ecological importance and sensitivity of the wetlands on the site is summarised in Table 14.

Table 14. Ecological Importance and Sensitivity Classes for the major wetland types on site

Wetland Type	EISC
Floodplains wetland	**Class C: Moderate** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these Wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.
Water courses	**Class C: Moderate** Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these Wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.

From the table the following can be concluded:

- The floodplain wetland of the Klein Marico River has been altered by alien species invasion and impoundments and is an important corridor for the ecosystem at a local scale. This contributed to the MODERATE EIS;
- Although the non-perennial water courses are still natural, they do not contribute as much to the natural ecosystem other than being habitat to fauna. These ecosystems therefore have a MODERATE EIS, though having a lower functional value compared to the

Klein Marico River floodplains.

5.3 Wet-ecoservices

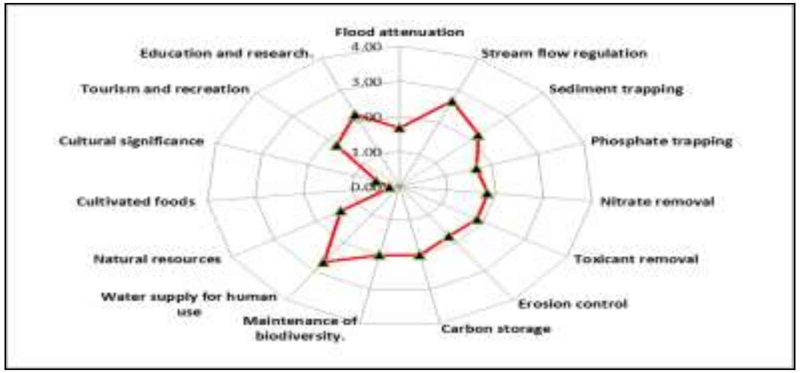
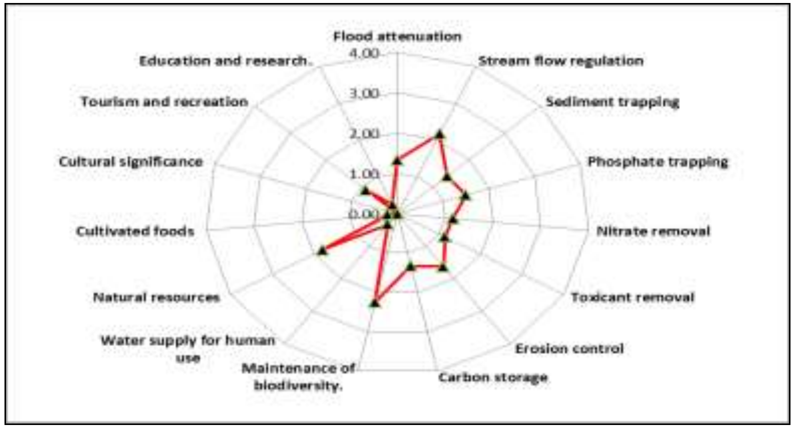
The Hydrological Functional and Importance (HFI) of all the wetland in the project area are considered to be Moderate and play a small role in moderating the quantity and quality of water of the Klein Marico River. The Klein Marico River floodplains and water courses with associated seeps do have a slightly better value in terms of the HFI (Table 15).

Direct Human Benefits obtained from the wetlands on site were considered to be Moderate for the perennial water sources in the project area (Klein Marico River), while the non-perennial water courses have a Very Low value in terms of direct human benefit indicating that the locals therefore have a low dependency on the wetland and seldom benefit from it (Table 15).

Table 15. Hydro-functional Importance and Direct Human Benefits of the wetlands in the Project Area

Wetland	**WET-Ecoservices**	
	Hydrofunctional Importance	**Direct Human Benefits**
Floodplains wetland	22: Moderately modified	12: Moderate Local people are moderately dependent on the wetland and benefit from it from occasionally
Water courses	20: Moderately modified	7: Very Low Local people rarely rely on the wetland and almost never benefit from it.

Table 16. Results and brief discussion of results the Wetland Ecosystem Services provided by the identified wetland units

Wetland Type	Discussion of WET-Ecoservices of wetland types
Floodplains wetland 	This floodplain wetland (Klein Marico River) is in a modified state due to sedimentation and alien species invasion. It mainly contributes in stream flow regulation and biodiversity maintenance. Other functions such as erosion control, flood attenuation and removal of toxicants, phosphates, nitrates and carbon storage also plays an important function. Direct human benefits rated moderate in general due to contributing as a potential tourism venture and direct water supply for irrigation of crops, while also contributing towards education and research.
Water courses 	The non-perennial water courses still plays some role in streamflow regulation several habitats still occur that support and maintain biodiversity. The direct human benefits for the non-perennial areas are very low, with the natural resources only benefit being gained in the form of grazing and wood harvesting.

6 IMPACT ASSESSMENT OF THE PROPOSED DEVELOPMENT ON THE WETLANDS

The objective of this section was to identify impacts and provide a list of actions and potential impacts associated with the various mining phases namely the planning and design phase, construction phase, operational phase, decommission phase and closure phase for the various mining components:

- Opencast Mining;
- Processing Plant and TSF;
- Support infrastructure including roads, workshops (but excluding portal areas and surface area).

6.1 PLANNING AND DESIGN PHASE

Planning and design is necessary to ensure that mitigation and impact management can be effectively implemented and minimise impacts in future. The planning and design phase of the mine will involve the following actions:

- Avoidance of sensitive wetland habitats through identification of alternatives;

No specific direct impacts will occur on the wetlands and water courses of the area during the planning phase.

6.2 CONSTRUCTIONAL PHASE

The development and start-up of the mining operation covers the period of time when considerable changes take place as the mine infrastructure, plant and facilities are constructed, and when the ore body is first exposed. The most immediate impacts are seen as disruptions and disturbances to wetlands due to site clearance for opencast mining, construction of the plant, tailings facility, access and haul roads and other mining related infrastructure. This is usually a significant change to the visual appeal of the area.

Exposure of rocks, ore and soils to rainfall and wind may lead to atmospheric contamination by dusts and increased erosion of the site and sedimentation of local water courses. An increase in the movement of construction vehicles will result in an increase in the dust levels in the area.

The following impacts will occur during the Construction Phase of the proposed Doornhoek Fluorspar Mine:

- The construction phase of the mining development will result in loss of and damage to natural wetland habitats if the vegetation is cleared for the development of infrastructure (plant site), pit footprints, access and haul roads, and laydown areas for the stockpiles and overburden dumps. Rehabilitation of some areas would be possible but there is likely to be long-term damage in large areas. Most wetland destruction will be caused during the construction phase. Where mining will occur through water courses / wetlands and at road crossings, wetland plant communities are likely to be impacted on a large spatial scale;
- The construction of buildings, fences and roads will inevitably result in natural movement patterns of wetland dependant fauna being disrupted and, to a varying degree depending on how different

species react to these barriers will result in the fragmentation of natural populations. The fencing of the mining area and construction of mining infrastructure will have a large, significant impact in fragmenting the wetland habitats on and around the site.

- The construction activities associated with the developments may result in widespread soil disturbance and is usually associated with accelerated soil erosion. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora. Sedimentation and silt migration of watercourses is another significant surface water impact. This is due to land degradation, soil erosion, construction activities and destruction of the riparian vegetation in the catchment. The result is highly suspended solid loads in the water, which may cause sedimentation affecting the hydrological characteristics of the catchment. High sediment loads often become trapped in impoundments, reducing their storage capacity (Walmsley et. al 1999). The use of heavy machinery during the construction process will result in the compaction of soil, resulting in decreased infiltration of rain water and increased surface run-off volumes and velocities leading to a greater erosion risk in the area. Soil compaction is likely to occur over some parts of the proposed corridors. The hardened surfaces and compacted soils of the development area will also lead to an increase in surface run-off during storm events which will likely be discharged via storm water outlet points, concentrating flows leaving the development area. The operation of heavy equipment and vehicles in and around the riparian zone of the lower Klein Marico River and its tributaries might cause destruction of the soil profile or soil compaction, thereby increasing erosion by reducing soil infiltration and causing overland flow (Hill & Kleynhans, 1999).
- Construction work of the magnitude contemplated for the proposed development will always carry a substantial risk of soil and water pollution, with large construction vehicles contributing substantially due to oil and fuel spillages. If not promptly dealt with, spillages or accumulation of waste matter can contaminate the surface water, leading to potential medium/long-term impacts on the wetlands of the site;

  The encroachment of alien vegetation in the riparian zones of most of the rivers can be considered to be at a serious to critical level. *Sesbania punicea* (glory pea), *Populus alba* and *Melia azedarach* (seringa) are present along the entire length of most of the rivers flowing westwards. It is clear that this problem will escalate if specific management actions are not taken. Cat claw creeper (*Macfadyena unguiscati*) is creating a localised, but serious problem in both the riparian and terrestrial vegetation in the lower reaches of the Klein Marico River. The construction of the mine will carry the greatest risk of alien invasive species being imported to the site, and the high levels of habitat disturbance also provide the greatest opportunities for such species to establish themselves, since most indigenous species are less tolerant of disturbance. The biggest risk is that seeds of noxious plants may be carried onto the site along with materials that have been stockpiled elsewhere at already invaded sites. Furthermore, the spread of the alien invasive species through the area will be accelerated when seeds are carried by stormwater into the wetlands on the site that will cause environmental degradation and indigenous species to be displaced. Continued movement of personnel and vehicles on and off the site, as well as occasional delivery of materials required for maintenance, will result in a risk of importation of alien species throughout the life of the project.

- Construction or disturbance during breeding season can precipitate long-term cumulative effect on wetland dependant fauna populations.

The following impacts for the on the wetlands apply to both the Doornhoek Fluorspar Mine for the various components during the construction phase:

6.2.1 Opencast Mining

- **Activity 1:** Vegetation clearing through wetlands and at road crossings;
- **Related impacts**
    - o Wetland habitat destruction or disturbance to ecosystems leading to reduction in the overall extent of a particular habitat;
    - o The construction through wetlands and mining through wetlands, as well as the removal of riparian vegetation and the mechanical alteration of the river beds and banks add to the deterioration of the habitat integrity through the alteration of flow patterns;
    - o Fragmentation of wetland dependant fauna habitats;
    - o Potential establishment and spread of declared weeds and alien invader plants
- **Activity 2:** Topsoil and subsoil stripping
- **Related impacts**
    - o Increased Soil erosion and sedimentation into wetlands;
- **Activity 3: Vehicle movement**
    - o Spillages of harmful substances to the wetland ecosystems;
    - o Soil compaction leading to increased Soil erosion and sedimentation into wetlands;

6.2.2 Processing Plant and tailings storage facility (TSF)

- **Activity 1:** Topsoil and subsoil stripping
    - o Increased Soil erosion and sedimentation;

  - Habitat degradation due to dust;
- **Activity 2: Vehicle movement**
  - Spillages of harmful substances to the wetland ecosystem;
  - Soil compaction leading to increased Soil erosion and sedimentation into wetlands;

6.2.3 Support infrastructure

- **Activity 1:** Topsoil and subsoil stripping
  - Increased Soil erosion and sedimentation;
- **Activity 3: Vehicle movement during construction of surface infrastructure, access road and bridges**
  - Spillages of harmful substances to the wetland ecosystem;
  - Soil compaction leading to increased Soil erosion and sedimentation into wetlands;

6.2.4 Cumulative Impact

The cumulative impacts associated with the construction phase are the same as discussed above for the different mining components. The rating will be higher compared to the individual component ratings as the landscape scarring of are permanent features affecting the wetlands and composition of the general vegetation patterns of the study area.

6.3 OPERATIONAL PHASE

The routine operational phases account for most of the environmental impacts associated with mining and are considered to have the greatest potential to drive environmental change. The extent to which mining operational activities act as drivers of environmental change depends in part on the type, scale, duration and magnitude of the activities, and the sensitivity of the receiving environment.

The removal and storage (stockpiling) of ore in the operational phase is usually the most intensive activity on any mine operation. The process involves exposure of ore bodies, followed by loading and transportation of the ore to the stockpile sites. These activities are characterized by large-scale disturbance due to noise and generation of dust from the movement of vehicles and possible wind-blown dust from stockpiles at the recovery plant.

Typical activities of the operational phase will include:

- Opencast mining of ore body;
- Processing of ore in the processing plant;
- Storage of tailings (revised TSF height is approx. 40 m.)

- Disposal of overburden on overburden dumps;
- Transporting of people and equipment;
- Transportation of product off-site;
- Transportation of supplies to the site;
- Handling and storage of hazardous materials and substances;
- Domestic waste generation, storage and disposal;
  - Water storage facilities;
  - Hazardous waste storage and disposal;

A short description of the impacts associated with the operational phase is included below:

- Impacts on water quantity (dewatering of wetlands): The development of an opencast fluorspar mine will have an impact on the water quantity of the region considering that water will drain into the open pits potentially causing the drying of the springs.
- The operational phase of the mine will have a very low impact on the vegetation of the proposed mining development site. Considering that most infrastructure (plant etc.) have already been constructed during this mining phase, the only impacts that might create habitat disturbance or loss of plant communities might be loss of plant communities and flora species of significance on the laydown areas of the overburden and stockpiles that used to represent natural vegetation communities.
- The spread of alien invasive plants on site is more INTENSE during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species. Although construction creates the suitable conditions for establishment of invasive species, the operational phase certainly carries by far the greatest risk of alien invasive species being spread through the area and even through the wetland systems to the greater region. This risk is further influenced by increased run-off as a result of exposed areas and hardened surfaces created during the construction phase of the mine.
- The increased hardened surfaces around infrastructure and exposed areas created alongside the open pit, as well as the roads and additional surface areas created on the slopes of the stockpiles and overburden dumps will have a definite impact on the potential erosion of exposed areas that will eventually cause sedimentation in the wetlands and streams of the area. Soil erosion promotes a variety of terrestrial ecological changes associated with disturbed areas, including the establishment of alien invasive plant species, altered plant community species composition and loss of habitat for indigenous flora.
- During the operational phase heavy machinery and vehicles as well as sewage and domestic waste

would be the main contributors to potential pollution problems.

- The impact of the operational phase of the mine relates more to the habitat loss of fauna as a result of specific mining activities. Furthermore, opencast developments can threaten migration routes or flight paths as a result of noise and dust pollution. Cumulative impact of illegal collecting, road kills or power line related deaths reduce population viability in the long-term. Some mining related habitats also favour species leading to un-natural competition with endemic fauna. Much of the impacts of the fauna related to the construction phase of the mining development also apply to the operational phase of the mine.

The following impacts for the on the flora and fauna apply to both the Doornhoek Fluorspar Mine for the various components during the operational phase:

6.3.1 Opencast Mining

- **Activity 1: Opencast mining**
    - Impacts on water quantity (dewatering of wetlands): The development of an opencast fluorspar mine will have an impact on the water quantity of the region considering that water will drain into the open pits potentially causing the drying of the springs.
- **Activity 2 Laydown areas of stockpiles and overburden dumps**
- **Related impacts**
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;
    - Increased soil erosion and sedimentation (increased runoff from laydown areas);
- **Activity 2: Materials handling, storage and transportation**
    - Increased soil erosion and sedimentation (increased runoff from laydown areas);
- **Activity 3: Crushing and stockpiling**
    - Increased soil erosion and sedimentation (increased runoff from hardened surfaces and slopes of stockpiles);
    - Potential establishment and spread of declared weeds and alien invader plants;

6.3.2 Processing Plant and tailings storage facility (TSF)

- **Activity 1: Stockpiling of ore**
- **Related impacts**
    - Potential establishment and spread of declared weeds and alien invader plants in wetlands;

- Spillages of harmful substances to the wetland ecosystem;
- Increased Soil erosion and sedimentation (increased runoff from laydown areas);

- **Activity 2: Materials handling and storage**
  - Spillages of harmful substances to the wetland ecosystem;
- **Activity 3: Disposal of tailings:**
  - Spillages of harmful substances to the wetland ecosystem;

6.3.3 Support infrastructure

- **Activity 1: Materials handling and storage**
  - Spillages of harmful substances to the wetland ecosystem;
- **Activity 2: Storm water management:**
  - Increased Soil erosion and sedimentation;
- **Activity 3: Vehicle movement during construction of surface infrastructure, access road and bridges**
  - Spillages of harmful substances to the ecosystem;
  - Increased Soil erosion and sedimentation;

6.3.4 Cumulative Impact

The cumulative impacts associated with the operational phase on the wetlands are the same as discussed above for the different mining components. The rating will be higher compared to the individual component ratings, especially if one considers that water extraction and dust pollution will be increased through the operation of the mines. This will contribute to a loss of diversity and species composition within wetlands over the larger area. Cumulative effects only become critical if there are no other suitable wetland habitats in the adjacent areas.

6.4 DECOMMISION PHASE

This phase starts when all the economically exploitable mineral reserves in an area have been extracted. The actions which mark this phase include:

- Cessation of mining;
- Removal of mine infrastructure
- Backfilling of the mined out areas

The only major impacts on the vegetation during this phase would be the potential increased invasion of alien species and weeds in the wetland areas, while the risks of spreading fires will also still exist. Otherwise, there should be no further negative impact on surrounding wetlands during decommissioning.

6.4.1 Opencast Mining

- **Activity 1: Cessation of mining**
- **Related impacts**
  - Potential establishment and spread of declared weeds and alien invader plants in wetlands;

6.4.2 Processing Plant and tailings storage facility (TSF)

- **Activity 1: Demolition of mining infrastructure**
- **Related impacts**
  - Potential establishment and spread of declared weeds and alien invader plants in wetlands / water courses;
  - Spillages of harmful substances to the wetland ecosystem;

6.4.3 Support infrastructure

- **Activity 1: Demolition of mining infrastructure**
- **Related impacts**
  - Potential establishment and spread of declared weeds and alien invader plants;
  - Spillages of harmful substances to the wetland ecosystem;

6.4.4 Cumulative Impact

The cumulative impacts associated with the decommissioning phase are the same as discussed above for the different mining components. The rating will be slightly higher compared to the individual component ratings.

6.5 CLOSURE PHASE

The closure phases of the mine involve rehabilitation actions to mitigate impacts caused during the construction and operational phase of the mine. Some of the rehabilitation actions include the following:

- Ripping and rehabilitation of all haul roads;
- Rehabilitation of the opencast areas and TSF;
- Seeding of ripped and rehabilitated surfaces;

Amongst the more pronounced post-closure impacts on flora are landscape scarring in the form of unrehabilitated mine facilities, discard dumps and open pits, as well as continuing environmental damage from wind-blown dusts and the dispersal of contaminated solid waste. If mitigation measures are correctly implemented there should be not be any further significant impact on the surrounding natural vegetation after closure though.

The following impacts are associated with the closure phase of the mine on the wetlands:

- Soil compaction is likely to occur over much of the rehabilitated area as a consequence of the storage and placement of soil and the change in structure following replacement. The poor soil cover associated with the cleared areas, stockpiles and overburden dumps also renders the site more susceptible to erosion and soil loss. It is probable that these soils will be transferred through the rehabilitated landscape into the draining water courses and receiving water bodies as described earlier. The rehabilitation of the site and decreased surfaces will however still reduce the risk of erosion and sedimentation carried into the wetlands and rivers during the closure phase, compared to the other phases;
- During the closure phase of the mine the risk of spillages are still pertinent, although the impact will mainly be limited to potential spillages from vehicles into water courses / wetlands. The impact will therefore be greatly reduced as a result of concurrent rehabilitation;
- The control of alien invasive species will be more pertinent during the closure phase of the mine and the risk of spreading is therefore reduced. Although the movement of vehicles on site during rehabilitation will still have a potential impact on the spreading of alien invasive species, the intensity of spread of alien invasive plants on site is more INTENSE during the operational phase of the mine due to the movement of vehicles over an extended area on and from the site, causing a higher risk of potentially spreading the seeds or vegetative material from invasive species into water resources;

6.5.1 Opencast Mining

- **Activity 1: Rehabilitation**
- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated areas in wetlands;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;

6.5.2 Processing Plant and tailings storage facility (TSF)

- **Activity 1: Rehabilitation**
- **Related impacts**
    - Positive impact through habitat improvement in rehabilitated wetland areas;
    - Potential establishment and spread of declared weeds and alien invader plants;
    - Spillages of harmful substances to the ecosystem;

6.5.3 Support infrastructure

- **Related impacts**
  - Positive impact through habitat improvement in rehabilitated wetland areas;
  - Potential establishment and spread of declared weeds and alien invader plants;
  - Spillages of harmful substances to the ecosystem;

6.5.4 Cumulative Impact

The cumulative impacts associated with the closure phase are the same as discussed above for the different mining components. The rating will be slightly higher compared to the individual component ratings, although much lower compared to the other phases of the development. The impacts associated with the rehabilitation of the mining sites are positive considering that the rehabilitated land will improve habitats in the area, even though it still represent degraded land.

7 QUANTITATIVE IMPACT ASSESSMENT

Table 17 indicate the impacts described above and specific ratings of significance the impact will potentially have on the wetlands and riparian ecosystem during the proposed mining activities according to the layout plan of the mining development:

Table 17. Quantitative impact assessment for the various mining components and mining phases

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigtion Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
Planning Phase																
1	Delay of mining onset	Obtaining of IWUL for crossings and mining through water courses / wetlands	**WOM**	**Negative**	Definite	5	Short term	1	Local	1	High	8	50	Moderate	Apply and obtain IWUL from DWS after liaison with relevant officials and site visit to the area	Can be avoided, managed or mitigated
			WM	**Negative**	Highly Probable	4	Short term	1	Local	1	Medium	6	32	Low		Can be reversed
Construction Phase																
2	Wetland destruction / fragmentation of wetland habitats	Clearing of vegetation for openpit through wetlands and water courses as well as road crossings	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Local	1	High	8	65	High		Can be avoided, managed or mitigated
3	Impediment of flow patterns	Clearing of vegetation for openpit through wetlands and water courses as well as road crossings	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High		Can be avoided, managed or mitigated
4	Soil erosion and sedimentation	Topsoil & subsoil stripping, exposure of soils, ore and rock to wind and rain during construction causing erosion and sedimentation in wetlands	**WOM**	Negative	Definite	5	Permanent	5	Site	2	High	8	75	High	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Local	1	Medium	6	44	Moderate		Can be avoided, managed or mitigated
5	Spreading and establishment of alien invasive species in wetlands	Vegetation clearing / vehicle movement	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	High	8	60	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low		Can be reversed
6	Spillages of harmful substances	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Long term	4	Site	2	Low	2	16	Negligible		Can be reversed
Operational Phase																
7	Dewatering of wetlands causing direct habitat loss / destruction	Opencast mining	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Definite	5	Long term	4	Site	2	High	8	70	High		Can be avoided, managed or mitigated
8	Soil erosion and sedimentation in wetland / water courses	Increased hardened surfaces around infrastructure and exposed areas around openpits, laydown areas of overburden dumps and stockpiles as well as TSF, road crossings	**WOM**	Negative	Definite	5	Permanent	5	Regional	3	High	8	80	High	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Medium	6	48	Moderate		Can be avoided, managed or mitigated
9	Spreading and establishment of alien invasive species in wetlands	Heavy machinery and vehicle movement on site	**WOM**	Negative	Highly Probable	4	Permanent	5	Site	2	Medium	6	52	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Highly Probable	4	Long term	4	Site	2	Low	2	32	Low		Can be reversed

Nr	Impact	Activity	Without or With Mitigation	Nature (Negative or Positive Impact)	Probability		Duration		Scale		Magnitude/ Severity		Significance		Mitigtion Measures	Mitigation Effect
					Magnitude	Score	Magnitude	Score	Magnitude	Score	Magnitude	Score	Score	Magnitude		
10	Spillages of harmful substances leading to water pollution in wetlands	Heavy machinery and vehicle movement on site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible		Can be reversed
Closure and Decommissioning Phase																
11	Improvement of wetland habitat through revegetation / succession over time	Rehabilitation of mining site	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Refer to section 8 of report	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate		Can be reversed
12	Soil erosion and sedimentation in wetlands	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible		Can be avoided, managed or mitigated
13	Spreading and establishment of alien invasive species in wetlands	Demolition of mining infrastructure / Cessation of mining / rehabilitation of mining site	WOM	Negative	Highly Probable	4	Long term	4	Regional	3	Medium	6	52	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Medium term	3	Site	2	Low	2	14	Negligible		Can be reversed
14	Spillages of harmful substances	Heavy machinery and vehicle movement on site	WOM	Negative	Highly Probable	4	Medium term	3	Regional	3	Medium	6	48	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Site	2	Low	2	10	Negligible		Can be avoided, managed or mitigated
Post-Closure Phase																
15	Improvement of wetland habitat at crossings through revegetation / succession over time	Natural Successional processes	WOM	Positive	Highly Probable	4	Long term	4	Local	1	Low	2	28	Low	Refer to section 8 of report	Can be avoided, managed or mitigated
			WM	Positive	Definite	5	Permanent	5	Local	1	Medium	6	60	Moderate		Can be reversed
16	Soil erosion and sedimentation	Exposed surfaces / unrehabilitated areas on site post closure / poor monitoring during LoM	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible		Can be avoided, managed or mitigated
17	Spreading and establishment of alien invasive species	Exposed surfaces / poor monitoring of revegetation on site	WOM	Negative	Highly Probable	4	Medium term	3	Site	2	Medium	6	44	Moderate	Refer to section 8 of report	May cause irreplaceable loss of resources
			WM	Negative	Probable	2	Short term	1	Local	1	Low	2	8	Negligible		Can be avoided, managed or mitigated

8 MITIGATION MEASURES

The development will have a definite impact on some of the natural environment of the site. To prevent major impacts on the water courses and wetland bisecting the area, specific mitigation measures should be implemented.

A management system has been developed to comply with the objectives and principles set out in this document. This system is based on the principle of managing the potential impacts using the best available technology, not entailing excessive cost. In this way, the technology is effective, but does not seriously impair economic stability of the development. Management measures required for the different phases of the mine which relates to biodiversity is presented in Table 18 below.

Table 18. . Wetland Management Plan to be implemented as part of the Environmental Management Programme Report for the Doornhoek Fluorspar Mine

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
Flora and Fauna Planning and Design phase									
Pre-mining	Mining through wetlands and road crossings across wetlands / water courses	Wetlands / water courses	Delay of mining onset	National Water Act Section 21 C and I	Obtaining of IWUL for crossings and mining through water courses / wetlands	Application forms completed as obtained from DWS	Apply and obtain IWUL from DWS after liaison with relevant officials and site visit to the area	2 years	Environmental Assessment Practitioner (EAP)
Construction Phase									
OC Mining, Support infrastructure, TSF and Plant	Clearing of vegetation	Wetlands / water courses	Wetland / water course destruction	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) National Water Act Section 21 C and I	• Prevent edge effects • Keep mining development footprint restricted to layout plans • To limit the habitat loss due to the increase of the mining footprint	Keep mining development footprint restricted to layout plans	• No activity must take place within the 1:100 year flood line or the delineated riparian habitat, whichever is the greatest, or within 500 m radius from the boundary of any wetland unless authorised by this licence • Existing vegetation composition must be maintained or improved by maintaining the natural variability in flow fluctuations. • No activities that negatively affect catchment yield, hydrology and hydraulics must be practised unless authorised • All construction and maintenance activities should be conducted in such a way that minimal damage is caused to the water courses riparian zone. Only necessary damage must be caused and, for example, unnecessary driving around in the veld or bulldozing natural habitat must not take place. Where impacts are unavoidable a water use licence application should be submitted to Department of Water & Sanitation. • Work in rivers, streams and riparian zones should preferably be done during the low flow season; • The construction camp must be located outside the extent of the watercourse(s) and must be recovered and removed within one (1) month after construction has been completed • During the construction phase vehicles must not be allowed to indiscriminately drive through any wetland areas. • Remove and relocate any plants of botanical or ecological significance as indicated by the ecologist or Environmental Control Officer (ECO); • Vegetation to be removed as it becomes necessary; • Construction should preferably take place in winter to reduce disturbance to breeding fauna and flowering flora; • Clearly demarcate the entire development footprint prior to initial site clearance and prevent construction personnel from leaving the demarcated area; • Monitoring should be implemented during the construction activities to ensure that minimal impact is caused to the wetlands of the area; • The ECO should advise the construction team in all relevant matters to ensure minimum destruction and damage to the wetland environment. The ECO should enforce any measures that he/she deem necessary. Regular environmental training should be provided to construction workers to ensure the protection of the habitat, fauna and flora and their sensitivity to conservation; • Indigenous riparian vegetation, including dead trees, outside the limits of disturbance indicated in the site plans must not be removed from the area	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
OC Mining, Support infrastructure, TSF and Plant	Clearing of vegetation / road construction	Wetlands / water courses	Impediment of natural flow		•		• Unless authorised by this licence, access and haul roads must not encroach into the extent of the watercourse(s) • No structures to be placed within the 1:100 year floodline and/or the delineated riparian areas unless authorised in this licence • Appropriate design and mitigation measures must be developed and implemented to minimise impacts on the natural flow regime of the watercourse i.e. through placement of structures/supports and to minimise turbulent flow in the watercourse • The diversion and impeding structures may not restrict river flows by reducing the overall river width or obstructing river flow. Any watercourse crossing must minimise its impacts on the watercourse and must be assessed and documented as such and be available for review • The indiscriminate use of machinery within the in-stream and riparian habitat will lead to compaction of soils and vegetation and must therefore be strictly controlled • The clear incision of the banks of the Klein Marico River indicates that this feature is highly erodible. The installation of energy dissipating structures, such as gabion wingwalls, to protect the banks of the feature is required as recommended by the submitted reports • Perform scheduled maintenance to be prepared for storms. Insure that culverts have their maximum capacity, ditches are cleaned, and that channels are free of debris and brush than can plug structures.	Continuous	Contractor / ECO
OC Mining, Support infrastructure, TSF and Plant	Topsoil & subsoil stripping	Wetlands / water courses	Soil erosion and sedimentation	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	• To prevent bank erosion of rivers and sedimentation of streams / wetlands in the area	Management of storm water on site; Minimize time that soil is left exposed after vegetation is cleared that will cause erosion and sedimentation	• Sediment trapping, erosion and storm water control should be addressed by a hydrological engineer in a detailed storm water management plan; • The overall macro-channel structures and mosaic of cobbles and gravels must be maintained by ensuring a balance (equilibrium) between sediment deposition and sediment conveyance maintained. A natural flooding and sedimentation regime must thus be ensured as far as reasonably possible • Steps must be taken to ensure that stormwater does not result in bank instability and excessive levels of silt entering the watercourse(s)/wetlands. • Stormwater must be diverted from construction works, access roads, linear infrastructure and must be managed in such a manner as to disperse runoff and to prevent the concentration of stormwater flow. • The velocity of stormwater discharges must be attenuated and the banks of the watercourses protected • Cover disturbed soils as completely as possible, using vegetation or other materials; • Minimize the amount of land disturbance and develop and implement stringent erosion and dust control practices. • Protect sloping areas and drainage channel banks that are susceptible to erosion and ensure that there is no undue soil erosion resultant from activities within and adjacent to the construction camp and Work Areas; • Repair all erosion damage as soon as possible to allow for sufficient rehabilitation growth; • Structures must be non-erosive, structurally stable and must not induce any flooding or safety hazard. • Structures must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas - debris must be removed and damages must be repaired and reinforced immediately • Existing flood terraces and deposition of sediments on these terraces to ensure optimum growth, spread and recruitment of these species must be maintained. • Necessary erosion prevention mechanisms must be employed to ensure the sustainability of all structures and activities and to prevent in-stream sedimentation • Stockpiling of removed soil and sand must be stored outside of the 1:100 flood line and/or delineated riparian habitat and/or the regulated area of a wetland, whichever is the greater, to prevent	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							being washed into the river and must be covered to prevent wind and rain erosion • Slope/bank stabilisation measures must be implemented with a 1:3 ratio or flatter and vegetated with indigenous vegetation immediately after the shaping • As much indigenous vegetation growth as possible should be promoted within the proposed development area in order to protect soil and to reduce the percentage of the surface area which is paved, hardened and/or compacted • Care must be taken to avoid excess silt entering the rivers; silt traps such as drift fences must be installed to intersect drainage by means adjacent to the workings of each of the bridges to contain silt. • All material works (such as tar, sand and gravel) that are left unused or spilled adjacent to the roadway should be immediately removed during the proposed crossing development		
OC Mining, Support infrastructure, TSF and Plant	Heavy machinery & vehicle movement on site	Water quality in permanent water courses	Spillages	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	• To prevent contamination of wetlands / water courses due to the spillages of hydrocarbons and reagents used in the process and during transportation of these substances • To reduce the risk of contamination of soils due to increased fuel deliveries	Active monitoring of potential spillages	• Pollution of and disposal/spillage of any material into the watercourse must be prevented, reduced, or otherwise remediated through proper operation, maintenance and effective protective measures. • Vehicles and other machinery must be serviced well outside the 1:100 year flood line or delineated riparian habitat, whichever is the greatest. • Oils and other potential pollutants must be disposed off at an appropriate licenced site, with the necessary agreement from the management of such a site • Vehicles must be checked for oil leaks and all maintenance must take place at a designated site further than 32 meters from the boundary of the wetland associated with each watercourse • All employees will be trained in cleaning up of a spillage. The necessary spill kits containing the correct equipment to clean up spills will be made available at strategic points in the plant area • Any hazardous substances must be handled according to the relevant legislation relating to transport, storage and use of the substance and all storage facilities must be equipped with large, clearly readable material safety data sheets (MSDS). • All reagent storage tanks and reaction units must be supplied with a bunded area built to contain sufficient capacity of the facility and provided with sumps and pumps to return the spilled material back into the system. The system must be maintained in a state of good repair and standby pumps must be provided. • Silt, litter and hydrocarbon (oil) traps must be installed to minimise the risk of pollutants entering the natural drainage system of the area. A register must be in place to indicate that oils are recovered/recycled or alternatively disposed in a licenced facility • Activities (including spill clean-up) must start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream works	Continuous	Contractor / ECO
OC Mining, Support infrastructure, TSF and Plant	Vegetation clearing, topsoil & subsoil stripping, vehicle movement on site	Wetlands / water courses	Potential establishment and spread of declared weeds and alien invader plants in wetlands / water courses	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	To implement an alien invasive eradication programme to manage and control alien species on the mine	Prevent and control of spreading and establishment of alien invasive species on the mining area and larger region	• Alien and invader vegetation must not be allowed to further colonise the area, and all new alien vegetation recruitment must be sustainably eradicated or controlled. Control involves killing the alien invasive plants present, killing the seedlings which emerge, and establishing and managing an alternative plant cover to limit re-growth and re-invasion. The control of these species should even begin prior to the construction phase considering that small populations of the AIS occur around the sites; • Institute strict control over materials brought onto site, which should be inspected for seeds of noxious plants and steps taken to eradicate these before transport to the site. Routinely fumigate or spray all materials with appropriate low-residual herbicides prior to transport to site or in a quarantine area on site. The contractor is responsible for the control of weeds and invader plants within the construction site for the duration of the construction phase; • Rehabilitate disturbed areas as quickly as possible to reduce the area where invasive species would be at a strong advantage and most	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							easily able to establish; • Institute a monitoring programme to detect alien invasive species early, before they become established and, in the case of weeds, before the release of seeds; • Institute an eradication/control programme for early intervention if invasive species are detected, so that their spread to surrounding natural ecosystems can be prevented; • A detailed plan should be developed for control of noxious weeds and invasive plants that could colonize the area as a result of new surface disturbance activities at the site. The plan should address monitoring, weed identification, the manner in which weeds spread, and methods for treating infestations.		
OPERATIONAL PHASE									
OC Mining, Support infrastructure, TSF and Plant	Opencast mining	Wetlands / water courses	Wetland destruction through dewatering of wetlands	NEMA Regulation 543 Section 32 NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32 National Water Act	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• A detailed surface water - groundwater study should be conducted by a hydrogeological engineer to indicate the extent of potential dewatering of wetlands / springs in the area • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase.	Continuous	Contractor / ECO
	Laydown areas of overburden dumps and stockpiles, crushing and stockpiling, crossings	Wetlands / water courses	Increased Soil erosion and sedimentation;	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Stormwater and run-off must be gently directed towards grasslands from where it migrates to watercourse(s) • Concurrent rehabilitation should occur during the operational phase on all exposed areas created by construction as well as roads, stockpiles and overburden dumps, especially at crossings. Only indigenous species should be used for rehabilitation. The following programmes should be implemented as part of the operational phase of the mine: o Concurrent rehabilitation programme o Alien invasive programme o Fire management programme o Educational and training programme on the conservation and wetland / riparian systems • As much indigenous vegetation growth as possible should be promoted within the proposed development area in order to protect soil and to reduce the percentage of the surface area which is paved, hardened and/or compacted. • Run-off from paved, hardened and compacted surfaces should be slowed down by the strategic placement of berms • Rehabilitation: revegetate or stabilise all disturbed areas as soon as possible. Indigenous trees can be planted in the buffer zone of the proposed development to enhance the aesthetic value of the site and stabilize soil conditions; • The vegetative (grass) cover on the soil stockpiles (berms) must be continually monitored in order to maintain a high basal cover. Such maintenance will limit soil erosion by both the mediums of water (runoff) and wind (dust); • Conservation of topsoil should be prioritized on site and done as follows: o Topsoil should be handled twice only - once to strip and stockpile, and secondly to replace, level, shape and scarify; o Stockpile topsoil separately from subsoil; o Stockpile in an area that is protected from storm water runoff and wind; o Topsoil stockpiles should not exceed 2.0 m in height and should be protected by a mulch cover where possible; o Maintain topsoil stockpiles in a weed free condition; o Topsoil should not be compacted in any way, nor should any object be placed or stockpiled upon it; o Stockpile topsoil for the minimum time period possible i.e. strip just before the relevant activity commences and replace as soon	Continuous	Contractor / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
							as it is completed. • Soils that have become compacted through the activities must be loosened to an appropriate depth to allow seed germination • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase.		
	Laydown areas of overburden dumps and stockpiles, crushing and stockpiling, crossings	Wetlands / water courses	Spillages of harmful substances to the wetlands ecosystems;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Vehicle maintenance only done in designated areas – spill trays, sumps to be used and managed according to the correct procedures. • Vehicles and machines must be maintained properly to ensure that oil spillages are kept to a minimum. • Fuel and oil storage facilities should be bunded with adequate storm water management measures. • Operational and Maintenance plan and schedule for management of sewage facilities should be compiled. An emergency plan should be compiled to deal with system failures and should include a down-stream notification procedure • Routine checks should be done on all mechanical instruments for problems such as leaks, overheating, vibration, noise or any other abnormalities. All equipment should be free of obstruction, be properly aligned and be moving at normal speed. Mechanical maintenance must be according to the manufacturer's instructions • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Laydown areas of stockpiles and overburden dumps	Wetlands / water courses	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Encroachment of additional exotic species and terrestrial species in riparian zones must be discouraged • Refer to mitigation measures needed during the operational phase that are similar to the mitigation measures for impacts during the construction phase	Continuous	Ecologist / ECO
DECOMMISSIONING PHASE									
OC Mining, Support infrastructure, TSF and Plant	Cessation of mining Demolition of mining infrastructure	Wetlands / water courses	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	To leave all affected areas in a safe condition	Continuous	Ecologist / ECO
	Cessation of mining Demolition of mining infrastructure	Wetlands / water courses	Soil erosion and sedimentation	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar are similar to the mitigation measures for impacts during the construction phase	Continuous	Contractor / ECO
	Demolition of mining infrastructure	Wetlands / water courses	Road mortalities of fauna	NEMBA Section 56 (1), 57 (1), 57 (2) and 57 (4) NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar	Continuous	Contractor / ECO
	Demolition of mining infrastructure	Wetlands / water courses	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the decommissioning phase that are similar	Continuous	Contractor / ECO
CLOSURE PHASE & POST CLOSURE PHASES									
OC Mining, Support infrastructure, TSF and Plant	Rehabilitation	Wetlands / water courses	Improvement of habitat through revegetation over time	NEMA Regulation 543 Section 32	• To ensure that the mining areas rehabilitated according to prescriptions • To shape and prepare	Rehabilitate within development footprint to ensure revegetation and rehabilitation impacts are kept within the mining	• The Licensee must embark on a systematic long-term rehabilitation programme to restore the watercourse(s) to environmentally acceptable and sustainable conditions after completion of the activities, which must include, but not be limited to the rehabilitation of disturbed and degraded riparian areas to restore and upgrade the	Continuous	Ecologist / ECO

Components	Activity	Aspect	Impact	Legal requirements	Objectives	Performance criteria	Mitigation Measures	Time frame	Responsible person
					the rehabilitation areas to blend in with the surrounding environment. • To rehabilitate all disturbed areas to a suitable post closure land use • To manage the social impact of closure on personnel who became redundant due to closure • To keep all the post closure monitoring in place and to ensure that the necessary reporting is done to the authorities and interested and affected parties	footprint areas	riparian habitat integrity to sustain a bio-diverse riparian ecosystem. • All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity • Plant vegetation species for rehabilitation that will effectively bind the loose material and which can absorb run-off from the mining areas. • Rehabilitate all the land where infrastructure has been demolished. • Monitor the establishment of the vegetation cover on the rehabilitated sites to the point where it is self-sustaining. • Protect rehabilitation areas until the area is self-sustaining. • Diversion trenches and storm water measures must be maintained • Water management facilities will stay operational and maintained and monitored until such a stage is reached where it is no longer necessary. • The mining areas will be shaped to make it safe. • All the monitoring and reporting on the management and rehabilitation issues to the authorities will continue till closure of the mine is approved. • Rehabilitated areas must have a vegetation basal cover of at least 15% at all times		
	Rehabilitation	Wetlands / water courses	Potential establishment and spread of declared weeds and alien invader plants	Alien and Invasive Species Regulations (GNR 599 of 2014) as part of the National Environmental Management: Biodiversity Act (10/2004)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• An active campaign for controlling invasive species must be implemented within disturbed zones to ensure that it does not become a conduit for the propagation and spread of invasive exotic plants • Monitor and manage invader species and alien species on the rehabilitated land until the natural vegetation can outperform the invaders or aliens.	Continuous	Contractor / ECO
	Rehabilitation	Wetlands / water courses	Soil erosion and sedimentation	CONSERVATION OF AGRICULTURAL RESOURCES ACT 43 OF 1983 NEMA Regulation 543 Section 32	Refer to Construction Phase objectives	Refer to Construction Phase criteria	• Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages instabilities and erosion with concomitant remedial and maintenance actions. • A comprehensive and appropriate rehabilitation and management programme to restore the watercourse(s) to environmentally acceptable and sustainable conditions after construction must be developed and submitted to the Provincial Head for written approval within one (1) month prior to a watercourse being directly affected. • A Wetland Management and Rehabilitation Plan for the activities must be compiled by a professional, independent, qualified and registered wetland specialist when wetlands are to be affected and submitted to the Provincial Head for written approval within one (1) month prior to a wetland being affected	Continuous	Contractor / ECO
		Wetlands / water courses	Spillages of harmful substances to the ecosystem;	National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) Section 11(1)	Refer to Construction Phase objectives	Refer to Construction Phase criteria	Refer to mitigation measures for the construction phase needed during the closure phase that are relevant	Continuous	Contractor / ECO

9 LAYOUT OPTION ANALYSIS

Different layout options were identified at a PFS level for the location of the Tailings Storage Facility (TSF) and the processing plant with subsequent different haul road and access road options. Table 19 indicates the most suitable layout option in terms of wetland impacts. The 4 layout options and wetland overlay is indicated in Figure 15 to 18

Table 19. Preferred and alternative layout options for the proposed Doornhoek Fluorspar Project

Options	Positives	Negatives	Recommendation
Layout Option 1	• Plant location close to resource • Infrastructure not impacting wetlands	• Plant located close to water course although outside buffer zone	**2nd most suitable option from a wetland point of view**
Layout Option 2	• Plant location close to resource	• TSF impacting on water course that will need diversion • Plant located on sloping terrain with high risk of impact on water courses to the north	**4th most suitable option from wetland impactpoint of view**
Layout Option 3	• Plant located close to access road for construction • Plant and TSF on less sensitive terrain (footprint surface area) compared to other options	• Plant located further away from resource area • TSF located close to water course although outside buffer zone	**1st – Most suitable option from a wetland point of view**
Layout Option 4	• Plant location close to resource • Infrastructure on less sloping terrain	• TSF and sections of plant impacting on pristine grassland and outcrop area	**3rd most suitable option from wetland point of view**

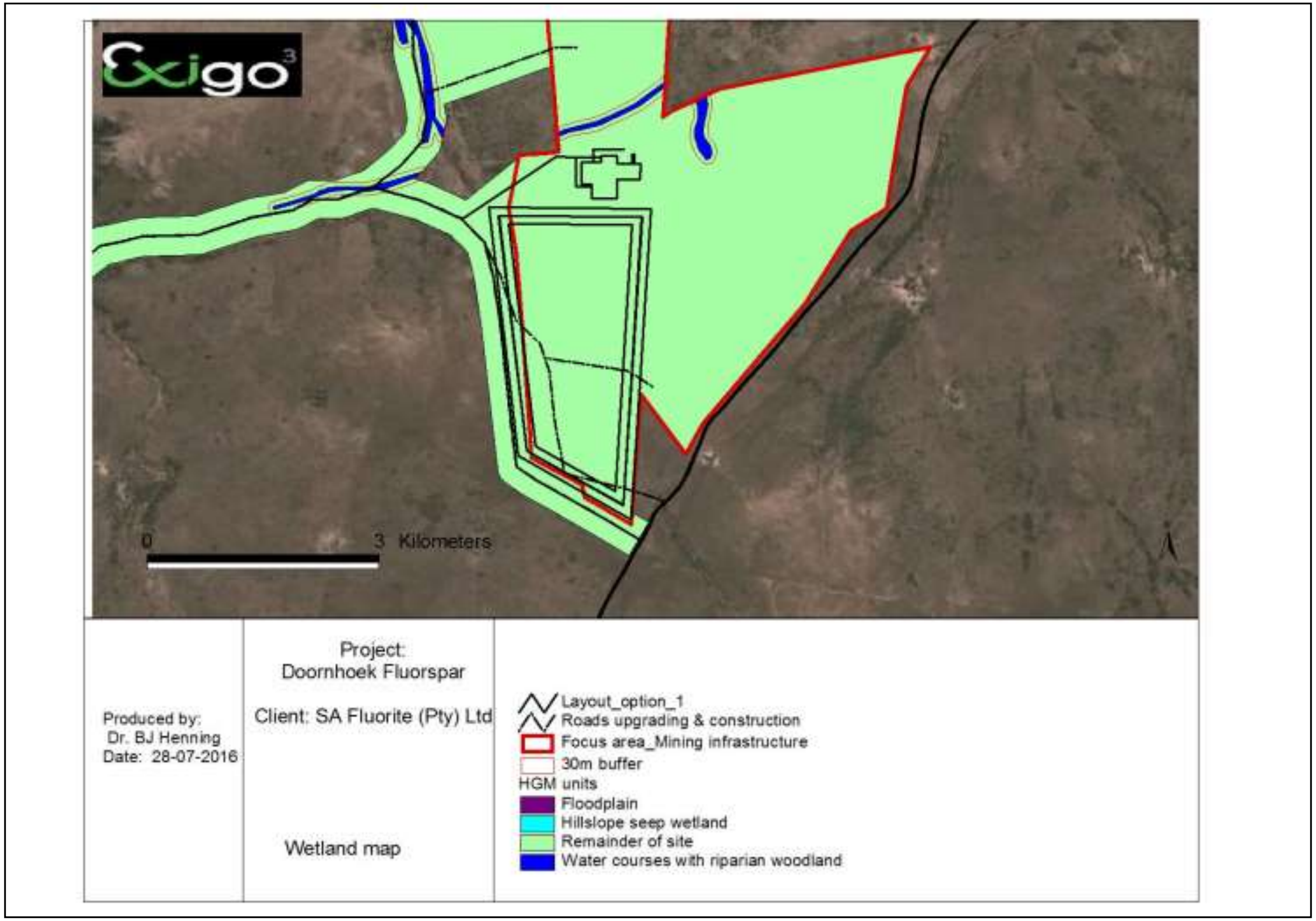


Figure 15. Layout option 1 wetland overlay map

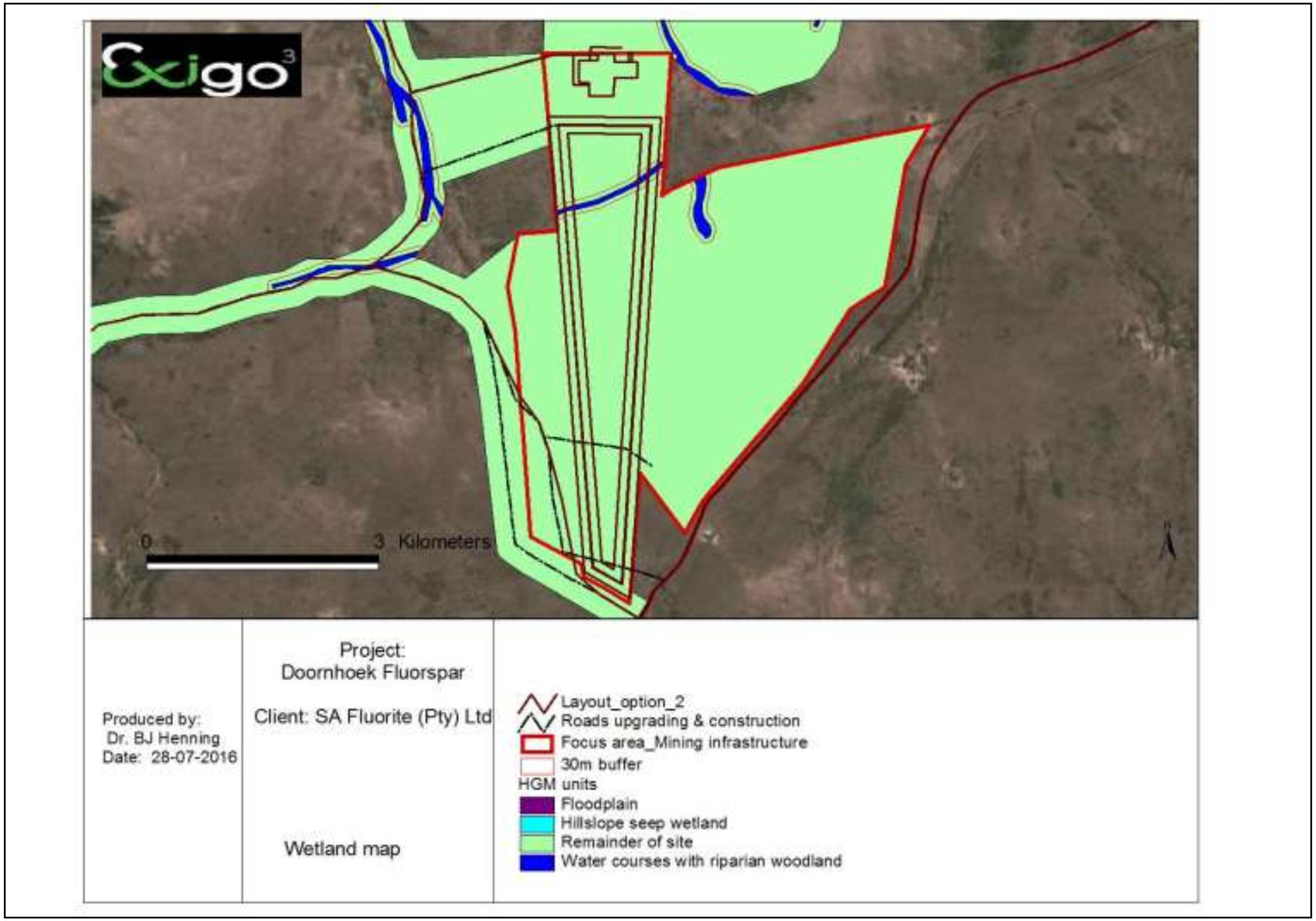


Figure 16. Layout option 2 wetland overlay map

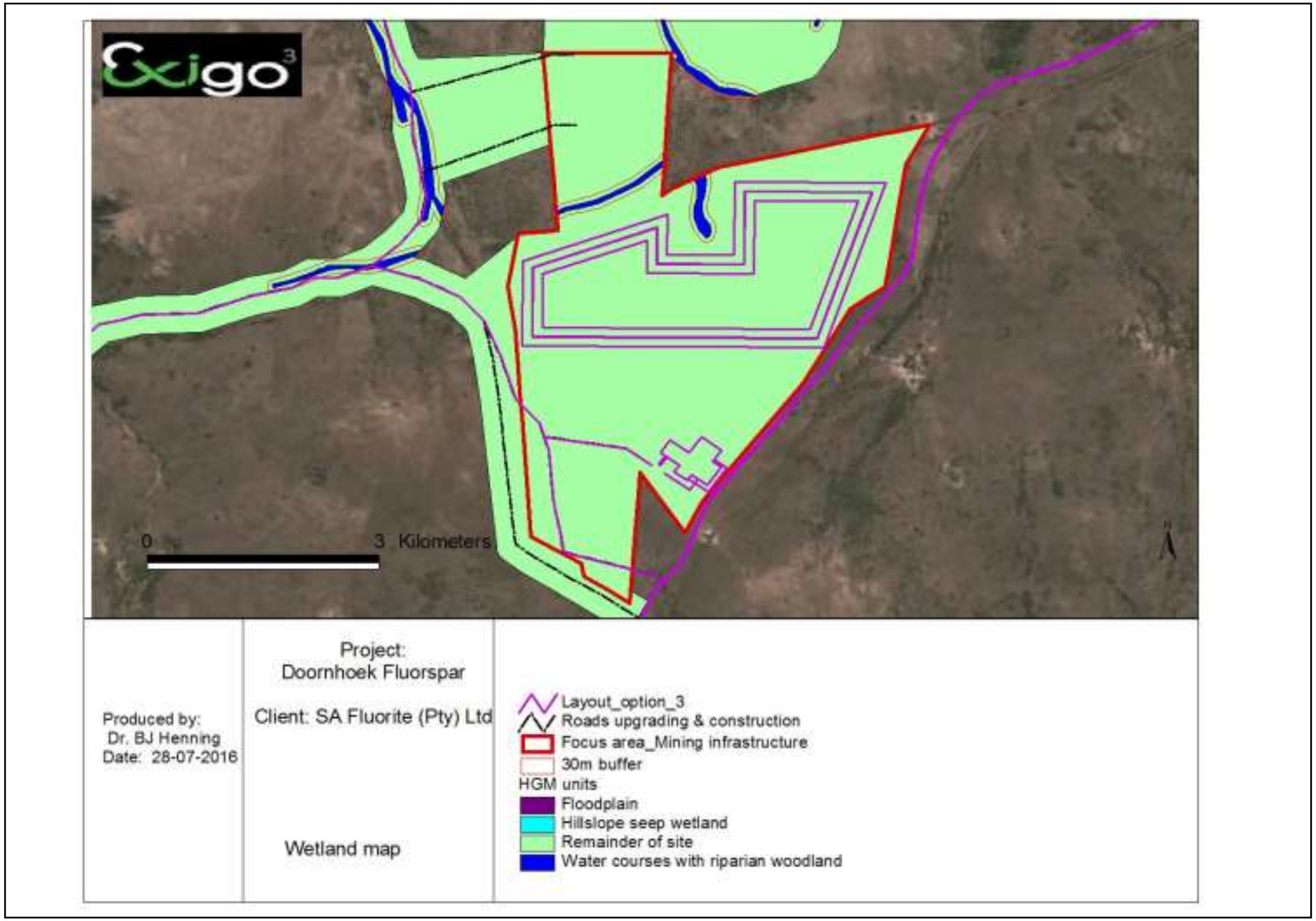


Figure 17. Layout option 3 wetland overlay map

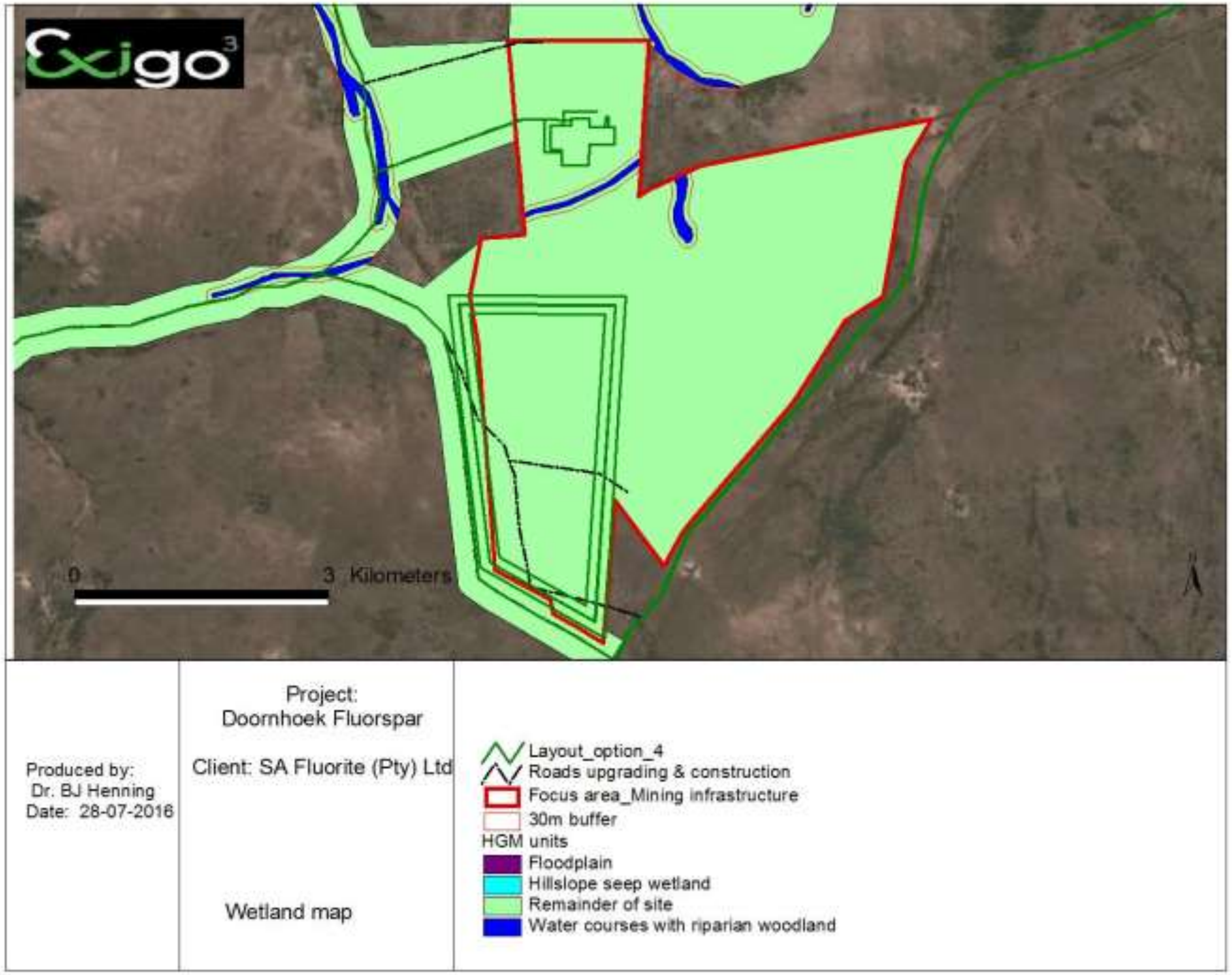


Figure 18. Layout option 4 wetland overlay map

10 DISCUSSION & CONCLUSION

The wetland delineation for the project was done according to the criteria set by the Department of Water Affairs and Forestry (2003) and the National Wetland Classification System for South Africa (SANBI, 2009). The soils, vegetation associated with wetlands and landscape were all used as parameters in identifying the wetland zones. The hydro-geomorphic units of the proposed development site can be classified as follows:

1. Floodplain wetland;
2. Hillslope seep wetlands;
3. Water courses with riparian woodland

Baseline soil information, landscape profile and vegetation were used to confirm wetland and terrestrial properties within the study area. The soils in the wetlands showed signs of wetness within 50cm of the surface and displayed typical hydromorphic characteristics.

The impacts associated with the site are reflected in the results of the wetland integrity assessments. Evidence was observed on site of transformation of the floristic characteristics of the site. Impacting activities which may have altered the expected floristic composition include overgrazing, impoundments, road crossings, mining and agricultural activities.

All of the above impacts have resulted in the current condition of the wetlands on site departing significantly from the reference or unimpacted condition of the wetland. This is reflected in the results of the PES assessment which indicates that the Klein Marico River floodplains are in a moderately modified condition (PES C) mainly due to alien species invasion, erosion and sedimentation of the river ecosystem, while the tributaries of the Klein Marico is largely in a natural state (PES B).

The EIS of the floodplain wetland of the Klein Marico River have been altered by alien species invasion and impoundments and is an important corridor for the ecosystem at a local scale. This ecosystem has a MODERATE EIS similar to its tributaries (water courses).

The Hydrological Functional and Importance (HFI) of all the wetland in the project area are considered to be Moderate and play a small role in moderating the quantity and quality of water of the Klein Marico River. The Klein Marico River floodplains and water courses with associated seeps do have a slightly better value in terms of the HFI.

Direct Human Benefits obtained from the wetlands on site were considered to be Moderate for the perennial water sources in the project area (Klein Marico River), while the non-perennial water courses have a Very Low value in terms of direct human benefit indicating that the locals therefore have a low dependency on the wetland and seldom benefit from it.

An impact assessment was conducted for the wetlands on site in addition to the buffer zones recommended to ensure the protection of the wetlands. Impacts relating to the proposed mining development on the wetlands are as follows:

- Permanent loss of wetland and their associated functions
- Impacts on water quantity (dewatering)
- Alteration of natural flow patterns
- Soil compaction and increased risk of sediment transport and erosion
- Water pollution
- Alien vegetation encroachment and spread of alien invasive species

Specific mitigation measures need to be implemented in the areas surrounding the wetland zones to prevent any impacts on the wetlands during the construction phase of the development. The wetland zones should be strictly seen as ecologically sensitive zones and no impact can occur on these ecosystems unless authorised by a licence. Provided that all the mitigation measures and recommendations surrounding the wetlands are strictly adhered to the development can be supported.

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12 APPENDIX A PES SCORES OF THE WETLANDS

Criteria and Attributes	Relevance	Floodplain wetlands	Water courses
Flow Modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural land. Changes in flow regime (timing, duration, frequency), volumes, velocity which affect inundation of wetland habitats resulting in floristic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.	3	2
Permanent Inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.	3	2
Water Quality Modification	From point or diffuse sources. Measure directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.	3	4
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.	2	4
Canalisation	Results in desiccation or changes to inundation patterns of wetland and thus changes in habitats. River diversions or drainage.	4	3
Topographic Alteration	Consequence of infilling, ploughing, dykes, trampling, bridges, roads, railway lines and other substrate disruptive activities which reduce or changes wetland habitat directly in inundation patterns.	3	4
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.	4	3
Indigenous Vegetation Removal	Transformation of habitat for farming, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and in increases potential for erosion.	3	4
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).	1	4
Alien Fauna	Presence of alien fauna affecting faunal community structure	3	4
Over utilisation of Biota	Overgrazing, overfishing, etc.	2	4
Total		**31**	**38**

Criteria and Attributes	Relevance	Floodplain wetlands	Water courses
Mean		**2.8**	**3.5**
Category		**Class C:** **Moderately Modified**	**Class B:** **Largely natural with few modification**
General management priorities		Moderately sensitive systems. A moderate risk of modifying the abiotic template and exceeding the resource base may be allowed. Risks to the well-being and survival of intolerant biota (depending on the nature of the disturbance) may generally be increased with some reduction of resilience and adaptability at a small number of localities. However, the impact of local and acute disturbances must at least partly be mitigated by the presence of sufficient refuge areas.	Sensitive systems. Only a small risk of modifying the natural abiotic template and exceeding the resource base should be allowed. Although the risk to the well-being and survival of especially intolerant biota (depending on the nature of the disturbance) at a very limited number of localities may be slightly higher than expected under natural conditions, the resilience and adaptability of biota must not be compromised. The impact of acute disturbances must be totally mitigated by the presence of sufficient refuge areas.

13 APPENDIX B EIS SCORES OF THE WETLANDS IN THE STUDY AREA

Determinant	Floodplain wetlands	Water courses
PRIMARY DETERMINANTS		
1. Rare & Endangered Species	3	0
2. Populations of Unique Species	1	0
3. Species/taxon Richness	2	1
4. Diversity of Habitat Types or Features	2	1
5. Migration route/breeding and feeding site for wetland species	2	1
6. Sensitivity to Changes in the Natural Hydrological Regime	3	1
7. Sensitivity to Water Quality Changes	3	1
8. Flood Storage, Energy Dissipation & Particulate/Element Removal	3	3
MODIFYING DETERMINANTS		
9. Protected Status	0	0
10. Ecological Integrity	1	3
TOTAL*	20	11
MEDIAN	2.0	1.1
OVERALL ECOLOGICAL SENSITIVITY AND IMPORTANCE	**Moderate**	**Moderate**

14 APPENDIX C. SCORES FOR THE WET-ECOSERVICES ASSESSMENT (KOTZE ET AL. 2005)

	Floodplains wetland	Water courses
	Hydro-functional Importance	
Flood attenuation	2	2
Stream flow regulation	3	3
Sediment trapping	3	2
Phosphate trapping	2	2
Nitrate removal	2	2
Toxicant removal	2	2
Erosion control	2	2
Carbon storage	3	2
Maintenance of biodiversity	3	3
Total Score	**22**	**20**
	Direct Human Benefits	
Water supply for human use;	3	1
Natural resources	2	2
Cultivated foods	1	1
Cultural significance	1	1
Tourism and recreation	2	1
Education and research	3	1
Total score	**12**	**7**