APPENDIX I5

WETLAND IMPACT ASSESSMENT

SPECIALIST STUDY:

WETLAND IMPACT ASSESSMENT FOR THE PROPOSED MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT (PHASE 2A) (MCWAP-2A)

COMPILED FOR:

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Declaration

The observations, conclusions and recommendations made in this report are based on the best available data and on best scientific and professional knowledge of the directors of INDEX (Pty) Ltd. The report is based on GIS programming and utilises satellite tracking to map survey points. Survey points are normally accurate to within 3 metres and which must be considered in the use of the information.

The directors of INDEX (Pty) Ltd exercises due care and diligence in rendering services and preparing documents. However, the company accepts no liability. The client, by receiving this document, indemnifies INDEX (Pty) Ltd and its directors and employees, by the use of the information contained in this document, against any action, claim, demand, loss, liability, cost, damage and expense arising from or in connection with services rendered.

The property and copyright of this report shall remain vested in INDEX (Pty) Ltd. The client that commissioned the report may use the information as he/she may think fit; but only for the land for which it was commissioned.

The author of this report is Dr J A Gouws; he is a registered scientist with SACNASP (No 400140/06) as well as a member of the Soil Science Society of South Africa.

General declaration:

- INDEX acted as the independent specialist in this application;
- Performed the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- There were no circumstances that could compromise INDEX's objectivity in performing such work;
- INDEX have expertise in conducting the specialist report relevant to this application, including knowledge of NEMA and its regulations and any guidelines that have relevance to the proposed activity;
- Index has not and will not engage in conflicting interests in the undertaking of the activity.

Signature of specialist

for INDEX(PTY) LTD

December 2018

Terms and definitions

1. "diverting" means to, in any manner, cause the instream flow of water to be rerouted temporarily or permanently;
2. "delineation of a wetland and riparian habitat" means delineation of wetlands and riparian habitat according to the methodology as contained in the Department of Water Affairs and Forestry, 2005 publication: A Practical Field Procedure for Delineation of Wetlands and Riparian Areas;
3. "extent of a watercourse" means:

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

   → (b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan.

4. "flow- altering" means to, in any manner, alter the instream flow route, speed or quantity of water temporarily or permanently;
5. "impeding" means to, in any manner, hinder or obstruct the instream flow of water temporarily or permanently, but excludes the damming of flow so as to cause storage of water;
6. The maps are projected as follows:

Projected Coordinate System:	Transverse Mercator
Central meridian:	27
Scale factor:	1
Linear Unit:	Meter
Geographic Coordinate System:	GCS WGS 1984
Datum:	WS84
Prime Meridian:	Greenwich
Angular Unit:	Degree

EXCLUSION FROM THIS GENERAL AUTHORISATION

This General Authorisation does not apply -

a. to the use of water in terms of section 21(c) or (i) of the Act for the rehabilitation of a wetland as contemplated in General Authorisation 1198 published in Government Gazette 32805 dated 18 Dec 2009,
b. to the use of water in terms of section 21(c) or (i) of the Act within the regulated area of a watercourse where the Risk Class is Medium or High as determined by the Risk Matrix (Appendix A).
c. in instances where an application must be made for a water use license for the authorisation of any other water use as defined in section 21 of the Act that may be associated with a new activity;
d. where storage of water results from the impeding or diverting of flow or altering the bed, banks, course or characteristics of a watercourse; and
e. to any water use in terms of section 21(c) or (i) of the Act associated with construction, installation or maintenance of any sewerage pipelines, pipelines carrying hazardous materials and to raw water and wastewater treatment works.

CONDITIONS FOR IMPEDING OR DIVERTING THE FLOW OF WATER OR ALTERING THE BED, BANKS, COURSE OR CHARACTERISTICS OF A WATERCOURSE

The water user must ensure that:

a. impeding or diverting the flow or altering the bed, banks, course or characteristics of a watercourse do not detrimentally affect other water users, property, health and safety of the general public, or the resource quality;
b. the existing hydraulic, hydrologic, geomorphic and ecological functions of the watercourse in the vicinity of the structure is maintained or improved upon;
c. a full financial provision for the implementation of the management measures prescribed in this General Authorisation, including an annual financial provision for any future maintenance, monitoring, rehabilitation, or restoration works, as may be applicable; and (d) upon written request of the responsible authority, they implement any additional management measures or monitoring programmes that may be reasonably necessary to determine potential impacts on the water resource or management measures to address such impacts.

1 BACKGROUND

Water requirements will increase in the Lephalale area due to various planned and anticipated developments associated with the Waterberg coalfields. The Department of Water and Sanitation (DWS) commissioned the proposed Mokolo and Crocodile River (West) Water Augmentation Project (Phase 2A) (MCWAP-2A) Feasibility Study to investigate the options for meeting the aforementioned water requirements.

The proposed MCWAP-2A, which entails the transfer of water from the Crocodile River (West) to the Steenbokpan and Lephalale areas, consist of:

1. Water Transfer Infrastructure (WTI); and
2. Borrow Pits.

The project is located within the western part of the Limpopo Province. The footprint of MCWAP-2A WTI traverses the Thabazimbi Local Municipality (LM) and Lephalale LM, which fall within the Waterberg District Municipality (DM).

The major scheme components for the proposed **MCWAP-2A WTI** include the following:

- Vlieëpoort Abstraction Weir on the Crocodile River (West);
- Low lift Pumping Station;
- Low lift Rising Main;
- Sedimentation Works;
- Balancing Reservoir;
- High lift Pumping Station;
- High lift Rising Main to and the Break Pressure Reservoir (BPR);
- Gravity Pipeline from BPR to and the Operational Reservoir (OR);
- Gravity pipeline from Operational Reservoir to Medupi Tee-off via Steenbokpan; and
- Ancillary infrastructure (gauging weirs, Crocodile (West) River Management System, access roads, accommodation, offices, workshops and security measures).

Construction material will be sourced from 23 Borrow Pits located at approximately 5 km intervals along the project footprint.

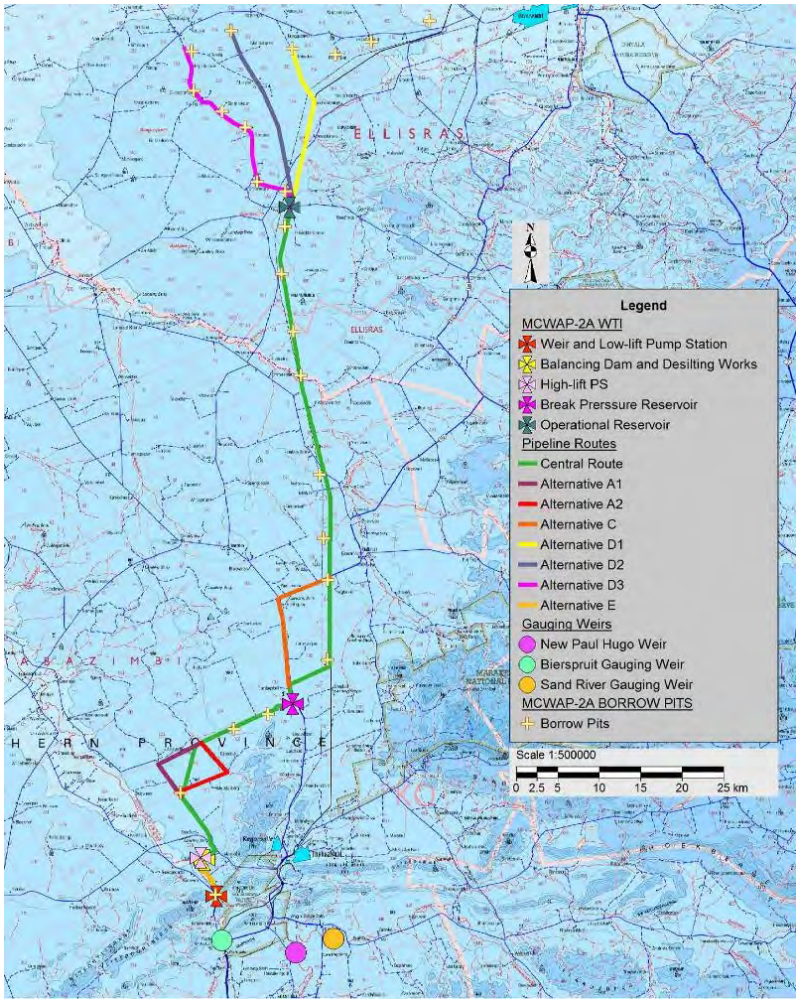


Figure 1. Locality of the site

The Terms of Reference for the wetland study specifies the following:

- All wetlands within 500 m of infrastructure and construction sites must be delineated;
- Undertake a risk assessment for all delineated wetlands;
- Assess the impacts (direct, indirect and cumulative) in terms of their significance (using suitable evaluation criteria) and suggest suitable mitigation measures. In accordance with the mitigation hierarchy, negative impacts should be avoided, minimised, rehabilitated (or reinstated) or compensated for (i.e. offsets), whereas

positive impacts should be enhanced. A risk-averse and cautious approach should be adopted under conditions of uncertainty;

- Possible impact on stabilisation of wetlands due to inadequate reinstatement and rehabilitation;
- Destabilisation of wetlands due to inadequate reinstatement and rehabilitation;
- Impacts to wetlands downstream of the abstraction point (surface-groundwater interactions); and
- Delineate riparian habitat and all wetlands in accordance with the Department of Water Affairs: Wetland delineation guidelines (2005) (Guideline): A practical field procedure for identification and delineation of wetlands and riparian areas (DWAF, 2005) (or any prevailing guidelines prescribed by DWS). This includes assessing terrain, soil form, soil wetness and vegetation unit indicators to delineate permanent, seasonal and temporary zones of the wetlands. Allocate conservation buffers from the outer edge of the temporary zones of the wetlands (provincial-specific).

The report conforms to the requirements of the Department of Water and Sanitation, and includes the following:

- Brief description of the natural environment that has an impact on wetland formation; climate, rainfall and temperature, soil conditions and vegetation;
- Present ecological status (PES) of the wetland;
- Discussion of aspects determining wetland formation;
- Wetland delineation;
- Impact assessment; and
- Conclusions and findings.

This assessment focused on the delineation of wetlands using four main indicators: terrain unit, vegetation, soil wetness and soil form. The soil indicators (wetness and form) were used as wetlands indicator but it also includes riparian vegetation as a confirmatory indicator.

During the review of the Draft EIA Report for the proposed MCWAP-2A: Water Transfer Infrastructure, concerns were raised by landowners with regards to the potential impacts of pipeline construction on a pan that is located on the Farm Taaiboschpan. The wetland specialist had considered the impacts on this specific pan as part of his assessment. However, as further mitigation, a deviation of the pipeline route was identified to avoid the pan by more than 500m.

The new route, which is termed Alternative D4, was also considered by the project team and incorporated in the final revision of this report.

Alternative D4 will terminate at a different point along the pipeline that was previously authorised as part of MCWAP Phase 1.

2 LEGISLATION

2.1 THE NATIONAL WATER ACT - WETLANDS

In Section 1(xxix) of the National Water Act (Act), a wetland is defined as "*land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land that is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil*."

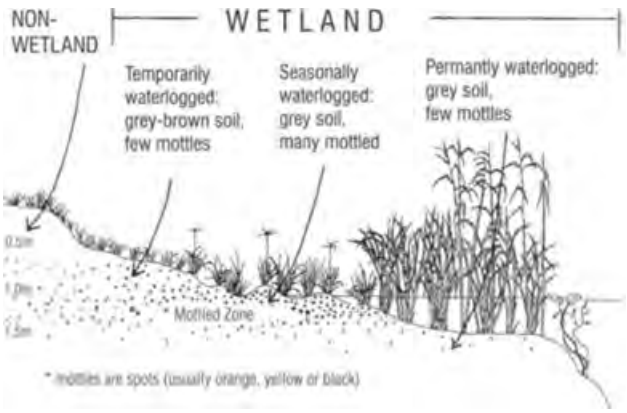
Riparian habitat is defined in Section 1((xxi) of the Act as "*the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or*

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 areas."

According to DWS (2005), wetlands must have one or more of the following attributes:

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

The following is quoted from the Department of Water Affairs: Wetland delineation guidelines (2005), and is a description of hydromorphic soils:



'A hydromorphic soil displays unique characteristics resulting from its prolonged and repeated saturation. Once a soil becomes saturated for an extended time, roots and microorganisms gradually consume the oxygen present in pore spaces in the soil. In an unsaturated soil, oxygen consumed in this way would be replenished by diffusion from the air at the soil surface. However, since oxygen diffuses 10 000 times more slowly through water than through air, the process of replenishing depleted soil oxygen in a saturated soil is significantly slower. Thus, once the oxygen in a saturated soil has been depleted, the soil effectively remains anaerobic. These anaerobic conditions make wetlands highly efficient in removing many pollutants from water, since the chemical mechanisms by which this is done need to take place in the absence of oxygen.

Prolonged anaerobic soil conditions result in a change in the chemical characteristics of the soil. Certain soil components, such as iron and manganese, which are insoluble under aerobic conditions, become soluble when the soil becomes anaerobic, and can thus be leached out of the soil profile.

Iron is one of the most abundant elements in soils and is responsible for the red and brown colours of many soils. Once most of the iron has been dissolved out of a soil as a result of prolonged anaerobic conditions, the soil matrix is left a greyish, greenish or bluish colour, and is said to be gleyed.

A fluctuating water table, common in wetlands that are seasonally or temporarily saturated, results in alternation between aerobic and anaerobic conditions in the soil. Lowering of the water table results in a switch from anaerobic to aerobic soil conditions, causing dissolved iron to return to an insoluble state and be deposited in the form of patches, or mottles, in the soil. Recurrence of this cycle of wetting and drying over many decades concentrates these bright, insoluble iron compounds.'

2.2 NATIONAL ENVIRONMENTAL MANAGEMENT ACT, 1998

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations (GNR 982) as amended in 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process (GNR 983) or the Scoping and EIA (EIA) (GNR 984) process depending on the scale of the impact. Provincial regulations that will require a BAR as set out in GNR 985 must also be considered.

In terms of NEMA's EIA Regulations and the National Water Act (Act), any development within the 1:50 year flood line and 32 m from the stream margin will trigger an environmental authorisation and a need of a water use licence. This regulation is supplemented by the NWA General Authorisation Notice in Relation to Section 21 water use.

2.3 NATIONAL WATER ACT, 1998

The National Water Act (Act) (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a freshwater resource unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Sections 21 (c) & (i).

However, according to General Notice 1199 as published in the Government Gazette No. 32805 of 2009, it must be noted that as defined by the Replacement General Authorisation in terms of Section 39 of the National Water Act, on account of the extremely sensitive nature of wetlands and estuaries, the Section 21(c) and (i) water use General Authorisation does not apply to:

- Any development within a distance of 500 metre upstream or downstream from the boundary of any wetland; and
- Any estuary or any water resource within a distance of 500 metre upstream from the salt mixing zone of any estuary.

2.4 GENERAL NOTICE 509 AS IT RELATES TO THE NWA (ACT 36 OF 1998)

In accordance with GN 509 of 2016, a regulated area of a watercourse for Section 21(c) and 21(i) of the NWA, 1998 is defined as:

- the outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
- in the absence of a determined 1 in 100-year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or
- a 500 m radius from the delineated boundary (extent) of any wetland or pan.

This notice should be read together with the Risk Assessment provisions in the General Authorisation Notice in Relation to Section 21.

3 WETLAND CLASSIFICATION

3.1 THE SOUTH AFRICAN NATIONAL BIODIVERSITY INSTITUTE (SANBI) [1]

SANBI was established on 1 September 2004 through the signing into force of the National Environmental Management: Biodiversity Act (NEMBA) No. 10 of 2004. NEMBA expands the mandate of the former National Botanical Institute to include responsibilities relating to the full diversity of South Africa's fauna and flora.

The Classification System that was developed allows for the identification of Hydro-geomorphic units (HGM Units) within an inland aquatic ecosystem.

HGM Units are distinguished primarily on the basis of the following:

- Landform, which defines the shape and localised setting of the aquatic ecosystem;

[1] SANBI Biodiversity Series 22 - Classification system for wetlands and other aquatic ecosystems in South Africa. (Ollis, et al. 2013).

- Hydrological characteristics, which describe the nature of water movement into, through and out of the aquatic ecosystem; and
- Hydrodynamics, which describe the direction and strength of flow through the aquatic ecosystem.

Seven primary HGM Types are recognised for Inland Systems:

- **River** - a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit;
- **Floodplain wetland -** a wetland area on the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by overtopping of the channel bank. Floodplain wetlands, as the name implies, generally occur on a plain and are typically characterised by a suite of geomorphological features associated with river-derived depositional processes, including point bars, scroll bars, oxbow lakes and levees. Floodplain wetlands must be considered as wetland ecosystems that are distinct from but associated with the adjacent river channel itself, which must be classified as a 'river'. Remember that some river channels, especially in the more arid parts of South Africa, are vegetated;
- **Valley-bottom wetland** (2 types) - a mostly flat wetland area located along a valley floor, often connected to an upstream or adjoining river channel. This can either be a channelled valley-bottom wetland with a river channel running through it; or an un-channelled valley-bottom wetland, which is characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows;
- **Depression** - a wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Although they may at times have a river flowing into or out of them, depressions are especially characterised by their closed (or at least near-closed) contour shape, which makes them relatively easy to identify on topographic maps. Depressions may be flat-bottomed (in which case they are often referred to as pans. The characterisation of the inflow characteristics of a depression is important in understanding the functioning of these types of aquatic ecosystems, and in their management. Depressions can be classified as 'exorheic' (i.e. outward-draining) or 'endorheic' (i.e. inward-draining) in terms of their outflow drainage, with a third option to categorise a depression with an artificially regulated outflow drainage as 'dammed';
- **Seeps** - a wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor; and
- **Wetland flat -** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat.

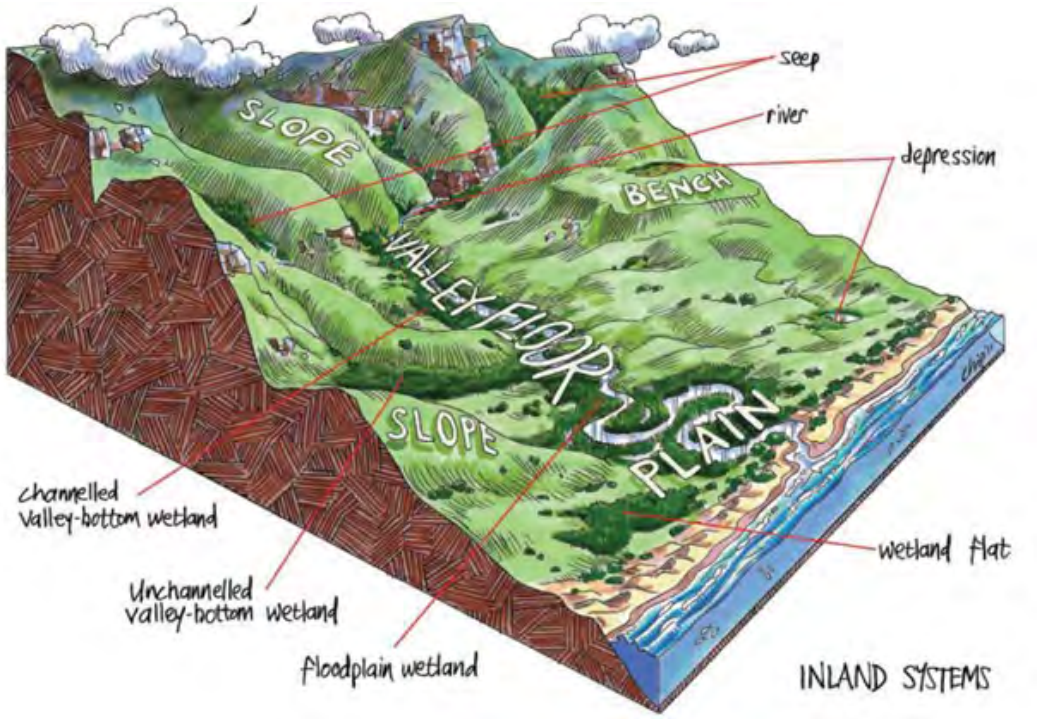


Figure 2. Wetland classification (Source - Ollis, et al. 2013)

3.2 PROCESS USED FOR THE DELINEATION OF WETLANDS

The importance of retaining and maintaining functional wetlands are well established - the process of establishing the boundaries less so. The following criteria discussed in *A Practical Field Guide for the Identification and Delineation of Wetlands and Riparian Areas*, published by the former DWAF are used as baseline information. According to these guidelines the main indicators are the following:

Soil condition

This is the primary criterion that signifies waterlogged conditions. These conditions manifest itself through plant communities that can tolerate hydromorphic soils. These plants are hydrophytes that are adapted to stresses imposed on plants through temporary or permanent waterlogged conditions.

For an area to be considered a wetland, redoximorphic features must be present within the upper 500 mm of the soil profile. Redoximorphic features are the result of the reduction, translocation and oxidation, i.e., precipitation of Fe (iron) and Mn (manganese) oxides that occur when soils are saturated for sufficiently long periods of time to become anaerobic. Only once soils within 500 mm of the surface display these redoximorphic features can the soils be considered to be hydric (wetland) soils. Redoximorphic features typically occur in three types:

- A reduced matrix - i.e., an in situ low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by “grey” colours of the soil matrix;
- Redox depletions - the “grey” or low chroma bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur; and
- Redox concentrations - Accumulation of iron and manganese oxides, which are also called mottles. These can occur as: Concretions - harder, regular shaped bodies; Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; or Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the

pore. They are recognized as high chroma colours that follow the route of plant roots and are also referred to as oxidised rhizospheres.[2]

Under most circumstances the presence or absence of redoximorphic features within the upper 500 mm of the soil profile alone is sufficient to differentiate between wetland and non-wetland.

Terrain morphology

Wetlands predominantly occur on valley bottoms and in seeps or depressions in other terrain forms.

Soil form

Soils that are gleyed or organic soils indicate permanently saturated zones. Soil forms that are heavily mottled and that have a grey matrix in the subsoil indicate seasonally and temporary waterlogged conditions. A list of qualifying soils is provided in the annexures.

Soil wetness

Soil colour is markedly influenced by the oxidation statues of manganese and iron. Yellow, red and reddish brown soil form under well-oxidised conditions and greyish colours when aeration is poorer. Prolonged periods of water saturation producing gleysation, which manifests in grey and blue mottles. These are conditions in which hydrophilic plants flourish. Qualifying colours, according to the Munsell colour chart are indicated in the annexures.

Vegetation

Vegetation is normally a reflection of the soil conditions and is an important visual method of finding areas where a wetland can occur:

- Large proportion of hydrophytes; emergent plants: reeds, sedges, and floating or submerged aquatic plants indicate permanently saturated wetlands;
- Hydrophilic sedges and a variety of grass and hydrophilic woody plants are dominant on seasonally waterlogged soils; and
- A variety of water tolerant grasses and woody species that may also occur on non-wetland areas can be indicative of temporarily waterlogged conditions.

Detail of the criteria is provided in the annexures.

3.3 METHOD FOR DELINEATION OF WETLANDS

The procedure followed is as follows:

- Aerial photography is used to determine possible wetlands;
- A corridor of 100 metres along the route was included in the survey (50 metres to each side of the proposed pipeline) and 50 metres from the boundary of non-linear items, like the weir, construction camps, pump stations, burrow pits, etc.;
- Terrain unit were identified to determine where wetlands are most likely to occur;
- Identification of hydromorphic (wetland) soils, soil form and wetness indicators were used to establish permanent, seasonal, and temporary wetland zones;
- Soils are classified in accordance with the Binomial Classification System for Southern Africa (Soil Classification Working Group, 1991, revised 2016). Initial delineation of the soil forms will take into account the following:

[2] Collins 2005

vegetation type, terrain form, colour and texture of the soil. The boundaries are then refined through soil auger and or soil probe. All qualifying soil forms are then investigated in more detail;

- Starting at the wetland edge, a probe is used to investigate the soil profile. Should the soil show typical gleyed properties, it is classified as wetland. Moving progressively further away from the pan or watercourse and assigning the soil properties, the wetland boundary is determined;
- Matrix colours and mottle of the subsoil at a depth less than 500 mm are then measured against the criteria indicated above and the areas of *Permanently* and *Seasonal waterlogged* conditions mapped; and
- Positions of observation points are taken with GPS and placed on a base map; and combined with texture and colour on aerial photographs. The final boundary of the wetland is then delineated and placed on a Geographical Information System (GIS) for incorporation in further planning.

3.4 NFEPA WETLANDS

National Freshwater Ecosystem Priority Areas for South Africa (or the 'NFEPA project') is a tool developed in 2011 and is now under the administration of Working for Water of DWS to indicate "*wetland ecosystem types and wetland condition on a national scale. The delineations were based largely on remotely-sensed imagery and therefore did not include historic wetlands lost through drainage, ploughing and concreting*." [3]

Because of the regional nature of the dataset, NFEPA it provides a general indication of the status wetlands.

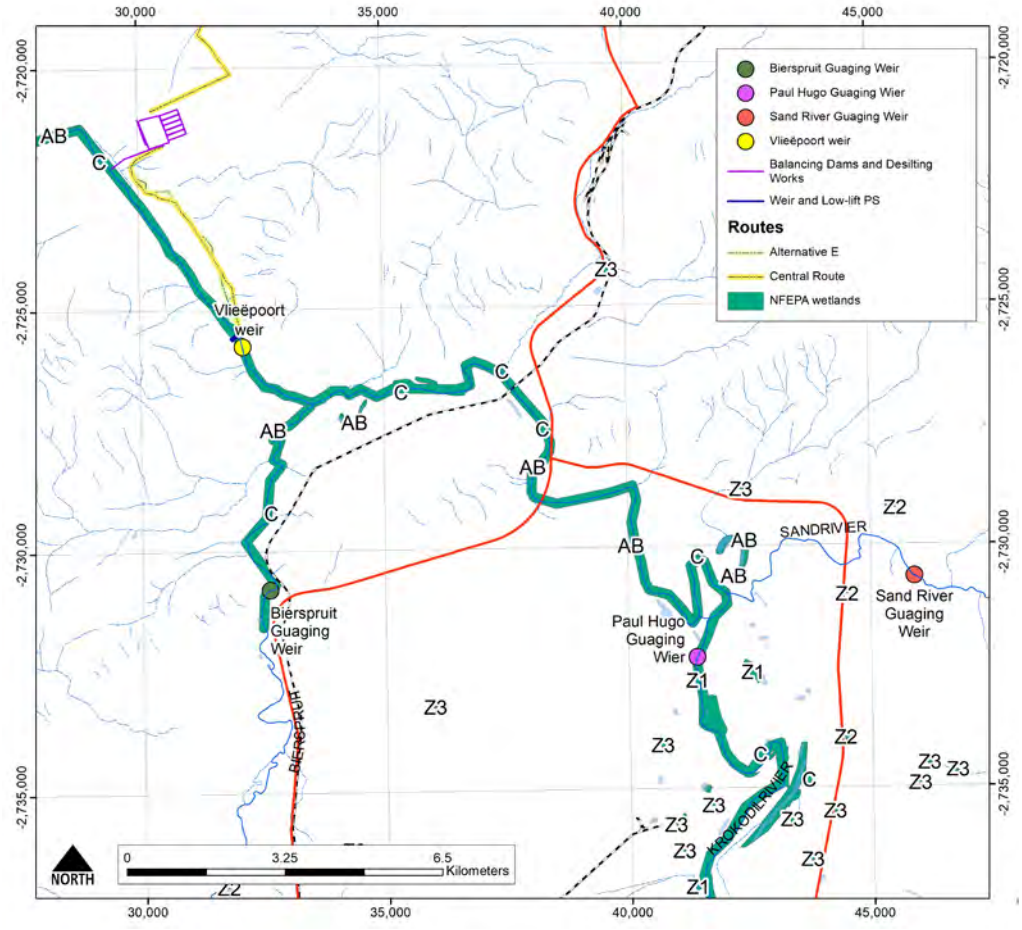


Figure 3. NFEPA classification of the Crocodile section of the project

[3] Extracted from SANBI GIS metadata.

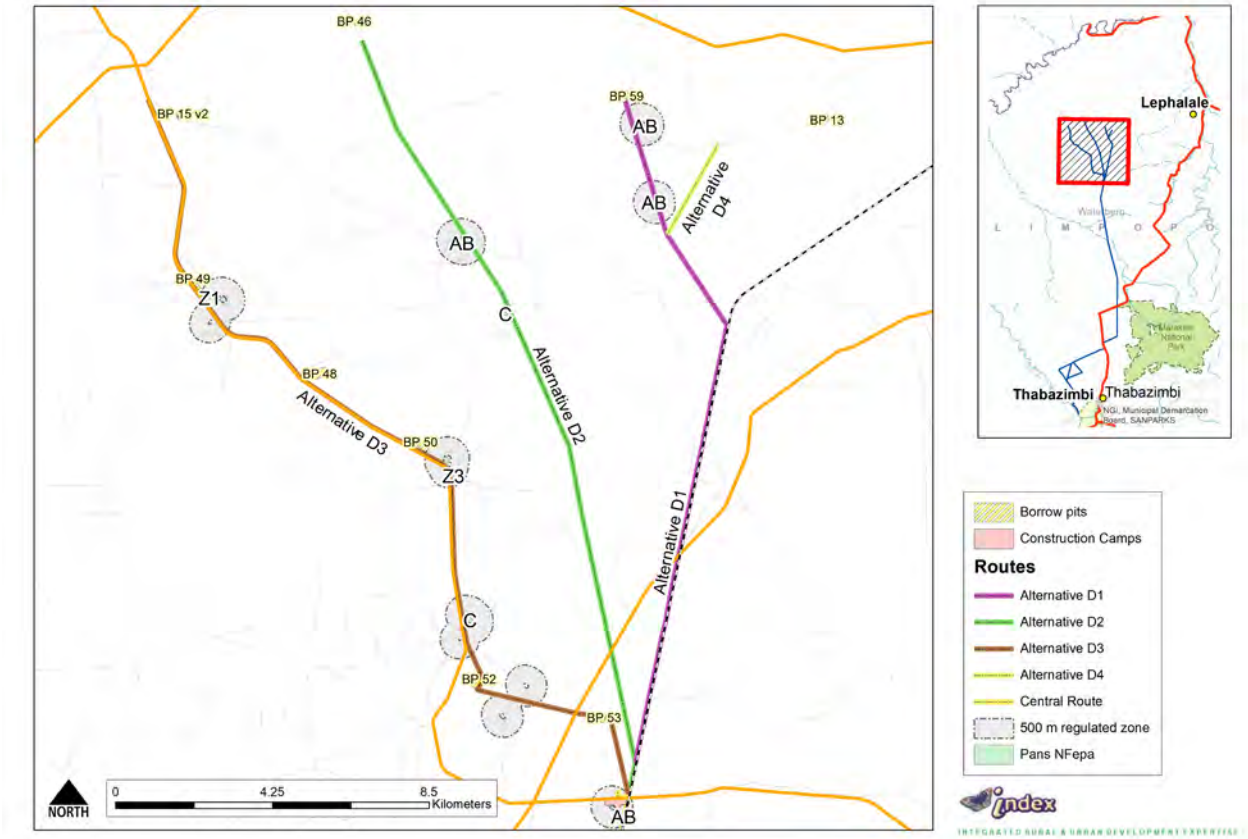


Figure 4. NFEPA classification of the Northern Sandy Plains section of the project

According to NFEPA classification, the wetland condition is as follows:

- AB: 75% of the wetlands are in a natural or good state;
- C: 25 to 75% of the wetlands are in a natural or good state;
- Z1: Heavily modified
- Z3: Critically modified

4 DESCRIPTION OF THE SITE

4.1 CLIMATE

The site is located in the western portion of Limpopo Province. It has a typical summer rainfall pattern.

A summary of the climate data is as follows:

Table 1. Average monthly temperature and rainfall at Thabazimbi

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Avg. Temperature (°C)	25,4	25,3	23,5	21,1	16,8	13,9	14,1	17,6	22,1	24,4	24,8	25,9
Min. Temperature (°C)	19,4	19,3	17,4	13,7	8,4	4,8	5,1	8,8	14,2	17,4	18,3	19,4
Max. Temperature(°C)	31,4	31,3	29,7	28,5	25,3	23	23,1	26,4	30	31,5	31,4	32,4
Rainfall (mm)	102	119	100	33	7	4	2	2	9	42	62	112

TEMPERATURE

The average monthly maximum of 32,9 ^{O}C is reached in January while the minimum of 4,8 ^{O}C is in June.

Weather data suggests that the area has experienced above normal maximum summer temperatures during 2015 to 2017 (refer to Figure 3).

RAINFALL

The average annual rainfall is 595 mm per year for most of the study area. The pipeline falls in the summer rainfall area.

WIND

Average wind speeds are around 8km/h but can experience gusts of more than 15 km/h or higher.

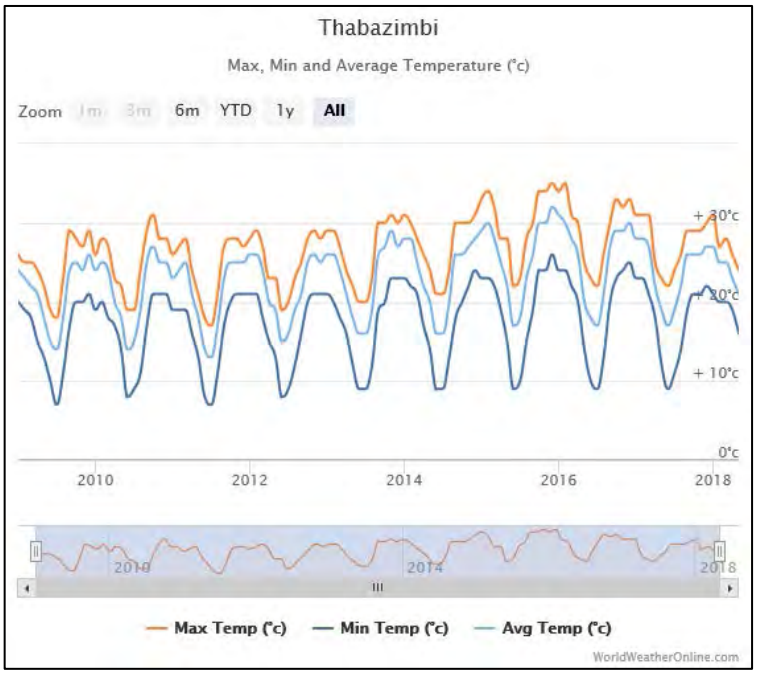


Figure 5.Temperature statistics for 2008 to 2018

4.2 VEGETATION

When rainfall is plotted against temperature at a ratio of 1:2 the resulting graph indicates the growing season.

The growing season commences in December when precipitation exceeds 50% of transpiration. This lasts until early April. The dry season with a rain deficit lasts for 8 months of the year (April to November). The winter period is dry with little or no vegetative growth. This is also reflected in the grazing capacity for livestock. Rehabilitation of the construction site must be programmed to coincide with the growing *season / moist period* between the beginning of December and the end of March.

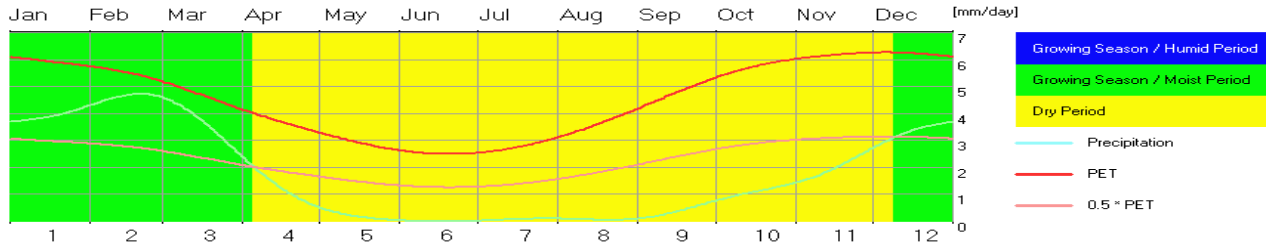


Figure 6. Climatogram of the study area

4.3 SOILS

Soil types that could occur on the site are based on the published Land Type Maps of the Department of Agriculture. It indicates the main soil types that occur within each catena of land zone (refer to Figure 5).

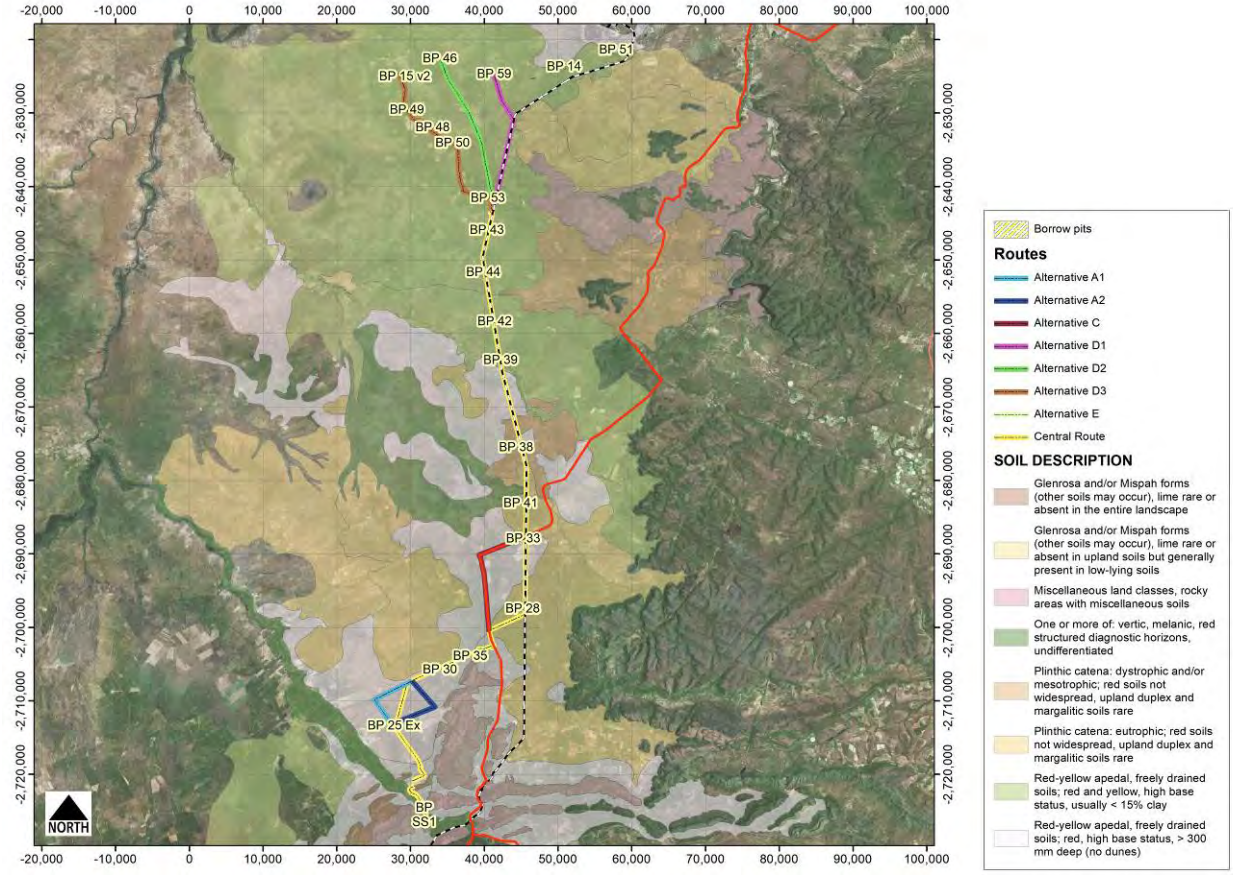


Figure 7. Soil types

Three main areas where wetlands occur were identified in the survey:

- The southern part on higher laying land that is in proximity of the Crocodile River that consists of Hutton soil forms. These are well oxidised soils that are red and reddish brown in colour with moderately developed blocky structure. The uplands soil types are Glenrosa, Mispah and Clovelly; they are not wetland soils because they hardly ever have perched water tables.

  The alluvial plains along the Crocodile River have a history of flooding as is evident from the uneven topography. Some of these soils are cultivated. The main soil types identified were Rensburg, Estcourt, and Oakleaf, while Dundee soils occur closer to the river. Some of these soils exhibit signs of periodic flooding and have hydromorphic properties typical of wetlands.

There are a number of old dry watercourses that consists of duplex soils (e.g., Estcourt, Sepane, Valsrivier and Kroonstad). Surface flow with little or no infiltration of rainwater takes place. Although they can be temporary waterlogged during rainstorms, they were found not to have gleyed properties within the top 500 mm, and that are not wetlands;

- The Matlabas River traverse the pipeline route at X-coordinate -161033 and Y-coordinate -2665359 (WG27).

  Dundee soils were identified on the river banks. Higher on the escarp are Glenrosa and Mispah soil types. The older flood plain south of the crossing is evident for satellite images, consists mainly of duplex soils or are well drained red soils, neither with perched water tables that would let them qualify as wetlands soils; and

- The northern portion occurs on sandy plains with no clear drainage pattern. The dominant soils are Oakleaf, Namib or Clovelly on the sandy portions and duplex soils on the shallow clay soils. This is also where pans are common.

4.4 HYDROLOGY

- The southern portion is drained by the Crocodile River. The higher laying land has very even slopes with recharge soils that dominate. The drainage system is A24J in the Limpopo River System;

  The river occasionally breaks it banks and saturates the alluvial plains with water.

- The central part of the route is drained by the Matlabas River and its tributaries in the A41C and A41B drainage regions. There is evidence from the soils surrounding the Matlabas River that flooding was or is common; and
- The northern portion is in the A41E drainage region. There are no rivers or streams in proximity of the western route alignments. The eastern alignments are in the Sandloop (A42J drainage region).

Figure 8. Drainage regions of the site

5 HYDROPEDOLOGICAL INTERPRETATION OF SOILS

Soil physical properties, such as the hydraulic conductivity and porosity, have an important impact on the occurrence and rates of hydrological processes which then manifests in its morphological properties such as colour, mottles, macro pores and carbonate accumulations. It is, therefore, an indicator of what happens to water once it is introduced to the soil profile. The process is illustrated below:

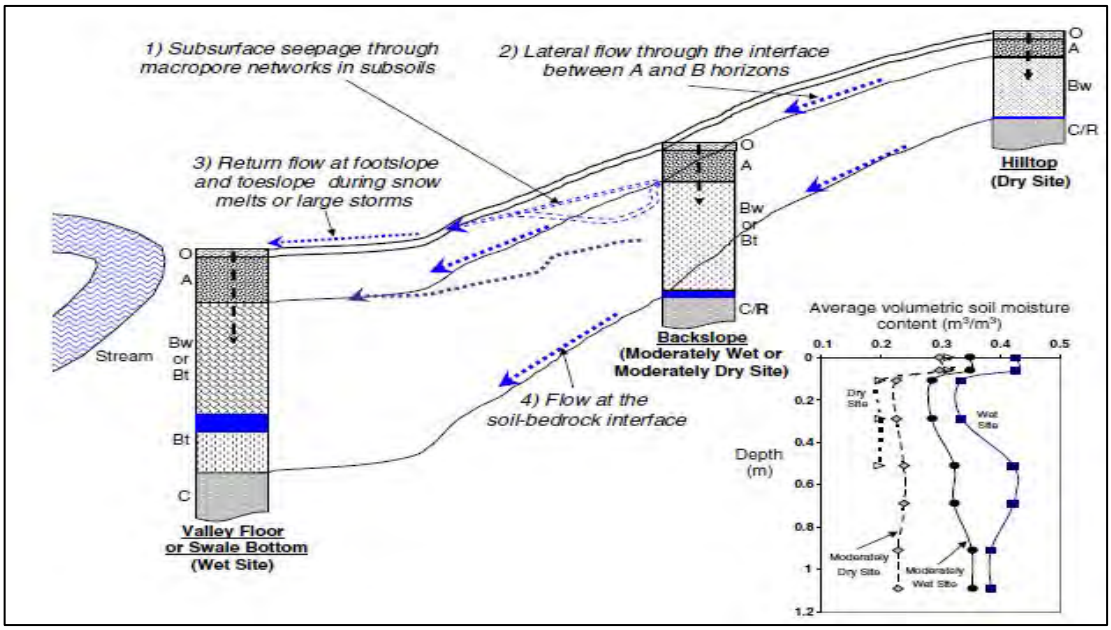


Figure 9. Hydropedological pathway (Lin et al, 2006)

5.1 HYDROPEDOLOGICAL BEHAVIOUR OF SOIL TYPES

RECHARGE SOILS

Red colours of the top- and subsoils are typically associated with freely drained soils, where rainfall flows into and through the profile. These soils are termed recharge soils, because they are likely to recharge groundwater, to again emerge at lower lying topography via the bedrock. The dominant flow direction in the recharge zone is vertical through the soil and into the fractured rock, from where it can recharge groundwater levels or downslope positions in the hillslope soils.

INTERFLOW SOILS

The second group of soils favours lateral flow. Lateral flow occurs due to differences in the conductivity of horizons where a subsoil layer prevents or restricts downward movement. This is manifest by lighter colour of the B-horizon. Lateral flow frequently occurs on soil/bedrock interfaces due to the permeability of the rock. Mottles (red, yellow and grey colours) in the B-horizon are the result of a fluctuating water table. The dominant flow direction in the interflow zone is lateral and takes place in or above the B-horizon.

RESPONSIVE SOILS

There are two types of soil that qualifies as responsive soils.

a) Soils characterised by grey colours of the lower B and C-horizons and dark colours of the topsoil horizon. These properties are indications that this profile is saturated for long periods of time. Because these soils are close to saturation, especially during peak rainy seasons, additional rainfall is unlikely to infiltrate the soils but will flow as overland flow (or surface runoff) downslope.

b) Very shallow soils where small amounts of rain can exceed saturation point. Any more than this will drain away as overland flow. Included in this group would be highly structured soils. The responsive zone is fed by lateral flowing water from the interflow zone as well as via the bedrock from the recharge zone or as surface flow where the soil is saturated.

5.2 FINDINGS ON THE PROPOSED MCWAP-2A SITE

CROCODILE RIVER

- The soil on the higher laying portions to the north was classified as Hutton and Glenrosa and is on the old pediment of the Waterberg. This is on the terrestrial zone. These are deep sandy loam and loam soils that are classified as recharge soils. Because of the small size, it probably does not contribute much to the flow of streams during the dry season;
- The old alluvial plains that contain Rensburg, Oakleaf and Dundee soil forms and are classified as responsive soils. The drainage is normally as surface flow towards or parallel to the river; and
- The riparian zone has steep slopes on sandy loam soils. The stream banks are less than 8 metres wide and will therefore not play a significant role in water supply to the stream.

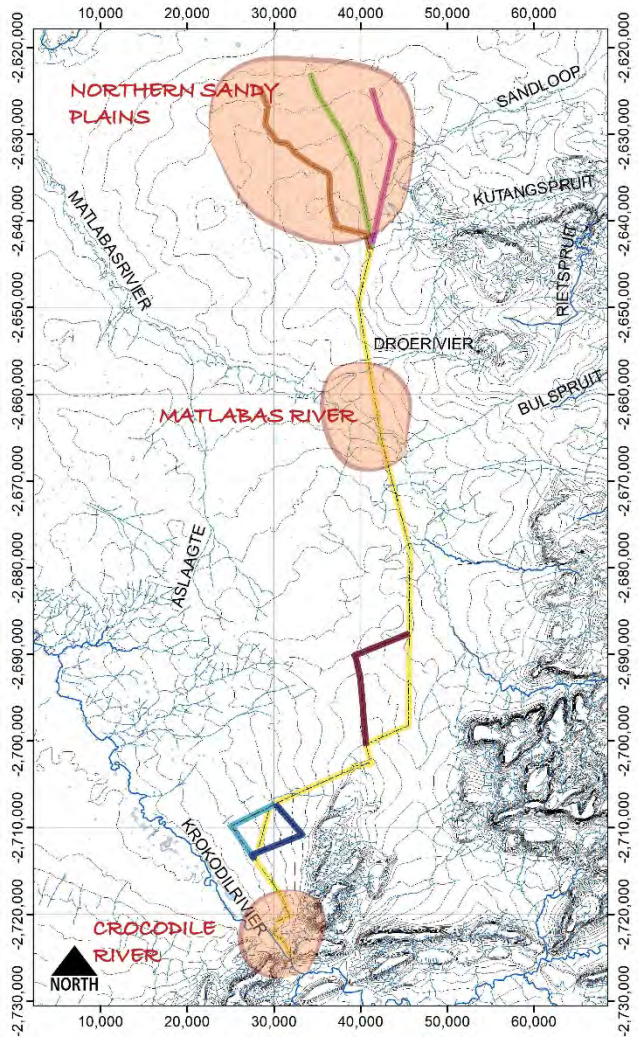


Figure 8. Hydropedology regions

MATLABAS RIVER

- The soil on the higher laying portions along the river was classified as Hutton and Glenrosa and is in the terrestrial zone. These are shallow sandy loam and loam soils that are classified as recharge soils; and
- Because of the low rainfall and soil conditions it is unlikely that these contribute significantly to the flow of the river.

NORTHERN SANDY PLAINS

- The underlying rock is sandstone and mudstone of the Matlabas Subgroup, Waterberg Group;
- Soils on the sandy areas are single grained yellow and reddish brown with a high water infiltration rate. These are classified as recharge soils. Because of the low rainfall and soil conditions it is unlikely that it contributes significantly to the pans, the extent is, however, not certain.
- Pans are scattered throughout the plains. The dominant soils are duplex identified as Estcourt, Sepane, Valsrivier and Kroonstad. These are responsive soils.

6 WETLAND DELINEATION

6.1 BACKGROUND

The object of the delineation procedure is to identify the outer edge of the temporary zone that contains hydromorphic soils. This outer edge marks the boundary between the wetland and adjacent terrestrial areas. Occurrence of standing water and hydrophilic plants and finally, soil conditions were used as the determinant of wetland boundaries.

6.2 RESEARCH FINDINGS

6.2.1 CROCODILE RIVER SECTION

TERRAIN MORPHOLOGY AND SOIL FORMATION

The site is deeply incised with a clear riverbed. There are no hydromorphic soils adjacent to the river. Moderately structured yellowish-brown soils were identified along the western bank. The deeper subsoil did not contain mottles or concretions that would indicate wetland conditions.

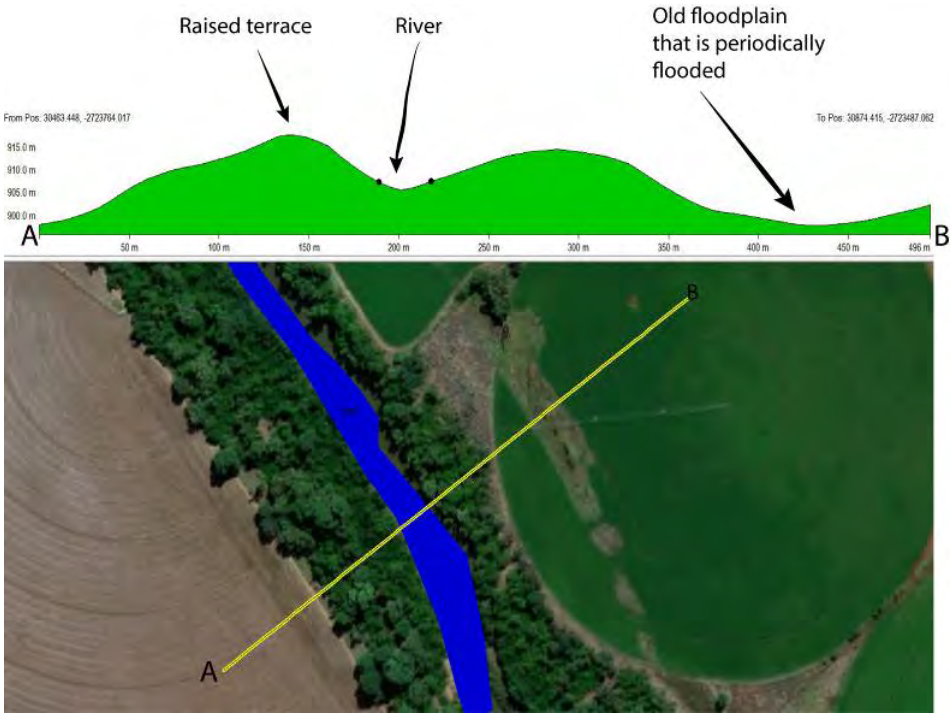


Figure 10. Terrain form of the Crocodile River section

About 30 metres form the riverbank is a seep that was formed on the old river terrace. This stretches the length of the river from where the weir is located up to the desilting works. There are a number of irrigation dams that were constructed as storage for irrigation along this lower-laying portion. The old floodplain is periodically flooded and in places, is covered with wetland plants. It is delineated as wetland due to the soil properties and flood hazard.

VEGETATION

Vegetation normally reflects the soil conditions and is therefore an important visual method to find wetlands.

According to the National Water Act, the definition of a wetland states that the vegetation is a primary indicator of a wetland, which must be present under normal conditions. Soil wetness indicators are as important. Soil form, terrain unit and vegetation units are used in a confirmatory role. The morphological indicators of the soil are far more permanent than the vegetation and the soil can display signs of wetness long after a wetland has been drained. *Phragmites australis, Typha capensis* and *Cyperus papyrus* were used as confirmatory signatures of wetlands.

The species that were identified on the dry depressions were *Pennicetum setaceum, Cymbopogon pospischilii, Cyperacea sp. Digitaria eriantha* and *Setaria sphacelata.*

A wetland was found along the Bierspruit, likely as a result of a depression created by construction of the R510. A culvert under the freeway connects the depression to the Bierspruit in the west.

Grass species identified around the site were *Cenchris ciliaris, Aristida sp, Heteropogon contortus, Eragrostis trichophora, Dicanthium annulatum, Phragmitis australis, P. clandestinum* (Kikuyu Grass) and *Cyperacea sp*.

WETLANDS CLASSIFICATION OF THE CROCODILE RIVER SECTION OF THE SITE (HYDRO-GEOMORPHIC UNITS)

The watercourse is classified as a *River* and as a stream wetland (the old floodplain). The outer edge of the old floodplain is the wetland boundary (refer to Figure 9).

The only wetland that will be affected by construction of the pipeline is the Vlieëpoort weir and low lift pumping station. Both the route alternatives from the pumping station to the balancing dam and desilting works is outside of the floodplain wetlands.

Borrow pit SS1 is located on the river floor and will only be exposed once the diversion canal is constructed. It falls into the River Wetlands.

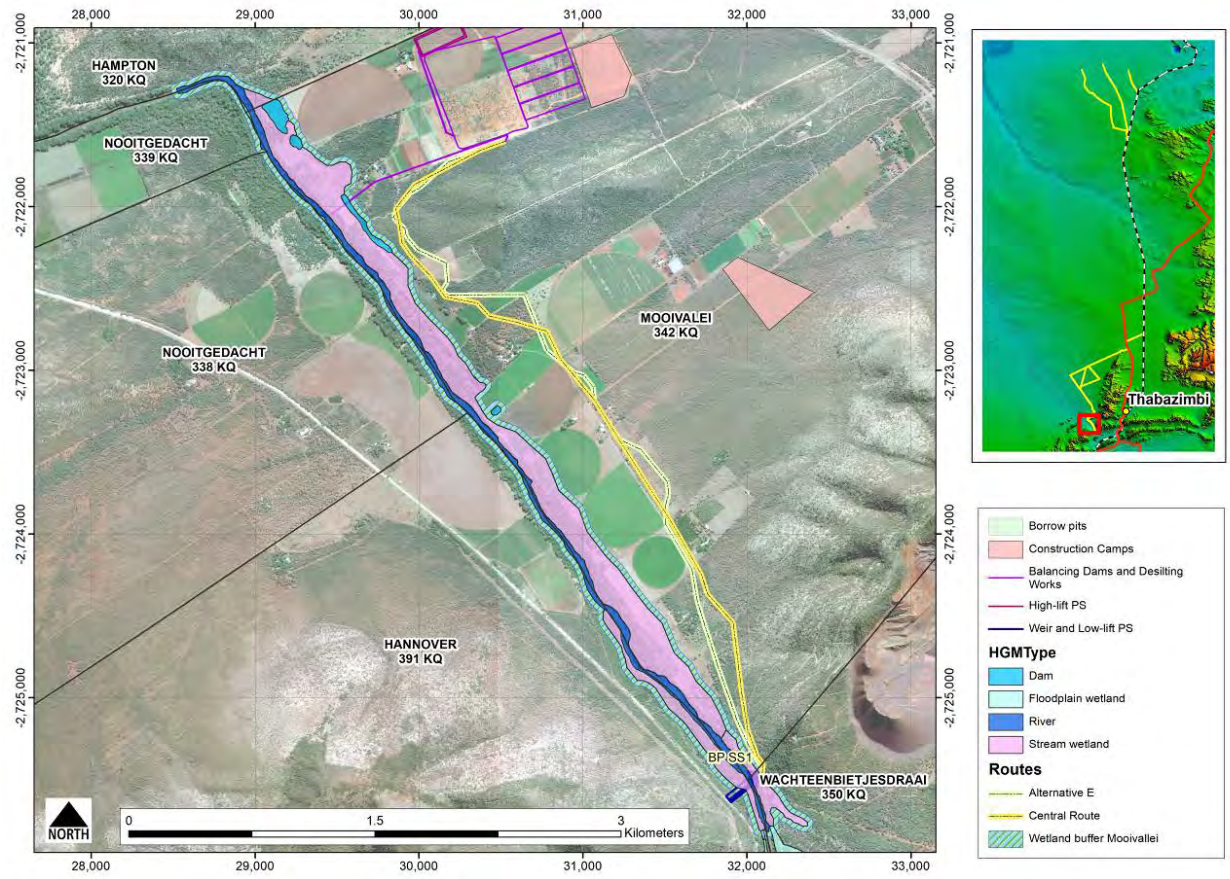


Figure 11. Weir Site classification and wetlands delineation and buffer

Photo 1. Encroachment of alien vegetation on the river bank

Photo 2. Wetland plants and riparian vegetation on the stream banks

Photo 3. Wetland area behind raised river bank. These are periodically flooded

Photo 4. Permanently saturated wetland area behind raised river bank

6.2.2 MATLABAS RIVER SECTION

TERRAIN MORPHOLOGY AND SOIL FORMATION

The Matlabas River is located in the centre portion of the pipeline route. Sandstone and shale is the underlying rock that gave rise to shallow Glenrosa, Clovelly and Hutton soils. The topography is even sloped with a steep bank towards the river. The surrounding land has shallow soil with no properties that would indicate wetlands. The only saturated soil is in the river bed.

VEGETATION

Riparian plants on the river bank are typically Bushveld thickets with *Rhus leptodictya*, *Mimusops zeyheri* and *Termitaria* thickets in the valleys. Other trees are *Olea europaea*, *Clerodendrum glabrum, Euphorbia ingens* and various *Vachellia* species. The only wetland species that were found occurs in the river and a narrow strip along the banks. Species identified and used as confirmatory signatures of wetlands were *Phragmites australis, Typha capensis* and *Cyperus papyrus*.

Photo 5. Phragmites australis along the river banks

*Photo 6.*The river bank is covered with *Vachellia*

WETLANDS CLASSIFICATION OF THE MATLABAS RIVER CROSSING SITE (HYDRO-GEOMORPHIC UNITS)

Figure 12 indicates HGM units within 500 metres of the route alignment. The only wetland that was found in a 100m corridor along the route is the river itself and the depression on the northern side on the river bank. The latter is an old excavation and does not play a role in silt trapping, water purification or retardation of storm water. There is an excavation approximately 500 metres south of the river, which is dry with no wetland properties. It was classified as a quarry (man-made).

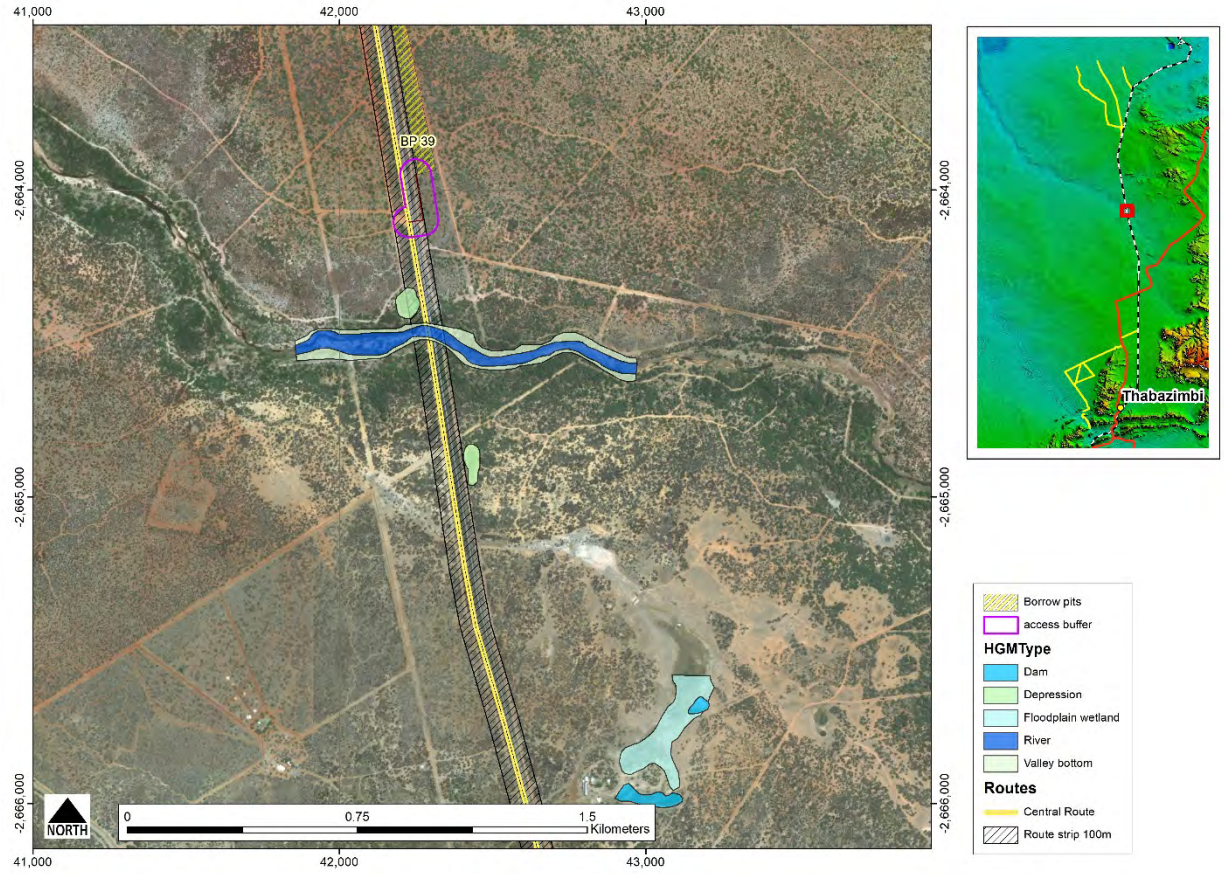


Figure 12. Wetlands classification of the Matlabas River section

6.2.3 NORTHERN SANDY PLAINS

Eleven depressions (pans) were found within 500 metres of the three route alignments (refer to Figure 11). There are no rivers or streams in this section.

Table 2. Detail of the Depressions along Route alignment D

Map Reference	EIS	PES	Saturation	Vegetation	Area (ha)	Distance from pipeline	X coordinate	Y coordinate
D1 1	C	C	Permanent	Wetlands	1,48	0	-161 867,9	-2 628 304,6
D1 2	C	B	Seasonal	Wetlands	2,40	180	-162 169,8	-2 626 211,8
D2 1	C	C	Seasonal	Bushveld/wetlands	6,01	30	-167 111,5	-2 629 377,9
D3 1	D	C	Seasonal	Bushveld thickets	0,93	510	-165 345,0	-2 641 438,9
D3 2	D	C	Seasonal	Bushveld thickets	1,33	600	-165 993,6	-2 642 261,0
D3 3	D	C	Seasonal	Bushveld thickets	0,22	185	-167 155,7	-2 640 182,6
D3 4	D	C	Seasonal	Bushveld thickets	5,05	70	-166 877,6	-2 639 627,4
D3 5	C	B	Permanent	Wetland	5,10	0	-167 487,5	-2 635 339,9
D3 6	D	C	Seasonal	Bushveld thickets	0,75	115	-173 927,3	-2 631 567,8
D3 7	D	C	Seasonal	Bushveld thickets	2,68	415	-173 586,2	-2 630 942,7
Junction	C	C	Permanent	Wetland	1,50	296	-163 016,7	-2 644 725,1

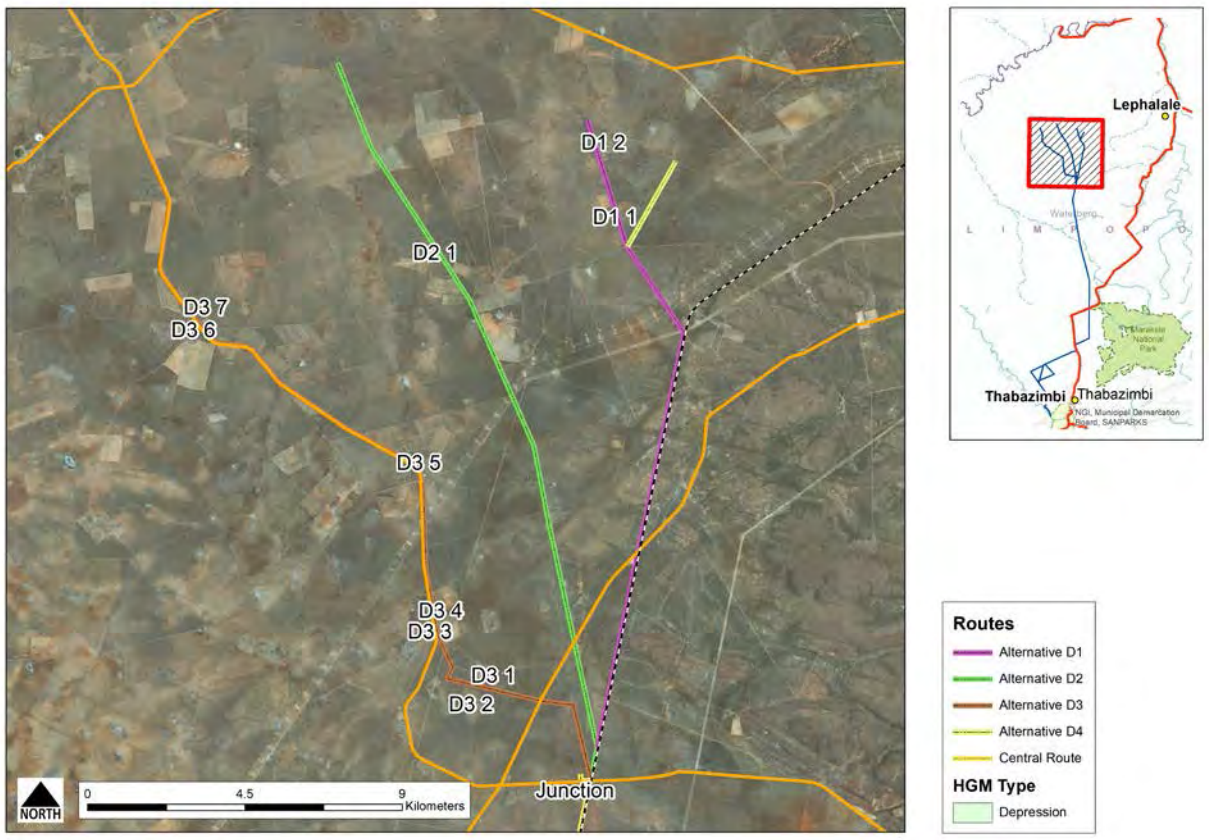


Figure 13. Positions of pans (depressions) within 500 metres of the D-route alignments

TERRAIN MORPHOLOGY AND SOIL FORMATION

The underlying rock is sandstone and mudstone. Soils on the sandy terrestrial areas are single grained yellow and reddish brown with a high water infiltration rate. No wetlands were found.

Pans are scattered throughout the plains. The dominant soils are duplex identified as Estcourt, Sepane, Valsrivier and Kroonstad. Wetlands occur only on the responsive soils where the infiltration rate is very slow.

VEGETATION

Typha capensis and *Cyperus papyrus* at located at the depressions and was uses to delineate the wetland boundaries.

The vegetation that is a typical of the sandy plains and that grows in proximity of the pans is as follows:

- Trees and shrubs: *Vachellia erioloba, V. nigrescens, Sclerocarya birrea. V. meflifera, V. nilotica, V. tortilis, Combretum apiculatum, C. imberbe, Terminalia sericea* and *Dichrostachys cinerea.*
- Graminoids: *Anthephora pubescens, Digitaria eriantha, Eragrostis pallens, E. rigidior, Schmidtia pappophoroides, Aristida congesta, V. diffusa, V. stipitata, Eragrostis superba* and *Panicum maximum.*
- Wetland vegetation that are present or can occur in the pans: *Bolboschoenus maritimus, B. hispidula, Cyperus congestus, C digitatus, C longus, Eleocharis acutangula, Fimbristylis complanata, Fuirena pubescens and Juncus spp.*

Leliefontein Pan is permanently saturated with water with well-established wetland plants Refer to Photo 7.

Many of the temporary saturated pans that are only flooded during rain events and then dry out. They are covered with terrestrial grass species and *Vachellia* for the remainder of the season.

Taaiboschpan will be temporarily inundated during the rainy season. But the soil dries up at the onset of the dry season. The survey was done on 24 June 2018. Photos provided by the owners of the farm Taaiboschpan for both the rainy and dry seasons, confirms inundation of Taaiboschpan where the flooded area intruded into Enkeldraai 314LQ. The photos also indicate *Vachellia tortilis* in the portion that was flooded. The soil preference of *V. tortillis* is sandy calcareous. It will likely not survive prolonged periods of totally water saturation (longer than 4 to5 months)[4]. The dry period allowed terrestrial grass species and *V. tortilis* to develop and the absence of sedges found in some of to permanently saturated pans.

Photo 7. T. capensis and C. papyrus at Route D3(5) (23.81256° S, 27.35596° E)

Photo 8. Southern section of D3(5). (23.81256° S, 27.35596° E)

[4] Personal communication with Prof. Lesley Brown.

Photo 9. Vachellia species in old dry depressions (23.84826° S, 27.35965° E)

Photo 10. Sandy plains with encroached Dichrostachys cinerea. (23.79039° S, 27.31774° E)

Photo 11. Permanently saturated pan indicating the prevalence of wetland plants

Photo 12. Seasonally saturated pan at Zandheuvel (23.77958° S, 27.33968° E)

WETLANDS CLASSIFICATION OF THE SITES (HYDRO-GEOMORPHIC UNITS)

Five depressions were found that could impact the route for the pipeline. Historical Google images indicate that the size of the wetlands fluctuates during the season and over years.

The pans are fed from surface runoff and during rainstorms and from seepage emanating from the recharge soils that surround the pans.

Wetlands within 500 metres with wetland properties are indicate in Figure 14. The figures that follow indicate details of each site.

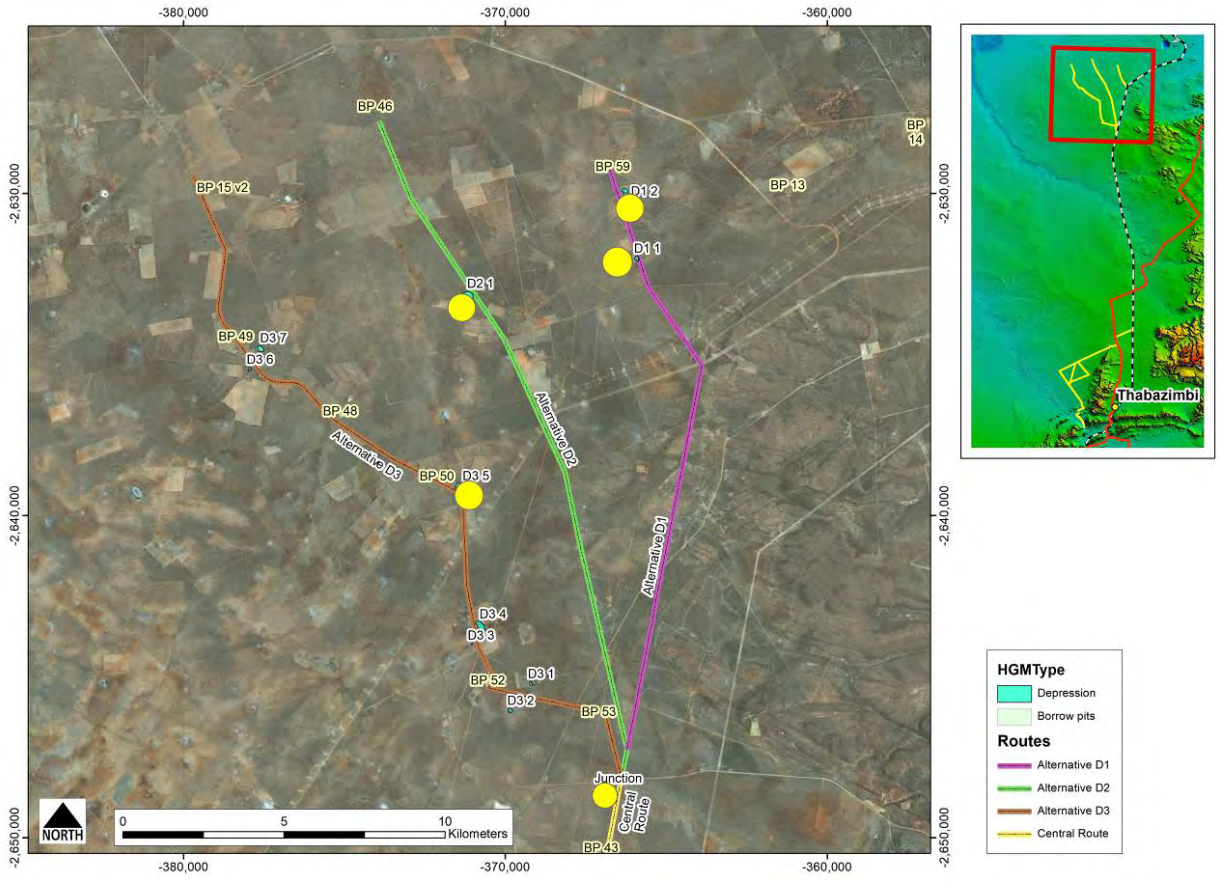


Figure 14. Depressions with wetland properties (indicated with yellow dots)

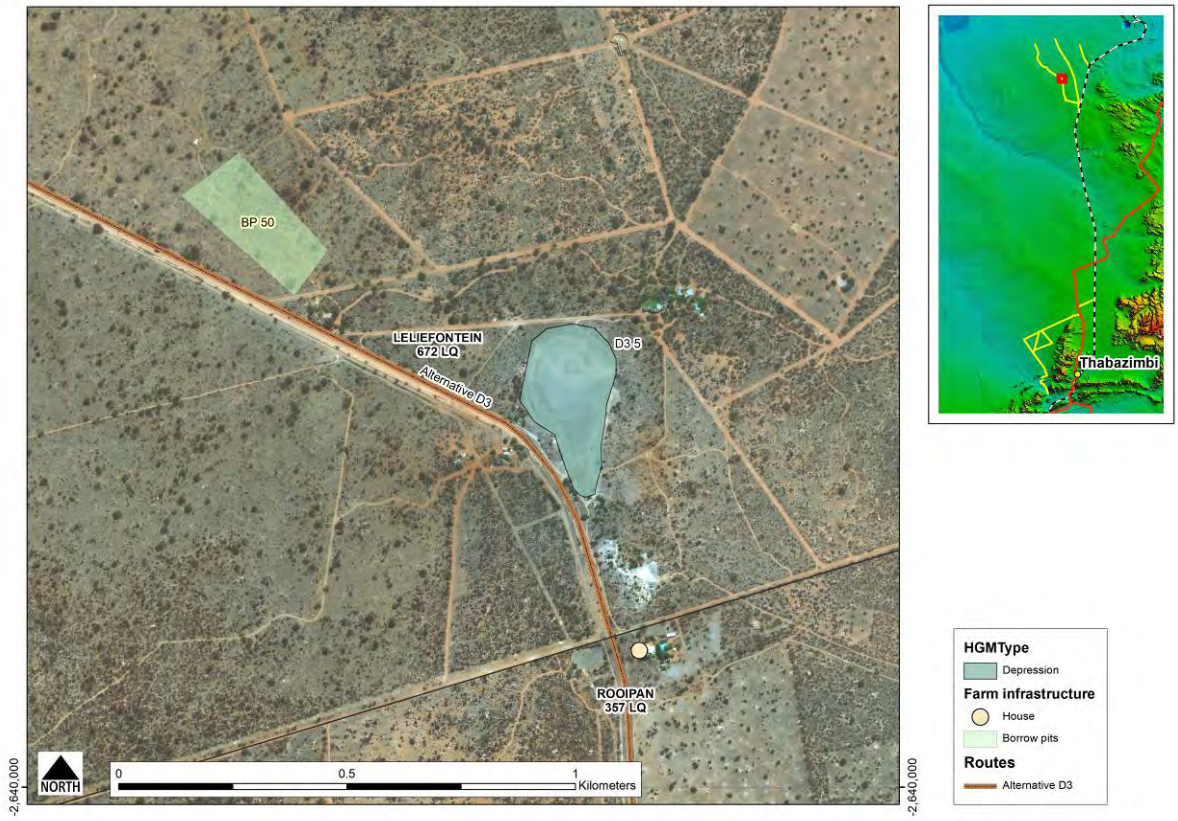


Figure 15. Wetland at D3(5) on the farm LELIEFONTEIN 672 LQ

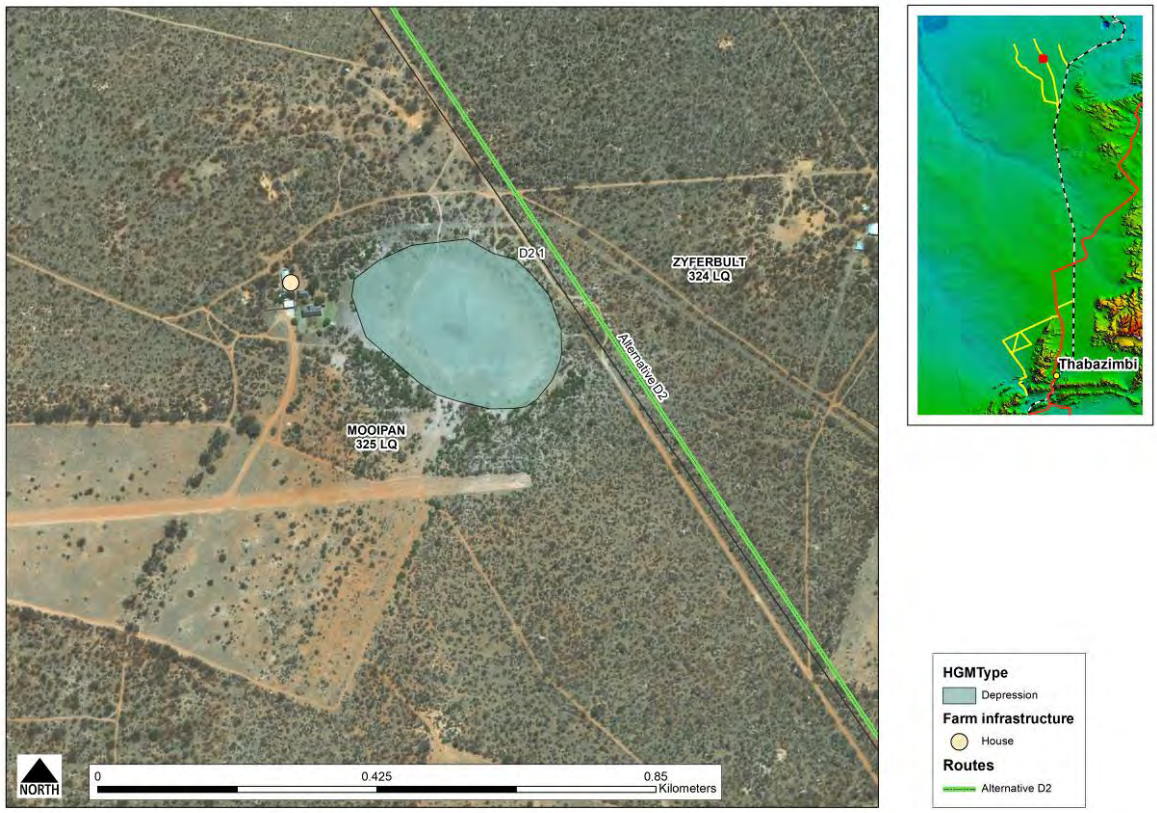


Figure 16 Wetland at D2(1) on the farm MOOIPAN 325 LQ

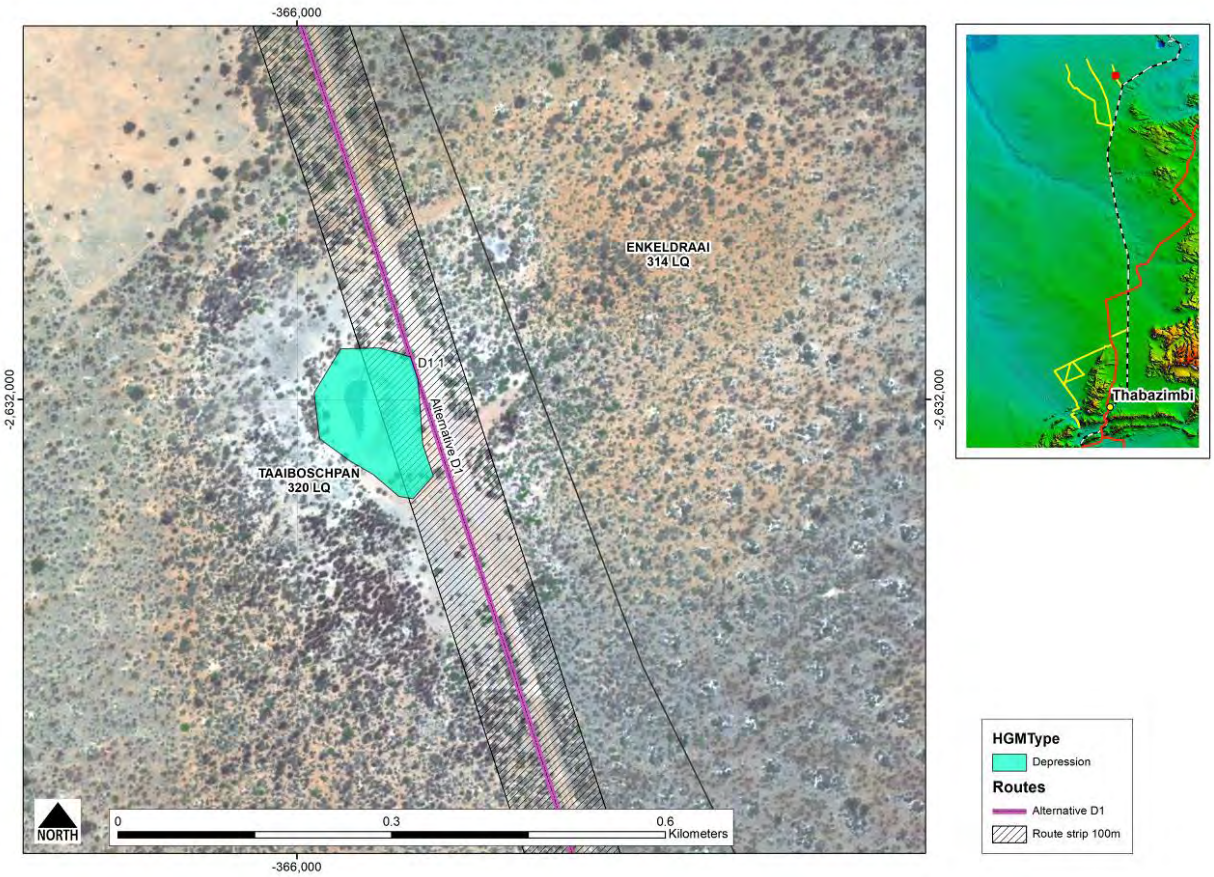


Figure 17. Wetland at D1(1) on the farm TAAIBOSCHPAN 320LQ

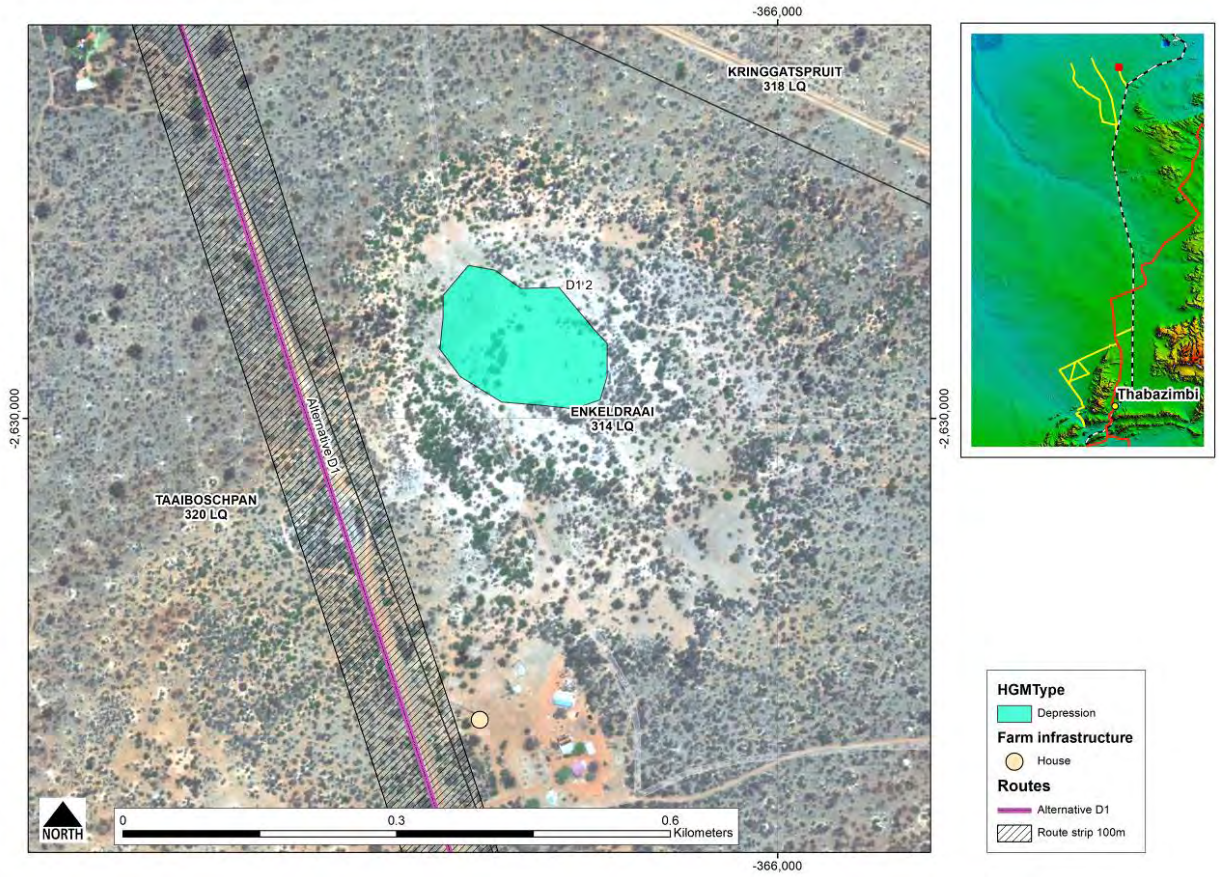


Figure 18. Wetland at D1(2) on the farm ENKELDRAAI 413LQ

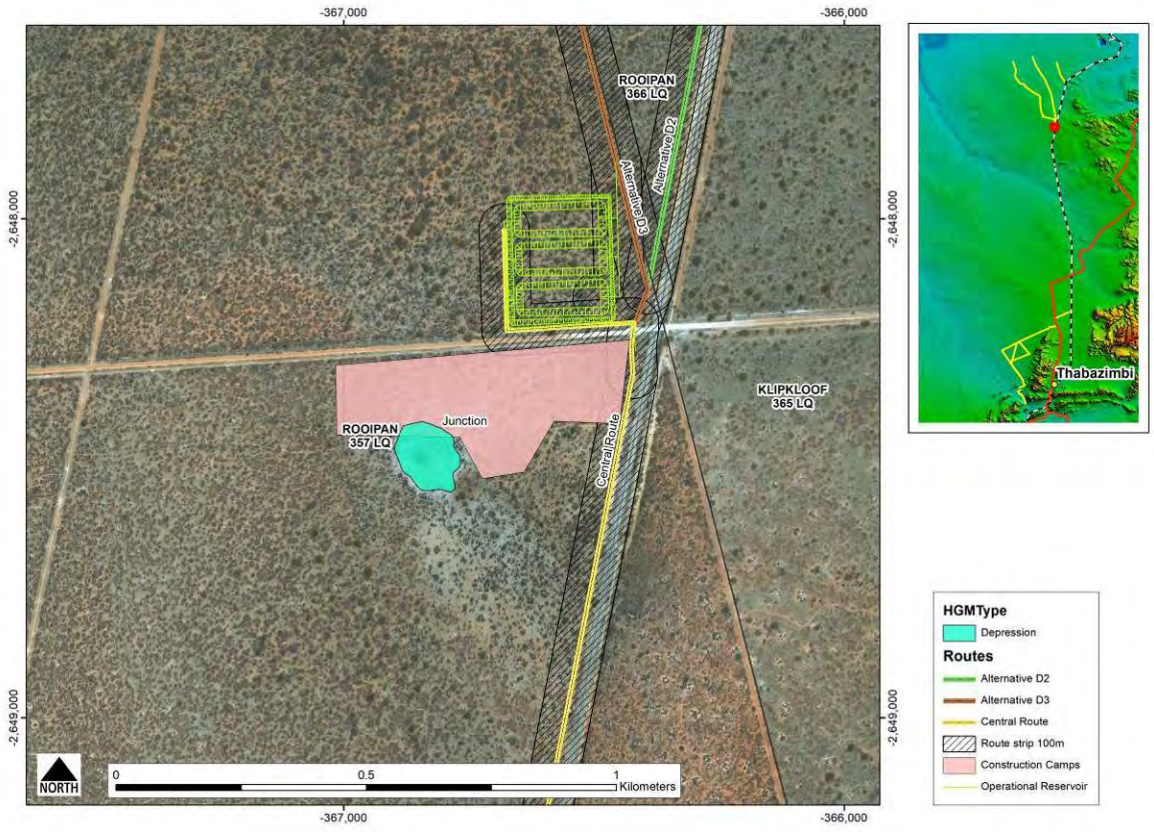


Figure 19. Wetland at Junction on the farm ROOIPAN 357 LQ

The Construction Camp at Rooipan 357 LQ is adjacent to the pan and within the buffer zone of 15 metres. The location of the camp will have a negative impact on the functioning of the pan habitat. It is recommended that the camp be relocated further east of the present proposal.

6.2.4 INUNDATION AREA ABOVE THE VLIEËPOORT WEIR

The Vlieëpoort Weir is located just upstream of a floodplain where the river formed oxbow lakes and isolated temporary watercourses. The latter is located just behind natural levees that were formed through regular flooding and depositing of silt on the river banks. Figure 20 indicates the morphological components of the Crocodile River just upstream of the weir.

The uneven topography of the floodplain is testament of periodic flooding. Although the soil is not gleyed throughout the floodplain, it warrants protection due to the riparian vegetation and the occurrence of the watercourses and the oxbow lakes.

A simulation run on the contours of the area that is expected to be inundated because of the weir's construction, indicates that very little of the stream bank will be flooded. The loss of habitat is confined to the river itself. The higher water level caused by the construction of the weir may, however, increase the deposits of silt on the floodplain and also promote wetland plants to develop.

- The temporary watercourses outside of the river banks are already well established and is unlikely to be negatively influenced by the construction of the weir.

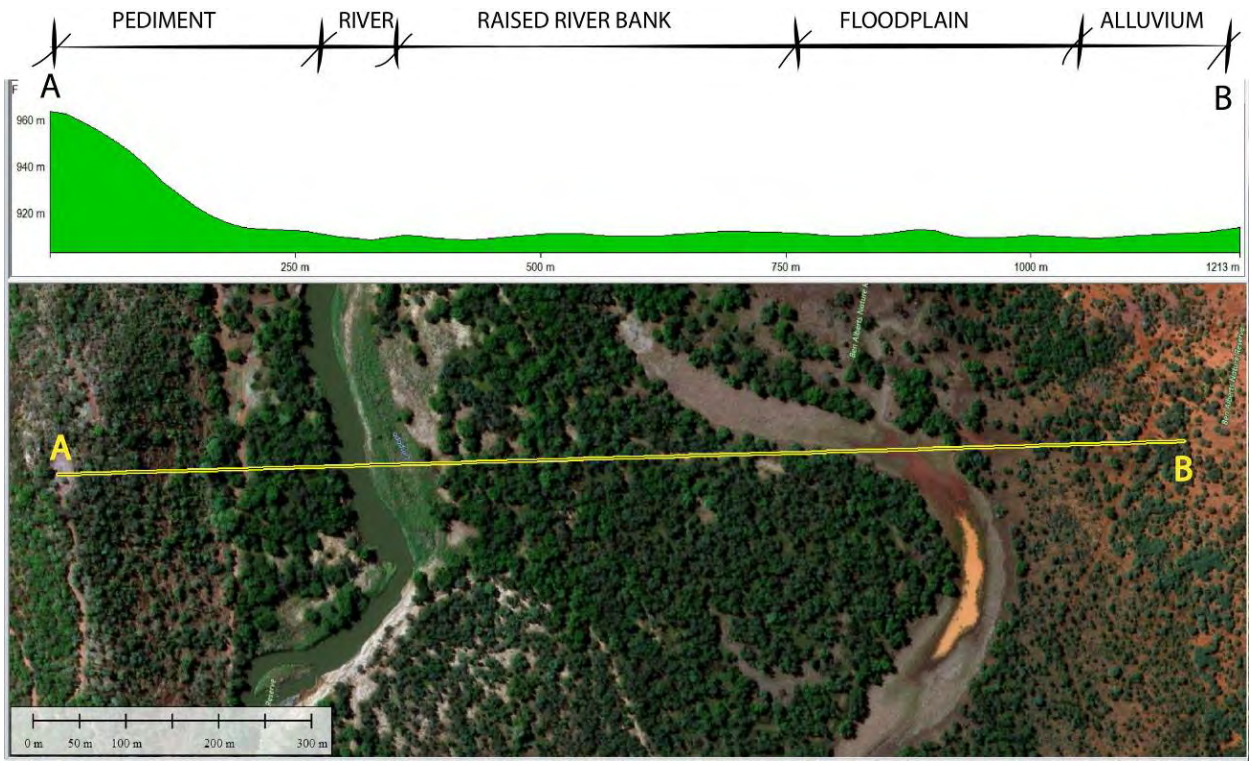


Figure 20. Profile indicating the Crocodile River Floodplain

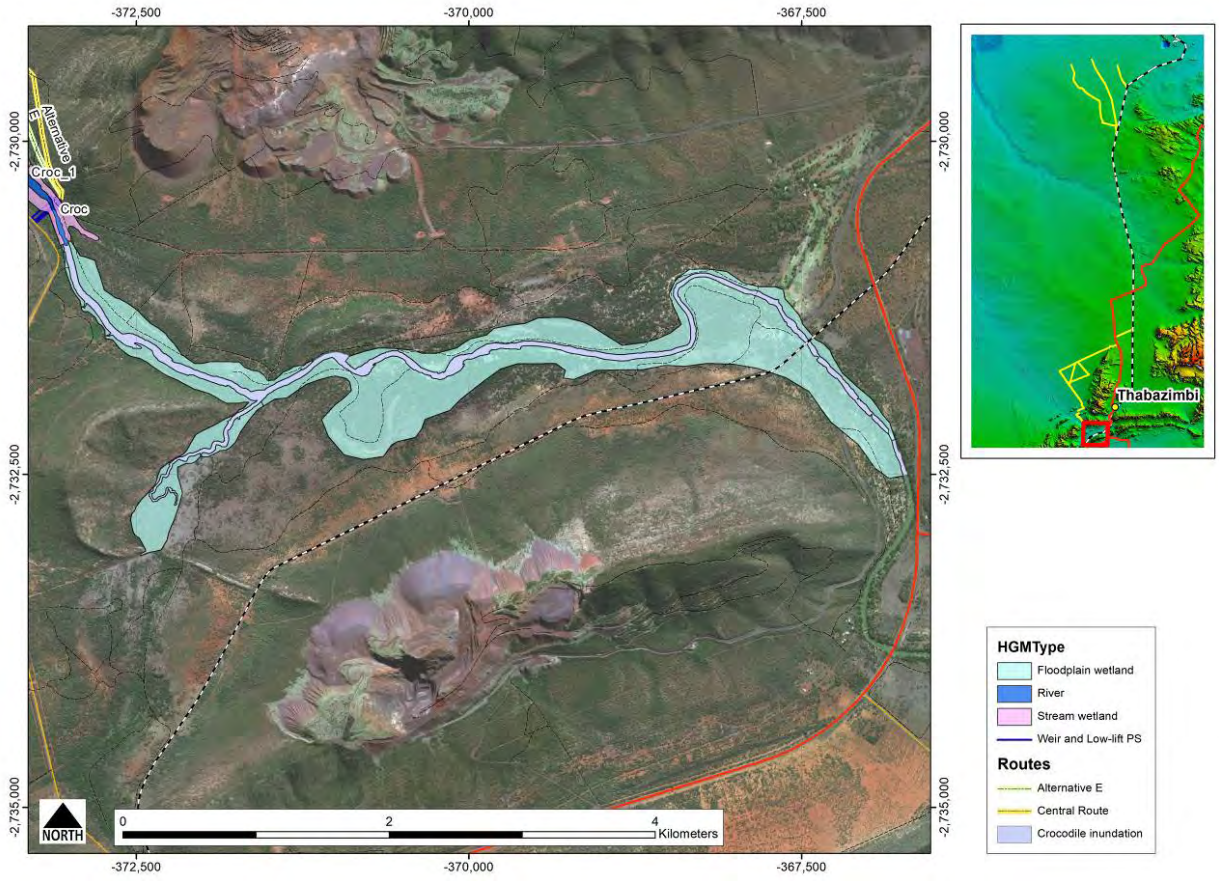


Figure 21. Wetland Type on the inundated area upstream of the Vlieëpoort Weir

6.2.5 GAUGING WEIRS

The Bierspruit and Sand River are the only two remaining significant watercourses along the Crocodile River (West) downstream of Roodekopjes Dam that has not been dammed (or gauged). The confluences of these two rivers with the Crocodile River (West) are located downstream of Hugo's Weir and upstream of Vlieëpoort. This means that the contributions made by the Sand River and Bierspruit to the flow in the Crocodile River (West) are not known other than through run-off calculations and cursory visual observations. The flows and specifically floods emanating from the two catchments could therefore have a significant impact on river flow patterns and riverine environment along the Crocodile River (West) downstream of Vlieëpoort.

Flow contributions from these sources should also be accounted for at the flow regimes at the Vlieëpoort Abstraction Works.

The positions of the weirs are as follows:

- Bierspruit - 24°40'53.10"S, 27°19'20.62"E;
- Sand River - 24°40'47.22"S, 27°27'12.75"E;
- Paul Hugo Weir - 24.69468120° S, 27.40914780° E

Photo 13. Weir position in Bierspriut[5]

Photo 14. Weir position at Sand River

The existing Paul Hugo Weir is situated approximately 20 km upstream of the proposed Vlieëpoort Weir site. It is on the Crocodile River and is an existing farmer abstraction weir. The intention is to construct a new crump weir about 70 metres downstream of the diversion weir at coordinates 24°41'40.86"S, 27°24'32.92"E.

SAND RIVER GAUGING WEIR

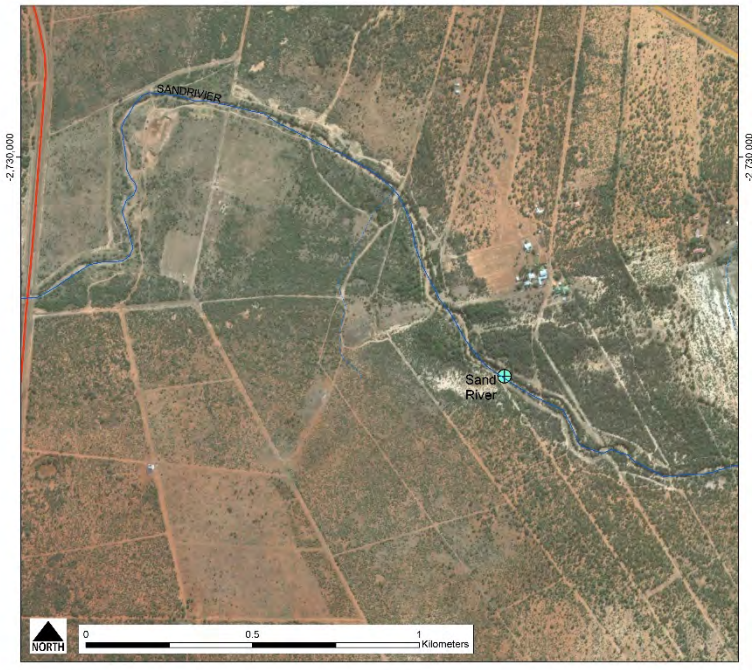


Figure 22. Sand River Gauging weir

Sand River is has a narrow strip of riparian vegetation.

There is a dam some 450 metres northwest of the proposed construction site.

No clear wetland could be observed in proximity of the planned construction site.

The HGM type is River.

PES Category B, largely natural.

[5] Photos from Final Scoping Report

NEW PAUL HUGO GAUGING WEIR

Figure 23. New Paul Huge Gauging weir

The new weir will be located in proximity of an existing weir on the Crocodile River. It is located on HAAKDOORNDRIFT 373 KQ. The river bank is covered with riparian vegetation, especially upstream of the weir. Some scouring and erosion is evident directly downstream of the weir.

The HGM type is River.

PES Category D, largely modified.

BIERSPRUIT GAUGING WEIR

Figure 24. Bierspriut Gauging weir

The weir will be located approximately 90 metres northeast of the river crossing at the bridge on Route 3872.

There is a dam at this crossing with facultative wetland plans around the edges that assists in flood attenuation and trapping sediments, of water from among other sources, the settlement ponds of mines some kilometre upstream. There are also some wetlands that developed in the river at that juncture as a result of the mining activities. They are, however, more than 800 metres upstream of the weir and should not have an influence on each other.

The HGM type is River.

PES Category D, largely modified.

6.2.6 LOSS OF WETLAND AREAS

The size of the wetlands that would be lost was not indicated. The sizes are as follows:

Vlieëpoort Weir:

- Wetlands: <0,5 ha
- Riparian vegetation: 11,4 ha

Inundated area:

- Wetlands: none
- Riparian vegetation: Uncertain

Matlabas Crossing

- Wetlands: none
- Riparian vegetation: <0,5 ha

Pans in on the northern sandy plains

- Where the pans are inundated for prolonged periods of the year and wetlands have developed, the pipeline route suggested is outside of the wetland ant its buffer. No wetlands will be lost.
- Taaiboschpan will be temporarily inundated during the rainy season. The catchment will be disturbed for the duration of construction. It will therefore, be a temporary loss.
- Alternative D4 is not in proximity of any wetland. There will be no loss if that route is followed.

7 BUFFER ZONE

In terms of legislation, wetlands and riparian zones are defined in the National Water Act as a water resource and any activities that are contemplated that could affect the wetlands requires authorisation (Section 21 of the National Water Act of 1998). In terms of NEMA's EIA Regulations and the National Water Act, any development within the 1:50 year floodline or 32 m from the stream margin will trigger an environmental authorisation.

A tool was developed by Department of Water and Sanitation to calculate the recommended protection buffer of aquatic ecosystems and was published by the Water Research Commission in 2014.[6] . The buffer requirements for the three scenarios were calculated and are as follows:

- Crocodile River section: 31 to 35 metres
- Matlabas River Section: 32 metres
- Northern Sandy Plains: 15 metres. (The support area to each pan may require additional buffer.)

The detail is provided in the Addenda.

The map of the buffer for the different sections is provided below.

[6] Macfarlane, D.M; Bredin, I.P.; Adams, J.B.; M.M. Zungu, Bate, G.C.; Dickens, C.W.S. 2014. Buffer zone tool for the determination of aquatic impact buffers and additional setback requirements for wetland ecosystems. Version 1.0. Water Research Commission, Pretoria).

7.1 CROCODILE RIVER SECTION

The area extends from the Vlieëpoort Weir to the Mooivallei boundary with Hampton 320KQ.

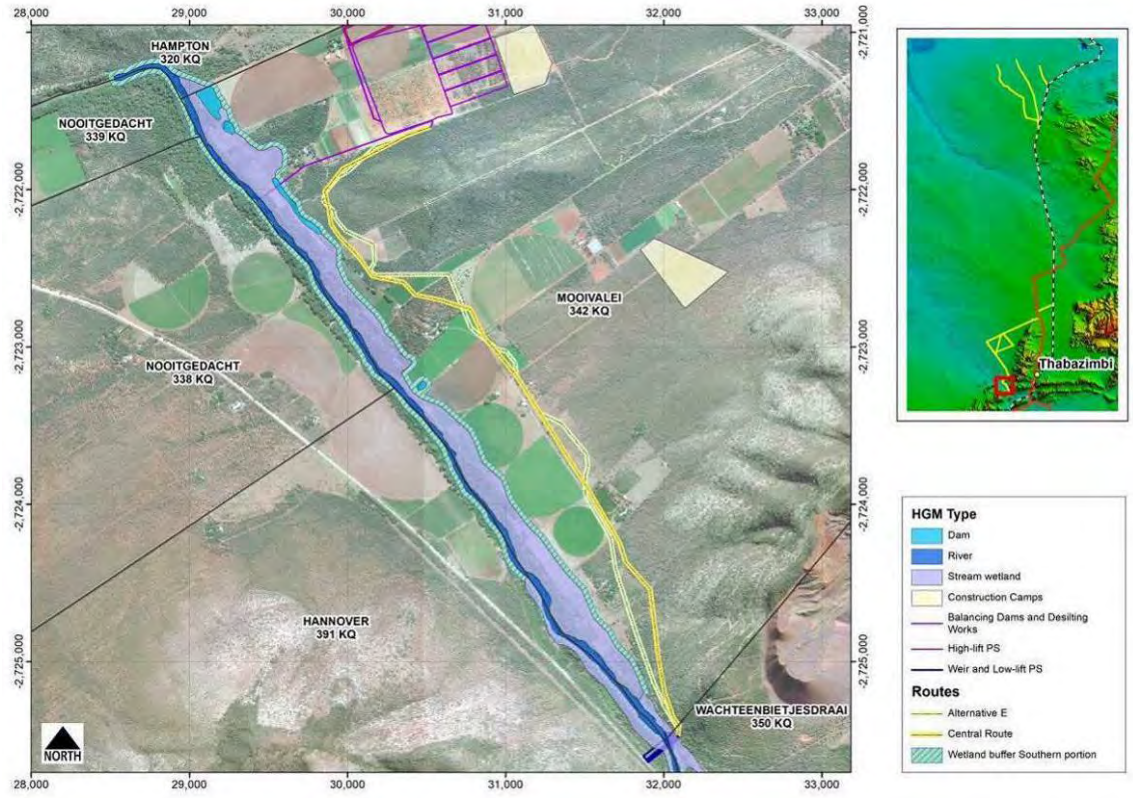


Figure 25. Buffer of the Crocodile River Section

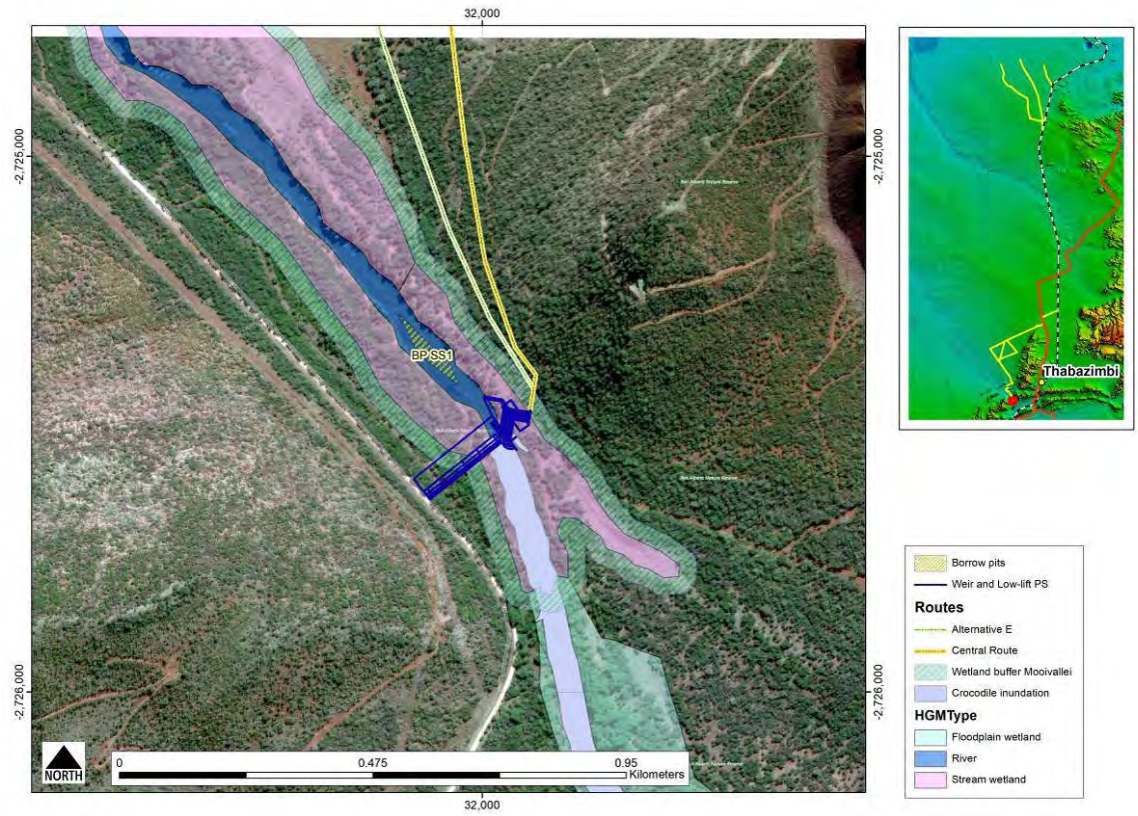


Figure 26. Buffer of the Weir and low-lift pump station

7.2 MATLABAS RIVER SECTION

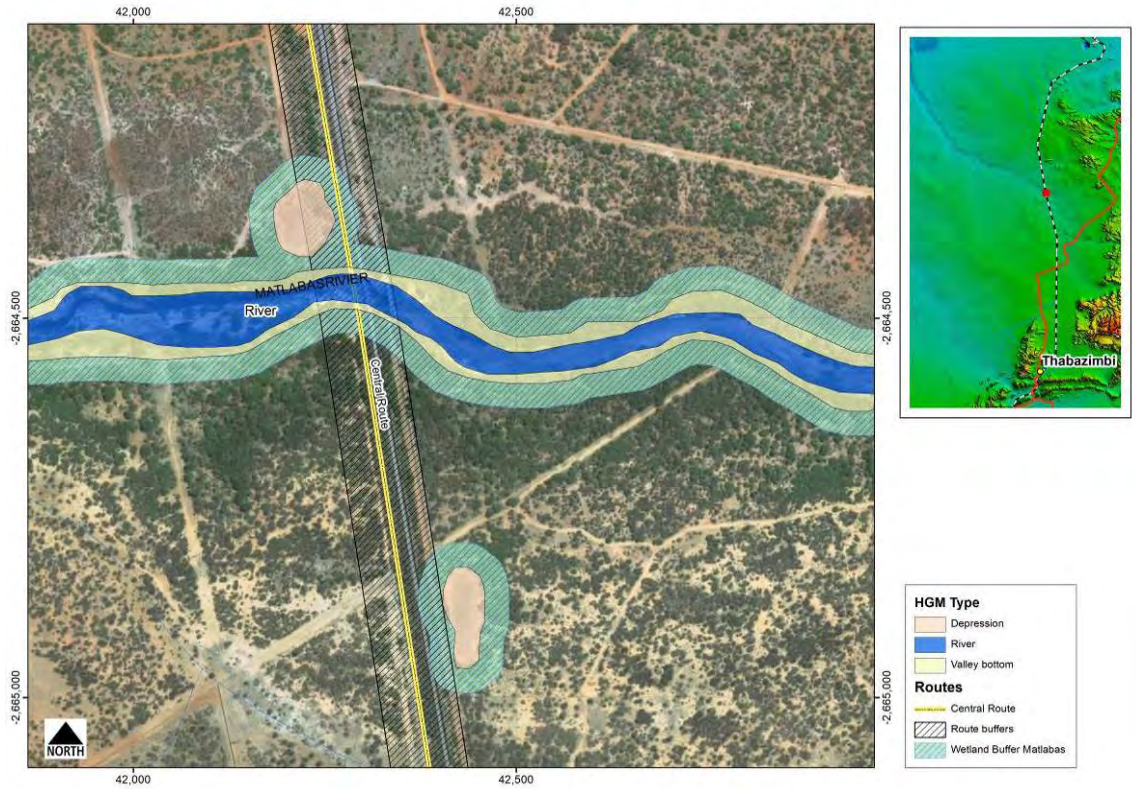


Figure 27. Buffer of the Matlabas River section

7.3 NORTHERN SANDY PLAINS

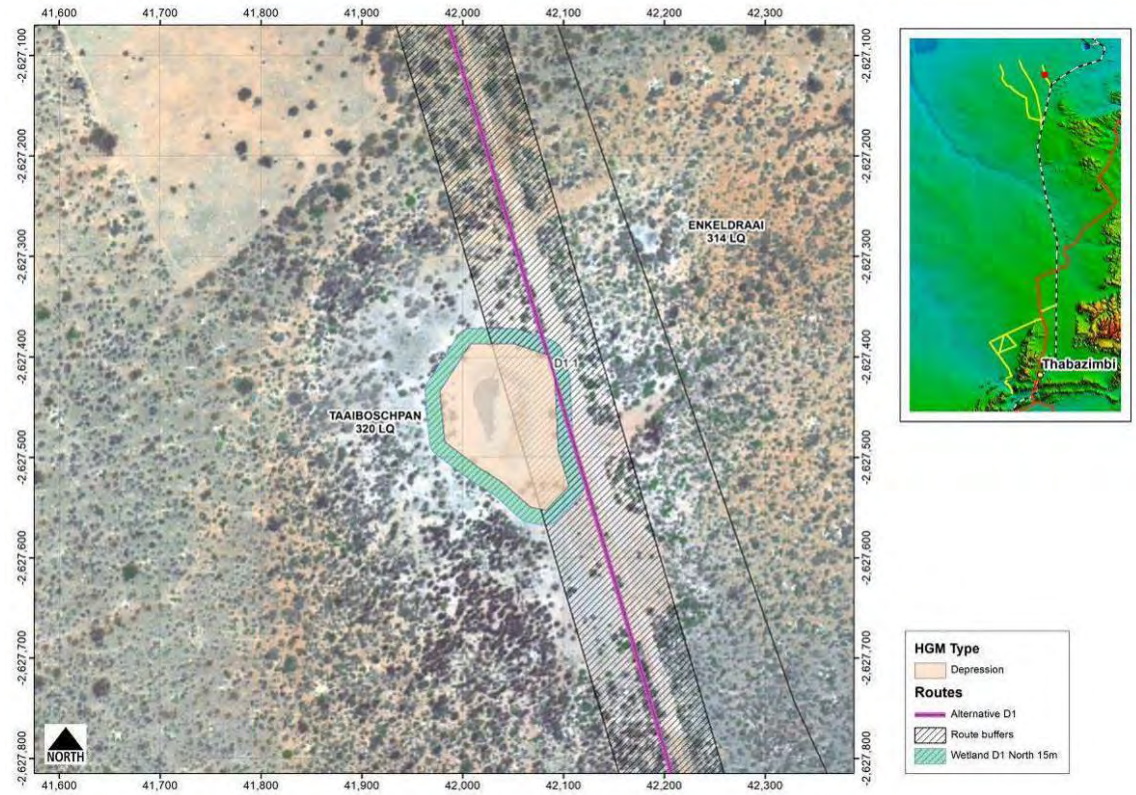


Figure 28. Buffer of Depression D1

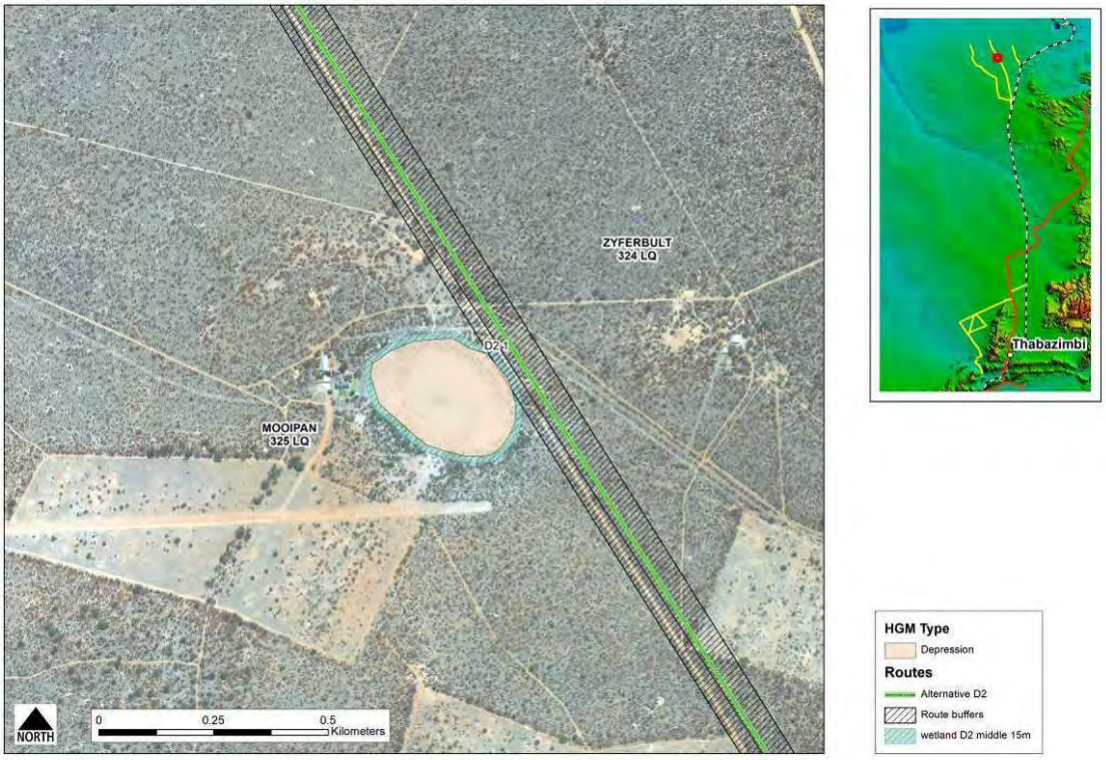


Figure 29. Buffer of Depression D2

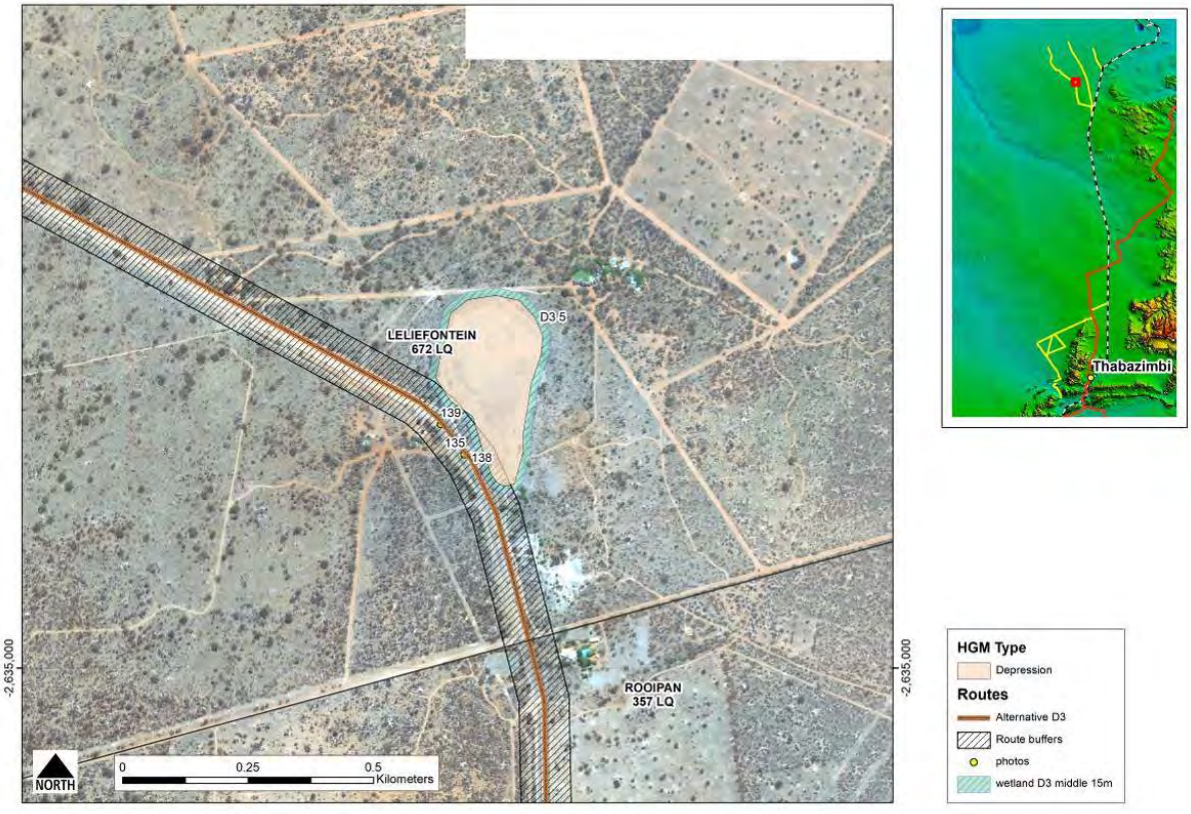


Figure 30. Buffer of Depression D3

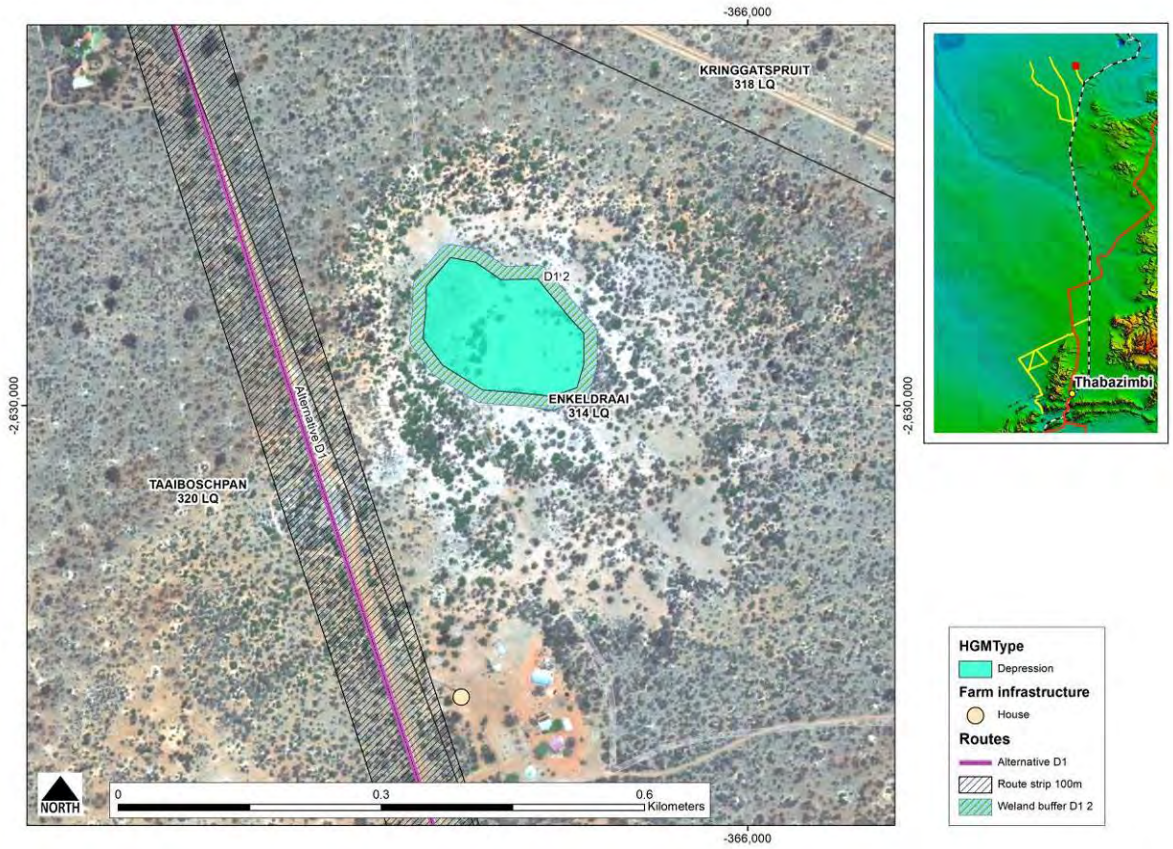


Figure 31. Buffer of Depression D1.1 - Enkeldraai 314LQ

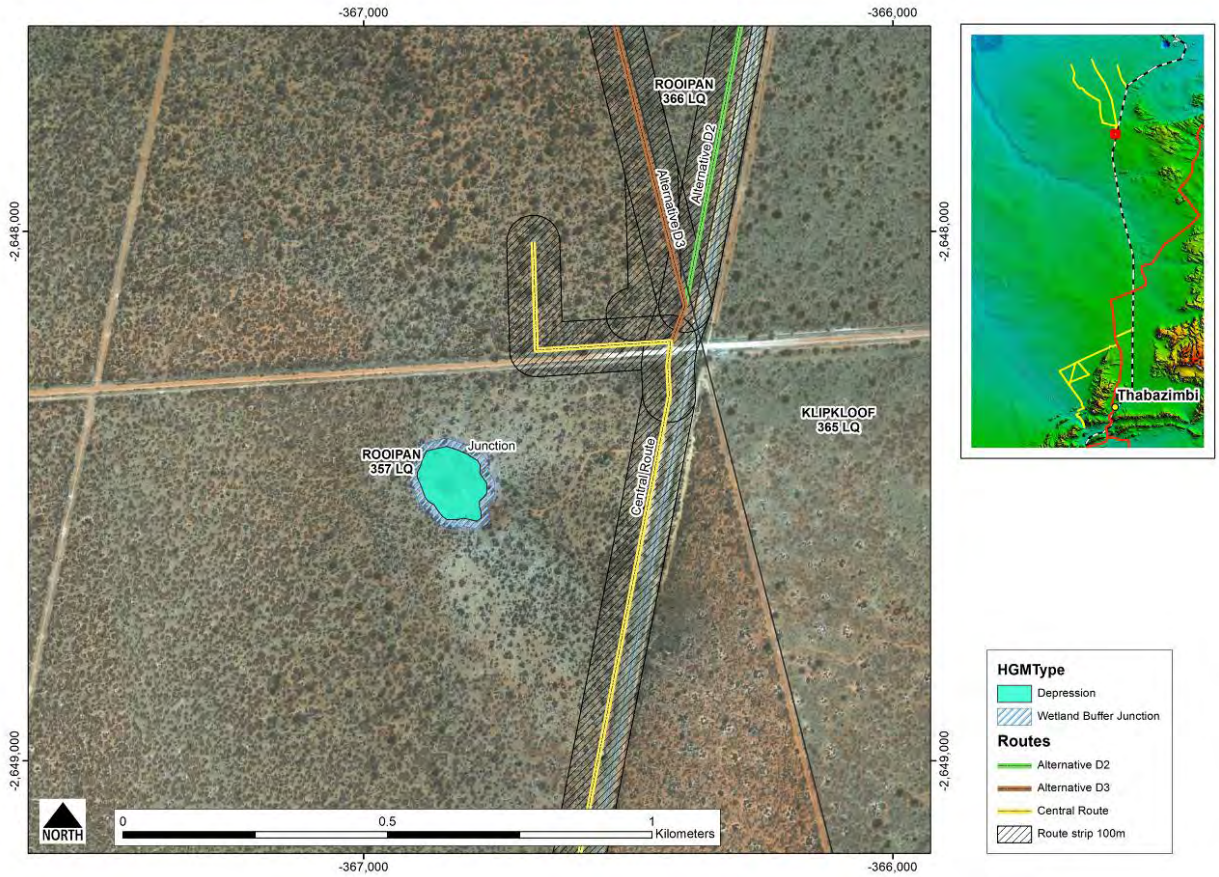


Figure 32. Buffer of Depression at Junction - Rooipan 357LQ

7.4 SAND RIVER, BIERSPRUIT AND NEW PAUL HUGO GAUGING WEIRS

Because the gauging weirs are in-stream structures, it is unlikely that they would influence stream flow; a buffer will not apply. There are some mitigation measures, however, that should be followed to minimize the impact of the construction process (see Section 9).

8 ECOLOGICAL IMPORTANCE AND SENSITIVITY

8.1 THE ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

The ecological importance of a water resource provides an expression of its importance to the maintenance of ecological diversity and functioning at local and wider scales (DWAF 1999). The Ecological Importance and Sensitivity (EIS) assess ecological importance and sensitivity, hydro-functional importance, and direct human benefits (DWA, 2013). See Table 3 below for EIS scores.

Table 3. Ecological Importance and Sensitivity classes. (DWA 2013, p43)

Ecological Importance and Sensitivity Categories	Range of EIS Score	EIS Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quality and quantity of water in major rivers.	>3 and <4	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river.	>2 and </=3	C
Low/Marginal: Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>1 and </=2	D
None: Wetlands that is rarely sensitive to changes in water quality/hydrological regime.	0	E

Table 4. EIS and PES of HGM units

X coord	Y coord	EIS	PES category	Reference	HGM Type	Saturation	Vegetation	Area	Distance from route
-172102	-2724482	A	B	Crocodile	River	Permanent	Riparian	21.29	0
-171551	-2725049	-	-	Croc dam	Dam	Permanent	-	0.09	500
-172030	-2724422	-	-	Croc dam	Dam	Permanent	-	0.18	700
-172075	-2724277	-	-	Croc dam	Dam	Permanent	-	0.22	470
-172191	-2724120	-	-	Croc dam	Dam	Permanent	-	0.52	650
-172890	-2723155	-	-	Croc dam	Dam	Permanent	-	1.34	100
-173075	-2722906	-	-	Croc dam	Dam	Permanent	-	0.1	550
-173199	-2722773	-	-	Croc dam	Dam	Permanent	-	0.24	650
-173319	-2722652	-	-	Croc dam	Dam	Permanent	-	0.45	800
-173437	-2722487	-	-	Croc dam	Dam	Permanent	-	1.8	800
-172116	-2724309	B	D	Crocodile	Stream wetland	Temporary	Lands_ thickets	71.16	80
-161033	-2665359	B	B	Mat	River	Permanent	Riparian	4.71	0

X coord	Y coord	EIS	PES category	Reference	HGM Type	Saturation	Vegetation	Area	Distance from route
-161029	-2665393	B	C	Matlabas	Valley bottom	Temporary	Thickets	1.79	0
-160908	-2665335	B	C	Matlabas	Valley bottom	Temporary	Thickets	2.1	0
-160638	-2666879	-	-	-	Depression	-	-	0.18	113
-160358	-2666818	-	-	-	Dam	-	-	0.87	300
-160197	-2666516	-	-	-	Dam	-	-	0.24	600
-160297	-2666595	-	-	-	Floodplain	-	-	3.9	400
-165345	-2641439	E	C	D3 1	Depression	Seasonal	Bushveld thickets	0.93	510
-165994	-2642261	E	C	D3 2	Depression	Seasonal	Bushveld thickets	1.33	600
-167156	-2640183	E	C	D3 3	Depression	Seasonal	Bushveld thickets	0.22	185
-166878	-2639627	E	C	D3 4	Depression	Seasonal	Bushveld thickets	5.05	70
-167488	-2635340	D	B	D3 5	Depression	Permanent	Wetland	5.1	0
-173927	-2631568	E	C	D3 6	Depression	Seasonal	Bushveld thickets	0.75	115
-173586	-2630943	E	C	D3 7	Depression	Seasonal	Bushveld thickets	2.68	415
-167112	-2629378	D	C	D2 1	Depression	Seasonal	Bushveld/wetlands	6.01	30
-161868	-2628305	D	C	D1 1	Depression	Permanent	Wetlands	1.48	0
-162170	-2626212	-	-	D1 2	Depression	-	-	2.4	180

- The Crocodile River stream wetland is classified as ***Category A.*** It is considered ecologically important and sensitive on a national or even international level;
- The Matlabas River is a Stream and is classified as ***Category B.*** It considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications; and
- The Depressions (pans) on the Northern Sandy plains are classified as ***Category C*** and ***D***. They are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications.

8.2 WETLAND ECOLOGICAL STATE (PES)

The ecological integrity or Present Ecological State (PES) of the HGM units within the study site was assessed for the current situation.

The assessment of the wetland systems identified extensive modifications within the wetlands itself and also the surrounding land. The changes in integrity are mostly reflected in relation to hydrology, geomorphology and vegetation.

The description of classes and score of the state of the wetland are as follows:

Table 5. Impact scores and Present Ecological State categories used by WET-Health for describing the integrity of wetlands

Description	Combined impact score	PES Category
Unmodified, natural.	0 – 0,9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1,9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3,9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota has occurred.	4 - 5,9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6 - 7,9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

- The habitat of the Crocodile River has seen few modifications. Further away from the river, much of the old terrace and floodplain is under cultivation and hence, totally modified. It is classified as Category D. The construction of the pipeline, however would not impact on the wetland.
- The crossing of the Matlabas is on PES Category B. It is ecologically still in good condition with only little modifications due to construction of the railway bridge. It contains wetland plants and is effective in impeding water flow during storms.

  The ecological status of the Matlabas River should also be determined during the high-flow period, prior to construction in order to determine the requirements for scouring (i.e. draining water from the pipeline, typically during maintenance).

- There are a number of depressions on the Northern Sandy Plains, of which one is Category B, the other two are Category C. These pans are small and have no effect on stream flow or capturing silt or chemicals. However, they play a role in maintaining biodiversity and in support of wildlife and insects, in an otherwise arid environment.

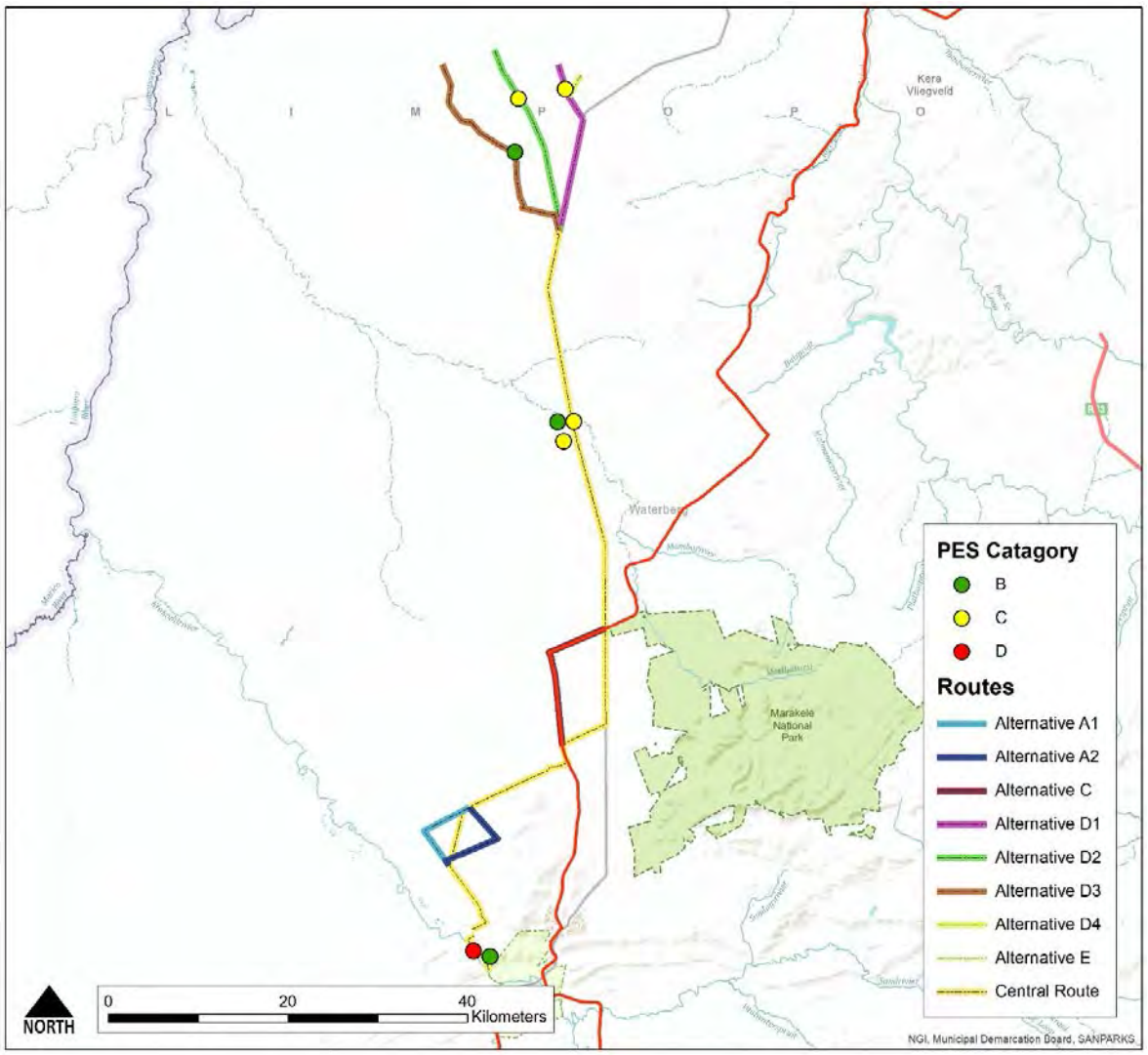


Figure 33. PES categories

8.3 ECOSERVICES

The overall goal of EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision-making. EcoServices includes the assessment of several ecosystem services (listed in Table 6) that the wetland provides to the ecosystem.

Table 6. Wetland benefits

INDIRECT BENEFITS (Regulating and supporting benefits)	
Flood attenuation	The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream.
Streamflow regulation	Sustaining streamflow during low flow periods.
Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters.
Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters.
Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters.
Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters.
Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
Carbon storage	The trapping of carbon by the wetland, principally as soil organic matter.
DIRECT BENEFITS	
Biodiversity maintenance	Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity.
Provision of water for human use	The provision of water extracted directly from the wetland for domestic, agriculture or other purposes.
Provision of harvestable resources	The provision of natural resources from the wetland, including livestock grazing, craft plants, fish etc.
Provision of cultivated foods	The provision of areas in the wetland favourable for the cultivation of foods
Cultural heritage	Places of special cultural significance in the wetland, e.g. for baptisms or gathering of culturally significant plants.
Tourism and recreation	Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife.
Education and research	Sites of value in the wetland for education or research.

The wetlands that occur in the study area were grouped according to potential ecological services that they can provide. The wetland reference numbers in Table 7 refer to the position indicated in Figure 34.

Table 7. Reference numbers, HGM type and area of wetland

Map Reference	HGM Type	Saturation status	Area (ha)	Reference Text	Distance from path
24	Depression	Permanent	5.05	D3 4	70
25	Depression	Permanent	5.10	D3 5	0
36	Depression	Permanent	1.36	Junction	450
27	Depression	Seasonal	2.68	D3 7	415
28	Depression	Seasonal	6.01	D2 1	30
29	Depression	Seasonal	1.48	D1 1	0
21	Depression	Temporary	0.93	D3 1	510

Map Reference	HGM Type	Saturation status	Area (ha)	Reference Text	Distance from path
23	Depression	Temporary	0.22	D3 3	185
26	Depression	Temporary	0.75	D3 6	115
30	Depression	Temporary	2.08	D1 2	180
37	Floodplain	Temporary	24.81	Upstream	
38	Floodplain	Temporary	11.07	Upstream	
39	Floodplain	Temporary	22.10	Upstream	
40	Floodplain	Temporary	145.87	Upstream	
41	Floodplain	Temporary	42.46	Upstream	
34	Stream wetland	Seasonal	4.87	Downstream	500+
35	Stream wetland	Seasonal	8.87	Downstream	500+
10	Stream wetland	Temporary	71.16	Downstream	350
14	Valley bottom	Temporary	1.79	Matlabas	0
15	Valley bottom	Temporary	2.10	Matlabas	0

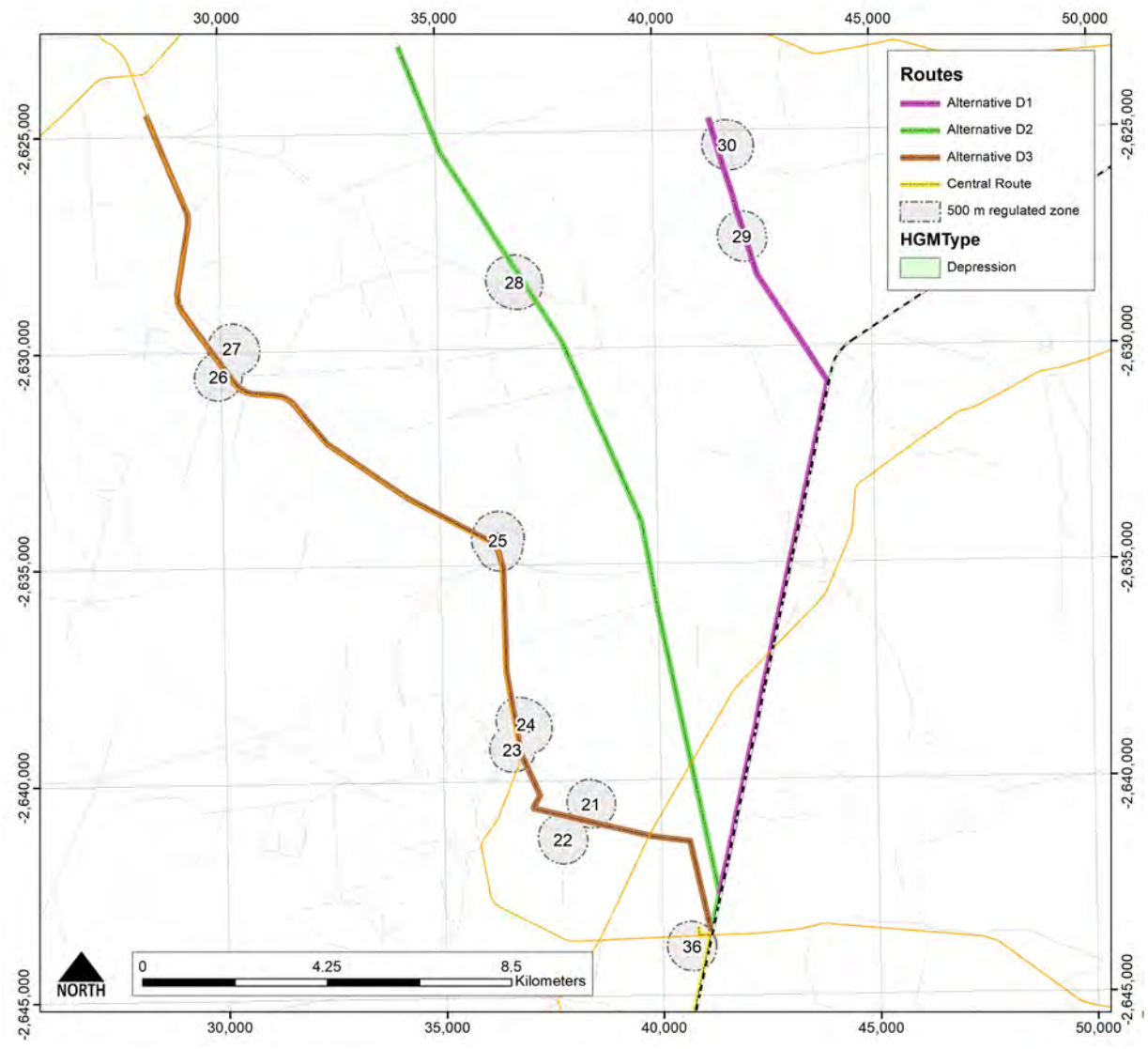


Figure 34. EcoServices reference numbers for the northern sandy plains

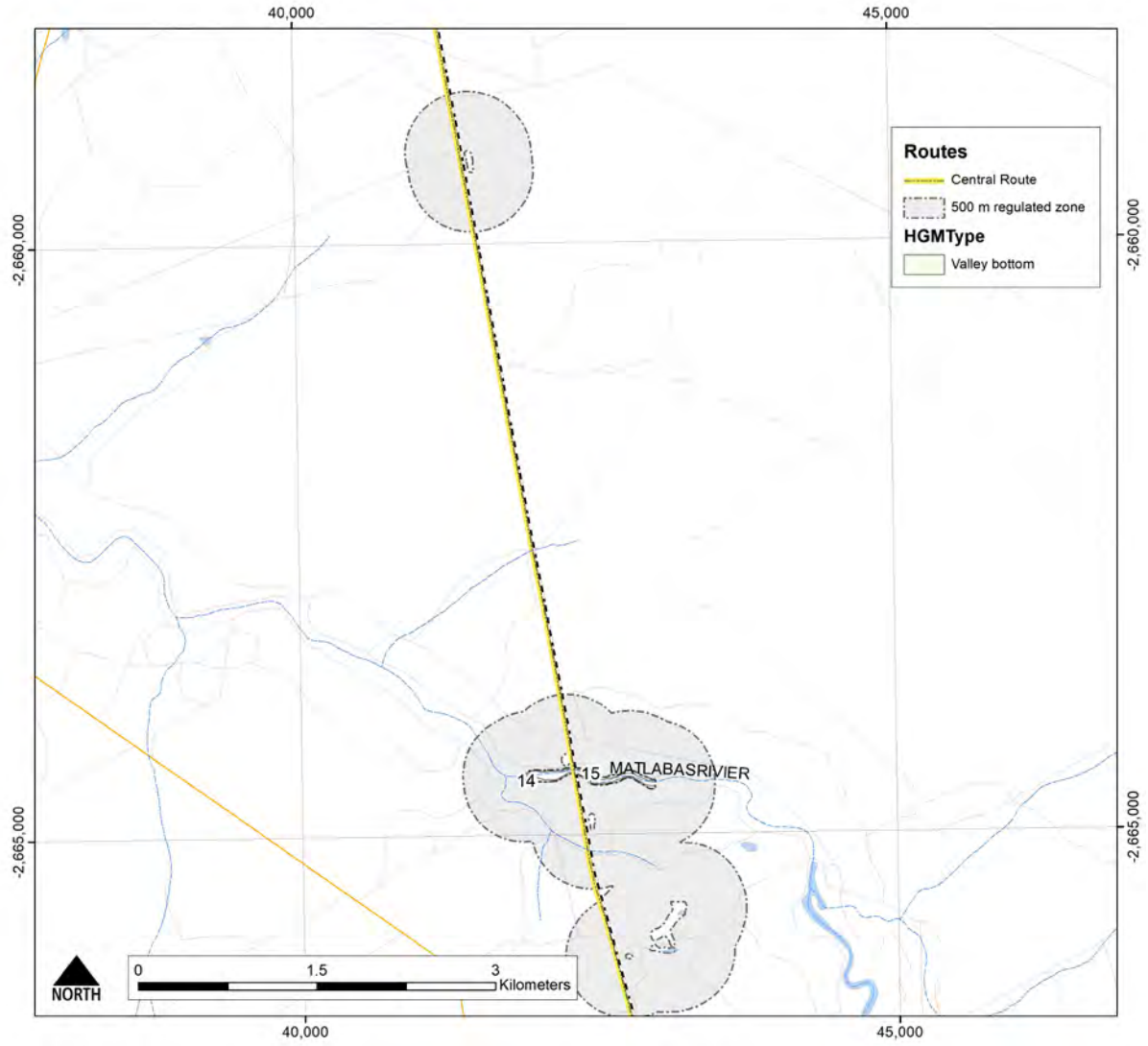


Figure 35. EcoServices reference numbers for the Matlabas section

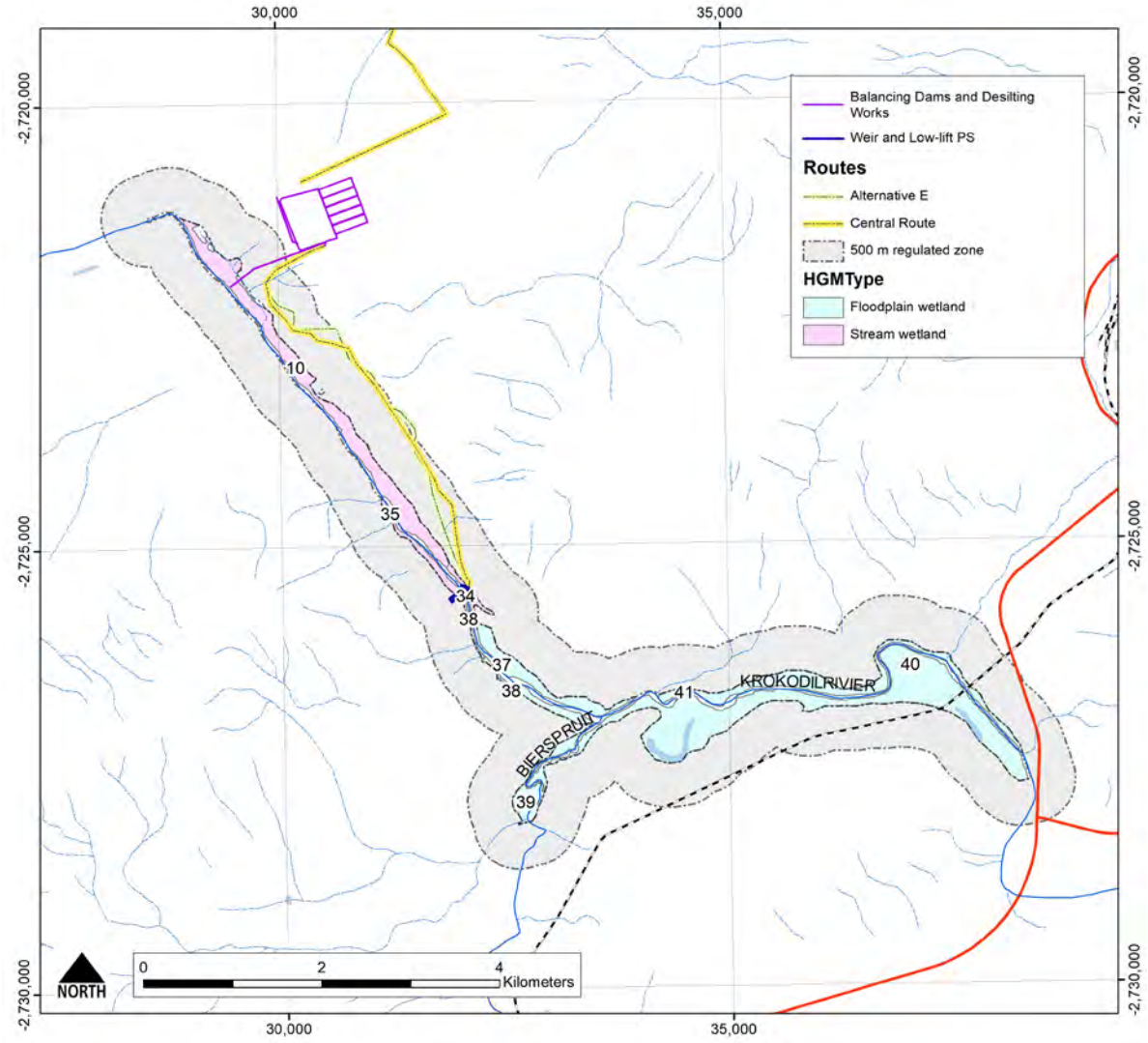


Figure 36. EcoServices reference numbers for the Crocodile River section

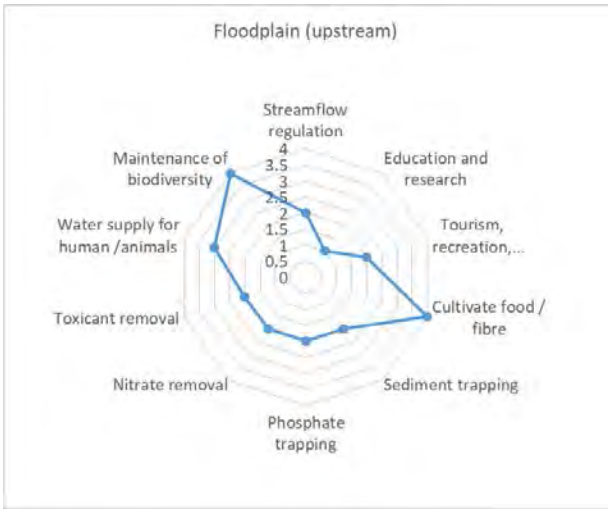
Floodplains up and downstream of the Vlieëpoort Weir provide high or moderately high services in maintenance of biodiversity and in supply of water to humans, animals and for irrigation. Their ability to trap sediments and ameliorate chemicals is intermediate or low. Refer to the figures below for details.

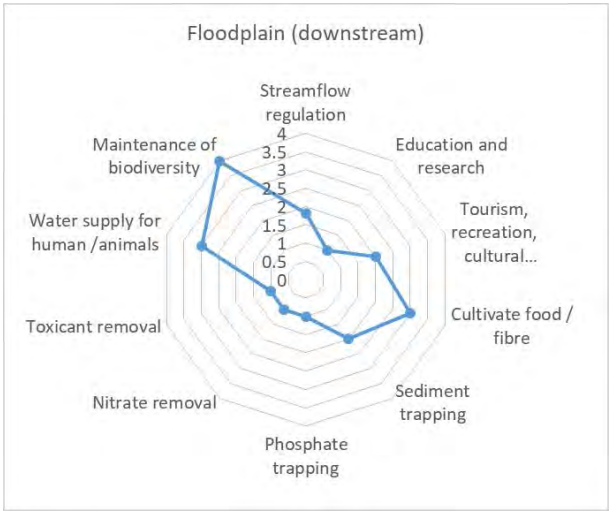
The pans (or depressions) are inward draining and thus, has little ability in streamflow regulation. Most of the pans are temporary saturated after rain events. They provide environmental services at a low or moderately low level. Those that are seasonally or permanently saturated with water can provide moderate to high level of services to maintenance of bio-diversity, water provision for animals, and can also support tourism at a moderately high level.

Table 8. EcoServices[7] provided by deferent wetland types [8]

Reference Text	HGM Type	Streamflow regulation	Education and research	Tourism, social significance	Cultivate food / fibre	Sediment trapping	Phosphate trapping	Nitrate removal	Toxicant removal	Water supply for human /animals	Maintenance of biodiversity
37 - 41	Floodplain (upstream)	2	1	2	4	2	2	2	2	3	4
10, 34, 35	Floodplain (downstream)	1.8	1	2	3	2	1	1	1	3	4
24, 25, 36	Depression (permanently saturated)	0	2	3	0	0	0	1	1	3	4
27, 28, 29	Depression (seasonally saturated)	0	1	2	0	0	0	0	1	2	2
21, 23, 26, 30	Depression (temporary saturated)	0	1	1	0	0	0	0	1	2	1

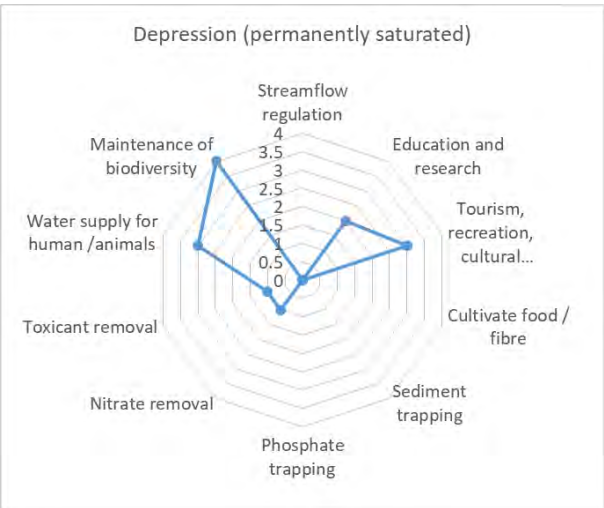
The following is a graphic illustration of the services that each wetland group provides:

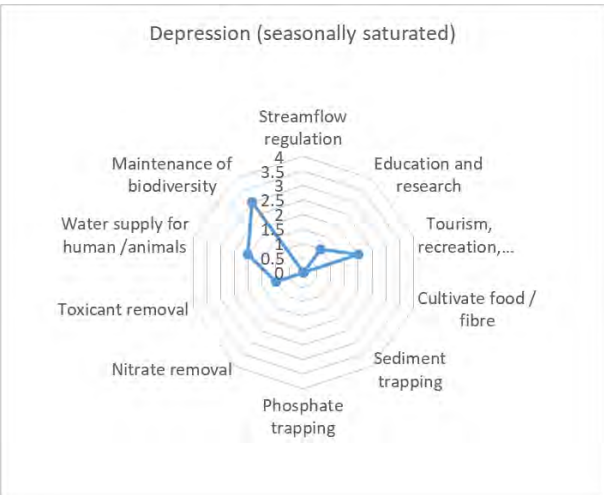


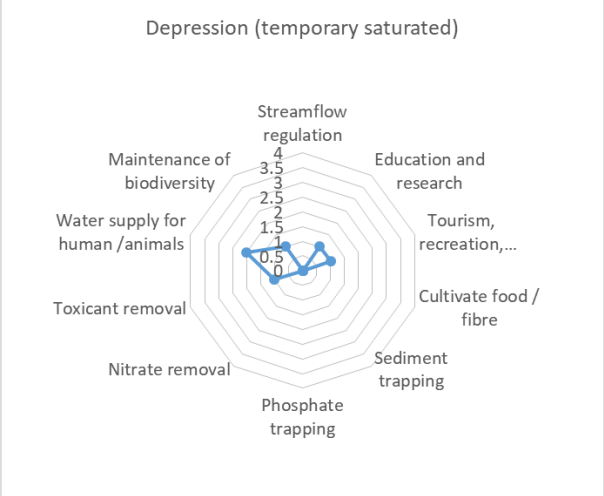


[7] Refer to Wet-EcoServices (WRC Report TT 339/09)

[8] The ecological services rating supplied by a wetland systems are ranked according to the following: 0 – Low, 1 – Moderately Low, 2 – Intermediate, 3 – Moderately High and 4 - High







9 IMPACT ASSESSMENT

9.1 IMPACT DESCRIPTION

The EIA quantitative impact assessment focuses on the direct and indirect impacts associated with the project. All impacts are analysed with regard to their nature, extent, magnitude, duration, probability and significance. The following is a description of the impacts:

- Nature (/Status)
  - → The project could either have a positive, negative or neutral impact on the environment.
- Extent
  - → Local - extend to the site and its immediate surroundings;
  - → Regional - impact on the region but within the province; and
  - → National - impact on an interprovincial scale. International - impact outside of South Africa.
- Magnitude

  Degree to which impact may cause irreplaceable loss of resources.

  - → Low - natural and social functions and processes are not affected or minimally affected;
  - → Medium - affected environment is notably altered; natural and social functions and processes continue albeit in a modified way; and

→ High - natural or social functions or processes could be substantially affected or altered to the extent that they could temporarily or permanently cease.

- Duration
  - → Short term - 0-5 years;
  - → Medium term - 5-11 years;
  - → Long term - impact ceases after the operational life cycle of the activity either because of natural processes or by human intervention; and
  - → Permanent - mitigation either by natural process or by human intervention will not occur in such a way, or in such a time span that the impact can be considered transient.
- Probability
  - → Almost certain - the event is expected to occur in most circumstances;
  - → Likely - the event will probably occur in most circumstances;
  - → Moderate - the event should occur at some time;
  - → Unlikely - the event could occur at some time; and
  - → Rare/Remote - the event may occur only in exceptional circumstances.
- Significance

  Provides an overall impression of an impact's importance, and the degree to which it can be mitigated. The range for significance ratings is as follows-

  - → 0 – Impact will not affect the environment. No mitigation necessary;
  - → 1 – No impact after mitigation;
  - → 2 – Residual impact after mitigation; and
  - → 3 – Impact cannot be mitigated.

The components of the project that will be assessed are as follows (refer to Figure 21 and Figure 22 below for locations):

Table 9. Impact description

	Nature (/Status)	Extent	Magnitude	Duration	Probability	Significance (0-no impact; 3 very high)
Weir and low lift pumping station (PS)	Neutral	Regional	Medium	Permanent	Certain	2
Alternative route alignment E	No impact					0
Balancing dam, desilting works, PS	No impact					0
Alternative route alignment A	No impact					0
Break pressure reservoir	No impact					0
Alternative route alignment C	No impact					0
Matlabas River crossing	Neutral	Local	Low	Short	Likely	1
Operational reservoir (OR)	No impact					0
OR Construction Camp	Negative	Local	Medium	Short	Likely	1
Alternative route alignment D						0
Depressions D1	Neutral	Local	Low	Short	Likely	1
Depressions D2	Neutral	Local	Low	Short	Likely	1
Depressions D3	Neutral	Local	Low	Short	Likely	1

	Nature (/Status)	Extent	Magnitude	Duration	Probability	Significance (0-no impact; 3 very high)
Depressions D4	No impact					0
BORROW PITS						
BP 13	No impact					0
BP 14	No impact					0
BP 15 v2	No impact					0
BP 25 Ex	No impact					0
BP 28	No impact					0
BP 30	No impact					0
BP 33	No impact					0
BP 35	No impact					0
BP 38	No impact					0
BP 39	No impact					0
BP 41	No impact					0
BP 42	No impact					0
BP 43	No impact					0
BP 44	No impact					0
BP 46	No impact					0
BP 48	No impact					0
BP 49	No impact					0
BP 50	No impact					0
BP 51	No impact					0
BP 52	No impact					0
BP 53	No impact					0
BP 59	No impact					0
BP SS1	Neutral	Local	Low	Short	Certain	2
GAUGING WEIRS						
Vlieëpoort weir	Neutral	Local	Low	Short	Unlikely	1
Sand River	Neutral	Local	Low	Short	Unlikely	1
Bierspruit	Neutral	Local	Low	Short	Unlikely	1
Paul Hugo	Neutral	Local	Low	Short	Unlikely	1

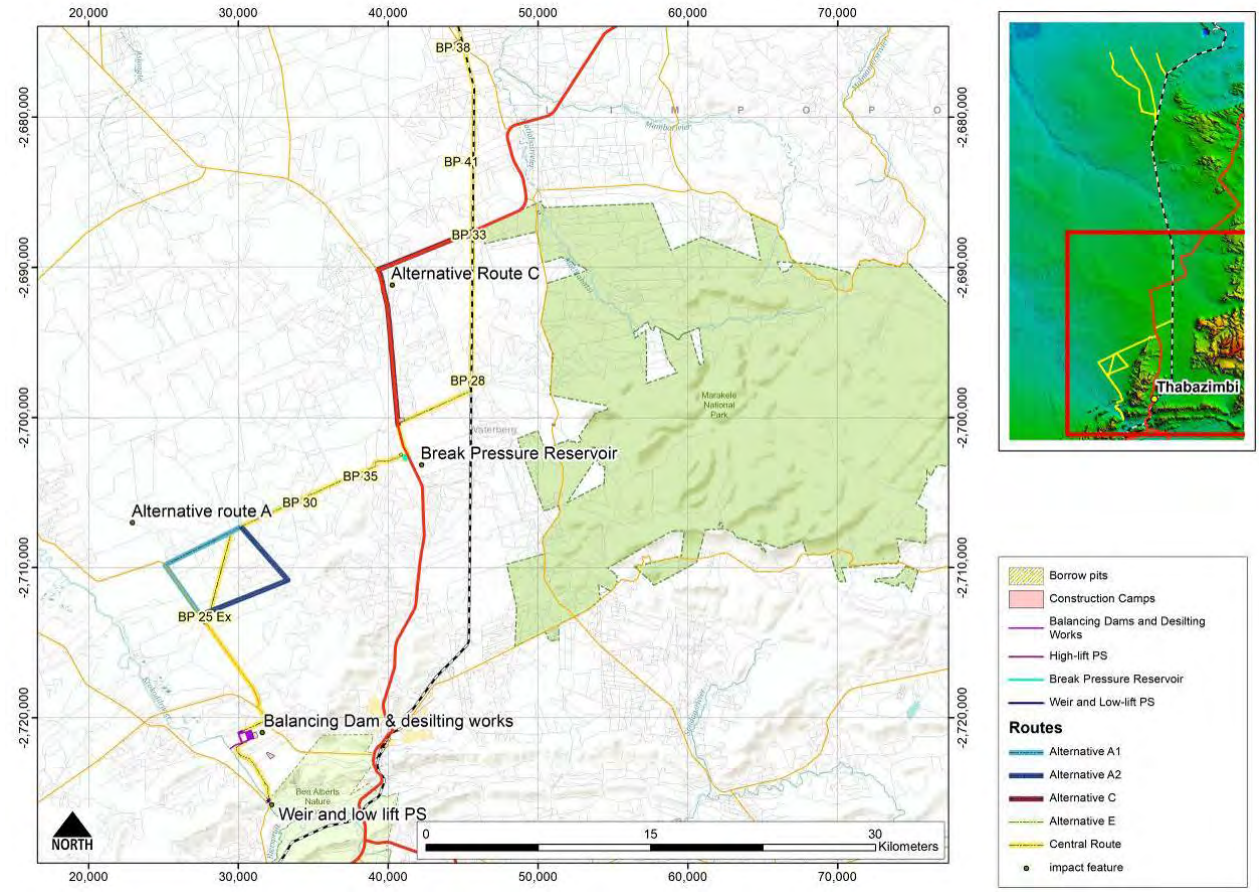


Figure 37. Impact location – southern portion

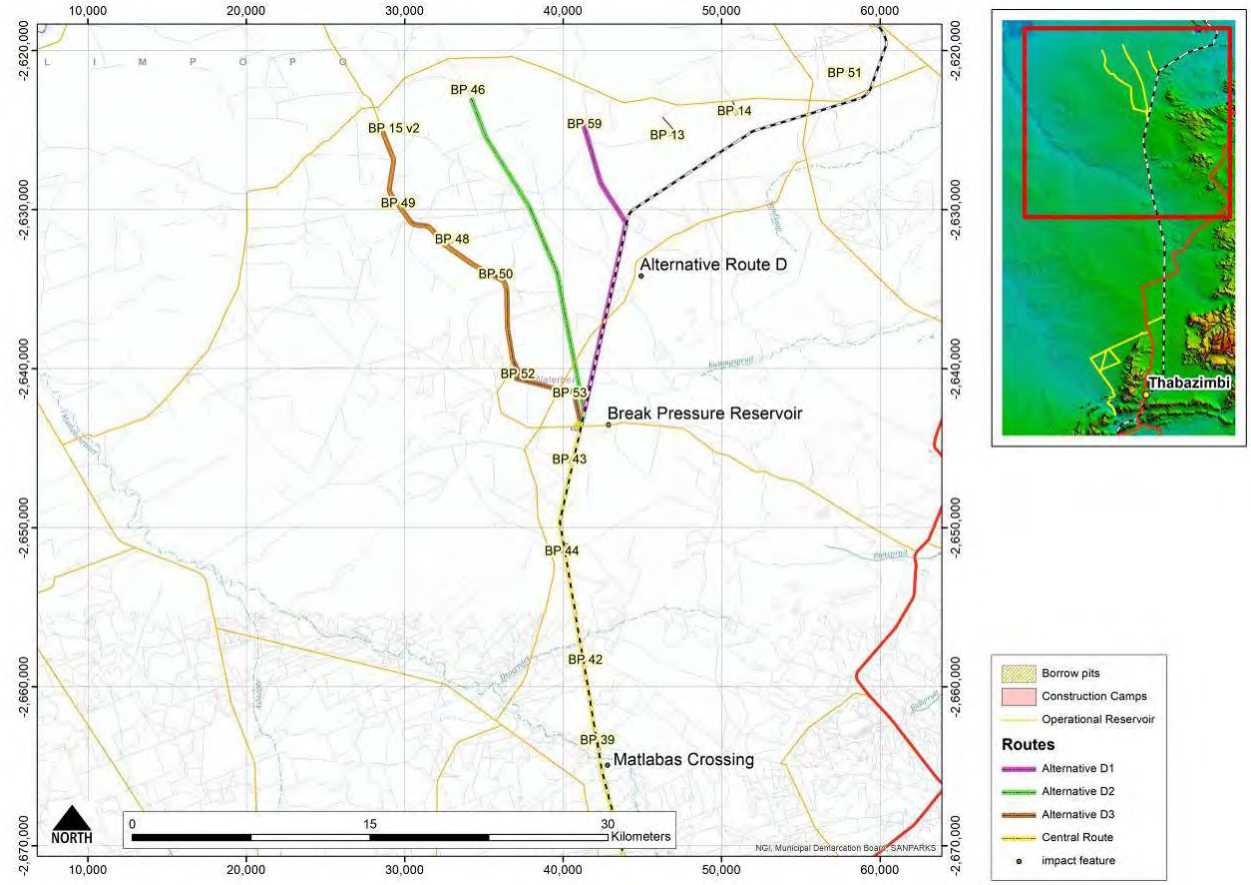


Figure 38. Impact location – northern portion

The direct and indirect effects of the development is assessed in terms of hydrology, biodiversity's integrity, water quality, plant harvesting, etc. (refer to Table 7).

Table 10. Direct and indirect wetland impacts (Kotze et al., 2005)

Indirect benefits	Hydrological benefits	Water purification
		Sustained stream flow
		Flood reduction
		Ground water recharge/discharge
		Erosion control
	Biodiversity conservation – integrity & irreplaceability	
	Chemical cycling	
Direct benefits	Water supply	
	Socio-cultural significance	
	Education and research	

Table 11. Environmental effect: Baseline (pre- construction) [9]

	Water purification	Sustained stream flow	Flood reduction	Ground water recharge	Erosion control	Biodiversity conservation	Chemical cycling	Water supply	Socio-cultural significance	Education and research
Inundated area above Vlieëpoort	+1	+1	+1	-	-	-	-	-	-	-
Weir and low lifting PS	-	-	-	-	-	-	-	-	-	-
Alternative route alignment E	-	-	-	-	-	-	-	-	-	-
Balancing dam and desilting works, PS	-	-	-	-	-	-	-	-	-	-
Alternative route alignment A	-	-	-	-	-	-	-	-	-	-
Break pressure reservoir	-	-	-	-	-	-	-	-	-	-
Alternative route alignment C	-	-	-	-	-	-	-	-	-	-
Matlabas River crossing	+1	+1	+1	-	-	-	-	-	-	-
Operational reservoir (OR)	-	-	-	-	-	-	-	-	-	-
OR Construction Camp	-	-	-	-	-	-	-	-	-	-
Alternative route alignment D										
Depressions D1	-	-	-	+1	-	+1	-	+1	-	-
Depressions D2	-	-	-	+1	-	+1	-	+1	-	-
Depressions D3	-	-	-	+1	-	+1	-	+1	-	-
Depressions D4	-	-	-	-	-	-	-	-	-	-
Borrow Pits 13 - 59	-	-	-	-	-	-	-	-	-	-
Borrow Pit SS1	-	-	-	-	-	-	-	-	-	-
Gauging weirs	-	-	-	-	-	-	-	-	-	-

[9] +1 = positive residual impact, 0 = no net impact, -1 = negative impact, - = not applicable

IMPACT AFTER CONSTRUCTION

- The portion that will be inundated occurs in a floodplain with many oxbow lakes and temporary saturated wetlands. These are outside of the normal flow of the river. Abstracting water at the Vlieëpoort Weir will likely cause fluctuating river levels upstream. Flow level variation is a natural process at present. While the effect may be exaggerated when pumping commences, the impact is unlikely to be significant. The riparian zone may increase in size because of the raised water level.
- The pipeline installation will have a temporary impact on the vegetation. The only portions of the pipeline that will impact on wetlands are in the Sandy Plain Portion where the alignments split for Route Alignment D. Traversing the wetlands will have a temporary impact on the vegetation but it will take time to recover to its former status.
- BP SS1 is the only borrow pit that is within the buffer of any wetland. It occurs within the stream of the Crocodile River. It is assumed that the diversion of the river to enable the construction of the Vlieëpoort Weir and Low lift Pumping Station will release the water below the position of BP SS1 and that borrowing will only take place once the stream bed is dry.

  The borrow pit will flood after the weir is completed, the diversion duct is removed and the water flow path returns to normal. Because it is located in the river bed, BP SS1 should not have any residual impact during the operational phase.

- The construction of the gauging weirs is instream and will have no residual impact on the ecology after rehabilitation.

9.2 IMPACT ASSESSMENT

The impact of the development of the impact features as discussed in Section 8.1 are as follows:

Table 12. Description of impact features

Feature	Description	Discussion
1. Construction of the Vlieëpoort Weir and Low lift pumping station		
PES	The habitat is currently in PES category B. Construction of the weir complex will create a reservoir upstream that will lead to the loss of habitat. The river banks are covered by alien invasive species. In general the habitat functions effectively below the point where the weir is proposed. Unless flow diminishes, this is not expected to change after construction of the weir and pumping infrastructure.	**Watercourse characteristics:** ▪ Hydraulic regime The basal cover is sufficient to retard flow and protect the bed against erosion. ▪ Water quality Water quality is a given and fluctuates with water levels. Water quality is unlikely to the affected by the construction of the weir. ▪ Geomorphology and sediment balance
Eco services	Despite the slight decreased ecological integrity, functioning remains at an intermediate level, particularly in terms of eco-services such as flood attenuation, sediment trapping, toxicant assimilation, and erosion control. Socio-cultural service	The flow velocity of the river will not change upstream of the weir but will diminish downstream. It is unlikely to impact on stream bank and streambed incision and erosion downstream.

	provision is deemed to be low because of restricted access to the river, reducing the opportunity to provide services such as water for tourism and recreation and to maintain biodiversity. The Crocodile River is a major source of irrigation water. This supply is regulated through an ELU (Section 35 of the NWA) and will be dealt with in accordance with the Act.	▪ Habitat and biota Proliferation of alien and invasive floral species has occurred over time. Many of the plants identified are invasive and should be eradicated. (CARA 2002 – Category 1).
EIS	This system is considered to be ecologically important at the affected site.	
REC (Recommended Ecological State)	The Crocodile River Stream Wetland is largely modified due to farming activities. Irrigation already takes place on the old riparian zone and will likely remain so.	
2. Construction of pipeline at Matlabas Rail crossing		
PES	The river now has a PES rating of B. There is some degradation that has taken place; but the habitat is largely intact with minimal modification. The impact of the pipeline will depend on the construction method employed; if buried, it will affect the PES temporarily. The present proposal is that the pipeline will be installed through horizontal drilling. Construction will then have little impact on the wetland.	**Watercourse characteristics:** ▪ Hydraulic regime Much of the catchment upstream is pristine as it is located in an area that focusses on nature-based tourism. Construction is unlikely to influence to flow characteristics of the Matlabas river. ▪ Water quality Water in this section of the tributary was not tested for quality. Construction, however, will not change the water quality. ▪ Geomorphology and sediment balance The flow velocity of the river will not change. Construction is unlikely to impact the Matlabas River. ▪ Habitat and biota Proliferation of alien and invasive floral species has occurred over time. Many of the plants identified are invasive and should be eradicated. (CARA 2002 – Category 1).
Eco services	The river functions at a high level, particularly in terms of eco- services such as flood attenuation, sediment trapping, toxicant assimilation, and erosion control. Socio-cultural service provision is deemed to be high, largely as a result of the surrounding tourism development. However, accesses to the services are limited because of its *Private Game Reserve* status.	
EIS	This system is considered to be ecologically important at the affected site.	
REC (Recommended Ecological State)	Construction in this sensitive habitat is likely to introduce silt and dust. The Environmental Management Plan for the construction should include measures to minimise the impact of construction and eradicate invasive plants and to improve and maintain the riparian vegetation.	

3. Installation of pipeline at depressions in the northern sandy plains		
PES	The present PES status is B and C. This status will be maintained post construction.	**Watercourse characteristics:** ▪ Hydraulic regime Not applicable
Eco services	The depressions are important habitats for fauna because it provides water in an otherwise arid environment. It is poor in sediment trapping or controlling water quality.	▪ Water quality Not applicable
EIS	This system is not considered to be ecologically important.	▪ Geomorphology and sediment balance Construction will not impact on the pan.
REC (Recommended Ecological State)	The system is largely unmodified and should remain in its present state after construction.	▪ Habitat and biota Construction should not impact on the pan.
4. Clearance and instream works at Borrow pit SS1		
PES	Only BP SS1 of all the borrow pits is within a wetland or riparian zone. It will be located in the river bed and it is not foreseen to have a residual impact after construction. The present PES status is B. This status will be sustained post construction.	**Watercourse characteristics:** ▪ Hydraulic regime Not applicable ▪ Water quality Not applicable
Eco services	The borrow pit BP SS1 will be submerged and will not contribute to eco services.	▪ Geomorphology and sediment balance Construction will not influence the sediment load or erosion of the banks.
EIS	This system is considered to be ecologically important at the location of the affected site.	▪ Habitat and biota
REC (Recommended Ecological State)	The system is largely unmodified and should remain in its present state after construction.	Construction should not impact the habitat.
5. Clearance and instream works at the Gauging Weirs		
PES	The gauging weirs will be constructed instream and will not influence the overall PES rating. It will be located in the river bed and it is not foreseen to have a residual impact after construction. The PES status will be sustained post construction.	**Watercourse characteristics:** ▪ Hydraulic regime Not applicable ▪ Water quality Not applicable
Eco services	Will not contribute to eco services.	▪ Geomorphology and sediment balance
EIS	This system is considered to be ecologically important at the location of the affected site.	Construction will not influence the sediment load or erosion of the banks.
REC (Recommended Ecological State)	The construction is instream and will not have a residual impact beyond the stream bank.	▪ Habitat and biota Construction will have a temporary impact because of vegetation will be removed to facilitate access to the site during construction.

9.3 RISK MATRIX

The purpose of the risk matrix is to determine the risk an activity will have on a water resource after mitigation measures have been implemented.

There are two impacts related to the Section 21 of the Act that were assessed, i.e.,

i) Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)]; and
ii) Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)].

Table 10 describes the risk of the development on the natural environment:

Table 13. Risk matrix

Activity	Aspect	Impact	Flow Regime	Physical & Chemical (Water Quality)	Habitat (Geomorphology and Vegetation)	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance
WEIR AND LOW-LIFT PS															
Divert water to construct weir	Clear vegetation of the land where the new weir will be built. Build a temporary canal to divert the water during construction of the weir.	Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)].	The river is perennial. Flows increase during rainfall events.	The site is moderately transformed with a small probability of capturing solids or chemicals. No additional pollutants are expected from the diversion.	The stream integrity is intact below the weir. The stream diversion will have a large impact for the distance of the diversion.	2	1	3	**8**	1	1	5	1	**8**	**64**
Construct and commission	Excavate existing watercourse. Build retaining structure. Re-divert water to new reservoir (weir).	Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)].				4	3	4	**11**	1	3	5	1	**10**	**110**
MATLABAS RIVER CROSSING															
Construct portal	Clear vegetation of the land where the portals will be built.	Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)]	The river is perennial but the pipeline will be constructed by horizontal drilling and will not impact on the flow of the river.	No impact is foreseen due to the construction method.	No impact is foreseen due to the construction method.	1	1	1	**3**	1	5	5	1	**12**	**36**
Construct and commission	The pipeline will be constructed by horizontal drilling or by excavation.	Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)].				3	1	4	**8**	1	1	5	1	**12**	**96**

Activity	Aspect	Impact	Flow Regime	Physical & Chemical (Water Quality)	Habitat (Geomorphology and Vegetation)	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance
CONSTRUCT PIPELINE ON DEPRESSIONS (OPTION D1 to D3) - worst case scenario															
Construct berm to retain water	Clear vegetation where the pipeline and berm will be constructed.	Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)]	The wetland is a depression with no flow. Construction will not impact on the flow regime.	The wetland is a depression with no flow. Construction will not impact on wetland water quality.	The impact on the vegetation will be for the duration of construction and the period for the vegetation to recover.	2	1	1	**4**	1	1	5	1	**8**	**32**
Construct and commission	Excavate the trench, install and backfill.	Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)]				2	1	2	**5**	1	1	5	1	**8**	**40**
CONSTRUCT PIPELINE ON DEPRESSIONS (OPTION D4) - preferred placement of the route															
Construct and commission	The new route (Alternative D4), was proposed after discussions with the land owners. This is the preferred route. Refer to Addendum 13.5 for detail.	No impact	No impact	No impact	No impact	-	-	-	**0**	-	-	-	-	**0**	**0**
CLEARANCE AND INSTREAM WORKS AT BORROW PITS (BP SS1)															
Prepare site	All activities related to the excavation will take place within the stream bed. The temporary canal that divert the water during construction of the weir must release the water below the BP.	Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)].	The temporary canal that diverts the water during construction of the weir must release the water below the BP. Construction will have no additional impact other than that created by construction of the weir and low lift pump station	The site is moderately transformed with a small probability of capturing solids or chemicals. No additional pollutants are expected during or after construction.	The stream integrity is intact below the weir. The stream diversion will have a large impact for the distance of the diversion because the river will be dry. No additional impact is foreseen by excavating BP SS1.	2	1	1	**4**	1	1	5	1	**8**	**32**
Construct and commission	Excavate in existing watercourse.	Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)].				2	1	1	**4**	1	1	5	1	**8**	**32**

Activity	Aspect	Impact	Flow Regime	Physical & Chemical (Water Quality)	Habitat (Geomorphology and Vegetation)	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance
CLEARANCE AND INSTREAM WORKS AT THE GAUGING WEIRS															
Prepare site	All activities related to the excavation will take place within the stream bed. There will be either a coffer dam or a temporary canal that divert the water during construction.	Impeding or Diverting the Flow of Water in a Watercourse [Section 21(c)].	The temporary canal that divert the water during construction or build a coffer dam. Construction will have no additional impact other than that created by construction of the weir.	The site is moderately transformed with a small probability of capturing solids or chemicals. No additional pollutants are expected during or after construction.	The stream diversion will have a large impact for the period of construction. No additional impact is foreseen after construction.	2	1	1	**4**	1	1	5	1	**8**	**32**
Construct and commission	Excavate in existing watercourse.	Altering the Bed, Banks, Course or Characteristics of a Watercourse [Section 21(i)].				2	1	1	**4**	1	1	5	1	**8**	**32**

Table 14. Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence is required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence is required.

THE *SIGNIFICANCE SCORES* FOR THE DIFFERENT ACTIONS ARE AS FOLLOWS:

IMPACTED WETLAND / ACTIVITY	IMPACT SCORE	IMPACT RATING
Weir and Low Lift PS	174	High
Matlabas River crossing	130	Moderate
Construct Pipeline on Depressions (Option 1) - Worst case scenario	72	Moderate without further mitigation
Construct Pipeline on Depressions (Option 4) - Preferred placement of the route	0	Low
Clearance and instream works Borrow pit (BP SS1)	64	Moderate without further mitigation
Clearance and instream works of the gauging weirs	64	Moderate without further mitigation

- The risk rating for the Vlieëpoort Weir and Pumping station is high;
- Matlabas River Crossing has a moderate risk; and
- The construction of the pipeline through the depressions poses low risk and will only influence the habitat for the duration of construction. However, it is possible to move the pipe alignment to miss the pans altogether. A new route (Alternative D4), was proposed after discussions with the land owners. This is now the preferred route. Refer to Addendum 13.5 for detail.
- BP SS1 impact is moderate without further mitigation. However, the risk is already accounted for by construction of the Vlieëpoort Weir and Pumping station.
- Constructing the gauging weirs impact is moderate without further mitigation.

10 MITIGATION MEASURES

10.1 CROCODILE RIVER SECTION

10.1.1 VLIEËPOORT WEIR AND LOW LIFT PUMP STATION

EXOTIC VEGETATION

Removal and subsequent management of these species is very important in maintaining the biodiversity value and integrity of the stream and wetland.

Exotic shrubs and creepers can be treated chemically in accordance with the recommendations of the Conservation of Agricultural Resources Act (CARA). The alien and invasive species were listed in the Government Gazette of 29 July 2016 published in terms of NEMBA (Act No. 10 of 2004). These procedures will apply to all sections where aliens and exotics need to be eradicated.

Although the abundance of exotic species is currently relatively low, control and management will ensure they don't proliferate and negatively affect the wetland system.

DUST SUPPRESSION

Dust is harmful to plants because it reduces their ability to transpire and respire, which will impede growth. From a biodiversity perspective, animals tend to shy away from leaves covered with dust. It is therefore, necessary to minimise dust.

Dust control, either by chemical means or by spraying water is effective and can mitigate the negative impact.

10.1.2 CLEARANCE AND INSTREAM WORKS BORROW PIT SS1

The site is within the confines of the river bed and no residual impact or risk is foreseen.

No mitigation necessary.

10.2 CONSTRUCT PIPELINE AT THE MATLABAS CROSSING

The river is perennial but the proposal is that the pipeline will be installed by horizontal drilling. It is proposed that construction will have a low impact on the flow of the river. However, if the line is installed by trenching, then the impact will be moderate for the short term by removal of wetland plants on the river bank, creating dust and by possible introducing silt downstream. These affects will be temporary.

The ecological status of the Matlabas River also needs to be determined during the high-flow period, prior to construction, in order to determine the requirements for scouring (i.e. draining water from the pipeline, typically during maintenance).

Dust control, either by chemical means or by spraying water is effective and can mitigate the negative impact of dust, topsoil should be separately stored and replaced to maintain the seed load and organic material.

10.3 CONSTRUCT PIPELINE ON DEPRESSIONS

PLACEMENT OF THE PIPELINE

There are four alternative routes for the pipe alignment. Each of them has one or more depression of significance that will be impacted on by the pipeline.

A 100 m corridor along the route alignment was allowed for in the impact assessment. In each case the route is in proximity of the depressions but does not enter the pan. It is possible to miss the pan altogether by placing the route on a specific side of the road, railway line or fence in order to miss the affected wetland.

It is recommended that the placement of the routes is as follows:

- Alternative D1: eastern side of fence and then cross over to the western side in order to miss the pan at Enkeldraai 314EQ;
- Alternative D2: eastern side of fence; and
- Alternative D3: western side of the road
- Alternative D4: will not be in proximity of any wetland.

If these recommendations are followed, then the construction of the pipeline will not impact on any of the pans.

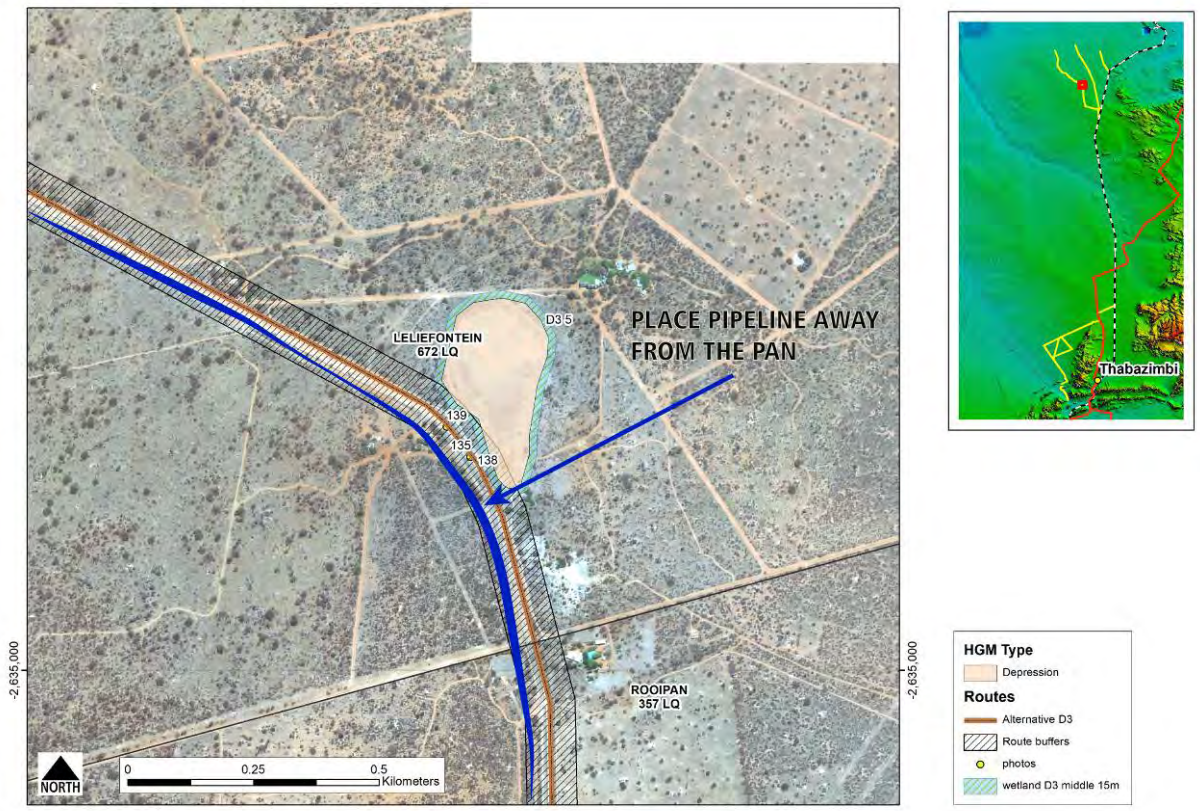


Figure 39. Pipeline placement on Leliesfontein to negate the impact on the wetland D3 5

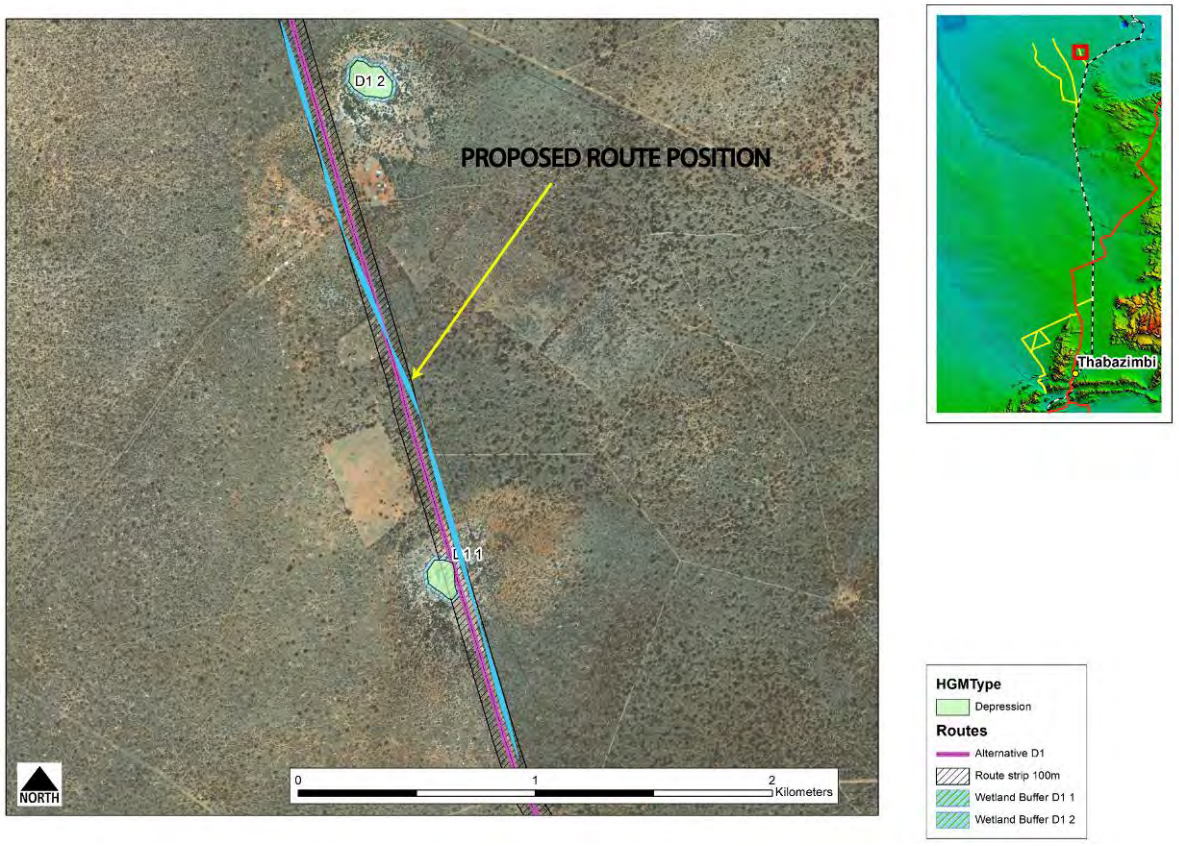


Figure 40. Pipeline placement on Enkeldraai and Taaiboshfontein to negate the impact on wetlands D1.1 and D1.2

Alternative D4 affects the Farm Enkeldraai, and the landowner of this property (Mr. T.J. Sauer) indicated that he has no objection to the pipeline traversing his farm. He was also notified of the intended route deviation.

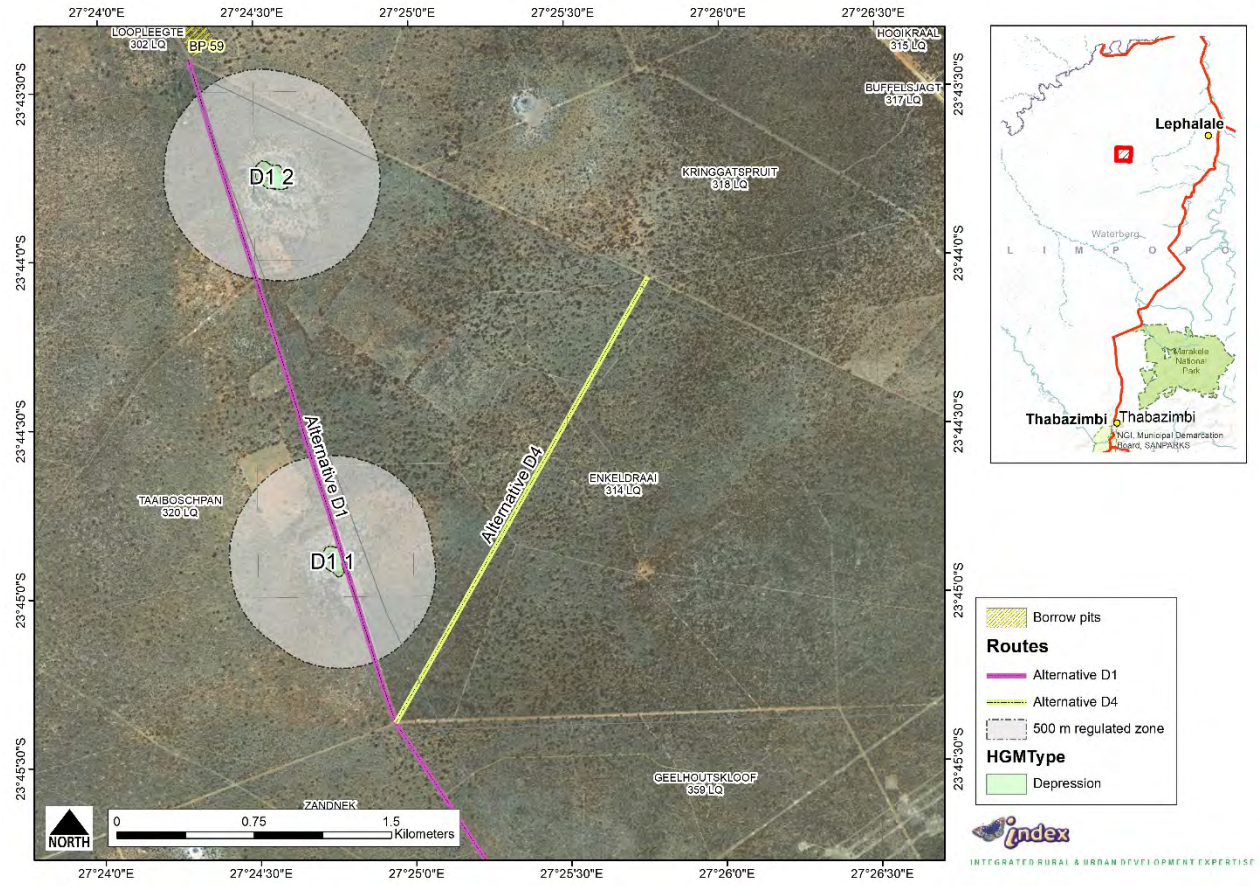


Figure 41. Pipeline placement of Alternative D4

The advantages of Alternative D4 are the following:

- There are no sensitive areas along the route from a wetland perspective;
- The two pans on Taaiboschpan are further away than 500 metres of the construction site. Due to the topography and distance, it is unlikely that there will be impact on the hydrology of the pans or on its habitat value for fauna and flora.

The preferred route for the sandy plain section (D alignments) is indicated below (also refer to Section 13.5)

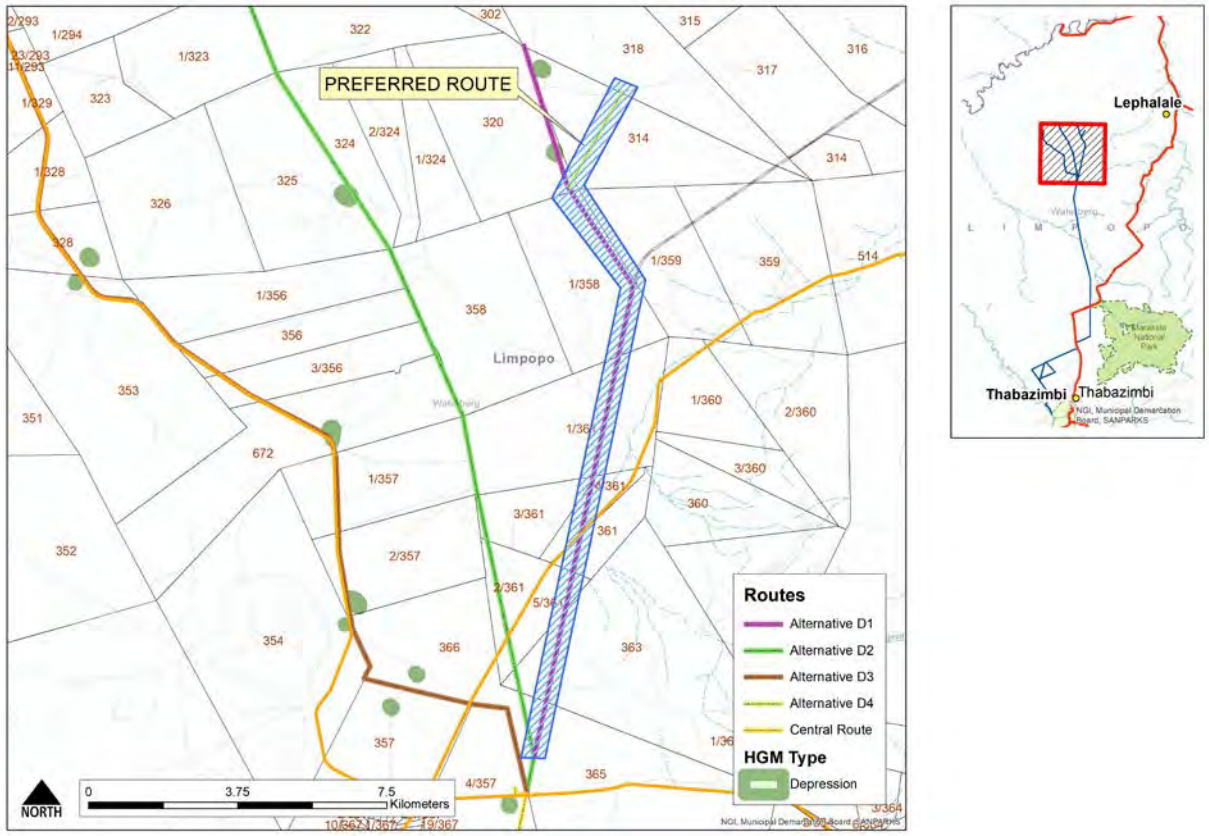


Figure 42. Preferred route I the Northern Sandy Palin Section

DUST SUPPRESSION

Dust is harmful to plants because it reduces their ability to transpire and respire and then impedes growth. Because animals tend to shy away from leaves covered with dust, generation of dust must be minimised.

Dust control, either by chemical means or by spraying water is effective and can mitigate the negative impact.

10.4 CONSTRUCTION OF THE GAUGING WEIRS

Three gauging weirs will be constructed. They are in the Sand River, Bierspruit and just downstream of the Paul Hugo weir in the Crocodile River. There are no wetlands that will be influenced. The impact and mitigation of the ecosystem is part of the biodiversity report that deals with vegetation.

11 CONCLUSION

Three areas will be affected:

- The stream wetland and riparian zone of the Crocodile River where the Vlieëpoort Weir and Low lift pump station will be constructed and also where the borrow pit (BP SS1) is located.

  The habitat is now in PES category B. Construction of the weir complex will create a reservoir upstream that will lead to the loss of habitat. In general, the habitat functions effectively below the point where the weir is proposed. This is not expected to change following construction of the weir and pumping infrastructure.

  The Risk Matrix classifies the Weir and Low lift pump station as a high risk activity;

- The Matlabas Stream Crossing

  The river now has a PES rating of B. There is some degradation that has taken place, but the habitat is largely intact with minimal modification that has taken place.

  The present proposal is that the pipeline be installed through horizontal drilling well below the surface; in which case construction will have little impact on the wetland. It is however an option to use trenching. Much of the catchment upstream is pristine because it is located in an area that focusses on nature-based tourism.

  Construction is unlikely to have a long term influence on the flow characteristics or water quality of the Matlabas River.

  Matlabas River Crossing has moderate risk because of the construction method that will be employed and the duration of construction.

- Pans along the different alternative D routes. They occur on the Northern Sandy Plains.

  This system is considered to be ecologically important in local context. The present PES status is B and C. This status will be maintained post construction. The depressions are important habitats for fauna because it provides water in an otherwise arid environment. It is poor in sediment trapping or controlling water quality.

  There are four alternative routes for the pipeline. D2 and D3 alignments each has one depression of significance that will be impacted on by the pipeline, while there are two pans in Route D1. Route alternative D4 diverts away from Route D1 where the route enters Enkeldraai and Taaiboschpan. This diversion results in the route effectively miss the two pans in Route D1.

  The construction of the pipeline along the Routes D1 to D3 poses low risk and will only influence the habitat for the duration of construction. A 100 m corridor along the route was allowed for in the impact assessment. In all cases the route is in proximity of the depression but does not enter the pan itself. However, it is still not total clarity of the regional hydrological functioning of the soils in proximity of the pans.

  It is possible to miss the pan altogether by placing the rout on a specific side of the road or fence or alternatively, follow Route D4 to stay clear of the pans altogether. It is recommended that the placement of the routes is as follows:

  → Alternative D1: Eastern side of fence and then cross over to the western side at Enkeldraai 314EQ;
  → Alternative D2: Eastern side of fence; and
  → Alternative D3: Western side of the road.
  → Alternative D4: Follow the fence. There will be no impact.

  If these recommendations are followed, then the construction of the pipeline will not impact on any of the pans.

  D4 is the preferred alignment.

- The Construction Camp at Rooipan 357 LQ is adjacent to the pan and within the buffer zone of 15 metres. The location of the camp will have a negative impact on the functioning of the pan habitat. It is recommended that the camp be relocated further east of the present proposal.
- Clearance and instream works at Borrow Pit SS1. The site is within the confines of the river bed and no residual impact or risk is foreseen and no mitigation is necessary.
- Three gauging weirs will be constructed. They are in the Sand River, Bierspruit and just downstream of the Paul Hugo weir in the Crocodile River. There are no wetlands that will be influenced.

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13 ADDENDA

13.1 BUFFER DETERMINATION

water & sanitation
Department: Water and Sanitation
REPUBLIC OF SOUTH AFRICA

BUFFER ZONE TOOL FOR THE DETERMINATION OF AQUATIC IMPACT BUFFERS AND ADDITIONAL SETBACK REQUIREMENTS FOR WETLAND ECOSYSTEMS

Note: For further guidance on the application of this tool, users should refer to the preliminary guideline for the determination of buffer zones. It is also important to note that buffer widths calculated by the model only cater for impacts associated with diffuse-source s defined to cater for other potential impacts. Finally, the buffer zone tool has been designed to be used one case study at a time.

Buffer attributes	Buffer Segment 1	Buffer Segment 2	Buffer Segment 3
Slope of the buffer	Very Gentle (0 - 2%)	Moderately steep (20.1 - 40%)	
Vegetation characteristics (Construction phase)	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	
Vegetation characteristics (Operational phase)	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	
Soil permeability	Moderately low: Moderately fine textured soils (e.g. loam)	Moderate: Moderately textured soils (e.g. sandy loam).	
Topography of the buffer zone	Concentrated flow paths dominate: Area of topography dominated by concentrated flow paths (i.e. depression, erosion gullies, drains)	Dominantly Non-uniform topography. Dominantly irregular topography with some major concentrated flow paths (i.e. erosion gullies, drains) that will substantially reduce	
Site-based aquatic impact buffer requirements (without additional mitigation measures)			
Construction Phase	31	35	Not Assessed
Operational Phase	31	35	Not Assessed

Figure 43. Buffer determination: Crocodile River Section

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BUFFER ZONE TOOL FOR THE DETERMINATION OF AQUATIC IMPACT BUFFERS AND ADDITIONAL SETBACK REQUIREMENTS FOR WETLAND ECOSYSTEMS

Note: For further guidance on the application of this tool, users should refer to the preliminary guideline for the determination of buffer zones. It is also important to note that buffer widths calculated by the model only cater for impacts associated with diffuse-source s defined to cater for other potential impacts. Finally, the buffer zone tool has been designed to be used one case study at a time.

Buffer attributes	Buffer Segment 1	Buffer Segment 2	Buffer Segment 3
Slope of the buffer	Very Gentle (0 - 2%)	Moderately steep (20.1 - 40%)	
Vegetation characteristics (Construction phase)	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	
Vegetation characteristics (Operational phase)	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	
Soil permeability	Moderately low: Moderately fine textured soils (e.g. loam)	Moderate: Moderately textured soils (e.g. sandy loam).	
Topography of the buffer zone	Concentrated flow paths dominate: Area of topography dominated by concentrated flow paths (i.e. depression, erosion gullies, drains)	Dominantly Non-uniform topography. Dominantly irregular topography with some major concentrated flow paths (i.e. erosion gullies, drains) that will substantially reduce	
Site-based aquatic impact buffer requirements (without additional mitigation measures)			
Construction Phase	15	15	Not Assessed
Operational Phase	15	15	Not Assessed

Figure 44. Buffer determination: Matlabas River crossing

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BUFFER ZONE TOOL FOR THE DETERMINATION OF AQUATIC IMPACT BUFFERS AND ADDITIONAL SETBACK REQUIREMENTS FOR WETLAND ECOSYSTEMS

Note: For further guidance on the application of this tool, users should refer to the preliminary guideline for the determination of buffer zones. It is also important to note that buffer widths calculated by the model only cater for impacts associated with diffuse-source s defined to cater for other potential impacts. Finally, the buffer zone tool has been designed to be used one case study at a time.

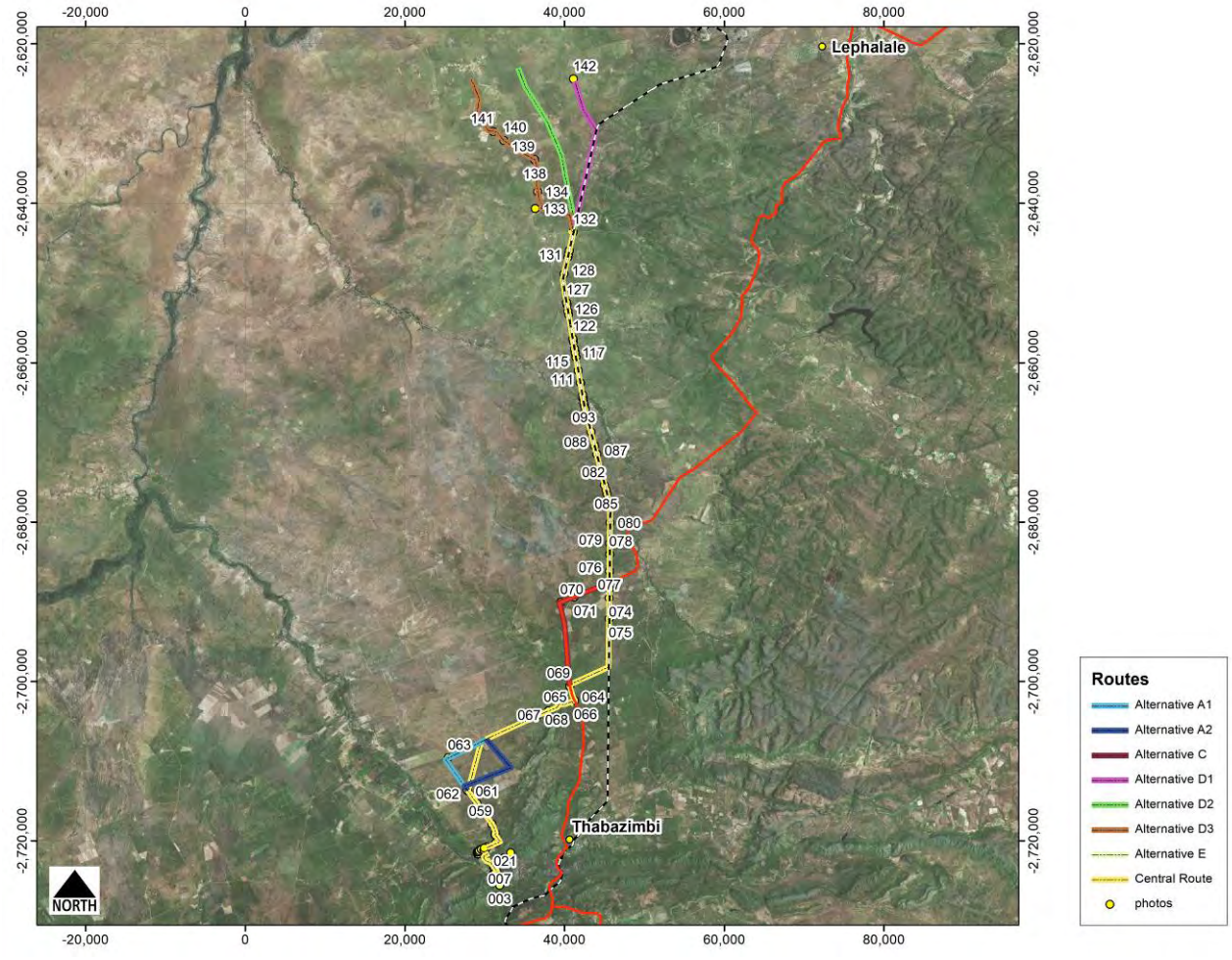
Refine desktop buffer requirements based on site-based investigations

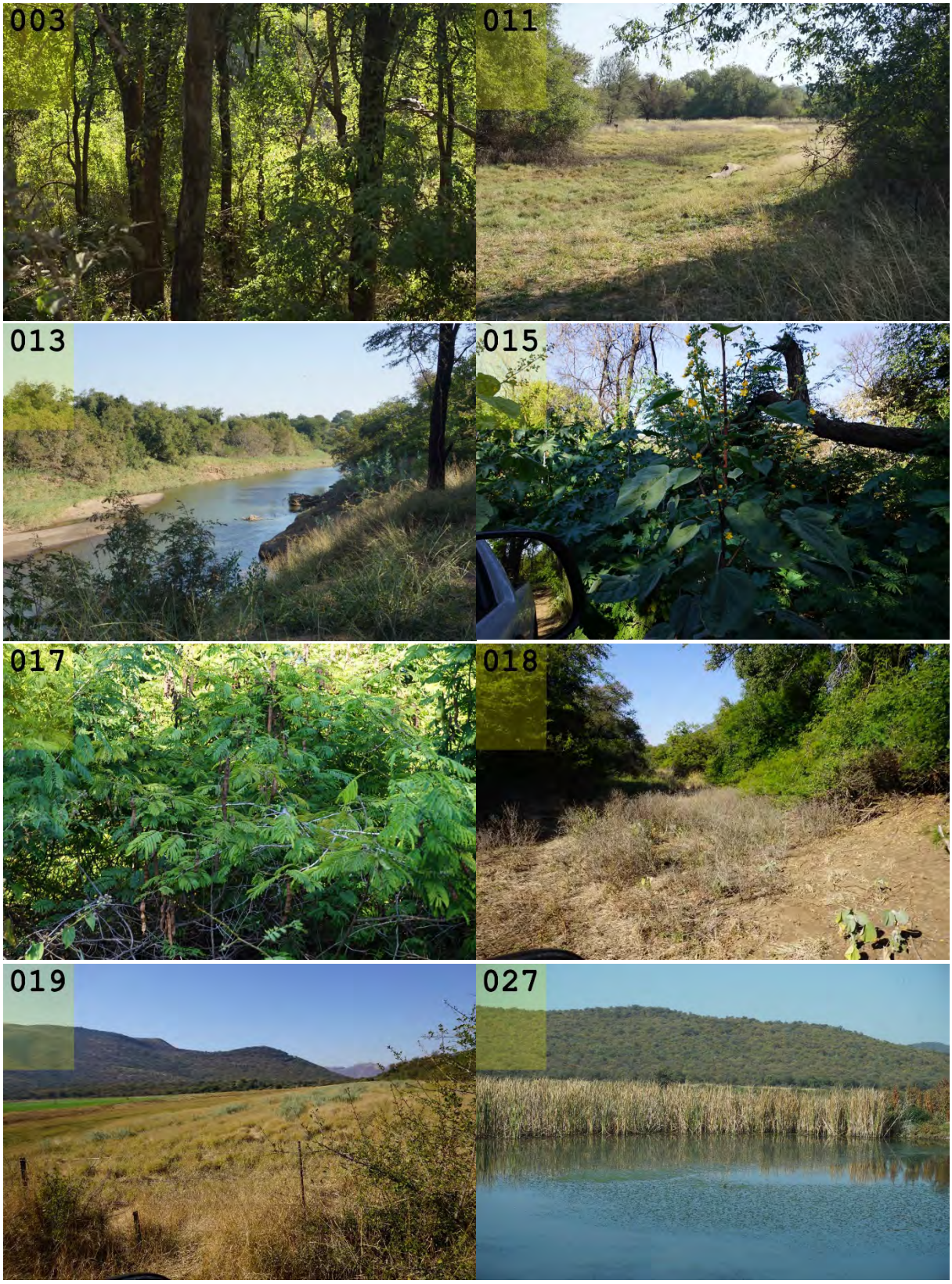
Buffer attributes	Buffer Segment 1	Buffer Segment 2	Buffer Segment 3
Slope of the buffer	Very Gentle (0 - 2%)	Very Gentle (0 - 2%)	
Vegetation characteristics (Construction phase)	Moderately low: Moderately low density with moderate basal cover (e.g. Forests, shrub dominated vegetation / heavily grazed grassland)	Low: Sparse vegetation cover with large areas of bare soil	
Vegetation characteristics (Operational phase)	Very high: Very dense vegetation, with very high basal cover (e.g. vetiver grass filter strips).	Low: Sparse vegetation cover with large areas of bare soil	
Soil permeability	Low : Fine textured soils with low permeability (e.g. clay loam and clay).	Low : Fine textured soils with low permeability (e.g. clay loam and clay).	
Topography of the buffer zone	Uniform topography: Smooth topography with no concentrated flow paths anticipated.	Uniform topography: Smooth topography with no concentrated flow paths anticipated.	
Site-based aquatic impact buffer requirements (without additional mitigation measures)			
Construction Phase	**15**	**15**	**Not Assessed**

Figure 45. Buffer determination: Depressions on the Northern Sandy Plains

13.2 OBSERVATIONS

Observation positions and photos

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13.3 CRITERIA FOR THE DELINEATION OF WETLANDS

Soil condition is the primary criterion that signifies waterlogged conditions. These conditions manifest itself through plants communities that can tolerate hydromorphic soils. These plants are hydrophytes that are adapted to tresses imposed on plants through temporary or permanent waterlogged conditions.

The importance of retaining and maintaining functional wetlands are well established - the process of establishing the boundaries less so. The following criteria discussed in *A Practical Field Guide for the Identification and Delineation of Wetlands and Riparian Areas*, published by DWAF are used as baseline information.

CRITERIA FOR THE IDENTIFICATION OF WETLANDS

According to DWAF, the main indicators are:

1) Terrain – Valley bottom and seep on slopes
2) Soil form indicator –
3) Soil wetness indicator
    a. Hue 2.5YR
        i. >5 value and <2 chroma, or
        ii. >6 value and <4 chroma
    b. Hue 10YR
        i. 4 value and <2 chroma, or
        ii. 5 value and <3 chroma, or
        iii. 6 value and <4 chroma
    c. Hue 7.5YR
        i. 5 value and <2 chroma, or
        ii. >6 value and <4 chroma
    d. Hue 5YR
        i. 5 value and <2 chroma, or
        ii. >6 value and <4 chroma
    e. Hue 5Y
        i. >5 value and <2 chroma, or
4) Vegetation indicator – Will contain hydrophyte plants

There are three wetland vegetation indicators, each associated with specific soil properties.

PERMANENTLY WATERLOGGED CONDITIONS ARE GREY COLOURED OR ORGANIC SOILS.

- Valley bottom terrain morphology;
- Champagne, Katspruit, Willowbrook and Rensburg soil form – all forms have gleyed subsoil;
- Wetness - prominent grey matrix, few to no high chromas within 500 mm.
- Vegetation
    - Large proportion of hydrophytes
    - Emergent plans: reeds, sedges, etc.;
    - Floating or submerged aquatic plants.

SEASONALLY WATERLOGGED SOILS HAVE A GREY MATRIX WITH MANY MOTTLES.

They usually occur just outside the area of normal base flow and are saturated for a significant portion of the rainy season.

- Valley bottom terrain morphology;
- Kroonstad, Longlands, Wasbank, Lamotte, Escourt, Klapmuts, Vilafontes, Kinkelbos, Cartref, Fernwood, Westleigh, Dresden, Avalon, Glencoe, Pinedene, Bainsvlei, Bloemdal, Witfontein, Sepane, Tukulu, Montagu.
- Wetness
  - Grey matrix (>10%)
  - Many high chroma mottles
- Vegetation
  - Hydrophilic sedges that are restricted to wetland areas

TEMPORARY WATERLOGGED SOILS ARE NORMALLY GREY-BROWN ON COLOUR WITH FEW MOTTLES.

- Valley bottom terrain morphology;
- Inhoek, Tstitsikamma, Houwhoek, Molopo, Kimberley, Jonkersberg, Groenkop, Etosha, Addo, Brandvlei, Glenrosa or Dundee.
- Wetness
  - Minimal grey matrix (>10%)
  - Few high chroma mottles
- Vegetation
  - Predominantly grasses which occur on non-wetland areas and hydrotropic species.
  - Predominantly woody species which occur on non-wetland areas and hydrotropic species.

Outside this zone is the adjacent terrestrial area that is not classified as wetlands.

PROCESS USED FOR THE DELINEATION OF WETLANDS

1) Soils are classified in accordance with the Binomial classification system for southern Africa (Soil Classification Working Group, 1991). Initial delineation of the soil forms will take into account the following: vegetation type, terrain form, colour and texture of the soil. The boundaries are then refined through soil auger and or soil probe. All qualifying soil forms are then investigated in more detail;
2) River and streams are then delineated in different components, i.e., base flow and riparian areas. Uplands water saturated areas are mapped (normally belonging to soil forms with gleyed subsoil. These boundaries will indicate the *permanently saturated zone*;
3) Matrix colours and mottle of the subsoil at a depth less than 500 mm are then measured against the criteria indicated above and the areas of Temporary and Seasonal waterlogged conditions mapped;
4) Positions of observation points are taken with GPS and placed on a base map, and combined with texture and colour on aerial photographs; the final boundary of the wetland is then delineated.

Indicator plants where wetlands may occur

Gramineae (Grasses)

1)	*Imperata cylindrica*	Temporary wetness
2)	*Setaria sphacelata*	Temporary and seasonal
3)	*Pennisetum thunbergii*	Temporary and seasonal
4)	*Hemarthria altissima*	Temporary and seasonal
5)	Paspalum urvillei	Temporary
6)	Paspalum dilatatum	Temporary
7)	*Paspalum distichum*	Seasonal and permanent
8)	Andropogon appendicularis	Temporary and seasonal
9)	*Ischaemum fasciculatum*	Seasonal and permanent

10) *Arundinella nepalensis* Temporary and seasonal
11) *Andorpogon eucomis* Temporary and seasonal
12) *Festuca caprina* Temporary and seasonal
13) *Aristida junciformis* Temporary and seasonal
14) *Eragrostis plana* Temporary
15) *Eragrostis planiculmis* Temporary and seasonal
16) *Phragmites australis* Permanent
17) *Leersia hexandra* Temporary and seasonal
18) *Miscanthus capensis* Temporary and seasonal
19) *Miscanthus junceus* Temporary and seasonal

Cyperaceae (Sedges)

1) *Cyperus sexangularis* Temporary and seasonal
2) *Cyperus latifolius* Seasonal and permanent
3) Cyperus fastigiatus
4) Cyperus marginatus
5) Fuirena pubescence
6) Kyllinga erecta
7) Scleria welwitschii
8) Eleocharis dregeana
9) Eleocharis limosa
10) Schoenoplectus brachycerus
11) Schoenoplectus corymbosus

Juncaceae (Rushes)

1) *Typhaceae* (Bullrushes) Permanent
2) Typha capensis

Potamogetonaceae (Pondweeds)

1) *Potamogeton thunbergii* Permanent

Asphodelaceae (Red-hot pokers) Wetland and non-wetland

1) Kniphofia species
2) Kniphofia linearfolia

Amaryllidaceae (Vlei lilies) Wetland and non-wetland

1) Crinum species
2) Crinum macowanii

Polygonaceae (Knotweeds) Permanent and or seasonal

1) Persicaria attenuate

Additional species form other families

1) *Xyris capensis*
2) *Satyrium hallackii*
3) *Ranaculus multifidus*
4) *Sium repandum*
5) *Gunnera repandum*
6) *Mentha aquatic*

13.4 RISK ASSESSMENT METHODOLOGY

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below:

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[5]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[6].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management

Act (No. 108 of 1997) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

RISK ASSESSMENT KEY

(Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

Table 15. Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table 16. Spatial Scale (How big is the area that the aspect is impacting on)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table 17. Duration (How long does the aspect impact on the resource quality)

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table 18. Frequency of the activity (How often do you do the specific activity)

Annually or less	1
6-monthly	2
Monthly	3
Weekly	4
Daily	5

Table 19. The frequency of the incident or impact (How often does the activity impact on the resource quality)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table 20. Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table 21. Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table 22. Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

Table 23. Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

13.5 SUPPLEMENTARY REPORT: ASSESSMENT OF ROUTE D4 AS ALTERNATIVE ALIGNMENT

SUPPLEMENTARY REPORT:

ASSESSMENT OF ROUTE D4 AS ALTERNATIVE ALIGNMENT

WETLAND IMPACT ASSESSMENT FOR THE PROPOSED MOKOLO AND CROCODILE RIVER (WEST) WATER AUGMENTATION PROJECT (PHASE 2A) (MCWAP-2A)

DECEMBER 2018

1 BACKGROUND

During the review of the Draft EIA Report for the proposed MCWAP-2A: Water Transfer Infrastructure, concerns were raised by landowners with regards to the potential impacts of pipeline construction on a pan that is located on the Farm Taaiboschpan 320LQ. The wetland specialist had considered the impacts on this pan as part of the assessment. However, as further mitigation, a deviation of the pipeline route was identified to avoid the pan by more than 500m.

The new route, Alternative D4 (shown in the map below), was considered by the project team and is the subject of this report. It was added as an addendum to the wetland report.

Although Alternative D4 will terminate at a different point along the pipeline that was previously authorised as part of MCWAP Phase 1. It is further mitigation to reduce the construction's impact on the wetlands along Alternative D1.

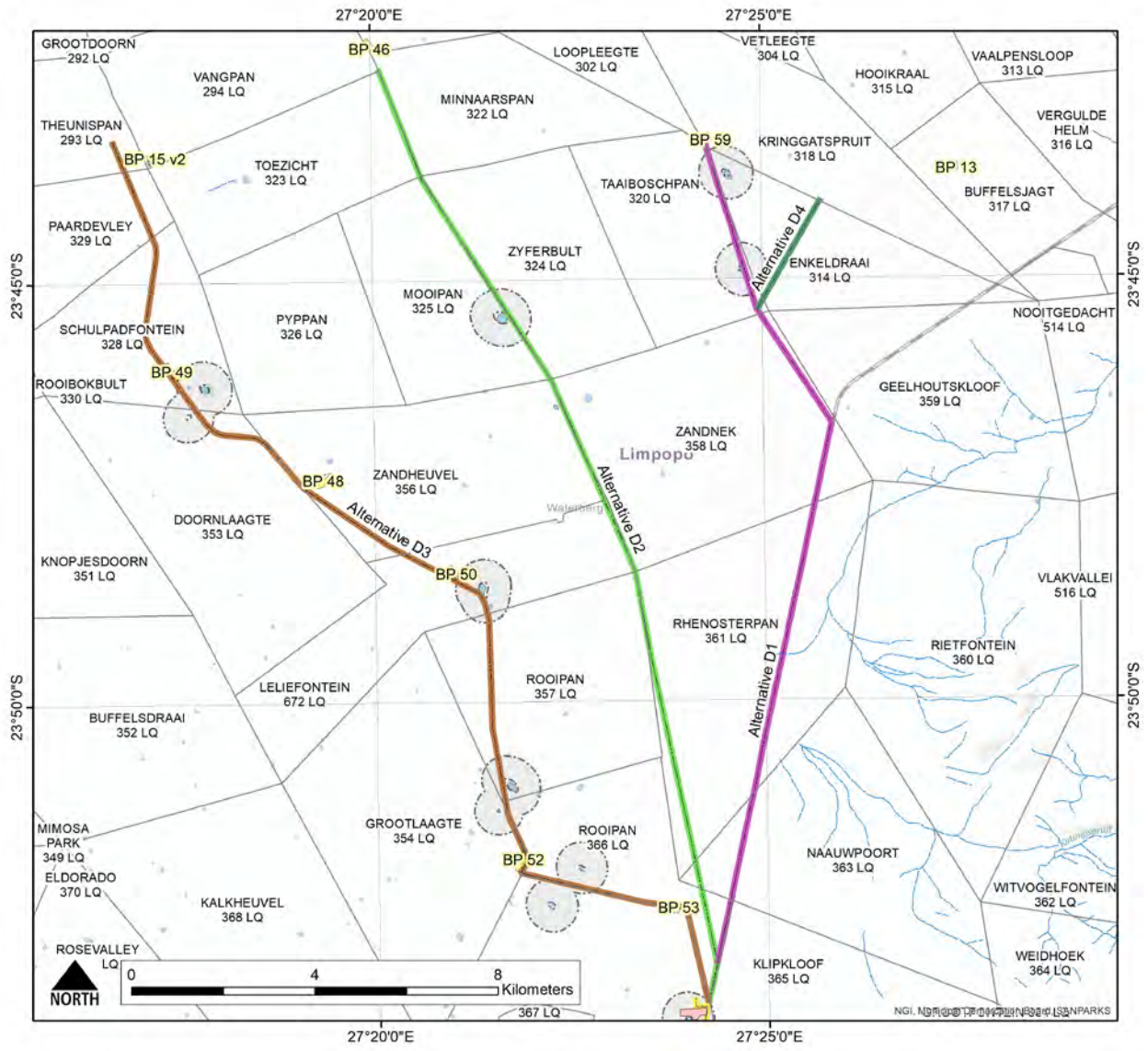

Figure 1. Alternative D routes and positions of pans

The two pans on Taaiboschpan are temporary saturated during the rainy season. The pans, however, contributes to the local and regional ecological functioning by creating a unique habitat for fauna and flora. While historical satellite images indicate that the saturated area is relatively small and is only wet for part of the year.

It is assumed that the pan's feeder source is primarily runoff, but with a further contribution from lateral water movement in the sand surrounding the pan.

With the uncertainty of the spatial and temporal contribution of rainfall on the pan, it was decided to investigate a further route as mitigation, which is Alternative D4. This pipeline will follow Alternative D1 and will divert in a north-easterly direction where it enters Enkendraai and Taaiboschpan. From here the route is alternative D4.

2 ALTERNATIVE ROUTE – D4

Alternative D4 affects the Farm Enkeldraai. The landowner of this property (Mr. T.J. Sauer) indicated that he has no objection to the pipeline traversing his farm. He was also notified of the intended route deviation.

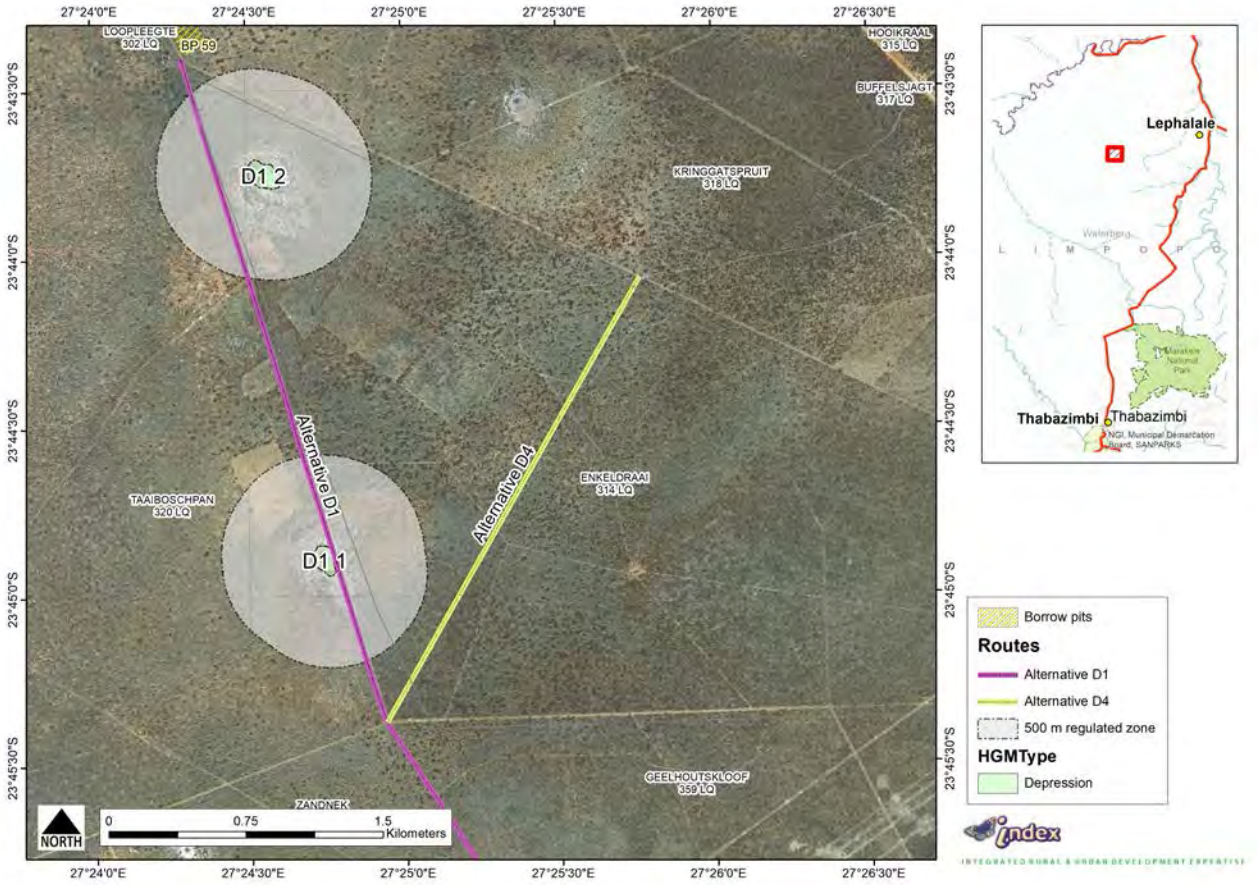

Figure 2. Route alignment D4. Indicating the 500m regulated area around the pans

KEY FINDINGS REGARDING ALTERNATIVE D4

- There are no sensitive areas along the route from a wetland perspective;
- The two pans on Taaiboschpan are further away than 500 metres of the new alignment. Due to the topography and distance of D4 to the pans, it is unlikely that there will be impact on the hydrology of the pans or on its habitat value for fauna and flora.
- This assessment found that there will be no significant impacts (different to what was assessed as part of Alternative D1).
- There were only two pans along Route D1; they were both further along the route that where the diversion of D4 is takes place.

3 RECOMMENDATIONS

The recommended route is to follow Alternative D1 up to the border of Taaiboschpan and then divert along Alternative D4 (refer to Figure 3).

Alternative D4 was incorporated into the Final EIA Report as the preferred option for the northern part of the pipeline route alternatives.

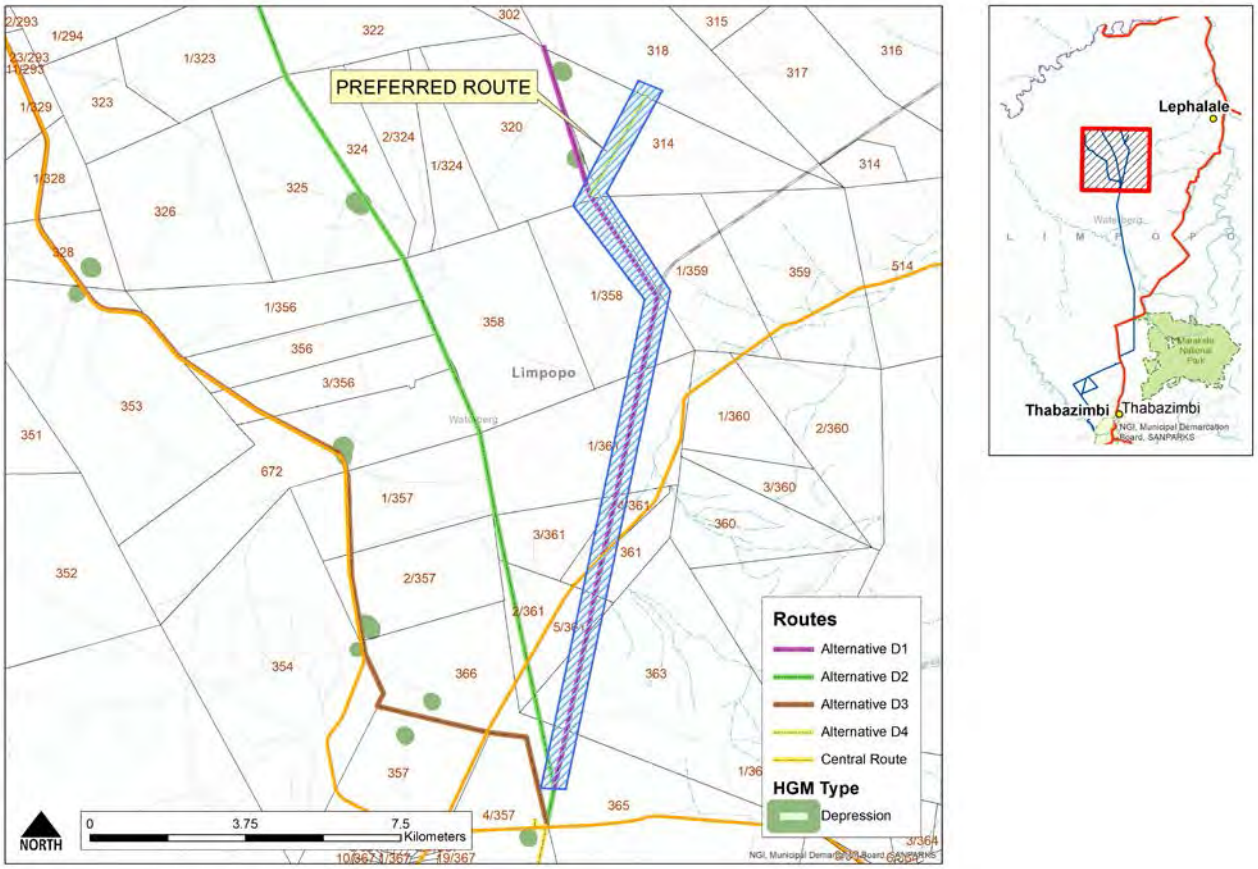

Figure 3. Preferred route alignment

4 CONCLUSIONS

Although the two pans on Taaiboschpan are temporary saturated during the rainy season, they contribute to the local and regional ecological functioning.

By diverting the route just before the pans on Taaiboschpan is further mitigation against impact on the wetland by construction of the pipeline.

The recommended route will follow Alternative D1 up to the border of Taaiboschpan and then divert to become Alternative D4.

Alternative D4 was incorporated into the Final EIA Report as the preferred option for the northern part of the pipeline route alternatives.