Nkurenkuru
ECOLOGY & BIODIVERSITY
SACNASP REG: 400502/14

WETLAND DELINEATION AND ASSESSMENT REPORT

GAS TRANSMISSION PIPELINE IN NIGEL, GAUTENG PROVINCE

April 2019

VERSION:

Draft 1

Prepared for:

SAVANNAH ENVIRONMENTAL

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DECLARATION OF CONSULTANT'S INDEPENDENCE

I, Gerhard Botha, as the appointed specialist hereby declare that I:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2014 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2014 (specifically in terms of regulation 13 of GN No. R. 326) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 48 of GN No. R. 326.

Gerhard Botha Pr.Sci.Nat 400502/14 (Botanical and Ecological Science)
April 2019

Field of expertise:
Wetland ecology, aquatic and wetland fauna & flora, terrestrial biodiversity, aquatic biomonitoring and wetland habitat evaluations.

EXECUTIVE SUMMARY

Nkurenkuru Ecology and Biodiversity was appointed by Savannah Environmental to undertake a specialist wetland assessment (delineation-, functional- and impact assessment) and to apply the Department of Water and Sanitation (DWS) Risk Assessment Matrix (RAM), as included in GN 509 of 2016, for the proposed construction of an underground transmission gas pipeline near Nigel, Gauteng Pronvince (City of Ekhurhuleni Metropolitan Municipality). The proposed pipeline will be approximately 10km long and 0.25m wide and will be constructed as close as possible to existing roads. This study has been commissioned to meet the requirements of the EIA process in the form of a Basic Assessment (BA) as set out by the National Environmental Management Act (1998) and a to meet the requirements of a Water Use License Application (WULA) as set out by the National Water Act (Act 36 of 1998). The proposed development will include two techniques namely conventional trenching or horizontal directional drilling (HDD).

Topographical and Hydrological Setting

- The project site is situated within the Upper Vaal Water Management Area (WMA) 8, Quaternary Catchment C21E (Vaal Downstream of the Vaal Dam Sub-area) and Ecoregion 11.03 (Highveld Ecoregion). The C21E Quaternary Catchment forms part of the middle reach region of the Blesbokspruit River, a tributary of the Suikerbosrand River (Sub-catchment). Furthermore, the location of the project site is within an elevated headwater region and as such this area comprise of numerous smaller drainage systems draining in a mostly eastern and south-eastern direction towards the low-lying valley-bottom system. From here water flows mostly in a southern direction along the valley-bottom wetland system, to finally drain into the Blesbokspruit River. Before draining into the Blesbokspruit River, a large amount of water is collected and stored within the Nigel Dam.
- The affected basin / catchment area (726ha) can be described as undulating plains with an average slope of 2.18%. The catchment is situated at elevations of between 1 541m and 1 670m above sea level. The lowest portion of the basin/catchment comprises an extensive valley-bottom wetland system draining water in a south-eastern direction into the Nigel Dam. Most of the surface flow/drainage within the basin occurs into this system, either as "contained" flows within tributary wetlands (primary source) or as surface runoff and later sub-surface flow. The catchment/basin is furthermore dotted with numerous isolated depressions (pan wetlands). The topographical profile of the proposed gas pipeline can be described as a highly undulating landscape situated between elevations; 1 572m and 1 612m (mean elevation: 1 595m) with an average slope of 1.6% (max slope: 5.2%).

Conservation context of water resources

» No river FEPA was identified within the area.
» No wetland FEPA was identified within the project site. NFEPA spatial data indicate that a number of wetlands are dotted around the project site and are not listed as FEPAs.
» The river catchment is furthermore, also not listed as a FEPA
» In terms of conservation threat status of wetland vegetation, intact wetlands within the Mesic Highveld Grassland Group 2 wetland vegetation type are classified as Critically Endangered (CSIR, 2011).
» According to the Gauteng C-Plan (Figure 13) the proposed project site falls largely within Ecological Support Areas (63.6%) whilst a fairly moderate portion of the project site (31.6%) include areas classified as "Important Areas". Only a small portion of "Irreplaceable Area" is included within the project site (4.7%) to the north.
» According to the National Biodiversity Assessment (NEM:BA) and National Vegetation Map (SANBI, 2011) the project site is located within the Blesbokspruit Highveld Grassland Ecosystem which is classified as Critically endangered (NEM:BA) and the Tsakana Clay Grassland vegetation type which is classified as Endangered (SANBI, 2011).
    - The landscape has however been highly modified with very little remaining vegetation communities that represent intact examples these vegetation types.

Desktop Assessment

» Water resources (wetland and watercourses) within a radius of 500m around the proposed gas transmission pipeline route were mapped and classified at a desktop level followed by a desktop rating of risk associated with the proposed activities. This was undertaken to guide field assessments and inform water use identification for the proposed project. Wetlands dominate the drainage features in this landscape and ranged in type from small seeps to broad and extensive valley bottom wetlands.
» During this desktop mapping and risk screening, twenty-eight (28) wetland features where identified within the catchment / basin. Of these features, nine (9) were identified within 500m of the proposed development with six (6) of these features identified as at significant risk (moderate or high risk) from the proposed development activities and would require further detailed assessment. The remaining three (3) wetland features were also mapped but were rated as of low risk and were not required to be further assessed.

Baseline assessment

- Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of six (6) wetland units.
- Wetland ecosystems dominate the drainage features in this landscape and include low lying un-channelled and channelled valley-bottoms as well as seeps and a few depression hydrogeomorphic (HGM) units.
- Valley-bottom wetlands occur within moderately confined, relatively gently sloping valley floor settings whereas seeps generally occur on the midslope to footslope topographies or at the head of valleys and lack distinct valley confinement. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic).
- The origin of most onsite wetlands is considered strongly linked to their typographical/geographical location as well as the presence of an impermeable clay layer found to occur generally at 20-60cm depth that results in a poorly drained 'perched' water table resulting in wetland formation. This is coupled with the relatively gentle topographic gradient across much of the study area.
- The soils in the study area provided a good indication of the level of wetness of the soils and proved to be the most reliable indicator for most of the assessment (apart from areas where significant soil disturbance have occurred) used to delineate the outer wetland boundary (i.e. boundary between temporary wetland and upland/terrestrial areas). While soil form and saturation periods varied slightly across the study area, typical;
  - permanent saturated wetland soils comprised dark grey to bluish grey clay (may become lighter grey deeper) characterised by low chromas with few to no mottling and medium levels of organic matter.
  - Seasonal saturated zones typically comprise of dark grey to grey-brown clay-loam and clay soils characterised by low chromas and distinct moderately to abundant (15-30%) high chroma mottles (yellow, orange and red redox concentrations), sometimes associated with black spots of manganese concentrations. Organic material within the seasonal zone was moderate-low.
  - The temporary wetland areas varied from dark grey-brown to dark yellowish brown clay-loam soils with few mottling (<7%). Mottles within the temporary zone vary from orange to red and are small to faint. Very little organic material occurs within this hydrogeomorphic zone.
- Vegetation was generally found to be a good indicator of the presence of wetland habitat and in some cases the level of soil wetness. A distinct transition from terrestrial/dryland grasses towards true wetland plants (hydrophytes) including *Typha capensis, Phragmites australis, Schoenoplectus corymbosus, Leersia hexandra, Juncus oxycarpus* and

Paspalum urvillei was evident in many instances during fieldwork, however the temporary wetland zone was almost indistinguishable from the surrounding upland (terrestrial sites), being dominated by the grasses *Themeda triandra, Eragrostis plana, E. chloromelas, Cymbopogon pospischilii* and *Hyparrhenia hirta*. Most wetlands were characterised by a vast zone of temporary saturated soils with smaller seasonal and permanent zones.

- While impacts varied across water resources, commonly occurring impacts include: significant catchment alterations (hard surfaces, reduction in roughage, mining, storm water discharge);
- Direct alterations and disturbances (alteration and reduction in vegetation cover as well as an alteration in hydrological character) due to overgrazing, trampling, infilling, moderate levels of erosion, impeding structures (road crossings and railway line), instream dams, artificial channelling, direct discharge of storm water and cultivation (historic and present).

» As a result, on catchment and onsite impacts, most water resources were assessed as being **Modified (D - E PES Classes).** A summary of the assessed wetland features and their calculated PES classes / scores are provided below:

PRESENT ECOLOGICAL STATE OF THE AFFECTED HYDROGEOMORPHIC UNITS		
UNIT	**Score**	**PES**
W1	6.7	E (Greatly Modified)
W2	5.3	D (Largely Modified)
W4	5.1	D (Largely Modified)
W5	9.2	F (Severely Modified)
W6	0.5	A (Largely Natural)
W9	2.6	C (Moderately Modified)

» Overall water resources are of **Low** to **Moderately Low** EI&S with the exception of W1 which was rated at of **High** EI&S. W15 is regarded as sensitive due to its relative high importance in providing biodiversity maintenance and water quality enhancement services primarily as well as its moderate-low sensitivity to external impacts. Wetland unit 1 provides a valuable corridor for movement (fauna and likely avifauna) as well as hydrological connectivity with important lower lying aquatic and wetland ecosystems as well as with surrounding terrestrial (primary and secondary) grasslands. Furthermore, water quality enhancement and maintenance are important for the maintenance of Nigel Dam, which is regarded as an important recreational area, and are vital for functionality and services provided by important downstream ecosystems. A summary the EI&S classes / scores are provided below.

ECOLOGICAL IMPORTANCE AND SENSITIVITY OF THE AFFECTED HYDROGEOMORPHIC UNITS			
UNIT	**TOTAL SCORE**	**MEDIAN SCORE**	**EI&S**
W1	26	3	B (High)
W2	17	1	D Low
W4	17	1.5	C Moderate
W5	9	1	D Low
W6	18	2	C Moderate
W9	16	2	C Moderate

- » Overall the importance of ecosystem services ranged from **Very Low** to **Moderately High** and none of the wetland units were assessed as being of High to Very High importance. Key services are linked with provision of regulating and supporting services and direct provisioning services (benefits) to local communities.

Impact Assessment and Mitigation Measures

- » The following activities are associated with the development and have been considered during the assessment of the potential impacts of the development on the identified wetland units.
  - Proposed construction of a gas transmission pipeline through watercourse and/or wetland crossings or within 500m of watercourses/wetlands near Nigel, Ekurhuleni Metropolitan Municipality, Gauteng Province.
  - Crossing of watercourses/wetlands will occur through either the traditional open-cut (trenching) method or the Horizontal Directional Drilling method (HDD).
- » The proposed development will involve the following methods of wetland and watercourse crossings:
  - Two wetland features will be directly impacted through trenching (Wetland 2 & 4); whilst
  - Two wetland features will be impacted through Horizontal Directional Drilling (HDD) (Wetland 1 and 5).
  - The remaining five wetland features will not be directly impacted through activities associated with the construction of the gas pipeline, with two wetlands potentially being indirectly impacted.
- » The majority of impacts associated with the development would occur during the construction phase as a result of the disturbance associated with the operation of heavy machinery at the site and the presence of construction personnel. The major risk factors and contributing activities associated with the development are identified below:
  - Loss/Disturbance of wetland habitat and fauna

- Potential impact on localised surface water quality
- Altered wetland hydrology due to interception / impoundment / diversion of flows
- Increase in sedimentation and erosion

» Various activities and development aspects (tabulated below) may lead to these impacts, however, these impacts can be adequately minimized or avoided provided the mitigation measures provided in this report are implemented and adhered to.

» A summary of pre- and post-mitigation impact significance ratings for the different impacts and risks factors identified for the proposed development are provided below:

PROPOSED NIGEL TRANSMISSION GAS PIPELINE			
Construction & Operational Phase			
Phase	**Impact**	**Significance Pre-Mitigation**	**Significance Post Mitigation**
Construction	Loss/Disturbance of wetland habitat and fauna	Low (27)	Low (8)
	Impact on localized surface water quality	Medium (32)	Low (5)
	Increase in sedimentation and erosion within the development footprint	Low (21)	Low (4)
Operation	Altered wetland hydrology due to interception/impoundment/diversion of flows.	Low (22)	Low (2)
	Impact on localized surface water quality	Low (22)	Low (2)

» Most of the wetland ecological impacts can be effectively mitigated on-site by implementing the following:

General mitigation measures applicable to all areas.

- Existing access roads to be used as far as possible.
- Limit the extent of the construction servitude to as small an area as possible. Ideally the construction disturbance footprint should be kept to an area no wider than 5 m.
- All material stockpiles and construction camps should be located outside wetland areas.
- Regular monitoring for erosion.
  - Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
  - Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.

  - Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary
- Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground pipeline has been completed.
  - Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain.
- All material stockpiles (other than soils removed during trenching) and construction camps should be located outside wetland areas.
- The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed.
- If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented.
- There should be reduced activity at the site after large rainfall events when the soils are wet.
- No offroad driving should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
- Institute environmental best practice guidelines as per the DWA Integrated Environmental Management Series for Construction Activities.
- Implement appropriate measures to ensure strict use and management of all hazardous materials used on site.
- Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.).
- Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.
- All soil contaminated due to leaks or spills should be remediated on site. If this is not possible, such contaminated soils must be disposed of in a suitable waste facility.
- No vehicles to refuel within watercourses/ riparian vegetation.
- Place spill kits on site which are operated by trained staff members for the ad-hoc remediation of minor chemical and hydrocarbon spillages.
- Waste should be stored on site in clearly marked containers in a demarcated area. All waste material should be removed at the end of every working day to designated waste facilities at the main construction camp/suitable waste disposal facility. All waste must be disposed of offsite.
- Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set

out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced.

- Regular inspections and maintenance of the pipeline must be undertaken during the operational phase, with any leaks repaired immediately.

Mitigation measures applicable for areas where the pipeline will be installed using the HDD Method:

- All construction activities occurring directly within wetland habitats (Wetland 1, 2 and 5) to take place within the dry season.
- The drilling rig should be placed on a plastic liner in order to avoid any potential soil contamination with hydrocarbon spillage or other associated pollutants.
- Regular monitoring should be conducted along the drilling route for potential frack-outs.
- Every effort must be made to avoid the release of drilling fluid into the wetlands.
- Used drilling liquid should be contained in a settling pond or similar structure, from where the fluid can either be re-used or removed from site.
- Where drilling fluid is observed at the surface, the "spill" should immediately be contained / recovered.
- A spill kit should always be on-site.
- A contingency plan (frack-out) should be in place which should consider the possibility of frack-out (and other contingencies) and the response actions that should be considered.
- Smothering of vegetation should also be avoided.
- Once excess drilling mud have been removed, the area will be seeded and/or replanted using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation.
- Revegetated areas will be monitored twice per year for two years subsequent to frack-out to confirm revegetation is successful.
- For W1 and 2 all activities and disturbances should be confined to the raised road reserve (as close as possible to the M45). All vegetation clearance and activities associated with the rig setup should subsequently occur within the raised road reserve (as close as possible to the M45 Road).
- No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve) of W1 and 2.
- For W1 and 2, the natural surface of the inundated and permanent saturated zone, including a 10m buffer should be considered as a NO-GO Zone.

- For W5, all activities and disturbances should occur outside of the delineated wetland boundary (including a 10m buffer area). Limit the extent of the construction servitude to as small an area as possible.

Mitigation measures applicable for areas where the pipeline will be installed using the Trenching Method and the wetlands will be directly impacted (Applicable for W4 and portion of W1 and W2 that will be trenched):

- Construction activities should be aimed to take place within the dry season as far as reasonably possible;
- All activities must be restricted to the raised portion of the road reserve (as close as possible to the existing road).
- Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;
- No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve).
- Wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel.
- Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).
- Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).
- Concentration and accumulation of flows along the servitude should be prevented by regularly providing for surface runoff to flow into the adjacent grassland rather than along the construction servitude and into the wetlands.

Mitigation measures applicable for areas where the pipeline will be installed using the Trenching Method and the wetlands will not be directly impacted (Applicable for W6 and W9):

- All activities restricted, as far as possible, within the elevated road reserve.
- Wetlands located in close proximity to the proposed pipeline route should be regarded and demarcated as no-go areas for vehicles and construction personnel.
- Excavated soils form the trench, made for the pipeline, should also be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench.
- Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be

replaced last (this will maximise opportunity for re-vegetation of disturbed areas).

- Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).

Conclusion

» With these mitigation measures in place, impacts on aquatic ecosystem integrity and functioning can be potentially reduced to a sufficiently low level. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.

» Based on the outcomes of this study, specifically also considering the existing disturbances impacting on the affected wetland and resulting in the modified condition of the affected wetland, together with the fact that expected impacts can be mitigated to Low significance through the application of a number of easily implementable mitigation measures, it is my considered opinion that the proposed gas pipeline project detailed in this report could be authorised from a wetland perspective.

» Based on the finding of this assessment as well as the DWS Risk Assessment (Risk Assessment Matrix and separate report) it can be concluded that that the proposed gas transmission pipeline could be considered for authorisation under a General Authorisation (GA), given the recommended mitigation and management measures provided within this report as well as the Risk Assessment Matrix

GAS TRANSMISSION PIPELINE IN NIGEL, GAUTENG PROVINCE

WETLAND DELINEATION AND ASSESSMENT REPORT

1 INTRODUCTION

1.1 Background to the assessment and area of study

Nkurenkuru Ecology and Biodiversity was appointed by Savannah Environmental (Pty) Ltd to undertake a wetland assessment for the proposed construction of an underground gas pipeline. The proposed project will entail a 10km and 0.25m wide gas transmission pipeline and associated infrastructure from the Consol Glass factory in Nigel to the Farm Grootfontein 165 Portion 44, Gauteng Province. The proposed pipeline will be constructed as close as possible to existing roads (within the road shoulder). Throughout the route a total of nine wetland features will be potentially impacted by the pipeline. Two wetland features will be directly impacted through trenching whilst two wetland features will be impacted through Horizontal Directional Drilling (HDD). The remaining five wetland features will not be directly impacted through activities associated with the construction of the gas pipeline however the development will occur within 500m of these wetland features. The focus of this specialist wetland study was to undertake a baseline assessment of the conditions and functionality of these identified wetlands that will either be directly or indirectly impacted on by the proposed development. This study has been commissioned to meet the requirements of the EIA process in the form of a Basic Assessment (BA) as set out by the National Environmental Management Act (1998) and a to meet the requirements of a Water Use License Application (WULA) as set out by the National Water Act (Act 36 of 1998).

1.2 Background to the proposed Nigel Gas Pipeline

The route of the proposed gas transmission pipeline is illustrated in Figure 2 below.

As mentioned, the proposed pipeline will be approximately 10km long and will be constructed as close as possible to existing roads. The proposed development is situated between Dunottar and Nigel, within the City of Ekurhuleni Metropolitan Municipality, Gauteng Province (Figure 1 and 2). The new transmission pipeline will connect to the existing gas pipeline just east of the R51 and M45 crossing, after which the pipeline will follow the M45 Road (southern road reserve) to the outer edge of the town of Dunnottar, where the proposed pipeline will go underneath the railway line and follow the outer periphery of the town southwards along Chaplan Avenue (eastern road reserve). From Chaplan Ave the pipeline will turn west along Annan Ave to eventually reach the T-junction with the M63 Road (Nigel-Dunnottar

Road). The gas pipeline will run south within the M63 Road's shoulder for approximately for approximately 6.5km after which the pipeline will cross onto the Visagie Weg Road for a short distance (0.4km) to finally connect to the Consol Glass Factory (east of Visage Weg Road).

The proposed development will include the following activities:

A. Trenching (also known as isolated open-cut)
   Open-cut installation techniques have been the traditional method of oil and gas pipelines, water lines, communication cables and other modern utilities for decades and allow for a relative quick trench-line excavation to take place, pipe installation to occur, and backfilling of the trench-line to follow immediately after installation. The trench size required for this pipeline will be relative narrow and shallow (between 0.5m and 0.9m wide and between 1 and 3 m deep) and subsequently the footprint of the trench can be regarded as relative limited.
B. Horizontal Directional Drilling is a specialist form of directional drilling designed to install pipelines under construction sites, rivers, roads and highways etc. This technique comprises of three stages namely:
   - Drilling of pilot hole:
     The first stage of the Horizontal Directional Drilling or HDD process begins with boring a small, horizontal hole, otherwise known as a pilot hole, under the crossing obstacle with a continuous string of steel drill rods.
   - Reaming out/pulling back of the pilot hole
     When the bore head and rod emerge on the opposite side of the crossing, a special cutter, called a back reamer, is attached and pulled back through the pilot hole. It is the job of the reamer to bore out the pilot hole so that the pipe can be pulled through.
   - Pulling the pipeline through.
     Finally, the pipe is pulled through the side of the crossing opposite the drill rig.

   Surface features typically include two small cleared drill pads (entrance and except locations) which comprise of:
   - Drill rig and power unit;
   - Drill pipe skid next to drill rig;
   - Silt fencing or similar erosion control measures;
   - Noise screens or other similar noise control measures;
   - Small entry pit;
   - Separation plant;
   - Holding tanks;
   - Fluid pumps;
   - Control cabin (housing controls and navigation equipment); and

- Stringing site (where pipe portions are assembled and strung prior to pulling back of the pipeline into the bored hole).

Furthermore, the proposed development will involve the following methods of wetland and watercourse crossings:

» Two wetland features will be directly impacted through trenching (Wetland 2 & 4); whilst
» Two wetland features will be impacted through Horizontal Directional Drilling (HDD) (Wetland 1 and 5).
» The remaining five wetland features will not be directly impacted through activities associated with the construction of the gas pipeline, with two wetlands potentially being indirectly impacted.

1.3 Terms of reference

The primary objective of the specialist wetland assessment was to provide information to guide the proposed gas pipeline development with respect to the potential impacts on the affected wetland ecosystems within the project site. The focus of this study was solely on the specific Hydrogeomorphic Units (HGMs), within a radius of 500m of the pipeline route, that will be impacted by the proposed development.

The focus of the work involved the undertaking of a specialist assessment of wetlands, which included the following tasks:

» Desktop identification and delineation of potential wetland and watercourse areas affected by the proposed development, or occurring within a 500m radius of the proposed development using available imagery, contour information and spatial datasets in a Geographical Information System (GIS);
» Undertaking a rapid water resource screening and risk assessment to determine which desktop delineated/mapped watercourses/wetlands are likely to be measurably affected by the proposed activities and are likely to trigger Section 21 (c) or (i) water use. This was used to flag watercourses/wetlands for further infield assessments as well as identify those watercourses/wetlands to be unaffected and not require further assessment (i.e. wetlands/rivers within adjacent catchments, upstream or some distance downstream of the predicted impact zone);
» Site-based (detailed in-field) delineation of the outer wetland boundary of wetland/watercourse areas within the project focal area and which were flagged during the desktop screening/risk assessment;
» Classification of wetlands and riparian areas and assessment of conservation significance based on available data sets;

- Description of the biophysical characteristics of the delineated freshwater habitats based on onsite observations and sampling (i.e. hydrology, soils, vegetation, existing impacts etc.);
- Baseline functional assessment of wetland habitats based on field investigations, involving the:
  - PES (Present Ecological State/Condition) of the delineated wetland units;
  - EIS (Ecological Importance and Sensitivity) of the delineated wetland units;
  - Direct and indirect ecosystem services (functions) importance of the delineated wetland units only.
- Impact assessment and identification of mitigation measures to reduce the significance of potential aquatic impacts for both the construction and operational phases of the pipeline project. For this section the same methodology and layout approach within the existing report was followed in order to maintain uniformity and coherence between the two reports.
- Compilation of a specialist wetland assessment report detailing the methodology and findings of the assessment, together with relevant maps and GIS information.

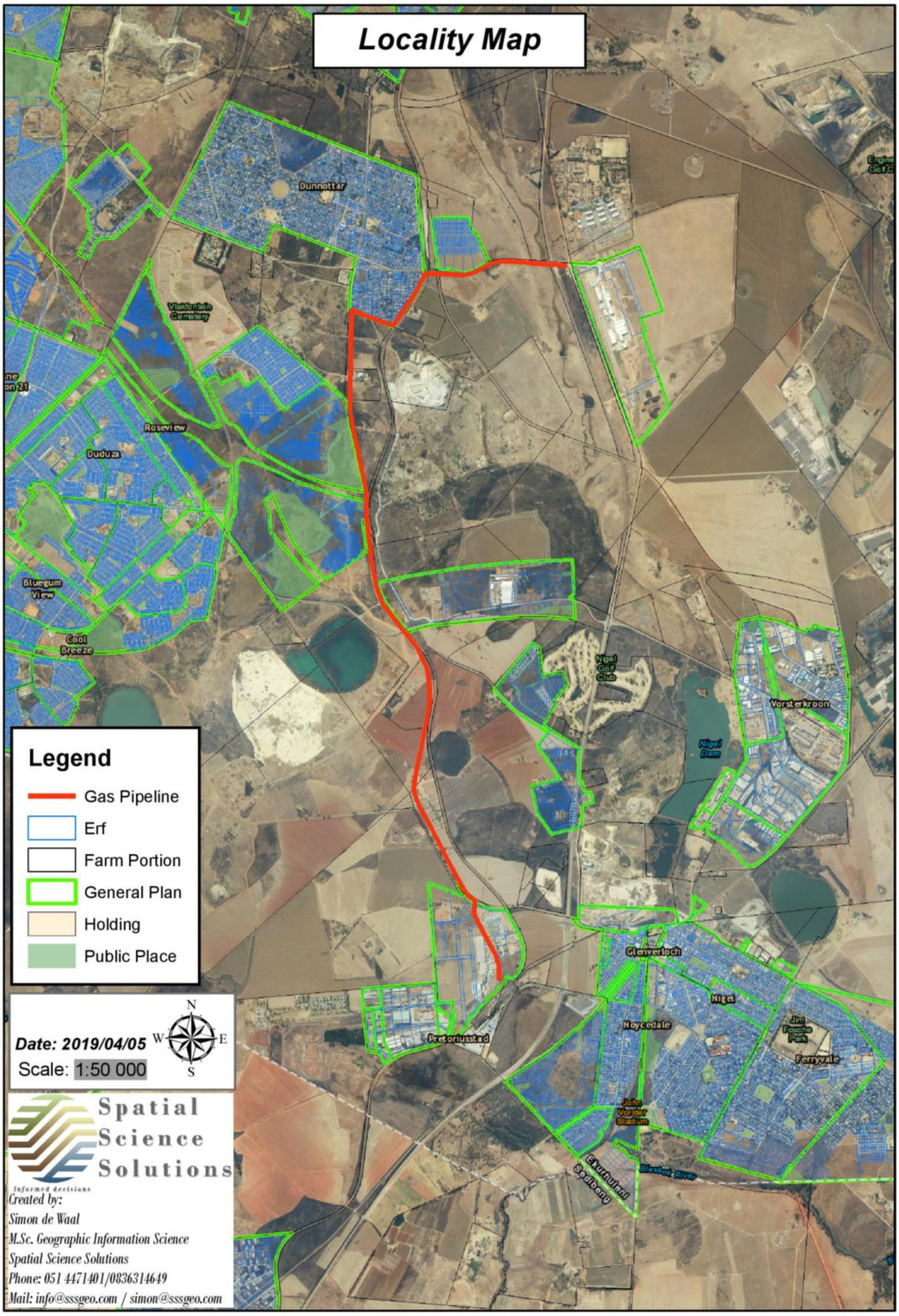


Figure 1: Location map of the proposed gas pipeline route near Nigel, Gauteng Province (compiled by Spatial Science Solutions Pty (Ltd)).

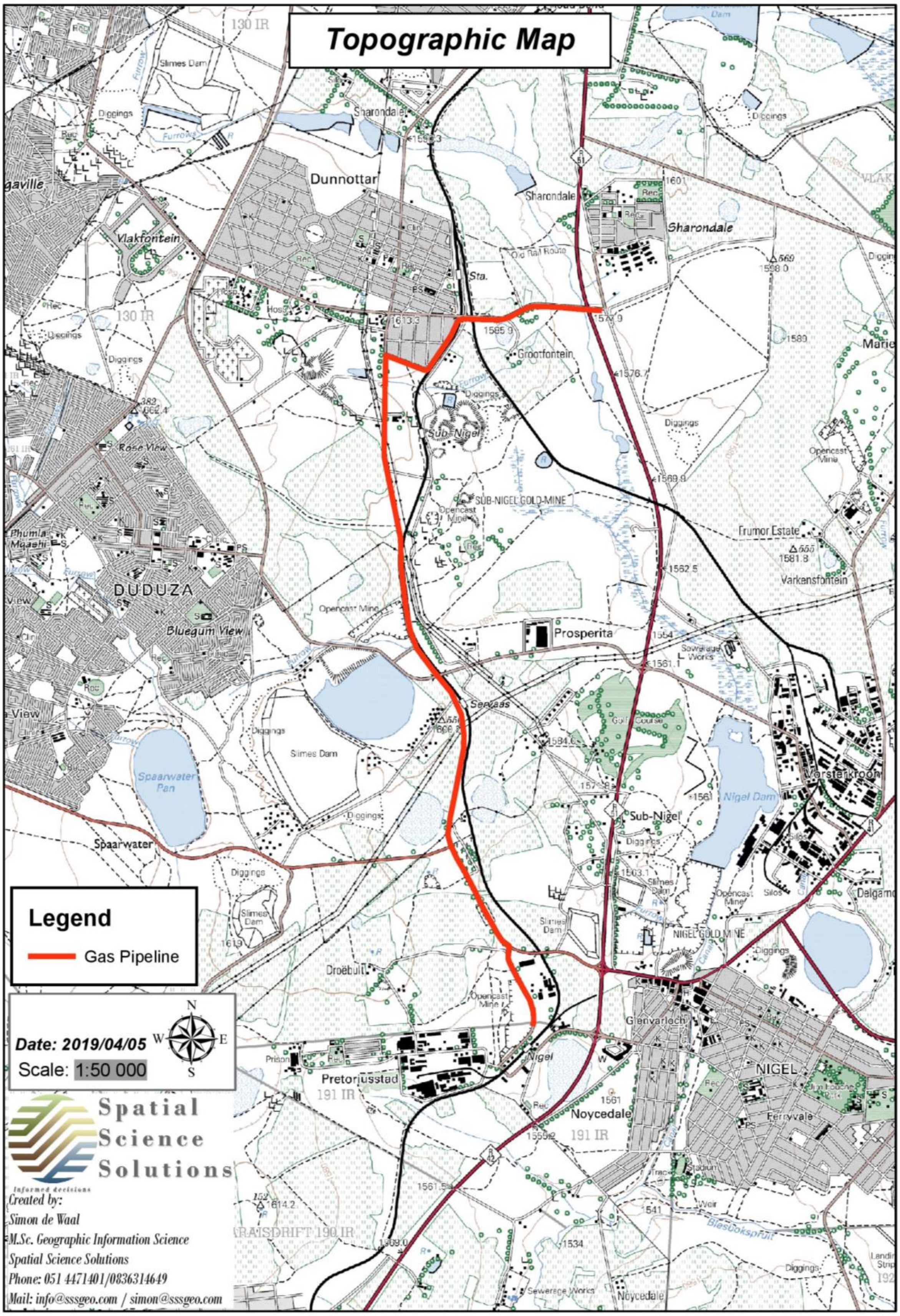


Figure 2: Topographical map of the proposed gas pipeline route near Nigel, Gauteng Province (compiled by Spatial Science Solutions Pty (Ltd)).

1.4 General assumptions and limitations

1.4.1 General assumptions

- This study assumes that the project proponent will make every effort to mitigate and/or offset negative impacts on the environment.
- GIS spatial datasets used as part of the field surveys (site demarcation) and analyses are accurate.

1.4.2 Limitations

The following refers to general limitations that affect the applicability of information represented within this report (also refer to Conditions of the Report):

- This report specifically focuses on the identification, delineation, and classification of the hydrological features occurring within a 500m radius of the proposed development and which will be impacted by the proposed gas pipeline
- This report deals exclusively with a defined assessment / study area, which due to the scale of the project occurs within 30-100 meters of the proposed development activities. The nature of water resources outside this focal area is largely informed by extrapolation of data collected and can be considered of low relatively confidence. This is especially applicable for large water resource units that extent well beyond the scope of this assessment.
- Accuracy of the maps, routes and desktop assessments are based on the current 1:50 000 topographical map series of South Africa;
- Hydrological assessments are based on a selection of available techniques that have been developed through the Department of Water and Sanitation (DWS) as well as the Water Research Council (WRC) based on site conditions and applicability. These techniques are however largely qualitative in nature with associated limitations due to the range of interdisciplinary aspects that have to be taken into consideration.
- Wetland boundaries must be identified and classified along a transitional gradient from saturated through to terrestrial soils which makes it difficult to identify the exact boundary of the wetland. The boundaries mapped in this specialist report therefore represent the approximate boundary of the wetland as evaluated by an assessor familiar and well-practiced in the delineation technique.
- The wetland boundaries delineated are based on sampling points along transects and thus the outer boundary of water resource units between these transects / sampling points was extrapolated using knowledge of the site, aerial photography, contours and the author's experience;

- Infield soil and vegetation sampling was only undertaken at strategic sampling points within the habitats likely to be negatively affected. The broader wetland and riverine systems (HGM units) were delineated at a desktop level with limited field verification and therefore a relatively low confidence/accuracy level;
- A single survey limited the amount of flora identified at the site;
- The vegetation information provided is based on onsite/ infield observations and not formal vegetation plots. As such, the species list provided only gives an indication of the dominant and/or indicator wetland/riparian species and thus only provides a general indication of the composition of the vegetation communities.
- No faunal sampling and/or faunal searches were conducted and the assessment was purely wetland and riverine habitat based.
- Accuracy of Global Positioning System (GPS) coordinates was limited to 4m accuracy in the field.
- The field assessment was undertaken in summer (February 2019). The assessment therefore does not cover the seasonal variation in conditions at the site. This will not have a significant impact on the conclusion made regarding the potential impacts and sensitivities of the study area.
- While every care is taken to ensure that the data presented are qualitatively adequate, inevitably conditions are never such that that is possible. The nature of the vegetation, seasonality, human intervention etc. limit the veracity of the material presented.
- This specific study area is affected by a variety of disturbances (historic and active) which restricts the use of available wetland indicators such as hydrophytic vegetation or soil indicators. Especially regular ploughing, desiccating of soils and cultivation along the outer boundaries of the wetlands (mostly within the temporary saturated zones) have had a significant impact on soil indicators and within such area's emphasis had to be shifted to typographical and geomorphological setting within the landscape as well as vegetation indicators where possible. Hence, a wide range of available indicators including historic aerial photographs are considered to help determine boundaries as accurately as possible.
- While disturbance and transformation of freshwater habitats can lead to shifts in the type and extent of freshwater ecosystems, it is important to note that the current extent and classification is reported on here.
- The PES, EIS and functional assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. We have made an effort to substantiate all claims where applicable and necessary.
- The EIS assessment did not specifically address in detail all the finer-scale ecological aspects of the water resources such as a list of aquatic fauna likely to occur (i.e. amphibians and fish) within these systems.

- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the field survey and based on the assessor's working knowledge and experience with similar development projects.
- The impact descriptions and assessment are based on the author's understanding of the proposed development based on the site visit and information provided.
- Evaluation of the significance of impacts with mitigation takes into account mitigation measures provided in this report and standard mitigation measures to be included in the Environmental Management Programme (EMPr).

1.5 Conditions of this report

Findings, recommendations and conclusions provided in this report are based on the authors' best scientific and professional knowledge and information available at the time of compilation. No form of this report may be amended or extended without the prior written consent of the author. Any recommendations, statements or conclusions drawn from or based on this report must clearly cite or make reference to this report. Whenever such recommendations, statements or conclusions form part of a main report relating to the current investigation, this report must be included in its entirety.

2 WATERBODY DELINEATION & CLASSIFICATION

The water body delineation and classification was conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (SANBI, 2009). These methods are contained in the attached Appendix 1, which also includes wetland definitions, wetland conservation importance and Present Ecological State (PES) assessment methods used in this report.

For reference the following definitions are applicable:

- **Drainage line**: A drainage line is a lower category or order of watercourse that does not have a clearly defined bed or bank. It carries water only during or immediately after periods of heavy rainfall i.e. non-perennial, and riparian vegetation may not be present.
- **Perennial and non-perennial**: Perennial systems contain flow or standing water for all or a large proportion of any given year, while non-perennial systems are episodic or ephemeral and thus contain flows for short periods, such as a few hours or days in the case of drainage lines.

- **Riparian**: the area of land adjacent to a stream or river that is influenced by stream-induced or related processes. Riparian areas which are saturated or flooded for prolonged periods would be considered wetlands and could be described as riparian wetlands. However, some riparian areas are not wetlands (e.g. an area where alluvium is periodically deposited by a stream during floods but which is well drained).
- **Wetland**: land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which under normal circumstances supports or would support vegetation typically adapted to life in saturated soil (Water Act 36 of 1998); land where an excess of water is the dominant factor determining the nature of the soil development and the types of plants and animals living at the soil surface (Cowardin et al., 1979).
- **Watercourse**: as per the National Water Act means -
  (a) a river or spring;
  (b) a natural channel in which water flows regularly or intermittently;
  (c) a wetland, lake or dam into which, or from which, water flows; and
  (d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks

3 DESCRIPTION OF THE STUDY AREA

3.1 Climate and rainfall

The climate associated with the study area has been derived from recorded and extrapolated climatic data (https://en.climate-data.org/africa/south-africa/gauteng/nigel-27242/) for Nigel (Figures 3 & 4). Nigel's' climate is classified as warm and temperate (Köppen-Geiger climate classification: Cwb). Nigel receives a significant amount of rainfall during the summer months, although the other seasons may also receive some precipitation. Rainfall for the region is moderate (681 mm annual) and occurs mainly in summer with relative dry winters. Mean annual rainfall is, as mentioned above, 681 mm with January being the wettest month, averaging about 117 mm, and July being the driest month, with an average of 7 mm. The average annual temperature in Nigel is 15.6°C with January being the warmest (Ave. 20.4°C) and June being the coldest (Ave 8.5°C). Frost is frequent to very frequent in winter (mean frost days up to 39 days per year).

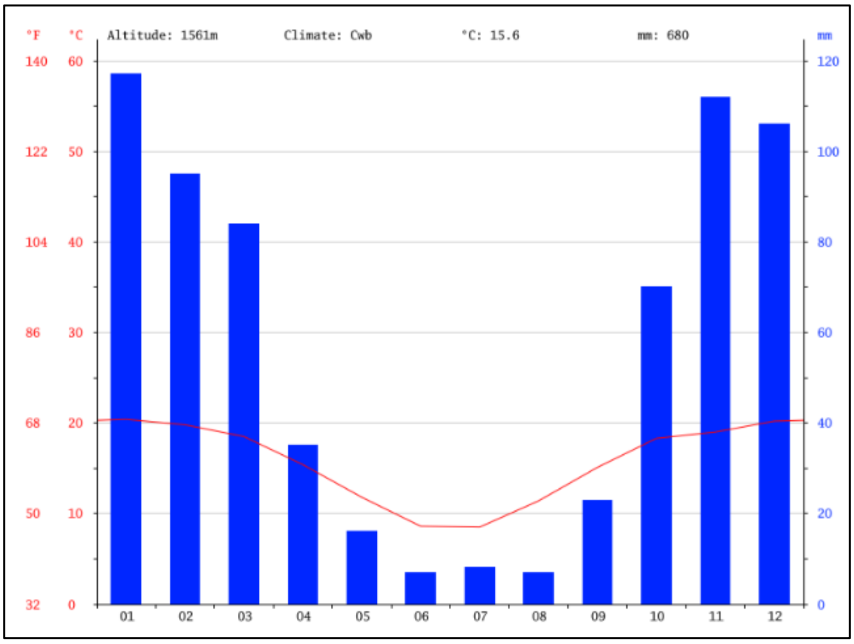


Figure 3: Climate graph of Nigel (https://en.climate-data.org/africa/south-africa/gauteng/nigel-27242/).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature (°C)	20.4	19.8	18.5	15.4	11.8	8.6	8.5	11.4	15.1	18.3	19	20.2
Min. Temperature (°C)	13.9	13.4	11.9	8	3.4	-0.3	-0.6	2.3	6.6	10.6	12.2	13.5
Max. Temperature (°C)	27	26.3	25.2	22.9	20.2	17.6	17.6	20.6	23.7	26	25.9	26.9
Avg. Temperature (°F)	68.7	67.6	65.3	59.7	53.2	47.5	47.3	52.5	59.2	64.9	66.2	68.4
Min. Temperature (°F)	57.0	56.1	53.4	46.4	38.1	31.5	30.9	36.1	43.9	51.1	54.0	56.3
Max. Temperature (°F)	80.6	79.3	77.4	73.2	68.4	63.7	63.7	69.1	74.7	78.8	78.6	80.4
Precipitation / Rainfall (mm)	117	95	84	35	16	7	8	7	23	70	112	106

Figure 4: Climate table of Nigel (https://en.climate-data.org/africa/south-africa/gauteng/nigel-27242/).

3.2 Physiography and soils

3.2.1 Landscape Features

According to Mucina and Rutherford (2006) the region can be described as flat to slightly undulating plains and low hills supporting short dense grasslands. This description is furthermore consistent with the land type classification (AGIS 2007) which classifies the landscape as Class A2 (level plains or plateaus with a local relief between 30-90m) with an average slope less than 8%. Land types represent areas that are uniform with respect to climate, terrain form, geology and soil. According to AGIS (2014), the project site is situated, within the land type Bb3. Across a landscape, usually five terrain units can be identified. Wetlands occur most frequently in valley bottoms (unit 5), but can also occur on crests, mid slopes and foot slopes (units 1, 3 and 4). The catena within land type Bb3 incorporate four terrain units, as shown in Figure 5.

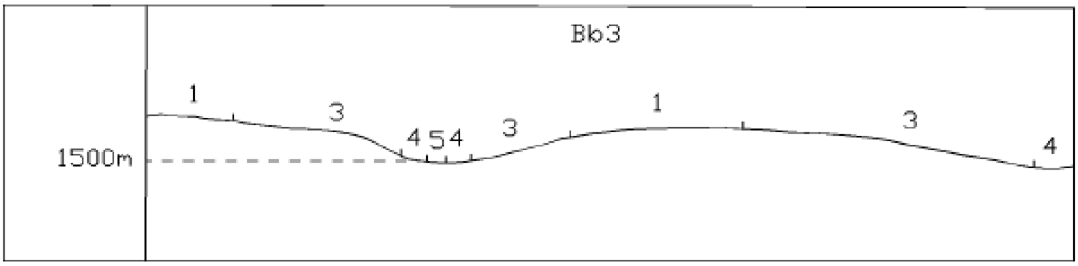
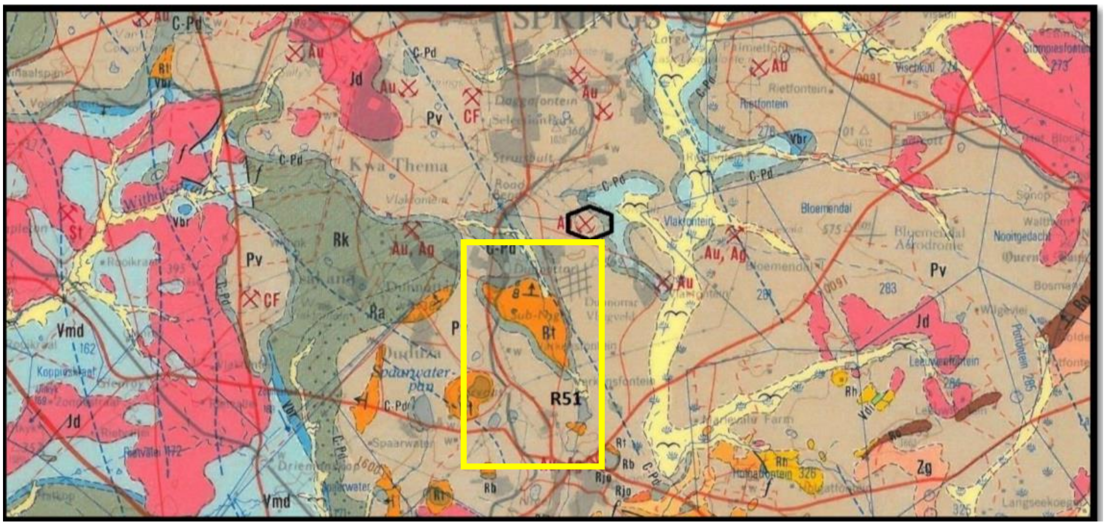


Figure 5: Terrain units occurring within the Bb3 land type.

At a finer scale the basin/catchment area (726ha) can be described as undulating plains with an average slope of 2.18% and a maximum slope of 21.16%. The catchment is situated at elevations of between 1 541m and 1 670m above sea level. The lowest portion of the basin/catchment comprises an extensive valley-bottom wetland system draining water in a south-eastern direction into the Nigel Dam. Most of the surface flow/drainage within the basin occurs into this system, either as "contained" flows within tributary wetlands (primary source) or as surface runoff and later sub-surface flow. The catchment/basin is furthermore dotted with numerous isolated depressions (pan wetlands). The topographical profile of the proposed gas pipeline can be described as a highly undulating landscape situated between elevations; 1 572m and 1 612m (mean elevation: 1 595m) with an average slope of 1.6% (max slope: 5.2%). Refer to Figure 7 for an illustration of the elevation of the project site and surrounding environment as well as the modelled drainage systems.

3.2.2 Geology

The northern half of the proposed gas pipeline route is predominantly situated on diamictite and shale of the Dwyka Formation (Karoo Supergroup) with some intrusion of ultrabasic rocks, pyroxenite and norite of the Thole Suite. The southern half of the route is predominantly situated on sandstone and shale of the Vryheid Formation (Ecca Group, Karoo Supergroup) (Figure 6)



Legend to maps and short explanation

- Pv – (brown) Sandstone, shale, coal beds. Vryheid Formation, Ecca Group, Karoo Supergroup
- C-Pd – (grey) Diamictite, shale. Dwyka Formation, Karoo Supergroup
- Jd – (pink) Dolerite
- Vmd – (blue) Dolomite, chert. Malmani Supergroup, Chuniespoort Group, Transvaal Supergroup
- Rt – (orange) Ultrabasic rocks, pyroxenite, norite. Suite Thole
- $\perp_8$ – Strike and dip of bed
- Purple line – Proposed gas pipeline route

Figure 6: Geology map of the development site. Obtained from 1:250 00 (2628) East Rand Geological Map (Keyser, Botha and Groenewald, 1986).

3.2.3 Soil and Landtypes

Detailed soil information is not available for broad areas of the country. As a surrogate landtype data was used to provide a general description of soil in the project site (landtypes are areas with largely uniform soils, topography and climate). The project site (500m buffer around development) is, as already mentioned is situated within the land type Bb3 (Land Type Survey Staff, 1987).

- <u>Class B: Plinthic catena: upland duplex and margalitic soils are rare</u>
  A typical catena (from high lying to low lying) in this class is Hutton, Bainsvlei, Avalon and Longlands soil forms and the valley bottom is occupied by soil with

a gley horizon (e.g. Rensburg, Willowbrook, Katspruit, Champaigne forms) In addition the following soils may be present in smaller parts: Glencoe, Wasbank, Westleigh, Kroonstad and Pinedene.

- Soil class Bb: The soils in this class are dystrophic and/or mesotrophic and red soils are not widespread. Plinthic soils must cover more than 10% of the area. Red soils occupy more than a third of the area. Duplex (Escourt, Sterkspruit, Swartland, Valsrivier and Kroonstad forms) and margalitic soils (Arcadia, Bonheim Mayo or Milkwood) are absent or occupy less than 10% of the soils present in the area.

Table 1: Soil forms and coverage per terrain unit (%) for the Bb3 land type (soils that are typically associated with wetlands are in blue font).

Soil Form	% Cover per Terrain Unit				Depth (mm)	Clay Content (%)		
	1	3	4	5				
Slope (%)	0-3	2-5	0-2	0-1		A	E	B21
Avalon Av26, Ruston Av16, Soetmelk Av36	20	35			700-1200	15-25		20-35
Msinga Hu26, Hutton Hu16	30	20	5		900-1200+	15-25		20-35
Bergville Av27, Bezuidenhout Av37	5	10	10	5	600-1100	20-30		35-45
Doveton Hu27, Farningham Hu17	10	10	5	5	>1200	20-30		35-45
Glencoe Gc26, Appam Gc16	10	10		5	600-900	15-20		15-25
Sibasa We13	5	5	10		400-500	15-25		35-45
Klipfontein Ms11	5	5	5	12	200-400	10-15		
Arniston Va31, Swartland Sw31			20	60	300-400	20-30		35-45
Longlands Lo21, Vasi Lo20, Albany Lo22			20		700-1000	5-20	5-20	30-40
Mispah Ms10					200-400	15-25		
Rensburg Rg20, Phoenix Rg10				40	400-600	40-60		
Killarney Ka20				30	300-400	15-25		30-45
Willowbrook Wo11				20	400-600	35-45		
Rydavale Ar30, Mngazi Ar10			5	10	400-600	40-60		
Uitvlugt Es34, Estcourt Es36			10		300-500	15-25	10-20	40-50
Mkambati Kd14, Umtentweni Kd21			10		700-1000	5-15	35-45	35-45
Pans/Panne	15							

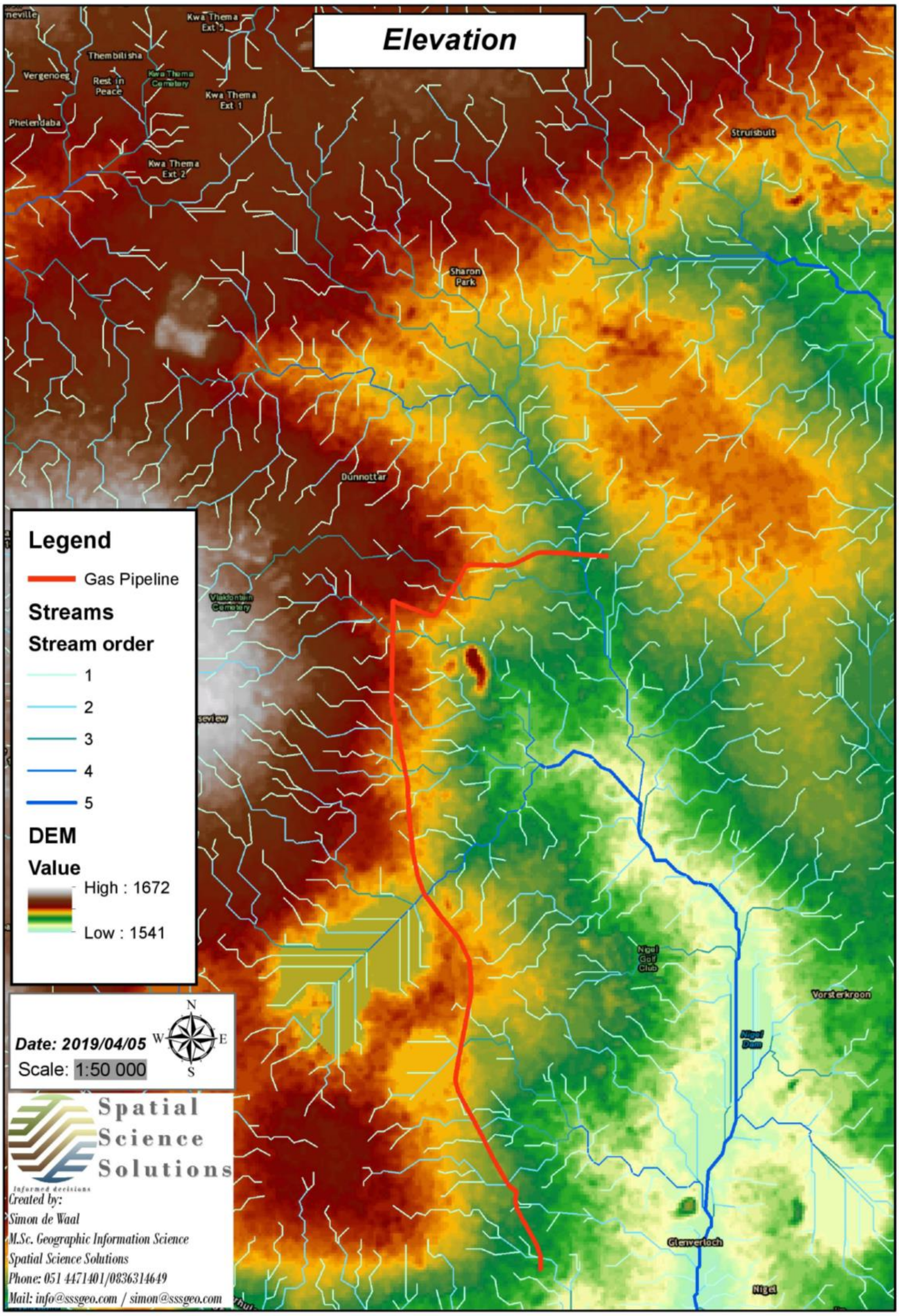


Figure 7: Topography of the proposed project site as well as surroundings and modelled drainage systems (compiled by Spatial Science Solutions Pty (Ltd)).

3.2.4 Regional Hydrological Setting

The project site is situated within the Upper Vaal Water Management Area (WMA) 8, Quaternary Catchment C21E (Vaal Downstream of the Vaal Dam Sub-area) and Ecoregion 11.03 (Highveld Ecoregion). The Upper Vaal Water Management Area (Upper Vaal WMA) includes the Vaal, Klip, Wilge, Liebenbergsvlei and Mooi Rivers and extends to the confluence of the Mooi and Vaal Rivers. It covers a catchment area of 55 565 km^2. This WMA includes the very important dams Vaal Dam, Grootdraai Dam and Sterkfontein Dam. The southern half of the WMA extends over the Free State, the north-east mainly falls within Mpumalanga and the northern and western parts in Gauteng and North West provinces respectively. The Upper Vaal is the uppermost WMA in the Vaal River catchment and one of five WMAs in the Orange River Basin. The Upper Vaal is divided in three sub-areas namely; the Vaal upstream of Vaal Dam, Wilge and the Vaal downstream of the Vaal Dam.

The project site is situated within the C21E Quaternary Catchment which forms part of the middle reach region of the Blesbokspruit River, a tributary of the Suikerbosrand River (Sub-catchment) (Figure 7). The southernmost point of the proposed gas pipeline route is situated less than 3km north of the Blesbokspruit River. As mentioned, the location of the project site is within an elevated headwater region and as such this area comprise of numerous smaller drainage systems draining in a mostly eastern and south-eastern direction towards the low-lying valley-bottom system (Figures 7-9). From here water flows mostly in a southern direction along the valley-bottom wetland system, to finally drain into the Blesbokspruit River. Before draining into the Blesbokspruit River, a large amount of water is collected and stored within the Nigel Dam (Figure 9).

The project site is furthermore located within the C21E-01447 Sub-quaternary Reach (DWS, 2014) (Figure 7). The Desktop PES of the relevant SQR (C21E-01447: Blesbokspruit River) is moderately modified (C Category) and a moderate change in ecosystem process and loss of natural habitats has taken place but the natural habitat remains predominantly intact. According to the DWS (2014), the water quality (WQ) and potential flow characteristics have been largely impacted and modified, whilst in-stream and riparian habitats have been moderately impacted and transformed. The most significant activities impacting on these characteristics and features are agriculture, small in-stream dams, large road crossings, towns, effluent and alien trees. The EI of C21E-01447 is Moderate due to the presence of 52 species (riparian, wetland and aquatic species) in this sub-quaternary catchment with two conservation important species. The main habitats for these species include incised channels with surface flows, grassy edges, riparian trees and shrubs, seepage and oxbow wetlands and shrubs, seepage and oxbow wetlands. The water level and flow changes determine the ES. The watercourse of C60E-02584 has a Moderate ES Mean Class Rating with fish species showing a high intolerance (sensitivity) for no-flow as well as a moderate sensitivity towards physico-chemical alterations (DWS, 2014).

The key biophysical features associated with the project site (500m radius around gas transmission pipeline route) area are summarised below in Table 2.

Table 2: Key biophysical details of the study area.

Biophysical Aspects	Desktop Biophysical Detals	Source
Elevation	Between 1 559m and 1 626m a.m.s.l. (Mean: 1 592m)	ArcGis 10.4 (ASTER GDEM- 30m)
Slope	Mean: 2.24%; Max: 18.71%; Min: 0%	ArcGis 10.4 (ASTER GDEM- 30m)
Mean annual precipitation (MAP)	694.75 mm	DWA, 2012
Mean annual potential evaporation (MAPE)	1 600 – 1 700mm	DWAF, 2012
Rainfall distribution	Early to late summer	DWAF, 2007
Mean annual temperature	15.6°C	DWAF, 2007
Median annual simulated runoff (mm) for quaternary catchment	28.6	DWA, 2012
Climatic Region	Moist Highveld Grassland	Kruger, 2006
Köppen-Geiger bioclimatic classification	Warm temperate, Winter dry, Warm Summers	Conradie, 2012
Geomorphic Province	North-western Highveld	Partridge *et.al.* 2010
Land Type	Bb3	AGIS
Geology	Shale and intrusive igneous rocks	SA Geological Society
Soils	Moderate to deep clayey loam soils	AGIS
Erodibility (Wind)	Somewhat susceptible (Sandy loam dominant)	AGIS
Erodibility (Water)	Low susceptibility	AGIS
Erodibility Index	Favourable	AGIS
Predicted Soil Loss	Very Low	AGIS
Water Management Area	Upper Vaal River	DWS
Quaternary catchment	C21E	DWS
Sub-quaternary reach	C21E-01447	DWS
Main collecting river in the catchment	Blesbokspruit into Suikerbosrand into Vaal	CSIR, 2011
Location in catchment	Middle reach of Blesbokspruit	DWS / CSIR, 2011
Noteworthy downstream watercourses/water resources	Vaal River	CSIR,2011
DWA Ecoregion (Level 1)	Highveld 11	DWA, 2005
DWA Ecoregion (Level 2)	11.03	DWA
NFEPA Wetland Vegetation Group	Mesic Highveld Grassland Group 2	CSIR, 2011
National Vegetation Types	Tsakane Clay Grassland	Mucina & Rutherford, 2011
Threatened Ecosystems	Blesbokspruit Highveld Grassland	NEM;BA, 2011

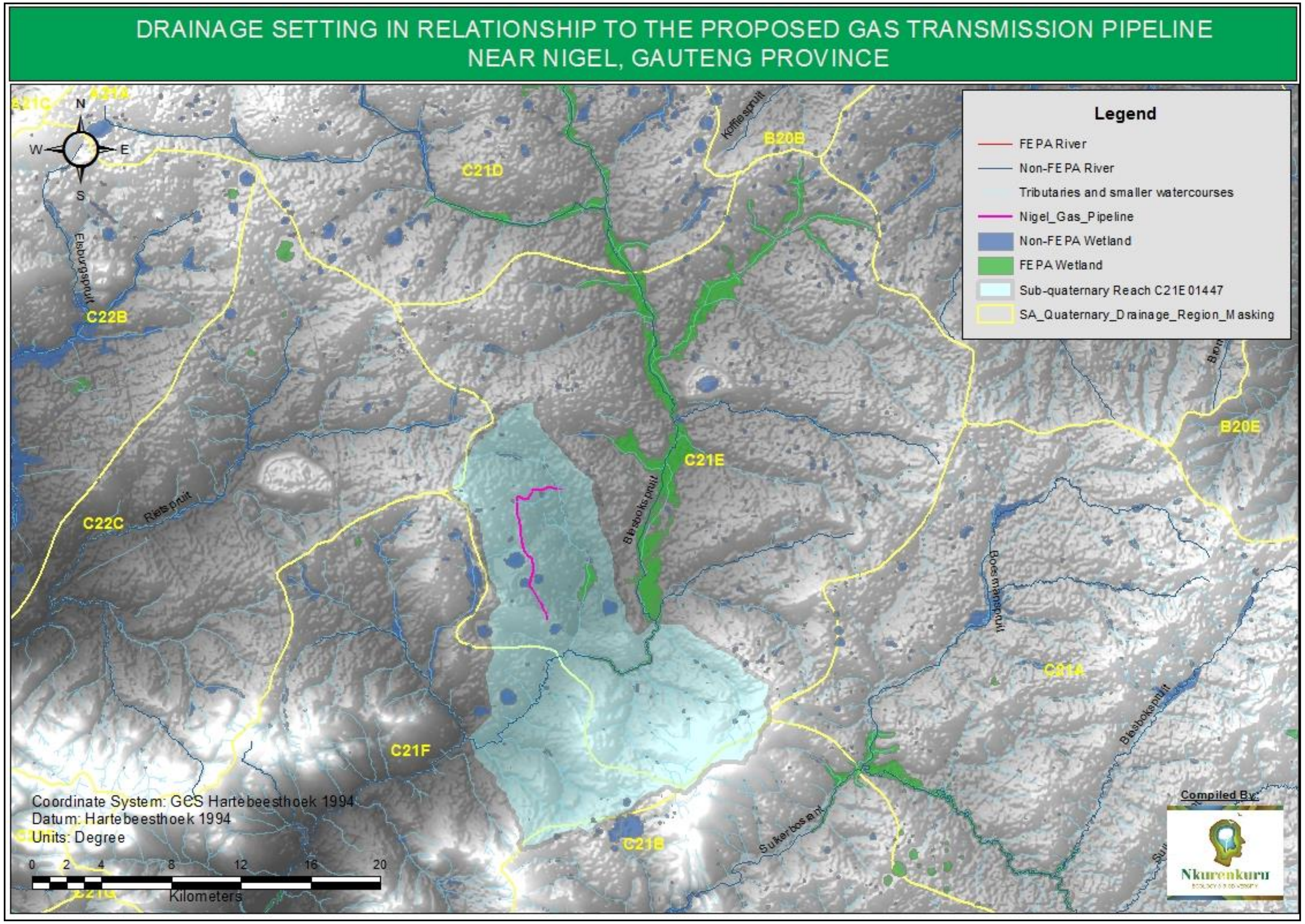


Figure 8: National Freshwater Ecosystem Priority Area Map showing FEPA features relative to the project site.

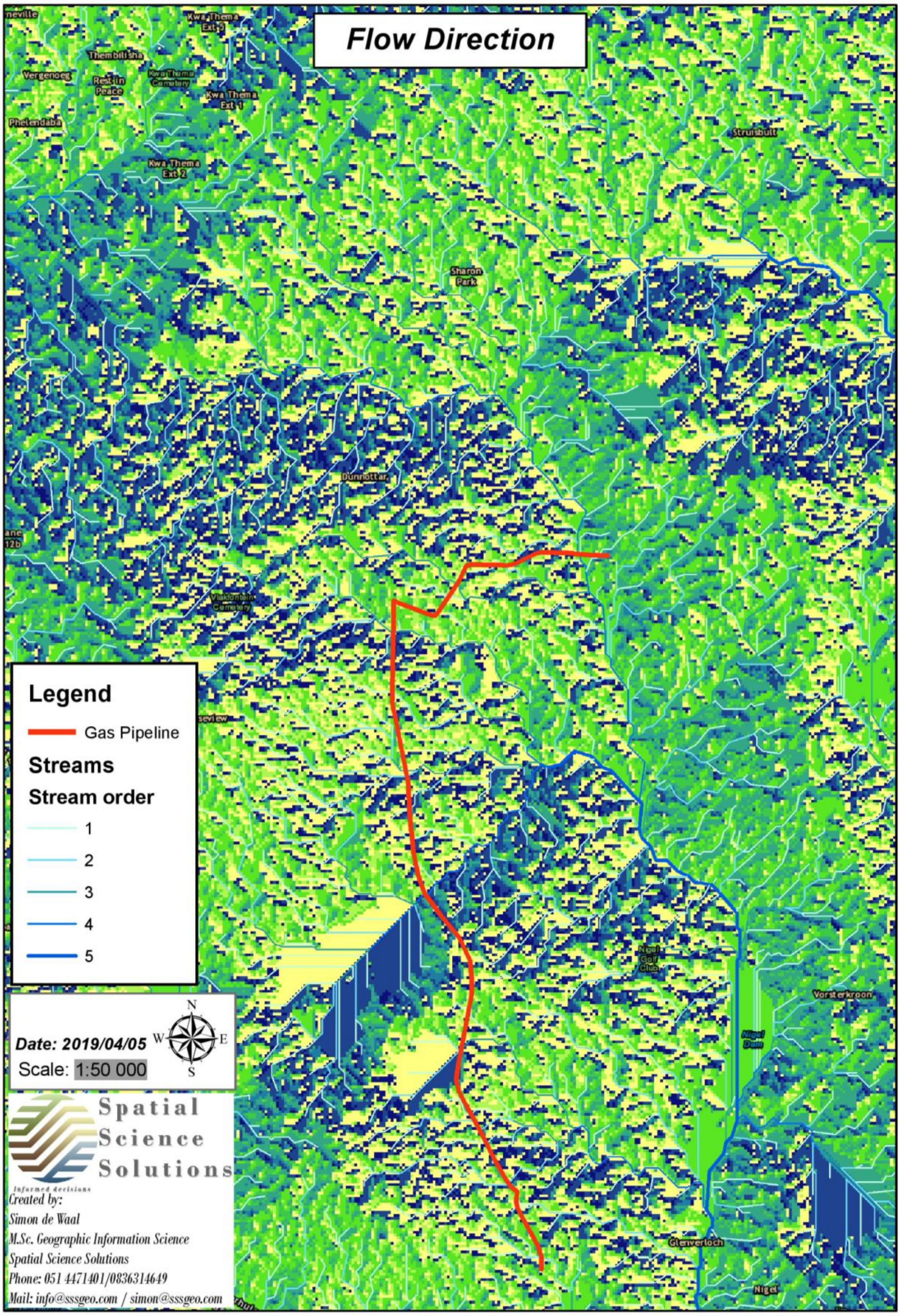


Figure 9: Modelled flow direction of the affected area as well as immediate surroundings (compiled by Spatial Science Solutions Pty (Ltd)).

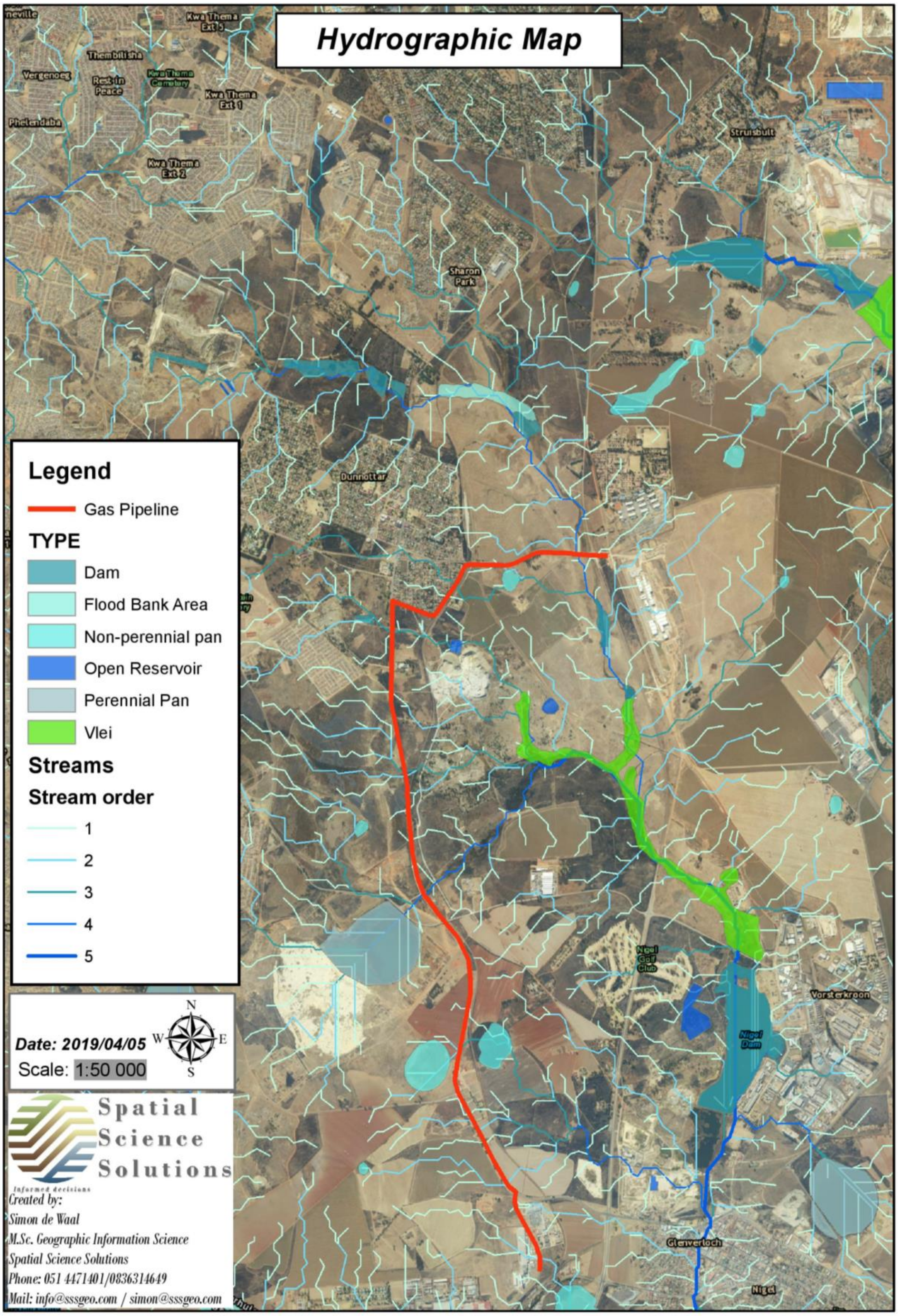


Figure 10: Hydrological map of the project site as well as immediate surroundings (compiled by Spatial Science Solutions Pty (Ltd)).

3.3 Conservation context of water resources

Understanding the conservation context and importance of the study area and surrounds is important to inform decision making regarding the management of the aquatic resources in the area. In this regard, national, provincial and regional conservation planning information is available and was used to obtain an overview of the study site. Key conservation context details of the project site and surrounds have been summarised in Table 3, below.

Table 3: Summary of the affected Sub-Quaternary Reach (SQR) Eco-status and impacts as well as the Eco-status and impacts for the surrounding SQRs.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
National Freshwater Ecosystem Priority Area (NFEPA) Assessment	Sub-quaternary Catchment planning units	Projects site within sub-quaternary catchment	No listed planning units
	NFEPA Wetlands	Wetlands potentially impacted by the proposed development	Only Non-FEPA Wetlands
	NFEPA Wetland Vegetation Group: Mesic Highveld Grassland Group 2	Herbaceous wetland vegetation along the pipeline route	Critically Endangered
National Threatened Ecosystems (SANBI & DEA, 2011) – remaining extent	Vegetation Type: Blesbokspruit Highveld Grassland	Untransformed and/or secondary terrestrial vegetation along the pipeline route	Critically Endangered
National Vegetation Map (Mucina & Rutherford, 2012)	Vegetation Type: Tsakane Clay Grassland	Untransformed and/or secondary terrestrial vegetation along the pipeline route	Endangered

PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
Gauteng Conservation Plan Version 3.3	Terrestrial Planning Units	Approximately 63.6% of project site	Ecological Support Area
		Approximately 31.6% of project site	Important Area
		Approximately 4.7% of project site	Irreplaceable Area

3.3.1 NFEPA (National Freshwater Ecosystem Priority Areas)

The National Freshwater Ecosystem Priority Area (NFEPA) project (Nel et al., 2011), is the first formally adopted national freshwater conservation plan that provides strategic spatial priorities for conserving the country's freshwater ecosystems and supporting the sustainable use of water resources that includes rivers, wetlands and estuaries. FEPA maps show various different categories, each with different management implications. The categories include river FEPAs and associated sub-quaternary catchments, wetland FEPAs, wetland clusters, Fish Support Areas (FSAs) and associated sub-quaternary catchments, fish sanctuaries, phase 2 FEPAs and associated sub-quaternary catchments, and Upstream Management Areas (UMAs). Categories that may be relevant to this study include river FEPAs, wetland FEPAs and associated catchments.

According to the available NFEPA spatial data (Figure 8) the following can be concluded in terms of FEPAs of the project site and immediate surroundings:

- » No river FEPA was identified within the area.
- » No wetland FEPA was identified within the project site. NFEPA spatial data indicate that a number of wetlands are dotted around the project site and are not listed as FEPAs.
- » The river catchment is furthermore, also not listed as a FEPA
- » In terms of conservation threat status of wetland vegetation, intact wetlands within the Mesic Highveld Grassland Group 2 wetland vegetation type are classified as Critically Endangered (CSIR, 2011).

3.3.2 Gauteng Conservation Plan (Version 3.3)

Gauteng Conservation Plan Version 3.3 contains two major categories to describe areas namely:

- » **Critical Biodiversity Areas (CBAs)** that contain three types of areas:
  - Irreplaceable areas, which are essential in meeting targets set for the conservation of biodiversity in Gauteng.
  - Areas that are important for the conservation of biodiversity in Gauteng
  - Conserved areas, which include all existing level 1 and 2 protected areas.

Level 1 and Level 2 protected areas are proclaimed in terms of relevant legislation (National Environmental Management Protected Areas Act, 2003 (Act No 57 of 2003) specifically for the protection of biodiversity (or for the purposes of nature conservation).

- » **Ecological Support Areas (ESAs).** ESAs are an imperative part of C-Plan 2 to ensure sustainability in the long term. ESAs are part of the entire hierarchy of biodiversity, but it is not possible to include all biodiversity features in them. Landscape features associated with ESAs (termed spatial surrogates for ESAs) that are essential for the maintenance and generation of biodiversity in sensitive areas, and therefore that require sensitive management were incorporated into C-Plan 3. Spatial surrogates include dolomite, rivers, wetlands, corridors for climate change and species migration, ridges and low-cost areas for Johannesburg and Tshwane.

According to the Gauteng C-Plan (Figure 13) the proposed project site falls largely within Ecological Support Areas (63.6%) whilst a fairly moderate portion of the project site (31.6%) include areas classified as "Important Areas". Only a small portion of "Irreplaceable Area" is included within the project site (4.7%) to the north.

It should be kept in mind that the data used in the C-Plan is mostly based on models and spatial data and the situation may differ slightly in the field. Thus, ground truthing is extremely important to determine whether the situation in the field corresponds with the spatial data.

3.3.3 National Biodiversity Assessment (NEM:BA) and National Vegetation Map (SANBI, 2011)

- The Blesbokspruit Highveld Grassland Ecosystem (Figure 12) is classified as Critically endangered and the Tsakana Clay Grassland vegetation type (Figure 11) is Endangered.
- The landscape has however been highly modified with very little remaining vegetation communities that represent intact examples these vegetation types.

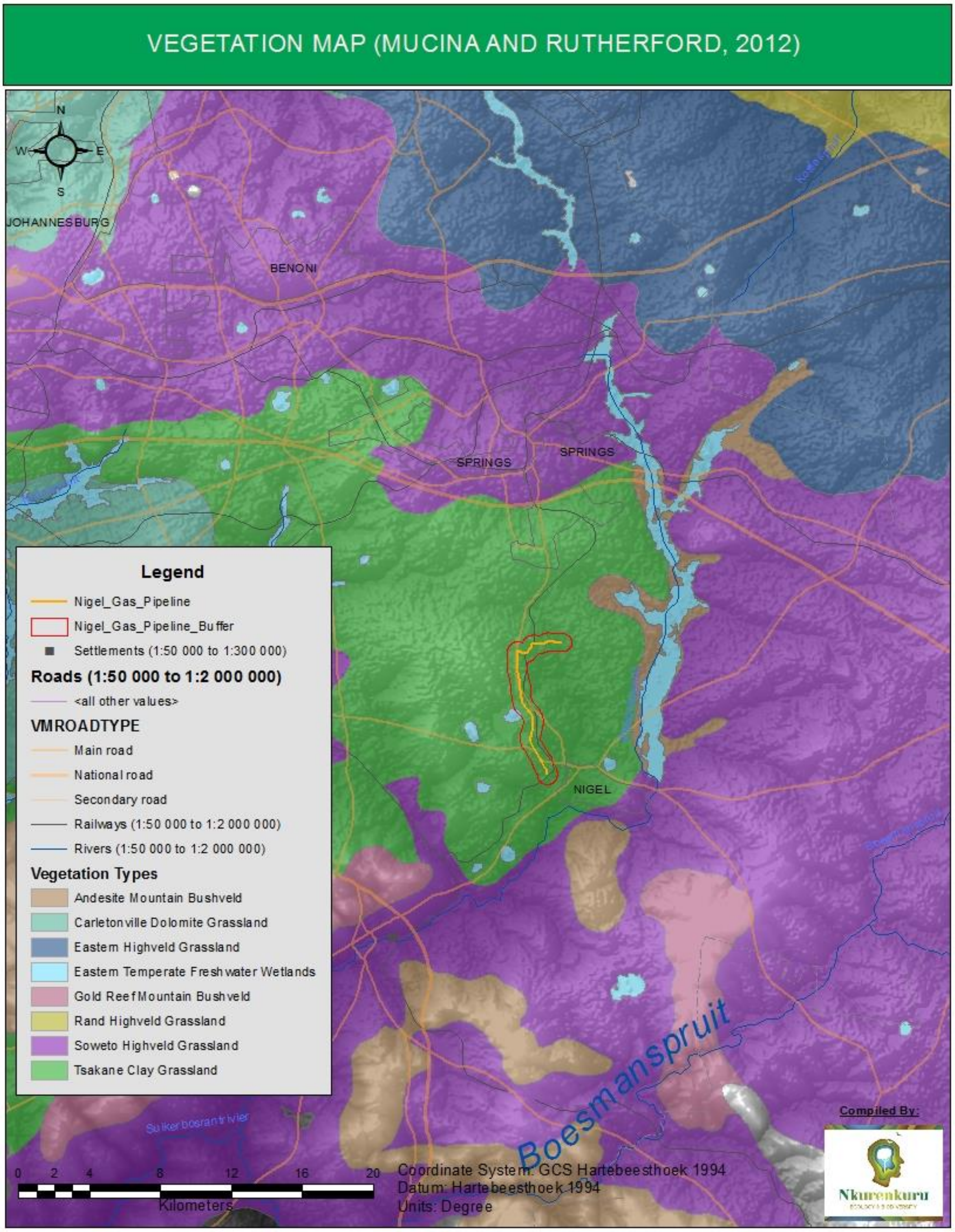


Figure 11: Location and extent of National Vegetation Types in relation to the proposed project site.

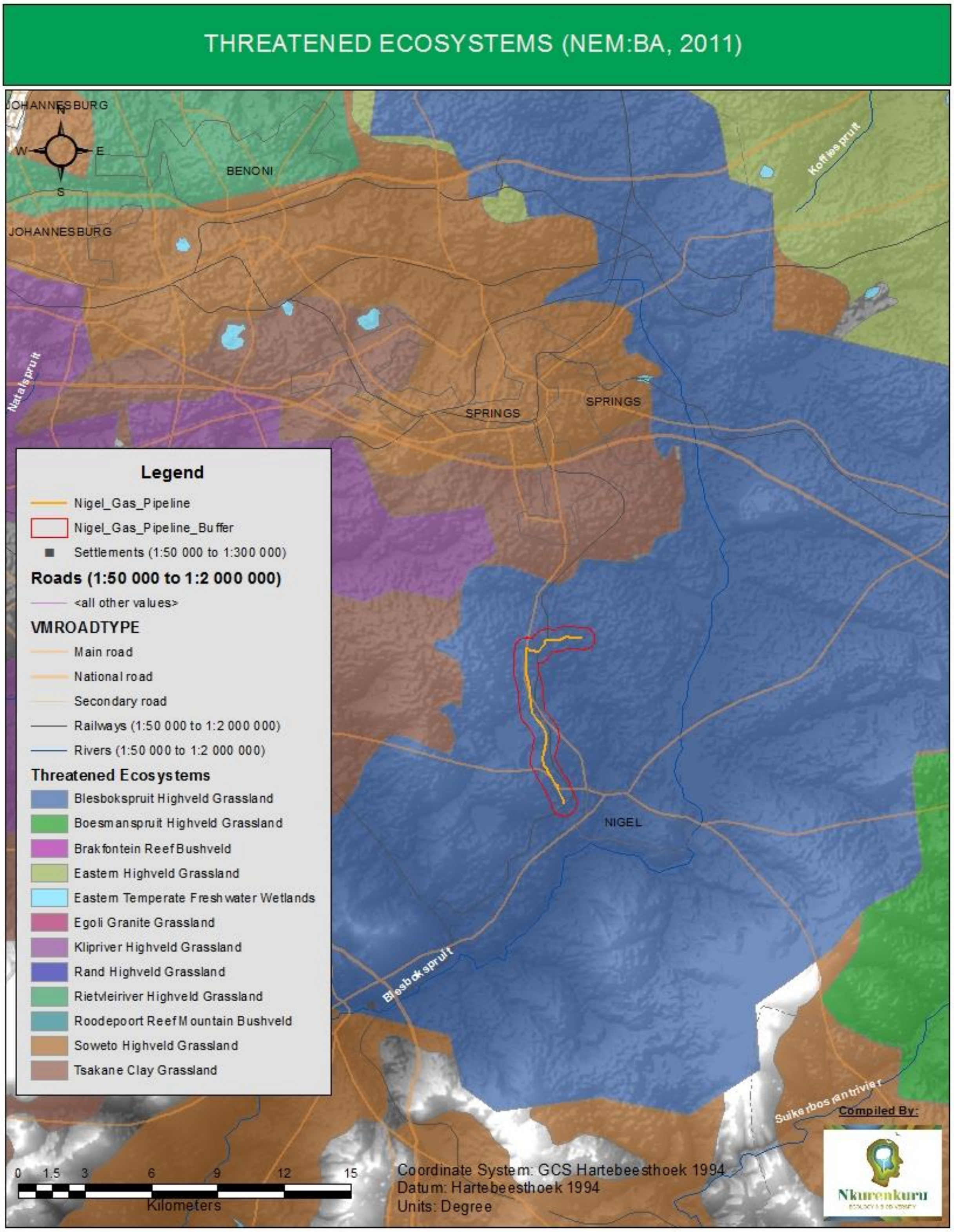


Figure 12: Location and extent of Threatened Ecosystems (original extent) in relation to the proposed project site.

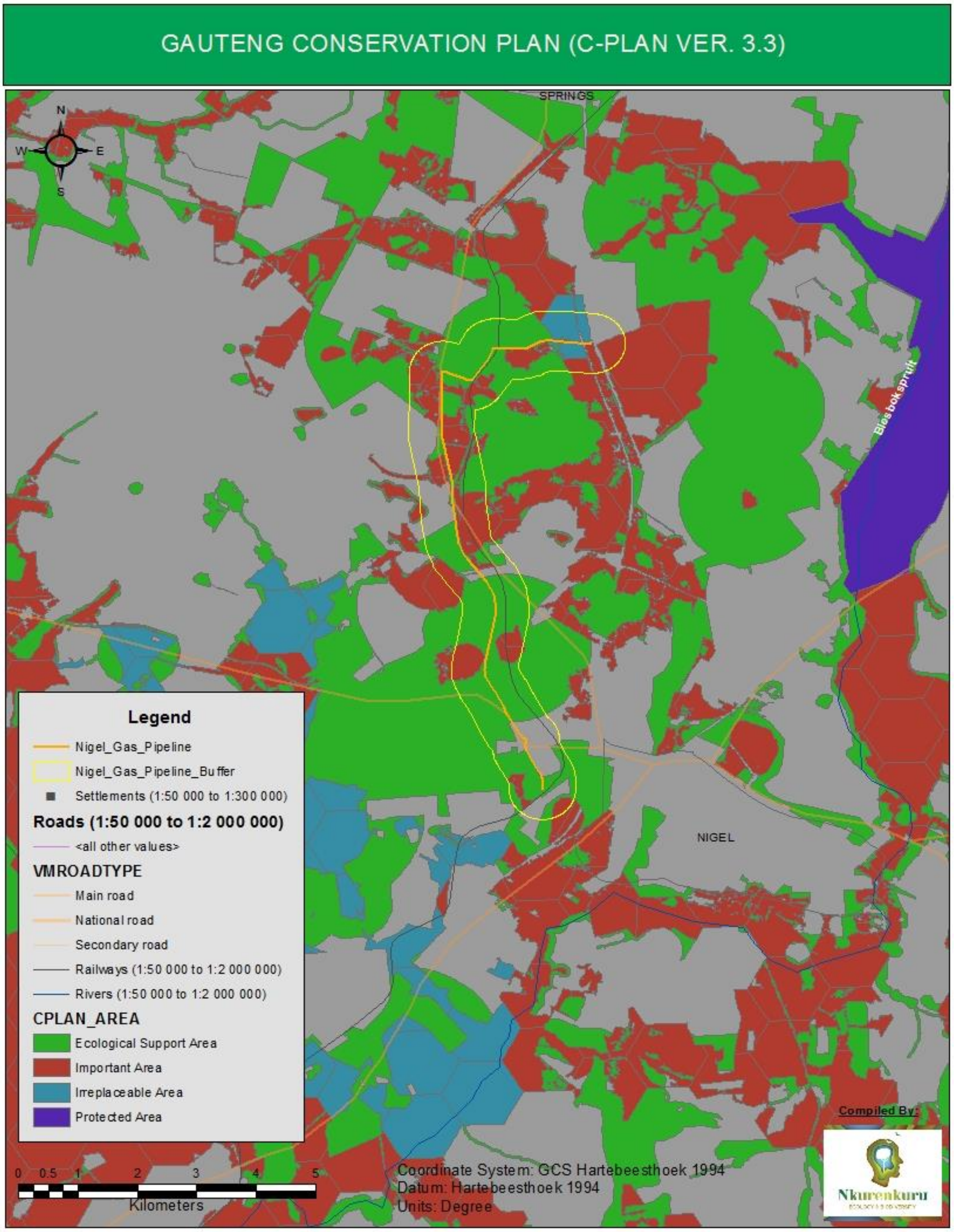


Figure 13: Location and extent of Threatened biodiversity according to the Gauteng Biodiversity Conservation Plan in relation to the proposed project site.

4 DESKTOP MAPPING AND WETLAND/WATERCOURSE RISK SCREENING

Water resources (wetland and watercourses) within a radius of 500m around the proposed gas transmission pipeline route were mapped and classified at a desktop level followed by a desktop rating of risk associated with the proposed activities. This was undertaken to guide field assessments and inform water use identification for the proposed project. A number of water resources (wetlands), were identified and rated. Wetlands dominate the drainage features in this landscape and ranged in type from small seeps to broad and extensive valley bottom wetlands.

The main risks associated with the construction and operations of the proposed activities are:

» Direct physical modification / destruction of wetlands within / in the vicinity of the footprint of the crossed by the proposed pipeline installation.
» Direct physical loss and/or modification of watercourses within the development site, both planned and accidental;
» Direct physical alteration of flow characteristics of watercourses within the development site and associated erosion and sedimentation impacts;
» Alteration of catchment surface water processes / hydrological inputs and associated erosion and sedimentation impacts; and
» Surface runoff contamination and local watercourse water quality deterioration.

The risk ratings for each of the mapped wetlands area presented in Table 4 and Figure 14 below. The proposed activities pose a potential high risk to a number of water resources units, particularly the units that which will be directly impacted by the planned infrastructure. A number of downstream/downslope systems in the vicinity of the activities (0-100m) also stand to be indirectly impacted and are generally at moderate risk of being impacted. Water resources located upstream/ upslope or within separate micro-catchments to the proposed activities were assessed as being at low or very low risk. Water resources at low to very low risk were not assigned a wetland unit number in order to highlight systems that would require further assessment.

Note: The risk ratings provided relates to the likelihood that a water resources unit may be measurably negatively affected to inform the Water Use License process. Thus, this is essentially risk screening, **not a risk assessment and risk ratings are not a representation of impact intensity / magnitude of the change.**

Table 4: Preliminary risk ratings for the mapped wetland units including rationale.

<table>
<tr><th>Risk Class</th><th>Wetland Unit Number</th><th>Rationale</th><th>Triggers baseline and impact assessment</th></tr>
<tr><td rowspan="3">High</td><td>W1</td><td rowspan="3">These water resources will be crossed by the proposed gas pipeline and are likely to incur direct and indirect (secondary impacts). Direct impacts may include the loss or modification of freshwater habitat (i.e. within the construction servitude) whereas expected secondary impacts are likely to be linked with construction runoff, road run-off, water quality and sedimentation of freshwater habitat.</td><td rowspan="3">Yes</td></tr>
<tr><td>W2</td></tr>
<tr><td>W5</td></tr>
<tr><td rowspan="3">Moderate</td><td>W4</td><td rowspan="3">These water resource units either directly downslope/downstream or directly adjacent to the proposed pipeline route. No direct impacts are expected although indirect secondary impact's linked with road run-off, water quality and sedimentation of freshwater habitat are likely to occur.</td><td rowspan="3">Yes</td></tr>
<tr><td>W6</td></tr>
<tr><td>W9</td></tr>
<tr><td rowspan="3">Low</td><td>W3</td><td rowspan="22">These water resource units are either located in separate micro-catchments or some distance downslope or downstream of the proposed development. Risk form secondary impacts are low and measurable impacts to these water resources are unlikely.</td><td rowspan="3">No</td></tr>
<tr><td>W7</td></tr>
<tr><td>W8</td></tr>
<tr><td rowspan="19">Very Low</td><td>N/A</td><td rowspan="19">No</td></tr>
<tr><td>N/A</td></tr>
<tr><td>N/A</td></tr>
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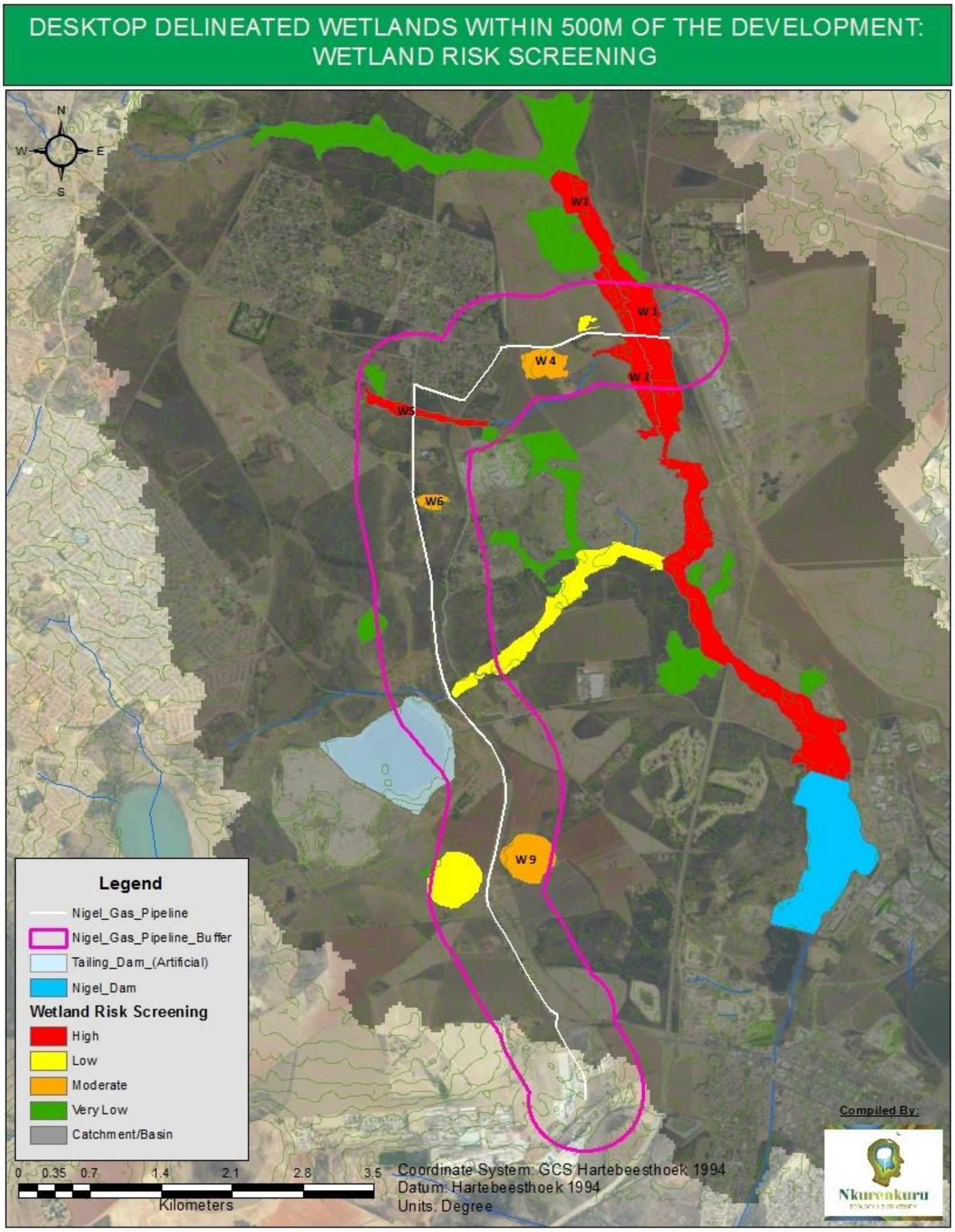


Figure 14: Desktop delineated wetlands and watercourses within 500m of the proposed development with risk screening ratings.

5 BASELINE ASSESSMENT RESULTS

The baseline habitat assessment, informed by on-site data collection, focused primarily on wetland units rated as being at **Moderate to High risk** of being impacted by the proposed activities (as per section 4 above). This section sets out the findings of the baseline assessment of those water resources units and includes:

» Delineation, Classification & Habitat Descriptions (Section 5.1);
» Present Ecological State (PES) Assessment (Section 5.2);
» Ecological Importance and Sensitivity (EIS) Assessment (Section 5.4);
» Wetland Ecosystem Services (function) Assessment (Section 5.3).

The on-site / in-field assessment of the wetlands indicators was conducted by Gerhard Botha from Nkurenkuru Biodiversity and Ecology on the 19th and 20th of February 2019.

Ultimately, it was found that there are <u>six</u> wetland features with a moderate to high risk of being impacted which required further assessment (included below).

5.1 Wetland classification, delineation and description

5.1.1 Wetland Delineation:

The water body delineation and classification were conducted using the standards and guidelines produced by the DWS (DWAF, 2005 & 2007) and the South African National Biodiversity Institute (2009).

For the DWS definitions of different hydrological features refer to Section 3.

Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of six (6) wetland units. Wetland ecosystems are the dominant drainage features in this landscape and include low lying unchanneled and channelled valley-bottoms, seeps as well as depressions (mostly endorheic) hydrogeomorphic (HGM) units. Valley-bottom wetlands occur within moderately confined, relatively gently sloping valley floor settings whereas seeps generally occur on the midslope to footslope topographies or at the head of valleys and lack distinct valley confinement. Depression wetlands, also known as pans, form within shallowed-out basins within the flatter landscape areas and are generally closed systems that are inward draining (endorheic).

The soils in the study area provided a good indication of the level of wetness of the soils and proved to be the most reliable indicator for most of the assessment (apart from areas where significant soil disturbance have occurred) used to delineate the outer wetland boundary (i.e. boundary between temporary wetland and upland/terrestrial areas). While soil form and saturation periods varied slightly across the study area, typical permanent saturated wetland soils comprised dark grey to bluish grey clay (may become lighter grey deeper) characterised by low chromas (10YR/2-4/1 or when Gley: 5PB/2.5-4 becoming 5-7) with few to no mottling and medium levels of organic matter. Dark grey to grey-brown clay-loam and clay characterised by low chromas (10YR/3-4/1; 10YR/2-5/2 and 7.5/4-5/1-2) and distinct moderately to abundant (15-30%) high chroma mottles (yellow, orange and red redox concentrations), sometimes associated with black spots of manganese concentrations, are indicative of the seasonal saturated zones. Organic material within the seasonal zone was moderate-low. The temporary wetland areas varied from dark grey-brown (7.5YR/3-5/2-4 and 10YR/3-5) to dark yellowish brown (10YR/3-5/4-6) clay-loam soils with few mottling (<7%). Mottles within the temporary zone vary from orange to red and are small to faint. Very little organic material occurs within this hydrogeomorphic zone. The origin of most onsite wetlands is considered strongly linked to their typographical/geographical location as well as the presence of an impermeable clay layer found to occur generally at 20-60cm depth that results in a poorly drained 'perched' water table resulting in wetland formation. This is coupled with the relatively gentle topographic gradient across much of the study area. Disturbance of the soil profile from infilling, excavation, historical cultivation and sediment deposition often yielded inconclusive soil samples in many areas.

Vegetation was generally found to be a good indicator of the presence of wetland habitat and in some cases the level of soil wetness. A distinct transition from terrestrial/dryland grasses towards true wetland plants (hydrophytes) including *Typha capensis, Phragmites australis, Schoenoplectus corymbosus, Leersia hexandra, Juncus oxycarpus* and *Paspalum urvillei* was evident in many instances during fieldwork, however the temporary wetland zone was almost indistinguishable from the surrounding upland (terrestrial sites), being dominated by the grasses *Themeda triandra, Eragrostis plana, E. chloromelas, Cymbopogon pospischilii* and *Hyparrhenia hirta*. Most wetlands were characterised by a vast zone of temporary saturated soils with smaller seasonal and permanent zones. At a desktop level using digital imagery, the contrast in texture between terrestrial and wetland vegetation was used in delineating the boundary of the wetland for sections of the wetland that were not ground-truthed in the field (i.e. areas beyond the site boundary).

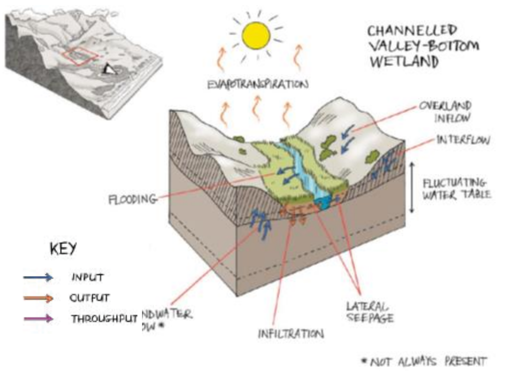
5.1.2 Wetland Classification and Habitat Assessment:

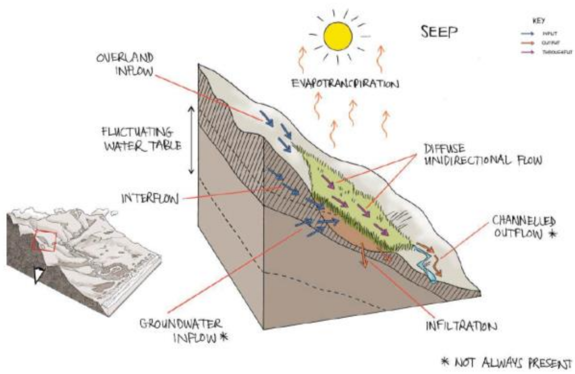
The infield delineation enabled the identification and mapping of seven (7) wetland systems, with special emphasis placed on six (6) wetland units rated as being at

Moderate to High risk of being impacted by the proposed activities, with the remainder being rated low risk following initial screening (and thus excluded further). Based on hydro-geomorphic setting these wetlands can be divided into three (3) wetland types namely; Channelled Valley-Bottom, Seeps and Depression wetlands. A brief description of these three broad types of wetlands is provided below in Table 5.

Table 5: Summary of wetland resource types (hydrogeomorphic types -HGM) encountered in the project site.

HGM Units	Description
Channelled Valley-Bottom	Wetland systems characterised by their location within moderately well-defined valley floors with the presence of an active channel, but without typical diagnostic floodplain features. Flows within these systems are characteristically confined within a define channel. Dominant water inputs to these wetlands are from the watercourse/channel flowing through the wetland, predominantly as surface flow resulting from flooding, or as a form of overland flow from adjacent hillslopes and other smaller watercourses and valley-bottom wetlands, with substantially less groundwater discharge. Water generally exits a channelled valley-bottom wetland in the form of diffuse surface or subsurface flow in the adjacent river, with infiltration into the ground and evapotranspiration of water also being potentially significant.
SEEPS	Wetlands located on gently to steep sloping hillslopes/valley sides fed primarily by lateral subsurface water inputs from shallow groundwater occurring over an impermeable substrate. Water movement driven by colluvial unidirectional movement. Water movement and through flow is generally as interflow with diffuse overland flow (sheetwash) becoming more prominent during and after rainfall events. Outflow can either be contained within a channel or without a channel.
Depressions	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. Depressions may be flat-bottomed (in which case they are often referred to as pans) or round-bottomed and may have any combination of inlets and outlets or lack them completely. Water input are typically surface and groundwater-fed. Wetland separated from underlying aquifer by lower permeability layer. Input from groundwater discharge, when groundwater table is high, precipitation, surface runoff and possibly spring flow. Groundwater input may be restricted by lower permeability layer. Output by evaporation and groundwater recharge when groundwater table low.





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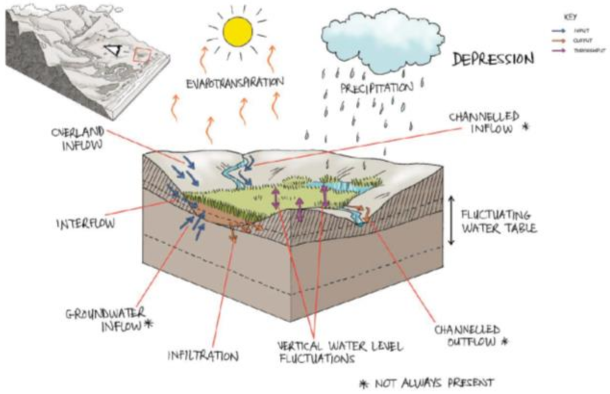

Figure 15: Conceptual illustration of the different HGM types, affected by the proposed development, showing the dominant inputs, throughputs and outputs of water (copied from Ollis et al., 2013).

Detailed descriptions of each wetland unit, including type, habitat/vegetation characteristics and notable existing impacts are provided below.

Wetland Unit 1 (W1):

- » <u>HGM TYPE</u>: Channelled Valley-bottom Wetland
- » <u>Extent</u>: 144ha
- » <u>Elevation:</u> 1 567m (Mean); 1 588m (Max); 1 548m(Min)
- » <u>Slope</u>: 2.12% (Mean); 6.44% (Max)
- » <u>Wetness Characteristics</u>: All three hydrogeomorphic zones are present with the temporary zone being the dominant zone. The seasonal zone is also relative well represented with the permanent zone mostly confined to the channels, back flooded area and shallow pools (reed and sedge beds).
- » <u>Soil Characteristics</u>:
  - Permanent saturated zone with a grey clayey soil matrix with medium organic material and no mottles
  - Seasonal saturated zone with a dark grey (can be bluish) clay to dark grey-brown clay/clay-loam soil matrix with little organic material and high chroma mottles (orange and yellow).
  - Temporary saturated zone with a dark grey-brown clay-loam matrix and almost no organic material and fewer high chroma mottles (orange and red).
- » <u>General Hydrological and Geomorphological Description</u>:
  - The most significant and extensive HGM unit within the affected basin. Most of the other HGM units and watercourses drain into this unit which in turn generally drain into a south to south-eastern direction, into the Nigel Dam. Less than 3km further south this system terminates into the Blesbokspruit River. Water inputs are primarily driven by surface water inputs from the watercourse channel as well as from other wetland tributaries and to a lesser extent from overland flow from adjacent

hillslopes, surface run-off and interflow. Lateral flows do however play an important role within the wetland itself contributing to water exchange between the channel and adjacent wetland areas. Low flows (flow during dry season) are typically strictly confined within the channel whilst some overbank flow and lateral inflow will saturate the seasonal and some of the temporary saturated zones. Dams and impeding structures have resulted in shallow flooded areas with the absence of clearly defined channels. Here throughflow is mostly diffuse through bulrush, reed and sedge beds until the water is channelled again through - for example - a culvert.

» General Vegetation Description:

- Permanent Saturated Zone: Channels and shallow seasonally inundated pools comprising of tall, dense plant communities typically T*ypha capensis, Pycreus polystachyos*, *Schoenoplectus corymbosus, Leersia hexandra, Persicaria lapathifolia* and *Juncus oxycarpus*. The most important phyto-communities within this zone are the dense T. capensis and *Phragmites australis* communities which typically form within the back-flooded sections, upstream of impeding structures such as large road crossings and dam structures.
- Seasonal saturated zone: Medium tall and relative dense wet grassland communities comprising of numerous grass and sedge species including; *Agrostis lachnantha, Andropogon appendiculatus, Eragrostis plana, Eragrostis planiculmis, Helictotrichon turgidulum, Paspalum dilatatum, Cyperus denudatus, Kyllinga erecta* and *Juncus effusus*. Also dominant within this zone are forbs such as; *Berkheya radula, Haplocarpha lyrata*, *Helichrysum aureonitens, Plantago virginica, Senecio inornatus* and *Verbena bonariensis*.
- Temporary saturated zone: Short to medium grassland varying in density from medium to relative sparse depending on the level of disturbance. Phyto-communities within this zone are dominated by grass species. Dominant species includes; *Paspalum diladatum, Eragrostis racemosa, E. plana, E. gummiflua, E. chloromelas, Cynodon dactylon, Aristida junciformis* and *Andropogon eucomus*

» Existing Impacts:

- Increase in flows (water inputs from catchment) due to:
  - Urban and mining activities;
  - Increase in hard surfaces (buildings, roads);
  - Storm water systems and artificial drainage systems channelling surface flow into the wetland;
  - Water release from a Sewage Treatment Plant; and
  - A general reduction in roughage (vegetation cover)
- Impacts within wetland boundaries
  - Number of small dams;

- Portions of the wetland have been artificially channelled;
- Infilling and excavation is probably the most significant impact within the wetland itself and is mostly associated with road crossings. These features act as barriers to the natural flow pattern and have resulted in an increase in flooding above the structures as well as strongly channelled flow through the culvert systems resulting in some desiccation of portions of the wetland downstream;
- Livestock grazing (predominantly cattle) and trampling have resulted in a decrease in roughage especially within the temporary zone where the exposed soils have become exposed to some levels of sheet erosion and soil capping; and
- Some of the outer portions of the wetland have been subjected to ploughing and cultivation.

Wetland Unit 2 (W2):

» HGM TYPE: Hillslope seepage
» Extent: 35.58ha
» Elevation: 1 582m (Mean); 1 588m (Max); 1 572m(Min)
» Slope: 2.09% (Mean); 4.9% (Max)
» Wetness Characteristics: All three hydrogeomorphic zones are present with the temporary zone being the overwhelmingly dominant zone. The seasonal zone is relative well represented within the northern portion of this wetland (north of the M45 Road) as well as below the point where water is artificially released via a storm water drain. The only permanent saturated zone is associated with the small dam structures located within the northern portion (north of the M45).
» Soil Characteristics:
  - Permanent saturated zone: Due to the fact that this zone was associated within the dam structures located in the northern portion of the wetland, well outside and beyond the potential impact area, it was not deemed necessary to conduct any soil samples within this zone.
  - Seasonal saturated zone with a grey clay to dark grey-brown clay/clay-loam soil matrix with little organic material and high chroma mottles (orange and yellow).
  - Temporary saturated zone with a grey-brown clay-loam matrix and almost no organic material and fewer high chroma mottles (orange and red).
» General Hydrological and Geomorphological Description:
  - The seep is situated along the western boundary of Wetland 1 and is an almost linear features, draining in an eastern direction, into Wetland 1. The western half of the seep has a straight to slightly convex slope (also slightly steeper slope) which transitions into a slightly concave slope

towards the eastern boundary. This seep is primarily fed by lateral inflow as well as surface runoff (to a lesser extent). However, surface input has been slightly increased due to an artificial storm water channel. Through flow is diffuse interflow as well as sheetwash.

» General Vegetation Description:
- Permanent Saturated Zone: Due to the fact that this zone was associated within the dam structures located in the northern portion of the wetland, well outside and beyond the potential impact area, it was not deemed necessary to conduct any vegetation sampling within this zone.
- Seasonal saturated zone: Medium tall and relative dense wet grassland communities comprising of numerous grass and sedge species including; *Pycreus mundtii, Themeda triandra*, *Cynodon dactylon, Imperata cylindrica*, *Andropogon appendiculatus, Eragrostis plana, Helictotrichon turgidulum, Paspalum dilatatum Cyperus denudatus, Kyllinga erecta* and *Juncus effusus*. Also dominant within this zone are forbs such as; *Berkheya radula, Haplocarpha lyrata*, *Helichrysum aureonitens, Plantago virginica, Senecio inornatus* and *Seriphium plumosum*.
- Temporary saturated zone: Short to medium grassland varying in density from medium to relative sparse depending on the level of disturbance. Phyto-communities within this zone are dominated by grass species. Dominant species includes; *Paspalum diladatum, Eragrostis racemosa, E. plana, E. gummiflua, E. chloromelas, Cynodon dactylon, Aristida junciformis* and *Andropogon eucomus.*

» Existing Impacts:
- Increase in surface inputs (overland flow) and a reduction in lateral flow (water inputs from catchment) due to:
  - Reduction in roughage (vegetation cover) due to overgrazing and removal of vegetation cover resulting in reduced infiltration;
  - Cultivation practices;
  - Hard surfaces (M45 Road) reducing water infiltration;
  - Artificial drainage channel (storm water channel);
  - Increase in hard surfaces (buildings, roads);
- Impacts within wetland boundaries
  - Two artificial dams within the northern portion of the wetland;
  - Overgrazing and trampling;
  - Sheet erosion and some rill erosion;
  - Soil capping;
  - M45 Road crossing;
  - Existing pipeline infrastructure;
  - Soil disturbance due to past cultivation and grading activities.

Wetland Unit 4 (W4):

- <u>HGM TYPE</u>: Depression Wetland
- <u>Extent</u>: 10.5ha
- <u>Elevation:</u> 1 602m (Mean); 1 607m (Max); 1 599m(Min)
- <u>Slope</u>: 2.26% (Mean); 5.1% (Max)
- <u>Wetness Characteristics</u>: All three hydrogeomorphic zones are present with the temporary zone being the dominant zone. The seasonal and permanent zone is restricted to the eastern half of the depression wetland due to surface runoff from the north being channelled into the eastern half of the wetland through a singular culvert. Inundation is seasonal following sufficient rainfall and compromise a small portion of the wetland.
- <u>Soil Characteristics</u>:
  - Permanent saturated zone with a grey clayey soil matrix with medium organic material. Mottles are very few and appear within the soil profile at a depth of >20cm and are typically yellow colour.
  - Seasonal saturated zone provided two variations. Near the permanent saturated area this zone comprised a dark-grey clayey soil matrix with less organic material than the permanent zone. Followed this layer is a light grey matrix comprising numerous and large orang mottles. Towards the western portion of this zone the soil comprises a yellowish-brown clay-loam soil matrix with little organic material and numerous high chroma mottles (red, orange and yellow).
  - Temporary saturated zone with a dark grey-brown clay-loam matrix and almost no organic material and fewer mottles (high chroma mottles; orange and red).
- <u>General Hydrological and Geomorphological Description</u>:
  - This depression wetland is a naturally near-closed contoured system with relative well-defined slopes to the west, north and south and a slightly open contoured area to the east where outflow may occur when sufficient levels of water have been collected. Subsequently outflow is in an eastern direction and in a diffuse manner. However, water inputs are very seldom sufficient enough for water to accumulate to the point where outward drainage can occur. Water inputs are typically predominantly from surface inputs and to a lesser extent from groundwater (due to restricted lower permeability layer). Water input and flooding characteristics have been largely affected by the surrounding land use practices and disturbances. Especially inflow from the west as well as the north has been significantly affected, to an extent where natural inflow has been reduced especially from the west. Drainage from the north has been channelled through a culvert associated with the elevated M45 Road. This has led to the channelling of water through a specific area and in turn has affected flooding characteristics. Flooding now mostly occurs in the eastern half of the

wetland with a small portion being inundated seasonally after sufficient rainfall. Some desiccation of the western portion has occurred.

» General Vegetation Description:
- Permanent Saturated Zone: Characterised by a relative short and dense vegetation cover dominated by sedges and moisture loving grass species. Key and diagnostic species within this unit includes: *Eleocharis dregeana, Juncus dregeanus Schoenoplectus decipeins* and *Eragrostis planiculmis.* Other noteworthy species includes; *Eragrostis micrantha, Pycreus macranthus*, *Aponogeton junceus, Cycnium tubulosom, Denekia capensis, Helichrysum aureonitens, Ranunculus meyeri* and *Cerastium spp.*
- Seasonal saturated zone: Medium tall and relative dense wet grassland communities comprising predominantly of; *Eragrostis planiculims, Kylinga erecta, Cyperus denudatus, Aristida junciformis, and Eragrostis gummiflua*. Other noteworthy species recorded within this zone includes; *Cycnium tubulosum, Eragrostis plana, Helichrysum rugulosum, Cynodon dactylon, Centella asiatica, Setaria sphacelata var. sericea, Ranunculus meyeri, Themeda triandra* and *Monopsis decipeins*.
- Temporary saturated zone: Highly disturbed vegetation layer comprising of moist grassland. Key and diagnostic species vary within this unit, depending on the level of disturbance. Typical species found within this unit includes; *Eragrostis plana, Helichrysum nodifolium, Cynodon dactylon, Eragrostis chloromelas, Eragrostis curvula, Aristida junciformis* and *Eragrostis gummiflua*.

» Existing Impacts:
- Catchment disturbances: Significantly impacted quantity and pattern of inflow as well as flooding extent and pattern:
  - Impeding structures: M45 road, railway line, other minor roads;
  - Cultivation practices;
  - Single culvert providing drainage underneath the M45 road, channelling surface flow into the wetland
- Impacts within wetland boundaries
  - Overgrazing and trampling;
  - Grading and excavation of wetland soil (western portion);
  - Past cultivation of a portion (south-western corner) of the wetland;
  - M45 Road and associated culvert (infilling and excavation);

Wetland Unit 5 (W5):

» HGM TYPE: Channelled Valley Bottom Wetland
» Extent: 9.82ha
» Elevation: 1 589m (Mean); 1 597m (Max); 1 585m(Min)
» Slope: 1.99% (Mean); 5.18% (Max)

» Wetness Characteristics: All three hydrogeomorphic zones are present with the temporary zone being the dominant zone. The permanent zone is a very narrow linear features largely impacted by artificial channelling. The seasonal saturated zone is slighter better represented within this wetland but the extent has also been impacted by the artificial drains. Upstream of the M63 road an extensive flooded area has been artificial created due to the road as well as a dam structure acting as impeding structures to the natural drainage of the wetland. Artificial flooding has resulted in a substantial increase in the permanent and seasonal saturated zones west of the M63 Road.

» Soil Characteristics: Soils have been significantly disturbed for large portions of this zone as a result of construction activities, artificial drainage systems as well as illegal mining activities. Large portions of the wetland have been "polluted" with excess infill material.

- Permanent saturated zone: Areas where soil disturbance are minimal are characterised by a dark-grey clayey soil matrix with medium organic material and no mottles.
- Seasonal saturated zone: Areas where soil disturbance are minimal are characterised by a dark grey-brown clay/clay-loam soil matrix with little organic material and high chroma mottles (orange and yellow).
- Temporary saturated zone: Areas where soil disturbance are minimal are characterised by grey-brown clay-loam matrix and almost no organic material and few high chroma mottles (orange and red). The grey-brown soil matrix transitions into a lighter orange-brown matrix, within which most of the mottles are concentrated.

» General Hydrological and Geomorphological Description:

- Hydrological and geomorphological integrity of this wetland have been significantly impacting through catchment as well as wetland disturbances. Drainage within the wetland occurs in an eastern direction and is partially diffuse (through dense reed beds) and partially confined (within artificial drainage channel) within the western portion of the wetland. East of the M63 road drainage is mostly confined within two artificial drainage channels, however these channels are shallow and overbank flow do occur during peak flow. Low flows are normally strictly restricted to the channels. Water inputs are driven primarily by surface water inputs from the watercourse channel, two seepage wetlands feeding into the head of the wetland as well as overland flow from adjacent hillslopes. Lateral flows also likely play a more significant role within the headwater portion of the wetland. Dams and impeding structures have resulted in shallow flooded areas north of the M63 Road. Out flow have been significantly restricted due to mining activities. The head region of the wetland is slightly concave (longitudinally) and contains a larger low-lying valley section confined be steeper sides (broader concave cross-section) in comparison with the rest of the wetland. As the wetland cross the M63 Road the wetland becomes more convex with a slightly steeper slope (longitudinally). The cross-section of the wetland also becomes slightly narrower and less concave east of the M63 Road. Some out flow does however occur as lateral flow and diffuse surface flow into a downstream wetland which ultimately feed into Wetland unit 1.

» General Vegetation Description: Vegetation structure and composition have been severely altered due to numerous forms of disturbances.
  - Permanent Saturated Zone: Back-flooded, shallow pools west of the M63 Road are dominated by dense *Phragmites australis* and to a lesser extent *Typha capensis* beds. Small, shallow inundated pools downstream of the M63 Road are either characterised by *dense Typha capensis* stands accompanied with *Leersia hexandra*, and *Paspalum urvillei* or by sedge dominated phyto-community comprising of *Kylinga melanosperma, K. erecta, Agrostis lachnantha, Leersia hexandra, Paspalum diladatum, Juncus* spp. and *Fuirena pubescens*. Vegetated channels typically comprise of *Cyperus congestus, Juncus oxycarpus, Juncus exertus, Paspalum diladatum, Verbena bonariensis, Cirsium vulgare, Schoenoplectus corymbosus* and *Plantago longissima*.
  - Seasonal saturated zone: Medium tall and relative dense wet grassland communities comprising of numerous grass and sedge species as well as alien forbs. Species typically recorded within this zone include; *Agrostis lachnantha, Verbena bonariensis, Kylinga erecta, Cyperus congestus, Cyperus congestus, C. denudatusFuirena pubescens, Cynodon dactylon, Berkheya radula, Plantago major, Cirsium vulgare* and *Setaria sphacelata.* Also relatively frequently observed within this zone are; *Andropogon eucomus, Eragrostis plana, Haplocarpha lyrata, Cotula anthemoides, Paspalum urvillei* and *Paspalum diladatum*.
  - Temporary saturated zone: Low density, short to medium mixed grassland. Typical species found within this unit includes; *Verbena bonariensis, Cynodon dactylon, Eragrostis chloromelas, Paspalum dilatatum, Aristida junciformis, Eragrostis plana, Hyparrhenia hirta, Plantago lanceolata* and *Senecio inornatus*.

» Existing Impacts:
  - Catchment disturbances: Significantly impacted quantity and pattern of inflow as well as flooding extent and pattern:
    - Impeding structures: M63 road, Carr Road and other minor roads;
    - Mining activities;
    - Soil disturbance and excavation activities;
    - Severe reduction in vegetation cover within the catchment;
    - Hard surfaces (southern periphery of the town of Dunnotar as well as well as a RDP housing development to the south-west)
  - Impacts within wetland boundaries

- Impeding features: M63 Road, Carr Road and two artificial dams north of the M63 road;
- Grading and excavation of wetland soil (western portion);
- Artificial channelling of surface runoff within the wetland;
- Water pipeline
- Illegal small-scale artisanal surface mining activities (just east of the R51 crossing of wetland feature 5)
- M45 Road and associated culvert (infilling and excavation);
- Large portions of the wetland have been "polluted" with excess infill material.
- Invasion with Alien Invasive Plants (AIPs).

Wetland Unit 6 (W6):

» HGM TYPE: Depression Wetland
» Extent: 9.82ha
» Elevation: 1 589m (Mean); 1 597m (Max); 1 585m(Min)
» Slope: 1.58% (Mean); 4.95% (Max)
» Wetness Characteristics: All three hydrogeomorphic zones are present with the temporary zone being the dominant zone. The seasonal zone is also relative well represented with the relatively restricted permanent zone.
» Soil Characteristics:
  - Permanent saturated zone with a grey clayey soil matrix with medium organic material. Mottles are very few and appear within the soil profile at a depth of >20cm and are typically yellow colour.
  - Seasonal saturated zone provided two variations. Near the permanent saturated area this zone comprised a dark-grey clayey soil matrix with less organic material than the permanent zone. Followed this layer is a light grey matrix comprising numerous and large orang mottles. Towards the western portion of this zone the soil comprises a yellowish-brown clay-loam soil matrix with little organic material and numerous high chroma mottles (red, orange and yellow).
  - Temporary saturated zone with a dark grey-brown clay-loam matrix and almost no organic material and fewer mottles (high chroma mottles; orange and red).
» General Hydrological and Geomorphological Description:
  - This depression wetland is a naturally near-closed contoured system with relative well-defined slopes to the west and north and a slightly open contoured area to the east where outflow may occur when sufficient levels of water have been collected. Subsequently outflow is in an eastern direction and in a diffuse manner (lateral outflow as well as overland flow). However, water inputs are very seldom sufficient enough for water to accumulate to the point where outward drainage

overland flow can significantly occur. Lateral outflow however, may occur more frequently. Water inputs are likely from both surface and sub-surface inputs (sub-surface or lateral flows may however be somewhat restricted in some areas due to lower permeability layer). Water input have not been significantly impacted, with some impacts occurring as a result of the M63 road as well as a reduction in roughage (vegetation cover) within the catchment (may influence infiltration rates). Subsequently, flooding and saturation within the wetland itself have remained largely unchanged.

» General Vegetation Description:
- Permanent Saturated Zone: Small zone to the east of the depression comprising mostly of short to medium sedges such as *Eragrostis planiculmis, Kylinga erecta, Cyperus denudatus, Themeda triandra, Eragrostis plana,* and *Schistostephium crataegifolium*. Other noteworthy species recorded within this zone included; *Cycnium tubulosum, Agrostis lachnantha, Berkeya radula, Helichrysum rugolosum, Leersia hexandra, Schoenoplectus decipeins, Panicum schinzii, Diclis reptans*, *Hermannia erodioides,* and *Cerastium arabidis*.
- Seasonal saturated zone: Wet grassland dominated by medium tall, moisture loving grasses. Key species includes; *Aristida junciflora, Kylinga erecta, Schistostephium crataegifolium, Agrostis lachnantha* and *Fuirena pubescens*. Other noteworthy species include; *Lobelia flaccida, Nidorela undulata, Senecio erubescens, S. inaequidens, Berkheya radula, Scabiosa columbaria, Eragrostis chloromelas, E. curvula. E. plana, Helichrysum rugulosum, Verbena bonariensis, Pycreus macranthus* and *Cotola anthemoides.*
- Temporary saturated zone: Overgrazed sparse grass cover comprising of sghort to medium tall grasses and various forbs including; *Eragrostis chloromelas, Themeda triandra, Cynodon dactylon, Ledebouria cooperi, L. revoluta* and *Hypoxis hemerocallideae*.

» Existing Impacts:
- Catchment disturbances: Slightly impacting quantity and pattern of inflow as well as flooding extent and pattern:
  - Impeding structures: M63 road;
  - Reduction of roughage (Vegetation): Secondary grassland (old ploughed land) and some overgrazing of the primary grassland.
- Impacts within wetland boundaries
  - Impeding features: Small portion of wetland (southern portion) impacted by gravel road);
  - Slight reduction of roughage: Some indication of grazing;

Wetland Unit 9 (W9):

- HGM TYPE: Depression Wetland
- Extent: 18ha
- Elevation: 1 588m (Mean); 1 596m (Max); 1 586m(Min)
- Slope: 2% (Mean); 6.84% (Max)
- Wetness Characteristics: All three hydrogeomorphic zones are present with the temporary zone being the dominant zone. The seasonal zone is also relative well represented with the permanent zone mostly confined to the channels, back flooded area and shallow pools (reed and sedge beds).
- Soil Characteristics:
  - Permanent saturated zone with a dark grey-brown clayey soil matrix with medium organic material and no mottles. The soil overlay a relative shallow bedrock
  - Seasonal saturated zone with a dark grey-brown clay/clay-loam soil matrix with little organic material and an abundance of high chroma mottles (orange and yellow). Soil depth in some areas restricted by shallow bedrock.
  - Temporary saturated zone with a reddish-brown clay-loam matrix and almost no organic material and fewer high chroma mottles (orange and red). Soil depth in some areas restricted by shallow bedrock, which may even become exposed.
- General Hydrological and Geomorphological Description:
  - This depression wetland is a naturally closed contoured system with relative well-defined slopes right around the wetland. Subsequently, no surface outflow can occur and water movement out of the wetland occur in the form of evaporation, evapotranspiration and lateral outflow (infiltration and sub-surface outflow). Water input occurs as overland flow, and interflow, mostly from the north and the east. Water inputs have been significantly impacted, with some impacts occurring as a result of the M63 road; railway line as well as agricultural practices surrounding the wetland (cultivation). Subsequently, flooding and saturation within the wetland itself have been altered to some extent.
- General Vegetation Description:
  - Permanent Saturated Zone: Small zone to the south-east of the depression comprising mostly of a dense grassland comprising of moisture loving species such as *Paspalum dilatatum, P. distichum, Panicum schinzii, Cyperus esculentis, C. denudatus, C. longus* and *Juncus oxycarpus*. Other noteworthy species recorded within this zone included; *Eleocharis dregeana, Schoenoplectus decipeins, Paspalum scrobiculatum* and *Schoenoplectus muricinux*.
  - Seasonal saturated zone: Wet grassland dominated by medium tall, moisture loving grasses. Key species includes; *Eragrostis plana, E. racemosa, E. gummiflua, E. planiculmis* and *Cynodon dactylon*. Other

noteworthy species include; *Pycreus mundtii, Kyllinga erecta, Panicum shinzii, P. maximum, Nidorela undulata* and *Agrostis montevidensis*.

- Temporary saturated zone: Medium tall grassland dominated by *Eragrostsis plana, E. chloromelas* and *Cynodon dactylon*.

» <u>Existing Impacts</u>:

- Catchment disturbances: Significantly impacted quantity and pattern of inflow as well as flooding extent and pattern:
  - Impeding structures: M45 road, railway line, other minor roads;
  - Cultivation practices;
  - Reduction in roughage (grading and removal of soil and overgrazing)
- Impacts within wetland boundaries
  - Overgrazing and trampling;
  - Infilling and excavation (railway line, power line);
  - Portions (outer fringe) of the temporary zone have been transformed through cultivation;
  - Reduced roughage due to overgrazing and trampling as well as the presence of smaller gravel (twin track) roads.

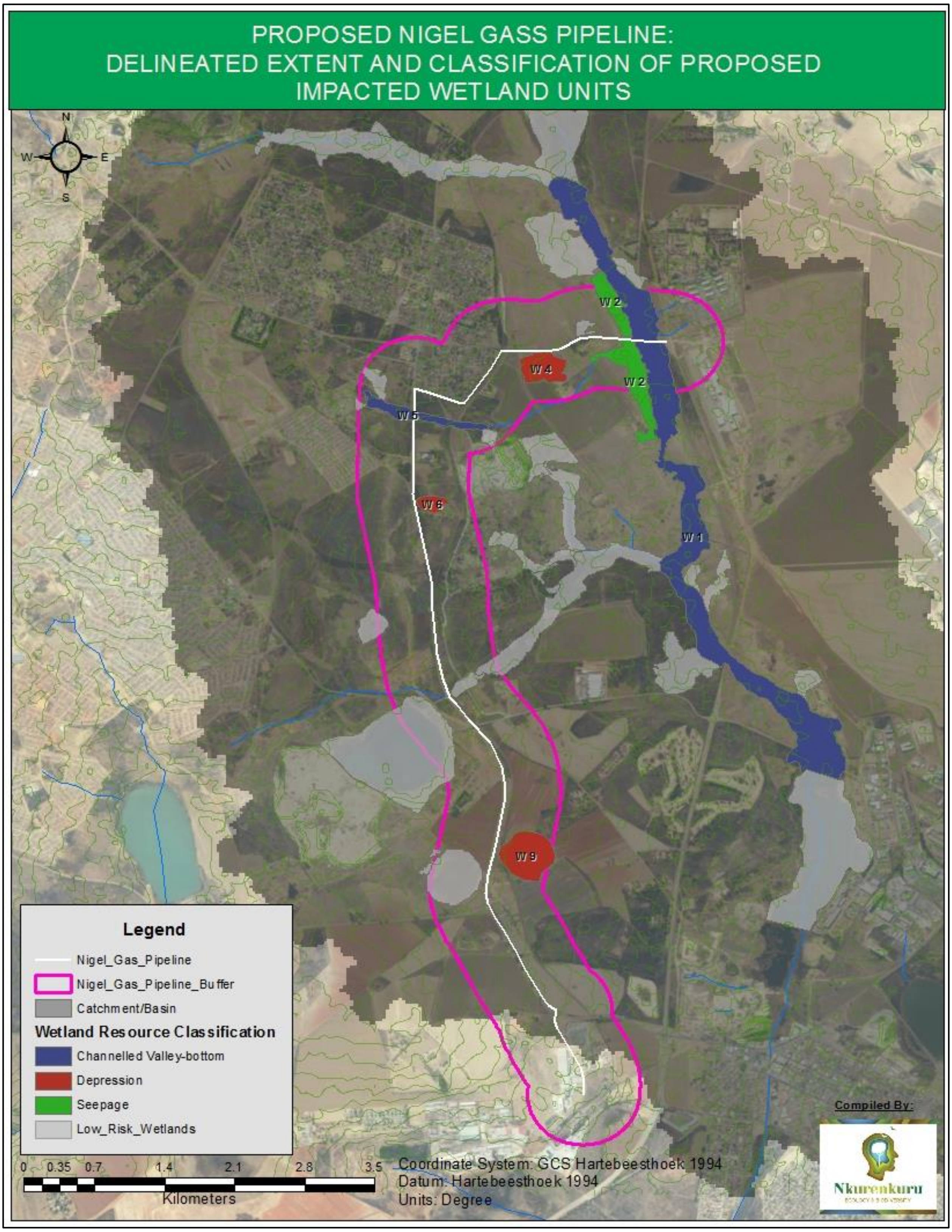

Figure 16: The delineated extent and classification of wetland resource units assessed within the project site.

Table 6: List of species recorded within the delineated wetland habitats.

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Bulrush	Typhaceae	*Typha capensis*	OW	Indigenous
Cyperoid	Cyperaceae	*Carex glomerabilis*	OW	Indigenous
Cyperoid	Cyperaceae	*Cyperus congestus*	F	Weed
Cyperoid	Cyperaceae	*Cyperus denudatus*	OW	Indigenous
Cyperoid	Cyperaceae	*Cyperus digitatus*	OW	Indigenous
Cyperoid	Cyperaceae	*Cyperus esculentis*	FU	Alien Plant
Cyperoid	Cyperaceae	*Cyperus longus var. tenuiflorus*	OW	Indigenous
Cyperoid	Cyperaceae	*Cyperus marginatus*	OW	Indigenous
Cyperoid	Cyperaceae	*Cyperus rigidifolius*	FU	Indigenous
Cyperoid	Cyperaceae	*Eleocharis dregeana*	OW	Indigenous
Cyperoid	Cyperaceae	*Eleocharis dulcis*	OW	Indigenous
Cyperoid	Cyperaceae	*Fimbristylis complanata*	OW	Indigenous
Cyperoid	Cyperaceae	*Fuirena pubescens*	OW	Indigenous
Cyperoid	Cyperaceae	*Kyllinga erecta*	F	Indigenous
Cyperoid	Cyperaceae	*Kyllinga melanosperma*	OW	Indigenous
Cyperoid	Cyperaceae	*Pycreus macranthus*	OW	Indigenous
Cyperoid	Cyperaceae	*Pycreus mundtii*	OW	Indigenous
Cyperoid	Cyperaceae	*Pycreus polystachyos var. polystachyos*	OW	Indigenous
Cyperoid	Cyperaceae	*Schoenoplectus brachyceras*	OW	Indigenous
Cyperoid	Cyperaceae	*Schoenoplectus corymbosus*	OW	Indigenous
Cyperoid	Cyperaceae	*Schoenoplectus decipeins*	OW	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Cyperoid	Cyperaceae	*Schoenoplectus muricinux*	OW	Indigenous
Dwarf Shrub	Asteraceae	*Felicia muricata*	OP	Indigenous
Dwarf Shrub	Asteraceae	*Seriphium plumosum*	FU	Weed
Dwarf Shrub	Scrophulariaceae	*Selago densiflora*	OP	Weed
Forb	Acanthaceae	*Crabbea acaulis*	OP	Indigenous
Forb	Alliaceae	*Tulbaghia acutiloba*	FU	Indigenous
Forb	Apiaceae	*Alepidea spp.*	F	Indigenous
Forb	Apnogetonaceae	*Aponogeton junceus*	OW	Indigenous
Forb	Apocynaceae	*Cordylogyne globosa*	F	Indigenous
Forb	Apocynaceae	*Xysmalobium spp.*	FU	Indigenous
Forb	Asteraceae	*Berkheya radula*	F	Indigenous
Forb	Asteraceae	*Berkheya setifera*	F	Indigenous
Forb	Asteraceae	*Bidens bipinnata*	OP	Alien Plant
Forb	Asteraceae	*Campaluclinium macrocephalum*	OP	Alien Invasive Plant (Category 1b)
Forb	Asteraceae	*Cirsium vulgare*	FU	Alien Invasive Plant (Category 1b)
Forb	Asteraceae	*Conyza bonariensis*	OP	Alien Plant
Forb	Asteraceae	*Cosmos bipinnatus*	OP	Alien Plant
Forb	Asteraceae	*Cotula anthemoides*	OW	Indigenous
Forb	Asteraceae	*Crepis hypocoeridea*	OP	Indigenous
Forb	Asteraceae	*Denekia capensis*	OW	Indigenous
Forb	Asteraceae	*Gazania krebsiana*	OP	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Forb	Asteraceae	*Geigeria burkei*	OP	Weed
Forb	Asteraceae	*Haplocarpha lyrata*	F	Indigenous
Forb	Asteraceae	*Haplocarpha scaposa*	FW	Indigenous
Forb	Asteraceae	*Helichrysum aureonitens*	FW	Indigenous
Forb	Asteraceae	*Helichrysum nudifolium*	FW	Indigenous
Forb	Asteraceae	*Helichrysum pallidum*	FU	Indigenous
Forb	Asteraceae	*Helichrysum pilosellum*	FW	Indigenous
Forb	Asteraceae	*Helichrysum rugulosum*	FU	Indigenous
Forb	Asteraceae	*Lactuca inermis*	OP	Weed
Forb	Asteraceae	*Nidorela undulata*	F	Weed
Forb	Asteraceae	*Oncosiphon piluliferum*	FU	Weed
Forb	Asteraceae	*Pseudognaphalium luteo-album*	FU	Weed
Forb	Asteraceae	*Schistostephium crataegifolium*	F	Indigenous
Forb	Asteraceae	*Schkuhria pinnata*	OP	Alien Plant
Forb	Asteraceae	*Senecio achilleifolius*	OW	Indigenous
Forb	Asteraceae	*Senecio erubescens*	OW	Indigenous
Forb	Asteraceae	*Senecio inaequidens*	FU	Indigenous
Forb	Asteraceae	*Senecio inornatus*	FW	Weed
Forb	Asteraceae	*Senecio spp.*	FW	Indigenous
Forb	Asteraceae	*Tagetes minuta*	OP	Alien Plant
Forb	Asteraceae	*Vernonia oligocephala*	FU	Indigenous
Forb	Brassicaceae	*Nasturtium officinale*	OW	Alien Invasive Plant (Category 2)

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Forb	Campanulaceae	*Wahlenbergia undulata*	FW	Indigenous
Forb	Caryophyllaceae	*Cerastium arabidis*	OW	Indigenous
Forb	Commelinaceae	*Commelina africana*	OP	Weed
Forb	Commelinaceae	*Cyanotis speciosa*	FW	Indigenous
Forb	Disacaceae	*Scabiosa columbaria*	FW	Indigenous
Forb	Eriocaulaceae	*Eriocaulon spp.*	OW	Indigenous
Forb	Fabaceae	*Indigofera spp.*	F	Indigenous
Forb	Fabaceae	*Lessertia spp.*	F	Indigenous
Forb	Fabaceae	*Trifolium africanum*	F	Indigenous
Forb	Gentianaceae	*Chironia palustris*	OW	Indigenous
Forb	Gentianaceae	*Chironia purpurascens*	F	Indigenous
Forb	Hypericaceae	*Hypericum lalandii*	OW	Indigenous
Forb	Lobeliaceae	*Lobelia flaccida*	F	Indigenous
Forb	Lobeliaceae	*Monopsis decipeins*	F	Indigenous
Forb	Malvaceae	*Hermannia depressa*	OP	Indigenous
Forb	Malvaceae	*Hermannia erodioides*	FW	Indigenous
Forb	Marsileaceae	*Marsilea macrocarpa*	OW	Indigenous
Forb	Onagraceae	*Oenothera biensis*	OP	Alien Plant
Forb	Onagraceae	*Oenothera rosea*	F	Alien Plant
Forb	Orobanchaceae	*Cycnium tubulosum*	OW	Indigenous
Forb	Oxalidaceae	*Oxalis obliquifolia*	F	Indigenous
Forb	Plantaginaceae	*Plantago lanceolata*	FU	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Forb	Plantaginaceae	*Plantago longissima*	OW	Indigenous
Forb	Plantaginaceae	*Plantago major*	F	Alien Plant
Forb	Plantaginaceae	*Plantago virginica*	F	Alien Plant
Forb	Polygalaceae	*Polygala hottentotta*	FW	Indigenous
Forb	Polygonaceae	*Persicaria lapathifolia*	OW	Alien Plant
Forb	Polygonaceae	*Persicaria serrulata*	OW	Alien Plant
Forb	Ranunculaceae	*Ranunculus meyeri*	OW	Indigenous
Forb	Ranunculaceae	*Ranunculus multifidus*	OW	Indigenous
Forb	Rubiaceae	*Pentanisia angustifolia*	OP	Indigenous
Forb	Scrophulariaceae	*Diclis reptans*	OW	Indigenous
Forb	Solanaceae	*Datura stramonium*	OP	Alien Invasive Plant (Category 1b)
Forb	Solanaceae	*Solanum sisymbrifolium*	OP	Alien Invasive Plant (Category 1b)
Forb	Verbenaceae	*Verbena aristigera*	OP	Alien Invasive Plant (Category 1b)
Forb	Verbenaceae	*Verbena bonariensis*	FU	Alien Invasive Plant (Category 1b)
Geophyte	Agavaceae	*Chlorophytum cooperi*	OP	Indigenous
Geophyte	Agavaceae	*Chlorophytum fasciculatum*	FU	Indigenous
Geophyte	Amaryllidaceae	*Nerine angustifolia*	OW	Indigenous
Geophyte	Hyacinthaceae	*Eucomis autumnalis*	FW	Indigenous
Geophyte	Hyacinthaceae	*Ledebouria cooperi*	F	Indigenous
Geophyte	Hyacinthaceae	*Ledebouria revoluta*	FW	Indigenous
Geophyte	Hypoxidaceae	*Hypoxis argentea*	F	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Geophyte	Hypoxidaceae	*Hypoxis hemerocallidea*	FW	Indigenous
Geoxylic suffrutex	Fabaceae	*Elephantorrhiza elephantina*	OP	Weed
Geoxylic suffrutex	Fabaceae	*Erythrina zeyheri*	FW	Indigenous (Protected)
Graminoid	Poaceae	*Agrostis lachnantha*	OW	Indigenous
Graminoid	Poaceae	*Agrostis montevidensis*	F	Indigenous
Graminoid	Poaceae	*Andropogon appendiculatus*	OW	Indigenous
Graminoid	Poaceae	*Andropogon eucomus*	OW	Indigenous
Graminoid	Poaceae	*Aristida bipartitia*	FU	Indigenous
Graminoid	Poaceae	*Aristida congesta*	OP	Indigenous
Graminoid	Poaceae	*Aristida junciformis*	FU	Indigenous
Graminoid	Poaceae	*Brachiaria spp.*	FU	Indigenous
Graminoid	Poaceae	*Cymbopogon pospischilii*	OP	Indigenous
Graminoid	Poaceae	*Cynodon dactylon*	FU	Weed
Graminoid	Poaceae	*Cynodon transvaalensis*	FU	Weed
Graminoid	Poaceae	*Eragrostis capensis*	FW	Indigenous
Graminoid	Poaceae	*Eragrostis chloromelas*	OP	Indigenous
Graminoid	Poaceae	*Eragrostis curvula*	OP	Weed
Graminoid	Poaceae	*Eragrostis gummiflua*	FW	Indigenous
Graminoid	Poaceae	*Eragrostis micrantha*	F	Indigenous
Graminoid	Poaceae	*Eragrostis plana*	FW	Indigenous
Graminoid	Poaceae	*Eragrostis planiculmis*	OW	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Graminoid	Poaceae	*Eragrostis racemosa*	FW	Indigenous
Graminoid	Poaceae	*Helictotrichon turgidulum*	F	Indigenous
Graminoid	Poaceae	*Hemarthria altissima*	OW	Indigenous
Graminoid	Poaceae	*Hyparrhenia hirta*	OP	Indigenous
Graminoid	Poaceae	*Imperata cylindrica*	OW	Indigenous
Graminoid	Poaceae	*Leersia hexandra*	OW	Indigenous
Graminoid	Poaceae	*Melinis repens*	OP	Indigenous
Graminoid	Poaceae	*Panicum coloratum var. coloratum*	FW	Indigenous
Graminoid	Poaceae	*Panicum maximum*	FW	Indigenous
Graminoid	Poaceae	*Panicum schinzii*	FW	Indigenous
Graminoid	Poaceae	*Paspalum dilatatum*	FW	Alien Plant
Graminoid	Poaceae	*Paspalum distichum*	OW	Alien Plant
Graminoid	Poaceae	*Paspalum scrobiculatum*	OW	Indigenous
Graminoid	Poaceae	*Paspalum urvillei*	OW	Alien Plant
Graminoid	Poaceae	*Pennisetum thunbergii*	F	Indigenous
Graminoid	Poaceae	*Phragmites australis*	OW	Indigenous
Graminoid	Poaceae	*Setaria incrassata*	OW	Indigenous
Graminoid	Poaceae	*Setaria pallide fusca*	OP	Weed
Graminoid	Poaceae	*Setaria sphacelata var. sericea*	FU	Indigenous
Graminoid	Poaceae	*Sporobolus africanus*	FU	Indigenous
Graminoid	Poaceae	*Sporobolus pyramidalis*	FW	Indigenous
Graminoid	Poaceae	*Themeda triandra*	FU	Indigenous

GROWTH FORM	Family	COMMON NAME	HYDRIC STATUS	ECOLOGICAL STATUS
Graminoid	Poaceae	*Tragus berteronianus*	OP	Weed
Graminoid	Poaceae	*Urochloa panicoides*	OP	Weed
Rush	Juncaceae	*Juncus dregeanus*	OW	Indigenous
Rush	Juncaceae	*Juncus effusus*	OW	Indigenous
Rush	Juncaceae	*Juncus exertus*	OW	Indigenous
Rush	Juncaceae	*Juncus lomatophyllus*	OW	Indigenous
Rush	Juncaceae	*Juncus oxycarpus*	OW	Indigenous
Rush	Juncaceae	*Juncus punctorius*	OW	Indigenous
Shrub	Rosaceae	*Cliffortia linearifolia*	FW	Indigenous
Tree	Aceraceae	*Acer buergerianum*	OP	Alien Plant
Tree	Anacardiaceae	*Searsia lancea*	OP	Indigenous
Tree	Fabaceae	*Acacia dealbata*	FU	Alien Invasive Plant (Category 2)
Tree	Meliaceae	*Melia azedarach*	OP	Alien Invasive Plant (Category 1b)
Tree	Myrtaceae	*Eucalyptus camaldulensis*	FU	Alien Invasive Plant (Category 1b)
Tree	Pinaceae	*Pinus spp.*	OP	Alien Invasive Plant (Category 2)
Tree	Salicaceae	*Populus canescens*	FU	Alien Invasive Plant (Category 2)
Tree	Salicaceae	*Salix babylonica*	F	Alien Plant
	* OW = Obligate Wetland; FW = Facultative Wetland; F = Facultative; FU = Facultative Upland; OP= Opirtunistic Upland Plant; R= Riparian			

5.2 Present Ecological Status (PES)

Wetlands form at the interface between terrestrial and aquatic environments, and between groundwater and surface-water systems. The complex interaction of inflows and outflows of water, sediment, nutrients and energy over time is what shapes the physical template of the wetland and understanding theses fluxes and interactions considered is fundamentally important in developing an understanding the occurrence, morphology and dynamics of different wetland systems (Ellery et al., 2009).

The current health or Present Ecological State (PES) of wetlands was assessed using the WET-Health tool (Macfarlane et al. 2008) which was applied at a rapid level 1 assessment level. WET-Health assesses wetland condition or PES based on an understanding of both catchment and on-site impacts. The approach to assessing wetland PES essentially works by comparing a wetland in its current state with the estimated baseline/reference state of the wetland.

The results of the wetland PES assessment are presented in Table 7.

- Two of the wetlands (Units W2 & W4) were assessed as being 'Largely Modified' ('D' PES) which implies that *a large change in ecosystem processes and loss of natural habitat and biota has occurred*.
- One wetland (Unit W5) was assessed as being 'Severely Modified' ('F' PES) which implies that *modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota*.
- One wetland (Unit W1) was assessed as being 'Greatly Modified' ('E' PES) which implies that *the change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable*.
- One wetland (Unit W9) was assessed as being 'Moderately Modified' ('C' PES) which implies *a moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact*.
- One wetland (Unit W6) was assessed as being 'Natural and Unmodified' ('A' PES).

Key existing impacts affecting the condition of the various wetland units include:

- Significant catchment alterations resulting in mostly a change (increase) in water inputs and flood peaks. Such catchment modifications are typically associated with:
    - Increase in hard surfaces such as roads (significant roads include; M45, M63, Carr Road), buildings, parking lots etc.;
    - Reduction in roughage (reduction in infiltration rate) due to poor land management, and agricultural activities (cultivation and livestock grazing);

- Mining activities within the catchment; and
- Discharge from storm water drainage systems.

» Alteration and disturbances within the wetland boundaries mostly resulting in a reduction in roughage (vegetation responsible for increase infiltration and regulation of surface water flow) and an alteration in the hydrological character of the wetland itself. Such alterations are mostly associated with:
  - Overgrazing and trampling;
  - Limited erosion (mostly in the form of sheet erosion typically associated with soil capping);
  - Impeding structures such as roads (M54- and M63 Routes as well as other minor roads), fill embankments, railway lines and artificial instream dams resulting in an increase in flooding and saturation upstream and some desiccation and artificial channelling of surface water downstream of impeding structures.
  - Construction of artificial drainage channels within some wetland features;
  - Direct discharge of storm water into wetlands, creating 'artificially wetter' conditions;
  - Discharge for a Waste Water Treatment Works (WWTW)
    - Name of WWTW: Carl Grundling;
    - GPS Coordinates: 26°23'17.69" S, 28°28'28.00" E
    - Capacity 5 Ml/d
    - Technology: Activated Sludge
    - Areas Generating: Sharon Park, Marievale, Dunnottar
    - Final effluent is chlorinated before re-use and discharging it into the Nigel Dam. The outflow of the dam flows into the Blesbokspruit
  - Historic drainage of wetlands;
  - Limited sediment deposition within low lying areas; and

Table 7: Summary of the Present Ecological Scores (PES) of the affected Hydrogeomorphic units.

PRESENT ECOLOGICAL STATE OF THE AFFECTED HYDROGEOMORPHIC UNITS				
UNIT	**Wet-Health Category**	**Score**	**PES**	**Comments**
W1	Hydro	8	F	This wetland was assessed as being Greatly Modified (E PES Class). The scores are largely driven by the altered water inputs and flood peaks from catchment disturbances such as; hardened surfaces (roads, buildings, parking lots etc.), discharge from storm water drainage systems and a sewage treatment plant, mining and activities, significant modification to tributary wetland and watercourse systems as well as a modification to vegetation communities from poor land
	Geomorph	6.1	E	
	Veg	6	E	
	OVERALL	**6.7**	**E**	

				management. In-wetland disturbances includes infilling and deposition, excavation, impeding structures, artificial channelling, modification to existing channels and general poor land management.
W2	Hydro	6.5	E	This seep wetland was assessed as being Largely Modified (D PES Class). The scores are largely driven by altered water inputs and flood peaks as well as a significant alteration to the vegetation of the wetland. Alterations to water inputs and flood peak characteristics are due to increase runoff from M45 Road and other hard surfaces, general poor land management and discharge from storm water drainage systems. In-wetland hydrological and vegetation alterations are due to artificial dam structures, over grazing and trampling, sheet erosion and soil capping, infilling and excavation associated with the M45 Road and pipeline crossing. roads, impeding features such as the railway line and the
	Geomorph	3.1	C	
	Veg	6.4	E	
	OVERALL	**5.3**	**D**	
W4	Hydro	7	E	This depression wetland was assessed as being Largely Modified (D PES Class). The scores are largely driven by severe altered water inputs and flood peaks as well as a significant alteration to the vegetation of the wetland. Alterations to water inputs and flood peak characteristics are due to increase runoff from M45 Road, agricultural practices (ploughing and cultivation), general poor land management and impeding features such as the railway line, M45 Road and other minor roads, artificial channelling of surface runoff through a culvert. Disturbance of wetland vegetation due to overgrazing and trampling, infilling and excavation associated with the M45 Road, historical cultivation practices and some destruction of vegetation ("artificial" soil disturbance).
	Geomorph	2.4	C	
	Veg	5.8	D	
	OVERALL	**5.1**	**D**	
W5	Hydro	9	F	This wetland was assessed as being Severely Modified (F PES Class). The scores are largely driven by significant catchment and wetland alterations. All aspects of the wetland (hydrology, geomorphology and vegetation) have been severely altered. Significant disturbances are associated with impeding structures such as the M63 Road, Carr Road, other minor road and dams, Mining activities, excavation activities, severe reduction in wetland and catchment roughage (vegetation) increase in hard surfaces within the catchment, artificial channelling of surface runoff within the wetland and water pipeline crossing.
	Geomorph	8.1	F	
	Veg	10.4	F	
	OVERALL	**9.2**	**F**	
W6	Hydro	1	B	This small depression wetland is largely natural and unmodified (A PES Class). Modifications within the wetland itself are absolutely minimal an include some impacts on vegetation due to grazing and small area to south impacted by a gravel road. Catchment disturbances that slightly impacted surface runoff include the M63 Road and some modification (slight reduction) to the vegetation cover.
	Geomorph	0.2	A	
	Veg	0.2	A	
	OVERALL	**0.5**	**A**	
W9	Hydro	2	C	This depression wetland was assessed as being Moderately Modified (C PES Class). The scores are largely driven by the altered water inputs and flood peaks due to catchment disturbances (M63 Road, Cultivation, infilling and excavation and poor land management) as well as alteration to the
	Geomorph	2	C	
	Veg	3.9	C	
	OVERALL	**2.6**	**C**	

				vegetation of the wetland through overgrazing, infilling and excavation associated with the railway line, M63 Road as well some areas exposed to cultivation).

5.3 Wetland Functional Assessment

Wetlands are known to provide a range of ecosystem goods and services to society, and it is largely on this basis that policies aimed at protecting wetlands have been founded. This section of the report provides a summary of the predicted level of importance of the various wetland ecosystems in terms of their effectiveness in providing aquatic ecosystem goods and benefits. WET- Ecoservices assessment method by Kotze et al. (2009) was used for this purpose.

This section of the report provides a summary of the predicted level of importance of the wetland systems assessed in terms of the supply and demand of the ecosystem services provided. Overall the importance of ecosystem services ranged from Very Low to Moderately High and none of the wetland units were assessed as being of High to Very High importance. Key services are linked with provision of regulating and supporting services.

A summary of the wetland functional assessment undertaken using the WET-Ecoservices assessment method for all wetland units, is presented in Table 8:

» As a general consequence of the moderate to large level of wetland degradation caused by the range of existing impacts to wetlands (discussed under section 5.2, above), wetland functioning has been reduced at varying levels.
» The results clearly highlight units W1 to be the most important at providing ecosystem services particularly water quality enhancing services, water flow regulations and maintenance of general biodiversity due to the gentle gradient, extent of wetland habitat, connectivity with larger and important downstream wetland and aquatic habitats, presences of fairly large patches of reed and bulrush beds as well as the presence of dams.
» Wetland W2 and the functioning and maintenance of this wetland's vegetation are locally important for the functioning and services provided by Wetland W1, providing stability and avoiding erosion and an increase sediment deposition (water quality) into Wetland W1.
» The most important ecosystem services provided by wetlands W4 – W9 are the enhancement of water quality through sediment-, Phosphate-, Nitrate trapping and toxicant removal. Subsequently the maintenance of an acceptable vegetation cover (roughage) are vital for such functions and services, especially dense reed and bulrush beds.
» Furthermore, Wetland W5 are also regarded as an important provider of recourses utilised by the residents of especially the informal settlement located to the west of the wetland.

- In comparison to Unit W1, Units W2, W4, W6 and W8 were found to be the least important at providing ecosystem services with most services ranging between moderately-low and moderate. As mentioned, the most notable services were identified as water quality enhancing services which were rated as being mostly of moderate importance. All other services were usually assessed as being of very low to low importance.
- All wetlands were assessed as being of least importance in terms of providing cultural services due to poor provision of direct benefits to humans and generally has a low level of appeal for this sort of activity, falling outside of major tourism areas.

Table 8: Summary of the WET-Ecoservices assessment for all wetland units.

Ecosystem Services		IMPORTANCE SCORES (0-4) AND RATINGS					
		W1	W2	W4	W5	W6	W9
REGULATING AND SUPPORTING SERVICES	Flood attenuation	2.3 M	1.9 ML	2.0 M	1.8 ML	2.0 M	2.4 M
	Streamflow regulation	2.7 MH	2.3 M	1.5 ML	2.3 M	1.2 ML	1.3 ML
	Sediment trapping	2.5 M	2.1 M	2.0 M	2.4M	1.5 ML	1.8 ML
	Phosphate trapping	3.0 MH	2.8 MH	2.4 M	2.4 M	1.6 ML	2.4 M
	Nitrate removal	3.1 MH	3.2 MH	2.8 MH	2.7 MH	1.8 ML	2.4 M
	Toxicant removal	3.1 MH	2.6 MH	2.3 M	2.7 MH	1.8 ML	2.4 M
	Erosion control	2.4 M	2.0 M	2.0 M	1.7 ML	2.3 M	2.3 M
	Carbon storage	2.3 M	1.3 ML	1.7 ML	0.7 L	2.0 M	2.0 M
	Maintenance of biodiversity	3.5 MH	2.3 M	3.0 MH	1.6 ML	3.0 MH	1.7 ML
PROVISIONING SERVICES	Water supply for human use	1.6 ML	0.9 L	1.1 ML	2.1 M	0.9 L	1.4 ML
	Natural resources	2.0 M	1.6 ML	1.2 ML	3.4 MH	2.6 MH	1.8 ML
	Cultivated foods	1.4 ML	0.4 VL	0.8 L	1.4 ML	1.4 ML	1.2 ML
CULTURAL SERVICES	Cultural significance	0.3 VL	0.0 VL	0.0 VL	1.0 ML	1.0 ML	0.0 VL
	Tourism and recreation	2.4 M	0.7 L	0.3 VL	0.3 VL	0.1 VL	0.3 VL
	Education and research	1.5 ML	1.0 ML	0.8 L	1.0 ML	1.3 ML	0.5 VL
Threats		3.0 MH	2.0 M	2.0 M	2.0 M	2.0 M	2.0 M
Opportunities		2.0 M	2.0 M	2.0 M	2.0 M	2.0 M	1.0 ML
Ratings and Symbols: 0 - 0.5 = VL (Very Low); 0.6 – 0.9 = L (Low); 1 – 1.9 ML (Medium Low); 2 – 2.5 = M (Medium); 2.6 – 3.5 MH (Medium High) and 3.6 – 4 = H (High)							

5.4 Ecological Importance and Sensitivity (EIS) Assessment

The Ecological Importance and Sensitivity (EIS) of a wetland is an expression of the importance of the aquatic resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity *(or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007).*

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits

A summary of the EI&S importance assessment scores and ratings for wetlands is provided in Table 9 below and indicates the following:

- Wetland unit W1 is considered to be of 'High' EIS, linked with their relative high importance in providing biodiversity maintenance and water quality enhancement services primarily as well as their moderate-low sensitivity to external impacts. Wetland unit 1 provides a valuable corridor for movement (fauna and likely avifauna) as well as hydrological connectivity with important lower lying aquatic and wetland ecosystems as well as with surrounding terrestrial (primary and secondary) grasslands. Furthermore, water quality enhancement and maintenance are important for the maintenance of Nigel Dam, which is regarded as an important recreational area, and are vital for functionality and services provided by important downstream ecosystems.
- Wetland units W4, W6 an W9 are considered to be of 'Moderate' EIS, linked with their moderately sensitivity to external impacts primarily as well as their low to moderate importance in providing biodiversity maintenance and water quality enhancement services.
- Wetland units W2 and W5 are considered to be of 'Low' EI&S, linked with their low functionality and sensitivity to external impacts. Furthermore, Wetland unit 5 have been rated as such due to the level of transformation and habitat loss this wetland has been subjected to.
- No red listed, CITES or nationally protected species were recorded within any of the wetlands.
- However, the following provincially protected species were recorded (according to Transvaal Nature Conservation Ordinance No. 12 of 1983: Schedule 2, 11 and 12) within some of the wetland units: *Eucomis autumnalis* (W1 & W2), *Nerine angustifolia* (W1) and *Erythrina zeyheri* (W4 & W6).
- *Hypoxis hemerocallidea* (W1, W4 and W6) was also recorded within some of the wetlands and even though this species is neither provincially nor nationally protected this species is prone to illegal collection and harvesting and populations may subsequently be vulnerable to such activities. Subsequently local populations of this species are regarded as locally important.
- All wetland units occurring within Critical Biodiversity Areas (CBA), according to the Gauteng C-Plan (Ver.3.3), were rated as 'Moderate' with regards to protected status whilst natural areas occurring within the Critically Threatened

Blesbokspruit Highveld Grassland Ecosystem (NEM:BA, 2011) and contributing to the functionality and maintenance of this ecosystems was rated as High.

Table 9: Score sheet for determining the ecological importance and sensitivity for the identified wetland units.

DETERMINANT		IMPORTANCE SCORES (0-4) AND RATINGS					
		W1	**W2**	**W4**	**W5**	**W6**	**W9**
PRIMARY DETERMINANTS	Rare & Endangered Species	3	3	2	0	2	0
	Populations of Unique Species	3	0	1	0	1	0
	Species/taxon Richness	3	1	1	1	2	2
	Diversity of Habitat Types or Features	3	1	1	1	1	1
	Migration route/breeding and feeding site for wetland species	2	1	0	1	0	0
	Sensitivity to Changes in the Natural Hydrological Regime	2	3	3	1	2	2
	Sensitivity to Water Quality Changes	2	3	3	1	3	3
	Flood Storage, Energy Dissipation & Particulate/Element Removal	3	1	2	1	2	2
MODIFYING DETERMINANTS	Protected Status	3	2	3	2	3	3
	Ecological Integrity	2	1	1	0	3	2
TOTAL		26	17	17	9	18	16
MEDIAN		3	1	1.5	1	2	2
OVERALL ECOLOGICAL SENSITIVITY & IMPORTANCE		**B High**	**D Low**	**C Moderate**	**D Low**	**C Moderate**	**C Moderate**

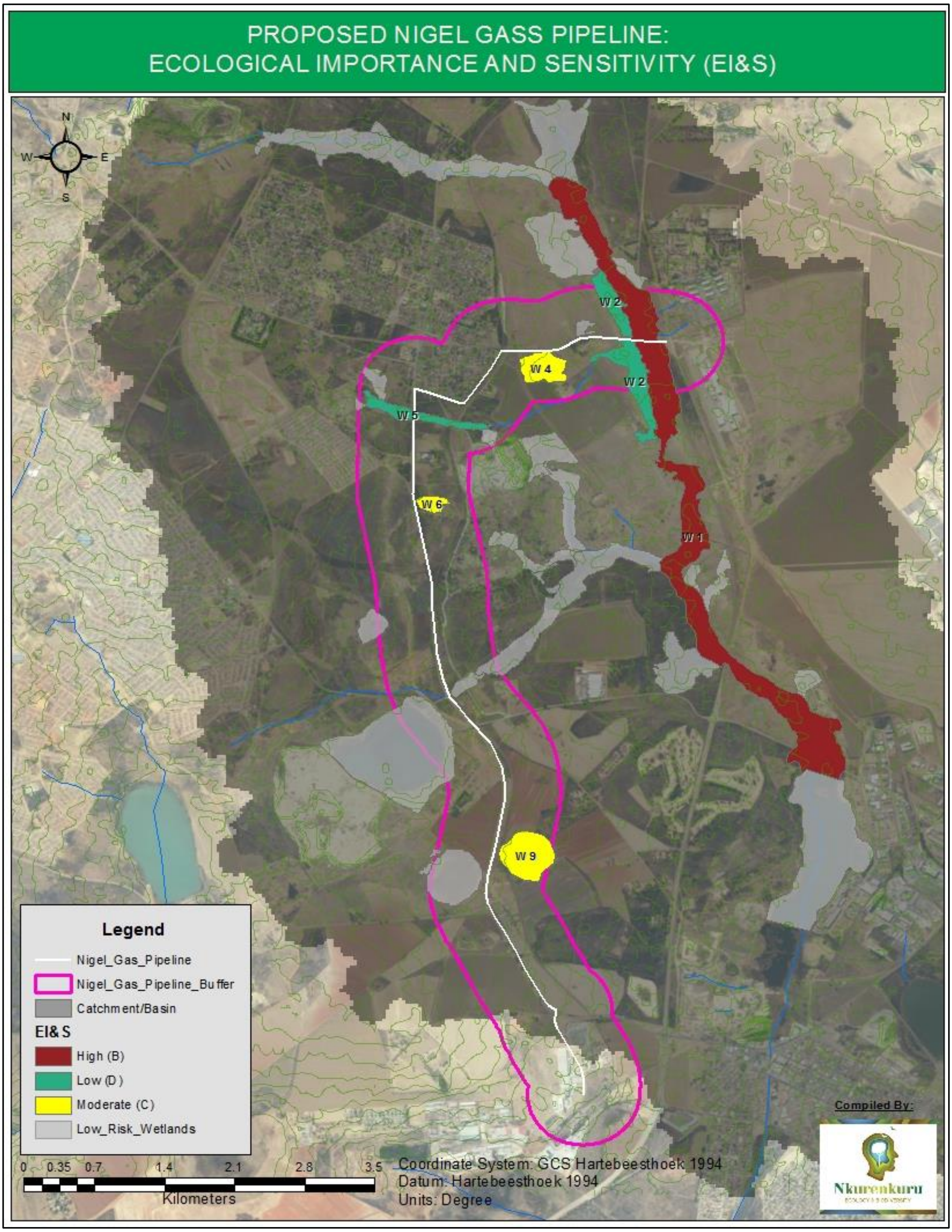

Figure 17: The delineated extent of wetland resource units as well as their Ecological Importance and Sensitivity Ratings.

6 IMPACT ASSESSMENT

During the impact assessment study a number of potential key issues / impacts were identified and these were assessed based on the methodology supplied by Savannah Environmental (Pty) Ltd. (refer to Appendix 2).

The following activities are associated with the development and have been considered during the assessment of the potential impacts of the development on the identified wetland units.

- Proposed construction of a gas transmission pipeline through watercourse and/or wetland crossings or within 500m of watercourses/wetlands near Nigel, Ekurhuleni Metropolitan Municipality, Gauteng Province.
- Crossing of watercourses/wetlands will occur through either the traditional open-cut (trenching) method or the Horizontal Directional Drilling method (HDD).

The proposed project will entail a 10km and 0.25m wide gas transmission pipeline and associated infrastructure from the Consol Glass factory in Nigel to the Farm Grootfontein 165 Portion 44, Gauteng Province. The proposed pipeline will be constructed as close as possible to existing roads (within the road shoulder). Throughout the route a total of six wetland features will be potentially impacted (directly and/or indirectly) by the pipeline. Three wetland features will be directly impacted through trenching whilst two wetland features will be impacted through HDD. Three wetland features will not be directly impacted through activities associated with the construction of the gas pipeline however the development will occur within 500m of these wetland features.

Construction and operation may lead to potential indirect loss of / or damage to wetlands and watercourses. This may potentially lead to localised loss of wetland habitat and may lead to downstream impacts that affect a greater extent of wetlands or impact on wetland function and biodiversity. Where these habitats are already stressed due to degradation and transformation, the loss may lead to increased vulnerability (susceptibility to future damage) of the habitat. Physical alteration to wetlands can have an impact on the functioning of those wetlands. Consequences may include:

- Increased loss of soil;
- Loss of/or disturbance to indigenous wetland vegetation;
- Loss of sensitive wetland habitats;
- Loss or disturbance to individuals of rare, endangered, endemic and/or protected species that occur in wetlands;
- Fragmentation of sensitive habitats;

- Impairment of wetland function;
- Change in channel morphology in downstream wetlands, potentially leading to further loss of wetland vegetation; and
- Reduction in water quality in wetlands downstream.

The location (micro-placing) of this activity within the wetland habitats have a significant bearing on the outcome of impact assessment, as the methodology of the risk assessment prescribes the highest severity rating for activities located within wetland habitat.

Furthermore, the selected method of crossing will also influence the potential significance of impacts on these identified wetland habitats and ultimately the outcome of the risk assessment.

For the benefits and disadvantages associated with the different pipe lying methodologies (trench and HDD) refer to Section 2.2.

Identification of Potential Impacts to be Assessed

The majority of impacts associated with the development would occur during the construction phase as a result of the disturbance associated with the operation of heavy machinery at the site and the presence of construction personnel. The major risk factors and contributing activities associated with the development are identified below before the impacts are assessed. These are not necessarily a reflection of the impacts that would occur, but rather a discussion on overall potential impacts and/or extent of these potential impacts that would occur if mitigation measures are not considered and/ or sensitive areas not avoided. The assessment of these impacts is outlined below.

- **Impact 1**: Loss/Disturbance of wetland habitat and fauna
- **Impact 2**: Potential impact on localised surface water quality
- **Impact 3**: Altered wetland hydrology due to interception / impoundment / diversion of flows
- **Impact 4:** Increase in sedimentation and erosion

Various activities and development aspects (tabulated below) may lead to these impacts, however, these impacts can be adequately minimized or avoided provided the mitigation measures provided in this report are implemented and adhered to.

The significance ratings applied in this section are based on the assumption that the construction and operation activities would be carried out according to widely accepted good practice. The management measures (mitigation measures) considered to be widely accepted good practice in this assessment, should also be specified in the Environmental Management Plan (EMP) to provide assurance that they will in fact be implemented. For completeness, these management measures are recorded within this impact assessment. Additional or site/wetland specific mitigation measures have also been considered and included in these ratings and as such should also be incorporated into the EMP.

6.2 Construction & Decommissioning Phase Impacts

Impact Nature: Loss/Disturbance of wetland habitat and fauna

This refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of wetland habitat, encroachment/colonisation of habitat by invasive alien plants and alteration of wetland geomorphological profiles (including stream beds and banks). Possible ecological consequences associated with this impact may include:

- » Reduction in representation and conservation of freshwater ecosystem/habitat types;
- » Reduction in the supply of ecosystem goods & services;
- » Reduction/loss of habitat for aquatic dependent flora & fauna; and
- » Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).

The physical removal and disturbance of narrow strips of wetland vegetation during the construction phase. This biological impact would however be localised, as a large portion of the remaining catchment would remain intact. Furthermore, most to almost all of the construction activities can be confined to the elevated road reserve or outside the wetland boundaries (HDD) and subsequently direct loss/disturbance of wetland habitat and fauna can be minimized.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Medium-term (3)
Magnitude	Low (4)	Small (0)
Probability	Probable (3)	Improbable (2)
Significance	**Low (27)**	**Low (8)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	

Mitigation	» Existing access roads to be used as far as possible. Limit the extent of the construction servitude to as small an area as possible. » Ideally the construction disturbance footprint should be kept to an area no wider than 5 m. » All material stockpiles and construction camps should be located outside wetland areas. » Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground pipeline has been completed. » All material stockpiles (other than soils removed during trenching) and construction camps should be located outside wetland areas. » The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. » If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented. » There should be reduced activity at the site after large rainfall events when the soils are wet. » No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » For Wetland 1, 2 and 5 (HDD): • All construction activities occurring directly within wetland habitats (Wetland 1, 2 and 5) to take place within the dry season. • The remaining construction activities should be aimed to take place within the dry season as far as reasonably possible. • Regular monitoring should be conducted along the drilling route for potential frack-outs. • Every effort must be made to avoid the release of drilling fluid into the wetlands. • Where drilling fluid is observed at the surface, the "spill" should immediately be contained / recovered. • Smothering of vegetation should also be avoided. • Once excess drilling mud have been removed, the area will be seeded and/or replanted using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation. • These rehabilitated and/or reseeded areas (where spillage of drilling mud may have occurred) must be be monitored twice per year for two years

	subsequent to frack-out to confirm revegetation is successful. • Used drilling liquid should be contained in a settling pond or similar structure, from where the fluid can either be re-used or removed from site. » For Wetland 1 & 2 (HDD): • All activities and disturbances should be confined to the raised road reserve (as close as possible to the M45 Road) • All vegetation clearance and activities associated with the rig setup should occur within the raised road reserve (as close as possible to the M45 Road). • No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve). • The natural surface of the inundated and permanent saturated zone of the wetlands, including a 10m buffer, should be considered as a NO-GO Zone. » For Wetland 5 (HDD): • All activities and disturbances should occur outside of the delineated wetland boundary (including a 10m buffer area). Limit the extent of the construction servitude to as small an area as possible. » For Wetland 4 and partially 1 and 2 (Trenching): • Construction activities should be aimed to take place within the dry season as far as reasonably possible; • All activities must be restricted to the raised portion of the road reserve (as close as possible to the existing road). • Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench; • No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve). • Wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel. • Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced

	last (this will maximise opportunity for re-vegetation of disturbed areas). • Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days). » <u>For Wetland 6 and 9 (Trenching outside of wetland boundary):</u> • All activities restricted, as far as possible, within the elevated road reserve. • Wetlands located in close proximity to the proposed pipeline route should be regarded and demarcated as no-go areas for vehicles and construction personnel. • Excavated soils from the, should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench. • Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). • Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).
Cumulative Impacts	Some limited loss of ecosystem functions and services especially those relating to water quality maintenance and enhancement.
Residual Impacts	Residual impact will be confined to the already disturbed road reserve which is already transformed and degraded. Limited residual impact within natural wetland areas, most likely a slightly altered form of vegetation following rehabilitation of the area.

Impact Nature: Impact on localized surface water quality

This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health aquatic ecosystems. Possible ecological consequences associated with this impact may include:

» Deterioration in freshwater ecosystem integrity; and

» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).

During preconstruction, construction and to a **limited degree** the operational activities, chemical pollutants (hydrocarbons from equipment and vehicles, cleaning fluids, cement powder, wet concrete, shutter-oil, etc.) associated with site-clearing machinery and construction activities could be washed downslope via the ephemeral systems.

Frack-out of drilling fluid with wetland areas as well as spillage of used drilling fluid from containment area during HDD may potentially result in:

- Temporary displacement of resident fauna;
- Smothering of benthic organisms and plant root systems;
- Increased turbidity of water quality; and
- Effects on water chemistry and wetland hydrology.

Appropriate ablution facilities should be provided for construction workers during construction of the power line and substation and on-site staff during the operation of the substation.

	Without Mitigation	**With Mitigation**
Extent	Local (2)	Local (1)
Duration	Medium-term (3)	Short-term (2)
Magnitude	Moderate (3)	Minor (2)
Probability	Highly Probable (4)	Very Improbable (1)
Significance	**Medium (32)**	**Low (5)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	Medium	Low
Can impacts be mitigated?	Yes, to a large extent.	
Mitigation	» Institute environmental best practice guidelines as per the DWA Integrated Environmental Management Series for Construction Activities. » Implement appropriate measures to ensure strict use and management of all hazardous materials used on site » Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter hydrocarbons from vehicles and machinery, cement during construction etc.) » Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.	

	» All soil contaminated due to leaks or spills should be remediated on site. If this is not possible, such contaminated soils must be disposed of in a suitable waste facility. » No vehicles to refuel within watercourses/ riparian vegetation. » Place spill kits on site which are operated by trained staff members for the adhoc remediation of minor chemical and hydrocarbon spillages. » Waste should be stored on site in clearly marked containers in a demarcated area. All waste material should be removed at the end of every working day to designated waste facilities at the main construction camp/suitable waste disposal facility. All waste must be disposed of offsite. » Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced. » For Wetland 1, 2 and 5 (HDD): • The drilling rig should be placed on a plastic liner in order to avoid any potential soil contamination with hydrocarbon spillage or other associated pollutants. • Regular monitoring should be conducted along the drilling route for potential spillage of drilling mud and other potential pollutants. • All activities must be restricted to the raised portion of the road reserve (as close as possible to the existing road). • Used drilling liquid should be contained in a settling pond or similar structure, from where the fluid can either be re-used or removed from site. • Every effort must be made to avoid the release of drilling fluid into the wetlands. • Where drilling fluid is observed at the surface, the "spill" should immediately be contained/recovered. • A spill kit should always be on-site. • A contingency plan (frack-out) should be in place which should consider the possibility of frack-out or other emergencies, and the response actions that should be considered. • Large spills should be pumped out of the wetland into a contained area as soon as possible and the remaining fluid should be dispersed with hoses. • Smothering of vegetation should also be avoided.

	• Once excess drilling mud have been removed, the area will be seeded and/or replanted using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation. • Revegetated areas will be monitored twice per year for two years subsequent to frack-out to confirm revegetation is successful
Cumulative Impacts	Decline / deterioration of water quality of important and larger downstream wetland and aquatic habitats. This impact is highly unlikely.
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.

Impact Nature: Increase in sedimentation and erosion within the development footprint.

This refers to the alteration in the physical characteristics of wetlands and rivers as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities. Possible ecological consequences associated with this impact may include:

- » Deterioration in freshwater ecosystem integrity; and
- » Reduction/loss of habitat for aquatic dependent flora & fauna.

This may furthermore, influence water quality downstream

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Very Short (1)
Magnitude	Low (2)	Small (0)
Probability	Probable (3)	Improbable (2)
Significance	**Low (21)**	**Low (4)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» All construction activities occurring directly within wetland habitats (Wetland 1, 2 and 5 to take place within the dry season. The remaining construction activities should be aimed to take place within the dry season as far as reasonably possible. » Existing access roads to be used as far as possible. » Limit the extent of the construction servitude to as small an area as possible.	

	» Ideally the construction disturbance footprint should be kept to an area no wider than 5 m. » Regular monitoring for erosion. • Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. • Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. • Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » Closure and rehabilitation of the disturbed areas (control stations and rig set-up) should commence as soon as the laying of underground pipeline has been completed. • Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain. » The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. » If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented. » There should be reduced activity at the site after large rainfall events when the soils are wet. » No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased. » For Wetland 1, 2 and 5 (HDD): • Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » For Wetland 1 and 2 (HDD): • All activities and disturbances should be confined to the raised road reserve (as close as possible to the M45 Road), • No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve).

	• The natural surface of the inundated and permanent saturated zone the wetland, including a 10m buffer should be considered as a NO-GO Zone » For Wetland 5 (HDD): • All activities and disturbances should occur outside of the delineated wetland boundary (including a 10m buffer area). » For Wetland 4 and partially 1 and 2 (Trenching): • Construction activities should be aimed to take place within the dry season as far as reasonably possible; • All activities must be restricted to the raised portion of the road reserve (as close as possible to the existing road). • No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve). • Wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel. • Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench; • Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). • Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days). • Concentration and accumulation of flows along the servitude should be prevented by regularly providing for surface runoff to flow into the adjacent grassland rather than along the construction servitude and into the wetlands. » For Wetland 6 and 9 (Trenching outside of wetland boundary): • All activities restricted, as far as possible, within the elevated road reserve. • Wetlands located in close proximity to the proposed pipeline route should be regarded and demarcated

	as no-go areas for vehicles and construction personnel. • Excavated soils form the trench should also be stockpiled on the upslope side of the excavated trench, so that eroded sediments off the stockpile are washed back into the trench. • Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas). • Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However due to the relative low mean annual runoff within the region this is not anticipated due to the nature of the development together with the proposed layout.
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.

6.3 Operation Phase Impacts

Impact Nature Impact 5 - Altered wetland hydrology due to interception/impoundment/diversion of flows

This refers to the alteration in the physical characteristics of wetlands and rivers as a result of increased turbidity and sediment deposition, caused by soil erosion, as well as instability and collapse of unstable soils during project operation. Possible ecological consequences associated with this impact may include:

- » Deterioration in freshwater ecosystem integrity; and
- » Reduction/loss of habitat for aquatic dependent flora & fauna.

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Long-term (4)
Magnitude	Low (2)	Low (2)
Probability	Probable (3)	Improbable (2)
Significance	**Low (21)**	**Low (14)**

Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Any erosion problems observed to be associated with the project infrastructure should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential. » Disturbed areas (areas at risk of erosion or already subjected to erosion) should be monitored for erosion problems (twice yearly within the first year of operation) and problem areas should receive follow-up monitoring (single inspection at the end of April the following year) to assess the success of the remediation. » Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas. » Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary. » There should be reduced activity at the site after large rainfall events when the soils are wet. » No driving off of hardened roads should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.	
Cumulative Impacts	Downstream erosion and sedimentation of the downstream systems. During flood events, any unstable banks (eroded areas) and sediment bars (sedimentation downstream) may be vulnerable to erosion. However due to low mean annual runoff within the region this is not anticipated due to the nature of the development together with the proposed layout.	
Residual Impacts	Altered streambed morphology. Due to the extent and nature of the development this residual impact is unlikely to occur.	

Impact Nature: Impact on localized surface water quality

This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water resources (i.e. water quality) such as wetlands & rivers as a result of water/soil pollution. The term 'water quality' must be viewed in terms of the fitness or suitability of water for a specific use (DWAF, 2001). In the context of this impact assessment, water quality refers to its fitness for maintaining the health aquatic ecosystems. Possible ecological consequences associated with this impact may include:

» Deterioration in freshwater ecosystem integrity; and
» Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species).

A potential leakage of the gas into the soil and wetland may lead to a Reduction in oxygen levels resulting in local anoxic conditions leading to the displacement of resident fauna and the suffocation of benthic organisms and vegetation

	Without Mitigation	**With Mitigation**
Extent	Local (1)	Local (1)
Duration	Long-term (4)	Short-term (1)
Magnitude	Moderate (6)	Small (0)
Probability	Improbable (2)	Very Improbable (1)
Significance	**Low (22)**	**Low (2)**
Status	Negative	Negative
Reversibility	High	High
Irreplaceable loss of resources	No	No
Can impacts be mitigated?	Yes, to a large extent	
Mitigation	» Regular inspections and maintenance of the pipeline must be undertaken during the operational phase, with any leaks repaired immediately. » All bare areas, as a result of the development, should be revegetated with locally occurring species, to bind the soil and limit erosion potential.	
Cumulative Impacts	Decline / deterioration of water quality of important and larger downstream wetland and aquatic habitats. This impact is highly unlikely.	
Residual Impacts	Residual impacts will be negligible after appropriate mitigation.	

7 DISCUSSION AND CONCLUSION

Nkurenkuru Ecology and Biodiversity was appointed by Savannah Environmental (Pty) Ltd to undertake a wetland assessment for the proposed construction of an underground transmission gas pipeline. The proposed project will entail a 10km and 0.25m wide gas transmission pipeline and associated infrastructure from the Consol Glass Factory in Nigel to the Farm Grootfontein 165 Portion 44, Gauteng Province.

This study has been commissioned to meet the requirements of the EIA process in the form of a Basic Assessment (BA) as set out by the National Environmental Management Act (1998) and a Water Use Licence Application as set out by the National Water Act (Act 36 of 1998).

Pipe-lying within the wetland areas are likely to occur via two potential methods namely:

- » Trenching (open-cut) Method: Activities includes excavation, laying of bedding material, pipe installation, backfilling and closure.
- » Horizontal Directional Drilling Method: Activities includes drilling of a pilot hole, reaming out/pulling back of the pilot hole and pulling the pipeline through.

According to the guidelines specified within GN509 of 2016 all wetlands within a radius of 500m of the pipeline were identified and mapped.

- » A total of nine (9) wetlands were identified.
- » Following a risk screening assessment, it was determined that six (6) of these wetlands will be impacted by the development, either directly or indirectly.
- » The remaining wetlands within the 500m radius were either located in separate micro-catchments or some distance downslope or downstream of the proposed development, to such an extent that low and measurable impacts to these wetlands would be unlikely. As such these wetlands were assigned a Low Risk Rating.
- » Of the six wetlands to be impacted by the development three wetlands (W1, 3 and 5) will be directly impacted by the development (crossed by proposed pipeline) and were subsequently awarded a High-Risk Rating.

» The remaining three wetlands (W4, W6 and W9) are situated outside of the development footprint but are either situated directly downslope or directly adjacent to the proposed pipeline footprint. No direct impacts are expected to occur, although indirect secondary impact's linked with road run-off, water quality and sedimentation of freshwater habitats are likely to occur. Subsequently these three wetlands were assigned a Moderate Risk Rating.

» Wetlands assigned either as High or Moderate Risk of being impacted were subjected to a detailed baseline assessment.

Catchment Context (Regional Hydrological Setting):

» The project site is located within the Upper Vaal Water Management Area (WMA) and within the DWS Quaternary catchment C21E. The proposed development will primarily take place upslope of the Nigel Dam and is regarded as part of the Blesbokspruit River Catchment, an important tributary of the Suikerbosrand River which in turn is one of the major tributaries of the Vaal River upstream of the Vaal Dam.

» The wetland vegetation group associated with the project area is Mesic Highveld Grassland Group 2 as defined by NFEPA (SANBI & DWS, 2014). At the wetland vegetation group level, the Mesic Highveld Grassland wetland vegetation group 2 has an ecosystem threat status of Critically Endangered.

Baseline Wetland Assessment

» According to the baseline assessment a total of three hydrogeomorphic units were identified namely; Channelled Valley-bottom, Seep and Depression Wetlands:
- W1: Channelled Valley-bottom Wetland
- W2: Seep
- W4: Depression
- W5: Channelled Valley-bottom Wetland
- W6: Depression
- D9: Depression

» Soil and vegetation sampling in conjunction with the recording of topographical features enabled the delineation of these six (6) wetland units.

» Channelled Valley-bottom wetlands are wetland systems characterised by their location within moderately well-defined valley floors with the presence of an active channel, but without typical diagnostic floodplain features. Flows within these systems are characteristically confined within a define channel. Dominant water inputs to these wetlands are from the watercourse/channel flowing through the wetland, predominantly as surface flow resulting from flooding, or as a form of overland flow from adjacent hillslopes and other smaller watercourses and valley-bottom wetlands, with substantially less groundwater discharge. Water generally exits a channelled valley-bottom wetland in the form of diffuse surface or subsurface flow in the adjacent river, with infiltration into the ground and evapotranspiration of water also being potentially significant.

» Seepage wetlands are wetlands located on gently to steep sloping hillslopes/valley sides fed primarily by lateral subsurface water inputs from shallow groundwater occurring over an impermeable substrate. Water movement driven by colluvial unidirectional movement. Water movement and through flow is generally as interflow with diffuse overland flow (sheetwash) becoming more prominent during and after rainfall events. Outflow can either be contained within a channel or without a channel.

» Depression or pan wetlands typically have with closed (or near-closed) elevation contours, which increase in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Depressions may be flat-bottomed (in which case they are often referred to as pans) or round-bottomed and may have any combination of inlets and outlets or lack them completely. Water inputs are typically surface and groundwater-fed. Wetland separated from underlying aquifer by lower permeability layer. Input from groundwater discharge, when groundwater table is high, precipitation, surface runoff and possibly spring flow. Groundwater input may be restricted by lower permeability layer. Output by evaporation and groundwater recharge when groundwater table low.

» The findings of the baseline wetland assessment suggests that owing to a range of existing impacts within the wetlands and catchment area (linked predominantly to alterations in water inputs and storm water runoff as well as surface water runoff through the wetland systems), the wetlands are generally in a modified condition with the level of modification varying according to the level of disturbance from 'Severely' modified (F PES Class) to 'Moderately' modified ('C' PES Class). Only one wetland (W6) was regarded as 'Natural / Unmodified' ('A' PES Class). Wetland Unit 1 (W1) was considered to be 'Greatly' Modified ('E' PES Class). Both Wetland Units 2 and 4 (W2, W4) were considered to be 'Largely' Modified ('D' PES Class). Wetland Unit 5 (W5) have been 'Severely' Modified, whilst Wetland 9 (W9) have been 'Moderately' Modified.

» Key existing impacts affecting the condition of the various wetland units include:
  - Significant catchment alterations resulting in mostly a change (increase) in water inputs and flood peaks. Such catchment modifications are typically associated with:
    - Increase in hard surfaces such as roads (significant roads include; M45, M63, Carr Road), buildings, parking lots etc.;
    - Reduction in roughage (reduction in infiltration rate) due to poor land management, and agricultural activities (cultivation and livestock grazing);
    - Mining activities within the catchment; and
    - Discharge from storm water drainage systems.
  - Alteration and disturbances within the wetland boundaries mostly resulting in a reduction in roughage (vegetation responsible for increase infiltration and regulation of surface water flow) and an alteration in the hydrological character of the wetland itself. Such alterations are mostly associated with:
    - Overgrazing and trampling;
    - Limited erosion (mostly in the form of sheet erosion typically associated with soil capping);
    - Impeding structures such as roads (M54- and M63 Routes as well as other minor roads), fill embankments, railway lines and artificial instream dams resulting in an increase in flooding and saturation upstream and some desiccation and artificial channelling of surface water downstream of impeding structures.
    - Construction of artificial drainage channels within some wetland features;
    - Direct discharge of storm water into wetlands, creating 'artificially wetter' conditions;
    - Direct discharge for a sewage treatment plant;
    - Historic drainage of wetlands;
    - Limited sediment deposition within low lying areas

» Interpretation of the WET-Ecoservices results clearly highlight unit W1 to be the most important at providing ecosystem services particularly water quality enhancing services, water flow regulations and maintenance of general biodiversity due to the gentle gradient, extent of wetland habitat, connectivity with larger and important downstream wetland and aquatic habitats, presences of fairly large patches of reed and bulrush beds as well as the presence of dams. The most important ecosystem services provided by wetlands W2 – W9 are the enhancement of water quality through sediment-, Phosphate-, Nitrate trapping and toxicant removal. Furthermore, Wetland W5 is also regarded as an important provider of recourses utilised by the residents of especially the informal settlement located to the west of the wetland. In comparison to Unit W1, Units W2, W4, W6 and W9 were found to be the least important at providing ecosystem services with most services ranging between moderately-low and moderate. As mentioned, the most notable services were identified as water quality enhancing services which were rated as being mostly of moderate importance. All other services were usually assessed as being of very low to low importance.

» Wetland unit W1 is considered to be of 'High' EI&S, linked with its relative high importance in providing biodiversity maintenance and water quality enhancement services primarily as well as its moderate-low sensitivity to external impacts. Wetland unit 1 provides a valuable corridor for movement (fauna and likely avifauna) as well as hydrological connectivity with important lower lying aquatic and wetland ecosystems as well as with surrounding terrestrial (primary and secondary) grasslands. Furthermore, water quality enhancement and maintenance are important for the maintenance of Nigel Dam, which is regarded as an important recreational area, and are vital for functionality and services provided by important downstream ecosystems. Wetland units W4, W6 an W9 are considered to be of 'Moderate' EI&S, linked with their moderately sensitivity to external impacts primarily as well as their low to moderate importance in providing biodiversity maintenance and water quality enhancement services. Wetland units W2 and W5 are considered to be of 'Low' EI&S, linked with their low functionality and sensitivity to external impacts. Furthermore, Wetland unit 5 have been rated as such due to the level of transformation and habitat loss this wetland has been subjected to.

Wetland Impacts and Mitigation

» The four key/major ecological impacts on the freshwater resources that are anticipated to occur are:

- Impact 1: Loss/Disturbance of wetland habitat and fauna
- Impact 2: Potential impact on localised surface water quality
- Impact 3: Altered wetland hydrology due to interception / impoundment / diversion of flows
- Impact 4: Increase in sedimentation and erosion

» Various activities and development aspects may lead to these impacts, however, these impacts can be adequately minimized or avoided provided the mitigation measures provided in this report are implemented and adhered to.

» A summary of pre and post mitigation impact significance ratings for the different impacts and risks factors identified for the proposed development are provided below (figure 9).

Table 10: Summary of pre and post mitigation impact significance ratings.

Construction & Operational Phase			
Phase	**Impact**	**Significance Pre Mitigation**	**Significance Post Mitigation**
Construction	Loss/Disturbance of wetland habitat and fauna	Low (27)	Low (8)
	Impact on localized surface water quality	Medium (32)	Low (5)
	Increase in sedimentation and erosion within the development footprint.	Low (21)	Low (4)
Operation	Altered wetland hydrology due to interception/impoundment/diversion of flows	Low (21)	Low (14)
	Impact on localized surface water quality	Low (22)	Low (2)

» Most of the wetland ecological impacts can be effectively mitigated on-site by implementing the following:

General mitigation measures applicable to all areas.

- Existing access roads to be used as far as possible.
- Limit the extent of the construction servitude to as small an area as possible. Ideally the construction disturbance footprint should be kept to an area no wider than 5 m.
- All material stockpiles and construction camps should be located outside wetland areas.
- Regular monitoring for erosion.
  - Any erosion problems observed, to be associated with the relating activity, should be rectified as soon as possible and monitored thereafter to ensure that they do not re-occur.
  - Silt traps should be used where there is a danger of topsoil or material stockpiles eroding and entering streams and other sensitive areas.
  - Construction of gabions and other stabilisation features to prevent erosion, if deemed necessary

- Closure and rehabilitation of the disturbed areas should commence as soon as the laying of underground pipeline has been completed.
    - Soils should be landscaped to the natural landscape profile with care taken to ensure that no preferential flow paths or berms remain.
- All material stockpiles (other than soils removed during trenching) and construction camps should be located outside wetland areas.
- The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed.
- If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented.
- There should be reduced activity at the site after large rainfall events when the soils are wet.
- No offroad driving should occur immediately following large rainfall events until soils have dried out and the risk of bogging down has decreased.
- Institute environmental best practice guidelines as per the DWA Integrated Environmental Management Series for Construction Activities.
- Implement appropriate measures to ensure strict use and management of all hazardous materials used on site.
- Implement appropriate measures to ensure strict management of potential sources of pollutants (e.g. litter, hydrocarbons from vehicles and machinery, cement during construction etc.).
- Implement appropriate measures to ensure containment of all contaminated water by means of careful run-off management on the development site.
- All soil contaminated due to leaks or spills should be remediated on site. If this is not possible, such contaminated soils must be disposed of in a suitable waste facility.
- No vehicles to refuel within watercourses/ riparian vegetation.
- Place spill kits on site which are operated by trained staff members for the ad-hoc remediation of minor chemical and hydrocarbon spillages.
- Waste should be stored on site in clearly marked containers in a demarcated area. All waste material should be removed at the end of every working day to designated waste facilities at the main construction camp/suitable waste disposal facility. All waste must be disposed of offsite.
- Working protocols incorporating pollution control measures (including approved method statements by the contractor) should be clearly set

out in the Construction Environmental Management Plan (CEMP) for the project and strictly enforced.

- Regular inspections and maintenance of the pipeline must be undertaken during the operational phase, with any leaks repaired immediately.

Mitigation measures applicable for areas where the pipeline will be installed using the HDD Method:

- All construction activities occurring directly within wetland habitats (Wetland 1, 2 and 5) to take place within the dry season.
- The drilling rig should be placed on a plastic liner in order to avoid any potential soil contamination with hydrocarbon spillage or other associated pollutants.
- Regular monitoring should be conducted along the drilling route for potential frack-outs.
- Every effort must be made to avoid the release of drilling fluid into the wetlands.
- Used drilling liquid should be contained in a settling pond or similar structure, from where the fluid can either be re-used or removed from site.
- Where drilling fluid is observed at the surface, the "spill" should immediately be contained / recovered.
- A spill kit should always be on-site.
- A contingency plan (frack-out) should be in place which should consider the possibility of frack-out (and other contingencies) and the response actions that should be considered.
- Smothering of vegetation should also be avoided.
- Once excess drilling mud have been removed, the area will be seeded and/or replanted using species similar to those in the adjacent area, or allowed to re-grow from existing vegetation.
- Revegetated areas will be monitored twice per year for two years subsequent to frack-out to confirm revegetation is successful.
- For W1 and 2 all activities and disturbances should be confined to the raised road reserve (as close as possible to the M45). All vegetation clearance and activities associated with the rig setup should subsequently occur within the raised road reserve (as close as possible to the M45 Road).
- No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve) of W1 and 2.

- For W1 and 2, the natural surface of the inundated and permanent saturated zone, including a 10m buffer should be considered as a NO-GO Zone.
- For W5, all activities and disturbances should occur outside of the delineated wetland boundary (including a 10m buffer area). Limit the extent of the construction servitude to as small an area as possible.

Mitigation measures applicable for areas where the pipeline will be installed using the Trenching Method and the wetlands will be directly impacted (Applicable for W4 and portion of W1 and W2 that will be trenched):

- Construction activities should be aimed to take place within the dry season as far as reasonably possible;
- All activities must be restricted to the raised portion of the road reserve (as close as possible to the existing road).
- Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;
- No activities or movement of any construction vehicles within the natural wetland surface (below the raised road reserve).
- Wetland areas other than the immediate areas of crossing are to be demarcated as no-go areas for vehicles and construction personnel.
- Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).
- Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).
- Concentration and accumulation of flows along the servitude should be prevented by regularly providing for surface runoff to flow into the adjacent grassland rather than along the construction servitude and into the wetlands.

Mitigation measures applicable for areas where the pipeline will be installed using the Trenching Method and the wetlands will not be directly impacted (Applicable for W6 and W9):

- All activities restricted, as far as possible, within the elevated road reserve.
- Wetlands located in close proximity to the proposed pipeline route should be regarded and demarcated as no-go areas for vehicles and construction personnel.

- Excavated soils form the trench, made for the pipeline, should also be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench.
- Excavated soils will need to be replaced in the same order as excavated from the trench, i.e. sub-soil must be replaced first and topsoil must be replaced last (this will maximise opportunity for re-vegetation of disturbed areas).
- Excavation of the trench, for the laying of the pipeline, should only take place immediately before placement of the pipeline (ideally the trench should not remain open for longer than 7 days).

With these mitigation measures in place, impacts on aquatic ecosystem integrity and functioning can be potentially reduced to a sufficiently low level. This would be best achieved by incorporating the recommended management & mitigation measures into an Environmental Management Programme (EMPr) for the site, together with appropriate rehabilitation guidelines and ecological monitoring recommendations.

Based on the outcomes of this study, specifically also considering the existing disturbances impacting on the affected wetland and resulting in the modified condition of the affected wetland, together with the fact that expected impacts can be mitigated to Low significance through the application of a number of easily implementable mitigation measures, it is my considered opinion that the proposed gas pipeline project detailed in this report could be authorised from a wetland perspective.

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9 APPENDICES:

9.1 Appendix 1. Survey methods

The assessment was initiated with a survey of the pertinent literature, past reports and the various conservation plans that exist for the study region. Maps and Geographical Information Systems (GIS) were then employed to ascertain, which portions of the proposed development, could have the greatest impact on the wetlands and associated habitats.

A two-day site visit was then conducted (19th and 20th of February, 2019) to ground-truth the above findings, thus allowing critical comment of the development when assessing the possible impacts and delineating the wetland areas.

» The following equipment were utilized during field work.
  - Canon EOS 450D Camera
  - Garmin Etrex Legend GPS Receiver
  - Bucket Soil Auger
  - Munsell Soil Colour Chart (2000)
  - Braun-Blanquet Data Form (for vegetation recording and general environmental recordings).

Wetland and riparian areas were then assessed on the following basis:

» Identification and delineation of wetlands and riparian areas according to the the procedures specified by DWAF (2005a).
» Vegetation type – verification of type and its state or condition based, supported by species identification using Germishuizen and Meyer (2003), Vegmap (Mucina and Rutherford, 2006 as amended) and the South African Biodiversity Information Facility (SABIF) database.
» Plant species were further categorised as follows:
  - Terrestrial: species are not directly related to any surface or groundwater base-flows and persist solely on rainfall.
  - Facultative: species usually found in wetlands (inclusive of riparian systems) (67 – 99% of occurrences), but occasionally found in terrestrial systems (non-wetland) (DWAF, 2005)
  - Obligate: species that are only found within wetlands (>99% of occurrences) (DWAF, 2005).
» Assessment of the wetland type based on the NWCS method discussed below and the required buffers.
» Mitigation or recommendations required.

Data sources consulted

The following date sources and GIS spatial information provided in the table below was consulted to inform the assessment. The data type, relevance to the project and source of the information has been provided.

Table 11: Information and data coverage's used to inform the wetland assessment

Data/Coverage Type	Relevence	Source
Colour Aerial Photography (2009)	Mapping of wetlands and other features	National Geo-Spatial Information
Latest Google Earth™ imagery	To supplement available aerial photography	Google Earth™ On-line
Proposed power line routes and substation locations.	Shows location to the porposed powerline routes and impacted zone	Client
NFEPA wetland Coverage	Shows location fo FEPA river and wetland sites.	CSIR (2011)
National Land-Cover	Shows the land-use and disturbances/transformations within and around the impacted zone.	DEA (2015)
SA National Land-Cover	Shows the expected land caracteristics including land form & shape, geology, soil types and slope gradients.	AGIS (2014)
Quaternary Drainage Regions	Indicates the drainage region and major tributaries and water sources.	DWS (2009)
Present Ecological State of watercourses	Shows the present ecological state of the affected non-perennial watercourses	Kleynhans (1999)

National Wetland Classification System (NWCS 2010)

Since the late 1960's, wetland classification systems have undergone a series of international and national revisions. These revisions allowed for the inclusion of additional wetland types, ecological and conservation rating metrics, together with a need for a system that would allude to the functional requirements of any given wetland (Ewart-Smith et al., 2006). Wetland function is a consequence of biotic and abiotic factors, and wetland classification should strive to capture these aspects.

The South African National Biodiversity Institute (SANBI) in collaboration with a number of specialists and stakeholders developed the newly revised and now accepted National Wetland Classification Systems (NWCS 2010). This system comprises a hierarchical classification process of defining a wetland based on the principles of the Hydrogeomorphic (HGM) approach at higher levels, with including structural features at the finer or lower levels of classification (SANBI 2009).

Wetlands develop in a response to elevated water tables, linked either to rivers, groundwater flows or seepage from aquifers (Parsons, 2004). These water levels or flows then interact with localised geology and soil forms, which then determines the form and function of the respective wetlands. Water is thus the common driving force, in the formation of wetlands (DWAF, 2005). It is significant that the HGM approach has now been included in wetland classification as the HGM approach has been adopted throughout the water resources management realm with regard the determination of the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) and WET-Health assessments for aquatic environments. All of these systems are then easily integrated using the HGM approach in line with the Eco-classification process of river and wetland reserve determinations used by the Department of Water Affairs.

The NWCS process is provided in more detail in the methods section of the report, but some of the terms and definitions used in this document are present below:

Definition Box Present

Ecological State is a term for the current ecological condition of the resource. This is assessed relative to the deviation from the Reference State. Reference State/Condition is the natural or pre-impacted condition of the system. The reference state is not a static condition, but refers to the natural dynamics (range and rates of change or flux) prior to development. The PES is determined per component - for rivers and wetlands this would be for the drivers: flow, water quality and geomorphology; and the biotic response indicators: fish, macroinvertebrates, riparian vegetation and diatoms. PES categories for every component would be integrated into an overall PES for the river reach or wetland being investigated. This integrated PES is called the EcoStatus of the reach or wetland.

EcoStatus is the overall PES or current state of the resource. It represents the totality of the features and characteristics of a river and its riparian areas or wetland that bear upon its ability to support an appropriate natural flora and fauna and its capacity to provide a variety of goods and services. The EcoStatus value is an integrated ecological state made up of a combination of various PES findings from component EcoStatus assessments (such as for invertebrates, fish, riparian vegetation, geomorphology, hydrology and water quality).

Reserve: The quantity and quality of water needed to sustain basic human needs and ecosystems (e.g. estuaries, rivers, lakes, groundwater and wetlands) to ensure ecologically sustainable development and utilisation of a water resource. The Ecological Reserve pertains specifically to aquatic ecosystems.

Reserve requirements: The quality, quantity and reliability of water needed to satisfy the requirements of basic human needs and the Ecological Reserve (inclusive of instream requirements).

Ecological Reserve determination study: The study undertaken to determine Ecological Reserve requirements.

Licensing applications: Water users are required (by legislation) to apply for licenses prior to extracting water resources from a water catchment.

Ecological Water Requirements: This is the quality and quantity of water flowing through a natural stream course that is needed to sustain instream functions and ecosystem integrity at an acceptable level as determined during an EWR study. These then form part of the conditions for managing achievable water quantity and quality conditions as stipulated in the Reserve Template.

Water allocation process (compulsory licensing): This is a process where all existing and new water users are requested to reapply for their licenses, particularly in stressed catchments where there is an over-allocation of water or an inequitable distribution of entitlements.

Ecoregions are geographic regions that have been delineated in a top-down manner on the basis of physical/abiotic factors. • NOTE: For purposes of the classification system, the 'Level I Ecoregions' for South Africa, Lesotho and Swaziland (Kleynhans et al. 2005), which have been specifically developed by the Department of Water Affairs & Forestry (DWAF) for rivers but are used for the management of inland aquatic ecosystems more generally, are applied at Level 2A of the classification system. These Ecoregions are based on physiography, climate, geology, soils and potential natural vegetation.

Wetland definition

Although the National Wetland Classification System (SANBI, 2009) is used to classify wetland types it is still necessary to understand the definition of a wetland. Wetland definitions as with classification systems have changed over the years. Terminology currently strives to characterise a wetland not only on its structure (visible form), but also to relate this to the function and value of any given wetland.

The Ramsar Convention definition of a wetland is widely accepted as "**areas of marsh, fen, peatland or water, whether natural or artificial, permanent or**

temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Davis 1994). South Africa is a signatory to the Ramsar Convention and therefore its extremely broad definition of wetlands has been adopted for the proposed NWCS, with a few modifications.

Whereas the Ramsar Convention included marine water to a depth of six metres, the definition used for the NWCS extends to a depth of ten metres at low tide, as this is recognised seaward boundary of the shallow photic zone (Lombard et al., 2005). An additional minor adaptation of the definition is the removal of the term 'fen' as fens are considered a type of peatland. The adapted definition for the NWCS is, therefore, as follows (SANBI, 2009):

WETLAND: an area of marsh, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed ten metres.

This definition encompasses all ecosystems characterised by the permanent or periodic presence of water other than marine waters deeper than ten metres. The only legislated definition of wetlands in South Africa, however, is contained within the National Water Act (Act No. 36 of 1998) (NWA), where wetlands are defined as "land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil." This definition is consistent with more precise working definitions of wetlands and therefore includes only a subset of ecosystems encapsulated in the Ramsar definition. It should be noted that the NWA definition is not concerned with marine systems and clearly distinguishes wetlands from estuaries, classifying the later as a watercourse (SANBI, 2009). The DWA is however reconsidering this position with regard the management of estuaries due to the ecological needs of these systems with regard to water allocation. Table 12 provides a comparison of the various wetlands included within the main sources of wetland definition used in South Africa.

Although a subset of Ramsar-defined wetlands was used as a starting point for the compilation of the first version of the National Wetland Inventory (i.e. "wetlands", as defined by the National Water Act, together with open waterbodies), it is understood that subsequent versions of the Inventory include the full suite of Ramsar-defined wetlands in order to ensure that South Africa meets its wetland inventory obligations as a signatory to the Convention (SANBI, 2009).

Wetlands must therefore have one or more of the following attributes to meet the above definition (DWAF, 2005):

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

It should be noted that riparian systems that are not permanently or periodically inundated are not considered true wetlands, i.e. those associated with the drainage lines.

Table 12: Comparison of ecosystems considered to be 'wetlands' as defined by the proposed NWCS, the National Water Act (Act No. 36 of 1998), and ecosystems are included in DWAF's (2005) delineation manual.

Ecosystem	**NWCS "wetland"**	**National Water Act wetland**	**DWAF (2005) delineation manual**
Marine	YES	NO	NO
Estuarine	YES	NO	NO
Waterbodies deeper than 2 m (i.e. limnetic habitats often describe as lakes or dams)	YES	NO	NO
Rivers, channels and canals	YES	NO[1]	NO
Inland aquatic ecosystems that are not river channels and are less than 2 m deep	YES	YES	YES
Riparian[2] areas that are permanently / periodically inundated or saturated with water within 50 cm of the surface	YES	YES	YES3

[1] Although river channels and canals would generally not be regarded as wetlands in terms of the National Water Act, they are included as a 'watercourse' in terms of the Act.
[2] According to the National Water Act and Ramsar, riparian areas are those areas that are saturated or flooded for prolonged periods would be considered riparian wetlands, opposed to non –wetland riparian areas that are only periodically inundated and the riparian vegetation persists due to having deep root systems drawing on water many meters below the surface.

Riparian areas that are not permanently / periodically inundated or saturated with water within 50 cm of the surface	NO	NO	YES[3]

Wetland importance and function

South Africa is a Contracting Party to the Ramsar Convention on Wetlands, signed in Ramsar, Iran, in 1971, and has thus committed itself to this intergovernmental treaty, which provides the framework for the national protection of wetlands and the resources they could provide. Wetland conservation is now driven by the South African National Biodiversity Institute, a requirement under the National Environmental Management: Biodiversity Act (No 10 of 2004).

Wetlands are among the most valuable and productive ecosystems on earth, providing important opportunities for sustainable development (Davies and Day, 1998). However, wetlands in South Africa are still rapidly being lost or degraded through direct human induced pressures (Nel et al., 2004).

The most common attributes or goods and services provided by wetlands include:

» Improve water quality;
» Impede flow and reduce the occurrence of floods;
» Reeds and sedges used in construction and traditional crafts;
» Bulbs and tubers, a source of food and natural medicine;
» Store water and maintain base flow of rivers;
» Trap sediments; and
» Reduce the number of water borne diseases.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

Table 13 summarises the importance of wetland function when related to ecosystem services or ecoservices (Kotze et al., 2008). One such example is

[3] The delineation of 'riparian areas' (including both wetland and non-wetland components) is treated separately to the delineation of wetlands in DWAF's (2005) delineation manual.

emergent reed bed wetlands that function as transformers converting inorganic nutrients into organic compounds (Mitsch and Gosselink, 2000).

Table 13: Summary of direct and indirect ecoservices provided by wetlands from Kotze et al., 2008.

Wetland benefits (goods and services)	**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	
		Provision of harvestable resources	
		Socio-cultural significance	
		Tourism and recreation	
		Education and research	

Relevant wetland legislation and policy

Locally the South African Constitution, seven (7) Acts and two (2) international treaties allow for the protection of wetlands and rivers. These systems are protected from the destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA), 1998 (Act No. 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act, 1998 (Act No. 36 of 1998);
- Conservation of Agricultural Resources Act, 1983 (Act No. 43 of 1983); and
- Minerals and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002).
- Nature and Environmental Conservation Ordinance (No. 19 of 1974)
- National Forest Act (No. 84 of 1998)
- National Heritage Resources Act (No. 25 of 1999)

Apart from NEMA, the Conservation of Agricultural Resources Act (CARA), 1983 (Act No. 43 of 1983) will also apply to this project. The CARA has categorised a large number of invasive plants together with associated obligations of the land owner. A number of Category 1 & 2 plants were found at all of the sites investigated, thus the contractors must take extreme care further spread of these plants doesn't occur. This should be done through proper stockpile management (topsoil) and suitable rehabilitation of disturbed areas after construction.

An amendment of the National Environmental Management was promulgated late December 2011, namely the Biodiversity Act or NEM:BA (Act No 10 of 2004), which lists 225 threatened ecosystems based on vegetation type (Vegmap, 2006 as amended). Should a vegetation type or ecosystem be listed, actions in terms of NEM:BA are triggered.

Other policies that are relevant include:

» Provincial Nature Conservation Ordinance (PNCO) – Protected Flora. Any plants found within the sites are described in the ecological assessment.
» National Freshwater Ecosystems Priority Areas – CSIR 2011 draft. This mapping product highlights potential rivers and wetlands that should be earmarked for conservation on a national basis.

National Wetland Classification System method

During this study, due to the nature of the wetlands and watercourses observed, it was decided that the newly accepted National Wetlands Classification System (NWCS) be adopted. This classification approach has integrated aspects of the HGM approached used in the WET-Health system as well as the widely accepted eco-classification approach used for rivers.

The NWCS (SANBI, 2009) as stated previously, uses hydrological and geomorphological traits to distinguish the primary wetland units, i.e. direct factors that influence wetland function. Other wetland assessment techniques, such as the DWAF (2005) delineation method, only infer wetland function based on abiotic and biotic descriptors (size, soils & vegetation) stemming from the Cowardin approach (SANBI, 2009).

The classification system used in this study is thus based on SANBI (2009) and is summarised below:
The NWCS has a six-tiered hierarchical structure, with four spatially nested primary levels of classification (Figure 15). The hierarchical system firstly distinguishes between Marine, Estuarine and Inland ecosystems (**Level 1**), based on the degree of connectivity the particular systems has with the open ocean (greater than 10 m in depth). **Level 2** then categorises the regional wetland setting using a combination of biophysical attributes at the landscape level, which operate at a

broad bioregional scale. This is opposed to specific attributes such as soils and vegetation. **Level 2** has adopted the following systems:

» Inshore bioregions (marine)
» Biogeographic zones (estuaries)
» Ecoregions (Inland)

Level 3 of the NWCS assess the topographical position of inland wetlands as this factor broadly defines certain hydrological characteristics of the inland systems. Four landscape units based on topographical position are used in distinguishing between Inland systems at this level. No subsystems are recognised for Marine systems, but estuaries are grouped according to their periodicity of connection with the marine environment, as this would affect the biotic characteristics of the estuary.

Level 4 classifies the hydrogeomorphic (HGM) units discussed earlier. The HGM units are defined as follows:

(i) Landform – shape and localised setting of wetland
(ii) Hydrological characteristics – nature of water movement into, through and out of the wetland
(iii) Hydrodynamics – the direction and strength of flow through the wetland.

These factors characterise the geomorphological processes within the wetland, such as erosion and depositing, as well as the biogeochemical processes.

Level 5 of the assessment pertains to the classification of the tidal regime within the marine and estuarine environments, while the hydrological and inundation depth classes are determined for the inland wetlands. Classes are based on frequency and depth of inundation, which are used to determine the functional unit of the wetlands and are considered secondary discriminators within the NWCS.

Level 6 uses of six descriptors to characterise the wetland types on the basis of biophysical features. As with Level 5, these are non-hierarchal in relation to each other and are applied in any order, dependent on the availability of information.

The descriptors include:
(i) Geology;
(ii) Natural vs. Artificial;
(iii) Vegetation cover type;
(iv) Substratum;
(v) Salinity; and

(vi) Acidity or Alkalinity.

It should be noted that where sub-categories exist within the above descriptors, hierarchical systems are employed, thus are nested in relation to each other.

The HGM unit (Level 4) is the **focal point of the NWCS**, with the upper levels (Figure 15 – Inland systems only) providing means to classify the broad bio-geographical context for grouping functional wetland units at the HGM level, while the lower levels provide more descriptive detail on the particular wetland type characteristics of a particular HGM unit. Therefore Level 1 – 5 deals with functional aspects, while Level 6 classifies wetlands on structural aspects.

In the past wetland conservation, has focused on biodiversity as a means of substantiating the protection of wetland habitat. However not all wetlands provide such motivation for their protection, thus wetland managers and conservationists began assessing the importance of wetland function within an ecosystem.

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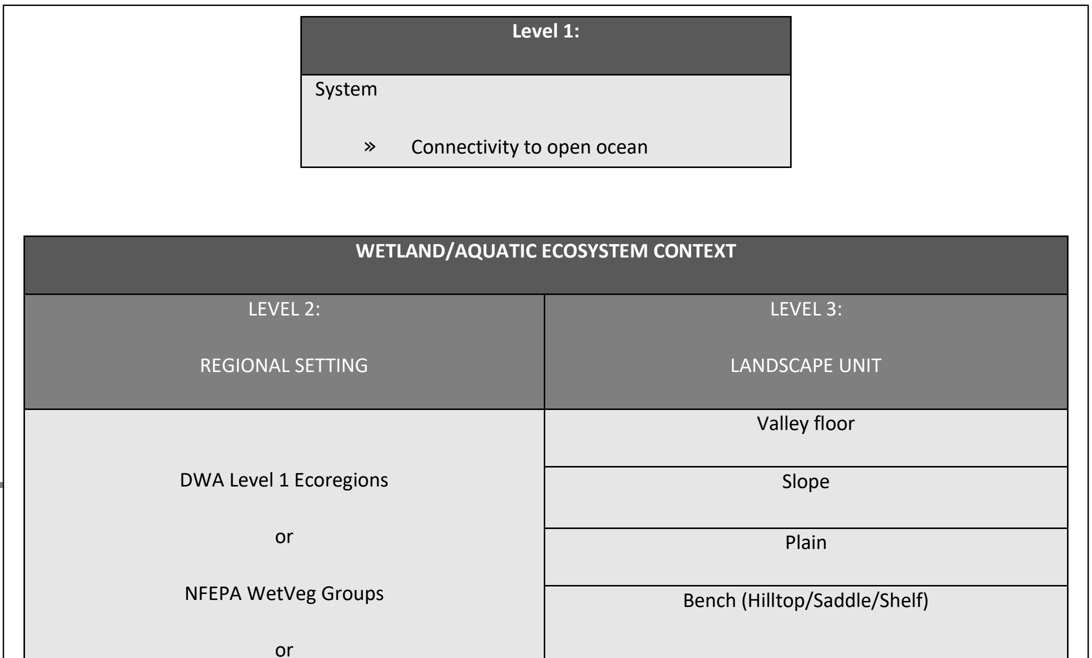

Figure 18: Basic structure of the National Wetland Classification System, showing how 'primary discriminators' are applied up to Level 4 to classify Hydrogeomorphic (HGM) Units, with 'secondary discriminators' applied at Level 5 to classify the hydrological regime, and 'descriptors' applied at Level 6 to categorise the characteristics of wetlands classified up to Level 5 (From SANBI, 2009).

Wetland condition and conservation importance assessment

Wetland functional assessment

» ***WET-Health Assessment (Wetland integrity/Present Ecological State)***

The Wet-Health tool (Macfarlane *et al.* 2008) was used to assess the Present Ecological State (PES) of wetlands by highlighting specific impacts within wetlands and within wetland catchment areas. For the purposes of this study, a Level 1 assessment was undertaken. While this is a rapid assessment, it is regarded as adequate to inform an assessment of existing impacts on wetland condition.

The WET-Health tool provides an appropriate framework for undertaking an assessment to indicate the functional importance of the wetland system that could be impacted by the proposed development. The assessment also helps to identify specific impacts thereby highlighting issues that should be addressed through mitigation and rehabilitation activities. The Level 1 assessment, approach relies on a combination of desktop and on-site indicators to assess various aspects of wetland condition, including:
Hydrology: defined as the distribution and movement of water through a wetland and its soils.
Geomorphology: defined as the distribution and retention patterns of sediment within the wetland.
Vegetation: defined as the vegetation structural and compositional state.

Each of these modules follows a broadly similar approach and is used to evaluate the extent to which anthropogenic changes have impacted upon wetland functioning or condition. While the impacts considered vary considerably across each module, a standardized scoring system is applied to facilitate the interpretation of results (Table 14). Scores range from 0 indicating no impact to a maximum of 10 which would imply that impacts had totally destroyed the functioning of a particular component.

Table 14: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 - 10

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete" deviation from natural" (Condition F) as depicted in Table 15, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic ecosystems.

Table 15: Guideline for interpreting the magnitude of impacts on wetland integrity (after Macfarlane *et al*. 2008)

PES CATEGORY	DESCRIPTION	RANGE
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitat and biota may have taken place.	1 – 1.9
C	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2 – 3.9
D	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9
E	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
F	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

An overall wetland health score is calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

» **Overall health rating**
= [(Hydrology*3)+(Geomorphology*2)+(Vegetation*2)]/7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

» ***Wetland Ecological Importance and Sensitivity (EIS)***

The outcomes of the wetland functional assessment were used to inform an assessment of the importance and sensitivity of wetland systems using the Wetland EIS (Ecological Importance and Sensitivity) assessment tool. The Wetland EIS tool includes an assessment of three components:

- Biodiversity support;
- Landscape scale importance;
- Sensitivity of the wetland to floods and water quality changes.

The maximum score for these components was taken as the importance rating for the wetland which is rated using Table 16.

Table 16: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
None, Rating=0	Rarely sensitive to changes in water quality/hydrological regime.
Low, Rating=1	One or a few elements sensitive to changes in water quality/hydrological regime.
Moderate, Rating=2	Some elements sensitive to changes in water quality/hydrological regime.
High, Rating=3	Many elements sensitive to changes in water, quality/hydrological regime.
Very High, Rating=4	Vary many elements sensitive to changes in water quality/hydrological regime.

» ***WET-EcoServices Assessment (functional importance)***

The WET-EcoServices tool (Kotze *et al*.,2009) was used to assess the demand for and supply of the wetland services under the broader categories of regulating and supporting services, provisional services and cultural services (Table 17). This was based on a rapid Level 1 assessment and was used to determine the importance of wetlands in providing different goods and services evaluated.

A Level 1 (rapid) WET-EcoServices tool is a suitable method for assessing the functioning of South African wetlands. Common wetland ecosystem goods and services that were evaluated using WET-EcoServices are described in Table 17, below.

Table 17: Descriptions of common wetland ecosystem goods and services (after Kotze *et al*., 2009)

ECOSYSTEM SERVICES	DESCRIPTION
Flood Attenuation	Refers to the effectiveness of wetlands at spreading out and slowing down storms flows and thereby reducing the severity of floods associated impacts.
Steam Flow Regulation	Refers to the effectiveness of wetlands in sustaining flows in downstream areas during low-flow periods.
Sediment Trapping	Refers to the effectiveness of wetlands in trapping and retaining sediments from sources in the catchment.
Nutrient & Toxicant Retention and Removal	Refers to the effectiveness of wetland in retaining, removing or destroying nutrients and toxicants such as nitrates, phosphates, salts, biocides and bacteria from inflowing sources, essentially providing a water purification benefit.
Erosion Control	Refers to the effectiveness of wetlands in controlling the loss of soil through erosion.
Carbon Storage	Refers to the ability of wetlands to act as carbon sinks by actively trapping and retaining carbon as soil organic matter.
Biodiversity Maintenance	Refers to the contribution of wetlands to maintain biodiversity through providing natural habitat and maintaining natural ecological processes.
Water Supply	Refers to the ability of wetlands to provide a relatively clean supply of water for local people as well as animals.

Harvestable Natural Resources	Refers to the effectiveness of wetlands in providing a range of harvestable natural resources including firewood, material for construction, medicinal plants and grazing material for livestock.
Cultivated Foods	Refers to the ability of wetlands to provide suitable areas for cultivation crops and plants for use as food, fuel or building materials.
Food for Livestock	Refers to the ability of wetlands to provide suitable vegetation as food for livestock.
Cultural significance	Revers to the special cultural significance of wetlands for local communities.
Tourism & Recreation	Refers to the value placed on wetlands in terms of the tourism-related and recreational benefits provided.
Education & Research	Refers to the value of wetlands in terms of education and research opportunities, particularly concerning their strategic location in terms of catchment hydrology.

The level of predicted importance of ecosystem services provided by wetlands was rated according to the rating table shown in Table 18, below. This was informed by wetland characteristics that affect the ability of wetlands to supply benefits and local and catchment context that affects the demand placed on wetlands to provide goods and services.

Table 18: Rating table used to rate level of ecosystem supply.

RATING	IMPORTANCE OR LEVEL OF SUPPLY OF ECOSYSTEM SERVICES
Low	The wetland is not considered to be important for providing these service/benefits.
Low-Moderate	The importance of the wetland in providing ecosystem goods and services is regarded as moderately low.
Moderate	The wetland is considered important for providing this particular ecosystem service to a moderate degree.
Moderate-High	The wetland is considered important for providing this particular ecosystem service to a high degree.
High	The wetland is considered very important for providing this particular ecosystem service to a high degree.

9.2 Appendix 2. Assessment of Impacts

The Environmental Impact Assessment methodology assists in the evaluation of the overall effect of a proposed activity on the environment. This includes an assessment of the significant direct, indirect, and cumulative impacts. The significance of environmental impacts is to be assessed by means of the criteria of extent (scale), duration, magnitude (severity), probability (certainty) and direction (negative, neutral or positive).

» The **nature**, which includes a description of what causes the effect, what will be affected and how it will be affected.
» The **extent**, wherein it is indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 was assigned as appropriate (with 1 being low and 5 being high).
» The **duration**, wherein it was indicated whether:
  - the lifetime of the impact will be of a very short duration (0 – 1 years) – assigned a score of 1;
  - the lifetime of the impact will be of a short duration (2 – 5 years) – assigned a score of 2;
  - medium-term (5 -15 years) – assigned a score of 3;
  - long term (> 15 years) – assigned a score of 4; or
  - permanent – assigned a score of 5;
» The **magnitude**, quantified on a scale from 0 – 10, where 0 is small and will have no effect on the environment, 2 is minor and will not result in an impact on processes, 4 is low and will cause a slight impact on processes, 6 is moderate and will result in processes continuing but in a modified way, 8 is high (processes are altered to the extent that they temporarily cease), and 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
» The **probability** of occurrence, which describes the likelihood of the impact actually occurring. Probability was estimated on a scale of 1 -5, where 1 is very improbable (probably will not happen), 2 is improbable (some possibility, but low likelihood), 3 is probable (distinct possibility), 4 is highly probable (most likely) and 5 is definite (impact will occur regardless of any prevention measures).
» The **significance**, was determined through a synthesis of the characteristics described above and can be assessed as **LOW**, **MEDIUM** or **HIGH**; and
» the **status**, which was described as either positive, negative or neutral.
» the degree of which the impact can be reversed,
» the degree to which the impact may cause irreplaceable loss of resources,
» the degree to which the impact can be mitigated.

The significance was calculated by combining the criteria in the following formula:

S=(E+D+M)P where;

» S = Significance weighting

» E = Extent
» D = Duration
» M = Magnitude
» P = Probability

The significance weightings for each potential impact are as follows;

» < 30 points: **LOW** (i.e. where the impact would not have a direct influence on the decision to develop in the area),
» 30 – 60 points: **MEDIUM** (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
» > 60 points: **HIGH** (i.e. where the impact must have an influence on the decision process to develop in the area).