WETLAND ECOLOGICAL ASSESSMENT AS PART OF THE ENVIRONMENTAL ASSESSMENT AND AUTHORISATION PROCESS FOR THE PROPOSED KATHU SUPPLIERS PARK IN THE NORTHERN CAPE PROVINCE.

Prepared for

SLR Consulting (Pty) Ltd

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Declaration

This report has been prepared according to the requirements of Section 32 (3b) of the Environmental Impact Assessments (EIA) Regulations, 2010 (GNR 543). We (the undersigned) declare the findings of this report free from influence or prejudice.

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EXECUTIVE SUMMARY

Scientific Aquatic Services (SAS) was appointed to conduct a wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Kathu suppliers park, on the farm Sekgame 461 in the Northern Cape Province, hereafter referred to as the subject property (Figure 1 and 2). The subject property is located directly to the south of the R380 roadway, adjacent to a residential area presently being developed as part of the town of Kathu.

DESKTOP ASSESSMENT

The following general conclusions were drawn on completion of the desktop assessment:

- According to the National Freshwater Ecosystems Priority Areas database (NFEPA, 2011), one wetland feature, a natural slope depression wetland, is located within the south western corner of the subject property.

WETLAND ASSESSMENT

The following general conclusions were drawn on completion of the wetland assessment:

- A site assessment was undertaken in March 2014 to determine the extent of wetland resources within the subject property. Three wetland features, an artificial dam, an artificial seep and a natural pan were encountered;
- The artificial dam is located within the eastern portion of the subject property, adjacent to the R380 roadway. This feature was constructed for the storage of grey water which is produced during mine operations and which is continuously pumped into the feature through a transfer scheme from the Kumba Iron Ore Sishen North Mine;
- The seepage of water from the dam within the eastern portion of the subject property has resulted in the saturation of soils in the surrounding areas. This prolonged saturation has resulted in the formation of hydromorphic soils which are capable of supporting obligate and facultative wetland species. The area surrounding the dam can therefore be defined as an artificial seep wetland;
- The natural pan is the same feature as indicated by the NFEPA database (2011) and is located within the south western portion of the subject property;
- The function and service provision was calculated for each of the wetland features. From the results of the assessment, it is evident that none of the features encountered within the subject property are regarded as being of exceptional importance in terms of function and service provision. All features are considered to provide a moderately low level of ecological function and service provision;
- It is highly unlikely that natural wetlands would have occurred in the areas where the artificial dam and seep wetland are currently located. It is therefore not possible to determine the Present Ecological State (PES) of the features because there is no natural reference state to use as a baseline for such an assessment. Neither the artificial dam nor the seep wetland was therefore assessed using WET-health;
- The pan is a natural feature and could therefore be assessed using WET-health. The pan calculated an overall score falling within the PES Category C (moderately modified);
- The Ecological Importance and Sensitivity (EIS) was calculated for each wetland feature:
  - The artificial seep calculated an EIS falling within Category C (moderate sensitivity); and
  - The artificial dam and the natural pan calculated an EIS falling within Category D (low/marginal sensitivity).
- The Recommended Ecological Category (REC) deemed appropriate to enhance and maintain current ecology as well as functionality of the natural pan is Category B (Largely natural);
- Although the dam and seep wetland are artificial features they still provide the habitat which support wetland faunal and floral species and play a role in terms of function and service provision. In order to safeguard the wetland habitat that has developed within the dam and surroundings it is therefore recommended that the seepage wetland remains free from development thereby acting as a buffer to the artificial dam;
- The natural pan has been significantly disturbed as a result of historic earth moving activities. However, with rehabilitation, it is deemed highly likely that the overall PES of the feature can be improved. A minimum buffer of 32m is therefore advocated in order to minimise any impact the

proposed development activities could have as well as to safeguard wetland resources during the operational phase of the development; and

- It should be noted that any activity occurring within wetland features or associated buffer areas will require authorisations in terms of Section 21 c & i of the National Water Act (NWA, Act 36 of 1998). Furthermore, development activities falling within 32m of wetland features will trigger activities as listed by the National Environmental Management Act (NEMA, Act 107 of 1998). In addition, the subject property falls within 500 meters of wetland features and therefore General Notice no. 1199 of 2009 as it relates to the NWA (Act 36 of 1998) will also apply.

WETLAND IMPACT ASSESSMENT

The table below serve to summarise the significance of perceived impacts on the wetland biodiversity of the subject property. Impacts associated with the loss of the artificial dam and seep wetland are likely to differ from those associated with the loss of the natural pan and were therefore assessed separately.

Impact significance was assessed for two separate alternatives:

- Alternative 1: All wetland features within the subject property will be permanently lost as a result of development activities; and
- Alternative 2: Wetland features will not be lost as a result of development activities.

Table A: Summary of impact assessment results.

Impact	Alternative	Wetland feature	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Alternative 1	Artificial dam and seep wetland	Medium Low (-ve)	Medium Low (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Low (-ve)

If alternative 1 is chosen as part of the future development plan all wetland features will be removed from the subject property. The overall impact significance will therefore remain the same before and after the implementation of mitigation measures. However, if alternative 2 is chosen as part of the future development plan the majority of the impacts can be effectively mitigated by proper planning, management and by the implementation of an effective rehabilitation plan.

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GLOSSARY OF TERMS

Alien vegetation	Plants that do not occur naturally within the area but have been introduced either intentionally or unintentionally.
Alien Invasive vegetation	Alien invaders are plants that are of exotic origin and are invading previously pristine areas or ecological niches

ACRONYMS

BGIS	Biodiversity Geographic Information Systems
EAP	Environmental Assessment Practitioner
EIS	Ecological Importance and Sensitivity
CARA	Conservation of Agricultural Resources Act
DWA	Department of Water Affairs
GIS	Geographic Information System
NFEPA	National Freshwater Ecosystem Priority Areas
PES	Present Ecological State
REC	Recommended Ecological Category
SANBI	South African National Biodiversity Institute
SAS	Scientific Aquatic Services
SCC	Species of Conservation Concern
Sp.	*Species*

1 INTRODUCTION

1.1 Background

Scientific Aquatic Services (SAS) was appointed to conduct a wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Kathu suppliers park, on the farm Sekgame 461 in the Northern Cape Province, hereafter referred to as the subject property (Figure 1 and 2). The subject property is located directly to the south of the R380 roadway, adjacent to an area presently being developed as part of the town of Kathu.

The final document, after consideration and description of the ecological sensitivity of the subject property, will aim to guide the property owner, Environmental Assessment Practitioner (EAP), authorities and development proponent, by means of recommendations, as to viability of each of the alternatives from an environmental perspective, with a specific focus on terrestrial and wetland ecology.

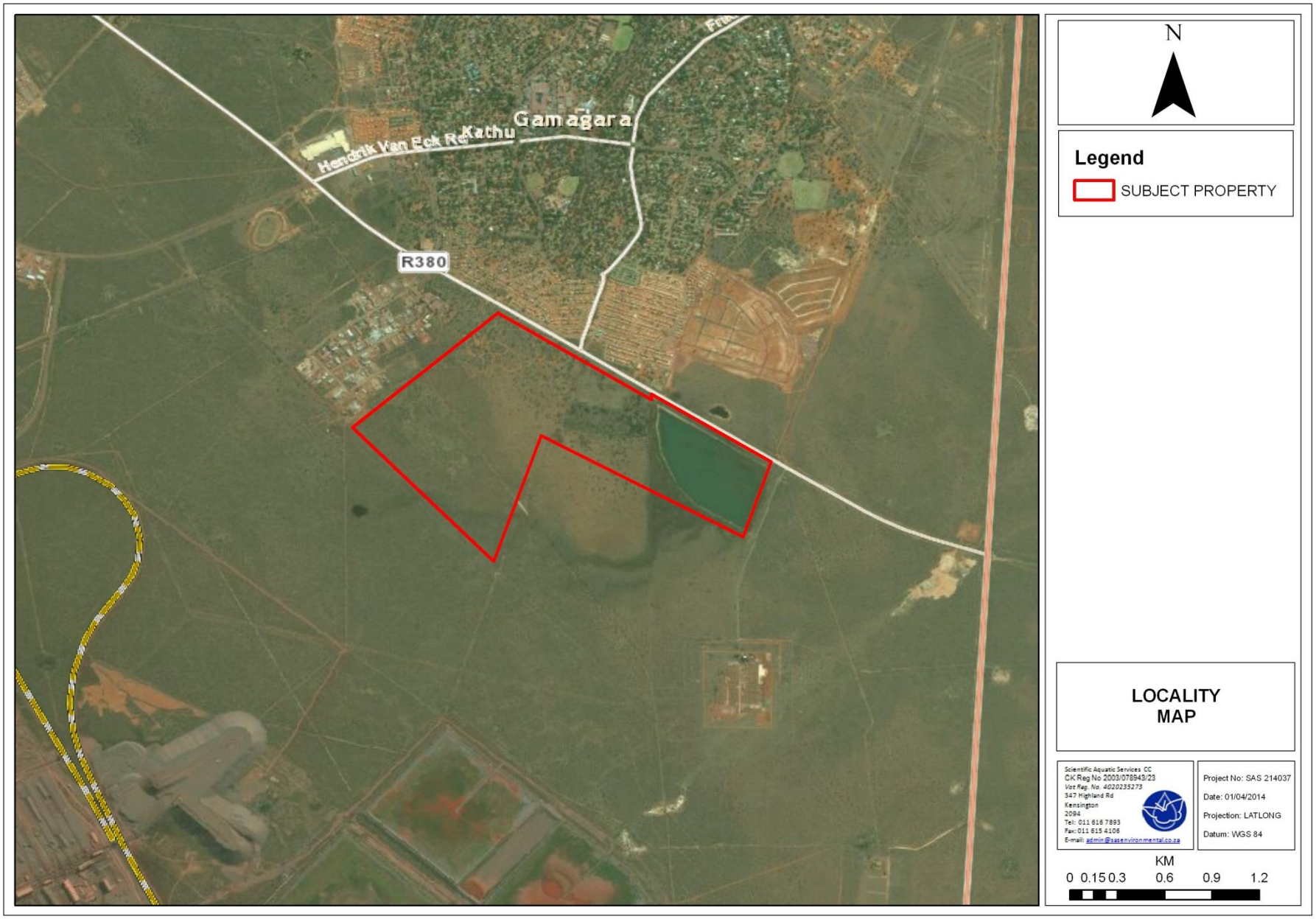

Figure 1: Digital satellite image depicting the location of the subject property in relation to surrounding areas.

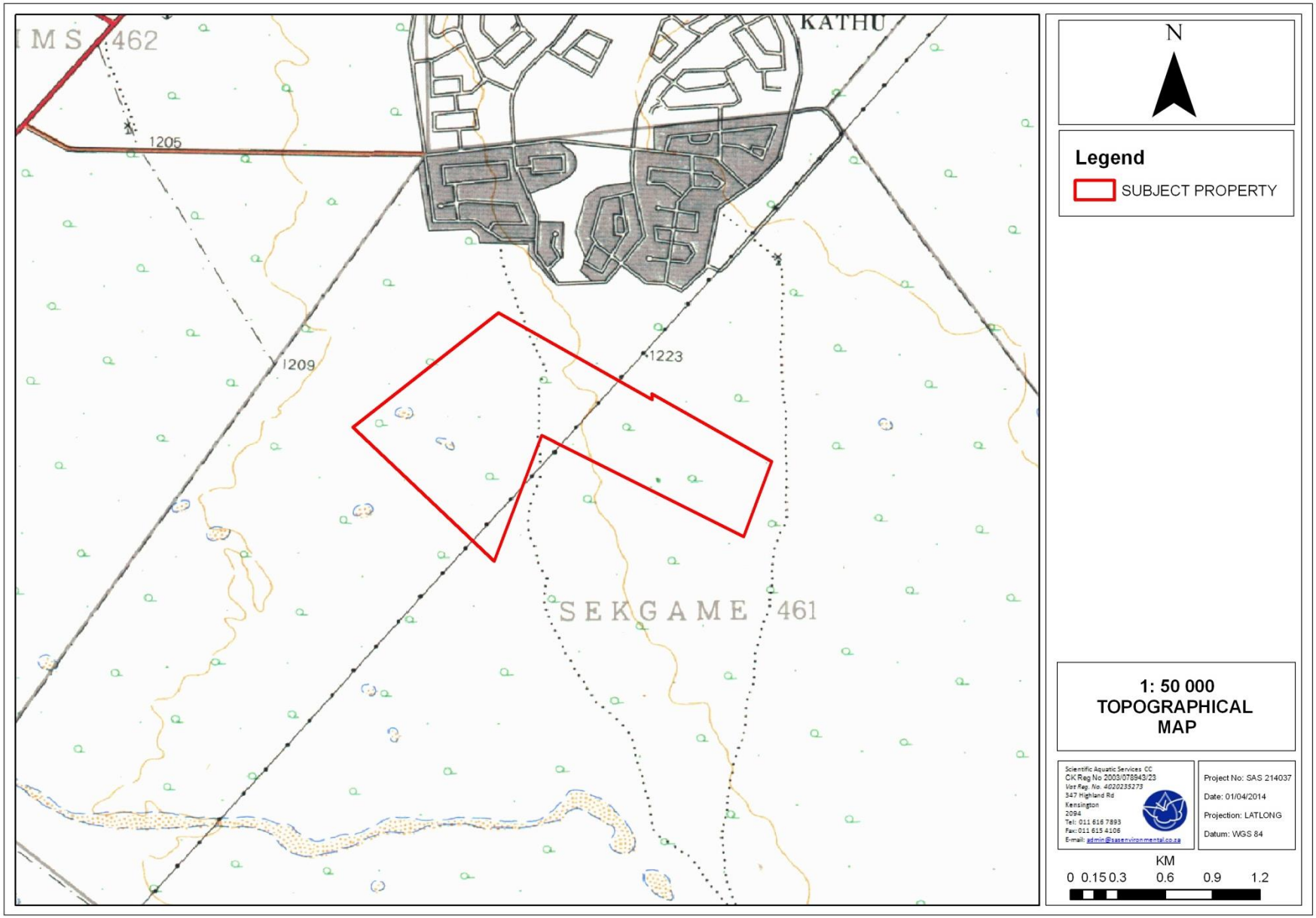

Figure 2: Location of the subject property depicted on a 1:50 000 topographical map in relation to surrounding areas

1.2 Scope

Specific outcomes in terms of this report are as follows:

- Classification of wetland features according the Classification System for Wetlands and other Aquatic Ecosystems in South Africa as defined by Ollis *et al*. (2013);
- Define the wetland services provided by the resources on the subject property according to the Method of Kotze *et al* (2009);
- Assess the wetland Health according to the resource directed measures guideline as defined by Macfarlane *et al*. (2009);
- Delineate the wetland temporary zone according to "DWA (Department of Water Affairs), 2005: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones";
- Determine the Ecological Importance and Sensitivity (EIS) of features according to the method as adapted from DWA (1999) for floodplains;
- Advocate a Recommended Ecological Category (REC) for the wetland features based on the findings of the EIS assessment;
- Determine the environmental impacts of the proposed development on the wetland features within the subject property;
- Define mitigatory measures to minimise impacts should the proposed activities proceed; and
- Identify wetland features located further from the proposed footprint that will still fall within the 500 m boundary of applicability of General Notice no. 1199 as it relates to the National Water Act (NWA, Act 36 of 1998).

1.3 Assumptions and Limitations

The following assumptions and limitations are applicable to this report:

- The wetland assessment was confined to the subject property as well as the immediate adjacent areas of relevance and does not include the neighbouring and adjacent properties. These were however considered as part of the desktop assessment;
- With ecology being dynamic and complex, some aspects (some of which may be important) may have been overlooked;
- The identification of the wetland temporary zone did prove difficult in some areas as a result of the significant disturbance of vegetation surrounding wetland features. However, the delineation as presented in this report is regarded as a best estimate of the boundary based on the site conditions present at the time of assessment;
- Wetland areas form transitional areas where an ecotone is formed as vegetation species change from terrestrial species to facultative and obligate wetland species. Within this transition zone some variation of opinion on the wetland boundary may occur, however if the DWA 2005 method is followed, all assessors should get largely similar results;
- Global Positioning System (GPS) technology is inherently inaccurate and some inaccuracies due to the use of handheld GPS instrumentation may occur. If more accurate assessments are required the wetland will need to be surveyed and pegged according to surveying principles; and
- The level of detail undertaken in the study is considered sufficient to ensure that the results of this assessment accurately define the Ecological Importance and Sensitivity (EIS) and the Present Ecological State (PES) of the of the subject property and to provide the relevant planners and decision makers with sufficient information to formulate an opinion in the viability of the proposed development form an ecological conservation viewpoint.

1.4 Indemnity and Terms of Use of this Report

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

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1.5 Legislative requirements

National Water Act, (NWA, Act 36 of 1998)

- The NWA (Act 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved;
- No activity may therefore take place within a watercourse unless it is authorised by DWA;
- Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from DWA in terms of Section 21 of the NWA.

General Notice 1199 as published in the Government Gazette 32805 of 2009 as it relates to the National Water Act, 1998 (Act 36 of 1998)

- Wetlands are extremely sensitive environments and as such, the Section 21 (c) and (i) water use General Authorisation does not apply to any wetland or any water resource within a distance of 500 meters upstream or downstream from the boundary of any wetland or estuary.

2 METHOD OF ASSESSMENT

The scope of work includes a literature review, followed by a site assessment undertaken on the 3rd, 4th and 5th of March 2014. Delineation of the wetland zones took place according to "DWAF, 2005: A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones". Aspects such as soil morphological characteristics, vegetation types and wetness were used to delineate the temporary zones of the wetlands according to the guidelines. The buffer zones were then delineated around the temporary zone. The wetland classification assessment was then undertaken according to the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems* (Ollis *et al*., 2013). In addition, the WET-Health (Macfarlane *et al.,* 2009), wetland ecological and socio-economic service provision (Kotze *et al.* 2009) and EIS of wetlands was determined. The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS Category for the wetland feature or group being assessed.

A detailed explanation of the wetland method of assessment is provided in Appendix A.

3 RESULTS OF WETLAND INVESTIGATION

3.1 National Freshwater Ecosystem Priority Areas

The NFEPA (2011) database was consulted in order to consider areas close to or within the subject property that may be of ecological importance. Aspects applicable to the subject property and surroundings are discussed below:

- The subject property falls within the Lower Vaal Water Management Area (WMA). Each Water Management Area is divided into several sub-Water Management Areas (subWMA), where catchment or watershed is defined as a topographically represented area which is drained by a stream or river network. The subWMA indicated for the subject property is the Molopo subWMA;
- The subWMA is not regarded to be of any importance in terms of fish sanctuaries, fish relocation or fish translocation;
- No rivers are located in close proximity to the subject property. The closest river system is the Ga-mogara River which is located approximately 12km to the south of the subject property;
- One wetland feature, a natural slope depression wetland, is located within the south western corner of the subject property. This feature is indicated to be in a natural or good condition with a greater than 75% natural land cover (Figure 15) and
- An additional natural bench depression wetland which is indicated to be in a natural or good condition is indicated approximately 300m to the south west of the subject property (Figure 15).

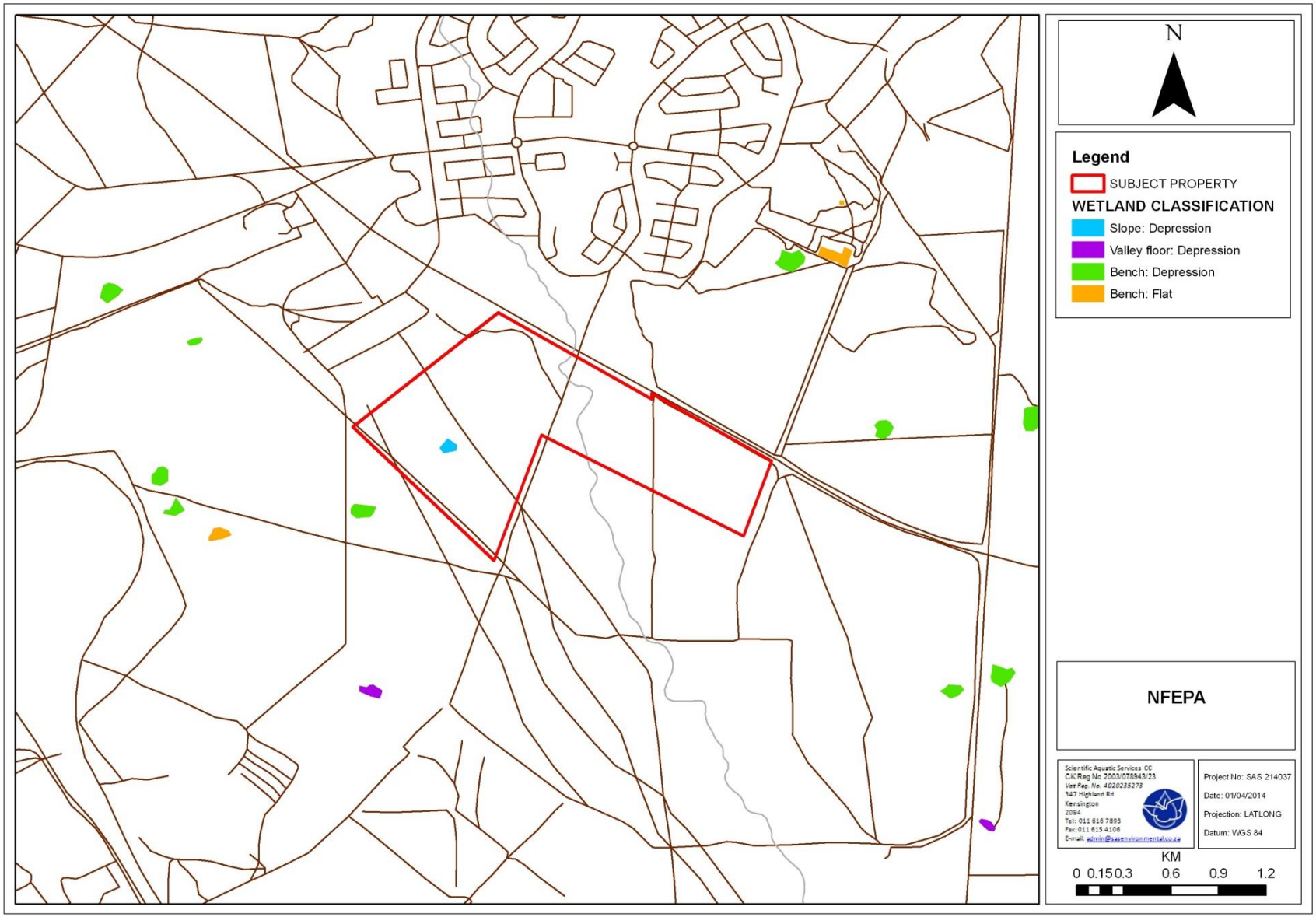

Figure 3: NFEPA wetland types within the subject property.

3.2 General Wetland Assessment Results

A site assessment was undertaken in March 2014 to determine the extent of wetland resources within the subject property. Three wetland features, a natural pan, an artificial dam and an artificial seep (Figure 15) were encountered and are discussed in detail below.

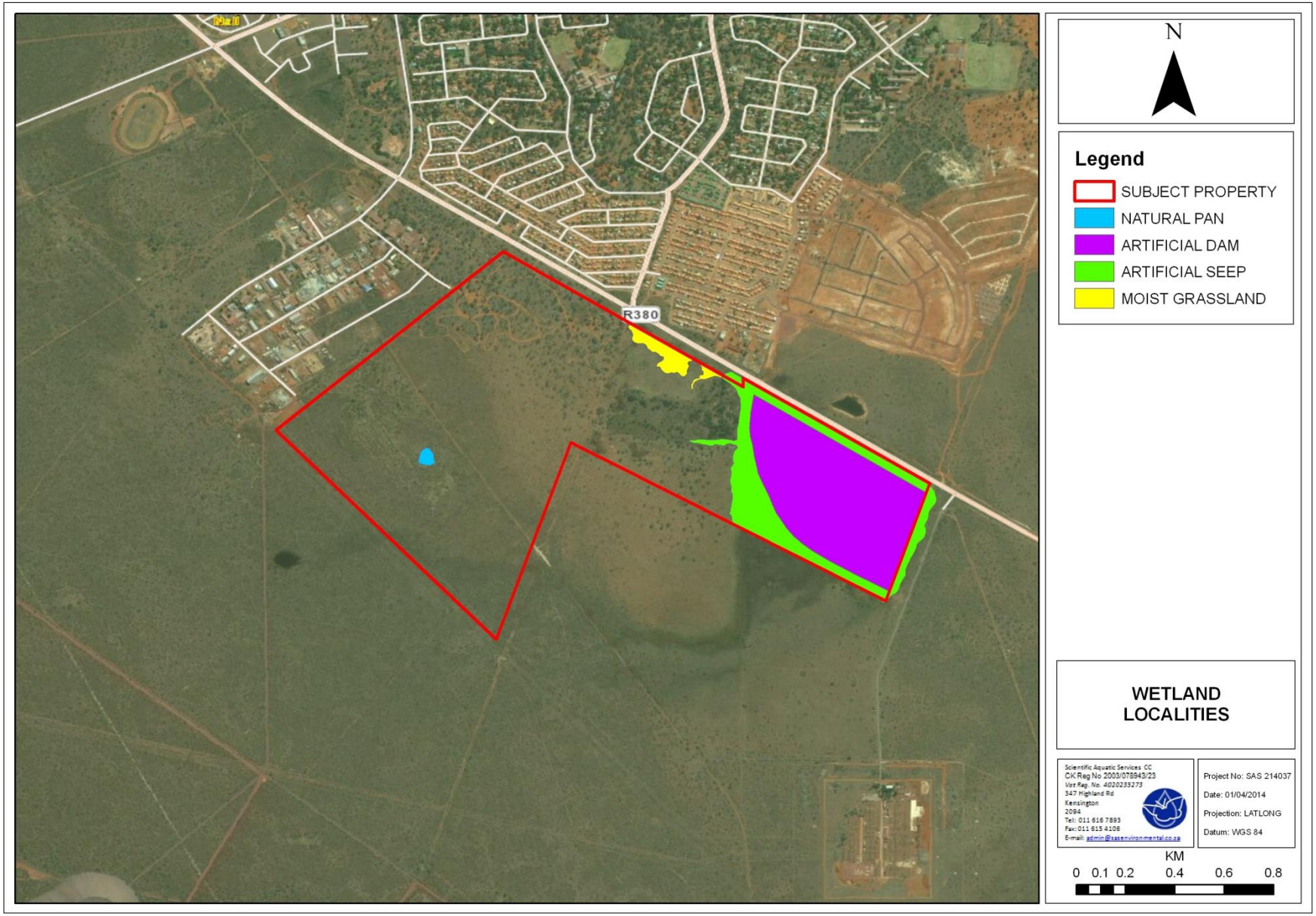

Figure 4: Wetland localities.

3.2.1 Artificial Dam

A large artificial dam is located within the eastern portion of the subject property, adjacent to the R380 roadway. This feature was constructed for the storage of grey water which is produced during mine operations and which is continuously pumped into the feature through a transfer scheme from the Kumba Iron Ore Sishen North Mine. At present the dam is dominated by the obligate[1] wetland species *Phragmites australis* and additional floral species identified bordering the dam included *Cyperus exculentus*, *Cortaderia selloana*, *Gomphocarpus fruticosus, Tamarix ramosissima* and *Pennisetum setaceum*. The majority of these species can be regarded as alien or invasive in the region. Although the dam is artificial in nature it has been present for a long enough period to allow for the establishment of avifaunal and amphibian communities.

It is considered highly unlikely that any natural wetland features were present within the eastern portion of the subject property prior to the construction of the dam and if the pumping of water into the dam is discontinued, and water drained from the area, all wetland conditions and characteristics will likely be lost.

Figure 5: Artificial dam

3.2.2 Artificial Seep Wetland

The seepage of water from the dam within the eastern portion of the subject property has resulted in the saturation of soils in the surrounding areas. This prolonged saturation has resulted in the formation of hydromorphic soils which are capable of supporting obligate and facultative[2] wetland species. The area surrounding the dam can therefore be defined as an artificial seep wetland. This large wetland system contained surface water at the time of the assessment and was characterised by the presence of the obligate and facultative wetland species such as *Phragmites australis* (Common Reed), *Typha capensis* (Bulrush)*, Juncus effusus* (Soft Rush) and *Scirpoides dioecus* (no common name), *Cyperus exculentus* (Yellow Nutsedge), *Kyllinga alba* (no common name), *Cortaderia selloana* (Pampas Grass) and *Andropogon eucomus* (Snowflake Grass). The seep wetland is also likely to provide the habitat to support a high diversity of faunal species with special mention of breeding habitat and cover for amphibian, avifaunal and invertebrate species. However, it should be noted that seepage areas to the west and north of the dam have been significantly disturbed as a result of historic earth moving activities and dumping of rubble and waste. This disturbance has resulted in the encroachment of alien and weed species including *Prosopis galndulosa* (Honey Mesquite), *Persicaria lapathifolia* (Pale Knotweed), *Datura stramonium* (Common Thorn Apple) and *Verbesina encelioides* (Golden Crownbeard) into the feature.

The seep wetland is a completely artificial feature which is augmented by water seeping from the artificial dam. The presence of this feature within the subject property is therefore considered to be

[1] Species almost always found in wetlands (greater than 99% of occurrence) (DWAF, 2005)
[2] Species usually found in wetlands (67% to 99% of occurrence) but occasionally found in non wetland areas (DWAF, 2005)

a deviation from the natural condition as areas currently considered wetland habitat were more than likely terrestrial prior to the development of the dam. It is therefore considered highly likely that drainage or lining of the dam will result in the removal of the water source which augments the seepage feature and will therefore result in the loss of the feature from the subject property.

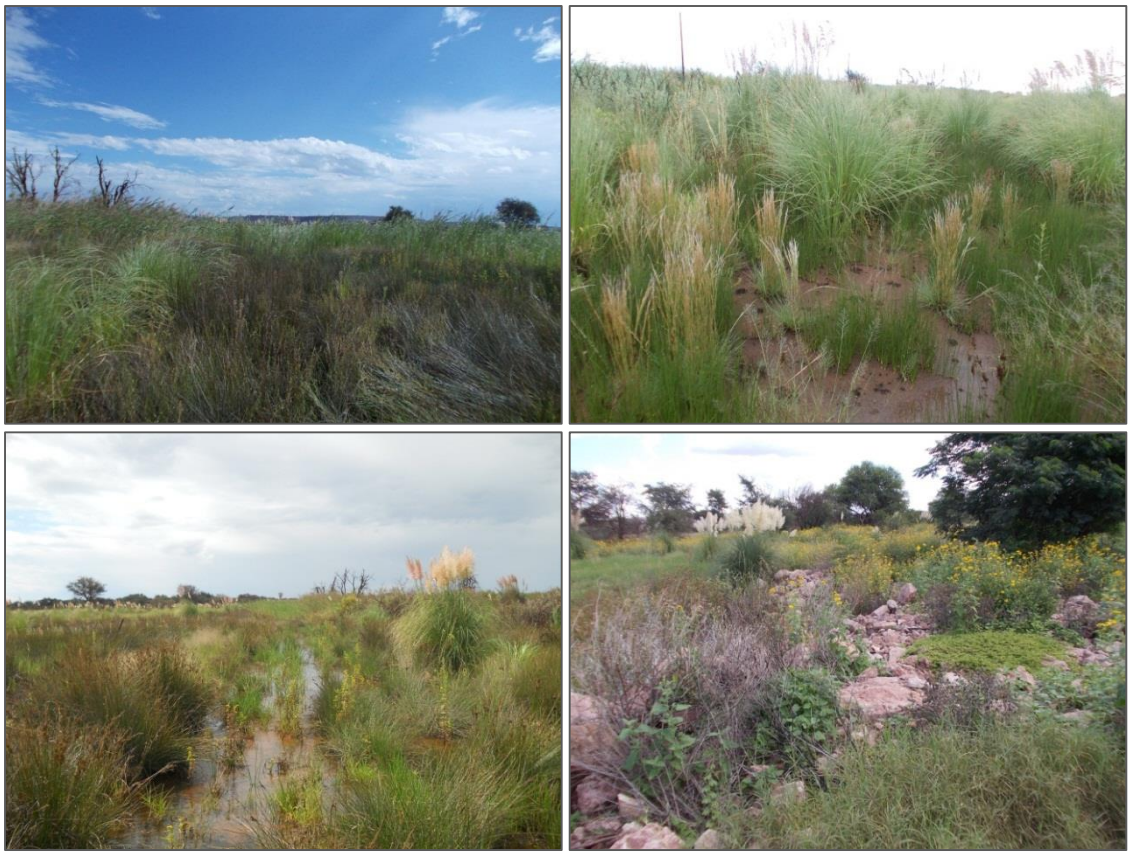

Figure 6: Artificial seep

3.2.3 Natural Pan

A natural wetland pan is located within the south western portion of the subject property. Species dominating the pan include the facultative wetland species *Panicum coloratum* (White Buffalograss) and *Urochloa panicoides* (Garden Urochloa). The pan did not contain any surface water at the time of the assessment, however, low chroma soils were observed.

This feature has been significantly disturbed as a result of historic earth moving activities and as a result of the dumping of rubble and litter within the feature which has decreased the PES of the feature substantially.

Figure 7: Natural pan.

3.2.4 Moist Grassland

Areas located to the west of the artificial dam and directly adjacent to the road edge are augmented by runoff from the road and by seepage from the dam. These areas are subtended by a shallow calcrete layer which prevents the vertical seepage of water out of the area. Although surface water was encountered within small depressional areas and moist conditions were present at the time of the assessment, soils did not show any signs of extended saturation and typical characteristics of hydromorphic soils were absent. These areas were characterised by the dominance of *Cynodon dactylon* (Couch Grass) which is a facultative wetland species but is also a species indicative of disturbance, and although scattered individuals of *Juncus effusus* (Soft Rush) were encountered, the low abundance of individuals of this species was not deemed sufficient to confirm the presence of wetland conditions. In addition, terrestrial floral species such as *Eragrostis lehmanniana* and *Eragrostis echinocloidea* which are not characteristic of wetland areas were identified scattered amongst the *Cynodon dactylon*.

Taking into consideration the findings above, the areas adjacent to the road can be defined as moist grasslands which are in the early stages of wetland development. These moist grasslands were therefore not assessed further within this report. However, it should be noted that the continued augmentation of these areas with runoff and seepage and the extended saturation of soils is likely to result in the creation of wetland conditions in the future.

Figure 8: Moist grassland

3.3 Wetland Characterisation

Features within the subject property were categorised with the use of the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa* (Ollis *et. al*, 2013). After the field assessment it can be concluded that three main wetland groups are present within the subject property, namely an artificial dam, an artificial seep wetland and a natural pan. The results are illustrated in the tables below.

Table 1: Classification for the artificial dam (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The subject property falls within the Southern Kalahari Ecoregion and within the Eastern Kalahari Bushveld vegetation group (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Depression: A landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.	Dammed - with channelled inflow

Table 2: Classification for the artificial seepage (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The subject property falls within the Southern Kalahari Ecoregion and within the Eastern Kalahari Bushveld vegetation group (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Seep: a wetland area located on gently to steeply sloping land and dominated by colluvial, unidirectional movement of water and material downslope	N/A

Table 3: Classification for the natural pan (SANBI 2013).

Level 1: System	Level 2: Regional Setting	Level 3: Landscape unit	Level 4: Hydrogeomorphic (HGM) unit	
			HGM Type	Longitudinal zonation / landform / Inflow drainage
An ecosystem that has no existing connection to the ocean but which is inundated or saturated with water, either permanently or periodically.	The subject property falls within the Southern Kalahari Ecoregion and within the Eastern Kalahari Bushveld vegetation group (NFEPA WetVeg).	Plain: An extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.	Depression: A landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.	Natural - without channelled inflow

3.4 Wetland Function Assessment

The function and service provision of all wetland features within the subject property was assessed based on Kotze *et. al*. 2009. The ecosystem services provided by the wetland features were scored and an average score for all the ecosystem services provided is presented in Table 6 below. Scores for the various ecosystem services are graphically presented in the radar plot in Figure 21.

Table 4: Wetland functions and service provision.

Ecosystem service	Artificial dam	Artificial seepage	Natural pan
Flood attenuation	0.1	1.5	1.1
Streamflow regulation	0	0	0
Sediment trapping	0	1	1.6
Phosphate assimilation	0.3	1.8	1
Nitrate assimilation	1	2	0.8
Toxicant assimilation	0.8	2	0.9
Erosion control	0.6	1.75	1.1
Biodiversity maintenance	0.7	0.8	0.8
Carbon Storage	0	0	0
Water Supply	3.3	0	0
Harvestable resources	0	0	0
Cultural value	0	0	0
Cultivated foods	0	0	0
Tourism and recreation	0	0	0
Education and resource	0	0	0
SUM	**6.8**	**10.9**	**7.3**
Average score	**0.5**	**0.7**	**0.5**

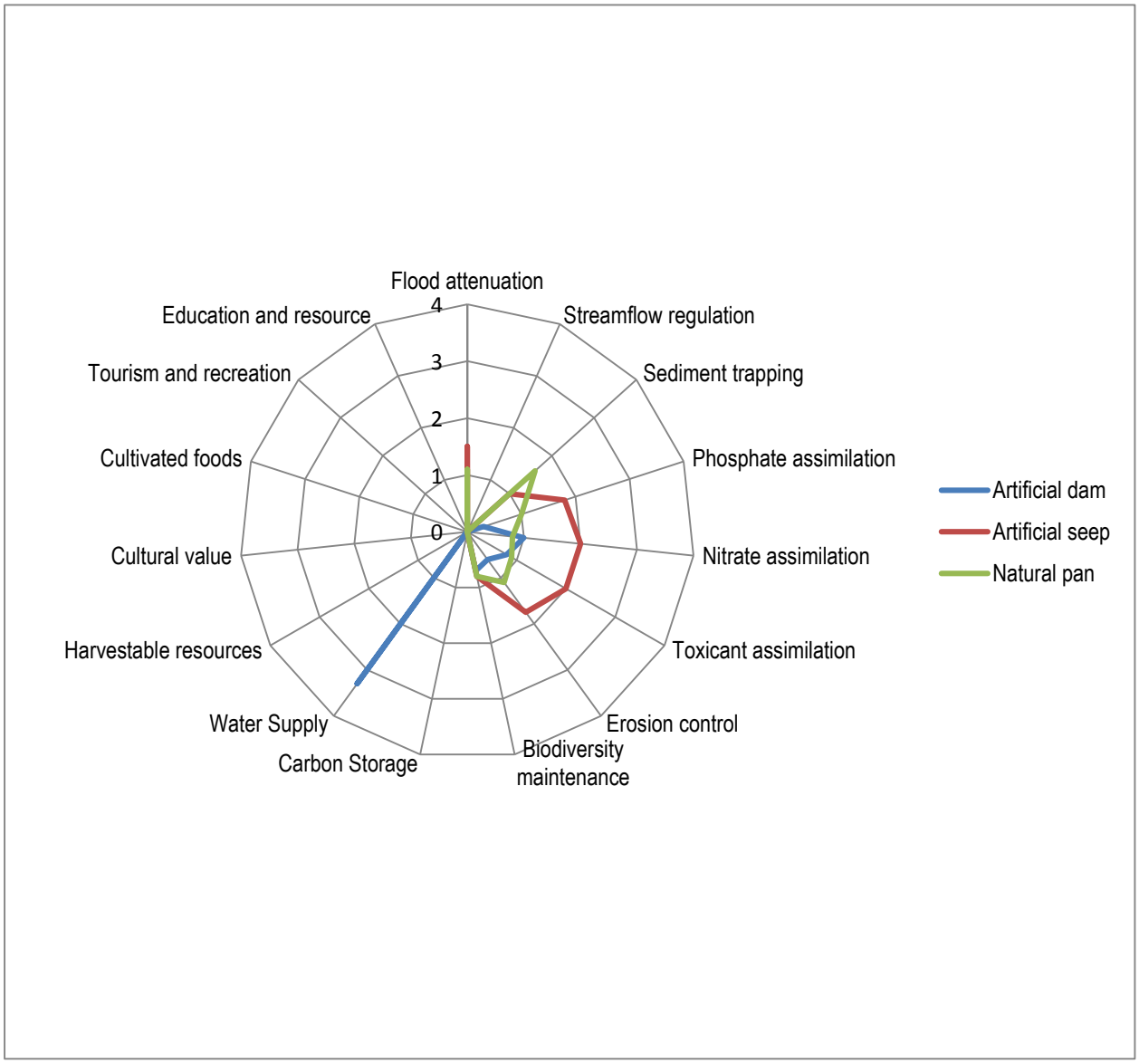

Figure 9: Radar plot of wetland services.

From the results of the assessment, it is evident that all wetland features within the subject property have a moderately low level of ecological function and service provision (Table 6). The artificial dam is an isolated feature which is not connected to any important natural downstream systems by means of surface flow. As a result, the feature does not play any role in terms of stream flow regulation and would only be of limited importance in terms of flood attenuation and sediment trapping. Furthermore, the dam lacks the continuous vegetative layer which would enable the enhanced assimilation of phosphates, nitrates and toxicants from water[3]. This decreases the features importance in terms of the assimilation of these substances.

The locality of the artificial seep adjacent to urban development and the R380 roadway increases its importance in terms of the assimilation of phosphates, nitrates and toxicants which may enter into it through surface runoff from surrounding areas. In addition, the moderately high vegetation cover associated with the feature will increase its ability to assimilate these chemicals.
The natural pan is situated within an area in which historic dumping activities and disturbance has occurred. This feature is therefore likely to play a small role in the trapping of sediment which is likely

[3] The greater the extent of vegetation cover and the more prolonged this cover, the greater will be the provision of microhabitat and organic matter critical for soil microbes involved in the assimilation of nitrates, phosphates and toxicants (Kotze *et al.* 2008)

to enter into the feature with surface runoff from surrounding disturbed areas. However, the pan is relatively isolated and is not located in close proximity to any large developed areas and roads, therefore its assimilation of phosphates, nitrates and toxicants is likely to be limited.

None of the features within the subject property are regarded to be of significant importance in terms of the maintenance of biodiversity in the area. Both the dam and seep wetland are artificial features with completely altered hydrology, sediment and water quality regimes. However, both features support indigenous floral and faunal wetland species which increases their importance slightly in terms of the maintenance of biodiversity. The pan, although natural, has been significantly disturbed as a result of dumping activities. However, the feature still supports indigenous wetland species which also increases its importance in terms of the maintenance of biodiversity slightly.

Water within the artificial dam is currently in use by the Kathu municipality for commercial/domestic purposes and the dam therefore calculated a high score for water supply. However, no significant importance was calculated for any of the features in terms of harvestable resources, cultivated foods or cultural value.

3.5 Wetland Health

A level 2 WET-health assessment was undertaken to determine the PES of the wetland features associated with the subject property. It is highly unlikely that natural wetlands would have occurred in the areas where the artificial dam and seep wetland are currently located. It is therefore not possible to determine the PES of the features because there is no natural reference state to use as a baseline for such an assessment. Neither the artificial dam nor the seep wetland was therefore assessed using WET-health.

The pan is a natural feature and could therefore be assessed using WET-health. However, it should be noted that the present geomorphological state of wetland features can only be assessed for features which are connected to the drainage network in some way (Macfarlane *et. al* 2009). The pan is an isolated, endorheic feature and the geomorphological health of this feature was therefore not assessed.

Table 5: Summary of the overall health of the wetlands based on impact score and change score including the trajectory of change should the development proceed.

Feature Type	Hydrology		Vegetation	
	Impact Score	Change Score	Impact Score	Change Score
Natural pan	A	↓↓	D	↓↓

The present hydrological state of the pan calculated a score that falls within Category B (largely natural). The pan is a non-perennial feature which contains water for limited periods of the year. The feature has not been canalised and no stream modification has taken place. However, significant dumping activities have taken place within the catchment of the feature and within the feature itself. Dumping of rubble and waste and the associated disturbance of the wetlands catchment may have had a negative impact on the hydrology of the feature.

The present state of the vegetation cover within the pan calculated a score that falls within Category D (Largely modified). Vegetation associated with the pan has been disturbed as a result of dumping activities. However, indigenous wetland species are still present within the feature.

The overall score for the pan which aggregates the scores for the two modules, namely hydrology and vegetation, was calculated using the formula as provided by the Wet-Health methodology[4] (altered with the removal of the geomorphology module). The pan calculated an overall score falling within the PES Category C (moderately modified). The PES was then used as a benchmark for the identification of an appropriate category for the EIS (section 6.6 below).

In terms of anticipated trajectory[5], should the development of the subject property not take place, it is considered to be highly likely that the PES of the pan would improve as natural vegetation would be allowed to re-establish over time. However, should the development of the subject property occur, the health of the pan would decrease.

3.6 Hydrological Function

Wetland hydrology generally refers to the inflow and outflow of water through a wetland. Therefore land is characterised as having wetland hydrology when, under normal circumstances, the land surface is either inundated or the upper portion of the soil is saturated at a sufficient frequency and duration to create anaerobic conditions[6].

The artificial dam is augmented by water which is pumped into the feature from the Kumba Iron Ore Sishen North mine, and the seep wetland is augmented by seepage from the dam. If the pumping of water into the dam is discontinued the hydrological functioning of both the dam and the seep wetland will therefore be lost and the system would cease to function as a wetland with terrestrial vegetation becoming re-established.

The pan is hydrologically isolated and can be considered endorheic (a landform with closed elevation contours). The feature therefore receives water from precipitation, diffuse surface flow, and groundwater and the dominant hydrodynamics within the feature are bidirectional vertical fluctuations. Disturbance within the pans catchment is likely to have resulted in the slight alteration of the flow patterns of water into the feature. However, if surrounding areas are cleared of dumped rubble and litter the hydrological functioning of the feature is likely to improve.

3.7 EIS Determination

The method used for the EIS determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS Category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS Category as listed in Table 9 below. A confidence score (Conf) is also provided on a scale of 0 to 4, where 0 indicates low confidence and 4 high confidence.

[4] ((Hydrology score) x 3 + (vegetation score) x 2))/ 5 = PES

[5] Anticipated change over the next 5 years.

[6] www.*forestandrange.org/new_wetlands*

Table 6: EIS determination.

Determinant	Artificial dam		Artificial seep		Natural pan	
	Score	Conf	Score	Conf	Score	Conf
PRIMARY DETERMINANTS						
1. Rare & Endangered Species	0	4	0	4	0	4
2. Populations of Unique Species	0	4	0	4	0	4
3. Species/taxon Richness	1	4	2	4	0	4
4. Diversity of Habitat Types or Features	0	4	1	4	0	4
5 Migration route/breeding and feeding site for wetland species	3	4	3	4	0	4
6. PES as determined by WET-Health assessment	N/A	4	N/A	4	2	4
7. Importance in terms of function and service provision	1	4	1	4	1	4
MODIFYING DETERMINANTS						
8. Protected Status according to NFEPA Wetveg	0	4	0	4	3	4
9. Ecological Integrity	3	4	3	4	1	
TOTAL	8		10		7	
MEDIAN	1		1.2		0.7	
OVERALL EIS	**D**		**C**		**D**	

Based on the findings of the study it is evident that the artificial seep has an EIS falling within Category C (moderate sensitivity) and that the artificial dam and the natural pan have an EIS falling within Category D (low/marginal sensitivity).

3.8 Recommended Ecological Category

The pan was calculated to have a moderately low level of ecoservice and function and falls within PES Category C (moderately modified). However, with rehabilitation, it is deemed highly likely that the overall PES of the feature can be increased. The REC deemed appropriate to improve the current ecology as well as functionality within this feature is therefore a Category B (largely natural).

Although the dam and seep wetland are artificial features they still provide some ecoservice and function and provide the habitat to support wetland species. In order to safeguard the wetland habitat that has developed within the dam and surroundings it is recommended that the seepage areas remain free from development and that general mitigation measures as listed in the impact assessment be adhered to.

3.9 Wetland Delineation

All wetland features were delineated according to the guidelines advocated by DWA (2005). It should be noted that the identification of the temporary zone did prove difficult in some areas as a result of the significant disturbance of vegetation surrounding wetland features. However, the delineation as presented in this report is regarded as a best estimate of the boundary based on the site conditions present at the time of assessment.

During the assessment, the following temporary zone indicators were used:

Artificial dam

- The dam wall created as a result of earth impoundments (terrain units) could be used as a primary indicator of the boundary of the feature. The terrain unit indicator was the only indicator deemed necessary to determine the boundary as almost the entire feature contains surface water.

Artificial seep

- The presence of the obligate wetland species *Juncus effusus* (Soft Rush) could be used as the primary indicator when determining the temporary zone boundary of the seep wetland.

Figure 10: Distinct boundary between the wetland temporary zone (foreground dominated by *Juncus effuses*) and terrestrial areas (background dominated by *Eragrostis lehmanniana*).

Natural pan

- The pan is located within an area displaying endorheic drainage and terrain units were therefore used as the primary indicator in determining the temporary zone boundary; and
- The presence of the facultative wetland species *Panicum coloratum* (White Buffalograss) could be used as a secondary indicator of the temporary zone boundary.

Figure 11: Natural pan.

3.10 Buffer Allocation

Both the dam and seep wetland are artificial features which cannot be considered representative of wetlands which one would naturally find in the region. These features only exist as a result of artificial augmentation processes which, if discontinued, would most likely result in the loss of wetland conditions. The loss of these wetland features would therefore not contribute to the overall loss of natural wetland habitat from the region. Although the dam and seep wetland are artificial features they currently provide the habitat to support wetland species and play a role in terms of function and service provision. In order to safeguard the artificial wetland habitat that has developed within the dam and surroundings it is therefore recommended that the seepage wetland remains free from development thereby acting as a buffer to the artificial dam.

The natural pan has been significantly disturbed as a result of historic earth moving activities. However, with rehabilitation, it is deemed highly likely that the overall PES of the feature can be increased. A minimum buffer of 32m is therefore advocated in order to minimise any impact the proposed development activities could have as well as to safeguard wetland resources during the operational phase of the development. The 32m buffer recommendation is also based on the legislative principles

as enshrined in the National Environmental Management Act (NEMA) (Activity 9 and 11 listing 1 of Government Notice R544 and Activity 16 Listing 3 of Government Notice R546 of 2010). Therefore, in line with the principle of cooperative governance the implementation of a 32 m buffer is considered industry best practice complying with the requirements of NEMA.

It should be noted that any activity occurring within wetland features or associated buffer areas will require authorisations in terms of Section 21 c & i of the NWA (Act 36 of 1998). Furthermore, development activities falling within 32m of wetland features will trigger activities as listed by NEMA (Act 107 of 1998). In addition, the subject property falls within 500 meters of wetland features and therefore General Notice no. 1199 of 2009 as it relates to the NWA (Act 36 of 1998) will also apply.
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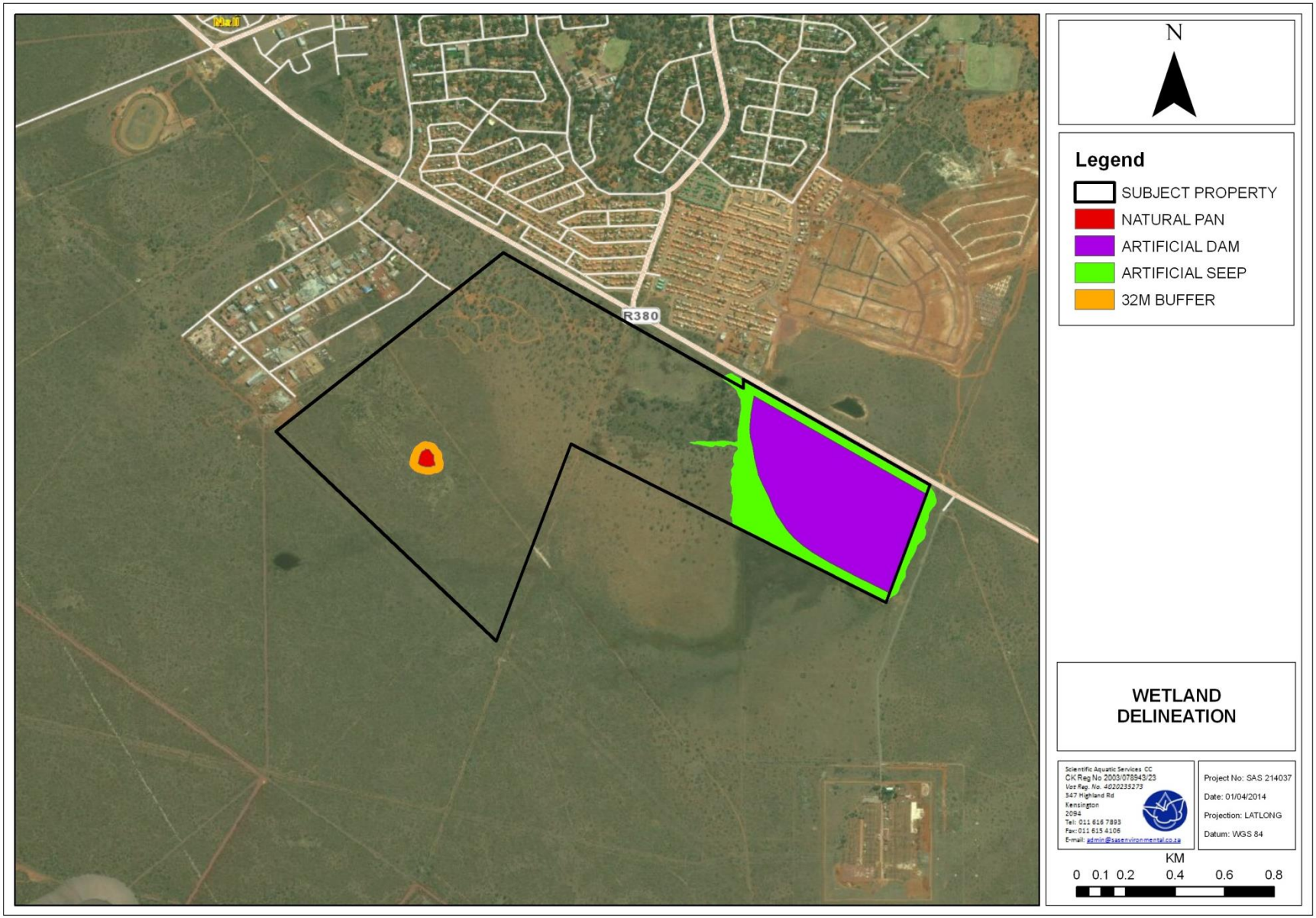

Figure 12: Natural pan with associated buffer.

4 IMPACT ASSESSMENT

The tables below serve to summarise the significance of potential impacts on the wetland ecology of the subject property. A summary of all potential pre-construction, construction and operational phase impacts is provided before the impact discussion. The sections below indicate the required mitigatory and management measures needed to minimise potential ecological impacts and presents an assessment of the significance of the impacts taking into consideration the available mitigatory measures, assuming that they are fully implemented.

The table below illustrates the mitigation hierarchy, a fundamental tool for impact mitigation (DEA *et. al*., 2013), as well as the forms of mitigation which may be applicable to this project.

Table 7: The Mitigation Hierarchy and the forms of mitigation which are applicable to the project.

Forms of mitigation	Applicability
Avoiding or preventing impacts	Impacts will be avoided or prevented if possible.
Minimise impacts	Impacts will be minimised where possible.
Rehabilitate impacts	Rehabilitation of areas disturbed as a result of construction activities will take place.
Offset impacts	An offset area is not deemed necessary as all impacts will either be avoided, prevented, minimised or rehabilitated.

4.1 Wetland Impact Assessment

The tables below serve to summarise the significance of perceived impacts on the wetland biodiversity of the subject property. Impacts associated with the loss of the artificial dam and seep wetland are likely to differ from those associated with the loss of the natural pan and were therefore assessed separately.

Impact significance was assessed for two separate alternatives:

- Alternative 1: All wetland features within the subject property will be permanently lost as a result of development activities; and
- Alternative 2: Wetland features will not be lost as a result of development activities.

IMPACT 1: LOSS OF WETLAND HABITAT AND ECOLOGICAL STRUCTURE

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement	Construction of infrastructure within wetlands and wetland buffer areas	Increased runoff volumes from hardened surfaces
Inadequate design of infrastructure	Site clearing and the disturbance of soils	Indiscriminate movement of operational vehicles through wetland areas
	Earthworks within wetland features	Ineffective stormwater drainage
	Movement of construction vehicles within wetlands	Inefficient aftercare and maintenance
	Inundation caused by ineffective stormwater drainage	
	Dumping of waste within wetland areas	

	Spills and leaks from construction vehicles	
	Inadequate management of edge effects during construction	
	Alien vegetation encroachment	

Alternative 1

All wetland habitat will be lost from the subject property as a result of development activities. Therefore the significance of impacts prior to and after the implementation of mitigation measures will remain the same. However, mitigation measures have been provided in order to ensure that impacts within surrounding natural areas are limited.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	5	3	3	2	5	8	10	80 (Medium High) Negative
Natural pan	5	2	2	2	5	7	9	64 (Medium Low) Negative

Essential mitigation measures

- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise environmental damage;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- The relevant approvals must be obtained from DWA for any activities within the wetland areas and associated buffers. In this regard special mention is made of water use licences in terms of section 21 c and i of the National Water Act as well as any authorisation that may apply as part of General Notice 1199 as published in the Government Gazette 32805 of 2009 as it relates to the National Water Act, 1998 (Act 36 of 1998);
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed; and
- Remove all alien and weed species encountered in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). However, care should be taken with the use of herbicides within areas close to the wetland feature to ensure no additional impacts occur due to the herbicide used.

Recommended mitigation measures

- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	5	3	3	2	5	8	10	80 (Medium High) Negative
Natural pan	5	2	2	2	5	7	9	64 (Medium Low) Negative

Probable latent impacts

- Wetland habitat within the subject property will be permanently lost.

Alternative 2

Wetlands within the subject property will not be permanently lost as a result of development activities. Development activities, if left unmitigated, may result in long term impacts on wetland habitat, however, with the implementation of mitigation measures the overall significance of impacts can be reduced.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	4	3	3	2	5	7	10	70 (Medium Low) Negative
Natural pan	4	2	2	2	5	6	9	54 (Medium Low) Negative

Essential mitigation measures

- Ensure that construction related activities do not encroach into the wetlands or wetland buffer zones;
- Limit the footprint area of the construction activity to what is absolutely essential in order to minimise environmental damage;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- The relevant approvals must be obtained from DWA for any activities within the wetland areas and associated buffers. In this regard special mention is made of water use licences in terms of section 21 c and i of the National Water Act as well as any authorisation that may apply as part of General Notice 1199 as published in the Government Gazette 32805 of 2009 as it relates to the National Water Act, 1998 (Act 36 of 1998);
- Edge effects of activities including erosion and alien/ weed control need to be strictly managed in wetland areas;
- Remove all alien and weed species encountered in order to comply with existing legislation (amendments to the regulations under the Conservation of Agricultural Resources Act, 1983 and Section 28 of the National Environmental Management Act, 1998). However, care should be taken with the use of herbicides within areas close to the wetland feature to ensure no additional impacts occur due to the herbicide used.
- Restrict construction vehicles to designated roadways. The indiscriminate movement of construction vehicles through wetland areas must be strictly prohibited;
- All spills should be immediately cleaned up and treated accordingly;
- Regularly inspect all construction vehicles for leaks. Re-fuelling must take place on a sealed surface area to prevent hydrocarbons reaching surface/subsurface water that could potentially flow to the wetland feature;
- Prevent run-off from work areas entering wetland habitats;
- Incorporate adequate erosion and stormwater management measures in order to prevent erosion and the associated sedimentation of the wetland areas. In this regard specific attention should be given to the attenuation of stormwater in order to prevent erosion;
- Sanitation facilities must be provided for the duration of the proposed development and all waste removed to an appropriate facility. These facilities must be located outside of the wetland features and must be regularly serviced;
- Implement waste management as contemplated in the Environmental Management Programme in order to prevent construction related waste from entering the wetland environment;
- Do not allow dumping of waste material within wetland areas at any stage of the development. Do not allow any temporary storage of building material within the wetland areas;
- All waste, with special mention of waste rock and spoils and remaining building material should be removed from the site on completion of the construction phase; and
- Rehabilitate the natural pan in order to improve the PES of the wetland habitat.

Recommended mitigation measures

- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	3	3	2	1	3	6	6	36 (Low) Negative
Natural pan	3	2	1	1	3	5	5	25 (Very Low)

								Negative

Probable latent impacts
- Vehicles will still use the service road surrounding the dam and may impact on wetland habitat; and
- Access to the dam and artificial seep cannot be restricted and anthropogenic activity may therefore create additional impact.

IMPACT 9: CHANGES TO WETLAND ECOLOGICAL AND SOCIO-CULTURAL SERVICE PROVISION

Aspects and activities register

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement	Construction of infrastructure within wetlands and wetland buffer areas	Increased runoff velocity and volume from hardened surfaces
Inadequate design of infrastructure	Earthworks within wetland features	Indiscriminate movement of operational vehicles through wetland areas
	Ineffective stormwater drainage	Insufficient aftercare and maintenance
	Site clearing and the removal of vegetation	Ineffective stormwater drainage
	Inadequate management of edge effects during construction	
	Indiscriminate movement of construction vehicles within wetlands	
	Spill of waste material and waste deposits into the wetland habitat	

Alternative 1

All wetland features will be lost from the subject property and all associated wetland functions and service provision will therefore be permanently removed. The implementation of mitigation measures will not reduce the impacts associated with this loss and impact significance will therefore remain the same before and after mitigation. However, mitigation measures have been provided in order to ensure that impacts within surrounding natural areas are limited.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	**5**	**2**	**3**	**2**	**5**	**7**	**10**	**70 (Medium Low) Negative**
Natural pan	**5**	**2**	**2**	**2**	**5**	**7**	**9**	**63 (Medium Low) Negative**

Essential mitigation measures:
- The footprint of construction related activities should be kept to a minimum; and
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas.

Recommended mitigation measures:
- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	5	2	3	2	5	7	10	70 (Medium Low) Negative
Natural pan	5	2	2	2	5	7	9	63 (Medium Low) Negative

Probable latent impacts
- Overall wetland function and service provision will be permanently lost.

Alternative 2

Wetland features and associated functions and service provision will not be permanently lost from the subject property. Development activities are likely to have negative impacts on wetland function and service provision, however, with the implementation of mitigation measures the overall significance of impacts may be reduced.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	4	2	3	2	5	6	10	60 (Medium Low) Negative
Natural pan	4	2	2	2	5	6	9	54 (Medium Low) Negative

Essential mitigation measures
- Ensure that construction related activities do not encroach into the wetlands or wetland buffer zones;
- The footprint of construction related activities should be kept to a minimum;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Prevent run-off from work areas entering wetland habitats;
- Incorporate adequate erosion management measures in order to prevent erosion and the associated sedimentation of the wetland features. Management measures may include berms, silt fences, hessian curtains and stormwater diversion away from areas susceptible to erosion. Care should however be taken so as to avoid additional disturbance during the implementation of these measures;
- Attenuate stormwater in order to prevent erosion;
- Sheet runoff from paved surfaces and access roads must be curtailed;
- Ensure that seepage from dirty water systems is prevented as far as possible;
- Implement an alien vegetation control program within wetland areas; and
- Rehabilitate the natural pan in order to improve function and service provision.

Recommended mitigation measures:
- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	2	2	1	1	3	4	5	20 (Very Low) Negative
Natural pan	2	2	1	1	3	4	5	20 (Very Low) Negative

Probable latent impacts
- Vehicles will still use the service road surrounding the dam and impacts created as a result of the disturbance may impact on wetland function; and
- Access to the dam and artificial seep cannot be restricted and anthropogenic activity may therefore create additional impact.

IMPACT 10: IMPACTS ON WETLAND HYDROLOGICAL FUNCTION AND SEDIMENT BALANCE

Activities leading to impact

Pre-Construction	Construction	Operational
Poor planning of infrastructure placement	Construction of infrastructure within wetlands and wetland buffer areas	Insufficient aftercare and maintenance leading to ongoing erosion and increased sedimentation due to poor management
Inadequate design of infrastructure with special mention of stormwater management structures	Site clearing and the removal of vegetation	Increased runoff velocity and volume due to increase in impervious surface associated with the development
	Site clearing and the disturbance of soils	Inundation caused by ineffective stormwater drainage
	Earthworks within wetland areas	
	Compaction and loss of wetland soils	
	Ineffective stormwater drainage	

Alternative 1

All wetland features will be removed from the subject property and the hydrological function and sediment balance lost. The implementation of mitigation measures will not result in the return of hydrological function and sediment balance and the significance of impacts therefore remains the same before and after mitigation. However, mitigation measures have been provided in order to ensure that impacts within surrounding natural areas are limited.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	**5**	**2**	**4**	**2**	**5**	**7**	**11**	**77 (Medium High) Negative**
Natural pan	**5**	**2**	**2**	**2**	**5**	**7**	**9**	**63 (Medium Low) Negative**

Essential mitigation measures:
- The footprint of construction related activities should be kept to a minimum; and
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;

Recommended mitigation measures
- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	5	2	4	2	5	7	11	77 (Medium High) Negative
Natural pan	5	2	2	2	5	7	9	63 (Medium Low) Negative

Probable latent impacts

- Wetland hydrological function and sediment balance will be permanently lost.

Alternative 2

Wetland features will not be permanently removed from the subject property and the hydrological function and sediment balance will not be permanently lost. Development activities may result in impacts on the hydrology and sediment balance of wetland features, however, with the implementation of mitigation measures the overall impact significance can be reduced.

Without Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	4	2	4	2	5	6	11	66 (Medium Low) Negative
Natural pan	4	2	2	2	5	6	9	54 (Medium Low) Negative

Essential mitigation measures:

- Ensure that construction activities do not encroach into the wetlands or wetland buffer zones;
- The boundaries of footprint areas are to be clearly defined and it should be ensured that all activities remain within defined footprint areas;
- Incorporate adequate erosion management measures in order to prevent erosion and the associated sedimentation of the wetland features. Management measures may include berms, silt fences, hessian curtains and stormwater diversion away from areas susceptible to erosion. Care should however be taken so as to avoid additional disturbance during the implementation of these measures;
- Attention should be given to attenuation of stormwater in order to prevent erosion;
- Sheet runoff from cleared areas and access roads needs to be curtailed;
- Any discharge of runoff into wetland features must be done in such a way as to prevent erosion. In this regard special mention is made of the use of energy dissipating structures in stormwater discharge;
- As much vegetation growth as possible should be promoted within the subject property in order to protect soils and to reduce the percentage of the surface area which is paved. In this regard special mention is made of the need to use indigenous vegetation species as the first choice during landscaping; and
- Rehabilitate the natural pan in order to improve the hydrological function and sediment balance of the feature.

Recommended mitigation measures

- N/A.

With Management	Probability of Impact	Sensitivity of receiving environment	Severity	Spatial scale	Duration of impact	Likelihood	Consequence	Significance
Artificial dam and seep wetland	2	2	1	1	3	4	5	20 (Very Low) Negative
Natural pan	4	2	1	1	5	6	7	42 (Low) Negative

Probable latent impacts

- Vehicles will still use the service road surrounding the dam and impacts created as a result of the disturbance may impact on wetland hydrology and sediment balance; and
- Access to the dam and artificial seep cannot be restricted and anthropogenic activity may therefore create additional impact.

4.2 Impact Assessment Conclusion

The table below serves as a summary of the key findings made during the impact assessment process.

Table 8: A summary of impact significance before and after mitigation.

Impact	Alternative	Wetland feature	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Alternative 1	Artificial dam and seep wetland	Medium Low (-ve)	Medium Low (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Low (-ve)

If alternative 1 is chosen as the preferred alternative all wetland features will be removed from the subject property. The overall impact significance will therefore remain the same before and after the implementation of mitigation measures. However, if alternative 2 is chosen as the preferred alternative the majority of the impacts can be effectively mitigated by proper planning, management and by the implementation of an effective rehabilitation plan.

4.3 Cumulative Impacts

Wetlands within the region are under continued threat due to ongoing mining development in the area. The loss of the natural pan feature from the subject property may therefore add to the cumulative effect on the loss of wetland areas within the region.

5 CONCLUSION

Scientific Aquatic Services (SAS) was appointed to conduct a wetland ecological assessment as part of the environmental assessment and authorisation process for the proposed Kathu suppliers park, on the farm Sekgame 461 in the Northern Cape Province, hereafter referred to as the subject property (Figure 1 and 2). The subject property is located directly to the south of the R380 roadway, adjacent to a residential area presently being developed as part of the town of Kathu.

DESKTOP ASSESSMENT

The following general conclusions were drawn on completion of the desktop assessment:

- According to the National Freshwater Ecosystems Priority Areas database (NFEPA, 2011), one wetland feature, a natural slope depression wetland, is located within the south western corner of the subject property.

WETLAND ASSESSMENT

The following general conclusions were drawn on completion of the wetland assessment:

- A site assessment was undertaken in March 2014 to determine the extent of wetland resources within the subject property. Three wetland features, an artificial dam, an artificial seep and a natural pan were encountered;
- The artificial dam is located within the eastern portion of the subject property, adjacent to the R380 roadway. This feature was constructed for the storage of grey water which is produced during mine operations and which is continuously pumped into the feature through a transfer scheme from the Kumba Iron Ore Sishen North Mine.
- The seepage of water from the dam within the eastern portion of the subject property has resulted in the saturation of soils in the surrounding areas. This prolonged saturation has resulted in the formation of hydromorphic soils which are capable of supporting obligate and facultative wetland species. The area surrounding the dam can therefore be defined as an artificial seep wetland;
- The natural pan is the same feature as indicated by the NFEPA database (2011) and is located within the south western portion of the subject property;
- The function and service provision was calculated for each of the wetland features. From the results of the assessment, it is evident that none of the features encountered within the subject property are regarded as being of exceptional importance in terms of function and service provision. All features are considered to provide a moderately low level of ecological function and service provision;
- It is highly unlikely that natural wetlands would have occurred in the areas where the artificial dam and seep wetland are currently located. It is therefore not possible to determine the Present Ecological State (PES) of the features because there is no natural reference state to use as a baseline for such an assessment. Neither the artificial dam nor the seep wetland was therefore assessed using WET-health;
- The pan is a natural feature and could therefore be assessed using WET-health. The pan calculated an overall score falling within the PES Category C (moderately modified);
- The Ecological Importance and Sensitivity (EIS) was calculated for each wetland feature:
  - The artificial seep calculated an EIS falling within Category C (moderate sensitivity); and
  - The artificial dam and the natural pan calculated an EIS falling within Category D (low/marginal sensitivity).
- The Recommended Ecological Category (REC) deemed appropriate to enhance and maintain current ecology as well as functionality of the natural pan is Category B (Largely natural);
- Although the dam and seep wetland are artificial features they still provide the habitat which support wetland faunal and floral species and play a role in terms of function and service provision. In order to safeguard the wetland habitat that has developed within the dam and surroundings it is therefore recommended that the seepage wetland remains free from development thereby acting as a buffer to the artificial dam;

- The natural pan has been significantly disturbed as a result of historic earth moving activities. However, with rehabilitation, it is deemed highly likely that the overall PES of the feature can be improved. A minimum buffer of 32m is therefore advocated in order to minimise any impact the proposed development activities could have as well as to safeguard wetland resources during the operational phase of the development; and
- It should be noted that any activity occurring within wetland features or associated buffer areas will require authorisations in terms of Section 21 c & i of the National Water Act (NWA, Act 36 of 1998). Furthermore, development activities falling within 32m of wetland features will trigger activities as listed by the National Environmental Management Act (NEMA, Act 107 of 1998). In addition, the subject property falls within 500 meters of wetland features and therefore General Notice no. 1199 of 2009 as it relates to the NWA (Act 36 of 1998) will also apply.

WETLAND IMPACT ASSESSMENT

The table below serve to summarise the significance of perceived impacts on the wetland biodiversity of the subject property. Impacts associated with the loss of the artificial dam and seep wetland are likely to differ from those associated with the loss of the natural pan and were therefore assessed separately.

Impact significance was assessed for two separate alternatives:

- Alternative 1: All wetland features within the subject property will be permanently lost as a result of development activities; and
- Alternative 2: Wetland features will not be lost as a result of development activities.

Table A: Summary of impact assessment results.

Impact	Alternative	Wetland feature	Unmanaged	Managed
Loss of wetland habitat and ecological structure	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Changes to wetland ecological and socio-cultural service provision	Alternative 1	Artificial dam and seep wetland	Medium Low (-ve)	Medium Low (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Very Low (-ve)
Impacts on wetland hydrological function and sediment balance	Alternative 1	Artificial dam and seep wetland	Medium High (-ve)	Medium High (-ve)
		Natural pan	Medium Low (-ve)	Medium Low (-ve)
	Alternative 2	Artificial dam and seep wetland	Medium Low (-ve)	Very Low (-ve)
		Natural pan	Medium Low (-ve)	Low (-ve)

If alternative 1 is chosen as part of the future development plan all wetland features will be removed from the subject property. The overall impact significance will therefore remain the same before and after the implementation of mitigation measures. However, if alternative 2 is chosen as part of the future

development plan the majority of the impacts can be effectively mitigated by proper planning, management and by the implementation of an effective rehabilitation plan.

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APPENDIX A

Method of Assessment

Wetland

A – 1 Desktop Study

A desktop study was compiled with all relevant information as presented by the South African National Biodiversity Institutes (SANBI's) Biodiversity Geographic Information Systems (BGIS) website (http://bgis.sanbi.org). Wetland specific information resources taken into consideration during the desktop assessment of the subject property included:

- National Freshwater Ecosystem Priority Areas (NFEPAs) (2011)
  - NFEPA water management area (WMA);
  - NFEPA wetlands/National wetlands map;
  - Wetland and estuary Fresh Water Ecosystem Priority Areas (FEPA);
  - FEPA (sub)WMA % area;
  - Sub water catchment area FEPAs;
  - Water management area FEPAs;
  - Fish sanctuaries;
  - Wetland ecosystem types;
- Prioritisation of City Wetlands

A – 2 Classification System for Wetlands and other Aquatic Ecosystems in South Africa

All wetland features encountered within the subject property were assessed using the *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems* (Ollis *et al*., 2013).

A summary of Levels 1 to 4 of the proposed Classification System for Inland Systems are presented in Table 1 and 2, below.

Table 1: Proposed classification structure for Inland Systems, up to Level 3.

<table>
<tr><th colspan="3">WETLAND / AQUATIC ECOSYSTEM CONTEXT</th></tr>
<tr><th>LEVEL 1:
SYSTEM</th><th>LEVEL 2:
REGIONAL SETTING</th><th>LEVEL 3:
LANDSCAPE UNIT</th></tr>
<tr><td rowspan="4">Inland Systems</td><td rowspan="4">DWA Level 1 Ecoregions
OR
NFEPA WetVeg Groups
OR
Other special framework</td><td>Valley Floor</td></tr>
<tr><td>Slope</td></tr>
<tr><td>Plain</td></tr>
<tr><td>Bench
(Hilltop / Saddle / Shelf)</td></tr>
</table>

Table 2: Hydrogeomorphic (HGM) Units for the Inland System, showing the primary HGM Types at Level 4A and the subcategories at Level 4B to 4C.

FUNCTIONAL UNIT		
LEVEL 4: HYDROGEOMORPHIC (HGM) UNIT		
HGM type	Longitudinal zonation/ Landform / Outflow drainage	Landform / Inflow drainage
A	**B**	**C**
River	Mountain headwater stream	Active channel
		Riparian zone
	Mountain stream	Active channel
		Riparian zone
	Transitional	Active channel
		Riparian zone
	Upper foothills	Active channel
		Riparian zone
	Lower foothills	Active channel
		Riparian zone
	Lowland river	Active channel
		Riparian zone
	Rejuvenated bedrock fall	Active channel
		Riparian zone
	Rejuvenated foothills	Active channel
		Riparian zone
	Upland floodplain	Active channel
		Riparian zone
Channelled valley-bottom wetland	(not applicable)	(not applicable)
Unchannelled valley-bottom wetland	(not applicable)	(not applicable)
Floodplain wetland	Floodplain depression	(not applicable)
	Floodplain flat	(not applicable)
Depression	Exorheic	With channelled inflow
		Without channelled inflow
	Endorheic	With channelled inflow
		Without channelled inflow
	Dammed	With channelled inflow
		Without channelled inflow
Seep	With channelled outflow	(not applicable)
	Without channelled outflow	(not applicable)
Wetland flat	(not applicable)	(not applicable)

Level 1: Inland systems

For the proposed Classification System, Inland Systems are defined as ***an aquatic ecosystem that have no existing connection to the ocean***[7] (i.e. characterised by the complete absence of marine exchange and/or tidal influence) but ***which are inundated or saturated with water, either permanently or periodically.*** It is important to bear in mind, however, that certain Inland Systems may have had an historical connection to the ocean, which in some cases may have been relatively recent.

Level 2: Ecoregions

For Inland Systems, the regional spatial framework that has been included at Level 2 of the proposed Classification System is that of Department of Water Affairs (DWA) Level 1 Ecoregions for aquatic ecosystems (Kleynhans *et al.,* 2005). There are a total of 31 Ecoregions across South Africa, including Lesotho and Swaziland (figure below). DWA Ecoregions have most commonly been used to categorise the regional setting for national and regional water resource management applications, especially in relation to rivers.

[7] Most rivers are indirectly connected to the ocean via an estuary at the downstream end, but where marine exchange (i.e. the presence of seawater) or tidal fluctuations are detectable in a river channel that is permanently or periodically connected to the ocean, it is defined as part of the estuary.

Level 2: NFEPA Wet Veg Groups

The Vegetation Map of South Africa, Swaziland and Lesotho (Mucina & Rutherford, 2006) groups vegetation types across the country according to Biomes, which are then divided into Bioregions. To categorise the regional setting for the wetland component of the NFEPA project, wetland vegetation groups (referred to as WetVeg Groups) were derived by further splitting Bioregions into smaller groups through expert input (Nel *et al*., 2011). There are currently 133 NFEPA WetVeg Groups. It is envisaged that these groups could be used as a special framework for the classification of wetlands in national- and regional-scale conservation planning and wetland management initiatives.

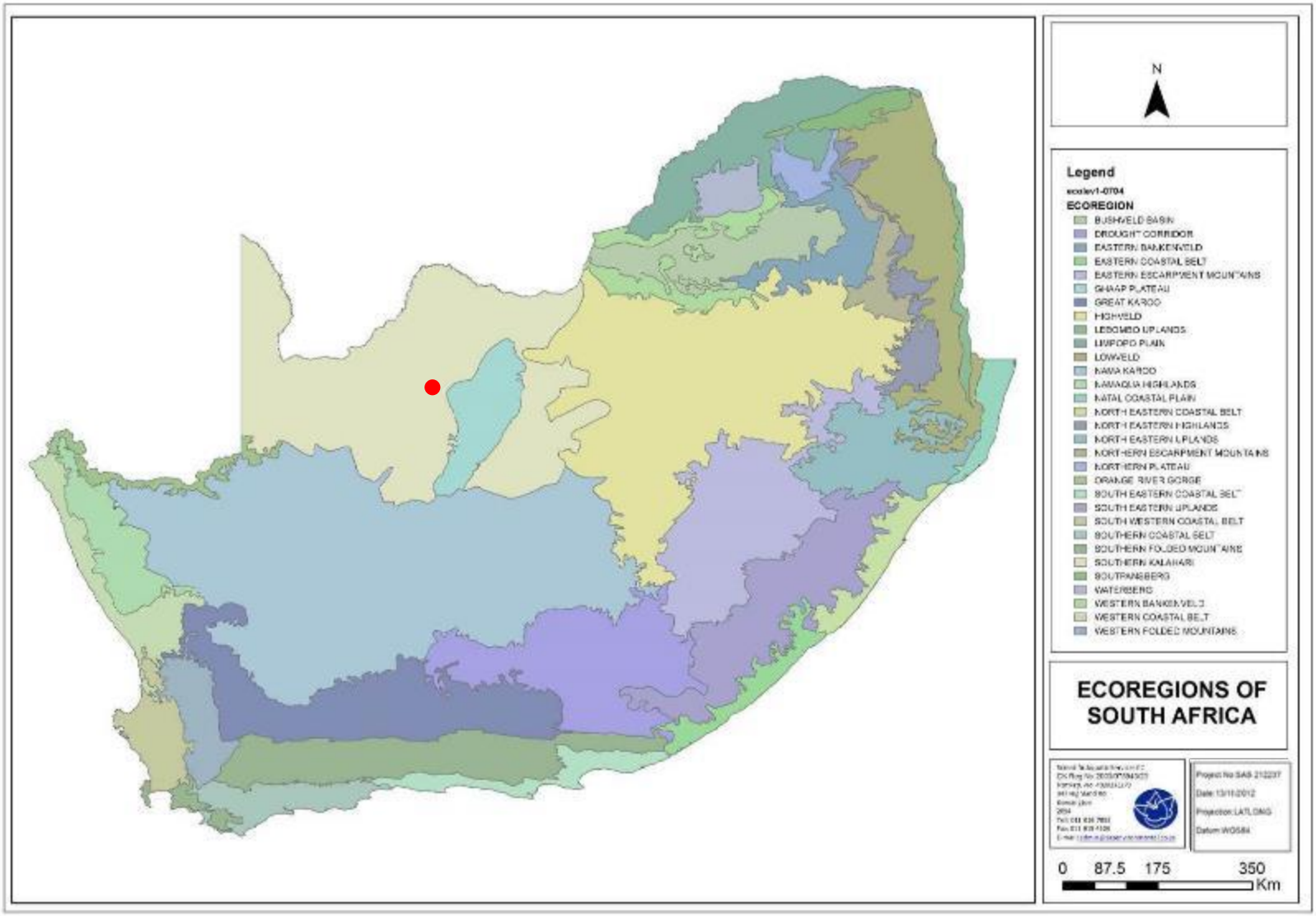

Figure 1: Map of Level 1 Ecoregions of South Africa, with the approximate position of the subject property indicated in red.

Level 3: Landscape Setting

At Level 3 of the proposed classification System, for Inland Systems, a distinction is made between four Landscape Units (Table 3) on the basis of the landscape setting (i.e. topographical position) within which an HGM Unit is situated, as follows (Ollis *et al.,* 2013):

- ***Slope*****:** an included stretch of ground that is not part of a valley floor, which is typically located on the side of a mountain, hill or valley.
- ***Valley floor:*** The base of a valley, situated between two distinct valley side-slopes.
- ***Plain:*** an extensive area of low relief characterised by relatively level, gently undulating or uniformly sloping land.
- ***Bench (hilltop/saddle/shelf):*** an area of mostly level or nearly level high ground (relative to the broad surroundings), including hilltops/crests (areas at the top of a mountain or hill flanked by down-slopes in all directions), saddles (relatively high-lying areas flanked by down-slopes on two sides in one direction and up-slopes on two sides in an approximately permendicular direction), and shelves/terraces/ledges (relatively high-lying, localised flat areas along a slope, representing a break in slope with an up-slope one side and a down-slope on the other side in the same direction).

Level 4: Hydrogeomorphic Units

Eight primary HGM Types are recognised for Inland Systems at Level 4A of the proposed National Wetland Classification Systems (NWCS) (Table 13), on the basis of hydrology and geomorphology (Ollis *et al*., 2013), namely:

- ***River:*** a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water.
- ***Channelled valley-bottom wetland:*** a valley-bottom wetland with a river channel running through it.
- ***Unchannelled valley-bottom wetland:*** a valley-bottom wetland without a river channel running through it.
- ***Floodplain wetland:*** the mostly flat or gently sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by over-topping of the channel bank.
- ***Depression:*** a landform with closed elevation contours that increases in depth from the perimeter to a central area of greatest depth, and within which water typically accumulates.
- ***Wetland Flat:*** a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat
- ***Seep:*** a wetland area located on (gently to steeply) sloping land, which is dominated by the colluvial (i.e. gravity-driven), unidirectional movement of material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend into a valley floor.

The above terms have been used for the primary HGM Units in the Classification System to try and ensure consistency with the wetland classification terms currently in common usage in South Africa. Similar terminology (but excluding categories for “channel”, “flat” and “valleyhead seep”) is used, for example, in the recently developed tools produced as part of the Wetland Management Series including WET-Health (Macfarlane *et al.,* 2009) and WET-EcoServices (Kotze *et al.,* 2008).

A – 3 WET-Health

Healthy wetlands are known to provide important habitats for wildlife and to deliver a range of important goods and services to society. Management of these systems is therefore essential if these attributes are to be retained within an ever changing landscape. The primary purpose of this assessment[8] is to evaluate the ecophysical health of wetlands, and in so doing promote their conservation and wise management.

Level of Evaluation

Two levels of assessment are provided by WET-Health:

[8] Kleynhans et al., 2007

- Level 1: Desktop evaluation, with limited field verification. This is generally applicable to situations where a large number of wetlands need to be assessed at a very low resolution; and
- Level 2: On-site evaluation. This involves structured sampling and data collection in a single wetland and its surrounding catchment.

Framework for the Assessment

A set of three modules has been synthesised from the set of processes, interactions and interventions that take place in wetland systems and their catchments: hydrology (water inputs, distribution and retention, and outputs), geomorphology (sediment inputs, retention and outputs) and vegetation (transformation and presence of introduced alien species).

Units of Assessment

Central to WET-Health is the characterisation of HGM units, which have been defined based on geomorphic setting (e.g. hillslope or valley-bottom; whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated) and pattern of water flow through the wetland unit (diffusely or channelled) as described under the *Classification System for Wetlands and other Aquatic Ecosystems*.

Quantification of Present State of a wetland

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. This takes the form of assessing the spatial *extent* of impact of individual activities and then separately assessing the *intensity* of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall *magnitude* of impact. The impact scores and Present State categories are provided in Table 3.

Table 3: Impact scores and categories of present State used by WET-Health for describing the integrity of wetlands.

Impact category	Description	Impact score range	Present State category
None	Unmodified, natural	0-0.9	A
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact.	2-3.9	C
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8-10	F

Assessing the Anticipated Trajectory of Change

As is the case with the Present State, future threats to the state of the wetland may arise from activities in the catchment upstream of the unit or from within the wetland itself or from processes downstream of the wetland. In each of the individual sections for hydrology, geomorphology and vegetation, five potential situations exist depending upon the direction and likely extent of change (Table 4).

Table 4: Trajectory of Change classes and scores used to evaluate likely future changes to the present state of the wetland.

Change Class	Description	HGM change score	Symbol
Substantial improvement	State is likely to improve substantially over the next 5 years	2	↑↑
Slight improvement	State is likely to improve slightly over the next 5 years	1	↑
Remain stable	State is likely to remain stable over the next 5 years	0	→
Slight deterioration	State is likely to deteriorate slightly over the next 5 years	-1	↓
Substantial deterioration	State is expected to deteriorate substantially over the next 5 years	-2	↓↓

Overall health of the wetland

Once all HGM units have been assessed, a summary of health for the wetland as a whole needs to be calculated. This is achieved by calculating a combined score for each component by area-weighting the scores calculated for each HGM unit. Recording the health assessments for the hydrology, geomorphology and vegetation components provides a summary of impacts, Present State, Trajectory of Change and Health for individual HGM units and for the entire wetland.

A – 4 Wetland function assessment

"The importance of a water resource, in ecological social or economic terms, acts as a modifying or motivating determinant in the selection of the management class".[9] The assessment of the ecosystem services supplied by the identified wetlands was conducted according to the guidelines as described by Kotze *et al* (2008). An assessment was undertaken that examines and rates the following services according to their degree of importance and the degree to which the service is provided:

- Flood attenuation
- Stream flow regulation
- Sediment trapping
- Phosphate trapping
- Nitrate removal
- Toxicant removal
- Erosion control
- Carbon storage
- Maintenance of biodiversity
- Water supply for human use
- Natural resources
- Cultivated foods
- Cultural significance
- Tourism and recreation
- Education and research

The characteristics were used to quantitatively determine the value, and by extension sensitivity, of the wetlands. Each characteristic was scored to give the likelihood that the service is being provided. The scores for each service were then averaged to give an overall score to the wetland.

Table 5: Classes for determining the likely extent to which a benefit is being supplied.

Score	Rating of the likely extent to which the benefit is being supplied

[9] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources, 1999*

<0.5	Low
0.6-1.2	Moderately low
1.3-2	Intermediate
2.1-3	Moderately high
>3	High

A – 5 Defining Ecological Importance and Sensitivity

The method used for the Ecological Importance and Sensitivity (EIS) determination was adapted from the method as provided by DWA (1999) for floodplains. The method takes into consideration PES scores obtained for WET-Health as well as function and service provision to enable the assessor to determine the most representative EIS category for the wetland feature or group being assessed.

A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates no importance and 4 indicates very high importance. The median of the determinants is used to assign the EIS category. A confidence score is also provided on a scale of 0 to 4, where 0 indicates low confidence and 4 high confidence.

Table 6: EIS Category definitions

EIS Category	Range of Median	Recommended Ecological Management Class[10]
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications.	>1 and <=2	C
Low/marginal Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications.	>0 and <=1	D

A – 6 Recommended Ecological Category

"A high management class relates to the flow that will ensure a high degree of sustainability and a low risk of ecosystem failure. A low management class will ensure marginal maintenance of sustainability, but carries a higher risk of ecosystem failure." [11]

The REC was determined based on the results obtained from the Present Ecological State (PES), reference conditions and Ecological Importance and Sensitivity of the resource (sections above). Followed by realistic recommendations, mitigation, and rehabilitation measures to achieve the desired REC.

A wetland may receive the same class for the PES, as the REC if the wetland is deemed in good condition, and therefore must stay in good condition. Otherwise, an appropriate REC should be assigned in order to prevent any further degradation as well as to enhance the PES of the wetland feature.

[10] Ed's note: Author to confirm exact wording for version 1.1
[11] Department of Water Affairs and Forestry, South Africa *Version 1.0 of Resource Directed Measures for Protection of Water Resources 1999*

Table 7: Description of REC classes.

Class	Description
A	Unmodified, natural
B	Largely natural with few modifications
C	Moderately modified
D	Largely modified

A – 7 Wetland Delineation

For the purposes of this investigation, a wetland habitat is defined in the National Water Act (NWA, 1998) as including the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterized by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas.

The wetland zone delineation took place according to the method presented in the final draft of "A practical field procedure for identification and delineation of wetlands and riparian areas" published by the Department of Water Affairs and Forestry (DWAF) in February 2005. Attention was also paid to wetland soil guidelines as defined by Job (2009) for the Western Cape. The foundation of the method is based on the fact that wetlands have several distinguishing factors including the following:

- The presence of water at or near the ground surface;
- Distinctive hydromorphic soils; and
- Vegetation adapted to saturated soils.

By observing the evidence of these features, in the form of indicators, wetlands and riparian zones can be delineated and identified. If the use of these indicators and the interpretation of the findings are applied correctly, then the resulting delineation can be considered accurate (DWAF 2005).

Riparian and wetland zones can be divided into three zones (DWAF 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year, but is saturated for a sufficient period, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The object of this study was to identify the outer boundary of the temporary zone and then to identify a suitable buffer zone around the wetland area.

A – 8 Ecological Impact Assessment

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

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

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[12]. The interaction of an aspect with the environment may result in an impact.
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise

[12] The definition has been aligned with that used in the ISO 14001 Standard.

and health effects due to poorer air quality. In the case where the impact is on human health or well-being, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is.

- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems.
- **Resources** include components of the biophysical environment.
- **Frequency of activity** refers to how often the proposed activity will take place.
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor.
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- **Spatial extent** refers to the geographical scale of the impact.
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria. Refer to the below. The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity and the frequency of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 10. The values for likelihood and consequence of the impact are then read off a significance rating matrix and is used to determine whether mitigation is necessary[13].

The assessment of significance is undertaken twice. Initial significance is based only natural and existing mitigation measures (including built-in engineering designs). The subsequent assessment takes into account the recommended management measures required to mitigate the impacts. Measures such as demolishing infrastructure, and reinstatement and rehabilitation of land, are considered post-mitigation.

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act (No. 108 of 1997) in instances of uncertainty or lack of information by increasing assigned ratings or adjusting final model outcomes. In certain instances where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

[13] Some risks/impacts that have low significance will however still require mitigation

LIKELIHOOD DESCRIPTORS

Probability of impact	**RATING**
Highly unlikely	1
Possible	2
Likely	3
Highly likely	4
Definite	5
Sensitivity of receiving environment	**RATING**
Ecology not sensitive/important	1
Ecology with limited sensitivity/importance	2
Ecology moderately sensitive/ /important	3
Ecology highly sensitive /important	4
Ecology critically sensitive /important	5

CONSEQUENCE DESCRIPTORS

Severity of impact	**RATING**
Insignificant / ecosystem structure and function unchanged	1
Small / ecosystem structure and function largely unchanged	2
Significant / ecosystem structure and function moderately altered	3
Great / harmful/ ecosystem structure and function Largely altered	4
Disastrous / ecosystem structure and function seriously to critically altered	5
Spatial scope of impact	**RATING**
Activity specific/ < 5 ha impacted / Linear features affected < 100m	1
Development specific/ within the site boundary / < 100ha impacted / Linear features affected < 100m	2
Local area / within 1 km of the site boundary / < 5000ha impacted / Linear features affected < 1000m	3
Regional within 5 km of the site boundary / < 2000ha impacted / Linear features affected < 3000m	4
Entire habitat unit / Entire system / > 2000ha impacted / Linear features affected > 3000m	5
Duration of impact	**RATING**
One day to one month	1
One month to one year	2
One year to five years	3
Life of operation or less than 20 years	4
Permanent	5

Table 8: Significance Rating Matrix.

	CONSEQUENCE (Severity + Spatial Scope + Duration)														
LIKELIHOOD (Frequency of activity + Frequency of impact)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
	2	**4**	**6**	**8**	**10**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
	3	**6**	**9**	**12**	**15**	**18**	**21**	**24**	**27**	**30**	**33**	**36**	**39**	**42**	**45**
	4	**8**	**12**	**16**	**20**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**	**60**
	5	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**
	6	**12**	**18**	**24**	**30**	**36**	**42**	**48**	**54**	**60**	**66**	**72**	**78**	**84**	**90**
	7	**14**	**21**	**28**	**35**	**42**	**49**	**56**	**63**	**70**	**77**	**84**	**91**	**98**	**105**
	8	**16**	**24**	**32**	**40**	**48**	**56**	**64**	**72**	**80**	**88**	**96**	**104**	**112**	**120**
	9	**18**	**27**	**36**	**45**	**54**	**63**	**72**	**81**	**90**	**99**	**108**	**117**	**126**	**135**
	10	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**	**100**	**110**	**120**	**130**	**140**	**150**

Table 9: Positive/Negative Mitigation Ratings.

Significance Rating	Value	Negative Impact Management Recommendation	Positive Impact Management Recommendation
Very high	126-150	Critically consider the viability of proposed projects Improve current management of existing projects significantly and immediately	Maintain current management
High	101-125	Comprehensively consider the viability of proposed projects Improve current management of existing projects significantly	Maintain current management
Medium-high	76-100	Consider the viability of proposed projects Improve current management of existing projects	Maintain current management
Medium-low	51-75	Actively seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Low	26-50	Where deemed necessary seek mechanisms to minimise impacts in line with the mitigation hierarchy	Maintain current management and/or proposed project criteria and strive for continuous improvement
Very low	1-25	Maintain current management and/or proposed project criteria and strive for continuous improvement	Maintain current management and/or proposed project criteria and strive for continuous improvement

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
- Risks/Impacts were assessed for all stages of the project cycle including:
  - Construction;
  - Operation; and
  - Rehabilitation.
- If applicable, transboundary or global effects were assessed;
- Individuals or groups who may be differentially or disproportionately affected by the project because of their *disadvantaged* or *vulnerable* status were assessed.
- Particular attention was paid to describing any residual impacts that will occur post-closure.

Mitigation Measure Development

The following points present the key concepts considered in the development of mitigation measures for the proposed development:

- *Mitigation* and *performance improvement measures* and actions that address the risks and impacts[14] are identified and described in as much detail as possible.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimization, mitigation or compensation.

Desired outcomes are defined, and have been developed in such a way as to be *measurable events with performance indicators, targets and acceptable criteria* that can be tracked over *defined periods*, with estimates of the *resources* (including human resource and training requirements) *and responsibilities for implementation*.

[14] Mitigation measures should address both positive and negative impacts