SPECIALIST STUDY:

WETLAND IDENTIFICATION AND BUFFER DETERMINATION OF PORTION 22 OF MODDERFONTEIN IR

COMPILED FOR:
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Wetland assessment

1 DECLARATION

The observations, conclusions and recommendations made in this report are based on the best available data and on best scientific and professional knowledge of the directors of INDEX (Pty) Ltd. The report is based on GIS programming and utilises site specific aerial photography to map survey points. Survey points are normally sum-meter accurate; which must be considered in the use of the information.

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

Signature of specialist

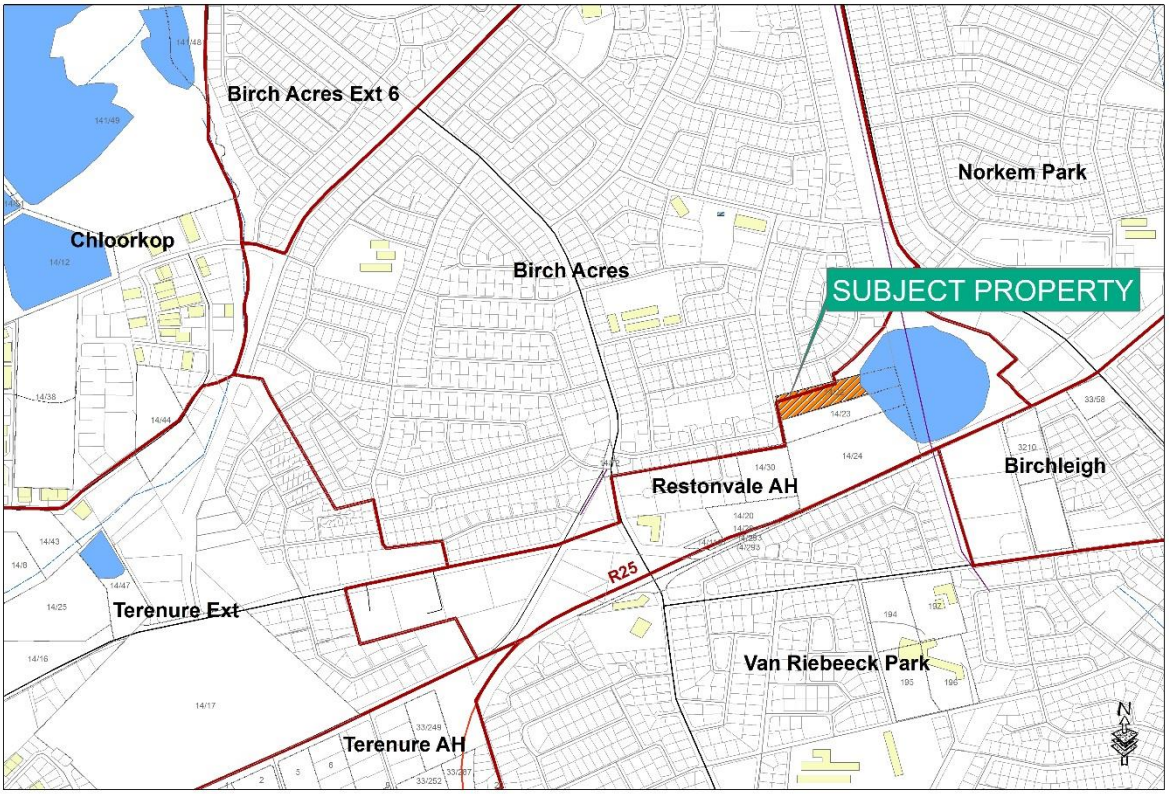
for INDEX(PTY) LTD

17 October 2016

2 TERMS OF REFERENCE

Index was requested by J G Joubert to delineation the wetland boundaries of Portion 22 of the farm Mooifontein, Ekurhuleni Metropolitan Municipality. This report was prepared based on site visits on 10 and 11 October 2016.

Figure 1. Locality of the site



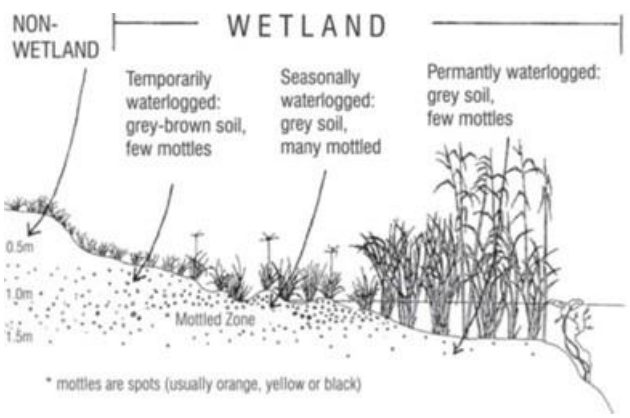
The report conform to all the requirements of the Department of Water Affairs and Forestry and the Gauteng Department of Agriculture and Rural Development (GDARD) and include the following:

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

This assessment focused on the delineation of wetlands using four main indicators: terrain unit, vegetation, soil wetness and soil form. The soil indicators (wetness and form) were the primary form of delineation, which is widely regarded as the most accurate method. The vegetation indicator was used as a confirmatory indicator of wetlands.

3 LEGISLATION

3.1 THE NATIONAL WATER ACT - WETLANDS



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

Riparian zones are described as "*the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are* inun*dated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas*."

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

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

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

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

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

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

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

3.2 NEMA - BUFFER

In terms of NEMA's EIA Regulations and the National Water Act, any development within the 1:50 year floodline and 32m from the stream margin will trigger environmental authorisation and a need of a water use licence.

4 WETLAND CLASSIFICATION

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

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

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

HGM Units are distinguished primarily on the basis of:

(i) Landform, which defines the shape and localised setting of the aquatic ecosystem.
(ii) Hydrological characteristics, which describe the nature of water movement into, through and out of the aquatic ecosystem.
(iii) Hydrodynamics, which describe the direction and strength of flow through the aquatic ecosystem.

Seven primary HGM Types are recognised for Inland Systems:

(i) River - a linear landform with clearly discernible bed and banks, which permanently or periodically carries a concentrated flow of water. A river is taken to include both the active channel and the riparian zone as a unit;
(ii) Floodplain wetland—a wetland area on the mostly flat or gently-sloping land adjacent to and formed by an alluvial river channel, under its present climate and sediment load, which is subject to periodic inundation by overtopping of the channel bank. Floodplain wetlands, as the name implies, generally occur on a plain and are typically characterised by a suite of geomorphological features associated with river-derived depositional processes, including point bars, scroll bars, oxbow lakes and levees. Floodplain wetlands must be considered as wetland ecosystems that are distinct from but associated with the adjacent river channel itself, which must be classified as a 'river'. Some river channels, especially in the more arid parts of South Africa, are vegetated;
(iii) Valley-bottom wetland - a mostly flat wetland area located along a valley floor, often connected to an upstream or adjoining river channel. This can either be a channelled valley-bottom wetland with a river channel running through it; or an un-channelled valley-bottom wetland, which is characterised by their location on valley floors, an absence of distinct channel banks, and the prevalence of diffuse flows.
(iv) Depression - a wetland or aquatic ecosystem with closed (or near-closed) elevation contours, which increases in depth from the perimeter to a central area of greatest depth and within which water typically accumulates. Although they may at times have a river flowing into or out of them, depressions are especially characterised by their closed (or at least near-closed) contour shape, which makes them relatively easy to identify on topographic maps. Depressions may be flat-bottomed (in which case they are often referred to as pans. The characterisation of the inflow characteristics of a depression is important in understanding the functioning of these types of aquatic ecosystems, and in their management. Depressions can be classified as 'exorheic' (i.e. outward-draining) or 'endorheic' (i.e.

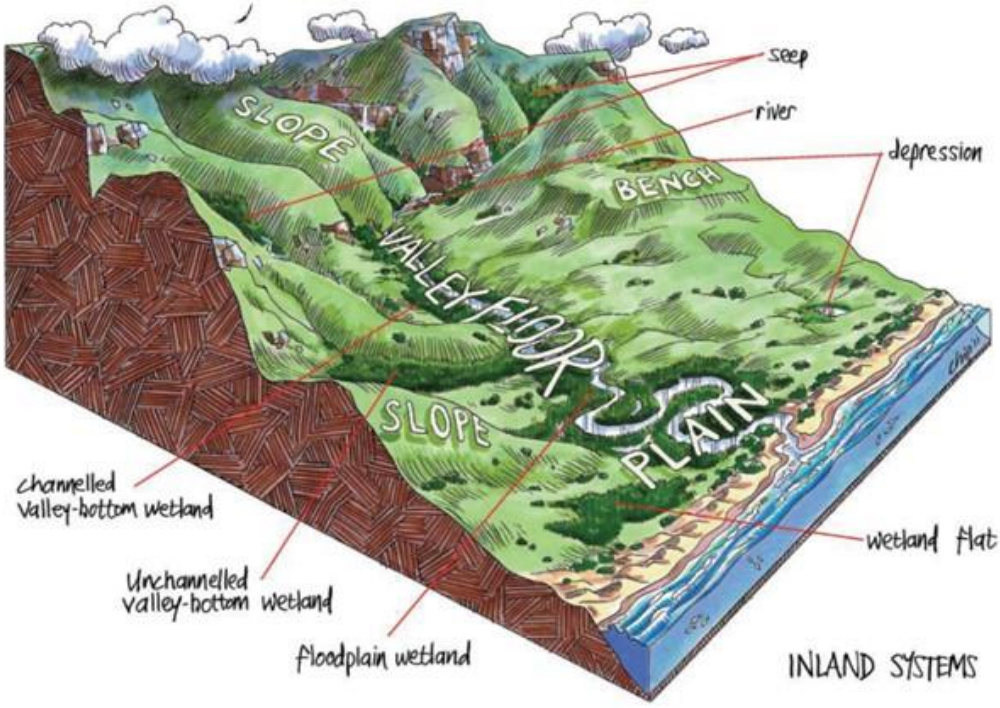
[1] SANBI Biodiversity Series 22 - Classification system for wetlands and other aquatic ecosystems in South Africa. (Ollis, et al. 2013).

inward-draining) in terms of their outflow drainage, with a third option to categorise a depression with an artificially regulated outflow drainage as 'dammed'.

(v) Seeps - a wetland area located on gently to steeply sloping land and dominated by colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor.

(vi) Wetland flat—a level or near-level wetland area that is not fed by water from a river channel, and which is typically situated on a plain or a bench. Closed elevation contours are not evident around the edge of a wetland flat.

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



4.2 PROCESS USED FOR THE DELINEATION OF WETLANDS

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

Soil condition

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

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

- A reduced matrix - i.e., an in situ low chroma (soil colour), resulting from the absence of Fe^{3+} ions which are characterised by "grey" colours of the soil matrix.

- Redox depletions - the “grey” or low chroma bodies within the soil where Fe-Mn oxides have been stripped out, or where both Fe-Mn oxides and clay have been stripped. Iron depletions and clay depletions can occur.
- Redox concentrations - Accumulation of iron and manganese oxides, which are also called mottles. These can occur as: Concretions - harder, regular shaped bodies; Mottles - soft bodies of varying size, mostly within the matrix, with variable shape appearing as blotches or spots of high chroma colours; or Pore linings - zones of accumulation that may be either coatings on a pore surface, or impregnations of the matrix adjacent to the pore. They are recognized as high chroma colours that follow the route of plant roots, and are also referred to as oxidised rhizospheres.[2]

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

Terrain morphology

Wetlands predominantly occur on valley bottoms and on seep in other terrain forms.

Soil form

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

Soil wetness

Soil colour is markedly influenced by the oxidation statues of manganese and iron. Yellow, red and reddish brown soil form under well-oxidised conditions and greyish colours when aeration is poorer. Prolonged periods of water saturation producing gleysation, where grey and blue mottles are formed and are a condition in which hydrophilic plants flourish.

Qualifying colours, according to the Munsell colour chart are indicated in the annexures.

Vegetation

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

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

Detail of the criteria is provided in the annexures.

4.3 METHODS FOR INVESTIGATION OF WETLAND SOILS

The procedure followed was as follows:

- Aerial photography to determine possible wetlands;
- Terrain unit study to determine where wetlands are most likely to occur;

[2] Collins 2005

- Identification of hydromorphic (wetland) soils, soil form and wetness indicators; to establish permanent, seasonal, and temporary wetland zones.
- Soils are classified in accordance with the Binomial Classification System for Southern Africa (Soil Classification Working Group, 1991, revised 2016). Initial delineation of the soil forms will take into account the following: vegetation type, terrain form, colour and texture of the soil. The boundaries are then refined through soil auger and or soil probe. All qualifying soil forms are then investigated in more detail;
- Starting at the pan edge, a probe is used to investigate the soil profile; should the soil show typical gleyed properties, it is classified as wetland. Moving progressively further away from the watercourse and assigning the soil properties, the wetland boundary is determined.
- Matrix colours and mottle of the subsoil at a depth less than 500 mm are then measured against the criteria indicated above and the areas of *Temporary* and *Seasonal waterlogged* conditions mapped;
- Positions of observation points are taken with GPS and placed on a base map, and combined with texture and colour on aerial photographs. The final boundary of the wetland is then delineated.

5 DESCRIPTION OF THE ENVIRONMENT

5.1 LAND USE

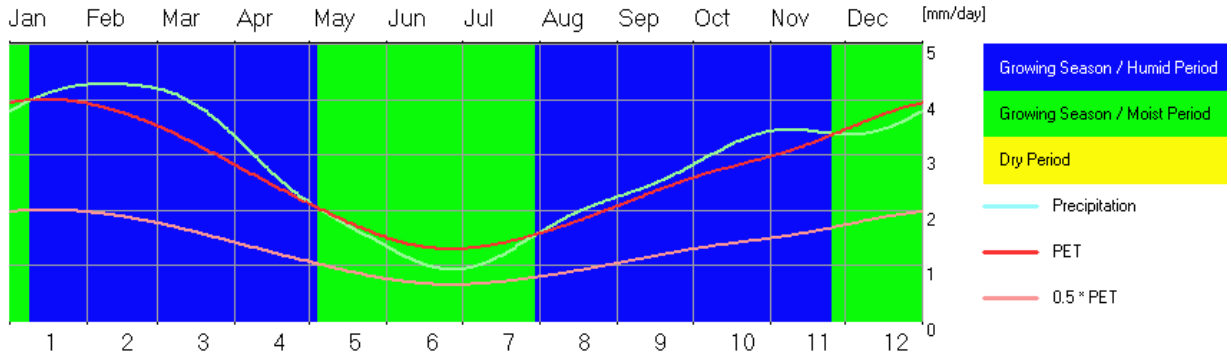
- The property is vacant.
- The surrounding properties are all residential.

5.2 NATURAL RESOURCES

5.2.1 Climate

- The rainfall is typical of the Highveld's summer rainfall pattern where more than 80% falls from October through to April. An average of 740 mm rain is received per year in the area, of which 628 mm is considered as effective rainfall during the active growing period that spans from December to the end of March. Flooding conditions can be expected throughout the year but the probability increases between November and March.
- The area experiences severe frost, which occurs frequently from mid-May to August. The summers are mild where temperatures above 32 degrees are seldom reached. The highest average maximum temperature of 27,09 degrees occurs in December. The average minimum temperature of 8,37 degrees occurs in June and July.

Figure 3. Climatogram



5.2.2 Topography

The site occurs on the footslopes of the topography. It drains towards the pan in the east. The dumped rubble was levelled up to about 20 to 30 metres from the edge of the pan. There is a steep gradient of a metre after which the land levels out.

Figure 4. Topography of the site

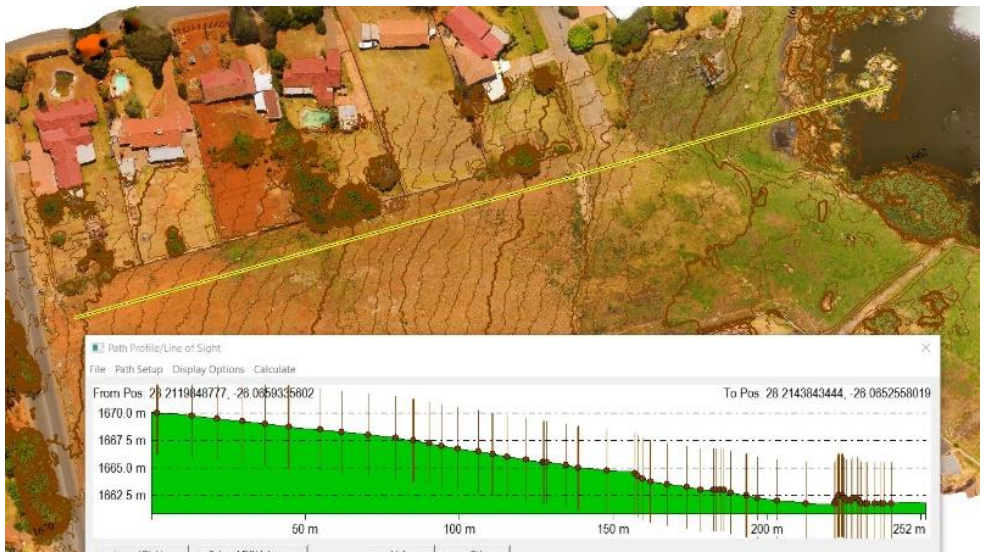
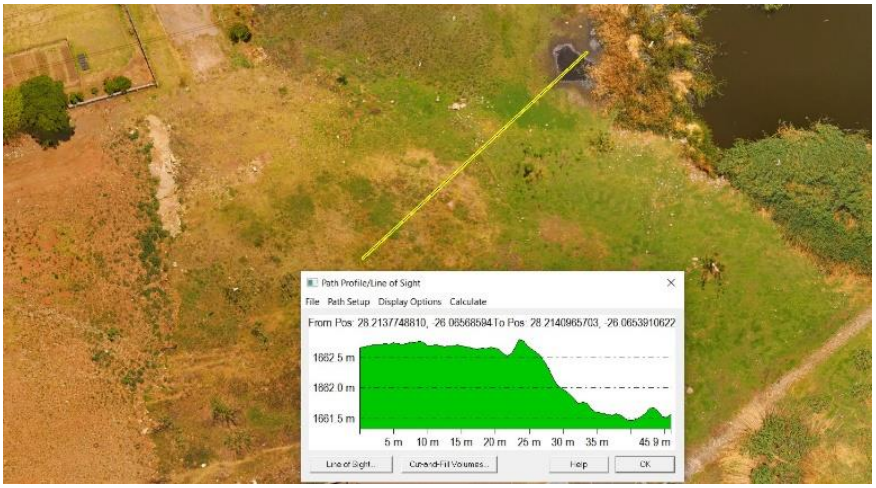


Figure 5. Profile indicating the boundary of the bubble



5.2.3 Soil

Three soil types were identified:

1) Red topsoil that overlies red subsoil, classified as Hutton. This soil occurs on the western half of the site.
2) Further downslope, bubble was flattened and then covered with reddish brown topsoil. This is classified as Witbank.
3) A small portion adjacent to the pan on the northern boundary is dark coloured soil with gleyed subsoil. The soil is classified as Willowbrook. This is the only wetland soil on the property.
4) The western boundary of the Willowbrook soil was delineated as the boundary of the wetlands.

Figure 6. Soil types

5.2.4 Hydrology

The pan is the only water body on the property.

5.2.5 Vegetation

- The western portion of the property is bare soil with some weeds.
- Reeds and rushes occurs on the edge of the pan and indicates the boundary of the wetland plants (see below for details).

5.2.6 Observations

A large number of observations were made in areas that qualify as potential wetland sites according to the topography; and plants. These points were logged on GPS and are described below:

Figure 7. Observation points

Table 2. Descriptions of observations

Observation	Vegetation	Soil type
1	Bare soil with few annual weeds	Hutton
2	Bare soil with few annual weeds	Hutton
3	Bare soil with few annual weeds	Hutton
4	Bare soil with few annual weeds	Hutton
5	Bare soil with few annual weeds	Hutton
6	Kikuyu	Witbank
7	Abundance of annual weeds	Witbank
8	Weeds	Witbank
9	Kikuyu	Witbank
10	Kikuyu	Witbank
11	Kikuyu	Witbank
12	Kikuyu	Witbank
13	Kikuyu	Witbank
14	Kikuyu and *Phragmites*	Witbank/Willowbrook

Observation	Vegetation	Soil type
15	Kikuyu	Witbank/Willowbrook
16	Pan	Willowbrook
17	Weeds	Willowbrook
18	Weeds	Willowbrook
19	Kikuyu	Willowbrook
20	Kikuyu	Witbank
21	Kikuyu	Witbank
22	Bare soil with few annual weeds	Witbank
23	Bare soil with few annual weeds	Witbank
24	Bare soil with few annual weeds	Witbank
25	Bare soil with few annual weeds	Witbank
26	Bare soil with few annual weeds	Witbank
27	Bare soil with few annual weeds	Witbank

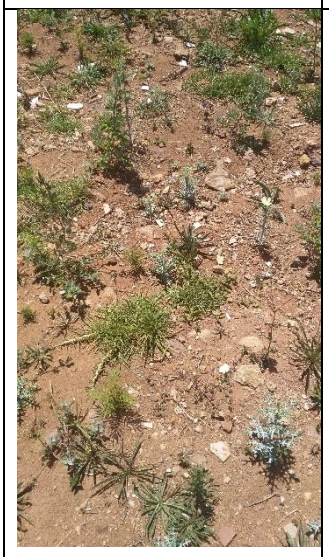
Photos at observation points:


Observation 1


Observation 2


Observation 3

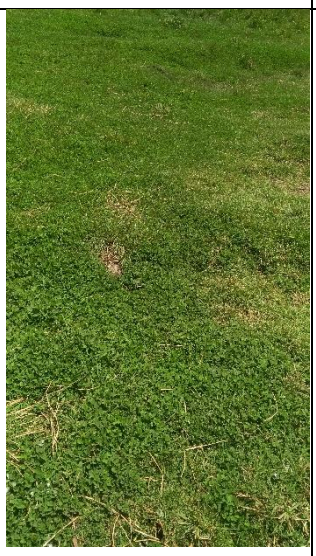

Observation 4


Observation 5


Observation 6


Observation 7


Observation 8

 Observation 9	 Observation 10	 Observation 11	 Observation 12
 Observation 13	 Observation 14	 Observation 15	 Observation 16
 Observation 17	 Observation 18	 Observation 19	 Observation 20

 Observation 21	 Observation 22	 Observation 23	 Observation 24
 Observation 25	 Observation 26	 Observation 27	

6 WETLAND DELINEATION

6.1 BACKGROUND

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

6.2 RESEARCH FINDINGS

6.2.1 Wetlands classification of the site

The water body is classified as a depression.

6.2.2 Terrain morphology and soil formation

The property slopes gradually towards the east. The wetlands occurs on the valley bottom next to the pan edge.

6.2.3 Vegetation

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

According to the National Water Act, the definition of a wetland states that the vegetation is the primary indicator of a wetland, which must be present under normal circumstances. In the field, however, the soil wetness indicators are the most important, and the other three indicators (soil form, terrain unit and vegetation unit) are used in a confirmatory role. The morphological indicators in the soil are far more permanent than the vegetation and the soil can display signs of wetness long after a wetland has been drained. The following hydrophytes were used as confirmatory signatures of wetlands:

- *Phragmites australis*
- *Typha capensis*
- *Cyperus papyrus*

6.3 DELINEATION OF WETLANDS

The wetlands that were identified and delineated on site were done so primarily by soil wetness indicators with the use of vegetation as a confirmatory indicator.

The wetlands identified consisted mostly of soils of the Willowbrook form. This soil form is recognised by the National Water Act (Department of Water and Sanitation) as being a permanent wetland zone soil. Together with the presence of hydrophytes (water loving plants such as *Phragmites australis, Typha capensis* and *Cyperus papyrus*), wetlands were delineated within the study sites with high confidence. It is important to note that these wetlands formed naturally due to their positions on the landscape.

It is recommended that these wetlands be preserved and incorporated into open space features for the proposed development.

The delineation are indicated in Figure 8.

7 BUFFER ZONE

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

The map of the buffer is indicated below:

Figure 8. Wetland

8 ECOLOGICAL IMPORTANCE AND SENSITIVITY

8.1 THE ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)

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

Table 4. Ecological Importance and Sensitivity classes. (DWA 2013, p43)

Ecological Importance and Sensitivity Categories	Range of EIS Score	EIS Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these systems is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems may be sensitive to flow and habitat modifications. They play a role in moderating the quality and quantity of water in major rivers.	>3 and <4	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems is not	>2 and </=3	C

Ecological Importance and Sensitivity Categories	Range of EIS Score	EIS Class
usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major river. **Low/Marginal**: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers. **None**: Wetlands that are rarely sensitive to changes in water quality/hydrological regime.	>1 and </=2 0	D E

The riparian condition of the pan in the study area are generally similar (depression) and can be classified as ***Low/Marginal - Category D*** because it is largely modified due to a loss and change of natural habitat and biota having occurred, but the basic ecosystem functions still being predominantly unchanged.

Table 5. Ecological Importance and Sensitivity classes

	Channelled valley bottom wetlands
Ecological Importance and Sensitivity	1.8
Hydro-functional Importance	1.4
Direct Human Benefits	0.1
Overall Importance and Sensitivity Score	1.8
Overall Importance and Sensitivity Category	D

8.2 WETLAND ECOLOGICAL STATE (PES)

The ecological integrity or Present Ecological State (PES) of the HGM units within the study site were assessed for the hydrology, geomorphology and vegetation components, and were assessed for the current scenario.

The assessment of the wetland systems for the current identified extensive modifications within the wetlands itself and also the surrounding landscape. The changes in integrity are mostly reflected across the three components, namely hydrology, geomorphology and vegetation. The impacts on the systems were linked to urbanisation.

Table 6. Impact scores and Present Ecological State categories used by WET-Health for describing the integrity of wetlands

Description	Combined impact score	PES Category
Unmodified, natural.	0 – 0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1 – 1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 - 5.9	D

Description	Combined impact score	PES Category
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6 - 7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

For ease of interpretation the scores for hydrology, geomorphology and vegetation are able to be simplified into a composite impact score for the HGM units by weighting the scores obtained as outlined in Macfarlane et al. (2007).

Table 7. Summary of the overall ecological integrity of the wetlands of the subject property

		Hydrology	Geomorphology	Vegetation	Composite Impact Score
Pan	Impact Score	1.5	2.0	4.0	2.3
	PES Category	B	B	D	C

The scores for hydrology, geomorphology and vegetation were again simplified into a composite impact score for the HGM units. According to this classification the ecological state is: '*A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact'*.

9 CONCLUSION

The whole property is vacant.

A small portion on the north-eastern part of the property consist of wetland and must be protected. There is abundant birds, insects and amphibians that survives in and around the pan. Some dumping of refuse is taking place in the eastern side of the pan that is damaging the habitat.

A buffer of 32 metres was placed along the wetland boundary in line with provision of legislation.

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Annexure A

Criteria for the delineation of wetlands

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

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

Criteria for the identification of wetlands

According to DWAF, the main indicators are:

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

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

Permanently waterlogged conditions are grey coloured or organic soils.

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

SEASONALLY WATERLOGGED SOILS HAVE A GREY MATRIX WITH MANY MOTTLES.

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

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

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

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

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

PROCESS USED FOR THE DELINEATION OF WETLANDS

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

Indicator plants where wetlands may occur

Gramineae (Grasses)

1)	Imperata cylindrical	Temporary wetness
2)	*Setaria sphacelata*	Temporary and seasonal
3)	*Pennisetum thunbergii*	Temporary and seasonal
4)	*Hemarthria altissima*	Temporary and seasonal

5) Paspalum urvillei — Temporary
6) Paspalum dilatatum — Temporary
7) *Paspalum distichum* — Seasonal and permanent
8) Andropogon appendicularis — Temporary and seasonal
9) *Ischaemum fasciculatum* — Seasonal and permanent
10) *Arundinella nepalensis* — Temporary and seasonal
11) *Andorpogon eucomis* — Temporary and seasonal
12) *Festuca caprina* — Temporary and seasonal
13) *Aristida junciformis* — Temporary and seasonal
14) Eragrostis plana — Temporary
15) *Eragrostis planiculmis* — Temporary and seasonal
16) Phragmites australis — Permanent
17) *Leersia hexandra* — Temporary and seasonal
18) *Miscanthus capensis* — Temporary and seasonal
19) *Miscanthus junceus* — Temporary and seasonal

Cyperaceae (Sedges)

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

Juncaceae (Rushes)

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

Potamogetonaceae (Pondweeds)

1) Potamogeton thunbergii — Permanent

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

1) Kniphofia species
2) Kniphofia linearfolia

Amaryllidaceae (Vlei lilies) — Wetland and non-wetland

1) Crinum species
2) Crinum macowanii

Polygonaceae (Knotweeds) — Permanent and or seasonal

1) Persicaria attenuate

Additional species form other families

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