SIYANQOBA WETLAND ASSESSMENT REPORT

WETLAND ASSESSMENT FOR THE PROPOSED RESIDENTIAL DEVELOPMENT OF SIYANQOBA EXTENSIONS ON THE FARM TWEEDAM AND LEEUWPOORT

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PREPARED FOR:

WANDIMA ENVIRONMENTAL SERVICES

PEOPLE - PLANET - PROSPERITY

PROJECT INFORMATION

REPORT TITLE:	Wetland Assessment Report
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PROJECT TITLE:	wetland assessment for the proposed residential development of Siyanqoba extensions on the farm Tweedam and Leeuwpoort
CLIENT:	Wandima Environmental Services
CONSULTANTS:	Ligoga Consulting & Trading cc
REPORT REF NO:	W13/07/26
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1. EXECUTIVE SUMMARY

Wandima Environmental Services were appointed by Vipcon Property Development as an independent environmental consultant to undertake Wetland Environmental Impact Assessment (EIA) for the proposed development of residential township project.

Ligoga Consulting & trading cc were appointed by Wandima to undertake Wetland assessment for the Siyanqoba extensions.

The scope of works is to undertake wetland assessment along the potion 0 of the Tweedam J.S farm and the remainder of portion 1 of the Leeuwpoort 283 J.S farms. The study area is located in Emalahleni local municipality within Mpumalanga Province, on potion 0 of the Tweedam 377 J.S farm and the remainder of potion 1 of the Leeuwpoort 283 J.S farm.

Field surveys were conducted in December 2013, during early summer period when the environment was hot. The field study was conducted regarding the vegetation types, rivers, catchment areas and wetlands of the specific study area. The National Water Act, the National Environmental Management Act, Maps, Google Earth and other relevant data sets were used, specifically with regard to watercourse and wetlands in the study area.

During field assessment multiple wetland were observed in the study area. None of the water course and the adjacent vegetation seen as pristine, most of the natural grassland vegetation has been totally transformed. This has a negative impact on the quality and function of the watercourse. The following wetlands were found and delineated in the study area: Valley bottom wetland on the east of the farm dams, Hillslope seepage on the south of the East farm dam and, hillslope seepage on the northwest side of the west farm dam. See figure below for the wetland type locations. All wetlands in the study site were assessed and delineated according to DWA guidelines and were considered sensitive (No Go Zone). The PES of wetlands in the study area was rated to be largely modified (category C).

There will be a need to apply for a water use licence for the proposed project with the sense that; there will be sewerage pipelines crossing the stream to the new proposed development of sewerage treatment plants. Therefore negative impacts are for seen. However recommended mitigating and management measures were implemented, therefore the activity is water use, and water use license need to be applied.

The nature of the proposed activity is such that the dams and their supporting hydrology will be affected by the proposed activity. Appropriate buffers and mitigation measures were recommended

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Acronyms and Abbreviations

Abbreviations	***Definitions***
DWA	Department of Water Affairs
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
Ha (ha)	Hactors
DEA	Department of Environmental Affairs
NWA	National Water Act

1. PROJECT INFORMATION

1.1 Background

Wandima Environmental Services were appointed by Vipcon Property Development as an independent environmental consultant to undertake Wetland Environmental Impact Assessment (EIA) for the proposed development of residential township project.

Vipcon (Pty) Ltd, Property Development and Project have seen a need and intend to develop a residential township called Siyanqoba extensions. The reason for developing this township is that; Emalahleni town is experiencing a rapid mushrooming of informal settlements. The government through its housing agencies is working hard trying to ameliorate this problem. The main influence resulted in creation of informal settlement is that; the town has experienced rapid industrial growth in the past few years with number of economic activities taking place around. These have attracted lot of people who came up looking for job opportunities; results in creating informal settlements in the form of shack dwellings.

Ligoga Consulting & trading cc were appointed by Wandima to undertake Wetland assessment for the Siyanqoba extensions.

1.1.1 Scope of work

The scope of works is to undertake wetland assessment along the potion 0 of the Tweedam J.S farm and the remainder of portion 1 of the Leeuwpoort 283 J.S farms.

1.2 Project Description

The study area is located in Emalahleni local municipality within Mpumalanga Province, on potion 0 of the Tweedam 377 J.S farm and the remainder of potion 1 of the Leeuwpoort 283 J.S farm (figure 2).

The proposed project will be consists of four (4) development phases totalling approximately 8000 residential erven, seven schools of 30.2 ha, one business centre of 10 ha, two public open spaces of 30 ha, three community facilities of 2 ha and one public transport centre of 5 ha. Two dams and borrow pits that are present on site will be used as public open space and are part of above mentioned ha. See the diagram below (figure 1).

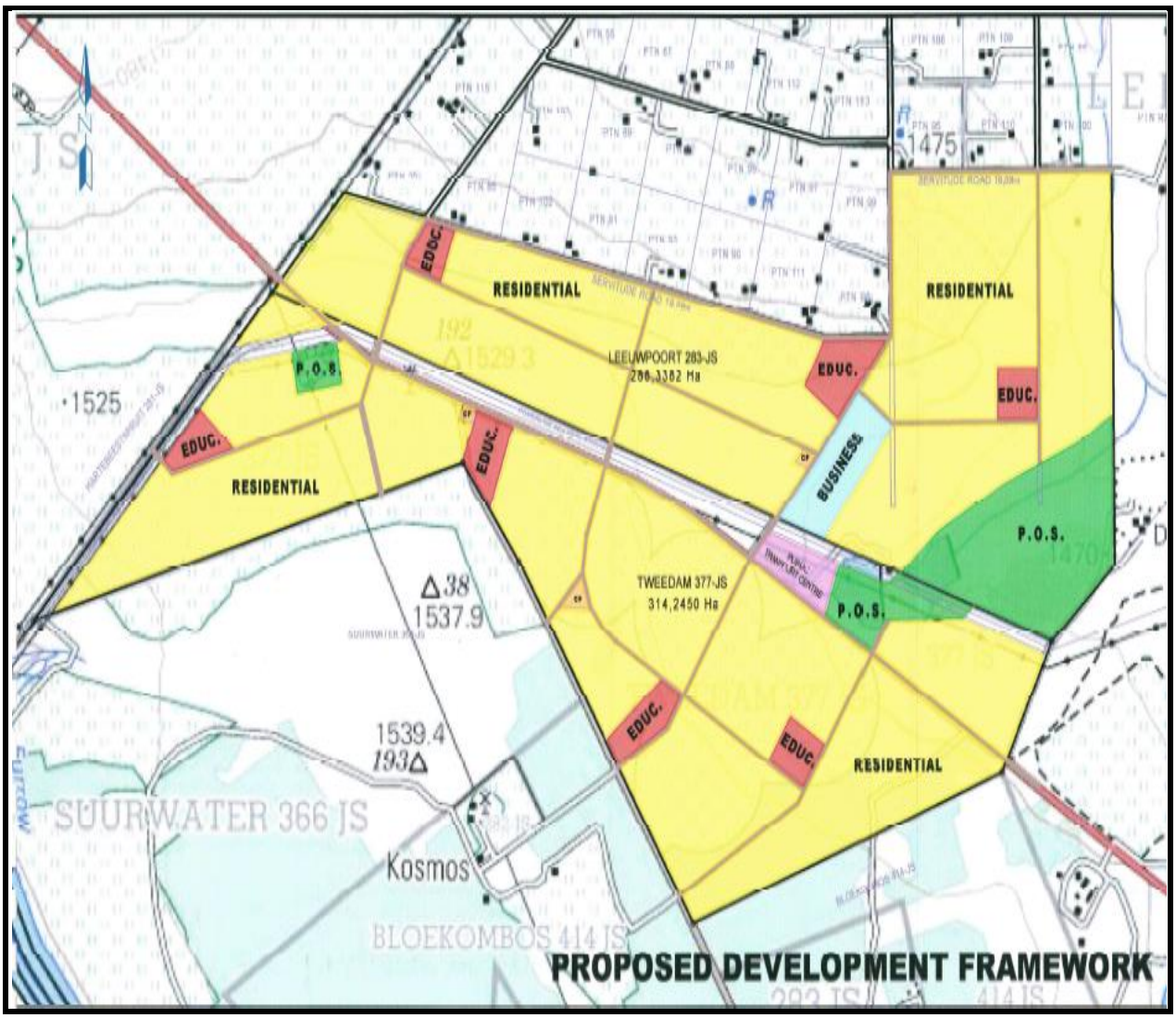

Figure 1: Indicates portions and activities for the proposed project.

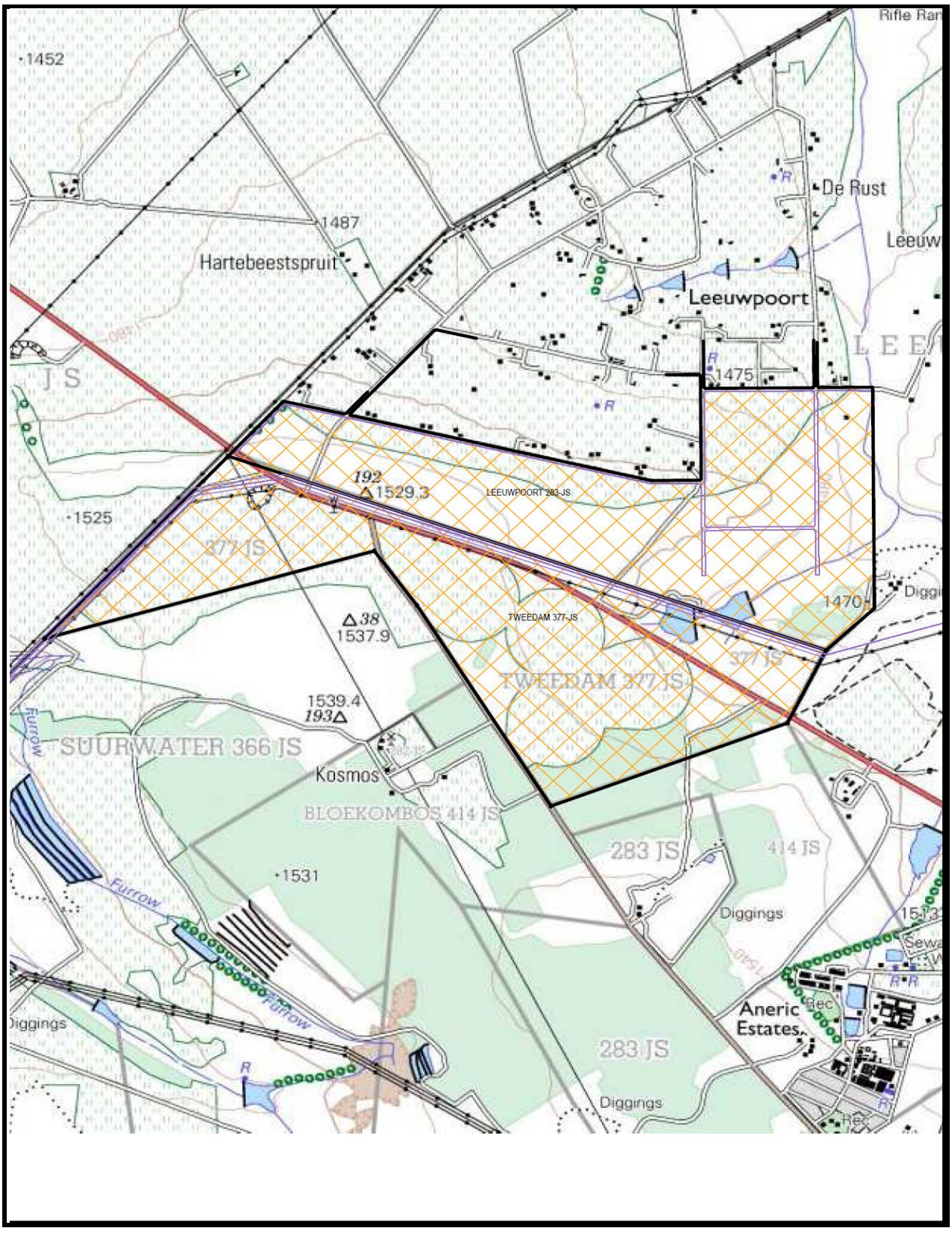

Figure 2: Shows a map of the study area and the portion of the proposed project.

1.3 Legal Requirements

The following legislations and policies were implemented during conduction of the assessment study.

1.3.1 The National Water Act (No 36 of 1998) that was published in the Government Gazette No 19182 of the Republic of South Africa, Volume 398, dated 26 August 1998 (hereafter abbreviated as the NWA). The NWA derives directly from the Fundamental Principles and Objectives for a New South African Water Law, and the National Water Policy's proposals for managing water resources.

1.3.3. National Environmental Management Act (Act 107 of 1998) NEMA, and supported by the National Framework for Sustainable Development (2006).

2. ENVIRONMENTAL CONDITIONS

2.1 Land Use

The study area is located in the high veld of Mpumalanga comprises of low slopes with flat vegetation, where the area experiences high rainfalls during summer seasons. Generally the land use of the region is typically used for farming include grazing and settlement (resident). Other land uses especially in the region is mostly known for its mining field typically coal mines and electrification infrastructure (power lines, etc.).

2.2 Climate

The area is situated on the High veld of Mpumalanga were the area experiences a humid and hot weather during summer seasons. During winter season the area is dry, with relatively moderate temperatures during the day and cold temperatures at night. The coldest month is usually July and the coldness is experienced mostly at night. High rain falls is experienced during summer months with an average of 553mm and increases with summer months.

2.3 Hydrology

The study region has several small streams, depression pans and rivers. The study region has a relatively high rainfall regime and during the summer rainy seasons these streams and rivers fill up quickly. The s soils and undulating landscape facilitate seepage and subsurface water flow, which very often allow for continued water seepage and movement into these water bodies long after rainy seasons and even into the dry, winter months in some cases where the catchment areas are large.No large perennial rivers were observed in the study area, only few small streams and drainage lines were observed. These drainage lines have small channels, which have no water in most part of the year. These small streams are non-perennial to semi-perennial; however, they are sometimes active during the rainy season, especially during summer. During field investigations these watercourses were identified and considered to be

sensitive (No-Go) zones. A number of manmade impoundments (farm dams) are also present, especially in the remainder of potion 0 of Tweedam 377 J.S farm (figure 3)

Figure 3: A farm dam that was observed within the study area in Tweedam 377 J.S farm.

2.4 Geology

The study area is situated in the Central Block of the Witbank Coalfields. The coalfield lithologies comprise sediments of the Dwyka and Vryheid Formations of the coal-bearing Ecca Group, Karoo Supergroup. The sediments have been deposited on an undulating pre-Karoo age basement, which had a significant influence on the nature, distribution and thickness of the sedimentary formations and coal measures. The geology of the study area is dominated by near horizontally bedded successions of shales, sandstones and coal layers. This succession of sedimentary rocks overlies the well-consolidated conglomerates / diamictites of the Dwyka Formation, but in places rests directly on felsites and granites of the pre-Karoo Basement.

A north south striking normal fault cuts across the site and divides the coal resource into distinct western and eastern parts. The fault cuts through the eastern limb of an anticline. A number of northeast-southwest trending, near-vertical dolerite dykes have intruded the coal.

2.5 Soils

The soils of the study area is characterised by generally shallow soils underlain by a hard plinthic horizon. The soils on the site have a relatively high clay content associated with the weathering of the schists and granites. The soils associated with this site range from moderately deep loamy to clay soils cultivated in the past to shallow soils, in some instances underlain by a well-developed ferricrete horizon, to rocky in places. The loam-clay soils semi-restrict easy infiltration of rainwater into the soil. Infiltrated water thus starts slowly percolating laterally through the soil profile along the aquitard. Most of this water is likely lost to evapo-transpiration over time.

2.6 Topography

The study area is situated in the eastern region of Mpumalanga, which is characterised by a gently undulating plateau with fairly broad to narrowly incised valleys such as the Olifants River valley. The general elevation of the area lies between 1 400 m and 1 600 m above mean sea level. To the west of Witbank lies a high point of 1650 m, although the town lies at an average altitude of approximately 1560 m.

2.7 Vegetation

The vegetation types found in the study area are as follows, namely grassland, woodland, wetland and disturbed vegetation. Grassland communities have the highest plant diversity and wetland vegetation the lowest. Floristic composition indicates that the vegetation of the Rocky Highveld Grassland has affinities to the grassland and savannah biomes and also to the Afro montane vegetation of the Great Escarpment.

There are numerous classification and naming systems used for vegetation types. It is the preference of the researches to use the latest and more detailed system of Mucina and Rutherford (2006). However, two other very important classification works of South African vegetation types are those of Acocks (1953) and Low &Rebelo (1996). The three classification systems do not correspond directly veld type for veld type. Therefore, the percentage of veld type named by Acocks and Low & Rebelo, which falls within Mucina & Rutherford's veld types, are highlighted in brackets in (Table 1).

Table 1: Comparison of veld type names

Mucina & Rutherford (2006)	Acocks (1953)	Low & Rebelo (1996)
Eastern Highveld Grassland	Bankenveld (42%); Northeastern Sandy Highveld (33%); Bankenveld to sourveld transition (80%)	Moist Sandy Highveld Grassland (69%)
Eastern Temperate Freshwater Wetlands	-	-
Rand Highveld Grassland	Bakenveld (64%)	Rocky Highveld Grassland (45%); Moist Sandy Highveld Grassland (21%)

3. METHODOLOGY

3.1 Field survey

The field study was conducted regarding the vegetation types, rivers, catchment areas and wetlands of the specific study area. The National Water Act, the National Environmental Management Act, Maps, Google Earth and other relevant data sets were used, specifically with regard to watercourse and wetlands in the study area.

Field surveys were conducted in December 2013, during early summer period when the environment was hot.

3.2 Wetlands

Wetlands are viewed as having a high sensitivity rating and are considered 'No-Go Zones'. During the course of field investigations no typical, natural or functional wetlands were identified in the study area. Wetlands and wetland vegetation were also not identified in the study area.

The method used for wetland assessment was based on the guidelines provided by the Department of Water Affairs (2005). This wetland delineation and assessment method stipulates features that identify the possible wetland areas. The following indicators were used

to determine whether an area contains wetlands or not, namely; terrain unit indicator, soil form indicator, soil wetness indicator, and vegetation indicator.

3.2.1 Terrain Unit Indicator

This indicator helps to identify those parts of the landscape where wetlands are more likely to occur. The Pan Wetland type is likely to occur at the crest; the floodplains and valley bottom wetlands are generally located in the deep valley areas of the landscape; and the hill slope seepage wetlands are generally found along the slopes.

The terrain unit pre-empted the present of a hillslope seepage wetlands and valley bottom wetland with drainage lines. However, this wetland indicator could not ascertain the presence of wetlands. Further assessments were undertaken by making use of a soil wetness indicator as discussed below in (3.2.3).

3.2.2 Soil Form Indicator

The permanent zone will always have either Champagne, Katspruit, Willowbrook or Rensburg soil forms present, as defined by the Soil Classification Working Group (1991).
The seasonal and temporary zones will have one or more of the following soil forms present (signs of wetness incorporated at the form level)

3.2.3 Soil Wetness Indicator

This wetland indicator identifies the morphological “signatures” developed in the soil profile as a result of prolonged and frequent saturation. According to DWAF guidelines, soil wetness is the most important indicator of wetland occurrence. This is because, compared to the vegetation indicator, soil wetness is not seasonally dependant. Wetland indicators remain in the soil as ‘markers’ of wetness even during the drought periods. The soil wetland indicator identifies the signatures which develop in the soil due frequent or prolonged saturation. The different zones of the wetland are delineated by the change in colour of the soil. The permanent zone has few mottles and gleyed; the seasonal zone has many mottles and gleying within 0.5 m depth of the soil profile; the temporary zone has few mottles and gleying of soil within 0.5 m depth of the soil profile. See diagram below for soil wetness classes (figure 4).

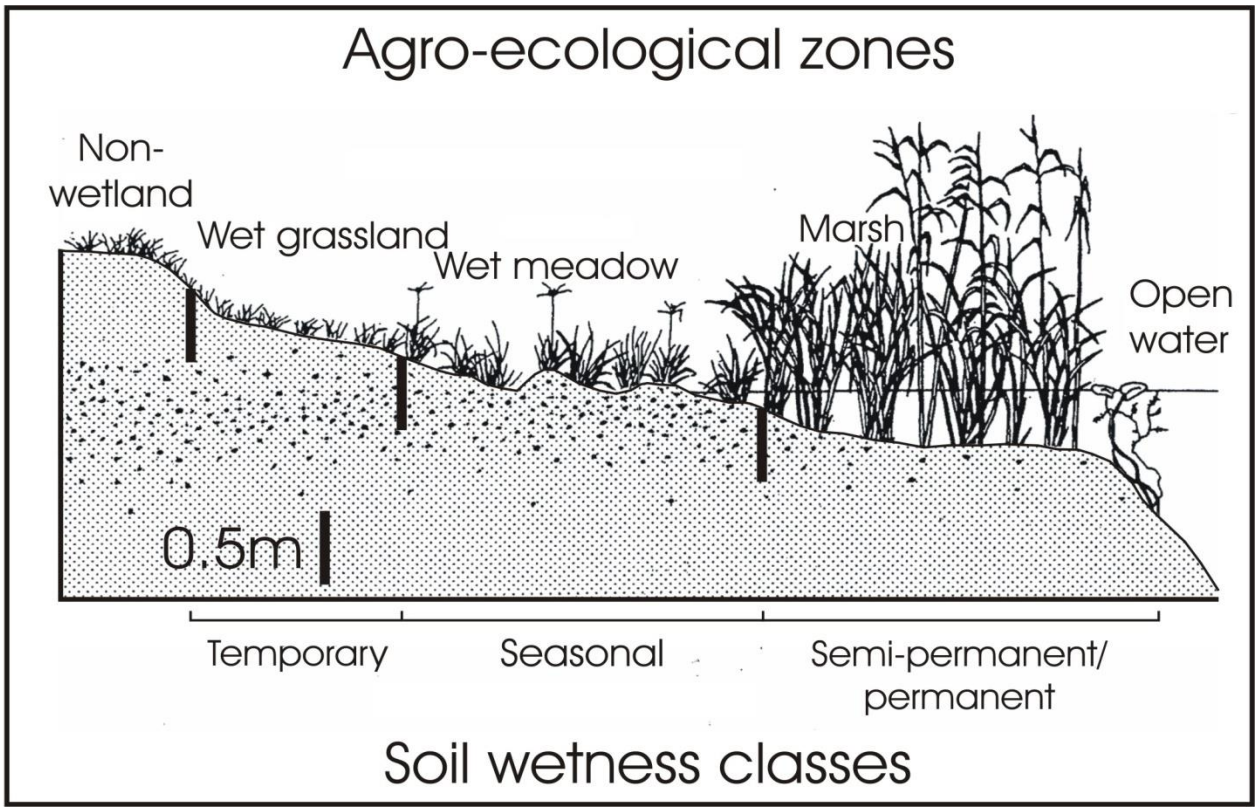

Figure 4: Illustrates the soil wetness classes.

All sampled sites along the stream did not present the soil marker indicators that are typically associated with wetland soils (figure 5). This wetland indicator alone suggests that; no functional wetland found around the study area. The findings suggest that what was observed in the study area can be identified as semi-perennial stream or channel. The proposed development of residential area shows to have little negative impacts on the surrounding soils and water courses; however mitigation measures were implemented to minimize the impact.

Figure 5: Indicates soil samples taken for soil wetness indicator during field study.

3.2.4 Vegetation indicator

This vegetation indicator identifies hydrophilic vegetation associated with frequently saturated soils. Generally, some vegetation is only ever found in highly inundated area, and this vegetation is referred to as obligate. The permanent wetland zones are dominated by bulrushes, where the temporary wetland zone comprises of facultative wetland plants.

In the case of Siyanqoba extensions on Tweedam 377 J.S farm and Leeuwpoort 283 J.S farm, during field assessment; facultative wetland plants were observed in the study area. It should be noted that the south part of the second farm dam from the main road contains no obligate or facultative plants, but is wetland.

3.2 Assumptions & Limitations

The site visit was conducted during December 2013, early summer season, where all streams and rivers were semi-dry. Most of the water courses are semi- perennial, they recharge and fill quickly during summer rain falls, it is recommended to monitor the site during summer rain fall to evaluate some points.

4. WETLAND DELINEATION

4.1 Wetlands

During field assessment multiple wetland were observed in the study area. None of the water course and the adjacent vegetation seen as pristine, most of the natural grassland vegetation has been totally transformed. This has a negative impact on the quality and function of the watercourse.

The following wetlands were found and delineated in the study area: Valley bottom wetland on the east of the farm dams, Hillslope seepage on the south of the East farm dam and, hillslope seepage on the northwest side of the west farm dam. See figure below for the wetland type and their locations.

All wetlands in the study site were assessed and delineated according to DWA guidelines and were considered sensitive (No Go Zone). A buffer of 32 metres was recommended for wetlands and 100m from dams.

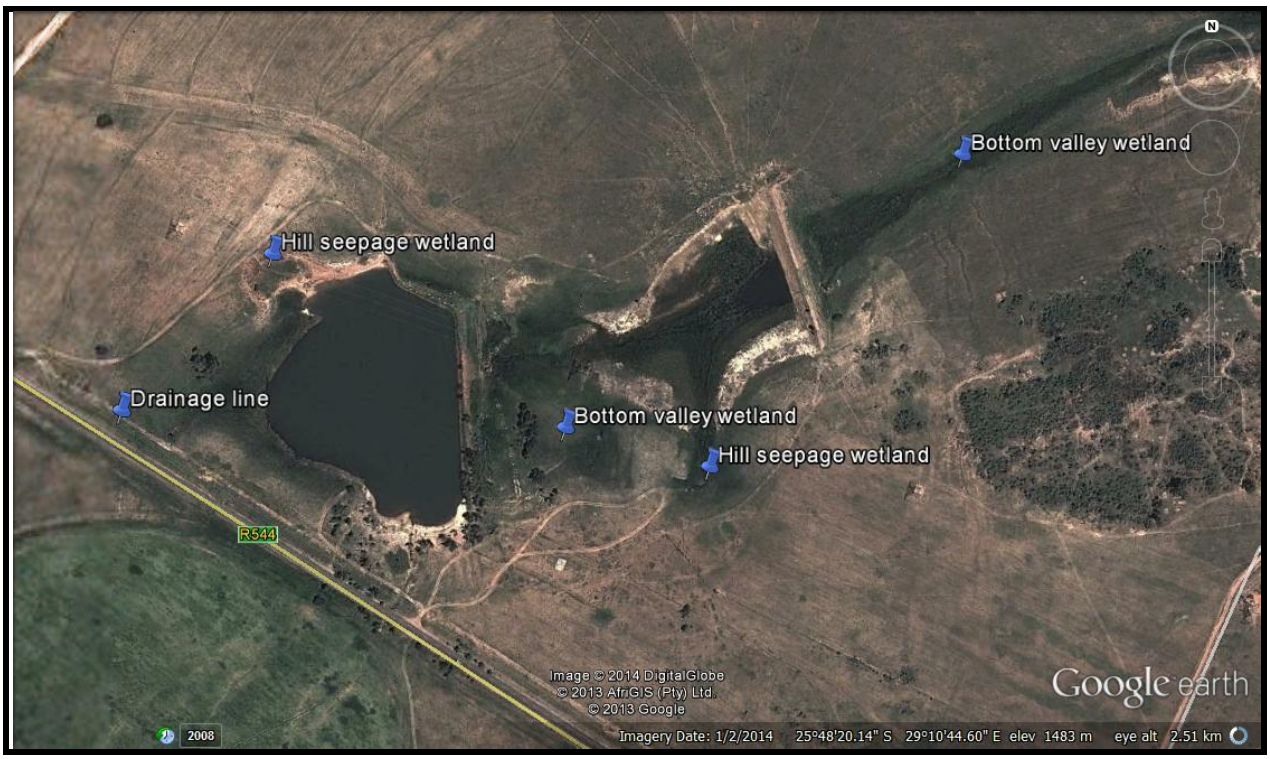

Figure 6: Location of wetlands in the study area.

Although the primary driving force behind all wetlands is water, due to its dynamic nature varying daily, seasonally and annually. It is not a very useful parameter for accurately identifying the outer boundary of a wetland. Long term monitoring is needed to accurately characterize the hydrology of a wetland and the extent of its saturation zones. As a result of this dynamic hydrology within and between wetlands, it is difficult to define the minimum frequency and duration of saturation that creates a wetland. Instead, an approach is commonly followed which identifies the indirect indicators of prolonged saturation by water: wetland plants (hydrophytes) and wetland (hydromorphic) soils. The presence of these distinctive indicators in an area implies that the frequency and duration of saturation is sufficient to classify the area as a wetland.

4.2 Present Ecological State (PES) of wetland

The Present Ecological State (PES) is the current (present) ecological condition (state) in which the watercourse or wetland is found, prior to any further developments or impacts from the proposed project.

The PES Method (DWA, 2005) was used to establish the present state or status (integrity) of the wetlands (and other watercourses) identified in the study area. The methodology is based on the modified Habitat Integrity approach of Kleynhans (1996, 1999) (Table 2).

Table 2 shows the criteria used for assessing the habitat integrity of wetlands and other watercourses, along with Table 3, which describes the allocation of scores for the various attributes. These criteria were selected based on the assumption that anthropogenic modification of the criteria and attributes listed under each selected criterion can generally be regarded as the primary causes of the ecological integrity of a wetland.

Table 2: The criteria used for Assessing the Habitat Integrity

Rating Criteria	Relevance
Hydrology	
Flow modification	Consequence of abstraction, regulation by impoundments or increased runoff from human settlements or agricultural lands. Changes in flow regime (timing, duration, frequency), volumes, and velocity, which affect inundation of wetland habitats resulting in floralistic changes or incorrect cues to biota. Abstraction of groundwater flows to the wetland.
Permanent inundation	Consequence of impoundment resulting in destruction of natural wetland habitat and cues for wetland biota.

Water quality	
Water Quality Modification	From point or diffuse sources. Measured directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Sediment Load Modification	Consequence of reduction due to entrapment by impoundments or increase due to land use practices such as overgrazing. Cause of unnatural rates of erosion, accretion or infilling of wetlands and change in habitats.
Geomorphology & Hydraulics	
Water Quality Modification	From point or diffuse sources. Measured directly by laboratory analysis or assessed indirectly from upstream agricultural activities, human settlements and industrial activities. Aggravated by volumetric decrease in flow delivered to the wetland.
Biota	
Terrestrial Encroachment	Consequence of desiccation of wetland and encroachment of terrestrial plant species due to changes in hydrology or geomorphology. Change from wetland to terrestrial habitat and loss of wetland functions.
Indigenous Vegetation Removal	Direct destruction of habitat through farming activities, grazing or firewood collection affecting wildlife habitat and flow attenuation functions, organic matter inputs and increases potential for erosion.
Invasive Plant Encroachment	Affects habitat characteristics through changes in community structure and water quality changes (oxygen reduction and shading).
Alien Fauna	Presence of alien fauna affecting faunal community structure.
Over utilisation of Biota	Overgrazing, over fishing, over harvesting of

	plant material, etc.

Table 3: Scoring Guidelines for Habitat Assessment

Scoring guidelines per criteria	
Natural / unmodified	5
Mostly natural	4
Moderately modified	3
Largely modified	2
Seriously modified	1
Critically modified (totally transformed)	0

Tables 3 & 4 provide scoring guidelines for the determination of the Present Ecological Status Category (PESC). This approach is based on the assumption that extensive degradation of any of the wetland attributes may determine the PESC (DWA, 2005).

Table 4: Wetland Integrity Categories

Category	Mean Score	Description
A	>4	Unmodified, natural condition.
D	>3 to 4	Largely natural with few modifications, but with some loss of natural habitats.
C	>2,5 to 3	Moderately modified, but with some loss of natural habitats
D	2 to 2,5	Largely modified. A large loss of natural habitats and basic ecosystem functions has occurred.
E	>0	Seriously modified. The losses of natural habitats and basic ecosystem functions are extensive.
F	0	Critically modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat.

The integrity of wetlands with a category rating of D, E & F were deemed to be Low. Category rating of C was deemed to be Medium, while Category rating of A & B was deemed to be high. Therefore wetlands observed in the study area falls under category C.

5. IMPACT ASSESSMENT

5.1 Existing Impact

The existing impacts on the watercourses within the study area are for seen. It is important to highlight the fact that cultivation in particular has had a negative impact on the integrity and quality of the watercourse and drainage lines in the study area and the surrounding region. There are no areas seen as pristine and most of the natural grassland vegetation has been totally transformed. This has a negative impact on the quality and function of the watercourse and their associated fauna and flora. Most watercourses in the study area and region have been modified.

5.2 Potential Impact

During field assessment, the proposed development will have negative impact on the natural environment and local water course. During construction phase, construction activities will have a direct impact to the farm dams, streams and surrounding environment; impact will result from poor management and licks from the sewerage pipes. Impact of flood is another factor, especially residential drainage systems; this area will experience soil erosion if no effective rehabilitation. However mitigating measures have been recommended to ensure that construction activities do not directly have impacts or the negative impacts that may occur are minimised. The map below indicates the arrangements of the proposed residential area, including dams and the stream as an open space (Figure 7).

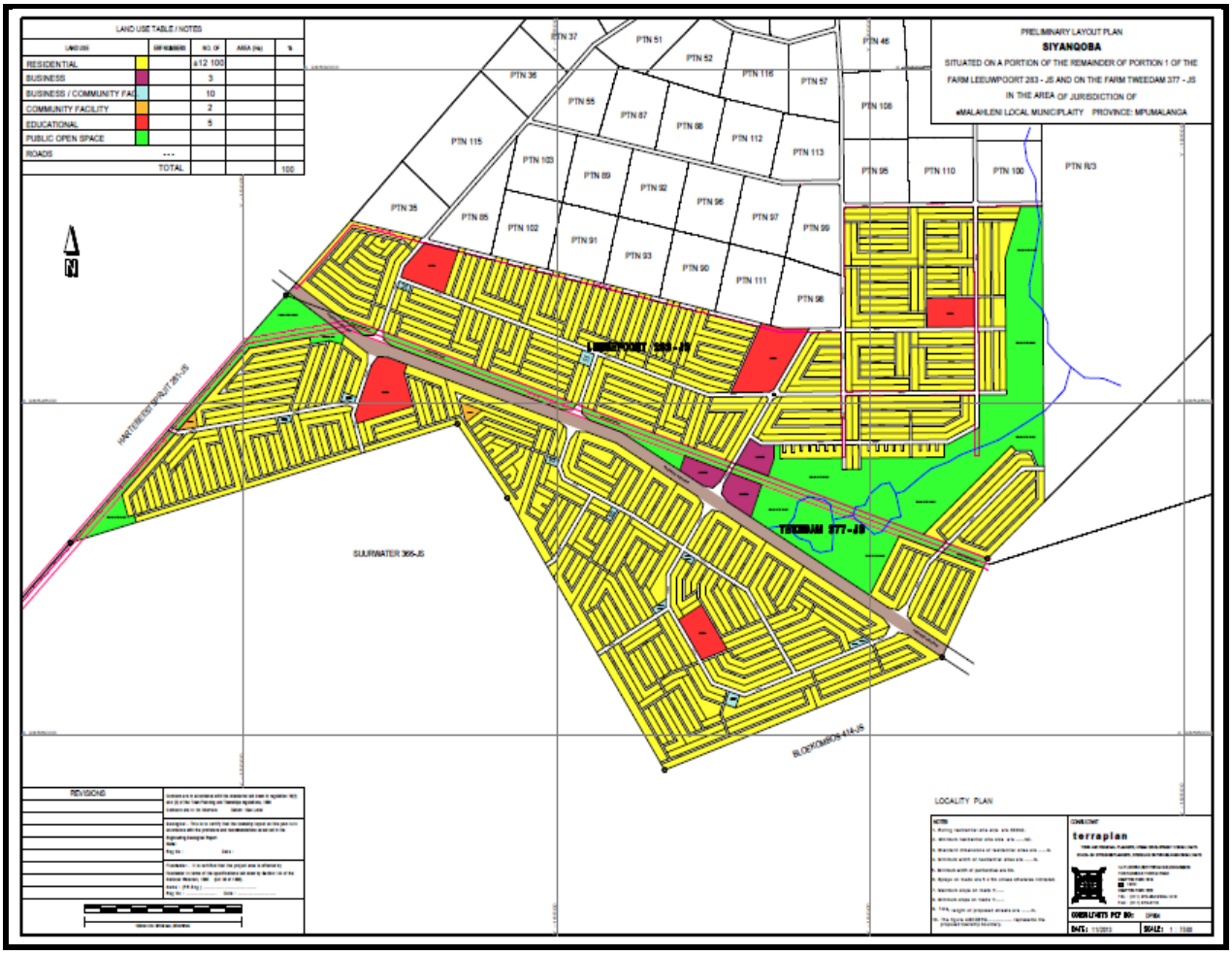

Figure 7: Indicates the arrangements of the proposed residential area, including dams and the stream.

6. MITIGATION MEASURES AND MANAGEMENT MEASURES OF IMPACT

The following mitigating and management measures will be taken into considered and implemented during operational and maintenance phases, with effort of reducing the negative impacts on the surrounding environment.

6.1 Construction Phase

- No construction activities will take place within a minimum of 100m from the edge of the dam and not less than 32m from the wetland.

- No indigenous trees, shrubs or reeds 100 m from the stream to be removed. Patches of exotic trees (especially black wattle (*Acacia mearnsii*) and weeping willow (*Salix baby lonica*)) within the large 100m corridor may be removed. This will also have a positive impact on the grassland environment.

- Disturbed surface areas in the construction phase to be rehabilitated immediately.

- No open trenches to be left or mounds of soils created during construction to be left.

- All hazardous materials *inter alia* paints, turpentine and thinners must be stored appropriately to prevent these contaminants from entering the environment;

- Spill-sorbs or similar type product must be used to absorb hydrocarbon spills in the event that such spills should occur;

- All construction material, equipment and any foreign objects brought into the area by contractors and staff to be removed after completion of construction**.**

- Removal of all waste construction material to an approved waste disposal site.

- No water for drinking or construction purposes of any kind may be extracted directly out of existing farm dams, streams or drainage line etc.

6.2 Maintenance Phase

- A proper waste management system should be implemented to avoid health threat to the surrounding environment, streams and the existing farm dams.

- The sewarge pipe lines should be monitored on regular basis for licks at all times as to maximize the confidentiality and significance of proper maintenance.

- Mechanical control to be of such a nature as to allow local grasses and other pioneers to colonise the previously disturbed areas, thereby keeping out alien invasive

- No chemical control (herbicides) of alien plants to be used. Herbicides could get into the water system and will have a detrimental effect on the environment.

- Disturbed areas have to be check before and after the summer rain season for signs of soil erosion due to run-off. Such sites need to be modified and rehabilitated to prevent ongoing erosion. These sites need to be monitored more closely than other sites which show no or minimal signs of erosion.

- No inspection or other vehicles to drive through drainage lines, along the bank margin of streams except where there are existing crossovers.

- It is recommended that the farm dams on the Tweedam 377 J.S have to be protected by fence and monitored. This is a means to offset any negative impact the construction might have.

7. WATER USE LEGAL ASSESSMENT

The nature of the proposed activities wil requires water use lisence, according to the National Water Act, 1998 (Act 36 of 1998), as defined in section 21of the NWA.

Water uses as defined in terms of Section 21 that will apply or have relevance to the proposed activity are;

- 21(c) impeding or diverting flow in a watercourse; and
- 21(i) altering the bed, banks course or characteristics of a watercourse.

The General Authorisations, specifically addressing the water uses defined under Section 21 (c) & (i) of the NWA, as published in the Government Gazette, provide a set of requirements which is an authorisation to which a water user must comply. If the water user cannot or the water use related activities exceeds the conditions or exclusions of the General Authorisation then a water use licence application is required.

8. GPS COORDINATES OF REFERENCES

Table 5: GPS Coordinates points

Places	Longitude	Latitude
1st Dam from R544 road	25°48'24,85"S	29°10'37,78"E
2nd Dam	25°48'21,79"S	29°10'46,01"E
Valley bottom wetland	25°48'13,87"S	29°10'55,00"E
Hillslope seepage	25°48'13,9"S	29°10'48,8"E
Hill slope seepage	25°48'22,0"S	29°10'47,4"E

9. CONCLUSION & RECOMMENDATIONS

The DWA wetland delineation and assessment guideline was used to assess the presence of wetlands on site. Indicators that were used for the assessment were: terrain unit, soil wetness and vegetation. Some of these wetland indicators were observed in the study area and found that the study area contains multiple wetlands. In terms of the National Water Act (Act 36 of 1998), all reasonable measures must be taken to prevent the pollution of a water resource. This responsibility extends to the owner of land, a person in control of land or a person who occupies or uses the land on which the polluting activity has occurred or could occur.

There will be a need to apply for a water use licence for the proposed project with the sense that; there will be sewerage pipelines crossing the stream to the new proposed development of sewerage treatment plants. Therefore negative impacts are for seen. However recommended mitigating and management measures were implemented, therefore the activity is water use, and water use license need to be applied.

The nature of the proposed activity is such that the dams and their supporting hydrology will be affected by the proposed activity. Appropriate buffers and mitigation measures were recommended.

11. PHOTOPLATES

Photo plate 1: A farm dams in potion 0 of Tweedam 377 J.S farms.

Photo plate 2: Electrification as typical example of land use of the study area in Leeuwpoort 283 J.S farm.

Photo plate 3: A previously cultivated land in the study area, in Leeuwpoort 283 J.S farm.

Photo plate 4: A Valley bottom wetland observed in the study area.

12. REFERENCES

- Acocks, J.P.H. 1988. 3rd ed. Veld types of South Africa. Memoirs of the Botanical Survey of South Africa 57: 1-146.

- Barnard, H.C. 2000. *An Explanation of the 1:500 000 general hydrogeologicalmap: Johannesburg 2526*. Department of Water Affairs & Forestry (DWA).

- Directorate water resource classification. Department of water affairs, South Africa, 2011. Classification of significant water resources in the Olifants water management area (wma 4): integrated units of analysis (IUA) delineation report. Report no: RDM/wma04/00/con/CLA/0311.

- Department of water affairs and forestry (DWA), 2005: a practical guideline procedure for the identification and delineation of wetlands and riparian zones.

- Heather MacKay, 1999. Guidelines for the delineation of wetland boundary and wetland zones. Department of Water Affairs and Forestry.

- Low, A.B. & G. Rebelo 1998. Vegetation of South Africa, Lesotho and Swaziland. Dept. Environmental Affairs and Tourism, Pretoria.

- Mucina, L. & M.C. Rutherford 2006. The vegetation of South Africa, Lesotho and Swaziland. SANBI, Pretoria.