Appendix 14
Stormwater and Erosion Management Plan

Longyuan Mulilo De Aar 1 Maanhaarberg Wind Energy Facility: Stormwater and Erosion Management Plan

Final Report

April 2014

Submitted by:

AECOM

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TITLE	:	*Longyuan Mulilo De Aar 1 Maanhaarberg Wind Energy Facility : Stormwater and Erosion Management Plan*
Project Team	:	*AECOM (Pty) Ltd – Isak Malherbe, Mike Wiese*
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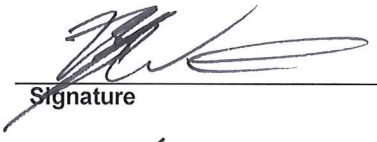
For AECOM SA (Pty) Ltd

Compiled by	:	MB Wiese Initials & Surname	 Signature	05/05/2014 Date
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Approved by	:	U Huber Initials & Surname	 Signature	05/05/2014 Date

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List of Abbreviations

AECOM	AECOM SA (Pty) Ltd
DWA	Department of Water Affairs
ha	hectares
km	kilometres
km^2	square kilometres
Longyuan Mulilo	Longyuan Mulilo De Aar Wind Power
m	metres
mamsl	metres above mean sea level
MAP	Mean Annual Precipitation
MW	Megawatt
N10	National Route 10
NEMA	National Environmental Management Act
NWA	National Water Act
SAWQG	South African Water Quality Guidelines
SWMP	Stormwater Management Plan
TSS	Total Suspended Solids
WEF	Wind Energy Facility
WRC	Water Research Commission

1. Introduction

1.1 Background

Longyuan Mulilo De Aar Wind Power (Longyuan Mulilo) has identified a site ideal for the development of a 100 MW Wind Energy Facility (WEF), located on the Swartkoppies and Kasarm Mountains, southwest of De Aar in the Northern Cape, South Africa, as indicated in **Figure 1.1**. The site extends across two farms portions and is in close proximity to the east of the site is a major ESKOM substation, Hydra, providing very good grid connectivity for the proposed WEF.

The National Route 10 (N10) between Hanover and Britstown, passing south of De Aar, is located to the north and east of the site. Railway lines are located to the north, east and south of the site.

1.2 Scope of study

AECOM SA (Pty) Ltd (AECOM) has been appointed by Longyuan Mulilo to compile a Stormwater Management Plan (SWMP) for the proposed WEF site. The scope of work associated with the SWMP includes the identification of hydrological impacts, as a result of the development of a WEF at the proposed site, on the surrounding environment, and guidelines / objectives for the formulation of mitigation measures to prevent :

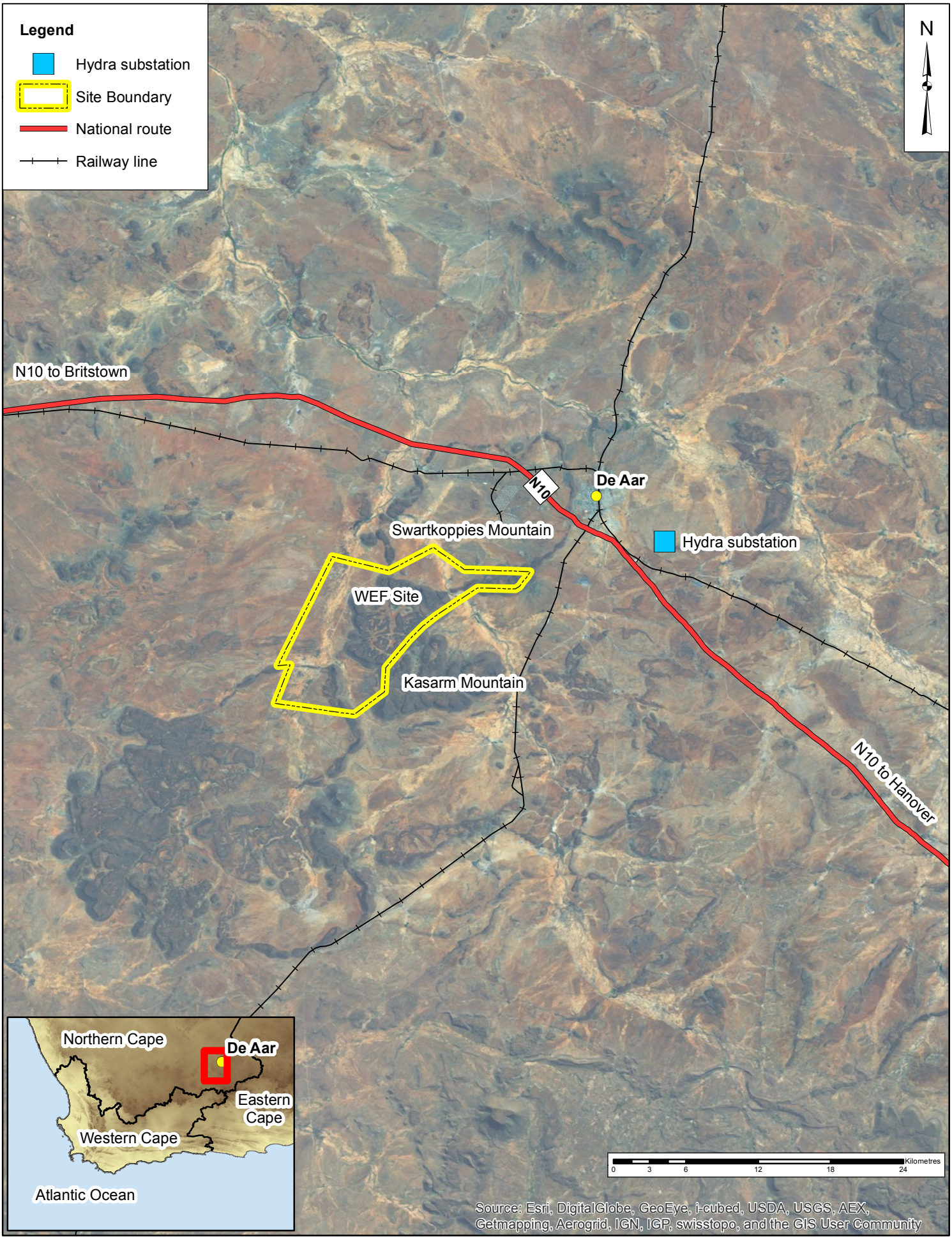
- The degradation of the natural environment.
- Impacts on the quality of water resources.
- Loss or damage to property.

1.3 Study limitations

The SWMP is based on information received during the preliminary design stage of the proposed WEF, which is subject to change during further development stages.

1.4 Study approach

During this investigation, hydrological impacts, as a result of the proposed wind farm site and layout, during both construction and operational phases, were identified based on a desktop approach. Guidelines / objectives for the formulation of mitigation measures are proposed in this report, with the aim to prevent or minimise the abovementioned hydrological impacts as far as practicable possible, as required by legislation.



Project Title:	**Longyuan Mullilo De Aar 1 Maanhaarberg Wind Energy Facility : Stormwater Management Plan**
Map Title:	**Locality plan**

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(When page size is: A4 portrait)

FIGURE 1.1

Projection:	Geographic - Hartbeeshoek 1994
Drawn by:	MB Wiese
GIS QC by:	NG Letoao
Approved by:	I Malherbe
Date:	March 2014
Map Ref.:	Figure 1.1 - Locality plan.mxd
Revision:	00
Project Nr.:	14C00570

Sources:

Surveyor general. 2011.
Water Resources of South Africa 2005 Study. 2008.
Environmental Potential Atlas for South Africa. 2001.

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De Aar 1 - Figure 1.1 - Locality plan (A4).mxd

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1.5 Structure of report

The report is structured as follow :

Section 1 describes the background to, purpose of and structure of this report.

In **Section 2** a description of the site is provided.

The legislative requirements applicable to this investigation is summarised in **Section 3**.

Section 4 presents the hydrological setting of the site.

Section 5 describes the necessary stormwater management procedures.

In **Section 0** the conclusions from this investigation are provided and recommendations are presented.

References are listed in **Section 7**.

2. Site description

The proposed WEF site is situated on two farm portions, RE/130 and the remaining extent of portion 2, RE 2/132, which comprise a total area of approximately 113 km^2, located southwest of De Aar. The WEF is located along the higher elevated, more mountainous eastern and north-eastern parts of the site, located on the Kasarm and Swartkoppie Mountains respectively, as indicated on **Figure 2.1**. These two mountains are separated by the non-perennial Elandsfontein River, which flows in a northerly direction across the site.

The part of the wind farm located on the plateau of the circular shaped Kasarm Mountain hosts 57 of the 67 wind turbines. Wind turbines will be erected on peaks, at this location approximately 1 380 to 1 480 mamsl, which generally increase in elevation along the edge of the plateau.

The remaining 10 wind turbines are located on the long and narrow south-west trending Swartkoppies Mountain. Elevations of these peaks range from approximately 1316 mamsl and 1385 mamsl at the south-western and north-eastern ends of the mountain respectively, to a maximum of approximately 1506 mamsl along the north-eastern edge of the site.

Each of the 67 wind turbines has a round foundation of 16 m diameter. An area of 0.35 ha, which includes the foundation, is required for the erection of each of the wind turbines, therefore covering a total area of approximately 23.5 ha.

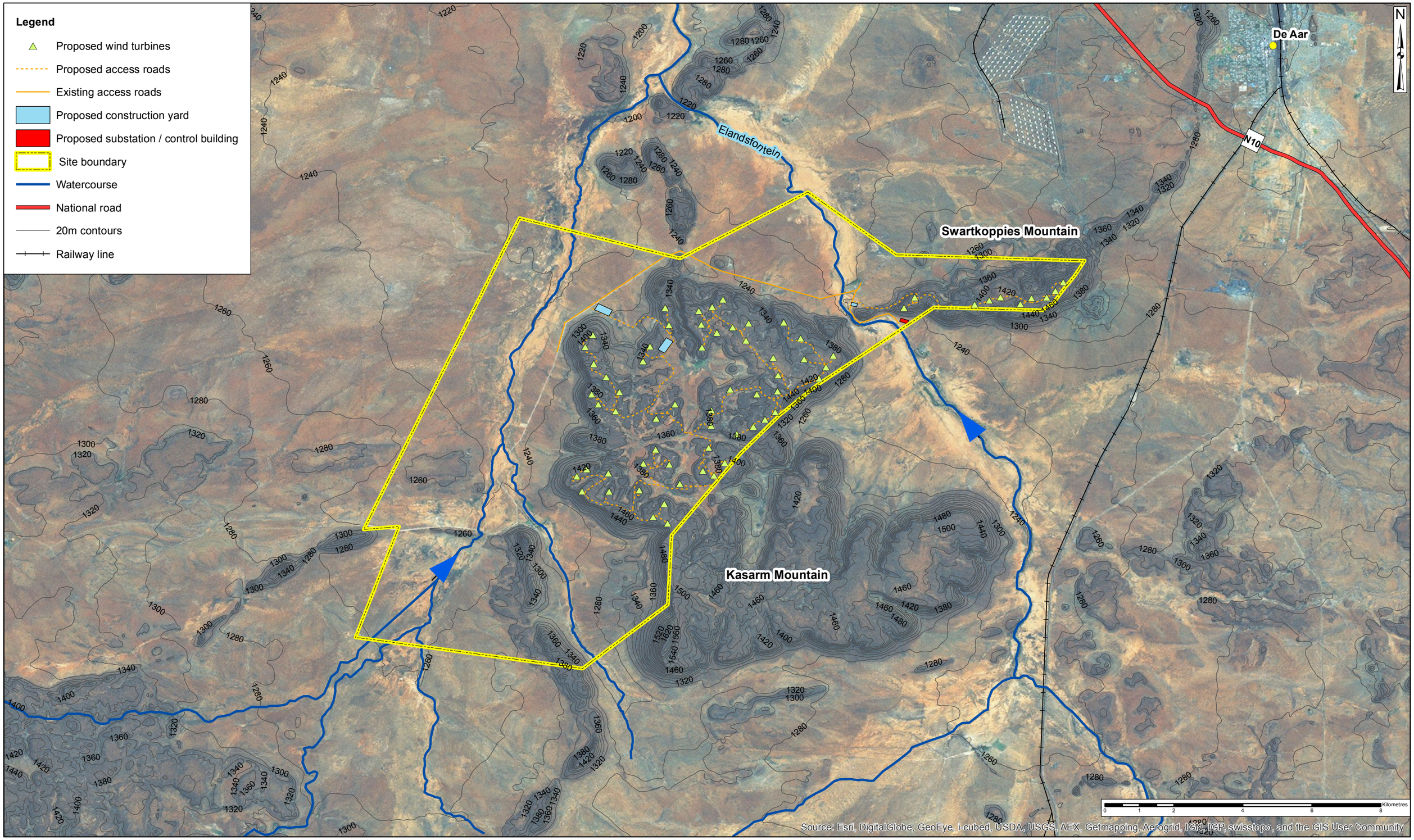
A network of approximately 4 m wide gravel roads is proposed, allowing access for construction, transportation and maintenance vehicles to the wind turbines. Roadways are aligned to existing farm roads as closely as possible to prevent unnecessary cut and fill and the construction of new roads where no farm roads exist. From **Figure 2.2** in can be concluded that the natural slopes in the mountainous areas are generally steep, which will necessitate steeply sloped roadways in certain areas. These gravel roads cover a total distance of approximately 55 km and tie into an existing road located along the northern and north-eastern boundary of the site.

Construction yards are proposed at three locations along the abovementioned road networks. A 400 x 200 m construction yard is proposed at the foot of the Kasarm Mountain and another of similar size is proposed on the plateau, in closer proximity to the location of wind turbines. A 150 x 100 m construction yard is proposed west of the Swartkoppies Mountain, as indicated in **Figure 2.1**.

Southwest of the Swartkoppies Mountains, adjacent to the Elandsfontein River, a substation / control building for the WEF has been proposed. The substation / control building is located in the vicinity of the floodplain of the Elandsfontein River.

Legend

- Proposed wind turbines
- Proposed access roads
- Existing access roads
- Proposed construction yard
- Proposed substation / control building
- Site boundary
- Watercourse
- National road
- 20m contours
- Railway line



Project Title:	**Longyuan Mulilo De Aar 1 Maanhaarberg Wind Energy Facility: Stormwater Management Plan**
Map Title:	**Site layout**

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FIGURE 2.1

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Date:	April 2014
Map Ref.:	Figure 2.1 - Site layout.mxd
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Project Nr.:	14C00570

Sources:

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Water Resources of South Africa 2005 Study. 2008.
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Legend

- Proposed wind turbine
- Proposed access roads
- Existing access roads
- Proposed construction yard
- Proposed substation / control building
- Site boundary
- Watercourse
- 20m contours

Eland sfontein

Swartkoppies Mountain

Kasarm Mountain

N

Kilometres
0 0.5 1 2 3 4

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Project Title:	**Longyuan Mulilo De Aar 1 Maanhaarberg Wind Energy Facility: Stormwater Management Plan**
Map Title:	**Topography**

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FIGURE 2.2

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Approved by:	I Malherbe
Date:	April 2014
Map Ref.:	Figure 2.2 - Topography.mxd
Revision:	00
Project Nr.:	14C00570

Sources:

Surveyor general. 2011.
Water Resources of South Africa 2005 Study. 2008.
Environmental Potential Atlas for South Africa. 2001.

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3. Legislative requirements

3.1 National Water Act

The National Water Act (NWA), 1998 (Act No 36 of 1998) provides the Department of Water Affairs (DWA) with the mandate to protect, use, develop, conserve, manage and control the country's water resources in an integrated manner. It provides the legal basis on which to develop tools and the means to affect this mandate. Chapters 3 and 4 of the NWA deals with polllution prevention and water use. The person who owns, controls, occupies, or uses the land in question is responsible for taking measures to prevent pollution of water resources. Any structures which may be located where they may have an impact on current water resources are governed by sections of the NWA and / or regulations published in terms of this Act.

The means necessary to prevent pollution of water resources can be broadly outlined as follows :

- Water contaminated by activities / infrastructure may not be discharged to water resources.
- Prevention of erosion.
- The separation of clean and "dirty" stormwater runoff.
- Monitoring programmes.

3.2 South African Water Quality Guidelines

The NWA, Section 21 (f) and (g), states that the discharging of water containing waste into a water resource and disposing of waste which may detrimentally impact on a water resource should be prevented. The South African Water Quality Guidelines (SAWQG) are a series of documents published by DWA, which forms an integral part of the water quality management strategy to safe keep and maintain the water quality in South Africa. These guidelines are used by the DWA as a primary source of information and decision-support to judge the fitness for use of water and for other water quality management purposes. The content of the SAWQG provides information on the ideal water quality and acceptable concentrations for various constituents of concern.

Construction sites are generally considered as an industrial activity, however, due to the nature of the WEF, the water quality guidelines for industrial use are considered onerous. It is therefore recommended that the water quality of stormwater runoff should adhere to the guidelines provided in Volume 7 : Aquatic Ecosystems of the SAWQG, to ensure acceptable conditions in the aquatic ecosystems downstream of the WEF, primarily focussing on the concentrations of Total Suspended Solids (TSS), which can be considered as one of the main constituents of concern due to the removal of vegetation and concentration of flow associated which result in accelerated erosion.

According to the abovementioned guideline, "any increase in TSS concentrations must be limited to < 10 % of the background TSS concentrations at a specific site and time".

3.3 National Environmental Management Act

The National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998) covers the control and management of environmental impacts and, *inter alia*, provides a framework for measures that "prevent pollution and ecological degradation; promotes conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development".

4. Hydrological setting

The catchment areas of the largest portion of the WEF site are confined to the area in the immediate vicinity of the proposed infrastructure due to its elevated location. These catchments are characterised by steep slopes, which is likely to result in high stream flow velocities of the many minor watercourses crossing the site. The Elandsfontein River and one of its tributaries flows across the east and west of the site, respectively, in a northerly direction, as indicated in **Figure 4.4**, which is located in quaternary catchment D62C. Approximately 18 km north of the wind farm site, the Elandsfontein River discharge into the Brak River, which in turn discharges into the Orange River.

Large parts of the catchment is characterised by wide, gently sloped, sandy floodplains, as indicated in **Figure 4.2**. The sparse grasslands predominate in these areas, with scattered scrub increasing towards the rocky slopes and surrounding outcrops, as illustrated in **Figure 4.3**. The general infiltration rate for the catchment is moderate to high, however, dolerite covering the ground surface of the high-lying areas results in lower infiltration rates in mountainous areas. The roads and turbines on the WEF site are largely situated within relatively minor catchments, due to their elevated position. Watercourses draining these catchments on the mountains have steep slopes, resulting in high velocities and associated high erosion potential should the groundcover be removed or disturbed. Some minor drainage lines pass through the site where the substation / control building is proposed, but the flow can quite easily be managed in this area.

The Mean Annual Precipitation (MAP) of the proposed WEF site is approximately 273 mm, with the highest monthly precipitation experienced between November and April (WRC, 2004), as indicated in **Figure 4.1**. Rainfall events in this area are of high intensity, resulting in flash floods. Shortly after rain events, surface water speedily seeps away or evaporates.

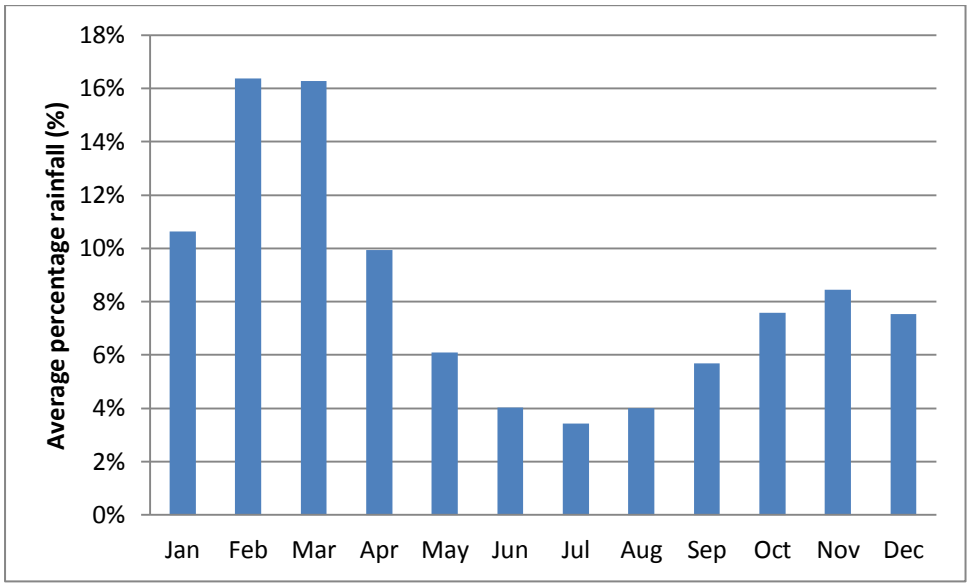
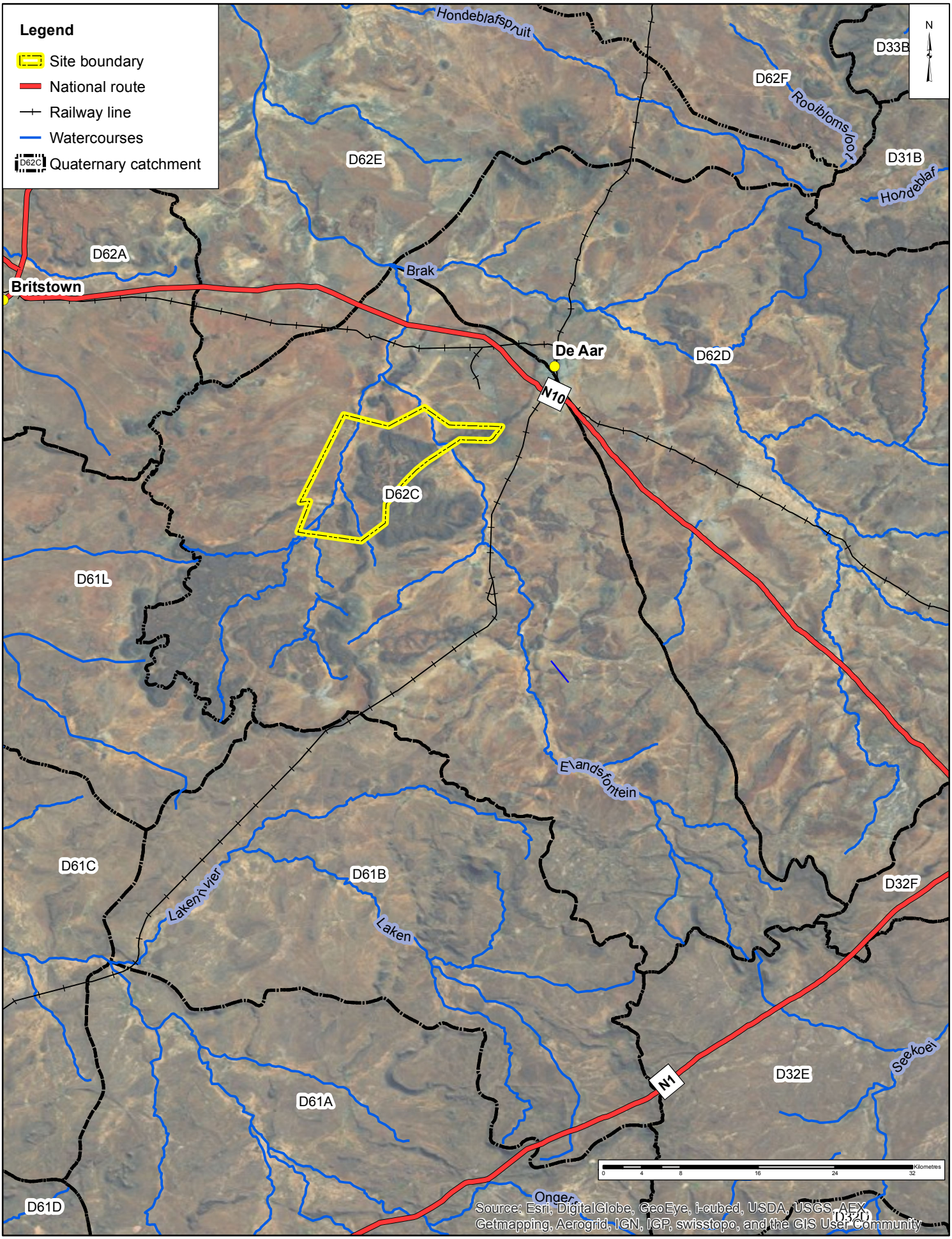


Figure 4.1 : Average percentage of MAP experienced each month

Figure 4.2 : Sparse grasslands covering the wide, sandy, gently sloped floodplains

Figure 4.3 : Scattered scrub and rocks along the steeper sloped and higher elevated areas



Project Title:	**Longyuan Mullilo De Aar 1 Maanhaarberg Wind Energy Facility : Stormwater Management Plan**
Map Title:	**Regional drainage**

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FIGURE 4.4

Projection:	Geographic - Hartbeeshoek 1994
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GIS QC by:	NG Letoao
Approved by:	I Malherbe
Date:	March 2014
Map Ref.:	Figure 4.4 - Regional drainage.mxd
Revision:	00
Project Nr.:	14C00570

Sources:

Surveyor general. 2011.
Water Resources of South Africa 2005 Study. 2008.
Environmental Potential Atlas for South Africa. 2001.

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5. Stormwater management

5.1 General

Stormwater management is required both during and after the construction of the WEF to prevent damage to property, degradation of water resources and negative impacts to the surrounding environment. The impacts during construction phase are temporary; however, the consequences of these impacts could be permanent, while impacts during operational phase are permanent and could result in a greater cumulative impact. Impacts during both these phases should be controlled at the source, to minimise or prevent the long-term and short-term impacts.

5.2 Construction phase

5.2.1 Possible impacts

Stormwater runoff could, in the case of the three temporary construction yards, potentially come in contact with areas dedicated for the handling of contaminants such as fuel storage areas or in the case of wind turbine sites or the substation / control building, with areas where potential contaminants such as concrete is being handled. This could result in contaminated stormwater runoff being discharged downstream.

During the construction of roads the removal or disturbance of vegetation could result in the concentration of flow and consequently in accelerated erosion along roads where steep slopes dominate, which will result in an increase of suspended solids and sedimentation of the downstream environment. Erosion of the proposed roads is further possible at watercourse crossings due to the concentration of flow. Removal or disturbance of vegetation from areas such as new roads, the construction yards and the substation / control building could also result in erosion due to the soil stability being affected.

5.2.2 Proposed mitigation measures

Typical mitigation measures for the impacts mentioned in **Section 5.2.1**, *inter alia* include :

Table 5.1 : Typical mitigation measures during construction phase

Impact	Typical mitigation measures
Contamination of stormwater runoff	• Construction areas such as construction yards, wind turbine sites and the substation / control building site should be protected from external stormwater runoff approaching these sites, by implementing cut-off drains or berms along the upstream boundary of the area to divert stormwater runoff away from the site and discharge diverted stormwater as per predevelopment conditions. • Inside the construction yard, stormwater runoff must be kept separate from areas dedicated to containing hazardous substances such as bunded areas for wash bays, fuel storage areas and refuelling areas.
Erosion	• Minimize the WEF footprint, disturbance of drainage paths and ground cover by, *inter alia,* fencing off construction areas and "no-go" areas. • Minimise the extent of earthworks. • Plan to reintroduce the existing topsoil and groundcover of disturbed areas after construction. • Encourage the use of natural flow paths downstream of construction sites. • Attenuate stormwater runoff and reduce flow velocities as much as possible with the use of small gabion weirs, stilling basins and vegetated swales. • Apply erosion control, e.g. by using straw bales, and good "house-keeping" practices. • The discharge of stormwater should be spread over a wide area to reduce the energy as a result of concentrated flow, and return to sheet flow downstream of the construction site. • Protect stockpiles from erosion. • Water quality must be monitored to ensure that the TSS concentration does not exceed the concentration limits stated in **Section 3.2**. • Trench breakers, such as earth or sand filled sacks, should be used to prevent or slow the unrestricted flow of water along an excavated trench. • Sediment traps need to be placed where sediment laden water is expected.

5.3 Operational phase

5.3.1 Potential impacts

During the operation of the wind farm, an increase in stormwater runoff is expected due to an increase in impervious surfaces, i.e. proposed roads and turbine foundations, in the Elandsfontein River catchment area. However, this increase in hardened surfaces can be considered negligible in comparison to the size of the upstream catchment. Therefore, very little to no increase in peak runoff from the catchment is expected.

Other potential impacts due to the additional hardened surfaces include erosion of the surrounding environment. Eroded material carried to downstream water resources can also result in the decrease in quality of downstream water resources, due to sedimentation.

Stormwater runoff in the vicinity of the substation / control building and wind turbines could come into contact with dedicated areas where hazardous substances are handled such as fuels and oils which could result in contaminated stormwater runoff being discharged downstream.

Structures such as the substation / control building could be impacted by localised flooding.

5.3.2 Proposed mitigation measures

Typical mitigation measures for the impacts mentioned in **Section 5.3.1**, *inter alia,* include the following measures, the majority which needs to be incorporated during the design phase of the project :

Table 5.2 : Typical mitigation measures during operational phase

Impact	Typical mitigation measures
Contamination of stormwater runoff	• Prevent stormwater runoff to come in contact with dedicated areas where hazardous substances are handled, by diverting flow with berms and cut-off drains to divert stormwater runoff away from the site and discharge diverted stormwater as per predevelopment conditions, and good house-keeping.
Erosion	• Where culverts are proposed, the number of culvert barrels should be maximised, resulting in a wider discharge area and less concentration of flow. • Downstream invert levels of culverts should tie into the natural ground level to prevent erosion downstream of the culvert. • Erosion protection measures, such as rip-rap, are required at the downstream end of culverts. • Where drifts are proposed, the drift should be designed so that the road surface follows the natural ground level, minimising the reduction of the cross-sectional area. • Apply erosion protection measures such as reno mattresses and stone pitching downstream of steep roadside channels. • Any sudden change in level at the downstream end of a drift should include a stilling basin to prevent erosion. • Protection of the wind turbine bases by means of a cut-off drain or berm along the uphill side of the base. • Stormwater infrastructure installed to mitigate possible hydrological impacts must be regularly maintained throughout the lifespan of the infrastructure to ensure its optimum functionality.

Impact	Typical mitigation measures
Flooding	• Protect structures such as the wind turbine bases and substation / control building from localised flooding by constructing cut-off berms / diverting flow on the uphill side in flood prone areas.

6. Conclusions and recommendations

6.1 Conclusions

From the SWMP of the proposed WEF site, located to the southwest of De Aar, it can be concluded that the majority of the hydrological impacts could potentially be of a water quality nature, due to the predominantly steep slopes of the site and the nature of the construction activities. The potential impacts primarily include erosion and stormwater runoff coming in contact with areas dedicated to collect, contain and treat hazardous substances such as fuel storage areas as well as localised flooding. Mitigation measures must be put into place to prevent or reduce the impact on the downstream environment, as described in **Section 5**.

6.2 Recommendations

The SWMP for the proposed WEF is based on information received during the preliminary design stage. It is recommended that the SWMP be updated when detail design information is available.

It is further recommended that the mitigation measures, included in **Section 5**, be implemented during the design, construction and operational phases of the project to achieve the stormwater management objectives outlines in this report.

7. References

Mulilo Renewable Energy (Pty) Ltd. 2010. *Environmental Impact Report for a proposed wind farm in De Aar*. Report compiles by DJ Environmental Consultants for Mulilo Renewable Energy (Pty) Ltd for submission to the Department of Water Affairs in November 2010.

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Water Research Commission (WRC). 2009. *WRC Report TT 380/08 : Water Resources of South Africa, 2005 Study (WR2005)*. Report compiled by the WR2005 consortium for the Water Research Commission in March 2009.

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Appendix 15
Open Space Management Plan

Open space management plan

Objectives:
The purpose of the Open Space Management Plan (OSMP) is to provide a framework for the integrated management of the natural and semi-natural areas within the wind energy facility (WEF). This requires managing and maintaining the ecosystem in a near-natural state and restoring and/or rehabilitating the ecosystems to such a state.

The overall objective of the OSMP is to restore and maintain the ecological infrastructure (i.e. intact ecosystems that deliver valuable services to people) that is found on site.

Project outline:
The Longyuan Mulilo De Aar WEF consists of 67 turbines, each with a generation capacity of 1.5 MW. The total wind farm footprint (67 ha) is spread over an area of 11 766 hectares (ha) accounting for 0.6% of the total area. The majority of the property will therefore remain undeveloped. The construction and presence of the WEF will however introduce unique effects to the area that should be managed in order to promote the maintenance of biodiversity within the site, ensure an intact ecosystem and does not have a long term negative impact on the local environment.

Relation to other plans
Given that the goal of the OSMP is to ensure biodiversity compatible management of the facility, it cannot be considered independently of the other environmental management plans at the site. In particular, the Stormwater and Erosion Management Plan, Revegetation and Rehabilitation Plan, and Alien Invasive Plant Management Plan should align closely with the OSMP.

The following elements are also considered part of OSMP:

Protection of surface water resources (streams, rivers and wetlands)
In terms of the sensitivity of the site, the larger streams and the wetland area are deemed to be the most sensitive and should be treated as ‘no-go’ areas. The remainder of the site tends to consist of small drainage features that are considered to be less ecologically significant. Due to the sensitivity of the plateau area as a whole as a recharge area for the wider Elandsfontein Catchment, it would be essential that water sources for the project should be obtained from, and sewage and solid waste or disposed of, outside of the plateau areas.

Proposed mitigation measures are as follows:

- Construction activities should as far as possible be limited to the identified sites for the proposed wind energy facilities and the identified access routes. No turbine (including its area of disturbance) should be located within 100m of drainage lines within the Elandsfontein River (measured from the centre of the channel). The small wetland area in the centre of the site as well as the larger stream channels should be considered as

'no-go' portions of the site. It is important that any of the cleared areas are rehabilitated after construction is completed.

- Existing road infrastructure should be utilized as far as possible to minimize the overall disturbance created by the proposed project. All crossings over drainage channels or stream beds should be such that the flow within the drainage channel is not impeded.
- Road infrastructure and transmission lines should coincide as much as possible to minimize the road network and impact of these activities. Where new access routes need to be constructed through the drainage channels, disturbance of the channels should be limited and the crossing should preferably be perpendicular to the channel. Transmission lines and roads created parallel to the channels should be located at least 20m away from the stream channel. Any disturbed areas within the stream or drainage channels should be rehabilitated
- Temporary roads created during the construction phase should also comply with the requisite 20m buffer and be rehabilitated once construction activities are complete.
- Monopoles for transmission lines should be placed outside of the recommended buffer for the streams/drainage lines (20m). After construction is complete and the areas monitored for growth of invasive alien plants.
- With regards to the proposed substation, consider either to divert the drainage channel(s) that currently pass through the site around the proposed substation and/or to do some minor adjustment to the location of the facility. Ensure that on-site storm water management is such that erosion within the drainage lines is minimised and that the channels are rehabilitated once construction activities are complete.
- Activities at the construction camps should as far as possible be limited to the identified footprint for construction camp sites. Cleared areas are rehabilitated after construction is completed. Ensure that on-site storm water management at the construction camps should be such that erosion within the drainage lines is minimised and that the channels are rehabilitated once construction activities are complete. Monitoring of these sites post-construction will need to take place to ensure that they have been adequately rehabilitated and do not provide opportunity of growth of invasive alien plants.
- Water for the construction phase of the project should be obtained for sources outside of the plateau areas. All materials on the construction sites should be properly stored and contained. Disposal of waste from the sites should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located at least 100m away from the drainage lines/ephemeral streams and regularly serviced. These measures should be addressed, implemented and monitored in terms of the Environmental Management Programme for the construction phase.
- Operational activities should as far as possible be limited to the wind turbine sites, the substation/control building and the identified access routes. Invasive alien plant growth should be monitored on an ongoing basis to ensure that these disturbed areas do not become infested with invasive alien plants. Any storm water run-off infrastructure must be maintained to mitigate both the flow and water quality impacts of any storm water leaving the wind energy facilities sites. Should any erosion features develop, they should be stabilised as soon as possible. Water sources for the operational phase of the project should be obtained from, and sewage and solid waste or disposed of, outside of the plateau areas for the operation phase.

Access control

- Access to the facility should be strictly controlled.
- All visitors and contractors should be required to sign-in.
- Signage at the entrance should indicate that disturbance to fauna and flora is strictly prohibited.

Prohibited activities

The following activities should not be permitted by anyone expect the landowner or his representatives:

- No fires within the site.
- No hunting, collecting or disturbance of fauna and flora, except where required for the safe operation of the facility and only by the Environmental Control Officer on duty with the appropriate permits and landowner permission.
- No domestic pets or livestock are permitted on site.
- No driving off of demarcated roads.
- No interfering with livestock.
- No use (e.g. swimming or washing of clothes or machinery) of any natural water resource.
- No marking / painting or any natural features (e.g. rock formations).

Ecological process areas

Ecological process areas, such as water resources and sensitive vegetation, were identified by respective specialists and designated as “no-go” areas and need to be protected adequately. Based on the ecological importance of aquatic environments, all construction activities shall remain outside of aquatic environments, with special efforts implemented to maintain an appropriate buffer, as recommended by the freshwater specialist, between construction related activities and any rivers / water course / wetlands / drainage lines. These no-go areas shall stay in place until construction of the infrastructure within the buffer area must commence. The recommended ecological sensitive areas and buffer areas, as indicated in Figure 1, shall be demarcated as “no-go” areas and construction activities shall remain outside these designated areas.

To ensure the protection of ecological process areas, the following mitigation measures are recommended:

- All works to be undertaken shall be within the boundary of the site.
- A “no-go” area shall extend on either side of the working area (i.e. all areas outside of the defined working area and designated access and construction roads).
- No equipment associated with earthworks shall be allowed outside of the working area and defined access and construction roads or within “no-go” areas, unless expressly permitted by the Environmental Control Officer / Engineer.

Fire risk management

Fires are not a regular occurrence at the site. However fires may occasionally occur under the right circumstances. Ignition risk sources in the immediate area include:

- Lightning strikes;

- Personnel within the facility; and
- Infrastructure, such as transmission lines.

In accordance with EMP, the Contractor shall ensure that there is basic fire-fighting equipment available on site at all times. The Contractor shall ensure that the employees are aware of the procedure to follow in the event of a fire.

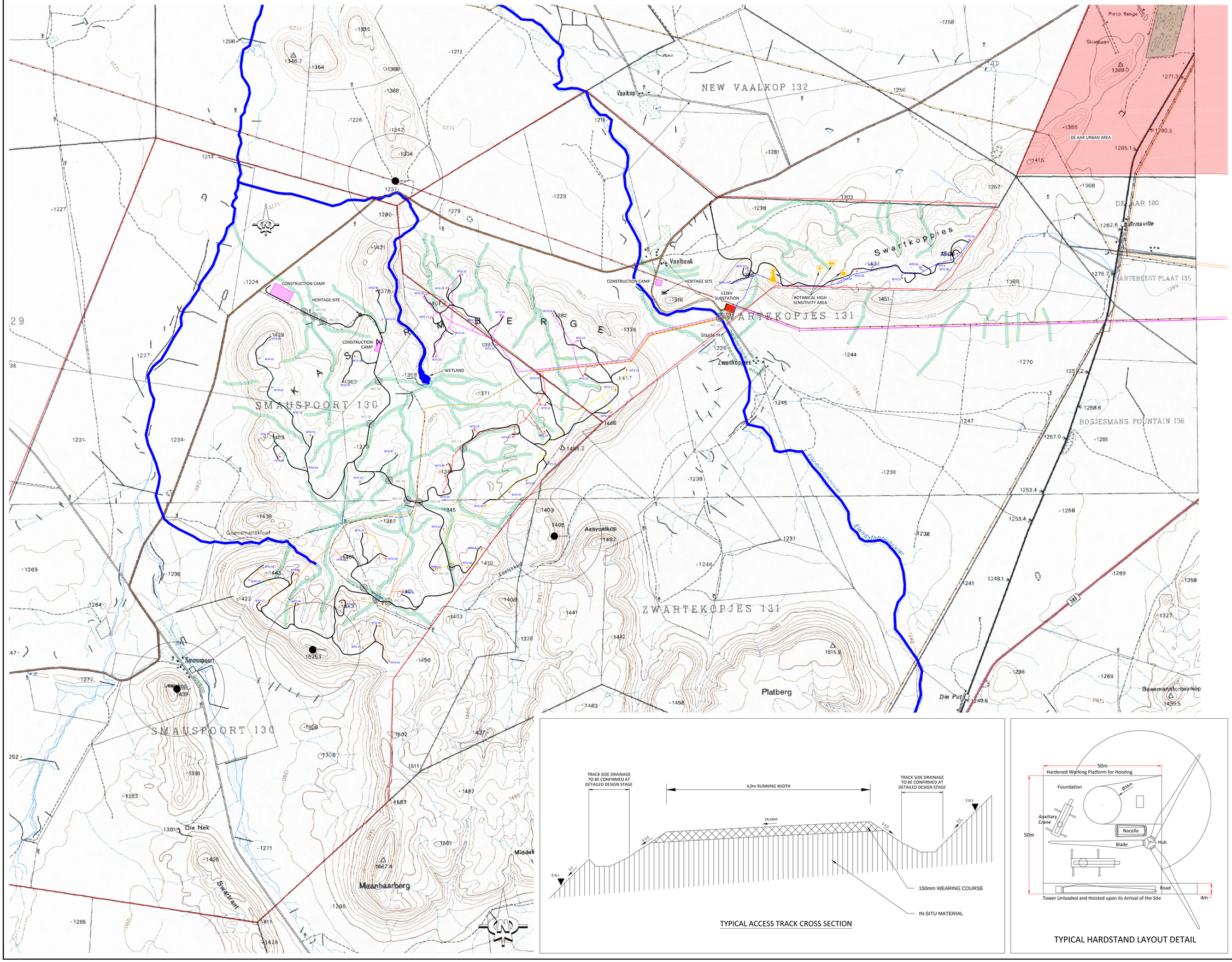
Grazing management
The development of the WEF will not prevent the site from being used for its current land use of extensive grazing land for free range sheep production. As the construction of turbines and associated infrastructure will only influence a small area of the total farm, normal grazing is permitted. Extensive grazing is therefore compatible with biodiversity maintenance provided that it is implemented according to the basic principles of sustainable grazing management.

Alien Plant Control
Alien invasive plants should be controlled according to the Alien Invasive Plant Management Plan.

Erosion Management
The facility should be inspected every 6 months for erosion problems or more frequently in the event of exceptional rainfall events. All erosion problems should be rectified according to the Stormwater Management Plan.

Adaptive management:
Ecosystems are complex and it is not always possible to predict how they will respond to management interventions. The OSMP should be reviewed annually for the first three years post construction to evaluate the effectiveness of management actions so that these can be adapted as appropriate.

The OSMP is intended to be a simple management tool that can be easily understood and used by the implementers and that is cost effective.



TYPICAL ACCESS TRACK CROSS SECTION

TYPICAL HARDSTAND LAYOUT DETAIL

ELECTRICAL LEGEND:

- 33kV (MV) OVERHEAD LINE ROUTE

CIVIL LEGEND:

- WATERCOURSE/STREAM WITH 20m BUFFER ZONE
- 4m ROADWAY CONSTRUCTION-OPERATION
- EXISTING ROADS
- EXISTING ESKOM LINES
- NEW 132kV OVER-HEAD LINE
- WTG — WIND TURBINE GENERATOR
- AQUATIC NO GO AREA
- WETLAND
- CONSTRUCTION YARD
- BOTANICAL HIGH SENSITIVITY AREA WITH 30m BUFFER
- HERITAGE AREA WITH 15m BUFFER
- WATER CROSSING
- VERREAUX EAGLE NEST WITH 800m BUFFER

TOTAL ROAD CUT VOLUME = 298 200 m³
TOTAL ROAD FILL VOLUME = 244 032 m³
TOTAL CRANE PAD CUT VOLUME = 95 475 m³
TOTAL CRANE PAD FILL VOLUME = 1 213 772 m³

NOTES:

1. ALL INFORMATION INDICATED ON THIS DRAWING WAS RECEIVED FROM 3rd PARTY SOURCES. AT CLIENTS REQUEST, DRAWING WAS COMPILED BY AECOM TO COORDINATE SERVICES.

AS-BUILT/RECORD DRAWING

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REV	DATE	REVISION DESCRIPTION	DRAWN

THE MASTER HELD AT THE AECOM CAPE TOWN OFFICE BEARS THE ORIGINAL SIGNATURE OF APPROVAL.

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REG. No. 1966/006628/07

DISCIPLINE: **ENERGY**

CLIENT: **LONGYUAN ENGINEERING SOUTH AFRICA**

PROJECT DESCRIPTION: **DE AAR MAANHAARBERG WIND FARM**

DRAWING TITLE: **SITE: ENVIRONMENTAL EXCLUSION ZONES**

FUNCTION	NAME	SIGNATURE
DESIGNED BY	B HOMANN	N/A
DRAWN BY	J FRANCKE	N/A
DESIGN CHECKED BY	LM BOTHA	N/A
DRAWING CHECKED BY	G BEETGE	N/A

APPROVAL - CONSULTANT

NAME	LM BOTHA	SIGNATURE	
DATE	2017-06-13	PROFESSIONAL REG No.	20130275

DRAWING STATUS CODES:		FIRST ISSUE DATE	2017-06-13	
D=DRAFT P=PRELIMINARY T=TENDER	F=FINAL R=REPORT C=CONSTRUCTION A=AS-BUILT/RECORD	SCALE 1:12 500	SHEET 1 OF 1	SHEET SIZE A0

AECOM DRAWING NUMBER

AECOM PROJ. No.	SUB-No.	DISCIPLINE	NUMBER	STATUS	REVISION
14C00570	01	90	**004**	**A**	**00**

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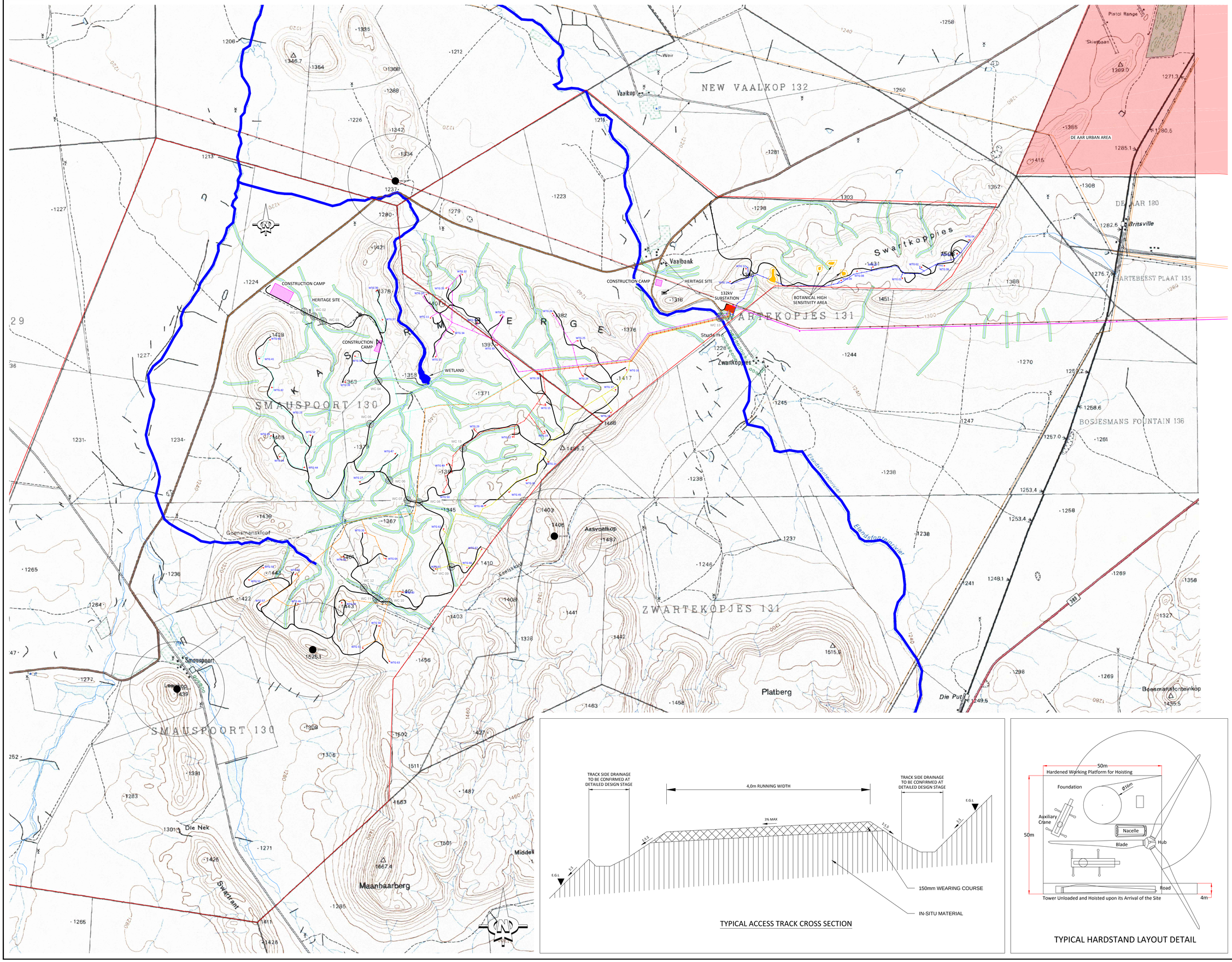
Appendix 16
Final Site Layout (i.e. "As Built" Layout) and Design Report



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DESIGN CHECKED BY	LM BOTHA	N/A
DRAWING CHECKED BY	G BEETGE	N/A

APPROVAL - CONSULTANT

NAME	LM BOTHA	SIGNATURE	
DATE	2017-06-13	PROFESSIONAL REG No.	20130275

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AECOM DRAWING NUMBER

AECOM PROJ. No.	SUB-No.	DISCIPLINE	NUMBER	STATUS	REVISION
14C00570	01	90	**004**	**A**	**00**

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Technical Note

Project:	**Longyuan Mulilo De Aar Maanhaarberg Wind Energy Facility (DA1)**
Subject:	**Final Design Report**
Prepared by:	**Michael Jonker** **February 2018**

Introduction
The purpose of this report is to update the "Preliminary Design Report" with final "As-Built" information.

Track Alignment
The final track alignment consists of:

- 60km of gravelled site road with an average width of 4.5m and a transverse gradient of ±3.5% to facilitate drainage. The road network consists of four (4) sections, namely NC, NE, NW and SW (Figure 1).
- Four watercourse crossings (Table 1).

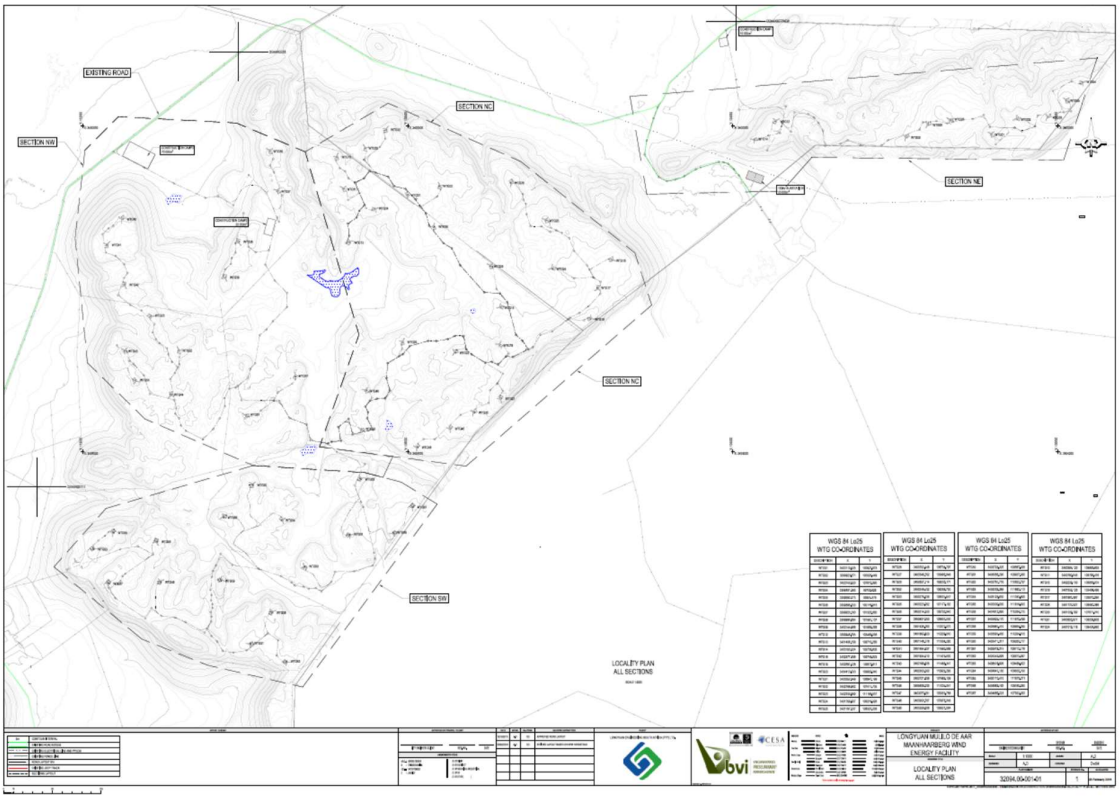

Figure 1: General layout of roads and hardstands

The final route includes a comprehensive road drainage system to reduce erosion and to facilitate stormwater drainage. The final route was also optimised to lessen the impact of steep gradient thereby reducing engineering works on site. Consequently, the final route reduces the significance of the following negative impacts associated with the construction of the wind farm:

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- Area disturbed by construction activities: By avoiding areas of steep gradient, the volume of cut and fill is reduced. This will reduce the overall development footprint and reduce construction time allowing for rehabilitation to commence at an earlier date.
- Freshwater impacts: By including a comprehensive road drainage system, freshwater impacts, such as erosion, sedimentation and disturbance of freshwater related habitats, triggered by engineering works at water crossings are reduced.

Watercourse crossings

Initially, fourteen new watercourse crossings were anticipated. The final route design only required four water course crossings (Table 1).

Table 1: Water course crossings initially proposed and as built water course crossings

WC No.	Old co-ordinate		New Co-ordinate	
	S	E	S	E
1	30°43'19.13"	23°55'02.20"		
2	30°43'17.478"	23°50'30.763"		
3	30°43'20.160"	23°50'36.932"		
4	30°43'22.760"	23°50'42.652"		
5	30°43'55.961"	23°51'17.493"		
6	30°44'19.378"	23°51'11.915"		
7	30°44'50.452"	23°51'23.600"		
8	30°45'3.133"	23°51'34.604"	30°45'01.260"	23°51'35.100"
9	30°45'2.666"	23°51'42.484"		
10	30°45'41.323"	23°52'2.933"	30°45'38.414"	23°52'02.199"
11	30°45'55.765"	23°51'20.438"	30°45'57.024"	23°51'22.215"
12	30°45'54.317"	23°51'15.864"	30°45'55.504"	23°51'14.968"
13	30°45'49.089"	23°51'6.671"		
14	30°44'33.343"	23°52'10.737"		

All watercourse crossings were installed in accordance with DWA guidelines and were based on the following principles:

- The alignment of the culvert will be parallel to the existing channel;
- The gradient of the culvert will be similar to the existing channel;
- The width of the culvert will be greater than the active width of the channel;
- The height of the culvert will be greater than the active height of the channel;
- There will be no hydraulic drops at the inlet or outlet of the culvert; and
- The culverts will be partially buried and natural bed material reinstated within the culvert.

The type and size of crossing was determined at the detailed design stage. However, during construction it was decided to opt for level crossing "dish drain" design as it allows the uninterrupted natural flow of water across a the specially prepared surface of the road where the dish drain is installed perpendicularly to the road section. Thus allowing the water to freely flow across the road surface. This design causes the least amount of interruption to the natural flow of water and also does not suffer from block cations or silting up over a long period of time.

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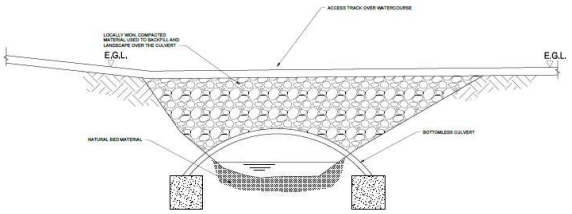
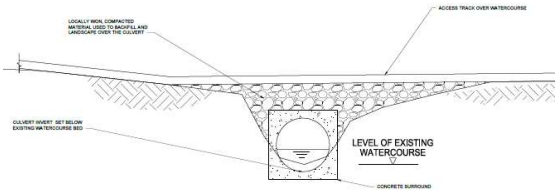
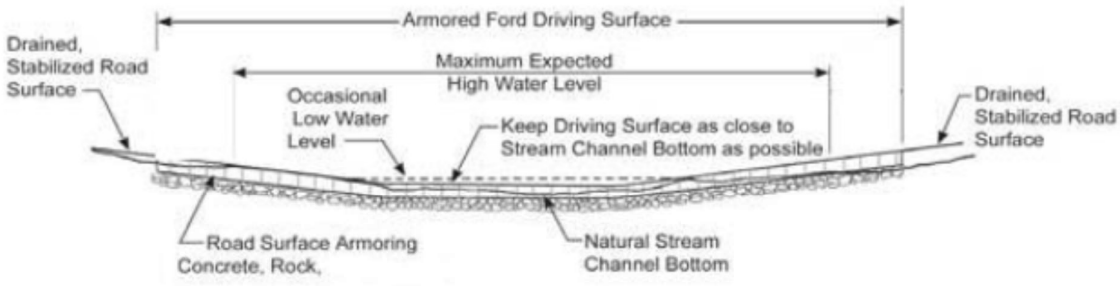
Typical watercourse crossings are shown below:



Bottomless Arch Culvert



Closed Pipe Culvert



Low level crossing

Following construction, the watercourse crossings will remain in place for the lifetime of the wind farm and will then be removed and the natural bed reinstated.

Track Design Specification

The horizontal and vertical alignment review and resulting track route where undertaken against the follow criteria:

- Track width;
  - Straight track (0 – 20°) – 4m
  - Bend (20 – 60°) – 5m
  - Bend (60 – 90°) – 6m
- Min horizontal curve – 35m (inside radius)
- Min vertical curve – 400m
- Longitudinal Gradient;
  - Preferred gradient – 10% (where possible)
  - Max gradient – 14%
- Track cross fall – 5% (max)

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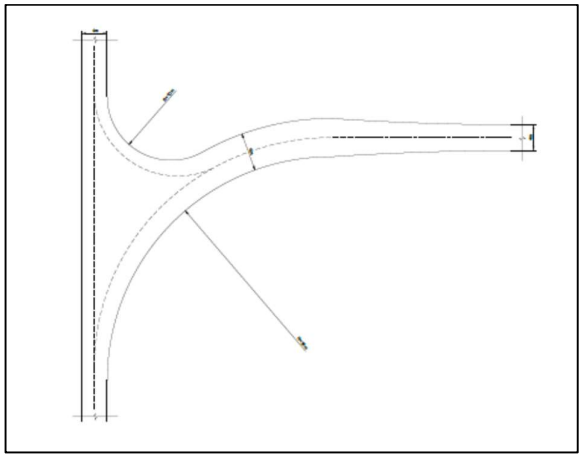
- Spacing between bends (>60°) – 40m

Typical junction is shown below



Crane Pad Alignment
The maximum cross fall for the crane pads is 1.5%, given the proposed crane pad dimensions are 50m x 50m the maximum height difference across the width / length of the crane pad is 0.75m.

The orientation of crane pads in the initial layout resulted in height differences up to 10m across the length and width of the crane pad. To try and minimise this and hence minimise the amount of cut and fill at these locations some of the crane pads have been reoriented, however due to the proposed wind turbine locations and the crane pad layout there are still locations where the height difference is up to 8m.

Typical Crane Pad is shown below:

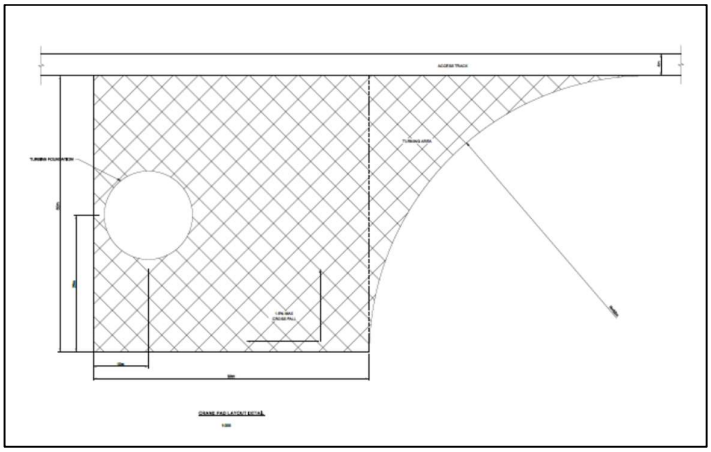


Figure 2: Typical hardstand

The wind turbine generators (WTG) each have a diameter of 16m and each consisting of approximately 350m^2 of concrete (Figure 3).

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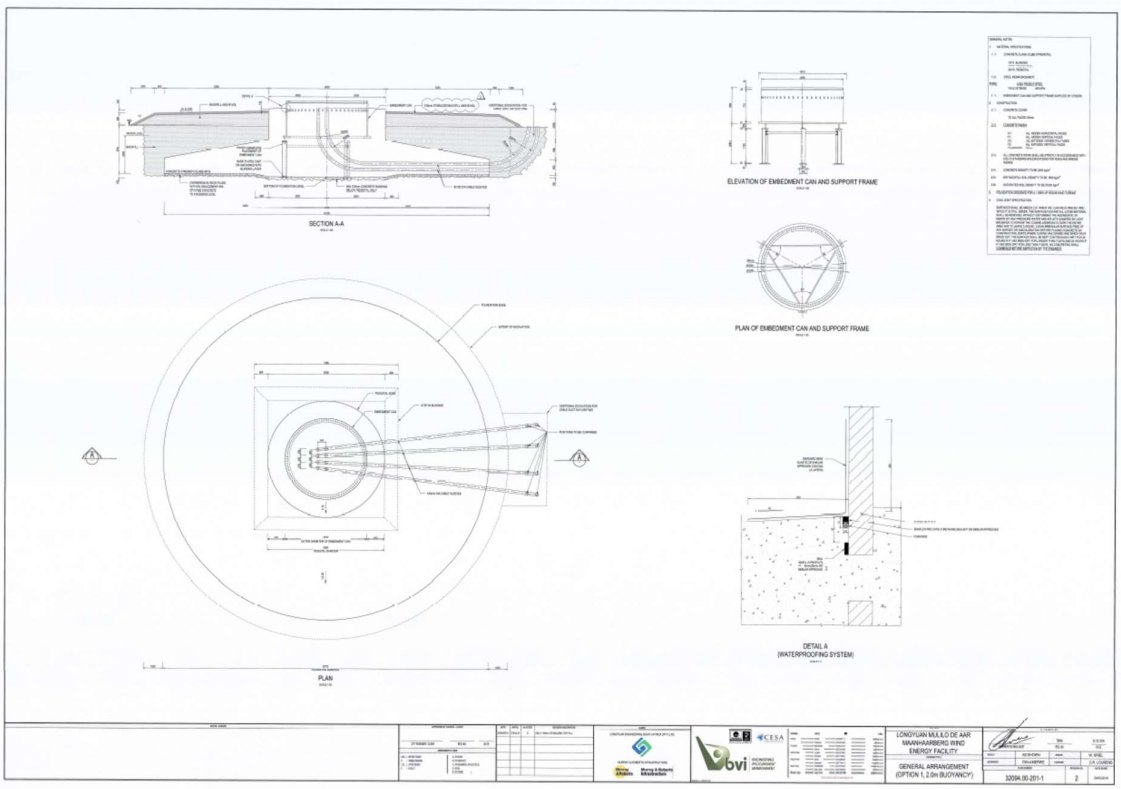

Figure 3: WTG foundation

Internal 33kV reticulation network

The 33kV network is divided into six circuits (Figure 4) consisting of MV overhead lines and MV cables. They are connected to the IPP Collector substation which is connected back-to-back to the Eskom Ndlovu 132kV substation (Figure 4).

The 132 kV Phiri Switching Station comprises a three (3) bay switching station configuration with two bays dedicated to the connection with the IPP substation and the third bay dedicated to the Hydra – Phiri 132 kV line. Space provision is made for possible future expansion of the switching station.

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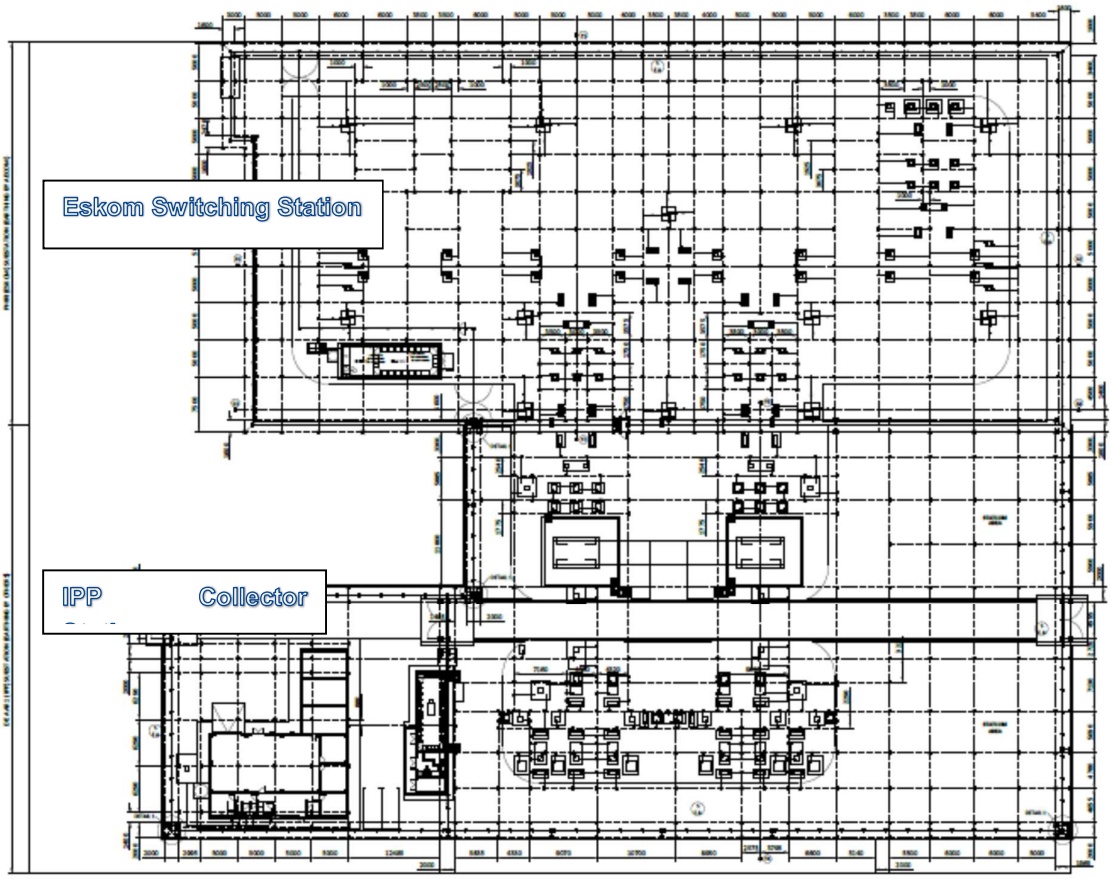

Figure 4: IPP Collector and Eskom Switching Station back-to-back configuration

The 33kV network consists of staggered vertical arrangement wooden poles and has the following phase conductor types: Chicadee, Hare and Mink. The total length of the network is 66km. Steel monopoles (cigar structures with pivotal bases) have been used for spans that exceed the limitations of the wooden poles.

As per the avifauna specialist recommendation[1], specified sections of the 33kV reticulation lines have been marked with bird flappers (Figure 5). Where more than one line runs in parallel, only the outer-most earthwires need to be marked (Figure 6).

In terms of the Environmental Management Programme (EMP), bird and bat specialists have been appointed to oversee the post-construction monitoring and to assist with the on-going management of bird and bat impacts that may emerge as operation phase progresses (adaptive management). Depending on the results of carcass searches, a range of mitigation measures will be considered.

[1] *Avifauna Walk-Through Report, prepared by Chris van Rooyen, dated April 2017*

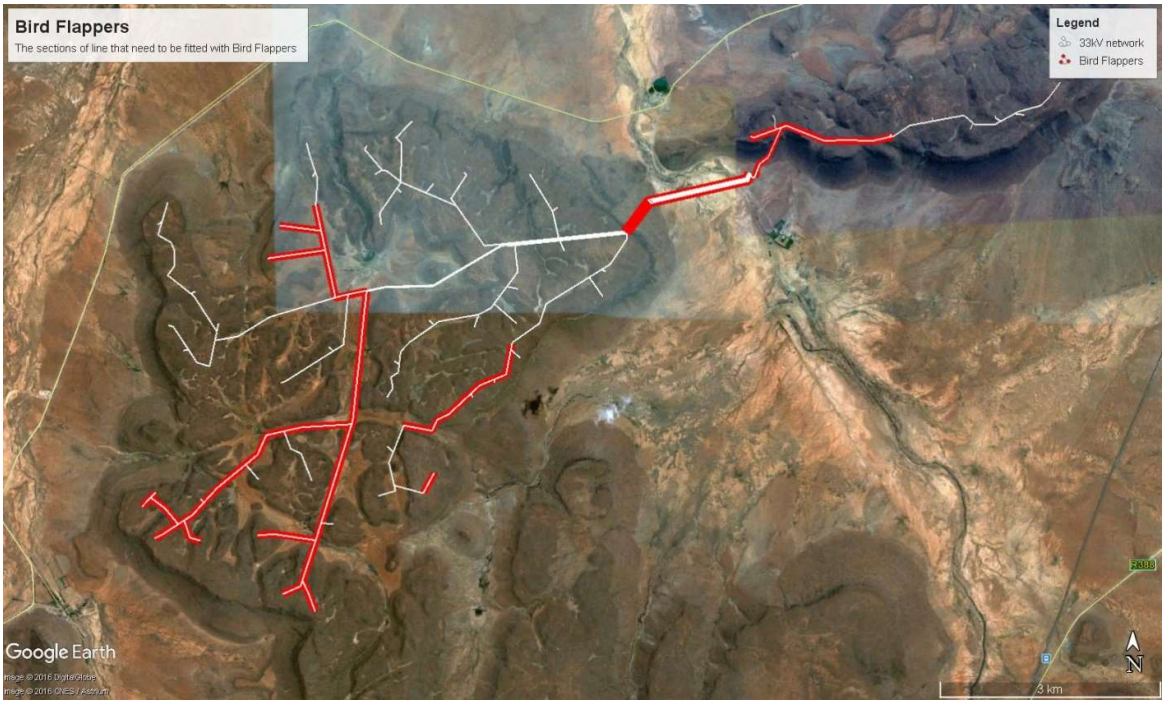

Figure 5: Sections of line to be fitted with bird flappers (C van Rooyen)

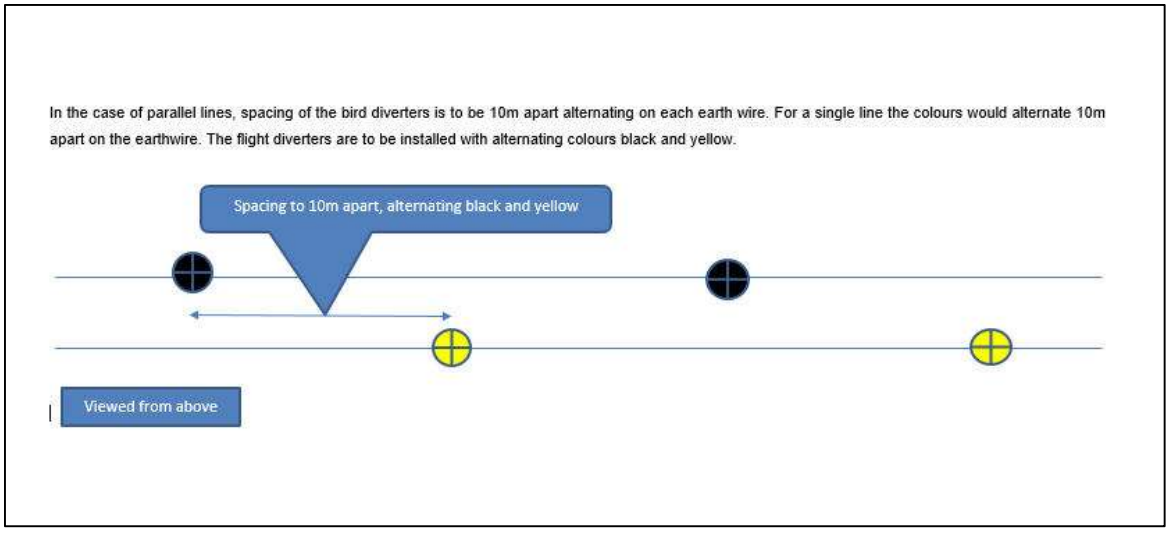

Figure 6: Bird flapper spacing (C van Rooyen)

Constraints and Restrictions

The main constraints and resections that present at DA1 are detailed below:

- High sensitivity botanical areas
  - Present on the north eastern ridge of the site,
- Heritage areas
  - Adjacent to construction yard 1 (north western ridge)
  - ZWK95 (heritage site) (located on the Kasarmberge on the farm Smauspoort)

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- Flood plains
    - Present across the of the site
- Wetland
    - Located approximately in the centre of the east site

All of these constraints have been fully avoided with appropriate drainage installed in low lying areas.

Where possible, a 35m buffer has been applied to minimise any potential impact on the watercourse.

Construction Issues

The main construction issues on site are a result of topography and the proposed wind turbine locations were all overcome with the optimisation of the horizontal and vertical track alignment. This allowed the facility to be constructed with the lowest possible impact on the environment.

However the result of the topography and the proposed wind turbine locations did lead to the below points:

- Crane pad construction – due to the proposed location of several wind turbines and the proposed crane pad layout significant engineering works were required to achieve the desired cross fall of 1.5%.
- Track construction – many of the steep gradients on were unavoidable and therefore to achieve a desired maximum gradient of 14% sections of cut of 6 – 8m are present.

Conclusions and Recommendations

The project commenced with operation 31 October 2017. In compliance with the EMP, an Environmental Officer (EO) has been appointed to oversee the environmental aspects associated with the site. The EO will monitor the operation phase in accordance with the EMP and the respective Environmental Authorisations.

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Appendix 17
TRAINING MATERIALS FOR ENVIRONMENTAL AWARENESS COURSE

ENVIRONMENTAL AWARENESS ON SITE

STAY INSIDE WORKING AREAS

INDAWO EKUSETYENZWA KUYO

BLY BINNE DIE TERREINGRENSE

DO NOT INJURE OR KILL ANY ANIMALS

SUKWENZAKALISA OKANYE UBULALE

IZILWANYANA ESAYITINI

MOENIE ENIGE DIERE BESEER OF DOOD NIE

TREES AND FLOWERS

IMITI KUNYE NEENTYATYAMBO

BOME EN BLOMME

SMOKING AND FIRE

UKUTSHAYA NEMILILO

ROOK EN VURE

PETROL, OIL AND DIESEL

PETROLI, OYILE NE DIZILI

PETROL, OLIE EN DIESEL

DUST

UTHULI

STOF

NOISE

INGXOLO

GERAAS

USE TOILETS PROVIDED

SEBENZISA IZINDLU ZANGASESE HAYI ITYHOLO

GEBRUIK DIE VOORSIENDE TOILETTE

ONLY EAT IN DEMARKATED EATING AREAS

TYELA KWINDAWO EZENZELWE OKO

EET SLEGS IN GEMERKTE GEBIEDE

RUBBISH

INKUNKUMA

VULLIS

TRUCKS AND DRIVING

IZITHUTHI NABAQHUBI BAZO

TROKKE EN BESTUUR

PROBLEMS - WHAT TO DO!

IINGXAKI - KUFUNEKA WENZENI?

PROBLEME - WAT OM TE DOEN!

Based on the City of Cape Town's Environmental Awareness Course

ENVIRONMENTAL AWARENESS COURSE

Based on the City of Cape Town's Environmental Awareness Course

LE YICOURSE EJONGENE NOLONDOLOZO NDALO

Based on the City of Cape Town's Environmental Awareness Course

ONGEWINGS BEWUSTHEIDSKURSUS

Based on the City of Cape Town's Environmental Awareness Course

WHAT IS THE ENVIRONMENT?

- Soil
- Water
- Plants
- People
- Animals
- Air we breathe
- Buildings, cars and houses

YINTONI LENTO IYINDALO?

- Mhlaba
- Amanzi
- Izityalo
- Abantu
- Izilwanyana
- Umoya esiwuphefumlayo
- Izindlu, imoto ne zakhiwo

WAT IS DIE OMGEWING?

- Grond
- Water
- Plante
- Mense
- Diere
- Lug wat ons inasem
- Geboue, voertuie en huise

WHY MUST WE LOOK AFTER THE ENVIRONMENT?

- It affects us all as well as future generations
- We have a right to a healthy environment
- Compliance with the Environmental Management Plan

YINTO INJONGO YOLONDOLOZO NDALO?

- Ichaphazela wonke ubani ndawonye nezizukulwana
- Sinelungelo kwimpilo elungileyo
- Compliance with the Environmental Management Plan

HOEKOM MOET ONS VIR DIE OMGEWING SORG?

- Dit raak ons almal sowel, as ons nageslagte.
- Ons het die reg tot 'n gesonde omgewing.
- 'Compliance with the Environmental Management Plan

HOW DO WE LOOK AFTER THE ENVIRONMENT?

- Report problems to your supervisor/ foreman
- Team work
- Follow the rules in the EMP

SINGAYI LONDOLOZA NJANI INDALO?

- Yazisa yonke into eyonakalayo kwi supervisor/foreman
- Ukusebenzisana njenqabasebenzi
- Landela imigaqo ekwi EMP

HOE MOET ONS VIR DIE OMGEWING SORG?

- Rapporteer enige probleme aan u toesighouer/voorman.
- Spanwerk.
- Volg die reëls van die OBP.

WORKING AREAS

Workers & equipment must stay inside the site boundaries at all times

INDAWO EKUSETYENZWA KUYO

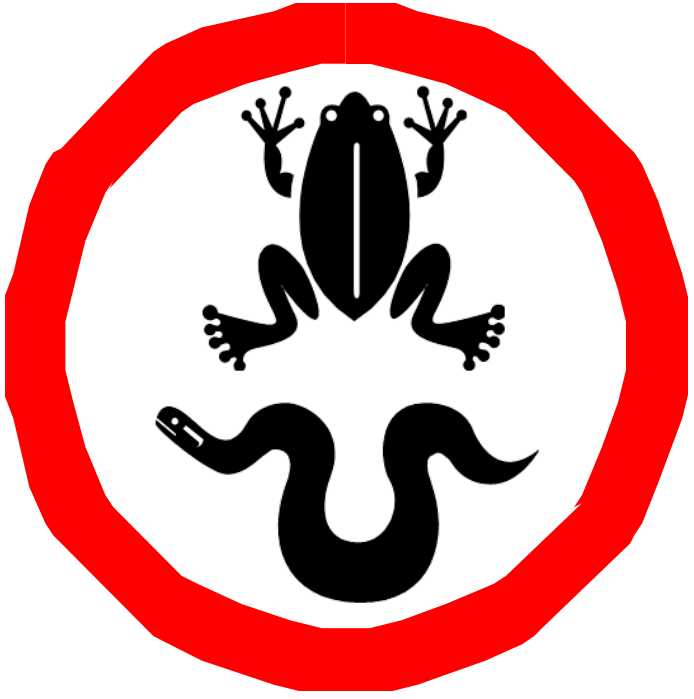
Abasebenzi kunye nezixhobo abasebenza ngazo mazingaphumi ngaphaya kwesayithi

WERK AREAS

Werkers en gereedskap moet ten alle tye binne die terreingrense bly.

ANIMALS

- Do not injure or kill any animals on the site
- Ask your supervisor or Contract's Manager to remove animals found on site



IZILWANYANA

- Sukwenzakalisa okanye ubulale izilwanyana esayitini
- Cela isupervisor okanye imanager ukuba kususwe esosilwanyana sisesayintini

DIERE

- Moenie enige diere op die terrein beseer of dood nie.
- Vra u toesighouer of Kontrakbestuurder om diere van die terrein te verwyder.

TREES AND FLOWERS

- Do not damage or cut down any trees or plants without permission
- Do not pick flowers
- Do not walk on area under rehabilitation

IMITI KUNYE NEENTYATYAMBO

- Ungonakalisi okanye ugawule imithi nezityalo ngaphandle kwemvume
- Sukukha izityalo ngaphandle kwemvume
- Do not walk on area under rehabilitation

BOME EN BLOMME

- Moenie enige plante of bome sonder toestemming beskadig of afsny nie.
- Moenie blomme pluk nie.
- Do not walk on area under rehabilitation

SMOKING AND FIRE

- Put cigarette butts in a rubbish bin
- Do not smoke near gas, paints or petrol
- Do not light any fires without permission
- Know the positions of fire fighting equipment
- Report all fires
- Do not burn rubbish or vegetation without permission

UKUTSHAYA NEMILILO

- Cima icigarette uyilahle emgqomeni
- Sukutshaya kufuphi negesi ipeyintini nepetroli
- Zazi izicimamlilo ukuba zihlalaphi
- Xela xakukho umlilo ovuthayo
- Sukubasa umlilo ngaphandle kwemvume
- Sukutshisa inkunkuma ngaphandle kwenvume

ROOK EN VURE

- Gooi sigaretstompies in 'n asblik.
- Moenie rook naby gas, verf of petrol nie.
- Moenie enige vure maak sonder toestemming nie.
- Weet waar brandbestrydings-toerusting is.
- Rapporteer alle vure.
- Moenie vullis of plante sonder toestemming verbrand nie.

PETROL, OIL AND DIESEL

- Work with petrol, oil & diesel in marked areas
- Report any petrol, oil & diesel leaks or spills to your supervisor
- Use a drip tray under vehicles & machinery
- Empty drip trays after rain & throw away where instructed

PETROLI, OYILE NE DIZILI

- Sebenzisa ezi zinto zingentla endaweni yazo
- Yazisa abaphetheyo xa zithe zachithakala
- Faka isitya sokungqanda ukuvuza ngaphantsi komatshini
- Chitha esositya emva kwemvula uchithe kwindawo oyalelweyo

PETROL, OLIE EN DIESEL

- Werk slegs in gemerkte gebiede met petrol, olie en diesel.
- Meld alle petrol, olie en diesel lekkasies onmiddelik aan.
- Gebruik 'n drupbak onder voertuie en masjienerie.
- Maak drupbakke leeg na reën, volgens instruksie.

DUST

- Try to avoid producing dust –
- Use water to make ground & soil wet

UTHULI

- Sukwenza uthuli xa usebenza
- Sebenzisa amanzi ukwenza ufumise indawo

STOF

Probeer om nie stof te maak nie en gebruik water om droë grond nat te maak.

NOISE

- Do not make loud noises around the site, especially near schools and homes
- Report or repair noisy vehicles

INGXOLO

- Sukwenza ingxolo xa usebenza
- Ripota okanye kulungiswe ingxolo leyo

GERAAS

- Moenie harde geluide maak op die konstruksieterrein nie, veral naby skole en huise.
- Rapporteer of herstel raserige voertuie.

TOILETS

- Use the toilets provided
- Report full or leaking toilets

I TOILETS - IZINDLU ZANGASESE

- Sebenzisa izindlu zangasese hayi ityholo
- Yazisa xa kukho eyonakeleyo okanye ezeleyo

TOILETTE

- Gebruik die voorsiende toilette.
- Rapporteer vol of lekkende toilette.

EATING

- Only eat in demarcated eating areas

- Put packaging & leftover food into rubbish bins

INDAWO YOKUTYELA

- Tyela kwindawo ezenzelwe oko
- Galela yonke inkunkuma wakugqiba ukutya emgqomeni

EET

- Eet slegs in gemerkte gebiede.
- Gooi verpakking en orige kos in vullisdromme.

RUBBISH

- Do not litter – put all rubbish (especially cement bags) into the bins provided
- Report full bins to your supervisor
- The responsible person should empty bins regularly

INKUNKUMA

- Galela yonke inkunkuma ngakumbi iingxowa zesamente emgqomeni
- Xela xa imigqomo izele kwi foreman yakho
- Umntu onxulumene nokuchithwa kwenkunkuma kufanele ayichithe

VULLIS

- Moenie rommelstrooi nie - plaas vullis (veral sement-sakke) in vullishouers.
- Rapporteer vol vullishouers aan u toesighouer.
- Vullishouers moet gereeld leeg gemaak word.

TRUCKS AND DRIVING

- Always keep to the speed limit
- Drivers - check & report leaks and vehicles that belch smoke
- Ensure loads are secure & do not spill

IZITHUTHI NABAQHUBI BAZO

- Gcina isantya
- Baqhubi zikhangeleni izinto ezonakeleyo
- Qinisekisa ukuba umthwalo ukhuselekile, kwaye ingachitheki

TROKKE EN BESTUUR

- Moet nooit die spoedgrens oorskry nie.
- Bestuurders moet voortuie nagaan en enige lekkasies of rokerige voortuie aanmeld.
- Maak seker dat alle vragte stewig is en nie mors nie.

PROBLEMS - WHAT TO DO!

- Report any breaks, floods, fires, leaks and injuries to your supervisor
- Ask questions!

IINGXAKI - KUFUNEKA WENZENI?

- Ripota xa kuqhekeziwe, isiphango, umlilo, ukuvuza ukwenzakala kuforeman
- Buza xa kukho into ongayiqondiyo

PROBLEME - WAT OM TE DOEN!

- Rapporteer alle brekasies, vure, lekkasies en beserings aan u toesighouer.
- Vra vrae!

Appendix 18
Proposed Strategy for the Mitigation of Raptor Unfriendly Poles on the 33kV Network at the WEF

PROPOSED STRATEGY FOR THE MITIGATION OF RAPTOR-UNFRIENDLY POLES ON THE 33kV NETWORK AT DE AAR 1 AND DE AAR 2 NORTH WIND FARMS

1. Problem statement

The 33kV networks at the De Aar 1 and De Aar 2 North pose an electrocution risk to birds, mostly medium to large raptors. The following Red Data raptors have been recorded electrocuted in the period August 2017 to August 2018:

- Martial Eagle (Endangered)
- Verreaux's Eagle (Vulnerable)
- Lanner Falcon (Vulnerable)

Apart from the above, several non-Red Data raptor species have been electrocuted, as well as corvids. The total number of recorded electrocutions come to 14 birds, which equates to 1.16 birds/month.

The electrocution problem is related mainly to the jumper cables on the strain poles, which are not sufficiently insulated to prevent bird electrocutions. Due to the pole top being inaccessible to the birds as a result of earth conductors looping over the pole top, the birds are forced to perch on the jumper cables. This leads them to be electrocuted via a phase to phase, or phase to earth short circuit when they make contact with the live and/or earthed components (see Figure 1).[1]

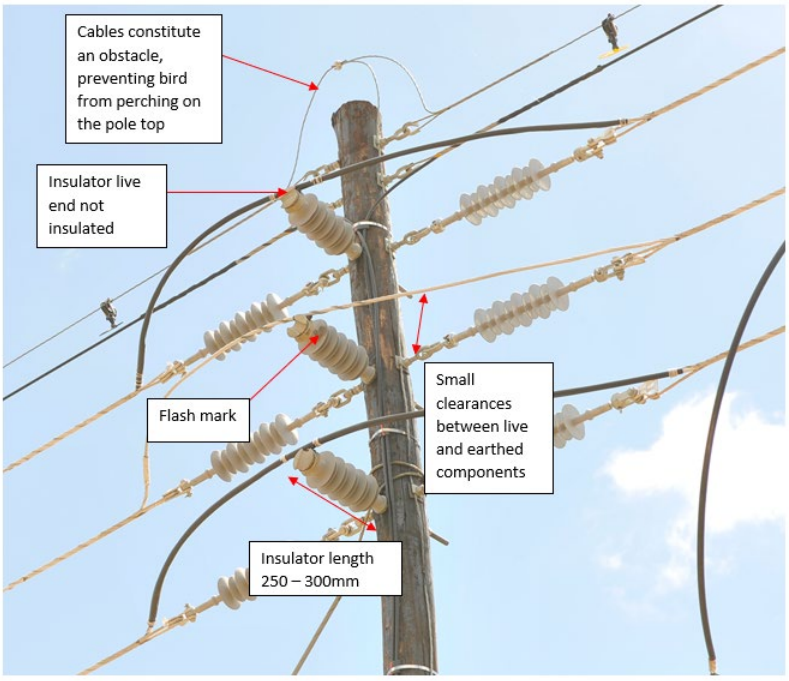


Figure 1: A typical angle strain pole 60 – 90 degrees indicating multiple risks from a potential bird electrocution perspective.

[1] A detailed exposition of the problem is provided for in the document titled INVESTIGATION INTO AVIAN MORTALITY AT LONGYUAN MULILO DE AAR WIND POWER (RF) (PTY) LTD (DA1) AND LONGYUAN MULILO DE AAR 2 NORTH (RF) (PTY) LTD (DA2N) dated 27 February 2018.

2. Proposed strategy to minimize the electrocution risk

Step 1: Provision of alternative safe perching space.

- All the strain poles must be fitted with a non-earthed T-perch on the pole top to draw the birds away from the jumper cables, so that they are drawn to rather land on the perch (see Figure 2 and 3).
- The perch cross-arm should be wide enough to accommodate two birds i.e. at least 1.3m and VERY STURDY to be able to carry the weight of two large eagles i.e. up to a combined weight of 9.5kg.
- The orientation of the cross-arm must be perpendicular to the dominant wind direction (see Appendix 1) for both De Aar 1[2] and De Aar 2 North[3].
- The fitting of all perches must be concluded within three months, starting as soon as possible.

Rationale: Raptors generally (but not always) tend to seek out the highest point on a structure to perch on. By providing a perch, a significant number of electrocutions could be avoided by providing an obvious (and safe) alternative perching platform. While this would not be a 100% effective solution to solve the problem, it should materially reduce the risk of electrocution.

Step 2: Monitoring the effectiveness of the perch

- The powerline network is currently inspected on a quarterly basis by carcass searchers, which are also conducting carcass searches under the turbines. All suspected electrocution mortalities which are discovered in this way, are recorded and reported to the avifaunal specialist.
- In addition to the current monitoring, all carcasses discovered under the powerline during monthly inspections by Longyuan maintenance staff must be reported to the avifaunal specialist for follow-up. The following must be recorded when a carcass is discovered:
    - The pole number;
    - The pole top must be photographed from several angles;
    - The carcass must be photographed both back and front;
    - The distance of the carcass from the pole must be measured;
    - Injuries must be noted;
    - If the carcass is fresh, it must be placed in a bag and stored in the on-site freezer at the substation.
    - Note if mitigation measures have been installed on the nearby poles

[2] Based on the predicted long-term wind analysis in the document titled ASSESSMENT OF THE ENERGY PRODUCTION OF THE PROPOSED DE AAR WIND FARM, Document number 111159-B-UKBR-R-01 dated 29 April 2014.

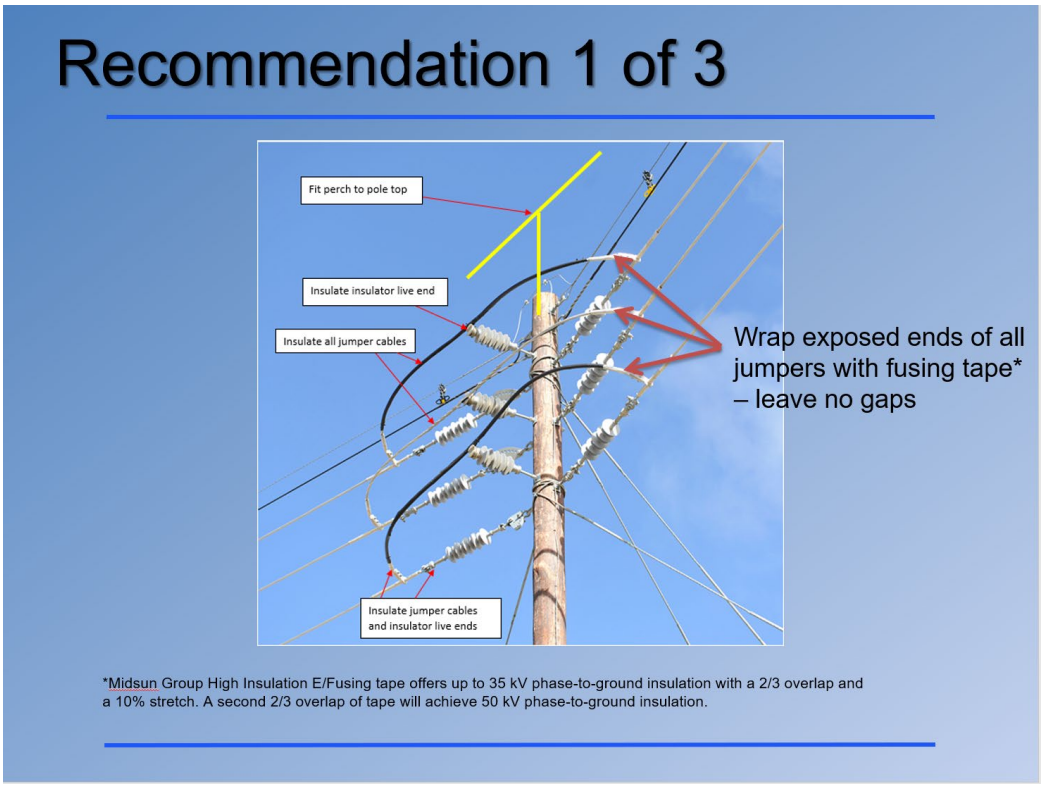
[3] Based on the predicted long-term wind analysis in the document titled ASSESSMENT OF THE ENERGY PRODUCTION OF THE PROPOSED DE AAR II NORTH WIND FARM, Document number 112021-B-UKBR-R-01dated 29 March 2014.

- All recorded network trips must be followed up with a line inspection to investigate if the trip was due to a bird electrocution. If a carcass is found, the procedure outlined in the previous bullet must be followed.
- If the monthly rate of electrocutions is reduced by 80% within 6 months after the fitting of the perches, no further steps need to be taken, but the monthly inspections and follow up of trips must continue indefinitely.
- The situation must be assessed every six months by the avifaunal specialist, to see if additional mitigation measures need to be implemented. If the monthly rate of electrocutions is not reduced by at least 80% after the introduction of a perch on the strain poles, further steps will need to be taken. This will need to take the form of comprehensive insulation of jumper cables on the strain poles.

Step 3: Insulation of structures

- If the insulation of dangerous components is required due to a continuing high rate of electrocutions, the insulation of dangerous components with a suitably tested insulation material will need to be implemented. A written warranty must be obtained from the manufacturer of the insulating materials that the dielectric strength will be sufficient to prevent a breakdown of insulation when the air gap is accidentally bridged by a bird. Information of how the product adhere to IEEE 1656-2010[4] or South African/Eskom equivalent should also be provided.

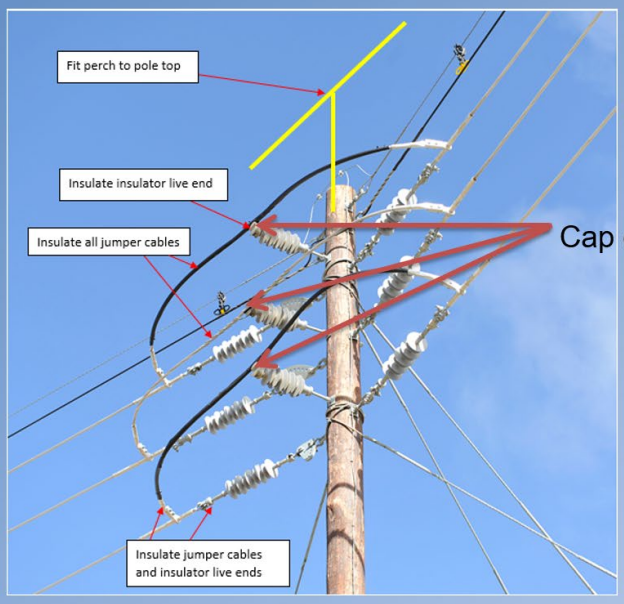
The following will be required:
Angle strain pole 60 – 90 degrees



[4] IEEE Guide for Testing the Electrical, Mechanical, and Durability Performance of Wildlife Protective Devices on Overhead Power Distribution Systems Rated up to 38 kV.

Version 4

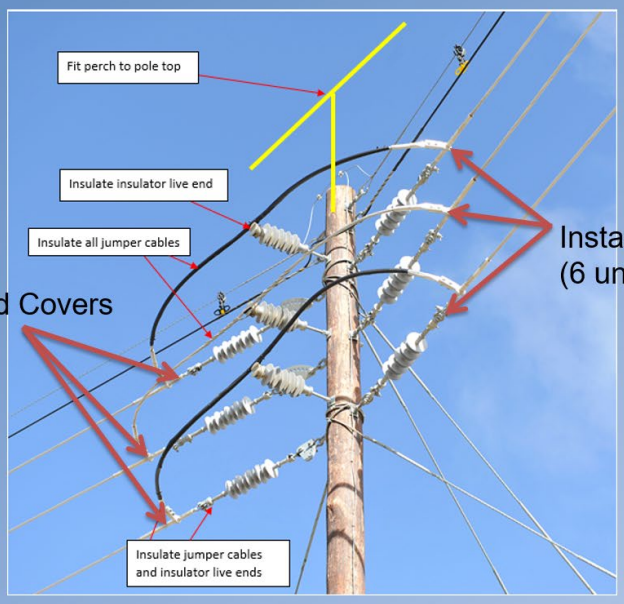
Recommendation 2 of 3



Cap each insulator*

*Power Line Sentry insulator cap and flexible line cover is attached with silicone line hose for applications such as covering over jumpers on double dead-ends, or cross-pins on buck-arm corners.
Note: Side and center tie units are available.

Recommendation 3 of 3



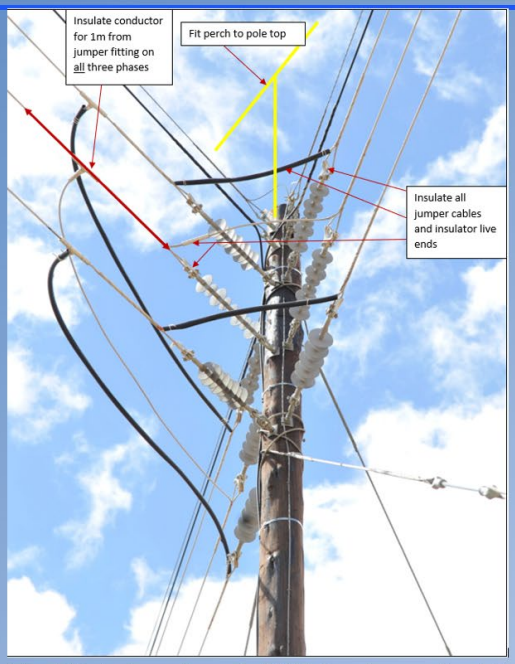
Install Deadend Covers

Install Deadend Covers (6 units total)*

*TE Connectivity covers rated for 35kV. http://www.te.com/usa-en/product-CU4483-000.html

Angle strain pole 0 – 60 degrees

Recommendation 1 of 3

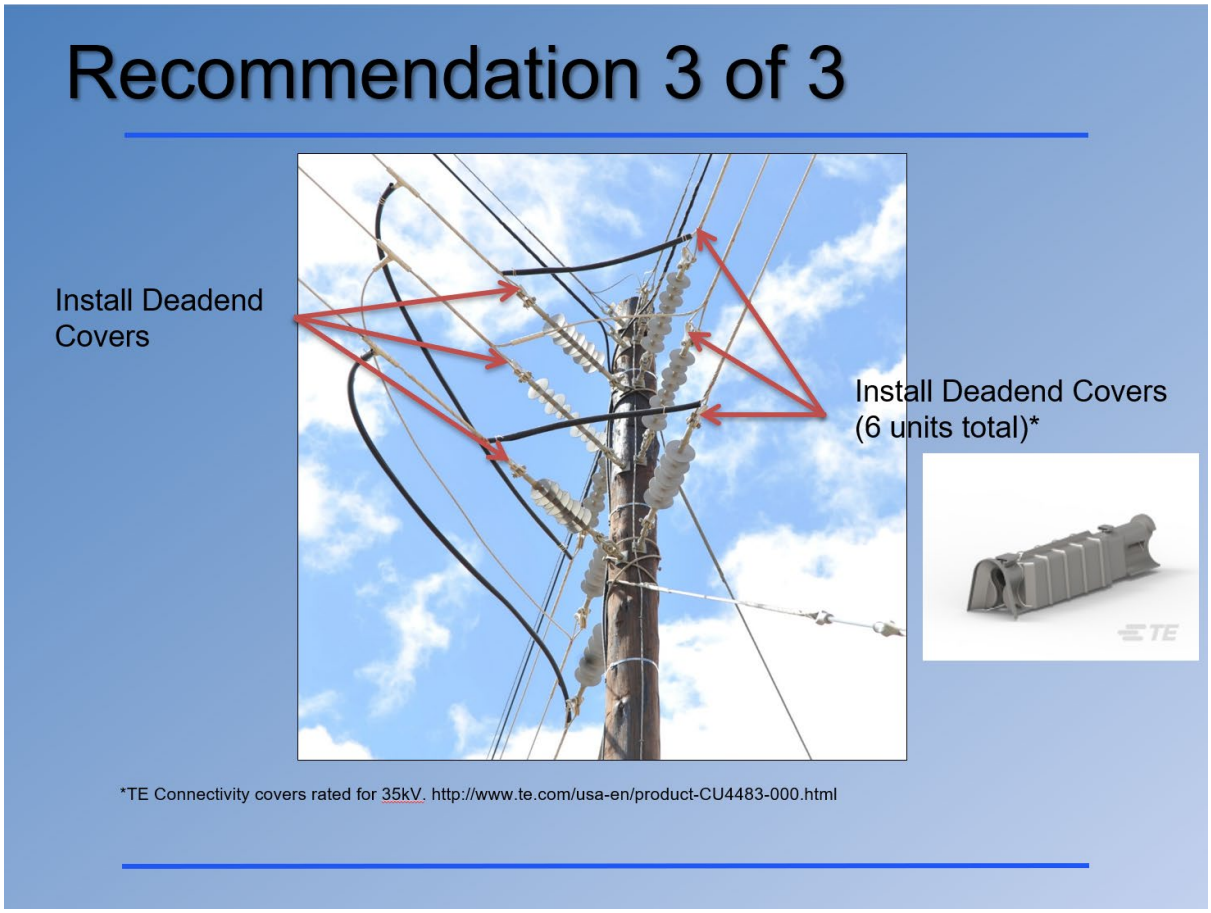


*Midsun Group High Insulation E/Fusing tape offers up to 35 kV phase-to-ground insulation with a 2/3 overlap and a 10% stretch. A second 2/3 overlap of tape will achieve 50 kV phase-to-ground insulation.

Recommendation 2 of 3

Wrap exposed ends of all jumpers with fusing tape* – leave no gaps

*Midsun Group High Insulation E/Fusing tape offers up to 35 kV phase-to-ground insulation with a 2/3 overlap and a 10% stretch. A second 2/3 overlap of tape will achieve 50 kV phase-to-ground insulation.



- The insulation of all the strain poles must be completed within a period of one year.

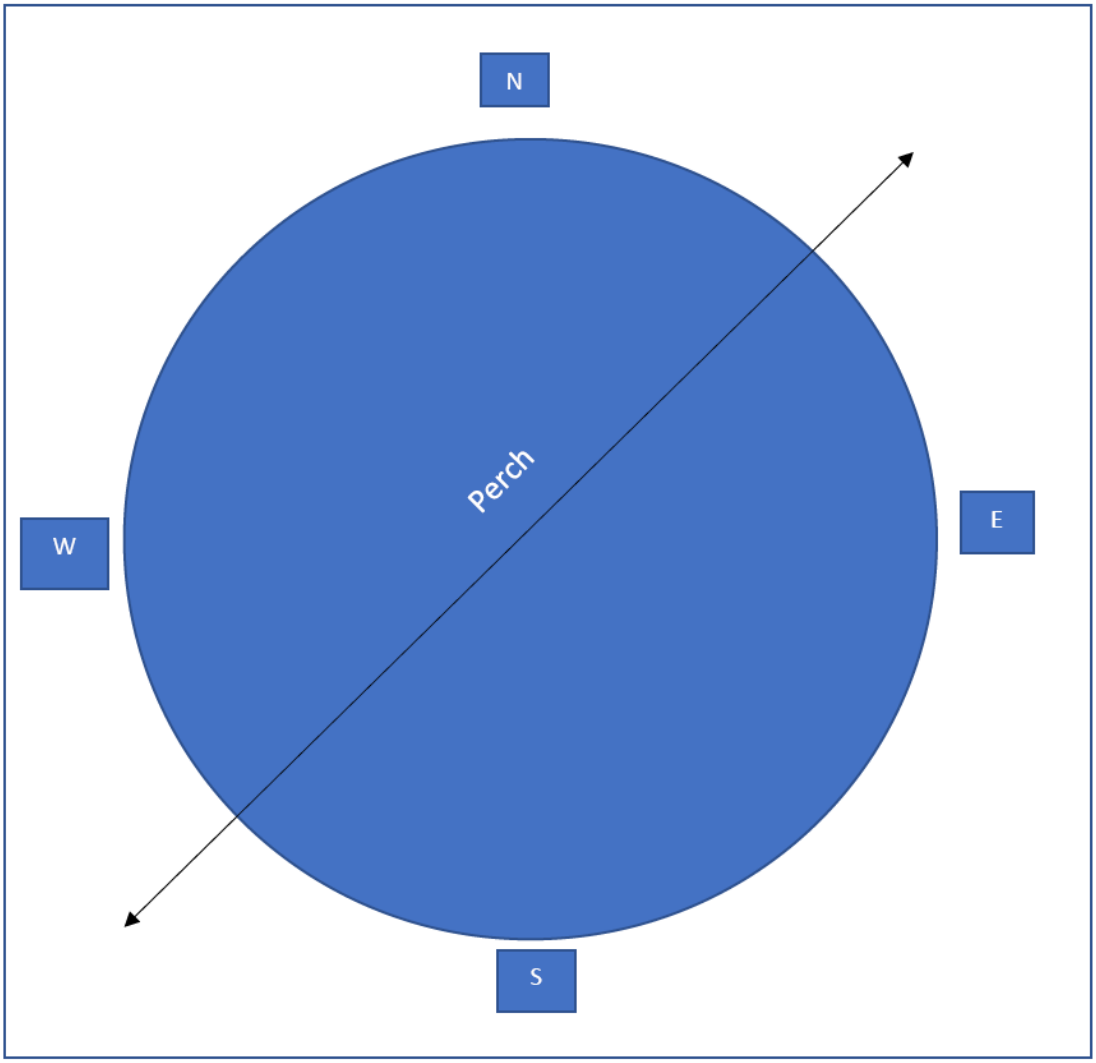
Step 4: Monitoring the effectiveness of the insulation

- The powerline network is currently inspected on a quarterly basis by carcass searchers, which are also conducting carcass searches under the turbines. All suspected electrocution mortalities which are discovered in this way, are recorded and reported to the avifaunal specialist.
- In addition to the current monitoring, all carcasses discovered under the powerline during monthly inspections by Longyuan maintenance staff must be reported to the avifaunal specialist for follow-up. The following must be recorded when a carcass is discovered:
    - The pole number;
    - The pole top must be photographed from several angles;
    - The carcass must be photographed both back and front;
    - The distance of the carcass from the pole must be measured;
    - Injuries must be noted;
    - If the carcass is fresh, it must be placed in a bag and stored in the on-site freezer at the substation.
- All network trips must be followed up with a line inspection to investigate if the trip was due to a bird electrocution. If a carcass is found, the procedure outlined in Section 2 must be followed.

- If the monthly rate of electrocutions is reduced by 80% within 6 months after the fitting of the insulation, no further steps need to be taken, but the monthly inspections and follow up of trips must continue indefinitely.
- The situation must be assessed every six months by the avifaunal specialist, to see if additional mitigation measures need to be implemented. If the monthly rate of electrocutions is not reduced by at least 80% after the introduction of a perch and insulation on the strain poles, further steps will need to be investigated and implemented.

APPENDIX 1

De Aar 1: Orientation of bird perch



De Aar 2 North: Orientation of bird perch