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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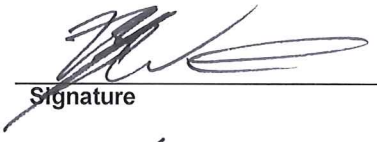
For AECOM SA (Pty) Ltd

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

Contents

List of Figures

List of Tables

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 :

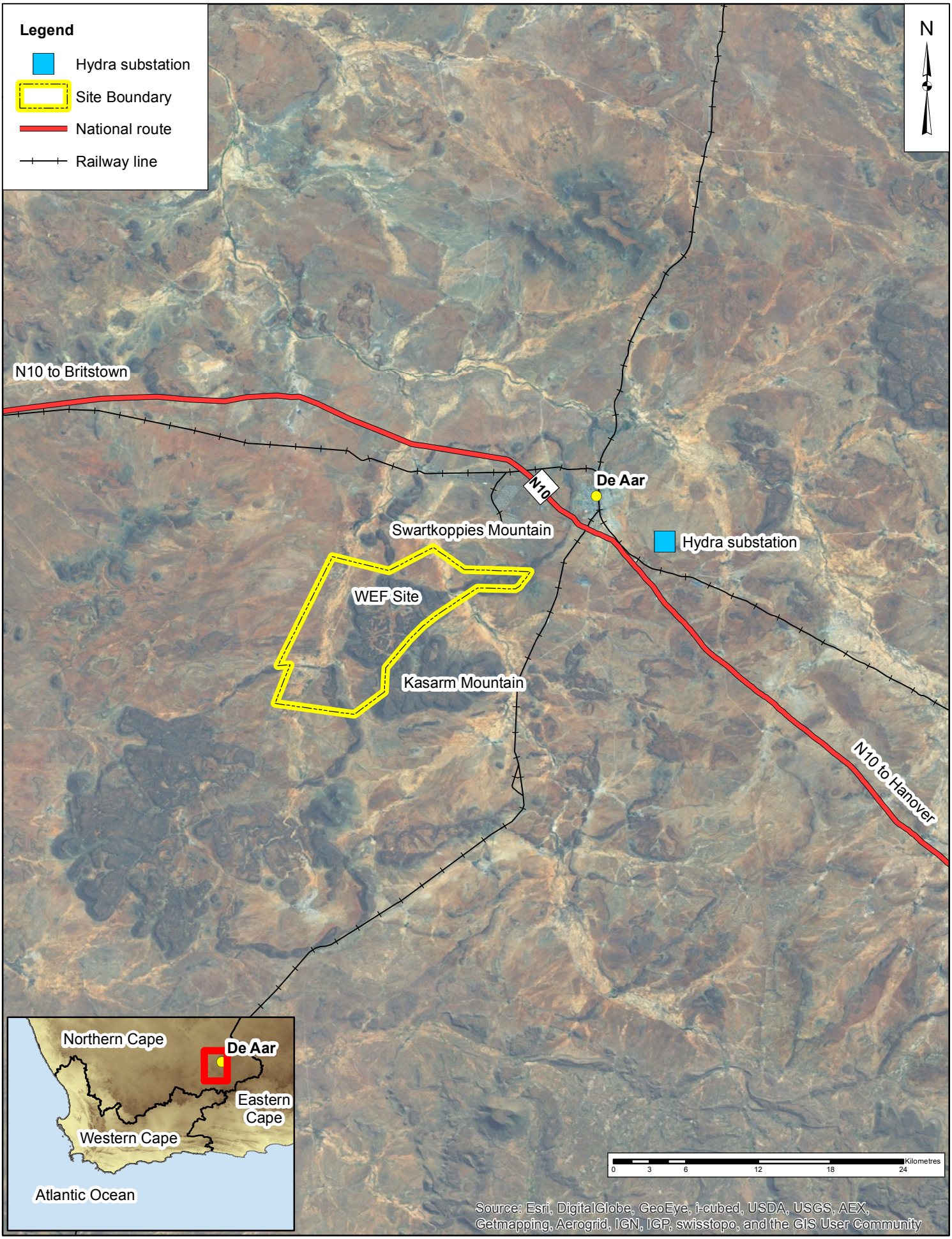
- The degradation of the natural environment.
- Impacts on the quality of water resources.
- Loss or damage to property.

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**

Scale 1:400 000
(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.

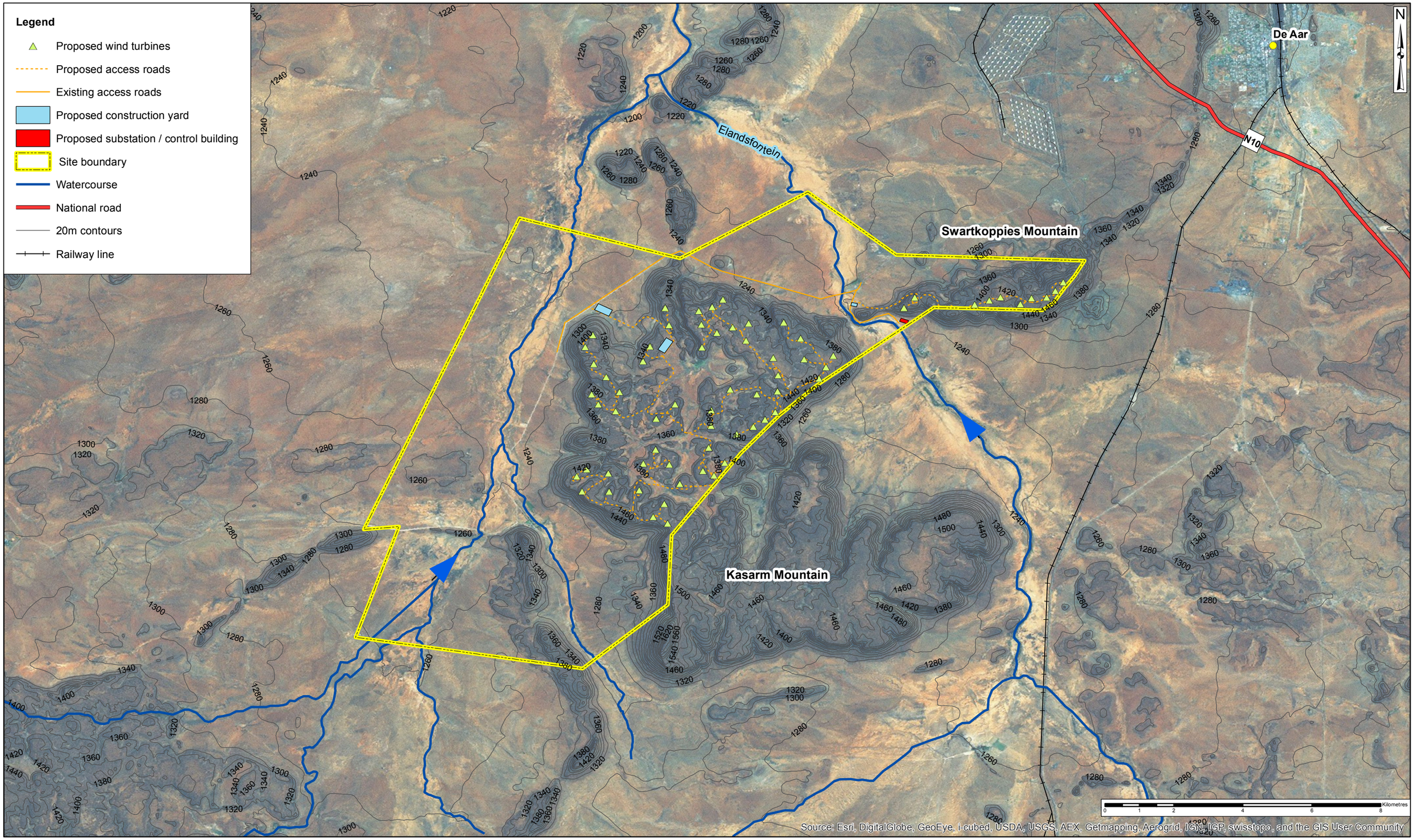
A network of approximately 4 m wide gravel roads is proposed, allowing access for construction, transportation and maintenance vehicles to the wind turbines. Roadways are aligned to existing farm roads as closely as possible to prevent unnecessary cut and fill and the construction of new roads where 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

Projection:	Geographic - Hartbeeshoek 1994
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GIS QC by:	NG Letoao
Approved by:	I Malherbe
Date:	April 2014
Map Ref.:	Figure 2.1 - Site layout.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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P:\FY14\14C00570\DRAW\C&I\WATER\RSRCS\WORKING\GIS PROJECTS\De Aar 1 - Figure 2.1 - Site Layout (A3).mxd

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

0 0.5 1 2 3 4 Kilometres

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**

Whilst every care has been taken in compiling the information on this map, AECOM cannot accept responsibility for any inaccuracies.

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Scale 1:50 000
(When page size is: A3 landscape)

FIGURE 2.2

Projection:	Geographic - Hartbeeshoek 1994
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GIS QC by:	NG Letoao
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.

P:\FY14\14C00570\DRAW\C&I\WATER\RSRCS\WORKING\GIS PROJECTS\De Aar 3 - Figure 2.2 - Site Layout (A3).mxd

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.

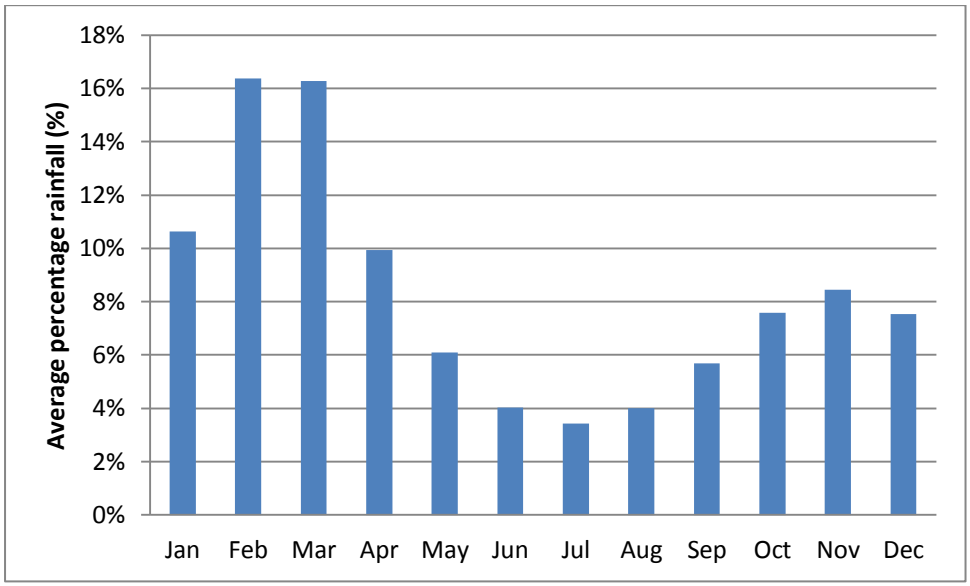
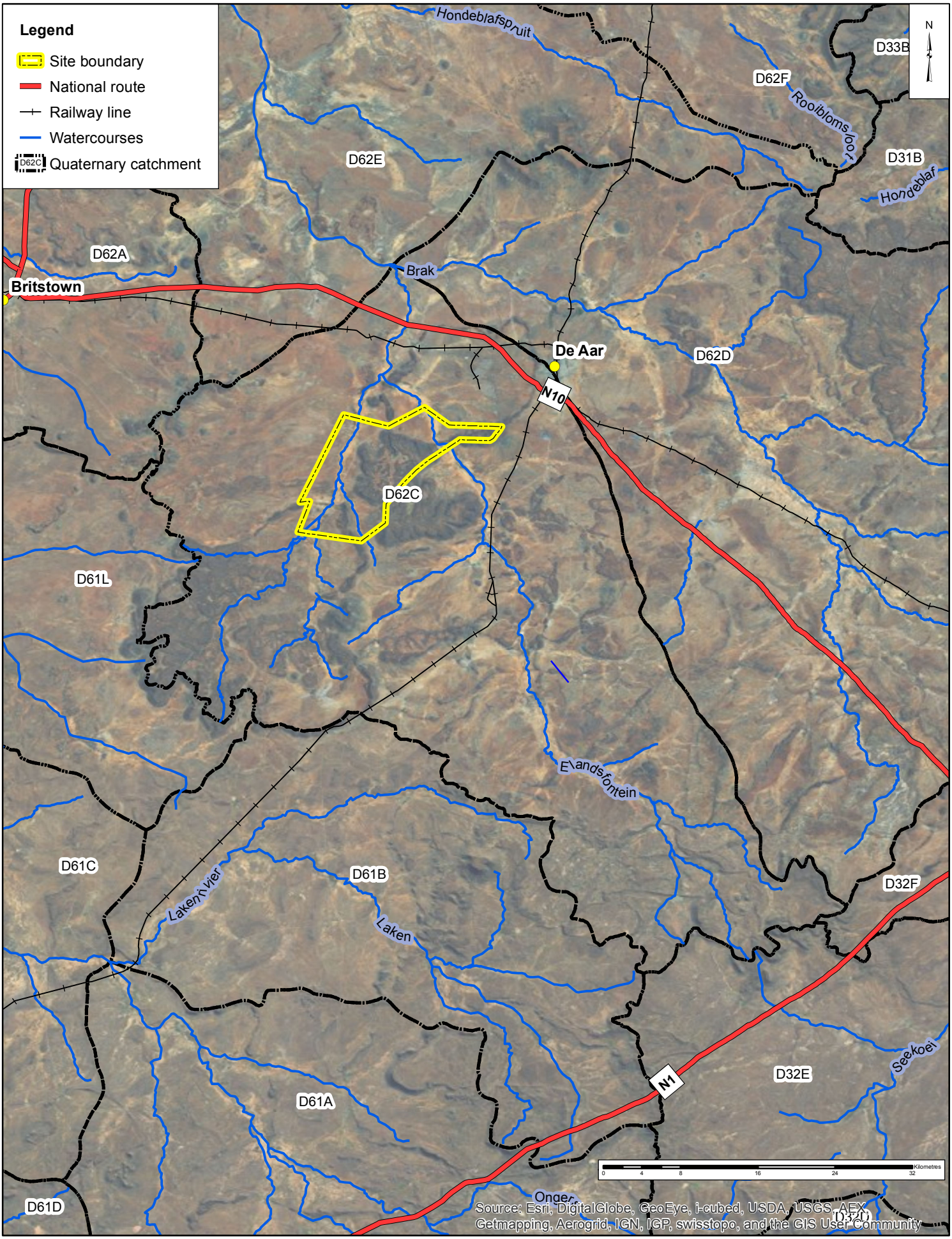


Figure 4.1 : Average percentage of MAP experienced each month

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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(When page size is: A4 portrait)

FIGURE 4.4

Projection:	Geographic - Hartbeeshoek 1994
Drawn by:	MB Wiese
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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P:\FY14\14C00570\DRAW\C&I\WATER\SRCS\WORKING\GIS PROJECTS\De Aar 1 - Figure 3.1 - Catchment delineation (A4).mxd

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.

Mulilo Renewable Energy (Pty) Ltd. 2010. *De Aar 1 : Maanhaarberg Wind Energy Facility Geotechnical Appraisal Report*. Report compiled by Geotechnics Africa for Mulilo Renewable Energy (Pty) Ltd in October 2010.

Water Research Commission (WRC). 1994. *WRC Report No 298/3.1/94 : Water Resources of South Africa, 1990 Study (WR90)*. Report compiled by the Water Resources 1990 Joint Venture for the Water Research Commission in 1994.

Water Research Commission (WRC). 2004. *WRC Report No 1156/1/04 : Development of a raster database of annual, monthly and daily rainfall for Southern Africa*. Report compiled by SD Lynch for the Water Research Commission in December 2004.

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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