PROPOSED HYDROPOWER STATION AND ASSOCIATED INFRASTRUCTURE AT BOEGOEBERG DAM ON THE ORANGE RIVER, NEAR GROBLERSHOOP, NORTHERN CAPE.

DEA Reference No: 14/12/16/3/3/2/568

FINAL ENVIRONMENTAL IMPACT REPORT

March 2014

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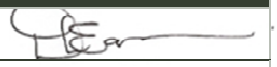
Author Signature		Author Signature	
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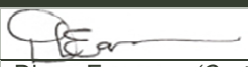
Approver Signature		Approver Signature	
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Proposed hydropower station and associated infrastructure at Boegoeberg Dam on the Orange River, near Groblershoop, Northern Cape

Non-technical summary (English) & Nie-tegniese opsomming (Afrikaans)

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Update Page

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NEMA requirements for Environmental Impact Reports - Guide to this report

The purpose of this section is to provide a guide to how this report has been structured in compliance with Regulation 31 of the National Environmental Management Act (No. 107 of 1998) which specifically pertains to Environmental Impact Reports.

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Regulation	Content as required by NEMA	Page/ Annexure
31(2)(a)	(i) Details of the EAP who prepared the report; and	Page 39 Section 2.3.1
	(ii) Details of the expertise of the EAP to carry out an environmental impact assessment.	Annexure E (EAP CVs)
31(2)(b)	A detailed description of the proposed activity.	Page 41 Section 3.1
31(2)(c)	A description of the property on which the activity is to be undertaken and the location of the activity on the property, or if it is (i) a linear activity, a description of the route of the activity; or	Page 66 Section 3.2.1
31(2)(d)	A description of the environment that may be affected by the activity and the manner in which the physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed activity.	Page 11 Section 1.1
31(2)(e)	Details of the public participation process conducted in terms of subregulation (1), including –	Page 66 Section 2.2
	(i) Steps undertaken in accordance with the plan of study;	Page 23 Section 1.5
	(ii) A list of persons, organisations and organs of state that were registered as interested and affected parties;	Annexure B (PPP)
	(iii) A summary of comments received from, and a summary of issues raised by registered interested and affected parties, the date of receipt of these comments and the response of the EAP to those comments; and	Annexure B (PPP)
	(iv) Copies of any representations and comments received from registered interested and affected parties.	Annexure B (PPP)
31(2)(f)	A description of the need and desirability of the proposed activity.	Page 73 Section 4
31(2)(g)	A description of identified potential alternatives to the proposed activity, including advantages and disadvantages that the proposed activity or alternatives may have on the environment and the community that may be affected by the activity.	Page 66 Section 3.2
31(2)(h)	An indication of the methodology used in determining the significance of potential environmental impacts.	Annexure F (Methodology)

31(2)(i)	A description and comparative assessment of all alternatives identified during the environmental impact assessment process.	Page 71 Section 3.2.8
31(2)(j)	A summary of the findings and recommendations of any specialist report or report on a specialised process.	Page 170 Section 5.15
31(2)(k)	A description of all environmental issues that were identified during the environmental impact assessment process, an assessment of the significance of each issue and an indication of the extent to which the issue could be addressed by the adoption of mitigation measures.	Section 0
31(2)(l)	An assessment of each identified potentially significant impact, including – (i) Cumulative impacts;	Section 5
	(ii) The nature of the impact;	Section 5
	(iii) The extent and duration of the impact;	Section 5
	(iv) The probability of the impact occurring;	Section 5
	(v) The degree to which the impact can be reversed;	Section 5
	(vi) The degree to which the impact may cause irreplaceable loss of resources; and	Section 5
	(vii) The degree to which the impact can be mitigated.	Section 5
31(2)(m)	A description of any assumptions, uncertainties and gaps in knowledge.	Page Section 2.3
31(2)(n)	A reasoned opinion as to whether the activity should or should not be authorised, and if the opinion is that it should be authorised, any conditions that should be made in respect of that authorisation.	Page 181 Section 6.11
31(2)(o)	An environmental impact statement which contains – (i) a summary of the key findings of the environmental impact assessment; and	Page 170 Section 5.15
	(ii) A comparative assessment of the positive and negative implications of the proposed activity and identified alternatives.	Page 181 Section 6.10
31(2)(p)	A draft environmental management programme containing the aspects contemplated in regulation 33.	Annexure E
31(2)(q)	Copies of any specialist reports and reports on specialised processes complying with regulation 32.	Annexure D
31(2)(r)	Any specific information that may be required by the competent authority; and	Annexure G
31(2)(s)	Any other matters required in terms of sections 24(4)(a) and (b) of the Act.	Annexure C

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Glossary of Terms

Environment	The surroundings (biophysical, social and economic) within which humans exist and that are made up of: i. the land, water and atmosphere of the earth; ii. micro-organisms, plants and animal life; iii. any part or combination of (i) and (ii) and the interrelationships among and between them; and iv. the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.
Environmental Impact Assessment (EIA)	A study of the environmental consequences of a proposed course of action.
Environmental Impact Report (EIR)	A report assessing the potential significant impacts as identified during the Scoping Phase.
Environmental Impact	An environmental change caused by some human act.
Environmental Management Programme (EMPr)	A document that provides procedures for mitigating and monitoring environmental impacts, during the construction, operation and decommissioning phases of a project.
Public Participation Process	A process of involving the public in order to identify needs and address concerns to contribute to more informed decision making relating to a proposed project, programme or development.
Scoping	A procedure for determining the extent of and approach to an EIA, used to focus the EIA to ensure that only the significant issues and reasonable alternatives are examined in detail.
Scoping Report	A report describing the outcomes of Scoping and the issues identified.

Abbreviations

ACO	Archaeology Contracts Office
BIA	Biodiversity Impact Assessment
CBA	Critical Biodiversity Area
CRR1	Comments and Response Report 1
CRR2	Comments and Response Report 2
CRR3	Comments and Response Report 3
DAFF	Department of Agriculture Forestry and Fisheries
dB	Decibels
DEA	Department of Environmental Affairs (previously Department of Environmental Affairs and Tourism)
DEA&DP	Department of Environmental Affairs and Development Planning
DEANC	Department of Environmental Affairs and Nature Conservation
DEAT	Department of Environmental Affairs and Tourism
DEA: Waste	Department of Environmental Affairs: Waste
DM	District Municipality
DMR	Department of Mineral Resources
DoE	Department of Energy
DSR	Draft Scoping Report
DWA	Department of Water Affairs
EA	Environmental Authorisation
EAP	Environmental Assessment Practitioner
EAPSA	Environmental Assessment Practitioners of South Africa
ECO	Environmental Control Officer
EFR	Environmental Flow Requirements
EIA	Environmental Impact Assessment
EIR	Environmental Impact Report
EIS	Ecological Importance and Sensitivity
EMF	Environmental Management Framework
EMPr	Environmental Management Programme
EP	Equator Principles
EPFI	Equator Principles Financial Institutions
ERA	Electricity Regulation Act (Act No. 4 of 2006)
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FROC	Frequency of Occurrence
FSR	Final Scoping Report
GG	Government Gazette
GN	Government Notice

GWh	Gigawatt hour
ha	Hectare
HIA	Heritage Impact Assessment
HV	High Voltage
Hz	Hertz
I&APs	Interested and Affected Parties
IDP	Integrated Development Plan
IEIM	Integrated Environmental Information Management
IEP	Integrated Energy Plan
IFC	International Finance Corporation
IPAP	Industrial Policy Action Plan
IPP	Independent Power Producer
IRP	Integrated Resource Plan
kWh	Kilowatt hour
kV	Kilovolt
LOR	Lower Orange River
LM	Local Municipality
MW	Megawatts
NCNCA	Northern Cape Nature Conservation Act (Act No. 9 of 2009)
NEMA	National Environmental Management Act (Act No. 107 of 1998) (as amended)
NEM:BA	National Environmental Management: Biodiversity Act (Act No. 10 of 2004)
NEM:WA	National Environmental Management: Waste Act (Act No. 59 of 2008)
NFA	National Forest Act 84 of 1998 (as amended)
NGO	Non-Government Organisation
NHRA	National Heritage Resources Act (Act No. 25 of 1999)
MPRDA	Mineral and Petroleum Resources Development Act (Act No. 28 of 2002)
NWA	National Water Act (Act No. 36 of 1998)
PES	Present Ecological State
PIA	Palaeontological Impact Assessment
PPA	Power Purchase Agreement
PPP	Public Participation Process
SAHRA	South African Heritage Resources Agency
SACNASP	South African Council for Natural Scientific Professions
SDF	Spatial Development Framework
ToR	Terms of Reference
TSP	Total Suspended Particles
WML	Waste Management Licence

1 INTRODUCTION AND BACKGROUND

The purpose of this Chapter is to introduce the project, describe the relevant legal framework within which the project will take place and to provide the listed activities (in terms of National Environmental Management Act (NEMA) and its 2010 EIA Regulations) that require environmental authorisation. It further serves to outline the approach to the project, within a set of assumptions and limitations.

1.1 INTRODUCTION

Boegoeberg Hydro Electric Power (Pty) Ltd (Boegoeberg Hydro) is proposing to construct a hydropower facility with a capacity of approximately 11 Megawatts (MW) at Boegoeberg Dam[1]. The proposed facility is located approximately 26 kilometres (km) south east of the town of Groblershoop in the Northern Cape and can be accessed via the National Road, N8 (see **Figure 1**). Aurecon South Africa (Pty) Ltd (Aurecon) has been appointed to undertake the requisite environmental process for purposes of environmental authorisation as required in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, on behalf of Boegoeberg Hydro.

This Environmental Impact Assessment (EIA) is for a proposed hydropower facility on the farm Zeekoebaart, made up of two portions (Remainder of Farm no. 306 and Portion 1 of Farm no. 306) and the transmission line corridor to Eskom's existing Fibre substation (see **Table 1-1).**

Table 1-1 | List of farms/ erven on which components of the hydropower facility and associated infrastructure are located and the respective landowners

Farm name	Farm/ Erf	Portion	Landowner
Farms/ Erven comprising the plant infrastructure			
Zeekoebaart	1	0	National Government of The Republic of South Africa
Zeekoebaart	306	2+3	Andre Johannes Geldenhuys & Susara Marthina
Zeekoebaart	306	0	Hendrik Lourens Fourie (Snr)[2]
Farms/ Erven comprising the transmission line corridor/ servitude			
Zeekoebaart	1	2	National Government of The Republic of South Africa
Zeekoebaart	9	1	Dirk Jacobus Francois Greeff
Zeekoebaart	9	4	Dirk Jacobus Francois Hanekom-Trustees
Zeekoebaart	10	0+19	Jan Willem Smit & Elizabeth Huibrecht
Zeekoebaart	10	7	Elim Boerdery Trust
Blinkfontein	10	6	Jacobus Salomon & Maria Visagie
Blinkfontein	10	4	Blaauwputs Trust
Rietfontein	11	2	Wilkot Boerdery Pty Ltd
Rietfontein	11	5	B J Groenewald Familie Trust

[1] The Boegoeberg Dam is actually a weir in the Orange River constructed between 1926 and 1933; however, it is commonly referred to as Boegoeberg Dam which convention is used in this report.
[2] Affairs represented by Poen Bergh at Becker Bergh & More

The proposed hydropower station would consist of the following components, which are described in detail in **Section 3.1**:

- An off-take structure above the existing Boegoeberg weir to facilitate the abstraction of water;
- A temporary upstream and downstream caisson (cofferdam) to exclude water from the construction works;
- Intake structure;
- Water conveyance infrastructure comprising a combination of either an open canal, or a tunnel to convey the water to the head pond;
- A head pond (associated with the canal alternative only);
- Steel (or other suitable pipeline material) penstocks to transfer the water to the power chamber;
- A power chamber to house the turbines and generation equipment;
- Outlet channel (tailrace) to return the abstracted water back into the river, downstream of the power chamber;
- A switchroom and transformer yard;
- A high voltage (HV) transmission line to evacuate the power to the nearby Fibre Substation;
- Sediment basins (for dredge spoil); and
- Access roads to the site and transmission line access tracks.

Energy generated by the proposed hydropower station would be evacuated from the site transformer yard *via* a proposed transmission line of not more than 132 kilovolt (kV) capacity to a nearby Eskom substation (**Figure 1**). The overhead transmission line would connect the power chamber to the Fibre Substation where it would feed into the national grid. Where existing roads do not exist for construction and maintenance purposes, new gravel access tracks of 4 metres (m) in width would be constructed to follow the transmission servitude. The transmission line will traverse through a number of farms, described further in **Section 3.1**. Access roads to the hydropower facility and associated structures would follow existing road alignments which would be upgraded to be six metres (6 m) in width.

In terms of the National Environmental Management Act No. 107 of 1998 (NEMA), the proposed project triggers a suite of listed activities which require authorisation from the competent environmental authority. Since the project is for the generation of energy, and energy projects are dealt with by the national authority, the competent authority is the national Department of Environmental Affairs (DEA). DEA's decision on whether to authorise the project or not will be based on the outcome of this EIA process.

The purpose of this Environmental Impact Report (EIR) is to undertake a comparative assessment of the relative significance of the potential environmental impacts for the proposed hydropower station and its alternatives. Accordingly, the EIR includes the following:

- A brief overview of the potential environmental impacts and reasonable alternatives identified during the Scoping investigation.
- A summary of the key findings of the various specialist studies as they pertain to the affected environment.
- An overview of the public participation process conducted during the compilation of the EIR.
- A detailed assessment of the significance of the potential environmental impacts for the various project alternatives. This assessment, which would use the methodology outlined in **Section 0**, would be informed by the findings of the specialist studies, and professional judgement of the Environmental Assessment Practitioner (EAP) and team members.

- An overview of the full range of mitigation measures, including an indication of how these would influence the significance of any potential environmental impacts, together with an Environmental Management Programme (EMPr). The mitigation measures have been informed by the specialist studies, professional experience and comments received from Interested and Affected Parties (I&APs). A set of recommendations is provided regarding the way forward, should any of the proposed alternatives be authorised in terms of NEMA.

1.2 TERMS OF REFERENCE FOR THE EIA

Aurecon was appointed by Boegoeberg Hydro as the independent Environmental Assessment Practitioner (EAP)[3] to undertake the requisite environmental processes as required in terms of NEMA[4] read with the NEMA 2010 EIA Regulations. The scope of the environmental work entails undertaking an EIA process in terms of the EIA Regulations (Applications for Scoping and EIA) for the proposed construction of the Boegoeberg hydropower station on the Farm Zeekoebaart (Remainder of 306 and Portion 1), and associated infrastructure on the Orange River, near Groblershoop, Northern Cape. This process includes the:

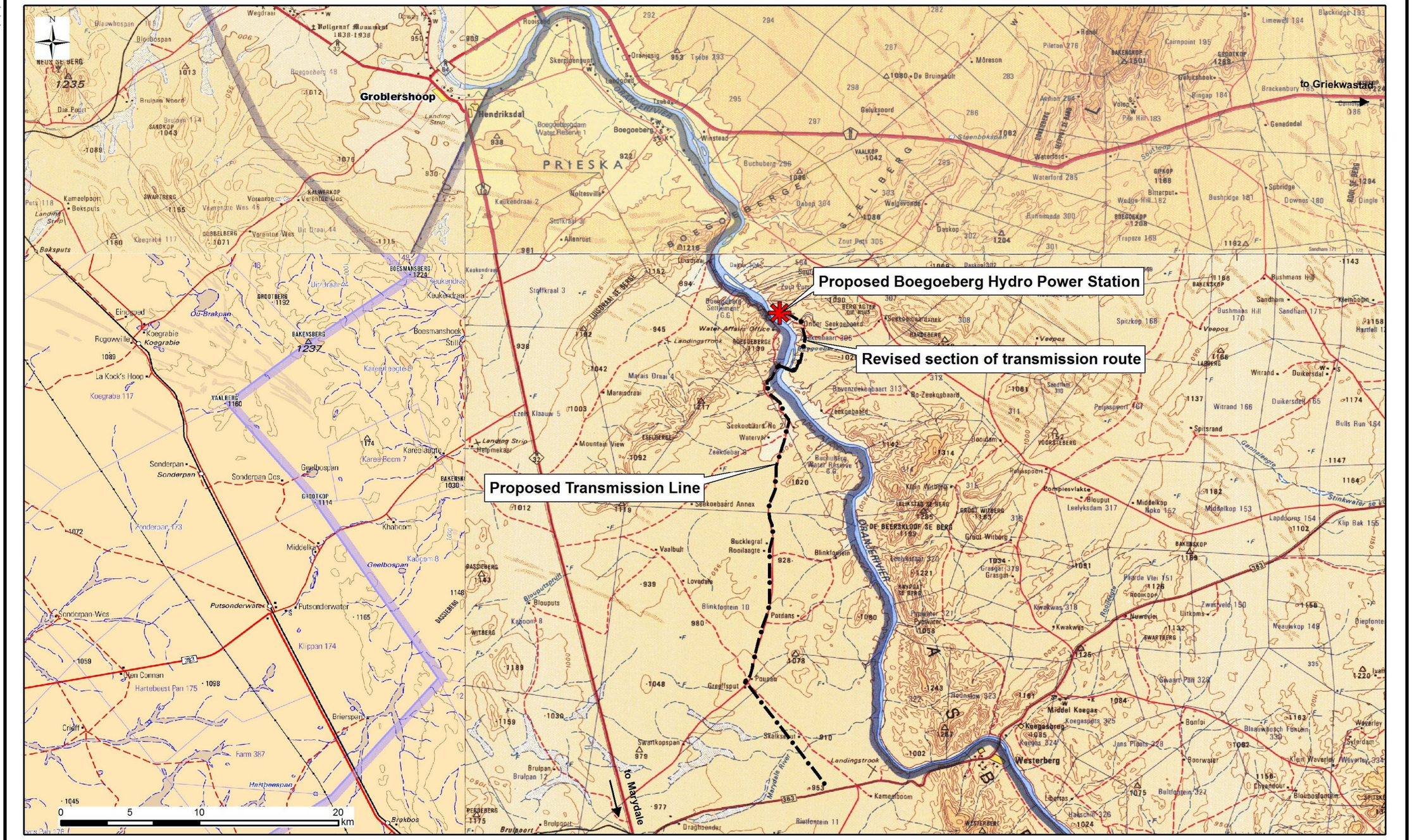
- Completion and submission of the requisite EIA application form to the competent authority (DEA).
- Undertaking of the regulatory processes including:
    - Drafting public information documents;
    - Completion and submission of scoping reports;
    - Pro-active consultation with relevant state departments;
    - Undertaking the necessary specialist investigations;
    - Completion and submission of environmental impact reports;
    - Public participation and associated engagement processes; and
    - Draft Environmental Management Programme (EMPr).

This EIA process is aimed at meeting specific requirements of the NEMA EIA Regulations promulgated on 18 June 2010[5]. In addition, the information contained in this report supports the requirements of legislation (Section 1.3) in order for the proposed project to be considered for decision making by the relevant competent authority. Although additional authorisation, licences and permits[6] may be required under other applicable legislation, it is understood that these cannot be considered until decision making under the NEMA EIA Regulations has been finalised.

The information collected during this EIA and the Public Participation Process (PPP) will be used to inform the other processes, such as the Water Use Licence application. The details of the PPP undertaken to date are summarised in **Section 2.2.**

Note that while it may become apparent at a later stage that additional legislation may be applicable; the Acts most relevant to the project and the environment have been included in the **Section 1.3**. Legislation and policies relating to energy generation, specifically renewable energy, have been summarised in Annexure C.

[3] Environmental Assessment Practitioners acting on behalf of Aurecon: Diane Erasmus, Charles Norman, Simon Clark and Andries van der Merwe (See Annexure H for Curricula Vitae of these individuals).
[4] Sections 16 and 17 of NEMA define the requirements for Environmental Assessment Practitioners.
[5] GN No. R 543, 544, 545, 546 and 547 in Government Gazette No. 33306 of 18 June 2010.
[6] This includes the Water Use License, Permits for removal of vegetation, DMR authorisation for borrow pits etc.



aurecon www.aurecongroup.com	DRAWING TITLE LOCALITY MAP	PROJECT TITLE PROPOSED BOEGOEBERG HYDRO POWER STATION ON FARM ZEEKOEBAARD 306 NEAR GROBLERSHOOP, NORTHERN CAPE	SCALE: 1:350,000 PAPER	DESIGNED DRAWN S.Swartz CHECKED	NOTES	1:350,000 Aurecon GIS FILE NAME boegoebergdam.mxd DRAWING NUMBER XXXXXXXXXXXXX
			APPROVAL			

Figure 1 | Locality map of the proposed Boegoeberg hydropower plant and associated transmission line (up to 132kV) routing (Transmission route partially rerouted 6/11/13)

1.3 LEGAL REQUIREMENTS AND STANDARDS

The legal framework within which this project occurs is complex and includes legislation, policy and principles derived from the Constitution of the Republic of South Africa Act (No. 108 of 1996), as well as the Promotion of Administrative Justice Act (No. 3 of 2000) and other statutes of general application. Specific pieces of legislation applicable to the proposed project are provided in **Table 1-2.**

Table 1-2 | Legislation and policy considered in preparation of the Environmental Impact Report

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
The Constitution of the Republic of South Africa Act ("the Constitution") (Act No. 108 of 1996)	The environmental right contained in Section 24 of the Constitution provides that everyone is entitled to an environment that is not harmful to his or her well-being.	Constitutional Court
National Environmental Management Act (Act No. 107 of 1998) (NEMA)	Several listed activities in terms of NEMA GN No. 544, 545 and 546, 18 June 2010, have been triggered and need to be authorised for the proposed hydropower station (also see 0).	DEA
National Water Act (Act No. 36 of 1998) (NWA)	The proposed hydropower station will divert water from the Orange River for the generation of electricity. The location of the hydropower station falls within the D81A quaternary catchment and the Lower Orange Department of Water Affairs (DWA) Water Management Area, and requires authorisation from DWA for the following activities as listed in section 21 of the NWA: 21(a) - Taking water from a water resource. 21 (c) Impeding or diverting flow of water in a watercourse. 21(i) Altering the bed, banks, course or characteristics of a watercourse. 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource.	Department of Water Affairs (DWA)
National Heritage Resources Act (Act No. 25 of 1999) (NHRA)	The development will change the character of a site exceeding 5,000m^2 in extent and includes the construction of an access road and transmission line exceeding 300m in length. As such the Act	South African Heritage Resources Agency (SAHRA)

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
	requires that a Heritage Impact Assessment (HIA) is undertaken for the proposed project.	
National Environmental Management: Biodiversity Act (Act No. 10 of 2004) (NEM:BA)	The hydropower station will be located in a Critical Biodiversity Area (CBA) which contains protected species listed in NEM:BA. Permits will be required for the removal of such species should the project receive a positive Environmental Authorisation (EA).	Northern Cape Department of Environmental Affairs and Nature Conservation (DEANC)
National Forest Act (Act No. 84 of 1998) (as amended) (NFA)	Section 12(1)(d) read with s15(1) and s62(2)(c) list protected tree species that may not be cut, destroyed or disturbed without a licence. Should the project be granted a positive EA, the relevant licences will be applied for if any endangered trees, as per those listed in the NFA, are to be cut, destroyed or disturbed.	Department of Agriculture, Forestry and Fisheries (DAFF).
Mineral and Petroleum Resources Development Act (Act No. 28 of 2002) (MPRDA)	Sourcing of material for road construction and foundation purposes (i.e. the use of borrow pits) is regarded as mining and accordingly is subject to the requirements of the Act. As the material would be sourced from two informal borrow pits on the farm, a mining permit would be required from Department of Mineral Resources (DMR).	Department of Mineral Resources (DMR)
Northern Cape Nature Conservation Act (Act No. 9 of 2009) (NCNCA)	Numerous sections (specifically Sections 50-51) under NCNCA deal with indigenous and protected plants. A permit in terms of NCNCA will be required if species listed in the Act are located on site and it would be necessary to remove or destroy them.	Northern Cape Department of Environmental Affairs and Nature Conservation (DEANC)
National Environmental Management: Waste Act (Act No. 59 of 2008) (NEM:WA)	Subsequent to the release of the draft EIR, Category C has be added to listed activities in terms of NEM:WA (GN 921, 29 November 2013). Activities under Category C need to meet the norms and standards and simply be registered with the Department (also see Section 1.5).	DEA Northern Cape
The National Energy Act (Act No. 34 of 2008)	In terms of the New Generation Regulations, the Integrated Resource Plan (IRP) has been developed by the Department of Energy (DoE) and sets out the new generation capacity requirement per technology, taking energy efficiency and the demand-side	Department of Energy (DoE)

Legal and Policy Requirements		
Title of legislation, policy or guideline	**Applicability to the project**	**Administrating Authority**
	management projects into account. This requires that new generation capacity must be met through the technologies and projects listed in the IRP and all Independent Power Producer (IPP) procurement programmes will be undertaken in accordance with the specified capacities and technologies listed in the IRP .	
The International Finance Corporation's (IFC) performance standards	A certain percentage of the funding for the proposed hydropower station would be sourced from the IFC. As such the IFC performance standards would be applicable to the proposed project.	The International Finance Corporation
Equator Principles (EP)	A certain percentage of the funding for the proposed hydropower station would be sourced from the Equator Principles Financial Institutions (EPFI's). As such the EP would be applicable to the proposed project.	Equator Principles Financial Institutions

The Hydropower Sustainability Assessment Protocol incorporates the three pillars of sustainability: social, economic, and environmental, and includes issues such as downstream flow regimes, indigenous peoples, biodiversity, infrastructure safety, resettlement, water quality, and erosion and sedimentation. The Protocol assesses the four main stages of hydropower development: Early Stage, Preparation, Implementation and Operation. Assessments rely on objective evidence to create a sustainability profile against some 20 topics depending on the relevant stage, covering all aspects of sustainability. The process undertaken is compliant with these overarching principles.

1.4 LISTED ACTIVITIES IN TERMS OF NEMA

NEMA is the primary legislation tasked with management of environmental resources and accordingly, identifies activities that require authorisation prior to commencement. NEMA, as amended, establishes the principles for decision-making on matters affecting the environment. Section 2 sets out the National Environmental Management Principles which apply to the actions of organs of state that may significantly affect the environment. Furthermore, Section 28(1) states that "every person who causes or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring". If such pollution or degradation cannot be prevented then appropriate measures must be taken to minimise or rectify such pollution or degradation.

Boegoeberg Hydro has the responsibility to ensure that the proposed activities, as well as the EIA process, conform to the principles of NEMA. In developing the EIA process, Aurecon has been cognisant of this need, and accordingly the EIA process has been undertaken in terms of the NEMA and the EIA Regulations promulgated on 18 June 2010.

In terms of the EIA regulations, certain activities are identified, which require authorisation from the competent environmental authority, in this case DEA, before commencing. Listed activities in Government Notice (GN) No. 545 require Scoping and EIA whilst those in GN No. 544 and 546 require a Basic Assessment (unless they are being assessed under an EIA process). The proposed project requires authorisation for activities listed in GN No. 544, 545 and 546 and, therefore, a Scoping and EIA process is required. Activities triggered by the proposed project are tabulated in **Table 1-3**.

Table 1-3 | Listed activities in terms of NEMA GN No. 544, 545 and 546, 18 June 2010, to be authorised for the proposed hydropower station and associated infrastructure

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
GN No. R544, 18 June 2010		
1	The **construction of facilities or infrastructure for the generation of electricity where**: i. **the electricity output is more than 10 megawatts but less than 20 megawatts**; or ii. the output is 10 megawatts or less but the total extent of the facility covers an area in excess of 1 hectare	The proposed hydropower station would have an electricity output of approximately **11MW**.
10	The **construction of facilities or infrastructure for the transmission and distribution of electricity:** i. **outside urban areas or industrial complexes with a capacity of more than 33 but less than 275 kilovolts**; or ii. inside urban areas or industrial complexes with a capacity of 275 kilovolts or more.	The hydropower plant would connect to the Eskom grid at the Fibre Substation via a **transmission line of not more than 132 kV capacity.**

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
11	The **construction of**: **i. canals;** ii. channels; iii. bridges; iv. dams; v. weirs; vi. bulk storm water outlet structures; vii. marinas; viii. jetties exceeding 50 square metres in size; ix. slipways exceeding 50 square metres in size; x. buildings exceeding 50 square metres in size; or **xi. infrastructure or structures covering 50 square metres or more** **where such construction occurs within a watercourse or within 32 metres of a watercourse**, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	The **footprint** of the proposed hydropower plant, which would be constructed within and **adjacent to the Orange River**, **would exceed 50 square metres and a canal may be required**.
18	The **infilling or depositing of any material of more than 5 cubic metres into**, or the dredging, excavation, removal or moving of soil, sand, shells, shell grit, pebbles or rock from i. **a watercourse**; ii. the sea; iii. the seashore; iv. the littoral active zone, an estuary or a distance of 100 metres inland of the high-water mark of the sea or an estuary, whichever distance is the greater- but excluding where such infilling, depositing, dredging, excavation, removal or moving i. is for maintenance purposes undertaken in accordance with a management plan agreed to by the relevant environmental authority; or ii. occurs behind the development setback line.	During construction of the proposed hydropower plant **more than 5 cubic metres of material could be removed from the Orange River**. **Infilling** may be required just upstream of the weir on the northern side of the off-take structure) near the intake structure. Furthermore a temporary coffer dam will be required for the construction phase.
23	The **transformation of undeveloped**, vacant or derelict **land to** – (i) residential, retail, commercial, recreational, industrial or institutional use, inside an urban area, and where the total area to be transformed is 5 hectares or more, but less than 20 hectares, or (ii) residential, retail, commercial, recreational, **industrial** or institutional use, **outside**	The **footprint** of the proposed hydropower plant, associated infrastructure including that of the construction site and access roads would **exceed 1 hectare on undeveloped land**.

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	an urban area and where the total area to be transformed is bigger than 1 hectare but less than 20 hectares; - except where such transformation takes place – (i) for linear activities; or (ii) for purposes of agriculture or afforestation, in which case Activity 16 of Notice No. R. 545 applies.	
GN No. R545, 18 June 2010		
10	The **construction** of facilities **or infrastructure for the transfer of 50 000 cubic metres or more water per day**, from and to or **between** any combination of the following: (i) water catchments, (ii) water treatment works; or (iii) **impoundments**, i. excluding treatment works where water is to be treated for drinking purposes.	The proposed hydropower station would involve the transfer of **more than 50, 000m^3 per day from and back into the Orange River**.
GN No. R546, 18 June 2010		
4	**The construction of a road wider than 4 metres** with a reserve less than 13,5 metres. (a) In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and **Northern Cape** provinces: i. In an estuary; ii. **Outside urban areas, in**: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) **National Protected Area Expansion Strategy Focus areas;** (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an International Convention; (ee) Critical biodiversity areas as identified in systematic biodiversity plans adopted by the competent authority or in bioregional plans; (ff) Core areas in biosphere reserves; (gg) Areas within 10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core areas of a biosphere reserve;	**Access roads** to the hydropower station **would be upgraded to approximately 6 m in width** and will be partly in a **National Protected Area Expansion Strategy Focus area**.

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
	(hh) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined. iii. In urban areas: (aa) Areas zoned for use as public open space; (bb) Areas designated for conservation use in Spatial Development Frameworks adopted by the competent authority or zoned for a conservation purpose; (cc) seawards of the development setback line or within urban protected areas.	
13	The **clearance of an area of 1 hectare or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation**, except where such removal of vegetation is required for: (1) the undertaking of a linear activity falling below the thresholds mentioned in Listing Notice 1 in terms of GN No. 544 of 2010. **Northern Cape** and Western Cape: i. In an estuary; **ii. Outside urban areas, the following**: (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) **National Protected Area Expansion Strategy Focus areas;** (cc) Sensitive areas as identified in an environmental management framework as contemplated in chapter 5 of the Act and as adopted by the competent authority; (dd) Sites or areas identified in terms of an International Convention; (ee) Core areas in biosphere reserves; (ff) Areas within10 kilometres from national parks or world heritage sites or 5 kilometres from any other protected area identified in terms of NEMPAA or from the core area of a biosphere reserve; (gg) Areas seawards of the development setback line or within 1 kilometre from the high-water mark of the sea if no such development setback line is determined.	The **associated infrastructure i.e roads and transmission line, borrow pits, and construction site** of the proposed hydropower station would be greater than **1 hectare (ha) and will be located in part of a National Protected Area Expansion Strategy Focus Area**

NO.	LISTED ACTIVITIES	ASPECT OF PROJECT
14	The **clearance of an area of 5 hectares or more of vegetation where 75% or more of the vegetative cover constitutes indigenous vegetation**, except where such removal of vegetation is required for: (a) purposes of agriculture or afforestation inside areas identified in spatial instruments adopted by the competent authority for agriculture or afforestation purposes; (b) the undertaking of a process or activity included in the list of waste management activities published in terms of section 19 of the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) in which case the activity is regarded to be excluded from this list; (c) the undertaking of a linear activity falling below the thresholds in Notice 544 of 2010.	The **footprint** of the proposed hydropower station together with associated infrastructure (such as roads and transmission lines) **could be greater than 5 ha and would be located in an area of at least 75 % indigenous vegetation**.
16	The **construction of:** i) jetties exceeding 10 square metres in size; ii) slipways exceeding 10 square metres in size; iii) buildings with a footprint exceeding 10 square metres in size; or **iv) infrastructure covering 10 square metres or more** **(a)** In Eastern Cape, Free State, KwaZulu-Natal, Limpopo, Mpumalanga and **Northern Cape:** i. In an estuary; ii. **Outside urban areas, in:** (aa) A protected area identified in terms of NEMPAA, excluding conservancies; (bb) **National Protected Area Expansion Strategy Focus areas**; where such construction occurs within a watercourse or within 32 metres of a watercourse, measured from the edge of a watercourse, excluding where such construction will occur behind the development setback line.	The **footprint** of the proposed hydropower facilities infrastructure, which would be constructed within and adjacent to the Orange River, would be **greater than 10 square metres and will be partly in National Protected Area Expansion Strategy Focus areas**.

1.5 APPLICABILITY OF NEM:WA TO THE PROPOSED PROJECT

The NEM:WA aims to regulate waste management in order to protect health and the environment by providing reasonable measures for the prevention of pollution and ecological degradation, and for facilitating the ecological sustainability of the development. The Act also defines the institutional arrangements required for the management of waste and provides the norms and standards for regulating the management of waste. The Act makes provision for the licensing of waste management activities as well as compliance and enforcement thereof.

Spoil (excavated earth materials) as General Waste:
According to Annexure 1 of the Waste Classification and Management Regulations, *"Excavated earth material not containing hazardous waste or hazardous chemicals"* is considered to be General Waste.

The construction phase of the proposed hydropower facility, in particular the construction of the water conveyance structure and removal of siltation, would generate general waste. At the time of the release of the Draft EIR it was understood that activity number 5, as listed in terms of NEM:WA Category B would be triggered by the storage of spoil and would need to be authorised for the proposed hydropower station. However, subsequent to the release of the Draft EIR, the Waste Classification and Management Regulations were updated and Category C was added to listed activities in terms of NEM:WA (GN 921, 29 November 2013). Activities under Category C need to meet the norms and standards[7] which is the foundation of the regulatory system established in terms of Section 7(1)(c) of the NEM:WA. Also, they must simply be registered with the Department and do not require a waste management license. As such, Boegoeberg Hydro will register these activities with the Department should their EIA application be successful. The water conveyance infrastructure would be required to transport the water from the intake structure to the power chamber. As discussed in detail in **Section 3.1.1** of the report, two alternatives are being assessed, namely a canal structure and a tunnel to convey the water. These structures require that materials are excavated, which are referred to as spoil materials[8]. The quantities of spoil that would be produced per alternative structure would be:

- *Tunnel (preferred option):* An approximate total of 115,000m³ spoil materials will be excavated from the weir, tunnel, power chamber, and tailrace. The largest amount of spoil would be generated by the construction of the tailrace. Off-take 20,000; tunnel 15,000; powerhouse, 35,000; tailrace 45,000: total 115,000
- *Canal:* An approximate total of 180,000 to 200,000 m³ spoil material will be excavated from the weir, canal, power chamber, and tailrace. The largest amount of spoil would be generated by the excavation of the canal.

Removal of sedimentation/silt (current practices and proposed dredging)

In addition to the management of spoil material excavated during the construction of the water conveyance structures, the removal of silt would also result in the production of spoil material.

Sedimentation of the Boegoeberg Dam is both an historical and on-going problem with approximately half its capacity lost to sedimentation according to DWA[9]. Sediment currently constrains inflow into the existing irrigation scheme and may impact on the sustainability of the proposed Boegoeberg Hydro Electric Project, although the effect on flow patterns arising from the operation of the hydroelectric project is not yet known. The developers of the Boegoeberg Hydro Electric Project are committed to the sustainability of both the project and the irrigation scheme. However, the current practice of

[7] Norms and standards provide requirements as to how waste should be stored in terms of NEM:WA.
[8] Spoil materials can be defined as refuse materials removed from an excavation and can contain rock, sand etc.
[9] http://www.dwaf.gov.za/Orange/Low_Orange/boegoebe.aspx

draining the storage to discharge built-up sediment on a regular basis will impact negatively on the financial viability of the hydroelectric project.

The current sediment management practice includes leaving the two sluice gates closest to the irrigation off-take partially open on a permanent basis to prevent sediment settling in front of the off-take. This practice releases water that could be used for the generation of hydropower. Alternatively, this release could be allowed to remain to contribute to the environmental flow for the project. An added benefit of ceasing the flow through the sluices would be that the water would have to pass over the weir crest, which would result in a less concentrated flow of water downstream of the weir. A relatively even flow of water over the crest of the weir also would result in the more even distribution of sediment downstream.

However, to achieve the above, i.e. closing of the two partially open sluices that are open on a permanent basis, would require an alternative solution. The proposed solution is to station a dredger on site to maintain a clear flow path to the hydroelectric project intake and the irrigation intake. The dredger would undertake periodic dredging, which would remove accumulated sediments; however, without the loss of water stored behind the weir wall. By implication, valuable water within the Orange River System will be retained for irrigation and electricity generation except in cases where sluices must be opened to maintain the requisite environmental flows.

The proposal is that sediment material removed from the weir basin will be drained and dried in sediment basins located near the proposed power chamber (**Figure 26**). It is proposed to sell the dry sediment to third parties for commercial applications, such as fill or building material. The process of obtaining the necessary mining permits from the Department of Mineral Resources (DMR) is currently being undertaken. As mentioned above, the sediment would fall under Category C and would need to meet the prescribed norms and standards for such material. Accordingly, Boegoeberg Hydro must register this with DMR.

The potential solution to sell the dredged material has been communicated with DWA during a meeting held on 25 November 2013 to discuss the proposed project in greater detail. DWA is agreeable to the idea of this sediment management program and have indicated their support for the removal of sediment from the Boegoeberg Dam. Studies are currently underway to enable the preparation of a detailed sediment management plan and precise details of how dredging will be undertaken. Further details on the proposed dredging operation are provided in **Section 3.1**.

1.6 COMPLIANCE OF THIS EIA WITH THE EQUATOR PRINCIPLES

The Equator Principles form a risk management framework which is adopted by private sector financial institutions, for determining, assessing and managing environmental and social risk in projects. The primary goal is to provide a minimum standard for due diligence, allowing for responsible risk decision-making. The principles, with an assessment of the compliance of this proposed project, are listed in **Table 1-4** below.

Table 1-4 | Compliance with the Equator Principles

Equator Principle	Summary of the Principle	Compliance
Principle 1: Review and Categorisation	When a Project is proposed for financing, an Equator Principle Finance Institution (EPFI) will, as part of its internal environmental and social review and due diligence, categorise it based on the magnitude of its potential environmental and social risks and impacts. Such screening is based on the environmental and social	This project is regarded as a Category B project.

	categorisation process of the International Finance Corporation (IFC). Using categorisation, the EPFI's environmental and social due diligence is commensurate with the nature, scale and stage of the Project, and with the level of environmental and social risks and impacts. The categories are: Category A – Projects with potential significant adverse environmental and social risks and/or impacts that are diverse, irreversible or unprecedented; Category B – Projects with potential limited adverse environmental and social risks and/or impacts that are few in number, generally site-specific, largely reversible and readily addressed through mitigation measures; and Category C – Projects with minimal or no adverse environmental and social risks and/or impacts.	
Principle 2: Environmental and Social Assessment	In terms of the EP, Category B Projects must undergo an Assessment process to address the relevant environmental and social risks and impacts of the proposed Project. The Assessment Documentation should propose measures to minimise, mitigate, and offset adverse impacts in a manner relevant and appropriate to the nature and scale of the proposed Project.	The EIA has been undertaken to comply with this principle.
Principle 3: Applicable Environmental and Social Standards	The Assessment process must comply with relevant host country laws, regulations and permits that pertain to environmental and social issues.	The EIA has been undertaken in compliance with the relevant legislation in South Africa
Principle 4: Environmental and Social Management System and Equator Principles Action Plan	For all Category A and Category B Projects, the Project proponent must develop or maintain an Environmental and Social Management System (ESMS). An Environmental and Social Management Plan (ESMP) must be prepared to address issues raised in the Assessment process and incorporate actions required to comply with the applicable standards.	The ESMS would be a Project proponent responsibility outside of this EIA (post receipt of an Environmental Authorisation). An Environmental Management Programme (EMPr) has been included as an annexure to the EIR.
Principle 5: Stakeholder Engagement	For all Category A and Category B Projects, Stakeholder Engagement is required as an ongoing process in a structured and culturally appropriate manner with Affected Communities. The consultation process must be tailored to the risks and impacts of the Project; the Project's phase of development; the language preferences of the Affected Communities; their decision-making processes; and the needs of disadvantaged and vulnerable groups. This process should be free from external manipulation, interference, coercion and intimidation.	A consultation process has been undertaken in line with South African legal requirements and appropriate to the risks arising from the project and level of concern raised by the interested and affected parties.
Principle 6: Grievance Mechanism	For all Category A and, as appropriate, Category B Projects, the Project proponent, as part of the ESMS, must establish a grievance mechanism designed to receive and facilitate resolution of concerns and grievances about the Project's environmental and	This would need to be developed by the Project proponent as part of the ESMS but it not considered essential to this category of

	social performance. The grievance mechanism is required to be scaled to the risks and impacts of the Project and have Affected Communities as its primary user.	project at the EIA stage.
Principle 7: Independent Review	For all Category A and, as appropriate, Category B Projects, an Independent Environmental and Social Consultant, not directly associated with the Project proponent, will carry out an Independent Review of the Assessment Documentation including the SMPs, the ESMS, and the Stakeholder Engagement process documentation in order to assess Equator Principles' compliance.	This is not considered essential to this category of project, given that the impacts are not considered to have significant environmental or risks.
Principle 8: Covenants	Furthermore for all Category A and Category B Projects, the Project proponent will covenant the financial documentation: a) to comply with the ESMPs and Equator Principles Action Plan (where applicable) during the construction and operation of the Project in all material respects; and b) to provide periodic reports in a format agreed with the EPFI (with the frequency of these reports proportionate to the severity of impacts, or as required by law, but not less than annually), prepared by in-house staff or third party experts, that i) document compliance with the ESMPs and Equator Principles Action Plan (where applicable), and ii) provide representation of compliance with relevant local, state and host country environmental and social laws, regulations and permits; and c) to decommission the facilities, where applicable and appropriate, in accordance with an agreed decommissioning plan.	This is the Project proponent's responsibility for the duration of the construction and operational phases of the project.
Principle 9: Independent Monitoring and Reporting	To assess Project compliance with the Equator Principles and ensure ongoing monitoring and reporting after Financial Close and over the life of the loan, the EPFI will, for all Category A and, as appropriate, Category B Projects, require the appointment of an Independent Environmental and Social Consultant, or require that the Project proponent retain qualified and experienced external experts to verify its monitoring information which would be shared with the EPFI.	This is the Project proponent's responsibility for the duration of the construction and operational phases of the project.
Principle 10: Reporting and Transparency	The following Project proponent reporting requirements are in addition to the disclosure requirements in Principle 5. For all Category A and, as appropriate, Category B Projects, the Project proponent will ensure that, at a minimum, a summary of the ESIA is accessible and available Online.	This will be available on the Aurecon website for the duration of the public review periods for the draft and final EIRs until after the Appeal period has passed.

1.7 COMPLIANCE OF THIS EIA WITH THE INTERNATIONAL FINANCE CORPORATION'S PERFORMANCE STANDARDS

The IFC Performance Standards are typically applied by international public sector financial institutions to manage environmental and social risks and impacts so that development opportunities are enhanced. The IFC has identified eight Performance Standards that establish criteria to be met

throughout the life of a project. These, with an assessment of the compliance of this proposed project, are outlined in **Table 1-5** below:

Table 1-5 | Compliance with the IFC PS

IFC Performance Standard	Description of the Performance Standard	Compliance
Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.	Performance Standard 1 has relevance to the undertaking of the ESIA process specifically, as it deals with the importance of: Integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; Effective community engagement with local communities; and Management of environmental and social performance throughout the life of the project.	The EIA has been undertaken to comply with these principles.
Performance Standard 2: Labour and Working Conditions.	Performance Standards 2 to 8 deal with management of impacts, emphasising the need to avoid such impacts as far as possible and where these cannot be avoided, to minimise them as far as possible. Notwithstanding this objective, it is recognised that residual impacts to workers, affected communities and the environment may remain, which may need to be managed through compensation and/or offsets.	This will form part of the conditions of engagement with contractors.
Performance Standard 3: Resource Efficiency and Pollution Prevention		These principles have been incorporated into the Environmental Management Programme.
Performance Standard 4: Community Health, Safety, and Security.		These principles have been incorporated into the Environmental Management Programme.
Performance Standard 5: Land Acquisition and Involuntary Resettlement		While the project entails limited land acquisition, the project will not result in involuntary resettlement.
Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources.		These principles have been addressed in the specialist studies and incorporated into the Environmental Management Programme.
Performance Standard 7: Indigenous Peoples.		There are no known indigenous people affected by the proposed project.
Performance Standard 8: Cultural Heritage		This aspect was addressed in the relevant specialist studies, i.e. a Cultural Heritage Impact Assessment.

1.8 SCOPE OF THE EIA

This EIA identifies and assesses the impacts that might arise should the proposed Boegoeberg Hydropower Station be constructed on the banks of the Orange River near Groblershoop. Arising from the issues and potential impacts identified during Scoping, Aurecon appointed the following independent specialists (refer to **Annexure D** for declarations of independence):

- Botanical – Dr D. McDonald (Bergwind Botanical Surveys and Tours cc);
- Aquatic – Mr J. MacKenzie (Mackenzie Ecological & Developmental Services CC);
- Heritage – Dr J. Orton (ACO Associates CC);
- Avifauna – Dr Andrew Jenkins (Avisense CC);
- Palaeontology-- Dr John Almond (Natura Viva); and
- Transport-- Dr WR Duff-Riddell (Aurecon).

The specialists have identified and comprehensively assessed the impacts for each of the environmental aspects associated with the proposed project. The findings of these assessments are included in **Section 0** of this report, with the full reports being provided in **Annexure D**.

Aurecon assimilated the specialist information and assessment outcomes in order to provide an integrated assessment of the proposed Boegoeberg Hydropower Station.This EIA process was informed by the series of national Environmental Guidelines[10] where applicable and relevant:

- Integrated Environmental Information Management (IEIM), Information Series 5: Companion to the NEMA EIA Regulations of 2010 (DEA, 2010);
- Implementation Guidelines: Sector Guidelines for the EIA Regulations (draft) (DEA, 2010);
- IEIM, Information Series 2: Scoping (Department of Environmental Affairs and Tourism (DEAT), 2002);
  IEIM, Information Series 3: Stakeholder Engagement (DEAT, 2002);
- IEIM, Information Series 4: Specialist Studies (DEAT, 2002);
- IEIM, Information Series 11: Criteria for Determining Alternatives in EIA (DEAT, 2004);
- IEIM, Information Series 12: Environmental Management Plans (DEAT, 2004);
- Integrated Environmental Management Guideline Series, Guideline 4: Public Participation, in support of the EIA Regulations. Unpublished (DEAT, 2005);
- Integrated Environmental Management Guideline Series: Detailed Guide to Implementation of the Environmental Impact Assessment Regulations. Unpublished (DEAT, 2007);
- Integrated Environmental Management Guideline Series (Guideline 7). Public Participation in the Environmental Impact Assessment Process (DEA, 2012); and
- DEA. Guideline on Need and Desirability (GN 792 of 2012 in Government Gazette (GG) 35746).

The following guidelines from the Department of Environmental Affairs and Development Planning (Western Cape) (DEA&DP) were also taken into consideration:

- Brownlie. 2005. Guideline for involving biodiversity specialists in the EIA process (June 2005),
- Winter & Baumann. 2005. Guideline for involving heritage specialists in the EIR process (June 2005),
- Guideline for Environmental Management Plans (June 2005),
- Guideline for determining the scope of specialist involvement in EIA Processes (June 2005),
- Guideline for the review of specialist input into the EIA Process (June 2005),
- Guideline on Alternatives. EIA Guideline and Information Document Series. (DEA&DP, October 2011),

[10] Note that these Guidelines have not yet been subjected to the requisite public consultation process as required by Section 74 of R385 of NEMA.

- Guideline on Need and Desirability. EIA Guideline and Information Document Series. (DEA&DP, October 2011); and
- Guideline on Public Participation. EIA Guideline and Information Document Series. (DEA&DP, October 2011).

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2 EIA METHODOLOGY

The purpose of this Chapter is to provide the reader with an overview of the EIA approach and methodology, public participation activities and stakeholder engagement, issues raised and an appreciation of the assumptions, limitations and gaps in knowledge prevalent at the time that this EIA was undertaken.

2.1 APPROACH TO THE PROJECT

As outlined in **Figure 2** there are three distinct phases in the EIA process, namely the Application, Scoping and EIA Phases. A description of the activities which have been, and will be, undertaken during each phase is provided in the following sections. Note that this report covers the third phase, *viz.* the Environmental Impact Assessment Report.

2.1.1 Application Phase

The Application Phase entailed the submission of an EIA Application Form to DEA, submitted on **13 June 2013** to apply for listed activities that would have required a Basic Assessment process. The application was submitted along with a cover letter requesting clarification on the applicability of activity listing 10 of Listing Notice 2 (NEMA) to the proposed project and the NEMA process to be followed. Acknowledgement of receipt of the EIA Application Form was received from DEA on **4 July 2013**. However, DEA rejected the application citing that activity listing 10 of Listing Notice 2 was applicable and indicated that a new application should be made. The updated Application Form was submitted on **4 July 2013**, applying for listed activities that would require a Scoping and EIA process. Acknowledgement of receipt of the new EIA Application Form was received from DEA on **12 July 2013**. The Application Form and DEA's letter of acknowledgement are included in **Annexure A**. The DEA reference numbers are indicated in **Table 2-1**.

Table 2-1 | DEA assigned reference numbers

DEA Ref No	NEAS Ref No
14/12/16/3/3/2/568	DEA/EIA/0001942/2013

Other tasks undertaken include:

- A Letter of Notification (included in **Annexure A**), in English and Afrikaans, was sent to directly affected landowners on **12 June 2013** to inform them of the proposed project and to invite them to register as Interested and Affected Parties (I&APs).

2.1.2 Scoping Phase

Scoping is defined as a procedure for determining the extent of, and approach to, the EIA phase and involves the following key tasks:

- Identification and involvement of relevant authorities and I&APs in order to elicit their interest in the project;
- Engagement with relevant authorities and I&APs;
- Identification and selection of feasible alternatives to be taken through to the EIA Phase;
- Identification of significant issues and/or impacts associated with each feasible alternative to be examined in the EIA; and

- Determination of a suitable methodology for the assessment and specific Terms of Reference (ToR) for any specialist studies required (Plan of Study for the EIA).

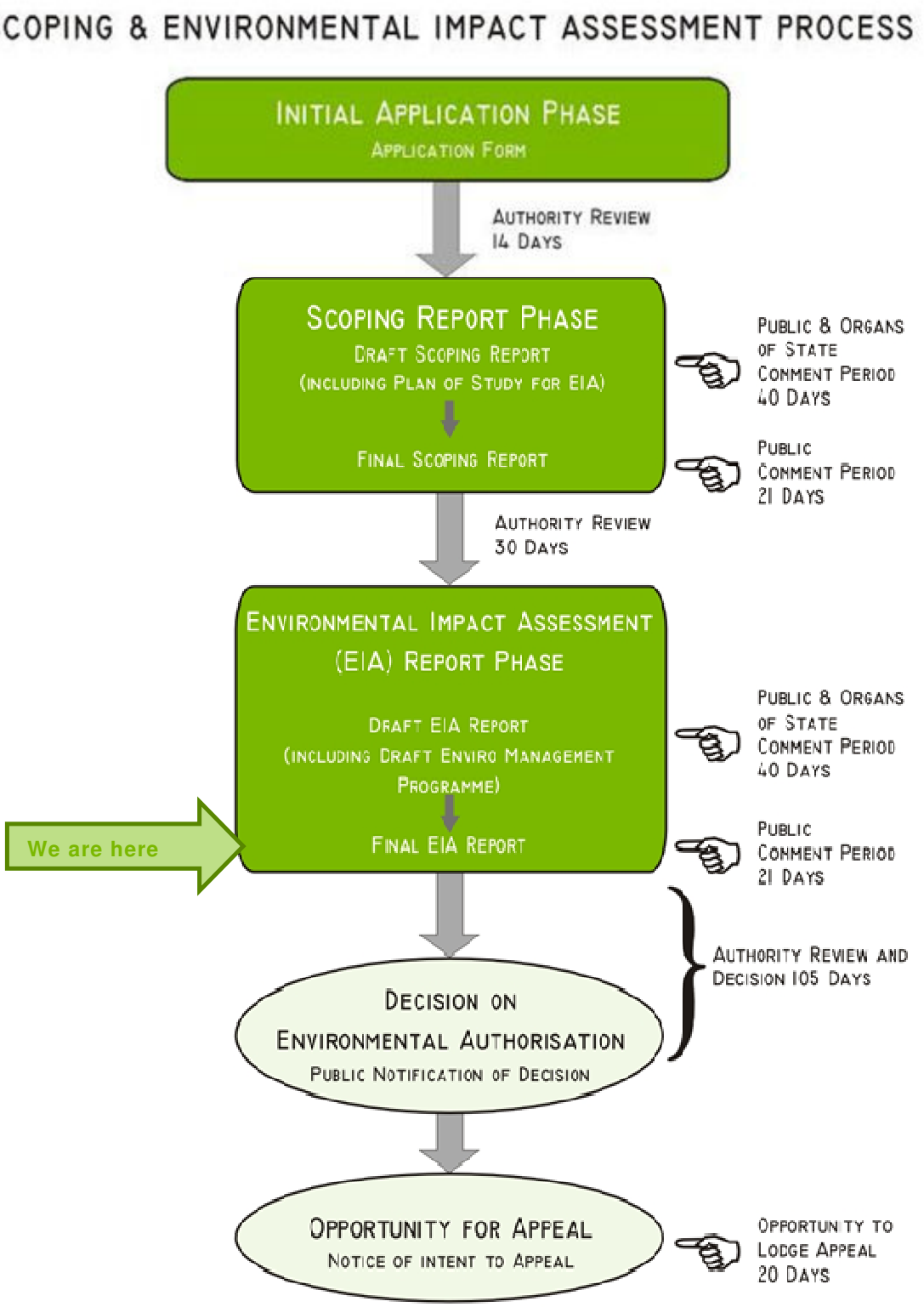

Figure 2 | The EIA comment periods process in terms of NEMA

The Scoping Phase involved a desktop review of relevant literature, including a review of previous environmental studies in the area:

- Proposed hydropower station on the Orange River near Kakamas, Northern Cape: Final BAR (Aurecon, 2011);
- Siyathemba IEMP (African EPA, 2007);
- !Kheis Local Municipality Integrated Development Plan (IDP), 2012 – 2017;
- Siyanda District Municipality Integrated Development Plan (IDP), 2012/2013 – 2017;
- Siyanda District Municipality Environmental Management Framework, 2008;
- Vegetation Map of South Africa (Mucina & Rutherford, 2006);
- ORASECOM. *Environmental Considerations Pertaining to the Orange River.* (RP (Pty) Ltd., Jeffares Green Parkman Consultants (Pty) Ltd, Sechaba Consultants, Water Surveys Botswana and Windhoek Consulting Engineers, 2007);
- ORASECOM. (2010). *Support to Phase 2 of the ORASECOM Basin-wide Integrated Water Resources Management Plan: Environmental Flow Requirements Volume 1 (W*RP, 2010)
- Proposed hydropower station on the Orange River in the vicinity of Augrabies, Northern Cape: Draft BAR (Aurecon, 2012).

An inception field trip took place on 21 June 2013 by the Aurecon EIA team and the proponent involving also landowners. The purpose of the field trip was to gain an understanding of key aspects such as:

- Biophysical aspects, including:
    - Terrestrial fauna and flora including avifauna;
    - Surface water resources;
    - Ecologically sensitive areas; and
    - Vegetation types on site.
- Socio-economic aspects, including:
    - Heritage issues;
    - Land use, including agricultural potential;
    - Visual and aesthetic matters including the location of the project in terms of roads, topography and proximity to houses;
    - Location of local communities;
    - Dust;
    - Employment opportunities; and
    - Tourism.

The information gathered during the site visit was used in refining the Plan of Study for the EIA and the ToR for the specialist studies to be undertaken during the EIA.

The Scoping Phase culminated in the preparation of a Scoping Report which included the information gathered during the desktop study and the site visit. The Scoping Report also outlined the Plan of Study for the EIA and provided the ToR for the specialist studies. Following the required public consultation and authority review, the Final Scoping Report was accepted by the DEA on 17 October 2013 enabling the EIA process to proceed. A copy of the acceptance letter is included in **Annexure A**.

2.1.3 EIA Phase

The Scoping Phase was followed by the EIA Phase. The specialist investigations undertaken in accordance with the Plan of Study for EIA are indicated in **Table 2-2**.

Table 2-2 | Specialist studies undertaken per the Plan of Study for the EIA

Study	Consultant and Organisation
Archaeological & Heritage Assessment	Mr Jayson Orton (ACO Associates)
Aquatic Ecology Assessment	Mr James MacKenzie (Mackenzie Ecological and Development Services)
Avifauna Assessment	Dr Andrew Jenkins (Avisense)
Botanical Assessment	Dr Dave MacDonald (Bergwind Botanical Surveys)

In response to comments received during the Scoping Phase, it was deemed prudent to also evaluate Palaeontological and Transport impacts. The following assessments were thus also undertaken (**Table 2-3).**

Table 2-3 | Additional desktop assessments undertaken

Study	Consultant and Organisation
Palaeontological Assessment	Dr John Almond (Natura Viva)
Transport Statement	Dr WR Duff-Riddell (Aurecon)

The EIA has culminated in a comprehensive EIA report which documents the outcomes of the abovementioned specialist investigations. The findings of the specialist investigations are summarised in **Section 0** and the full reports are included in **Annexure D**.

2.2 THE PUBLIC PARTICIPATION PROCESS

Consultation with affected stakeholders and the public forms an integral component of this investigation and achieves the following:

- Enables stakeholder groups and I&APs to identify their issues and concerns about the proposed activities, ensuring that these are addressed in the EIA process; and
- Creates a transparent process and ensures that I&APs are well informed about the project.

As much information as was available at any given time has been provided to inform I&APs who were afforded numerous opportunities to review and comment on the proposed project. Currently there are **109** I&APs registered on the project database (see **Annexure B** for a list of I&APs). The Public Participation Process is indicated in **Figure 2** as part of the EIA process.

The objectives of public participation are to provide information to the public, identify key issues and concerns at an early stage, respond to the issues and concerns, provide review opportunities, and to accurately document the process, and issues raised and responses provided. The PPP has been managed to meet these objectives throughout the EIA. Authority and stakeholder engagement undertaken to date is summarised in **Table 2-4**.

Table 2-4 | Summary of authority and stakeholder engagement to date

Task	Details	Date
Stakeholders notification (relevant authorities and I&APs)		
Submission of Applications for Authorisation	The revised application for environmental authorisation was submitted to DEA. Refer to **Annexure A** for proof of submission as well as the Acknowledgment of Receipt from DEA.	**4 July 2013**

Task	Details	Date
Stakeholder Identification	The initial database of I&APs included the directly affected landowners, the adjacent landowners, relevant district and local municipal officials, relevant national and provincial government officials, and environmental and other community organisations in the area. This database was augmented via chain referral during the EIA process, and was updated as new I&APs were identified throughout the project life-cycle. The list of I&APs is included in **Annexure B**.	**July 2013**
Site Notices	Site notices, in English and Afrikaans, were placed at the entrance of the proposed Boegoeberg Hydro Electric Project; the Groblershoop Public Library, and !Kheis Local Municipality offices. Proof of site notices are included in **Annexure B.**	**17 July 2013**
Newspaper Advertisements	Advertisements were placed in the following newspapers (refer to **Annexure B** for copies of the advertisements): • Kalahari Bulletin; and • Die Volksblad.	**18 July 2013** **17 July 2013**
Review of Scoping Reports		
I&APs and Authorities	All registered I&APs were informed of the availability of the draft and final Scoping Reports by means of post and/ or email. Relevant state departments, as listed in **Annexure B,** were notified of the reports and requested to submit comments. Copies of the Scoping Reports were made available for review at the following places: • Groblershoop Public Library; and • !Kheis Local Municipality in Groblershoop The reports were also available on the Aurecon website[11]. Electronic copies (CD) of the reports were made available on request. Authorities and I&APs were provided with 40-days to review the Draft Scoping Report (DSR) and 21 days to review the Final Scoping Report (FSR), and were invited to submit comments in writing to the Aurecon team.	Comment period for the DSR: **17 July 2013 to 26 August 2013** Comment period for the FSR: **16 September 2013 to 10 October 2013**
Public Meeting	I&APs were invited to a public meeting on 7 August 2013 to discuss the findings of the DSR at the Groblershoop Library Hall, 97 Oranjestraat, Groblershoop at 17h00-19h00. I&APs were requested to RSVP by 29 July 2013. However, only one I&AP responded to the invitation (DWA) and the number of RSVPs was insufficient to warrant the meeting. It was, thus, cancelled and a meeting was held with DWA directly.	**7 August 2013 (cancelled)**
Addressing Comments Received	All comments received on the DSR were collated into a Comments and Responses Report 1 (CRR1). The responses to these comments from the proponent and the EAP were also provided in the CRR which was included in **Annexure B** of the FSR. All parties that submitted comments were provided with a copy of CRR2.	**17 July 2013 to 26 August 2013**
EIA Phase		
I&APs and Authorities	All registered I&APs were informed of the availability of the Draft EIA Report by means of post and or email. Relevant state departments, as listed in **Annexure B**, were notified of the report and requested to submit comments. Copies of the report were made available for review at the following places: • Groblershoop Public Library; and • !Kheis Local Municipality in Groblershoop. The report was also available on the Aurecon website. Electronic copies (CD) of the reports were made available on request. Authorities and I&APs were provided with 40-days to review the Draft EIA report and 21 days to review the Final EIA Report, and were invited to submit comments in writing to the Aurecon team.	Comment period for the Draft EIA Report: **2 December 2013 to 29 January 2014** Comment period for the Final EIA Report: **17 March 2014 to 7 April 2014**

[11] http://www.aurecongroup.com- indicate "Current Location" as "South Africa" and click on the "Public Participation" link.

Task	Details	Date
Focus Group Meetings	A Focus Group meeting with !Kheis Municipality representatives was held on 10 February 2014 at the Municipality Offices to discuss the findings of the Draft EIR. An additional Focus Group Meeting with the Boegoeberg Water Users Association (BWUA) was also held on 10 February 2014 at the Boegoeberg Hall. For the notes of these meetings and presentations, refer to Annexure B.	**10 February 2014**
Public Meeting	I&APs were invited to a public information session on 10 February 2014 to discuss the findings of the Draft EIR at the Boegoeberg Community Hall. For the notes of this meeting and presentations, refer to Annexure B.	**10 February 2014**
Addressing Comments Received	All comments received on the Draft EIA Report were collated into a Comments and Responses Report 3 (CRR3). The responses to these comments from the proponent and the EAP have been included in CRR3 which is annexed to the Final EIR. All parties that submitted comments will be provided with a copy of CRR3. All comments received on the FEIR will be forwarded to DEA for their consideration and decision making.	**January 2014**
Notification of DEA Decision-making		
Notification of the Department's Decision	All registered I&APs will be notified of DEA's decision within 12-days from the date of the decision. All registered I&APs will be notified of the Appeal process by means of letters sent by post or e-mail and an advert will be placed in Die Volksblad and the Kalahari Bulletin.	**TBA**

2.2.1 Issues Raised

All issues raised by I&APs and key stakeholders during the respective comment periods for the DSR and FSR were recorded in CRRs, along with responses from Boegoeberg Hydro and the EAP. CRR1, CRR2 and CRR3 include all comments raised on the DSR, FSR and DEIR, respectively and are included in **Annexure B**, along with copies of full comments received.

To date, the following key issues and/ or comments were raised by I&APs and authorities:

Comments on the DSR:

- Eskom made comment on the transmission lines crossing the river and the impact on avifauna;
- Department of Agriculture, Forestry & Fisheries (DAFF) requested EIA documentation;
- Neighbouring farmers requested that the study take into account the impacts on their roads due to increased traffic;
- WWF-SA registered as an I&AP but stated that they had no comments at this time,
- SAHRA requested that an opinion on the impacts on palaeontology must be provided,
- DWA requested information about the details of the project, process followed, advertising and approval of infrastructure on DWA land. Subsequent to DWA's request, a meeting with DWA representatives was held on 8 August 2013 where various aspects of the project were discussed, the minutes of which are included in CRR3 in **Annexure B**.

Comments on the FSR:

- David S Fourie of farm 307 & 308 Seekoeibaardsnek noted his concerns on the routing of the access road through his farm and requested firming up an agreement with regard to access control, livestock safety, proposed tarred sections for dust suppression and maintenance of the main road (required due to increased traffic).
- Department of Agriculture made comment with respect to the Conservation of Agricultural Resources Act (Act No. 43 of 1983) and that the project should take cognisance of the utilisation and protection of watercourses, flood areas and that rezoning would be applicable.

Comments on the DEIR:

- SAHRA stated that they have no objection to the project but provided conditions to be met;
- DoE stated that they are satisfied with the report and wished for a successful EA;
- DAFF provided a notice of receipt and confirmed that the application has been captured in their electronic AgriLand tracking and management system;
- Civil Aviation Authority (CAA) requested to be provided a .kml (Google Earth) file reflecting the footprint of the proposed development site including the proposed overhead electric power line route, also indicating the highest structure of the project and the overhead electric power transmission line; and
- South African National Roads Agency SOC Limited (SANRAL) had no comment, seeing that the national road will not be affected.

Main comments on the DEIR from Focus Group and Public Information Sessions:

!Kheis FGM

- Concern was expressed on how the project would affect the local community through social influences, HIV, tuberculosis, and, specifically, pregnancy, further straining existing health care facilities in the area due to imported labour;
- The number and type of jobs that would be created were queried, in particular, to enable the municipality to understand what types of skills training would be necessary to ensure the community would be ready when the development started; and
- It was queried if flooding has been taken into account.

BWUA FGM

- The Boegoeberg Water Users Association registered their concern that they had not been registered as stakeholders.
- They stated that there was not enough information about how dredging will be done (including removal of material from the dam to the sedimentation basins) and what guarantees can be given to ensure that water quality and flow will not be affected.
- Concern was raised that communication has not been directly with the Water Users Association. They stated that they do not want communication to come to them through DWA or any other body. They also stated that the EIA team should communicate directly with them.
- People will be affected for 120 km along the irrigation canal. They stated that economic development initiatives cannot be limited to a 50 km radius but must account for the full range of affected users along the canal.
- Concern was raised that promises have been made in other EIAs that have not been fulfilled – they requested guarantees to ensure there is full accountability and that all mitigation measures committed to will actually be implemented.
- Road deterioration in the area from construction vehicles on other projects is a major issue for residents in the area and a request was made to show workable solutions for this project.
- Concern was registered that the project would impact on the integrity of the dam wall and they need assurances in this regard.

The following concerns were raised in the Boegoeberg Public Information Session:

- Impact on fish migration from upstream to downstream.
- Impact on the resident Fish eagles.
- Impact of sediment deposited at the tailrace.
- How debris deposited during high flows would be cleaned and where would the material be dumped.
- How storm water would be managed.
- Effects on tourism from visual impacts and effects on recreational fishing activities.
- The impact of the removal of 100 year old trees and other indigenous vegetation.

- Road deterioration in the area from construction vehicles on other projects is a major issue for residents in the area and a request was made to show workable solutions for this project.
- Where the construction staff would be housed.
- A current occupier would lose his house which would impact on a tourism camp and 4x4 business[12].

Full comments along with responses are provided in the relevant CRRs for the entire process (**Annexure B)**.

2.2.2 Authority Involvement

Authorities have been involved with this project since the Application Phase. It is anticipated that beyond providing key inputs into the EIA, the continued involvement of authorities will ultimately expedite the process by ensuring that the final documentation satisfies the respective authority requirements and that the authorities are fully informed with respect to the nature and scope of the proposed hydropower facility. The following authorities and parastatals have been requested to comment on the proposed project:

- DEA;
- Siyathemba Local Municipality;
- Siyancuma Local Municipality;
- !Kheis Local Municipality;
- Siyanda District Municipality;
- DWA;
- DAFF;
- DEANC;
- Department of Agriculture, Land Reform & Rural Development (Northern Cape);
- SAHRA;
- Northern Cape Provincial Heritage: *Boswa ya Kapa Bokone*;
- Department of Energy (Northern Cape);
- Transport, Roads & Public Works (Northern Cape)
- SANRAL
- National Department of Transport
- Northern Cape Tourism Authority
- Eskom Holdings SOC Limited; and
- DoE.

2.2.3 Decision making

Based on the information presented in this Final EIR the competent authority, DEA, will make a decision regarding the EIA application. The Environmental Authorisation (EA) will either be to authorise the proposed activities (usually with conditions) or to reject the application for the proposed activities. [13]

Once DEA have made their decision on the proposed project, all registered I&APs on the project database will be notified of the decision within 12 calendar days of the Environmental Authorisation having been issued. As a minimum, the decision will be advertised in the Volksblad and Kalahari Bulletin newspapers used to inform I&APs of the proposed project. Should anyone (a member of public, a registered I&AP, or the Applicant) wish to appeal DEA's decision on the EIA application, a

[12] To the best knowledge of the proponent and EAP, based on the current understanding at the time of undertaking the EIA and drafting this Final EIR, the occupier of the land has no legal claim to the land.
[13] In the event that DEA requires additional information, this will be requested and, once provided, DEA will reconsider the submission.

Notice of Intention to Appeal in terms of Section 62 of NEMA must be lodged with the Minister of Water and Environmental Affairs within 10 calendar days of the I&AP being notified.

2.3 ASSUMPTIONS, LIMITATIONS AND GAPS IN KNOWLEDGE

In undertaking this investigation and compiling the EIR, the following has been assumed:

- The strategic level investigations undertaken by DoE regarding South Africa's proposed energy mix prior to the commencement of the EIA process are technologically acceptable and robust;
- The information provided by the Project proponent is accurate and unbiased; and
- The scope of this investigation is limited to assessing the environmental impacts associated with the proposed hydropower station and connections to the grid. The EIA does not include any infrastructure upgrades which may be required from Eskom to increase capacity in the local grid to accommodate the proposed project.

The gaps in knowledge that were evident during the Scoping Phase included:

- Total spoil amounts and the corresponding amount to be used for the farm revetments.
- Total amount of wearing course required from borrow pits for access roads.

The gaps in knowledge that were evident during the EIA Phase included:

- The specific method for dredging sediment in the Boegoeberg Dam.
- Quality and type of sediment that will be removed through dredging. This will only become available once sampling has been completed and will inform the detailed sedimentation plan.

The planning for the proposed project is at a feasibility level of detail and, therefore, some specific details are not available at this stage of planning. This EIA process forms part of the suite of feasibility studies, and as other studies progress, more information will become available which may not be available in the EIA process. DEA, and other authorities, will be requested to issue their comments and ultimately their environmental decision to inform the detailed design phase of the project to enable the type of refinements that typically occur after feasibility studies have been completed. Undertaking the EIA process in parallel with other feasibility studies does have a number of benefits, for example, integrating environmental aspects into the layout and design, ultimately encouraging a more environmentally sensitive and sustainable project.

2.3.1 Independence

The requirement for independence of the environmental assessment practitioner is aimed at reducing the potential for bias in the environmental assessment process. Neither Aurecon nor any of its sub-consultants are subsidiaries of Boegoeberg Hydro, nor is Boegoeberg Hydro a subsidiary of Aurecon. Furthermore, Aurecon does not have any interests in secondary or downstream developments that may arise out of the authorisation of the proposed project.

Aurecon selected a team of experienced specialists and multi-disciplinary practitioners in order to execute this EIA efficiently:

EIA Team
The Project Director, Mr Andries van der Merwe is appropriately qualified and registered with the relevant professional bodies. Mr van der Merwe is a certified Environmental Engineer registered with the Engineering Council of South Africa (PrEng) and holds a B Eng. (Civil) degree.

The Project Manager, Mrs Diane Erasmus is a Certified EAP with the Environmental Assessment Practitioners of South Africa (EAPSA). Mrs Erasmus is the designated EAP for the proposed project.
Mr Charles Norman is a senior environmental consultant at Aurecon and acts as an internal reviewer and to provide guidance where and when required.
Mr Simon Clark is an appropriately qualified member of the team with a BA in Environmental Management from the University of South Africa.

Aurecon is bound by the codes of conduct for SACNASP and EAPSA. The CV summaries of the key Aurecon staff are included in **Annexure E**.

3 THE PROPOSED PROJECT

The purpose of this Chapter is to describe the proposed project, including alternatives (which are discussed in terms of location, activity, site layout and technology), with specific reference to the construction, operation and decommissioning of the hydropower station

3.1 DESCRIPTION OF THE PROPOSED PROJECT

The proposed Boegoeberg Hydro Electric Project will be located on the farm Zeekoebaart (*Remainder of Farm no. 306 and Portion 1 of Farm no. 306*) located approximately 26 km south east of the town of Groblershoop in the Northern Cape, South Africa.

Coordinates of the middle point of the proposed power chamber	
29° 2'19.62"S	22°12'6.74"E

The proposed facility would be a run-of-river hydropower scheme capable of producing approximately 11 MW of electricity through two or three Kaplan turbines, each having equal capacity. Run-of-the-river facilities use conventional hydropower technology to produce electricity by using the natural flow and drop in elevation of a river, by diverting the flow and passing the water, under pressure, through a penstock (pipeline) to drive turbines. The water drives (spins) the turbines (due to the static head created between the inlet works and the low point at the outlet of the power house in which the turbines are located), which take potential energy from the water to generate electricity (in the same way that a coal-fired power station creates steam to turn turbines and wind turbines are turned by wind). Apart from storage afforded by the existing Boegoeberg Weir, there will be no additional storage of water in- or off-stream, and, therefore, the power station will be subject to seasonal river flows (and is unlikely to operate during low flow periods, thereby having negligible impact on the natural flow regime). The process of the generation and distribution of electricity through a run-of- the-river hydro plant is illustrated in **Figure 3**.

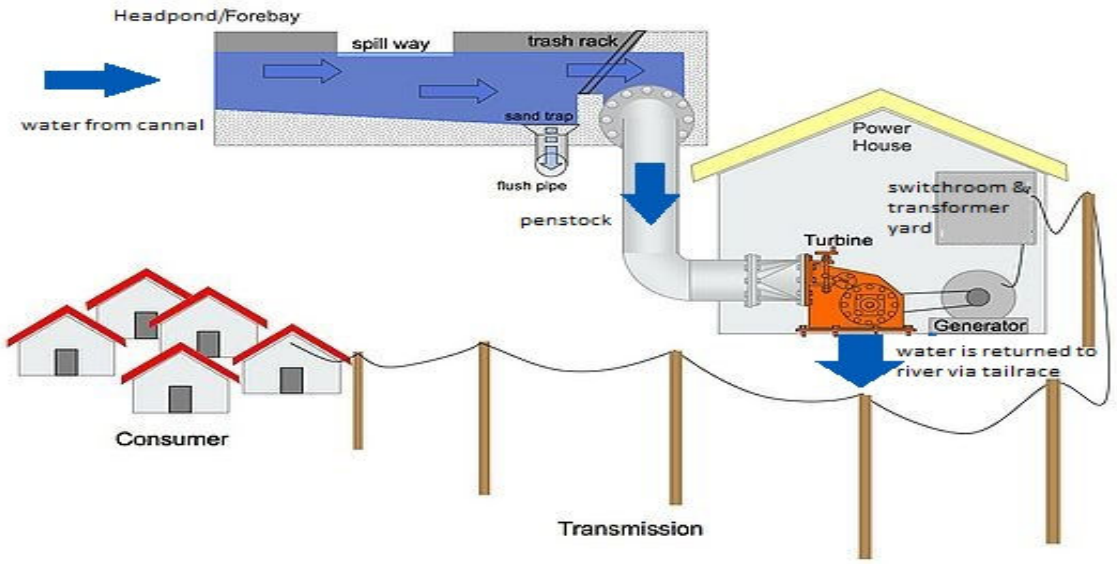

Figure 3 | Illustration of the electricity generation process for a run-of-river hydropower station [Source: https://energypedia.info (Accessed: 28 June 2013)]

According to Eskom's 2010 financial statements, the average Eskom residential customer uses approximately 212 kilowatt hours (kWh) per month. Current calculations show approximately 6,300,000 kWh hours of energy would be generated by the proposed facility per month, with a load factor of between 50% and 70% (depending on the time of year). It is estimated that the Boegoeberg Hydro Electric Project will generate enough energy to power, on average, 30,000 homes.

3.1.1 Components of the Hydropower Station

This section describes each component of the hydropower station in more detail.

A run-of-river hydropower station, as proposed, consists of the following main components (refer to **Figure 4** and the detailed description below):

- Intake infrastructure:
  - The existing Boegoeberg Weir
  - Off-take Weir (below the normal water surface level) constructed in the Boegoeberg Weir pool to regulate flow into the water conveyance infrastructure and provide a physical; barrier against the drawdown of water below agreed levels and to ensure irrigation and environmental flows
  - Inlet structure, which may contain up to two sluice gates (only applicable in the case of the canal alternative) that close automatically to stop flow to the power chamber in the event of floods~~;~~
- Temporary upstream caisson (coffer dam), which will be required in the weir pool to exclude water from the works during construction;
- Water conveyance infrastructure (i.e. canal or tunnel) to direct water from the river to the forebay;
- Head pond/ forebay allowing a steady flow to the turbines. The head pond also allows for the extraction of sediment from the water (only applicable in the case of the canal alternative);
- Power station intake structure/ penstock; comprising a sluice, gate or enclosed pipe intake structure, with screens preventing debris in the water from entering the penstock that conveys water to the turbines;
- Power chamber to house the turbines and equipment used to generate electricity;
- Sediment basins (for dredge spoil); and
- Outlet works/ tailrace to return the water back into the river, downstream of the power chamber.

Ancillary infrastructure includes access roads for use during construction and for maintenance purposes during operation, transmission line(s) for evacuating the energy produced by the hydropower station to the Eskom national grid, a switchroom, and transformer yard.

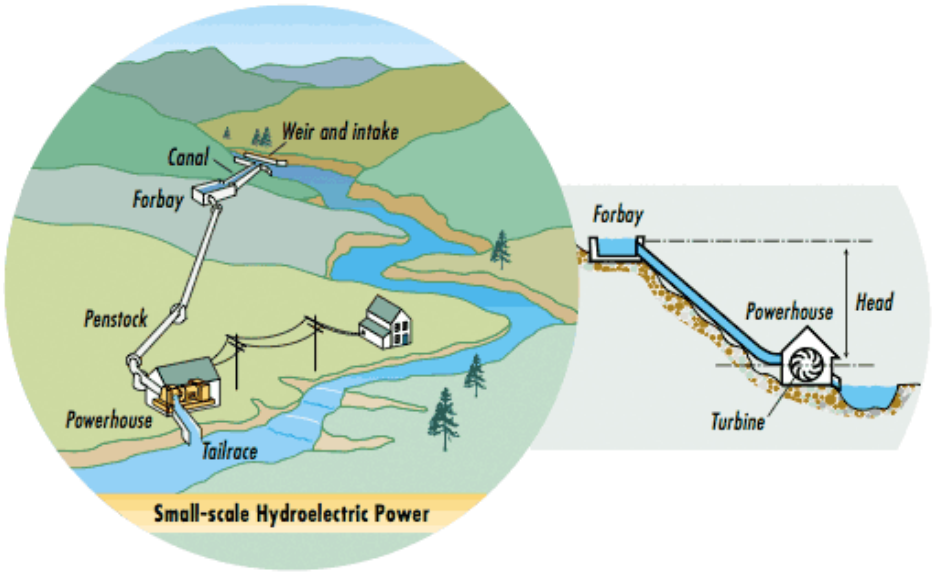

Figure 4 | Illustration of a run-of-river hydropower station [Source: http://enermed.cres.gr (Accessed: 28 June 2013)]

The location of the various components is indicated in **Table 3-1**.

Coffer dam

A coffer dam provides a temporary enclosure (used for construction) within a body of water by creating a watertight work environment where the works are isolated and water pumped out to allow river flow to bypass the foundation works area (**Figure 5**). A coffer dam would be built upstream of the intake structure. This would exclude water from the construction works by bypassing the footprint of this construction site to enable the construction of the off-take weir and inlet structure. Any mechanical equipment will be installed after the majority of the civil construction works are completed.

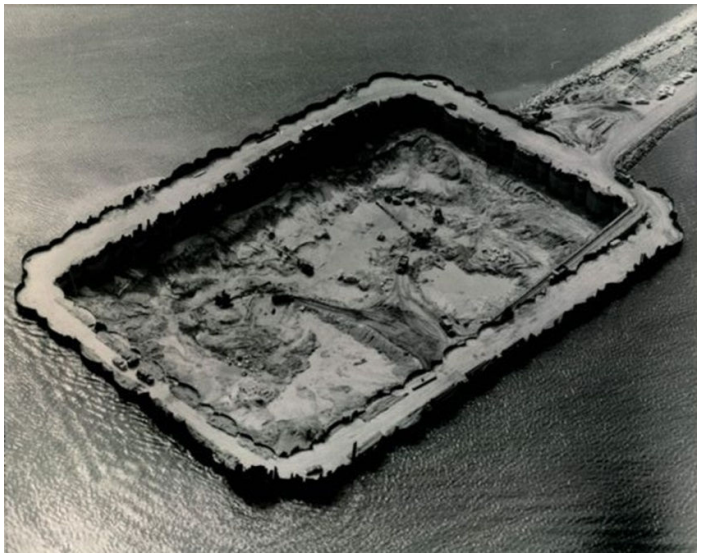

Figure 5 | Example of a coffer dam (Source: Coffer dam http://www.whalingcity.net/picture_hurricane_barrier.html)

Weir and Off-take Structure

The weir, which may require controlled blasting to construct on suitable foundations (refer to **Figure 7)** regulates flow into the off-take channel. The weir would be designed and constructed to allow existing permitted flow volumes to pass the weir and remain within the Orange River and only take water for power generation that is surplus to the irrigation, scour and environmental flow requirements. The Boegoeberg weir is approximately 11m high (as measured from the river bed). However, sediment has filled the reservoir such that the depth of water is estimated to be 6m upstream of the weir. It is proposed that up to 120m³/s would be diverted from the river. This diverted flow would then pass through the hydropower plant infrastructure and be returned to the river approximately 400m downstream of the off-take weir. A debris boom will be placed upstream of the off-take weir to prevent passage of debris into the hydro power facility. The following environmental and technical requirements have been considered as part of the flow diversion required for the hydropower plant:

- An uninterrupted flow equivalent to the demand of the local irrigation scheme, which would pass through the irrigation inlet on the left bank;
- An environmental release in a quantity to be agreed must pass over the weir crest (or through opened sluices) and down the river at all times;
- The hydro scheme requires a flow of up to 120m^3/s when sufficient river flow is available after environmental releases;
- The project may include a system for flushing sediment that could build up in the water conveyance infrastructure upstream of the power chamber.

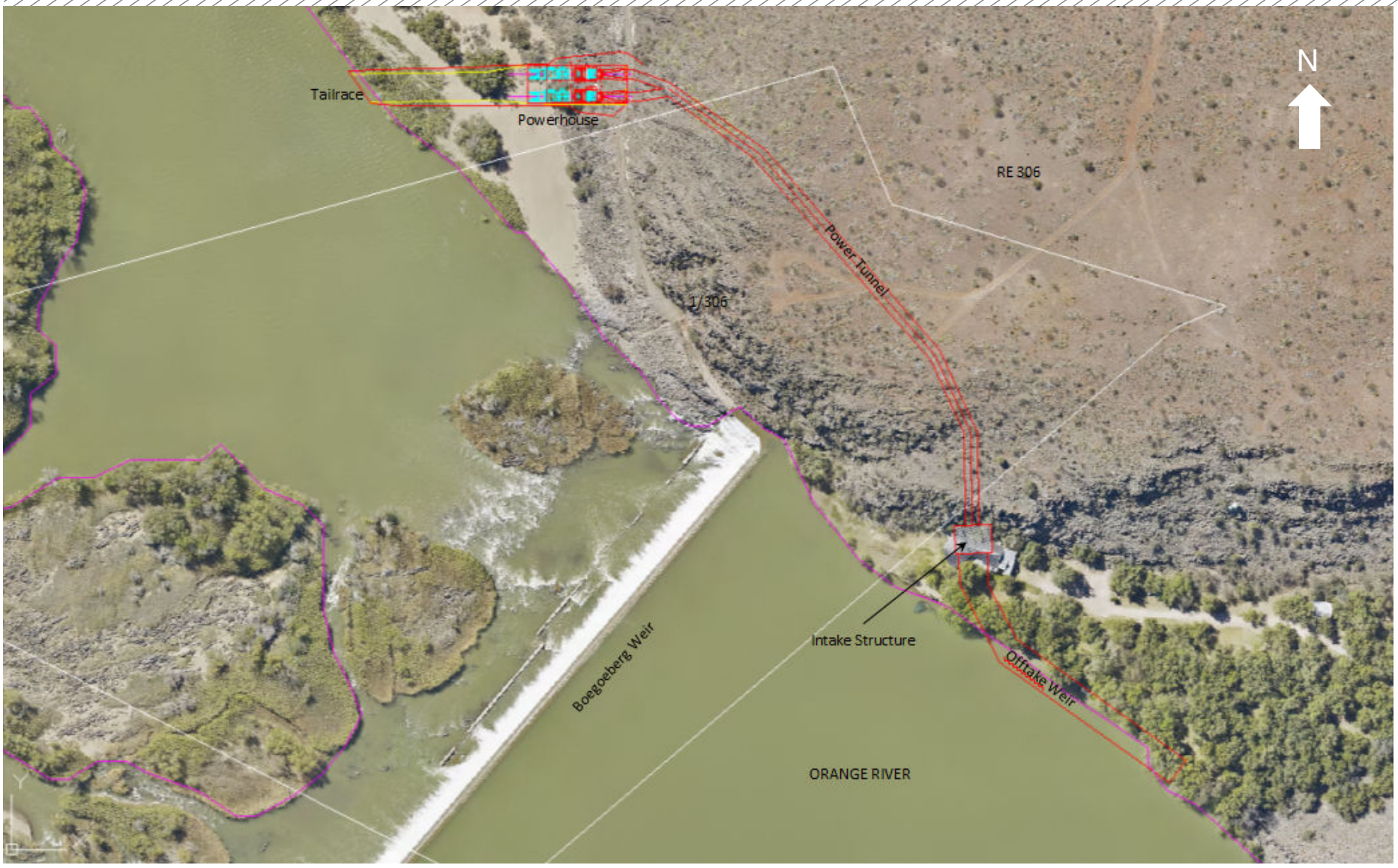

Figure 6 | Layout (tunnel alternative) of proposed project components on site (Not to scale)

Figure 7 | Boegoeberg weir, taken from the southern bank. The power station would be situated on the northern bank.

The main criterion for the selection of the proposed site was that there was sufficient elevation, providing the necessary static head, between the off-take and release points to enable the transport of water to the power station to produce the maximum amount of power based on the physical properties of the site.

The off-take (refer to **Figure 13**) would consist of a predominantly concrete structure built into the riverbank 100 m to 250 m upstream of the existing weir wall. The off-take weir would be engineered in consultation with DWA and their requirements in order not to affect the existing weir's structural integrity. Downstream of the off-take weir and channel, an inlet structure would be built, which may comprise trash racks, stoplogs[14] and gates. The trash rack prevents the intake of debris such as branches or trees.

The operable gate would regulate the volume of water which enters the canal or tunnel downstream. The regulation of the volume of water entering the off-take and inlet structure will be necessary, to amongst other things:

a. limit the flow of water to the power station during low flow periods to ensure the obligations to maintain the environmental reserve flow in the Orange River are met; and
b. ensure that only the volume of water required for electricity generation is transferred to the water conveyance infrastructure during peak flows in the Orange River.

Temporary upstream and downstream caissons

A caisson is a watertight structure used to keep water out of a construction area. Caissons are required upstream of the off-take weir and downstream of the tailrace. The caissons to be constructed for the Boegoeberg project could be constructed as two parallel walls, forming a double-walled enclosure, with the space between the two parallel walls filled with granular material, such as gravel, sand or broken rock so as to form a barrier to the intrusion of water. Once the caisson is constructed, water is pumped out so as to permit construction work to commence. Once construction of the

[14] A log, plank, or steel or concrete beam that fits into a groove or rack between walls or piers to prevent the flow of water through an opening in a dam, conduit, or other channel.

permanent works within the caisson is complete, the caisson is removed, allowing water to flow into the off-take structure. This type of caisson reduces the potential for reduced water quality through increased erosion and siltation as opposed to the embankment type coffer dams.

Figure 8 | Example of an intake structure with trash racks and cleaner (Source: Entura).

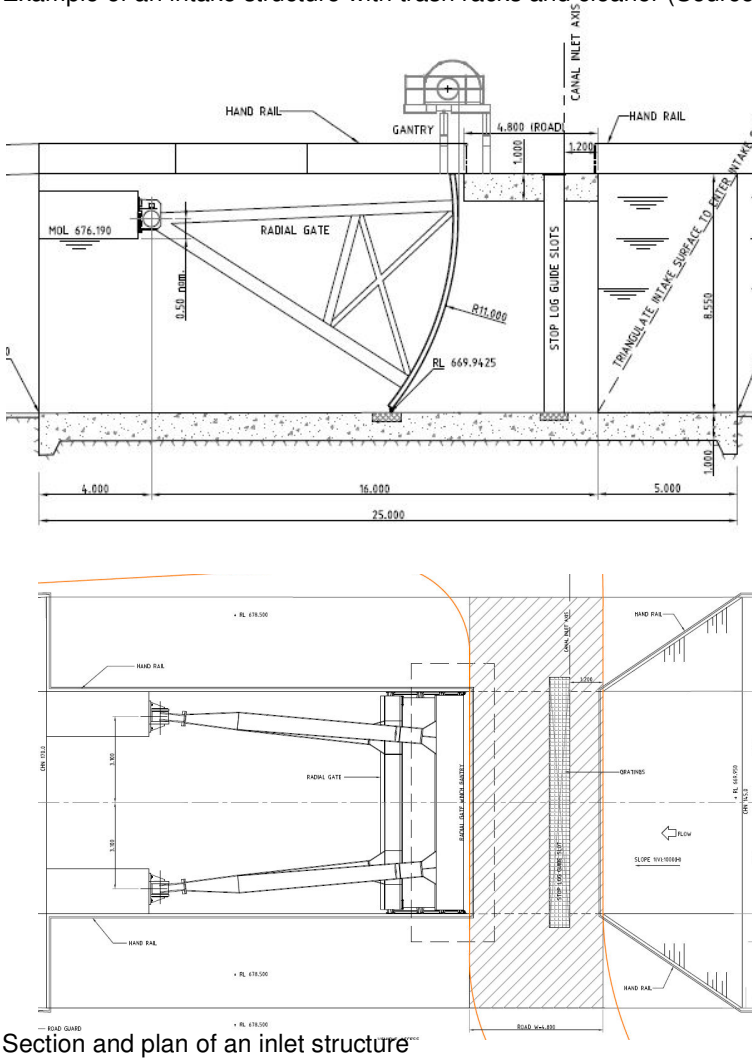

Figure 9 | Section and plan of an inlet structure

Water Conveyance Infrastructure

The water conveyance infrastructure transports the water from the river in the off-take structure, located upstream from the weir, to the power chamber. It will comprise either of an open canal or twin tunnel to convey the water to the power chamber.

Canal: The option of a canal (**Figure 10**) is a feasible alternative although it is not preferred as it would require quite extensive blasting and remove a significant portion of the existing koppie. The canal would follow contours as much as possible so as to maintain a constant gradient throughout its length, without losing too much of the static head. The topography will determine the amount of material that needs to be removed for construction of the canal.

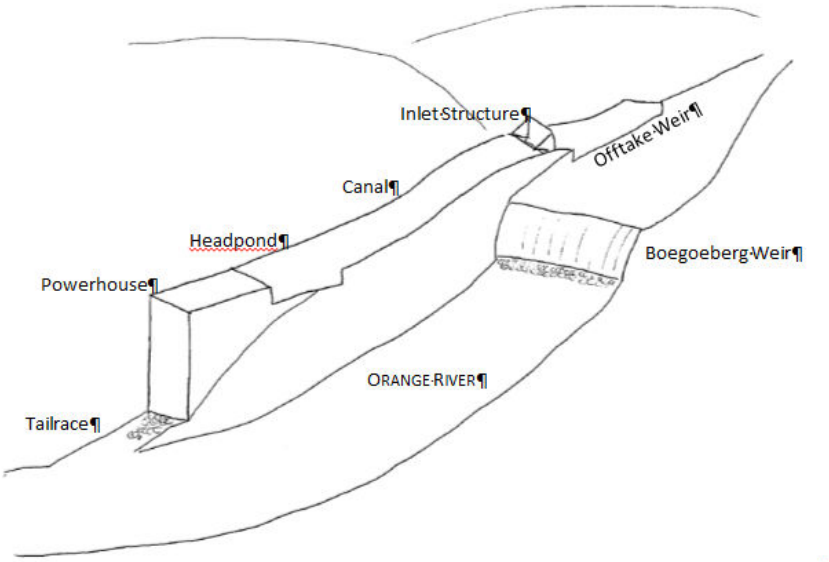

Figure 10 | Sketch of the canal alternative at Boegoeberg

The depth of the canal would vary depending upon, amongst other things, the topography of the terrain through which it is passing and the geological conditions of the ground in which it is constructed. Preliminary analyses estimate that a typical cross-section for the canal would be in the order of 10 m deep and 15 m wide at the floor of the canal.

Tunnel (Preferred alternative): Preliminary analyses estimate that the tunnel (**Figure 11**) would be as follows:

a. Either one tunnel of 6m x 6.75m or two tunnels approximately 4.0m wide by 4.5m high, concrete lined, to convey the required volume of water; and
b. Approximately 300m in length.

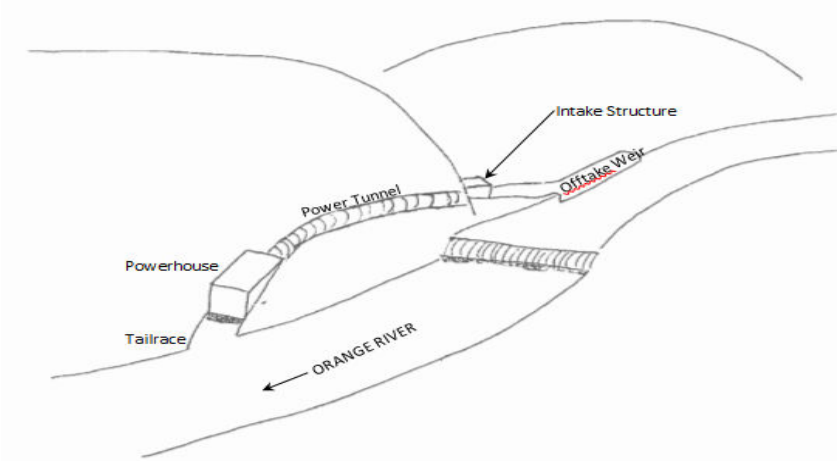

Figure 11 | Sketch of the tunnel alternative at Boegoeberg

Figure 12 | Example of a tunnel (Source: Entura)

Figure 13 | Example of an open channel (Source: http://www.hydro.com.au/energy/our-power-stations/derwent (Accessed: 10 September 2013)

The open canal would be fenced to ensure animals and people cannot fall into the canal, with a bridge built over the canal to allow access to Boegoeberg Weir. A storm water drain located up-slope of the canal would prevent storm water entering the canal. Storm water would be diverted around the project infrastructure and returned to the river. The canal would be concrete lined (see **Figure 13**).

Head pond: The head pond is only required for the canal alternative. The purpose of the head pond, also called the forebay, is to accumulate water temporarily in order to control the rate of flow into the penstock (**Figure 14**). The head pond's secondary function is to allow for debris (i.e. silt, sediment, etc.) to settle so that it does not enter the facility and damage the turbines. The head pond would be located downstream of the water conveyance infrastructure (canal alternative) and immediately upstream of the power station intake structure. The head pond will be a small concrete structure cut into the hillside with sluices to discharge built up sediment back to the river. An overflow/ spillway from the head pond may be required in the event of machine shutdown or in the event that the flow of water in the water conveyance infrastructure is otherwise greater than that able to be utilised by the turbines.

Figure 14 | Example of a small head pond (only applicable in the case of the canal alternative). (Source: energypedia.info (Accessed: 28 June 2013)]

This overflow/spillway would have low water velocities (compared to that of the turbine) and would provide a controlled release of water from the head pond into the river downstream. It also assists in the regulation of the volume of water in the head pond.

Power Station Intake Structure (Penstock)

For the canal alternative, a concrete intake structure comprising gates at the upstream end of the penstock will transfer water from the head pond to the penstock (**Figure 15)**. For the tunnel option, this function is performed by the penstock, an enclosed conduit of approximately 5.0m wide by 6.0m high, which will convey water to the power chamber. The gates would operate in an emergency to shut off flow into the penstock, or to enable maintenance of the penstock. The penstocks have been designed to be below ground to reduce the visual impact.

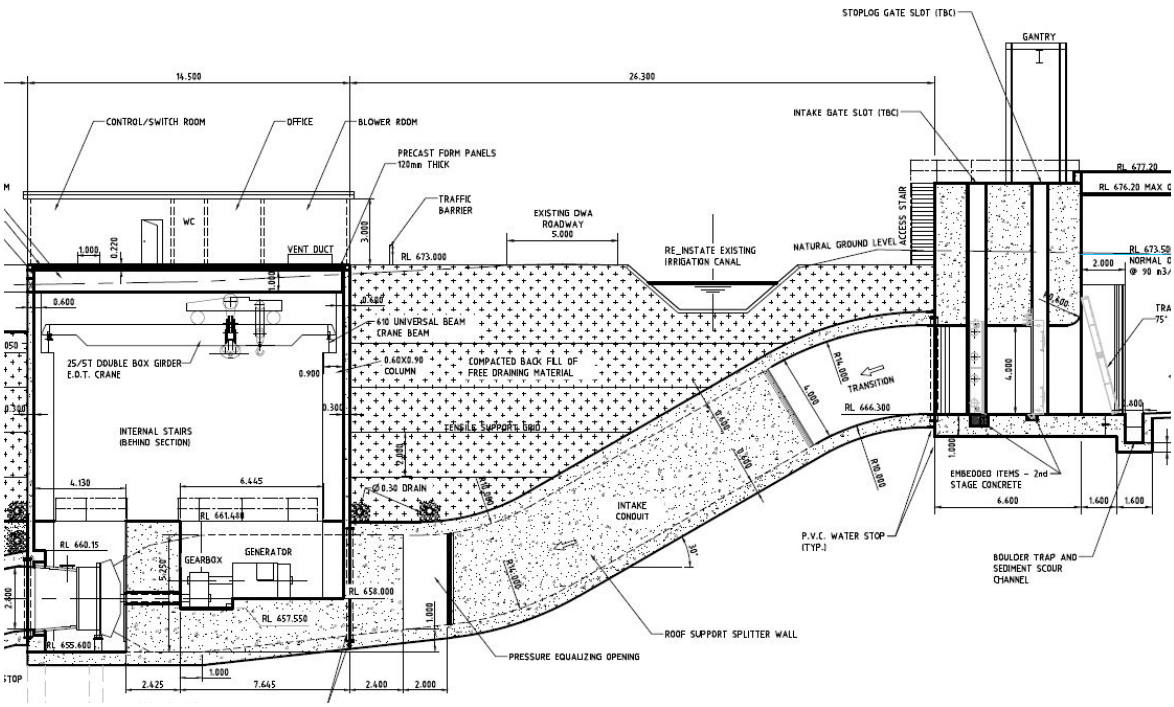

Figure 15 | Example of a penstock (Source: energypedia.info (Accessed: 28 June 2013)]

Power chamber

The power chamber houses the turbines and generation units within a turbine hall (**Figure 16** and **Figure 17**). The power chamber will be located approximately almost immediately downstream of the intake structure. The power chamber dimensions will be approximately 30m x 15m x 20m (l x b x h). A crane would be positioned within the power chamber for the installation and removal of the turbines and generators as well as for any maintenance required during operation.

Figure 16| Example of a power chamber (Source: http://www.lowimpacthydro.org/Accessed: 28 June 2013).

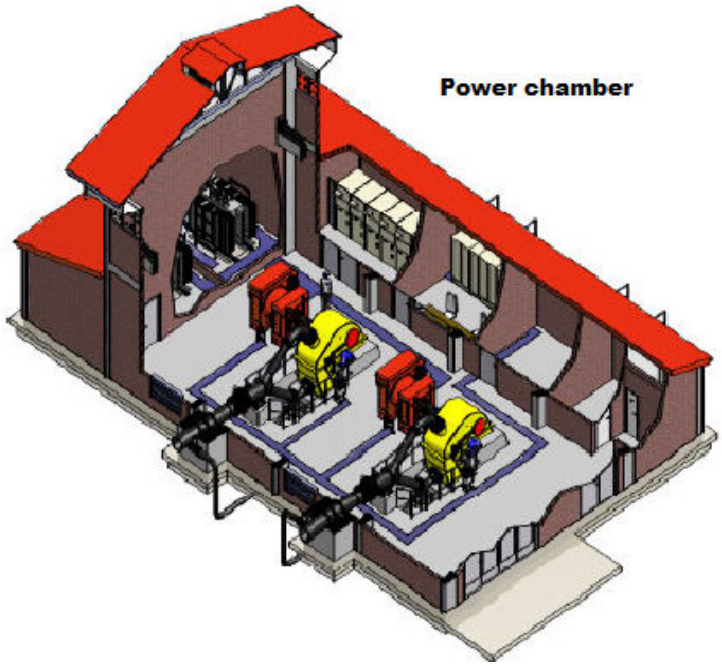

Figure 17 | Illustration of a chamber (Source: http://www.lcclao.com (Accessed: 28 June 2013)]

Turbines and Generators

Water flows from the elevated head pond or tunnel down the penstock into the turbines. The flowing water applies pressure on the turbine blades causing the shaft to rotate which in turn is connected to an electrical generator which converts the motion of the shaft into electrical energy (**Figure 18**).The turbines to be used at the Boegoeberg Hydro Electric Project would be Kaplan type turbines (based on the head and flow characteristics of the site).

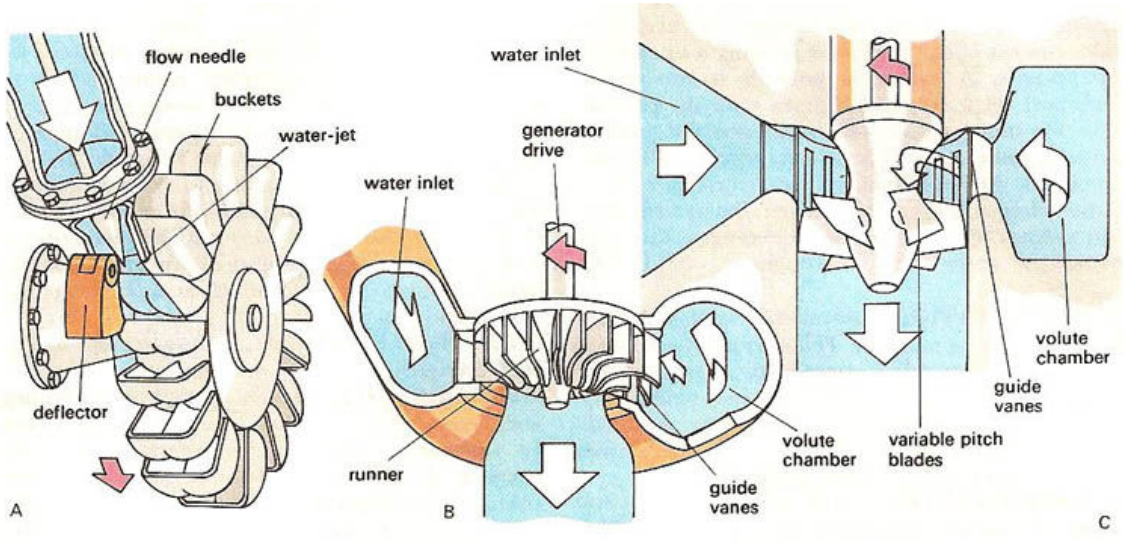

Figure 18 | Illustration of the three main types of water turbines: (A) Pelton wheel; (B) Francis turbine; (C) Kaplan turbine(Source: The Encyclopaedia of Alternative Energy accessed 8 July 2013)

Outlet Works/ Tailrace

Water will be released from the power chamber, via a draft tube, into a tailrace canal (**Figure 19**). This tailrace canal/ tunnel terminates in the river where preliminary analysis suggests that the water would be released at a maximum velocity of approximately 2 m/s (but this velocity would vary depending on the volume of water entering the power station at any given point in time). The tailrace canal would be approximately 100 m long. The tailrace will have a width of about 20 m and a depth of about 4.0 m, and may be concrete lined.

Switchroom

The switchyard will be a small platform approximately the size of a triple bay garage. It would be located in the vicinity of the power chamber, outside the 1:100 year flood line, and its final location would be informed by the detailed design of the power chamber. An area of approximately 20 m by 20 m would be required for the structure. The switchroom may also be located within the power house.

Transformers

The transformers will be located immediately adjacent to the power chamber in the switchyard. The electricity produced by the generators will be stepped up from 11kV to 33kV (or 132kV if required by Eskom) and then evacuated to the Eskom Fibre Substation via a 33kV (or 132kV) transmission line.

Figure 19 | Example of a power chamber and associated infrastructure (source: http://www.photosensitive.com (Accessed: 28 June 2013)]

High Voltage (HV) Transmission Infrastructure

The HV transmission infrastructure of no more that 132kV (**Figure 20**) is to be located above ground and would connect into Eskom's 132 kV transmission system via the Fibre Substation approximately 36 km south of the plant (**Figure 21**). The transmission line route was revised based on the botanical specialist's recommendation to route it around a section of riverine vegetation.

Figure 20 | Example of a 33kV transmission line on the left and a 132kV transmission lines on right (Source: www.electrical-contractor.net (Accessed 9 September 2013)

Figure 21 | Eskom's Fibre substation where the transmission line would connect to the national grid

3.1.2 Construction of the proposed hydropower station

The construction of the proposed hydropower station will take approximately 24 months. During the construction period, several major tasks will need to be completed, as described below.

Hydropower plant and associated infrastructure: dimensions and construction footprint

The proposed hydropower plant and associated infrastructure dimensions of each component of the proposed development are provided in **Table 3-1**.

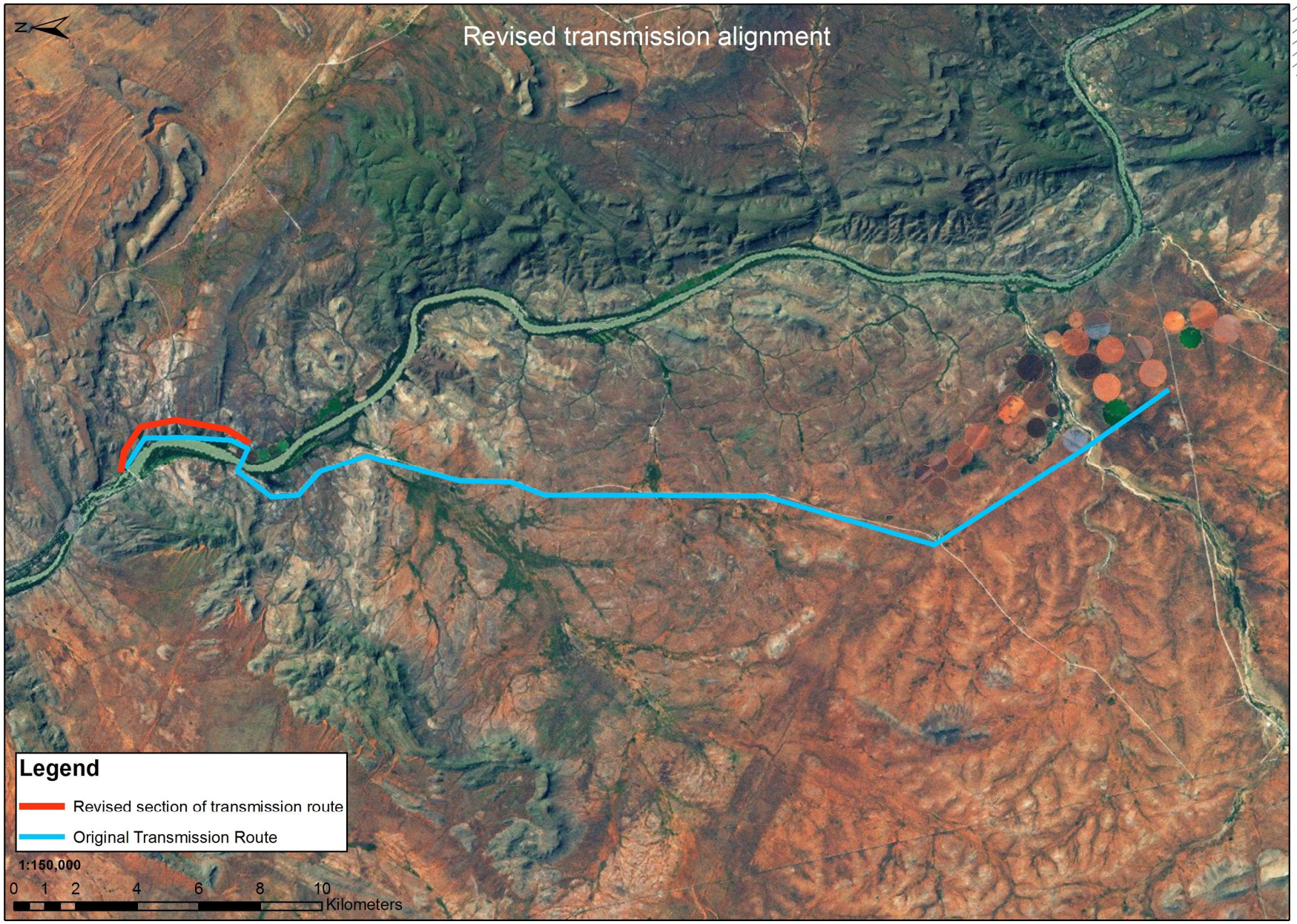

Figure 22 | Revised transmission alignment taking cognisance of environmental sensitivities

Table 3-1 | Dimensions, footprint and location for both temporary and permanent plant infrastructure

Permanent site infrastructure			
Component	**Dimension (WXL)**	**Total footprint (m^2)**	**Approximate coordinates**
Off-take infrastructure	20m x 150m	3,000m^2	29° 2'28.68"S, 22°12'15.93"E
Water conveyance infrastructure a) Canal b) tunnel	35m x 230m 6m x 6.75m x 300m	8,000m^2 Nil (underground)	29° 2'23.41"S, 22°12'10.53"E
Power station intake structure/ penstock	20m x 20m	Nil (underground)	29° 2'19.88"S, 22°12'7.04"E
Power chamber (i.e. Turbines and generator)	38m long x 30m wide	1140m2	29° 2'19.62"S ,22°12'6.74"E
Outlet works/ tailrace	30m x 160m	4800m2	29° 2'19.29"S, 22°12'4.29"E
Switchroom/ Transformer yard	20m x 20m	400m^2	29° 2'19.31"S, 22°12'6.93"E
High Voltage (HV) Transmission Infrastructure	Maximum - 30m x 41,000m Probable – 15m x 41,000m (30m for 132kV or 15m for <132kV)	1,230,000m^2 (however this is the entire servitude each pylon would take up a small percentage of this)	Start 29° 2'19.31"S, 22°12'6.93"E Mid-point 29°11'21.44"S, 22°11'50.96"E Finish 29°20'44.58"S, 22°14'2.22"E
Access roads ***Site Access*** a) Existing b) New ***Transmission route*** c) Existing d) New	~ 8.5km x 6m - ~ 25km x 4m ~16km x 4m (subject to final confirm in design phase)	51000 m^2 - - 64,000m^2	Start 29° 2'19.31"S, 22°12'6.93"E Mid-point 29°11'21.44"S, 22°11'50.96"E Finish 29°20'44.58"S, 22°14'2.22"E
Spoil material	Reuse options include farm revetments to prevent flooding of fields and/or in the upgrade and establishment of access roads	Maximum of ~ 200,000m^3 [15].	Access roads: as above Revetments: Start 29° 4'11.84"S, 22°12'44.39"E Mid-point 29° 4'10.08"S, 22°12'39.39"E Finnish 29° 4'10.70"S,

[15] Tunnel (preferred option): An approximate total of 70,000; 115,000m^3 spoil material will be excavated from the weir, tunnel, power chamber, and tailrace. The largest amount of spoil would be generated by the construction of the tunnel tailrace. Off-take 20,000m^2; tunnel 15,000m^2; powerhouse, 35,000m^2; tailrace 45,000m^2: total 115,000m^2
Canal option: An approximate total of 180,000 to 200,000m^3 spoil material will be excavated from the weir, canal, power chamber, and tailrace. The largest amount of spoil would be generated by the excavation of the canal.

Component	Dimension (WXL)	Total footprint (m^2)	Approximate coordinates
			22°12'35.25"E
Borrow pits ***a)*** Existing farm borrow pits	BP1 Circumference ~250m BP2 Circumference ~200m		29° 3'4.27"S, 22°14'4.01"E 29° 3'13.20"S, 22°14'50.38"E
Sediment basins	3 x 30m x 30m Total area may be bigger due to embankments and cuttings & sediment study results	2700m^2	Centre basin 1: 29°02'18.13"S, 22°12'08.65" Centre basin 2: 29°02'16.28"S, 22°12'07.37" Centre basin 3: 29°02'14.56"S, 22°12'05.97"
Temporary site infrastructure			
a) Site office b) Construction yard c) Staff accommodation	50m x 75m	3750m^2	29° 2'27.23"S, 22°12'24.42"E

Site Access

Access to the site during the construction period would be via roads of approximately 6m in width. The access roads would, in part, be an expansion of the existing Zeekoebaart farm roads, and would be gravel. Where possible, these construction access roads would be constructed to a standard suitable for permanent site access for the construction and operational phases of the project. As far as possible, existing road alignments will be modified to be approximately 6 m wide to accommodate construction vehicles. Section 3 of **Figure 23** illustrates the existing access road that would be upgraded. There is a short section of road to divert construction traffic around the farm house of Mr David S Fourie (Farms 307 & 308 Seekoeibaardsnek); however, in this instance, this section of road with be less than 4 m wide.

Water Conveyance Route (only applicable to the canal alternative, not the tunnel)

Construction of the water conveyance structure would involve the clearing of vegetation along the alignment as required. The alignment will be cleared for a width of 30 m. A temporary construction corridor of 6 m width would be required adjacent to the alignment in order for the construction machinery to manoeuvre. Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. excavator). Hard rock will be loosened by means of controlled blasting before being excavated. The concrete lining of the canal or tunnel would cast *in-situ*.

Head pond (only applicable to the canal alternative, not the tunnel)

Similar to the water conveyance route, the head pond site would be cleared and excavated. An area of 400 m^2 will be cleared. Depending on the geology of the site, controlled blasting might be required to loosen up hard rock that cannot be excavated mechanically. Any required concrete lining of the head pond would be cast *in-situ*.

Penstocks

The penstocks would be steel or concrete, and would be partially buried.

Power chamber

Construction of the power chamber would involve the clearing of vegetation of an area of approximately 450m^3. Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. tracked excavator). Hard rock will be loosened by means of controlled blasting before it is excavated.

Tailrace

Construction of the tailrace would involve the clearing of vegetation of an area of approximately 3000m². Once cleared, any soft or intermediate material will be excavated by mechanical means (i.e. tracked excavator. Hard rock will be loosened by means of controlled blasting before it is excavated.

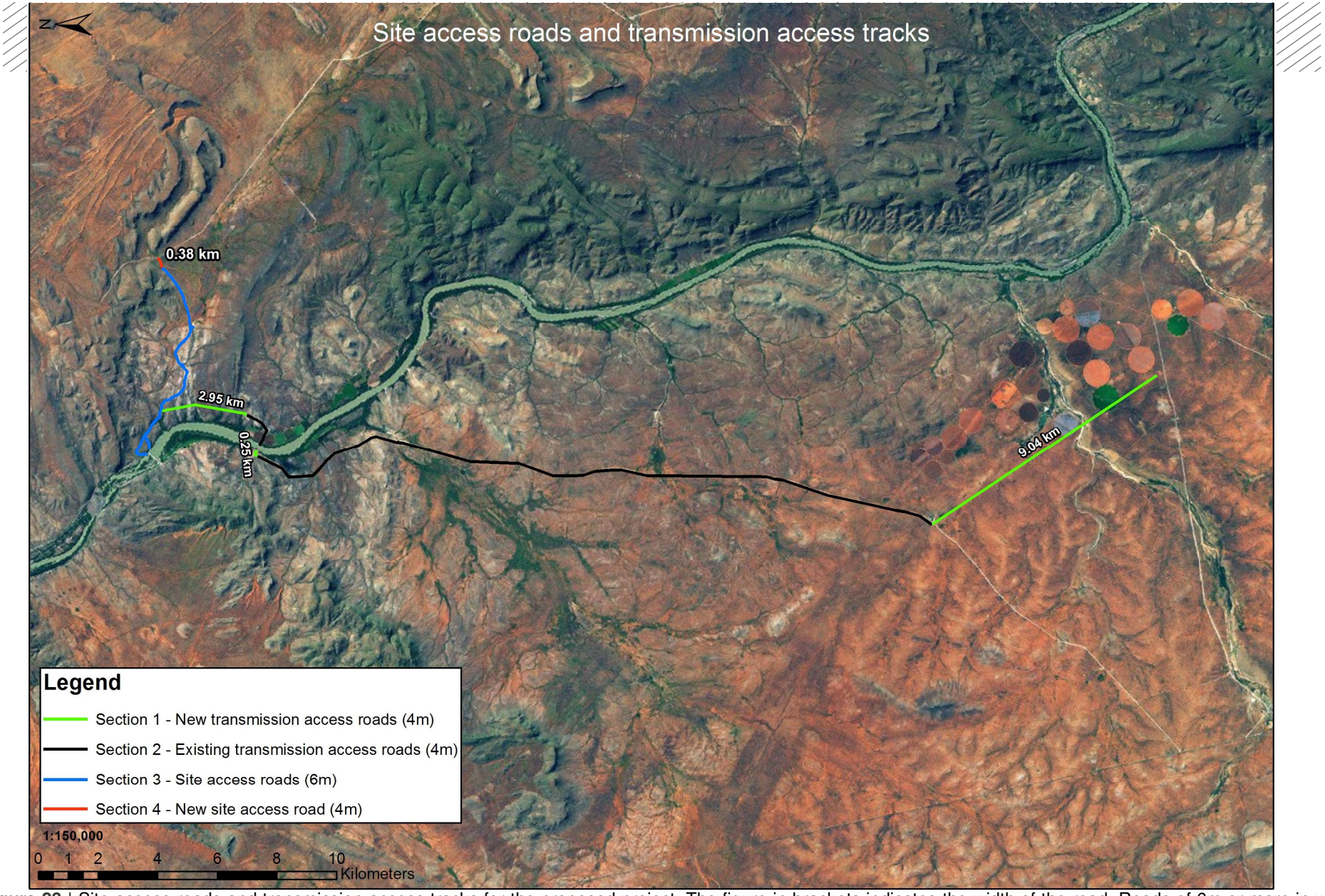

Figure 23 | Site access roads and transmission access tracks for the proposed project. The figure in brackets indicates the width of the road. Roads of 6m or more in width have been applied for in terms of NEMA.

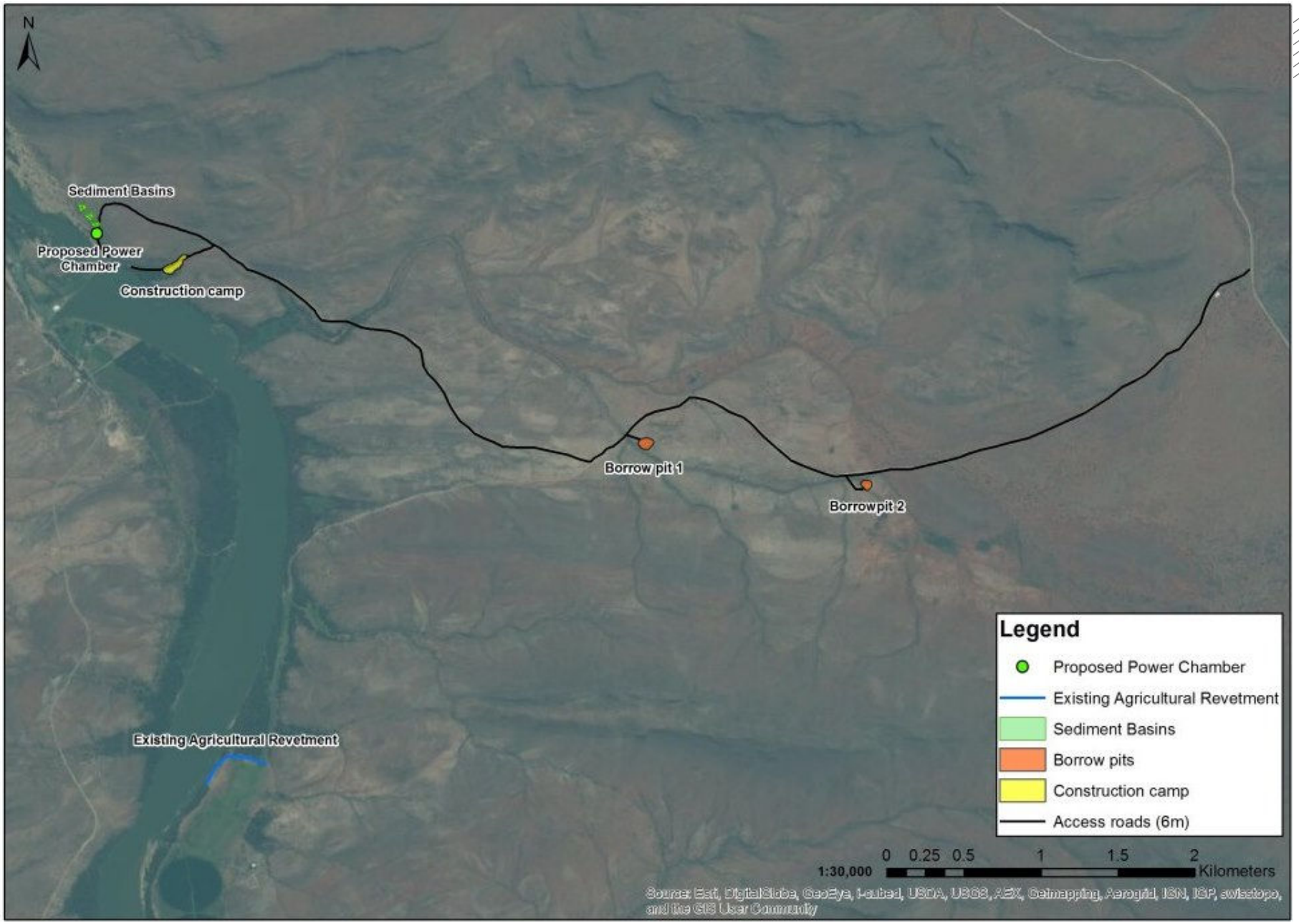

Figure 24 | Location of access roads, borrow pits, construction camp, revetments and sediment storage basins for the proposed project

Figure 25 | Location of new site access road for the proposed project

Transmission Line

The overhead transmission line would follow existing access roads where possible to a width of 4m. Approximately 12.24km of new access tracks would be required. The transmission line would be constructed to Eskom standards appropriate to the rating of the line finally decided upon. **Figure 23** illustrates the existing transmission access road (Section 2) and the new tracks (Section 1) required.

Site Infrastructure

A site office would be located near the site of the construction works. It would house the administrative personnel for the construction works and would have its own services and amenities. The peak construction workforce is estimated to be approximately 150 to 200 people. Accommodation for the workforce would be in temporarily constructed houses close to the site as indicated in **Figure 24**.

Spoil Material

- *Canal*

  An approximate total of 180,000 to 200,000m³ spoil material will be excavated from the weir, canal, power chamber, and tailrace. The largest amount of spoil would be generated by the excavation of the canal.

- *From Tunnel (preferred option)*

  An approximate total of 70,000m^3 to 115,000m³ spoil materials will be excavated from the weir, tunnel, power chamber, and tailrace.

Several options have been assessed for the removal and disposal and/or re-use of spoil material. Where possible, backfilling of excavated material will be undertaken to reduce spoil quantities.

Re-use options include:

- Aggregate for concrete production to be used in the construction of the proposed hydropower facility and its associated infrastructure.
- Bunds around the proposed sediment (silt) basins.

Additional and alternative uses for spoil materials:

- Access roads to be upgraded and sections of the transmission access roads to be constructed.
- Rehabilitation of existing agricultural revetments on landowner's farm to protect agricultural fields from periodic flooding (as requested by the landowner).

A combination of the above options may be required to try to ensure the maximum possible reuse of spoil, thereby minimising disposal.

Classification of excavated earth materials as waste

According to Annexure 1 of the Waste Classification and Management Regulations, *"Excavated earth material not containing hazardous waste or hazardous chemicals"* is considered to be General Waste. Subsequent to the release of the Draft EIR, Category C has been added to listed activities in terms of NEM:WA (GN 921, 29 November 2013). Activities under Category C need to meet the norms and standards and be registered with the Department.

Borrow pits

Material would be needed for upgrading and re-gravelling the existing gravel roads to a maximum width of 6 m. Suitable gravel is not always readily available and may have to be specifically sourced. Two informal borrow pits on the farm have been identified as suitable sources of wearing course and

are in close proximity to the roads that will require upgrading. At this stage it is not known if material will need to be sourced from the borrow pits and if so, in what quantities. This will be determined during detailed design. A mining permit would be required from the Department of Mineral Resources (DMR) should the borrow pits need to be used. In this regard, an application for a mining permit will be submitted to DMR by Boegoeberg Hydro**.**

Sediment removal (dredging)

As discussed in **Section 1.5**, sedimentation of the Boegoeberg Dam is problematic, with approximately half its capacity lost to sedimentation according to DWA. Sediment currently constrains inflow into the existing irrigation scheme and may impact on the sustainability of the proposed Boegoeberg Hydro Electric Project. The proposed operation of the Boegoeberg Hydro Electric Project will result in a change in the patterns of flow within the existing reservoir and could alter the current equilibrium, which could, in turn, threaten the sustainability of both the hydroelectric project and the irrigation scheme. A sediment management program has been proposed to be implemented by the owners of the Boegoeberg Hydro Electric Project to ensure the sustainability of the project and that the flow into the existing irrigation scheme is at least maintained, if not improved. As such, the developers of the Boegoeberg Hydro Electric Project are committed to the sustainability of both the project and the irrigation scheme. However, the current practice of draining storage to scour built up sediment on a regular basis is wasteful of water and not considered sustainable for the hydroelectric project.

Various sediment management options have been investigated. Although dredging by dredger is an expensive option for sediment management, it is the preferred option based on the constraints of all other potentially feasible options. The proposed solution is to station a dredger on site to maintain a clear flow path to the hydroelectric project intake and the irrigation intake. The dredger would undertake periodic dredging, which would remove accumulated sediments; however, without the loss of water stored behind the weir wall. The weir will still require periodic draining for maintenance purposes by DWA. However, the frequency of this action can be reduced if dredging operations are successfully implemented. Dredging is typically used to remove reservoir deposits when other measures are unsuitable. A dredger draws sediment and water out of the reservoir and pumps it to a location where the sediment can be drained and disposed (in this case, sold for reuse as fill or building material).

Proposed Dredge Operations

At the proposed Boegoeberg Hydro Electric Project, the dredger would be located on a barge that would be housed on the right bank of the river upstream of the hydroelectric project off-take weir. When in use, the dredger would operate in the vicinity of the irrigation off-take and the hydroelectric project off-take weir. A pipe would convey the “slurry” from the dredger to sediment basins located downstream of the powerhouse as shown in **Figure 26**.

Sediment basins would be filled and allowed to drain, discharging sediment-free water back to the Orange River. When dry, the sediment can be used as fill material or, if the properties are suitable, it could be used as building material. It is envisaged that there will be no disruption to normal operations of the weir during dredging cycles.

Studies are currently underway to enable the preparation of a detailed sediment management plan.

Impact of Dredge Operations

Dredging operations will have an impact on the operation of Boegoeberg Weir and on the way sediment is currently managed. When the Boegoeberg Hydro Electric Project is in operation, the operators of the project will attempt to maintain the water level behind the weir as close to the Boegoeberg Weir crest as possible. When flows exceed the design capacities of both the hydroelectric project and the irrigation canal, spill will occur.

The process of obtaining the necessary mining permits for dredging from the Department of Mineral Resources (DMR) is currently being undertaken. As mentioned above, the sediment is considered a Category C waste and would need to meet the norms and standards and be registered with the Department in terms of NEW:WA. The potential solution to sell the dredged material has been communicated to DWA during a meeting held on 25 November 2013 to discuss the proposed project in greater detail. DWA is agreeable to the idea of this sediment management program and has indicated their support for the removal of sediment from the Boegoeberg Dam.

The left bank irrigation canal supplies water to 7,560 ha of farmland in the Boegoeberg Dam Irrigation Area, most of which is used for field crops and a small portion for fodder crops.[16] Talks are currently underway with the Boegoeberg Water Users Association, as the custodian tasked to ensure that water users along the ~120 km agricultural canal have access to ater. These talks are to address concerns related to the construction and operation of the proposed power station and to explain the dredging process in greater detail. Boegoeberg Hydro will ensure that agricultural flows are maintained as a first priority, an aspect on which any Water Use Licence will be conditional.

As stated, studies are currently underway to enable the preparation of a detailed sediment management plan and details of the preferred option of dredging, requirements for the Water Use Licence from DWA. These will be provided to both DEA and DWA for their consideration, and discussed with the Boegoeberg Water Users Association. Refer to **Annexure E** for the Boegoeberg Sediment Management Method Statement and illustration of the proposed arrangement.

[16] http://www.dwaf.gov.za/Orange/Low_Orange/boegoebe.aspx

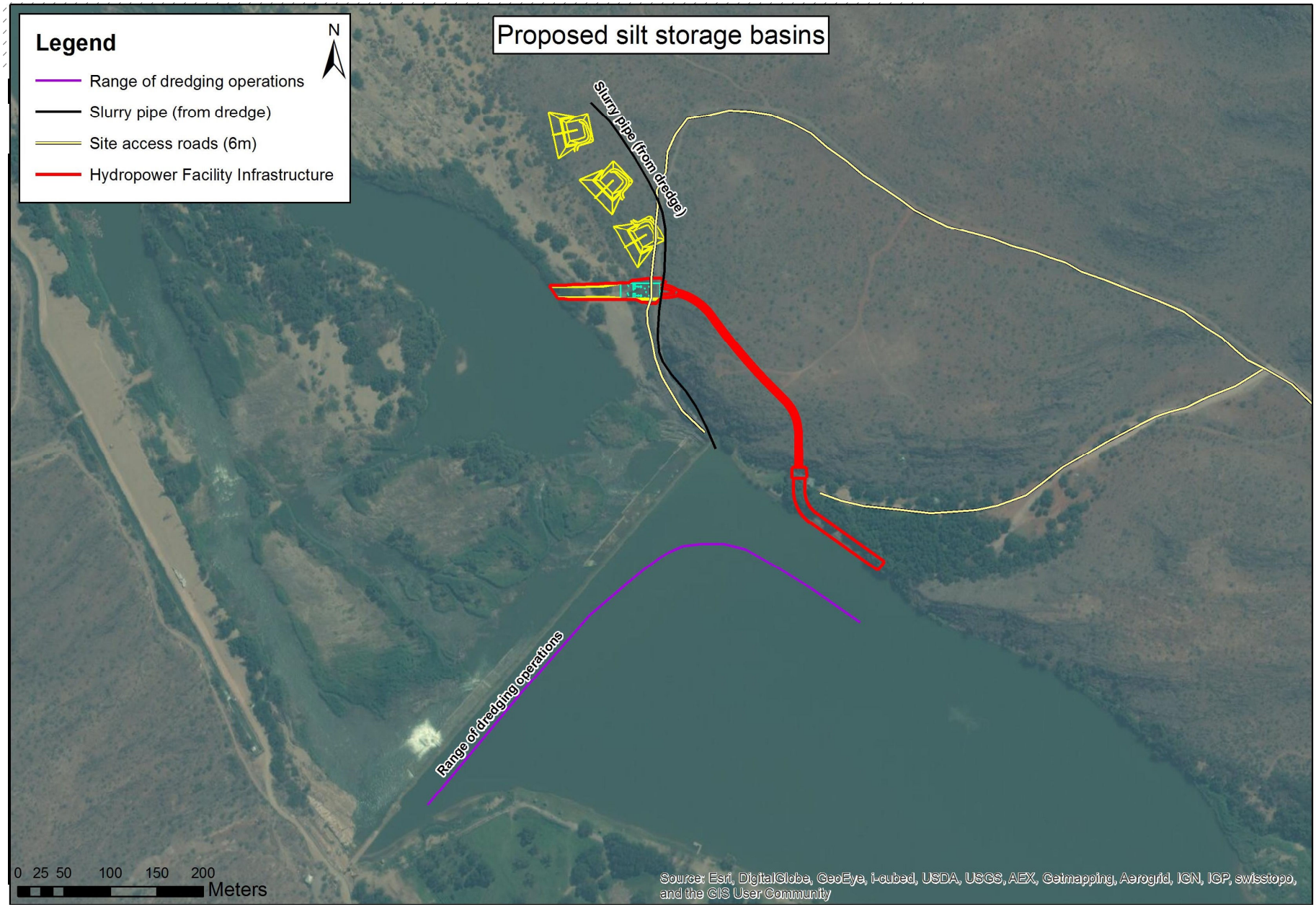

Figure 26 | Proposed sediment storage basins and dredging operations

3.1.3 Operation of the hydropower station

The operational lifespan of the hydropower plant is estimated to be approximately 60 to 80 years. The turbines are designed to operate continuously and with minimal maintenance intervention throughout the operational lifespan of the facility.

During the operational phase of the project, staff would undertake routine maintenance and the operation of the facility would be done remotely, consequently, there would be no need for ancillary buildings to accommodate permanent site personnel.

It is estimated that the operational phase will result in between four to six job opportunities. Vehicles would use the permanent access roads to travel to the power chamber for work. On occasions, maintenance activities would be required on other areas of the project, which may require heavier construction equipment. This equipment would be restricted to the access roads and the work site to minimise impacts on the environment.

On-going dredging will be required to remove sediment loads that accumulate behind the Boegoeberg Dam. The sediment would be monitored and removed via a dredger to a bunded area downstream, as discussed above. It is estimated that removal would happen on a monthly basis depending on water conditions and seasonal high flows when high sediments are mobilised. Approximately 2,500 m^3 of silt would be removed every month in order to maintain flows to both the irrigation canal and the hydropower station.

3.1.4 Decommissioning of the proposed hydropower station

As the proposed hydropower station is to be constructed under the Renewable Energy Independent Power Producer Procurement (REIPPP) Program, the minimum operational period will be 20 years (which is the duration of the PPA signed between Eskom and the developer). However, as the entire infrastructure, such as roads, transmission, and power chamber, etc. would already be established, and the energy source (water) is a renewable one, the proposed project could potentially continue to be operated beyond this. As such, the facility will most likely be upgraded with the latest applicable technology and/or existing infrastructure will be maintained for further use after the expiration of the initial PPA.

Should the facility be decommissioned, which is unlikely, all components will have to be disassembled, removed and recycled as far as possible. Depending on the best available option at the time, any above ground structures must be demolished unless an alternative use is found for them. Decommissioning would have to be undertaken as per the environmental legislation relevant at that time and under the supervision of an independent Environmental Control Officer (ECO).

The rehabilitation of the disturbed areas would form part of any decommissioning phase. The aim would be to restore the land to its original substratum characteristics (or as near as possible). The prescribed restoration activities will be described in an EMPr specifically prepared for decommissioning (at the appropriate time).

3.2 CONSIDERATION OF ALTERNATIVES

3.2.1 Introduction

NEMA requires that alternatives be considered during the EIA process. According to DEAT (2004) "*an alternative can be defined as a possible course of action, in place of another, that would meet the same purpose and need*".

The DEA&DP 2013 guideline for alternatives states that *"every EIA process must identify and investigate alternatives, with feasible and reasonable alternatives to be comparatively assessed. If, however, after having identified and investigated alternatives, no feasible and reasonable alternatives were found, no comparative assessment of alternatives, beyond the comparative assessment of the preferred alternative and the option of not proceeding, is required during the assessment phase. What would, however, have to be provided to the Department in this instance is proof that an investigation was undertaken and motivation indicating that no reasonable or feasible alternatives other than the preferred option and the no-go option exist."*

"Alternatives", in relation to a proposed activity, means different means of meeting the general purpose and requirements of the activity, which may include alternatives to—

(a) the property on which or **location** where it is proposed to undertake the activity;
(b) the type of **activity** to be undertaken;
(c) the design or **layout** of the activity;
(d) the **technology** to be used in the activity;
(e) the **operational** aspects of the activity; and
(f) the option of not implementing the activity ("**No-Go**" alternative).

In addition to the list above, the 2013 Department of Environmental Affairs and Development Planning (DEA&DP) Guidelines on Alternatives also considers the following as alternatives:

(a) **Demand alternative:** Arises when a demand for a certain product or service can be met by some alternative means (e.g. the demand for electricity could be met by supplying more energy or using energy more efficiently by managing demand).
(b) **Input alternative:** Input alternatives are applicable to applications that may use different raw materials or energy sources in their process (e.g. industry may consider using either high sulphur coal or natural gas as a fuel source).
(c) **Routing alternative:** Consideration of alternative routes generally applies to linear developments such as power line servitudes, transportation and pipeline routes.
(d) **Scheduling and timing alternative:** Where a number of measures might play a part in an overall programme, but the order in which they are scheduled will contribute to the overall effectiveness of the end result.
(e) **Scale and Magnitude alternative:** Activities that can be broken down into smaller units and can be undertaken on different scales (e.g. for a housing development there could be the option of 10, 15 or 20 housing units. Each of these alternatives may have different impacts).

The Scoping Phase screened alternatives to derive a list of feasible alternatives assessed in detail in the current EIA, which are explored in detail below. The following types of alternatives were considered to be most pertinent to the proposed project:

- Layout alternatives dependent on the scale and magnitude alternative;
- Technology alternatives;
- Transmission line routing alternatives;
- Scale and magnitude alternatives; and
- No-Go Alternative.

The purpose of this section of the report is to describe all potential alternatives that were scoped during Scoping and which were carried through to the EIA Phase of the project for further assessment.

3.2.2 Location Alternatives

South Africa is on the verge of increasing the percentage contribution made by renewable energy power generation to the existing energy mix. In response to this opportunity for large scale renewable

energy production, HydroSA[17] has identified potential hydro power sites across the country and is currently pursuing the best suited locations for hydropower production, one of which is the proposed Boegoeberg Hydro Electric Project.

A number of options were considered for the location of this site. The applicant investigated 12 sites along the Lower Orange River, from Hopetown to Vioolsdrift. Most of these opportunities would involve extensive tunnelling (approximately 8 km to 10 km at each site), with an 8 m to 12 m drop in elevation. For these projects to be feasible, a flow rate of100 m^3/s is required for 80% of the time (which is unlikely to occur on the Lower Orange River). Furthermore, they would all require extensive infrastructure to be built and connections to the existing grid were generally 50 km or more away. As such, most of these sites were not considered to be feasible. A few sites were, however, considered to be feasible.

A project at Neusberg weir near Kakamas is under construction, which has an installed capacity of 12 MW. The Neusberg Hydro Electric Project was selected in the second bid round of the REIPPP program. The applicant has initiated an EIA for a new site at Riemvasmaak near Augrabies for a 40 MW hydropower plant (DEA Ref. No. 14/12/16/3/3/1/681) and at Orange Falls near Onseepkans for a 20 MW hydropower plant (DEA Ref. No. 14/12/16/3/3/2/568).

Furthermore, the applicant also investigated five sites on the Thukela River. These sites would require tunnel lengths ranging from 1km to 2.5km, with elevation drops ranging from 13m to 32m. Two of these sites with tunnel lengths of 1km to 1.3km have received positive EAs but currently are not feasible as the construction costs are too high. Of the three remaining sites, two are still being investigated for future development.

The Boegoeberg site was selected for the following reasons:

- The suitable hydrology allows the project to be considered economically feasible. Most rivers in South Africa do not provide the hydrological condition required for the development of small hydro opportunities. In this regard, only the Orange and Thukela rivers present themselves as viable options for smaller hydropower schemes;
- There is a good difference in elevation between abstraction and release points for water (also called head), which, therefore, requires only a small diversion of water to make the project feasible;
- The site is already developed and there is an existing weir; and
- There is potential for socio-economic development in the !Kheis Local Municipality from the project.

A number of location alternatives were considered in the vicinity of the Boegoeberg weir at the initiation of the project, including options along the northern and southern banks of the river. Due to various reasons, such as ownership of land, technical complexity and length of routes, these options were discarded in favour of the currently proposed alternative. The proposed project balances the need for a significant difference in elevation in the river with the length of the required canal or tunnel, and is considered most suitable from a technical perspective. As such, this EIA has only investigated the preferred location alternative.

3.2.3 Activity Alternatives

There are numerous policies and pieces of legislation which govern the generation of energy in South Africa. The legal requirements are described in detail in **Annexure C**. The need for additional energy

[17] HydroSA identifies commercially viable run of the river hydropower sites in South Africa. Boegoeberg Hydro Electric has been established to pursue this particular opportunity at the Boegoeberg Dam.

generation in South Africa is well documented, as summarised in **Annexure C** (Forward planning of Energy in South Africa) which covers the following policies and legislation:

- Policies regarding greenhouse gas and carbon emissions;
- White Paper on the Energy Policy of the Republic of South Africa (1998);
- White Paper on Renewable Energy (2003);
- National Energy Act (No. 34 of 2008) and Electricity Regulation Act (ERA) (No. 4 of 2006);
- Integrated Energy Plan for the Republic of South Africa (2003);
- Integrated Resource Plan (2010); and
- Regional Methodology for Wind Energy Site Selection (Department of Environmental Affairs and Development Planning (DEA&DP), 2006 Guideline Document).

Furthermore, numerous policies and legislation have been promulgated indicating the mixture of renewable and non-renewable energy which South Africa wishes to pursue. These strategic documents provide the road map for the activity alternatives available to South Africa. Hydro SA has identified a number of projects for hydropower generation across South Africa, aimed at meeting these stated goals, hydropower in particular.

The site, situated on the banks of the Orange River near Groblershoop, is suitable for a small hydro given the reasons provided in **Section 3.2.2**.

Boegoeberg Hydro is a company which specialises in hydropower generation. As such, only hydropower generation will be considered for the proposed Boegoeberg site by this company.

3.2.4 Site Layout Alternatives

The current site layout has been compiled and refined based on *inter alia* the following criteria:

- Technical constraints, namely:
  - Construction alongside the Boegoeberg weir;
  - Spatial orientation requirements of project components and associated infrastructure (e.g. roads); and
  - Layout relative to other existing infrastructure, such as power lines.
- Environmental constraints, namely:
  - Hydrological profile of the river;
  - Topographical constraints relative to construction requirements;
  - Botanical and faunal constraints (presence of sensitive or protected plant communities or fauna); and
  - Aesthetics.

It should be noted that due to the specific hydrological profile and the constraints presented by the rugged terrain, there are limited and very specific locations for the proposed infrastructure that can be considered in order to utilise the energy potential of the hydropower resource effectively. As such, this EIA has only investigated alternatives for the water conveyance infrastructure. It was indicated in the Scoping Report that alternatives for the power chamber, head pond and tailrace would be investigated. However, given the design requirements and the already limited footprint of the currently proposed infrastructure, it was determined that the structural components have already been optimally designed, with the environmental impact minimised while addressing plant operation requirements. The only site layout alternatives investigated in the EIA are, therefore, for the water conveyance infrastructure, namely a tunnel (which is preferred) or an excavated canal.

3.2.5 Technology Alternatives

There are two main types of turbines, namely impulse and reaction turbines (**Figure 27**). The impulse turbine generally uses the velocity of the water stream which hits each bucket on the runner. An impulse turbine is generally suitable for high head, low flow applications. A reaction turbine develops power from the combined action of pressure and moving water, which flows over the blades rather than striking each individually.

The type of hydropower turbine selected for a project is based on the following selection criteria:

- "Head" which is the differential in elevation between the water in the forebay and the outlet works;
- “Flow”, or volume of water, at aparticular site;
- Depth at which the turbine must be set (civil works);
- Turbine efficiency; and
- Turbine cost.

Reaction turbines are generally used for sites with lower head and higher flows compared with the impulse turbines. The turbines selected were based on the head and flow characteristics of the site. The most suitable are the Kaplan turbines (**Figure 28**) as these are well adapted to these characteristics. As such, this EIA has only investigated the preferred technology alternative, namely the Kaplan turbine.

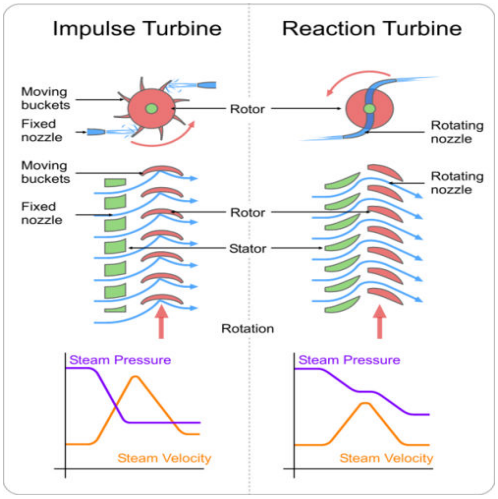

Figure 27 | Impulse and reaction turbines [Source: http://en.wikipedia.org, 5 July 2013)]

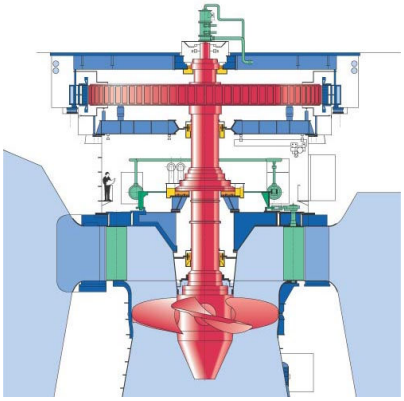

Figure 28 | Kaplan turbine and generator
[source: http://en.wikipedia.org/wiki/File:S_vs_kaplan_schnitt_1_zoom.jpg, 28 November 2013)]

3.2.6 Routing Alternatives

The layout for the transmission line follows the established road alignments as far as possible. Where the transmission line extends beyond the established road alignment it follows the shortest available route towards the existing Eskom Fibre Substation to the south in order to limit impacts (**Figure 22**). Two transmission line alternatives were originally proposed. Alternative 1, where the transmission line would cross the river below the Boegoeberg Weir is no longer feasible due to the span required and is, thus, not being pursued. However, transmission alternative 2, as proposed, has been adapted under advisement of the botanical specialist where it was recommended that a section of the transmission line be moved away from the river based on sensitive riverine habitat. This recommendation was endorsed by both the avifaunal and aquatic specialists. The revised alignment is now presented as the preferred alternative.

3.2.7 No-Go alternative

The assessment of alternatives must at all times include the "no-go" alternative. The "no-go" alternative will be the baseline against which all other alternatives are measured. The "no-go" alternative in this instance is defined as the *status quo*; i.e. no construction of any kind on the site, and no additional hydropower generation as would be achieved with this project.

3.2.8 Summary of Alternatives

Based on the investigations and reasons provided earlier, it is proposed that the following alternatives be assessed:

- **Location alternatives** – Boegoeberg dam, Farm 306 Zeekoebaart.
  - Only the current location of the proposed hydropower station will be considered.
- **Activity alternatives**
  - Energy generation by means of a hydropower station; and
  - "No-go" alternative to hydropower energy production.
- **Site layout alternatives**
  - Two water conveyance alternatives, open canal or tunnel (preferred).
- **Routing Alternatives**
  - Transmission line (alternative 2) and road access; and
  - Revised transmission line (alternative 2) and road access alternative to avoid botanically sensitive area.
- **Technology alternatives** – Kaplan hydropower turbines.
  - Only one technology alternative will be considered.

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4 NEED AND DESIRABILITY

The purpose of this Chapter is to describe the need and desirability of the proposed hydropower station as it relates to the local context. To provide a comprehensive analysis, the questions posed in the DEA&DPs Need and Desirability Guidelines (2011) have been addressed. The chapter also gives a brief assessment of sustainability which forms part of the EIA Report.

4.1 MOTIVATION FOR THE PROJECT

The 2009 DEA&DP Guideline for Need and Desirability highlights the obligation for all proposed projects which trigger the environmental regulations to be considered in light of (amongst others) the National Framework for Sustainable Development, the spatial planning context, broader societal needs, and financial viability. This information allows the authorities to contemplate the strategic context of a decision on the proposed project. This section seeks to provide the context within which the need and desirability of the proposed project should be considered.

As noted previously the need for renewable energy is well documented. Hydropower generation is desirable as it:

- Utilises a renewable and natural resource available to South Africa;
- Creates a more sustainable economy by promoting South Africa's energy policy towards energy diversification;
- Provides baseload[18] power, which other renewable energy technologies typically do not, as they are dependent on the vagaries of wind and sunlight. As such, hydropower can, for instance, replace coal-fired power stations as baseload stations, which other renewable technologies cannot do commercially without storage capacity.
- Reduces the demand on scarce resources such as water, as well as non-renewable resources such as coal by promoting energy generating facilities which are less resource intensive[19].
- Assists in meeting nationally appropriate emission targets in line with global climate change commitments, by reducing reliance on coal as an energy source.
- Reduces and, where possible, eliminates pollution by using cleaner energy generating mechanisms and reducing the demand on carbon based fuels.
- Assists in alleviating energy poverty by providing energy in rural areas to stimulate local economies.
- Promotes local economic development by creating jobs and promoting skills development.
- Enhances energy security by diversifying generation to reduce reliance on coal as a primary energy source and promoting renewable energy generation.

[18] Baseload is the amount of power required to meet minimum demands based on reasonable expectations of customer requirements. Baseload power stations are devoted to the production of baseload supply and produce energy at a constant rate. Examples of baseload plants using non-renewable fuels include nuclear and coal-fired plants. Among the renewable energy sources, hydroelectric, geothermal, biogas, biomass, solar thermal with storage and ocean thermal energy conversion can provide baseload power (https://en.wikipedia.org/wiki/Base_load_power_plant, accessed 26/06/2013)

[19] A hydropower station only uses water for turning the turbines that generate electricity. Water is not consumed during energy production.

4.1.1 Utilising resources available to South Africa

South Africa currently generates the majority of its required electricity from coal, of which there is an abundant supply at national level. However, national government is on the verge of augmenting the existing generation capacity of thermal and nuclear power plants with renewable energy power generation, thus, creating the framework that will lead to an increase in the supply of clean energy for the nation.

4.1.2 Meeting nationally appropriate emission targets in line with global climate change commitments

As can be seen by the numerous policies and legislation described in **Section 1.3,** the need for renewable energy is well documented. Due to concerns, such as climate change and the on-going exploitation of non-renewable resources, there is increasing international pressure on countries to increase their share of renewable energy generation. The proposed hydropower facility is expected to contribute positively towards climate change mitigation.

Renewable energy is recognized internationally as a major contributor in diminishing the effects of climate change, as well as providing a wide range of environmental, economic and social benefits that can contribute towards long-term global sustainability.

Hydropower is a source of “green” electricity as for every 1 MWh of “green” electricity used instead of traditional coal powered stations, one can:

- Save water;
- Avoid Sulphur Dioxide (SO_2) emissions;
- Avoid Carbon Dioxide (CO_2) emissions;
- Avoid ash production; and
- Contribute to social upliftment.

4.1.3 Enhancing energy security by diversifying generation

The establishment of the proposed hydropower generation facility would strengthen the existing electricity grid for the area. Moreover, the projects would contribute towards meeting the national energy target as set by DoE. Should the proposed hydropower site and development identified by Boegoeberg Hydro be acceptable, it is considered viable that long term benefits for the community and society in Groblershoop would be realised, as highlighted above, and as required by DoE in its REIPPP.

The proposed project would also have international significance as its contributes to South Africa being able to meet some of its international obligations by aligning domestic policy with internationally agreed strategies and standards as set by the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Copenhagen Accord and United Nations Convention on Biological Diversity, to which South Africa is a signatory.

4.1.4 Creating a more sustainable economy

The Northern Cape has a semi-arid climate and, particularly the Groblershoop area, has large tracts of open land which are sparsely inhabited. The towns are generally small with limited job opportunities. The need to improve the quality of life for all, and especially for the poor, through job creation is critical in South Africa. It is expected that the proposed project would contribute directly to the upliftment of individuals and societies in which it is located. Skills development, the transfer thereof, and local community involvement are three priorities. Community involvement would either be through direct employment or indirectly through service industries. This will be enhanced as far as possible through application of REIPPP directives and guidelines. It is anticipated that job opportunities amounting to

between 2,400 (100 labourers' x 24 months) to 3,600 (150 labourers x 24 months) person months would be created during construction depending on the procurement method of the primary contractor.

In addition to local skills development and job creation, the following potential benefits could be realised:

- Reducing the demand on scarce resources, such as water, as the generation of hydro energy does not consume water unlike coal-fired facilities that consume both water and coal;
- Reducing pollution as the generation of energy from hydropower facilities produces no pollution unlike coal-fired facilities;
- Local economic development as indicated in **Table 4-2**; and

Numerous studies and reports have attempted to quantify the employment creation potential of renewable energy per unit of power installed or generated. AGAMA Energy (2003) established that hydropower has equal creation potential to wind technologies as indicated in **Table 4-1**.

Table 4-1 | Renewable energy employment potential in terms of the gross direct jobs created per GWh for the various technologies (Agama Energy, 2003)

Employment per GWh						
Technology	**Fuel /GWh**	**Manufacture /GWh**	**Installation /GWh**	**O&M /GWh**	**Other /GWh**	**Total /GWh**
Solar thermal	0	3	7	0.4	0	10.4
Solar PV	0	32.9	21.2	4.4	3.5	62
Wind	0	8.4	1.3	2.6	0.3	12.6
Bio-energy	0	3.55	3.55	7.2	0	14.3
Hydro	0	8.4	1.3	2.6	0.3	12.6

Furthermore, the IRP (see **Annexure C**) allows for an additional 20,409 MW of renewable energy in the electricity blend in South Africa by 2030. Of the aforementioned, 130 MW is reserved for small hydro. While there are a number of renewable energy options (including, *inter alia*, wind and solar) being pursued in South Africa, many more renewable energy projects are required to meet the targets set by the IRP. Consequently, based on this requirement for renewable energy, Hydro SA is pursuing a number of hydropower projects of which this project is one.

Table 4-2 | The applicability of NEMA Sustainability Principles to the proposed project

NEMA Sustainable Development Principle	Consideration for these proposed projects and EIA Process
(1) The principles set out in this section apply throughout the Republic to the actions of all organs of state that may significantly affect the environment and – • Shall apply alongside all other appropriate and relevant considerations, including the State's responsibility to respect, protect, promote and fulfil the social and economic rights in Chapter 2 of the Constitution and in particular the basic needs of categories of persons disadvantaged by unfair discriminations; • Serve as the general framework within which environmental management and implementation plans must be formulated; • Serve as guidelines by reference to which any organ of state must exercise any function when taking any decision in terms of this Act; or any statute provision concerning the protection of the	All principles will be considered in the adjudication of the application for environmental authorisation.

environment; • Serve as principles by reference to which a conciliator appointed under this Act must make recommendations; and • Guide the interpretation, administration and implementation of this Act, and any other law concerned with the protection or management of the environment.	
(2) Environmental management must place people and their needs at the forefront of its concern, and serve their physical, psychological, developmental, cultural and social interests equitably.	This EIA process considered both the natural and socio-economic environments and mitigation measures are provided in response to this principle as included in the EMPr in **Annexure E**.
(3) Development must be socially, environmental and economically sustainable.	The need to improve the quality of life for all, and especially for the poor, through job creation, is critical in South Africa. It is expected that the proposed project would contribute directly to the upliftment of individuals and societies in which it is located. The proposed project would include the following benefits that would contribute to environmental and social sustainability: • Reducing the demand for scarce resources, such as water, since the generation of energy from hydropower facilities consumes no water unlike coal-fired facilities; • Reducing pollution as the generation of energy from hydropower facilities produces no pollution during operation unlike coal-fired facilities; • Local economic development; • Local skills development; • Construction industry businesses will benefit from an increase in the demand for their goods, materials and services; • Increased business activity will result in improved spending power; and • Increased competitiveness of the region in terms of energy generation.
(4) (a) Sustainable development requires the consideration of all relevant factors including the following:	
i. That the disturbance of ecosystems and loss of biological diversity are avoided, or where they cannot be altogether avoided, are minimised and remedied;	Disturbance of the ecosystem and loss of biological diversity will be minimised through design measures and appropriate mitigation measures. The advantage of developing a hydropower facility at Boegoeberg Dam is that this site has already undergone extensive physical alteration with the dam itself and associated infrastructure. EIA investigations were undertaken, which identified environmentally sensitive areas and found no fatal flaws which would prevent the development from proceeding. These sensitive areas have informed the preliminary design of the proposed hydropower facility to ensure that sensitive areas are avoided to limit the disturbance of ecosystems. Furthermore, an EMPr was compiled to ensure that mitigation measures proposed in the EIR are implemented during

		planning, construction, operations and decommissioning.
ii.	That pollution and degradation of the environment are avoided, or, where they cannot be altogether avoided, are minimised and remedied;	An EMPr was compiled to ensure that mitigation measures proposed in the EIR are implemented during planning, construction, operations and decommissioning.
iii.	That the disturbance of landscapes and sites that constitute the nation's cultural heritage is avoided, or where is cannot be altogether avoided, is minimised and remedied;	A Heritage and Palaeontological impact assessment were undertaken during the EIA. Recommendations of the studies are described in **Section 0.6.**
iv.	That waste is avoided, or where it cannot be altogether avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;	This project shall generate the least amount of waste possible by properly planning material procurement (ordering, transportation and delivery), ensuring proper material handling and storage to reduce the avoidable generation of wastage (i.e. broken and damaged materials) and reusing potential waste materials on site, wherever possible. As much of the inevitable waste generated shall be recovered and sorted for donation, reuse elsewhere or stored separately for recycling as economically feasible.
v.	That the use and exploitation of non-renewable natural resources is responsible and equitable, and takes into account the consequences of the depletion of the resource;	This project will increase South Africa's electricity generation capacity through renewable energy technologies and will not utilise non-renewable sources for energy generation. Run-of-river hydropower energy systems have very little impact on the environment, making them one of the cleanest power-generating technologies available. During operation, they produce no air pollution or hazardous waste, and they do not consume water. The more electricity generated from hydropower ultimately decreases our reliance and dependence on fossil fuels and on imported sources of energy. Finally, hydropower can be an effective economic development driver, especially in areas where there is currently little economic impetus. In addition, the following are benefits of hydropower: • Hydropower is a renewable energy source based on a natural resource. • Hydropower is non-polluting. Unlike coal-fired power stations, hydro stations do not emit greenhouse gases or carcinogens into the air during operation. • Hydropower electricity generation does not consume Water. Minimal maintenance is required. • Hydropower schemes have some of the longest operational lifespans of any energy generation schemes.
vi.	That the development, use and exploitation of non-renewable resources and the ecosystems of which they are part do not exceed the level beyond which their integrity is jeopardised;	The most significant non-renewable resource utilised by most power generation facilities is water. However, as the hydropower facility does not consume water in order to generate electricity it does not exploit non-renewable resources during operation. The removal of vegetation can also be viewed as use of non-

	renewable resources. This is assessed in **Section 5.1**.
vii. That a risk-averse and cautious approach is applied which takes into account the limits of current knowledge about the consequences of decisions and actions; and	Limitations and gaps in knowledge have been highlighted and taken into account in the EIA process. The information provided in the EIR is sufficient for decision-making purposes, and where there is uncertainty with predictions, monitoring, inclusive of remedial actions, if required, is recommended.
viii. That negative impacts on the environment and on people's environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.	The impacts on the people of Groblershoop were investigated and mitigation measures proposed which aim at reducing negative impacts and enhancing benefits. .
(b) Environmental management must be integrated, acknowledging that all elements of the environment are linked and interrelated, and it must take into account the effects of decisions on all aspects of the environment and all people in the environment by pursuing the selection of the best practicable environmental option.	This EIA was undertaken in accordance with the legal requirements as a fundamental guiding principle. The outcomes of the specialist studies have been integrated to provide an integrated assessment of the proposed hydropower facility.
(c) Environmental justice must be pursued so that adverse environmental impacts shall not distribute in such a manner as to unfairly discriminate against any person, particularly vulnerable and disadvantaged persons.	The EIA process, including the public participation process, outlined the possible impacts on the various groupings of people of Groblershoop and mitigation measures are proposed to reduce negative impacts and enhance benefits, in particular, considering the vulnerable and disadvantaged.
(d) Equitable access to environmental resources, benefits and services to meet basic human needs and ensure human wellbeing must be pursued and special measures may be taken to ensure access thereto by categories of persons disadvantaged by unfair discrimination.	Environmental resources, such as the areas ecology, freshwater ecosystems, and land use, were considered and avoidance or mitigation measures are provided in the EMPr to ensure that none of these resources are compromised, thereby limiting access thereto.
(e) Responsibility for the environmental health and safety consequences of a policy, programme, project, product, process, service or activity exists throughout its life-cycle.	The EIA process considered the environmental, health and safety consequences of the development through the construction and operational life of the project.
(f) The participation of all interested and affected parties in environmental governance must be promoted, and all people must have the opportunity to develop the understanding, skills and capacity necessary for achieving equitable and effective participation by vulnerable and disadvantaged.	Ample opportunities for public participation were provided to all I&APs throughout the EIA process as described in **Section 2.2**.
(g) Decisions must take into account the interests, needs and values of all interested and affected parties, and this includes recognising all forms of knowledge, including traditional and ordinary knowledge.	The EIA process has taken cognizance of all interests, needs and values adopted by all interested and affected parties.
(h) Community wellbeing and empowerment must be promoted through environmental education, the raising of environmental awareness, the sharing of knowledge and experience and other appropriate means.	The EIA process has taken cognizance of all interests, needs and values espoused by all I&APs. Ample opportunities for public participation were provided to all I&APs throughout the EIA process.
(i) The social, economic and environmental impacts of activities, including disadvantages and benefits, must be considered, assessed and evaluated, and decisions must be appropriate in the light of such consideration	**Section 5.9** provides information on the socio-economic impact assessment.

and assessment.	
(j) The right of workers to refuse work that is harmful to human health or the environment and to be informed of dangers must be respected and protected.	The project area is subject to the health and safety requirements of the Occupational Health and Safety Amendment Act, No. 181 of 1993.
(k) Decisions must be taken in an open and transparent manner, and access to information must be provided in accordance with the law.	The EIA process has been thoroughly documented and all relevant information known to the EAP, as well as written comments received, have been included in the reporting for consideration by the authorities.
(l) There must be intergovernmental coordination and harmonisation of policies, legislation and actions relating to the environment.	The relevant authorities have been notified of the project and provided with opportunity to comment. This authority involvement process has been documented in the EIA documentation.
(m) Actual or potential conflicts of interest between organs of state should be resolved through conflict resolution procedures.	There has been no conflict between Departments to date.
(n) Global and international responsibilities relating to the environment must be discharged in the national interest.	The establishment of the proposed Boegoeberg hydropower scheme would strengthen the existing electricity grid for the area. Moreover, the project will contribute towards meeting the national energy target as set by DoE. Renewable energy is recognized internationally as a major contributor in protecting the climate, nature and the environment, as well as providing a wide range of environmental, economic and social benefits that can contribute towards long-term global sustainability.
(o) The environment is held in public trust for the people, the beneficial use of environmental resources must serve the public interest and the environment must be protected as the people's common heritage.	The impacts are documented in the EIR to inform decision-makers regarding potential ramifications of the proposed project so that an informed decision can be taken. In this regard, it is submitted that hydropower electricity generation does meet the criterion of the beneficial use of an environmental resource (water), which is in the public's interest.
(p) The costs of remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage, or adverse health effects must be paid by those responsible for harming the environment.	Mitigation measures are recommended in this EIR to minimise negative impacts and enhance benefits, which, as implemented, are for the cost of the proponent.
(q) The vital role of women and youth in environmental management and development must be recognised and their full participation therein must be promoted.	Public participation of all I&APs has been promoted and opportunities for engagement been provided during the EIA process.
(r) Sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.	Specialist assessments were undertaken to investigate the biophysical and social impacts that this project may have. The outcome of the specialist's assessments indicates how significant impacts can be mitigated. Furthermore, the proposed development is not sited within a sensitive, vulnerable, highly dynamic, or stressed ecosystem. Where sensitivities have been identified, the project design has been revised to avoid these areas and features.

The questions posed in the DEA&DP's Need and Desirability Guidelines (2011) have been used as a framework to assess the needs and desirability of the proposed project, as required in terms of the NEMA (**Table 4-3**).

Table 4-3 | Discussion related to specific questions in the Needs and Desirability Guideline (DEA&DP, 2011)

Need and Desirability	
Need (Timing)	
Question	Response
1. Is the land use (associated with the activity being applied for) considered within the timeframe intended by the existing approved Spatial Development Framework (SDF) agreed to by the relevant environmental authority i.e. is the proposed development in line with the projects and programmes identified as priorities within the Integrated Development Plan (IDP)?	There is currently no SDF available for the area (p. 14 of the Siyanda District IDP). Although no SDF exists, the IDP (2012 – 2017) identifies two primary development objectives (p.26 of the Siyanda District IDP): • Promoting the growth, diversification and transformation of the provincial economy. • Poverty reduction through social development. The IDP (2012 – 2017) lists the following macro-level conditions for growth (p.26 of the Siyanda District IDP): • Enhancing infrastructure for economic growth and social development. To give effect to the above, one of the high-level development targets set in the Northern Cape is (p.26 of the Siyanda District IDP): • To provide adequate infrastructure for economic growth and development by 2014. The proposed project, which will generate sustainable electricity, will, therefore, help to promote development and economic growth.
2. Should development, or if applicable, expansion of the town/ area concerned in terms of this land use (associated with the activity being applied for) occur at this point in time?	Yes. As per the response to question 1 above, the proposed project would contribute to the provision of adequate infrastructure for economic growth and social development, albeit not by 2014 (but a little later), as per the high-level targets set in the Siyanda District IDP (p.26 of the Siyanda District IDP). Furthermore, South Africa is actively pursuing renewable energy projects.
3. Does the community/ area need the activity and the associated land use concerned (is it a societal priority)?	Yes. The stated mission of !Kheis Municipality is as follows: • 'To promote economic development to the advantage of the communities within the boundaries of the !Kheis Municipality. This will be done by the establishment and maintenance of an effective administration and a safe environment in order to attract tourists and investors to the area' • To create an environment in which to empower the Community through capacity building and skills development, as well as for economic growth in order to reduce unemployment and poverty with at least 5%, by June 2014 (!Kheis Local Municipality IDP, 2012 - 2017). The proposed hydropower station would not only create job opportunities for the local community, as the construction of the facilities require a wide range of skill, which the District can, to a degree, supply, but will also be a source of income to the landowners. Secondary economic impacts may include an increase in service amenities through an increase in local spending by contractors and an associated demand for accommodation.

Need and Desirability	
Need (Timing)	
Question	Response
4. Are there necessary services with appropriate capacity currently available (at the time of application), or must additional capacity be created to cater for the development?	Yes. The Municipality has confirmed that there is sufficient capacity to provide the necessary services to the project. (Refer to **Annexure H** for the confirmation of services letter). Services for this project will be sourced from this Municipality.
5. Is this development provided for in the infrastructure planning of the municipality, and if not, what will the implication be on the infrastructure planning of the municipality (priority and placements of services)?	No. It should be noted that once the proposed project is operational, there would be a very limited requirement for municipal services. Also, the proposed project does not infringe on infrastructure planning by the municipality.
6. Is this project part of a national programme to address an issue of national concern or importance?	Yes. The establishment of the proposed facility would strengthen the existing electricity grid for the area. Moreover, the project would contribute towards meeting the national energy target as set by the DoE, of a 30% share of all new power generation being derived from IPPs. The Industrial Policy Action Plan (IPAP2, 2010) recommends a sector focussed approach identifying key sectors with potential to be developed. The sectors identified in the IPAP2 documents renewable energies**.** The proposed hydropower project, although not specifically mentioned, will further facilitate the realisation of this development objective. The Integrated Resource Plan (IRP 2010) developed by DoE for the 2010 to 2030 period aims to achieve a "*balance between an affordable electricity price to support a globally competitive economy, a more sustainable and efficient economy, the creation of local jobs, the demand on scarce resources such as water and the need to meet nationally appropriate emission targets in line with global commitments*". The final IRP provides for an additional 20,409MW of renewable energy in the electricity mix in South Africa by 2030.
Desirability (Placing)	
Question	Response
1. Is the development the best practicable environmental option (BPEO) for this land/ site?	*Yes.* !Kheis LM is a very arid region of the Northern Cape where agricultural potential is limited to irrigated agriculture. Irrigation activities are mainly situated along the Orange River and include crops such as lucerne, grapes and wheat, with subsidiary crops of vegetables, deciduous fruits and maize. The site for the facility does not fall within a cultivated area and has a low agricultural potential. The hydropower plant is small scale and is unlikely to have any effect on the *status quo* farming activities.
2. Would the approval of this application compromise the integrity of the existing approved Municipal IDP and SDF as agreed to by the relevant authorities?	No. The project is in line with the Siyanda DM IDP (2012-2017) which has a stated vision to "enhance economic development for the benefit of the community of the Siyanda District area. We do this by creating and maintaining an effective administration and a safe environment to attract

Need and Desirability	
Need (Timing)	
Question	Response
	tourists and investors". The Siyanda District IDP is informed by a Regional Development Strategy that puts additional emphasis on specific aspects and strategic priority areas, notably that of infrastructure maintenance and economic development. There is currently no SDF available for the Siyanda DM or !Kheis LM.
3. Would the approval of this application compromise the integrity of the existing environmental management priorities for the area (e.g. as defined in Environmental Management Frameworks (EMFs)), and if so, can it be justified in terms of sustainability considerations?	No. The Siyanda DM EMF (2008) has prioritised the protection of Alluvial Thicket along the Orange River. However the Siyanda DM EMF (2008) also states that "By adopting a policy that only rocky outcrops within the river system should be considered for development provided that they can be reached without causing significant environmental impacts and that they are not sensitive in terms of their aesthetic value." The proposed construction footprint is dominated by a rocky outcrop and would be in line with this recommendation. Furthermore, the EIA process would ensure that the proposed facilities would be environmentally sustainable. Although the site falls within a CBA, the site layout has been adapted in line with specialists' recommendations..
4. Do location factors favour this land use (associated with the activity applied for) at this place?	Yes. The site was selected based on the following criteria: • The site has an existing weir. • Hydrologically suitable characteristics such as a head (drop in elevation) to enable electricity generation; • Existing database to inform engineering decisions - flow rate annual measurements collected for Boegoeberg and Neus DWA stations. • Suitable topography and accessibility for construction. • Favourable land ownership. • Feasibility of project design to accommodate environmental sensitivities, taking note of technical and financial considerations. • Relatively easy grid connectivity and proximity to grid access via the Fibre Substation.
5. How will the activity or the land use associated with the activity applied for, impact on sensitive natural and cultural areas (built and rural/ natural environment)?	Potential impacts associated with the proposed project have been assessed. Refer to the impact assessment findings in Chapter 5 of the EIR.
6. How will the development impact on people's health and wellbeing (e.g. in terms of noise, odours, visual character and sense of place, etc.)?	Potential impacts associated with the proposed project have been assessed. Refer to the impact assessment findings in EIA in Chapter 5 of the EIR.
7. Will the proposed activity or the land use	The socio-economic impacts have been assessed and discussed in the

Need and Desirability	
Need (Timing)	
Question	Response
associated with the activity applied for, result in unacceptable opportunity costs?	Chapter 5 of the EIR.
8. Will the proposed land use result in unacceptable cumulative impacts?	Potential cumulative impacts associated with the proposed project been assessed and discussed in the Chapter 5 of the EIR.

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5 BIOPHYSICAL AND SOCIO-ECONOMIC IMPACT ASSESSMENT

This section forms the focus of this EIR. It contains a detailed assessment of the construction, operations and decommissioning impacts associated with the proposed project on the affected biophysical and socio-economic environment, using standard Aurecon assessment methodology. Mitigation measures to enhance positive impacts and reduce negative impacts are described.

As mentioned in **Section 2.1**, the Scoping Phase identified various impacts on the biophysical and socio-economic environment that are anticipated to occur during construction and operations. These impacts are described below in the following order:

- Disturbance of flora and fauna;
- Disturbance of avifauna;
- Sedimentation and erosion of water ways;
- Impact on local economy (employment) and social conditions;
- Impact on heritage resources (including palaeontology);
- Impact on agricultural land;
- Visual impacts;
- Traffic impacts ;
- Noise impacts (including blasting);
- Impacts related to spoil;
- Dust impacts; and
- Impacts related to the storage of hazardous substances on site.

These impacts on the biophysical and socio-economic environments were assessed in terms of the methodology outlined in the Plan of Study for EIA (for ease of reference the methodology is included in **Annexure F**). For each impact assessed, mitigation measures have been proposed to reduce and/or avoid negative impacts and enhance positive ones. . These mitigation measures are also incorporated into the EMPr to ensure that they are implemented during the planning, construction, operational and decommissioning phases. The EMPr forms part of the EIR and, therefore, the implementation of the EMPr specifications will become a binding requirement on the proponent should this project be authorised.

5.1 IMPACT ON FLORA

The Boegoeberg Dam area and surrounding properties over which the transmission line would extend are all located within the Nama Karoo Biome, Bushmanland Bioregion (Rutherford & Westfall, 1994; Rutherford, Mucina & Powrie, 2006; Mucina *et al.*, 2006). Potential issues relevant to the flora of the study area include impacts on endemic and 'Red Data' species, sensitive habitats, and cumulative impacts of all the components of the project.

Dr David J. McDonald of Bergwind Botanical Surveys & Tours CC was appointed to undertake a Botanical Impact Assessment (BIA). The study considered a range of potential botanical impacts. A field assessment was undertaken on 1 and 2 October 2013. The BIA is included in **Annexure D**, with the findings and recommendations of the study summarised below.

5.1.1 Description of the Environment

Three vegetation types are found, namely Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. The Boegoeberge are named after the mid-high shrub *Croton gratissimus* (boegoe; lavender fever-berry) which occurs on the rocky hills.

- *Red List plant species, protected plants and trees of the study area*

Neither Lower Gariep Broken Veld nor Bushmanland Arid Grassland is listed in the National List of Threatened Ecosystems (Government Gazette, 2011) but Lower Gariep Alluvial Vegetation is listed as Endangered A1 (the A1 criterion means there is irretrievable loss of natural habitat with the remaining natural habitat of this type ≤ biodiversity target +15%). However, the Lower Gariep Alluvial Vegetation will not be greatly affected by the proposed project.

Nevertheless, particular emphasis is to be placed on minimising loss or damage of *Boscia albitrunca* (Shepherds' Tree), a nationally protected plant species. An application to DAFF for permission to remove trees from the construction zone of the hydro-power plant would be required. No Red List Species (Raimondo *et al*., 2009) were found during the survey and the chances of the project affecting such species are **low (-)** to **very low (-)**.

- *National Protected Area Expansion Strategy Focus Area (NPAES)*

Part of the project site would be located in a National Protected Area Expansion Strategy Focus Area (NPAES), namely the Gariep NPAES Focus area as identified on South African National Biodiversity Institute Biodiversity Geographical Information Systems website. However the facility itself and the majority of the associated infrastructure are not actually located in this focus area but rather adjacent thereto. **Figure 29** shows the facility footprint and associated infrastructure within the Focus area.

The proposed development activities which would occur within the Focus area consist of upgrading the existing access roads to 6m, a temporary construction site which occurs in an already disturbed area (Figure 3) and a transmission line with an associated track of 4m. Components of the proposed development and have been overlaid with the NPAES Focus area in figures 1 and 2)
Furthermore the botanical specialist's findings concluded the overall impact on flora will be Medium (-) to Low (-). The largest impact will be at the hydro-power site (which falls outside of the NPAES area) with the transmission line likely to have a Low (-) impact. Mitigation measures should be meaningfully applied, particularly in the post-construction phase. Such measures would reduce the impact of the hydropower plant on flora from Medium (-) to Low (-). The following triggers where included in the initial application made to the Department of Environmental Affairs but additional detail has now been added to take cognisance of the NPAES focus area.

- *Ecology sensitivity assessment*

The sensitivity assessment identifies those parts of the study area that have conservation value or that may be sensitive to disturbance. Riparian vegetation areas of "**medium**" sensitivity are shown in **Figure 30**. The majority of the site was deemed to be of "**low - medium**" sensitivity.

The impacts are assessed below. The assessment has been undertaken separately for the hydropower facility and ancillary infrastructure as the impacts are anticipated to be different.

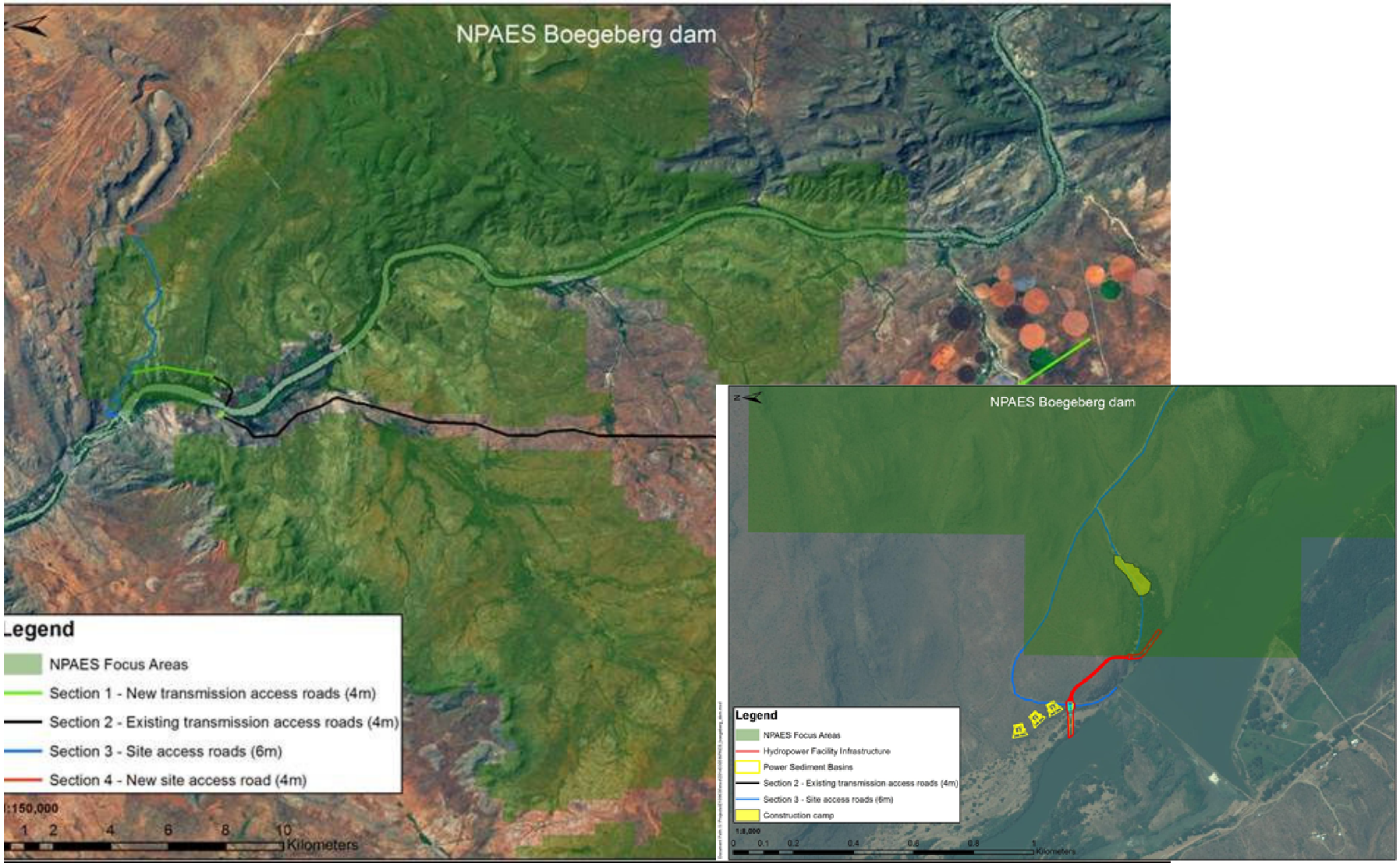

Figure 29. | **NPAES overlaid with the proposed hydropower facility components**

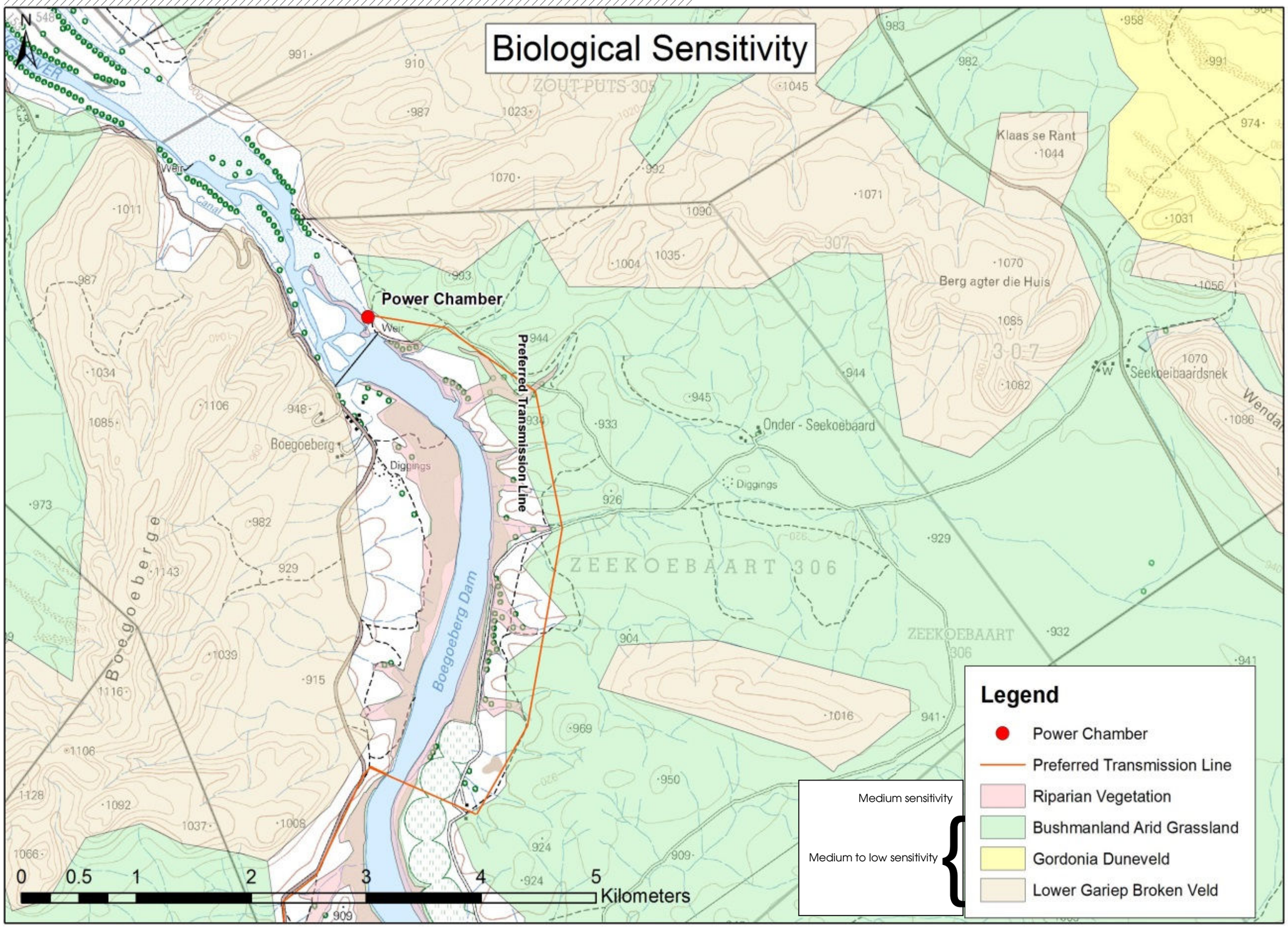

Figure 30 | Botanical sensitivity map

5.1.2 Impact Assessment

The impacts of the respective elements of the Boegoeberg hydro power project as they pertain to vegetation and flora are given below.

5.1.2.1 Construction phase

Off-take structure

The Lower Gariep Alluvial Vegetation is represented by only *Searsia pendulina* in the area of the 'off-take' to the hydro power plant (**Figure 31**). *S. pendulina* is a common species with low botanical sensitivity. No species with high conservation value such as *Euclea pseudebenus* (Cape ebony) or *Vachellia erioloba* (camel thorn tree) were found in the area.

Figure 31 | Searsia pendulina lining the east bank of Boegoeberg Dam where the off-take structure would be located (Source: D.McDonald 2013)

Access roads

Along the access road to the site numerous trees of *S. pendulina* and *Ziziphus mucronata* (blinkblaar wag-'n-bietjie) trees would have to be cut and trimmed to provide access for vehicles and equipment. The access road to the construction site would follow an existing farm road which would require widening; however this would not adversely affect vegetation.

Roads to access both the construction site for the hydropower plant, construction camp and transmission lines are well-established. Apart from the need for widening and upgrading in some places, there would be little further impact on vegetation and therefore this element of the project would have **low (-)** impacts a before and after mitigation.

Conveyance infrastructure

Alternative 1 - Canal

To enable construction of the off-take canal, the entire side of the hill or koppie adjacent to the east side of the Boegoeberg weir would need to be excavated. The vegetation on the west part of the koppie would be lost. While most of the vegetation is not sensitive, a number of *Boscia albitrunca* (Shepherd's tree; Witgatboom) trees (a protected species) (Alias, Milton, Herrmann & Seymour, 2003) would be lost. It is estimated that in the order of eight (8) *B. albitrunca* trees would need to be removed, requiring a permit from DAFF.

Figure 32 | The Boegoeberg weir with DWA access track and koppie on the east side. The small green tree amongst the rocks is Boscia albitrunca (Source: D. McDonald 2013)

Alternative 2 –Tunnel (preferred)

Construction of the open canal would result in the excavation of the side of the hill or koppie adjacent to the east side of the Boegoeberg weir, as outlined above. The tunnel option would only require an entry and exit point into the koppie itself (**Figure 32**). The footprint in terms of vegetation destruction is limited and, therefore, this option is preferred from a botanical perspective, based on the reduced removal of vegetation overall.

Tailrace

For construction of the tailrace, an area of 3,000m² would be cleared. The vegetation in the area is not dense or sensitive, consisting mostly of reed-beds and *Searsia pendulina* trees.

Construction camp

A construction camp with site office, crusher plant and other construction equipment, as well as temporary accommodation for personnel, would be required. Establishment of the construction camp, although in an already disturbed area, would likely have **medium (-)** impacts, as personnel may move outside the camp footprint into more sensitive vegetation, potentially stripping vegetation for firewood or trampling vegetation while using these areas for informal ablutions. These impacts can be limited and/or mitigated by strict adherence to 'No Go' zones outside the construction camp footprint. This could lower the impact to l**ow (-)**. The site is indicated in **Figure 33**.

Figure 33 | The proposed site for the construction camp which is already impacted by disturbance from agricultural activities (Source: D. McDonald 2013)

Transmission lines

Transmission line was not assessed as it was not considered feasible. The transmission lines are routed through mainly through Bushmanland Arid Grassland which is considered to be of medium to low sensitivity. Transmission line 2 (section close to the power station) was originally routed through sensitive riverine vegetation but rerouting this small section behind the koppie and along the existing road network ensures that the route does not impact on sensitive vegetation.

Sediment basins

The sediment basins for the deposition of dredged silt are proposed on the alluvial plain. The sediment basins will result in clearance of vegetation, which are located in an area of alluvial vegetation which is not considered sensitive. These structures are limited in size and will be constructed and drained in a controlled manner to reduce the opportunity for sediment laden runoff from these structures.

Borrow pits

The two borrow pits that may be required are extensions of the borrow pits on the farm Zeekoebaart 306 and are already disturbed by excavation of material, which results in clearance of vegetation and potential for erosion and dust, as well as sedimentation of water courses after extreme rain events because of exposed surfaces. These borrow pits are located in Bushmanland Arid Grassland and the vegetation has low sensitivity. However, they are in close proximity to watercourses and, therefore, measures would have to be taken to prevent disturbance of the watercourses, either through impeding water flow or increasing silt-load in the watercourse due to runoff water from the borrow pits. However, should rehabilitation of the entire borrow pit occur following on construction, this would have a positive impact on the environment

5.1.2.2 Construction impacts

Boegoeberg Hydropower Plant Layout 1

The potential impact on flora from the hydropower plant alternative 1 (Off-take weir, head-pond and open canal, power house and tailrace) is considered to be of medium magnitude, and of local extent, anticipated to continue throughout the construction period. It is, therefore, predicted to be of **high (-)** significance without mitigation. The significance of this impact could be reduced to **medium (-)** with mitigation.

Boegoeberg Hydropower Plant Layout 2 (preferred)

The potential impact on flora from the hydropower plant alternative 2 (Off-take weir, tunnel, power house and tailrace) is considered to be of low-medium magnitude and of local extent, anticipated to continue throughout the construction period. It is, therefore, of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1

The potential impact on flora is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. It is, therefore, of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 2

The potential impact on flora is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. It is, therefore, of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Revised Transmission route 2 (preferred)

The potential impact on flora is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. It is, therefore, of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation. Although the overall significance of this alternative remains the same as for Alternative 2, impacts on riverine

habitat will be greatly reduced and, therefore, this is the preferred alternative from a botanical perspective.

Access roads
Roads to access both the construction site for the hydro-power plant, construction camp and the transmission line are well-established. Apart from the need for widening and upgrading in some places, there would be little impact on vegetation. The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low (-)** significance with or without mitigation.

Construction camp
Establishment of the construction camp, although in an already disturbed area, would be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Borrow pits
The two borrow pits that may be required would be extensions of the borrow pits on the farm Zeekoebaart 306. The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low (-)** significance with or without mitigation.

Sediment Basins
The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout construction. Therefore, the impact is of **low (-)** significance with or without mitigation.

5.1.2.3 Operational impact

Boegoeberg Hydropower Plant Layout 2 (preferred)
- Off-take weir and tunnel.
- Power house and tailrace.

The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance with or without mitigation.

Transmission route 1 & revised Transmission route 2 (preferred)
The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance with or without mitigation.

Access roads
The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance with or without mitigation.

Construction camp
The construction camp will be removed once construction has been completed. The area occupied by the camp will be rehabilitated according to the specifications provided in the EMPr and the Vegetation Management Plan. By implication, there cannot be any impacts arising from the construction camp during operations.

Sediment Basin

The potential impact on flora is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance with or without mitigation.

5.1.2.4 Decommissioning impact

The potential impact of the removal of all infrastructure on flora in terms of decommissioning is considered to be of low magnitude, of local extent (transmission line) and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low (-)** significance with or without mitigation. Should the facility and all ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning (residual impacts) will be low positive in terms of the floral environment.

5.1.2.5 Cumulative impacts

There are no similar developments proposed close to this site, based on the limited opportunities to pursue feasible hydropower on the Orange River. The proposed project has a small footprint and is linked to existing infrastructure (the weir). Furthermore, provided the construction and operational activities of the project remain contained within the proposed footprint and disturbed areas along the river bank are rehabilitated, the significance of negative impacts on flora would reduce further. Other than hydro plants, there are few other developments close to the proposed site. However, negative impacts on flora resulting from all phases of this proposed development would be amplified by the construction and operation of multiple projects of any type (including agricultural and recreational) along this stretch of the Orange River, should the impacts on flora of each project not be well managed.

5.1.2.6 No-Go alternative

The No-Go Alternative would have a neutral impact on flora as the *status quo* would remain

5.1.3 Mitigation Measures

While a permit will be needed to remove *B. albitrunca* from site, no provincially protected plant species which are likely to be damaged or removed were noted during the study. However, as a precautionary measure, it is recommended that the Department of Environment Affairs and Nature Conservation, Northern Cape be given the opportunity to inspect the hydro power site prior to construction to ensure that if any additional permits are required, they can be timeously obtained.

5.1.3.1 Preconstruction mitigation

- An application for removal of *B. albitrunca* (Shepherds' Tree) would be required prior to the start of construction.
- Topsoil should be removed from the construction area and stockpiled for future rehabilitation use.
- Cleared vegetation should be chipped, bagged and stored for application as mulch in rehabilitation work.

5.1.3.2 Construction mitigation

An ECO should be appointed to be on site for the duration of the construction period (24 months). The ECO should, *inter alia*, be responsible for the following:

- The ECO should ensure that no unnecessary damage is caused to any vegetation despite the vegetation being generally of low sensitivity.
- The ECO should ensure that areas outside the site construction and construction camp footprints are designated as 'No Go' areas and that these areas are respected.
- The ECO should monitor the use of roads to ensure that no driving off roads into the surrounding veld occurs. Any such activity should result in fines and the necessary remedial action to repair damage.

- The ECO should monitor roads for run-off and erosion into the adjacent veld. Any negative impacts, such as erosion, should be reported and remedial action taken.
- The ECO should identify and take action to remove and destroy any alien plants, such as *Prosopis glandulosus* (mesquite) that could be stimulated by disturbances arising from construction activities.

5.1.3.3 Post-construction phase

- In the post-construction phase, the ECO would be responsible for ensuring that the construction zone of the hydropower plant and construction camp are rehabilitated or left in a state that would permit the natural vegetation to re-colonise naturally. Tasks would include the following:
-
- Soil should be flattened and graded, i.e. no heaps of soil or piles of rock to be left.
- No deep ruts or channels should remain.
- Any temporary access roads and the construction zone alongside the canal should be scarified to alleviate compaction by heavy vehicles and to aerate the soil to permit re-colonization by local flora.
- Attend to all recommended mitigation measures concerning vegetation and vegetation rehabilitation in the EMPr.
- Flatten or mould disturbed areas to form uniform surfaces.
- Scarify the disturbed areas to break up any compaction due to vehicles.
- Restoration work should take place in late summer to ensure that all rehabilitation areas are prepared before the end of February. The intention would be to benefit from the autumn rains (highest rainfall is in March).
- Replace topsoil from stockpile to the depth at which it was removed.
- Spread chipped organic material over the topsoil as a mulch to enhance the water-holding capacity of the soil.
- The areas being rehabilitated should be watered twice a week until there are positive signs of plant establishment. This is to supplement rainfall and to encourage vegetative cover before the following winter.
- Trees such as *Searsia pendulina* and *Ziziphus mucronata* should be planted in strategic places, e.g. at the construction camp site and in the vicinity of the tail-race to re-create groves of trees. These trees should be actively watered for at least three months after planting to promote establishment.
- No hydro-seeding using exotic or grasses non-native to the area should be permitted. The natural grass species have the capacity to quickly and successfully recolonize disturbed sites and this should be encouraged by watering as noted above.
- The mitigation measures outlined above should be undertaken to ensure that disturbances caused by the project are ameliorated as far as possible in the post-construction phase. In this regard, it is important that the post-construction 'clean-up' is meticulously carried out to return all areas to as near-natural a state as possible.

5.1.3.4 Monitoring of re-vegetation

- The progress of vegetation rehabilitation should be monitored by the ECO and reported quarterly for 36 months post-construction. Measurable targets for this must be determined by a restoration practitioner, in consultation with the ECO, at the commencement of rehabilitation activities.
- Any alien invasive vegetation such as *P. glandulosa* (mesquite) that appears in disturbed areas or near the hydropower site, particularly along the banks of the Orange River, should be removed and destroyed by the developer.

5.1.4 Flora Impact Table

Table 5-1 and **Table 5-2** indicate how the significance ratings of the various impacts were derived.

Table 5-1 | Flora Impact Table

	Project	Key activities	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Boegoeberg Hydropower Plant Layout 1	Construction activities (traffic, noise, dust hazardous materials and clearing of vegetation)	Local	High	Long term	High negative	Medium negative	Definite	Certain	Irreversible
	Boegoeberg Hydropower Plant Layout 2 (preferred, i.e. Tunnel)		Local	Medium	Long term	Medium negative	Low negative	Definite	Certain	Irreversible
	Roads	Widening and upgrading	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Construction camp	Establishment and operation of construction camp and crusher	Local	Medium	Short term	Medium negative	Low negative	Definite	Certain	Reversible
	Transmission Route 2	Construction of lines	Local	Medium	Long term	Medium negative	Low negative	Definite	Certain	Reversible
	Borrow Pits	Removal of gravel	Local	Low	Short term	Low negative	Low negative	Definite	Certain	Irreversible
	Sediment basins	Construction of sediment basins	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
Operational phase	Boegoeberg Hydropower Plant Layout 1	Maintenance and operation of power station	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Boegoeberg Hydropower Plant Layout 2 (preferred, i.e. Tunnel)		Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Roads	Maintenance	Local	Low	Long term	Low negative	Low negative	Definite		Irreversible
	Transmission Route 2	Maintenance of lines	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Sediment basins	Deposition of sediment	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible

	Project	Key activities	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Decommissioning activities[20]	Roads	Closure of certain roads which will not be required	Local	Low	Short term	Low negative	Low negative	Definite	Certain	Irreversible
	Transmission Route 1	Removal of lines	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Transmission Route 2	Removal of lines	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Sediment basins	Removal of sediment basins	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
No Ge	No construction of Hydropower plant	N/A	Local	Zero	Long term	Neutral		Definite	Definite	N/A

Table 5-2 | Cumulative botanical impacts

	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Impacts on Flora	Local	Very low	Long term	Low (negative)	Probable	Sure	Irreversible

[20] The decommissioning activities themselves will have a low negative impact. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive in terms of the floral environment.

5.1.5 Flora Conclusions

The overall impact on flora will be **Medium (-)** to **Low (-).** The largest impact will be at the hydro-power site with the transmission line likely to have a **Low (-)** impact. Mitigation measures should be meaningfully applied, particularly in the post-construction phase. Such measures would reduce the impact of the hydropower plant on flora from **Medium (-)** to **Low (-)**.

5.2 IMPACT ON AVIFAUNA

The birds of greatest potential relevance and importance in terms of possible impacts arising from the hydropower plant are likely to be the following:

- Wetland birds, foraging, roosting and/or nesting in the immediate area;
- Cliff-nesting birds, resident on the rock faces overlooking the site; and
- Endemic passerines and large terrestrial species and raptors located in the area affected by the transmission line.

Dr Andrew Jenkins of Avisense Consulting was appointed to undertake an avifauna impact assessment. The assessment included a desktop review of relevant literature and a two day site visit (conducted on 23-24 August, 2013) to determine the avian habitats present at the site and within the surrounding environment. The avifaunal study is included in **Annexure D.** The findings and recommendations of the avifauna study are summarised below.

The anticipated impacts of the hydropower facility and associated infrastructure on avifauna include:

- Habitat destruction;
- Disturbance by construction and maintenance activities, and, possibly, by the operation of the facility;
- Possible displacement or disturbance of sensitive species; and
- Mortality caused by collision with the transmission line and electrocution of avifauna.

Based on the avifauna observed during the site visit and documented avifaunal information on the general area, 11 priority species are recognised as key in the assessment of avian impacts of the proposed Boegoeberg hydropower station. These are mostly nationally and/or globally threatened species, which are known to occur, or could occur, in relatively high numbers in the development area and which are likely to be, or could be, negatively affected by the proposed development (**Table 5-3**).

Table 5-3 | Priority bird species considered central to the avian impact assessment process for the proposed hydropower station

Common name	Scientific name	SA conservation status/ (Global conservation status)	Risk posed by		
			Collision	Electro-cution	Disturbance / habitat loss
Cape Eagle-Owl	*Bubo capensis*	-	Moderate	High	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	High	-	Moderate
African Fish-Eagle	*Haliaetus vocifer*	-	High	High	Moderate

Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	High	High	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	High	High	Moderate
Secretary bird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	High	-	Moderate
Peregrine Falcon	*Falco peregrinus*	Near-threatened	High	Moderate	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	High	Moderate	-
Goliath Heron	*Ardea goliath*	-	High	Moderate	Moderate
Black Stork	*Ciconia nigra*	Near-threatened	High	Moderate	Moderate

5.2.1 Description of the Avifaunal Environment

The impact zone of the proposed hydropower facility largely comprises areas of dry, grassy Karoo veld around the broader periphery of the development area, as well as the riverine area itself (**Figure 34**). This is overlaid on the hilly, rocky terrain of the Boegoeberge, with small areas of exposed, vertical rock presenting habitat for cliff-nesting birds. At least 217 bird species are considered likely to occur with some regularity within the anticipated impact zone of the proposed hydropower development, including 65 endemic or near-endemic species, 10 red-listed species, and three species – Ludwig's Bustard (*Neotis ludwigii)*, Blue Crane (*Anthropoides paradiseus)* and Sclater's Lark (*Spizocorys sclater)i* – which are endemic and red-listed (Barnes 1998, 2000).

Figure 34 | Large piscivorous[21] birds (herons, egrets and cormorants) resting on and hunting from the inner edge of the Boegoeberg weir

[21] Describes a carniveousthat consists largely of fish, though a piscivorous diet may also include similar aquatic foods such as aquatic insects, molluscs and crustaceans.

5.2.2 Avifauna Impact Assessment

Specific impacts of the proposed site are most likely to be manifested in the following ways:

- Habitat loss/change/degradation and disturbance impacts on the waterbird (e.g. herons, cormorants, egrets, storks and African Fish Eagle) and cliff-nesting communities (e.g. Verreaux's Eagle, other montane raptors and storks), and to a lesser extent on populations of woodland and regionally endemic Karoo passerines, associated with construction and decommissioning activities on the development site, as well as with maintenance and operation of the plant itself.
- Habitat loss/degradation and disturbance impacts on large terrestrial birds (e.g. bustards, korhaans and Secretary bird) and savannah raptors (e.g. Martial Eagle), and to a lesser extent on populations of woodland and regionally endemic Karoo passerines, associated with construction and maintenance of the transmission line.
- Mortality of waterbirds, raptors and large terrestrials birds in collisions with and/or electrocution on the transmission line.

In addition, some waterbird species may benefit from the imposed changes on river flow or water quality, and species such as Martial Eagle, a suite of smaller raptors, corvids and the Sociable Weaver may colonise and roost and/or breed in the various utility structures making up the development.

The impacts are assessed below. The assessments for the proposed layout below have been separated in order to assess the layout and the transmission line separately as the impacts are expected to be different.

5.2.2.1 Construction phase impact

Construction activities would result in a direct negative impact on the avifauna in the area caused by the loss of vegetation, habitat and disturbance and collision with structures being constructed.

Table 5-4 | Potential avifaunal impacts during the construction phase.

Common name	Scientific name	SA conservation status/ (Global conservation status)	Risk posed by		
			Collision	Electrocution	Disturbance / habitat loss
Cape Eagle-Owl	*Bubo capensis*	-	Moderate	High	Moderate
Ludwig's Bustard	*Neotis ludwigii*	Vulnerable (Endangered)	High	-	Moderate
Kori Bustard	*Ardeotis kori*	Vulnerable	High	-	Moderate
African Fish-Eagle	*Haliaetus vocifer*	-	High	High	Moderate
Martial Eagle	*Polemaetus bellicosus*	Vulnerable (Near-threatened)	High	High	Moderate
Verreaux's Eagle	*Aquila verreauxii*	-	High	High	Moderate
Secretary bird	*Sagittarius serpentarius*	Near-threatened (Vulnerable)	High	-	Moderate
Peregrine Falcon	*Falco peregrinus*	Near-threatened	High	Moderate	-
Lanner Falcon	*Falco biarmicus*	Near-threatened	High	Moderate	-
Goliath Heron	*Ardea goliath*	-	High	Moderate	Moderate
Black Stork	*Ciconia nigra*	Near-threatened	High	Moderate	Moderate

Table 5-5 | Construction phase activities, associated impact and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Disturbance/displacement associated with noise and movement of construction equipment and personnel. • Loss or degradation of avian habitat through site clearance, road upgrade and establishment of the camp, lay-down and assembly areas.	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines. • All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines.

Layout (preferred)
The potential impact on birds as a result of disturbance, displacement, and loss or degradation of habitat is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact on birds for both transmission line alternatives as a result of disturbance, displacement, and loss or degradation of habitat is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.2.2.2 Operational phase impact

Operational impacts on avifauna include habitat loss, disturbance and displacement of sensitive species by maintenance activities and operation of the hydropower facility, and mortality caused by collision with or electrocution by the transmission line. **Table 5-6** details potential avifaunal impacts during the operational phase.

Table 5-6 | Operational phase activities, associated impacts and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Loss of habitat to space occupied by hydropower station and associated infrastructure, and disturbance / displacement associated with routine maintenance work. • Interruption of regular water flow and/or changes in water turbidity. • Mortality in collisions with power lines, or by electrocution.	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines. • Wetland bird community. • Collisions: Wetland bird community, cliff-nesting raptors, large terrestrial species when flying. • Electrocution: Large species roosting on transmission infrastructure.

Layout (preferred)
The potential impact on birds as a result of disturbance, displacement, and loss or degradation of habitat is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact for both transmission line alternatives on birds as a result of mortality is considered to be of medium magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **high (-)** significance without mitigation. The significance of this impact could be reduced to **low-medium (-)** with mitigation.

5.2.2.3 Decommissioning phase impact

All decommissioning activities would result in a negative direct impact on the avifauna around the hydropower site through disturbance associated with noise and the movement of decommissioning equipment and personnel. **Table 5-7** details potential avifaunal impacts during the decommissioning phase. Should the facility and ancillary infrastructure, in particular, the transmission line, be removed in their entirety, most of the impacts following decommissioning (residual impacts) will be low positive in terms of the avifaunal environment.

Table 5-7 | Decommissioning phase activities, associated impacts and anticipated avifaunal receptors

Project Aspect/ activity	Receptors Affected
• Disturbance/displacement associated with noise and movement of decommissioning equipment and personnel.	• All birds on site; key species – wetland bird community (herons, cormorants, African Fish-Eagle), cliff-nesting raptors (Verreaux's Eagle), endemic passerines.

Layout (preferred)
The potential impact on birds as a result of disturbance is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact for both transmission line alternatives on birds as a result of disturbance is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.2.2.4 Cumulative impacts

While there are existing transmission lines close to the proposed transmission line, the impact of both the transmission line and the power plant are regarded as very low negative with mitigation. Based on the low significance of the impact, as well as that there are no other similar developments proposed close to this site, the cumulative impacts on avifauna is not considered significant. However, negative impacts on avifauna resulting from all phases of this proposed development would be amplified by the construction and operation of multiple projects of any type (including agricultural and recreational) along this stretch of the Orange River, should the impacts on avifauna of each project not be well managed.

5.2.2.5 No-Go impacts

The No-Go Alternative would have a neutral impact as the *status quo* would remain.

5.2.3 Mitigation Measures

The following mitigation measures apply to all alternatives and are recommended to mitigate all potential impacts to avifauna:

- Minimise the total construction footprint.
- Restrict construction time to a reasonable minimum.
- Minimise noise and disturbance associated with construction activities. Minimise noisy activities, such as blasting during the Verreaux's Eagle breeding season (approximately April/May to September/October).
- Minimise noise and disturbance associated with maintenance activities at the plant once it becomes operational.
- Route the transmission line away from the immediate vicinity of the Orange River as it evacuates power from the plant and avoid the riparian vegetation along the bank of the river (Revised Alternative 2).
- Minimise the length of any new transmission line installed.
- Ensure that all new lines are marked with bird flight diverters (Jenkins *et al.* 2010) along their entire length and that all new transmission line infrastructure is adequately insulated and bird friendly in configuration (Lehman *et al,.* 2007).
- In addition to bird flight diverters, use industry standard aviation balls to mark the transmission line where it crosses the Orange River, to ensure that the line is maximally visible to birds using the river course as a flyway.
- In the interests of understanding the longer-term and cumulative impacts of run-of-river hydro developments in South Africa, and with a view guiding impact assessments for future developments of this kind, it would be ideal to institute a control modulated before:after monitoring programme. This should be particularly aimed at quantifying and comparing waterbird numbers on the affected length of river. The results of such a programme could also inform any additional impact mitigation that might be required. However, this recommendation cannot be made a condition of authorisation.

5.2.4 Avifauna Impact Table

Table 5-8 and **Table 5-9** indicate how the significance ratings of the various impacts were derived.

Table 5-8 | Impact rating of avifauna impacts

	Project component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction	Layout (preferred, i.e. Tunnel)	Disturbance	Local	Low - Medium	Short	Low-Medium	Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Roads	Disturbance	Local	Low - Medium	Short	Low-Medium	Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 1	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 2	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
		Habitat loss / degradation	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
Operational	Layout (preferred, i.e. Tunnel)	Habitat loss & disturbance	Local	Low - Medium	Long	Low-Medium	Low	Definite	Certain	Reversible
	Roads	Habitat loss & disturbance	Local	Low	Long	Low-Medium	Low	Definite	Certain	Irreversible
	Transmission Route 1	Habitat loss & disturbance	Local	Low	Long	Low	Very Low	Definite	Certain	Irreversible
		Mortality	Local	Medium	Long	High	Low-Medium	Probable	Sure	Irreversible
	Transmission Route 2	Habitat loss & disturbance	Local	Low	Long	Low-Medium	Low	Definite	Certain	Reversible
		Mortality	Local	Medium	Long	High	Low-Medium	Probable	Sure	Irreversible
Decommissioning activities[22]	Layout (preferred, i.e. Tunnel)	Disturbance	Local	Low	Short	Low-Medium	Low	Definite	Certain	Reversible
	Roads	Disturbance	Local	Low	Short	Low-Medium	Low	Definite	Certain	Reversible
	Transmission Route 1	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible
	Transmission Route 2	Disturbance	Local	Low	Short	Low	Very Low	Definite	Certain	Reversible

*Mitigation measures are described in detail in Section 5.2.3.

Table 5-9 | Cumulative avifauna impacts

Mitigation	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Without Mitigation	Medium	Permanent	Medium	Definite	Certain	Irreversible
With Mitigation	Low	Permanent	Low	Definite	Certain	Irreversible

[22] The decommissioning activities themselves will have a low negative impact. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive in terms of the avifaunal environment.

5.2.5 Avifauna conclusion

Overall, the proposed hydropower development is likely to have relatively little significant, long-term impacts on the avifauna of the area. Careful and responsible implementation of the required mitigation measures – including minimising the size of the construction footprint and the severity of disturbance arising from construction, maintenance and operational activities, and ensuring that the attendant transmission line is designed to minimse avian mortality risk - should reduce impacts to sustainable levels throughout the life of the development.

5.3 IMPACT ON FAUNA

According to a number of biodiversity databases (SABIS:SABIF, IUCN) consulted, a number of faunal species (reptile, amphibian and mammal) are known to occur in the greater study area.

5.3.1 Description of the environment

There are a number of smaller mammals endemic to the Northern Cape in the study area, such as carnivores, including the bat-eared fox, Cape fox, slender mongoose, yellow mongoose, suricate, caracal, striped polecat and black-backed jackal, and a number of smaller antelope species, such as springbok, klipspringer and duiker. The fauna in the area is dependent on the quality and type of habitats provided by the flora.

5.3.2 Faunal Impact Assessment

The proposed project may potentially disturb resident fauna through noise and physical barriers created by the proposed project, and may cause animals to leave the area. The potential impacts are assessed below.

5.3.2.1 Construction phase

All infrastructure and alternatives
Affected fauna would generally be mobile and would relocate during the construction phase. It is likely that they will recolonise the area, once construction has been completed and the disturbed areas rehabilitated. Small insects and reptiles may not be as mobile and habitat destruction would have significant impacts on the immediate populations. However, these are not likely to be localised to this area only and should be well represented elsewhere.

Based on the above, the potential impact on fauna during construction due to disturbance, habit loss and displacement is considered to be of low to medium magnitude, of local extent and short term. Therefore, the impact is of **low (-)** significance without mitigation. With the implementation of mitigation measures, this is anticipated to reduce to **very low (-)** significance. Furthermore there would be no difference in significance between alternatives.

5.3.2.2 Operational phase

All infrastructure and alternatives
Operation and maintenance of the proposed project would entail very few on-site activities and, as such, disturbance of animals and / or habitats is likely to be limited. Existing human activities in the area are likely to have habituated larger animals to the presence of humans and, as such, it is anticipated that any disturbance would result in animals leaving an area for a short period, if at all, and returning once the disturbance has passed. As such, the potential impact of the proposed project on fauna is considered to be of low magnitude, of local extent and long term. Therefore, the impact is of **low (-)** significance, with or without mitigation, for all alternatives.

5.3.2.3 Decommissioning

All infrastructure and alternatives
Any affected fauna would generally be largely mobile and would relocate during the decommissioning phase. They are likely to recolonise the area, once the decommissioning phase has been completed and the disturbed areas rehabilitated.

Based on the above, the potential impact on fauna during decommissioning activities, due to disturbance, habit loss and displacement is considered to be of low to low magnitude, of local extent and short term. Therefore, the impact is of **low (-)** significance without mitigation. With the implementation of mitigation measures, this is anticipated to reduce to **very low (-)** significance. Furthermore there would be no difference in significance between alternatives.

5.3.2.4 No-go

The no-go option would result in the status quo for the fauna on site.

5.3.2.5 Cumulative impacts

There are few developments are proposed for the area and these are widely spaced and are unlikely to result in significant cumulative impacts on fauna.

5.3.3 Mitigation measures

The following mitigation measures are recommended for the construction phase for all project alternatives:

- In all cases, the construction of access roads must be designed for minimal impact e.g. use existing access roads and restrict new roads to the shortest distance through non-sensitive areas as identified in the botanical report. All construction must take place within the footprint of the proposed hydropower facility and associated construction site.
- Ensure that the Vegetation Management Plan plan is implemented. The construction phase must be closely monitored by an ECO who needs to identify any areas that would require rehabilitation in the post-construction phase. The restoration of those areas must follow the construction phase as quickly as possible (Refer to **Annexure E**).
- The site must be cleared in sections as required for construction and not all at once.
- The open canal (should this option occur) will act as a barrier to movement, and also as a drowning risk for local fauna. The canal should be fenced with crossing areas for fauna. This would require specialist input during the detailed design phase.

5.3.4 Fauna Impact Table

Table 5-10 and **Table 5-11** indicate the various impacts and how their significance ratings were determined.

Table 5-10 | Impact rating of faunal impacts

Project	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Layout (all project alternatives) Construction phase	Without mitigation	Local	Low-medium	Short term	Low (-)	Probable	Unsure	Reversible
	With mitigation	Local	Low	Short term	Very-low (-)	Probable	Unsure	Reversible
Layout (all project alternatives) Operational phase	Without mitigation	Local	Low	Long term	Low (-)	Probable	Sure	Irreversible
	With mitigation	Local	Low	Long term	Low (-)	Probable	Sure	Irreversible
Layout (all project alternatives) Decommissioning phase[23]	Without mitigation	Local	Low- medium	Short term	Low (-)	Probable	Sure	Reversible
	With mitigation	Local	Very Low	Long term	Very Low (-)	Probable	Sure	Reversible

*Mitigation measures are described in detail in Section 5.3.3.

Table 5-11 | Cumulative fauna impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Cumulative fauna impacts	Without mitigation	Local	Low	Long term	Low (-)	Probable	Unsure	Reversible
	With mitigation	Local	Low	Long term	Low (-)	Probable	Unsure	Reversible

5.3.5 Fauna Conclusion

The affected faunal species are largely mobile and the impact of construction of the various project components is not anticipated to have a significant impact on animals. Small, less mobile species will be more affected by the destruction of localised habitats but are well represented in the area and, thus, the impact is not considered significant. There are no threatened, near threatened or protected species of potential concern that are likely to occur on site.

[23] The decommissioning activities themselves will have a low negative impact. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive in terms of the faunal environment.

5.4 IMPACT ON AQUATIC ECOLOGY

The study area occurs within the D73B quaternary catchment of the Lower Orange DWA water management area in the Northern Cape. James Mackenzie was appointed to undertake an Aquatic Ecology Assessment to determine the potential impacts that the proposed hydropower facility may have on the aquatic ecology of the study area. Aquatic Ecosystem and Health Assessments were also undertaken to provide information on the ecological condition and ecological importance and sensitivity of the aquatic resources. The site was visited in October 2013 where the characterisation, mapping and integrity assessments of the freshwater features were undertaken. The detailed aquatic ecology assessment report is included in **Annexure D**. Findings and recommendations from the assessment are provided below.

5.4.1 Description of the Environment

The assessed area occurs directly downstream of the Boegoeberg Dam wall and is a mere 5 km upstream of Environmental Flow Requirements (EFR) site 2[24]. All areas described below are referenced in **Figure 35**, as well as in **Figure 36** to **Figure 43**. The Boegoeberg Dam wall does not have a fish ladder, so the existing infrastructure is an existing barrier to fish movement. Below the wall, there are varied and complex hydraulic habitats ranging from rapids and runs, to deeper slow pools. The main channel comprises several mid-channel bars with smaller channels in-between. However, the site can be generally described by three main sub-channels (labelled 1 through 3). The left and centre channels (labelled 1 and 2) are bedrock dominated with fast flowing, rocky habitats, while the right channel (labelled 3) is characterised by slower, deeper flows and is mainly alluvial in nature (other than at the dam wall where rapids occur). The proposed hydro scheme is likely to increase water delivery to the right alluvial channel and decrease flow in the bedrock channels. This is likely to scour the right channel. The riparian vegetation is dominated by reeds and woody vegetation (labelled r and w respectively, where w1 is high density woody vegetation and w2 low density) and is characterised as Lower Gariep Alluvial Vegetation (Mucina & Rutherford, 2006), which is considered to be an endangered unit. Features described above are photographically shown spatially in **Figure 35**.

Table 5-12 | Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS)

Boegoeberg

EIS: HIGH (quaternaries / delineations (reach in this instance) that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases, may have a substantial capacity for use).

- Highest scoring metrics are instream and riparian rare /endangered biota, unique riparian biota, flow intolerant instream biota, taxon richness of riparian biota, diversity of riparian habitat types, critical riparian habitat, refugia, migration corridor.

PES: Category C (the system is moderately modified i.e. loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged).

- Loss of frequency of large floods, agricultural return flows, higher low flows than natural in the dry season, drought and dry periods, decreased low flows at other times, release of sediment, presence of alien fish species and barrier effects of dams.

Driver Components	PES	TREND	REC	AEC↓
IHI HYDROLOGY	E			
WATER QUALITY	C		C	D
GEOMORPHOLOGY	C	0	C	C
INSTREAM IHI	C/D			
RIPARIAN IHI	B/C			
Response Components	**PES**	**TREND**	**REC**	**AEC↓**
FISH	C	0	C	D
MACRO INVERTEBRATES	C	0	C	D
INSTREAM	C	0	C	D
RIPARIAN VEGETATION	B	0	A/B	B/C
RIVERINE FAUNA	C	0	B	C
ECOSTATUS	C	0	B/C	C
EIS	HIGH			

[24] The site that was used for the Reserve determination conducted in 2010 (Louw & Koekemoer (eds), 2010). All data and information from the site are relevant to this project.

Figure 35 | Aerial view of the site to be impacted by the proposed development, showing three channels that comprise the main Orange River downstream of the dam wall, and the proposed alignment of the hydro scheme (dark blue line). Channel 1 most likely results from the permanently open sluices.

Channel 1

Channel 2

Channel 3

Reed banks (r)

Dense woody riparian vegetation (w1)

Sparse woody vegetation and sandy banks / bars (w2)

Rapid and fast deep instream habitats in channel 1 downstream of dam wall

Slow deep habitats in channel 3

Figure 36 | Photographs representing locations according to Figure 31 showing instream and riparian habitats downstream of the Boegoeberg Dam wall

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) are summarised below for various components of the riverine environment. Also, provided is an integrated Ecological Status (Ecostatus) for the reach downstream of the Boegoeberg Dam. Potential impacts of the proposed activity

have two main components. Those pertaining to the aquatic or instream environment are mainly flow related, while those pertaining to the riparian / wetland environment are mainly non-flow related.

The river below the dam wall was divided into three channels during the survey, as detailed above:

- A right-hand channel which consisted mostly of slow deep and shallow habitat with sandy bottom substrate; and
- A middle and left-hand channel with rocky rapid and riffle habitat.

The right-hand and middle channels are of less importance in terms of fish as the habitat diversity is low with minimal cover. The left-hand channel is of higher importance due to various flow depth classes being present as well as ample cover in terms of rocks and the depth of the water.

Figure 37 indicates the habitat in the left-hand channel downstream from the dam wall, which will be affected by the proposed development. This habitat will be dry during the low flow season.

Figure 37 | Downstream view of dominant habitat of left-hand channel (Channel 1) below the site

Figure 38 shows the right-hand channel (Channel 3) of the river below the dam wall consisting of slow shallow water and deep sandy habitat. Very little cover is present at these habitats.

Figure 38 | Dominant habitat of right-hand channel (Channel 3) at site

Figure 39 and **Figure 40** show the habitat directly below the dam wall on left of the main river channel that will be affected and laid dry during low flows.

Figure 39 | Main habitat section below dam expected to be dry or lost during low flow periods, should sluices not be kept open

Figure 40 | Main section of habitat on left-hand of river below dam could to be dry or lost if environmental flows are not met, or sluices opened to compensate for no spill over the weir crest

The flow was measured to be 42m^3/s further downstream from the site at the time of the survey. There are, however, two channels within the reach between the Boegoeberg Weir and the gauging station, the overflow of which supplements the flow in the Orange River from an irrigation canal that flows parallel to the river on the left bank. One of these channels (upper channel) delivers approximately 5m^3/s to the river. The outlet of this channel falls within the lower reaches of the affected area, which means that this additional inflow will help mitigate the effects of the proposed water abstraction. This channel should maintain fish and fish habitats in this area within the deeper sections of the main river and its deeper pools during low flow periods.

Both the channels from the irrigation channel have adequate and even fast flow with ample habitat and cover in terms of water column and rocky substrate. Overhanging vegetation is also abundant. These two channels are, therefore, of importance as they provide additional habitat for fish and flow to the main river.

When the above is taken into account, it can be reasoned that the flow over the Boegoeberg Dam wall was approximately 30m^3/s at the time of the survey. Assuming a spread of flow between the three channels identified within the main channel below the weir, it can be estimated that there was a flow of approximately 10m^3/s per channel[25]. It was observed during the survey that half of the observed flow should be adequate to maintain the river during low flows. This calculates to 5m^3/s per channel (i.e. 15m^3/s for the three channels combined within the main stream). The flow of the upper supplementing channel from the irrigation canal falling within the affected reach will, therefore, be of high importance to the site as it will provide flow to the left-hand channel which was identified as the most important section of the river within the development area.

Figure 41 indicates the upper channel falling within the development area. The channel has a fast deep flowing stream with ample cover for fish (water column, rocks, and vegetation overhang). These channels are important as they provide additional habitat for fish.

[25] This does not take account of the open sluices to flush sediment.

Figure 41 | Fast flow from the upper irrigation canal to the main river in impacted area of site

Figure 42 | General habitat characteristics of the stream channels fed from the irrigation canal feeding into the Orange River

Figure 42 shows the general habitat of the lower channel flowing from the irrigation canal into the Orange River. Rocky substrate (rocks, cobbles, and gravel) seems to be dominant (**Figure 43**). This is also the preferred habitat of species such as yellowfishes, labeos and rock catfish. The additional habitat created by these side channels from the irrigation canal are important and will help with the mitigation of the upstream impacts from the proposed development.

Figure 43 | Substrate in the side channels in area and downstream of site

5.4.2 Flow Requirements

The project would consist of an off-take structure at the weir and a canal/ tunnel of up to 400 m long. The hydro scheme requires a flow of up to 120m^3/s when sufficient river flow is available after environmental releases[26], known as the Environmental Flow Requirement (EFR). EFRs were determined as part of the Reserve Determination Study on the Orange River at EFR 2 (downstream of Boegoeberg Dam) and have been applied to this study. There are different flow requirements for fish and macroinvertebrates for different Ecological Categories (ECs). A detailed description of the flow requirements for the wet and dry season for each of the aquatic components is provided in Annexure D.

The proposed development is likely to have less of an impact on high (flood) flow requirements. However, the high flows are important in that they flush the system, as indicated in **Table 5-13**. Some of the smaller floods (Class I flood) could be reduced by the proposed development. Class 1 floods were set at 150 to 200m^3/s. Such floods also prevent the establishment of terrestrial and alien (especially *Prosopis glandulosa* and *Nicotiana glaucea*) species in the marginal and lower zones. The high flow results are provided in **Table 5-18** with detailed motivations shown in **Table 5-19**.

Table 5-13 | The recommended number of high flow events required at the Boegoeberg site

FLOOD RANGE (m^3/s)	INVERTEBRATES	FISH	VEGETATION	GEOMORPHOLOGY	FINAL* (No of events)	MONTHS	DAILY AVERAGE (m^3/s)	DURATION
PES and REC: C								
150-200	3	3	3	2	3	Nov, Dec, Jan	150	6
300-400	1	1	1	1:2	1	Feb	350	8
850-1000	1:3		1:3	1:5	1:3	Mar	850	12
2000+			1:5+	1:10	1:5+	Late summer		
AEC↓: D								
150-200	1	2	2	1	2	Nov, Jan	150	6
300-400	1:1	0	1:1	1:3	1	Feb	350	8
850-1000			1:3	1:5	1:3	Mar	850	12
2000+			1:5+	1:10	1:5+			

The low and high flows were combined to produce the final flow requirements to maintain the current EC of Category C, as well as the flows which would result in a Category D EC (**Table 5-15** and **Table 5-16**). The EFR table shows the results for each month for high flows and low flows separately. Floods with a high frequency are not included in the modelled results as they cannot be managed.

The flows set by the Reserve should be adequate to attain the specific EC for fish at the Boegoeberg Site, as the requirements for the different life-stages of the indicator guild (semi-rheophilic) are well documented and were prominently considered in determining the stress index for the site. The floods recommended by the Reserve will also be adequate to ensure that all applicable flood requirements of the fish assemblages (including migration and spawning cues, flushing of sediment, etc.) will be provided for (**Table 5-14**).

[26] This is the specific quantity, timing, and quality of water flow in a system required to sustain ecosystems and the human livelihoods and well-being that depend on these ecosystems, as determined scientifically for a specific body of water.

Table 5-14 | Identification of instream functions provided by the floods identified for geomorphology and riparian vegetation

FLOOD RANGE (m3/s) FLOOD CLASS (instantaneous peak)	Geomorphology and riparian vegetation motivation	Fish flood functions						Invertebrate flood functions				Riverine fauna		
		Migration cues & spawning	Migration habitat (depth etc.)	Clean spawning substrate	Create nursery areas	Resetting water quality	Inundate vegetation for spawning	Breeding and hatching cues	Clear fines	Scour substrate	Reach or inundate specific areas	Scour lower zone habitats	Create floodplain habitats	Invigorate riparian vegetation habitats
150 - 200	Required to inundate 50 to 60% of marginal and lower zone vegetation (*Gomphostigma virgatum, Cyperus marginatus, Persicaria decipiens, P. lapathifolia, Phragmites australis* and *Salix mucronata*). Prevents establishment of upper zone (*Acacia karoo*) and terrestrial species in the lower zone. Required to begin inundation of the *Crinum bulbispermum* population which will support reproductive demands. Required during growing season (spring to summer: Nov - Jan).												[1]	
300 - 400	Required to flood lower zone riparian species (*S. mucronata* and *P. australis*) and inundate about 50% of the *C. bulbispermum* population. This will flush sediment in seasonal channels and facilitate recruitment opportunities at higher levels, but create flooding disturbance at the lower limits which also maintains habitat and vegetative patchiness. These floods may cause some scour in the marginal zone, again, important for maintaining patchiness and similarly maintain seasonal channels. Required during summer (Nov - Jan).												[2]	
850 - 1000	Required to begin inundation of *Searsia pendulina* (which is where the tree line starts). Will facilitate recruitment and vigour of upper zone woody species, but also prevent their encroachment into the lower zone. Similarly, these floods are also useful for preventing territorialisation and expansion of exotic species such as *P. galndulosa*. Activation of the *Tamarix usneoides* population (i.e. no inundation, but sufficient soil moisture to facilitate recruitment and maintain reproductive outputs). Larger floods are also important to scour marginal and lower zone habitats and maintain open patches. Needed late in the growing season (Feb, Mar).													[3]
2000 - 2500	Large and infrequent flood to inundate about 50% of the *T. usneoides* population. Important to maintain *T. usneoides* recruitment, but also to scour large sections of the macro-channel bed and maintain overall patchiness. Also creates flooding disturbance for upper zone and bank woody species such as *S. pendulina, A. karoo* and *Z. mucronata*. Useful to reduce exotic perennial species, especially *P. glandulosa*. Also activates lower limit of *A. erioloba*.													[4]
[1]	Inundate channels in anatomising area behind island on right hand bank. Supply a mosaic of habitats for fish and eventually for wetland fauna to forage in. Scour channels, supply embankments for nesting and tunnelling.													
[2]	Larger floods are important to scour marginal and lower zone habitats and maintain open patches resulting in mudflats and alluvial sandbars as habitat.													
[3]	Main motivation for these flows is for the riparian vegetation to be invigorated, to which the riparian fauna will react accordingly.													
[4]	Main motivation for these flows is for the riparian vegetation to be invigorated, to which the riparian fauna will react.													

Table 5-15 | EFR table (final flows) for the PES (which is also the REC): C

Desktop version:		2	Virgin MAR (MCM)	10573.7
BFI	**0.329**	**Distribution type**		**Vaal**
MONTH	**LOW FLOWS**		**HIGH FLOWS**	
	Maintenance (m^3/s)	**Drought (m^3/s)**	**Daily average (m^3/s) on top of base flow**	**Duration (days)**
OCTOBER	28.211	0.627		
NOVEMBER	36.708	13.665	150	6
DECEMBER	39.92	19.512	150	6
JANUARY	47.269	21.408	150	6
FEBRUARY	61.393	31.478	350	8
MARCH	60.014	31.051	850	12
APRIL	53.153	11.705		
MAY	39.716	10.906		
JUNE	30.813	11.3		
JULY	24.956	10.919		
AUGUST	23.653	10.171		
SEPTEMBER	24.231	6.115		
TOTAL MCM	1230.5	467.2	566.4	
% OF VIRGIN	11.64	4.42	5.36	
Total IFR	1797			
% of MAR	16.99			

Table 5-16 | EFR table (final flows) for the AEC↓: D

Desktop version:		2	Virgin MAR (MCM)	10573.7
BFI	**0.304**	**Distribution type**		**Vaal**
MONTH	**LOW FLOWS**		**HIGH FLOWS**	
	Maintenance (m^3/s)	**Drought (m^3/s)**	**Daily average (m^3/s) on top of base flow**	**Duration (days)**
OCTOBER	11	0.627		
NOVEMBER	17	10.459	150	6
DECEMBER	20	12.055		
JANUARY	25	15.286	150	6
FEBRUARY	34	20.908	350	8
MARCH	34	20.891	850	12
APRIL	29	11.705		
MAY	20	10.906		
JUNE	13	7.867		
JULY	11	5.475		
AUGUST	10	4.902		
SEPTEMBER	9	4.973		
TOTAL MCM	609.4	329.2	532.1	
% OF VIRGIN	5.76	3.11	5.03	
Total IFR	1141.5			
% of MAR	10.8			

As a result of the absence of any true rheophilic fish species in this system, the large semi-rheophilic flow guild was selected as indicator group for setting flows (**Table 5-17**). This group generally requires fast shallow, fast intermediate and fast deep flow-depth categories over good quality substrate (gravel and cobbles) for spawning. Egg and embryo development also takes place in these habitats, while

larvae prefer slow deep, with substrate, as optimal habitats. Juvenile and adult specimens have a high preference for slow deep, fast shallow, fast intermediate and fast deep habitats with substrate and water column as cover. Flows should furthermore remain adequate to allow migration between reaches, thus, depth in riffle and rapids should remain adequate, especially during the wet season. Emphasis was placed on the requirements of the *Labeobarbus* species (*L. kimberleyensis* and *L. aeneus*) within this group in setting flows.

Table 5-17 | Summarised habitat requirements for different life stage of the large semi-rheophilic indicator group (Louw and Koekemoer (Eds.), 2010)

Fish sp.	Spawning	Egg and embryo development	Larvae	Juveniles	Adults
Labeobarbus aeneus	**FS, FI over substrate**. Spring to midsummer (September to January). Fast (>0.3 m/s) with substrate (gravel and cobbles). Flowing water, well oxygenated and low sediments loads. *L. aeneus* breeds from spring through to mid-summer after the first substantial rains of the season.	**FS with substrate (gravel/cobbles).** Flows to last long enough for eggs to hatch and embryos to develop. Sudden pulse after spawning may cause many of the eggs to be washed out of the spawning beds and die in the deeper, less oxygenated pools and also be smothered by silt. Also, if the flow subsides it could result in higher temperatures and lower oxygen, thus, killing the developing embryos or leaving them stranded. The fertilised eggs of BAEN incubate for 3 to 8 days at 18-21.5^{o}C, where after the embryos remain in the gravel for a further period.	**SD with substrate.** (October to February). Cover, flow, oxygen and low silt loads. At swim-up they require suitable flows to move them away from the spawning beds to the nursery areas, usually shallow backwaters which are warmer. If the backwaters are not there due to too high or too low flows, the larval fish will die out as this is a very critical stage where they have to start eating. Larvae are initially inactive and sink to the bottom, not becoming mobile until 4 to 6 days after hatching. At this stage, they begin feeding on microscopic organisms.	**FS, FI and SS with substrates. SD at night.**	**SD, FD, FI and FS with substrates and water column.**
Labeobarbus kimberleyensis	**FS and FD with substrates** (**gravel, cobbles)** flowing water, well oxygenated and low sediments loads. The breeding season extends from mid to late summer. The species requires gravel beds in flowing water to spawn.	**FS and FI with substrate (gravel/cobbles).** Flows to last long enough for the embryos to develop and hatch out. The incubation period is 2 to 3 days and larvae become mobile after a further 3 to 4 days at 23-25^{o}C.	**SD with substrate.**	**FI and SD with substrates.**	**SD, FD and FI with substrates and water column.**

5.4.3 Aquatic Ecology Impact Assessment

Potential impacts of the proposed activity have two main components. Those pertaining to the aquatic or instream environment are mainly flow related, while those pertaining to the riparian / wetland environment are mainly non-flow related.

The main impact to the instream environment is the potential loss of spawning habitats characterised by bedrock substrates and fast flowing water, which are important to rheophilic fish species, such as yellowfish. Other fish, such as the Orange River mudfish and the rock catfish also utilise these habitats for spawning. Maintenance of these habitats requires certain minimum flows as well as the correct

frequency and timing of small floods. The diversion of water from Boegoeberg Dam before it spills has the potential to reduce flows that are required for habitat maintenance directly downstream of the dam wall. Mitigation potential of this impact is high and outlined in detail as specific flows required for each month of the year. These flows were determined as part of the Reserve determination study conducted in 2010 (Louw & Koekemoer (Eds)).

The main impacts to the riparian environment are the removal and disturbance of indigenous riparian vegetation and the promotion of invasion of disturbed sites by alien perennial species, such as *Prosopis glandulosa*. The current riparian zone is characterised as Lower Gariep Alluvial Vegetation (Mucina & Rutherford, 2006), which is considered to be an endangered unit. While it is unlikely that removal will be avoidable for the off-take and outflow structures, the routing of the power transmission lines so as to not be within the riparian zone (except where direct crossing is unavoidable) will mitigate this impact significantly. Where direct crossing of riparian zones or drainage channels is required, mitigation would be to not (as far as is possible) place towers within these areas, but to span them. Mitigation for invasion by alien vegetation species would require physical removal on site after construction and for the first few years of operation.

The impact of the proposed hydropower station will only be local, and the river should again attain its current integrity downstream of the tailrace of the plant. It is, however, important to protect rare spawning areas and ensure their functioning in order to ensure the survival of already scarce and endangered fish species, such as the largemouth yellowfish and the rock catfish.

The impacts are assessed below. The assessment has been undertaken separately for the hydropower facility and the ancillary infrastructure as the impacts are anticipated to be different.

5.4.3.1 Construction phase impacts

Due to the intensive nature of the construction activities for the hydropower facility which would occur both within and on the banks of the river, potential impacts on significant aquatic features is anticipated within the proposed development area. These impacts include the following:

- Sediment input into the river (deterioration of bottom substrate habitats for biota), elevated turbidity;
- Water quality deterioration (increased turbidity, accidental spills, sanitation spills, erosion from stored aggregates), especially disturbance of fine sediments in the weir;
- Increased invasion by alien plant species, especially perennial aggressive species such as *Prosopis glandulosa* and *Sesbanea punicea*;
- Bank destabilisation and erosion, especially given the alluvial nature of the majority of banks;
- Noise and visual (increased activity of people and construction equipment) disturbance to riparian fauna;
- Physical disturbance, such as excavations and clearing, which may include blasting, in or near the river;
- Waste reticulation and removal;
- Cutting into rock and rock faces at the site with resultant loss of natural rock features and a deterioration of the aesthetic value of area; as the area has recreational value around the dam;
- Decreased overhanging vegetation for cover for fish results in decreased Frequency of Occurrence (FROC) of species with preference for these habitats;
- Loss of habitat (cover) due to the removal of riverine vegetation also results in increased exposure to predators;
- Decreased abundance, and therefore FROC related to over utilisation of fish for human consumption (especially during construction when foreign workers enter an area with good fishing potential);

- Poaching and over-fishing of fish using nets by construction force (gill and seine nets, often home-made); and
- Reduced spawning success resulting in decreased FROC of many species, due to erosion and siltation.

Layout (preferred)
The potential impact on aquatic ecology as a result of construction is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 1
The potential impact for transmission route 1 on aquatic ecology as a result of construction is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. The impact is, therefore, of **medium-high (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 2 (preferred)
The potential impact for transmission route 2 on aquatic ecology as a result of construction is considered to be of medium magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

5.4.3.2 Operational phase impacts

Operational impacts anticipated are as follows:
- Potential erosion / bank destabilisation at the outlet point;
- Decreased wet season flows in the river section between the intake and outlet, especially in the bedrock habitats in channels 1 and 2 (**Figure 44**) i.e. left and central channels;
- Maintenance / clearing of riparian vegetation in power line servitudes along the river bank;
- Open canal (should this option occur) acting as a barrier to faunal movement, and also as a drowning risk.
- Release of pulsed flows in-between the intake and outflow if turbines are switched off frequently due to technicalities rather than flows becoming too low.
- Loss in abundance and diversity of especially fast instream habitats, as result of decreased base flows;
- Decrease in FROC and abundance of fish species with preference for fast habitats;
- Reduced spawning success resulting in decreased FROC of many species;
- Flow modification resulting in the absence of spring flushes resulting in reduced habitat suitability and stimulation from modified flow patterns that can disrupt the normal breeding cycle; and
- Increased turbidity and disturbed bottom substrates, reduced bottom substrate quality and water quality for indigenous fish (especially breeding habitats) due to bank destabilisation, vegetation removal and storm water run-off, as well as flow regulation that changes the existing flow patterns.

5.4.3.3 Impact of no flow or very low flow on fish directly below Boegoeberg Dam

The proposed off-take structure would consist of a predominantly concrete wet side weir built into the riverbank 120m to 250m upstream of the existing weir wall. The tailrace canal would be approximately 100m long. The impact of water abstraction for the proposed hydropower station at Boegoeberg will, therefore, be experienced over a distance of 400m, reaching from above the weir to below, with the tailrace and impacted area downstream of the weir expected to be 100m to 150m long.

The minimum flow required for operation of one turbine is 15m/s. The hydro scheme will require an operational flow in excess of the current flows experienced during low flow season, implicating that the river channel directly below the weir will be dry during low flow seasons for a distance of 100m to 150m. This is important because, at this flow, any negative effects on the immediate downstream habitats cannot be attributed to the hydro (inflowing water will merely accumulate behind the weir, unless sluices are opened

Unnatural zero flow conditions are generally undesirable for rivers as this negatively affects the biotic integrity of the system. The biotic integrity of the area or site at Boegoeberg Weir is, however, already compromised due to the presence of the weir. The main impacts of large weirs such as the one at Boegoeberg are mainly flow regulation, upstream inundation, instream habitat loss, and the loss of migration of fish further upstream. The most important habitat which will be impacted below the weir is the rapid and riffle habitat with rocky substrate.

The rapids below the dam wall are not unique to the reach and rapids and cobble beds also occur further downstream. However, the loss of spawning habitat below the dam will have a negative impact on the spawning success of the fish in this reach, and these types of habitats need to be protected as they become less and less due to the impact of dams (inundation) and water abstraction from rivers. The area directly below the weir is, therefore, mainly of importance in terms of spawning for fish and habitat for stream loving aquatic species, including fish species such as yellowfish. However, the loss of flow in the rapids directly below the dam wall will only be of high significance for the immediate site (i.e. at the dam wall), but of lower significance to the reach.

Other habitats that occur below the dam wall, such as the slow deep channels with marginal vegetation in the mid- and right-hand sections of the river, will also be affected, but this is of lesser importance as it is utilised to a lesser extent by fish. These habitats are also more abundant throughout the system (Kotze and Koekemoer, 2010). The main criterion for fish at the site is that there should be enough flow during the high flow season over the weir to facilitate spawning in the rapid and rocky habitat below the weir (see **Figure 44** below for comparison of flow scenarios).

The impact of no flow at the site is considered to be low as a relatively short length of river (100m to150m) will be affected, during low flow seasons/periods.

Ensuring the release of water into this stretch of river to attain a PES of category C is regarded the mitigation to offset the negative impact of the power station of flows and ecological systems dependent on the flow. Failure to achieve such flow would result in the unmitigated impact occurring. Thereafter, the EFR would be achieved, as all diverted water would be returned to the system. In low flow periods the power station would not operate.

Impact of dredging in Boegoeberg Dam

The area above the dam is historically scoured to manage the problem of siltation in the dam. Subsequent to the release of the DEIR, a sediment management statement was compiled and provided to the aquatic specialist to assess. The aquatic specialist has noted that; “If the operators of the hydro-electrical scheme adhere to the proposed sediment removal or dredging plan for Boegoeberg Dam, there will be no foreseen negative impacts on the river system. According to this plan, sediment will be removed from the system, which will result in positive effects and outcomes for all parties involved and the ecosystem in general.”

Layout (preferred)

The potential impact on aquatic ecology as a result of operation is considered to be of low-medium magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

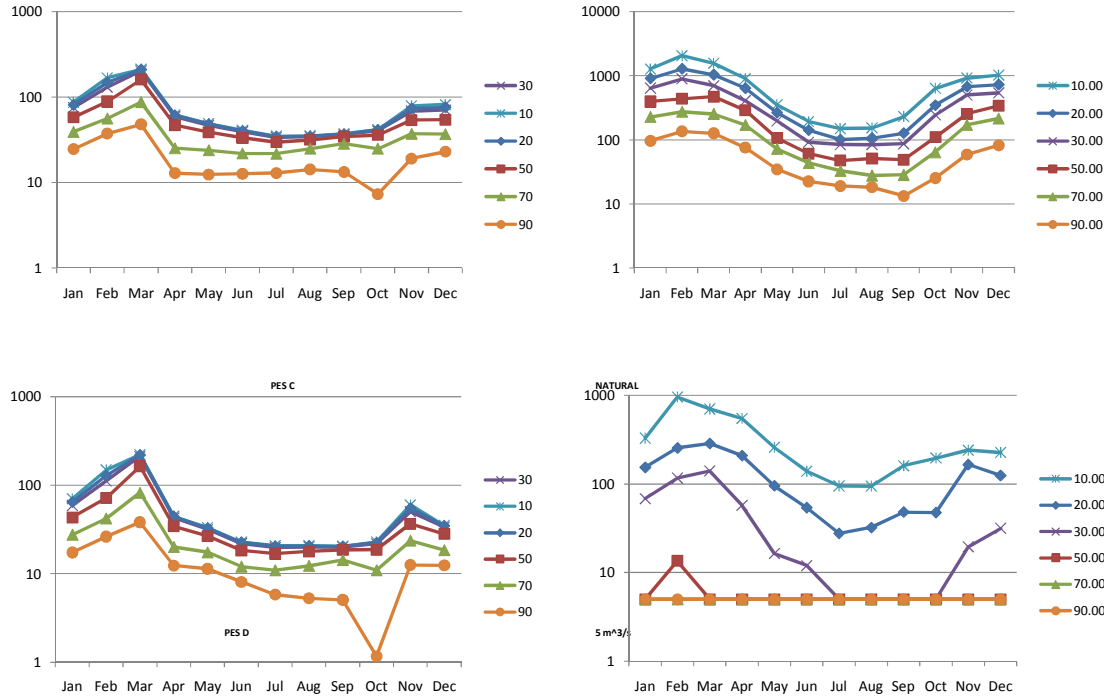

Figure 44 | Comparison of flow scenarios: top left – PES C; top right – Natural; bottom left – PES D; bottom right – 5m3/s

Transmission route 1 & Transmission route 2 (preferred)

The potential impact for both transmission alternatives on aquatic ecology during operation is considered to be of medium magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance without mitigation, should the towers be placed within aquatic habitats. The significance of this impact could be reduced to **very low (-)** with mitigation (i.e. location of towers outside of such habitats).

5.4.3.4 Decommissioning phase impacts

Layout (preferred)

The potential impact on aquatic ecology as a result of decommissioning is considered to be of low-magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low-medium (-)** significance without mitigation. The significance of this impact could be reduced to **low-very low (-)** with mitigation.

Transmission route 1 & Transmission route 2 (preferred)

The potential impact for both transmission alternatives on aquatic ecology during decommissioning is considered to be of low magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low (-)** significance without mitigation. The significance of this impact could be reduced to **very low (-)** with mitigation.

5.4.3.5 Cumulative impacts

Based on the limited opportunities to pursue feasible hydropower options on the Orange River, the relatively far distances between currently proposed projects, and the minimal footprint, the overall cumulative impact from the hydropower station should be limited and of a low significance. Furthermore, provided the construction and operation activities of the project remain contained within the project footprint and any disturbed areas within the aquatic features are rehabilitated, the significance would reduce further.

5.4.3.6 No-Go alternative

The No-Go Alternative would have a neutral impact as the *status quo* would remain from an aquatic ecology perspective.

5.4.4 Mitigation Measures

5.4.4.1 Construction phase mitigation measures

The following mitigation measures are proposed for the construction phase for all project alternatives:

- Minimise the footprint by the demarcation of impact zones (such as fencing / markers to limit access elsewhere).
- Minimise removal or disturbance of adult trees especially *A. erioloba* and *Searsia pendulina* specimens.
- Ensure construction camps are fenced and set back at least 100m from any watercourse.
- The collection of firewood from riverine areas by construction workers should be prohibited.
- Relocation of a portion of the transmission line from the riparian zone along the Orange River to traverse the terrestrial zone.
- Use of erosion control measures to minimise erosion at excavation sites or aggregate storage sites. Construction activities to take place in the dry season as far as possible.
- Ensure aggregate storage outside of riparian zones / drainage channels.
- Employ recognised best practice with respect to machinery washing and maintenance; procedures for discarding unused concrete; storage of hazardous materials; provision of sanitation facilities, erosion prevention, etc.
- Removal of perennial alien species such as *Prosopis glandulosa* and *Sesbanea punicea* at sites disturbed or cleared by construction activities. Care should be taken not to introduce additional seed or propagules of alien species that may be present in aggregates brought to site.
- Vegetate areas that are not meant to stay barren as soon as possible after construction with a local indigenous species.
- Employ best practice for design and prevention of bank erosion, especially since alluvium is fine on the right bank. Minimised vegetation removal on banks will help with stabilisation.
- Restrict unnecessary movement of people and plant in the riparian zone or drainage channels.
- Prevent unnecessary disturbance of substrates, fauna or flora.
- Employ recognised best practice measures to prevent spillage of pollutants of any kind into the river, either directly or via soak aways.
- Make use of natural materials, such as rock from site, in the construction of the plant, wherever possible.
- Rehabilitate marginal and riparian vegetation after construction, where necessary.
- Prohibit fishing by construction workers from start of construction regardless of fishing techniques. Apply regulations firmly.
- Minimise bank destabilisation, vegetation removal and erosion.

5.4.4.2 Operational Phase mitigation measures

The following mitigation measures are proposed for the operational phase for all project alternatives:

- Correct design and reinforcing to prevent bank cutting, especially at high flows.
- Conservation of as much vegetation cover as possible during construction will also mitigate in the longer term.
- Ensure rehabilitation of vegetation after construction.
- Ensure environmental flows occur before intake comes into operation. Allow small and moderate flood requirements to pass over the dam wall in keeping with final flow requirements.

- Monitor flows through the turbines at sub-daily resolution, and ensure adequate maintenance of turbines to promote consistency in operation as and when flows enter the intake.

5.4.4.3 Decommissioning phase mitigation measures

The relevant mitigation measures proposed for the construction phase should be applied during the decommissioning phase for all project infrastructure and activities.

5.4.5 Aquatic Impact Table

Table 5-18, **Table 5-19**, **Table 5-20** and **Table 5-21** indicate how the significance ratings of the various impacts were derived.

Table 5-18 | Construction impact rating of aquatic ecology impacts

Project Component	Key activities and /or impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred, i.e. Tunnel)	Riparian vegetation removal / clearing	Local	Low	Long Term	Low	Low	Definite	Certain	Irreversible
Roads		Local	Medium	Long Term	Medium	Low	Probable	Certain	Irreversible
Transmission Route 1& 2		Local	Medium	Long Term	Medium	Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Sediment input into the river channel/s	Local	Medium	Short term	Medium	Low	Probable	Certain	Irreversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Irreversible
Transmission Route 1& 2		Local	Low	Short term	Low	Very Low	Probable	Certain	Irreversible
Hydropower Layout (preferred, i.e. Tunnel)	Water quality deterioration	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1& 2		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Increased invasion by alien plant species	Local	Medium	Long Term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Medium	Long Term	High	Low	Probable	Certain	Reversible
Transmission Route 1& 2		Local	Medium	Long Term	High	Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Bank destabilisation and erosion	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Roads		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1& 2		Local	Low	Short term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Noise and visual disturbance to riparian fauna	Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Roads		Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Transmission Route 1& 2		Local	Medium	Short term	Low	Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Physical disturbance such as excavations and clearing, which may	Local	Medium	Short term	Medium	Medium	Probable	Certain	Reversible
Roads		Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible

Project Component	Key activities and /or impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Transmission Route 1& 2	include blasting, in or near the river	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Waste reticulation and removal	Local	Low	Short term	Low	Very Low	Probable	Sure	Reversible
Roads		Local	Low	Short term	Very Low	Neutral	Probable	Sure	Reversible
Transmission Route 1& 2		Local	Low	Short term	Very Low	Neutral	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Cutting into rock and rock faces at site –	Local	Low	Short term	Low	Low	Probable	Sure	Irreversible
Hydropower Layout (preferred, i.e. Tunnel)	Decreased overhanging vegetation for cover for fish predators	Local	Low	Short term	Low	Low	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Decreased abundance, related to over utilization of fish for human consumption	Local	High	Short term	Medium	Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Reduced spawning success, due to erosion and siltation	Local	Medium	Short term	Medium	Low	Probable	Certain	Reversible

*Mitigation measures are described in detail in **Section 5.4.4**.

Table 5-19 | Operation impact rating of aquatic ecology impacts

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred, i.e. Tunnel)	Potential erosion / bank destabilization at the outlet point	Local	Low	Short Term	Low	Low	Probable	Sure	Irreversible
Hydropower Layout (preferred, i.e. Tunnel)	Decreased wet season flows in river section between the intake and outlet	Local	Medium	Long term	Medium	Low	Probable	Sure	Irreversible
Hydropower Layout (preferred, i.e. Tunnel)	Birds colliding with overhead power lines,	Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Roads	which cut across riparian corridors	Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1& 2		Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible
Transmission Route 1& 2	Maintenance / clearing of vegetation in power line servitude	Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
Hydropower Layout (preferred, i.e. Tunnel)	Open canal (should this option occur) acting as a barrier to faunal movement, and also as a drowning risk	Local	Low	Long term	Low	Very Low	Probable	Certain	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Pulsed flows in the section of river between intake and outflow if turbines switched off frequently	Local	Low	Long term	Low	Low	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Loss in abundance and diversity of especially fast instream habitats as result of decreased base flows	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Decrease in FROC and abundance of fish species with preference for fast habitats	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Reduced spawning success resulting in decreased FROC of many species	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible
Hydropower Layout (preferred, i.e. Tunnel)	Flow modification: Absence of spring flushes, reduced habitat suitability and stimuli, flow pattern disrupts	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
	normal breeding cycle								
Hydropower Layout (preferred, i.e. Tunnel)	Increased turbidity and disturbed bottom substrates, reduced bottom substrate quality and water quality for indigenous fish	Local	Medium	Long term and/or Intermittent during operation	Medium	Low	Probable	Sure	Reversible

Table 5-20 | Decommissioning activity impact rating of aquatic ecology impacts[27]

Project Component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Hydropower Layout (preferred, i.e. Tunnel)	Rubble generation and removal	Local	Low	Long Term	Medium	Low	Definite	Certain	Irreversible
Roads		Local	Low	Long Term	Low	Very Low	Probable	Certain	Irreversible
Transmission Route 1& 2		Local	Low	Long Term	Low	Very Low	Probable	Certain	Reversible

Table 5-21 | Cumulative aquatic ecology impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Impact to surface water ecosystem	No mitigation	Regional	Medium/ Low	Longer term	Low (-)	Probable	Sure	Reversible

[27] The decommissioning activities themselves will have a low negative impact. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive in terms of the aquatic environment.

5.4.6 Aquatic Ecology Conclusions

The impact of the proposed hydropower station will only be local, and the river should again attain its current integrity downstream of the tailrace of the plant. It is, however, important to protect rare spawning areas and ensure its functioning in order to ensure the survival of already scarce and endangered fish species, such as the largemouth yellowfish and the rock catfish. The significance of the transmission alternative 2 is likely to be less negative as it avoids riparian habitat.

The area below the Boegoeberg Weir is mainly important in terms of spawning for fish. It is, however, expected that there would be enough flow over the weir during floods (high flow season) to facilitate spawning. The supplementing flows (two channels observed) from the irrigation canal will help mitigate no flow effects from the proposed development. These channels also provide the preferred habitat for more sensitive species. There will be less of a negative impact if the flows from the irrigation canal can be maintained and, therefore, it is recommended that such flows are continued as a priority.

The affected river reach (100m) is relatively short if the extent of the development and the size of the Orange River are taken into account. The impact can, therefore, be seen as low negative for the affected reach.

The advantages of the development outweigh the disadvantages to the system, but it is important to note that, from a conservation point of view, the development and the effect of total loss of flow still remain undesirable to the natural area and the ecosystem. Therefore, it is submitted that the environmental flows, as determined for this section of the Orange River, be maintained.

The tailrace from the hydro power scheme may also provide new habitat for fish as it will most probably flush sand and sediment from the right-hand channel creating new rocky substrate for fish, should there be rock underneath.

Lastly, it is highly likely that there will be reed encroachment in the impacted section of the Orange River.

5.5 IMPACT ON AGRICULTURE

In South Africa there is a scarcity of high potential agricultural land, with less than 14% of the total land area of the country being suitable for dry land crop production. Therefore, areas which are suitable for agricultural purposes should be protected from non-agricultural land uses.

5.5.1 Description of the Environment

Agricultural production in the Groblershoop area comprises stock farming, wine production, table grapes and sultanas (the area is currently a main source of export for table grapes and sultanas). A modern abattoir, with approximately 130 employees, processes livestock from surrounding farms, while the local wine cellars have an annual intake of ~12,000 tons of grapes (http://www.groblershoop.co.za/). The Boegoeberg Dam feeds an irrigation canal that supplies downstream farms with water for irrigation. It should be noted that the agreed agricultural flow to the irrigation canal would be maintained with irrigators receiving their water allocation before any water is used for the proposed project. In particular, in periods of low flow, water to the agricultural canal would be prioritised.

Agricultural activities on the farm on which the project is located, Zeekoebaart, currently consist of a mix of stock farming and irrigated land, used primarily in the production of maize.

5.5.2 Agricultural Impact Assessment

The proposed hydropower station and ancillary infrastructure are to be located next to the Boegoeberg Dam on the banks of the Orange River. Given both the location and associated topography of the area surrounding the hydropower station, the land offers very little in the way of agricultural opportunity.

Furthermore, the limited footprint of the hydropower station would have little to no impact on current or future agricultural production. However, potential impacts on agricultural resources could arise from with the access roads to the hydropower plants, which need to be widened to 6m (albeit, not new roads are required). This impact is predicted to be extremely limited. The transmission line would follow existing road alignments and only three sections, totalling ~12.24km, would need new access roads for construction and maintenance of the line (**Figure 22**). However, these sections would not pass through agriculturally productive areas.

Water would only be diverted for 250 m and returned to the Orange River again. Therefore, no water would be lost and the project will not impact on irrigation farmers downstream in terms of direct river abstractions by irrigators. The proposed hydropower station will result in a change in the patterns of flow within the existing reservoir. However, the agricultural flow requirements will need to be met before water is used for hydropower purposes and, as such, the power station will not negatively affect water flows to the irrigators[28]. To optimise the available water for both the power station and the irrigation canal, a sediment management program would be implemented by the owners of the Boegoeberg Hydro Electric Project. This is proposed by means of dredging, as described in Section 3.1.2.

The impacts are assessed below. The assessment has been undertaken separately for the hydropower facility and the ancillary infrastructure as the impacts are anticipated to be different.

5.5.2.1 Construction phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **very low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout the construction period. Therefore, the impact is of **low (-)** significance with or without mitigation.

5.5.2.2 Operational phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **very low (-)** significance with or without mitigation. With dredging operations, the assurance of water availability to the irrigation canal may improve.

[28] It is important to note that the off-take weir (below the normal water surface level) will be constructed in the Boegoeberg Weir pool to regulate flow into the water conveyance infrastructure and to provide a physical barrier against the drawdown of water below agreed levels thereby ensuring irrigation and environmental flows.

Transmission route 1 & Revised Transmission route 2 (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout operations. Therefore, the impact is of **low (-)** significance with or without mitigation.

5.5.2.3 Decommissioning phase impact

Layout (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **very low (-)** significance with or without mitigation.

Transmission route 1 & Transmission route 2 (preferred)
The potential impact on agriculture is considered to be of low magnitude, of local extent and is anticipated to continue throughout the decommissioning period. Therefore, the impact is of **low (-)** significance with or without mitigation.

5.5.2.4 Cumulative impacts

Given the inherently low agricultural potential of the region and the nominal footprint of the proposed infrastructure, projected cumulative impacts on agricultural production are considered **low (-).**

5.5.2.5 No-Go impact

The No-Go Alternative would have a neutral impact as the *status quo* would remain.

5.5.3 Mitigation Measures

The proposed mitigation measures would reduce the potential impacts on current agricultural production and soil resources.

5.5.3.1 Construction phase mitigation measures

The following mitigation measures are required during the construction phase to mitigate the loss of agricultural land and the degradation of soil resources for all alternatives:

- A planned, phased approach must be adopted to clear areas only when they are required for construction. Also, clearing activities should be kept to a minimum.
- All normal agricultural activities should continue in unaffected areas.
- Land rehabilitation and re-vegetation must be initiated as soon as possible after disturbance (Vegetation Management Plan - **Annexure E**).
- The Soil Erosion Plan must be implemented (**Annexure E**).

5.5.3.2 Operational phase mitigation measures

The following mitigation measures are required during the operational phase to mitigate the loss of agricultural land and the degradation of soil resources for all alternatives:

- Initiate land rehabilitation and re-vegetation as soon as possible and continue to visually monitor land for early detection of degradation (Vegetation Management Plan - **Annexure E**).
- Allow normal agricultural activities to continue in unaffected areas.

5.5.4 Agriculture Impact Table

Table 5-22 and **Table 5-23** indicate the various impacts and how their significance ratings were determined.

Table 5-22 | Impact rating of agricultural impacts

	Project	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction phase	Layout (all alternatives)	Without mitigation	Local	Low	Construction	Low (-)	Definite	Sure	Reversible
		With mitigation	Local	Low	Construction	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	Without mitigation	Local	Low	Construction	Low (-)	Definite	Sure	Reversible
		With mitigation	Local	Low	Construction	Low (-)	Definite	Sure	Reversible
Operational phase	Layout (all alternatives)	Without mitigation	Local	Very Low	Long term	Very Low (-)	Definite	Sure	Reversible
		With mitigation	Local	Very Low	Long term	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	Without mitigation	Local	Very Low	Long term	Very Low (-)	Definite	Certain	Reversible
		With mitigation	Local	Very Low	Long term	Very Low (-)	Definite	Certain	Reversible
Decommissioning phase activities[29]	Layout (all alternatives)	Without mitigation	Local	Very Low	Decommissioning Period	Very Low (-)	Definite	Sure	Reversible
	Transmission lines (all alternatives)	With mitigation	Local	Very Low	Decommissioning Period	Very Low (-)	Definite	Sure	Reversible

*Mitigation measures are described in detail in **Section 5.5.3**.

Table 5-23 | **Cumulative agricultural impacts**

Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Cumulative loss of agricultural production / grazing land	Regional	Low	Long term	Very Low (-)	Probable	Unsure	Reversible

[29] The decommissioning activities themselves will have a low negative impact. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive in terms of agricultural resources.

5.5.5 Agriculture Conclusion

The location of the proposed hydro plant is not agriculturally productive and the small scale of the infrastructure would not impede or limit current or future agricultural production.

5.6 IMPACT ON HERITAGE

The National Heritage Resources Act, 1999 (NHRA) (Act No. 25 of 1999) protects a variety of heritage resources including palaeontological, prehistoric and historical material (including ruins) more than 100 years old (Section 35), human remains older than 60 years and located outside of a formal cemetery administered by a local authority (Section 36) and non-ruined structures older than 60 years (Section 34). Landscapes with cultural significance are also protected under the definition of the National Estate (Section 3 (3.2d)). Section 38 (2a) states that if there is reason to believe that heritage resources will be affected then an impact assessment report must be submitted to the relevant heritage authority.

In order to assess any potential impacts of the hydropower plant on heritage resources in the project area, a Heritage Impact Assessment (HIA) was undertaken by Mr Jayson Orton of ACO Associates cc (ACO). The HIA was informed by a literature survey and a field survey, which was conducted on 9 September 2013 to examine specific locations considered to be of heritage interest and also to conduct random examinations of other areas. The HIA is included in **Annexure D**.

5.6.1 Description of the Heritage Environment

Due to the length of the transmission line, the affected area is variable in character. At the Boegoeberg Dam, the Orange River is about 500 m wide and islands of silt and reeds occur immediately downstream of the weir. The power station and associated pipelines and/ or channals would be placed at the foot of a small cliff at the north-eastern end of the weir. The very limited floodplain upstream (to the southeast) is grassed and used as a campsite, while the floodplain downstream is sandy with riverine vegetation.

The transmission line would run along the river for the first part, encountering similar environments, but then it would cross the river and follow a local road moving away from the river and through the arid far eastern Bushmanland. In these areas, the substrate is generally rocky and vegetation cover is limited.

5.6.1.1 Archaeology

Few archaeological resources were found. Above the cliff at the Boegoeberg Weir, an extensive scatter of stone artefacts was recorded. Most are likely to be Middle Stone Age (MSA) (**Figure 45**) but a few grindstones (**Figure 46**) and other isolated flaked artefacts are probably Late Stone Age (LSA). There is no obvious occupation site but the position offers an excellent view over the valley and was no doubt repeatedly used for short periods.

On the sandy floodplain just downstream of the weir is a small and very ephemeral archaeological site. It consists of a scatter of rocks that may well have been used to anchor a hut. Two artefacts and one fragment of ostrich eggshell were associated with the stones. No other signs of occupation were seen anywhere else on the sandy floodplain.

The most interesting archaeological site was a cluster of low stone walls on the south side of the river and on the mountain slope close to the power line crossing point. A total of twelve features were recorded at the site. The features included straight walls, semi-circles, L-shapes and small mounds of rocks (**Figure 47**). Only one flaked stone artefact was found within the semi-circle. It was a banded ironstone flake. These stone walls are fairly typical of pre-colonial walling from the Karoo (Hart 1989;

Sampson 1984, 1985) and some may have been hunting blinds – that they face down towards the river valley offers further support for this.

Figure 45 | Banded ironstone artefacts and a typical MSA blade found on site

Figure 46 | Two quartzite lower grindstones

Figure 47 | Interesting clusters of low stone walls

Another archaeological aspect is rock art. Although none was seen during the survey, there is said to be a rock art site in the mountains near the start of the access road to the farm. This was not located during the survey.

5.6.1.2 Graves

One informal graveyard and two isolated graves/probable graves were located (**Figure 48**). The graveyard lies alongside the access road to Zeekoebaart and one grave is within about one metre of the edge of the road. There are at least eight graves all placed in a single row. In the sandy floodplain just downstream of the cliff where the Boegoeberg weir is located, two possible graves were found. One is a cement headstone seemingly propped up in the sand. Its caption reads: “Rus in vrede Gert Peters oorlede die 10 April 1953, 62 jaar, die seun van die mens.” According to the land owner, the

person had drowned upstream but had been buried on the spot where his body washed up. It is possible that this headstone is out of position and might even have been moved downstream from another location. Nearby, some 50 m to the northwest, is a stone cairn that seems very much like a burial cairn. Whether the cement headstone in fact belongs with this cairn is unknown, but it is possible that two graves are present. Many people died during construction of the Boegoeberg Weir but it is not known where they were buried.

Figure 48 | Headstone and a Stone Cairn

5.6.1.3 Built environment

No built environment of heritage significance will be directly affected by the proposed project but a few farm buildings are located in close proximity to the project. At the Boegoeberg Dam, there is a modern building at the campsite which has no heritage significance. During construction of the weir, a school and hospital were apparently built but the whereabouts of these is not known. However, on the road leading to the farm there is a house dating to the late 19th or early 20th century, which has high heritage significance. It is a very good example of vernacular architecture, which was found to be generally rare in the study area. It is about 15 m from the access road and, therefore, it will not be impacted. The transmission line would also pass close to a small stone kraal (**Figure 49**).

Figure 49 | Vernacular house and small stone kraal

The Boegoeberg Weir itself is a heritage structure since it was built between 1929 and 1933, and the dam has a long history.

The weir was proposed in the late 1920s as a job creation project for poor Afrikaaners in the region. The idea of a weir and irrigation canal was, however, being considered as early as 1872. The first plan put together was only in 1895 but it was considered too costly and was shelved. The idea was frequently discussed in parliament until, in 1906, the scheme was revived but in a different and cheaper configuration. Work began in 1906 using black labour but stopped in 1907 as the costs were deemed to be too high.

Then, in 1929, with the Great Depression and a severe drought South Africa, the government ordered construction of the Boegoeberg Weir to provide labour for poor whites. Although built by the Department of Irrigation, the funding was supplied by the Department of Labour. The weir and canal were treated as separate developments and the construction camp for the weir was on Zeekoebaart (the location of this camp is not known and there are no such remains obviously evident close to the power station area). Coffer dams were made from sandbags and all work on these and the main weir was carried out by hand. Although people of colour were not allowed to work on the project, white children as young as nine years old were, at times, employed. As stated above, a school and hospital were also built. Approximately 50 people (including 38 children) are said to have died during the project.

Although the weir had proceeded far enough to begin supplying the irrigation canal with water by 1932, it was only in 1934 that the 121 km long irrigation canal was completed. **Figure 50** shows the dam under construction.

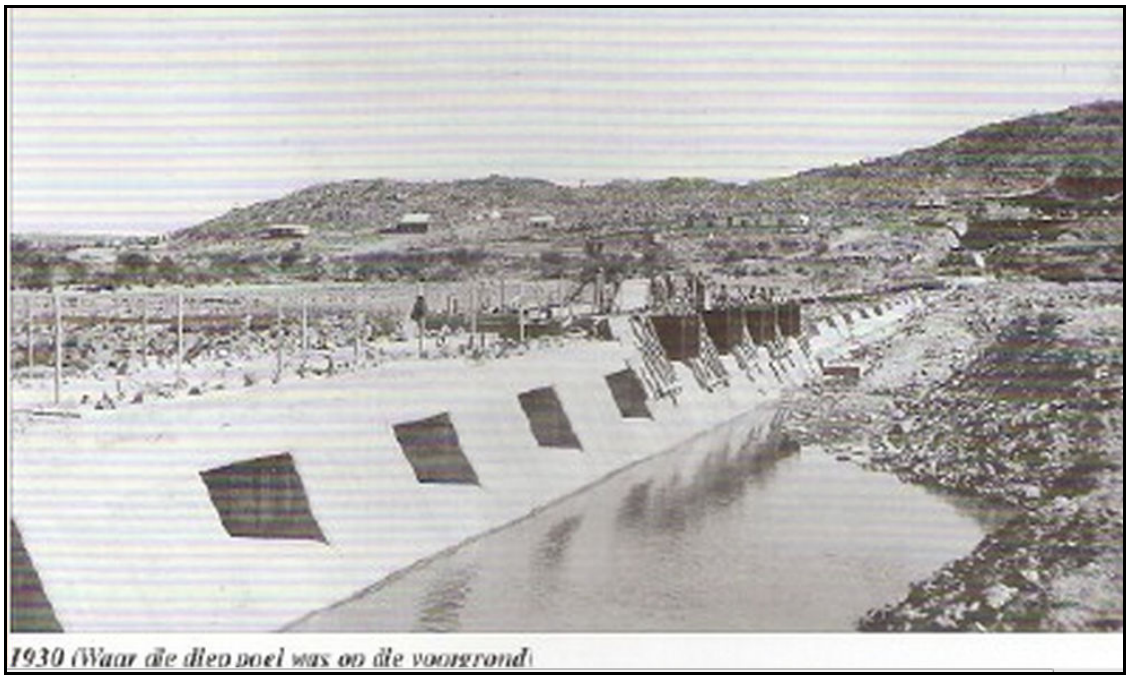

Figure 50 | Boegoeberg Weir during construction in 1930. Source: www.boegoebergecoroute.co.za.

5.6.1.4 Cultural landscapes and scenic routes

There are no significant cultural landscapes in the study area. It is generally remote and the gravel roads through the study area receive little traffic. None of the roads within proximity to the site can be regarded as scenic routes. There is a campsite close to the dam on the southern bank and the dam itself provides a scenic environment as part of a recreational resource.

5.6.1.5 Living heritage

A song entitled “Boegoeberg se dam” was written but no further information on this could be found. The song has been produced by various artists over the years, so, it is part of Afrikaner heritage. Eve Boswell (mid-20th century) and Die Van Wyk Broers (2004) both sang the song. It is possible that the song was written during construction of the weir, as implied by a post on the website www.boerevryheid.co.za (2007), although the veracity of this claim cannot be ascertained.

5.6.2 Heritage Impact Assessment

In general, very little heritage resources will be impacted by the proposed project. The only impacts of any significance are those related to archaeological artefacts and graves, the impact of which would

be a high negative. Although other aspects of heritage do occur in the vicinity, these will not be directly affected and can be avoided during the development. Note that all impacts would take place at the construction phase and (assuming that the graves continue to be avoided) no new impacts would occur during operation and decommissioning.

The impacts are assessed below. The assessment has been undertaken separately for the hydropower facility and the ancillary infrastructure as the impacts are anticipated to be different.

5.6.2.1 Construction phase impact

Layout
Damage and/or destruction of archaeological resources through both channel and road construction, while limited at the power station area, is likely to be of higher magnitude than along the transmission line route.

Transmission line
While mitigation will be required above the cliff area to reduce impacts, there is little of concern along the transmission line where only small holes would be excavated and the general disturbance footprint is substantially smaller.

5.6.2.2 Operational- and decommissioning phase impact

Impacts to archaeological/heritage resources would occur during construction and, thereafter, no additional impacts are predicted during operations and decommissioning. This is because, once such resources are impacted or destroyed, they cannot be recreated.

5.6.2.3 No-Go Alternative

The No-Go alternative would result in the maintenance of the *status quo*. Impacts to archaeological resources would continue at a very limited scale through trampling by grazing livestock and possibly collection of artefacts by visitors to the farm.

5.6.2.4 Cumulative impacts

Cumulative impacts are not very easy to assess, since archaeological resources, in particular, are point-specific. Each is unique and, while the general locations of archaeological sites could often be predicted, there is no guarantee that a site would be found in an expected location. For this reason, one cannot be sure how many archaeological sites would be lost relative to the number and type of sites occurring in the local and wider regions. A review of reports conducted for other renewable energy projects in the area suggests that the MSA and LSA sites found surrounding Boegoeberg Dam are fairly typical of the wider area and that the significance of any cumulative impacts would be **very low (-)**.

5.6.3 Mitigation Measures

As described above, historical archaeological material was rather limited. However, some parts of the main study area remain important and require mitigation through avoidance.

The following mitigation measures are recommended:

- The archaeological mitigation will involve establishing a sampling grid over the flat area at the top of the cliff and excavating/collecting artefacts from various areas. It should be borne in mind that the scatter is likely to extend well beyond the area inspected during this survey. The site should also be carefully examined to determine if any spatial patterning is evident. It can be very easily mapped using a hand-held GPS. This area is particularly vulnerable since it is likely that much machinery would be brought in and that work on blasting the cliff for the water conveyance channel would largely occur from this point.

- For graves, mitigation will involve temporary fencing and complete avoidance of all known and possible graves. Since the small graveyard is in such a vulnerable position immediately alongside a gravel access road, a permanent fence and gate could be considered.
  - The gravestone (ZKB2013/003) and stone cairn (ZKB2013/002) immediately downstream of the power station site should be temporarily cordoned off and carefully avoided throughout construction work.
  - Excavation in the silts immediately below the weir should be carefully monitored just in case there are other burials or cement headstones have been washed downstream from other locations during floods.
  - If the road passing the graveyard at ZKB2013/004 is to be used for access to the transmission line, then the graves must be cordoned off and avoided during and after development (due to its generally sensitive location, erection of a permanent fence around this graveyard could be considered).
  - Archaeological mitigation should be carried out at site ZKB2013/001 on the platform at the top of the cliff prior to construction.
  - The stone structures at BDW2013/001, specifically the one near the road, should be avoided during and after construction. Careful placement of towers will be required to ensure that these structures are spanned but care should be taken to avoid damage to them during construction.

Table 5-24 | Co-ordinates of important heritage sites

Site Name	Co-ordinates	
ZKB2013/001	S29 02 22.5 E22 12 15.9	S29 02 23.4 E22 12 11.8
	S29 02 23.4 E22 12 14.4	
ZKB2013/002	S29 02 17.3 E22 12 05.4	
ZKB2013/003	S29 02 18.8 E22 12 06.5	
ZKB2013/004	S29 03 23.0 E22 12 55.1	
ZKB2013/005	S29 03 59.0 E22 12 52.4	
BDW2013/001	S29 04 26.8 E22 12 04.5	S29 04 23.2 E22 12 06.5
	S29 04 26.3 E22 12 04.4	S29 04 23.0 E22 12 06.8
	S29 04 26.0 E22 12 04.3	S29 04 23.7 E22 12 06.3
	S29 04 25.4 E22 12 04.8	S29 04 23.9 E22 12 06.4
	S29 04 23.1 E22 12 05.9	S29 04 27.1 E22 12 05.3
	S29 04 23.2 E22 12 06.1	S29 04 26.8 E22 12 06.8

5.6.4 Heritage Impact Table

Table 5-25 and **Table 5-26** indicate how the significance ratings of the various impacts were derived.

Table 5-25 | Impact rating of heritage impacts

	Project component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Layout (preferred, i.e. Tunnel)	Destruction of archaeological stone artefact scatters on the cliff above the weir.	Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
	Roads		Local	Medium	Long term	Medium	Low	Definite	Certain	Irreversible
	Transmission Route		Local	Low	Long term	Low	Low	Probable	Certain	Irreversible
No-Go Option		Disturbance of archaeological artefacts through livestock trampling and collection of artefacts by members of the public.	Local	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible
Construction phase	Layout (preferred, i.e. Tunnel)	Disturbance or destruction of graves below the weir and/or along the access road.	Local	High	Long term	High	Low	Unlikely	Certain	Irreversible
	Roads		Local	High	Long term	High	Low	Probable	Certain	Irreversible
	Transmission Route		Local	Low	Long term	Low	Low	Unlikely	Certain	Irreversible
No-Go Option		Disturbance of graves through natural processes, such as storm events and floods.	Local	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible

*Mitigation measures are described in detail in **Section 5.6.3**.

Table 5-26 | Cumulative heritage impacts

Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Heritage	Site specific	Low	Permanent	Low (-)	Definite	Sure	Irreversible

5.6.5 Heritage Conclusion

This assessment has shown that impacts to heritage resources are likely to be of medium significance and that these could be reduced to low significance through mitigation.

5.7 IMPACT ON PALAEONTOLOGY

The extent of the proposed development (over 5,000 m^2) falls within the requirements for a HIA in terms of Section 38 of the NHRA. The various categories of heritage resources recognised as part of the National Estate in Section 3 of the NHRA include, among others:

- Geological sites of scientific or cultural importance;
- Palaeontological sites; and
- Palaeontological objects and material, meteorites and rare geological specimens.

During Scoping, SAHRA requested that a palaeontological study be undertaken to assess whether or not the development will impact upon palaeontological resources. The minimum requirement was a letter from a palaeontologist to indicate if a full study is unnecessary. As such, Dr J.E. Almond of Natura Viva was appointed to undertake a desktop Palaeontological Impact Assessment (PIA) which has been informed by a review of relevant scientific literature and geological maps relevant to the study area. The PIA is included in **Annexure D**.

5.7.1 Description of the Environment

The Boegoeberg hydropower project study area lies within the Lower Vaal and Orange Rivers geomorphic province (Partridge *et al.*, 2010). The development footprint of the proposed Boegoeberg Hydropower Station and associated 132 kV transmission line overlie areas of the Northern Cape Province that are underlain by potentially fossilifous sedimentary rocks of Precambrian, and younger, Tertiary or Quaternary age.

The northern and central portions of the region are largely underlain by Precambrian (Late Archaean to Middle Proterozoic) sediments, metasediments and volcanic rocks along the western margin of the ancient Kaapvaal Craton.

Three major Precambrian rock successions were mapped in the area:

- Late Archaean (c. 2.7Ga = billion years old) volcanics of the Ventersdorp Supergroup (Zeekoebaart Formation, Rz) comprising andesitic lavas and tuffs (ashes) with minor interbeds of marble.
- The Ventersdorp rocks are overlain with an unconformable or faulted contact by marine carbonates of the Campbell Rand Subgroup (Ghaap Group, Transvaal Supergroup Vgd) that were deposited on the western edge of the Kaapvaal Craton (Griqualand West Basin) in Late Archaean times, some 2.56 billion years ago (Erikkson *et al.*, 2006).
- During early Proterozoic times (c. 1.9 Ga) the varied succession of shallow marine shelf to fluvial continental sediments of the Olifantshoek Supergroup were deposited unconformably on the older Precambrian basement rocks. Some 100 million years or so later, the Olifantshoek sedimentary rocks were deformed and thrust south-eastwards onto the edge of the Kaapvaal Craton as a result of continental collision events (probably between the Congo and Kaapvaal Cratons) to form part of the Ubendian Belt (Kheis Orogeny; Moen 2006, McCarthy & Rubidge 2005). Olifantshoek Supergroup sediments dominate the terrain around and immediately to the south of the Boegoeberg Dam area, to the southeast of the major Dabep Fault that defined the contact with the Namaqua-Natal basement rocks to the west (Moen 2006, see also structural study of the study region by Altermann & Hälbich 1990).

The southern portion of the study region is underlain by granitoid rocks of the ancient Archaean basement, mapped as the Skalkseput Granite. These last rocks form part of the Marydale – Prieska granite-greenstone terane on the southwestern edge of the Kaapvaal Craton and have been dated to

between 3 and 2.7 billion years ago (Robb et al., 2006). Since they are entirely unfossiliferous, they are not regarded as significant in terms of palaeontological resources and are not discussed further.

The Precambrian bedrocks are mantled in many areas by a range of much younger superficial deposits. These include most notably Quaternary aeolian sands of the Gordonia Formation (Qg, Kalahari Group) as well as various alluvial sediments (gravels, sands, silts) associated with the major drainage systems, such as the Orange and Marydale Rivers, plus smaller ephemeral stream beds. Relict patches of older terrace or pediment gravels ("High Level Gravels") are not mapped along this stretch of the Orange River. Other (unmapped) superficial deposits that are indeed present include rocky colluvium (scree), sheetwash and downwasted surface gravels, and residual soils on the valley slopes and mountainous areas. Most of these younger deposits are probably Quaternary to Recent in age.

5.7.2 Impact Assessment

Once constructed, the operational and decommissioning phases of the hydropower facilities would not involve further adverse impacts on palaeontological resources.

The impacts are assessed below.

5.7.2.1 Construction phase impact

The construction phase of the development will entail surface clearance and substantial excavations into the superficial sediment cover as well as locally into the underlying bedrock, notably for tunnels, the turbine chamber, as well as transmission line tower installations. In addition, sizeable areas of bedrock may be sealed-in or sterilised by infrastructure, such as the construction camp as well as new gravel roads. All these developments may adversely affect fossil heritage preserved at or beneath the surface of the ground within the study area. These resources may be destroyed, disturbed or result in fossils that are permanently sealed-in and no longer available for scientific research or other public good.

No areas or sites of exceptional fossil heritage sensitivity or significance have been identified within the Boegoeberg hydropower project study area. The footprint of the hydropower station itself, where substantial excavations are anticipated, is underlain by tectonically deformed Precambrian sedimentary bedrocks of the Olifantshoek Supergroup that are not known to contain fossil remains. It is also noted that potentially fossiliferous ancient river gravels are *not* mapped along this section of the Orange River.

The majority of the transmission line from the Boegoeberg Dam site to the Fibre Substation traverses bedrocks of very low to zero palaeontological sensitivity - mainly Ventersdorp Group lavas, basement granites, Kalahari sands. Campbell Rand Subgroup marine carbonates crossed by the transmission line approximately 7 km south of the dam site might contain fossil stromatolites (microbial mounds) but these rocks are probably tectonically deformed and only a small outcrop area is of concern.

The overall impact significance of the construction phase of the proposed hydropower plant and associated transmission line is assessed as **low (-)** with regard to palaeontological heritage resources. This is due to:

- The general scarcity of fossil remains within the bedrocks and superficial deposits represented;
- The moderately high levels of bedrock deformation;
- The comparatively small development footprint; and
- The extensive superficial sediment cover mapped within the study area.

This assessment applies equally to all site layout and transmission line route alternatives under consideration since the impacts in all cases will be very similar.

5.7.2.2 Operational and decommissioning phase

Once constructed, the operational and decommissioning phases of the hydropower facilities would not involve further adverse impacts on palaeontological heritage.

5.7.2.3 No-Go Alternative

The "no-go" alternative (i.e. no hydropower station and transmission line development) will have a neutral impact on fossil heritage resources.

5.7.2.4 Cumulative impacts

Provided that the recommended mitigation measures are carried through, it is likely that any potentially negative impacts of the proposed hydropower facilities on local fossil resources would be substantially reduced and, furthermore, they would partially offset by the *positive* impact represented by increased understanding of the palaeontological heritage of the Northern Cape.

5.7.3 Mitigation Measures

During the construction phase, all substantial bedrock excavations should be generally monitored for fossil remains by the responsible ECO. In particular, the ECO should be alerted to the possibility of fluvial gravels containing transported, disarticulated bones and teeth of fossil mammals. Should significant fossil remains such as vertebrate bones and teeth, shells, plant-rich fossil lenses or dense fossil burrow assemblages be exposed during construction, the ECO should safeguard these, preferably *in situ*, and alert SAHRA[30] as soon as possible so that appropriate action can be taken by a professional palaeontologist at the developer's expense. Mitigation would normally involve the scientific recording and judicious sampling or collection of fossil material as well as associated geological data (e.g. stratigraphy, sedimentology, taphonomy).

In addition, the following mitigation measures need to be included in the EMPr (for all project developments):

- All South African fossil heritage is protected by law (NHRA) and fossils cannot be collected, damaged or disturbed without a permit from SAHRA or the relevant Provincial Heritage Resources Agency;
- The palaeontologist concerned with mitigation work would need a valid fossil collection permit from SAHRA and any material collected would have to be curated in an approved depository (e.g. museum or university collection); and
- All palaeontological specialist work would have to conform to international best practice for palaeontological fieldwork and the study (e.g. data recording, fossil collection and curation, and final report) should adhere as far as possible to the minimum standards for Phase 2 palaeontological studies recently developed by SAHRA (2013).

5.7.4 Palaeontology Impact Tables

Table 5-27 and **Table 5-28** indicate how the significance ratings of the various impacts were derived.

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Table 5-27 | Impact rating of palaeonotogical impacts

Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All alternatives	Disturbance, damage or destruction of fossils preserved at or below the ground surface during the construction phase	No mitigation	Local	Very low	Long term	Low (-)	Probable	Unsure	Irreversible
		Mitigation	Local	Very low	Long term	Low (-)	Probable	Unsure	Irreversible

*Mitigation measures are described in detail in **Section 5.7.3**.

Table 5-28 | Cumulative palaeontological impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Disturbance, damage or destruction of fossils preserved at or below the ground surface	No mitigation	Local	Low to Very low	Long term	Low (-)	Probable	Unsure	Irreversible
	Mitigation	Local	Low to Very low	Long term	Low (-)	Probable	Unsure	Irreversible

5.7.1 Palaeontology Conclusion

The overall impact significance of impacts to palaeontological heritage resources during construction of the proposed hydropower plant and associated transmission line is assessed as **low (-).**This applies equally to all site layout and transmission line alternatives under consideration since the anticipated impacts in all cases will be very similar. Importantly, ihe impacts are limited to the construction phase.

5.8 VISUAL IMPACTS

5.8.1 Description of the Environment

The location of the proposed project is at the site of the existing Boegoeberg Dam, which is a dominant feature in the landscape. There is infrastructure and equipment for the weir on the southern bank upstream of the weir as well as an established campsite for visitors to the dam (Boegoeberg Dam Holiday Resort). The northern banks of the river above the weir are wooded, with a house and campsite within this area. There is a koppie with indigenous vegetation immediately upstream of the proposed power chamber, through which the water conveyance infrastructure I will be tunnelled. Below the weir, the site is less disturbed, although an irrigation canal runs parallel to the southern bank.

While the area is disturbed visually, the Boegoeberg Dam area is nonetheless a highly scenic area on the Orange River. The predominant landuse in the area is agricultural and recreational, although the equipment associated with the dam wall provides some form of industrial type activity (cranes).

The area is not densely populated and not many people would be visually affected by the proposed project. The exception is when the camp site is used during holiday periods and weekends. However, the campsite to the south of the river is above the weir and, once the construction period is over, the larger components of the project, such as the power chamber, would not be visible from the dam or the campsite, although it will be visible from the weir itself and from areas downstream of the dam. To the best knowledge of the proponent and EAP, based on the current understanding at the time of undertaking the EIA and drafting this Final EIR, the campsite to the north of the river, close to the site (Trans Boegoe) was no longer operational.

Figure 51 to **Figure 52** illustrate the site and surrounds.

Figure 51 | View of the weir, the Boegoeberg Dam and the downstream area from the koppies to the north of the river bank

Figure 52 | View of the weir and area downstream of the weir close to where the water conveyance channel and power chamber are proposed

Figure 53 | View of the site where the power chamber is proposed. The weir can be seen to the right of the photo. The water conveyance infrastructure from the intake structure to the powerhouse would be tunnelled through the koppie.

Figure 54 | View of the northern bank from the southern bank. The power station would be located on the northern bank close to the koppie.

Figure 55 | View of the area downstream of the weir, with equipment for operation of the weir visible in the foreground, and the irrigation canal evident to the left of the photo.

The construction period would last approximately 24 months and the majority of construction would be screened by the weir itself, and trees upstream of the weir, with limited receptors near to the site. However, with fairly intensive construction activities taking place for a large percentage of this period, there will be an increase in the number of people and vehicles travelling through the area.

5.8.2 Visual Impact Assessment

Visual and scenic resources include abstract qualities and connotations that are by their nature difficult to assess or quantify as they often have cultural or symbolic meaning. It is necessary, therefore, to consider quantitative criteria (such as viewing distances), and qualitative criteria (such as sense of place), in visual assessments. An assessment, therefore, relies on the evaluating both objective and subjective aspects, including the context of the proposed project within the surrounding area.

The methodology to determine the level of visual impact of the planned infrastructure involves a consideration of the existing visual environment. This comprises understanding the existing landscape setting and how the planned infrastructure is seen from various viewing locations. In this way, the visual character of the landscape, as well as visual sensitivity of the various viewing locations can be determined. The visual modification of the planned infrastructure is determined by considering the visual characteristics of the planned infrastructure in the context of the landscape within which it is

seen. A combined consideration of both visual sensitivity and visual modification determines impact and gives some direction on mitigation strategies.

Oberholzer (2005) developed a system to allow for assessment in terms of the visual sensitivity of the site in relation to the intensity of the type of development, as shown in **Table 5-29**. The proposed development is deemed to be a Category 2 development, according to his scale; i.e. small-scale infrastructure, while the type of environment is considered to be of medium scenic, cultural or historical significance. As such, the predicted visual impact is minimal.

Table 5-29 | Key categories of development

Type of environment	Level of intensity				
	Category 1 development	**Category 2 development**	**Category 3 development**	**Category 4 development**	**Category 5 development**
Protected/wild areas of international, national, or regional significance	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected	Very high visual impact expected
Areas or routes of high scenic, cultural, historical significance	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected	High visual impact expected	Very high visual impact expected
Areas or routes of medium scenic, cultural or historical significance	Little or no visual impact expected	**Minimal visual impact expected**	Moderate visual impact expected	High visual impact expected	High visual impact expected
Areas or routes of low scenic, cultural, historical significance / disturbed	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected	High visual impact expected
Disturbed or degraded sites / run-down urban areas / wasteland	Little or no visual impact expected. Possible benefits	Little or no visual impact expected. Possible benefits	Little or no visual impact expected	Minimal visual impact expected	Moderate visual impact expected

The visual impacts were also considered in terms of the standard methodology provided for the assessment of impacts in this EIA. The greatest impact will be during the construction phase.

The impacts are assessed below. The assessment has been undertaken separately for the hydropower facility and the ancillary infrastructure as the impacts are anticipated to be different.

5.8.2.1 Construction phase impact

Layout

The visual impact of the proposed hydropower facility and associated infrastructure is considered to be of high intensity, short term and site specific and, therefore, of **low (-)** significance, without mitigation.

Transmission line

The visual impact of the proposed transmission line is considered to be of high intensity, short term and local and, therefore, of **low (-)** significance, without mitigation.

5.8.2.2 Operational- and decommissioning phase impact

Layout
The visual impact during the operational period is considered to be low intensity, long term and site specific; therefore, of **low (-)** significance.

Transmission line
The visual impact from the transmission line during the operational period, being visually linked to existing similar type infrastructure, is considered to be low intensity, long term and site specific; therefore, of **low (-)** significance.

5.8.2.3 No-Go Alternative

The No-Go alternative would result in the maintenance of the *status quo*. Impacts to visual resources would continue at a very limited scale.

5.8.2.4 Decommissioning

The decommission activities would have a similar **low (-)** to the construction phase.

5.8.2.5 Cumulative impacts

It is unlikely that potentially negative impacts on visual resources of the proposed hydropower facilities coupled with other visual impacts already existing and proposed would have any higher significance than what is currently assessed as (**low (-)**.

5.8.3 Mitigation measures

The following recommendations should be adhered to (and should be included in the EMPr for the project):

- Construction yards should be restricted in extent as far as possible and should be screened by visually impermeable material, if practical;
- Trees that screen the inlet works must be retained to reduce the visual impact on the recreational users of the dam:
- The power chamber should be screened with trees indigenous to the area, which occur naturally on the river bank,
- The power chamber building should be as low as possible and painted in muted colours to blend in with the colours of the natural environment, thereby reducing the levels of contrast.

5.8.4 Visual Impact Table

Table 5-30 and **Table 5-31** indicate how the significance ratings of the various impacts were derived.

Table 5-30 | Impact rating of visual impacts

	Project component	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Layout (preferred, i.e. Tunnel)	Impact on visual and scenic resources	Local	High	Long term	Low	Low	Definite	Certain	Irreversible
	Transmission Route (1&2)		Local	Low	Long term	Low	Low	Probable	Certain	Reversible
Operational phase	Layout (preferred, i.e. Tunnel)	Impact on visual and scenic resources	Local	Low	Long term	Low	Low	Unlikely	Certain	Irreversible
	Transmission Route(1&2)		Local	Low	Long term	Low	Low	Unlikely	Certain	Reversible
No-Go Option		Visual impacts would continue at a very limited scale	Local	Very low	Long term	Very low	Very low	Probable	Certain	Irreversible

*Mitigation measures are described in detail in **Section 5.8.3.**

Table 5-31 | Cumulative visual impacts

Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Impact on visual and scenic resources	No mitigation	Local	Low	Permanent	Low (-)	Definite	Sure	Irreversible

5.8.5 Visual Conclusion

Given the location of the site, limited number of visual receptors and the current transformed visual landscape, visual impacts arising from the proposed hydro power facility and ancillary infrastructure are not regarded as significant, in particular, if the recommended mitigation measures are implemented.

5.9 SOCIAL IMPACTS INCLUDING IMPACT ON LOCAL ECONOMY AND EMPLOYMENT

Subsequent to the release of the DEIR, Boegoeberg Hydro commissioned a socioeconomic overview of the study area, as required for the DoE IPP bidding process. Tony Barbour of Environmental Consulting and Research was appointed to undertake the study. While this study was not part of the EIA, the socioeconomic section has been updated with the specialist's findings, where relevant.

5.9.1 Description of the environment

The project site is located in three local municipalities, on the boundary of the !Kheis and Siyacuma Local Municipalities. The access roads are located in the Siyancuma Local Municipality. The transmission lines are located mainly in the Siyathemba Local Municipality. However, part of the transmission line crosses the !Kheis Local Municipality. The Economic Development Programme (to be developed and implemented as part of the IPP process) will benefit all three municipalities as they fall within the designated 50km radius stipulated by the DoE.

The affected roads are provincial and private roads and therefore not a municipal function. The impacts associated with the transmission line are expected to be very low. Thus, the impacts on these two municipalities are expected to be limited. While the bulk of the infrastructure is not in the !Kheis Municipality, the majority of the socio-economic impacts will be experienced in this municipality. The closed downstream community from the project area is Boegoeberg town, and the agricultural canal (managed by the Boegoeberg Water Users Association) is located in the ! Kheis Municipality. The greatest potential for a negative impact is should the power station impact on the release of water to the irrigation canal. For this reason, the focus of the discussion in this section is on the !Kheis Local Municipality.

5.9.1.1 Demographics

The project is located near Groblershoop which falls within the !Kheis Local Municipality (LM) within the ZF Mgcawu District Municipality District Municipality (DM) (known before 1 July 2013 as Siyanda). This areas falls within the north western quadrant of the Northern Cape Province, the largest province in South Africa. The LM covers 11,107 km^2 and the DM is 102,524 km^2 in extent. The LM is home to 7.0% of the DM at 16,637 people and the DM has a total population of 236,783 (Census, 2011). The area is very sparsely populated as evident from the low population density measured in persons per square kilometre, which is 1.5 for the LM, 2.3 for the DM and 3.1 for the province. As a comparison, the national average is 42 people per square kilometre (Census, 2011). The LM had a growth rate of 0.06% between 2001 and 2011, which is lower than the province, which was 1.4%.

The majority of the LM is coloured (85.4%), with a smaller representation of black people (6.9%) and white people (5.4%) with very few Asians (1%) **(Table 5-32)**. The demographic composition by age reflects a higher number of children (age 0-14 years) at 5823, with youth (15 to 35 years) slightly lower at 5374, adults between 36 and 64 years at 4657, and the elderly, 64 years and above, at 784 (**Table 5-33**).

Table 5-32 | Demographic composition

Group	Percentage
Black African	6,9%
Coloured	85,4%
Indian/Asian	1%
White	5,4%
Other	1,4%

Table 5-33 | Overview of key demographic indicators for the ZFMDM and KLM

	ZFMDM		KLM	
ASPECT	**2001**	**2011**	**2001**	**2011**
Population	202160	236763	16538	16637
% Population <15 years	30.8	28.4	34.4	35.0
% Population 15-64	64.1	66.4	60.6	60.3
% Population 65+	5.1	5.1	5.0	4.7
Households	48100	61097	4080	4146
Household size (average)	3.7	3.5	4.0	3.9
Formal dwellings %	83.9	79.4	78.8	66.3
Dependency ratio per 100 (15-64)	56.0	50.5	65.1	65.9
Unemployment rate (official) - % of economically active population	26.5	19.2	20.0	28.0
Youth unemployment rate (official) - % of economically active population 15-34	32.1	22.7	26.4	34.3
No schooling - % of population 20+	16.8	9.5	22.4	13.5
Higher Education - % of population 20+	4.8	6.3	3.8	4.5
Matric - % of population 20+	16.1	21.7	10.5	14.0

Source: Compiled from StatsSA Census 2011 Municipal Fact Sheet

The average household size in the LM is 3.9 people, similar to the DM and the province at 3.7 (Census, 2011). More than a third of households are headed by females (33.6%), which is slightly less than the DM (35.7%) and the province (39%) (Census, 2011).

5.9.1.2 Service Provision

In terms of services in the LM, 16.7% of households have access to piped water inside their dwelling or yard. Less than 1% of the population has no access, with the remainder having access to piped water further than 200 m away. This is significantly less than the provincial average of 97% and the national average of 91%. The ZF Mgcawu DM (previously Siyanda DM) Integrated Development Plan (IDP) (2013-2014) highlights the importance of water provision and availability as a constraint to economic activity in many of the towns.

With respect to sanitation, 43.8% of households in the LM have flush toilets, 20.83% have pit toilets, 20.74% have no toilets, 1.98% have bucket toilets with the remainder having chemical toilets or other.

This is lower than the provincial average which is 66% and the national average of 57% in terms of flush toilets.

In terms of energy source for lighting, 64.02% of households have access to electricity, with 30.36% only having candles, less than 2.72% having solar, and the remainder having either paraffin, gas, other or no energy for lighting. This is far less than the DM at 86.6% and national average of 85%.

The access to refuse removal in the LM is less favourable than the province as a whole with 50.53% of households having refuse removed by the council, compared to the provincial average (73.31%) and the national average (64%).

Overall, the service provision in the LM is extremely poor, with a lot of potential for improvement. The IDP notes that growth in population often exceeds the growth of service provision thereby increasing backlogs (Siyanda DM, 2013-14).

Hospitals are located in Kakamas (Kai! Garib), Keimoes (Kai! Garib), Upington and Gordonia (//Khara Hais) and Postmasburg (Tsantsabane). There are five hospitals in the DM. There are only two Community Health Facilities in the DM and Kecoolnhardt (Kai! Garib) and Rietfontein (Mier) are the only settlements that have these facilities. The clinics are generally located in settlements along the main routes through the municipality, namely the N14 and the N10 in the case of Kai !Garib and !Kheis. There are 52 clinics in the DM. Kai !Garib has the most clinics, 18, followed by //Khara Hais that has 14 clinics (Siyanda DM, 2013-14). !Kheis Municipality has health facilities available in Groblershoop, Wegdraai, Topline, (Mobile), Grootdrink, Boegoeberg, Gariep (mobile; once a week) and Opwag (mobile; once a week). While each clinic has access to a nursing sister, the IDP notes that the majority are understaffed and that the availability of medicines is a major issue. In addition, no services are available when the nursing sister is not on duty. The nearest hospital is Upington, 120 km from Groblershoop. In terms of education facilities, Groblershoop has two primary schools, and one secondary school (Siyanda DM, 2013-14). There is a library and a community hall. Social counselling services in the !Kheis LM are provided by a Non-Government Organisation (NGO). The entire !Kheis LM is serviced by two qualified social workers. The social challenges in the area identified in the IDP include, family violence and child abuse. High unemployment and low household income levels are a major contributing factor to the area's social challenges. Sports facilities are limited to Groblershoop, where a sport stadium was built in 2001, and Topline. The facility in Topline was built in 2008 and needs upgrading. The IDP notes that the other towns in the !Kheis LM do not have sports and recreational facilities.

5.9.1.3 Education

A critical factor affecting quality of life is the standard of education within a community. According to Census (2011), the population of the LM has a low level of education. As many as 13.5% of the population aged 20 and older have no schooling, 14% have a matric and only 4.5% have a higher education.

5.9.1.4 Welfare

In this region, the greatest social problems are illiteracy and poverty. According to the last socioeconomic survey in 2000, approximately 60% of the inhabitants have a monthly household income of between R0 – R800. Adult literacy is also below standard (Siyanda DM, 2013-14).

5.9.1.5 Employment and Earnings

According to Statistics South Africa Labour (2012) the community and social services sector is the largest employer in the province at 29%, followed by the agricultural sector (16%), wholesale and retail trade (14%), finance (8%) manufacturing (6%) and mining (6%),

Lack of employment opportunities has been identified as a challenge within the DM. There is a high rate of unemployment in the LM which is 28%. This is slightly lower than the DM unemployment rate at 34.4%, the rate in the province 28.1% and the national rate of 39% (Census, 2011).

5.9.1.6 Economy

The Northern Cape economy has shown significant recovery since 2000/2001 when it had a negative economic growth rate of -1.5% (LED Strategy). The provincial economy reached a peak growth rate of 3.7% in 2003/2004 but remained the lowest of all provinces. The Northern Cape is the smallest contributing province to South Africa's economy (only 2% to South Africa's GDP per region in 2007). According to the Siyanda DM, 2013-14 agriculture is the major economic contributor and compromises of grape production, which is mainly exported to Europe, owing to specific grapes types that are ripe and ready for export before the grapes of other countries can reach these markerts. Agriculture also includes livestock and game farming. Agriculture has undergone extensive restructuring since the opening up of the South African economy and substantial growth took place between 1998 and 2002. This growth was, however, impacted on by mounting pressures from market competition and legislative changes.

Agricultural Enterprises

Agriculture and agri-processing is also a key economic sector. Approximately 2% of the province is used for crop farming, mainly under irrigation in the Orange River Valley and the Vaalharts Irrigation Scheme. Approximately 96% of the land is used for stock farming, including beef cattle and sheep or goats, as well as game farming. The agricultural sector contributed 5.8% to the Northern Cape GDP per region in 2007, which was approximately R1.3 billion, and it employs approximately 19.5% of the total formally employed individuals (NCSDF, 2012). The sector is experiencing significant growth in value-added activities, including game-farming. Food production and processing for the local and export market is also growing significantly.

The Orange River area delivers a major part of South Africa's table grape production. The Orange River Producers Alliance is a table grape industry that is renowned as supplier of fresh table grapes to Europe, with an output of more than 20 million cartons (OABS, 2012)

More than 90% of Africa's total dried vine fruit farm production is produced through 1250 sultana grape growers in the Northern Cape, who produced more than 50,000 tons in 2010. The sultanas produced here comprise more than 80% of that which is exported primarily to Europe and eastern countries (OABS, 2012).

SAD Vine Fruit Pty (Ltd) is located in Upington and owns the largest dried vine fruit processing and packaging plant in South Africa, employing more than 350 persons. It has intakes at Groblershoop, Mylpaal, Louisvaleweg, Keimoes, Kakamas and Vredendal (OABS, 2012).

The Orange River Wine Cellars Co-op, also based in Upington, is the second largest winemaking cooperative in the world and has wine cellars are at Groblershoop, Grootdrink, Upington, Keimoes and Kakamas. This co-op has more than 740 members who produce wine grapes and 445 farmers who produce grape juice (OABS, 2012).

Livestock Farming

According to the Siyanda IDP, 2013-14, livestock farming occurs mainly on large farms where farming is extensive. The large majority of these farms are privately owned. In the jurisdiction of the Siyanda District Municipality there are approximately 1,600 farm land units, which belong to 890 owners. Due to the difference in the carrying capacity of the land, there are fairly large differences in the sizes of the farms. The carrying capacity of the land in this area can differ considerably. The central parts of the region consist mainly of semi-desert areas and are, therefore, with a few exceptions, mainly suitable for extensive livestock farming.

Lastly, it should be mentioned that a large variety of game can be found on both private and conservation areas in the region, forming an important base for the well-established game industry in the region. More than 1,000 game farmers have been registered with the Department of Environmental Affairs and Nature Conservation which is also an indication of the extent of the industry in the region.

Irrigation Farming

According to the Siyanda IDP, 2013-14, although the largest part of the Siyanda District Municipal Area is taken up by extensive livestock farming, there is also limited intensive irrigation farming in the surroundings of Byna-Bo and Schuitdrift (Southern Farms). This area is known worldwide for its table grapes, which are usually the first to reach the markets in Europe and other international countries. This is a very intensive industry and it contributes greatly to the economy of the region. Agriculture is still the major industry in the district, contributing to job creation and economic growth.

Mining

The mining sector is the largest contributor to the provincial GDP, contributing 28.9% to the GDP in 2002 and 27.6% in 2008. The mining sector is also important at a national level. In this regard, the Northern Cape produces approximately 37% of South Africa's diamond output, 44% of its zinc, 70% of its silver, 84% of its iron-ore, 93% of its lead and 99% if its manganese.

Tourism & Heritage in the district

The tourism industry plays a key role in the South African economy, both from its contribution to GDP and from its contribution to employment. Tourism is dependent on both domestic and foreign visitors, both in the sense of domestic visitors to the DM and Northern Cape and also in the sense of national as well as international visitors. Tourism is one of the most important economic sectors in the Northern Cape as well as within the Siyanda District Municipality. The industry is noted as the fastest growing component of the economy by the Siyanda District Municipal IDP (2007 – 2011).

Boegoeberg Dam itself is especially popular for fishing, camping and water sport enthusiasts (!Kheis IDP 2012-2017), with a campsite on the southern banks and the Trans Boegoe camp on the northern bank at the site of the intake works.

Economic development in the Northern Cape is hampered by the vastness of the area and the remoteness of its communities in rural areas. Development is also hampered by the low education and skills levels in the province. As a result, unemployment in the Northern Cape presents a major challenge.

5.9.2 Socio-economic Impact Assessment

5.9.2.1 Construction phase impacts

Throughout the construction phase, various impacts are anticipated for all project alternatives as described below.

Direct Employment and Skills Development

The construction of the proposed hydropower facilities would require a workforce which would translate into direct employment. Employment opportunities created by the construction phase would equate to approximately 150 to 200 (at peak) people over a period of 24 months. Approximately 75% of the jobs created would be filled from the local community. Approximately 80% would be allocated to South African citizens and 75% specifically for black citizens (HydroSA 2013, pers. comm.) 58% of the opportunities would require skilled employees of which 20% would be black.

Statistics set out in **Section 5.9.1.3** indicate that, in terms of education, the population has a low level of education with only 14% having completed matric. This is linked to a limited skills base coupled with a high level of unemployment. Of the skills required onsite, there would be potential opportunities for low skilled security staff and construction workers. Should these staff require training, the developer is committed to providing training onsite.

The positions created that will require more highly skilled staff from outside the local area or region would have a positive impact on the wider economy. However, this impact is less significant at the regional level due to the relatively small number of jobs created in comparison with the size of the regional labour force.

For all alternatives, the potential employment generation and skills development impact of the hydropower facility is considered to be of low magnitude, of local and regional extent and limited to the construction phase. Therefore, the impact is of **low (+)** significance which can be increased to **low-medium (+)** with mitigation

Economic Multiplier Effects

Economic multiplier effects are the positive ripple effects in the economy as a result of direct expenditure through a development such as the proposed hydropower facility. Apart from direct job creation (considered above), multiplier effects could also include 'indirect effects', such as additional jobs and economic activity generated through the supply of goods and services to the development. 'Induced effects' include employment and other economic activities generated by the re-spending of wages earned by those directly and indirectly employed on the project, such as construction workers spending their wages in local shops as an example (United States Department of Energy, 1997).

The turbines will be sourced abroad, and therefore, imported. However, the rest of the components required will be from South Africa, with the some from the Northern Cape and will benefit for the local economy.

At a LM and DM level, there are likely to be economic multiplier effects from the use of local goods and services which include, but are not limited to, construction materials and equipment, and workforce essentials such as food, clothing, safety equipment, and other goods. The percentage of the workforce that would be employed from the local area would most likely spend their entire salaries within the local area or region. Although it is likely that onsite accommodation would be provided, it is likely that the non-local staff would also visit Groblershoop during their free time and this additional spend would provide an indirect boost to the local economy. However, it is hard to quantify extent to which these benefits can be achieved.

For all alternatives, the potential impact of the hydropower facility is considered to be of low magnitude, of local and regional extent and limited to the construction phase. Therefore, economic multiplier effects are considered of **low (+)** significance which can be increased to **low-medium (+)** with mitigation.

Indirect effects of additional workers on site

Additional workers on the site during construction may have indirect effects, such as increased security issues for neighbouring farms and damage to property, the risk of veld fire, poaching and stock theft. It is estimated that approximately 150 to 200 (at peak) workers would be required. Of these, approximately 90-120 at peak will require overnight accommodation either onsite or in the community. It is possible that the site may accommodate as many as 60% of the workforce. This number of people on site constitutes a risk to the biophysical environment as we well as the security of the neighbours. A strict code of conduct needs to be enforced and monitored. Services would be provided and agreements with the municipality would ensure the environmental impacts on the property are limited.

For both Layout Alternatives 1 and 2, the potential impact of the hydropower facility is considered to be of low magnitude, of local extent and limited to the construction phase. Therefore indirect effects arising from the construction of the proposed hydro power station are of **medium (-)** significance which can be reduced to **low (-)** with mitigation.

Impacts of a non-local workforce on society

The introduction of a non-local workforce has the potential to result in social disruption, both physical and emotional, during construction. Such disruption could result in an increased demand on social infrastructure such as accommodation, health facilities, transport facilities and so on. Social ills, including the spread of diseases such as HIV/AIDS, crime and social conflict are also a potential risk.

However, the degree to which society is disrupted largely depends on the level of local employment achievable and, in the case of this project, 70% of the workforce is expected to be sourced locally, with outsiders being accommodated temporarily onsite or in Groblershoop.

Being a smaller but prominent node in the District, the infrastructure within Groblershoop is likely to have the capacity to absorb the additional people. In terms of social ills, however, there is an existing substance and alcohol abuse problem in the area which is often linked to crime - this has the potential to be exacerbated by newcomers. There is also the likelihood that many of the community members are unemployed and seeking alternative opportunities to subsist. There is potential for conflict with unemployed residents that feel resentment towards outsiders being selected for jobs to which they feel entitled.

The potential impact for all layout alternatives and the hydropower facility is considered to be of low magnitude, of local extent and limited to the construction phase. Therefore, the impact of a non-local work force for the proposed hydro power station is of **low (-)** significance which could be reduced to **very low (-)** with mitigation.

Disruption or damage to adjacent properties

As a result of construction activities described in **Section 3**, disruption or damage to adjacent properties (including access arrangements) is a potential issue and may include a temporary increase in noise and dust, or the wear and tear of private farm roads for access to the site.

The potential impact for both layout alternatives is considered to be of low magnitude, of local extent and limited to the construction phase. Therefore, disruption impacts are of **low (-)** significance which could be reduced to **very low (-)** with mitigation.

Safety issues

While the power station would be located on private property, construction activities could pose a safety risk for people in the area, especially children, particularly during holiday seasons when the dam is used for recreation. Fencing off these components and ensuring security on site to keep people out of the danger area would reduce the safety risks.

5.9.2.2 Operational phase Impacts

Operational impacts anticipated for all project alternatives are described below.

Direct Employment and Skills Development

Maintenance would be carried out throughout the lifetime of the hydropower facility. Activities include technical maintenance, clearing of debris and fault finding, if necessary. The operation of the facility would require a workforce, which would, however, be significantly smaller than the workforce required for construction and, therefore, limited direct employment would be generated. Operational employment has been calculated as 5 to 6 people for the design life of 20 years. Of these

opportunities, 80 would be allocated to South African citizens and 75% specifically for black citizens (HydroSA, 2013).

In terms of skills, the project would create job opportunities for a wide range of skills, 58% would be skilled employees and 20% would be black skilled employees. In addition, 75% of the jobs created would be from the local community and the developer is committed to providing onsite training to local community members employed for operations (HydroSA, 2013).

For all alternatives, the potential impact is considered to be of low magnitude, of local and regional extent and long term. Therefore, direct employment and skills development impacts are of **low (+)** significance which would remain **low (+)** with mitigation.

Economic Multiplier Effects

Economic multiplier effects generated from the supply of local goods and services to the facility during operations would include maintenance tools, supplies and equipment which may be technology specific and, therefore, not necessarily available within the region or district.

Furthermore, the operational remuneration for the hydropower facility for highly-skilled employees, skilled individuals and non-skilled employees will be received over a period of 20 years. This could benefit the local economy through money spent on items such as basic essentials, namely food, clothing, and other goods. Leakage is the loss of income generated from the facility to other economies. There is a lower potential for leakage from the local economy if employees are sourced locally as most of their salaries would be spent locally within the district or region.

Regardless of the layout alternative, the potential impact is considered to be of low magnitude, of local and regional extent and long term; therefore of **low (+)** significance which would remain **low (+)** with mitigation.

Landowner revenue

The facility would increase the profitability of the land leased from farmers and will provide an additional income for the landowner of Zeekoebaart Farm. Although this direct financial benefit is fairly limited, as it will only benefit the one landowner in question, this income could be used to reinvest in agricultural activities on this farm with benefits for the local economy, or it could enter the local economy through other investments or through additional spend.

For both layout alternatives, the potential impact is considered to be of low magnitude, of local extent and long term; therefore of **low (+)** significance without mitigation. No mitigation is recommended.

Diversification of the local economy

Increasing the contribution of the renewable energy sector to the local economy could assist with diversification and provide greater stability. The economy of the ZF Mgcawu DM is founded on community services, agriculture, transport and tourism, with the service sector supporting a large proportion of the labour force within !Kheis LM. It is recognised that diversification of the district economy is one of the key challenges that needs to be addressed in order to facilitate economic growth (Siyanda IDP, 2013-2014).

The growth in the renewable energy sector in this part of the country could, therefore, contribute towards diversification and stability of the economy, reducing employment vulnerability with positive impacts for the local economy and communities. Therefore, the potential impact is considered to be of low magnitude, of local extent and long term; therefore of **low (+)** significance without mitigation regardless of the layout alternatives. No mitigation is recommended.

The cumulative impact for all alternatives would be the same and is considered to be of medium magnitude, local, regional and national in extent and long term to permanent; therefore of **medium (+)** significance. No mitigation is recommended.

Safety issues

While the power station would be located on private property, there are a number of components, especially the water conveyance channel if open, the tunnel (if constructed) and the forebay that could pose a safety risk for people in the area, especially children, particularly during holiday seasons when the dam is used for recreation. Fencing off these components would reduce the safety risks.

5.9.2.3 Decommissioning phase impacts

Decommissioning and restoration activities are likely to have similar impacts as those identified for the construction phase. There are likely to be fewer skills and training opportunities available because, at the end of the projected IPP contract of 20 years, skills would already be established.

The impact from decommissioning activities for both Layout Alternative 1 and 2 would be the same. The impact on the local economy is considered to be of **low (+)** significance and the other impacts on society, in general, as being of **very low (-)** significance.

5.9.2.4 Cumulative Impacts

Construction phase

The sudden spate of renewable energy development proposals within the Northern Cape, and South Africa in general, has been driven by National Government. The abundant renewable resources in the Northern Cape led to a high concentration of renewable energy facility proposals with associated concerns regarding the potential negative cumulative impact on the environment. However, very few facilities have been proposed in the immediate area of this proposed facility.

The cumulative impact for all alternatives would be the same and is considered to be of medium magnitude, local and regional in extent and for the duration of the construction phase; therefore of **medium (+)** significance.

5.9.3 Mitigation Measures

5.9.3.1 Construction Mitigation

The following mitigation measures are proposed to be implemented during the construction phase for all alternatives:

- It is recommended that the local employment policy, as stated by the proponent, be implemented, audited and accompanied by a training programme. The policy must be based on a 'local's first' policy, specifically for low skilled jobs and should aim to recruit at least 20% of the jobs from the local community. This should also apply to all contracting firms.
- A local procurement policy should be adopted by the applicant to maximise the benefit to the local economy.
- Implement a policy of "no employment at the gate" to prevent loitering.
- The site should be secured to reduce safety risks.
- A comprehensive employee induction programme should cover land access protocols and fire management. This is addressed in the EMPr.
- A comprehensive employee induction programme should address issues such as HIV/ AIDS and Tuberculosis, as well as alcohol and substance abuse. The induction should also address a code of behaviour for employees that would align with community values.

- The EMPr also addresses noise and dust control. A 24 hour system for receiving and addressing complaints should be established before the commencement of the construction phase. Local farmers and residents should be informed of the contact number.
- Housing has to be restricted to the approved construction camp.

5.9.3.2 Operational Mitigation

The following operational mitigation measures are proposed for all project alternatives:

- It is recommended that the local employment policy as stated by the proponent is implemented, audited and accompanied by a training programme. The policy must be based on a 'local's first' policy, specifically for low skilled jobs and should aim to recruit at least 20% of the jobs from the local community.
- It is recommended that the developer adopts a local procurement policy which would maximise the benefit to the local economy and minimise leakage.
- Components of the development that may pose a safety risk to the public must be fenced securely to prevent unauthorised access.

5.9.4 Socio-economic Impact Table

Table 5-34 and **Table 5-35** indicate how the significance ratings of the various impacts were derived.

Table 5-34 | Construction socio-economic impacts

Project component	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All Alternatives	Direct employment and skills development	Without mitigation	Local and Regional	Low	Construction	Low (+)	Probable	High	Reversible
		With mitigation	Local and Regional	Low-Medium (+)	Construction	Low-Medium (+)	Probable	High	Reversible
All Alternatives	Economic Multiplier Effects	Without mitigation	Local and Regional	Low	Construction	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low-Medium (+)	Construction	Low-Medium (+)	Probable	Low	Reversible
All Alternatives	Indirect effects of additional workers on site	Without mitigation	Local	Low	Construction	Low (-)	Probable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Probable	Medium	Irreversible
All Alternatives	Impacts of a non-local workforce on society	Without mitigation	Local	Low	Construction	Low (-)	Improbable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Improbable	Medium	Irreversible
All Alternatives	Disruption or damage to adjacent properties	Without mitigation	Local	Low	Construction	Low (-)	Probable	Medium	Irreversible
		With mitigation	Local	Very Low (-)	Construction	Very Low (-)	Probable	Medium	Irreversible
	Potential negative or positive cumulative effects	Without mitigation	Local and Regional	Medium	Construction	Medium (-)	Probable	Medium	Irreversible
		With mitigation	Local and Regional	Medium	Construction	Medium (-)	Probable	Medium	Irreversible

Table 5-35 | Operational socio-economic impacts

Project component	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
All Alternatives	Direct Employment and Skills Development	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	High	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	High	Reversible
All Alternatives	Economic Multiplier Effects	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alternatives	Landowner revenue	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alternatives	Diversification of the local economy	Without mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
		With mitigation	Local and Regional	Low	Long term	Low (+)	Probable	Low	Reversible
All Alternatives	Potential negative or positive cumulative effects	Without mitigation	Local, Regional and National	Medium	Long term / Permanent	Medium (+)	Probable	Medium	Reversible
		With mitigation	Local, Regional and National	Medium-High (+)	Long term / Permanent	Medium (+)	Probable	Medium	Reversible

*Mitigation measures are described in detail in **Section 5.9.3.1 & 5.9.3.2**

5.9.5 Social Conclusions

From a social point of view, any of the proposed alternatives are considered sustainable as the impacts would be of equal magnitude and significance regardless of which alternative is implemented.

5.10 IMPACT ON ENERGY PRODUCTION

As noted in Section 4.1.3, South Africa aims to procure 6,925 MW of renewable energy. The proposed project could, therefore, contribute positively towards this goal.

5.10.1.1 Description of the Environment

Historical trends in electricity demand in South Africa have shown a consistent increase in demand. There have been some years where the demand levels off or decreases but, over the long term, there has been an increasing electricity demand. 130 MW (of the 6925 MW) has been allowed for hydropower and this project would contribute 11 MW towards this target. Given the current situation in the country where the electricity reserve margin remains extremely low and the capacity to supply additional electricity is still limited, the proposed hydropower facility would be able to provide electricity to assist in meeting the energy demand within South Africa.

5.10.1.2 Energy Impact Assessment

Since hydropower is a clean source of energy and, given the need for increased production capacity in South Africa, the potential impact of the proposed project on energy production is considered to be of low magnitude, regional extent and long term; therefore of **low (+)** significance, without or with mitigation measures. No difference in significance would result from the proposed alternatives.

5.10.1.3 Mitigation Measures

No mitigation measures are recommended.

5.10.1.4 Energy Impact Table

Table 5-36 indicates how the significance rating for energy was determined.

Table 5-36 | Energy impact table

	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Operational phase	All Alternatives	Increased energy	Without mitigation	Regional	Low	Long term	Low (+)	Definite	Certain	Reversible
			With mitigation	Regional	Low	Long term	Low (+)	Definite	Certain	Reversible

*No mitigation measures are proposed.

5.11 IMPACT ON TRAFFIC

Construction vehicles are likely to make use of the existing roads, including the N10, N8 and DR3040, to transport equipment and material to the construction site. The anticipated traffic to and from the site is indicated in **Figure 56**. These truckloads would be distributed throughout the construction period (24 months).

A desktop Traffic Impact Statement was undertaken by Dr Wayne Duff-Riddell of Aurecon to examine specific aspects considered to be of concern. The Traffic Impact Statement is included in **Annexure D**. In addition, a Traffic Management Plan and a Transportation Management Plan have been drafted and are included in **Annexure E** as per DEA requirements.

5.11.1 Description of the Environment

It is anticipated that the route from Cape Town via Upington to the site would utilise the N10, N8, DR3040 road networks. Zeekoesbaart's private access roads would be used to transport the various components to site (**Figure 56**).

Figure 56 | Affected road networks

Table 5-37 | Daily and irregular anticipated traffic to and from the site

5.11.2 Traffic Impact Assessment

Activity	Anticipated trips	Average trips
Construction - Daily		
Site Management	3 x 2 trips to and from site by Light Duty Vehicle (LDV) per day	6 LDV trips per day
Site staff	3 x 2 trips to and from site by taxis per day	6 taxi trips per day
Site visitors	2 trips to and from site per week	0.4 LDV trips per day

Sub-contractors	60% of the above items per day	7.45 trips per day
Construction - Irregularly		
Cement Trucks	24 trips over 24 months	1 trip per month
Reinforcing	24 trips	1 trip per month
Tunnel Equipment	10 trips	< 0.5 trip per month
Construction Equipment	12 trips	0.5 trip per month
Mechanical Equipment	12 trips	0.5 trip per month
Turbines & generators	6 Trips to site	6 Trips to site
Deliveries	1 trip per day	30 trips per month
Operation and Management (O&M)		
O&M	5 Trips a week	5 Trips a week

5.11.2.1 Construction phase

On average, 6.4 Light Duty Vehicles (LDVs) and 6 Taxis would access the site daily (excluding weekends). The additional vehicles on the roads could potentially result in more accidents and/or traffic congestion. However, the potential impact of the project on traffic during the construction phase is considered to be of **low** magnitude, of regional extent with duration limited to the construction phase; therefore of **low (-)** significance, without mitigation. Through the implementation of mitigation measures, the significance could be reduced to **very low (-)**. No difference in significance would result from the proposed alternatives.

A specific concern was raised with respect to traffic passing close to the farmhouse of Mr David S Fourie of Farms 307 & 308 Seekoeibaardsnek. He was concerned about dust, noise and safely impacts on his residence. By diverting the traffic around his house (on a new road < 4 m wide), as indicated in **Figure 23**, the impact can be reduced to acceptable levels.

Concerns have also been raised that the condition of provincial roads are deteriorating as a result of construction activities in the region related to renewable energy projects. Such concerns are noted, and the project proponent will urge the provincial authorities to maintain these roads in order to reduce this impact.

5.11.2.2 Operational phase and decommissioning phase

The potential impact of the project on traffic during the operational phase is considered to be very low since additional traffic would be very limited to and from the site. It is, therefore, expected to be of very low magnitude, of local extent and with a long term duration; therefore of **very low (-)** significance, with and without mitigation. No difference in significance would result from the proposed alternatives.

The removal of structures during the decommissioning phase would result in a negative impact. It is expected to be of very low magnitude, of local extent and with a similar duration as the construction phase; therefore of **very low (-)** significance, with and without mitigation.

5.11.2.3 Cumulative impacts

The cumulative potential impact of renewable energy projects on transport is considered to be of medium magnitude, of regional extent and short term; therefore of **medium (-)** significance, with or without mitigation. No difference in impact significance would result from the proposed alternatives.

5.11.3 Mitigation Measures

- The Traffic Management Plan, as part of the EMPr (Annexure E) must be implemented.
- The Transportation Management Plan, as part of the EMPr (Annexure E) must be implemented.

5.11.4 Traffic Impact Table

Table 5-38 details the significance of the anticipated traffic impacts.

Table 5-38 | Traffic impact table

	Project	Key impacts	Mitigation	Extent	Magnitude	Duration	SIGNIFICANCE	Probability	Confidence	Reversibility
Construction Phase	All Alternatives	Accidents and/ or traffic congestion	Without mitigation	Regional	Medium	Construction phase	Low (-)	Probable	Sure	Reversible
			With mitigation	Regional	Low	Construction phase	Very Low (-)	Probable	Sure	Reversible
Operational and Decommissioning[31] Phase	All Alternatives	Accidents and/ or traffic congestion	Without mitigation	Local	Very low	Long term	Very Low (-)	Probable	Sure	Reversible
			With mitigation	Local	Very low	Long term	Very Low (-)	Probable	Sure	Reversible
Cumulative	All Alternatives	Accidents and/ or traffic congestion	Without mitigation	Regional	Medium	Short term	Medium (-)	Probable	Unsure	Reversible
			With mitigation	Regional	Medium	Short term	Medium (-)	Probable	Unsure	Reversible

*Mitigation measures are described in detail in **Section 5.11.3**

[31] The Decommissioning Phase refers to the decommissioning activities. Should the project be removed in its entirety, the long term impact on traffic will predicted to be neutral or low positive.

The following impacts associated with the proposed project have been accessed as having a potentially low to negligible impact and, therefore, do not have accompanying impact tables.

5.12 NOISE IMPACTS

Noise is generally defined as unwanted sound transmitted through a compressible medium such as air. Noise is reported in decibels (dB). Sound, in turn, is defined as any pressure variation that the ear can detect. The number of pressure variations per second is referred to as the frequency of sound and is measured in hertz (Hz). Human response to noise is complex and highly variable as it is subjective rather than objective. The hearing of a young, healthy person ranges between 20Hz and 20,000Hz.

In terms of sound pressure level, audible sound ranges from the threshold of hearing at 0dB to the pain threshold of 130dB and above. Even though an increase in sound pressure level of 6dB represents a doubling in sound pressure, an increase of 8dB to 10 dB is required before the sound subjectively appears to be significantly louder. Similarly, the smallest perceptible change is about 1 dB.

Many factors affect the propagation of noise from source to receiver. The most important of these are:

- The type of source and its sound power;
- The distance between the source and the receiver;
- The extent of atmospheric absorption (attenuation);
- Wind speed and direction;
- Temperature and temperature gradient;
- Obstacles such as barriers or buildings between the source and receiver;
- Ground absorption;
- Reflections;
- Humidity; and
- Precipitation

5.12.1 Description of the Environment

Noise sensitive community members include residences on surrounding farms. The closest of these are residences directly opposite the Boegoeberg Dam on the southern bank of the river at 1.2km from the inlet works and 1.9 km for the power chamber[32]. The campsite on the southern bank upstream of the weir is occupied during weekends and specifically over the December holiday period - this site would be the closest public sensitive receptor area.

Baseline noise levels within the project area are considered ‘rural’ where average day and night-time noise levels are between 45 and 35 dBA[33], respectively.

5.12.2 Noise Impact Assessment

Noise will be generated during the construction, operation and decommissioning phases of the proposed project. Construction and decommissioning activities are often similar. Potential sources of noise during the construction phase are increased traffic, operation of heavy machinery during the construction period, blasting, and additional people in the area.

[32] This excludes the house at the site, as to the best knowledge of the EAP and the project proponent at the time of compiling this EIR, this house will no longer be occupied.
[33] The measurement of sound pressure levels

5.12.2.1 Construction phase impacts

Construction related noise is mostly associated with the use of diesel mobile equipment, earthworks, concrete batching and building finishing operations. The level and character of the construction noise will be highly variable as different activities with different plant/ equipment take place at different times, over different periods, in different combinations, in different sequences and on different parts of the construction site.

The construction phase is expected to have the most notable impact on environmental noise levels and may result in levels above the South African National Standards (SANS) guideline at the site boundaries. With mitigation in place, these impacts could be brought into compliance.

5.12.2.2 Operational phase impacts

The site is located in a rural setting with both agricultural and recreational activities surrounding the area of Boegoeberg Dam. Generally, there is very little disturbance to the ambient noise levels. The construction of the proposed hydropower station could potential introduce increased noise levels.

Noise levels generated by the proposed turbines are considered to be generally low and it is often the other auxiliaries that create a higher noise. However, on occasion there may be a certain level of a low frequency “rumble” from the turbines. The turbines will generate noise consistently during the plant’s operation. Noises and vibrations within small hydroelectric plants come from the generator, gearbox, turbine and transformers. Other than the transformers, these components will be encased in the power chamber which would reduce noise levels during operation. It is anticipated that operating equipment would have sounds levels of approximately 80dBA inside the turbine hall. It is expected that the slight increase in traffic would be immaterial in comparison with current traffic related noise.

It is expected that noise will be generated from the following operational phase installations and activities:

- Inlet works, tunnel and power chamber with tailrace;
- Switchyard with transformers;
- Corona noise from overhead power lines;
- Traffic.

5.12.2.3 Decommissioning phase impacts

It is expected that noise generated from decommissioning phase activities will be similar but not as intense or long term as construction phase noise levels. Thereafter, there will be no noise from the power station, if it ceases to be operational and all infrastructure is removed.

5.12.2.4 Cumulative impacts

The potential for cumulative noise impacts exists near major roads such as the N8. Other industrial type noise sources are distant enough from the proposed hydro power station and sensitive receptors that cumulative impacts are unlikely.

5.12.3 Mitigation Measures

5.12.3.1 Construction phase

The noise mitigation measures to be considered during the construction phase are as follows (for all alternatives):

- Construction site yards, workshops, concrete batching plants, and other noisy fixed facilities should be located well away from noise sensitive areas.

- Stationary noisy equipment, such as compressors and pumps, should be encapsulated in acoustic covers, screens or sheds, where possible. Portable acoustic shields should be used in the case where noisy equipment is not stationary (i.e. angle grinders, chipping hammers, etc).
- Vehicles should avoid unnecessary use of the reverse gear to minimise annoyance caused by reverse sirens. Consideration of alternative safety measures may be necessary when taking such a measure.
- All diesel powered equipment must be regularly maintained and kept at a high level of serviceability. This must particularly include the regular inspection and, if necessary, replacement of intake and exhaust silencers. Any change in the noise emission characteristics of equipment must serve as a trigger for withdrawing it for maintenance.
- Truck traffic should be routed away from noise sensitive areas, where possible.
- Noisy operations should be combined so that they occur where possible at the same time.
- Instruction of employees on low-noise work methods, for example, the handling of structural steel and the use of radiotelephony rather than shouting for communication.
- Machines in intermittent use should be shut down in the intervening periods between work or throttled down to a minimum.
- Construction activities are to be contained to reasonable hours during the day and early evening.
- Night-time activities near noise sensitive areas should not be allowed. Careful consideration must be given as to how to manage construction activities over weekends and during the holiday periods.
- With regard to unavoidable, very noisy construction activities in the vicinity of noise sensitive areas, the contractor should liaise with local residents and owners on how best to minimise the impact, and the local population should be kept informed of the nature and duration of intended activities.

5.12.3.2 Operational phase

The noise mitigation measures to be considered during operations are as follows (for all alternatives):

- The design of all major plant components should incorporate all the necessary acoustic design aspects required to ensure that the generated noise from the facility does not exceed the SANS 10103 maximum equivalent continuous day/night rating level (LRdn) of 70 dBA for industrial areas at the project boundary.
- The design should also take into account the maximum allowable equivalent continuous day and night rating levels of the potentially impacted sites outside the facility boundary. Where the noise level at such an external site is presently lower than the maximum allowed, the maximum shall not be exceeded. Where the noise level at the external site is presently at or exceeds the maximum, the existing level shall not be increased by more than what is considered as acceptable in SANS 10103.
- The latest technology incorporating maximum noise mitigation measures for components of the facility should be designed into the system. The sound power level of each piece of equipment should be such that the sound pressure level (LP – i.e. the noise level) measured at 1 m from the surface of the given plant/equipment should not exceed 85 dBA. When ordering plant and machinery, manufacturers should be requested to provide details of the sound power level. Where possible, those with the lowest sound power level (most quiet) should be selected.
- The design process is to consider, *inter alia*, the following aspects:
    - The position and orientation of buildings on the site.
    - The design of the buildings to minimise the transmission of noise from the inside to the outdoors.
    - The insulation of particularly noisy plant and equipment.
    - All plant, equipment and vehicles are to be kept in good repair.

- Where possible, very noisy activities associated with maintenance, should not take place at night.

5.12.4 Noise Conclusions

All the alternatives would have very similar noise impacts and would likely be of equal magnitude and significance. With the introduction of appropriate mitigation measures, these impacts would be reduced to acceptable levels.

5.13 DUST IMPACTS

Hydropower technology results in no direct air emissions during operation as no fossil or other fuels are combusted. However, air pollution in the form of dust emissions will occur during the construction phase.

5.13.1 Description of the Environment

Meteorological conditions govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. Air temperature is an important parameter for the development of the mixing and inversion layers. It also determines the rate of dissipation of pollutants before they reach ground level. Incoming solar radiation determines the rate of development and dissipation of the mixing layer. Relative humidity is an inverse function of ambient air temperature, increasing as ambient air temperature decreases. On average, temperatures in the area range between 19°C in June to 33°C in January.

Precipitation represents an effective removal mechanism of atmospheric pollutants and is, therefore, frequently considered during air pollution studies. Evaporation is a function of ambient temperature, wind and the saturation deficit of the air. Evaporation rates have important implications for the design and implementation of effective dust control programmes. The area falls within a summer rainfall belt with the annual mean rainfall recorded in the Northern Cape Province reported as 527 mm, with the maximum value of 2,031mm and minimum value of 200 mm (Schulze, 1997).

Particulates represent the main pollutant of concern during the construction of the hydropower facilities. Airborne particulate matter comprises a mixture of organic and inorganic substances, ranging in size, shape and density.

5.13.2 Dust Impact Assessment

It is anticipated that the following activities would result in dust generation.

Materials handling

The handling of topsoil and gravel for construction could be a potential significant source of dust generation at the various transfer points. The quantity of dust generated depends on various climatic parameters, such as wind speed and precipitation, in addition to non-climatic parameters such as the nature and volume of the material handled. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, as a result of exposure to strong winds. Increases in the moisture content of the material being transferred will decrease the potential for dust emission, since moisture promotes the aggregation and cementation of fines to the surfaces of larger particles.

The number of transfer points, the quantity of material, the moisture content of the material and the hourly wind speed will determine the amount of Total Suspended Particle (TSP) emissions deriving from the various transfer points. Construction is assumed to be a 12-hour, five day a week operation for the 24 month period. Materials handling operations can be mitigated through water sprays that can result in a 50% reduction in dust generation.

Windblown dust from stockpiles

Wind erosion is a complex process, including three different phases of particle entrainment, transport and deposition. It is primarily influenced by atmospheric conditions (e.g. wind, precipitation and temperature), soil properties (e.g. soil texture, composition and aggregation), land-surface characteristics (e.g. topography, moisture, vegetation and non-erodible elements) and land-use practice (e.g. farming, grazing and mining).

Moisture will act as a binding agent and reduce wind erosion emission by around 50%, depending on the amount of water applied.

Dust from roads

Vehicle-entrained dust emissions from unpaved roads are significant sources of dust, especially where there are high traffic volumes on a road. The force of the wheels travelling on unpaved roads causes the pulverisation of surface material. Particles are lifted and dropped from the rotating wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed. The quantity of dust emissions from unpaved roads will vary linearly with the volume of traffic expected on that road.

5.13.2.1 Construction phase

It is unlikely that site dust fallout impacts during construction will be significant due to the limited construction footprint and minimal construction loads anticipated on the access roads. With mitigation in place, primarily comprising of water sprays, these impacts can be reduced.

5.13.2.2 Operational phase

Emissions to air associated with the operational phase would only result from maintenance vehicles. These are regarded as insignificant.

5.13.2.3 Decommissioning phase

The decommissioning phase activities will mainly include materials handling activities, wind erosion and, to a lesser extent, vehicle and equipment movement on-site and on the access road. Thereafter, there will be no dust from the power station, if it ceases to be operational and all infrastructure is removed.

5.13.3 Mitigation Measures

Generic management objectives are provided to address potential dust generation from the proposed hydropower facility and associated infrastructure (all alternatives) throughout the project life-cycle.

- Water sprays to be applied at the area to be cleared should significant amounts of dust be generated. Moist topsoil will reduce the potential for dust generation when tipped onto stockpiles.
- Ensure travel distance between clearing area and topsoil stockpiles are kept to a minimum.
- Ensure exposed areas remain moist through regular water spraying during dry, windy periods.
- Cover disturbed areas with previously collected topsoil and replant indigenous species.

Specifications to manage dust are provided in the Erosion Management Plan as part of the EMPr (Annexure E).

5.13.4 Dust Conclusions

The temporary nature of the construction activities, and the likelihood that these activities will be localised and on small areas at any given time, would reduce the potential for significant off-site dust impacts. All of the proposed alternatives would have similar magnitude and significance dust impacts.

5.14 STORAGE OF HAZARDOUS SUBSTANCES ON SITE

Construction of the hydropower infrastructure (i.e. off-take channel, intake structure, powerhouse, tunnel, penstocks, tailrace, etc.), together with ancillary works, may result in hazardous substance spills to the surrounding environment that could affect the well-being of fauna, flora and humans. In turn, the water quality in the Orange River has the potential to be affected by these general civil construction activities, including installation of the hydro generator equipment, which contains oils and hydrocarbons and on-site waste management.

- Sources and activities that may contribute to hazardous substance spills include:
  - Leaking construction equipment (e.g. generators) during site preparation and/or earthworks
  - Plant used during construction
  - Leaking Plant
- Hydraulic pipes and/or fuel pipes bursting during operation
  - Spillage from chemical toilets onsite due to bad management (i.e. not being serviced regularly, not secured to the ground, bad placement, etc.)
- Untrained staff not using hazardous substances correctly

5.14.1 Impact Assessment

The volume to be stored and used onsite falls well below the triggers of a listed activity in terms of NEMA. Therefore, the impacts were not assessed using the assessment methodology provided in Annexure F. However, the necessary precautionary measures would be in place and have been included in the EMPr (Hazardous Substances Control Plan, including Monitoring Measures).

5.14.2 Mitigation Measures

The management and protection of the environment would be achieved through the implementation of the EMPr (Hazardous Substances Control Plan, including Monitoring Measures **Annexure E**), which *inter alia* specifies the storage details of hazardous compounds and the emergency procedures to follow in the event of a spillage.

5.15 SUMMARY OF POTENTIAL IMPACTS

A summary of all the potential impacts from the proposed project is included in **Section 6.2.**

5.16 BOEGOEBERG HYDRO COMMITMENTS

Boegoeberg Hydro recognises that by constructing the hydropower facility near Groblershoop, it constitutes a change in the predominant land-use and would result in impacts (both positive and negative) to the biophysical and social environments. Furthermore, as this is a long-term project Boegoeberg Hydro takes cognisance of the need to create a sustainable environment within the community. Part of the IPP bid application requirements to construct a renewable project requires a strict, comprehensive Economic Development Plan to be submitted. This plan would detail the various job creation, socio economic development, skills development, local content and ownership criteria. A letter of commitment from Boegoeberg Hydro to this effect is included in **Annexure H**.

In order to create a sustainable environment, Boegoeberg Hydro proposes to:

- Create a local community trust which has an equity share in the project to benefit historically disadvantaged communities;
- Initiate a training strategy to facilitate employment from the local community;
- Give preference to local suppliers of components for the construction of the facility;

- Put in place a maintenance plan to ensure that broken components or materials are recycled or are disposed in an environmentally responsible manner;
- Recycle the facilities' components should the facility be decommissioned; and
- Rehabilitate the site to its original state prior to the construction of the hydropower facility, as far as practically possible.

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6 RECOMMENDATIONS AND CONCLUSION

This section concludes the report and provides information on the way forward.

6.1 Alternatives considered

The proposed project consists of an 11 MW hydropower facility and ancillary infrastructure.

As per the requirements of NEMA, this EIA investigation has contemplated and assessed potential environmental impacts associated the following range of project alternatives:

- **Location alternatives** – Boegoeberg Dam, Farm 306 Zeekoebaart
  - Only the current location of the proposed hydropower station has been considered.
- **Activity alternatives**
  - Energy generation by means of a hydropower station.
  - "No-go" alternative to the proposed hydropower station.
- **Site layout alternatives**
  - Water conveyance alternative 1 - open channel.
  - Water conveyance alternative 2 - tunnel (preferred).
- **Routing Alternatives**
  - Transmission line and road access alternative - alternative 1 (cross river below weir).
  - Transmission line and road access alternative - revised alternative 2 (preferred) behind koppie.
- **Technology alternatives**
  - Kaplan hydropower turbines.

6.2 Summary of predicted impacts

This Final EIA Report provides a comprehensive assessment of the environmental issues and potential impacts associated with each of the abovementioned alternatives of the proposed project. Alternatives and the environmental and social impacts were derived in response to inputs from consultation with I&APs, provincial and local authorities, and the EIA project team. **Table 5-39** provides a summary of the significance of the environmental impacts associated with this proposed project.

Table 5-39 | Summary impact table

IMPACTS	PROJECT ASPECT	Construction		Operation		Decommissioning activities[34]	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
Impact on flora	Layout 1 (channel)	High (-)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Layout 2 (tunnel)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Access Road	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Transmission lines (both alternatives)	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	Construction site	Medium (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	No- Go	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Impact on avifauna	Both layout alternatives	Low - Medium (-)	Low (-)	Low - Medium (-)	Low (-)	Low - Medium (-)	Low (-)
	Transmission alternatives 1 and 2 (habitat loss and disturbance)	Low (-)	Very Low (-)	Low - Medium (-)	Low (-)	Medium (-)	Medium-Low (-)
	Transmission 1 and 2 (Mortality)			High (-)	Low - Medium (-)		
Impact on fauna	Layout & transmission lines (all alternatives)	Low (-)	Very low (-)	Low (-)	Low (-)	Low (-)	Very low (-)
Impact on Agriculture	Both layout alternatives	Low (-)	Very Low (-)	Very low (-)	Very low (-)	Very Low (-)	Very Low (-)
	Transmission lines & access roads	Low (-)	Low (-)	Very low (-)	Very low (-)		
Aquatic Ecology	Layout (all alternatives)	Medium (-)[35]	Low (-)	Medium (-)	Low (-)	Low (-)	Very low (-)
	All transmission corridors and roads	Low (-)	Very low (-)			Very low (-)	Very low (-)
Palaeontology	Both layout alternatives	Low (-)	Low (-)				
	All transmission lines	Low (-)	Low (-)				
Impact on heritage	Layout (archaeology)	Medium (-)	Low (-)				
	Layout (graves)	High (-)	Low (-)				
	Transmission (archaeology)	Low (-)	Low (-)				

[34] Decommissioning impacts assessed refer to decommissioning activities. Should the facility and ancillary infrastructure be removed in their entirety, most of the impacts following decommissioning will be low positive, especially in terms of the biophysical environment.

[35] Failure to allow for the EFR over the Boegoeberg weir will result in the unmitigated impact being felt for the stretch of river between the existing weir and the tailrace. Thereafter, the EFR would be achieved , as all diverted water would be returned to the system. In low flow periods the power station would not operate.

IMPACTS	PROJECT ASPECT	Construction		Operation		Decommissioning activities[34]	
		No Mitigation	With Mitigation	No Mitigation	With Mitigation	No Mitigation	With Mitigation
	Transmission (graves)	Low (-)	Low (-)				
	Roads (archaeology)	Medium (-)	Low (-)				
	Roads (graves)	High (-)	Low (-)				
Visual impacts	Both layout alternatives	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
	All transmission alternatives	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)	Low (-)
Social impacts	Both layout alternatives (Direct employment and skills development; Economic Multiplier Effects)	Low (+)	Low (+)	Low (+)	Low (+)		
	Both layout alternatives (Additional workers on site)	Low (-)	Very Low (-)				
	Both layout alternatives (Landowner revenue Diversification of the local economy)			Low (+)	Low (+)		
Impact on energy production	Both layout alternatives			Low (+)	Low (+)		
Impact on traffic	Both layout alternatives	Low (-)	Very Low (-)	Very Low (-)	Very Low (-)	Low (-)	Very Low (-)

6.3 Level of confidence in assessment

With reference to the information available at this stage of the proposed project's planning cycles, the confidence in the environmental assessment undertaken is regarded as being acceptable for decision-making, specifically in terms of the environmental impacts and risks. The EAP believes that the information contained within the FSR and this Final EIR is adequate to inform DEA and enable DEA to determine the environmental acceptability of the proposed project and its alternatives.

It is acknowledged that the project's details will evolve during the detailed design and construction phases to a limited extent and that there are certain aspects that will need to be addressed via the implementation of the EMPr and subsidiary management plans. However, these are unlikely to change the overall environmental acceptability of the proposed project (taking note that any significant deviation from what was assessed in this EIR should be subject to a separate assessment. If this was to occur, an amendment to the EA may be required, in which case the prescribed process would be followed).

6.4 Construction phase impacts

With reference to **Table 5-39**, there are two impacts of high significance that were identified, namely Flora and Heritage. With the implementation of mitigation measures, this **high (-)** heritage impact (specifically the impact on graves) can be mitigated to a **low (-)** significance. **high (-)** for the botanical impact would be mitigated to **medium (-)** for the channel option for the water conveyance structure. However, it should be noted that the preferred alternative (tunnel option for the water conveyance structure) would have a **low (-)** significance after mitigation. The most significant (**medium (-)**) construction phase impacts to the biophysical and social environment, without mitigation, were on flora and aquatic ecology. With the implementation of the proposed mitigation measures, the impact ratings could be reduced to **low (-) or very-low (-)**.

Also, it should be noted that potential positive impacts on the local economy (employment) and social conditions would result and these would be of **low (+)** significance, with and without mitigation measures for all alternatives. Direct employment and skills development, and economic multiplier effects can be enhanced to a **low (+)** significance, with mitigation measures for all alternatives.

6.5 Operational phase impacts

The operational impacts were assessed and the potential avifaunal impacts were rated as having a **high (-)** significance without mitigation. The high significance rating given to the avifaunal impacts is associated with the transmission line (all alternatives) and this level of significance would reduce to **low – medium (-)** with mitigation.

Also, it should be noted that two potential positive impacts on the local economy (employment) and energy production would be of **low (+)** significance, with and without mitigation measures for all alternatives.

6.6 Decommissioning phase

The decommissioning phase activity impacts were assessed and the potential avifauna impacts were rated to be of **medium (-)** significance, without mitigation measures for all alternatives, which could be reduced to **medium-low (-)** respectively with the implementation of the EMPr.

6.7 Recommendations

Section 5 outlines the mitigation measures which, if implemented, could significantly reduce the negative impacts and enhance positive impacts associated with the project. These mitigation measures have been incorporated in the EMPr (**Annexure E**) for all alternatives. Where appropriate,

the mitigation measures, and any others, identified by DEA should be enforced as Conditions of Authorisation in the EA, should DEA issue a positive EA.

6.8 Sustainability of the project

While it is accepted that there are negative impacts attached to all forms of power generation, hydropower, which is based on a renewable resource, namely water, is considered more sustainable than power generated from coal or other non-renewable resources. Given that hydropower can act as a baseload energy source, it effectively provides a reserve capacity to back up intermittent renewable sources, such as wind and solar. This provides diversity in the generation capacity of South Africa, strengthening the overall system.

There are, however, different types of hydropower schemes, many of which are considered less sustainable. This is because of the impacts associated with large storage dams, habitat destruction on a large scale, impacts on ecological processes and social impacts such as resettlement. Run-of-river hydropower schemes have a much smaller environmental footprint compared to traditional reservoir storage hydro projects, with little or no storage requirements. This reduces the impact on vegetation, bird and faunal habitats, and communities and does not require resettlement of people. Rehabilitation is also easier because of the smaller areas affected. There is a very low potential for risk to water quality and, importantly, water is not used, rather, it is returned back to the river after passing through the turbines. In the case of the Boegoeberg hydropower project, the power station is linked to an existing weir, decreasing the need for infrastructure and increasing the environmental sustainability of the project. The project will almost exclusively use existing roads and the transmission line will tie into nearby existing transmission infrastructure.

Run-of-river hydropower stations further meet sustainability goals in that they help meet greenhouse gas emission reduction targets, as part of a worldwide effort to reduce the causative factors to climate change. The energy produced by a hydropower station displaces energy produced by polluting sources, such as oil, coal and gas, and reduces reliance on carbon-intensive, non-renewable energy. There are zero greenhouse gas emissions from such a power station once it is operational. The power stations also have very long project lives, reducing the need for replacement and/or upgrading on a regular basis.

It must be borne in mind, however, that while run-of-river power projects can be environmentally sustainable, the level of sustainability decreases when these projects are located in green-field sites or when landscapes are affected by multiple power lines, roads and water diversions. This increases the cumulative impacts of hydropower projects, so that while the site specific impacts may be acceptable, the impacts at a larger scale are amplified to unacceptable levels.

In the case of the proposed Boegoeberg hydropower station, which has a particularly small footprint (short distance between intake and outlet works), is linked to existing infrastructure and is not predicted to increase environmental and social impacts significantly at a regional (cumulative) level, the environmental sustainability of the project is considered high.

6.9 Site sensitivity

The site sensitivities are indicated on the following figures (**Figure 57**, **Figure 58** and **Figure 59**), showing both sensitivities and the proposed project infrastructure.

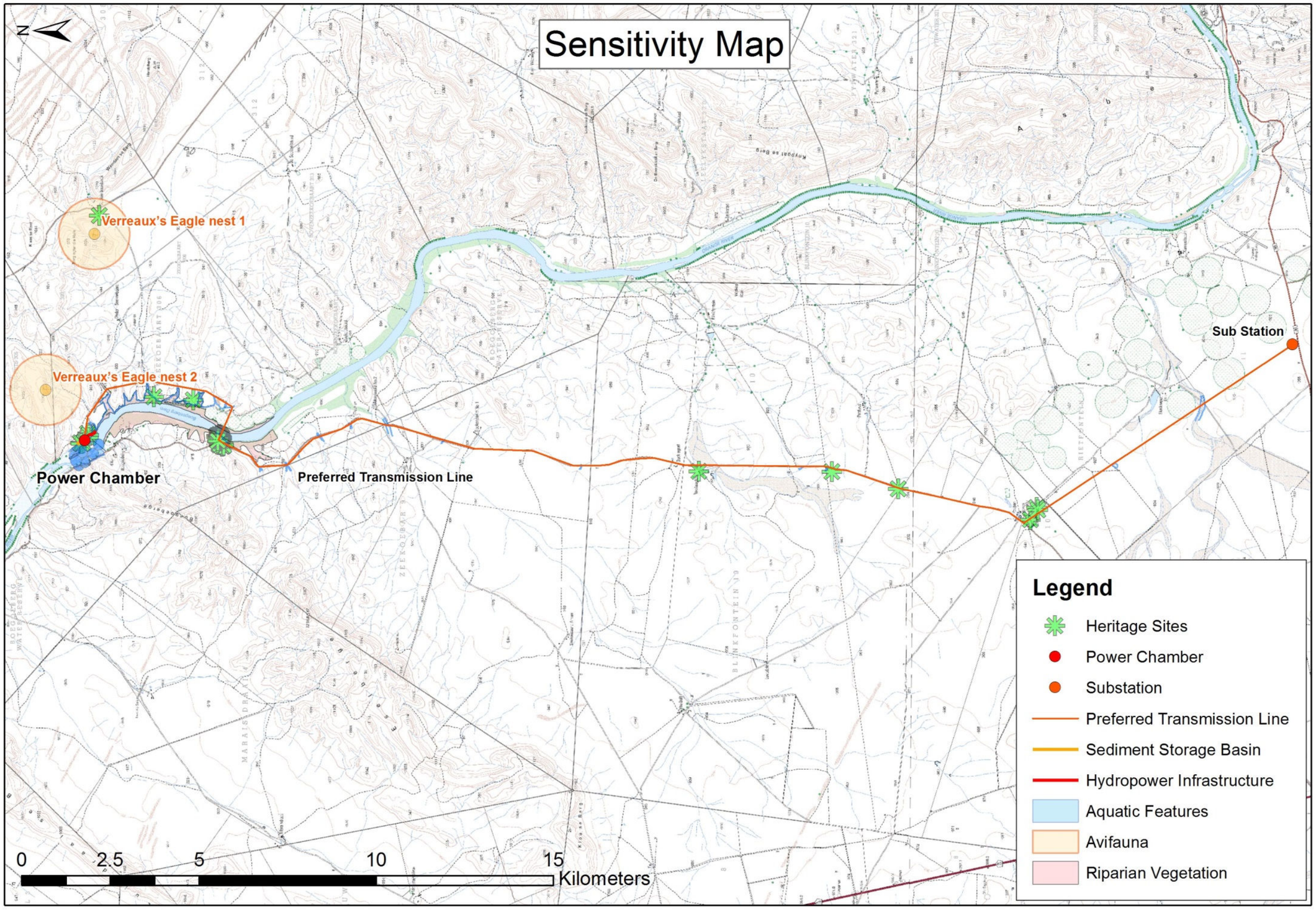

Figure 57 | Sensitive ecological areas and the proposed project (all components)

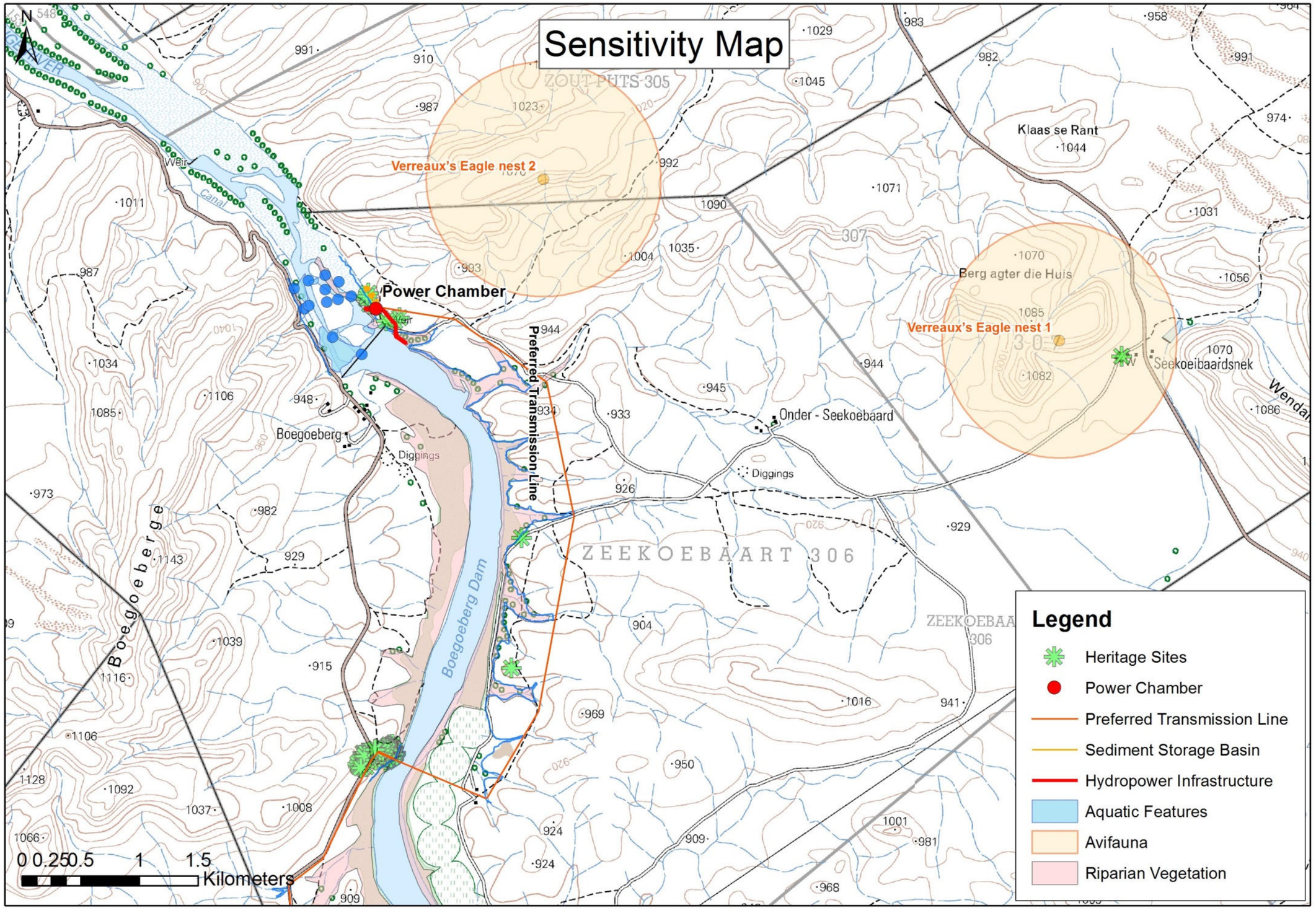

Figure 58 | Sensitive ecological areas and the proposed project (revised transmission)

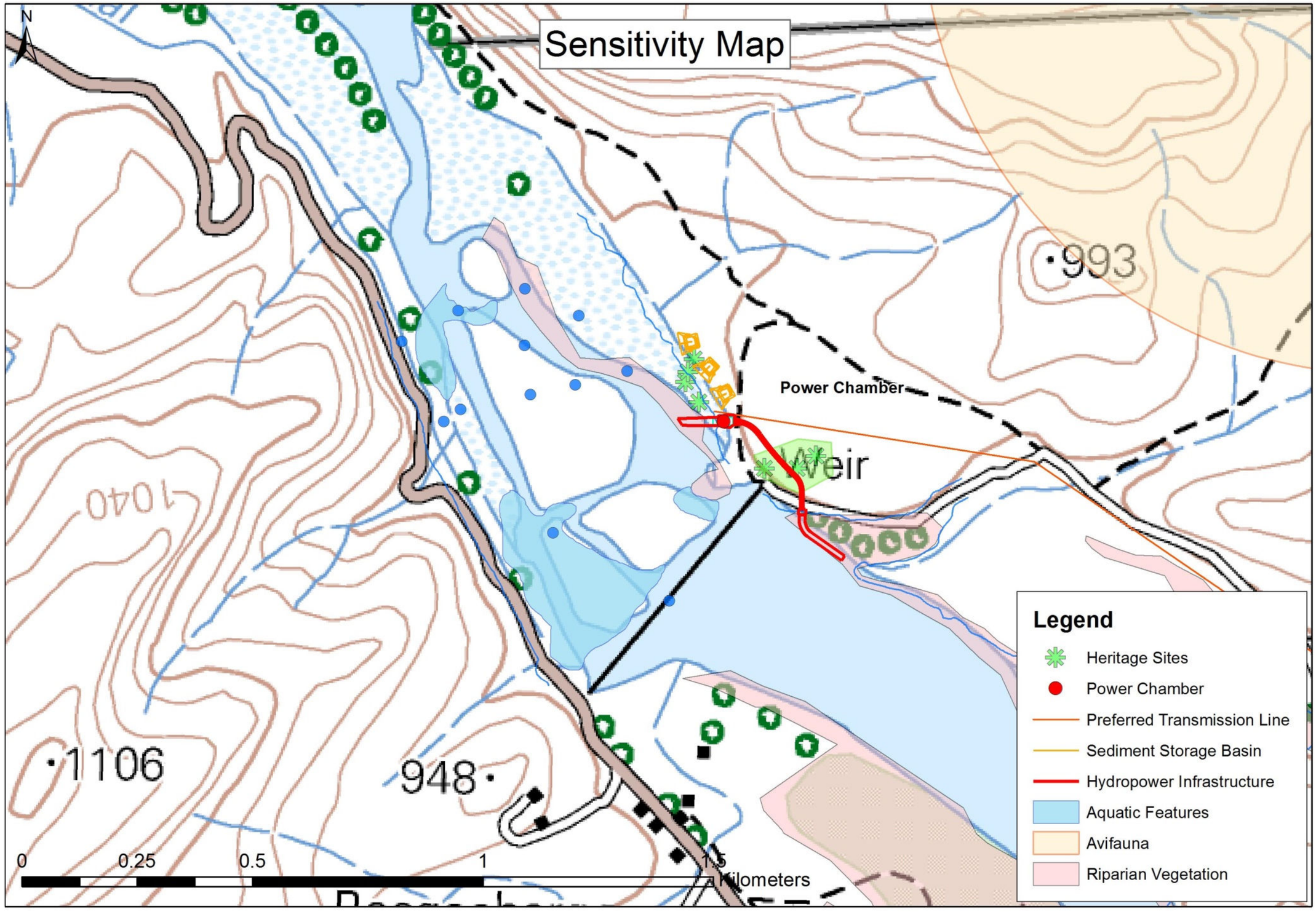

Figure 59 | Sensitive ecological areas and the proposed project (power chamber and associated infrastructure)

6.10 Considerations in identification of preferred alternatives

In order to identify the preferred alternative, the EAP evaluated all the recommendations and impact assessments determined by the respective specialists. Based on the specialist findings, it was evident that layout alternative 2 (namely, the tunnel option) was preferred, with the tunnel ultimately having a smaller footprint, which also takes environmentally sensitive areas into consideration. Therefore, based on the ratings provided by the specialists, the project could be authorised since the impacts are of an acceptable level. As for the transmission line alternatives and associated access roads which were assessed, the preferred route (revised alternative 2) was deemed acceptable by all specialists since it avoids identified sensitive riverine areas and, can, therefore be authorised (**Figure 57**, **Figure 58** and **Figure 59**).

6.11 EAP's opinion with respect to authorisation

Regulation 32(2)(m) of the EIA Regulations requires that the EAP includes an opinion as to whether the activity should be authorised or not.

Based on the outcome of this EIA, the EAP is of the opinion that the proposed hydropower project should be authorised as the incremental local and regional benefits outweigh negative impacts. The proposed project substantially meets the NEMA principles (**Table 4-2**) as well as the Need and Desirability criteria (**Table 4-3**). The significance of negative impacts can be reduced with effective and appropriate mitigation. If authorised, the implementation of an EMPr and its subsidiary management plans should be included as a Condition of Authorisation.

Based on the outcome of this EIA, the EAP is of the opinion that the following project alternatives are preferred and should be authorised:

- **Location alternatives**
  - Boegoeberg Dam, Farm 306 Zeekoebaart.
- **Activity alternatives**
  - Energy generation by means of a hydropower station.
- **Site layout alternatives**
  - Water conveyance by way of tunnel (preferred).
- **Routing Alternatives**
  - Transmission Route 2 (revised) (preferred route).
- **Technology alternatives**
  - Kaplan hydropower turbines.

6.12 Way Forward

The current phase of public participation comprising the public review of this Final EIR commenced on **17 March 2014** and I&APs are afforded 21-days to provide comments on this Final EIR, until **7 April 2014**. The Final EIR is to be lodged in the Groblershoop Public Library, Municipal buildings and on the Aurecon website, and I&APs will be notified of the availability of the report.

All comments received on the Final EIR will be forwarded to DEA for final decision-making and, therefore, the EAP will not collate the comments into a CRR nor will the EAP respond to comments.

Once the 21 day public review period has been completed, the Final EIR, including the CRRs (1, 2 and 3),will be submitted to DEA for review. DEA must, within 60 days, do one of the following:

- Accept the report;
- Notify the applicant that the report has been referred for specialist review;
- Request amendments to the report; or
- Reject the report if it does not materially comply with the regulations.

If the report is accepted, DEA must within 45 days:

(a) Grant authorisation in respect of all or part of the activity applied for; or

(b) Refuse authorisation in respect of all or part of the activity.

Once DEA issues their decision on the proposed project, all registered I&APs on the project database will be notified of the outcome of the decision within 12 calendar days of the date of the decision. I&APs will also be informed of the Appeal procedure.

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Unit/Office : Cape Town Delivery Centre **Date :** 17 March 2013