Botanical Assessment
for
Boegoeberg Hydro-power Project at Boegoeberg Dam on the Orange River, near Groblershoop, Northern Cape Province

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Prepared for Aurecon South Africa (Pty) Ltd

October 2013

National Legislation and Regulations governing this report

This is a 'specialist report' and is compiled in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended, and the Environmental Impact Assessment Regulations, 2010.

Appointment of Specialist

David J. McDonald of Bergwind Botanical Surveys & Tours CC was appointed by Aurecon South Africa (Pty) Ltd to provide specialist botanical consulting services for the assessment of the botanical attributes of the area at Zeekoebaart (Remainder of Farm No. 306 and Portion 1 of Farm No. 306) near Groblershoop Northern Cape Province, which would be the receiving environment of the proposed Boegoeberg Hydro-power Project. The consulting services comprise an assessment of potential impacts of the proposed project on the terrestrial flora and vegetation found in the designated study area.

Details of Specialist

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Expertise

Dr David J. McDonald:

- Qualifications: BSc. Hons. (Botany), MSc (Botany) and PhD (Botany);
- Botanical ecologist with over 30 years' experience in the field of Vegetation Science;
- Founded Bergwind Botanical Surveys & Tours CC in 2006;
- Has conducted over 300 specialist botanical / ecological studies;
- Has published numerous scientific papers and attended numerous conferences both nationally and internationally (details available on request).

Independence

The views expressed in the document are the objective, independent views of Dr McDonald and the survey was carried out under the aegis of, Bergwind Botanical Surveys and Tours CC. Neither Dr McDonald nor Bergwind Botanical Surveys and Tours CC have any business, personal, financial or other interest in the proposed development apart from fair remuneration for the work performed.

Conditions relating to this report

The content of this report is based on the author's best scientific and professional knowledge as well as available information. Bergwind Botanical Surveys & Tours CC, its staff and appointed associates, reserve the right to modify the report in any way deemed fit should new, relevant or previously unavailable or undisclosed information become known to the author from on-going research or further work in this field, or pertaining to this investigation

This report must not be altered or added to without the prior written consent of the author. This also refers to electronic copies of the report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

	(For official use only)
File Reference Number:	12/12/20/
NEAS Reference Number:	DEAT/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended and the Environmental Impact Assessment Regulations, 2010

PROJECT TITLE

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

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The independent specialist appointed in terms of the Regulations

I, **David Jury McDonald** , declare that

- I act as the independent botanical specialist in this application
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of section 24F of the Act.

Signature of the specialist:

Bergwind Botanical Surveys & Tours CC

Name of company (if applicable):

22 October 2013

Date:

CONTENTS

1. List of Acronyms & Glossary

Aurecon – Aurecon South Africa (Pty) Ltd, the lead consultant agency

DAFF – Department of Agriculture, Forestry and Fisheries

ECO – Environmental Control Officer

Boegoeberg Hydro - Boegoeberg Hydro Electric Power (Pty) Ltd ,, the project proponent

kV -- kilovolt

MW -- megawatt

NEMA -- National Environmental Management Act (No. 107 of 1998), as amended

2. Executive Summary

A botanical study and impact assessment was carried out at the farm Zeekoebaart 306 and the Boegoeberg Dam near Groblershoop, Northern Cape Province to determine the potential impact of a hydro-power scheme on the natural vegetation. The hydro-power project entails the construction and operation of a power-generating infrastructure including off-take and discharge facilities as well as power-evacuation power-lines.

The vegetation types in the study area are Lower Gariep Alluvial Vegetation, Lower Gariep Broken Veld and Bushmanland Arid Grassland. Lower Gariep Alluvial Vegetation is considered an Endangered type but it was found that the proposed project, with mitigation measures applied, would have a **Low negative** impact on this vegetation. Likewise, impacts of associated infrastructure such as power transmission lines would have a **Low negative** impact on Bushmanland Arid Grassland, the main vegetation type through which these transmission lines would extend. Lower Gariep Broken Veld would hardly be affected and since it is Least Threatened impacts would be **Low negative**.

Mitigation measures to rehabilitate areas disturbed by construction are proposed and should be carefully observed to maximize post-construction restoration of as much of the terrain impacted by construction as possible.

Particular emphasis is placed on minimizing loss or damage of *Boscia albitrunca* (Shepherds' Tree), a nationally protected plant species. Application for permission to the Department of Agriculture, Forestry & Fisheries to remove trees from the construction zone of the hydro-power plant would be required.

3. Introduction

Modern-day demands for electrical energy in southern Africa and the need to produce power from renewable sources point strongly to the need for development of hydro-electric power. Generation of hydro-power has been investigated at various locations in South Africa but there are relatively few locations where such installations are feasible or cost-effective. One of the sites considered acceptable from feasibility and cost perspectives is the proposed hydro-power site at Boegoeberg Dam near Groblershoop, Northern Cape Province.

Aurecon South Africa (Pty) Ltd (Aurecon) has been appointed to carry out the required environmental assessment process in terms of the National Environmental Management Act (No. 107 of 1998) (NEMA), as amended, on behalf of Boegoeberg Hydro Electric Power (Pty) Ltd (Boegoeberg Hydro), the proponent of the project. Bergwind Botanical Surveys & Tours CC was in turn commissioned by Aurecon to conduct a botanical baseline assessment of the area of the proposed Boegoeberg Hydro project and its associated infrastructure to determine the possible impacts on natural vegetation of the proposed off-take (abstraction) site, canal / pipeline route, power-house sites and transmission lines routes.

The botanical impact assessment takes careful note of the requirements and recommendations of CapeNature (Western Cape Province), Department of Environment Affairs and Nature Conservation, Northern Cape Province and the Botanical Society of South Africa for proactive assessment of biodiversity of sites where there is a proposed change of land use or potential impact (positive or negative) on natural vegetation. The study follows published guidelines for evaluating potential impacts on the natural vegetation in an area earmarked for some form of development (Brownlie 2005) as well as the documented guidelines for specialists in the Western Cape Province. Note is also taken of the Northern Cape Conservation Act, 2009 (Act No. 9 of 2009) and Regulations (2011).

4. Background

4.1 Project description

The proposed installation would be a run-of-river hydro-power scheme capable of producing a maximum of 11 MW of electrical power. Water would be abstracted from the Orange River approximately at Boegoeberg Dam and channeled via a pipe or canal through two or three power-generating turbines before being released back into the river system approximately 400 m downstream of the Boegoeberg Dam wall (weir). The main components of the scheme are:

- An off-take structure above the existing Boegoeberg weir to facilitate the abstraction of water;

- A temporary upstream and downstream caissons (cofferdams) to exclude water from the construction works;
- 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;
- 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) distribution line to evacuate the power to a nearby Fibre Substation;
- Sediment basins; and
- Access roads to the site.

Energy generated by the proposed hydropower station would be evacuated from the transformer yard via a proposed overhead transmission line of not more than 132 kilovolt (kV) capacity to the Eskom Fibre Substation from whence it would feed into the national grid. New gravel access roads of 4m in width would be constructed to follow the transmission servitude, where existing roads do not exist, for construction and maintenance purposes.

5. Terms of Reference

5.1 Impact Assessment

- Provide a broad description of the botanical characteristics of the site and surrounds;
- Identify and describe biodiversity patterns at community and ecosystem level (main vegetation type, plant communities in vicinity and threatened/ vulnerable ecosystems species), at species level (Red Data Book species, presence of alien species) and in terms of significant landscape features;
- Assess the potential direct and indirect and cumulative impacts resulting from the proposed development (including the canal / pipelines, power-house, transmission lines and associated infrastructure e.g. access roads), both on the footprint and the immediate surrounding area, during construction and operation;
- Comment on whether or not biodiversity processes would be affected by the proposed project, and if so, how these would be affected;
- A detailed description of appropriate mitigation measures that can be adopted to reduce negative impacts and improve positive impacts for each phase of the project, where required; and
- Consider any relevant guidelines and take cognisance of the Department of Environmental Affairs and Development Planning guideline: “Guideline for involving

biodiversity specialists in EIA processes" (Brownlie, 2005) as well as the requirements of the Botanical Society of South Africa (BotSoc) and CapeNature in developing an approach to the botanical investigation; and

- Assist in the assessment of the sustainability of the project, based on criteria contained in the draft scoping report.

5.2 EMPr

- Outline all measures to be undertaken to manage residual impacts (i.e. impacts that remain after optimisation of design and planning) for the construction, operation and decommissioning phases, with an indication of the following:
- Who should be responsible for implementation of all aspects of the EMPr
- Details of frequency of implementation of each measure
- Envisaged outcome of each action
- If applicable, provide a monitoring plan for the relevant aspects to indicate the following:
    - Aspects to be measured
    - Responsible person/body
    - Frequency of monitoring actions
    - Standards to be met
    - Reporting requirements

6. Approach to Study

The study area at Boegoeberg Dam was visited on 1 and 2 October 2013. The study area was traversed by vehicle and on foot and a Garmin ® GPSMap 62S was used to track the route and record selected waypoints (Appendix 1). Observations were made at the respective waypoints and recorded with a photographic record of the vegetation and selected plant species. Particular attention was given to the possibility of finding endemic and 'Red Data' species.

The recorded information forms the basis for assessing the botanical / habitat sensitivity of the study area to inform any imposition of constraints on the proposed hydro-electric infrastructure that could be dictated by sensitive habitat.

7. Assumptions & Limitations

The field work for the baseline assessment was carried out in spring when the study area was dry and most plants not in an active state of growth. The ideal time for a botanical survey would have been in autumn (March or April) at the time of the highest rainfall. However, the season of

survey is not viewed as a major limitation since adequate botanical data was collected, resulting in a moderate to high level of confidence in the conclusions drawn from the study.

8. Baseline Description

8.1 The Study Area

8.1.1 Locality

The study area is located alongside the Orange (Gariep) River on both the east and west sides of the Boegoeberg Dam which is in turn located 27 km south-east of Groblershoop in the !Kheis Local Municipality, ZF Mgcawu District Municipality (formerly Siyanda District Municipality) and Siyathemba District Municipality, Northern Cape Province (Figure 1).

Figure 1. Location of the Boegoeberg Dam (red square) in the Northern Cape Province, South Africa.

Three areas of focus have been identified (1) the site of the hydro-power infrastructure; (2) the route of the ± 40 km of the overhead power transmission lines from the Orange River crossing point to the Fibre Substation; (3) the route of the overhead transmission lines on the east side of the river from the transformer yard and switching station to a transformer near the Rugbreek Boerdery Farmstead and then across the Orange River to the west side. These areas differ in character so are described separately below.

8.1.1.1 Hydro-power infrastructure site

The hydro-power infrastructure is proposed to be constructed near to the Boegoeberg Dam wall or weir on the east side, on the farm on the farm Zeekoebaart (Remainder of Farm No. 306 and Portion 1 of Farm No. 306) (referred to henceforth as Zeekoebaart 306). The proposed location of the power-house is at S 29° 02' 19.63" E 22° 12' 06.87" (Figure 2). The construction for the hydro-power infrastructure would involve building either a canal or a pipeline which would affect the hill (Ongeluk Formation lava) on the east side of the dam wall which would either be excavated (for canal) or tunnelled (for pipeline).

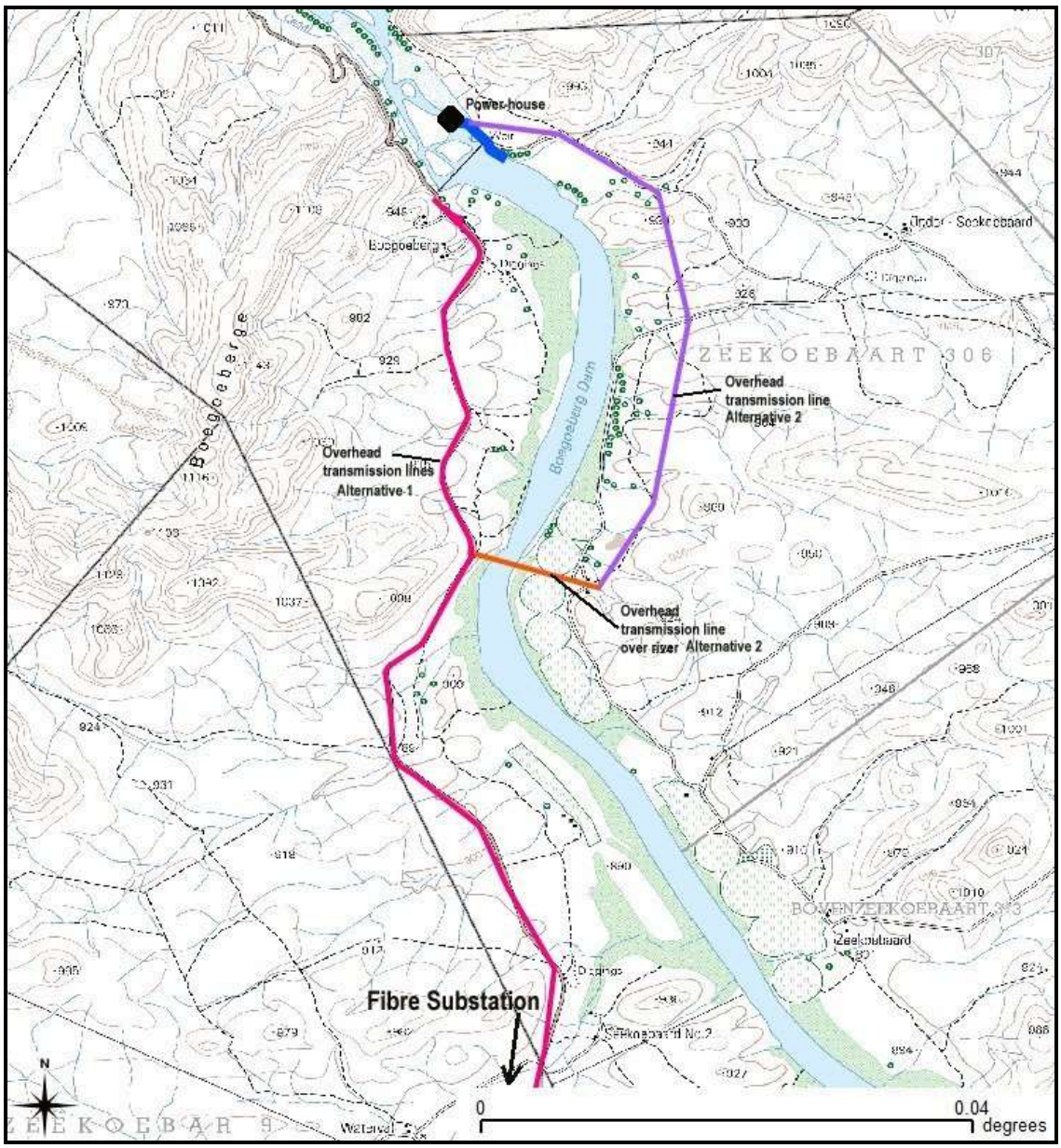


Figure 2. Portion of 1:50 000 Map Sheet 2922AA Boegoebergdam (Chief Directorate: National Geo-spatial Information) with the proposed Boegoeberg Hydropower infrastructure site indicated as a blue line with the power-house site shown as a black dot. The Alternative 1 evacuation transmission line route (section of) is shown as a red line and the Alternative 2 evacuation transmission line route is shown as mauve and orange lines on the east side and crossing the river.

8.1.1.2 Transmission line route: west side of the Orange River to Fibre Substation (Alternative 1)

The Alternative 1 proposed power evacuation transmission lines would be aligned on the west side of the Orange River following the road from Boegoeberg Dam i.e. from the vicinity of the dam wall to the entrance to the farm 'Greeffsput' and then along a farm road to the farm 'Skalksput' and thereafter to the Fibre Substation (Figure 2). The transmission lines would traverse the undulating landscape which has vegetation with little variation along the entire route.

8.1.1.3 Transmission line route: east side of the Orange River (Alternative 2)

The Alternative 2 proposal for evacuation of power from the generation point would be to align an overhead transmission line from the transformer yard on a route east of the Orange River and east of the areas normally flooded by high water (flood) levels to a transformer hub near the Rugbreek Boerdery Farmstead. This route would traverse undulating terrain with natural veld (see description below), completely avoiding the riparian zone. The power line would be approximately 5.4 km (Figure 2).

From the transformer near the Rugbreek Boerdery Farmstead an overhead transmission line would extend westwards across the agricultural fields and then across the Orange River to a point on the west bank (a distance of approximately 1.1 km) from which it would then follow the proposed transmission line route along the existing gravel road southwards to 'Greeffsput'.

8.1.2 Geology, Soils, Topography and Land Types

8.1.2.1 Geology

The geology of the Northern Cape is complex and contains parts of the Namaqua- Natal Metamorphic Province, Kheis Province and Kaapvaal Craton (Norman & Whitfield 2006; Cornell *et al.* 2006). The study area lies at the interface of the Kaaien Terrane and Kheis Province, at the south-western margin of the Kaapvaal Craton (Transvaal Supergroup) (Cornell *et al.* 2006). The stratigraphic units recognized are shown in Figure (3) with the strata found at the proposed hydro-power site being representative of the Olifantshoek Supergroup, Ongeluk Formation lava and Brulpan Group (Dabep Formation) (Moen, 2006). The transmission line route on the west side of the river would traverse zeolite and greenschist facies of the Marydale – Prieska granite-greenstone terrane (Robb *et al.* 2006).

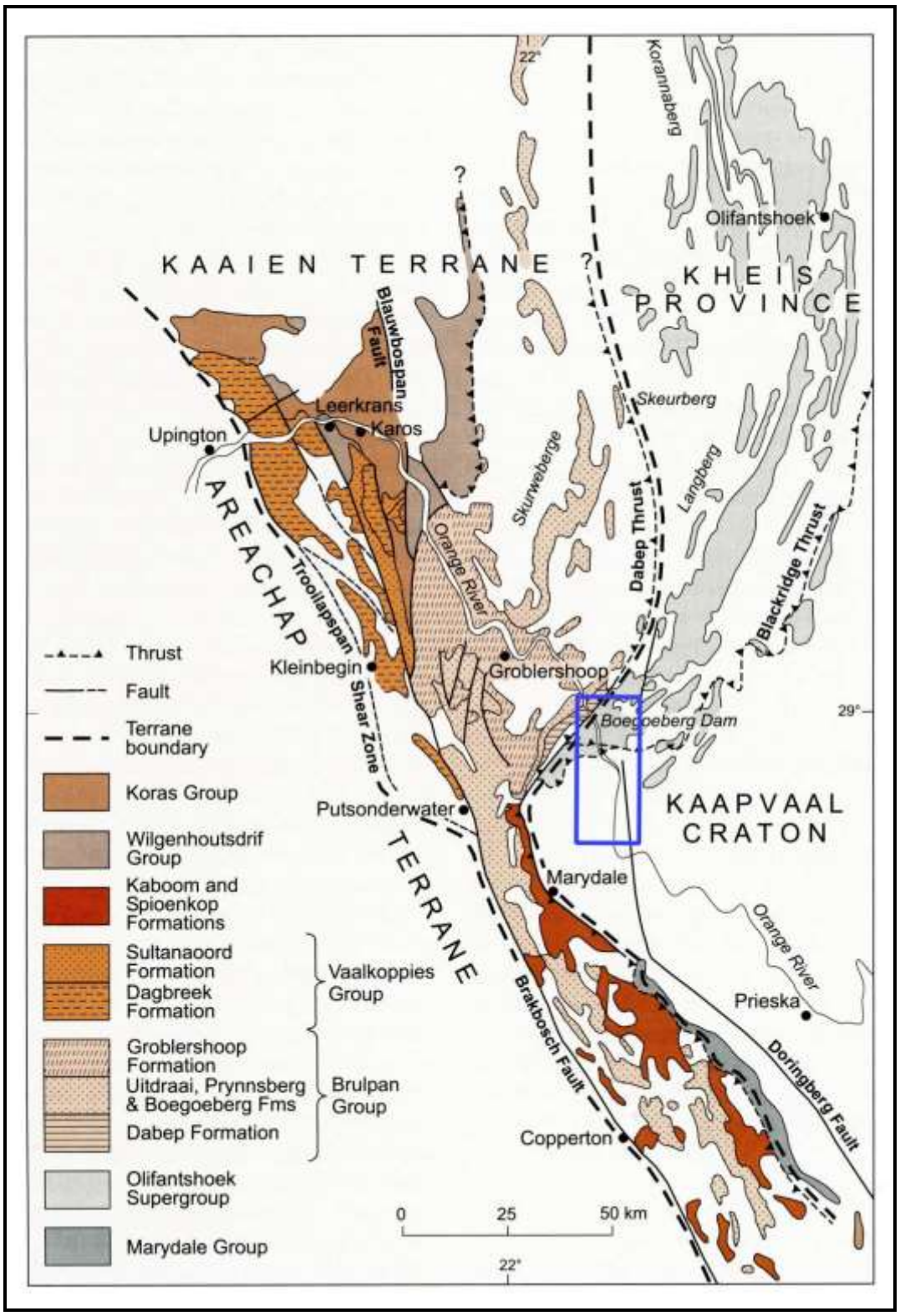


Figure 3. Stratigraphic geological map of part of the Northern Cape Province showing the study area outlined in blue (after Cornell *et al.* 2006)

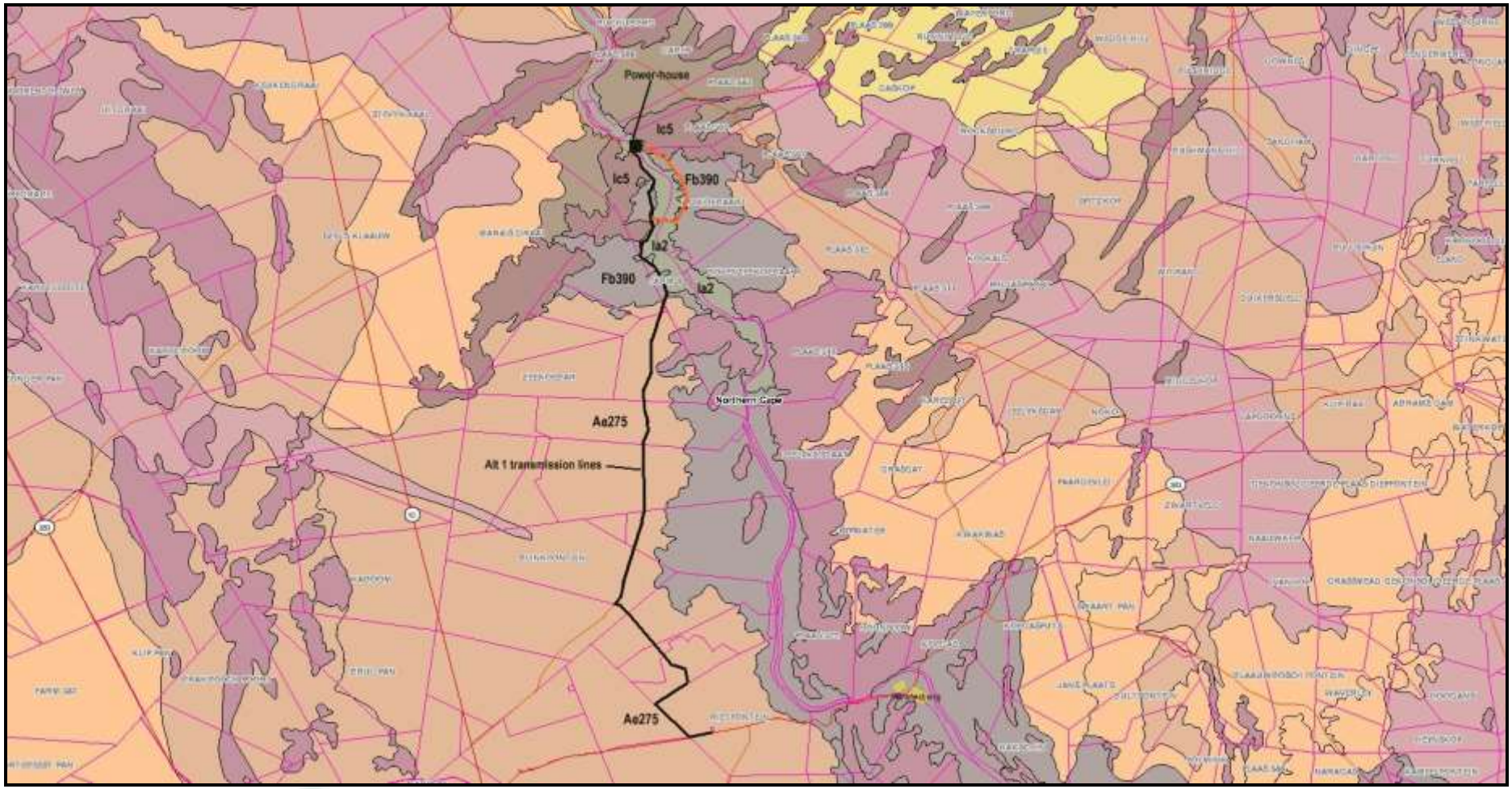


Figure 4. Land type map of the Boegoeberg study area with the Alternative 1 transmission line route shown as a black line and the Alternative 2 transmission line route shown as a red line. The land types traversed by the transmission lines and found at the site of the hydro-power project are Ae275, Fb390, Ia2 and Ic5 as described in the text. ,

8.1.2.2 Soils and Land Type of the Boegoeberg Hydro-power infrastructure site

Owing to the characteristics of the proposed hydro-power project and requirement for channeled water flow and adequate 'head', the infrastructure can only be contained in a limited area on the east side of the Boegoeberg Dam. The banks of the Orange River at Boegoeberg Dam consist of consolidated alluvial sediments over bedrock. This land type is **Ia2** indicating the Tertiary to Recent alluvial sediments of which the soil is composed. The power-house, below the weir, would also be constructed in an area of this land-type.

The canal or pipeline would mostly be aligned in an area of land type **Ic5** which indicates rocky terrain with little or no soil (Figure 4).

8.1.2.3 Soils and Land Type of the Alternative 1 Transmission line route

The first part of the Alternative 1 transmission line route would be through an area with land types **Ia2** (alluvial sediments), **Ic5** (rocky terrain with little or no soil) and **Fb390** (shallow rocky soils of the Glenrosa and Mispah forms with lime rare in the upland soils but generally present in low-lying soils) (Figure 4).

The second part and greater length of the Alternative 2 transmission line route would traverse an area dominated by the **Ae275** land type. The geology is described as 'andesite, dacite and tuff (Zeekoebaart Formation); Draghoender gneiss; Skalkseput granite; schist, quartzite and amphibolite (Dagbreek Formation); surface deposits of sand, alluvium and calcrete are common; sporadic sand dunes'. The soils are freely drained red and yellow apedal soils with red soils having a high base status and generally greater than 300 mm deep. No sand dunes are found (Land Type Survey Staff, 1972--2006) [Figure 4].

8.1.2.4 Soils and Land Type of the Alternative 2 Transmission line route

The Alternative 2 transmission line route would traverse a small area of rocky terrain near the power-house, classified as land type **Ic5**. It would then cross an area of undulating terrain with shallow rocky soils (land type FB390) to the Rugbreek Boerdery Farmstead. From there it would cross the cultivated alluvium alongside the Orange River (land type **Ia2**) before joining the Alternative 1 transmission line route on the west side of the river (Figure 4).

8.1.3 Climate

The study area falls within the Nama Karoo Biome and is in one of the most arid regions of South Africa. Long-term records indicate that rainfall is greatest between January and April with a distinct peak in March (autumn). Groblershoop, the nearest town with measured rainfall and temperatures has a mean annual rainfall of 108 mm (Figure 5), mean summer daytime temperature (December to February) of 37 °C and mean winter night temperature (June & July) of 4 °C (Figure 6). Climate diagrams for the two major vegetation types found in the study area, Lower Gariep Broken Veld (Figure 7a) and Bushmanland Arid Grassland (Figure 7bB) from Mucina *et al.* (2006) show that the soil moisture stress as a measure of aridity, is 85% and 86 % respectively. At no time during the year does water availability exceed evaporative demand and therefore a state of permanent drought exists.

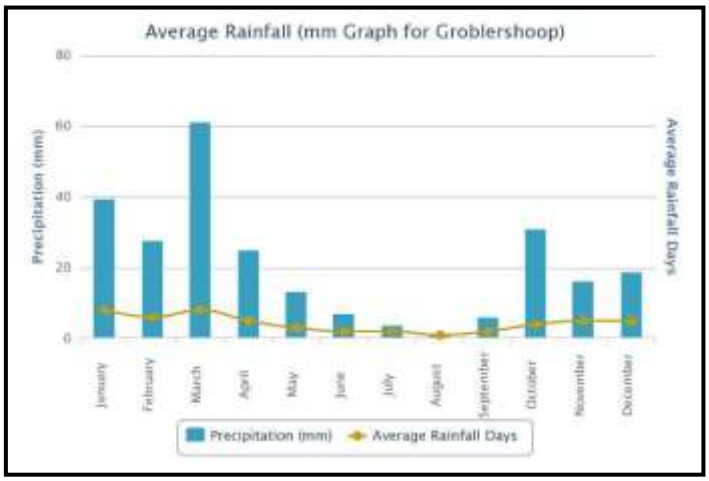


Figure 5. Mean monthly rainfall for Groblershoop (Source: www.worldweatheronline.com)

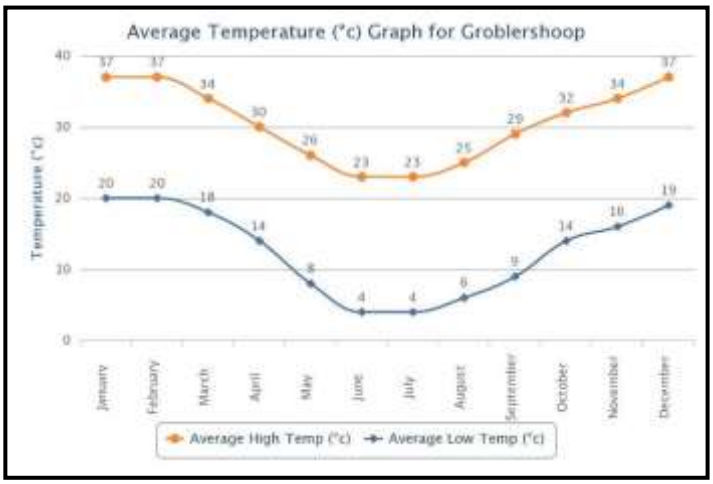
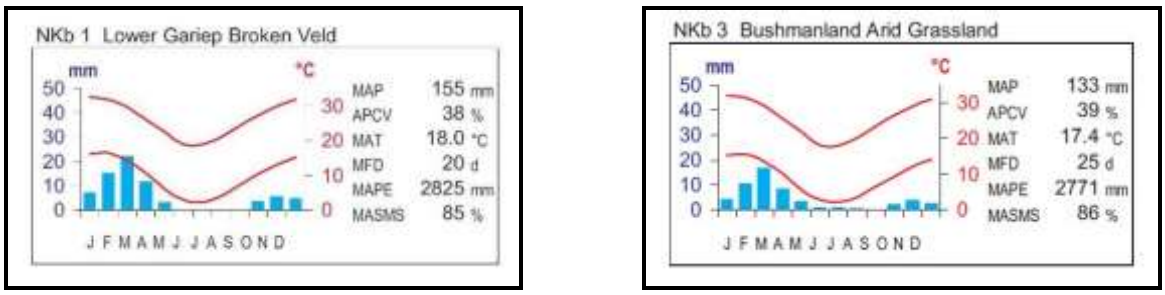


Figure 6. Mean monthly temperature for Groblershoop (Source: www.worldweatheronline.com)



6a 6b

Figure 6. Climate diagrams for Lower Gariep Broken Veld and Bushmanland Arid Grassland (from *Mucina et al*., 2006 in Rutherford & Mucina, 2006) showing MAP – Mean Annual Precipitation; ACPV = Annual Precipitation Coefficient of Variance; MAT = Mean Annual Temperature; MFD = Mean Frost Days; MAPE = Mean Annual Potential Evaporation; MASMA = Mean Annual Soil Moisture Stress.

8.2 Vegetation classification and Conservation Status

8.2.1 General Description

Farm Zeekoebaart 306, the Boegoeberg Dam area and the remaining properties over which the transmission lines would extend are all located within the Nama Karoo Biome, Bushmanland Bioregion (Rutherford & Westfall, 1994; Rutherford, Mucina & Powrie, 2006; Mucina *et al.*, 2006). 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.

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%).

8.2.1.1 Lower Gariep Alluvial Vegetation

As the name suggests Lower Gariep Alluvial Vegetation is found on recently deposited alluvial sediments along the Orange (Gariep) River. The development of this vegetation types depends on its location. In some places on the upper banks the vegetation forms dense thickets of thorn trees (*Vachellia karoo* and to a lesser extent *Vachellia erioloba*) with other species such as *Searsia pendulina, Ziziphus mucronata, Maerua gilgii* and *Lycium bosciifolium* also present. Other prominent trees are *Euclea pseudebenus* and *Tamarix usneoides*. The riverine thickets are often invaded by exotic mesquite (*Prosopis glandulosa* var. *glandulosa*) which forms dense, impenetrable, thorny thickets. In the main river channels and occasionally where water persists in the mainly dry side channels the dominant species is *Phragmites australis* which forms extensive reed-beds.

The reason for the loss of Lower Gariep Alluvial Vegetation in general is the intensive agriculture (mainly vineyards, citrus and lucerne) on the alluvial soils along the Orange (Gariep) River.

In the study area Lower Gariep Alluvial Vegetation is found at the proposed off-take or abstraction point for the Boegoeberg Hydro-power installation and lining the river banks along the Orange River on the east and west sides above and below the Boegoeberg weir (Figure 7). In the area of the proposed off-take or abstraction point the Lower Gariep Alluvial Vegetation is almost a monotypic stand of *Searsia pendulina*, with occasional occurrence of *Ziziphus mucronata*.

Figure 7. View southwards over Boegoeberg Dam showing Lower Gariep Alluvial Vegetation on both banks.

8.2.1.2 Lower Gariep Broken Veld

Lower Gariep Broken Veld has a disjunct distribution along the lower Orange River valley and is associated rugged ultrametamorphic koppies and inselbergs (the Hardeveld) interspersed with low plains, along the Orange (Gariep River) from Onseepkans to Augrabies in the west and from Boegoeberg to Prieska in the east including along a ridge west of Groblershoop from Karos in the north to Marydale in the south (Mucina *et al.* 2006 in Mucina & Rutherford, 2006). At Zeekoebaart 306 it is found on the hill immediately east of the Boegoeberg weir and on the hills and ridges making up the Boegoeberge on both side of the Orange River

The vegetation of the Lower Gariep Broken Veld is sparse, dominated by shrubs and dwarf shrubs with perennial grasses. Annual species are more prominent in spring. Tall *Aloe dichotoma* var. *dichotoma* is found as scattered isolated individuals or groups with the ubiquitous blackthorn or swarthaak (*Vachellia mellifera* subsp. *detinens*) being a prominent feature. *Euphorbia avasmontana* is also characteristic of this vegetation type (Figure 8). A list of important plant taxa is provided by Mucina *et al.* (2006).

Figure 8. Lower Gariep Broken Veld with the characteristic *Euphorbia avasmontana*.

8.2.1.3 Bushmanland Arid Grassland

Bushmanland Arid Grassland (Figure 9) is much more widespread than either of the other vegetation types which occur in the study area. It occurs over a wide expanse in the Northern Cape Province from the Bushmanland Basin in the south to the vicinity of the Orange River in the north and from Prieska in the east to Aggeneys in the west (Mucina *et al.* 2006). In the study area it interleaves with Lower Gariep Broken Veld and has numerous plant species in common with the latter type.

One of the striking differences between the Lower Gariep Broken Veld and Bushmanland Arid Grassland is the deeper yellow and red soils that support a relatively greater abundance of 'white grasses' (*Aristida* and *Stipagrostis species*) in the latter.

Figure 9. Bushmanland Arid Grassland with low trees of *Vachellia mellifera* subsp. *detinens*.

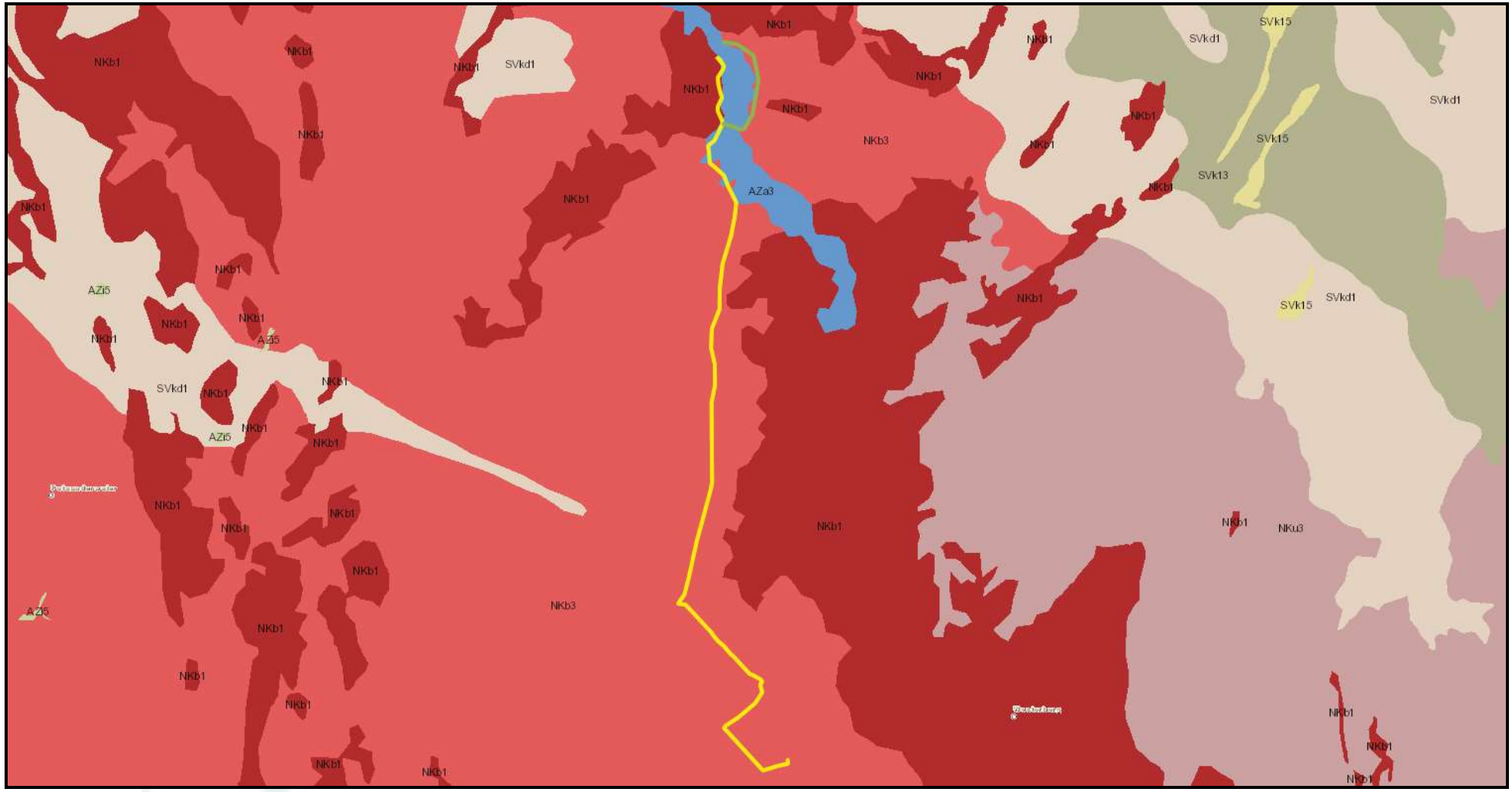


Figure 10. Portion of the national vegetation map (Mucina *et al.* 2005) with the transmission line routes (Alternative 1 = yellow; Alternative 2 = green 7 yellow) superimposed. The affected vegetation types are AZa3 – Lower Gariep Alluvial Vegetation (blue); NKb1 – Lower Gariep Broken Veld (dark red); NKb3 – Bushmanland Arid Grassland (light red).

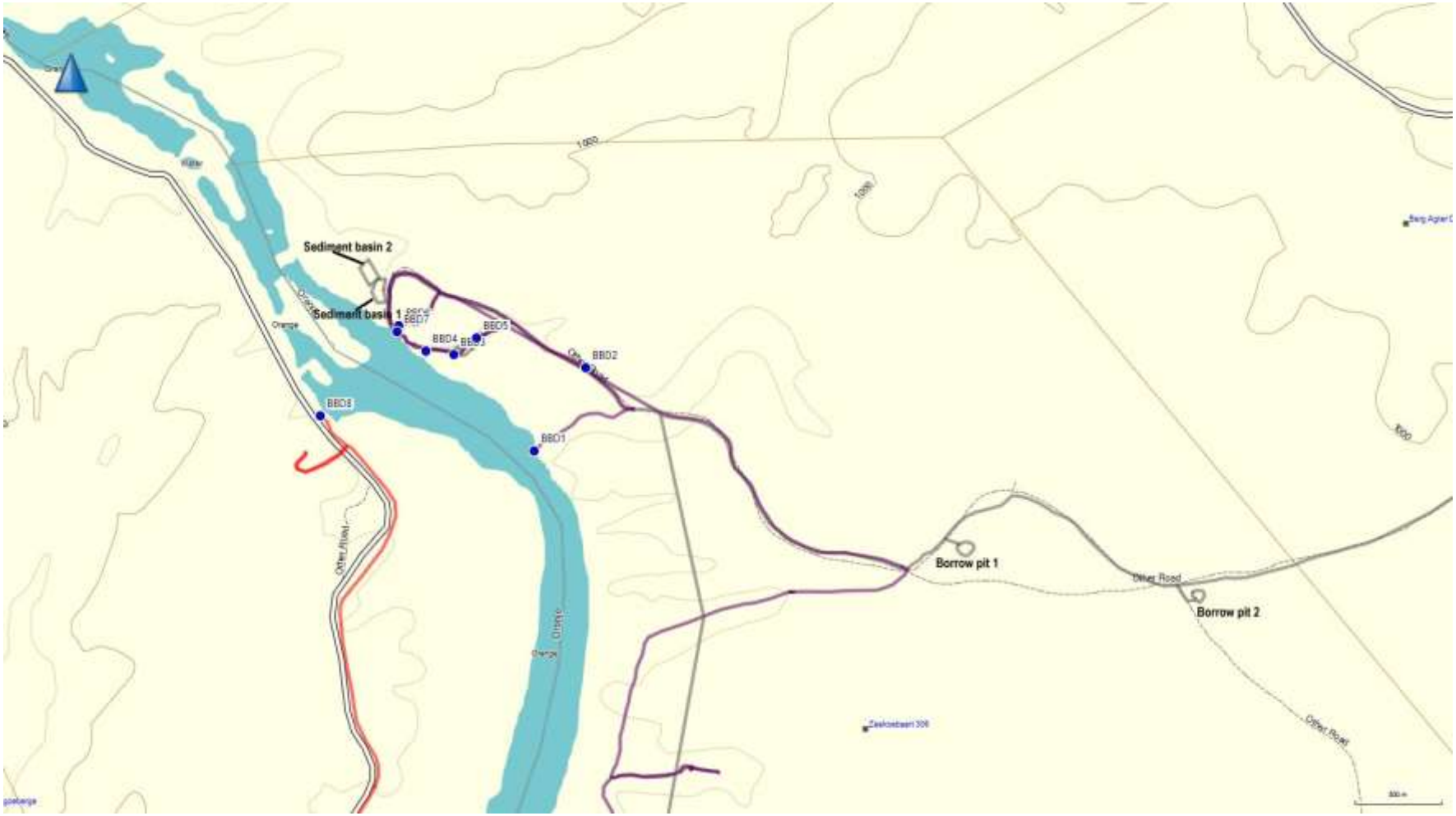


Figure 11a. Topographical map of the northern part of the Boegoeberg Hydro-power study area with botanical sample waypoints (BBD#) and sample tracks (Day 1 = dark magenta; Day 2 = red). Waypoint BBD5 highlighted is the site of the proposed construction camp. Borrow pits 1 & 2 are located along the entrance road and the sediment basins (1 & 2) close to the hydro-power plant.

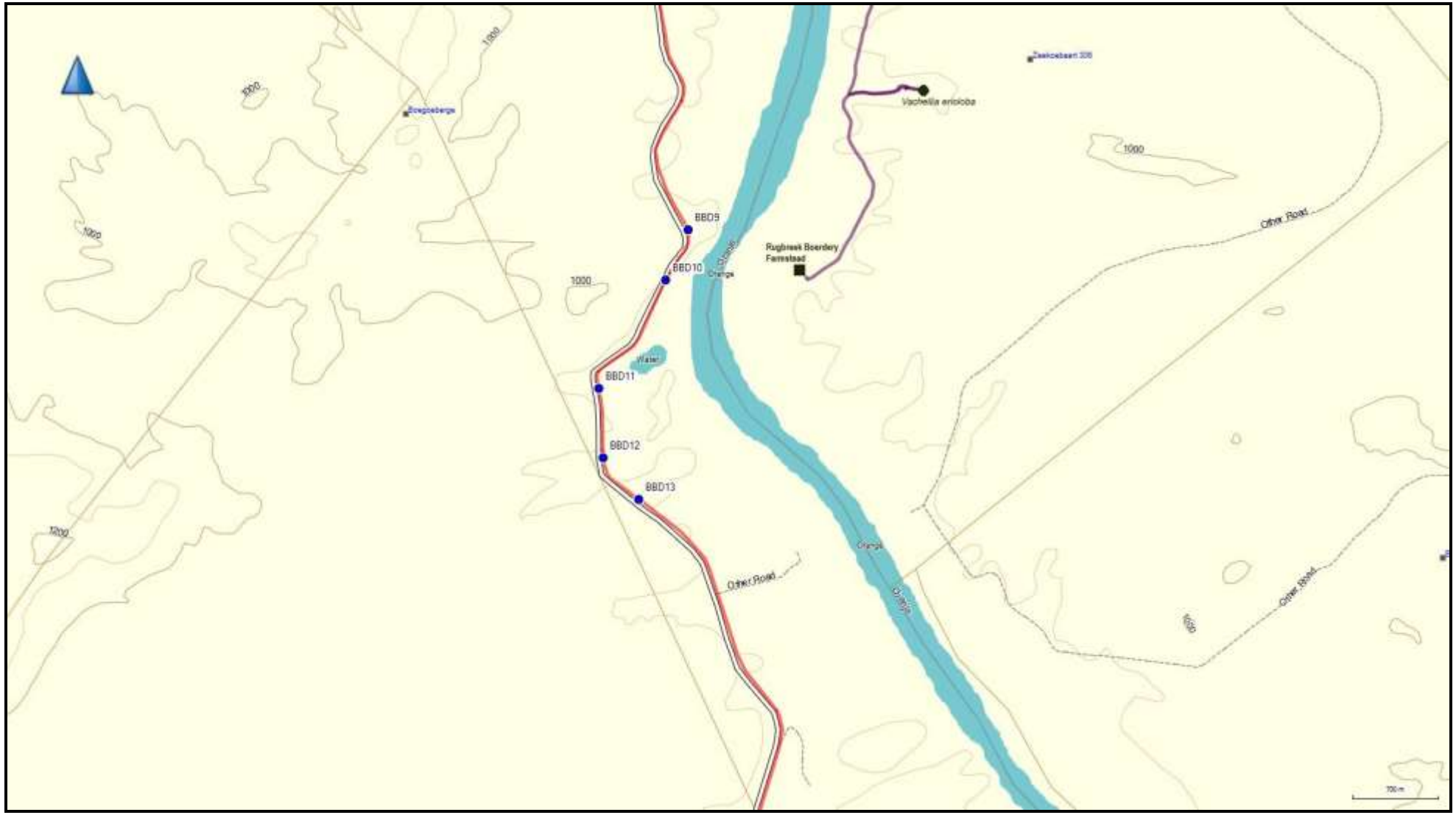


Figure 11b. Topographical map of the central part of the Boegoeberg Hydro-power study area with botanical sample waypoints (BBD#) and sample tracks (Day1 = dark magenta; Day 2 = red).

Figure 11c. Topographical map of the southern part of the Boegoeberg Hydro-power study area with botanical sample waypoints (BBD#) and sample track (Day 2 = red)

8.2.2 Vegetation affected by the proposed hydro-power project

8.2.2.1 Vegetation of the Boegoeberg Hydro-power infrastructure site

Only small areas of Lower Gariep Alluvial Vegetation and Lower Gariep Broken Veld would be affected by the Boegoeberg Hydro-power plant. The Lower Gariep Alluvial Vegetation is represented by only *Searsia pendulina* in the area of the 'off-take' to the hydro-power plant (waypoint BBD4) (Figure 12). *S. pendulina* is a common species with low botanical sensitivity. No other species with high conservation value such as *Euclea pseudebenus* (Cape ebony) or *Vachellia erioloba* (camel thorn tree) were found in the area. 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 (waypoint BBD3) (Figure 13). Once the construction is complete, these trees would coppice or re-sprout from the cut surfaces and they would not suffer any permanent damage. The access road to the construction site would follow an existing farm road which would require widening but this would not adversely affect any vegetation. It must be emphasized that impacts on (loss of) Lower Gariep Alluvial Vegetation would be minimal and **Low negative**.

Figure 12. *Searsia pendulina* lining the east bank of Boegoeberg Dam where the off-take structure would be located.

Figure 13. The access road though the resort presently on the east side of Boegoeberg Dam. The overhanging trees of *Ziziphus mucronata* and *Searsia pendulina* would need to be cut to give access to construction vehicles and equipment.

Figure 14. The east bank of Boegoeberg Dam close to the weir. This area which is covered with grass and not botanically sensitive would be excavated for the off-take canal (View southwards).

To allow for construction of the off-take canal or pipeline the side of the hill or koppie adjacent to the east side of the Boegoeberg weir would be excavated for building a canal (one alternative) or tunnelled (second and preferred alternative). If the canal option is pursued the vegetation on the west part of the koppie would be lost. Most of the vegetation is not sensitive, however, a number of *Boscia albitrunca* (Shepherd's tree; Witgatboom) trees (a protected species) (Alias, Milton, Herrmann & Seymour, 2003) would be lost depending on the construction method. It is estimated that in the order of eight (8) *B. albitrunca* trees would need to be removed, for which a permit would be required from the Department of Agriculture, Forestry & Fisheries (DAFF). A tree of *Ficus cordata* (Namaqua rock fig) growing on the west face of the koppie would also be lost, however, this species is not rare or protected. If the tunnel option is implemented the loss of vegetation would be greatly reduced.

Figure 15. View northwards over the Boegoeberg weir (mid-ground) with vegetated bank on the east side that would be excavated for the off-take canal.

Figure 16. Part of the koppie immediately east of the Boegoeberg weir.

Figure 17. The DWA access road alongside the koppie at the Boegoeberg weir. Note the small *Ficus cordata* (Namaqua Rock Fig) on the rock face in the mid-ground.

Figure 18. The Boegoeberg weir with DWA access track and koppie on the east side. The small green tree amongst the rocks is *Boscia albitrunca*.

Figure 19. View northwards from the summit of the koppie on the north side of Boegoeberg Dam. The reaches of the Orange River below the dam are seen with the proposed power-house, transformer yard, switch-room to be located approximately in the position indicated by the black arrow.

8.2.2.2 Vegetation of the Alternative 1 Transmission Line route

The Alternative 1 transmission line route was originally proposed to cross the Orange River below the Boegoeberg weir. It would then have continued for a short distance (approximately 3.5 km) through rocky terrain with Lower Gariep Broken Veld, touching marginally on Lower Gariep Alluvial Vegetation at one point. Alternative 1 has been found to not be feasible so has fallen away. From the point where the Alternative 2 transmission line route would meet the original Alternative 1 route (at S 29° 04’ 24.95” E 22° 12’ 07.5”) (Figure 20) for the entire remainder of the common route to the Fibre Sub-station, the transmission lines would pass through Bushmanland Arid Grassland.

Figure 20. View from the gravel road on the west side of Boegoeberg Dam, looking eastwards over the Orange River along the existing Eskom power-line route to Rugbreek Boerdery at Zeekoebaart 306 on the east side of the river.

A transmission line servitude (Eskom) exists on the west side of the gravel road for 3.17 km southwards before its crosses the road at S 29° 05’ 48.77” E 22° 12’ 13.25”. The servitude is kept clear of tall shrubs and low trees such as *Vachellia mellifera* subsp. *detinens* (Figure 21).

However, where *Boscia albitrunca* trees are found they have been left untouched (Figure 22). The Bushmanland Arid Grassland has low botanical sensitivity apart from the presence of protected *B. albitrunca* trees. It would be prudent to construct the proposed new transmission line in the same servitude on the west side of the road to the point where it crosses, to minimize further clearing of low trees. A new servitude would be required (west of the road) from S 29° 05' 48.77" E 22° 12' 13.25" to the entrance to Greeffsput. It would require that all *B. albitrunca* trees should not be removed or damaged. However, since the density of these trees is not great, it should be possible with little or no difficulty to avoid them.

Figure 21. The Eskom transmission lines on the west side of the gravel road from Boegoeberg Dam (west) southwards. Note how the servitude has been cleared of tall shrubs and small trees, notable *Vachellia mellifera* subsp. *detinens* (blackthorn; swarthaak).

Figure 22. The Eskom power-line with old *Boscia albitrunca* tree in the foreground. These trees must be avoided since they are protected.

8.2.2.3 Vegetation of the Alternative 2 Transmission Line route

At the transformer yard and where the transmission line would cross the river from Rugbreek Boerdery the vegetation is Lower Gariep Alluvial Vegetation. Impacts on this vegetation type would be minimal because the overhead lines would be spanned over the vegetation. The major

part of the route from the transformer yard to Rugbreek Boerdery on the farm Zeekoebaart 306 would pass through Bushmanland Arid Grassland. It could be purposefully aligned to follow the existing farm road (Figure 23) which would also be the access road to the power-house site, obviating the need for an additional road for construction and maintenance of the transmission line. *Boscia albitrunca* trees are found in the vegetation along this route (Figure 24) but, as described above, they can and should be avoided by construction activities. The route should also be aligned so as to avoid the seasonal watercourses and 'inlets' or 'washes' of the Orange River with reed beds (*Phragmites australis*) which are inundated during floods (Figure 25).

Figure 23. Gravel farm road on Zeekoebaart 306 which would provide access to the Boegoeberg Hydro-power project site. This is also the proposed route for the Alternative 2 transmission line which would traverse Bushmanland Arid Grassland vegetation.

Figure 24. Bushmanland Arid Grassland on rocky soils along the Alternative 2 transmission line route. The majority of small trees are *Vachellia mellifera* subsp. *detinens.*

Figure 25. Inlet or 'wash' of the Orange River which is inundated at times of flooding. The vegetation is dominated by common reed (*Phragmites australis*).

9. Description of Alternatives

Numerous alternatives have been described in the draft scoping report such as technical alternatives which have little bearing on impacts on vegetation and flora. The most important alternatives regarding vegetation are the hydro-power site and associated construction area, access roads and transmission line alternatives.

9.1 Site alternatives

Owing to the design requirements of the Boegoeberg Hydro-power plant, only one site alternative is possible i.e. the location on the east side of the Boegoeberg weir as shown in Figure 26.

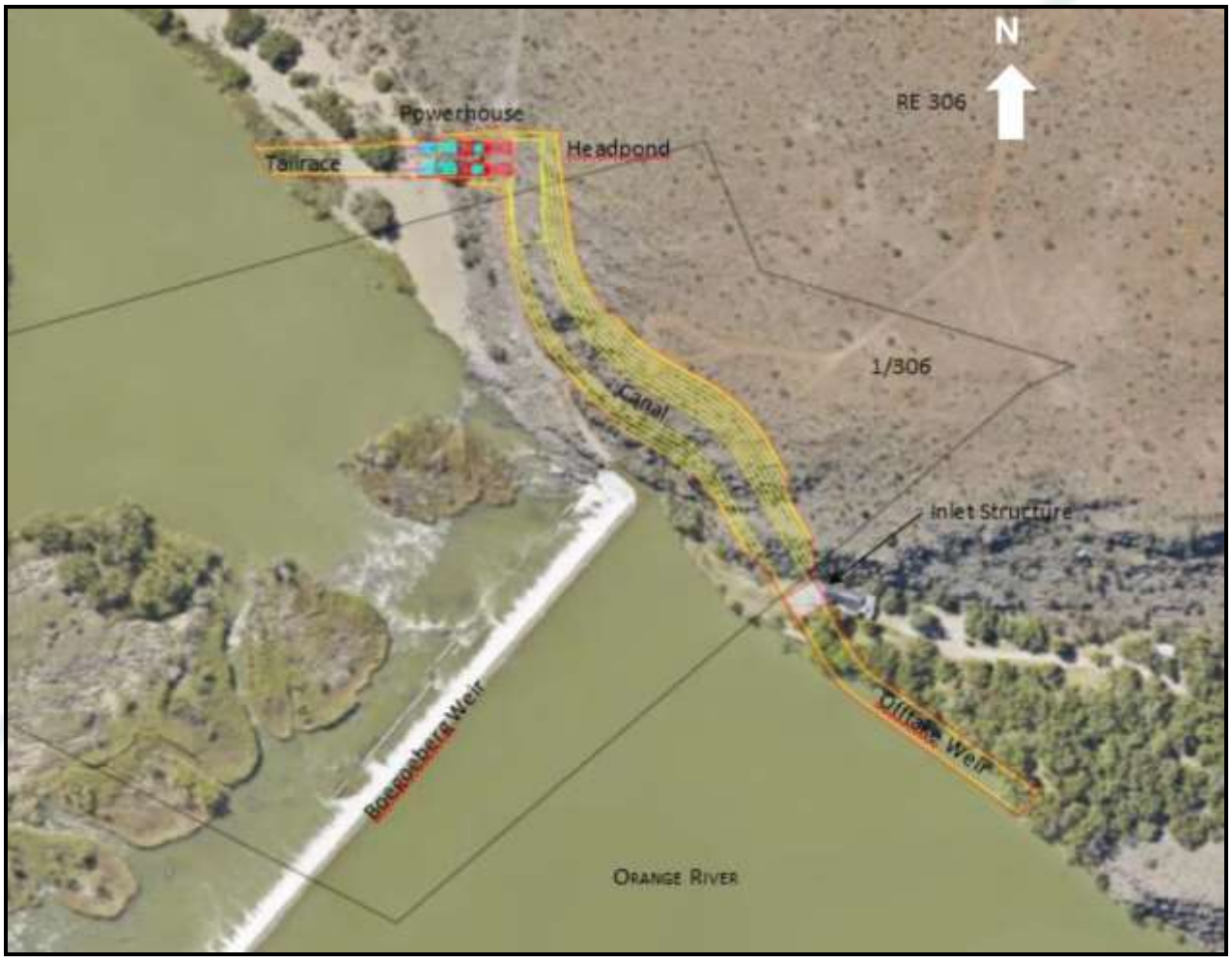


Figure 26. Aerial view of the proposed hydro-power infrastructure at Boegoeberg Dam on the farm Zeekoebaart 306 (Source: Boegoeberg Hydro-Power Final Scoping Report, Aurecon)

9.1.1 Water Conveyance Route

Water would be conveyed either by canal (Alternative 1) or by tunnel (Alternative 2, preferred) from the off-take to the head-pond. The tunnel would consist of two approximately 7.5 m wide by 9.0 m high concrete-lined tunnels of approximately 300 m in length. There would be considerable disturbance of vegetation using either of these methods but it would be localized. If the canal alternative is pursued the alignment would be cleared for a width of 30 – 40 m inclusive of the construction zone. This would virtually remove the koppie on the east side of the Boegoeberg weir.

9.1.2 Tailrace

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

9.1.3 Construction camp

A construction camp with site office, crusher etc. and temporary accommodation for personnel would be located at a site indicated by waypoint BBD5 [S 29° 2'25.44" E 22°12'26.77") [Figure 11a]. The latter site is already disturbed (Figure 27) and is an ideal site for the proposed temporary construction camp.

Figure 27. The proposed site for the construction camp which is already impacted by disturbance from agricultural activities.

9.2 Access road alternatives

Farm roads are well-defined at Zeekoebaart 306 and apart from the requirement for the road to be widened, no further road-building would be necessary to allow for access of construction

vehicles etc. Therefore only one access road alternative is proposed i.e. use of existing farms roads with upgrading where required.

9.3 Transmission line alternatives

Two transmission line alternatives were originally proposed:

- Alternative 1 would extend from the Boegoeberg Hydro-power transformer yard and switching station across the Orange River below the Boegoeberg weir to the west side. From there it would follow the gravel for a distance of 27.5 km to the entrance to Greeffsput, after which it would be aligned along farm roads for a distance of 12.8 km via Skalksput to the Fibre Substation. The first section i.e. where the transmission line would cross the river below the Boegoeberg Weir is not feasible thus is not being pursued.

- Alternative 2, which would give greater management flexibility, would extend from the Boegoeberg Hydro-power transformer yard and switching station along the farms roads of Zeekoebaart 306 on the east side of the hills flanking the Orange River to the Rugbreek Boerdery Farmstead. From this point it would extend over the Orange River to meet the Alternative 1 route at approximately 3.5 km along its length. From that point to the Fibre Sub-station the Alternative 1 and Alternative 2 routes would be the same.

9.4 Borrow pits

Two borrow pits are proposed. They would be extensions of two existing borrow pits on the farm Zeekoebaart 306 (Figure 11a). These borrow pits are in close proximity to seasonal watercourses.

9.5 Silt basins

Two silt basins for the deposition of dredged silt are proposed on the alluvial plain to the north-east of the Boegoeberg Weir and north of the proposed hydro-plant (Figure 11a). These silt basins would receive silt dredged from behind the Boegoeberg Weir which would be necessary to ensure continuous adequate flow of water through the hydro-plant. The silt basins would be constructed to allow the escape of water to dehydrate the silt which would then be commercially used.

10. Impact Assessment

The impacts of the respective elements of the Boegoeberg Hydro-power project as they pertain to influencing vegetation and flora are given in Table 1.

Owing to the nature of the project but limited areal extent there will be **High negative** impacts caused by the construction of the hydro-power plant and associated infrastructure (apart from the transmission lines) if the Alternative 1 option i.e. the canal is built. Mitigation of impacts of this alternative would not be simple since the landscape would be dramatically changed. Some remedial re-vegetation could be possible but this would take a long time and would result in **Medium negative** impacts after mitigation.

Construction of a tunnel would have lower negative impacts on the vegetation and flora since it would be underground and would affect vegetation on the surface much less than the canal option. The impact would be **Medium negative** which, with careful implementation and mitigation, could be reduced to **Low negative**.

Roads to access both the construction site for the hydro-power 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 negative** impacts a before and after mitigation.

Establishment of the construction camp, although in an already disturbed area, would be likely to have **Medium negative** impacts. These impacts could be mitigated and limited by strict adherence to ‘No Go’ zones outside the construction camp. This could lower the impact to **Low negative**.

The proposed Alternative 1 transmission line route (now considered as not feasible) would have had roughly equal impact as far as vegetation and flora are concerned as the Alternative 2 route which is being pursued. The vegetation types through which they would be aligned would not be adversely affected and the impact before mitigation is rated as **Low negative**. The most important mitigation measure would be to ensure no damage to *Boscia albitrunca* trees.

The impact of disposal of spoil material is not assessed here since there is presently no clarity as to where the spoil material could be disposed apart from possible use for the roads and possibly for revetments to protect local agricultural fields from flooding.

The two borrow pits envisaged would be extensions of the borrow pits on the farm Zeekoebaart 306. These borrow pits are located in Bushmanland Arid Grassland and the vegetation has low sensitivity. However, they are in close proximity to watercourses so measures would have to be taken to prevent disturbance of the watercourses either through impeding water flow or increasing silt-load in the watercourse in runoff water from the borrow pits. Overall the impact of the borrow pits would be **Low negative**.

Table 1. Assessment of impacts of the various elements of the Boegoeberg Hydro-power Project.

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
Construction phase	Boegoeberg Hydro-power Plant Layout 1 (preferred)	1. Off-take weir and tunnel. 2. Turbine chamber , head-pond, tailrace.	Local	Medium	Long-term	Medium negative	Low negative	Definite	Certain	Irreversible
	Boegoeberg Hydro-power Plant Layout 2	1. Off-take weir and canal. 2. Turbine chamber, head-pond, tailrace	Local	Medium	Long term	High negative	Medium negative	Definite	Certain	Irreversible
	Roads	Widening and upgrading	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Construction camp	Establishment of construction camp and crusher	Local	Medium	Short term	Medium negative	Low negative	Definite	Certain	Reversible
	Transmission Route 2	Construction of lines	Regional	Medium	Long term	Medium negative	Low negative	Definite	Certain	Reversible
	Borrow Pit 1	Removal of gravel	Local	Low	Short-term	Low negative	Low negative	Definite	Certain	Irreversible
	Borrow Pit 2	Removal of gravel	Local	Low	Short-term	Low negative	Low negative	Definite	Certain	Irreversible
	Silt depot 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Silt depot 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Boegoeberg Hydro-power Plant Layout 1 (preferred)	1. Off-take weir and canal Turbine chamber, head-pond, tailrace.	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
Operational phase	Boegoeberg Hydro-power Plant Layout 2	1. Off-take weir and tunnel. 2. Turbine chamber, head-pond, tailrace	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Roads	Widening and upgrading	Local	Low	Long term	Low negative	Low negative	Definite		Irreversible
	Construction camp	Use of construction camp and crusher	Local	Low	Short term	Low negative	Low negative			Irreversible
	Transmission Route 2	Maintenance of lines	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Borrow Pit 1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Borrow Pit 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Silt basin 1	Deposition of silt	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	Reversible
	Silt basin 2	Deposition of silt	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	Reversible

	Project	Key impacts	Extent	Magnitude	Duration	SIGNIFICANCE (Without mitigation)	SIGNIFICANCE (With Mitigation)	Probability	Confidence	Reversibility
	Boegoeberg Hydro-power Plant Layout 1 (preferred)	1. Off-take weir and tunnel 2. Turbine chamber, tailrace.	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
	Boegoeberg Hydro-power Plant Layout 2	1. Off-take weir and canal. 2. Turbine chamber, head-pond, tailrace	Local	Low	Long term	Low negative	Low negative	Definite	Certain	Irreversible
Decommissioning phase	Construction camp	Removal of construction camp and crusher.	Local	Low	Short term	Low negative	Low negative	Definite	Definite	Reversible
	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	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Transmission Route 2	Removal of lines	Regional	Low	Long term	Low negative	Low negative	Definite	Certain	Reversible
	Borrow Pit 1	Restoration of vegetation	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Borrow Pit 2	Restoration of vegetation	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Silt basin 1	Removal of silt basin	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
	Silt basin 2	Removal of silt basin	Local	Low	Long-term	Low negative	Low negative	Definite	Certain	N/A
No Go	No construction of hydro-power plant	N/A	Regional	Low	Long-term	Low negative	Low negative	Definite	Definite	N/A
	No construction of hydro-power plant	N/A	Regional	Low	Long-term	Low negative	Low negative	Definite	Definite	N/A

11. Mitigation measures

The construction of the Boegoeberg hydro-power infrastructure will involve considerable earthworks and substantial damage to the koppie and its vegetation immediately east of the Boegoeberg weir. Limited mitigation could be implemented to offset the likely damage so the best that could be achieved would be to re-vegetate disturbed areas as much as possible. There is, however, one definite drawback and that is the aridity of the environment and the slow rate of growth of woody plant species. This should be taken into account. It would therefore be necessary to actively water areas to enhance plant growth once the disturbance has terminated.

Actions prior to 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.

General steps for post-construction vegetation rehabilitation are as follows:

- 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 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 depth of at least 100 mm on the surface of disturbed areas.
- Spread chipped organic material over the topsoil as a mulch to enhance water-holding capacity of the soil.
- The areas being rehabilitated should be watered areas twice a week for two to three months 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.

Monitoring of re-vegetation

- The progress of vegetation re-habilitation should be monitored reported on a monthly basis for four to six months post-construction. Measurable targets should be determined by a restoration practitioner give the characteristic of the local environment.
- Any alien invasive vegetation such as *Prosopis glandulosa* (mesquite) that appears in disturbed areas or near the hydro-power site, particularly along the banks of the Orange River, should be removed and destroyed.

12. Environmental Management Programme

12.1 Environmental Control Officer (ECO)

A qualified Environmental Control Officer should be appointed to implement and manage the Environmental Management Programme (EMPr). That person should be well-appraised of the nature of the vegetation found within the scope of the project.

12.2 Responsibilities of the ECO: Construction Phase

The ECO should, inter alia, be responsible for the following:

(1) Ensuring that despite the vegetation being generally of low sensitivity, no unnecessary damage is caused to any vegetation.
(2) That areas outside the site construction area and construction camp designated as 'No Go' areas are observed.
(3) Monitoring the use of roads to ensure that no driving off roads into surrounding veld is permitted. Any such activity should result in fines and appropriate remedial action to repair any damage.
(4) Monitoring roads for run-off and erosion into the adjacent veld in the event of heavy rain. Any negative impact such as erosion should be reported and remedial action taken.
(5) Any alien plants such as *Prosopis glandulosus* (mesquite) that could be stimulated by disturbance should be identified and action taken to remove and destroy these plants (see above under mitigation measures).

12.3 Responsibilities of the ECO: Post-construction Phase

In the post-construction phase the ECO would be responsible for ensuring that the construction zone of the hydro-power plant and construction camp are left in a state that would permit the natural vegetation to naturally re-colonize.

(1) Soil should be flattened and graded, i.e. no heaps of soil or piles of rock to be left.
(2) No deep ruts or channels to be left.
(3) 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.
(4) Attend to all recommended mitigation measures concerning vegetation and vegetation rehabilitation.

13. Recommendations

- Application for removal of Boscia albitrunca (Shepherds' Tree) would be required.
- No provincially protected plant species were noted in the study which are likely to be damaged or removed. However, as a precautionary measure it is recommended that the Department of Environment Affairs and Nature Conservation, Northern Cape, should be well appraised of the project. This department should be given the opportunity to inspect the hydro-power site at an early stage prior to construction to ensure that if any permits are required they can be timeously obtained.
- The mitigation measures outline above should be carefully observed to ensure that disturbance caused by the project is ameliorated as far as possible in the post-construction phase. It is extremely important that post-construction 'clean-up' is meticulously carried out to return all areas to as near-natural as possible.

14. Conclusions

The vegetation in the construction zone of the Boegoeberg Hydro-power plant is Lower Gariep Alluvial Vegetation and Bushmanland Arid Grassland and to a limited extent Lower Gariep Broken Veld. The Lower Gariep Alluvial Vegetation (Endangered) will not be greatly affected and no important (protected) tree species in this vegetation would be impacted. A number of *Boscia albitrunca* (protected) trees would be destroyed by the construction of the off-take canal and permission from DAFF would be required to remove these trees.

The transmission lines would traverse Bushmanland Arid Grassland with **Low negative** impact. However, it is cautioned that *Boscia albitrunca* trees also occur as scattered individuals throughout this vegetation. They can and should be avoided when transmission line poles are erected.

No Red List Species (Raimondo *et al.* 2009) were found in the survey and the chances of the project affecting such species are low to very low.

Overall impact will be **Medium** to **Low negative, if the tunnel option is implemented**. The largest impact will be at the hydro-power site with the transmission lines likely to have a **Low negative** impact. Mitigation measures should be carefully applied, particularly in the post-construction phase. Such measures would reduce the **Medium negative** impact of the hydro-power plant from **Medium negative** to **Low negative**.

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Report submitted October 2013; amended and updated 26 November 2013

Appendix 1.

Table 1. Botanical sample waypoints in the Boegoeberg Hydro-power Project study area.

Waypoint	Latitude	Longitude	Vegetation type	Sensitivity at waypoint
BBD1	S 29 02 46.3	E 22 12 38.2	Lower Gariep Alluvial Vegetation	Low
BBD2	S 29 02 31.0	E 22 12 48.4	Bushmanland Arid Grassland	Low
BBD3	S 29 02 28.5	E 22 12 22.1	Lower Gariep Alluvial Vegetation	Medium
BBD4	S 29 02 28.0	E 22 12 16.6	Lower Gariep Alluvial Vegetation	Medium
BBD5	S 29 02 25.4	E 22 12 26.8	Bushmanland Arid Grassland	Low
BBD6	S 29 02 23.3	E 22 12 11.1	Transitional between Bushmanland Arid Grassland Lower Gariep Broken Veld	Medium
BBD7	S 29 02 24.4	E 22 12 10.9	Transitional between Bushmanland Arid Grassland Lower Gariep Broken Veld	Medium
BBD8	S 29 02 39.9	E 22 11 55.6	Lower Gariep Broken Veld	Low
BBD9	S 29 04 22.1	E 22 12 08.4	Bushmanland Arid Grassland	Low
BBD10	S 29 04 35.3	E 22 12 02.0	Bushmanland Arid Grassland	Low
BBD11	S 29 05 03.4	E 22 11 43.4	Bushmanland Arid Grassland	Low
BBD12	S 29 05 21.6	E 22 11 44.4	Bushmanland Arid Grassland	Low
BBD13	S 29 05 32.5	E 22 11 54.4	Bushmanland Arid Grassland	Low
BBD14	S 29 06 57.1	E 22 12 28.1	Bushmanland Arid Grassland	Low
BBD15	S 29 07 18.6	E 22 12 22.9	Bushmanland Arid Grassland	Low
BBD16	S 29 12 28.0	E 22 11 49.0	Bushmanland Arid Grassland	Low
BBD17	S 29 14 44.2	E 22 11 28.9	Bushmanland Arid Grassland	Low
BBD18	S 29 16 46.9	E 22 11 02.9	Bushmanland Arid Grassland	Low
BBD19	S 29 19 32.3	E 22 12 48.5	Bushmanland Arid Grassland	Low
BBD20	S 29 20 53.2	E 22 13 10.6	Bushmanland Arid Grassland	Low
BBD21	S 29 20 51.2	E 22 14 03.4	Bushmanland Arid Grassland	Low

Appendix 2.

CURRICULUM VITAE

Dr David Jury McDonald Pr.Sci.Nat.

Name of Firm: Bergwind Botanical Surveys & Tours CC. (Independent consultant)

Work and Home Address: 14 A Thomson Road, Claremont, 7708

Tel: (021) 671-4056 **Mobile:** 082-8764051 **Fax:** 086-517-3806

E-mail: dave@bergwind.co.za

Website: www.bergwind.co.za

Profession: Botanist / Vegetation Ecologist / Consultant / Tour Guide

Date of Birth: 7 August 1956

Employment history:

- 19 years with National Botanical Institute (now SA National Biodiversity Institute) as researcher in vegetation ecology.
- Five years as Deputy Director / Director Botanical & Communication Programmes of the Botanical Society of South Africa
- Seven years as private independent Botanical Specialist consultant (Bergwind Botanical Surveys & Tours CC)

Nationality: South African (ID No. 560807 5018 080)

Languages: English (home language) – speak, read and write
Afrikaans – speak, read and write

Membership in Professional Societies:

- South Africa Association of Botanists
- International Association for Impact Assessment (SA)South African Council for Natural Scientific Professions (Ecological Science, **Registration No. 400094/06**)
- Field Guides Association of Southern Africa

Key Qualifications :

- Qualified with a M. Sc. (1983) in Botany and a PhD in Botany (Vegetation Ecology) (1995) at the University of Cape Town.
- Research in Cape fynbos ecosystems and more specifically mountain ecosystems.
- From 1995 to 2000 managed the Vegetation Map of South Africa Project (National Botanical Institute)
- Conducted botanical survey work for AfriDev Consultants for the Mohale and Katse Dam projects in Lesotho from 1995 to 2002. A large component of this work was the analysis of data collected by teams of botanists.

- **Director: Botanical & Communication Programmes** of the Botanical Society of South Africa (2000—2005), responsible for communications and publications; involved with conservation advocacy particularly with respect to impacts of development on centres of plant endemism.

- Further tasks involved the day-to-day management of a large non-profit environmental organisation.

- **Independent botanical consultant** (2005 – to present) over 300 projects have been completed related to environmental impact assessments in the Western, Southern, Northern and Eastern Cape, Karoo, Gauteng, Limpopo and Lesotho. A list of reports (or selected reports for scrutiny) is available on request.

Higher Education

Degrees obtained
and major subjects passed:

B.Sc. (1977), University of Natal, Pietermaritzburg
Botany III
Entomology II (Third-year course)

B.Sc. Hons. (1978) University of Natal, Pietermaritzburg
Botany (Ecology /Physiology)

M.Sc - (Botany), University of Cape Town, 1983.
Thesis title: 'The vegetation of Swartboschkloof, Jonkershoek, Cape Province'.

PhD (Botany), University of Cape Town, 1995.
Thesis title: 'Phytogeography endemism and diversity of the fynbos of the southern Langeberg'.

Certificate of Tourism: Guiding (Culture: Local)
Level: 4 Code: TGC7 (Registered Tour Guide: WC 2969).

Employment Record:

January 2006 – present: Independent specialist botanical consultant and tour guide in own company:
Bergwind Botanical Surveys & Tours CC
August 2000 - 2005 : Deputy Director, later Director Botanical & Communication Programmes, Botanical Society of South Africa
January 1981 – July 2000 : Research Scientist (Vegetation Ecology) at National Botanical Institute
January 1979—Dec 1980 : National Military Service

Further information is available on my company website: www.bergwind.co.za