

**Freshwater Assessment for the Proposed Strengthening of National Route 27
Section 7 & 8 between the Western/Northern Cape Border and Calvinia**

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Executive Summary

The South African National Roads Agency Limited (SANRAL) is proposing to strengthen and partially reconstruct certain structures on the R27 between the Western / Northern Cape border and Calvinia. The proposed project comprises of upgrading of the approximately 73-km road section by strengthening the existing layers and limited widening of the road; widening of three bridges and the possible widening or reconstruction of some of the major culverts; and the development of a number of borrow areas for the sourcing of road-building material and crushed aggregates. Water is also required for construction purposes.

The Oorlogskloof River is in a moderately modified ecological state, with low ecological importance and sensitivity. The expected impacts of the proposed activities are likely to be of a very low significance and limited to the already disturbed area surrounding the existing road and bridges, as well as the borrow pits and quarries. They are also likely to mostly occur while construction activities are taking place. Provided that the following recommended mitigation measures are implemented the significance of the impact is expected negligible:

- *Construction activities taking place within the river channel and riparian zone should be limited as far as possible to ensure minimum disturbance of this area. Disturbed areas within the riparian zones should be rehabilitated as soon as possible after construction has been completed and revegetated with suitable indigenous riparian vegetation.*
- *Construction should preferably take place during the low flow period.*
- *All rubble and waste material resulting from the construction activities should be removed from the river and drainage channels.*
- *Invasive alien plants should be removed from the riparian zone of the disturbed areas.*
- *Runoff from the construction sites should be prevented from entering the stream but should rather be diverted through screens and off-channel retention ponds.*
- *All materials on the construction sites should be properly stored and contained.*
- *Disposal of waste from the sites should also be properly managed.*
- *Construction workers should be given ablution facilities at the construction sites that are located away from the river system and regularly serviced.*
- *Stockpiled material at the quarries and borrow pits must be removed from the drainage/stream channel and the sites rehabilitated after material has been removed.*

The only proposed activity of concern is the proposed abstraction of water from the Doring River for Construction purposes. Due to the conservation and tourism value of the Doring River downstream of the proposed abstraction site, it is recommended that an alternative water source be found. A water use authorization application will need to be submitted to the Department of Water Affairs Western Cape Regional Office for approval of the water use aspects of the proposed activities, and in particular the proposed construction activities associated with the upgrade of the bridges.

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Annexure A: Details of Specialist and Declaration of Interest

1. BACKGROUND

The South African National Roads Agency Limited (SANRAL) is proposing to strengthen and partially reconstruct certain structures on the R27 between the Western / Northern Cape border and Calvinia (Figure 1). The proposed project comprises of upgrading of the approximately 73-km road section by strengthening the existing layers and limited widening of the road; widening of three bridges and the possible widening or reconstruction of some of the major culverts; and the development of a number of borrow areas for the sourcing of road-building material and crushed aggregates. Water is also required for construction purposes.

CCA Environmental (Pty) Ltd (CCA) has been appointed by Aurecon (Pty) Ltd, the engineering consultant for the proposed project, on behalf of the SANRAL, to act as the independent environmental consultant to undertake the necessary Basic Assessment process and associated public consultation process for the proposed project. This report is to inform the freshwater component of the Basic Assessment process.



Figure 1. Aerial view of the R27 between Nieuwoudtville and Calvinia with the Oorlogskloof River (Google Earth, 2011)

2. TERMS OF REFERENCE

The following general Terms of Reference apply to this Specialist Study:

- Include the completed form entitled “Details of specialist and declaration of interest” as required by the Department of Environmental Affairs (DEA), together with a short CV indicating qualifications and experience, in the specialist report.

- Review previous work done in the area and describe the baseline conditions that exist in the study area.
- Provide a full assessment report on any sensitive areas identified in the road reserve as well as the seven borrow pit sites and four bridge sites.
- Provide a brief outline of the approach used in the study. Assumptions, sources of information and the difficulties with predictive models must also be clearly stated.
- If applicable, provide a brief description of any consultation process that was undertaken, as well as a brief description and copies of any comments that were received during any consultation process.
- Identify and assess potential impacts of the construction, operational and closure/decommissioning phases, as relevant in the case of each site. To ensure that specialists use a common standard, the determination of the significance of the assessed impacts will be undertaken in accordance with CCA's Convention for Assigning Significance Ratings to Impacts. A table template for reporting on impact assessment is provided in Attachment C for use in assessment reports.
- Identify feasible ways in which impacts could be mitigated and benefits enhanced giving an indication of the likely effectiveness of such mitigation and how these could be implemented in the construction and management of the proposed development.
- Identify and assess any cumulative impacts arising from the proposed project.
- Identify and list all legislation and permit requirements that are relevant to the development proposal in the specific field of expertise, and provide guidance for compliance with any relevant legislation.
- Indicate the reliability of information utilised in the assessment of impacts, as well as any constraints to which the assessment was subjected (e.g. any areas of insufficient information or uncertainty).
- Indicate whether any of these areas of insufficient information or uncertainty associated with the specialist study would impact on the decision whether or not to authorise the proposed project.
- Comply with guidelines on specialist study requirements for EIA provided by the Department of Environmental Affairs (DEA) and the Department of Environmental Affairs and Development Planning (DEA&DP) of the Western Cape Province², as well as the requirements listed in Sections 17 and 32(2) of the EIA Regulations 2010 dated 18 June 2010 promulgated in terms of Chapter 5 of NEMA.

The specific Terms of Reference for the freshwater ecosystem assessment are as follows:

- Provide a broad, baseline description of the freshwater systems (including rivers, watercourses and wetlands) of the study area, placing it in a regional context.
- Provide specific information relating to the freshwater systems on each borrow pit and bridge site, with reference to locations of special concern and their conservation status and/or ecological importance, which can be used as baseline information for the assessment of potential impacts of the proposed project.
- Provide guidance on any special standards prescribed by the Department of Water Affairs (DWA) or any other authority in relation to the freshwater systems included in this study.

- Identify, describe and assess the impacts of the proposed activities and any activity alternatives on freshwater ecosystems.
- Recommend appropriate, practicable mitigation measures that will reduce all major (significant) impacts or enhance potential benefits, if any.
- Advise on the appropriate procedure(s) and format(s) to be followed in relation to a Water Use Licence (WUL) Application for Section 21 (a), (c) and (i) water uses (taking water from a water resource; impeding or diverting the flow of water in a watercourse; and altering the bed, banks, course or characteristics of a watercourse) as required for the proposed project.
- Compile the documentation required for a Water Use Licence (WUL) Application for submission to the relevant authority.

3. APPROACH TO THE STUDY AND STUDY LIMITATIONS AND ASSUMPTIONS

Input into this report was informed by a combination of desktop assessments of existing freshwater ecosystem information for the study area and catchment, as well as by a more detailed assessment of the freshwater features along the section of the road to be upgraded and at the bridge sites. The river health assessment was carried out using South African Department of Water Affairs developed methodologies. River Health assessments were carried out to provide information on the ecological condition and ecological importance and sensitivity of the river systems to be impacted.

The site was visited in April 2011. During the field visit, the characterisation, mapping and integrity assessments of the freshwater features were assessed. This information/data was used to inform the potential impact of the proposed activities as well as the recommended mitigation measures.

Limitations and uncertainties often exist within the various techniques adopted to assess the condition of ecosystems. The following limitations apply to the techniques and methodology utilized to undertake this study:

- Analysis of the freshwater ecosystems was undertaken according to nationally developed methodologies and was undertaken at a rapid level which was considered a suitable level of evaluation for this freshwater impact assessment.
- Recommendations are made with respect to the adoption of buffer zones for the proposed activities, based on river and wetland ecosystem functioning and site characteristics. These recommendations are based on professional opinion due to the lack of a formal methodology for buffer zone determination within South Africa.

4. USE OF THIS REPORT

This report reflects the professional judgment of its author. The full and unedited content of this should be presented to the client. Any summary of these findings should only be produced in consultation with the author.

5. OVERVIEW OF THE PROPOSAL

5.1. Overview of the Study Area

The study area lies between the Northern/Western Provincial Border in the Vanrhyns Pass and Calvinia (Figure 2). The area lies on the Onder-Bokkeveld Plateau along the wide Oorlogskloof River Valley. The area consists largely of natural and open areas with some livestock farming and the towns of Nieuwoudtville and Calvinia. Approximately 70 kilometers of the R27 regional road was considered that included four bridges over the Oorlogskloof River. Seven existing borrow pits and six possible water sources for the construction activities were also considered that were situated a short distance north and south of the R27 road (Figure 3).

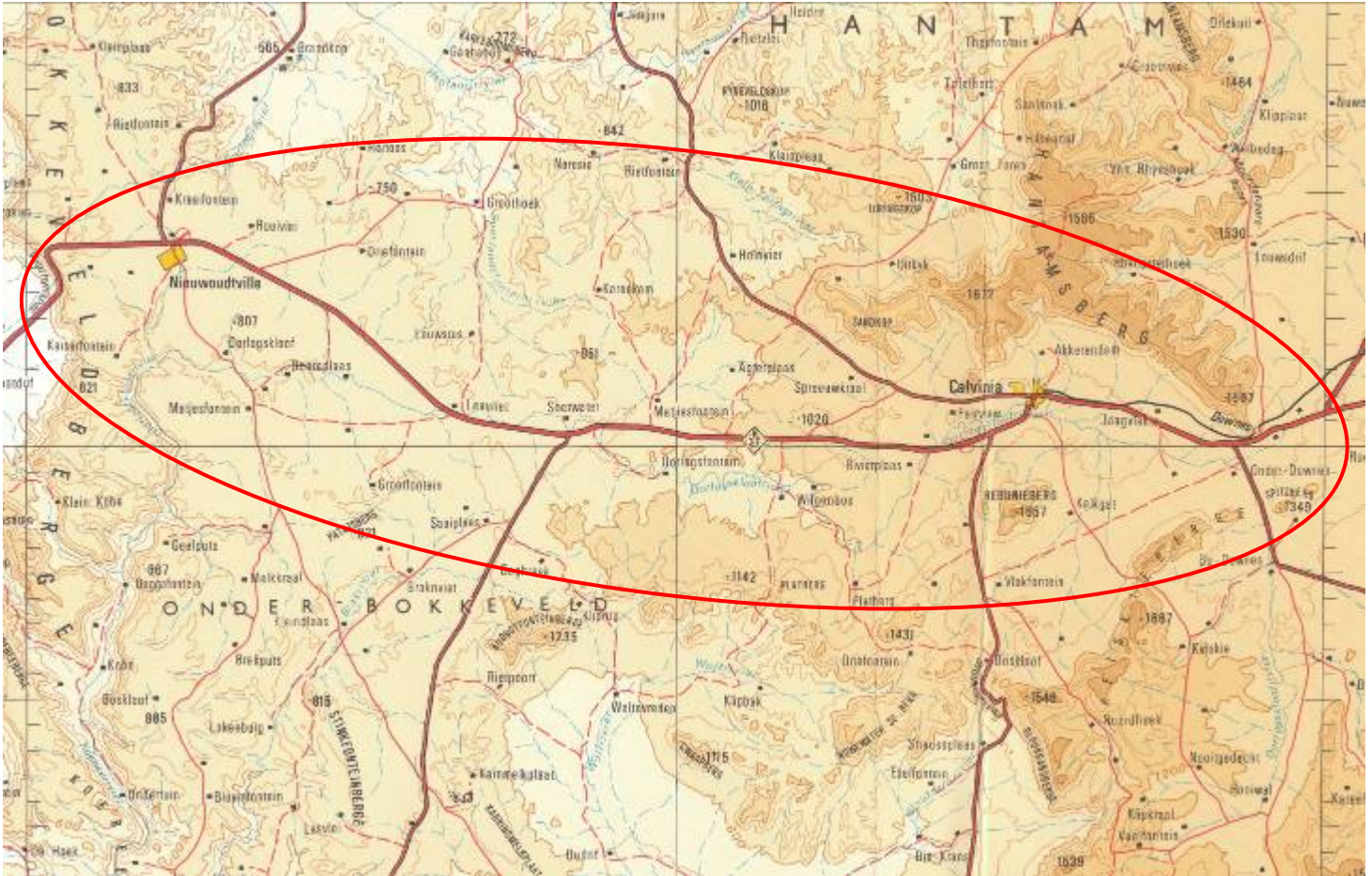


Figure 2. Locality 1 in 500 000 topographical map (3117 Calvinia) of the study area

5.2. Activity Description

The strengthening and partial reconstruction of portions of the R27, Sections 7 and 8, between the Western/Northern Cape Provincial border (km 40.0) and Calvinia (km 70.0) will comprise of the following main components (Figure 3):

- Road works: The upgrading of the approximately 73-km road section by strengthening the existing layers and limited widening of the road;

- Bridges and culverts: The widening of three (of the four) bridges and the possible widening or reconstruction of some of the major culverts; and
- Borrow pits: The development of a number of borrow areas for the sourcing of road-building material and crushed aggregates. Seven potential borrow pits were identified for this assessment.

Six potential water sources were also identified to provide water for construction purposes.



Figure 3. Aerial image of the proposed road upgrade with locality of quarries (Q), borrow pits (BP), bridges (BR) and water sources (WS)

5.3. Legal Requirements

The following Acts, regulations and ordinances are applicable to the development:

- **The National Environmental Management Act (Act No. 107 of 1998)**

Chapter Seven of the NEMA states that:

“Every person who causes, has caused 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, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment”.

The Act also clearly states that the landowner, or the person using or controlling the land, is responsible for taking measures to control and rectify any degradation. These may include measures to:

- “(a) investigate, assess and evaluate the impact on the environment;*
- (b) inform and educate employees about the environmental risks of their work and the manner in which their tasks must be performed in order to avoid causing significant pollution or degradation of the environment;*
- (c) cease, modify or control any act, activity or process causing the pollution or degradation;*
- (d) contain or prevent the movement of pollutants or degradation; or*
- (e) eliminate any source of pollution or degradation; or*
- (f) remedy the effects of the pollution or degradation.”*

- **NEMA Basic Assessment Regulations, GN R543 of 2010**

Activities listed in terms of Chapter 5 of NEMA in Government Notice No. R. 544, 5 and 6 trigger a mandatory Basic Assessment, or even a full scoping EIA process, prior to development.

The National Environmental Management Second Amendment Act (Act No.8 of 2004) provided for formal procedures for offenders in terms of Section 24G to apply for rectification of the unlawful commencement of listed activities.

- **National Water Act, 1998 (Act No. 36 of 1998)**

The purpose of the National Water Act is to provide a framework for the equitable allocation and sustainable management of water resources. Both surface and groundwater sources are redefined by the Act as national resources which cannot be owned by any individual, and rights to which are not automatically coupled to land rights, but for which prospective users must apply for authorisation and register as users. The National Water Act also provides for measures to prevent, control and remedy the pollution of surface and groundwater sources.

- **Regulations Requiring that a Water User be Registered, GN R.1352 (1999)**

Regulations requiring the registration of water users were promulgated by the Minister of the Department of Water Affairs (DWA) in terms of provision made in section 26(1)(c), read together with section 69 of the National Water Act, 1998. Section 26(1)(c) of the Act allows for registration of all water uses including existing lawful water use in terms of section 34(2). Section 29(1)(b)(vi) also states that in the case of a general authorisation, the responsible authority may attach a condition requiring the registration of such water use. The Regulations (Art. 3) oblige any water user as defined under section 21 of the Act to register such use with the responsible authority and effectively to apply for a Registration Certificate as contemplated under Art.7(1) of the Regulations.

- **General Authorisation in terms of s. 39 of the National Water Act, GN R 1199 of 2009**

Government Notice R1199 was issued as a revision of the General Authorisations (No. 1191 of 1999) for Section 21 (c) and (i) water uses as defined under the National Water Act (Act 36 of 1998). The revision was published and came into effect on 2009/12/18. According to the preamble to Part 6 of the National Water

Act, “*This Part establishes a procedure to enable a responsible authority, after public consultation, to permit the use of water by publishing general authorisations in the Gazette...*”

“The use of water under a general authorisation does not require a licence until the general authorisation is revoked, in which case licensing will be necessary...”

It is likely that the proposed activities will fall within the listed activities that can be Generally Authorised at the Western Cape Regional Office of the Department of Water Affairs, however an application for authorisation of the proposed activities will need to be submitted to them for confirmation that this is the case.

- **Conservation of Agricultural Resources Act (Act 43 of 1983)**

The objective of this Act is to provide for the conservation of the natural agricultural resources of the Republic by the maintenance of the production potential of land, by the combating and prevention of erosion and weakening or destruction of the water sources, and by the protection of the vegetation and the combating of weeds and invader plants. The Act makes provision for the Minister to prescribe control measures, which need to be adhered to by landowners to whom they apply. These control measures can relate to activities such as the cultivation of virgin soil, the irrigation of land, the utilization and protection of vleis, marshes, water sponges, water courses and water sources, the regulating of the flow pattern of run-off water, and the utilization and protection of the vegetation. Control measures may contain prohibitions and obligations, but also make provision for exemptions to be granted and for different control measures to be applied to different forms of land use. A landowner who fails to comply with any control measure is guilty of an offence.

6. AQUATIC SYSTEMS IN THE STUDY AREA

6.1. Description of the Study Site

a. Physical Characteristics

The study area is largely located on the Nieuwoudtville/Onder-Bokkeveld Plateau between Calvinia and Nieuwoudtville. The area lies within the Olifants-Doring River catchment, with the Oorlogskloof River and its tributaries flowing parallel to the R27 road (Figure 4). The surround topography is relatively flat within the wide river valley of the Oorlogskloof, with the Hantams Mountains in the East and the escarpment on the Bokkeveld Mountains in the west. The surrounding farming activities occur along and within the river channels and have moderately modified the riverine habitat. In particular, large shallow farm dams have been constructed near Calvinia to impede winter surface water runoff.



Figure 4. A view of the wide Oorlogskloof River Valley near Calvinia with the Hantams Mountains in the background

b. Climate

Calvinia has a Mediterranean climate and normally receives about 146mm of rain per year mostly during winter. The area has its lowest rainfall (1mm) in January and the highest (23mm) in June (Figure 5). The average midday temperatures for Calvinia range from 15.3°C in July to 30.6°C in January. The region is the coldest during July when the mercury drops to 1.4°C on average during the night.

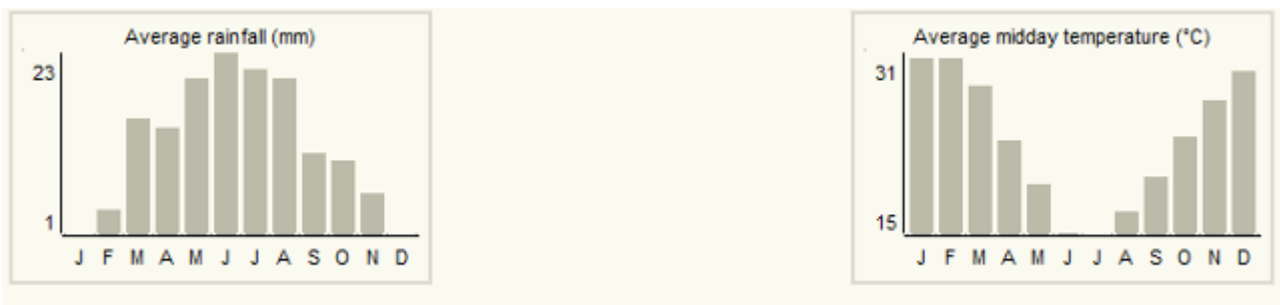


Figure 5. Average monthly rainfall for the area (SA Explorer, 2008)

c. Geology and Soil

The major geological features of the Onder-Bokkeveld plateau area and the adjoining Karoo are sandstone, shale, diamictite and an intrusive rock called dolerite. Table Mountain group sandstones occur primarily within the Vanrhyns Pass while the Bokkeveld Group shale and sandstones and the mixed, glacially-derived Dwyka Group diamictite occur to the east on the plateau. All of these relatively flat lying beds overlie much more ancient, folded and metamorphosed rocks of the Gariiep and Nama Groups, which formed between 600 and 500 million years ago by processes involving sedimentation and continental collision. These rocks are the grey phyllites and quartzites of the Knersvlakte and the red sandstones and shales which lie below the escarpment north of Nieuwoudtville and in the Koebee Valley.

The types of soils discernable from Figure 6 comprise largely of red, shallow soils on rock for much of the area (reddish areas in Figure 6), with soils with marked clay accumulation surrounding Calvinia and the central portion of the study area (orange and olive areas in Figure 6).

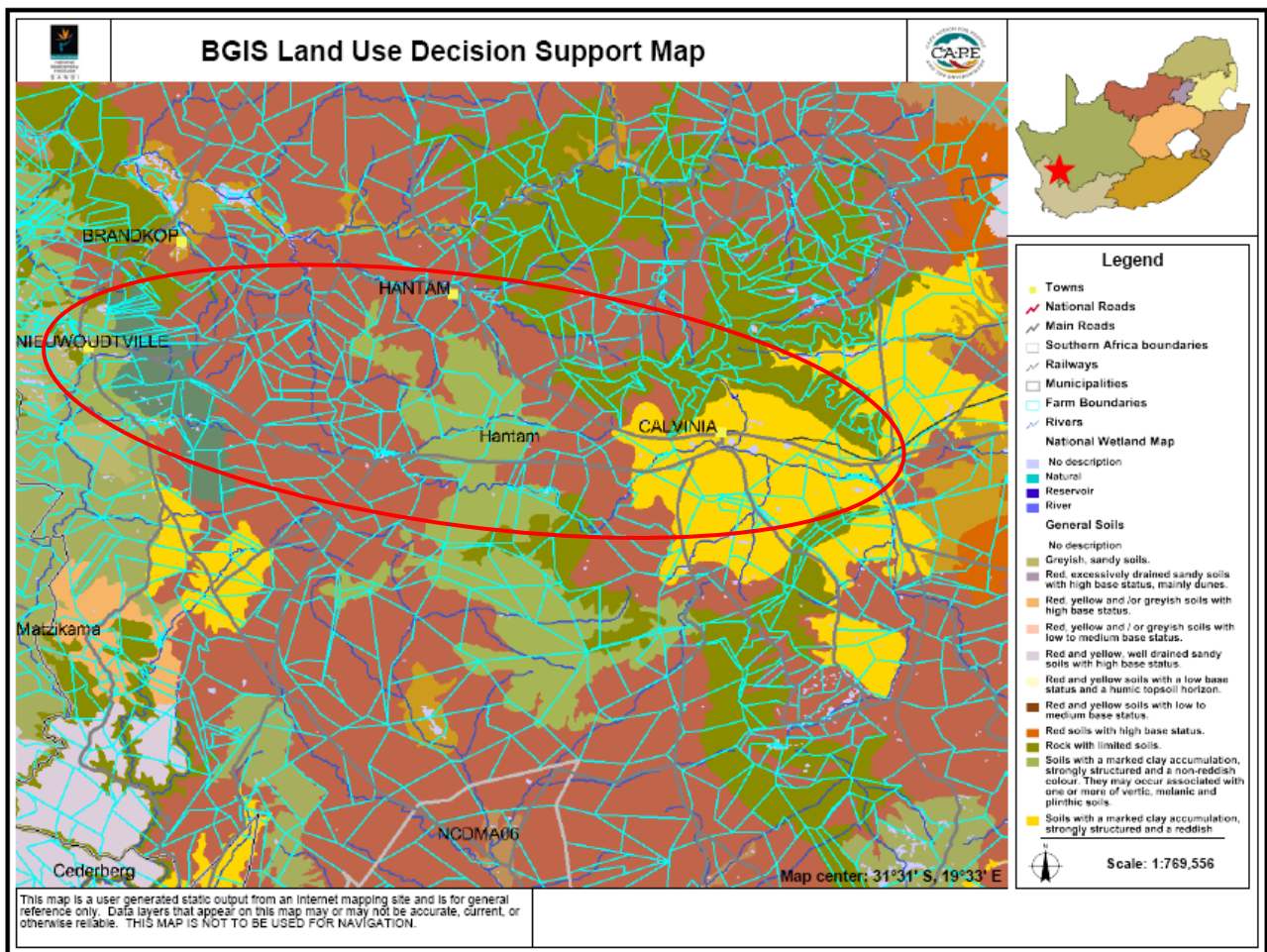


Figure 6. Soil map for the area (Biodiversity GIS, 2009)

d. Flora

The natural vegetation type that is dominant throughout the study is Hamtam Karoo vegetation type (least threatened), with Nieuwoudtville Shale Renosterveld (endangered) in the north-east and some Nieuwoudtville-Roggeveld Dolerite Renosterveld (least threatened) in the west (Figure 7). The vegetation is still largely natural in the higher lying and more remote areas, however closer to the towns and outside of the towns the vegetation has largely been modified by agricultural as well as urban activities.

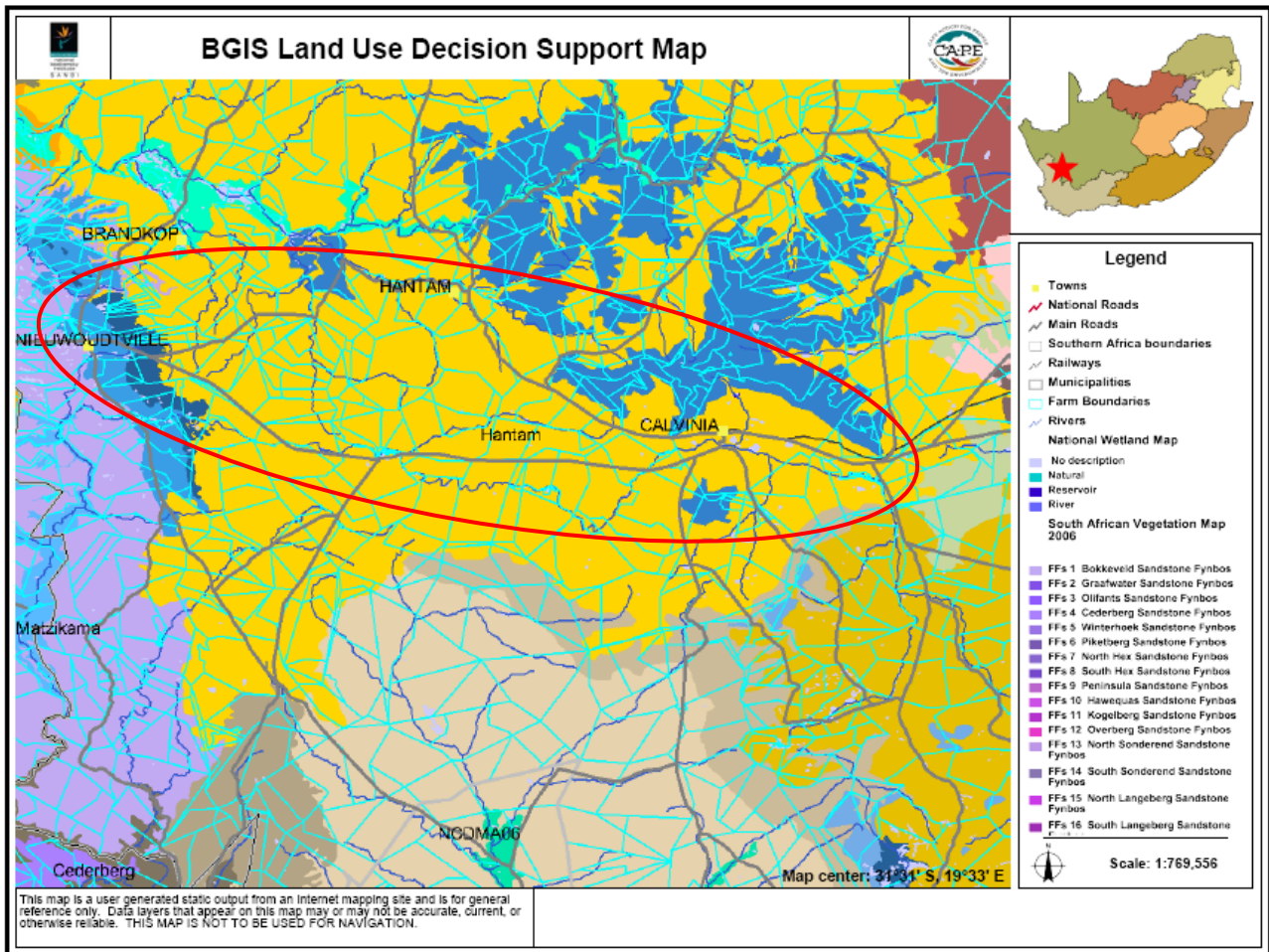


Figure 7. Vegetation map for the area (SANBI Biodiversity GIS)

e. Aquatic features and fauna

The main freshwater feature in the study area is the Oorlogskloof River (Figure 8). The river originates in the Roggeveldberge and flows westward past Calvinia and Nieuwoudtville. South of Nieuwoudtville it enters the Koebeeberge and flows through a deep riverine gorge where it is known as the Koebee River. It flows southwards to its confluence with the Doring River, a major tributary of the Olifants River which enters the Atlantic Ocean on the west coast of South Africa. The river is discussed in more detail in the following section. Another Doring River, which is a tributary of the Hantam River, flows north and westward within the Olifants/Doring River System is also included within the study area.



Figure 8. The Oorlogskloof River near Calvinia



Figure 9. The Doring River near Nieuwoudtville

f. Land use

The area surrounding Nieuwoudtville and Calvinia consists largely of natural areas (Figure 10). The urban areas of Nieuwoudtville and Calvinia occur at the western and eastern extents of the study area. These towns are surrounded by some cultivated agriculture, which is scattered mostly along the watercourses in the area and consists largely of grazing for sheep farming. The area is also an important area for eco-tourism, with Nieuwoudtville being well known for its bulbs which flower in the spring.

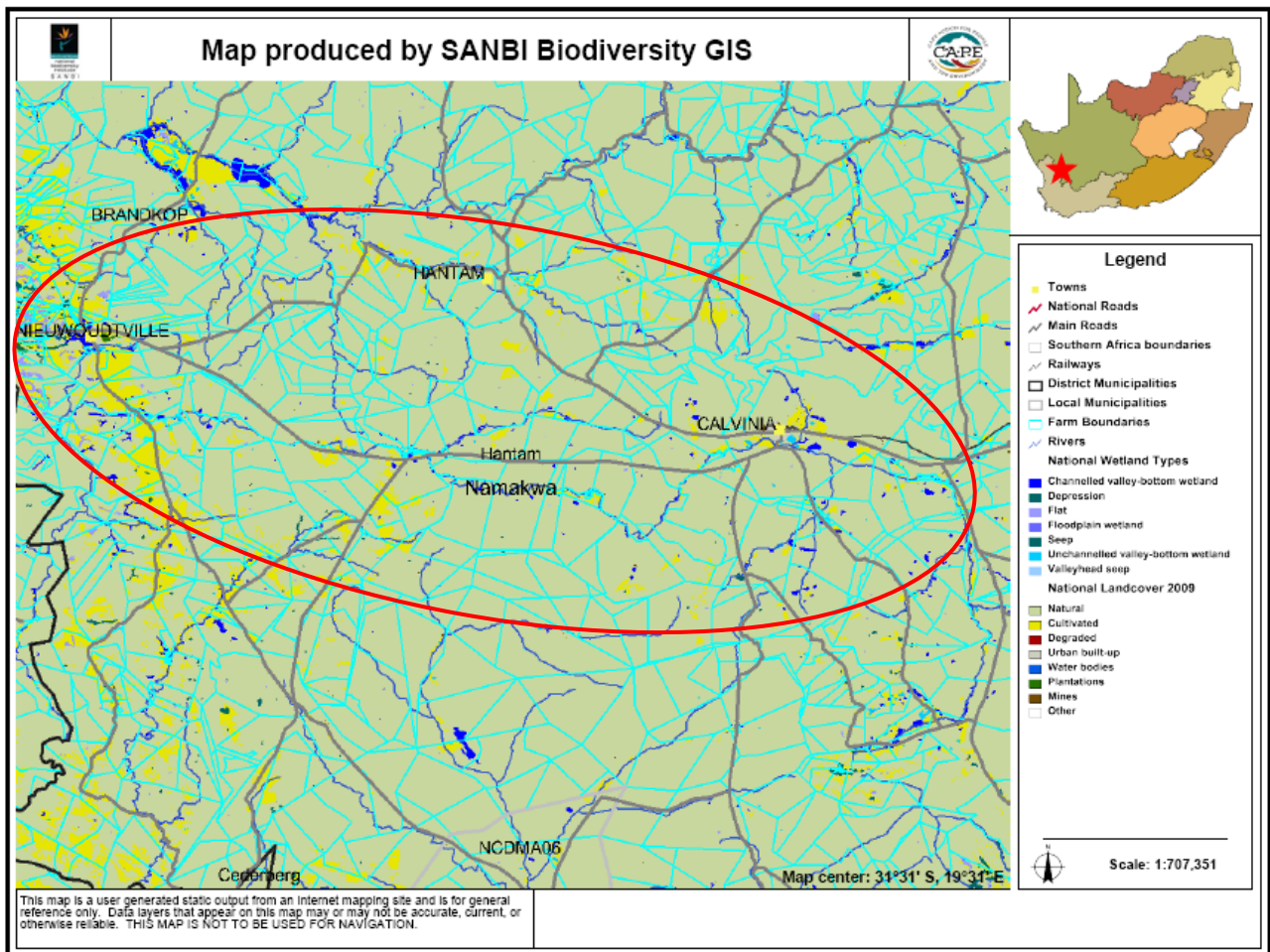


Figure 10. Land cover map for the area (SANBI Biodiversity GIS, 2011)

6.2. Freshwater Assessment of the Study Area

The Index for Habitat Integrity (IHI) and a Site Characterisation were used to provide information on the ecological condition of the Oorlogskloof and Doring Rivers.

a. River classification

In order to assess the condition and ecological importance and sensitivity of the stream, it is necessary to understand how the stream might have appeared under unimpacted conditions. This is achieved through classifying rivers according to their ecological characteristics, in order that it can be compared to ecologically similar rivers.

River typing or classification involves the hierarchical grouping of rivers into ecologically similar units so that inter- and intra-river variation in factors that influence water chemistry, channel type, substratum composition and hydrology are best accounted for. Any comparative assessment of river condition should only be done between rivers that share similar physical and biological characteristics under natural conditions. Thus, the classification of rivers provides the basis for assessing river condition to allow comparison between similar river types. The primary classification of rivers is a division into Ecoregions. Rivers within an ecoregion are further divided into sub-regions.

Ecoregions are groups of rivers within South Africa, which share similar physiography, climate, geology, soils and potential natural vegetation. For the purposes of this study, the ecoregional classification presented in Department of Water Affairs and Forestry in 1999, which divides the country's rivers into 18 ecoregions, was used. The river assessed lies within the Great Karoo Ecoregion, with the characteristics as described in Table 1.

Sub-regions (or geomorphological zones) are groups of rivers, or segments of rivers, within an ecoregion, which share similar geomorphological features, of which gradient is the most important. The use of geomorphological features is based on the assumption that these are a major factor in the determination of the distribution of the biota. Table 2 provides the geomorphological features of the streams assessed.

Table 1. Characteristics of the Great Karoo Ecoregion (Dominant Types In Bold)

Main Attributes	Characteristics
Terrain Morphology: Broad division	Plains; Low Relief; Plains Moderate Relief; Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills, Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief; Table-Lands: Moderate and High Relief
Vegetation types	Valley Thicket; Central Nama Karoo; Eastern Mixed Nama Karoo; Great Nama Karoo; Upper Nama Karoo; Lowland Succulent Karoo; Upland Succulent Karoo; Escarpment Mountain Renosterveld;
Altitude (m a.m.s.l)	300-1700
MAP (mm)	0 to 500
Rainfall seasonality	Very late summer to winter
Mean annual temp. (°C)	10 to 20

b. Site Characterisation

The Oorlogskloof and Doring rivers both have a bedrock-and-sand/silt substrate. As they drain Karoo and mountain fynbos vegetation, they are frequently turbid and are seasonal in nature. Vegetation within the streams is also of a wetland nature, filled with phragmites reeds, with *Juncus* sp. reeds and grasses. This vegetation is likely sustained for much of the year by sub-surface and groundwater contributions rather than surface water flows.

From the Site Characterisation assessment, the geomorphological and physical characteristics of the rivers can be classified as shown in Table 2.

Table 2. Geomorphological and Physical features of the Oorlogskloof River

Geomorphological Zone	Lower foothill river
Lateral mobility	Unconfined on the plateau but confined within kloof and hilly areas
Channel form	Simple
Channel pattern	Single and multiple thread: low sinuosity
Channel type	Mixed (alluvium with bedrock)
Channel modification	Moderate modification (farming into riparian zone and some alien vegetation encroachment)
Hydrological type	Seasonal to ephemeral
Ecoregion	Great Karoo
DWA catchment	E24K, E32E, E40A to C
Vegetation type	Hantam Karoo with Nieuwoudtville Shale and Dolerite Renosterveld
Rainfall region	Winter

c. Index of Habitat Integrity

The evaluation of Index of Habitat Integrity (IHI) provides a measure of the degree to which a river has been modified from its natural state. This assessment was undertaken for the Oorlogskloof and upper Doring rivers (Tables 3 and 4). The methodology (DWAF, 1999) involves a qualitative assessment of the number and severity of anthropogenic perturbations on a river and the damage they potentially inflict upon the system. These disturbances include both abiotic and biotic factors, which are regarded as the primary causes of degradation of a river. The severity of each impact is ranked using a six-point scale with 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact).

The IHI assessment is based on an evaluation of the impacts of two components of the rivers, the riparian zone and the instream habitat. Assessments are made separately for both components, but data for the riparian zone are interpreted primarily in terms of the potential impact on the instream component.

The estimated impact of each criterion is calculated as follows:

$$\text{Rating for the criterion} / \text{maximum value (25)} \times \text{weight (percent)}$$

The estimated impacts of all criteria calculated in this way are summed, expressed as a percentage and subtracted from 100 to arrive at an assessment of habitat integrity for the instream and riparian components respectively. The total scores for the instream and riparian zone components are then used to place the habitat integrity of both in a specific habitat category.

Oorlogskloof River:

The Oorlogskloof River downstream of Calvinia (Figure 11) was assessed during the site visit. The results from the habitat integrity assessment are shown in Table 3.

Table 3. Index of Habitat Integrity Assessment results and criteria assessed in the Oorlogskloof River downstream of Calvinia

Instream Criteria	Weight	Score	Riparian Zone Criteria	Weight	Score
Water abstraction	14	8	Water abstraction	13	8
Flow modification	13	12	Inundation	11	3
Bed modification	13	7	Flow modification	12	11
Channel modification	13	5	Water quality	13	7
Water quality	14	7	Indigenous vegetation removal	13	10
Inundation	10	3	Exotic vegetation encroachment	12	9
Exotic macrophytes	9	3	Bank erosion	14	11
Exotic fauna	8	4	Channel modification	12	5
Solid waste disposal	6	4			
Category		C	Category		D

The Oorlogskloof River downstream of Calvinia is in a moderately modified state with the major impacts being some flow modification, farming within the riparian zone (removal of riparian vegetation and tramping of livestock within the river channel) and a low density of invasive alien vegetation growth (*Prosopis* sp.).



Figure 11. View of the Oorlogskloof River downstream of Calvinia

Doring River:

The Doring River near Nieuwoudtville (Figure 12) has a largely natural habitat with minimal habitat disturbance activities. The results from the habitat integrity assessment are shown in Table 4.

Table 4. Index of Habitat Integrity Assessment results and criteria assessed in the Doring River near Nieuwoudtville

Instream Criteria	Weight	Score	Riparian Zone Criteria	Weight	Score
Water abstraction	14	5	Water abstraction	13	5
Flow modification	13	3	Inundation	11	4
Bed modification	13	8	Flow modification	12	3
Channel modification	13	6	Water quality	13	3
Water quality	14	3	Indigenous vegetation removal	13	7
Inundation	10	4	Exotic vegetation encroachment	12	4
Exotic macrophytes	9	2	Bank erosion	14	8
Exotic fauna	8	2	Channel modification	12	6
Solid waste disposal	6	4			
Category		B	Category		B



Figure 12. The Doring River downstream of the R357 road bridge

d. Ecological Importance and Sensitivity (EIS)

EIS (Table 5) considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table 6). The median of the resultant score is calculated to derive the EIS category (Table 7).

Table 5. Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their 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 substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/ marginal	Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

Table 6. Definition of the four-point scale used to assess biotic and habitat determinants presumed to indicate either importance or sensitivity

Four point scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table 7. Results of the EIS assessment for the Oorlogskloof and Doring rivers





Biotic Determinants	Oorlogskloof River	Doring River
Rare and endangered biota	2	2
Unique biota	2	2
Intolerant biota	1	1
Species/taxon richness	2	2
Aquatic Habitat Determinants		
Diversity of aquatic habitat types or features	1	2
Refuge value of habitat type	1	2
Sensitivity of habitat to flow changes	2	2
Sensitivity of flow related water quality changes	1	2
Migration route/corridor for instream and riparian biota	2	2
National parks, wilderness areas, Nature Reserves, Natural Heritage sites, Natural areas, PNEs	2	2
RATINGS	1.6	1.9
EIS CATEGORY	low	Moderate/low

The Oorlogskloof River is considered to be of a low Ecological Importance and Sensitivity, while the Doring River is considered to be of a moderate to low sensitivity.





6.3 Assessment of Sites

The proposed borrow pit sites, quarries, bridges and water sources that were assessed are discussed in the following tables:

Table 8. Assessment of Borrow Pit Sites

Borrow Pit Site No.	Google Earth image	Photo	Comment
1. R27-7 km 51 LHS 6.9			<p>Kliprivier Farm borrow pit is sited at the top of a small hill, adjacent to an existing borrow pit. There are no expected aquatic ecosystem issues.</p>
2. R27-8 km 9.5 LHS 0.2			<p>Buffelsvlei Farm borrow pit sited adjacent to a small drainage line. The vegetation around the pit is in good condition and 3 porcupines were sighted in the pit. Aardvark hole inhabited by the porcupines were also found on the south-west bank of the pit. The pit is not linked to the drainage channel and the proposed expansion of the pit is to the north-east, away from the drainage therefore no aquatic ecosystem issues are foreseen at this site. However it is recommended that if this pit is utilized, access to the pit does not disturb the drainage channel and that the pit is meaningfully rehabilitated in terms of its future storage of water.</p>

<p>3. R27-8 Km 32.6 RHS 6.2</p>			<p>Iceland Spar Mine Site: The borrow pit is sited at the top of a small hill, at an existing mine with numerous stockpiles. Only the stockpiles will be removed. While there is some drainage down the hill side, there are no expected aquatic ecosystem issues.</p>
<p>4. R27-8 km 39.8 LHS 0.1</p>			<p>Matjiesfontein Farm: this borrow pit is currently being utilized for the storage of water. With flow from the adjacent drainage channels being diverted into the pit. Should this pit be extended as proposed (white polygon in Google image), the site should be rehabilitated to allow for more efficient use of the water and the landowner should contact DWA regarding authorization for the storage of water in the pit.</p>

<p>5. R27-8 km 45.0 RHS 0.2</p>			<p>Doega Farm: The site is on previously disturbed ground with no visible drainage or aquatic features. No freshwater issues are expected.</p>
<p>6. R27-8 km 50.4 LHS 0.1</p>			<p>The site is on previously disturbed ground with no visible drainage or aquatic features. No freshwater issues are expected.</p>













<p>7. R27-8 km61.6 RHS</p>			<p>The site is on previously disturbed ground with no visible drainage or aquatic features. No freshwater issues are expected.</p>
<p>8. R27-8 km 64.2 RHS 11.0</p>			<p>Vlakkefontein Farm: The borrow pit is an existing borrow pit with no visible drainage or water features. There are no expected aquatic ecosystem issues.</p>

Table 9. Assessment of Bridge Sites

Bridge Site Number	Google Earth image	Photo	Comment
1. R27-8 km 22.69			<p>Oorlogskloof River Bridge (47.8 m by 10.4m with 4 piers). No major structural works planned. River dominated by phragmites, with some <i>Juncus</i> sp, weedy shrubs and <i>Prosopis</i> sp. The bed was largely dry and consisted of an alluvial substrate with bedrock. The southern bank is highly eroded. No freshwater issues are expected at the bridge, with the recommendations provided in the following section.</p>
2. R27-8 km 34.92			<p>Soetwater River Bridge - (30.1 m by 7.86m with 2 piers). Bridge to be widened on both sides by 1.27m.</p>

<p>3. R27-8 km 59.2</p>			<p>Oorlogskloof River Bridge - (48.2 m by 8m with 4 piers). Bridge to be widened on both sides by 1.20m.</p>
<p>4. R27-8 km 67.1</p>			<p>Oorlogskloof River Bridge - (84.5 m by 7.1m with 4 piers). Bridge to be widened on one side only.</p>

Table 10. Assessment of Water Abstraction Sites

Water Abstraction Site Number	Google Earth image	Photo	Comment
1. R27-7 km 51 LHS 7.1			<p>Doring River, Kliprivier Farm: The river channel at the R27 bridge is dominated by <i>Phragmites</i> reeds, with some <i>Juncus</i> sp and grass sp. downstream The bed was dry and consisted of an alluvial substrate with bedrock. This proposed water source is 350m upstream of the Nieuwoudtville waterfall, an important tourism feature for the area. The river also consists largely of river valley bottom wetland habitat and has been identified as a Freshwater Ecosystem Protected Area. It is therefore advised that an alternative water source be utilized for this area. The river flow is also of a seasonal nature and would not be a reliable water source as construction activities may need to take place during the dry season. Authorization will need to be given from DWA for the intended water abstraction.</p>
2. R27-8 km 32.6 RHS 1.5			<p>Soetwater Farm: Water is to be taken from an existing water pump. If the water to be abstracted is within the existing authorization for Soetwater Farm then no additional authorization from DWA is required.</p>

<p>3 R27-8 km 35 RHS 0.15</p>			<p>Toekoms Farm: Water is to be taken from an existing water pump. If the water to be abstracted is within the existing authorization for Soetwater Farm then no additional authorization from DWA is required.</p>
<p>4 R27-8 km 36.0 LHS 0.5</p>			<p>Soetwater Farm: Water is to be taken from an existing water pump. If the water to be abstracted is within the existing authorization for Soetwater Farm then no additional authorization from DWA is required.</p>
<p>5. R27-8 km 60.0 RHS 0.02</p>			<p>Rivier Farm: Water is to be taken from an existing water pump. If the water to be abstracted is within the existing authorization for Soetwater Farm then no additional authorization from DWA is required.</p>

6 R27-8 km
32.6 RHS 6.2



Bloedzuigerfontein farm: Water is to be taken from an existing water pump. If the water to be abstracted is within the existing authorization for Soetwater Farm then no additional authorization from DWA is required.

7. ASSESSMENT OF IMPACTS

a. Description and assessment of Impacts of proposed activities

This section provides an assessment of the potential impacts to freshwater ecosystems that are likely to be associated with the proposed development activities. The impact assessment and recommended mitigation measures are grouped according to the various proposed activities, that is the proposed upgrade of the road and the bridges; the use of the borrow pits; and the abstraction of water for construction purposes.

The roadway and bridges are already in existence adjacent to the river channel and within the riverbed, respectively, and together with a number of other physical modifications to the river bed and channel of the upper and lower reach of the river (as described in the previous section), have resulted in a moderately to largely modified aquatic ecological condition in the river within the reach to be impacted on by the proposed activities. Therefore the likely impacts of the proposed upgrade of the road and bridges are expected to be mostly of limited intensity and of a short term, during the construction phase. Longer term impacts that are likely to occur as a result of the proposed activity are the encroachment of invasive alien vegetation into the riparian zone, where the banks have been disturbed by the construction activities. The water used for construction purposes is also mostly already allocated water, with only the proposed abstraction from the Doring River near Nieuwoudville being of concern.

With regards to the borrow pits, these are also existing disturbances and for many of the proposed sites, the opportunity actually exists for some rehabilitation of the sites once the stockpiles have been removed.

Impact of proposed upgrade of the road and bridges:

- Nature of Impact: A limited impact on the riparian habitat of the Oorlogskloof River and its tributaries that are crossed by the R27 road (Table 9) is expected during the construction phase due to the activities associated with road and bridge upgrades.

Significance of impacts without mitigation: A localized impact of low intensity that is expected to have a low to negligible overall significance in terms of its impact on the identified aquatic ecosystems in the area. The existing riparian habitat has already been disturbed by surrounding farming activities, with much of the vegetation associated with the river being limited to within the river channel. The disturbance of riparian habitat during and after the construction activities provides an opportunity for invasive alien plants to proliferate in these areas that are already in a disturbed condition.

Proposed mitigation: It is important that the existing riparian zones that provide this buffering function for the river are rehabilitated after construction is completed by revegetating the areas disturbed by the construction activities with suitable indigenous riparian plants, such as mentioned *Acacia Karoo*. Invasive alien plants that currently exist within the immediate area of the construction activities should also be removed and the sites should be monitored post-construction

for a period of three years to ensure that these disturbed areas do not become reinfested with invasive alien plants.

Significance of impacts after mitigation: The opportunity exists for the current state of the riparian zones adjacent to the roadway to be improved. A localized, short-term impact will still occur during the construction phase; however, the overall significance of the impact on the aquatic ecosystems is expected to be very low.

- Nature of Impact: A temporary impedance of the flow in the Oorlogskloof River at the river crossing sites may occur as a result of construction activities within the river channel.

Significance of impacts without mitigation: The construction activities would be expected to have a very limited impact on the flow in the stream in terms of the extent and duration.

Proposed mitigation: Activities within the river channel during the construction phase should be limited as far as possible in terms of their spatial and temporal extent. Construction should preferably take place before the onset of the winter rainfall to ensure minimal impact on flow. In the longer term, the upgraded bridge structures should not impede the flow and in particular the low flow in the river. All rubble and waste material associated with the bridge structures upgrade that is within the channel should be removed after construction is complete.

Significance of impacts after mitigation: A localised impact of low intensity that is expected to have a low overall significance in terms of its impact on the identified aquatic ecosystems in the area during construction phase only. An impact of negligible significance is expected post-construction.

- Nature of impact: Water quality impairment and an increase in turbidity - Impairment of the surface water quality could potentially occur, namely sedimentation during the construction phase.

Significance of impacts without mitigation: A localized impact of low intensity that is expected to have a low overall significance in terms of its impact on the identified aquatic ecosystems in the area.

Proposed mitigation: Runoff from the construction site(s) should be prevented from entering the river and should rather be diverted through screens and off-channel retention ponds. All materials on the construction sites should be properly stored and contained. Disposal of waste from the sites should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located away from the river system and regularly serviced. These measures should be addressed, implemented and monitored in terms of the EMP for the construction phase.

Significance of impacts after mitigation: Provided that the mitigation measures are effectively implemented the water quality impacts of the development should be of low to negligible significance.

Impact of the extraction of road construction materials from the proposed borrow pits:

- **Nature of Impact:** An impact of very limited significance is expected on the drainage characteristics of minor tributaries of the Oorlogskloof River associated with some of the proposed borrow pits during and after the construction phase, namely: Borrow Pits 2 and 4 (Table 8). This is due to the fact that the borrow pits are already in existence and most of the sites with drainage concerns can be rehabilitated.

Significance of impacts without mitigation: The above-mentioned borrow pits occur in close proximity to minor tributaries and drainage channels of the Oorlogskloof and Doring Rivers. As a result of past activities the habitat and flow in these channels have been impacted on. These habitat and flow modifications can however be mitigated once removal of materials from these sites has been completed.

Proposed mitigation: All stockpiled material from the borrow pits should be removed from the drainage channels or stream beds and the channel rehabilitated with the removal of invasive alien plants. Where access to the borrow pit is through the drainage channel, disturbance of the channel should be limited.

Significance of impacts after mitigation: The opportunity exists for the current state of the riparian zones adjacent to the borrow pits and quarries to be improved. A localized, short-term impact will still occur during the construction phase; however, the overall significance of the impact on the aquatic ecosystems is expected to be a low positive impact.

Impact of the abstraction of water for the road construction purposes at the proposed sites:

- **Nature of impact:** A moderate significance impact for the proposed water abstraction could be expected for the site in the Doring River only. All the other sites are expected to have a negligible impact due to the fact that the water abstraction is via an existing groundwater allocation.

Significance of impact without mitigation: Moderate to high due to the sensitivity of the downstream ecosystem

Proposed mitigation: It is recommended that an alternative water source be sought.

Cumulative impact of the overall project activities on freshwater ecosystems:

The area to be impacted by the proposed activity is already moderately modified as a result of previous road construction activities as well as modification of the river banks and drainage channels by adjacent farming activities and the impacts from the two towns, Calvinia and Nieuwoudtville. These activities have all contributed to a modification of both the instream and riparian aquatic habitats and the introduction of invasive alien plants into the riparian zone. Considering that the proposed activities are to the existing road, one can expect that the cumulative impact of this activity on the river system will be of a low significance.

b. Summary of assessment of potential impacts of the proposed activities:

Construction Phase:

Potential impact on freshwater features	Proposed upgrade of R27 and bridges
Nature of impact:	Limited disturbance of freshwater related habitats at the construction sites and possibly for a short distance downstream of the structures
Extent and duration of impact:	Localised short term impacts
Intensity of Impact	Low
Probability of occurrence:	Probable as a result of construction activities within stream bed and riparian zones
Degree to which impact can be reversed:	Medium to high
Irreplaceability of resources:	Medium
Cumulative impact prior to mitigation:	Very low due to the existing degraded state of the river
Significance of impact pre-mitigation	Very low
Degree of mitigation possible:	Very low
Proposed mitigation:	<ul style="list-style-type: none"> ➤ There should be minimal use of machinery within the river channel and riparian areas and disturbance within this area should be kept to a minimum. ➤ The rehabilitation and re-vegetation of disturbed areas must take place post construction. Only appropriate indigenous riparian vegetation may be used for re-vegetation of disturbed areas.
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

Potential impact on freshwater features	Proposed upgrade of R27 and bridges
Nature of impact:	A temporary impedance of flow during construction activities
Extent and duration of impact:	Localised short term impacts
Intensity of Impact	Low
Probability of occurrence:	Probable depending on the extent of construction activities within stream bed
Degree to which impact can be reversed:	High
Irreplaceability of resources:	Low
Cumulative impact prior to mitigation:	Low
Significance of impact pre-mitigation	Very low
Degree of mitigation possible:	Very low
Proposed mitigation:	<ul style="list-style-type: none"> ➤ Minimise duration and extent of construction activities in the river – construction should also take place in the low flow season. ➤ Clearing of debris and hard rubble associated with the construction activities should be undertaken post construction.
Cumulative impact post mitigation:	Very Low to negligible impact
Significance after mitigation	Very Low

Potential impact on freshwater features	Proposed upgrade of R27 and bridges
Nature of impact:	Downstream water quality impacts as a result of runoff from construction activities
Extent and duration of impact:	Localised short term impacts
Intensity of Impact	Low
Probability of occurrence:	Probable
Degree to which impact can be reversed:	High
Irreplaceability of resources:	Low
Cumulative impact prior to mitigation:	Low
Significance of impact pre-mitigation	Low
Degree of mitigation possible:	Very low
Proposed mitigation:	<ul style="list-style-type: none"> ➤ Runoff from the construction site should be prevented from entering the river but should rather be diverted through screens and off-channel retention ponds. (see previous comments) ➤ All materials on the construction site should be properly stored and contained. ➤ Disposal of waste from the sites should also be properly managed. Construction workers should be given ablution facilities at the construction sites that are located away from the river system and regularly serviced. ➤ These measures should be addressed, implemented and monitored in term of the EMP for the construction phase.
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

Potential impact on freshwater features	Proposed abstraction of water for construction purposes in the upgrade of R27
Nature of impact:	A short term reduction of flow during construction activities
Extent and duration of impact:	Localised short term impacts
Intensity of Impact	High
Probability of occurrence:	Probable depending on flow in river
Degree to which impact can be reversed:	Medium
Irreplaceability of resources:	Fully reversible
Cumulative impact prior to mitigation:	Low
Significance of impact pre-mitigation	Low
Degree of mitigation possible:	None
Proposed mitigation:	➤ Identify an alternative water source.
Cumulative impact post mitigation:	Low
Significance after mitigation	Low

Operation Phase:

Potential impact on freshwater features	Proposed upgrade of R27 and bridges
Nature of impact:	Limited <i>disturbance of freshwater related habitats</i> at the bridges and along the length of the road where construction activities have taken place
Extent and duration of impact:	Localised longer term impacts
Intensity of Impact	Low
Probability of occurrence:	Probable as a result of construction activities within stream bed and riparian zones
Degree to which impact can be reversed:	Medium to high
Irreplaceability of resources:	Low
Cumulative impact prior to mitigation:	Very low due to the existing degraded state of these streams, as well as the impacts of the flooding that took place
Significance of impact pre-mitigation	Very low
Degree of mitigation possible:	Very low
Proposed mitigation:	➤ Disturbed areas should be monitored and kept free of invasive alien plant growth.
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

Potential impact on freshwater features	Proposed removal of road building material from borrow pit sites 2 and 4
Nature of impact:	Limited <i>disturbance of freshwater related habitats</i> at the above-mentioned borrow pits
Extent and duration of impact:	Localised longer term impacts
Intensity of Impact	Low
Probability of occurrence:	Probable as a result of material removal activities within stream bed and riparian zones
Degree to which impact can be reversed:	High
Irreplaceability of resources:	Medium
Cumulative impact prior to mitigation:	Very low due to the existing degraded state of the river
Significance of impact pre-mitigation	Low
Degree of mitigation possible:	Moderate
Proposed mitigation:	<ul style="list-style-type: none"> ➤ Stockpiled material must be removed from the drainage/stream channel. ➤ The rehabilitation and re-vegetation of disturbed areas must take place post construction. Only appropriate indigenous riparian vegetation may be used for re-vegetation of disturbed areas.
Cumulative impact post mitigation:	Very Low
Significance after mitigation	Very Low

8. CONCLUSIONS AND RECOMMENDATIONS

The Oorlogskloof River is in a moderately modified ecological state, with low ecological importance and sensitivity. The expected impacts of the proposed activities are likely to be of a very low significance and limited to the already disturbed area surrounding the existing road and bridges, as well as the borrow pits. They are also likely to mostly occur while construction activities are taking place. Provided that the following recommended mitigation measures are implemented the significance of the impact is expected negligible:

- Construction activities taking place within the river channel and riparian zone should be limited as far as possible to ensure minimum disturbance of this area. Disturbed areas within the riparian zones should be rehabilitated as soon as possible after construction has been completed and revegetated with suitable indigenous riparian vegetation.
- Construction should preferably take place during the low flow period.
- All rubble and waste material resulting from the construction activities should be removed from the river and drainage channels.
- Invasive alien plants should be removed from the riparian zone of the disturbed areas.
- Runoff from the construction sites should be prevented from entering the stream but should rather be diverted through screens and off-channel retention ponds.
- All materials on the construction sites should be properly stored and contained.
- Disposal of waste from the sites should also be properly managed.
- Construction workers should be given ablution facilities at the construction sites that are located away from the river system and regularly serviced.
- Stockpiled material at the borrow pits must be removed from the drainage/stream channel and the sites rehabilitated after material has been removed.

The only proposed activity of concern is the proposed abstraction of water from the Doring River for Construction purposes. Due to the conservation and tourism value of the Doring River downstream of the proposed abstraction site, it is recommended that an alternative water source be found. A water use authorization application will need to be submitted to the Department of Water Affairs Western Cape Regional Office for approval of the water use aspects of the proposed activities, and in particular the proposed construction activities associated with the upgrade of the bridges.

9. REFERENCES

Department of Water Affairs and Forestry. (1999). *Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0*. Resource Directed Measures for Protection of Water Resources, Pretoria, South Africa.

Department of Water Affairs and Forestry. (2005). *River Ecoclassification: Manual for Ecstatus Determination (Version 1)*. Water Research Commission Report Number KV 168/05. Pretoria.

ANNEXURE A

DETAILS OF SPECIALIST AND DECLARATION OF INTEREST

APPENDIX 1: DECLARATION OF INDEPENDENCE BY THE INDEPENDENT PERSON WHO COMPILED A SPECIALIST REPORT OR UNDERTOOK A SPECIALIST PROCESS

I Antonia Belcher, as the appointed independent specialist hereby declare that I:

- act/ed as the independent specialist in this application;
- regard the information contained in this report as it relates to my specialist input/study to be true and correct, and
- do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- have and will not have no vested interest in the proposed activity proceeding;
- have disclosed, to the applicant, EAP and competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the NEMA, the Environmental Impact Assessment Regulations, 2010 and any specific environmental management Act;
- am fully aware of and meet the responsibilities in terms of NEMA, the Environmental Impact Assessment Regulations, 2010 (specifically in terms of regulation 17 of GN No. R. 543) and any specific environmental management Act, and that failure to comply with these requirements may constitute and result in disqualification;
- have ensured that information containing all relevant facts in respect of the specialist input/study was distributed or made available to interested and affected parties and the public and that participation by interested and affected parties was facilitated in such a manner that all interested and affected parties were provided with a reasonable opportunity to participate and to provide comments on the specialist input/study;
- have ensured that the comments of all interested and affected parties on the specialist input/study were considered, recorded and submitted to the competent authority in respect of the application;
- have ensured that the names of all interested and affected parties that participated in terms of the specialist input/study were recorded in the register of interested and affected parties who participated in the public participation process;
- have provided the competent authority with access to all information at my disposal regarding the application, whether such information is favourable to the applicant or not; and
- am aware that a false declaration is an offence in terms of regulation 71 of GN No. R. 543.

Note: The terms of reference must be attached.



Signature of the specialist:

15 May 2011

Date:

APPENDIX 2: ATTACHED CURRICULUM VITAE:

Full Name	Antonia Belcher
Profession	Aquatic Ecologist and Environmental Management (P. Sci. Nat. 400040/10)
Contact details	60 Dummer Street, Somerset West, 7139; Telephone: 082 883 8055

Relevant work experience:

Due to my involvement in the development and implementation of the River Health Program in the Western Cape, I have been a key part of the team that has undertaken six catchment or area wide 'state-of-river' assessments as well as routine monitoring and specialised assessments of rivers and wetlands in all the major catchments for the Western Cape.

Relevant work experience follows:

- Belcher, A. 2007. Freshwater Assessment Input into The Storm water Master Plan for the Upper Mosselbank River Near Durbanville, City of Cape Town.
- Belcher, A. 2008. Ecological Assessment of the Vlermuiskelderskloof Spruit. Proposed construction of an instream dam, Farm 143 Portion 4, Napier.
- Belcher, A. 2008. Freshwater Ecological Screening Study: Helderberg Integrated Waste Management Facility.
- Belcher, A. 2009. Freshwater Assessment: Proposed Upgrading of the Grabouw Wastewater Treatment Works.
- Belcher, A. 2009. Freshwater Assessment input into the Environmental Management Plan for Moorreesburg and Malmesbury.
- Belcher, A. 2009. Freshwater Assessment for the Proposed Improvement of Structures along the R27, Section 10 and 11 between Kenhardt and Keimoes.
- Belcher, A. 2010. Freshwater Assessment for the Proposed Improvement of National Route 7 Section 1 between the Melkbos and Atlantis Intersections