ROCK ENVIRONMENTAL CONSULTING (PTY) LTD

P.O. Box 40541
Moreleta Park
0044
601 Rubenstein Drive
Moreleta Park
www.rockeco.co.za

PROPOSED WIDENING OF THE N4 ALONG SECTION 5B BETWEEN BELFAST (KM 29.8) AND CROSS ROADS (KM 58.76), THE PROPOSED INTERCHANGE AT MILLY'S FILLING STATION AND THE PROPOSED INTERCHANGE AT MACHADODORP, MAPUTO DEVELOPMENT CORRIDOR, EMAKHAZENI LOCAL MUNICIPALITY, MPUMALANGA PROVINCE.

ENVIRONMENTAL MANAGEMENT PROGRAMME

Prepared for:

DEPARTMENT OF ENVIRONMENTAL AFFAIRS
ATTENTION: DIRECTOR: INTEGRATED ENVIRONMENTAL AUTHORISATIONS
PRIVATE BAG X 447
PRETORIA
0001

On behalf of:

SOUTH AFRICAN NATIONAL ROADS AGENCY LIMITED
MR M. MPHAHLELE
ENVIRONMENTAL SPECIALIST
PO BOX 415
PRETORIA
0001

Contact Person(s): **Pieter van der Merwe / Rowan van Tonder**

Tel: +27 12 997 4742
Fax: +27 12 997 0415
Email: rockec@lantic.net
Reg no: 99/28567/07
Director: PN van der Merwe B Sc(Hon) B Sc (Hon)
Environmental Management

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ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP) AND EXPERTISE

- EAP: P.N. van der Merwe (Director)
  - Expertise: Environmental Impact Assessments in Land-use and Infrastructure Development.
  - Years of experience: 24. Qualifications: B.Sc. Hons. Environmental Management PU for CHE.
- EAP: Rowan van Tonder
  - Expertise: Currently involved with various applications for activities under the National Environmental Management Act (NEMA) (Act 107 of 1998), Mineral and Petroleum Recourses Development Act 2002 (Act No. 28 of 2002), and National Environmental Management: Waste Act, 2008 (Act 59 of 2008).
  - Years of experience: 8. Qualifications: M.Sc. Botany (Conservation Management), B.Sc. Hons. Physical Geography - Environmental Management at TUKS. (FOR AN EXTENDED DETAILS, SEE APPENDIX 6 - EAP CV).

GENERAL TERMS AND ABBREVIATIONS:

Audit: Regular inspection and verification of implementation of the EMPr

Bund: A sealed enclosure under or around a storage facility to contain any spillage

Batch plant: Concrete or plaster mixing facility and associated equipment and materials

Contractor: Principal persons or company undertaking the construction of the development

Development site: Boundary and extent of development works and infrastructure

Engineer: Person who represents the client and is responsible for enforcing the technical and contractual requirements of the project

ECO: Environmental Control Officer: - Person tasked with monitoring implementation of the EMP during construction (* Refer to below)

Emergency situation - An incident, which potentially has the ability to significantly impact on the environment, and which could cause irreparable damage to sensitive environmental features. Typical situations amongst others are:

- Large spills of petroleum products and lubricants on site,
- Potential damage, erosion and slumping of unstable slopes,

- Indiscriminate dumping of construction waste on site, and accessing exclusion zones

RE/PM: Resident Engineer/Project Manager: - Person representing the Engineer on site

1. Introduction

This Environmental Management Program (EMPr) describes impact mitigation measures to be implemented during the construction and operation phases of the proposed N4 road upgrade and new interchange at Machadodorp.

The careful implementation and management of activities on site, during the entire process of project construction and operation, is vitally important. Focus should be placed on the activities to occur on the site of the proposed N4 road upgrade and new interchange at Machadodorp; however, consideration of the adjacent environment (socially and ecologically) is equally important. The mitigation measures represented in this EMPr should not be seen as static measures, but rather as methodologies that can be updated and improved during implementation, as and when site conditions become clearer. However, this EMPr sufficiently serves to provide the most practicable methods to promote sound environmental management during the construction and operational phases of the development.

The measures and principles are provided to assist placing impacts identified in another perspective - more towards the firm potential of mitigating the impacts during the development and implementation of the project. But this, as already mentioned, also implies that during the course of the project certain adaptations can be made or will be eminent during the construction implementation period. These adaptations will be the result of the EMPR monitoring exercise that is planned to take place during the construction period. The EMPR subsequently is an on-site working and dynamic document.

This section of the report provides recommendations on matters relating to the impact of the development on the physical environment, the biological environment and the social

environment (of the site and study area) by describing mitigation measures that are to be implemented.

2. Project Description

A proposed upgrading/widening of the existing N4, between Belfast (at kilometre mark 29.9 E) and Cross Roads (at kilometre mark 58.76 E) (see Fig. 1, pg. 37), is a linear entity which traverse different environmental conditions, characteristics and landscapes along the narrow corridor of its route. The attached locality map indicates its locality. (refer to the detailed map in Appendix 3A). More in particular it stretches from the interchange at Belfast towards the west, along the indicated alignment until it reaches the Waterval-Boven and Schoemanskloof split (Cross Roads) towards the east. The proposed access interchange at Machadodorp will also imply the construction of a short section of road which is proposed to improve access and traffic flow between the N4 and Carolina though the R541.

A broad study area was created around the new proposed interchanges at Milly's (probable at this stage) and for Machadodorp. Although no details of a proposed interchange at Milly's are available, a study area was determined that would accommodate a similar type of interchange as found at the Dalmanutha interchange. In fact there is also no absolute certainty at this stage that an interchange will be established at Milly's filling station.

The proposed upgrading and widening is planned within the proclaimed road reserve. An additional/extended 15 to 20m of road reserve, to the south of the existing road reserve will form part of this application and study area. As a result of widening several new service roads (with an additional 16m of reserve) especially to be used by farmers, will be constructed parallel and south of the new widened road reserve. This is to provide safe access onto the N4. It will be established in areas along this section of the N4 where unsafe accesses currently occur within relatively short distances from each other or at places with limited or dangerous traffic movement visibility. The accesses in these areas will be grouped into a single access where possible, to create safer traffic conditions and points of access onto the N4.

3. Description of the Environmental Aspects of the Activity

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
Geology	The route commences in the west at the Belfast interchange on Karoo sediments and crosses onto sediments of the Transvaal Supergroup, which extend to the end of the project. The Machadodorp Volcanics occur beyond the eastern limit of the project. On the Ecca area, the diabase occurs as boulder-strewn low ridges, generally occurring to the north of the N4. These are mostly in the form of sills or sheets, with occasional narrow dykes. The sills and sheets are intruded into the westward dipping sediments. Diabase, though more prevalent in the Ecca, is also present as limited occurrences in the Transvaal sediments. The uppermost formation of the Transvaal sediments, the Magaliesberg Quartzite Formation, are faulted into contact with the overlying Ecca. It occurs as a narrow, north-south trending band and locally forms low ridges with frequent rock outcrops on them. The Silverton Shale Formation comprises shales and flaggy shales (slate) and extends to the end of the project. These give rise to fairly subdued, rolling topography, with some low, rounded hills at the eastern end of the project. <u>Impacts:</u> • Blasting/Drilling of geology to accommodate bridge and road foundations.
Topography	The 'terrain type' of the area is classified as level plains with some relief to irregular plains with high hills and ridges. The terrain contains some distinct topographical sections, namely: ▫ A ridge between km 39 and km 42; ▫ Driefontein Spruit at km 43.3;

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	▫ De Kroon Spruit at km 47.5; ▫ Elands River at km 51.7; ▫ Tautes River at km 54; ▫ High hills between km 54 and km 56.2 Shallow valleys and natural drainage lines commonly occur in the study area. The slopes of the area have a very gentle slope to very steep slopes. The site falls within the Elands Quaternary catchment area (X21F catchment). <u>Impacts:</u> • Blasting/Drilling of geology to accommodate bridge and road foundations may alter the topography slightly.
Soil, Land Capability and Land Use	The land potential, and specifically the agricultural potential of a site, is determined by the combination of climate, soil conditions and slope prevailing in that region or site, resulting in the classification of areas with similar agricultural land potential. These land potential classes range from "Very High Potential" to "Very Low Potential". The Department of Agriculture has mapped the agricultural potential of South Africa. Using this mapping files, (Agricultural Geo-Referenced Information System[AGIS]), it can be seen that the study area as well as surrounding the site, the agricultural potential ranges from non-arable low to moderate potential grazing land to moderate potential arable land. The study area does represent large parts of terrain where intensive or extensive cultivation are or were practised. The area is characterized by agriculture. <u>Impacts:</u> • Soil compaction. • Possible soil erosion due to removed vegetation. • Surface disturbance and topsoil removal.
Flora	The study area is situated in the Lydenburg Montane Grassland. This vegetation type is characterized by grassland dominated by Aristida junciformis subsp. galpinii, Eragrostis curvula and

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	Themeda triandra. The vegetation types on site are further categorized by low shrubs like Phymaspermum acerosum and Anthospermum rigidum subs. rigidum. The ridges / outcrops of the study area itself also bring forth various concerns regarding possible red data flora. Impacts: • Stripping of surface vegetation during construction.
Fauna	The mammal study found that the N4 upgrade will have a small footprint when interpreted in the context of the relatively pristine and extensive grazing range in the district. In reality the development site has already been altered for the N4 in its present configuration, and that must be taken into consideration. The lush stand of grass within the road reserve serves as an excellent refuge for skittish small terrestrial mammals, and also as sponge for storm water. This habitat subcomponent will be replaced by the new road surface but a new sanctuary will naturally develop within the newly demarcated road reserve. The avifaunal study found that although the habitat along the route of the N4 highway offers suitable habitat for 13 Red Data avifaunal species, it is unlikely that the broadening of the N4 highway will have any negative effects on these Red Data avifaunal species due to a lack of or only suboptimal habitat conditions for these species. Most of the areas along the route of the N4 have already been disturbed by past and present human activities and more suitable habitat exits for these species in other areas surrounding the study area. The herpetofaunal study found that due to the presence of three habitat types, the study route have a good number of 85 possible herpetofauna species that could occur on the site. The possibility exists that three Red Data herpetofaunal species (Breyer's long-tailed seps, coppery grass lizard, large-scaled grass lizard) occur on the study site. The study site falls inside the Lydenburg Montane Grassland (Gm18) which has Vulnerable status. The study site contains part of a water catchment area

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	which, as an ecological mechanism, is very important. The rivers, streams and the drainage lines as well as their buffer zones should be considered as ecologically highly sensitive. <u>Impacts:</u> • Removal of surface vegetation thereby depleting food sources. • Human presence resulting in emigration of animals. • The disturbances of the vegetation cover and natural habitat will have a limited impact on the wildlife. However, it should be viewed against the background of the disturbances by human movement and activities through the area.
Surface Water	Sensitive features include the various rivers (Elands River & Tautes Loop), streams (Driefontein Spruit& De Kroon Spruit) and drainage lines with their associated wetlands. In the order of twelve wetlands occur in the study area which is often associated with drainage ways (perennial and non-perennial) containing prominent or wide flood plains. The potential impact of construction activities during the widening process of the N4 is identified as an important issue which need detail assessment and mitigation. The following wetlands were observed along the route (according to Galago): The systems of the study route all feed into the Elands River, including the Tautes River. A total of 32 aquatic ecosystems were observed along the route (nine of these are artificial systems). The study area has channelled valley bottom-, unchannelled valley bottom -, depression-, and seepage wetlands. <u>Impacts:</u> • Impacts on the river beds and wetlands will be caused by

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	the construction of bridges and possible siltation into rivers and wetlands. • Drainage line could be altered or blocked by construction activities.
Ground Water	Use of ground water resources is possible but is it anticipated that natural surface water sources would be used. A water license application is being conducted in this regard. WULA will concentrate on affecting the river banks. Impacts: • Low potential environmental impact predicted. • Temporary toilets (chemical) left unmanaged can leak raw sewage and effluent into the soil, surface and even ground water sources, during the construction phase.
Air Quality	Dust will be generated by vehicular movements on site. The tipper trucks from the nearby towns will also add to the negative impact on air quality, but only during the construction phase. Impacts: • Low potential environmental impact. • During the construction phase; dust could cause problems for nearby human settlements. During the construction phase the air quality will be the same as it currently is.
Noise	Noise generation by operating air compressors, excavators and other heavy machinery. Noise is also generated by the construction workers. Impacts: • Low potential environmental impact. • Noise from the traffic will be an inconvenience to a certain extent for some existing residential properties adjacent to the road in Machadodorp.
Visual	Visual and aesthetic elements of importance has been considered with respect to the proposed widening of the N4, but

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	will in general not be affected by the proposed activities of this project. Such elements are the hilly landscape and at places wide open horizons and hill slopes and drainage way valleys. During the site investigations and assessment it was noted that that current rock faces and cuttings need to be altered to accommodate widening of the N4. This will for instance occur in the vicinities of km 37.2 to 37.6, km 40.6 to 41.5, 43.0 to 43.2, 50.8 to 51.2, km 53.0 (R541 - Dullstroom that goes underneath the new bridge of the proposed interchange at Machadodorp and km 54.1 to 55.4. For the purpose of this report it needs to be noted that the widening of the road at Km 41.1 to 41.6 is anticipated to have an impact on the aesthetic quality of living conditions at the farm stead under the ownership of the Kempen family. The existing farm stead is approximately 91 m form the current road surface. The distance between the farm stead and the proposed road surface will be closer; approximately 84.2 m. A minor increase in traffic noise is expected, but it will be mitigated by the presence of the road cutting <u>Impacts:</u> • No significant impact. • Waste, such as building rubble and empty cement bags can be a negative visual impact if not collected and disposed of correctly.
Sensitive Landscapes	Sensitive landscapes identified will include all the drainage lines, streams, rivers and wetlands affected by the N4 upgrade and its interchanges. The aquatic delineation study identified a total of 37 aquatic ecosystems along the route (11 of these are artificial systems). A buffer of 50 meters (wetlands) and 100 meters (riparian areas) with a buffer of 32 meters for drainage lines must be applied.

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	Impacts: • Removal of surface vegetation thereby depleting food sources. • Human presence resulting in emigration of animals. • The disturbances of the vegetation cover and natural habitat will have a limited impact on the wildlife. However, it should be viewed against the background of the disturbances by human movement and activities through the area. • The movement of water into wetlands could be altered by construction activities. • Erosion of stream- and river banks due to vegetation removal. • Increased runoff due to removal of vegetation and increased soil compaction can lead to siltation of the riverbed downstream.
Sites of Archaeological and Cultural Interest	During the site investigations for the Scoping stage, focus was also placed on the presence of any stone built structure remnants, ruins, grave sites, monuments, complete built structures and the presence of artefacts. Based on preliminary observations, only the cemetery's boundary wall, at Machadodorp, could be affected by the widening of the N4 as well as by one on the interchange alternatives for Machadodorp. The assessment up to now of the terrain did not reveal issues related to heritage significance or impact on elements of historical or heritage value. The Berg-en-Dal Monument commemorating the Battle of Berg-en-Dal in 1900 as one of the last battles in the 2nd Anglo-Boer War needs to be noted as important. A narrow strip of land will encroach on the battle area in the widening of the N4 road reserve. Impacts: • No significant impact.
Socio-economic	The study area is characterized by various land use entities. The

Environmental Aspects	N4 Road Upgrade & Preferred/Proposed Machado Interchange
	its support to the community, like: ⊥ Job opportunities during the construction phase. ⊥ Local economic boost.
Interested and Affected Parties	Main concern is that Machadodorp will be economically negatively affected by the closing of the main entrance to Machadodorp.
Cumulative	The cumulative impact of the development on the social environment is positive. Safer roads. Seen at a wider scale the additional developments are not physically connected, but the removal of vegetation cover, such that the soil surface is exposed, may lead to increased soil erosion in the area. Where the removal of agricultural land is of a temporary nature it may add to a bigger combined loss of agricultural land in local area.

4. Sensitivity Maps

Also refer to Appendix 8 of the EIA report.

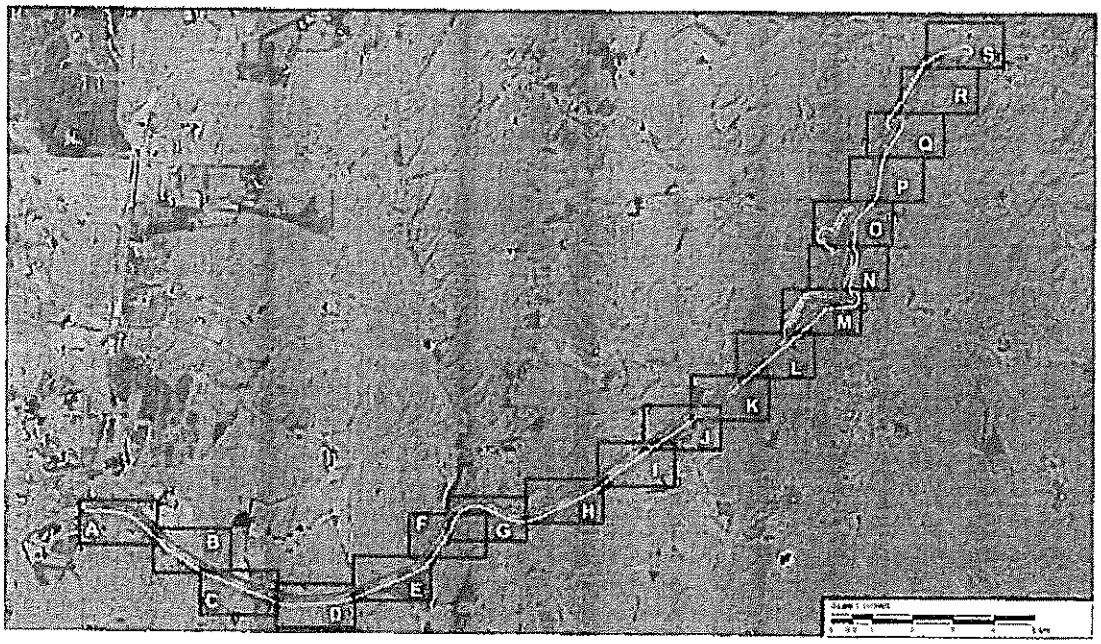
The following maps show the sensitivity of the study route in terms of faunal species and the aquatic ecosystems which include wetlands and riparian areas. Only medium and highly sensitive areas are indicated and the other areas that are not highlighted reflect a low sensitivity.

Sensitivity mapping rules:

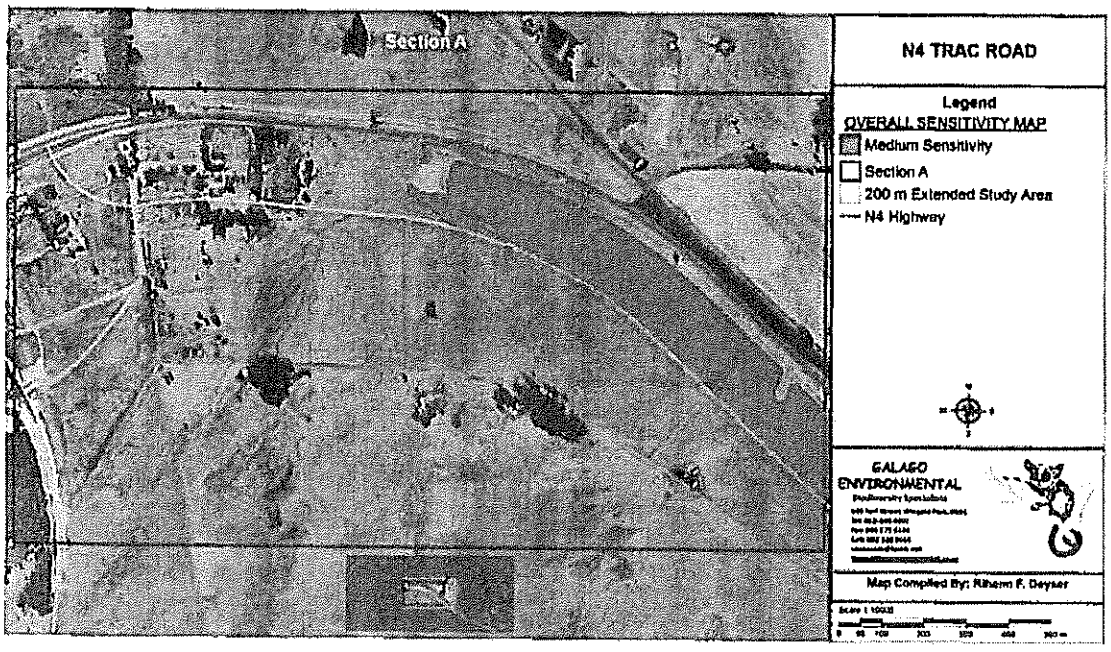
BIODIVERSITY ELEMENT	SENSITIVITY MAPPING RULE
Mammal and herpetofaunal habitat	Sensitive mammal and herpetofaunal wetland habitat + wetland buffers
Avifauna	Sensitive avifaunal habitat & 50 m buffers for the Half Collared Kingfishers
Wetland and Riparian areas	Wetland area + 50 m buffer, riparian areas + 100m buffer and drainage lines

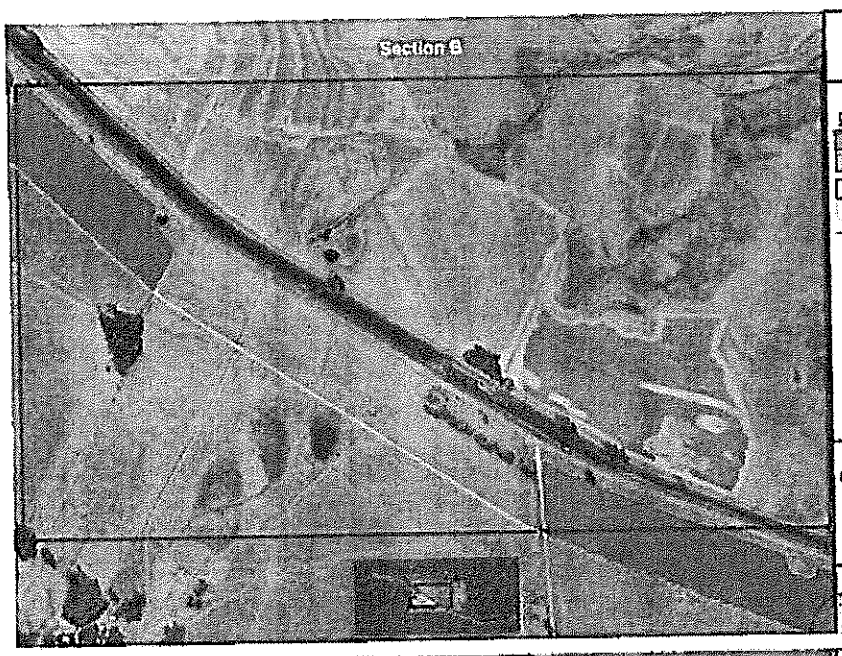
	+ 32 m buffer areas

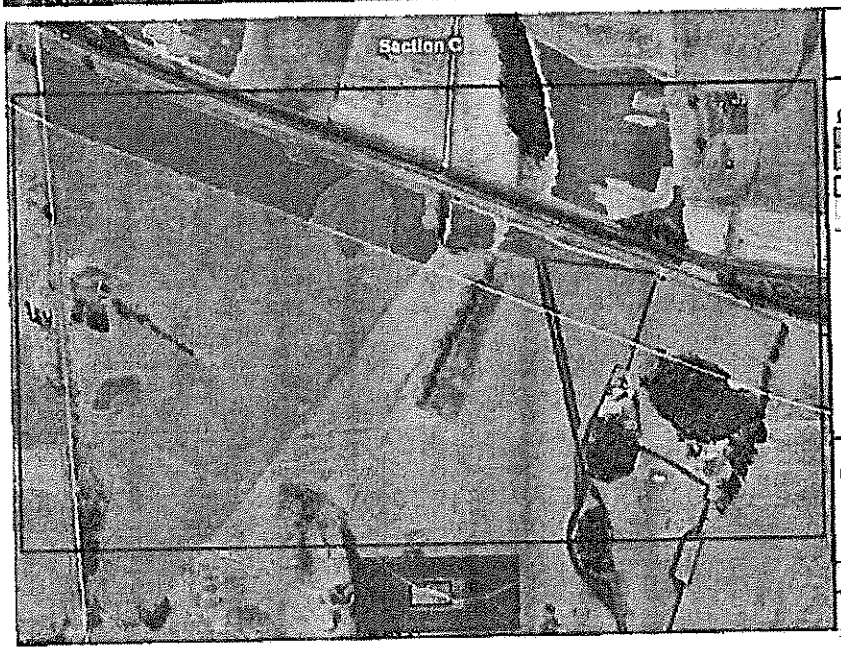
The study route was divided into different sections by the specialists for detail mapping as seen in figure below.



The following maps will reflect each section from A to S.




Section B
N4 TRAC ROAD
Legend
OVERALL SENSITIVITY MAP
Medium Sensitivity
High Sensitivity
Section B
200 m Extended Study Area
N4 Highway
GALAGO ENVIRONMENTAL
Map Compiled By: Rikarna F. Geyser


Section C
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Legend
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N4 Highway
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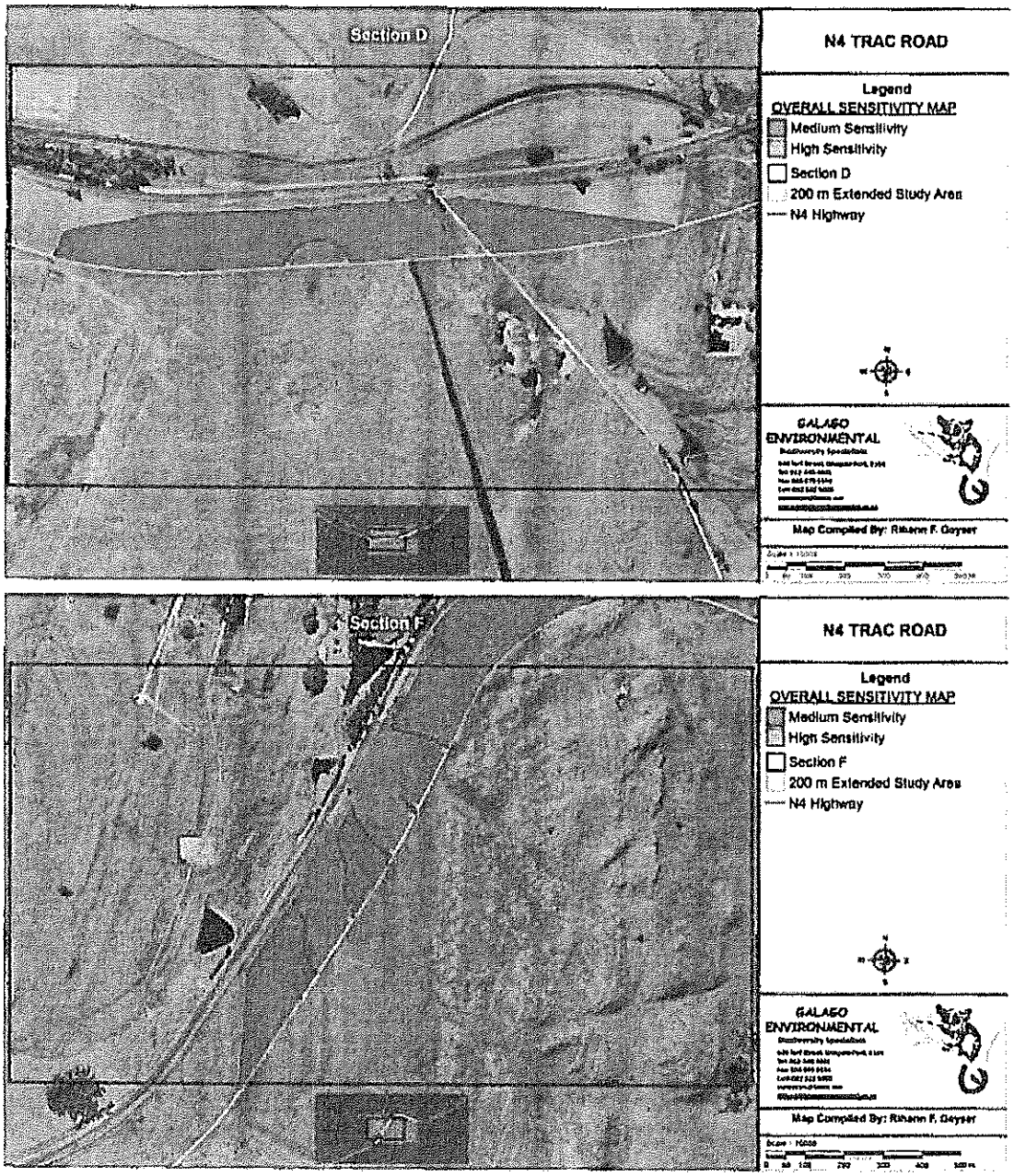
Map Compiled By: Rikarna F. Geyser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High Sensitivity
Section D
200 m Extended Study Area
N4 Highway
GALAGO ENVIRONMENTAL
Map Compiled By: Rihann F. Geyser
Section F
N4 TRAC ROAD
Legend
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High Sensitivity
Section F
200 m Extended Study Area
N4 Highway
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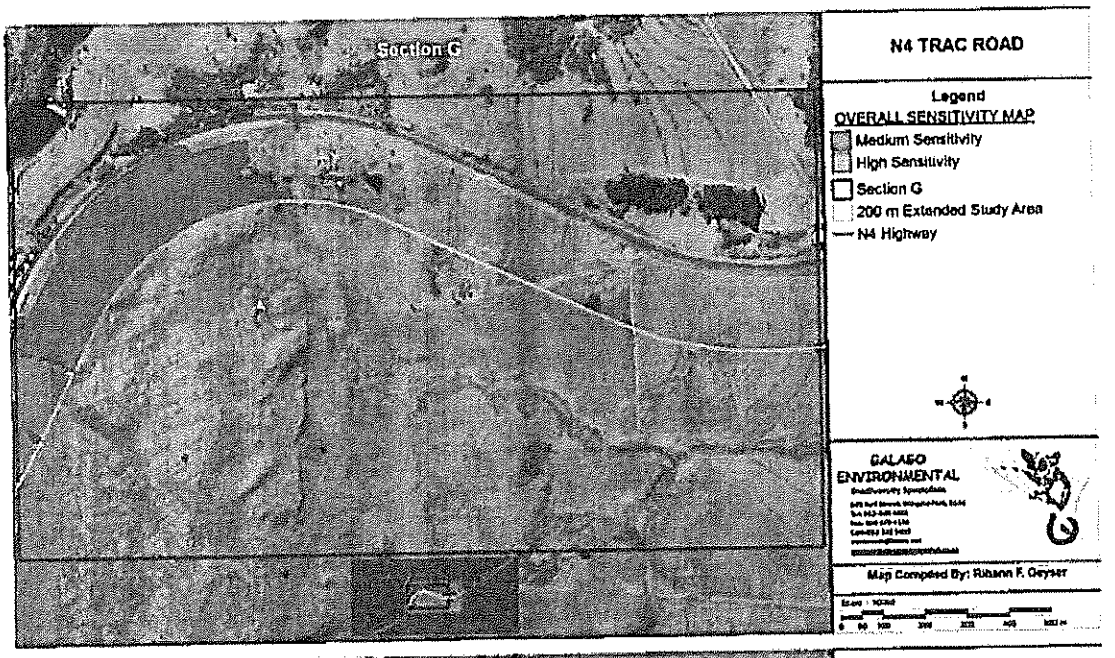
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N4 TRAC ROAD
Legend
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Section G
200 m Extended Study Area
N4 Highway
GALAGO ENVIRONMENTAL
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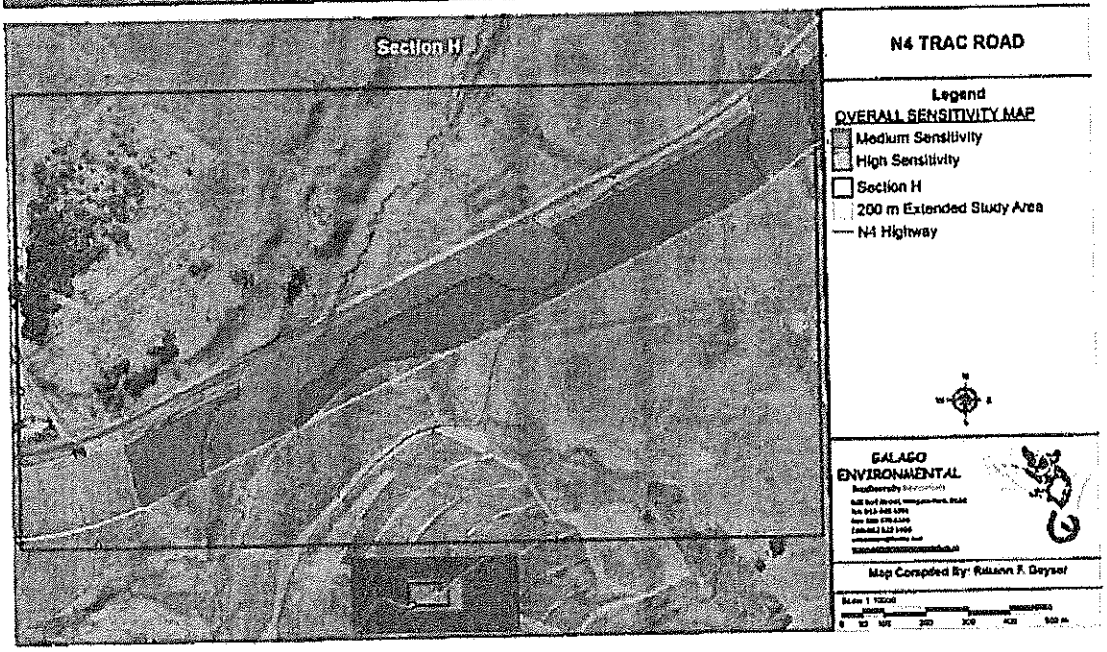
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N4 Highway
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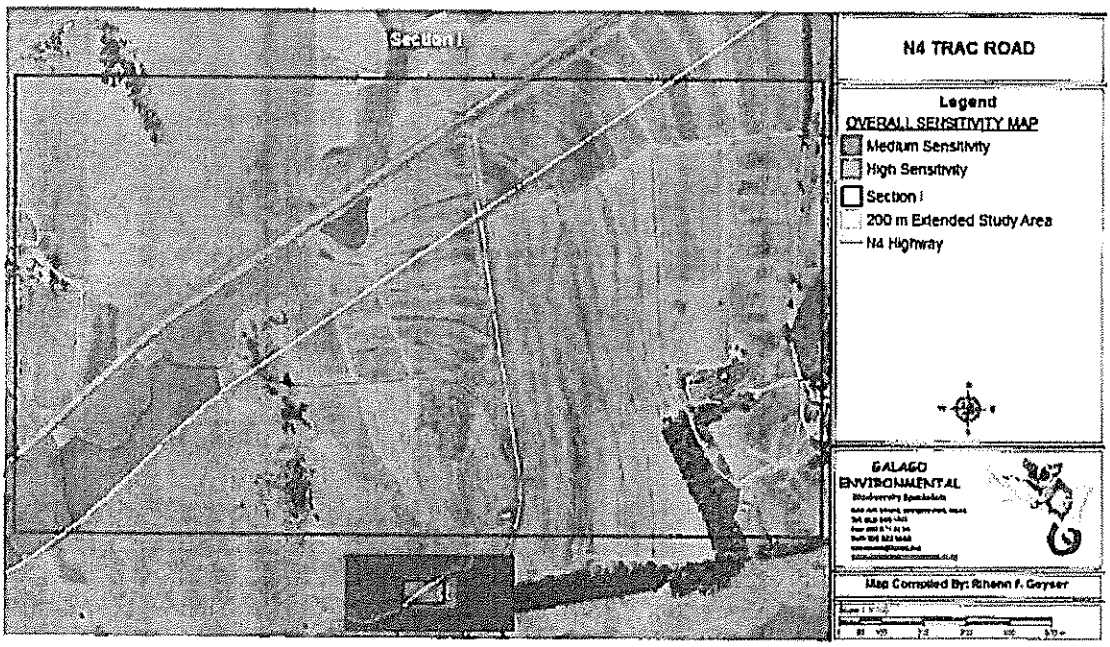
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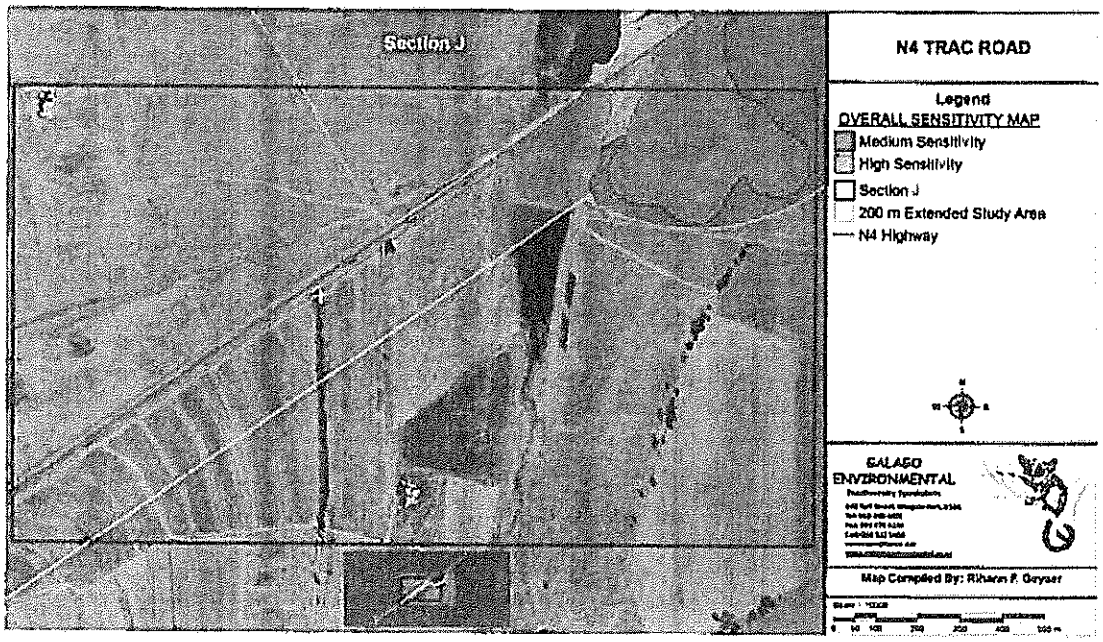
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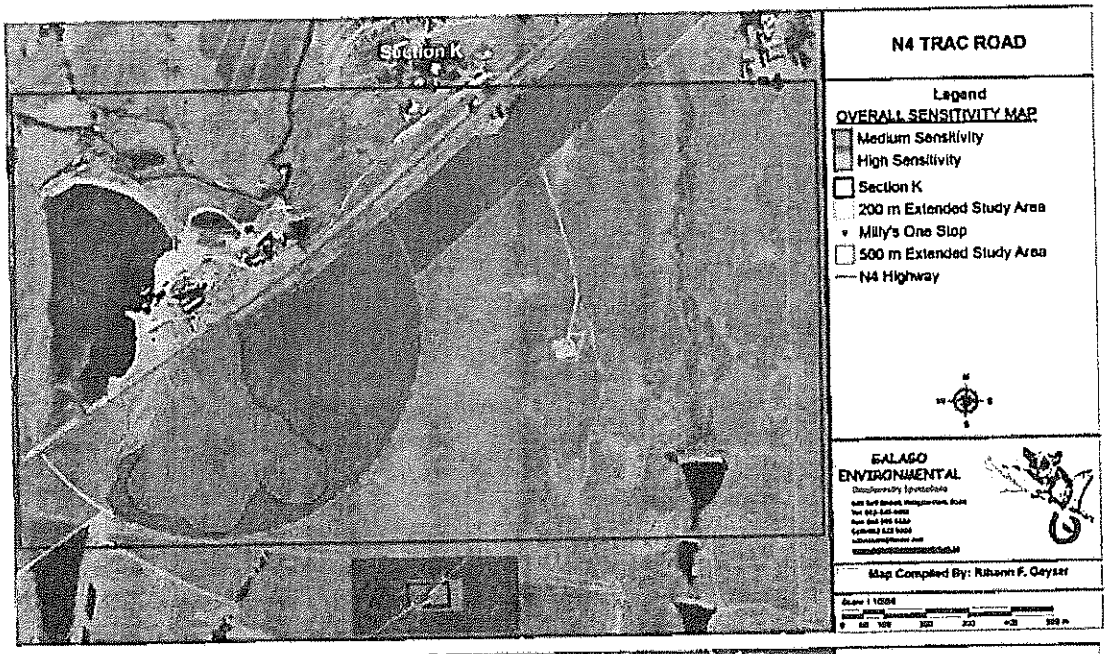
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200 m Extended Study Area
Milly's One Stop
500 m Extended Study Area
N4 Highway
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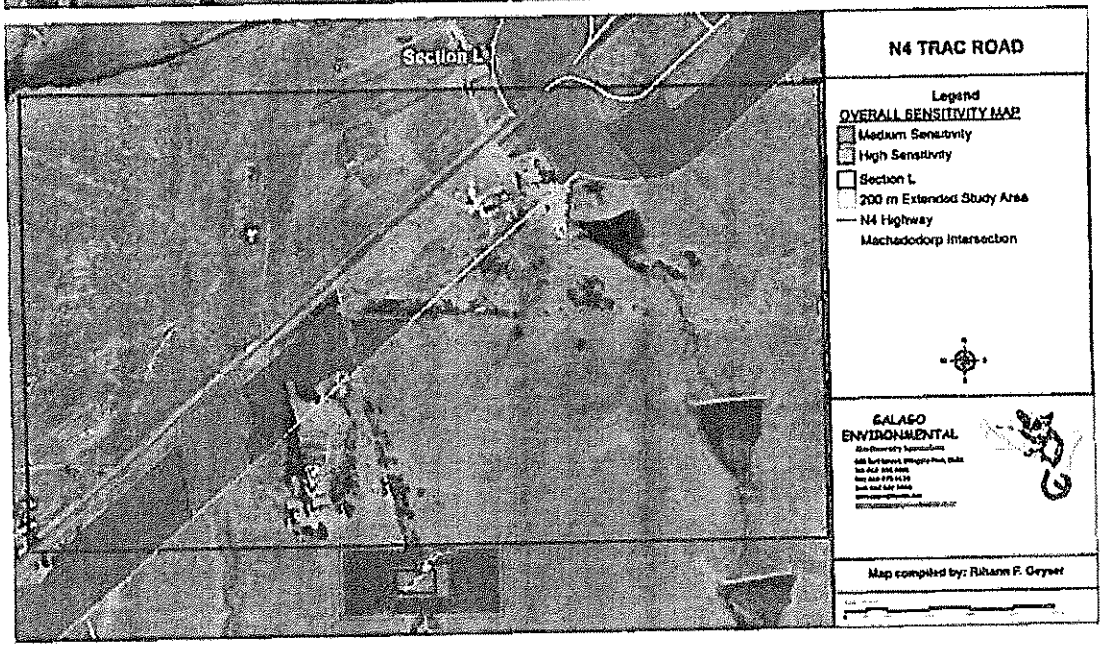
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200 m Extended Study Area
N4 Highway
Machadodorp Intersection
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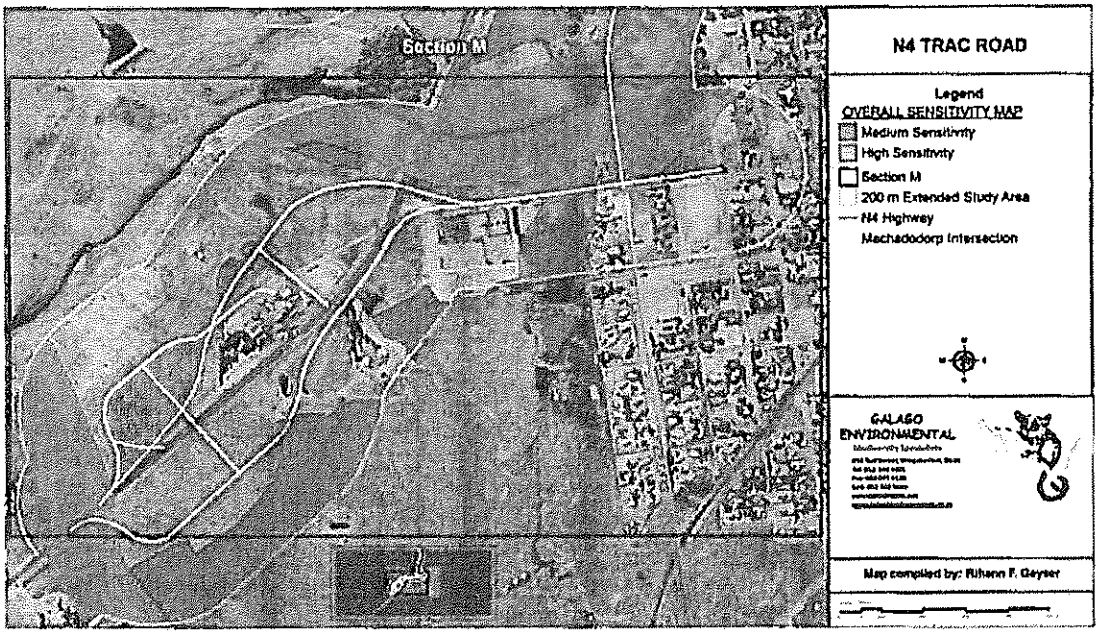
Map compiled by: Rihann F. Geyser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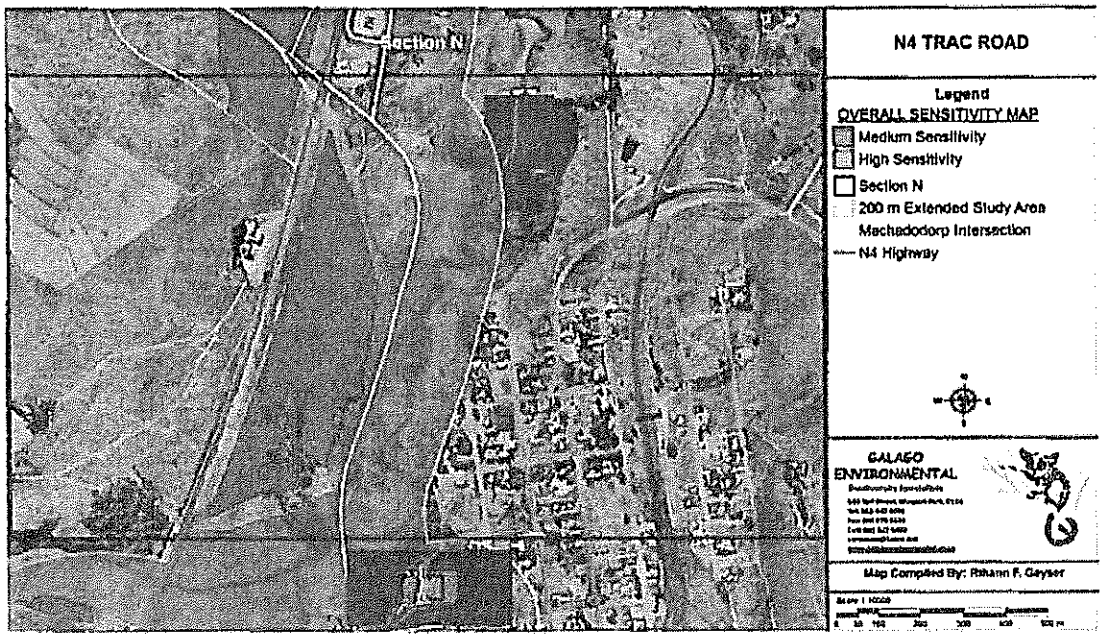
N4 Highway
Machadodorp Intersection
GALAGO ENVIRONMENTAL
Map compiled by: Rihann F. Geyser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Section N
200 m Extended Study Area
Machadodorp Intersection
N4 Highway
GALAGO ENVIRONMENTAL
Map Compiled By: Rihann F. Geyser


Section O
N4 TRAC ROAD
Legend
OVERALL SENSITIVITY MAP
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200 m Extended Study Area
Machadodorp Intersection
N4 Highway
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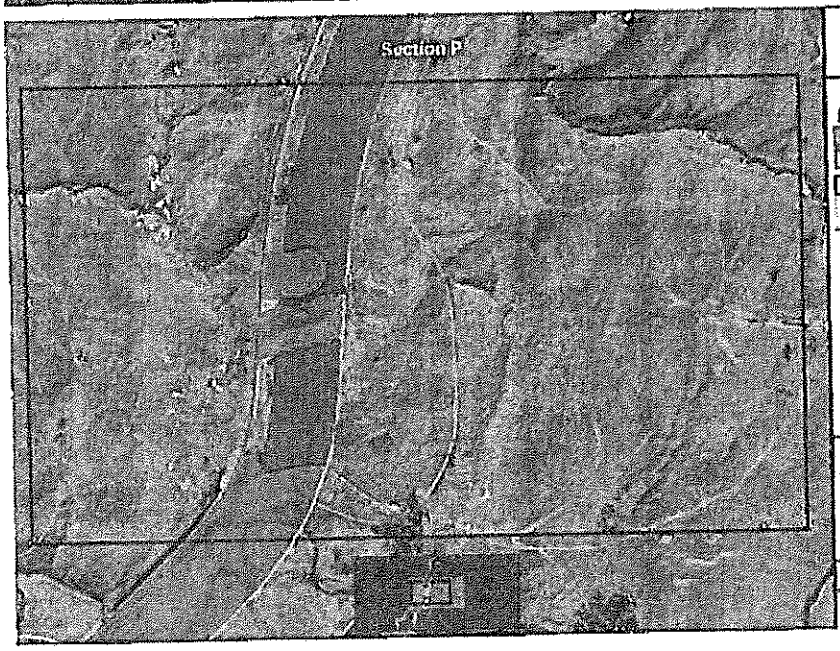
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GALAGO
ENVIRONMENTAL
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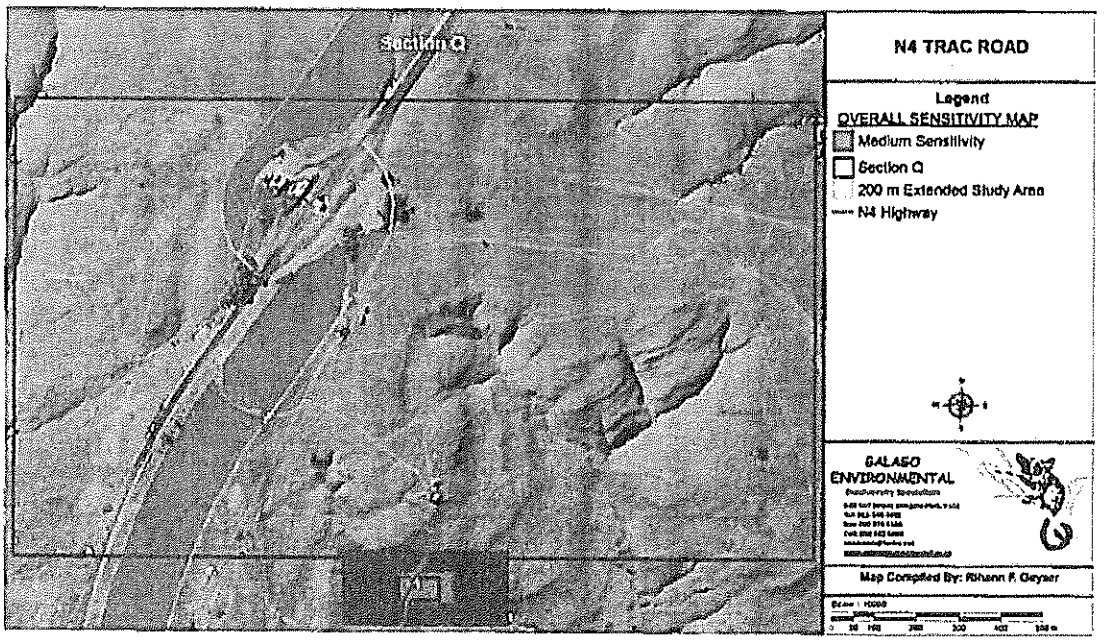
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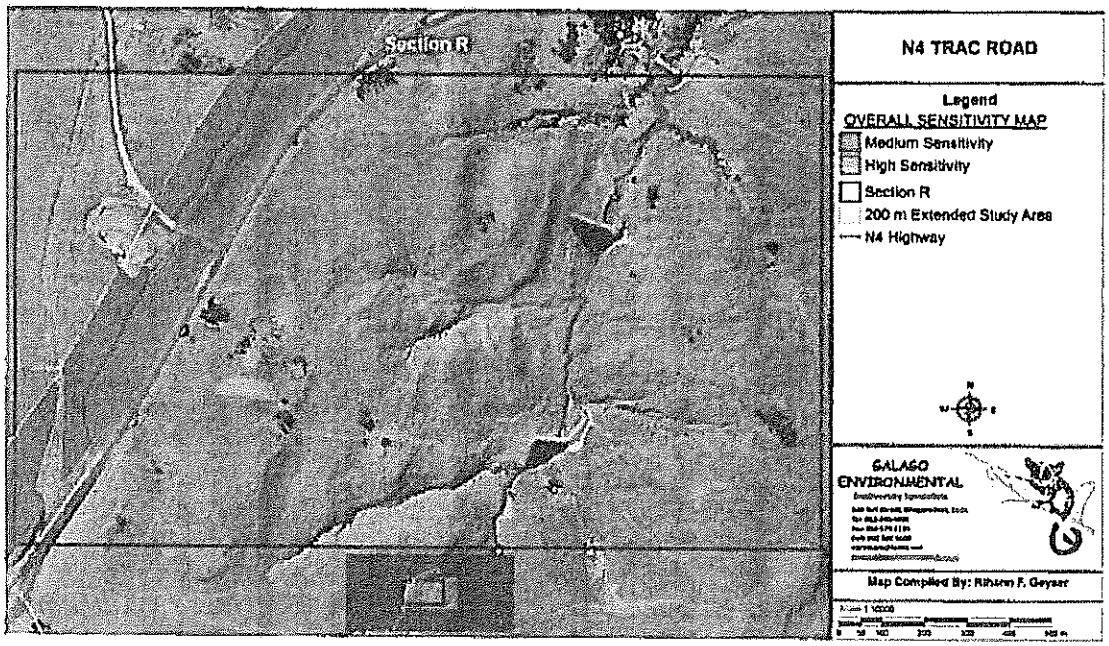
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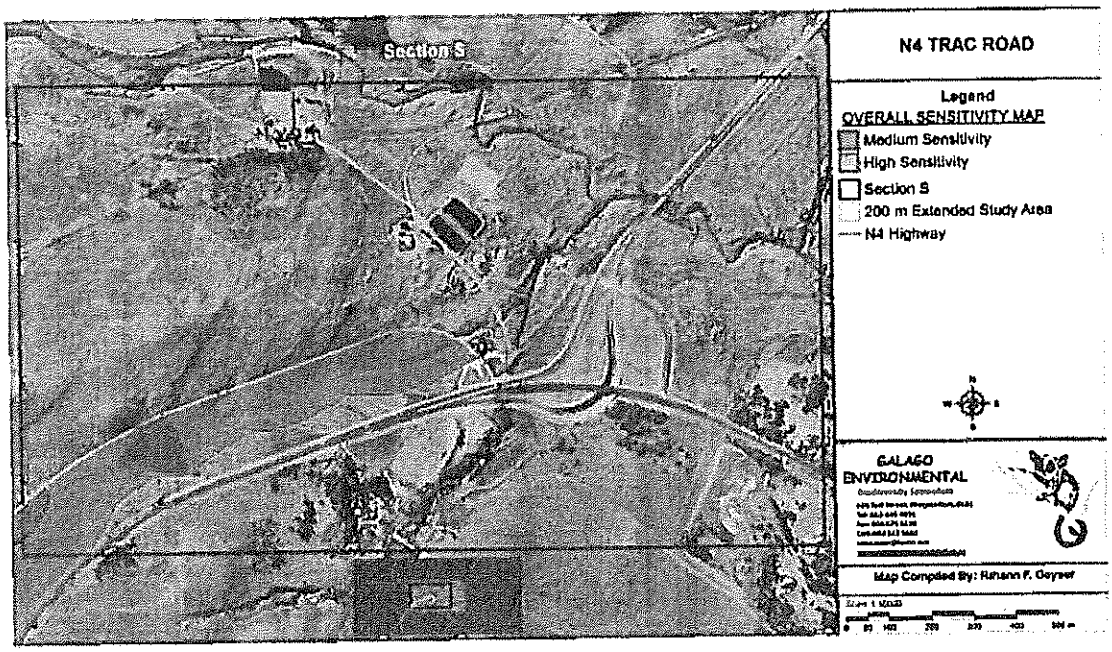
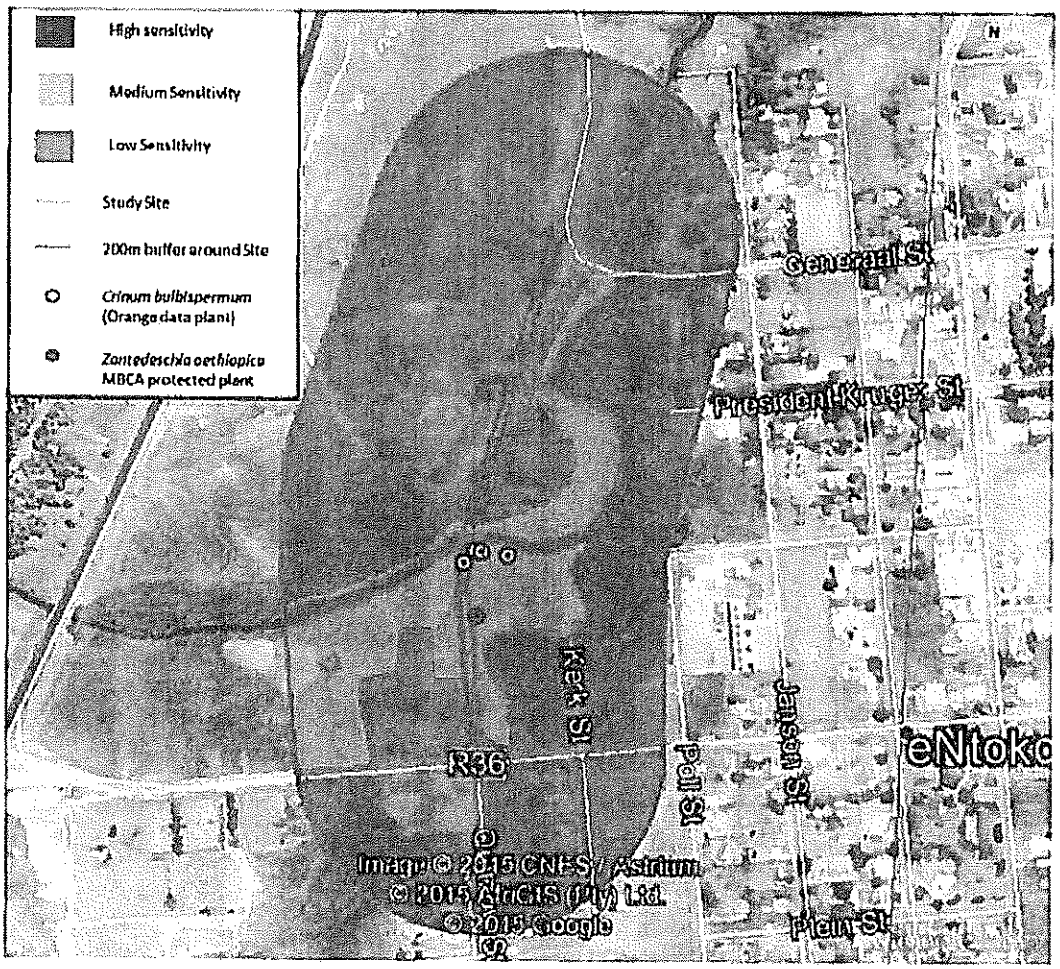
N4 Highway
GALASO
ENVIRONMENTAL
Map Compiled By: Rihann F. Geyser

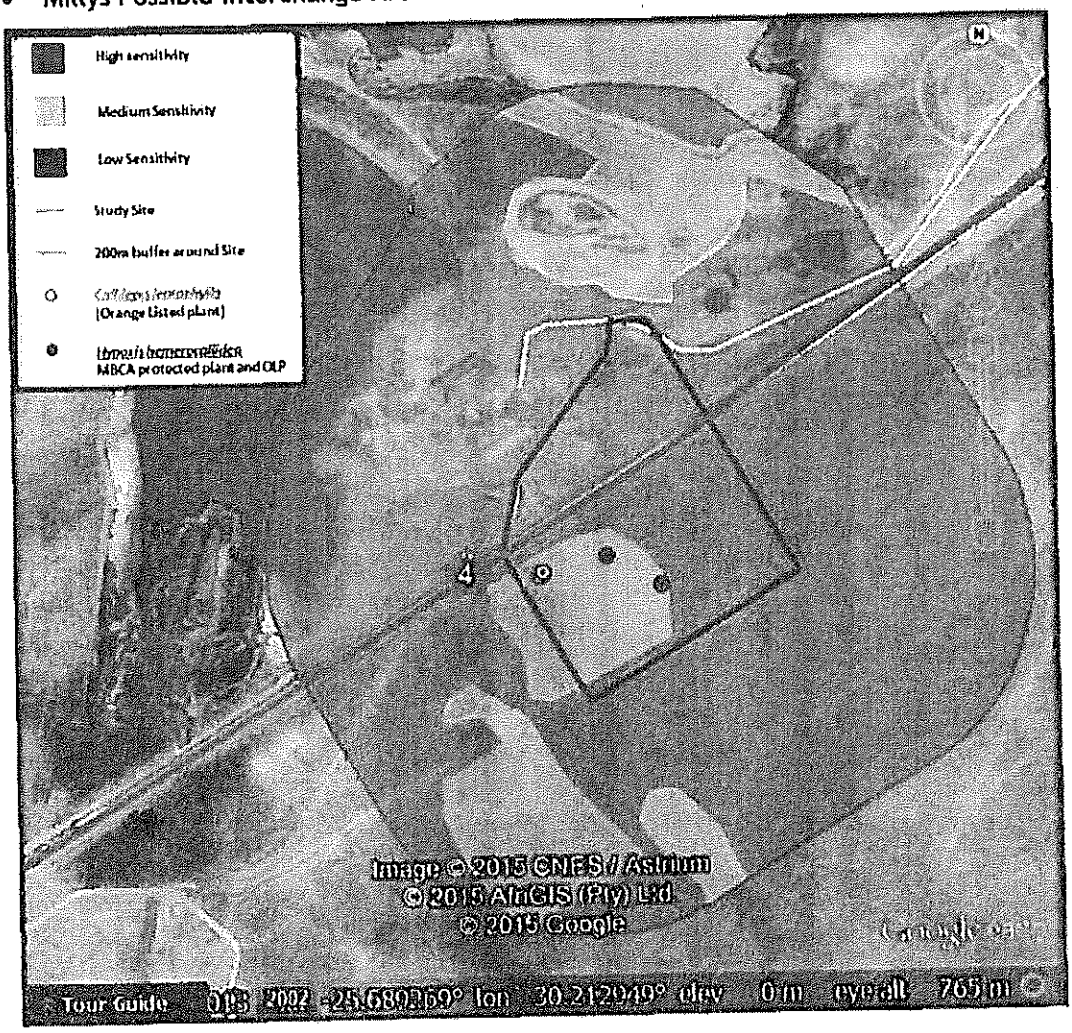


The following set of sensitivity maps focus on the vegetation along the route affected in specific areas of concern. Areas containing untransformed natural vegetation of conservation concern, high diversity, habitat complexity, red list organisms and / or systems vital to sustaining ecological function are considered sensitive. In contrast, areas that are transformed and have little importance for ecological functioning are considered to be of low sensitivity. No sensitivity map was drawn up for this route as it is in access of 20 km. Areas contained in the Mpumalanga Biodiversity Conservation Plan (MBCP), see Appendix 3A of the EIR, and identified as Circle A and B in Figure 3, of the Vegetation Assessment Report, is deemed as high sensitivity areas and corresponds with the rating given in the MBCP.

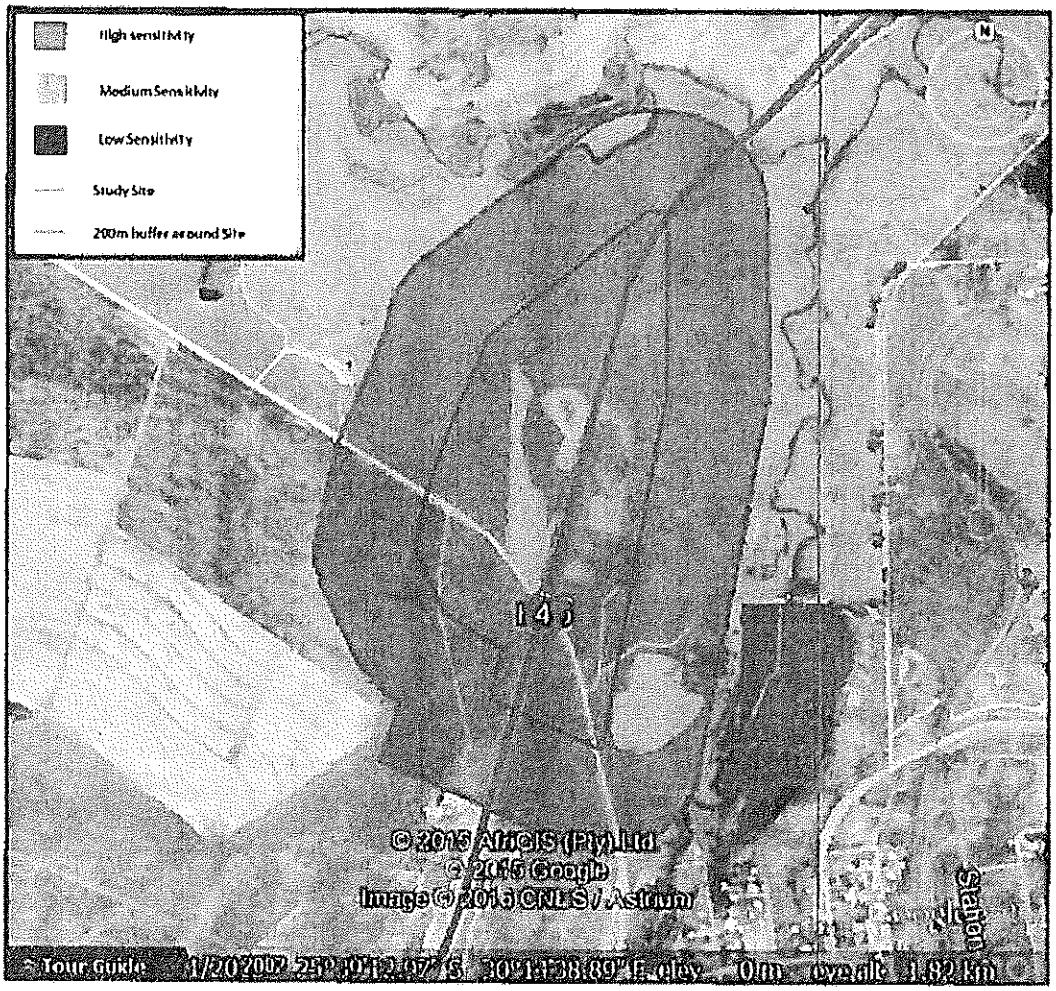
- Machadodorp R36 Link



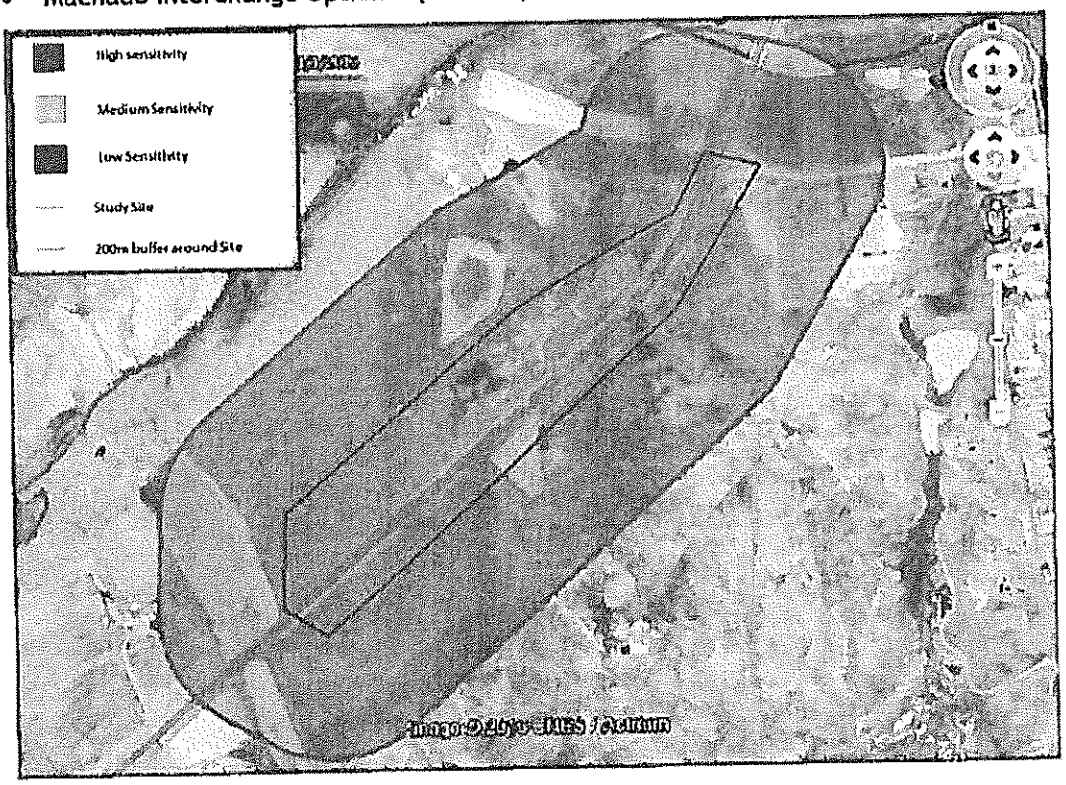
- Millys Possible Interchange Area



- Machado Interchange Option 1 (1A)



- Machado Interchange Option 2 (1B & 1C)



5. Description of the Impact Management Objectives for all Phases of the Development

5.1 Recommendations Applicable to the Planning and Design Phase

There are a number of potential impacts that can be mitigated through careful design of technical/physical project components. The following design components are relevant in this regard:

- Providing safe access to and from the proposed construction sites;
- Determine safe access points along this section N4;
- Determining to most suitable and affordable area for the interchange to be implemented;
- Design proper storm water infrastructure to prevent excessive erosion occurring;

- Visual and aesthetic impacts of the road development on the surrounding environment - rehabilitation of exposed/cleared will be an important component in this regard.

Implementation responsibility: The site engineer will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2 Impact Mitigation During the Pre-Construction & Construction Phase

This stage represents the period immediately after site hand over. The contractor must be made aware of the contents of the EMPr, even if there are sections in the tender documentation which referred to environmental impact management measures to be budged for and implemented.

The following "rules" must be implemented to make the document relevant and handy on site:

- The EMPr shall not be removed from the site office
- The EMPr shall be updated when necessary
- The EMPr shall be readily available to the Resident Engineer/Project Manager, and the site manager
- The ECO shall monitor the state/condition of the document and how it is kept on site. He will provide new printed copied when the EMPr is updated or adapted.
- The EMPr shall be available on site to any Interested and affected party but shall not be removed or copied to such a party or person.

The Environmental Policy that can be put forward for the construction of the N4 upgrade and interchange should be read as follow and should be pinned up at the Construction office.

The objective and aim of the final product of this road development is the creation of an environmentally sound transport facility that will be seen and function as an environmental asset in biophysical and socio-economic terms. The objective will be achieved through careful implementation of all measures pertaining to the protection of the environment during construction and operational stages of the project.

This policy will be conveyed to the appointed main contractor and his team by the Resident Engineer during the construction phase.

5.2.1 Management of impacts on vegetation cover and faunal habitats

The clearing and removal of the existing vegetation (also consisting of cropland), for the construction of the activity, will be necessary. However, due to the existence of indigenous pristine grassland and wetland vegetation and the size of area affected, the significance of this impact is rated as high. The management of impact on natural vegetation cover is important to keep the overall impact on the natural environment and current ecological conditions as low as possible.

The propagation of exotic species and weeds will need to be controlled during the construction phase, as there are many activities on site that could lead to the establishment of weeds - including compaction of the soil by heavy machinery, construction waste, stockpile areas, fringes of the site office terrain, and fringes of temporary access roads, etc. Weed species should be removed on a four-week basis. It is recommended that only the same grass composition of the area be used in the landscaping/rehabilitation process and that trees/natural bushes are incorporated into the landscaping design where appropriate.

Members of the community who collect plants of medicinal value must be allowed to collect such material in the road reserve two weeks before clearance of vegetation starts.

The crossing of natural drainage systems should be minimized and only constructed at the shortest possible route, perpendicular to the natural drainage system. Where possible, bridge crossings should span the entire stretch of the buffer zone. The appropriate agency should implement an ongoing monitoring and eradication program for all invasive and weedy plant species growing within the servitude. Rehabilitation of natural vegetation should proceed in accordance with a rehabilitation plan compiled by a specialist registered in terms of the Natural Scientific Professions Act (No. 27 of 2003) in the field of Ecological Science.

Innovative landscaping or re-vegetation of the site towards the end of the construction stage will contribute significantly to the visual and aesthetic attractiveness of the site and

will also solve the problems associated with the removal of vegetation cover, including soil erosion, dust generation and the flourishing of weeds and/or other unwanted exotic species in the long term.

Where a road is to traverse a wetland, measures are required to ensure that the road has minimal effect on the flow of water through the wetland, e.g. by using a high level clear span bridge or box culverts rather than pipes. Prior to construction, fences should be erected in such a manner to prevent access and damage to any sensitive areas identified in a sensitivity mapping exercise. Sealing of surfaces under a bridge or gabion construction should be avoided.

Disturbance to any wetlands during construction should be minimized. A plan for the immediate rehabilitation of damage caused to wetlands should be compiled by a specialist registered in accordance with the Natural Scientific Professions Act (No. 27 of 2003) in the field of Ecological Science. This rehabilitation plan should form part of the EMPR and a record book should be maintained on site to monitor and report on the implementation of the plan. Engineering measures are recommended to lower the risk of spillages into any wetlands located within 200 m of the road.

Where possible, work should be restricted to one area at a time, as this will give the smaller birds, mammals and reptiles a chance to weather the disturbance in an undisturbed zone close to their natural territories.

The ECO must be alerted to the fact that the snaring or hunting of wild animals often takes place in the vicinity of construction sites. This must be punished if there if proof that such a practice is conducted by members of the construction team. The contractor must ensure that no fauna is disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance. It is suggested that where work is to be done close to the drainage lines, these areas be fenced off during construction, to prevent heavy machines and trucks from trampling the plants, compacting the soil and dumping in the system. During the construction phase, noise must be kept to a minimum to reduce the impact of the development on the fauna residing on the site. Alien and invasive plants must be removed.

A comprehensive surface runoff and storm water management plan should be compiled, indicating how all surface runoff generated as a result of the road development (during both the construction and operational phases) will be managed (e.g. artificial wetlands / storm water and flood retention ponds) prior to entering any natural drainage system or wetland and how surface runoff will be retained outside of any demarcated buffer/flood zones and subsequently released to simulate natural hydrological conditions. This plan should form part of the EMPr.

Where roads traverse streams/rivers, an underpass should provide for the movement of aquatic as well as terrestrial species through the inclusion of appropriate buffer zones within the underpass (a 32 m buffer zone from the edge of the riparian zone recommended for rivers within the urban areas and a 100 m buffer zone from the edge of the riparian zone recommended for rivers outside the urban area).

Suitable terrestrial underpasses should be provided to facilitate safe movement of animals, specifically where roads traverse important species/climate change corridors or ridges or habitat suitable for any Red/Orange List amphibian/ reptile/ mammal species. Underpasses should be accessible to maintenance staff and should be cleared of accumulated material at least at the start of each rainy season.

5.2.2 Management of impacts on soil (stability and erosion of disturbed surfaces)

Given the topography of the site, sheet and gully erosion (which is typically experienced when construction takes place during the summer rainfall months) of the topsoil layer could occur. If surface erosion DOES become prevalent during the construction phase, it should be curbed through control measures such as placing sand bags at the highest point to stop the cutting back of rill/gully and at the lowest point of water run-off areas to halt the sediment transport and erosion that will otherwise occur.

Aspects that typically impact on soil conditions are blasting activities, excavations for the founding of foundations, establishment of stockpile areas, removal and/or clearance of vegetation, movement of construction vehicles, and maintenance of construction vehicles, construction camp establishment and sanitation provision to workers during the

construction period. Therefore, the following recommendations pertaining to soil conservation practices are made:

- Topsoil should be stockpiled separately from subsoil. The height of the stockpiles may not exceed 2.5 m and the stockpiles should not be stored for more than a one year period.
- Topsoil must be stripped from all areas, where construction activities are going to take place, to be re-used in landscaping the site.
- If any blasting activities occur on site, the blasted rocks and heavy rock material must be transported to an external venue. These rocks are not allowed to rest on site. If the rocks are left on site, the soil will be greatly compacted, which will promote the growth of weeds.
- Any excess overburden material that is generated may not be dumped in a random manner. Dumping sites should be predefined, agreed upon and adhered to.
- Any embankments created adjacent to the roads or any drainage lines must be stabilised during construction and re-habilitated afterwards.
- Generally, surface water must be prevented from damming or creating gully erosion. This can be achieved by placing sandbags along the boundaries of steep working areas where higher intensity surface run-off may occur.
- All rills and erosion channels developing during the construction period or during the operational and maintenance period should be backfilled and consolidated immediately.
- The movement and maintenance of construction vehicles may only take place in pre-determined and delineated areas. Only planned and formal routes for hauling of material should be used.
- Soil contamination during construction vehicle maintenance or as a result of fuel storage on site is easily prevented, but in the event of such an accident, the spill should immediately be cleaned up by absorbing the worst of the fluid with saw dust and then disposing of the saw dust and the first bit of the soil layer.
- Fuel storage areas should be bounded effectively and all applicable safety standards must be adhered to.

In terms of the stability of excavations, it is strongly recommended that all excavations exceeding 1.5 m should have proper sidewall protection to ensure the safety of workers. Seepage may result in the destabilising of the soils above the seepage and special precautions may be required. The contractor is responsible for the implementation of suitably designed support systems. Constructed embankments exceeding 1.5 m, or as deemed necessary by the design engineer, can be stabilised/protected by means of retaining walls. Embankments should be adequately compacted and protected from erosion.

5.2.3 Construction vehicle maintenance and fuel storage

Vehicles may not be serviced within 200 m of any stream or drainage course in general. Servicing must be limited to designated areas within the construction camp only. These designated areas must be identified as least sensitive. No temporary fuel storage tanks or containers will be erected closer than 200 m from a drainage course and refuelling have to be done by means of fuel bowers.

One workshop area should be established. This will be situated in the construction camp. The workshop area should be able to handle minor servicing, while major servicing will take place at the applicable agents. If major servicing of heavy equipment needs to take place on the site, personnel or contractors specializing in this field will service the vehicles on site. This action will be strictly monitored by the ECO.

The storage of fuel on the site must not exceed 80 000 litres in total to avoid a new application for authorization needed. Fuel storage areas must be bunded effectively and all applicable safety standards have to be adhered to. Bunding have to in containment volume be 110% of the total volume of the storage tanks. Bunding must be done by building a plastered double brick wall round the tanks.

In the unlikely event of soil being severely contaminated by oil, fuel or chemical leakages shall be removed and disposed of at a waste disposal site identified by the RE. All major servicing of plant and vehicles will be done off site, at the contractor's premises. All used oil shall be retained and disposed of by recycling at a recycling centre or disposal in any other manner approved by the ECO.

The contractor shall educate workers on the appropriate methods for workshop maintenance and fuel points to prevent fuel and oil being washed out of the containment areas. The ideal situation would be to have only one fuel point, but the size of the terrain makes it highly unpractical for this measure to be practically applicable. Approximately two refuelling points will be required, but this may change in future to three when the final phase is constructed. These will all be adequately bunded. Mobile or tanker refuelling must take place only where there are sufficient Bunding structures in place.

- The contractor will provide a concave concrete floor slab to prevent erosion and infiltration of the ground water by petroleum products.
- The slab shall drain into the temporary oil skimming tank
- The contractor shall provide double layered brick bunded walls around the maintenance area. These walls must be kept well maintained to prevent storm water flow through the bunded areas.
- Where the drain passes through or across the bund wall the contractor shall provide a means of preventing flow so that in the event of a leak or overflow from the skimming tank all liquids can be contained by the bund walls.
- All major spillage of oil onto concrete surfaces shall be controlled by the use of an approved absorbent material.
- Toxins and oil recovered shall be collected in drums and disposed of in the same manner as for used vehicle oil.
- All servicing must take place at the contractor's premises. Minor services to take place at the permanent camp.
- Wash bays for construction vehicles must drain into catch pits, separation tanks and into a sealed compartment from where the treated water can be used for dust suppression. Al drainage systems associated with the wash bays must be cleaned every two weeks or when required.

Implementation responsibility: The main contractor and RE will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.4 Stock pile areas and other storage facilities

- Temporary material storage areas and/or vehicle and equipment parking areas may not be established close to water courses - perennial or non-perennial.

- Stock piles take up natural area space and it is therefore recommended that stock pile areas and building material storage facilities not be established in the areas where surface disturbance is to be limited.
- No equipment may lie in undesignated areas as this will contribute to soil compaction and even the spreading of weeds.
- Stockpiles of over burden material and topsoil must be protected during heavy rainfalls. Topsoil may not be allowed to be washed away. Topsoil as a growth medium for vegetation must be protected at all costs. This topsoil must be used during the rehabilitation of disturbed sections. Protection of topsoil can be enhanced by grass seeding of topsoil stockpiles. A grass cover over the topsoil stockpiles will stabilize the slopes and will put organic material and grass seed back into the soil prior to being used as topsoil on the terrain.
- All stockpile and equipment storage areas, if this is not part of the Site office and construction camp, must be fenced.

The "**protection of stockpiled topsoil must be done as follows:**

- Place sand bags along the toe lines of the stock pile areas.
- Top soil stripping in windy or rainy conditions must be avoided as far as possible
- The handling of topsoil must be limited as far as possible. Although it is preferable for the topsoil to be handled as little as possible, it cannot be guaranteed that it will not be handled more than twice. Topsoil handling will be determined by practical considerations and actions on site as the project progresses.
- Although it would be preferable to make the height of topsoil stock piles no more than 2 m, it is just not possible the majority of the time on site due to the huge volumes of topsoil and spoil that need to be stockpiled.
- Soils from different zones must be kept separate and distinguishable.
- Stockpiles will be cleared form alien vegetation before being re-introduced.

The storage of aggregate must comply with the following:

- Fine aggregate shall be stored on a compacted earth platform.
- The contractor shall ensure so that no excessive amount of fine aggregate is washed from the storage area onto the rest of the site with the use of barriers designed to the satisfaction of the RE. Coarse aggregate shall be stored, as a minimum, on a surface of compacted inert sub-base material.

In terms of fill and layer works material the following must be implemented:
The stockpiled area is to be ripped and re-vegetated upon removal of stockpiled material. Clearly defined borders for the stockpiling of material shall be stipulated by the Project Manager and the contractor shall contain stockpile within these boundaries.

Implementation responsibility: The main contractor & RE will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.5 Community and traffic safety during the construction period

- The safety of the community within the residential plots along the road is of utmost importance throughout the construction period.
- Vehicular movement to and from the site must be adequately sign posted and adhered to.
- Adequate and correct signage and road marking.
- Monitoring of dust levels on those paths "off the link roads" which heavy vehicles will cross, will be essential. Increased dust levels will impair the vision of passing vehicles.
- Large construction vehicles might impact on road safety circumstances. It is the duty of the contractors to ensure that safety measures are implemented and adhered to and the drivers are aware of the patterns of the traffic movement in the surrounding area.

The residential areas of places close to activity nodes are important in this respect. These places are teaming with the movement of pedestrians and vehicles and therefore special care must be taken to warn the community of the dangers associated with the construction phase through the appropriate warning signs.

- It is recommended that the Resident Engineer must discuss construction times and schedules with the relevant Emergency Services and local authority as well as the relevant traffic department and SAPS.
- The movement of workers in the area must be monitored closely to prevent loitering and subsequent crime. The labour force during construction must be well administered and full ID records must be kept on file for all workers.

- If blasting is undertaken the necessary safety measures must be implemented by the blasting contractor. No explosives will be stored on the site at any stage of the project

Implementation responsibility: The main contractor & RE will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.6 Waste disposal and management

- The uncontrolled disposal of construction waste and litter must strictly be prevented during the construction period.
- Waste related to construction includes the following. (This inventory must be expanded upon as the construction period progresses).

Solid waste:

Plastic and rubber packaging material, Plastic tubing, Concrete slabs, Concrete piping, Metal tubing, Metal brackets, Batteries of all types and sizes, Fence wires, Corrugated iron, Food packaging - paper, carton and polystyrene, Beverage tins and plastic bottles, Plastic containers of all sized and uses, Glass material e.g. glass sheets and glass bottles or other containers, Paper waste e.g. office waste paper, Paper packaging material - e.g. empty cement bags, Metal drums or other smaller containers, e.g. for paints and resins or other solvents, Bricks and mortar, waste or broken computer hardware and cables and wires.

Liquid waste:

Sewage waste from chemical toilets, Waste water for washing of equipment, sanitation water for general cleaning of facilities and workers, Used lubricants and hydraulic fluids and grey water generated at the construction camp that will be contained in conservancy tanks may not be used be to undertake dust suppression activities on site.

- Uncontrolled disposal of waste near any site of construction activities must be communicated to all the workers to be unacceptable. Special attention must be paid to the occurrence of empty cement bags. These bags may not be left to lie around and litter the environment. The cement bags must be placed in a central collection point and removed from the site.

- Waste generated by the workers that reside on site may not be allowed to lie around. The construction workers must be instructed to keep their surroundings clean and to dispose of their litter in designated areas only. Contravention of such actions will result in a fine being issued along with disciplinary action. The person responsible for each contractor must be informed of the strict rules in this regard. The money collected from any fines issued to contractors is to be put towards the on-going rehabilitation and protection of the wetlands around the site.
- The collection of waste at a central collection facility(s) must be arranged. This must include collection points for solid as well as all liquid waste, which would include mechanical fluids disposed of during vehicle maintenance. Waste must be disposed of at the nearest licensed municipal site. In the case of oils it is important to import the services of an oil recycling company to collect used oil.
- Waste must be collected regularly from these collection points and disposed of at municipal waste sites that are licensed to handle waste of this sort. All waste material associated with the construction period must be removed from the terrain. The frequency of waste removal depends on the varying intensity of waste generation. This matter will be monitored closely by the ECO.

The specific steps that will be imposed and implemented are:

- The placement of a sufficient number of large wastes skips at key points on the development terrain. The waste skips (not to be metal drums) must be provided by one of the reputable waste contractors.
- The waste skips must be removed from the site once their full capacity has been reached. The waste skips will typically contain a mixture of domestic and construction waste. No liquid waste will be placed in these skips.
- Separate waste containers to be provided by the waste contractor for liquid waste other than liquid sanitation waste e.g. oils, paints, lubricants etc.
- Full record must be kept of the collections and collection dates and frequency.
- Proof of all disposal at the municipal waste site, be it a general waste site or a hazardous waste site must be provided to the Resident engineer and filed for auditing.
- Chemical toilet/ sanitation systems for workers will be serviced by the provider of the service and proof of such service with all the necessary details will be provided to the Resident engineer and filed for auditing

- Toxic and hazardous waste material (of which an inventory will be compiled as construction progresses) will be stored in separate drum containers in a covered and enclosed area to protect it from the elements and scavengers. Bins and containers must be reusable but should not be rinsed or washed on site.
- Typical toxic waste usually generated on a residential construction site will be:
    - Paints and solvents such as thinners and additives
    - Resins and fibre glass
    - Used batteries
- Waste containers must be transported from the site by the responsible waste contractor to be appointed by the contractor if the contractor is not in the position to remove waste form the site.
- Waste material of a fine/dusty nature or containing a fine/dusty component, to be transported on trucks must be covered.
- In terms of sanitation, a sufficient number of chemical toilets must be established by the contractor and no French drain systems must be installed. Eight workers per chemical toilet are recommended. These toilets have to be monitored for any leakages. No person is allowed to use any area other than the chemical toilets. Toilet systems must be located within walking distance from work areas. No chemical toilets must be placed closer than 60 m from any drainage way or places where storm water may accumulate.

Implementation responsibility: The resident engineer and contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Removal of waste from the terrain will be the responsibility of a certified waste contractor.

5.2.7 Management of impacts on air quality

Construction activities such as vegetation clearance, blasting activities, excavating soil, topsoil removal, trenching and storage as well as the movement of construction vehicles GENERATE DUST. The dust will influence the air quality in the immediate vicinity of the construction activities. If the air quality exceeds acceptable standards, residents as well as construction workers could experience health problems. Therefore, the following mitigation measures should be implemented:

- The management of dust generation to curb dust pollution during construction is of particular importance as a section of the construction site is closer to residential and commercial land uses. Therefore dust suppression, as a normal daily practice, is important.
- Roads used for transport purposes for the construction vehicles, must be sprayed wet with water on a regular basis, as conditions allow. This practise must obviously be avoided with heavy rains, since excessive wetting of the surfaces will lead to greater erosion problems.
- Confining vehicular movement to designated routes only, will reduce dust levels substantially.
- It is not possible for the ECO to monitor on a daily basis this problem. This issue must be strictly and wilfully monitored and implemented by the Resident Engineer.
- The monitoring of dust will be done visually by the ECO. The actual dust fall out measures in gram per cubic meter will not be measured.

Implementation responsibility: The resident engineer and contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.8 Noise generation

The impact of the proposed development on the ambient noise levels during the construction period is rated to have a moderately significant impact on the social environment of the community. Therefore, noise mitigation measures are required in order to keep the noise generated by construction activities as low as possible. The following noise mitigation measures as a result of construction actions must be considered:

- Construction must take place during daylight hours. The management and control of construction noise must be implemented especially in areas closer to the residential plots. No construction work may take place from Saturdays 12:00 to Mondays 7:00.
    - Summer 7:00 - 17:00
    - Winter 7:30 - 17:-00

Well-oiled and maintained machinery will impose a lesser sound intrusion to the surroundings than heavy machinery which is not regularly serviced. Silencers must be well maintained in the working machines as surrounding land owners may object to the increased noise levels.

Noise in terms of blasting activities:

Blasting activities has a very high likelihood of happening due to Magaliesberg quartzite being prevalent at certain areas.

- Before blasting can be undertaken, the public has to be informed of the plan with more than 1 week in advance to ensure that any precautions that need to be taken are done.
- Blasting should only be considered in the last resort in close proximity of any town/residential area.
- Blasting size has to be limited to the utmost minimum without limiting the construction of the road to ensure that the blasting force is minimized.
- Blasting can only be undertaken in daytime and only on a predetermined date, as agreed with by the local police station
- Blasting noise has to be dampened by the use of blasting damping materials. This will ensure that blasting will only be experienced as a vague blast in the distance.

Implementation responsibility: The resident engineer and contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.9 Construction camp establishment and decommissioning

Construction camp establishment can have a significant impact on the environment in terms of water and soil contamination - due to aspects like the storage and handling of hazardous substances (including fuels and lubricants); the storage, movement and possible maintenance of construction vehicles and other heavy machinery; domestic waste production and noise. Therefore, the placement and management of activities within construction camps is important.

- The location of the construction camp must be determined only after consultation between the Resident Engineer and the project manager. The process of choosing

the correct site must be done with great care taking environmental factors into consideration. Construction camp sites may only be erected in an area identified as least sensitive, but which is still very safely accessible.

- The lay out and locality of the construction camp must be planned by the applicant in conjunction with the project manager, the resident engineer and the appointed Environmental Control Officer (ECO). When looking at the terrain it is recommended that the site office and construction camp (including the workshop) may not be placed in a terrain where natural vegetation is still dominant. *The best option is always to choose a site where there is an existing homestead or farmstead with a disturbed yard.*
- The principles followed are that the construction camp must be located as centrally as possible on site in order to limit the movements of workers and vehicle movements, and where it will not be placed close to any sensitive area on terrain and particularly not close to any natural drainage way.
- Temporary accommodation for workers must as far as possible be by means of prefabricated units or containers to reduce surface impact and easing the rehabilitation and clean-up after construction.
- The number of workers who may reside on-site must be kept to a minimum. Those workers present at night should be on site only to look after construction equipment and register taken of those workers present to eliminate crime in the area.
- A control system of workers residing on the site will have to be kept in place to prevent workers squatting on the land.
    - The construction camp must be fenced.
    - Fires for cooking purposes must be in cooking screens and gas stoves as energy source must be promoted.
- The making of open fires on the construction site cannot be fully prohibited. But it needs to be stressed that may cause veldt fires in the drier months.

The rules for this must be as follows:

- An open fire must be made on a piece of corrugated iron sheet.
- All fires must be extinguished once the food preparation or heating is completed.
- Hot ash must not be disposed of among vegetation or any flammable substance

Other General measures associated with the camp and site office area:

- All aboveground petroleum product (diesel, oil and petrol) storage tanks shall be placed in bunds with sumps. The minimum bund capacity will be at least 110% of the storage capacity.
- In the event of a spill, pumping of the product, either for recovery or for disposal must be done as quickly as possible to reduce the amount of vapours being released into the environment.
- All drainage from fuel storage areas shall be diverted to the separating facilities and settling ponds.
- Oils shall be stored in sealed drums in a bunded area.
- Used oils shall be stored similarly and shall be recycled by private dealers identified by the developer or disposed of in a manner approved by the ECO.
- Cement shall be delivered in sound and properly secured bags or in approved bulk containers.
- Cement products in bags shall be stored in an enclosed storage area underlain by a concrete platform with the bags themselves raised off the ground with the use of pallets.
- The storage facility and surrounding area shall be swept and cleaned regularly as required to ensure that cement products do not enter the surrounding environment.

All temporary erected structures, including the construction camp(s) and or construction office(s) must be demolished and removed after completion of the construction phase. This includes all fencing, piping, drains and sumps as well as tanks or other containers that were utilised during the construction period.

Implementation responsibility: The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.10 General rehabilitation of the construction site

It is important that rehabilitation will commence as soon as feasible on each of the construction areas to run concurrent with the construction phase and not to be left until completion of the works. This will increase the chances of successful rehabilitation.

All areas disturbed by development activities will be rehabilitated on completion of the construction phase. The following general procedure will be followed:

- Removal of all construction facilities and materials from site, cleaning up of any remaining oil or other spills and removal of all construction waste from site;
- Shaping of the disturbed areas to blend with the surrounding landscape;
- Placing of topsoil on all disturbed areas (minimum depth 150 mm);
- Organic fertilizers must be added to the topsoil prior to seeding (if required).
- Re-vegetation of all areas where topsoil is placed using a mixture of indigenous grasses and bushes;
- Maintenance of these areas until an acceptable cover has been established. Acceptable cover shall mean 75% ground cover with no gaps exceeding 500 mm. Maintenance may include watering, mowing and weeding as well as preventing the development of erosion channels or, backfilling where they have occurred.

Stockpile Areas

Once stockpiles have been removed the ground surface is to be inspected for compaction. Should it be required, the surface is then to be ripped and the prescribed re-vegetation process followed.

Rehabilitation of Construction Camps

Rehabilitation will be necessary in the following areas:

- Concrete and compacted earth platforms;
- Removal of fuel storage tanks;
- Removal of chemical toilets; and
- Access roads running into and through the camps.

Concrete platforms will need to be broken up and rubble removed. The prescribed re-vegetation process must then be followed. No new borrow pit will have to be established for the project. The exposed surface must be checked for contaminants and if any is found, the contaminated soil is to be removed along with the concrete to a site acceptable to the ECO and the RE. The re-vegetation process described below must then be followed.

Re-vegetation Process

The basic re-vegetation steps which will be implemented where and if required are detailed below:

Step 1: Prepare the area to be re-vegetated for top-soiling - this may require soil ripping, scarifying and/or digging of steps or terraces. The scarification should take place to a minimum depth of 150 mm. If ridges are formed, they should be approximately 100 mm high and 400 mm wide.

Step 2: Stockpiled topsoil must be placed on areas to be re-vegetated to a minimum depth of 100 mm, spread when dry by means of hand raking or mechanical means to a uniform thickness.

Step 3: If required when sodding or hydro seeding, appropriate organic fertilisers must be applied and worked into the soil to a minimum depth of 150 mm.

Step 4: Fresh, good quality seed - which is certified by the supplier and free from contamination by seeds of other species - can be used for the re-vegetation process, although seed harvested from site is preferable. The rehabilitation grass seed mix will be seeded at a minimum density of 30 kg/ha, utilising a mixture of suitable species. The mixture must also always include at least one legume species.

Step 5: Mulch should be applied to protect the seeded area from erosion. The mulch should be composed of straw or other cellulose-rich material and free of undesirable seeds. The mulch must not be excessively fresh and green or in an advanced state of decomposition as it could smother growth. It must be applied to a depth and density that will prevent erosion by wind and water, but not completely block out the access of sunlight to the soil or prevent penetration by young plants.

Step 6: Re-vegetated areas are to be enclosed within an erected safety barrier to prevent excessive trampling and any other factors that might cause erosion or compaction. No road building equipment, trucks or other heavy equipment will be permitted onto re-vegetated areas.

Step 7: Re-vegetated areas must be irrigated on a regular basis, or as required.

Step 8: An appropriate maintenance and monitoring program must be implemented. This program will include monitoring of the success of seed germination, growth of the plants, removal of invasive weeds, replanting of areas where re-vegetation has not been successful once the cause of the inhibiting factor has been identified and remedied, and repair of any funnels or erosion channels.

5.2.11 Archaeology and Cultural Sites

- Should archaeological objects of any nature (including fossils, graves or remains of structures) be found, the developer will stop all construction activity, and notify Rock Environmental Consulting (PTY) Ltd. immediately. The Provincial Heritage Resources Agency of Mpumalanga (MPHRA) will be consulted for further investigation and clarification.
- All finds of human remains must be reported to the nearest police station.
- Human remains or any burial ground or part thereof that are deemed to be of cultural significance may not be destroyed, damaged, altered, exhumed or removed from their original positions without a permit from MPHRA.
- Work in areas where artefacts are found must cease immediately.
- Under no circumstances must the Contractor, his/her employees, his/her sub-contractors or his/her sub-contractors' employees remove, destroy or interfere with archaeological artefacts. Any person who causes intentional damage to archaeological or historical sites and/or artefacts could be penalised or legally prosecuted in terms of the National Heritage Resources Act, 25 of 1999.
- A fence at least 2m outside the extremities of the site must be erected to protect archaeological sites.
- All known and identified archaeological and historical sites must be left untouched.
- Work in the area can only be resumed once the site has been completely investigated. The Project Manager will inform the Contractor when work can resume.

Implementation responsibility: The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.

5.2.12 *Water quality monitoring and storm water*

- A river and wetland rehabilitation plan will be compiled before construction can commence. This will ensure that impacts on the river ecosystems are monitored and minimized. The Monitoring Plan (from the WULA report) by the specialist is attached to this EMPr.
- Debris and other obstructing materials must be removed from the site and erosion preventing structures installed. This is done to prevent damming of water and increasing flooding danger.
- Removed soil and stockpiling of soil must occur outside the extent of the wetland and river areas to prevent siltation and increased runoff during construction. This includes the wetland buffer zones and 1:100 year flood lines.
- Location of proper toilet facilities: The impact of human waste on the system is immense. Chemical toilets must be provided which should always be well serviced and spaced as per occupational health and safety laws.
- Spill kits on site: In case of accidental spills of oil, petroleum products etc., good oil absorbent materials must be on hand to allow for the quick remediation of the spill. The kits should also be well marked and all personnel should be educated to deal with the spill. Vehicles must be kept in good working order and leaks must be fixed immediately on an oil absorbent mat. The use of a product such as SUNSORB™ is advised.
    - SUNSORB™ is an organic product that is neither toxic nor abrasive. It is manufactured from the waste of the sunflower industry and has a worldwide patent pending as a hydrocarbon absorbent.
    - SUNSORB™ is a truly environmentally friendly product as it is completely natural, biodegradable and minimizes leaching resulting in no damage to the environment in either its manufacturing or disposal.
    - SUNSORB™ has been lab tested and proven to be ideal for the absorption of hydrocarbons on both land and water.
    - SUNSORB™ absorbents provide the ultimate in cost-effective as well as environmentally responsible solutions for hydrocarbon spill clean- ups
- No plant machinery may be stored or left near the wetland areas, when not in use.
- Frequent inspection of the wetland site must be done to ensure that no harmful practices occur on site.

- A photo collection must be taken from fixed demarcated spots to detect changes in the wetland over time. These photographs must be dated and should include all of the wetland sites.
- No construction personnel are allowed to collect, harvest or kill any species of fauna and flora on the site.
- Any species of fauna encountered during the construction phase should be moved to a safe location where no harm can be bestowed on the species.
- If appropriate water rights are received for the extraction of water from the stream, appropriate access and extraction facilities should be created within the construction (fenced) area. Extra care should also be taken to ensure the extraction site is not polluted in any form and the extraction process itself is not detrimental to the health of the wetland. Siltation prevention devices must be placed and inspected daily.
- If water is sprayed on the construction surface for any reason during the construction process, utmost care must be taken to ensure the runoff water does not pollute the wetland or any of the associated catchment areas. A storm water cut-off drain should be constructed between the construction area and the wetland to ensure that storm water flowing through the construction area can't flow into the wetland. The water from the cut-off drain must be collected in a sedimentation pond before entering the wetland system.
- Any new erosion gullies must be remediated immediately.
- Construction activities near the wetland should commence during the dry season or when flows are at their lowest where reasonably possible.
- Regular inspection of erosion preventing devices is needed.
- Demarcation of no access areas: The construction site must be fenced to ensure no trespassing occurs on the site. Frequent foot or vehicle access will further damage the wetland system. Strict access control to the fenced areas must be adhered to.
- Access routes should be demarcated and located properly so that no damage to the wetland system can occur. These roads must be adhered to at all times. A large turning place must be provided for larger trucks and machinery. No grading of temporary access roads is allowed as this will create dust and water runoff problems.
- Sediment barriers should be placed along the wetland gully above and below the construction site in pairs of three.

- Increased runoff due to removal of vegetation and increased soil compaction must be managed to ensure the prevention of siltation and the maximum stream bank stability.
- The velocity of storm water must be attenuated and spread. As far as possible the link between the storm water channel and the local environment must be maintained. This is to ensure water movement into the soils and ensuring the survival of associated wetland vegetation.
- Storm water leaving the site downstream must be clean and of the same quality as in situ before it enters the construction site (upstream). Proper measures must be in place to ensure sedimentation is trapped before construction activities commence around the wetland area.
- Any requirements of the Water Use License Application have to be met in accordance with the Water Act.

5.2.13 Management of impacts on existing infrastructure

- All existing services in the road reserve such as power cables, telecommunications etc. has to be communicated to the respective owners and measures undertaken to either remove the services, or keep it under the road.
- The impact on existing infrastructure will be managed carefully.
- All access to adjacent land will be accommodated as it is a pre-requisite for the construction of any road construction.
- The maintenance of storm water drainage culverts along the road is a primary action once the road is operational and must take place frequently on an on-going basis. The maintenance not only ensures the unhindered flow of run-off but also ensure that drainage canals acts functionally as movement corridors for especially from species.

5.2.14 Management of impacts on ridges

- Where possible, trees naturally growing on the site should be retained as part of the landscaping in the road reserve.
- Measures to ensure that these trees survive the physical disturbance from the proposed development should be implemented. A tree surgeon and/or horticulturalist should be consulted in this regard. The ridge on site must be fenced off before construction commences.

- An appropriate management authority (TRAC) that must be contractually bound to implement the Environmental Management Programme (EMPr) and Environmental Authorization (EA) during the operational phase of the development should be identified and informed of their responsibilities in terms of the EMPr and EA.
- All areas designated as sensitive in a sensitivity mapping exercise should be incorporated into a buffer zone system. The road development should to be on the areas of lowest sensitivity. The crossing of natural drainage systems should be minimized and only constructed at the shortest possible route, perpendicular to the natural drainage system. Where possible, bridge crossings should span the entire stretch of the buffer zone.

5.3 Impact Mitigation During the Operational Phase

Mitigation of impacts during the operational phase is of great importance, as there are long-term issues that are of relevance.

5.3.1 Noise

A follow up noise monitoring exercise is recommended at the area where houses are very close to the N4 and its interchange.

5.3.2 Erosion

All road fill and drainage structures have to be checked and maintained on regular intervals to ensure that no erosion takes place along the road surface. Sedimentation needs to be prevented from entering the river and wetland areas.

5.3.3 General

- The road surface should be checked regularly and maintained.
- The road should not be allowed to deteriorate to a point where it is not repairable.
- Repairs/Alterations on the road should be conducted under the proper safety measures. Road sighs and applicable reflective and safety clothing has to be present when work is carried out on the constructed road.
- The road needs to be administered and maintained by TRAC up to a stage where the road is no longer their responsibility, on which stage the responsibility will fall onto SANRAL.

5.3.4 *Waste Management (solid waste)*

Section 20 of the Environment Conservation Act (Act 73 of 1989) states that no person shall dispose waste in any manner other than at a disposal site, for which a permit has been issued by the Minister of Water Affairs and Sanitation.

Therefore, as mentioned, any possible waste generated, by public transport through the area, during the operation of the N4 and its interchange must be collected/cleaned-up on a regular basis, which in turn is to be collected and emptied at the nearest municipal solid waste disposal site. The products that will typically be generated by maintenance workers and the traveling public include empty food cans, leftover foods, paper, plastic and bottles. Recycling is always desirable and if the separation of waste can be encouraged and implemented, this would be highly beneficial.

Implementation responsibility: The applicant will be responsible for the implementation of the above measures as an on-going process during operational phase.

5.4 Closure Phase

This is a national highway and a very import corridor between South Africa and Mozambique. No closure phase is foreseen.

6. Proposed Mechanisms for Monitoring

It is recommended by the Environmental Practitioner that an Environmental Control Officer (ECO) be appointed by the applicant. The ECO will be the person involved with the development of the project and also be responsible for the monitoring of the implementation of the EMPr. It may be different parties during the different phases of the project.

- This person may be appointed by the appointed engineer or indirectly by the applicant/client. It must, however, be a person with adequate technical and environmental knowledge to understand and implement this management programme.
- The contractor will appoint a site environmental control officer (SECO). The SECO will be there daily on site to manage the daily issues of the construction.

- TRAC will appoint an independent ECO to monitor the construction quarterly. The ECO will be there to audit the WULA, EMPR (DMR) and EA (inclusive of all other environmental permits) quarterly.
- TRAC will do monthly monitoring of the site (Reggy Nkosi).
- The ECO must report to the applicant on a regular basis or frequency.
- The ECO has the authority to stop works during construction if in his opinion there is a serious threat to, or impact on the environment caused directly from the construction operations. This authority is to be limited to emergency situations (see definitions) where consultation with the engineer or developer is not immediately possible. In all such work stoppage situations the ECO is to inform the engineer and developer of the reasons for the stoppage as soon as possible.
- Upon failure by the contractor or his employees to show adequate consideration to the environmental aspects of this contract, the ECO may recommend to the engineer to have the contractor's representative or any employee(s) removed from the site or work suspended until the matter is remedied. No extension of time will be considered in the case of such suspensions and all costs will be borne by the contractor.

A monitoring report will be written each month, after 2 site visits have taken place and giving to the appropriate authority. This report will give a point scale of implementation measures. This may be the construction site manager, contractor, safety officer, and engineer.

CONSTRUCTION PHASE:

MONITORING TYPE	FREQUENCY			
	DAILY	WEEKLY	MONTHLY	QUARTERLY
WEED ERADICATION			X	
EROSION CONTROL			X	
WASTE MANAGEMENT		X		
DUST CONTROL	X			
NOISE MONITORING	X			

SAFETY	X			
HAZARDOUS SUBSTANCE		X		

Compliance with the EMPr was rated according to the system detailed below:

SCORE	COMPLIANCE RATING	DEFINITION
5	Full Compliance	All requirements and conditions have been addressed or met.
4	Substantial Compliance	Between 75 and 100% met
3	Broad Compliance	Between 50 and 75% met
2	Partial Compliance	Between 25 and 50% met
1	Non-Compliance	Less than 25% met
0	Major Non-Compliance	None of the requirements and conditions has been addressed or met.

6.1 Environmental Awareness Plan

6.1.1 Training programmes:

1. Occupational Health and Safety (OHS) - Done internally by Health of Officer.
2. Personal Protection Equipment (PPE) - Done internally by Safety Officer.
3. Environmental training
    a. program 1 - Introduction to Environment, Ecosystems and Habitats. Including symbiotic interactions.
    b. program 2 - Environmental Degradation, Soil, Air, Noise, Water and Ground water Pollution. Erosion.

Programmes 1 and 2, the OHS and PPE training is something that is done either annually or bi-annually depending on the need identified by management of the road development. Program 3 regarding the environmental training and awareness will be implemented a.s.a.p. before the construction phase begins. Management will also arrange for training bi-annually for 2 to 4 hour sessions at a time. Training will either be done internally or externally. Internal training will be done by the Environmental Management Department and externally training providers will be sourced as approved by TRAC.

6.1.2 Monitoring of awareness

Bi-monthly Health and Safety meetings are held where relevant issues regarding health, safety and environment are discussed and feedback is given. Environmental awareness should be incorporated into the compulsory 'Tool box talks' that include health and safety issues. These should be done on a monthly basis.

7. A TABULAR VERSION OF ENVIRONMENTAL ASPECTS, IMPACTS, MITIGATION AND PERSONS RESPONSIBLE FOR THE PROPOSED ROAD UPGRADE AND NEW INTERCHANGE

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
Vegetation clearance for the footprint of the proposed upgrading of the road and interchange (C). Clearance of vegetation in the establishment of infrastructure (C)	Soil layers, soil surface, indigenous vegetation cover.	The removal of vegetation cover, such that the soil surface is exposed, may lead to increased soil erosion in certain areas. The existing vegetation will be permanently removed to accommodate the footprint of the development. Where the removal of surface vegetation is of a temporary nature only, the establishment of weeds is a threat. The topsoil layer is required to rehabilitate the unused areas (i.e. for re-vegetating the area).	Weed species should be removed on a four-week basis. It is recommended that only indigenous species be used in the landscaping process, and that trees are incorporated into the landscaping design where appropriate. Innovative landscaping of the site towards the end of the construction stage will contribute significantly to the visual and aesthetic attractiveness of the site and will also solve the problems associated with the removal of vegetation cover, including soil erosion, dust generation and the flourishing of weeds and/or other unwanted exotic species in the long term.

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			The topsoil layer is required to rehabilitate the unused areas (i.e. for re-vegetating the area). The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Excavations for the foundations of the road development, as listed above (C).	Soil layers, vegetation (Crops included) and faunal habitats.	The existing vegetation will be permanently removed to accommodate the foundations of the necessary structures. Stockpiles will be created due to this and needs to be situated at an appropriated location to prevent unnecessary compaction or natural vegetation removal.	All stockpile areas, if situated outside the eventual paved area, should be ripped and ploughed at the end of the construction period to loosen soil surfaces for the natural propagation of vegetation and/or to allow for landscaping of the area. The same applies to other temporarily disturbed areas on site, which are vulnerable to the propagation of unwanted species (weeds). It is important that the contractor implements weed control through physical and/or approved chemical eradication methods. Only registered herbicides should be used to curb this problem.

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Stockpiling of excavated material (C)	Soil and vegetation cover.	Stockpiles cause compaction of the soil, which promotes the establishment of weed species. The establishment of weeds greatly reduces the pristine quality of the natural vegetation on site. Stockpiles should not be situated within 200 m from any water bodies or water courses, as sedimentation transport into such systems is undesirable. Furthermore, stockpiles should not be situated in any sensitive environment.	All stockpile areas, if situated outside the eventual paved area, should be ripped and ploughed at the end of the construction period to loosen soil surfaces for the natural propagation of vegetation and/or to allow for landscaping of the area. The same applies to other temporarily disturbed areas on site, which are vulnerable to the propagation of unwanted species (weeds). It is important that the contractor implements weed control through physical and/or approved chemical eradication methods. Only registered herbicides should be used to curb this problem. Weed species should be removed on a four-week basis. It is recommended that only indigenous species be used in the landscaping process, and that trees are incorporated into the landscaping design.

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			The temporary storage of construction material and especially fuel must be carefully monitored by the site engineer to prevent the risk of accidental spillage or disposal of any such material that will contaminate soil surfaces, surface and subsurface water. All liquid material must, where applicable, be stored on solid concrete surfaces and must be surrounded by bunds. Bunding is also applicable to fuel and mechanical oil storage areas (although it is not anticipated that fuel storage on site will be necessary). Bunding walls should not be less than 30 cm high. Storage containers must be inspected regularly to prevent leaks that could contaminate the site. Innovative landscaping of the site towards the end of the construction stage will contribute significantly to the visual and aesthetic attractiveness of the site and will also solve the problems associated with the removal of

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			vegetation cover, including soil erosion, dust generation and the flourishing of weeds and/or other unwanted exotic species in the long term. The topsoil layer is required to rehabilitate the unused areas (i.e. for re-vegetating the area). The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Stockpiling building materials (C)	Soil and vegetation cover.	Stockpiles will need to be established for the storage of aggregate, bricks and cement, etc. As mentioned, stockpiles cause compaction of the soil surface, which leads to the growth of unwanted weed species.	All stockpile areas, if situated outside the eventual paved area, should be ripped and ploughed at the end of the construction period to loosen soil surfaces for the natural propagation of vegetation and/or to allow for landscaping of the area. The same applies to other temporarily disturbed areas on site, which are vulnerable to the propagation of unwanted species (weeds). It is important that the contractor implements weed control through physical and/or

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			approved chemical eradication methods. Only registered herbicides should be used to curb this problem. Weed species should be removed on a four-week basis. It is recommended that only indigenous species be used in the landscaping process, and that trees are incorporated into the landscaping design. The temporary storage of construction material and especially fuel must be carefully monitored by the site engineer to prevent the risk of accidental spillage or disposal of any such material that will contaminate soil surfaces, surface and subsurface water. All liquid material must, where applicable, be stored on solid concrete surfaces and must be surrounded by bunds. Bunding is also applicable to fuel and mechanical oil storage areas (although it is not anticipated that fuel storage on site will be necessary). Bunding walls should not be less than 30 cm high. Storage containers must be inspected regularly to

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
		increased surface run-off volume and speed, which could lead to the creation of erosion gullies. All road surfaces generate storm water, which should be controlled by preventing the storm water from crossing the road. Storm water must be allowed to spread out gradually over a large surface area to protect the soil surface against erosion.	bags at the highest point to stop the cutting back of rill/gully and at the lowest point of water run-off areas to halt the sediment transport and erosion that will otherwise occur. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Maintenance of storm water management systems (where applicable) (O)	Soil surfaces, drainage patterns and surface water.	Maintenance of storm water outlets is required to ensure that they don't get blocked (i.e. no longer fulfil their function) or result in erosion.	To prevent storm water outlets blocking a regular schedule of cleaning out the outlets must be in place. This will be determined by the nature of the environment. The owner and maintenance staff will be responsible for the implementation of the above measures as an on-going process during operational phase.
Generation of construction waste (C)	Soil, vegetation, aesthetic quality of the site and surface water run-off, water and ground water	Waste, such as building rubble and empty cement bags can be a negative visual impact if not collected and disposed of	No littering by any personnel is permissible. The site manager/contractor should conduct regular site clean-ups to keep the site litter free - as

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
	resources.	correctly. Further to littering the site and adjacent areas, poor control and illegal dumping of construction waste can pollute surface water run-off, as well as lead to the promulgation of weed species.	litter is not only aesthetically displeasing, but it is also harmful to the environment. All domestic solid waste produced must be disposed of in waste bins situated on site. The bins should be emptied into a covered skip (for storage) on a regular basis, until its collection and removal to a municipal waste disposal site (preferably on a weekly or bi-weekly basis). Proof of disposal of waste material at a registered waste disposal site must be shown after off-loading of each waste load, which should then be logged or registered for control purposes. Control measures in terms of the National Building Regulations and standard requirements laid down by the local authority, with regards to spillage and waste disposal, must strictly be adhered to. General waste disposal management involves the collection of construction waste at a central collection facility, which should be pre-arranged and implemented. This should

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			include making points available for solid as well as liquid waste. The resident engineer and contractor will be responsible for the implementation of the above measures as an on-going process during construction phase. Removal of waste from the terrain will be the responsibility of a certified waste contractor.
General structure maintenance (O)	Visual quality, also surface water quality and vegetation cover.	The design and nature of development will determine the impact of the proposed development on the visual quality of the study area. Maintenance of the development as a whole will prevent a further negative impact on the visual quality of the study area. The disposal of construction rubble (both during construction and maintenance) causes impacts on the natural environment (including faunal ecology, surface water and vegetation) if disposed of illegally. Compaction of soil surfaces	Although the current visual character of the site will be changed, landscaping can play an important role in enhancing the visual character of the area. Neat, well-maintained panels and fencing will not negatively impact on the visual and aesthetic quality of the site, although the site consists mainly of natural vegetation. Poor maintenance of the development as a whole will have a small effect on the visual and aesthetic quality of the area. Therefore, general maintenance on a regular basis will form an important component of the operational

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
		and the propagation of weeds are typical impacts.	phase of the proposed development. No high flood-lights should be installed on the developed site. The site engineer will be responsible for the implementation of the above measures as an on-going process during construction/operational phase.
Collection and disposal of solid domestic waste (C)	Aesthetic quality, surface water run-off, subsurface and groundwater quality, vegetation and fauna.	Poor waste collection and handling will pollute the environment (affecting fauna, groundwater, surface water and aesthetic environment). No illegal dumping of domestic waste will be tolerated. Untidy collection points and windblown refuse can cause human / animal conflicts, as foul odours from such areas will attract wild animals and cause other problems (pests / diseases), as well as water pollution.	No littering by any personnel is permissible. The site manager/contractor should conduct regular site clean-ups to keep the site litter free - as litter is not only aesthetically displeasing, but it is also harmful to the environment. All domestic solid waste produced must be disposed of in waste bins situated on site. The bins should be emptied into a covered skip (for storage) on a regular basis, until its collection and removal to a municipal waste disposal site (preferably on a weekly or bi-weekly basis). Proof of disposal of waste material at a registered waste

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			disposal site must be shown after off-loading of each waste load, which should then be logged or registered for control purposes. The resident engineer and contractor will be responsible for the implementation of the above measures as an on-going process during construction phase. Removal of waste from the terrain will be the responsibility of a certified waste contractor.
Collection and disposal of construction waste (C)	Aesthetic quality, subsurface and ground water quality, vegetation and fauna.	No construction waste may be illegally dumped into the surrounding areas, as the effects of illegal dumping on the environment are devastating. Poor waste collection and handling will have a negative impact on several environmental aspects. A waste collection agreement between the applicant and the local authority will be essential.	The generation of construction waste occurs at every site under development and construction. Due to the costs involved in the disposal of this material at municipal or other licensed waste sites, the contractor or sub-contractor may be tempted to illegally dump waste at concealed locations to save on costs. Therefore, strict control is required from the main contractor on site to control this issue. Proof of disposal of waste material at a registered waste disposal site must be

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			waste contractor.
Temporary employment created during the construction phases of the proposed development(C)	Social aspects	There will be positive impacts in terms of social upliftment and job creation within the broader region.	The HR manager of the client and contractor will be responsible for the employment as an on-going process during construction phase.
Long term employment opportunities and wealth to be generated by the proposed development (O)	Social aspects	There will be positive impacts in terms of social upliftment and job creation within the broader region. New skills would have been gained during the during the construction phase.	The HR manager of the client will be responsible for the employment as an on-going process/maintenance during operational phase.
Transportation of workers to and from the development site (C)	Air quality, soil surface and social aspects (including traffic and worker safety).	Vehicles used to transport workers must never be overloaded; worker safety is of utmost importance. Vehicles used to transport workers must not exceed the speed limit and no vehicle may deviate from the existing routes on the site, to ensure safety of the workers and conservation of the area. Poorly maintained vehicles will have a large negative impact on air quality.	The dust will influence the air quality in the immediate vicinity of the construction activities. If the air quality exceeds acceptable standards, residents as well as construction workers could experience health problems. Therefore, the following mitigation measures should be implemented: ¤ The emissions from run down, old machinery will greatly pollute the air. Therefore, well serviced machinery and heavy vehicles that are maintained in a good

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			working order should be used. ▫ Regular wetting of exposed soil surfaces along routes that will be utilised by heavy vehicles is required at least twice a day to minimise the amount of dust generated by vehicles - this is especially important at the two access points to the site. Noise mitigation measures are required in order to keep the noise generated by construction activities as low as possible - given the site's relatively close proximity to adjacent industries. This can be achieved by ensuring that only well-oiled, well maintained machinery is used, as such machinery will produce less noise than poorly serviced machinery. For example, poor maintenance of exhaust systems will produce unnecessary noise pollution. Furthermore, working hours for construction should be limited to between 07h00 and 17h00 on week days, as construction outside of these time frames will be a nuisance to adjacent dwellers (in the

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			adjacent residential area). Construction times should be limited to between 08h00 and 12h00 on Saturdays and no construction activities should be allowed on Sundays. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Construction camp establishment (C)	Aesthetic impacts, social aspects, subsurface and groundwater quality, generation of domestic waste, vegetation removal, soil surface compaction and faunal impacts.	The generation of domestic waste, as well as the provision of sewage facilities, within the construction camp could potential impact on the aesthetics of the site as well as the quality of subsurface and groundwater if not properly managed and implemented. The removal of sections of natural vegetation would most likely be needed for the establishment of the camp, and soil surfaces would become compacted as a result of activities within the camp.	Same as above. No liquid waste material should be disposed of on or near the site during construction, or in any non-designated areas. A firm arrangement must be made to place chemical toilets on the construction site (within the construction camp to be erected). A sufficient number of chemical toilets need to be provided; in the range of 1 per every 8 workers. These toilets must be well maintained and inspected on a daily basis to ensure that they are clean and functioning properly. The toilets must be within walking distance from the work areas.

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			No person is allowed to use any area, other than the chemical toilets provided, as a toilet. No washing of people and/or goods should take place on cleared surfaces, as this water should not be allowed to drain into the adjacent storm water canal. In the event of accidental spillage of liquid substances, like paints and resins, it is important to implement the correct emergency procedures and clean-up operations. Pollution of surfaces should be limited at all costs. All hazardous waste should be kept separate in a lined skips or drums and stored in a bunded area. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Sanitation provision to workers during the working day (C)	Subsurface soil, surface water and subsurface water quality.	Subsurface soil contamination and contamination of surface/subsurface water quality could occur if the	Same as above. No liquid waste material should be disposed of on or near the site during construction, or in

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
		ablution facilities provided are not according to standard. A temporary impact is possible; however, it can easily be prevented.	any non-designated areas. A firm arrangement must be made to place chemical toilets on the construction site (within the construction camp to be erected). A sufficient number of chemical toilets need to be provided; in the range of 1 per every 8 workers. These toilets must be well maintained and inspected on a daily basis to ensure that they are clean and functioning properly. The toilets must be within walking distance from the work areas. No person is allowed to use any area, other than the chemical toilets provided, as a toilet. No washing of people and/or goods should take place on cleared surfaces, as this water should not be allowed to drain into the adjacent storm water canal. In the event of accidental spillage of liquid substances, like paints and resins, it is important to implement the correct emergency procedures and clean-up operations. Pollution of surfaces should be limited at all costs. All hazardous waste should be

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			kept separate in a lined skips or drums and stored in a bunded area. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Movement of construction vehicles on site (C)	Air quality, soil and vegetation cover.	Movement will cause limited or localised disturbances and temporary soil compaction, which promotes the establishment of weed species. Dust will be generated by vehicular movements on site.	The dust will influence the air quality in the immediate vicinity of the construction activities. If the air quality exceeds acceptable standards, residents as well as construction workers could experience health problems. Therefore, the following mitigation measures should be implemented: ▫ The emissions from run down, old machinery will greatly pollute the air. Therefore, well serviced machinery and heavy vehicles that are maintained in a good working order should be used. ▫ Regular wetting of exposed soil surfaces along routes that will be utilised by heavy vehicles is required at

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			least twice a day to minimise the amount of dust generated by vehicles - this is especially important at the two access points to the site. Noise mitigation measures are required in order to keep the noise generated by construction activities as low as possible - given the site's relatively close proximity to the adjacent landowners. This can be achieved by ensuring that only well-oiled, well maintained machinery is used, as such machinery will produce less noise than poorly serviced machinery. For example, poor maintenance of exhaust systems will produce unnecessary noise pollution. Furthermore, working hours for construction should be limited to between 07h00 and 17h00 on week days, as construction outside of these time frames will be a nuisance to adjacent dwellers (in the adjacent residential area). Construction times should be limited to between 08h00 and 12h00 on Saturdays and no

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			construction activities should be allowed on Sundays. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Maintenance of construction vehicles (C)	Soil, vegetation and surface water.	In the event of on-site repairs and servicing, soil surfaces, vegetation, and run-off may be locally contaminated. Spillage of fuel through faulty bowsers is a possibility, if not controlled. It is anticipated that no fuel storage facilities will occur on the site other than temporary storage of diesel in drums.	General waste disposal management involves the collection of construction waste at a central collection facility, which should be pre-arranged and implemented. This should include making points available for solid as well as liquid waste - including mechanical fluids disposed of during vehicle maintenance. All hazardous waste must be stored in sealed and suitably marked containers and placed in bunded area for removal to a hazardous waste landfill site by the contractor. Hazardous waste could include used oils and fluorescent light tubes, as examples. The contractor should refer to the relevant Department of Water Affairs and Sanitation (DWAS) guidelines for the classification

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			of hazardous waste. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Traffic safety on the main road (C and O)	Social aspects.	All access points to the construction site; therefore motorists using the N4 will be negatively impacted on by slow moving construction vehicles.	Construction vehicles will be utilising the whole stretch between Belfast and Cross Roads, which is a busy road. Therefore, proper sign posting and traffic control measures along the routes utilised by these vehicles is crucial throughout the construction period; to warn motorists of any imminent, potentially dangerous situations. It is necessary to warn motorists of slow moving vehicles to and from the site to reduce the risk of accidents. The access points especially are high risk areas for accidents. Therefore, well posted warning signs are essential. Children and unauthorised persons should not have access to the construction site. All workers should be properly attired, with safety hats and clearly visible,

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			reflective clothing - such that they are easily visible to the truck and heavy machinery drivers. Drivers must be instructed to and should comply with the recommended speed limit for heavy vehicles in urban areas, which is between 35 - 45 km per hour. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.
Noise generation by operating air compressors, excavators and other heavy machinery. Noise is also generated by the construction workers (C)	Impacts on faunal species and surrounding land owners.	Excessive noise levels on site may negatively impact upon the behaviour and movements of site fauna. The significance rating and mitigation of this potential impact will need to be dealt with effectively in the EIA report. Surrounding land owners may also potentially be negatively impacted upon by excessive noise levels on site during construction.	The impact of the proposed development on the ambient noise levels during the construction period is rated to have a moderately significant impact on the social environment of the community. Therefore, noise mitigation measures are required in order to keep the noise generated by construction activities as low as possible - given the site's relatively close proximity to some of the adjacent landowners. This can be achieved by ensuring that only well-oiled, well maintained

ENVIRONMENTAL ASPECT C: construction stage O: operational phase	ENVIRONMENTAL COMPONENT THAT MAY BE AFFECTED	NATURE AND DESCRIPTION OF THE POTENTIAL IMPACT/ISSUE	MITIGATION MEASURES AND PERSON/S RESPONSIBLE
			machinery is used, as such machinery will produce less noise than poorly serviced machinery. For example, poor maintenance of exhaust systems will produce unnecessary noise pollution. Furthermore, working hours for construction should be limited to between 07h00 and 17h00 on week days, as construction outside of these time frames will be a nuisance to adjacent dwellers (in the adjacent residential area). Construction times should be limited to between 08h00 and 12h00 on Saturdays and no construction activities should be allowed on Sundays. The main contractor will be responsible for the implementation of the above measures as an on-going process during construction phase.

8. RECOMMENDATIONS AND MITIGATION MEASURES FROM SPECIALISTS

Heritage and Cultural specialist (see original report for more detail):

Other than the above there are no visible restrictions or negative impacts in terms of heritage associated with the site. In terms of heritage, the above taken into account, this project can proceed. The proposed site does not contain any surface archaeological deposits; a possible reason is previous infra-structure development and farming activities in the greater study area. The possibility of sub-surface findings always exists and should be taken into consideration. If sub-surface archaeological material is discovered work must stop and a heritage practitioner preferably an archaeologist contacted to assess the find and make recommendations.

The study area does contain marked graves. One municipal cemetery and a farm cemetery are situated in the study area. The possibility of graves not visible to the human eye always exists and this should be taken into consideration. It is important to note that all graves and cemeteries are of high significance and are protected by various laws. Legislation with regard to graves includes the National Heritage Resources Act (Act 25 of 1999) whenever graves are 60 years and older. Other legislation with regard to graves includes those when graves are exhumed and relocated, namely the Ordinance on Exhumations (no 12 of 1980) and the Human Tissues Act (Act 65 of 1983 as amended). If sub-surface graves are discovered work should stop and a professional preferably an archaeologist contacted to assess the age of the grave/graves and to advice on the way forward.

Ecological Assessments - Specialists (see original report for more detail):

A. Fauna (Mammals, Avifauna and Herpetofauna):

- A wetland rehabilitation plan must be compiled and strictly enforced in order to ensure the future functionality of the aquatic systems.
- An Environmental Control officer specialising in Wetlands must be appointed for the duration of the construction and rehabilitation phase to ensure that the conditions set out in the EMPr as well as rehabilitation plan are enforced.
- Every effort should be made to retain the linear integrity, flow dynamics and water quality of the drainage lines.

- Maximise the width of bridges to benefit water flow and wetlands along riparian zones.
- A buffer zone of 50 m must be provided from the edge of the riparian zone of the Eland River for Half-collared Kingfishers.
- Education of the construction staff about the value of wildlife and environmental sensitivity must be undertaken.
- Restrict access to the suitable and sensitive habitats of faunal species.
- The contractor/contractors must ensure that no fauna are disturbed, trapped, hunted or killed during the construction phase. Conservation-orientated clauses should be built into contracts for construction personnel, complete with penalty clauses for non-compliance.
- Implement a policy within the development that only indigenous plant species be used in the rehabilitation of the road reserve.
- Remove all exotic, invasive vegetation and implement a monitoring and eradication plan to keep the site free from invasive plants.
- If the Breyer's long-tailed seps, coppery grass lizard, large-scaled grass lizard, or any herpetological species are encountered or exposed during the construction phase, they should be removed and relocated to natural areas in the vicinity. No vehicles should be allowed to move in or across the wet areas or drainage lines and possibly get stuck. This leaves visible scars and destroys habitat, and it is important to conserve areas where there are tall reeds or grass, or areas where there is short grass and mud.
- It is suggested that where work is to be done close to the drainage lines, these areas be fenced off during construction, to prevent heavy machines and trucks from trampling the plants, compacting the soil and dumping in the system.
- During the construction phase, noise must be kept to a minimum to reduce the impact of the development on the fauna residing on the site.

B. Wetland/Aquatic:

- An alien vegetation eradication programme should be implemented on the site to remove the alien vegetation from the wetland and terrestrial areas.
- An environmental control officer (ECO), specialising in aquatic systems (AECO) must be appointed throughout the project to ensure the longevity of the impacted aquatic system.

- The use of cement lined channels must be avoided at all costs and lining must be done with Loffel stones (or Amourflex stones) or similar products. This is to prevent the loss of habitat to aquatic organisms living in the system.
- The ramps for the in- and out flows from the construction site must be lined with Reno mattresses and or gabions to prevent structure undermining and to ensure flow is dispersed and mitigated. Vertical steps should not exceed 200 mm, to ensure aquatic fauna movement and migration.
- The use of gabion structures, well keyed into the surrounding bank walls and secured to the ground is recommended.
- If any construction activity must occur within the riparian areas then it must commence from upstream proceeding downstream with proper sedimentation barriers in place to prevent sediments and pollution moving downstream from the site. This includes non-perennial systems.
- The removal and translocation of impacted hydrophytes must be done prior to construction commencing.
- Due to the nature of the system, construction should preferably commence during the dry months.
- All sensitive areas together with the associated buffer zones should be fenced during the construction phase to prevent any human activity from encroaching onto these areas. Monitoring of the fences is of paramount importance to ensure no infringement of the fences occurs.
- Removal of debris and other obstructing materials from the site must take place and erosion-preventing structures must be constructed. This is done to prevent damming of water and increasing flooding danger.
- Removed soil and stockpiling of soil must occur outside the extent of the watercourse to prevent siltation and increased runoff during construction. This includes the buffer zones and 1:100 year flood lines.
- Proper toilet facilities must be located outside the sensitive areas: The impact of human waste on the system is immense. Chemical toilets must be provided which should always be well serviced and spaced as per occupational health and safety laws, and placed outside the buffer and 1:100 year flood lines.
- Spill kits must be stored on site: In case of accidental spills of oil, petroleum products etc., good oil absorbent materials must be on hand to allow for the quick remediation of the spill. The kits should also be well marked and all personnel

should be educated to deal with the spill. Vehicles must be kept in good working order and leaks must be fixed immediately on an oil absorbent mat. The use of a product such as Sunsorb is advised.

- No plant machinery may be stored or left near the aquatic areas, when not in use.
- Frequent inspection of the site must be done to ensure that no harmful practices occur on site.
- A photo collection must be taken from fixed demarcated spots to detect changes in the construction area over time. These photographs must be dated and should include the entire site.
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- No construction personnel are allowed to collect, harvest or kill any species of fauna and flora on the site.
- Any species of fauna encountered during the construction phase should be moved to a safe location where no harm can be bestowed on the species.
- If water is sprayed on the construction surface for any reason during the construction process, utmost care must be taken to ensure the runoff water does not pollute the system or any of the associated catchment areas. A stormwater cut-off drain should be constructed between the construction area and the aquatic system to ensure that stormwater flowing through the construction area cannot flow into the aquatic system. The water from the cut-off drain must be collected in a sedimentation pond before entering the aquatic system.
- Any new erosion gullies must be remediated immediately.
- Construction should commence during the dry season or when flows are at their lowest where reasonably possible.
- Regular inspection of erosion preventing devices is needed.
- Construction camps: Plant parking areas and material stockpiles must be located outside the extent of the wetland.
- Access routes should be demarcated and located properly so that no damage to the system can occur. These roads must be adhered to at all times. A large turning place must be provided for larger trucks and machinery. No grading of temporary access roads is allowed as this will create dust and water runoff problems.
- Increased runoff due to removal of vegetation and increased soil compaction must be managed to ensure the prevention of siltation and the maximum stream bank stability.

- The velocity of storm water must be attenuated and spread. As far as possible the link between the stream and the local environment must be maintained. This is to ensure water movement into the soils and ensuring the survival of associated vegetation.
- Storm water leaving the site downstream must be clean and of the same quality as in situ before it enters the construction site (upstream). Preconstruction measures must be in place to ensure sediments are trapped.
- The overall alluvial characteristics of the drainage line (balance between sand, gravel, and stone) must be similar to before construction to ensure natural systems of flooding and sedimentation deportation and conveyance occur.

C. Flora:

Mitigation measures for impact on natural vegetation:

- Unnecessary impacts on surrounding natural vegetation must be avoided.
- The construction impacts must be contained within the footprint of the infrastructure.
- Disturbed areas beyond the footprint of the infrastructure must be rehabilitated as quickly as possible.
- Keep as far as possible on the old tar road running parallel to the N4.

Mitigation measures for Loss of individual or threatened plants:

- Undertake targeted surveys for threatened plants within the footprint of the proposed infrastructure. This must be undertaken at an appropriate time of the year to detect potentially affected species and must be undertaken by a suitably qualified specialist.
- Various samples of 1 declining species (*Boophone disticha*) found close to the construction path need to be protected and if needed, relocated (orange listed plants).
- Around 5 individuals of 1 declining species (*Eucomis autumnalis*) found close to the construction path need to be protected and if needed, relocated (orange listed plants). These plants were found more than 40 meters into the field and it is possible that they could be avoided in the scope of work.
- 2 protected plants in terms of the Mpumalanga Nature Conservation Act 10 of 1998 as amended are situated within the proposed development path. These plants will need a permit to be removed or picked.
- 2 declining species namely *Callilepis leptophylla* and *Boophone Disticha* found within the study area and need to be protected and if needed, relocated (orange listed plants)

- Construction camps and access roads have to be strictly monitored not to transgress onto the areas where the *Eucomis autumnalis* plants are situated.
- Unnecessary impacts on surrounding natural vegetation must be avoided.
- The construction impacts must be contained within the footprint of the infrastructure. Disturbed areas beyond the footprint of the infrastructure must be rehabilitated as quickly as possible.

Mitigation measures for establishment and spread of declared weeds and alien invader plants:

- Disturbance of indigenous vegetation must be kept to a minimum. Where disturbance is unavoidable, disturbed areas should be rehabilitated as quickly as possible once construction is completed.
- Soil stockpiles should not be translocated from areas with alien plants into the site and within the site alien plants on stockpiles must be controlled so as to avoid the development of a soil seed bank of alien plants within the stock-piled soil.
- Any alien plants must be immediately controlled.
- An on-going monitoring program should be implemented to detect and quantify any aliens that may become established and provide information for the management of aliens.

The following recommendations are made with regards to the proposed development:

1. An Environmental Control Officer must be appointed to oversee mitigation measures during construction and will be responsible for the monitoring and auditing of the contractor's compliance with the conditions of the Environmental Impact Management Plan.

2. All areas deemed of high sensitivity must be protected as far as possible and any activity within these areas needs to be restricted.

3. All orange data plants from the Declining list of the IUCN (five different plant species) found on site (see Appendix 1), have to be avoided and, where present close to construction, have to be demarcated and protected. If orange data plants have to be removed from the construction path, they have to be relocated to an

area as close as possible to the original area to preserve population dynamics of the communities.

4. Orange listed plant relocation has to be undertaken before construction and in accordance with a proper Orange data plant relocation and management plan.

5. All plants listed as protected in the Mpumalanga Nature Conservation Act 10 of 1998 (three different species) have to be avoided and where present close to construction, have to be demarcated and protected. If any of these species occur within the construction path, a permit will be needed to relocate these plants from the Mpumalanga conservation authorities.

6. All plant species identified as protected in accordance with the MBCP and in need of relocation have to be relocated by means of a plant relocation plan/program to be compiled by a suitable and qualified person.

7. A wetland study should be conducted, in order to determine the true extent of the wetland and buffer zones to the wetland, as well as the need for water-use licenses and other permit requirements.

8. Areas to be disturbed by construction activity as well as areas for ancillary activities such as stock piles, storage yards or site offices must be clearly demarcated in already disturbed areas or areas where they will cause minimal disturbance. The extent of the areas must be minimised and demarcated by preferably using steel droppers and nylon rope between the markers. Construction activities and materials must at all times be contained within the demarcated sites.

9. An alien invasive management program has to be compiled and implemented before construction commences for the 33 recorded alien and invasive plant species recorded on site. This plan should include measures to control these plants.

WATER MONITORING PLAN

for

N4-5B

6 MONITORING PLAN

A Monitoring Plan has been compiled for the proposed Upgrading/Widening Project as part of the Rehabilitation Plan. For the full Rehabilitation Plan refer to **APPENDIX 18**.

The main goal of the monitoring of the rehabilitation process is to ensure that the methods and phases of the rehabilitation process are implemented and to detect any causes for concern during the processes. Most importantly, the monitoring program is conducted to detect if the proposed rehabilitation methods, as designed, are efficient and operational.

Due to the complexity of the rehabilitation process, it is proposed that a specialist Aquatic Environmental Control Officer (AECO) be on site for the duration of the construction process. This is advised as the possible impacts on the aquatic ecosystem are of such a concern that a trained person be instated for the full length of the construction and rehabilitation phases. It is also proposed that the person be appointed for a period after the completion of the project to ensure the success of the rehabilitation over a longer period than the construction phase itself. This period length is at the discretion of the ECO, the Developer, and the AECO and the Department of Water and Sanitation.

6.1 MONITORING OBJECTIVES

The AECO will be tasked with the health of the wetland environment through the identification and mitigation of any environmental problems encountered and will have the power to stop any construction related activity affecting negatively on the wetland system. This must be in line with the current state of the environment and targets to improve on the state of the environment through rehabilitation.

To assign a timetable for the monitoring of the impacts is not achievable since the construction periods are not known. It is therefore suggested that at the discretion of the AECO, the developer and the contractor, the timetable be decided on an adaptive time basis to adjust to the needs of the parties. It is proposed that a monthly inspection (and reporting) be conducted. It is important to ensure the correct aspects are adhered to during the monitoring of the site (refer to **Table 6-1**). This is only recommended and may differ in the water use licence.

Table 6-1: Aspects and Monitoring Requirements of the Study Site

Aspect	Monitoring Requirements
Baseline condition prior to the impact	See wetland delineation report
Aspects Requiring Monitoring	▪ Water quality parameters (WQP) (as per baseline and Target Water Quality Range (TWQR set by DWA) upstream (if possible) and downstream. ▪ General construction related impacts

Aspect	Monitoring Requirements
TWQR Parameters	▪ Soap, oil and grease (SOG), ▪ Hydrocarbons (TPH), ▪ pH, ▪ Dissolved oxygen, ▪ Total dissolved salts, ▪ Suspended solids, ▪ Nitrate, Nitrite and Phosphate,
TWQR Frequency	Weekly during construction, with monthly follow-up until a year after construction
TWQR	As for aquatic ecosystems guideline by the Department of Water Affairs. Maximums can also be given in the WUL.
Responsible Party	Owner/Developer and construction company should appoint the AECO. Remediation work is the responsibility of the construction crews.
Frequency of monitoring, and/or timeframes	Monthly assessments of the Fish population, SASS5
Targets for each aspect monitored impact	The construction should have a neutral impact on the system and thus the *in situ* conditions
Photographic record of construction and impacts	A photographic record must be kept of the road upgrade. Reference images should be taken from a fixed point, before, during and after the construction.
Indicators for measuring the progress of each target	Water Quality: the indicators should not exceed the parameters set out in the in situ conditions. **Photographic image references:** should be used based on visual observations of change
Environmental driver monitoring	Rainfall, temperature
Corrective actions implemented if monitoring is not progressive	As per the AECO monthly reports

6.2 WATER QUALITY MONITORING

The sample sites proposed are at the same location as the baseline that was done during the delineation study (**Figure 6-1**). The results from the delineation study must also be used as the baseline for the construction phase.

6.3 MONITORING REPORTING

6.3.1 MONITORING AND TIME TABLE

It is advised that an AECO specialising in aquatic systems be on site for the duration of the construction process. This is advised as the possible impacts on the wetland are of such a concern that a trained person be instated for the full length of the construction and rehabilitation process. The AECO will be tasked with the health of the wetland environment through the identification and mitigation of any environmental problems encountered and will have the power to stop any construction related activity impacting negatively on the wetland system. The AECO will also be tasked with the following time table in terms of the wetland project (refer to **Table 6-2**). Proper

follow up programs for the eradication of alien vegetation is important. If the program neglects to do follow-ups the initial eradication work would be in vain and the problem will increase in scale.

Table 6-2: Monitoring Time Table

Daily:	▪ Ensure wetland areas outside the construction areas are not being unduly imposed on by construction activities or accessed by any means. ▪ Ensure no species of fauna and flora is being utilized by the construction workers or destroyed. ▪ Any reported problems to be inspected immediately and mitigating actions taken to ensure no prolonged damage occurs to the site. ▪ Rainfall and temperature (can be provided by the construction crews).
Weekly:	▪ Inspection of sedimentation traps. ▪ Inspection of aquatic plants occupying the wetland areas to make sure the plants is not disturbed. ▪ Inspection of aquatic plants removed and kept for later reintroduction, to ensure their health. If any problems are found with the plants a solution should be sought as soon as possible.
Monthly:	▪ Monthly dated photographs should be taken from fixed high importance spots (marked on a map) and should be compared to the in situ situation and if the need arises the correct mitigating actions should be taken. ▪ Ensure environmental training of construction workers is up to date. ▪ Report on the state of the environment during construction.

6.3.2 REPORTING

Reporting frequency should be at the discretion of the AECO based on needs in terms of compliance. The water quality results should be indicated on a spread sheet with date of sample, maximum and minimum TWQR and the results clearly indicated. If any major aspects occurred this must also be indicated (such as high rainfall events). Photographic records of fixed points should include first image taken (before construction) and latest image on the same page for comparative ease.

Table 6-3: Proposed Reporting Format for the Wetland ECO

Number	Format
1)	Activity
2)	Comments
3)	Action to be taken
4)	Date for compliance
5)	Action group
6)	Frequency of action
7)	Impact description
8)	Penalty
9)	Progress of reported impact

6.3.3 PENALTIES FOR NON-COMPLIANCE

As a guide the Department of Water Affairs and Forestry (2005) "Environmental Best Practice Specifications: Construction Integrated Environmental Management" can be used for penalties on the site. It is of utmost importance that the developer and the construction crews accept the penalties and the penalty system is included in the tender documentations.

6.3.4 MONITORING CONCLUSION

The monitoring of the rehabilitation process is of paramount importance to ensure the efficiency thereof. If rehabilitation does not occur as stipulated, then corrective measures must be enforced through the audit findings and reports. Communication between the rehabilitation implementer, the author of the rehabilitation plan, the developer, and the construction contractor is of principal importance to ensure execution of the rehabilitation plan. If any areas of concern are found then they must be explored to determine the extent of and solution to the problem.

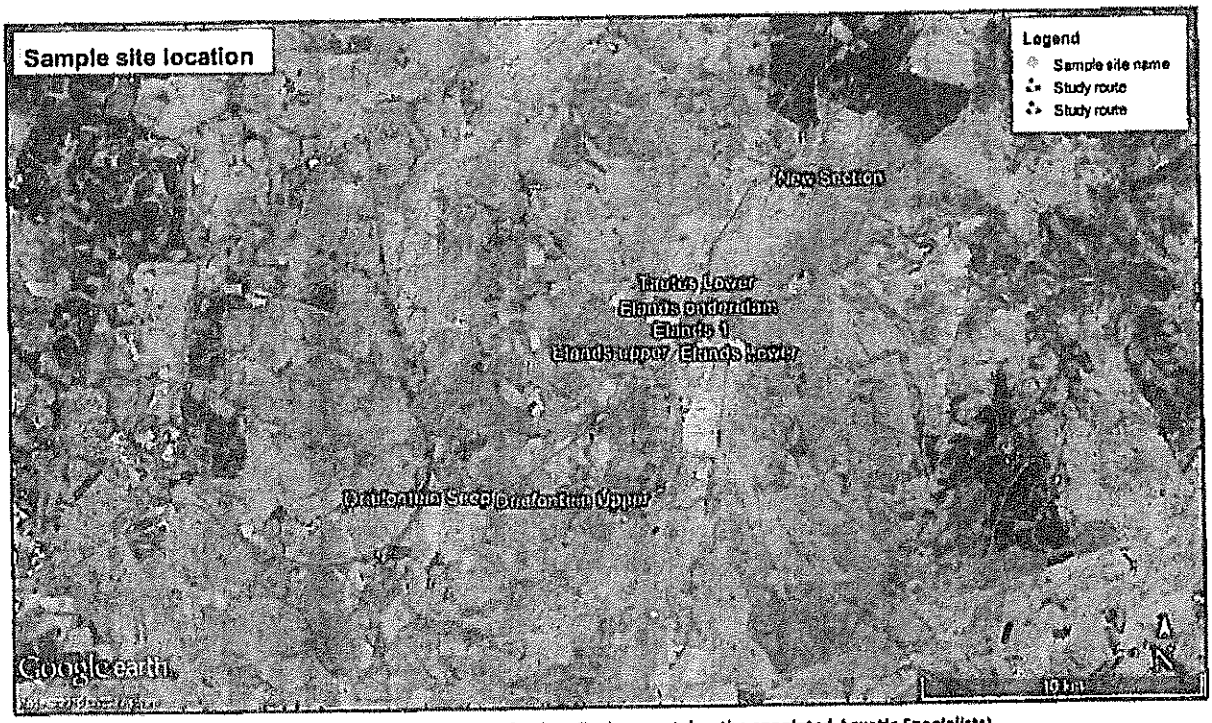

Figure 6-1: Proposed Sample Site Localities (image courtesy of Galago Environmental as the appointed Aquatic Specialists)