PROPOSED R102 PARTIAL INTERCHANGE & PEDESTRIAN BRIDGE IN THE PHOENIX/MOUNT EDGECOMBE AREA, ETHEKWINI MUNICIPAL AREA, KWAZULU-NATAL

Terrestrial Vegetation Assessment Report

Version 1.0

13 October 2015

Eco-Pulse Environmental Consulting Services

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Report No: EP191-01

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Suggested report citation:

Eco-Pulse Consulting, 2015. Proposed R102 Partial Interchange and Pedestrian Bridge in the Phoenix/Mount Edgecombe Area, EThekwini Municipal Area, KZN. Specialist Terrestrial Vegetation Assessment Report. Unpublished report prepared by Eco-Pulse Environmental Consulting Services for Royal HaskoningDHV. Version 1.0, 13 October 2015.

SPECIALIST ASSESSMENT REPORT DETAILS AND DECLARATION OF INDEPENDENCE

This is to certify that the following specialist vegetation assessment report has been prepared has been prepared independently of any influence or prejudice as may be specified by the Department of Agriculture and Environmental Affairs (DAEA).

Document Title:	Proposed R102 Partial Interchange development: *Specialist Terrestrial Vegetation Assessment Report*
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Field of study/Expertise	Ecology
Professional Affiliations:	Professional Natural Scientist registered with SACNASP (reg: 400332/13)
Date:	13 October 2015
Version Number:	1.0
Report No.	EP191-01
Client:	Royal HaskoningDHV (RHDHV) on behalf of the KwaZulu-Natal Department of Transport

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The relevant experience of specialist team members from Eco-Pulse Consulting involved in the assessment and compilation of this report are briefly summarized below. *Curriculum Vitae's* of the specialist team are available on request.

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EXECUTIVE SUMMARY

The KwaZulu-Natal Department of Transport (KZN DoT) is proposing to construct a partial interchange to link the R102 and M41 highways and upgrade sections of the regional road R102 located in the Phoenix/Mount Edgecombe suburbs of eThekwini Municipality, KwaZulu-Natal. In addition, a pedestrian bridge is proposed to facilitate the crossing of the R102 road by pedestrians. An Environmental Authorisation (EA) was previously obtained for the planned road infrastructure development/upgrade; however, three additional components have now been proposed which did not form part of the previous assessment and authorisation, including the P79 grade separation, M41 north-bound off-ramp and a Pedestrian bridge crossing the R102. Eco-Pulse Environmental Consulting Services (Eco-Pulse) was appointed by Royal HaskoningDHV (RHDHV) on behalf of the KZN DoT to undertake a Terrestrial Vegetation Survey and Habitat Impact Assessment for the three additional components of the interchange development project. The three focal areas of the vegetation survey including the P79 grade separation, M41 north-bound off-ramp and a Pedestrian bridge crossing the R102 were visited at the onset of summer (September 2015). The main findings of the specialist terrestrial vegetation assessment and report outcomes have been summarized below.

i. The KwaZulu-Natal Coastal Belt (CB 3) vegetation type is the natural vegetation type characterising the site. It is characterised by grasslands on undulating coastal plains and forest patches in valleys.

ii. A number of terrestrial vegetation communities were identified and assessed for each component of the interchange development:

    1. Within the P79 grade separation study area, three (3) terrestrial vegetation communities were identified including the Wooded Alien Thicket, Wooded Grassland and *Hyparrhenia filipendula* Grassland. The Wooded Alien Thicket and Wooded Grassland Community were assessed as being characterised largely by alien plant species and not reminiscent of the benchmark vegetation type (KwaZulu-Natal Coastal Belt). As such these vegetation communities were assessed as being of low sensitivity. The *Hyparrhenia filipendula* Grassland exhibited a species composition which is reminiscent of the benchmark vegetation and as such was assessed as being of moderate ecological sensitivity.

    2. At the M41 north-bound off-ramp study area the vegetation community present was identified as Wooded alien thicket, an alien dominated thicket that does not resemble the benchmark vegetation type. In terms of sensitivity this community was assessed as being of low ecological sensitivity.

    3. At the proposed pedestrian bridge, two (2) vegetation types were identified. These include the Wooded alien thicket and the Ruderal herbaceous community. Both were characterised alien vegetation and did not resemble the benchmark vegetation type. They were assessed as being of low ecological sensitivity.

Assessment Focal Area	Vegetation Community	Ecological Sensitivity	Level of naturalness	Level of disturbance/ transformation
A; P79 grade separation	*Hyparrhenia filipendula* open grassland	**Moderate**	High	Low
	Wooded grassland	**Low**	Moderately low	Moderately high
	Wooded alien thicket	**Low**	Low	High
B: M41 north-bound off-ramp	Wooded alien thicket	**Low**	Low	High
C: Pedestrian bridge	Ruderal herbaceous community	**Low**	Low	High
	Wooded alien thicket	**Low**	Low	High

iii. Based on a desktop survey of the site, Ten (10) plant species of conservation concern were predicted to occur at the site but none of these species were recorded during the site survey. During field investigations, four (4) plant species of conservation importance where recorded within the construction impact zone and/or within adjacent habitats. These included:

1. *Scadoxus puniceus* (Snake lily) – relatively abundant at the P79 grade separation study area;
2. *Dioscorea sylvatica* (Elephant's foot) at the P79 grade separation study area;
3. *Barringtonia racemosa* (Powder-puff tree – protected tree) at the M41 north-bound off-ramp study site; and
4. *Aloe marlothii* (Mountain aloe) at the pedestrian bridge study site.

Handling of these species will require either an Ordinary Permit from EKZNW (for Specially Protected herbaceous plants) or a licence from DAFF (for listed protected trees).

iv. A total of 42 alien plant species were recorded of which 29 are categorised invasive alien plants (IAPs). Of the 29 IAPs, 22 are categorised as falling under categories 1a and 1b and subject to compulsory control according to the NEM:BA. The level of IAPs infestation is currently high and therefore IAP infestation is expected to be a serious problem if the site is poorly management. A comprehensive IAPs control plan has been included in this report to assist in combatting IAPs.

v. Other key potential impacts linked with the development may include the direct and permanent loss of terrestrial vegetation and habitat, indirect loss of vegetation and habitat through pollution, loss of plants species of conservation concern and fragmentation of habitat, and the potential loss of ecosystem goods & services provided by the terrestrial vegetation and habitat, including erosion control and biodiversity support among others. These impacts ranged from low to moderate ecological significance, with the permanent loss of intact/natural grassland habitat regarded as being of a moderate significance, with the same impact for degraded/low sensitivity vegetation communities regarded as being moderately low in terms of impact significance. The remaining impacts were generally rated as low to moderately low in terms of their significance.

vi. Minimising the construction footprint particularly within the road reserve, controlling IAPs, properly managing pollutants and rehabilitating the site post construction (as per the recommendations and guidelines outlined in this report)will aid in avoiding, limiting and reducing adverse impacts linked with the development to an environmental acceptable level or low ecological significance. The direct loss of vegetation and habitat within the development footprint will be difficult to mitigate however, but the largely degraded nature of the habitats impacted should not trigger the need for a biodiversity offset and should be compensated instead through on-site rehabilitation of degraded terrestrial vegetation and habitat in the vicinity of the development (i.e. within the road reserve). Protected species identified within the construction footprint can be easily translocated through proper management at the site.

vii. The proposed development is considered acceptable on the provision that the impact mitigation and management measures proposed in this report are adhered to. It is therefore recommended that Section6 of this report which deals with 'Impact Mitigation/Management' be included in an Environmental Management Programme (EMPr) for the development and also referenced in the Environmental Authorisation (EA) for this project as a specific condition of the EA.

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DEFINITION OF TERMS

Biodiversity	The wide variety of plant and animal species occurring in their natural environment (habitats). The term encompasses different ecosystems, landscapes, communities, populations and genes as well as the ecological and evolutionary processes that allow these elements of biodiversity to persist over time.
Conservation	The safeguarding of biodiversity and its processes (often referred to as Biodiversity Conservation).
Erosion (gulley)	Erosion is the process by which soil and rock are removed from the Earth's surface by natural processes such as wind or water flow, and then transported and deposited in other locations. While erosion is a natural process, human activities have dramatically increased the rate at which erosion is occurring globally. Erosion gullies are erosive channels formed by the action of concentrated surface runoff.
Ezemvelo KZN Wildlife	Ezemvelo KwaZulu-Natal Wildlife, the local conservation authority for the Province of KwaZulu-Natal.
Endemic	Refers to a plant, animal species or a specific vegetation type which is naturally restricted to a particular defined region (not to be confused with indigenous). A species of animal may, for example, be endemic to South Africa in which case it occurs naturally anywhere in the country, or endemic only to a specific geographical area within the country, which means it is restricted to this area and grows naturally nowhere else in the country.
Grassland	A grassland is a vegetation community in which grasses are the most conspicuous plants
Habitat	The general features of an area inhabited by animal or plant which are essential to its survival (i.e. the natural "home" of a plant or animal species).
Indigenous	Naturally occurring or "native" to a broad area, such as South Africa in this context.
Invasive alien plants	Alien invasive species (IAPs) means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.
Mitigate/Mitigation	Mitigating impacts refers to reactive practical actions that minimize or reduce in situ impacts. Examples of mitigation include "changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites". Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).
Residual Impacts	Impacts that remain after the proponent has made all reasonable and practicable changes to the location, siting, scale, layout, technology and design of the proposed development, in consultation with the environmental assessment practitioner and specialists (including a biodiversity specialist), in order to avoid, minimize, and/or repair/restore negative impacts on, amongst others, biodiversity (DEA&DP, 2007). That is, after consideration has been given to the first three measures in the mitigation hierarchy.
Risk	A prediction of the likelihood and impact of an outcome; usually referring to the likelihood of a variation from the intended outcome.
Systematic conservation plan	An approach to conservation that prioritises actions by setting quantitative targets for biodiversity features such as broad habitat units or vegetation types. It is premised on conserving a representative sample of biodiversity pattern, including species and habitats (the principle of representation), as well as the ecological and evolutionary processes that maintain biodiversity over time (the principle of persistence).
Threatened ecosystem	In the context of this document, refers to Critically Endangered, Endangered and Vulnerable ecosystems.
Threat Status	Threat status (of a species or community type) is a simple but highly integrated indicator of vulnerability. It contains information about past loss (of numbers and / or habitat), the number and intensity of threats, and current prospects as indicated by recent population growth or decline. Any one of these metrics could be used to measure vulnerability. One much used example of a threat status classification system is the IUCN Red List of Threatened Species (BBOP, 2009).
Transformation (habitat loss)	Refers to the destruction and clearing an area of its indigenous vegetation, resulting in loss of natural habitat. In many instances, this can and has led to the partial or complete breakdown of natural ecological processes.
Wetland	Refers to land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water,

	and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil (National Water Act, 1998).

ABBREVIATIONS/ACRONYMS USED

CBA	Critical Biodiversity Area
CR	Critically Endangered (threat status)
DAFF	Department of Forestry and Fisheries
DOT	Department of Transport
DWS	Department of Water and Sanitation (formerly DWA/F)
EKZNW	Ezemvelo KwaZulu-Natal Wildlife: as defined in Act 9 of 1997 to be the KZN Nature Conservation Service
EMPr	Environmental Management Programme
EN	Endangered (threat status)
GIS	Geographical Information Systems
GPS	Global Positioning System
IAPs	Invasive Alien Plants
LT	Least Threatened (threat status)
NEMA	National Environmental Management Act No.107 of 1998
NEM:BA	National Environmental Management: Biodiversity Act No.10 of 2004
NT	Near Threatened (threat status)
NWA	National Water Act No.36 of 1998
SANBI	South African National Biodiversity Institute
VU	Vulnerable (threat status)

1 INTRODUCTION

1.1 Locality

Eco-Pulse Environmental Consulting Services (Eco-Pulse) was appointed by Royal HaskoningDHV (RHDHV) on behalf of the KZN Department of Transport (DoT) to undertake a Terrestrial Vegetation Survey and Habitat Impact Assessment for the proposed construction of the R102 partial Interchange and Pedestrian bridge development. The development area is located in Mount Edgecombe/Phoenix North suburbs of Durban within the eThekwini Municipal Area, KwaZulu-Natal. A locality map has been provided as Figure 1, below.

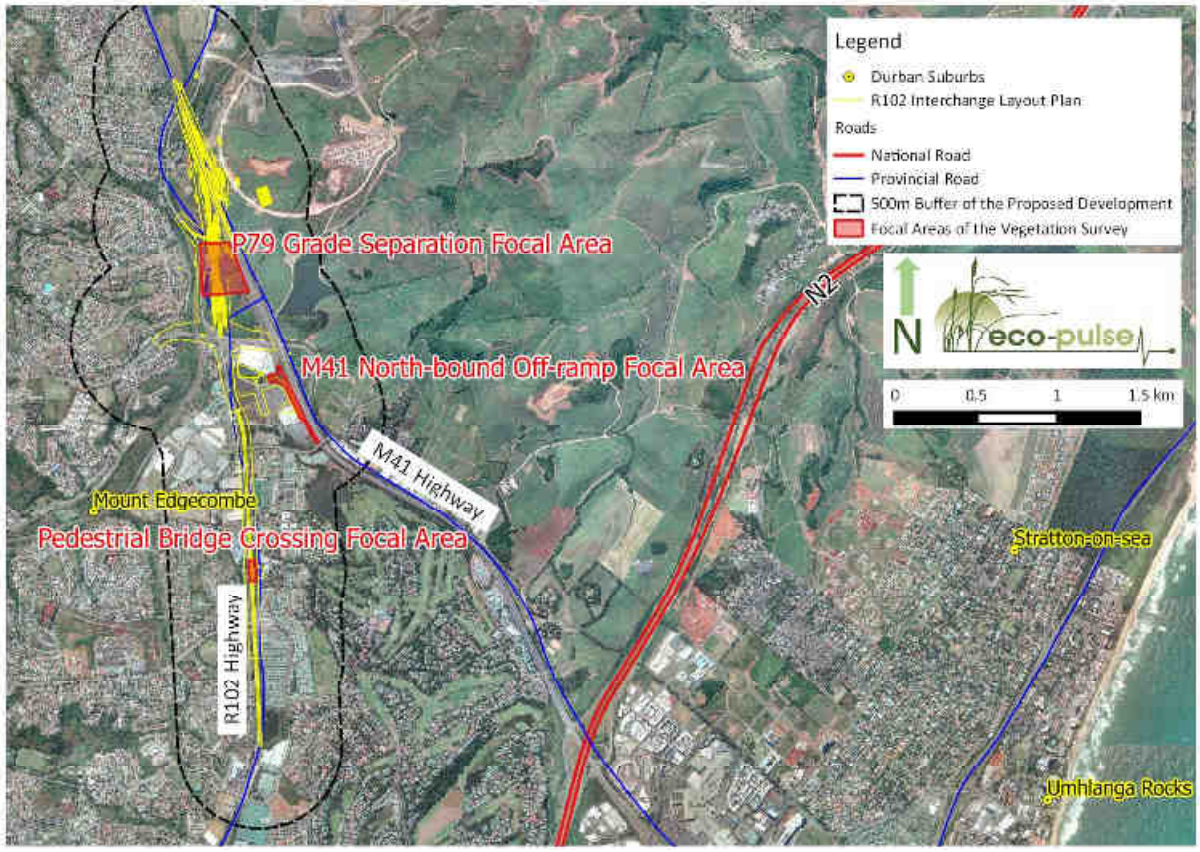

Figure 1 Locality map showing the proposed development in 'yellow' and focal study areas of the vegetation assessment in 'red'.

1.2 Project Background and Description

The KwaZulu-Natal Department of Transport (KZN DoT) is proposing to construct a partial interchange to link the R102 and M41 highways, upgrade sections of the R102 road and develop a pedestrian bridge to facilitate the crossing of the R102 road by pedestrians at the location shown in Figure 1. An Environmental Authorisation (EA) was previously obtained for the planned road infrastructure development/upgrade; however, three additional components have now been proposed which did not form part of the previous application for Environmental Authorisation (EA). The focus of the terrestrial vegetation survey and impact assessment was centred on these three additional components which include:

A. P79 grade separation;
B. M41 north-bound off-ramp; and
C. Pedestrian bridge crossing the R102.

The Specialist Terrestrial Vegetation Survey and Impact Assessment Report serves to inform the current application for EA now required for the three additional components of the development. Note that wetland habitat and vegetation was excluded from this assessment as this has already been assessed as part of the Specialist Wetland and Aquatic Habitat Impact Assessment undertaken by Eco-Pulse Consulting in August/September 2015.

The development layout plan shown in Figure 1, as well as the following engineering design drawings were made available to the ecologists of Eco-Pulse Consulting to inform the assessment of the development road impact on the terrestrial vegetation communities:

i. Mt. Edgecombe Partial Interchange: Road Layout Plan No. C29324;
ii. Mt. Edgecombe Partial Interchange: Road Layout Plan of drawings No. C29325;
iii. Duffs Road – Phoenix Northern Spinal Road: Design/Expropriation/Services Plan No. C33287; and
iv. Duffs Road – Phoenix Northern Spinal Road: Design/Expropriation/Services Plan No. C33288.

1.3 Scope of Work

The scope of work associated with the specialist terrestrial vegetation and habitat impact assessment was as follows:

- Contextualization of the study area in terms of important biophysical characteristics and terrestrial conservation planning information available at the time of the study, including:
    - Ezemvelo KZN Wildlife's Terrestrial Systematic Conservation Plan (CPLAN, 2010);
    - Ezemvelo KZN Wildlife's Provincial Vegetation Map (2012).
- Mapping exercise using available desktop GIS coverage's to map untransformed terrestrial vegetation and differentiate between different vegetation/habitat units in the vicinity of the proposed ramps and pedestrian bridge (*excluding wetland/aquatic habitats and vegetation already delineated by Eco-Pulse in August 2015*).
- Desktop identification of species of conservation concern (flora/plants) potentially occurring on the property based on available species records for the region (i.e. SANBI's online threatened species database: PRECIS) and considering the habitat preferences of these species in light of the habitat represented at the site.
- Field survey of the terrestrial vegetation and habitat within the proposed development zone of the proposed P79 grade separation, M41 north-bound off-ramp and pedestrian bridge and the immediate surrounding area (within 50-100m).
- Basic survey of the fauna occurring in the area using visual observations of species as well as evidence of their occurrence noted during the single field visit (e.g. burrows, excavations, animal tracks etc.).

- Identification and mapping of the geographic location of any plant species of conservation concern (i.e. threatened or protected plants/trees) noted during the site assessment that may be considered a fatal flaw to the project.
- Assessment of the vegetation condition against the benchmark condition (as per Mucina & Rutherford Veld Type, 2006).
- Development of a terrestrial vegetation sensitivity map, showing areas of high, medium and low sensitivity based on the vegetation/habitat characteristics.
- Assessment of the scope, scale and significance of potential ecological impacts to terrestrial vegetation and habitat arising from the project, including broad comment on any cumulative impacts likely to arise from the project.
- Specialist impact management/mitigation recommendations to avoid/reduce the ecological significance of identified impacts, including the allocation of appropriate set-backs for sensitive areas.
- Discuss permit/licensing requirements with regards to protected plant species identified on site.
- Describe any assumptions made and any uncertainties or gaps in knowledge, as well as identifying the need for any future specialist inputs should these be deemed relevant to the project.
- Compilation of a single *Specialist Terrestrial Vegetation and Habitat Impact Assessment Report* outlining the methods and outcomes of the assessment.

1.4 Relevant Environmental Legislation

Terrestrial ecosystems, their habitat and vegetation are governed in South Africa by the following legislation:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- National Environmental Management Act (NEMA) No. 107 of 1998) inclusive of all amendments;
- National Environmental Management: Biodiversity Act (NEMBA) No. 10 of 2004;
- Conservation of Agricultural Resources Act No. 43 of 1983;
- National Forests Act No. 84 of 1998; and
- At a Provincial level, plant species are protected by the Natal Nature Conservation Ordinance (No. 15 of 1974).

2 APPROACH AND METHODS

2.1 Approach to the Assessment

The following approach to the aquatic assessment was taken:

1. **Desktop assessment of terrestrial plant species and vegetation types** using available GIS and online datasets for the Province to identify flora species and vegetation types of conservation concern to inform the assessment.
2. **Field identification of flora, description and delineation of vegetation communities and recording GPS location of conservation important species**.
3. **Assessment of the sensitivity of delineated vegetation communities** based on vegetation condition and presence of sensitive/conservation important species.
4. **Identification, description and assessment of significance of** impacts to delineated vegetation communities.
5. **Recommendation of impact management/mitigation measures** to deal with anticipated ecological impacts, including planning and design recommendations.
6. **Recommendations regarding plant permit/licence requirements.**

2.2 Data Sources Consulted

The following data sources and GIS spatial information provided listed in Table 1 (below) was consulted to inform the specialist assessment. The data type, relevance to the project and source of the information has been provided.

Table 1. Data sources and GIS information consulted to inform the terrestrial vegetation assessment.

DATA/COVERAGE TYPE	RELEVANCE	SOURCE
2013 Colour aerial photography	*Desktop mapping of drainage network*	EThekwini Municipality dataset
Latest Google Earth ™ imagery	*To supplement available aerial photography where needed*	Google Earth™ On-line
2m Elevation Contours (GIS Coverage)	*Desktop mapping of drainage network*	EThekwini Municipality dataset
EThekwini Geology (GIS Coverage)	*Assessment of underlying geology controlling soil formation and aspects of wetland/river geomorphology*	EThekwini Municipality dataset
South African Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation*	Mucina & Rutherford (2006)
KwaZulu-Natal Vegetation Map (GIS Coverage)	*Classify vegetation types and determination of reference primary vegetation*	EKZNW (2011)
KZN Rivers (GIS Coverage)	*Highlight potential onsite and local rivers and wetlands and map local drainage network*	SA Rivers dataset
SANBI On-line threatened species database	*Used to identify potentially occurring threatened plant species for the region*	SANBI on-line database (2013)

2.3 Methods Used

2.3.1 Field survey

A field survey of the vegetation at the target site was undertaken on the 29th September 2015 (at the onset of the summer season). A number of transects were walked across the site, providing good coverage of the project area habitats and vegetation. The following data was collected in the field:

- Species inventory of all plant species identified in the field. Where species could not be identified, samples and photographs were taken to confirm at a later stage using available literature;
- Estimation of the relative abundance of each species was also undertaken;
- Identification of different habitats and vegetation communities present, including species composition, structure and general condition;
- Identification and description of any anthropogenic impacts to the vegetation communities; and
- The location of any species of conservation concern (listed protected trees/threatened species) was recorded using a GPS (Global Positioning System).

2.3.2 Species of conservation concern

Species of conservation concern are species that have a high conservation importance in terms of preserving South Africa's high biological diversity. If a subpopulation of a species of conservation concern is found to occur on a proposed development site, it would be one indicator that development activities could result in significant loss of biodiversity, bearing in mind that loss of subpopulations of these species will either increase their extinction risk or may in fact contribute to their extinction (see Figure 2, below). A description of the different SANBI categories of species of conservation concern is provided in Table 2, below.

Flora of conservation significance (including threatened, protected and rare species) likely to occur in the various habitats of the study area were assessed at a desktop level using the outputs of SANBI's PRECIS (National Herbarium Pretoria Computerized Information System) electronic database for the quarter degree grid 2931CA (http://posa.sanbi.org). The habitat requirements/preferences for each plant species of conservation concern was reviewed (based on available literature) and was then compared with the habitat occurring on the site in order to estimate the likelihood of these species occurring on the target property. The presence/absence of these species was then verified during field surveys.

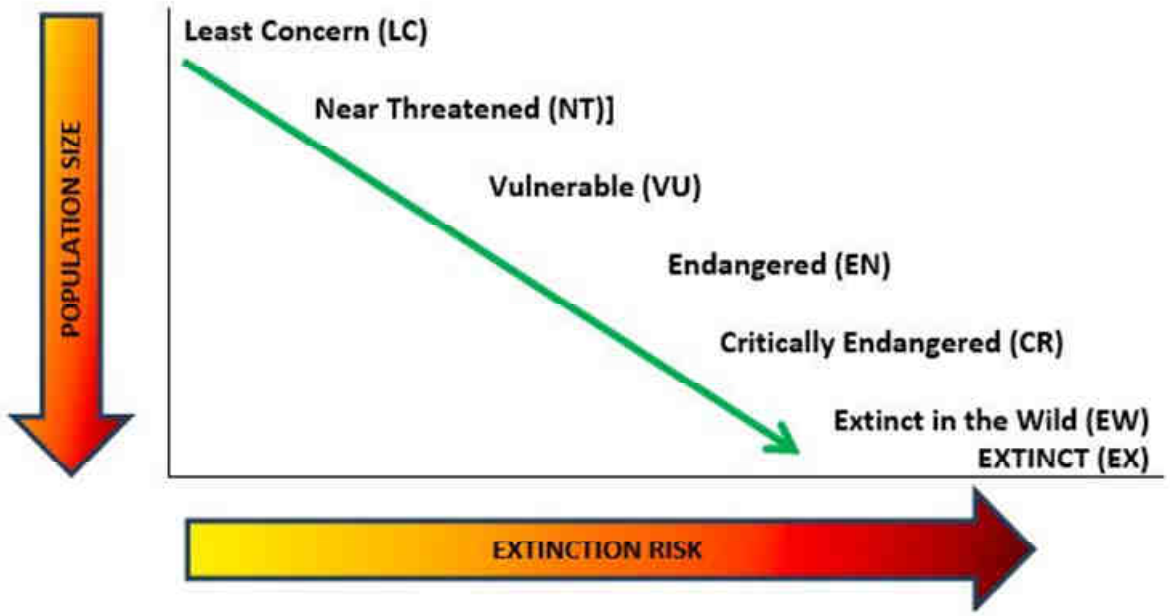

Figure 2 Graph showing the relationship between population size and extinction risk, distinguishing between the various species threat statuses (after SANBI, 2010).

Table 2. South African Red List Categories for species of conservation significance (after SANBI, on-line at http://redlist.sanbi.org/eiaguidelines.php).

INCREASING RISK OF EXTINCTION

Status	Category	Description
SPECIES OF CONSERVATION CONCERN	**Critically Endangered, Possibly Extinct (CR PE)**	Possibly Extinct is a special tag associated with the category Critically Endangered, indicating species that are highly likely to be extinct, but the exhaustive surveys required for classifying the species as Extinct has not yet been completed. A small chance remains that such species may still be rediscovered
	Critically Endangered (CR)	A species is Critically Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Critically Endangered, indicating that the species is facing an extremely high risk of extinction.
	Endangered (EN)	A species is Endangered when the best available evidence indicates that it meets at least one of the five IUCN criteria for Endangered, indicating that the species is facing a very high risk of extinction.
	Vulnerable (VU)	A species is Vulnerable when the best available evidence indicates that it meets at least one of the five IUCN criteria for Vulnerable, indicating that the species is facing a high risk of extinction.
	Near Threatened (NT)	A species is Near Threatened when available evidence indicates that it nearly meets any of the IUCN criteria for Vulnerable, and is therefore likely to become at risk of extinction in the near future.
	Critically Rare	A species is Critically Rare when it is known to occur at a single site, but is not exposed to any direct or plausible potential threat and does not otherwise qualify for a category of threat according to one of the five IUCN criteria.
	Rare	A species is Rare when it meets at least one of four South African criteria for rarity, but is not exposed to any direct or plausible potential threat and does not qualify for a category of threat according to one of the five IUCN criteria.
	Declining	A species is Declining when it does not meet or nearly meet any of the five IUCN criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline of the species.
	Data Deficient - Insufficient Information (DDD)	A species is DDD when there is inadequate information to make an assessment of its risk of extinction, but the species is well defined. Listing of species in this category indicates that more information is required and that future research could show that a threatened classification is appropriate.
OTHER	**Data Deficient - Taxonomically Problematic (DDT)**	A species is DDT when taxonomic problems hinder the distribution range and habitat from being well defined, so that an assessment of risk of extinction is not possible.
	Least Concern (LC)	A species is Least Concern when it has been evaluated against the IUCN criteria and does not qualify for any of the above categories. Species classified as Least Concern

Status	Category	Description
		are considered at low risk of extinction. Widespread and abundant species are typically classified in this category.
	Not Evaluated (NE)	A species is Not Evaluated when it has not been evaluated against the criteria. The national Red List of South African plants is a comprehensive assessment of all South African indigenous plants, and therefore all species are assessed and given a national Red List status. However, some species included in Plants of southern Africa: an online checklist are species that do not qualify for national listing because they are naturalized exotics, hybrids (natural or cultivated), or synonyms. These species are given the status Not Evaluated and the reasons why they have not been assessed are included in the assessment justification.

2.3.3 Assessment of ecological impacts

The information from the baseline terrestrial vegetation assessment was used to inform an assessment of the likelihood and significance of potential impacts to terrestrial vegetation and habitat associated with the proposed development project. For the purposes of this assessment, the rating of impact significance was undertaken according to an ecological impact assessment methodology developed by Eco-Pulse Consulting for EIAs, which is based on the Guideline Document on EIA Regulations of Environmental Affairs and Tourism (DEAT, 1998) and the Integrated Environmental Management Information Series: Impact Significance (DEAT, 2002). This process routinely includes the following tasks: impact identification, impact prediction and impact evaluation. Further details of the assessment method used to ascertain impact 'significance' is contained in **Annexure A.**

2.3.4 Identification of mitigation measures

'Mitigation' is a broad term that covers all components involved in selecting and implementing measures to conserve biodiversity and prevent significant adverse impacts as a result of potentially harmful activities to natural ecosystems. The mitigation of negative impacts on biodiversity is a legal requirement for authorisation purposes and must take on different forms depending on the significance of impacts and the particulars of the target area being affected. The Guideline for Biodiversity Impact Assessment (Ezemvelo KZN Wildlife, 2013) was used to guide the assessment of impacts and to inform the identification of suitable mitigation measures. According to the document, the guiding principle with regards to biodiversity conservation and sustainable development adopted by KZN Wildlife is one of "*no net loss of biodiversity and ecosystem processes*".

To achieve this principle, a proactive approach to planning and biodiversity conservation must be adopted that is enabled by following the 'mitigation hierarchy', described in Figure 3, below. The application of the mitigation hierarchy is intended firstly, to strive to avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided, to minimise, rehabilitate, and then finally offset any remaining significant residual impacts. The mitigation hierarchy is inherently proactive, requiring the on-going and iterative consideration of alternatives in terms of project location, siting, scale, layout, technology and phasing until the proposed development can best be accommodated without incurring significant negative impacts to the receiving environment. In cases where the receiving environment cannot support the development or where the project will destroy the natural resources on which local communities are wholly dependent for their livelihoods or eradicate unique

biodiversity; the development may not be feasible and the developer knows of these risks, and can plan to avoid them, the better. In the case of particularly sensitive ecosystems, where biodiversity impacts can be severe, the guiding principle should generally be "*anticipate and prevent*" rather than "*assess and repair*".

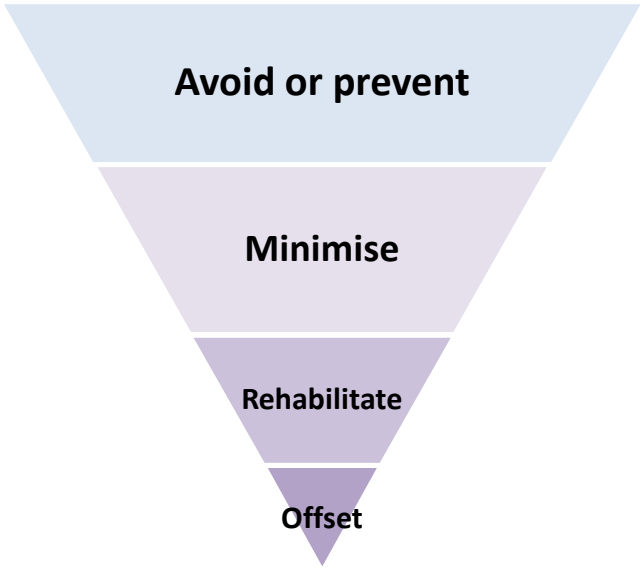

Figure 3 Diagram illustrating the 'mitigation hierarchy' (after DEA *et al*., 2013).

2.4 Assumptions and Limitations

The following limitations and assumptions apply to this assessment:

- This report deals exclusively with a defined area and the extent and nature of the vegetation and habitat/ecosystems in that area.
- The study focused on 'terrestrial' or dryland vegetation and wetland/aquatic vegetation and habitats were not included as these have already been dealt with separately in the Specialist Wetland and Aquatic Assessment Report compiled by Eco-Pulse in August/September 2015.
- The location of species of conservation concern was recorded using a Garmin Montana™ Global Positioning System (GPS) and captured on a map of the area using a Geographical Information System (GIS). GPS accuracy was limited to 3-5m and recording points beneath tree cover is likely to have further reduced GPS accuracy in heavily vegetated areas.
- The field assessment was undertaken in spring/onset of summer (late September 2014). The assessment therefore does not cover the seasonal variation in conditions at the site.
- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked.
- Sampling by its nature, means that generally not all aspects of ecosystems can be assessed and identified. Due to the moderately small extent of the site, the area was quite intensively sampled, reducing the risk of overlooking species.

- Information on the threat status of plants species was informed largely by the SANBI Threatened Species Online database, which was assumed to be up to date and accurate at the time of compiling this report. Any changes made after the compilation of the report are therefore not covered.
- While an assessment of the potential occurrence of species of conservation concern has been undertaken, and is informed by readily available information, this provides only a surrogate indicator of the likelihood of such species occurring. This is however regarded as appropriate given the level of habitat degradation/transformation across much of the project area.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological concerns arising from the vegetation field surveys and based on the assessor's working knowledge and experience with similar development projects.
- Additional information used to inform the assessment was limited to data and GIS coverage's available for the Province/Local Municipality at the time of the assessment.
- The focus of this assessment was on surveying the vegetation of the target property. Whilst no fauna was actively observed during the field visit, it is to be noted that faunal surveys were not undertaken or included as part of the assessment.

3 DESKTOP CONTEXTUAL SURVEY

3.1 Regional / Local Biophysical Setting

A summary of key biophysical setting details of the study area and surrounds are presented in Table 3, below.

Table 3. Key biophysical setting details of the study area.

Biophysical Aspects	Desktop Biophysical Details	Source
Elevation a.m.s.l	85-110m	Google Earth™
Mean annual precipitation (MAP)	983.2mm	Schulze, 1997
Rainfall seasonality	Early, Mid-Summer	DWAF, 2007
Mean annual temperature	16 - 22 °C	DWAF, 2007
Potential Evaporation (mm) Mean Annual A-pan Equivalent	1644.6mm for U20M 247.3mm for U30B	Schulze, 1997
Geology	Karoo dolerite, Pietermaritzburg shale, Vryheid shale, Berea formation (leached) & alluvium in the uMhlangane River	eThekwini geology dataset
DWA Ecoregion	17.01 (North-Eastern Coastal Belt)	DWA, 2005

3.2 Benchmark/Reference Vegetation

The study area falls within both the Savanna Biome (one of the four main biomes in KwaZulu-Natal as described by Mucina and Rutherford, 2006)) and regionally within the Indian Ocean Coastal Belt Bioregion (Mucina & Rutherford, 2006). At a local scale, the study area falls within the KwaZulu-Natal Coastal Belt (CB 3) Vegetation Type (ibid). The extent of the vegetation type is shown in Figure 4 (below). This classification is consistent with the KZN Vegetation Types (EKZNW, 2012). EKZNW (2012) also identified several other vegetation types which occur within the general vicinity of the study areas. Of particular relevance is the Freshwater Wetlands: Subtropical Freshwater Wetland (AZf6) which occurs next to the proposed pedestrian bridge crossing (see Figure 5). It should be noted that the site is transformed as the benchmark vegetation types reflect historical vegetation coverages. The KwaZulu-Natal Coastal Belt (CB 3) Vegetation Type is the reference or benchmark vegetation type by which the findings of the vegetation survey will be compared with in order to establish the level of habitat degradation and transformation. Details of the KwaZulu-Natal Coastal Belt Vegetation Type are provided below.

KwaZulu-Natal Coastal Belt (CB3)

National Threat Status: Endangered (EN)
Provincial Threat Status: Critically Endangered (CR)
Conservation Status: Conserved only in Ngoye, Mbambuzi and Vernon Crookes Nature Reserves.

Important taxa characterising the KwaZulu-Natal Coastal Grassland include: **Graminoids** include: *Aristida junciformis subsp. galpini* (d), *Digitaria eriantha* (d), *Panicum maximum* (d), *Themeda triandra* (d), *Alloteropsis semialata subsp. Ecklonia, Cymbopogon caesius, C. nardus, Eragrostis curvular, Eulalia villosa, Hyparrhenia filipendula* and *Melinis repens*. **Herbs** include: *Berkheya speciosa subsp. speciosa* (d), *Cyanotis speciosa* (d), *Senesio glaberrimus* (d), *Alepidea longifolia, Centella glabrata, Cephalaria oblonbgofolia, Chamaecrista*

mimosoides, Conostomium natalense, Crotalaria lanceolata, Dissotis canescens, Eriosema squarrosum, Gerbera ambigua, Hebenstretia comosa, Helichrysum symosum subsp. symosum. H. subsp. latifolia, Senecio albanensis, S. bupleuroides, S. coronatus, S. nigricans, Venonia galpinii, V. oligonoides, Hypoxis filiformis, Ledebouria floribunda, Pachycarpus asperiflius, Schizocarphus nervosus, Tritonia disticha. **Low shrubs** include*: Clutia pulchella, Gnidia kraussiana, Phyllanthus glaucophylus, Tephrosia polystachya*. **Woody climbers** include: *Abrus laevigatus, Asparagus racemosus* and *Smilax anceps*. **Small tree & Tall Shrubs** include: *Bridelia micrantha* (d), *Phoenix reclinata* (d), *Syzygium cordatum* (d), *Acacia natalitia, Albizia adianthifolia* and *Antidesma venosum*.

Figure 4 Map showing the outputs of the National vegetation type map according to Mucina and Rutherford (2006).

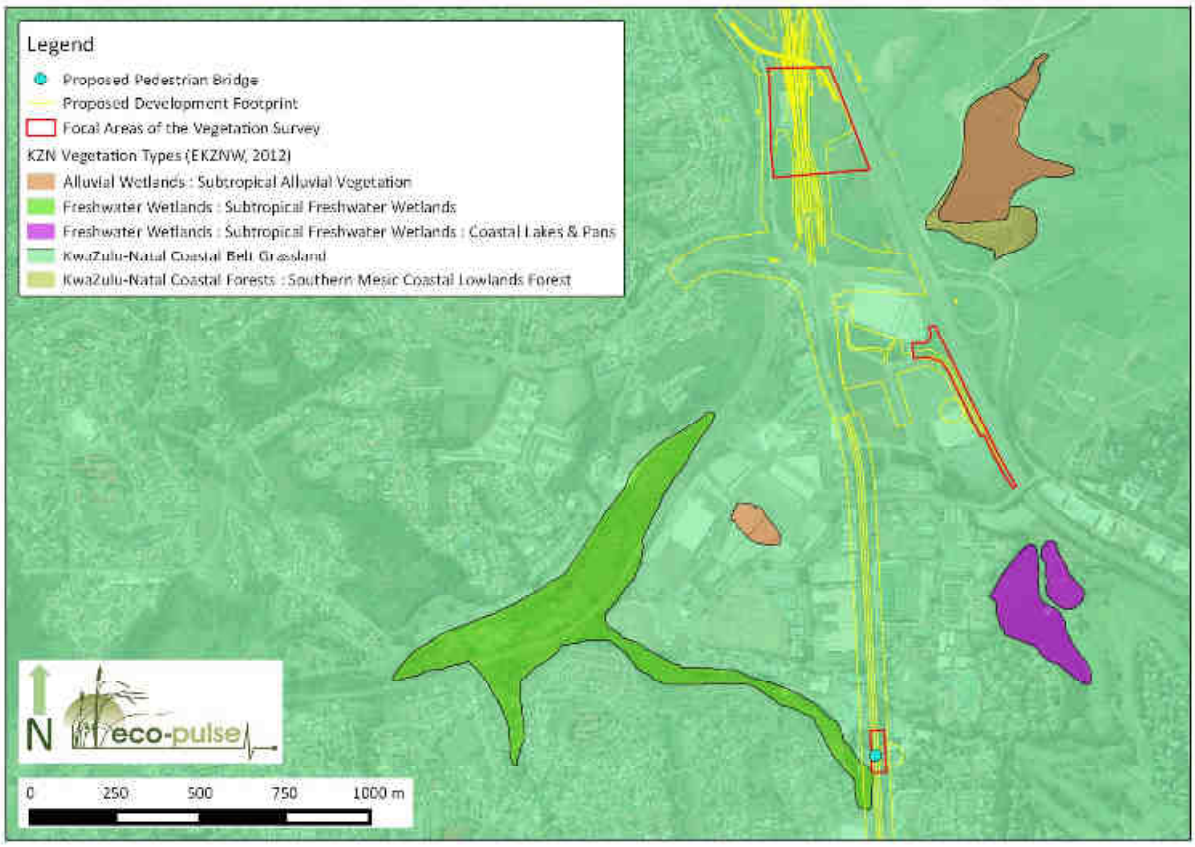

Figure 5 Map showing outputs of the Provincial vegetation type map for the study area according to EKZNW (2012).

3.3 Conservation Context

Understanding the conservation context and importance of the study area and surrounds is important to inform decision making regarding the management of the terrestrial ecosystems and habitats in the area. In this regard, national, provincial and regional conservation planning information available and was used to obtain an overview of the study site. Key conservation context details of the project site and surrounds have been summarised in Table 4, below.

Table 4. Key conservation context details for the focal areas of the vegetation survey.

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
National Vegetation Types (Mucina & Rutherford, 2006) Ecosystem Threat Status NBA 2011	KwaZulu-Natal Coastal Belt (CB 3)	Intact terrestrial areas within and beyond the study site	**Endangered**
PROVINCIAL AND REGIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
KZN Vegetation Types (EKZNW, 2012)	KwaZulu-Natal Coastal Belt Grassland	Intact terrestrial areas (Poorly represented within	**Critically Endangered**

NATIONAL LEVEL CONSERVATION PLANNING CONTEXT			
Conservation Planning Dataset	**Relevant Conservation Feature**	**Location in Relation to Project Site**	**Conservation Planning Status**
		the study area)	
	Freshwater Wetlands: Subtropical Freshwater Wetland (AZf6)	Intact areas falling just outside the study area (Poorly represented within the surrounding area)	**Vulnerable**
KZN Terrestrial Conservation Plan (EKZNW, 2010)	Biodiversity Priority Areas	Entire development footprint	**Critical Biodiversity Area 1 (Mandatory)**
Durban Metropolitan Open Space System (D'MOSS)	Undeveloped Freshwater and Terrestrial Areas	Riparian area associated with the uMhlangane River, dams and golf course area	**Conservation Area**

Conservation concerns and features of particular importance to the study area are summarised below as follows:

3.3.1 Terrestrial Systematic Conservation Plan (CPLAN)

The entire construction footprint is classified as a "Critical Biodiversity Area 1 (Mandatory)" in terms of the KZN Terrestrial Systematic Conservation Plan (see Figure 6). This classification means that these planning units represent the only localities for which the conservation targets for one or more of the biodiversity features contained within can be achieved (i.e. there are no alternative sites available - EKZNW, 2011). It is worth noting that the distribution of the biodiversity features is not always applicable to the entire extent of the PU (Planning Unit), but is more often than not confined to a specific niche habitat (e.g. a forest or wetland) reflected as a portion of the PU in question. The following flora and vegetation types are known or modelled to exist within Critical Biodiversity Area 1 for the study area:

i. North Coast grassland (Vegetation Type);
ii. KwaZulu-Natal Coastal Forest (Vegetation Type);
iii. *Vernonia africana/Vernonella africana* (Extinct flora, South African Endemic); and
iv. *Barleria natalensis* (Extinct flora, South African Endemic).

Table 5. CPLAN categories and their descriptions.

Critical Biodiversity Area 1 Mandatory	The CBA 1 Mandatory areas are Identified as having an Irreplaceability value of 1, these planning units represent the only localities for which the conservation targets for one or more of the biodiversity features contained within can be achieved i.e. there are no alternative sites available.
Critical Biodiversity Area 2 Mandatory	CBA2 indicate the presence of one (or more) features with a very high irreplaceability score. In practical terms, this means that there are alternate sites within which the targets can be met, but there aren't many. This site was chosen because it represents the most optimal area for choice in the systematic planning process, meeting both the target goals for the features concerned, as well as a number of other guiding criteria such as high agricultural potential area avoidance, falls within a macro-ecological corridor etc.
Critical Biodiversity Area 3 Optimal	CBA3 indicate the presence of one (or more) features with a low irreplaceability score. Derived in the same way as outlined for CBA2 described above, the determination vision of these PU's is driven primarily by the guiding layers.

Biodiversity Area	Unshaded planning units are 'available' to meet conservation targets if any planning units classified as Biodiversity Priority Area 2 or 3 are lost / transformed.
Protected Areas	These area protected areas e.g. nature reserves.
100% Transformed	These are areas which are 100% transformed according to the KwaZulu-Natal landcover 2005 coverage.
Outside KwaZulu-Natal	Areas outside KZN.

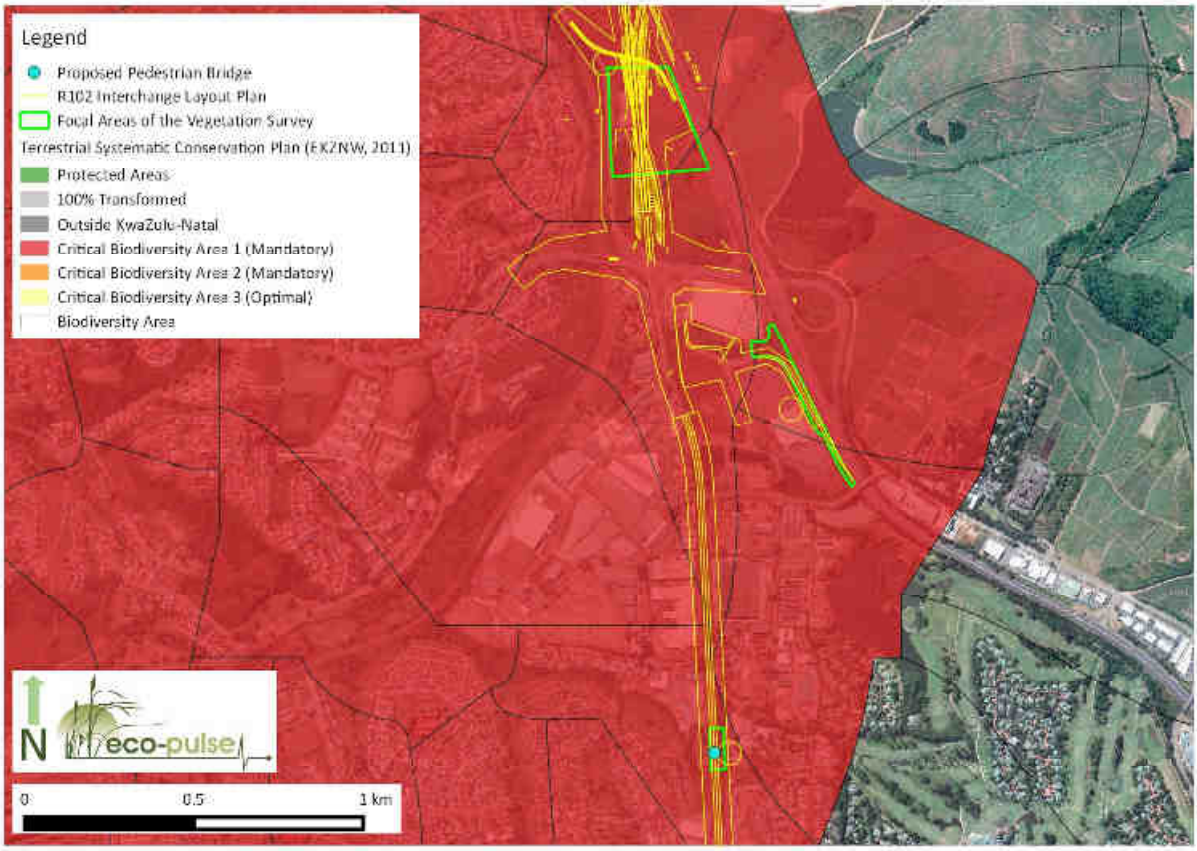

Figure 6 Terrestrial Systematic Conservation Plan for KZN (Ezemvelo KZN Wildlife, 2010).

3.3.2 Durban Metropolitan Open Space System (D'MOSS)

The Durban Metropolitan Open Space system or D'MOSS is made up of a series of interconnected open spaces that incorporate areas of high biodiversity value and other supporting elements, delivering a range of ecosystem goods and services including water supply, food, raw materials, soil formation processes, nutrient cycling, erosion control, flood attenuation and climate change mitigation (i.e. carbon storage capacity). The ecosystem goods and services provided free of charge by D'MOSS were conservatively valued in 2003 to be in the order of R3.1 billion per annum, excluding the value that open space contributes to tourism. Without these free services, the municipality would require an unaffordable increase to its budget to provide these services, especially in rural areas where communities rely heavily on the natural environment for daily needs (online reference: http://www.durban.gov.za). D'MOSS is incorporated into the city's Integrated Development Plan (IDP),

associated Strategic Development Framework (SDF) and the regional Spatial Development Plans (SDP). D'MOSS areas identified around the study area are unlikely to be directly impacted by the proposed development (Figure 7, below).

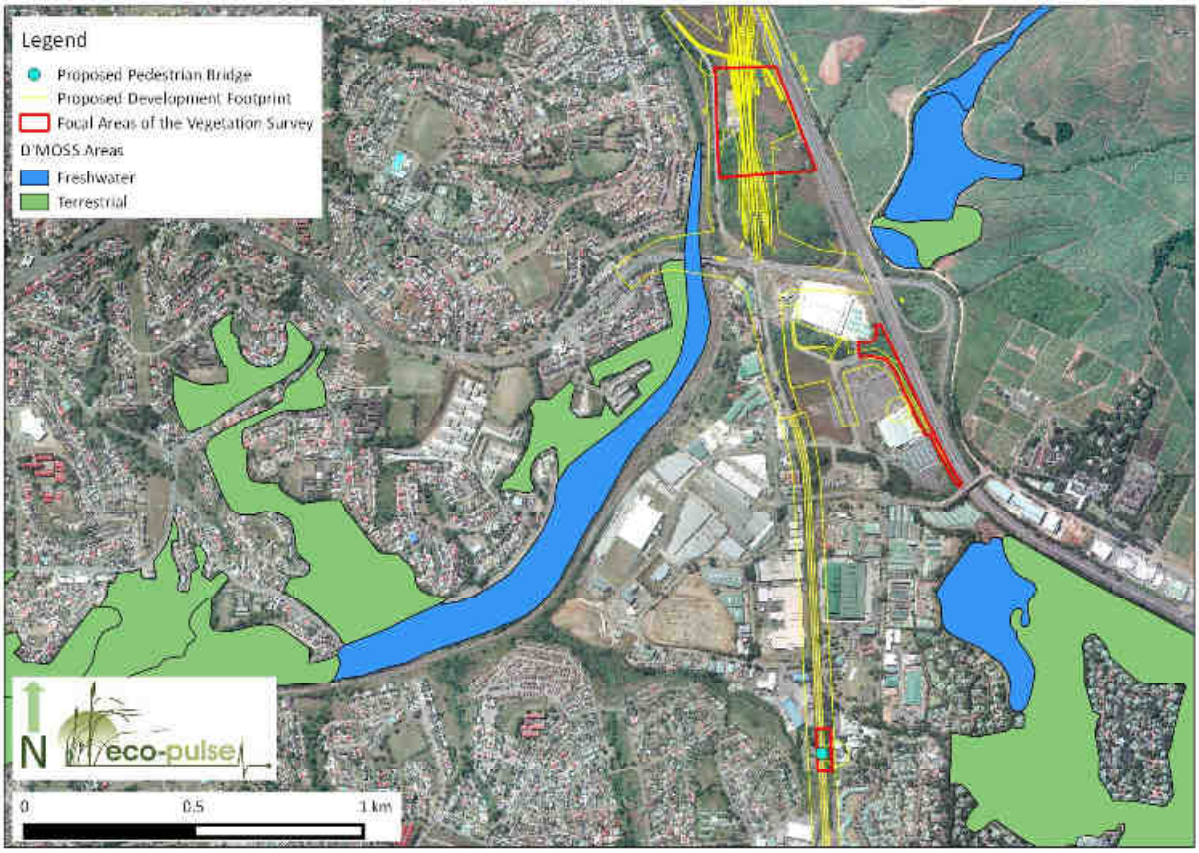

Figure 7 Map showing the Durban Metropolitan Open Space System coverage (eThekwini Municipality, 2011).

3.3.3 Regional connectivity

Maintaining connectivity between natural areas is considered critical for the long term persistence of both ecosystems and species, in the face of human development and changes in global climatic conditions. Natural ecological corridors/linkages are therefore considered crucial for allowing species to migrate naturally and to accommodate shifts in species ranges in response to climate change. Due to high levels of infrastructural development within the local area, natural connectivity has already been severely compromised, with only small, fragmented pockets of semi-natural grassland and bushland/thicket habitat remaining in many instances. Exotic vegetation has also replaced large areas of natural habitat. Natural ecological linkage is severed by a number of large, multi-lane tarred roads and industrial/commercial development.

3.3.4 Potential plant species of conservation concern

Species of conservation concern, in the context of this vegetation assessment, are plant species that have a high conservation importance in terms of preserving South Africa's high biological diversity and include threatened species that have been classified as 'at high risk of extinction in the wild'. Protected species are listed in either international conventions, National Acts and/or Provincial Ordinances that regulate activities such as the hunting, collection and trade of species.

Interrogation of SANBI's website and threatened species database and the outputs of the Provincial Terrestrial Systematic Conservation Plan (or CPLAN) indicated flora of conservation concern that could potentially occur in the project area. This was based primarily on a desktop assessment of associated species-specific habitat requirements and distributional ranges (with field verification to confirm the presence of these species during the field survey). This information is summarized below in Table 6. Based on the habitat requirements/preferences and distributional/altitudinal ranges for these key species, a number of Declining, Near Threatened (NT) and Critically Endangered, Possible Extinct (CR PE) plants could potentially occur within the more intact vegetation habitat at the site. ***Field investigations did not confirm the presence of any of these species at the site; however, the potential occurrence of some of the species cannot be overlooked entirely.***

Table 6. Potential species of conservation concern for the study area terrestrial habitats.

FAMILY	BOTANICAL NAME	THREAT STATUS[1]	SA ENDEMISM	DESCRIPTION	Potential Occurrence on Site
FABACEAE	***Lotononis dichiloides***	**CR (EW)**	**Endemic**	Perennial herb	Unlikely
ASPHODELACEAE	***Kniphofia littoralis***	**NT**	**Endemic**	Perennial herb	Unlikely
CELASTRACEAE	***Elaeodendron croceum***	**Declining**	No	Perennial tree	**Possible**
ASTERACEAE	***Vernonia africana (Vernonella africana)***	**Extinct**	**Endemic**	Herb	Unlikely
ACANTHACEAE	***Barleria natalensis***	**Extinct**	**Endemic**	Herb	Unlikely
AMARYLLIDACEAE	***Crinum macowanii***	Declining	No	Perennial. Geophyte	**Possible**
HYPOXIDACEAE	***Hypoxis hemerocallidea***	Declining	No	Perennial. Geophyte	**Possible**
ORCHIDACEAE	***Disperis woodii***	Declining	No	Perennial. Geophyte, herb	**Possible**
PASSIFLORACEAE	***Adenia gummifera***	Declining	No	Perennial, climber, succulent	**Possible**
RHIZOPHORACEAE	***Cassipourea malosana***	Declining	No	Perennial, Shrub	**Possible**

[1] **Key to Threat Status**: CR = Critically Endangered, NT = Near Threatened

4 VEGETATION SURVEY FINDINGS

4.1 Vegetation community descriptions

Terrestrial vegetation communities discussed in this report were classified according to plant species composition, vegetation structure and level of degradation/transformation. These are described in detail below. A full list of the 74 plant species identified within the study area as part of the terrestrial vegetation survey is provided in **Annexure B** at the back of this report. *Please note that only terrestrial vegetation communities are discussed in this report. The reader is referred specifically to the Specialist Wetland and Riparian Habitat Impact Assessment Report prepared by Eco-Pulse Consulting (September 2015) for descriptions of wetland/aquatic habitat and vegetation types.*

4.1.1 Vegetation communities at the proposed P79 grade separation

The terrestrial environment and habitats at the proposed P79 grade separation was characterised by three (3) distinct terrestrial vegetation communities, namely (i) **Wooded alien thicket** along the existing R102 highway to the west; (ii) **Wooded grassland** in the southern portion of the site; and (iii) ***Hyparrhenia filipendula* grassland** along the north-eastern edge of the study area, as shown in Figure 8, below. A substantial portion of the study area in the north-west was transformed (existing construction site camp) and another stripped of vegetation and left bare during recent construction of bulk pipeline infrastructure in the south-eastern section of the focal area assessed. The central portions of the focal study area comprised wetland/riparian habitat which were not assessed as part of this study (*see habitat and vegetation description in the Specialist Wetland Assessment Report by Eco-Pulse, 2015*).

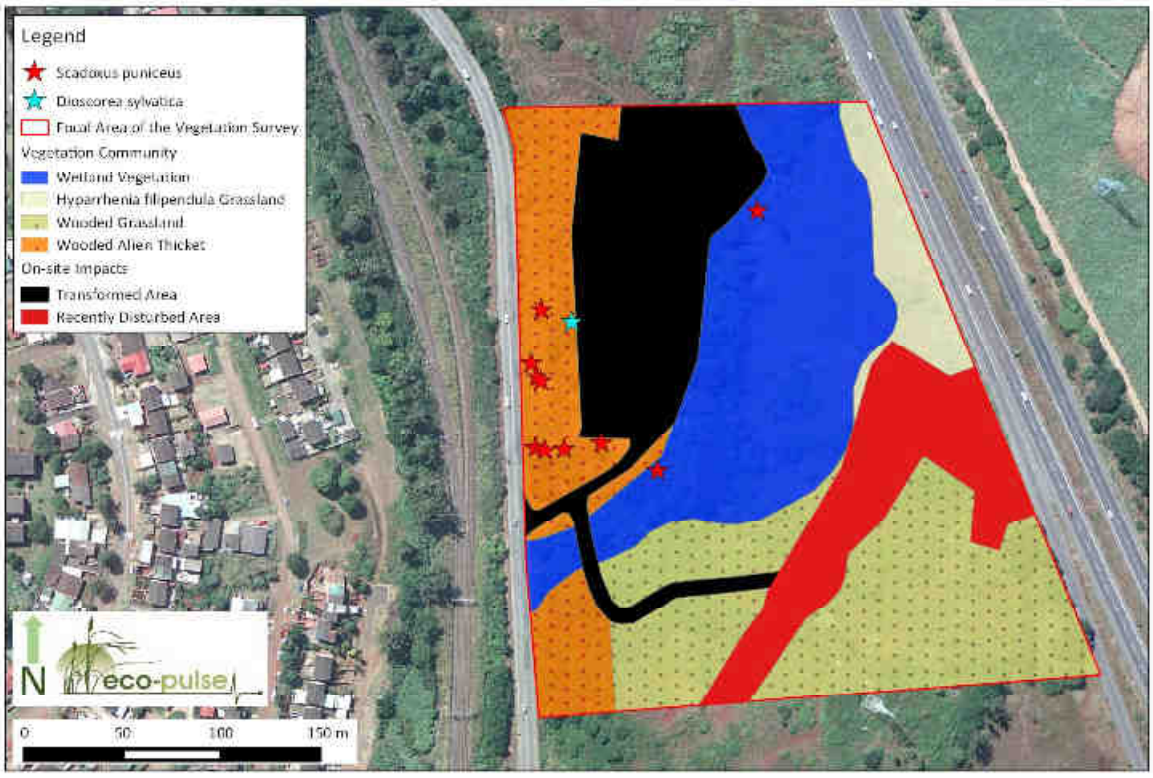

Figure 8 Map showing terrestrial and aquatic vegetation communities within the focal assessment area at the proposed P79 grade separation.

Descriptions of each of the three (3) terrestrial vegetation communities are provided below. Note that alien/exotic species are shown in "**Red**" text. Refer to **Annexure B** for the complete plant species list.

- The **wooded alien thicket** occurred on a slope to the west historically disturbed during construction of the existing R102 road infrastructure. It was found to comprise of a mix of short woody and arborescent species in the interior and ruderal grass and herbaceous species along the edge. Characteristic and dominant woody species included invasive alien plants such as *Melia azedarach, Tecoma stans, Leucaena leucocephala* and *Schinus terebinthifolius*. Beneath and interspersed between the woody alien species were dense impenetrable stands of arborescent alien species including *Chromolaena odorata, Lantana camara, Tithonia diversifolia* and to a lesser extent, *Ricinus communis* within the more recently disturbed areas. These alien species are fast growers that proliferate under disturbance and replace indigenous vegetation. In open areas along the edge of this community was a mix of ruderal grasses and herbaceous plant species particularly creeper and climbers. Common grass species included *Echinochloa colona, Cynodon nlemfluensis, C. dactylon* and less common grasses included *Melinis repens, Sorghum halepense and Hyparrhenia filipendula*. Common creepers and climbers included *Cardiospermum grandiflorum*, ***Dioscorea sylvatica (Vulnerable threat status)***, *Ipomoea alba, I. purpureum, Neonotonia wightii, Passiflora suberosa* and *Pueraria montana*. Indigenous trees were low in abundance and included ***Cassipourea glummiflua (Vulnerable threat status)***, *Trema orientalis, Dombeya cymosa* and *Erythrina lysistemon*. Due to historical disturbances and high alien infestation levels in this community, the wooded alien thicket community can be considered secondary in nature and of low sensitivity. Notwithstanding the aforementioned, this community contains two plants species protected under Schedule 12 of the Natal Nature Conservation Ordinance of 1974 namely ***Scadoxus puniceus*** (Snake lily) and ***Dioscorea sylvatica*** (Elephant's foot/Wild yam). Any disturbance/destruction to these plants will require an Ordinary Permit from the EKZNW permits office.

- The **wooded grassland** occurring in the southern site focal area was likely naturally open coastal grassland that has become subject to woody alien encroachment with the absence of fire. The woody component comprised of shrubs and a few scattered trees, dominated by alien species and the groundcover was vegetated with indigenous grasses and a moderate abundance of pioneer and ruderal herbaceous species. Small areas within the community have been historically disturbed as evidenced by an excavation and a soil stockpile. Dominant woody species included invasive alien trees such as *Schinus terebinthifolius, Leucaena leucocephala* and *Melia azedarach* and dominant shrubs included *Chromolaena odorata, Lantana camara* and Senna didymobotrya. The groundcover layer included the following indigenous grasses: *Hyparrhenia filipendula, Imperata cylindrica, Melinis repens* as well as a number of herbs typical of degraded areas such as *Tagetes minuta* and *Bidens pilosa*. Along the edges of the recently cleared pipeline servitude were numerous pioneer and alien plants including *Melia azedarach* saplings, *Ricinus communis, Lantana camara, Senna didymobotrya, Gomophocarpus physocarpus, Bidens pilosa, Tagetes minuta, Plantago lanceolata* and *Ipomoea alba*. When considering the level of alien infestation and current disturbances, this community is considered to be of a relatively low sensitivity.

- The ***Hyparrhenia filipendula* open grassland** is dominated exclusively by the indigenous, locally common grass species, *Hyparrhenia filipendula*. Other grass species recorded in low abundance included *Aristida junciformis* and *Imperata cylindrica*. Herbaceous species were limited to a few specimens of *Gomophocarpus physocarpus, Desmodium incanum* and *Hypoxis angustifolia*. A mosaic of small clumps of woody alien species such as *Chromolaena odorata, Albizia lebbeck* and *Schinus terebinthifolius* were also evident within the largely open grassland which appears to be under threat of woody plant encroachment. This community extends extensively into the wetland area. In terms of sensitivity this unit is considered to be of moderate sensitivity because it is characterised largely by indigenous vegetation with limited alien infestation.

A selection of digital photographs taken during the site visit, showing the terrestrial vegetation communities within the study focal area at the proposed P79 grade separation are provided below:

Study area at the proposed P79 grade separation

Photo 1: View of the interior of the Wooded alien thicket community. In the foreground is *Tecoma stans*, an aggressive woody alien invader plant.

Photo 2: View of the edge of the Wooded alien thicket community on the steep slope taken from the R102 Highway.

Photo 3: View of the Wooded grassland community. In the foreground are arborescent species namely *Chromolaena odorata* and *Lantana camara*.

Photo 4: View of the *Hyparrhenia filipendula* open grassland community with a few scattered woody clumps of alien species.

Photo 5: *Dioscorea sylvatica* (Elephant's foot/Wild yam) growing along the edge of the Wooded alien thicket. This species is protected ubder the Schedule 12 of the Natal Nature Conservation Ordinance.

Photo 6: *Scadoxus puniceus* (Snake lily) growing in the Wooded alien thicket vegetation community.This species is protected under the Schedule 12 of the Natal Nature Conservation Ordinance.

Photo 7: Cleared pipeline servitude traversing the Wooded grassland community ot the south of the site.

Photo 8: *Ricinus communis* invading the edges of the recently cleared and siturbed pipeline servitude.

4.1.2 Vegetation community at proposed M41 north-bound off-ramp

The study area at the proposed M41 north-bound off-ramp is comprised of a **Wooded Alien Thicket** occupying the entire focal study area as shown in Figure 9. A description of the terrestrial vegetation community is provided below. Note that alien/exotic species are shown in "**Red**" text. Refer to **Annexure B** for the complete plant species list.

The **Wooded Alien Thicket** community occurring at the site of the proposed M41 north-bound off-ramp is confined to the remaining untransformed parcels of land within the existing M41 road reserve on the western side of the highway and in-between buildings and the current M41 road infrastructure. The southern portion of this unit is dominated exclusively by a thick stand of impenetrable *Leucaena leucocephala* thicket which has almost entirely replaced the indigenous vegetation at the site. Leucaena is an aggressive invader alien shrub or small tree that proliferates in disturbed areas and along roadsides and is well known in the eThekwini Metro. It was recorded growing from the top of the road embankment towards the low-lying areas within the storm water drains in the road reserve. Additional exotic/alien invasive species such as *Psidium guajava* and *Tecoma stans* were also recorded in the interior of the alien thicket community and the exotic creeper *Ipomoea indica* was observed

climbing on trees along the edge of the vegetation unit. The top of the road embankment was also covered by a couple of native grasses such *Panicum maximum* and *Setaria megaphylla* and a herbaceous weedy plant species, *Plantago lanceolata,* was also noted. Moving north the species composition changed as more dense, woody alien tree species became common, such as *Litsea glutinosa, Tecoma stans, Melia azedarach, Solanum mauritianum, Cestrum laevigatum, Senna didymobotrya* along with limited indigenous woody species such as *Syzygium guineense, Ficus sur, Trema orientalis* and *Barringtonia racemosa*. It should be noted that *Litsea glutinosa* stood out as a dominant woody species. Invasive alien creepers, particularly *Cardiospermum grandiflorum,* dominated the understorey along with a mix of saplings, mainly *Litsea glutinosa*. The ecological sensitivity of this community was considered to be relatively low due to the community being largely characterised by alien vegetation, with only a few locally common indigenous trees and grasses remaining. *Barringtonia racemosa* (Powder-puff tree) recorded within the riparian forested section of this community and is a protected tree under the National Forest Act. If it is to be disturbed and destroyed a licence must be applied for from the Department of Agriculture, Forestry and Fisheries (DAFF).

Figure 9 Map showing the single terrestrial vegetation community and riparian forest community within the study focal area at the proposed M41 north-bound off-ramp.

A selection of digital photographs taken during the site visit of the wooded alien thicket vegetation community within the study focal area at the proposed M41 north-bound off-ramp is provided below.

Study area at the proposed M41 north-bound off-ramp

Photo 9: Thick stand of impenetrable *Leucaena leucocephala* thicket along the M41 Highway and road reserve.

Photo 10: Interior of the *Litsea glutinosa* dominated Wooded alien vegetation community.

Photo 11: Dense mat of *Cardiospermum grandiforum* invading the open canopy areas within the Wooded alien thicket.

Photo 12: *Barringtonia racemosa* (Powder-puff tree) growing on the stream bank at the site. This species is a Protected Tree under the National Forest Act.

4.1.3 Vegetation community at the proposed pedestrian bridge crossing

Two vegetation communities were identified within the study area linked with the proposed pedestrian bridge crossing thus, (i) **Ruderal herbaceous community** within in the R102 road reserve on the western side, and (ii) **Wooded alien thicket** within the road reserve on the eastern side of the R102, as shown in Figure 10, below.

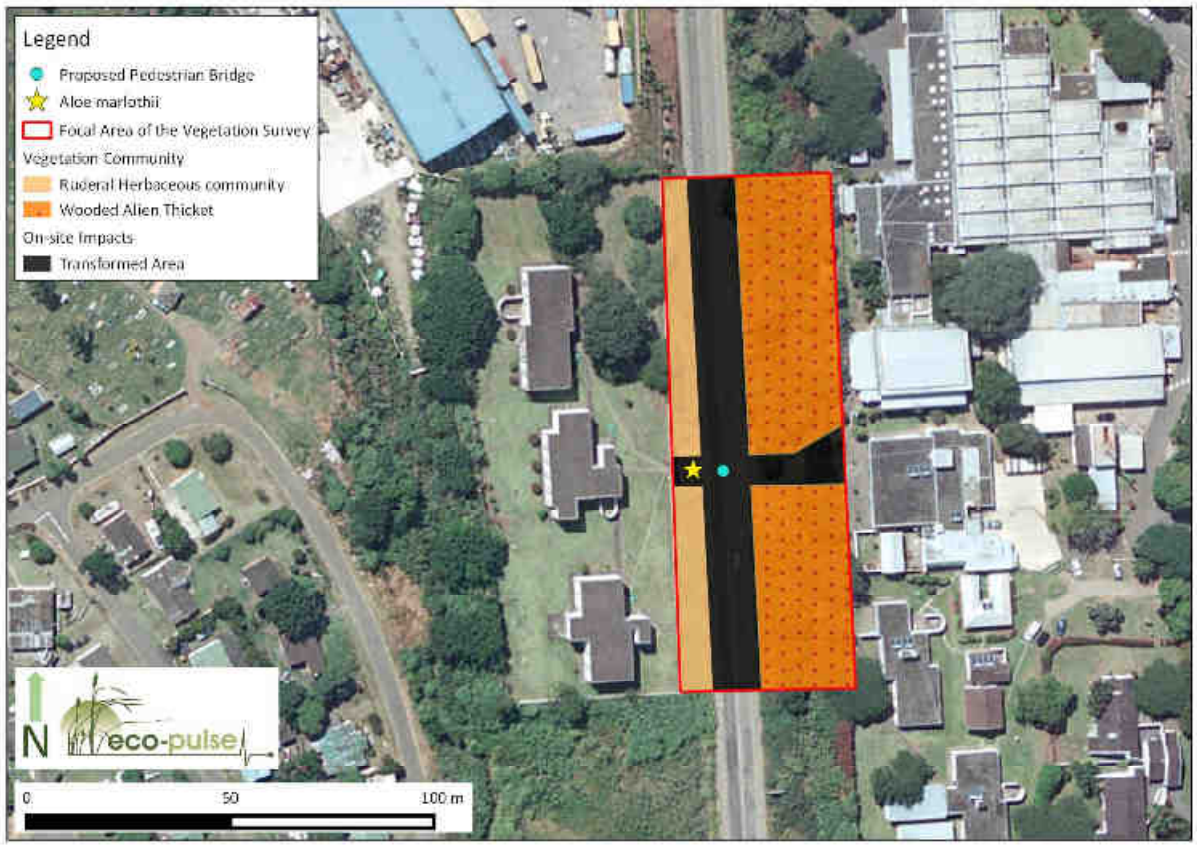

Figure 10 Map showing the two terrestrial vegetation communities within the study area at the proposed pedestrian bridge crossing.

Descriptions of each of the two (2) terrestrial vegetation communities are provided below. Note that alien/exotic species are shown in "**Red**" text. Refer to **Annexure B** for the complete plant species list.

- The **ruderal herbaceous community** within the R102 road reserve on the western side is dominated by grasses and short herbaceous plants that are generally common along road verges. Clumps of *Pennisetum purpureum*, an invasive alien grass, were recorded in the southern portion of the study focal area. Other grasses recorded in low abundance included locally common pioneer species such as *Sporobolus africanus, Cynodon dactylon* and *Panicum maximum*. The herbaceous layer was characterised by a number of ruderal species including, *Hypochaeris radicata, Parthenium hysterophorus, Plantago lanceolata Amaranthus sp., Bidens pilosa, Achyranthes aspera, Senecio sp*. and *Conyza sp*. A few arborescent species recorded included *Tithonia diversifolia, Ricinus communis, Solanum mauritianum, Senna didymobotrya* and *Acalypha sp*. Indigenous trees were limited to only a few specimens of locally common and species of least concern: *Ziziphus mucronata, Trichilia emetica* and saplings of *Strelitzia nicolai*. The community, being dominated by pioneers, weeds and alien plants with few locally common trees and grasses, was regarded as being secondary and of low ecological sensitivity. Notably, a few planted *Aloe malothii* were observed along the road verge (lcoations shown in Figure 10). This species is protected under the Schedule 12 of the Natal Nature Conservation Ordinance. Any disturbance/destruction to these plants will require an Ordinary Permit from the EKZNW permits office.

- The **Wooded alien thicket** within the R102 road reserve on the eastern side is secondary in nature and characterised by a mix of woody alien species including *Tecoma stans, Eucalyptus sp. Melia azedarach, Morus alba, Shinus terebinthifolius, Litsea glutinosa* and *Hibiscus rosa-sinensis*. Growing in between the woody tree species were a few invasive alien creepers namely *Ipomoea alba* and *Passiflora suberosa*. The understorey of the woody alien thicket was poorly developed due to limited sunlight penetration and was found to be covered in leaf litter. On the edges of the thicket, however, the following species were recorded *Pennisetum purpureum, Bougainvillaea sp*., and limited ruderal grasses. This second community, also being dominated by pioneers, weeds and alien plants with few locally common trees and grasses, was regarded as being secondary and of low ecological sensitivity.

A selection of digital photographs taken during the site visit of the two invaded communities within the study focal area at the proposed pedestrian bridge is provided below:

Study area at the proposed pedestrian bridge

Photo 13: Clumps of *Penisetum purpureum* within the Ruderal herbaceous community.

Photo 14: View of the herbaceous layer with a few *Aloe malothii* in the middle. This species is protected under the Schedule 12 of the Natal Nature Conservation Ordinance.

Photo 15: View of the Wooded alien thicket community taken from the opposite side of the R102 Highway.

Photo 16: View of the interoir of the Wooded alien thicket community. Note the poorly developed understorey layer due to limited sunlight penetration.

4.2 Comparison with benchmark vegetation type

When comparing the vegetation communities defined for the study area with the benchmark vegetation, KwaZulu-Natal Coastal Belt (CB3) - as described by Mucina and Rutherford (2006), the various vegetation communities were assessed as being largely dis-similar from the reference/benchmark vegetation state. In terms of species composition, vegetation communities identified on site were generally characterised and dominated by alien plant species with the exception of the *Hyparrhenia filipendula* dominated open grassland community associated with the study area at the proposed P79 grade separation. Although the *Hyparrhenia* grassland community was dominated by indigenous species, it still cannot be considered a true reference/representation of the KwaZulu-Natal Coastal Belt vegetation type which is typically dominated by the grasses *Aristida junciformis subsp. galpinii, Digitaria eriantha, Panicum maximum* and *Themeda triandra*. Table 7 (below) highlights the differences between the current vegetation communities and the native reference vegetation type.

Table 7. Comparison between the benchmark vegetation unit, KwaZulu-Natal Coastal Belt (CB3) as described by Mucina and Rutherford (2006) against delineated vegetation communities.

Parameter	KwaZulu-Natal Coastal Belt (CB 3)	Delineated plant communities (species in "Red" are exotics)
Dominant grass and tree species	*Aristida junciformis subsp. galpini, Digitaria eriantha, Panicum maximum, Themeda triandra*	*Hyparrhenia filipendula, Imperata cylindrica, Melinis repens, Echinochloa colona*
Other common grass species	*Alloteropsis semialata subsp. Ecklonia, Cymbopogon caesius, C. nardus, Eragrostis curvular, Eulalia villosa, Hyparrhenia filipendula, Melinis repens*	*Sporobolus africanus, Cynodon nlemfluensis, C. dactylon, Panicum maximum, Sorghum halepense*
Dominant Herbs	*Berkheya speciosa subsp. speciosa, Cyanotis speciosa, Senesio glaberrimus*	*Chromolaena odorata, Bidens pilosa, Tagetes minuta, Plantago lanceolata,*
Other herbs	*Alepidea longifolia, Centella glabrata, Cephalaria oblonbgofolia, Chamaecrista mimosoides, Conostomium natalense, Crotalaria lanceolata, Dissotis canescens, Eriosema squarrosum, Gerbera ambigua, Hebenstretia comosa, Helichrysum symosum subsp. symosum. H. subsp. latifolia, Senecio albanensis, S. bupleuroides, S. coronatus, S. nigricans, Venonia galpinii, V. oligonoides, Hypoxis filiformis, Ledebouria floribunda, Pachycarpus asperiflius, Schizocarphus nervosus, Tritonia disticha*	*Plectranthus sp., Scadoxus puniceus, Widelia trilobata, Senecio consanguineous, Parthenium hysterophorus, Hypochaeris radicata, Conyza sp., Amaranthus sp., Achyranthes aspera*
Low shrubs	*Clutia pulchella, Gnidia kraussiana, Phyllanthus glaucophylus, Tephrosia polystachya.*	*Lantana camara, Ricinus communis, Senna didymobotrya, Tithonia diversifolia,*
Woody climbers	*Abrus laevigatus, Asparagus racemosus, Smilax anceps.*	*Cardiospermum grandiflorum, Diploclylos palmatus, Ipomoea alba, I. purpureum, Mimosa pigra, Neonotonia wightii, Passiflora suberosa, Pueraria montana*
Dominant Small trees and tall shrubs	*Bridelia micrantha, Phoenix reclinata, Syzygium cordatum*	*Tecoma stans, Litsea glutinosa, Leucaena leucocephala, Melia azedarach, Shinus terebinthifolius, Morus alba, Syzygium guineense,*
Other small trees and tall shrubs	*Acacia natalitia, Albizia adianthifolia, Antidesma venosum.*	*Eucalyptus sp., Albizia lebbeck, Eucalyptus sp., Hibiscus rosa-sinensis, Acalypha sp., Dombeya cymosa, Erythrina lysistemon, Ficus sur, Hibiscus rosa-sinensis, Mangifera sp., Phoenix reclinata, Psidium guajava, Solanum mauritianum, Strelitzia nicolai, Trema orientalis, Trichilia emetica, Ziziphus mucronata, Barringtonia racemosa, Cestrum laevigatum*

4.3 Ecological Sensitivity of Terrestrial Vegetation Communities

The ecological sensitivity of the various vegetation communities was assessed in terms of the following criteria:

- species composition and similarity with the benchmark vegetation type;
- level of alien plants, pioneer encroachment and weeds;
- woody encroachment of grassland habitats and ecosystems;
- presence/absence and relative abundance of conservation important species (endemic plants and protected/threatened species); and
- the level of onsite impacts/degradation caused by humans/animals.

Based on this, the results of the assessment (see summary Table 8, below) indicate that the *Hyparrhenia filipendula* dominated open grassland habitat associated with the proposed P79 grade separation focal area is of moderate sensitivity due to its limited level of degradation/disturbance, high level of naturalness (% natural composition) and limited extent of alien infestation. All other communities considered in the study were assessed as being of low sensitivity due to the secondary nature of the plant communities, moderate to high levels of alien plant/weed infestation, poor natural plant proportion and diversity and high level of degradation caused by humans. Terrestrial vegetation/habitat sensitivity maps are included as Figures 11 – 13 on the pages that follow.

Table 8. Summary tale comparing the various terrestrial vegetation communities assessed in terms of their ecological sensitivity.

Assessment Focal Area	Vegetation Community	Ecological Sensitivity	Level of naturalness	Level of disturbance/ transformation
A; P79 grade separation	*Hyparrhenia filipendula* open grassland	**Moderate**	High	Low
	Wooded grassland	**Low**	Moderately low	Moderately high
	Wooded alien thicket	**Low**	Low	High
B: M41 north-bound off-ramp	Wooded alien thicket	**Low**	Low	High
C: Pedestrian bridge	Ruderal herbaceous community	**Low**	Low	High
	Wooded alien thicket	**Low**	Low	High

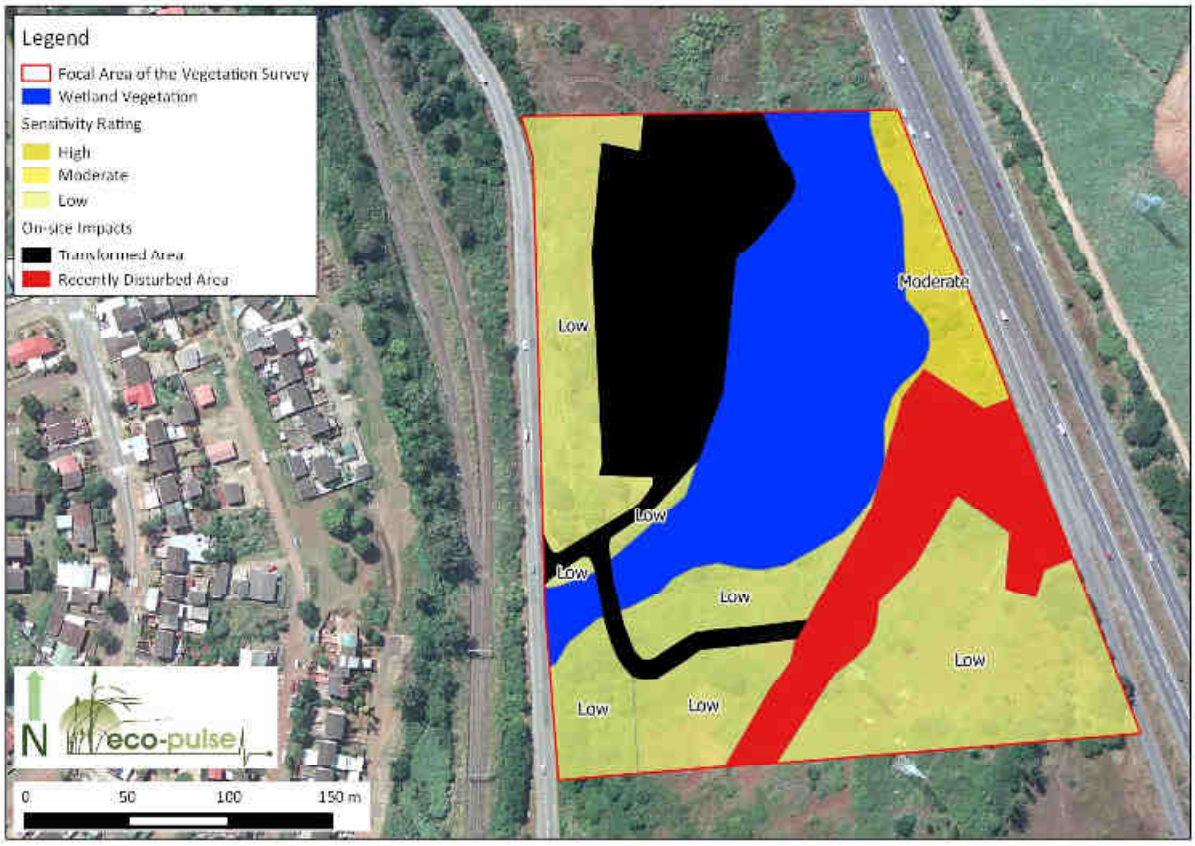

Figure 11 Terrestrial vegetation/habitat sensitivity map for the focal study area at the proposed P79 grade separation.

Figure 12 Terrestrial vegetation/habitat sensitivity map for the focal study area at the proposed M41 north-bound off-ramp.

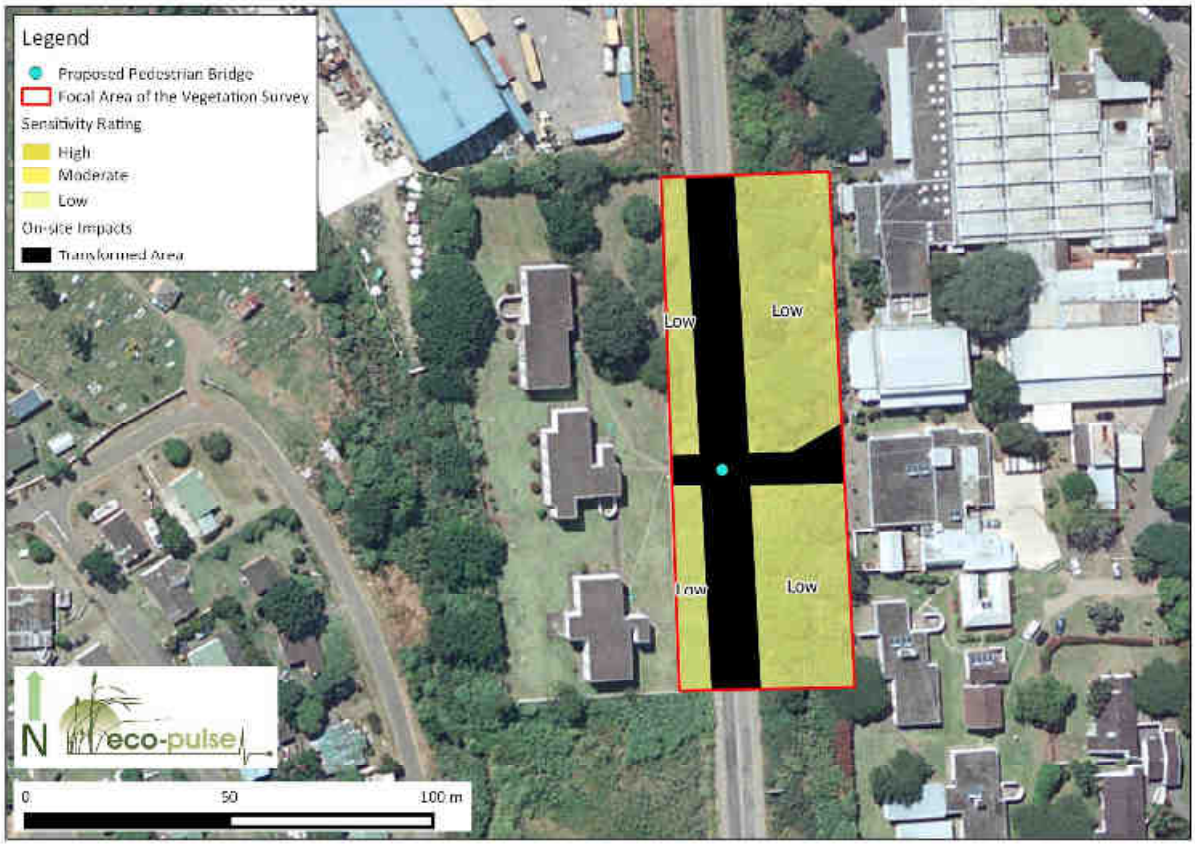

Figure 13 Terrestrial vegetation/habitat sensitivity map for the focal study area at the proposed pedestrian bridge crossing.

5 IMPACT ASSESSMENT

5.1 Impact Identification and Description

Typical ecological impacts to terrestrial vegetation and habitat likely to be associated with the development project are discussed in detail below. While an attempt has been made to separate impacts into categories, there is inevitably some degree of overlap due to the inherent interrelatedness of many ecological impacts.

IMPACT 1: Destruction/loss of terrestrial vegetation & habitat

This refers to the direct physical destruction, complete removal or partial destruction/disturbance of vegetation by machinery and workers during road construction, impacting directly on the ecological condition and availability of habitats. *Possible ecological consequences associated with this impact may include:*

- *Reduction in the representation and conservation of vegetation types/communities;*
- *Reduction/loss of habitat for fauna; and*
- *Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered plants).*
-

Impact Description

The direct destruction and disturbance of vegetation/flora will take place for terrestrial habitats within and in the vicinity of the construction/development footprint of the R102 interchange and pedestrian bridge. Whilst this impact is typically associated with activities within the construction zone but may extend beyond this footprint if construction activities are not carefully managed. The impacts on vegetation will be most significant in areas that are still largely natural and which contain or support important fauna and flora Construction activities occurring within close proximity to natural habitat and plant communities containing fauna and flora that may have medicinal-use, use in crafts or can be used for construction/building purposes can lead to an increase in the pressure on these natural resources through hunting/poaching/trapping of plants, animals, reptiles or insects from these locations. . Site clearing may also result in the removal of important plant species, exacerbate habitat fragmentation and reduce the availability of habitat for local wildlife. Although most plant species were identified as being IAPs, they can still play a role in the provision of habitat and control of soil erosion. The planned interchange development is also likely to also impact on species of conservation concern, particularly *Scadoxus puniceus* (Blood Lily). This species is specially protected by the Natal Nature Conservation Ordinance of 1974. This impact can be potentially and quite effectively mitigated by identifying species locations and avoiding disturbance of these species or through the relocation of protected species to adjacent undisturbed areas. In addition, locally common species of 'Least Concern (SANBI) will also be affected through direct loss of these plant species. Whilst this may seem acceptable given the low indigenous plant diversity and high levels of invasive alien plants characterising the majority of habitats, cumulative loss of biodiversity is often a cause of species becoming threatened or endangered. Terrestrial vegetation and habitat transformation for agriculture and infrastructural development is already regarded as high within the eThekwini Municipal Area and the R102 development (road infrastructure footprint) will contribute to further increased levels of remaining vegetation and habitat transformation, albeit that the extent of untransformed terrestrial vegetation impacted by the project will be relatively low.

Without mitigation this impact can potentially be quite significant. If managed properly, the probability and extent of this impact can be reduced significantly.

IMPACT 2: Modification of vegetation community and habitat through disturbance

This refers to the secondary effects of vegetation disturbance, including but not limited to: erosion risk and encroachment/colonisation of terrestrial habitats by Invasive Alien Plants f or IAPs. Possible ecological consequences associated with this impact may include:

- *Reduction in representation and conservation of vegetation types/communities;*
- *Reduction/loss of habitat for fauna; and*
- *Reduction in and/or loss of species of conservation concern (i.e. rare, threatened/endangered species*

Impact Description

Similar to the direct loss of vegetation and habitat discussed above, secondary modification of vegetation composition and structure through the disturbance associated with construction activities in the vicinity of terrestrial vegetation and habitat can have a detrimental impact on the composition, structure and floral diversity of terrestrial vegetation communities. The colonization of areas by weeds and IAPs (Invasive Alien Plants) poses a risk to indigenous plant species and would be facilitated by disturbance of natural vegetation and surface soil layers during construction. Disturbance of soil and clearing of vegetation during construction encourages the establishment of pioneer vegetation, in many cases weeds and Invasive Alien Plants (IAPs). IAPs can have far reaching detrimental effects on native biota and has been widely accepted as being a leading cause of biodiversity loss. They typically have rapid reproductive turnover and are able to outcompete native species for environmental resources, alter soil stability, promote erosion, change litter accumulation and soil properties and promote of suppress fireFailure to manage stripping of vegetation, topsoil and rehabilitation can lead to serious IAP infestation which compromises the quality of habitat provided by the vegetation community. Clearing and disturbance is also likely to result in an increase in edge habitat immediately adjacent to disturbed areas, which can be particularly devastating for adjacent areas that are largely free of alien plants. Edge habitat is characterized by a predominance of generalist and alien species that are usually highly competitive species which can invade areas of established vegetation, resulting in a loss of sedentary species of mature habitats which are normally considered sensitive. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows. Edge effects will be lower for grasslands and generally higher for wooded communities. Although the impact is initiated during the construction phase, it is really an operational issue as recovery of vegetation community types is a long term process. Uncontrolled fires caused either accidentally or intentionally, can also exacerbate impacts to natural vegetation, particularly if these take place under unfavourable weather conditions.

Without mitigation this impact can be considered as relatively moderate in terms of impact severity due to the sandy/erodible nature of the soils and steep slopes at the site and the already high existing levels of disturbance and IAP infestation. Although impacts would be localized, erosion is likely to persist or worsen over time if not addressed. If managed properly, the probability and extent of this impact can be reduced quite significantly. Rapid and effective rehabilitation of these areas will be important for reducing erosion risk. Whilst levels of alien plants at the site are already high, this should not undermine the importance of careful impact management to reduce the severity and likelihood of additional disturbance-related impacts.

IMPACT 3: Pollution of soils, water and vegetation

This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water, soil and air resources which inevitable impacts on vegetation.

Impact Description

Terrestrial vegetation and habitats are susceptible to pollution, like all other natural resources and ecological infrastructure. Pollution impacts on vegetation can either be direct or secondary in nature. Direct impacts relate to the physiological changes of vegetation upon direct contact with pollutants whilst secondary impacts relate to the physiological changes of vegetation as a response to its polluted environment e.g. contaminated soil/water. Potential contaminants and their relevant source may include:

- **Hydrocarbons** – leakages from petrol/diesel stores and machinery/vehicles, spillages from poor dispensing practices;
- **Oils and grease** - leakages from oil/grease stores and machinery/vehicles, spillages from poor handling and disposal practices;
- **Cement** - spillages from poor mixing and disposal practices;
- **Bitumen** - spillages from poor application, handling and disposal practices;

Contaminants such as hydrocarbons, solids and pathogens may be generated during the construction phase from a number of potential sources (examples include petrol/diesel, oil/grease, paint, cement/concrete and other hazardous substances). These contaminants have the capacity to negatively affect soil ecosystems including sensitive or intolerant species of flora and fauna. Where significant changes in soil/water quality occur, this will ultimately result in a shift in flora and soil microbes species composition, favouring more tolerant species, and potentially resulting in the localised exclusion of any sensitive species. When these pollutants come into contact with plants they often result in the destruction of plant parts e.g. leaves ultimately resulting in the death of the plant.

Because these pollutants linger in the soil for extensive periods of time, they may inhibit the establishment of vegetation during rehabilitation of disturbed areas. Relatively inert pollutants such as cement and bitumen products do not have an acute impact on vegetation but can suppress plant growth. The risk of solid waste pollution (litter) is likely to be limited and is likely to arise from workers unless appropriate controls are in place. The impacts on vegetation will be most significant in areas that are still largely natural and which contain or support important flora and fauna and lowest in cases where vegetation has been largely transformed or invaded by alien plants.

Without mitigation this impact can be considered as moderately low severity with localised impacts anticipated. If mitigatory actions are employed, the risk of this impact can be managed to acceptable levels. Management of pollutants through on-site mitigation measures will be key in protecting the environment from the detrimental effects of pollutants and contaminants.

IMPACT 4: Reduction/loss of ecosystem goods and services

This refers to the reduction in the level of supply of ecosystem goods and services (such as biodiversity support, carbon sequestration, erosion control, flood control, etc.) provided by natural terrestrial ecosystems and habitats including grasslands, woodlands, bushland and forests.

Impact Description

Terrestrial ecosystems such as grasslands, woodlands and natural forests can provide a range of important ecosystem goods and services to society. They typically support a rich diversity of locally common and endemic grasses, trees, wild flowers, invertebrates, reptiles, birds and other animals. Other services provided by these ecosystems include their role in reducing runoff and attenuating downstream flooding, assisting with binding topsoil and controlling erosion as well as their role in storing atmospheric carbon, especially in the topsoil. Benefits to local communities may include medicinal plants, firewood, building materials and thatching grass. The loss of grassland and woodland vegetation and habitat will likely contribute somewhat to the concomitant reduction in the level of ecosystem goods and benefits provided by these ecosystems. Habitat fragmentation is also a major problem in the eThekwini municipal Area and the R102 development will likely result in further fragmentation of habitat in an areas that has seen severe levels of destruction and fragmentation of natural habitats due to human infrastructure development. and agriculture (sugarcane farming).

This impact will be difficult to mitigate and will be far less significant for secondary vegetation communities dominated by pioneer species, weeds and IAPs than those in a more natural state.

5.2 Impact Significance Assessment

Impact significance is defined broadly as a measure of the '*desirability, importance and acceptability of an impact to society*' (Lawrence, 2007). The degree of significance depends upon two dimensions: the measurable characteristics of the impact (e.g. intensity, extent, duration) and the importance societies/communities place on the impact. Put another way, impact significance is the product of the value or importance of the resources, systems and/or components that will be impacted and the intensity or magnitude (degree and extent of change) of the impact on those resources, systems and/or components.

An attempt has been made to quantify the relative significance of the range of potential negative impacts identified in Section 5.1, with a summary of the results of the impact significance assessment provided in Table 9 (below) for both moderate and low ecological sensitivity vegetation communities. The significance of the identified potential impacts of the proposed interchange development on terrestrial vegetation communities identified was assessed for the following realistically possible scenarios:

i. **Realistic "poor mitigation" scenario** – this is a realistic worst case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.

ii. **Realistic "good mitigation" scenario** – this is a realistic best case scenario involving the effective implementation of construction mitigation, incorporation of the majority of design mitigation, good operational maintenance and successful rehabilitation. Please note that this realistic scenario does not assume that unrealistic mitigation measures will be implemented and/or measures known to have poor implementation success (>90% of the time) will be effectively implemented.

*Further information on the results of the impact assessment is contained in **Annexure A** at the back of this report.*

Impact Significance Assessment:

i. **Destruction/loss of vegetation and habitat**: Direct impacts to terrestrial vegetation and habitat will definitely occur within the road developed footprint and will lead to the permanent loss of vegetation within this zone. The signify cane of the impact will be moderate for the more intact and natural vegetation communities and moderately low for those communities that have been largely transformed and dominated by IAPs. The significance of the impact was assessed as moderate due to the high level of degradation of the existing vegetation communities that stand to be lost. This impact will be inherently difficult to mitigate, however The direct loss of vegetation and habitat within the development footprint will be difficult to mitigate, however the largely degraded nature of the habitats impacted should not trigger the need for a biodiversity offset and should be compensated instead through on-site rehabilitation of degraded terrestrial vegetation and habitat in the vicinity of the development (i.e. within the road reserve). The extent of the physical area disturbed can be reduced through careful onsite management by avoiding areas outside of the development footprint as far as practically possible. Protected species identified within the construction footprint can be easily translocated through proper management at the site.

ii. **Modification of vegetation community and habitat through disturbance**: The disturbance of adjacent terrestrial areas to the construction/development footprint is likely to result in the temporary clearing of vegetation and disturbance of soils, leaving these areas prone to soil erosion and IAP/weed and pioneer plant colonisation. This will have a negative impact on the ecology and long-term sustainability of terrestrial vegetation and habitat in adjacent areas, which will be more significant for the more intact/natural communities than those that are already highly disturbed and infested with IAPs and weeds. The significance of this impact can be potentially reduced to a low significance through careful site management to avoid unnecessary disturbance of vegetation and habitat adjacent to the development and through adequate onsite rehabilitation of areas disturbed during contruction.

iii. **Pollution of vegetation**: Under a poor mitigation scenario, it is anticipated that the mismanagement and/;or accidental spillage of potentially hazardous products/contaminants

such as hydrocarbons, bitumen, paint, oils and grease could result in the pollution/contamination of the soils and vegetation within the construction area and adjoining areas. Soil pollution will affect the establishment of vegetation during rehabilitation. With this in mind, the significance of the impact under a poor mitigation situation is expected to be moderately low, but when managed as per the onsite management and mitigation recommendations outlined in this report, the significance can be lowered to a generally low and acceptable level.

iv. **Reduction/loss of ecosystem goods and services:** The terrestrial grassland and wooded communities provide some level of ecosystem goods and services supply, most likely linked to their role in controlling soil erosion, providing limited habitat for terrestrial and aquatic species within a highly fragmented environment and regulating water runoff. These services, whilst provided to a limited degree by the predominantly highly modified terrestrial vegetation communities and habitat affected by the development, will be lost to an extent due to the development of hardened surfaces across vegetation within the development footprint. This is regarded as being of moderately low impact significance and can be potentially reduced to a low significance through careful site management to avoid unnecessary disturbance of vegetation and habitat adjacent to the development and through adequate onsite rehabilitation of disturbed terrestrial areas.

Table 9. Assessment of the significance of ecological impacts associated with the proposed R102 Interchange for terrestrial vegetation communities and habitat of 'Moderate' and 'Low' Ecological Sensitivity.

IMPACT		Impact Significance			
		Vegetation Communities of 'Moderate' Ecological Sensitivity		Vegetation Communities of 'Low' Ecological Sensitivity	
		Poor mitigation	Good mitigation	Poor mitigation	Good mitigation
1	**Destruction/loss of vegetation and habitat**	**Moderate**	**Moderate**	**Moderately Low**	**Moderately Low**
2	**Modification of vegetation community and habitat through disturbance**	**Moderate**	**Low**	**Moderately Low**	**Low**
3	**Pollution of soils and vegetation**	**Moderately Low**	**Low**	**Low**	**Low**
4	**Reduction/loss of ecosystem goods and services**	**Moderately Low**	**Low**	**Moderately Low**	**Low**

*Further information on the results of the impact assessment is contained in **Annexure C** at the back of this report.*

6 IMPACT MITIGATION & MANAGEMENT

6.1 Implementation and monitoring of mitigation measures

In terms of Section 2 and Section 28 of NEMA (National Environmental Management Act, 1998), the land owner is responsible for any environmental damage, pollution or ecological degradation caused by their activities "inside and outside the boundaries of the area to which such right, permit or permission relates". In dealing with the range of potential ecological impacts to natural ecosystems and biodiversity highlighted in this report, this would be best achieved through the incorporation of the management & mitigation measures (recommended in sections 6.2 – 6.5 of this report) into an **Environmental Management Programme (EMPr**) for the development project. The EMPr should be separated for construction & operational phases of the proposed development.

The EMPr should define the responsibilities, budgets and necessary training required for implementing the recommendations made in this report. This will need to include appropriate monitoring as well as impact management and the provision for regular auditing to verify environmental compliance. The EMPr should be enforced and monitored for compliance by a suitably qualified/trained ECO (Environmental Control Officer) with any additional supporting EO's (Environmental Officers) having the required competency skills and experience to ensure that environmental mitigation measures are being implemented and appropriate action is taken where potentially adverse environmental impacts are highlighted through monitoring and surveillance. The ECO will need to be responsible for conducting regular site-inspections of the construction process and activities and reporting back to the relevant environmental authorities with findings of these investigations. The ECO will also need to be responsible for preparing a monitoring programme to evaluate construction compliance with the conditions of the EMPr.

6.2 Construction Phase Impact Mitigation Guidelines

The following project-specific mitigation measures are recommended during the construction phase of the project. These must be implemented in conjunction with any generic measures provided in the Environmental Management Programme (EMPr):

A. Vegetation loss mitigation

- Vegetation removal within the road servitude must be kept to an absolute minimum. Clearing must only be done where necessary.
- All indigenous tree species removed from the construction footprint must be replaced preferably with the same species were possible at a ratio of 3:1 (thus 1 lost; 3 planted).

- Revegetation of all disturbed soils within the road reserve must be undertaken immediately following construction.
- Keep the clearing of vegetation through sensitive grassland areas to a minimum and attempt to ensure that clearing occurs in parallel with the construction progress where practically possible.
- Where possible, cut vegetation to ground-level rather than removing it completely, leaving root systems intact to ensure rapid re-colonization in areas that are not to be permanently hardened.
- Inform site staff that under no circumstance may firewood or medicinal plants be harvested.
- No open fires to be permitted in the vicinity of grassland/woodland vegetation, whether indigenous or not. Ensure that no refuse wastes are burnt on the site or on surrounding premises.
- Ensure that all workers on site know the proper procedure in case of a fire occurring on site. Ensure adequate fire fighting equipment is available and train workers on how to use it.
- Protected species of plants/trees are not to be removed or damaged where possible; otherwise a license is required by law. Where protected or rare/threatened species are suspected to occur on the basis of habitat characteristics and where these are likely to be disturbed during construction, a plant 'rescue' operation must be undertaken by an appropriate specialist prior to construction. The ECO will need to demarcate/mark any indigenous trees that may be impacted and the necessary permits for plant removal/relocation of any threatened/protected species will need to be prior to removing trees (refer to **Section 7: Plant Permits/Licensing**).
- As far as practically possible, indigenous plants/trees should be removed intact and relocated/used in rehabilitation. Smaller trees (less than 3-4m high) can be easily removed intact and replanted in suitable areas outside of the construction zone.
- Invasive Alien Plants that have colonised the construction site must be removed/controlled (see **Section 6.3: Invasive Alien Plant Eradication and Control Programme**).

B. Construction site demarcation, access routes and 'No Go' areas

With regards to accessing the sites and avoiding disturbing adjoining terrestrial areas, the following is recommended:

- Construction activities, site camps and equipment lay-down areas must be limited to the road servitude wherever possible and not to be located within sensitive/undisturbed vegetation or habitat.
- The outer edge of the construction servitude/working area (as defined above) must be clearly demarcated for the entire construction phase using an orange hazard fence where practical/appropriate.
- The proposed limits of land disturbance (construction zone) should be physically marked off to ensure that impacts are limited as far as possible.
- All demarcation work must be signed off by the ECO before any work commences.

- Terrestrial areas outside of the road reserve are considered 'No-Go' areas. Access through and construction activities within the No-Go areas are strictly prohibited in these areas and needs to be controlled.
- Access must be confined to the existing road infrastructure where possible and disturbed areas within the road reserve.
- Access routes should be designed to limit potential impact on the environment, bearing in mind steep slopes and areas that are already showing reduced groundcover and soil erosion.
- Wherever possible, blading new tracks with a grader must be avoided, and any new temporary access routes/vehicle tracks should be created by simply driving over the ground cover without removing grass cover/topsoil.

C. Contractor induction and staff environmental awareness/training

- Training needs must be identified prior to commencement of the project, based on the available and existing capacity of site and project personnel.
- Staff environmental induction must take place prior to construction commencing and any sub-contractors utilised must be inducted before starting work onsite. All contractor employees must receive basic environmental awareness training and shall be educated on the requirements of the EMPr.
- It is vital that all personnel are adequately trained to perform their designated tasks to the accepted standards.
- A copy of the EMPr, containing the mitigation and management procedures for working within terrestrial habitats, will need to be made available at the construction site offices/site camp at all times.

D. Soil Management (Stockpile areas)

- All stockpile areas must be established on disturbed areas within the road reserve.
- Erosion/sediment control measures such as silt fences, concrete blocks and/or sand bags must be placed around soil/material stockpiles to limit sediment runoff from stockpiles.
- Stockpiles of construction materials must be clearly separated from soil stockpiles in order to limit any contamination of soils.
- Stockpiled soils are to be kept free of weeds and are not to be compacted. The stockpiled topsoil must be kept moist and this can be achieved through irrigation of topsoil stockpiles on a weekly basis.
- If soil stockpiles are to be kept for more than 3 months they must be hydroseeded.
- The slope and height of stockpiles must be limited to 2m.
- Spoil material must be hauled to a designated spoil site or landfill site. No spoil material must be pushed down slope or discarded on site.

E. Erosion control measures

Storm water and erosion control measures must be implemented during the construction phase to ensure that erosion is avoided or minimised. In this regard, the following measures should be implemented:

- Any clearing should be done immediately before construction, rather than leaving soils exposed to the elements (phased approach). Construction activities should be scheduled to minimise the duration of exposure of bare soils on site, especially on steep slopes.
- Vegetation/soil clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected, clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Construction on steep slopes will need to ensure that adequate slope protection is provided.
- Dewater any constructed trenches or other excavations in a manner that does not cause erosion and does not result in heavily silt-laden water flowing downslope. Water must be pumped out into a well-vegetated area to facilitate sediment trapping and reduce the chance of sediment entering downstream wetlands or rivers/streams.
- Run-off generated from cleared and disturbed areas such as access roads and slopes must be controlled using erosion control (e.g. sand bags, earthen berm etc.) and sediment trap measures (e.g. silt fences).
- Sediment barriers (e.g. silt fences, sandbags, hay bales, earthen filter berms or retaining walls) must be established to counter erosion and sedimentation impacts to vegetation. Sediment barriers should be regularly maintained and cleared so as to ensure effective drainage.
- Berms, sandbags and/or silt fences must be maintained and monitored for the duration of the construction phase and repaired immediately when damaged. The berms, sandbags and silt fences must only be removed once vegetation cover has successfully re-colonised the disturbed areas post-rehabilitation.
- After every rainfall event, the contractor must check the site for erosion damage and rehabilitate this damage immediately. Erosion rills and gullies must be filled-in with appropriate material and silt fences or fascine work must be established along the gulley for additional protection until grass has re-colonised the rehabilitated area.

F. Pollution prevention measures

The following pollution prevention measures must be implemented at the site:

- The proper storage and handling of hazardous substances (e.g. fuel, oil, cement, bitumen, paint, etc.) needs to be administered. Construction materials liable to spillage are to be stored in appropriate containment structures (e.g. drip-trays).
- Storage containers must be regularly inspected so as to prevent leaks.
- All employees handling fuels and other hazardous materials are to be properly trained in their safe use, environmental restrictions and methods for proper disposal.
- Hazardous storage and re-fuelling areas must be bunded prior to their use on site during the construction period. The bund wall should be high enough to contain at least 110% of any stored volume.
- Mixing and/or decanting of all chemicals and hazardous substances must take place on a tray, shutter boards or on an impermeable surface and must be protected from the ingress and egress of stormwater.

- Cement/concrete batching is to be located in an area of low environmental sensitivity away from water courses and must first be approved by the ECO. No batching activities shall occur directly on the ground.
- Drip trays should be utilised at all fuel/chemical dispensing areas. Provide drip-trays beneath standing machinery/plant.
- No refuelling, servicing nor chemical storage should occur outside the established construction camp.
- Routinely check machinery/plant for oil or fuel leaks each day before construction activities begin.
- Vehicle maintenance should not take place on site unless a specific lined and bunded area is constructed within the construction camp for such a purpose.
- Ensure that transport, storage, handling and disposal of hazardous substances is adequately controlled and managed. Correct emergency procedures and cleaning up operations should be implemented in the event of accidental spillage.
- Spillages of fuels, oils and other potentially harmful chemicals should be cleaned up immediately and contaminants properly drained and disposed of using proper solid/hazardous waste facilities (not to be disposed of within the natural environment). Any contaminated soil from the construction site must be removed and rehabilitated timeously and appropriately.
- An emergency spill response procedure must be formulated and staff is to be trained in spill response. All necessary equipment for dealing with spills of fuels/chemicals must be available at the site.
- Contaminated water containing fuel, oil or other hazardous substances must never be released into the environment. It must be disposed of at a registered hazardous landfill site.
- Sanitation – portable toilets (1 toilet per 30 users is the norm) to be provided where construction is occurring and away from watercourses such as rivers and wetlands. Workers need to be encouraged to use these facilities and not the natural environment.

G. Management of solid waste

- Provide adequate rubbish bins and waste disposal facilities on-site and educate/encourage workers not to litter or dispose of solid waste in the natural environment but to use available facilities for waste disposal.
- Clear and completely remove from site all general waste, constructional plant, equipment, surplus rock and other foreign materials once construction has been completed.
- Recycling/re-use of waste is to be encouraged.
- Litter generated by the construction crew must be collected in rubbish bins and disposed of weekly at registered sites by a registered waste management company.
- Dumpling of litter, refuse, wastes, rubbish, rubble, debris and builders wastes within and around the construction site is prohibited. The construction site must be kept clean, tidy and free from rubbish.

H. Wildlife management

- No wild animal may under any circumstance be hunted, snared, captured, injured, killed, harmed in any way or removed from the site. This includes animals perceived to be vermin (such as snakes, rats, mice, etc.).
- Any fauna that are found within the construction zone must be moved to the closest point of natural or semi-natural vegetation outside the construction corridor.
- The handling and relocation of any animal perceived to be dangerous/venomous/poisonous must be undertaken by a suitably trained individual.

6.3 Invasive Alien Plant Eradication and Control Programme

An IAP eradication and control programme must be developed for areas disturbed during construction and will need to comprise of the following three (3) phases:

i. **Initial control phase:** This involves the initial, intensive clearing and drastic reduction of existing alien plant infestations at the site. Must be undertaken during the construction period.

ii. **Follow-up control phase:** The follow-up phase involves the control of seedlings, root suckers and coppice growth after the initial control phase to control re-growth of alien seed. Must be undertaken during the construction phase through to the rehabilitation phase.

iii. **Maintenance control phase:** This final phase involves a programmed control of alien plants to sustain or maintain low alien plant numbers by suppressing regeneration. Depending on the success of the initial phases this maintenance phase may be carried out at intervals ranging from quarterly clean ups to once a year clean-ups. Must be undertaken during the operational phase of the proposed development.

A **Method Statement for IAP clearing and control** has been compiled and details the requirements and strategy for IAP eradication & control within disturbed terrestrial areas of the site. The method statement is presented below.

Method Statement 1. *IAP Eradication & Control for terrestrial areas*

1 Planning for IAP Control:

Proper planning and preparations are fundamental to achieving cost-effective and successful IAP control. The following steps must be followed during planning:

i. The contractor must visit the site and assess the extent of IAP infestation and topographic challenges he will have work in.
ii. Identify and gather field equipment and personal protective equipment (PPE) required.
iii. Gather all chemicals required to control IAPs. Only herbicides registered for use on the target species may be used (*note that the application of herbicides on different types of alien invasive plant species is limited in South Africa. It is therefore necessary to assess the herbicide's activity such as its residual effect in the soil; it ability to work under wet conditions etc.).*
iv. Train project workers and supervisors on target IAPs and identified clearing methods. This may include: environmental protection with emphasis on aquatic resources, IAP identification; safety training for use of specialised equipment such as chainsaws; specialised training for working in difficult or sensitive terrain and under difficult climatic conditions.

2 Strategy for IAP eradication/control:

The strategy for the removal of IAPs and weeds on the site shall be in accordance with the following

practice measures and guidelines for control/eradication of IAPs:

i. Identify, locate and demarcate Protected indigenous plants (i.e. ***Scadoxus puniceus***) and large indigenous trees that should be conserved within areas to be cleared.
ii. Begin clearing at the top of the valley, moving down towards the riparian zone at the southern end of the site.
iii. Keep the team working in a line, with the daily tasks pegged out where possible.
iv. Target dense infestations of woody and herbaceous alien plants, focusing on the removal of Invasive Alien Plants (IAPs).
v. Recommended methods of IAP control and their application are summarised in Box 1, below.
vi. For large specimens that cannot be easily removed entirely, cut plants as low to ground as possible and apply herbicide to all cut surfaces and exposed roots. The "cut-stump" application method is the safest method of applying herbicides.
vii. The roots system of large, mature trees (including exotics) often play an important role in stabilising soil and therefore the cutting down or up-rooting of large mature specimens of trees is not generally advocated. It is recommended instead that large exotic trees (such as *Melia azedarach, Eucalyptus sp.*) be ring-barked and poisoned/painted with the relevant herbicides.
viii. All IAPs must be removed carefully and exposed soil should be covered with cut vegetation or leaf litter that is free of weed seeds to ensure that re-growth of alien flora will not occur.
ix. Press any loosened soil down carefully but firmly and mulch with plant material where possible.
x. All alien seeds, fruit bulbs, tubers and stems must be stacked and burnt onsite or removed for disposal at a registered land fill for example.
xi. Stack/move the slashed brush off the stumps to aid herbicide application and re-establishment of indigenous plant species.
xii. Stack the brush into hips for collection and disposal at a landfill site.

3 Follow-up control:

Follow-up inspections are necessary to ensure the success of the control phase. It is preferable to follow up on an area and remove all seedlings or treat re-sprouting plants, rather than treat a new area. Follow-up operations must be carried out if inspections establish that initial removal efforts have failed or have had a limited impact.

4 Maintenance:

Maintenance control entails conducting regular control of invasive alien plants. This helps to sustain low alien plant numbers and keep the alien plants in check. Inspections of the site must be carried out every six (6) months.

5 Monitoring requirements:

The site should be monitored through visual inspections at regular intervals to determine whether IAP control has been successful and if further follow-up treatment is required.

Notes on the use of herbicides in IAP control:

Note that herbicide application will need to be carried out strictly in accordance with the manufacturer's specifications and according to current legislation (*see **Annexure E** for list of common recommended herbicides and their restrictions*). The following pollution and safety measures must be also adhered to regarding the handling, use and storage of herbicides:

i. All herbicides, concentrated and diluted, must be stored in a secure and covered area, or off-site under lock and key.
ii. All containers into which the herbicide or mixers are decanted must be clearly marked and a copy of the original label secured to the container.
iii. Herbicides must at all times be applied according to the recommendations on the labels.
iv. All MSDS sheets are to be made available on site along with a fully kitted Medical Aid Kit.
v. Herbicide equipment must under no circumstances be washed in a local stream, river or wetland Suitable protective clothing like gloves, aprons, overalls and eye protection must be worn by herbicide applicators at all times.
vi. The correct protective clothing is to be used in line with manufacturer's instructions and/or the Occupational Health & Safety Act, Act 85 of 1993 (and amendments).
vii. Avoid contact of herbicide with skin and eyes.
viii. After contact, all applicators must wash their hands with soap and water or as recommended on the herbicide label.

There are various means of controlling invasive alien plants in South Africa. The primary methods are discussed below in Box 1. The suitability of control methods depends on a number of factors, including practical constraints, economic constraints and applicability of methods for particular species of alien plants. It is generally advised that a form of integrated control be implemented, based on a combination of two or more of the control measures outlined below (depending of course on the species present at the site). Further information on species-specific control recommendations can be found in Table 10. Selection of the appropriate methods of control should be based on the following criteria:

- **Species to be controlled:** herbicides are registered for specific species. Selection should be based on "*A Guide to the use of Herbicides*" issued by the Directorate: Agricultural Production Inputs and labels and information brochures provides by herbicide suppliers.
- **Size/age of target plants:**
    - For **seedlings:** hand-pulling or hoeing and foliar applications of herbicides for dense stands.
    - For **saplings:** hand-pulling or hoeing, foliar applications of herbicides for dense stands, basal stem treatments and cut stump treatments recommended.
    - For **mature trees**: ring barking, frilling, basal stem treatments and cut stump treatments recommended.
- **Density of stands:** Overall applications of herbicide can be made to dense stands of seedlings or saplings. Where dense stands of large trees are present, treatment of standing trees may be appropriate to obviate the problem of disposing felled trees.
- **Accessibility of terrain:** In inaccessible areas, methods that rely on the minimum amount of transportation of equipment and chemicals should be given preference.
- **Environmental considerations:** Riparian/wetland areas require a careful approach to treatment/control. Only herbicides approved for use in wetland/riparian areas are to be considered because washed-away herbicides often end up in aquatic systems.
- **Desirable vegetation:** Control methods that will cause the least damage to desirable vegetation must be considered. Selective herbicides or mixes that will not damage other desirable vegetation should be applied where relevant.
- **Disposal of dead vegetation:** Where possible, utilizable wood should be removed after tree felling. This is also the case for trees that could cause the blockage of water courses. Brushwood should be spread rather than stacked to limit soil damage in instances where burning is planned.
- **Cost of application:** the cost of application and re-treatment should be taken into consideration when selecting methods/herbicides, etc.

Box 1. Alien Plant Control Methods

The control methods detailed below have been adapted from the ARC-PPRI (Agricultural Research Commission: Plant Protection Research Institute) Weed Research Programme (online at www.arc.agric.za/arc-ppri/), the DWA Working for Water Programme ((http://www.dwaf.gov.za/wfw/Control/) and eThekwini Municipality's *Practical tips on the management and eradication of invasive alien plants* (EcoFiles Sheet 4. Local Action for Biodiversity).

1 Mechanical control

Mechanical control entails physically damaging or removing the target alien plant. Mechanical control is generally labour intensive and therefore expensive, and can also result in severe soil disturbance and erosion. Different techniques can be applied and include uprooting/hand-pulling, felling, slashing, mowing, ring-barking or bark stripping. This control option is only really feasible in sparse infestations or on a small scale, and for controlling species that do not coppice after cutting. Species that tend to coppice (e.g. *Eucalyptus spp., Melia azedarach)* need to have the cut stumps or coppice growth treated with herbicides following mechanical treatment.

- **Hand pulling/uprooting:** The hand-pulling should be reserved for small plants and shrubs with shallow root systems (not recommended for trees with a stem diameter of more than 10cm). Grip the young plant low down and pull out by hand (using gloves). Uprooting is similar but is undertaken on slightly older individuals with the major drawback being that a relatively large area can be disturbed with the soils being altered and opening the area up to re-infestation.
- **Chopping/ cutting/ slashing:** This method is most effective for plants in the immature stage, or for plants that have relatively woody stems/trunks. An effective method for non re-sprouters or in the case of re-sprouts (coppicing), it must be done in conjunction with chemical treatment of the cut stumps. Cut/slash the stem of the plant as near as possible to ground level. Paint re-sprouting plants with an appropriate herbicide immediately after they have been cut.
- **Strip bark:** Using a bush knife, strip bark away from tree from waist height down to soil. Cambium is stripped with the bark. No herbicide used.
- **Felling:** Large trees can be cut-down in their entirety, however, this is often not recommended unless absolutely necessary as large trees can play a pivot role in soil protection and biodiversity maintenance.
- **Girdling:** Girdling involves cutting a groove or notch into the trunk of a tree to interrupt the flow of sap between the roots and crown of the tree. The groove must completely encircle the trunk and should penetrate into the wood to a depth of at least 1.5 centimetres on small trees, and 2.5 to 4 centimetres on larger trees. The effectiveness of girdling can be increased by using herbicides.

2 Chemical control

Chemical control involves the use of registered herbicides to kill the target weed. The use of herbicide is often essential to the success of an eradication/control programme as it greatly reduces the re-growth potential of alien plants. Unfortunately, if the wrong herbicide is chosen, one can potentially cause more harm than good to the environment. When choosing the most appropriate herbicide, one needs to consider the following:

- **Relative toxicity to humans/animals**
- **Selective vs non-selective herbicides**: There are advantages and disadvantages to using each type. When dealing with light to moderate infestations in grass-dominated veld types, a broad-leaf selective herbicide is recommended so as to reduce the danger that spray drift could kill natural grass. In areas of heavy infestation, a non-selective herbicide is recommended.
- **Residual effect**: Some active ingredients in herbicides will remain in the environment for months, even years, before denaturing. Others start to denature as soon as they enter the soil. If a persistent herbicide is used, ensure that it is not used near any watercourse or area with a high water table (such as wetlands & riparian areas).
- **Is the herbicide registered for the target species:** A list of registered herbicides can be obtained from the Department of Water Affairs: Working for Water Programme – Policy on the Use of Herbicides for the Control of Alien Vegetation (January 2002). Also see http://www.arc.agric.za/arc-ppri/Pages/Weeds%20Research/Specific-IAP-Species-and-their-control-according-to-botanical-names.aspx

Some additional recommendations regarding herbicide use include:

- Herbicides should be applied during the active growing season.
- Always observe all safety precautions printed on the labels and manufacturer's instructions when mixing and applying herbicide.
- Herbicides can be applied in various ways. They can be sprayed onto dense infestations or painted onto the main stem of the plant or cut stump.

- Spraying herbicide on small infestations is not recommended, rather cut and apply herbicide to the stumps either with a brush.
- Spraying should be restricted to windless days when there is less risk of droplets drifting onto non-target species.
- Pressure or flow regulators should be fitted to sprayers for overall application. Spraying should be restricted to plants waist height or lower, but also ensuring there is sufficient foliage to carry the applied herbicide to the root system of the target plant.
- For water-based applications, Actipron Super Wetter should be added where recommended on the herbicide label, at a rate of 1.75/ha for dense-closed stands of alien vegetation.
- For all water-based treatments, a suitable brightly coloured dye should be added to the mix to ensure that all target plants are treated. For diesel-based applications, Sudan Red Dye should be added.
- Chemical control of IAPs is not recommended in aquatic systems due to the risk of water pollution, but may be used in conjunction with cutting or slashing of plants.
- Chemicals should only be applied by qualified personnel.
- Only herbicide registered for use on target species may be used.
- Follow the manufacturer's instructions carefully.
- Appropriate protective clothing must be worn.
- Only designated spray bottles to be used for applying chemicals.
- The number of herbicides for safe use under wet conditions is very limited.

3 Biological control

Biological weed control involves the releasing of natural biological enemies to reduce the vigour or reproductive potential of an invasive alien plant. Research into the biological control of invasive alien plants is the main activity of the Weeds Research Programme of ARC-PPRI and a list of biocontrol agents released against invasive alien plants in South Africa can be downloaded from their website. To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF).

4 Mycoherbicides

A mycoherbicide is a formulation of fungal spores in a carrier, which can be applied to weeds in a similar way as a conventional chemical herbicide (using herbicide application equipment). The spores germinate on the plant, penetrating plant tissues and causing a disease which can eventually kill the plant. Mycoherbicides are indigenous to the country of use and therefore are already naturally present in the environment and do not pose a risk to non-target plants. Under natural conditions they do not cause enough damage to the weed to have a damaging impact and are therefore mass produced and applied in an inundative inoculation, which leads to an epidemic of the disease knocking the weed population down. Mycoherbicides need to be re-applied at regular intervals.

5 Integrated control

It is frequently advisable to use a combination of two or more of the control method mentioned above, which is referred to as *integrated control*. Killing plants without cutting down causes the least disturbance to the soil and is the ideal.

The following integrated control options are available:

- **Basal bark and stem application**: apply recommended herbicide mixed in diesel carrier to the base of the stem of trees (<25cm stem height) and saplings. This method is appropriate for plants with thin bark or stems up to 25cm in diameter. Do not cut the bark. Apply herbicide mix with paintbrushes or using a coarse droplet spray from a narrow angle solid cone nozzle at low pressure. For multi-stemmed plants, each stem must be treated separately.
- **Ring barking**: Invasive trees growing away from any structures or roads can be ring-barked, poisoned and left standing rather than felled. They will slowly collapse over time and can establish habitat for birds, etc. Strip all bark and cambium from a height of 75cm to 100cm down to just below soil level. Cut a ring at the top and pull strips. All bark must be removed to below ground level for good results. Where clean de-barking is not possible due to crevices in the stem or where exposed roots are present, a combination of bark removal and basal stem treatments should be carried out. Bush knives or hatchets should be used for debarking.
- **Frilling:** Using an axe or bush knife, make angled cuts downward into the cambium layer

through the bark in a ring. Ensure to effect the cuts around the entire stem and apply herbicide into the cuts.

- **Cut stump treatment**: This is a highly effective and appropriate control method for larger woody vegetation that has already been cut off close to the ground. The appropriate herbicide should be applied to the stump using a paintbrush within 30 min of being cut. Apply recommended herbicide mixture to the cut surface with hand sprayers, a paintbrush or knapsack sprayer at low pressure. Apply only to the cambium or outer layer of large stumps and the entire cut surface of small stumps. Ensure the stumps are cut as low to the ground as practically possible (about 10 – 15 cm or as stipulated on specific herbicide label). Herbicides are applied in diesel or water as recommended for the herbicide. Applications in diesel should be to the whole stump and exposed roots and in water to the cut area as recommended on the label.
- **Scrape and paint**: This method is suitable for large vines and scrambling plants i.e. creepers. Starting from the base of the stem, scrape 20-100cm of the stem to expose the sapwood just below the bark. Within 20 seconds apply the herbicide to the scraped section. Do not scrape around the stem. Stems over 1cm in diameter can be scraped in 2 sides. Leave the vines to die in place to prevent damaging any indigenous plants they may be growing over.
- **Foliar spray:** This is not an advocated method of application by unqualified applicators due to the danger of spraying indigenous species. Should be restricted to droplet application made directly on the leaves on plants that are no higher than knee height. Use a solid cone nozzle that ensures an even coverage on all leaves and stems to the point of runoff. Do not spray just before rain (a rainfall-free period of 6 hours is recommended) or before dew falls. Avoid spraying in windy weather as the spray may come into contact with non-target plants. Spraying dormant or drought stressed plants is not effective as they do not absorb enough of the herbicide.

6 Disposal of alien plant material

Treated/removed alien plant material will need to be removed from the site and disposed of at a proper/registered receiving area such as a local registered land fill site.

Table 10. List of the common IAPs occurring at the site and their recommended control/treatment methods[2].

Scientific name & Common name	NEM:BA Category	Control method	Herbicide Trade Name	Time between clearings / applications
Acacia mearnsii Black Wattle	1b	• Uproot small plants • Ring bark large trees • Cut stump/frill	Kaput 100 Gel	3 months
Albizia lebbeck		• Uproot small plants • Ring bark large trees	N/A	3 months
Canna indica Indian-shot	1b	• Dig up and uproot completely	N/A	3 months
Cardiospermum grandiflorum Balloon vine	1b	• Hand pulling/hoeing • Uproot	N/A	3 months
Cestrum laevigatum Inkberry	1b	• Hand pull young plants • Cut & spray	Hatchet	3 months
Chromolaena odorata Triffid weed	1b	• Hand pull young plants • Cut & spray	Lumberjack	3 months
Eucalyptus sp. Gum tree	3	• Uproot small plants • Ring bark large trees • Cut stump/frill	Hatchet or Lumberjack or Kaput 100 Gel	3 months
Hedychium coronarium White ginger lily	1b	• Cut & spray	Hatchet	3 months
Ipomoea sp.	1b	• Foliar spray	Springbok or Glyphosate 500	3 months
Lantana camara Lantana	1b	• Dig up young plants • Cut & spray	Hatchet	3 months

[2] *Please see Annexure D for photos of some of the IAPs listed in this report.*

Scientific name & Common name	NEM:BA Category	Control method	Herbicide Trade Name	Time between clearings / applications
Leucaena leucocephala Leucaena		• Basal stem	Garlon	3 months
Litsea glutinosa Indian laurel	1b	• Uproot small plants • Ring bark large trees • Cut stump/frill	N/A	3 months
Caesalpinia decapetala Mauritius thorn		• Foliar spray	Garlon or Glyphosate 500	3 months
Melia azedarach Syringa	1b	• Hand pull saplings • Lopping / Pruning • Ring bark large trees • Cut stump / Frill	Hatchet or Lumberjack	3 months
Mimosa pigra Sensitive		• Hand pull young plants • Foliar spray	Springbok or Glyphosate 500	3 months
Morus alba *Mulberry*	2	• Uproot small plants • Ring bark large trees • Cut stump/frill	Hatchet	3 months
Montana hibiscifolia Bush daisy	1b	• Hand pull small plants • Cut stump treat bigger specimens	Kilo or Glyphosate 500	3 months
Parthenium hysterophorus Demonia weed	1b	• Foliar spray	Access	3 months
Passiflora subpeltata Granadillas	1b	• Hand pulling/hoeing • Uproot	N/A	3 months
Pennisetum purpureum Napier Grass	1b	• Hand pull young plants • Foliar spray mature plants	Systemic grass herbicides e.g. Springbok	3 months
Psidium guajava Guava		• Looping pruning • Cut-stump / Frill	Hatchet	3 months
Pueraria montana Kudzu vine		• Foliar spray	Garlon	3 months
Ricinus communis Castor-oil Plant	1b	• Hand pull young plants • Cut stump treat mature plants	Hatchet	3 months
Rivina humilis Blood berry	1a	• Dig up and uproot completely	N/A	3 months
Senna didymobotrya Peanut butter cassia	1b	• Hand pull young plants • Cut stump treat	Hatchet	3 months
Schinus terebinthifolius Brazilian Pepper Tree	1	• Hand pull young • Basal stem	Garlon	3 months
Solanum mauritianum Bugweed	1b	• Hand pull saplings • Cut stump treat	Hatchet or Kaput 100 Gel	3 months
Tecoma stans Yellow bells	1b	• Uproot small plants • Ring bark	N/A	3 months
Tithonia diversifolia Mexican Sunflower	1b	• Dig up and uproot completely	N/A	3 months
Additional weeds at low infestation levels				
• *Bidens pilosa (Blackjack)*, • *Tagetes minuta (Tall Khakhi weed), and* • *Widelia trilobata* (Singapore daisy).		• Hand pulling/hoeing • Uprooting	No treatment required.	3 months

6.4 Rehabilitation Guidelines

Terrestrial vegetation/habitat rehabilitation guidelines for implementation during and post-construction have been included below. *All natural areas disturbed by construction activities must be rehabilitated once construction activities have ceased.*

6.4.1 Land preparation measures

The following are general land preparation requirements for all areas requiring rehabilitation:

- All rubble, litter, foreign materials and waste products needs to be removed from the construction area and disposed of at proper local waste disposal/landfill facilities. *Minimise additional disturbance by limiting the use of heavy vehicles and personnel during clean-up operations*
- Any soil stockpiles/spoil material must spread evenly on the ground to match the natural slope.
- All Invasive Alien Plants (IAPs) and weeds must be removed from target sites, preferably by uprooting (refer to the detail contained in **Section 6.3: Invasive Alien Plant Eradication and Control Programme**).
- All embankments are to be shaped to the specification of the project or recommendations of the engineer/ECO.
- Any erosion features within the construction site must be stabilised. Compacted soil infill, rock plugs, gabions, excavation and reshaping or any other suitable measures can be used for this purpose.
- Where significant soil compaction has occurred, the soil may need to be ripped in order to reduce the bulk density of the soil such that vegetation can become established at the site. Rip and / or scarify all disturbed and compacted areas of the construction site. The ECO with the assistance of the engineer will specify whether ripping and / or scarifying is necessary, based on the site conditions.
- Immediately after ripping and scarifying disturbed areas, about 300mm of topsoil must be applied on top. The thickness of the topsoil maybe reduced at the instruction of the engineer only if 300mm of topsoil compromises the integrity of the works.
- Topsoil must be placed in the same area from where it was originally stripped. If there is insufficient topsoil available from a particular soil zone to produce the minimum specified depth, topsoil of similar quality may be brought from other areas. Where topsoil is lost during construction as a result of erosion, topsoil will need to be imported to the site and re-established. Such topsoil must be sourced commercially and legally.
- The topsoil must be compacted to similar compaction levels as natural soils in the area. The engineer will provide detailed advice on this.
- For seeding, the soil needs to be prepared to optimise germination. This is typically undertaken by hand hoeing to loosen the soil in the seedbed but should be firm enough to facilitate good contact between the seeds and the soil.
- Other relevant land preparation methods are illustrated in Figure 14, below.

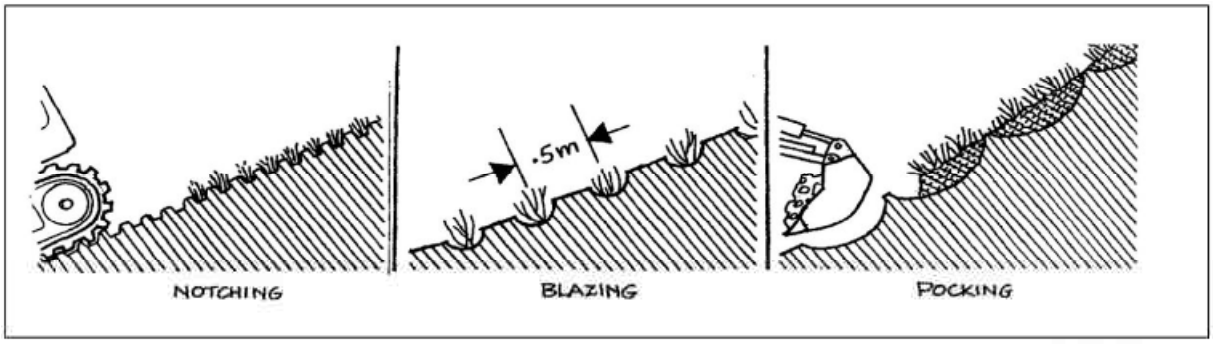

Figure 14 Methods of preparing the land for planting (Source: EThekwini Municipality, 2002).

6.4.2 Stabilising steep slopes/Road batters

Road batters linked with the R102 interchange and associated road infrastructure range from gentle to steep slopes on which vegetation must be established. Where slopes are gentle, general land preparation requirements will apply but where slopes are steep, soft intervention techniques will need to be employed to provide sufficient slope stabilisation.

- As a principle, soft interventions should be favoured over hard interventions wherever possible. These include the following:
    - Soil savers;
    - Vegetation blankets or mats;
    - Geo-cells; and
    - Fibre rolls or bags.
- It is important to note that bioengineering interventions are vulnerable to failure if not adequately implemented or poorly maintained.
- Retaining structures such as silt fences, sandbags, hay bales, brush packs, timber logs placed in continuous lines following the slope contours or cut-off trenches can be used across the entire slope to retain eroded sediment.
- Use sand bags or timber logs place at regular intervals along the contour of slopes to retain sediment and stabilize the soils.
- Temporary sediment barriers will need to remain in place until such time as revegetation and stabilization of disturbed areas is judged to be a success and the risk of erosion/sedimentation has been reduced to a respectfully low level.

6.4.3 Revegetation of disturbed terrestrial areas

Immediately after preparing the soil, revegetation must commence in order to help bind the soil and prevent soil erosion and to inhibit IAP/weed establishment which will compete with the natural vegetation for space, light, nutrients and water. In this regard, the following mitigation measures must be implemented for road batters, roadside drains and disturbed terrestrial habitats/vegetation within the road reserve:

<u>Method 1</u>: Sodding (disturbed grassland areas)

- Runner grass sods composed of indigenous species must be laid out on all road batters and secured in place using wooded pegs. Use of grass sods is the most preferred revegetation method because it offers instant protection of vulnerable areas. It is best to install the sod as soon as it is delivered.
- Earthen side drains characterised by low water saturation rates will need to be re-vegetated with grass sods and those characterised by high water saturation rates will need to be re-vegetated with rescued tall robust vegetation such as *Typha capensis* (Common bulrush), *Cyperus dives* (Giant sedge) *and Phragmites australis* (Common reed).
- **No exotic/alien plants are to be used in sodding.**
- Prior to installing sods, rake or harrow to achieve a smooth, final grade.
- Lay the grass sods as indicated in Photo 1 and Figure 15 (below) then peg each on to the ground using wooden pegs/stakes.
- When sodding is carried out in alternating strips, or other patterns the areas between the sods should be seeded immediately after the sodding (See Photo 2, below).
- Immediately after revegetation, the grass sods must be watered thoroughly. Watering must be undertaken on a daily basis until such time as the sod becomes well rooted within the soil. Thereafter, less frequent watering should be sufficient until such time as the vegetation is established to the satisfaction of the rehabilitation implementer and ECO/resident engineer.

Photo 1: Layering of grass sods on a slope.

Photo 2: Strip sodding with hydroseeded areas covered in geofabrics (e.g. soil saver).

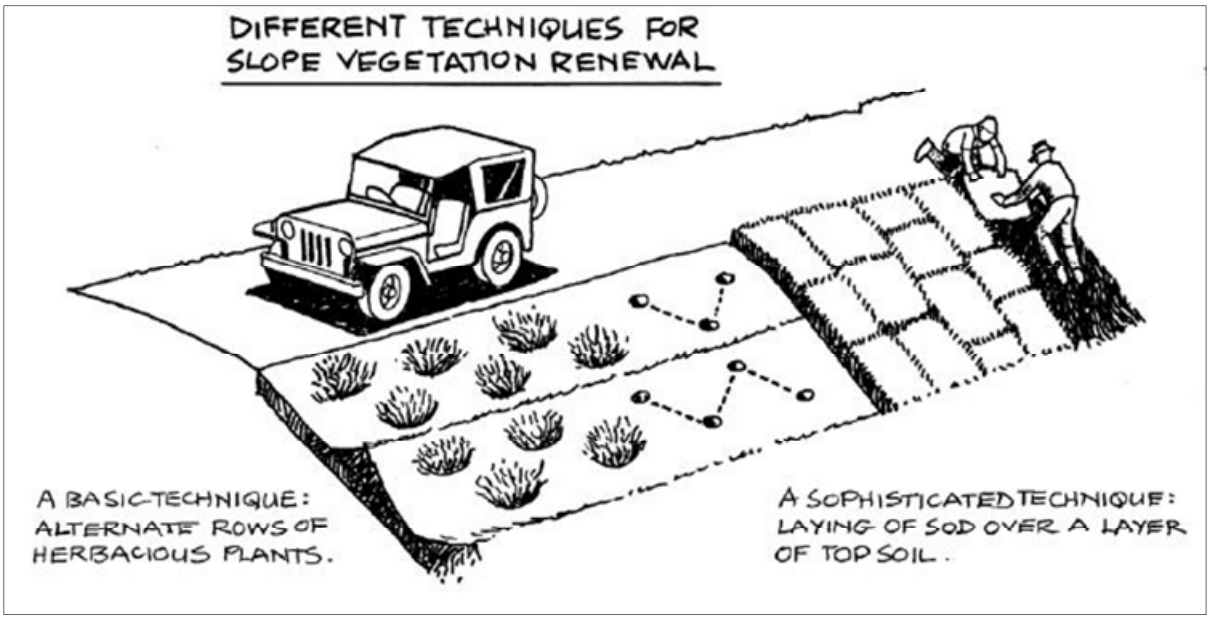

Figure 15 Techniques for slope revegetation (Source: EThekwini Municipality, 2002).

Method 2: Hydroseeding (road embankments)

- Hydroseeding is the second preferred option to re-vegetating slopes. The advantages of hydroseeding include faster germination, increased plant survival, and the ability to cover large, often inaccessible areas rapidly.
- The slurry (basic materials) for hydroseeding must consists of water, seed, fertiliser, anti-erosion compounds (soil binders) and organic supplements to enhance grass growth.
- Prior to hydroseeding water must be sprayed over target area to provide added moisture.
- The target groundcover of re-vegetated areas shall be no less than 80% of specified vegetation and there must be no bare patches of more than 500 x 500 mm in maximum dimension.
- Ideal species for hydroseeding include runner and short tufted species, such as *Cynodon dactylon* or suitable alternative indigenous grasses species.
- **No exotic/alien plants are to be used in hydroseeding.**

Method 3: Revegetating with plugs and seeds (for Retaining Walls, etc.)

- All retaining walls must be vegetated with indigenous grass species. This involves use of pre-cast concrete modules which are stacked in a staggered pattern that creates planting pockets.
- The pockets are then filled with topsoil and other soil enhancements such as mulch or manure.
- A mix of indigenous grass and herbaceous species will need to be planted in each planting pocket.
- A planting palette comprising of the following species must be utilised: **Grasses**: *Melinis repens, Aristida junciformis, Digitaria eriantha, Eragrostis curvular, Panicum maximum, Chloris gayana* **Herbs**: *Helichrysum symosum, Ledebouria floribunda, Asystasia gangetica, Dissotis canescens, Senecio sp., Scillia sp., Helichrysum sp., Smilax anceps, Lobelia sp.,* **Succulent plants**: *Aloe maculata,* **Small shrubs**: *Tecomaria capensis.*

Method 4: Tree Planting in wooded areas

- For each indigenous tree removed in the terrestrial zone during construction, three indigenous replacement trees of the same species should be planted.
- The following tee species mix is recommended for use in revegetating wooded terrestrial areas based on documented indigenous species occurrence within the study area and surrounds : *Acacia robusta* (Narrow-pod Robust Thorn), *Albizia adianthifolia* (Flat Crown), *Aloe marlothii* (Mountain Aloe), *Aloe ferox* (Bitter Aloe), *Aloe transkei* (Beach Aloe), *Acacia xanthophloea* (Fever tree), *Antidesma venosum* (Tasselberry), *Brachylaena discolor* (Silver coastal leaf), *Bridelia micrantha* (Mitzeeri), *Cryptocrya latifolia* (Broad-leaved Laurel), *Dalbergia obovata* (Climbing flat bean), *Erythrina lysistemon* (Sacred Coral Tree), *E. caffra* (Coral Tree), *Ficus burkei* (Common Wild Fig), *Ficus natalensis* (Natal Fig), *Searsia chirindensis* (Red Current), *Trema orientalis* (Pigeonwood), *Phoenix reclinata* (Wild Date Palm), *Protorhus longifolia* (Red Beech), *Psychotria capensis (*Blackbird tree*), Trichilia emetica* (Natal Mahogany), *Millettia grandis (Umzimbeet), Strelitzia nicolai* (Wild Banana) and *Ziziphus mucronata* (Buffalo Thorn).
- **No exotic/alien trees or plants to be planted.**
- The following planting procedures are recommended:
    - All tree holes shall be square in plan (minimum of 600mm length x 600mm width x 700mm deep);
    - Holes are to be backfilled with excavated soil in a ratio of 3:1 with compost. Where possible, any available topsoil should be placed in the hole at the level where the tree root ball will rest.
    - All trees shall be tied (using a tree tie) to a suitable timer stake planted in the ground to a depth of at least 500mm. The stake shall have a minimum diameter of 35mm and shall be at least 300mm taller than the planted tree;
    - The planting of shrubs will be in accordance with the tree planting method with the exception that the holes are to be smaller;
    - Do not plant trees in straight lines but at random with approximately 3-5m gaps between trees; and
    - Water retaining basins/berm of at least 500mm diameter are to be formed around each tree (do not simply leave the excavated plant hole partially backfilled for this purpose – the berm must be raised above the natural soil level).

6.5 Operation-Phase Impact Mitigation Guidelines

While construction-related impacts are to be addressed through best management practices and drafting of an Environmental Management Programme (EMPr) for the development project, there are a range of longer-term aspects that need to be addressed to ensure that operational-phase impacts are managed in such a way as to limit impacts on terrestrial habitats and biodiversity. Operational-phase environmental impact/risk management and mitigation guidelines have been provided in this regard and are included below:

A. IAP control

It is the responsibility of the developer/applicant to eradicate and control n invasive alien plants (IAPs) that invade the road servitude and all areas disturbed during construction and operation of the proposed road infrastructure. As such the ecologists from Eco-Pulse Consulting recommend the implementation of a bi-annual annual IAP monitoring and clearing exercise for the first year post-rehabilitation. Thereafter, IAPs clearing can be undertaken annually. In terms of Section 75 of NEMBA, the following applies to the control & eradication of IAPs:

- The control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs;
- Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment; and
- The methods employed to control and eradicate a listed invasive species must also be directed at the new growth, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

Refer specifically to **Section 6.3: Invasive Alien Plant Eradication and Control Programme**.

B. Erosion control and bank stability concerns

Where soil erosion or bank instability concerns exists at the site, particularly for steep rehabilitated embankments, etc., it is recommended that these areas be monitored to inform the need for further intervention. Where erosion/instability concerns persist, these will need to be addressed as per the construction mitigation measures for soil erosion in **Section 6.2** and the rehabilitation recommendations in **Section 6.4**).

7 PLANT PERMIT/LICENCE REQUIREMENTS

Four (4) plant species of conservation importance namely *Scadoxus puniceus* (Snake lily), *Dioscorea sylvatica* (Elephant's foot), *Barringtonia racemosa* (Powder-puff tree) and *Aloe marlothii* (Mountain aloe) were recorded within the focal assessment areas included in the specialist terrestrial vegetation survey.

i. ***Scadoxus puniceus*** is protected under Schedule 12 of the Natal Nature Conservation Ordinance (No. 15 of 1974) which lists Specially Protected Plants of the KwaZulu-Natal. Handling of this plant species will require an Ordinary Permit from the Ezemvelo KZN Wildlife.

ii. ***Dioscorea sylvatica*** is protected under Schedule 12 of the Natal Nature Conservation Ordinance (No. 15 of 1974) which lists Specially Protected Plants of the KwaZulu-Natal. Handling of this plant species will require an Ordinary Permit from the Ezemvelo KZN Wildlife.

iii. ***Barringtonia racemosa*** is a protected tree (National Tree Number 524) under Section 15(1) of the National Forest Act No. 84 of 1998 and a licence will need to be applied for from the Department of Agriculture, Forestry and Fisheries (DAFF) for the removal/damage of this tree species.

iv. ***Aloe marlothii*** is protected under Schedule 12 of the Natal Nature Conservation Ordinance (No. 15 of 1974) which lists Specially Protected Plants of the KwaZulu-Natal. Handling of this plant species will require an Ordinary Permit from the Ezemvelo KZN Wildlife.

GPS locations of the four plant species is provided in Table 11 and plant locations are shown in Figure 16 and 17, below. The entire road servitude will need to be searched for conservation important plants prior to commencement of construction. Once found, the necessary permits/licences will need to be applied for from the relevant office. *Note that protected aquatic species documented in the Wetland and Aquatic Assessment Report (Eco-Pulse, September 2015) will also need to be included in this plant search and rescue effort.*

Table 11. GPS locations of protected plant species identified: *Scadoxus puniceus*, *Dioscorea sylvatica, Aloe marlothii* and *Barringtonia racemosa*.

Protected Plant Species	**No**. (see Figure 10)	GPS Coordinates
Scadoxus puniceus	**1.**	29°41'43.05"S, 31° 2'7.41"E
	2.	29°41'44.78"S, 31° 2'3.32"E
Dioscorea sylvatica	**3.**	29°41'44.98"S, 31° 2'3.90"E
Scadoxus puniceus	**4.**	29°41'45.72"S, 31° 2'3.13"E
	5.	29°41'45.95"S, 31° 2'3.24"E
	6.	29°41'46.01"S, 31° 2'3.31"E
	7.	29°41'47.18"S, 31° 2'3.21"E
	8.	29°41'47.22"S, 31° 2'3.39"E
	9.	29°41'47.20"S, 31° 2'3.75"E
	10.	29°41'47.09"S, 31° 2'4.46"E
	11.	29°41'47.57"S, 31° 2'5.52"E

Protected Plant Species	No. (see Figure 10)	GPS Coordinates
Barringtonia racemosa	**12.**	29°42'8.52"S, 31° 2'19.53"E
	13.	29°42'9.18"S, 31° 2'22.01"E
Aloe marlothii	**14.**	29°42'47.05"S, 31° 2'14.16"E

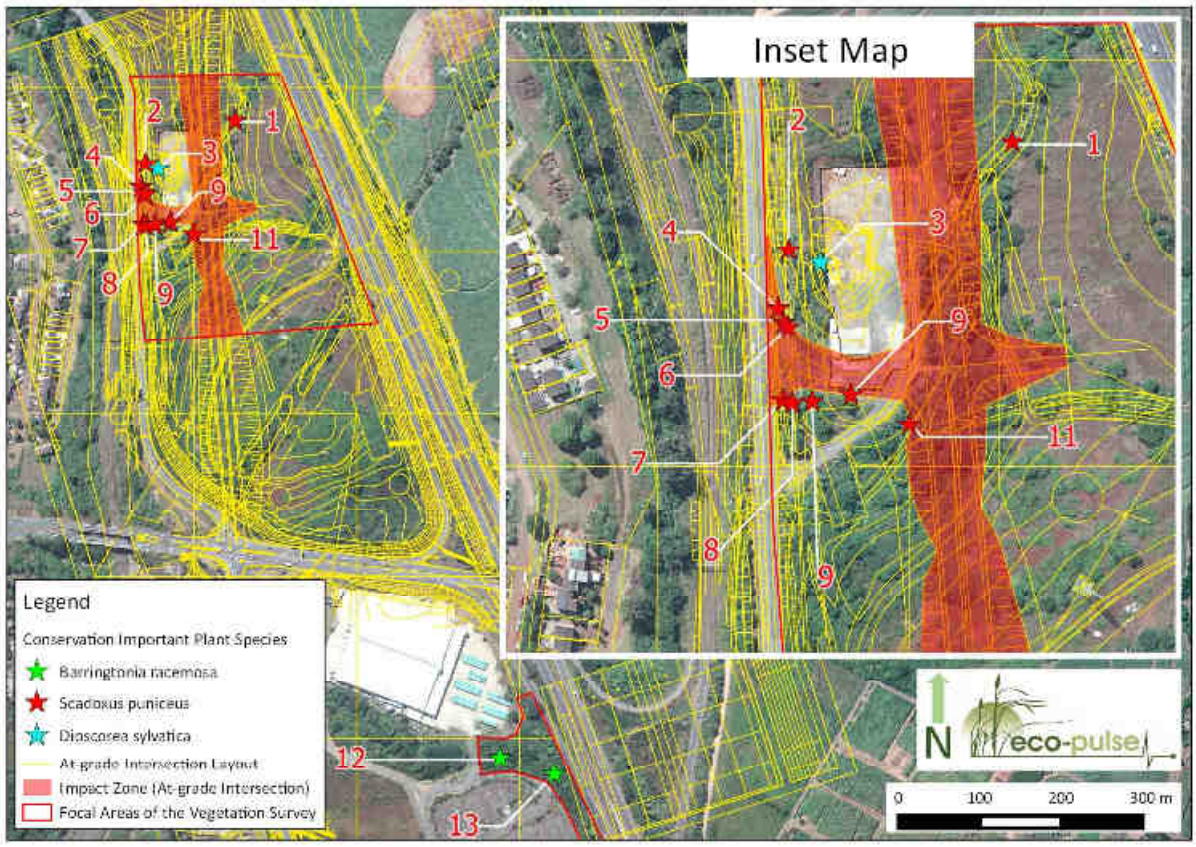

Figure 16 Map indicating the location of protected plants species: *Scadoxus puniceus*, *Dioscorea sylvatica* and *Barringtonia racemosa* recorded within the focal assessment areas of the vegetation survey.

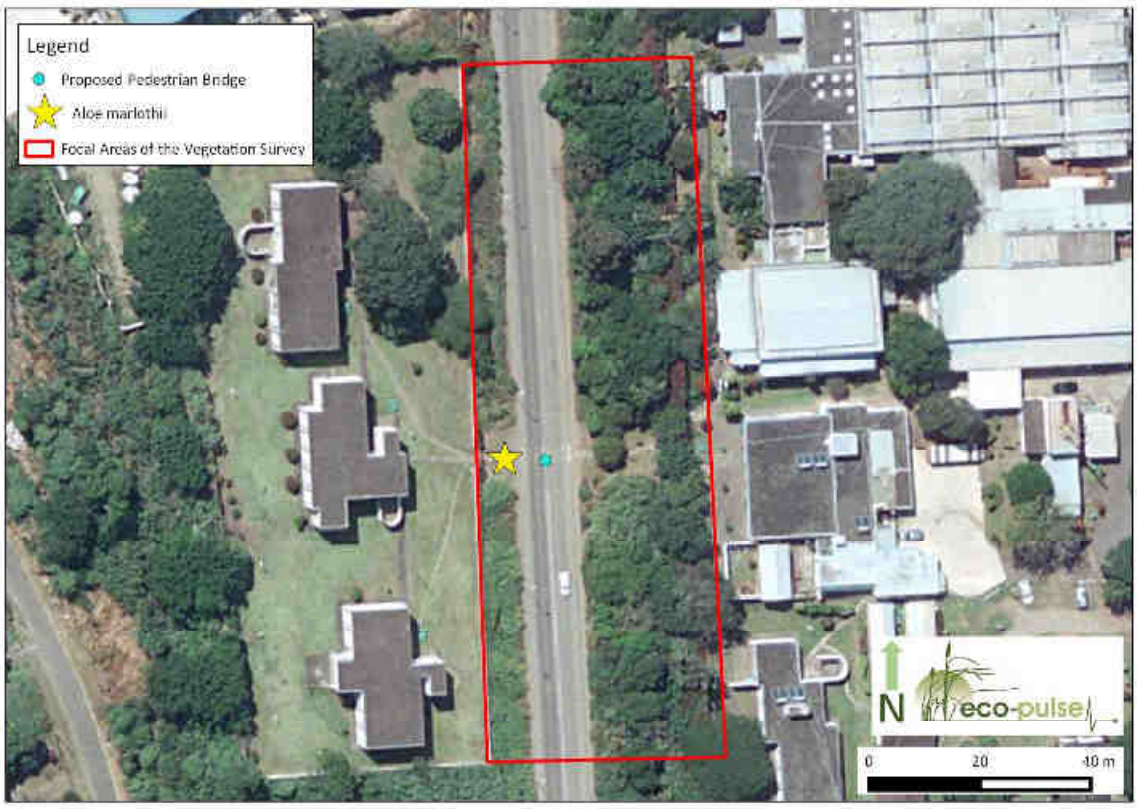

Figure 17 Map indicating the location of protected plants species: *Aloe marlothii* recorded within the focal assessment areas of the vegetation survey.

8 CONCLUSION

The specialist terrestrial vegetation survey and undertaken at the onset of summer (September 2015) for the three additional components (P79 grade separation, M41 north-bound off-ramp and a Pedestrian bridge) of the R102 interchange and road upgrade project near Mt Edgecombe/Pheonix (eThekwini Metro) identified the presence of four distinct vegetation communities thus, **(i) Wooded Alien Thicket, (ii) Wooded Grassland, (iii) *Hyparrhenia filipendula* open Grassland and (iv) Ruderal Herbaceous Community** within the three (3) focal areas of the survey. The *Hyparrhenia filipendula* open Grassland was assessed as being of moderate ecological sensitivity (characterised by an indigenous grass species and low alien plant infestation/disturbance levels). This community falls largely outside the construction impact zone and is likely to remain un-impacted by the proposed development merely by avoiding impacts to this area. The other remaining three (3) vegetation communities were generally characterised by high levels of disturbance and invasive alien plant infestation levels (with low to very low natural plant diversity) and as such were assessed as being of low ecological sensitivity. These stand to be directly impacted by the development either through direct loss or disturbance linked with construction activities.

Four (4) plant species of conservation concern (protected tree/plant species), namely *Scadoxus puniceus* (Snake lily), *Dioscorea sylvatica* (Elephant's foot), *Barringtonia racemosa* (Powder-puff tree) and *Aloe marlothii* (Mountain aloe) were identified within and around the construction impact zone and are likely to be impacted by development. The locations of these species identified were recorded and should be relatively easy to translocate and therefore do not pose any restrictions to the proposed development. However, handling of these species will require either Ordinary Permit from EKZNW (for Specially Protected herbaceous plants) or a licence from DAFF (for listed protected trees).

Key potential impacts linked with the development include direct loss of vegetation and habitat, indirect loss of vegetation and habitat through pollution, loss of plants species of conservation concern, fragmentation of habitat and increased IAPs colonisation and infestation post-disturbance. The level of IAPs infestation is currently high and therefore IAP infestation is expected to be a serious problem if poorly managed, particularly within those habitats that are largely weed/alien free (i.e. namely the *Hyparrhenia filipendula* open Grassland). IAP species control and eradiation guidelines have been included in this report to assist in combatting IAPs at the site. Minimising the construction footprint particularly within the road reserve, controlling IAPs, properly managing pollutants and rehabilitating the site post construction will aid in limiting adverse impacts linked with the development and reducing the ecological significance of most impacts to an acceptably low level. To this end, recommendations and guidelines for impact management and rehabilitation of disturbed terrestrial habitats have been included in Section 6 of the report.

The proposed development is considered acceptable on the provision that mitigation measures proposed in this report are adhered to. It is therefore recommended that Section 6 of this report which deal with 'Impact Mitigation/Management' be included in the Construction Environmental

Management Programme (EMPr) and also referenced in the Environmental Authorisation (EA) for this project as a specific condition of the EA.

Should you have any queries regarding the findings and recommendations in this Specialist Vegetation Survey and Habitat Impact Assessment Report, please contact Eco-Pulse Environmental Consulting Services (Eco-Pulse).

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9 REFERENCES

Bromilow, C., 2010. Problem Plants and Alien Weeds of South Africa. Third Edition. Briza Publications, Pretoria, South Africa.

DAFF (Department of Agriculture, Forestry and Fisheries). 2010. Policy Principles and Guidelines for Control of Development Affecting Natural Forests.

DEAT (Department of Environmental Affairs and Tourism). 1998. Guideline Document on EIA Regulations of Environmental Affairs and Tourism.

DEFRA (Department for Environment, Food and Rural Affairs). 2005. Controlling soil erosion: A manual for the assessment and management of agricultural land at risk of water erosion in lowland England. Crown copyright, 2005. United Kingdom.

Didham, R. K., Tylianakis, J. M., Hutchison, M. A., Ewers, R. M. and Gemmell, N, J. 2005: Are invasive species the drivers of ecological change, *Trends in Ecology and Evolution,* 20 (9), p470-474.

EKZNW, 2010. Terrestrial Systematic Conservation Plan: Minimum Selection Surface (MINSET). Unpublished GIS Coverage [tscp_minset_dist_2010_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

EKZNW (Ezemvelo KwaZulu-Natal Wildlife), 2013. Norms and standards for Biodiversity Offsets: KwaZulu-Natal Province, South Africa.

EKZNW (Ezemvelo KwaZulu-Natal Wildlife), 2011. Biodiversity Impact Assessment Handbook for KwaZulu-Natal. Version 1.0, Final Draft, June 2011. EKZNW IEM Section.

eThekwini Municipality, 2009. Generic EMP for Construction Activities.

Jewitt, D. 2011. Conservation Targets and Status for Vegetation Types in KZN. Ezemvelo KwaZulu-Natal Wildlife: Biodiversity Conservation Planning Division, Pietermaritzburg, South Africa. October 2011.

Lawrence, D.P., 2007. Impact significance determination - Designing an approach. Environmental Impact Assessment Review 27 (2007) 730 - 754.

Mooney, H.A., 2005. Invasive alien species: the nature of the problem. In: Mooney, H.A., Mack, R.N., McNeely, J.A., Neville, L.E., Schei, P.J., Waage, J.K. (Eds.), Invasive Alien Species: A New Synthesis. Island Press, Washington, DC, pp. 1–15.

Mucina, L. and Rutherford, M. C. (eds) 2006. The Vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

Pooley, E., 2005. A field guide to Wildflowers of KZN and the Eastern Region. First Edition, second impression. Natal Flora Publications Trust.

SANBI (South African Biodiversity Institute), 2010. Threatened Species: A guide to Red Lists and their use in conservation. Threatened Species Programme, Pretoria, South Africa. 28 pp.

Scott-Shaw, C.R and Escott, B.J. (Eds), 2011. KwaZulu-Natal Provincial Pre-Transformation Vegetation Type Map – 2011. Unpublished GIS Coverage [kznveg05v2_1_11_wll.zip], Biodiversity Conservation Planning Division, Ezemvelo KZN Wildlife, P. O. Box 13053, Cascades, Pietermaritzburg, 3202.

SE Solutions. 2014. Sharpening the Tool: New techniques and methods in environmental impact assessment. Course presented by SE Solutions.

Van Ginkel, C.E., Glen, R.P., Gordan-Gray, K.D., Cilliers, C.J., Muasya and van Deventer, P.P., 2011. Easy identification of some South African Wetland Plants (Grasses, Restios, Sedges, Rushes, Bulrushes, Eriocaulons and Yellow-eyed grasses). WRC Report No. TT 459/10.

Van Oudtshoorn, F., 2006. Guide to grasses of Southern Africa. Pretoria, South Africa.

Van Wyk, B. and Van Wyk, P. 2007. Field Guide to Trees of Southern Africa.

Van Wilgen, B.W., Forsyth, G., Le Maitre, D.C., Wannenburgh, A., Kotze, J.D.F., Van den Berg, E. and Henderson, L. 2012. An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. Biological Conservation **148**: 28–38.

10 ANNEXURES

ANNEXURE A: Detailed Assessment Methods.

A1 Impact significance assessment

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact (or resource being affected), and the likelihood / probability of the impact occurring. In light of this understanding, significance can only be assessed if one knows the importance or value of the environmental change/impact. Thus, end point or eventual impacts that can be valued like impacts to water resources, ecosystem services and biodiversity conservation can only be assessed in terms of significance and are referred to as ultimate consequences of an activity or a suite of impacts. Put another way, the significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed.

For the purposes of this assessment, the assessment of potential impacts was undertaken using an "Impact Assessment Methodology for EIAs" adopted by Eco-Pulse (2015). This assessment was informed by baseline aquatic information contained in this report relating to the sensitivity of habitats and potential occurrence of protected species as well as information on the proposed development provided by the client and experience in similar projects in South Africa. The approach adopted is to identify and predict all potential primary and secondary/indirect impacts resulting from an activity from origin (e.g. catchment land hardening) to end point (e.g. loss of ecosystem services as a result of erosion). Thereafter, the approach is to rate intensity as the realistic worst case consequence (end-point / ultimate) of an activity (according to Table 12 below) and then assess the likelihood of this consequence occurring as well as the extent and duration of the impact.

Impact significance = (impact intensity + impact extent + impact duration) x impact likelihood.

This formula is based on the basic risk formula: **Risk = consequence x probability**

Table 12. Criteria and numerical values for rating environmental impacts.

Score	Rating	Description
Intensity (I) – defines the magnitude and importance of the impact		

Score	Rating	Description
16	**High**	Loss of human life. Deterioration in human health. High impacts to water resources: · Critical / severe local scale (or larger) ecosystem modification/degradation and/or collapse. · Critical / severe local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Critical / severe ecosystem impact description:</u> Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components permanently ceases and are irreversibly impaired (system collapse). Rehabilitation and remediation often impossible. If possible, rehabilitation and remediation often unfeasible due to extremely high costs of rehabilitation and remediation. · Extinction of habitat type or serious impact to future viability of a critically endangered habitat type. · Extinction of species or serious impact to survival of critically endangered species.
8	**Moderately-High**	· Loss of livelihoods. · Individual economic loss. Moderately-high impacts to water resources: · Large local scale (or larger) ecosystem modification/degradation and/or collapse. · Large local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Large ecosystem impact description:</u> Impact affects the continued viability of the systems/components and the quality, use, integrity and functionality of the systems/components are severely impaired and may temporarily cease. High costs of rehabilitation and remediation, but possible. · Measurable reduction in extent of endangered and critically endangered habitat types. · Measurable reduction in endangered and critically endangered floral and faunal populations.
4	**Moderate**	Moderate impacts to water resources: · Moderate local scale (or larger) ecosystem modification/degradation and/or collapse. · Moderate local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Moderate ecosystem impact description:</u> Impact alters the quality, use and integrity of the systems/components but the systems/components still continue to function but in a moderately modified way (integrity and functionality impaired but major key processes/drivers somewhat intact / maintained). · Measurable reduction in vulnerable habitat types. · Measurable reduction in non-threatened habitat types resulting in an up-listing to threatened status. · Measurable reduction in near-threatened and vulnerable floral and faunal populations. · Measurable reduction in non-threatened floral and faunal populations resulting in an up-listing to threatened status.
2	**Moderately-Low**	Moderately-low impacts to water resources: · Small but measurable local scale (or larger) ecosystem modification / degradation. · Small but measurable local scale (or larger) modification (reduction in level) of ecosystem services and/or loss of ecosystem services. <u>Small ecosystem impact description:</u> Impact alters the quality, use and integrity of the systems/components but the systems/components still continue to function, although in a slightly modified way. Integrity, function and major key processes/drivers are slightly altered but are still intact / maintained. · Reduction in non-threatened endangered habitat types with no up-listing to threatened status. · Reduction in non-threatened floral and faunal populations with no up-listing to threatened status.
1	**Low**	Negative change to onsite characteristics but with no impact on: · Human life · Human health · Local water resources, local ecosystem services and/or key ecosystem controlling variables · Threatened habitat conservation/representation · Threatened species survival

Score	Rating	Description
Extent (E) – relates to the extent of the Impact Intensity		
5	**Global**	The scale/extent of the impact is global/worldwide.
4	**National**	The scale/extent of the impact is applicable to the Republic of South Africa
3	**Regional**	Impact footprint includes the greater surrounding area within which the site is located (e.g. between 20-200km radius of the site).
2	**Local**	Impact footprint extends beyond the cadastral boundary of the site to include the areas adjacent and immediately surrounding the site (e.g. between a 0-20km radius of the site).
1	**Site**	Impact footprint remains within the cadastral boundary of the site.
Duration (D) – relates to the duration of the Impact Intensity		
5	**Permanent**	The impact will continue indefinitely and is irreversible.
4	**Long-term**	The impact and its effects will continue for a period in excess of 30 years. However, the impact is reversible with relevant and applicable mitigation and management actions.
3	**Medium-term**	The impact and its effects will last for 10-30 years. The impact is reversible with relevant and applicable mitigation and management actions.
2	**Medium-short**	The impact and its effects will continue or last for the period of a relatively long construction period and/or a limited recovery time after this construction period, thereafter it will be entirely negated (3 – 10 years). The impact is fully reversible.
1	**Short-term**	The impact and its effects will only last for as long as the construction period and will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase (0 – 3 years). The impact is fully reversible.
Probability (P) – relates to the likelihood of the Impact Intensity		
1	**Definite**	More than 75% chance of occurrence. The impact is known to occur regularly under similar conditions and settings.
0.75	**Highly Probable**	The impact has a 41-75% chance of occurring and thus is likely to occur. The impact is known to occur sporadically in similar conditions and settings.
0.5	**Possible**	The impact has a 10-40% chance of occurring. This impact may/could occur and is known to occur in low frequencies under the similar conditions and settings.
0.2	**Unlikely**	The possibility of the impact occurring is low with less than 10% chance of occurring. The impact has not been known to occur under similar conditions and settings.
0.1	**Improbable**	The possibility of the impact occurring is negligible and only under exceptional circumstances.

Table 13. Impact significance categories and definitions.

Impact Significance	Impact Significance Score Range	Definition
High	**18 - 26**	Unacceptable and fatally flawed. Impact should be avoided and limited opportunity for offset/compensatory mitigation. The proposed activity should only be approved under special circumstances.
Moderately High	**13 – 17.9**	Generally unacceptable unless offset/compensated for by positive gains in other aspects of the environment that are of critically high importance (i.e. national or international importance only). Strict conditions and high levels of compliance and enforcement are required. The potential impact will affect a decision regarding the proposed activity require that the need and desirability for the project be clearly substantiated to justify the associated ecological risks.
Moderate	**8 – 12.9**	Impact has potential to be significant but is acceptable provided that there are strict conditions and high levels of compliance and enforcement. If there is reasonable doubt as to the successful implementation of the strict mitigation measures, the impact should be considered unacceptable. The potential impact should influence the decision regarding the proposed activity and requires a clear and substantiated need and desirability for the project to justify the risks.
Moderately Low	**5 – 7.9**	Acceptable with moderately-low to moderate risks provided that specific/generic mitigation applied and routine inspections undertaken. The potential impact may not have any meaningful influence on the decision regarding the proposed activity.

Low	**0 – 4.9**	The potential impact is very small or insignificant and should not have any meaningful influence on the decision regarding the proposed activity. Basic duty of care must be ensured.

A confidence rating was also given to the impacts rated in accordance with Table 14, below:

Table 14. Confidence ratings used when assigning impact significance ratings.

Level of confidence	Contributing factors affecting confidence
Low	A low confidence level is attributed to a low-moderate level of available project information and somewhat limited data and/or understanding of the receiving environment.
Medium	The confidence level is medium, being based on specialist understanding and previous experience of the likelihood of impacts in the context of the development project with a relatively large amount of available project information and data related to the receiving environment.
High	The confidence level is high, being based on quantifiable information gathered in the field.

ANNEXURE B: Plant species list (exotic species shown in "Red*" text).

No.	*Botanical/Latin Name*	Common Name	Status	NEM:BA Category	Type	Threat Status (SANBI)	Focal Assessment Area		
							P79 grade separation	M41 off-ramp	Pedestrian Bridge
1.	*Acacia sieberiana*	Paperback thorn	Indigenous		tree	LC (Least Concern)	X		
2.	*Acalypha sp.**		Exotic		shrub	N/A			X
3.	*Achyranthes aspera**	Burweed	Exotic		herb	N/A			X
4.	*Albizia lebbeck**	Lebbeck tree	Exotic	1b	Tree	N/A	X		
5.	*Aloe marlothii*	Mountain Aloe	Indigenous		Succulent herb	LC			X
6.	*Amaranthus sp.**	Pigweed	Exotic		herb	N/A			X
7.	*Barringtonia racemosa*	Powderpuff Tree	Indigenous		Tree	**Protected Tree (DAFF)**		X	
8.	*Bidens pilosa**	Blackjack	Exotic		Herb	N/A	X	X	X
9.	*Bougainvillaea sp.**	Bougainvillaea	Exotic		shrub	N/A			X
10.	*Caesalpinia decapetala*	Mauritius thorn	Exotic	1b	shrub	N/A		X	
11.	*Canna indica**	Indian-shot	Exotic		Flowering plant	N/A	X		
12.	*Cardiospermum grandiflorum**	Balloon vine	Exotic	1b	Creeper/climber	N/A	X	X	
13.	*Cestrum laevigatum**	Inkberry	Exotic	1b	tree	N/A	X	X	X
14.	*Chromolaena odorata**	Triffid weed	Exotic	1b	Shrub	N/A	X	X	
15.	*Commelina benghalensis**	Benghal wandering jew	Exotic		Creeper/climber	N/A	X		
16.	*Conyza sp.**	Horseweed	Exotic		herb	N/A			X
17.	*Cassipourea gummiflua*	Large-leaved onionwood	Indigenous		Tree	**Vulnerable**	X		
18.	*Cynodon dactylon*	Couch grass	Indigenous		grass	LC	X		X
19.	*Cynodon nemfluensis*	Star grass	Indigenous		grass	LC	X		X
20.	*Desmodium incanum*	Sweethearts	Indigenous		creeper	Not evaluated	X		
21.	*Dioscorea sylvatica*	Elephants foot	Indigenous		climber	**Protected Species**	X		
22.	*Diploclylos palmatus**	Lollipop climber	Exotic	1a	Creeper/climber	N/A	X		

No.	Botanical/Latin Name	Common Name	Status	NEM:BA Category	Type	Threat Status (SANBI)	Focal Assessment Area		
							P79 grade separation	M41 off-ramp	Pedestrian Bridge
23.	*Dombeya cymosa*		Indigenous		tree	LC	X		
24.	*Drimiopsis maculata*	African hosta	Indigenous		Succulent herb	**Protected Species**	X		
25.	*Echinochloa colona*		Indigenous		grass	LC	X		
26.	*Erythrina lysistemon*	Sacred coral tree	Indigenous		tree	LC	X		
27.	*Eucalyptus sp.**	Gum tree	Exotic	1b	Tree	N/A			X
28.	*Ficus sur*	Cluster fig	Indigenous		Tree	LC		X	
29.	*Hibiscus rosa-sinensis**	China rose	Exotic		tree	N/A			X
30.	*Hyparrhenia filipendula.*	Thatching grass	Indigenous		Grass	LC	X		
31.	*Hypochaeris radicata*	Hairy wild lettuce	Indigenous		herb	Not evaluated			X
32.	*Hypoxis angustifolia*	Molinyana	Indigenous		herb	LC	X		
33.	*Imperata cylindrica*	Cottonwool grass	Indigenous		Grass	LC	X		
34.	*Ipomoea alba**	Morning glory	Exotic	1b	creeper/climber	N/A	X		X
35.	*Ipomoea purpurea**	Common morning glory	Exotic	1b	Creeper/climber	N/A	X		
36.	*Lantana camara**	Common lantana	Exotic	1b	Shrub	N/A	X		
37.	*Leucaena leucocephala**	Leucaena	Exotic	2	Shrub	N/A	X	X	X
38.	*Litsea glutinosa**	Indian laurel	Exotic	1b	Tree	N/A		X	X
39.	*Mangifera sp.*	Mango	Exotic		tree	N/A		X	
40.	*Melia azedarach**	Syringa	Exotic	3	Tree	N/A	X	X	X
41.	*Melinis repens*	Natal Redtop	Indigenous		grass	LC	X		
42.	*Mimosa pigra**	Sensitive weed	Exotic	1b	creeper	N/A	X		

No.	Botanical/Latin Name	Common Name	Status	NEM:BA Category	Type	Threat Status (SANBI)	Focal Assessment Area		
							P79 grade separation	M41 off-ramp	Pedestrian Bridge
43.	*Morus alba**	Mulberry tree	Exotic	3	Tree	N/A	X		X
44.	*Neonotonia wightii**		Exotic		creeper	N/A	X		
45.	*Oxalis sp.*	Sorrel	Indigenous		herb	LC	X		
46.	*Panicum maximum*	Guinea grass	Indigenous		grass	LC	X	X	X
47.	*Parthenium hysterophorus**	Famine weed	Exotic	1b	herb	N/A	X		X
48.	*Passiflora suberosa**	Indigo Berry	Exotic	1b	Creeper/climber	N/A	X	X	X
49.	*Pennisetum purpureum**	Napier grass	Exotic	2	Grass/reed	N/A	X		X
50.	*Phoenix reclinata*	Wild date palm	Indigenous		Tree	LC		X	
51.	*Plantago lanceolata*	Ribwort plantain	Indigenous		Herb	LC	X	X	X
52.	*Plectranthus sp.*		Indigenous		herb	LC		X	
53.	*Psidium guajava**	Guava	Exotic	3	shrub	N/A	X	X	
54.	*Pueraria montana**	Kudzu vine	Exotic	1a	Creeper/climber	N/A	X		
55.	*Ricinus communis**	Castor-oil plant	Exotic	2	Tree	N/A	X		X
56.	*Scadoxus puniceus*	Snake lily/Blood lily	Indigenous		Lily	**Protected Species**	X		
57.	*Schinus terebinthifolius**	Brazilian Pepper tree	Exotic	1b	Tree	N/A	X		X
58.	*Senecio consanguineous**	Ragwort	Exotic		herb	N/A	X		
59.	*Senna didymobotrya**	Peanut butter cassia	Exotic	1b	Shrub	N/A	X	X	X
60.	*Setaria megaphylla*	River bristle grass	Indigenous		Grass/reed	LC		X	
61.	*Smilax anceps*	Leg ripper	Indigenous		Creeper/climber	LC	X	X	X
62.	*Sorghum halepense**	Johnson grass	Exotic		Grass	N/A	X		
63.	*Solanum mauritianum**	Bugweed	Exotic	1b	Tree	N/A	X	X	X
64.	*Sporobolus africanus*	Rats tail dropseed	Indigenous		grass	LC	X		X
65.	*Strelitzia nicolai*	Natal wild banana	Indigenous		Tree	LC			X

No.	Botanical/Latin Name	Common Name	Status	NEM:BA Category	Type	Threat Status (SANBI)	Focal Assessment Area		
							P79 grade separation	M41 off-ramp	Pedestrian Bridge
66.	*Syzygium guineense*	Water pear	Indigenous		Tree	LC		X	
67.	*Tagetes minuta**	Tall Khakhi weed	Exotic		Herb	N/A	X		
68.	*Tecoma stans**	Yellow bell	Exotic	1b	Tree	N/A	X	X	X
69.	*Thelypteris interrupta*	Hottentot's fern	Indigenous		Fern	LC		X	
70.	*Tithonia diversifolia**	Mexican sunflower	Exotic	1b	Shrub	N/A	X	X	X
71.	*Trema orientalis*	Pigeonwood	Indigenous		Tree	LC	X	X	
72.	*Trichilia emetica*	Natal mahogany	Indigenous		tree	LC			X
73.	*Widelia trilobata**	Singapore daisy	Exotic		Herb	N/A	X		
74.	*Ziziphus mucronata*	Buffalo thorn	Indigenous		tree	LC			X

ANNEXURE C: Impact significance assessment results.

Proposed R102: Impact Significance Assessment for Moderate Sensitivity Terrestrial Vegetation Communities								
IMPACT SIGNIFICANCE: With Poor Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction/loss of vegetation and habitat**	Negative	Site	Moderate	Permanent	Definite	**Moderate**	Medium
2	**Modification of vegetation community and habitat through disturbance**	Negative	Local	Moderate	Permanent	Highly Probable	**Moderate**	Medium
3	**Pollution of soils and vegetation**	Negative	Local	Moderate	Long term	Possible	**Moderately Low**	Low
4	**Reduction/loss of ecosystem goods and services**	Negative	Local	Moderately-Low	Long term	Highly Probable	**Moderately Low**	Low
IMPACT SIGNIFICANCE: With Good Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction/loss of vegetation and habitat**	Negative	Site	Moderate	Permanent	Definite	**Moderate**	Medium
2	**Modification of vegetation community and habitat through disturbance**	Negative	Site	Moderate	Medium term	Possible	**Low**	Medium
3	**Pollution of soils and vegetation**	Negative	Site	Moderate	Short term	Unlikely	**Low**	Low
4	**Reduction/loss of ecosystem goods and services**	Negative	Site	Moderately-Low	Medium term	Possible	**Low**	Low

Proposed R102: Impact Significance Assessment for Low Sensitivity Terrestrial Vegetation Communities								
IMPACT SIGNIFICANCE: With Poor Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction/loss of vegetation and habitat**	Negative	Site	Low	Permanent	Definite	**Moderately Low**	Medium
2	**Modification of vegetation community and habitat through disturbance**	Negative	Local	Low	Permanent	Highly Probable	**Moderately Low**	Medium
3	**Pollution of soils and vegetation**	Negative	Local	Moderately-Low	Long term	Possible	**Low**	Low
4	**Reduction/loss of ecosystem goods and services**	Negative	Local	Low	Long term	Highly Probable	**Moderately Low**	Low
IMPACT SIGNIFICANCE: With Good Mitigation								
No.	**IMPACT**	**Status**	**Extent**	**Intensity**	**Duration**	**Probability**	**Significance**	**Confidence**
1	**Destruction/loss of vegetation and habitat**	Negative	Site	Low	Permanent	Definite	**Moderately Low**	Medium
2	**Modification of vegetation community and habitat through disturbance**	Negative	Site	Low	Medium term	Possible	**Low**	Medium
3	**Pollution of soils and vegetation**	Negative	Site	Moderately-Low	Short term	Unlikely	**Low**	Low
4	**Reduction/loss of ecosystem goods and services**	Negative	Site	Low	Medium term	Possible	**Low**	Low

Annexure D: Pictures of some of the dominant Invasive Alien Plants occurring on the site and requiring eradication/control.

Tecoma stans

Cardiospermum grandiflorum

Pennisetum purpureum

Montanoa hibiscifolia

Tithonia diversifolia

Solanum mauritianum

Canna indica

Melia azedarach

Morus alba

Annexure E: Selection of environmentally-friendly herbicides, their restrictions and adjuvant.

Trade Name	Restrictions	Adjuvant
Hatchet	a. Non selective, systemic residual herbicide b. Harmful if swallowed c. May cause eye and skin irritation d. Do not inhale mist e. Avoid spray drift onto desirable crops f. Mildly corrosive g. Weed resistance possible h. Mix should not be allowed to run off treated stumps i. Cut stump treatments more effective than foliar treatments j. Complete mix, nothing to be added, except water a. Not compatible with diesel	-
Kaput 100 Gel	a. Do not treat areas where plants that are sensitive to the active ingredients, such as broadleaf crops, fruit and desirable indigenous trees and ornamentals may come into direct contact with the product. b. Avoid contact with soil in the root zone of desirable plants or with soil in which such plants are to be grown. c. Do not allow chemical residues and spillages to contaminate rivers, dams, soil and areas not under treatment.	-
Kilo	a. Non-selective systemic granular herbicide b. Tallow amine free adjuvant c. Poisonous if swallowed d. Eye irritant e. Aerial application, 3km exclusion zone f. Do not inhale spray mist g. Anti-foaming agent needs to be added h. Withholding period is 14 days for crop planting a. Weed resistance possible	-
Lumberjack	b. Systemic water soluble herbicide c. May cause skin and eye irritation, even burns d. Flammable e. Eye protection and permeable gloves needed f. Prevent spray drift onto desirable vegetation g. Weed resistance possible i. Apply to cut stumps immediately	BP crop oil