PRELIMINARY ECOLOGICAL SURVEY FOR THE PROPOSED BAMBOO BEEMA RENEWABLE ENERGY SITES; ILLEMBE DISTRICT MUNICIPALITY, KWAZULU-NATAL

Compiled for **TRIPLO4 SUSTAINABLE SOLUTIONS** by:
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1. INTRODUCTION:

Green Grid Energy (Pty) Ltd, represented by Mr. Derek Naidoo has appointed Triplo4 Sustainable Solutions to evaluate the environmental requirements for the proposed two new renewable energy sites (henceforth called the Beema Bamboo sites) situated adjacent to the Tugela River in the Beema area within the Ilembe District Municipality. Triplo4 Sustainable Solutions as an Independent Environmental Practitioner appointed Mr. C.L. Cook to provide a basic description of the vegetation and fauna and current ecological status/habitat integrity of the proposed site and to provide appropriate management recommendations for the proposed agricultural activities associated with the bamboo plantations.

Project Description:

The project proposes the following three main components:

- **Tissue Culture Facility**: To be established at Dube Trade Port where existing facilities with the required services (water and electricity) can be converted / utilised with minimal effort and costs.
- **Bamboo Plantation**: Approximately 500 hectares of plantation to be established from the plants produced at the Tissue Culture Facility at the most suitable location or locations (sites 1 & 2 constituting the survey below) for harvesting within two years and annually thereafter. Approximately 30,000m^3 of water storage capacity will be required to ensure adequate irrigation via abstraction of water from the Tugela River.
- **Power Plant**: 3,6MW Biomass Power Plant to be established within Isithebe Industrial Park within Mandeni with provision of Energy to Eskom Power Station within the Business Park.

Beema Bamboo has 72 chromosome (2n = 72) and naturally sterile, hence the bamboo never flowers. The perennial vairety Beema bamboo, due to its sterile nature, avoids the expenditure due to replanting. Beema bamboo can grow in all types of soil. However, the preferred soil is acidic light soil, loamy soil, red soil and sandy loam soil. Beema Bamboo needs approximately 60cm soil depth and the ideal pH 5 – 6.5. However, it can be made to grow in alkaline soils up to pH 8 with soil adjustments. The water requirement for Beema bamboo is similar to sugarcane which is 2000 mm per annum. The water requirement for bamboo would be 10 to 20 l per plant, depending on the prevailing weather conditions when the Beema bamboo is grown at an intensity of 2500 plants per hectare. Beema bamboo needs ample sun light and best suited for tropical and sub-tropical weather with 10 to 14 hours of sunlight.

The assignment is interpreted as follows: **Determine the current ecological status of the vegetation and fauna and the potential ecological impacts of the Beema Bamboo sites on the immediate environment**. In order to compile the report the following had to be done:

Initial preparations:

- Obtain all relevant maps including aerial photographs (Google images) of the existing and proposed church and school development and adjacent land usage, and information on the natural environment.
- An initial site investigation (25th September 2013) to assess the current environmental status of the proposed new renewable energy sites with special emphasis on remaining natural habitats.
- Identify problematic areas which require immediate attention as well as management, e.g. degraded areas, bank erosion, reclamation areas, alien vegetation.
- Make management recommendations and mitigatory measures for the current as well as potential environmental impacts pertaining to the Bamboo plantations.

1.1 OBJECTIVES OF THE PRELIMINARY ECOLOGICAL SURVEY/ HABITAT ASSESSMENT

- To provide a basic description of the vegetation and fauna occurring within and around the proposed Beema Bamboo sites site.
- To provide a description of any threatened plant or animal (mammals, birds, reptiles and amphibians) occurring or likely to occur within Beema Bamboo sites and immediate adjacent areas.
- To describe the available habitats on site including areas of important conservation value or areas most likely to form important habitat for remaining threatened plant and animal species.
- To determine the outer edge of the riparian zone of the Tugela River as well as associated drainage lines or wetland habitats.
- To determine potential impacts of the bamboo plantations on the remaining natural vegetation and associated fauna.
- To provide management recommendations to mitigate negative and enhance positive impacts of the proposed renewable energy or Beema Bamboo sites development.

1.2 SCOPE OF STUDY

- An initial ecological survey documenting the dominant vegetation on the site and recording sightings and/or evidence of present fauna.
- An assessment of the ecological habitats, evaluating conservation importance and significance with special emphasis on any wetland or riparian habitats and the current status of threatened plant and animal species (Red Data Species), within the proposed Beema Bamboo sites site.
- Literature investigations with which to augment field data were necessary.
- Identification of potential ecological impacts that could occur as a result of Beema Bamboo sites site and assess the significance of these, where possible.
- Investigate feasible and practical management recommendations that should be implemented to reduce or minimize the impacts, should the project be approved.
- Documentation of the findings of the study in a report.

1.3 CONSTRAINTS AND LIMITATIONS OF SHORT DURATION ECOLOGICAL AND FAUNAL SURVEYS

- Limitation to a base-line ecological survey for only 1 day (8 hours) during the early spring months (September 2013). Due to financial as well as time constraints no comprehensive vegetation or faunal surveys conducted but merely a basic ecological/habitat assessment based on the brief one day site visit.
- Due to the large sizes of the proposed sites emphasis was placed on remaining natural habitats including Kwazulu-Natal Coastal Belt and Eastern Valley Thicket vegetation in various stages of transformation and degradation, perennial and non-perennial drainage lines, seasonally inundated seepage wetlands and the Tugela River and associated riparian zone.
- The large areas of on the proposed two sites are completely transformed due to previous agricultural activities.
- Due to the dense thickets within the flood bench of the Tugela access was restricted. Due to the steep topography of the wooded ravines limited access was possible.
- The majority of habitats surrounding the proposed Beema Bamboo sites site have already been completely transformed due to previous agricultural activities as well as current agricultural activities.
- The majority of animal species are extremely seasonal only emerging after sufficient heavy early summer rainfall (October-November). No comprehensive vegetation or faunal surveys have been conducted on the site.

- No surveys have been conducted on the potential impacts of the proposed water abstraction from the Tugela River on the associated riparian zone as well as aquatic fauna (macro-invertebrates, fish, reptiles (crocodiles) and amphibians).
- The majority of threatened faunal species are extremely secretive and difficult to observe even during intensive field surveys conducted over several seasons/ years. The majority of threatened plant species are seasonal and only flower during restricted periods.
- The presence of threatened species on site is assessed mainly on habitat availability and suitability as well as desk research (literature, personal records) and previous surveys conducted in similar habitats between 2010-2013).

2. METHODOLOGY

2.1 *Predictive methods*

A 1:50 000 map of the study area was provided showing existing infrastructure and the proposed two alternative energy sites or Beema bamboo plantations. This was used as far as possible in order to identify potential "hot-spots" along the proposed two Beema bamboo plantation sites, e.g. Patches of undisturbed grassland-bushveld vegetation, rivers, footslope seepage wetlands, perennial and non-perennial drainage lines as well as historic agricultural areas. Satellite imagery of the area was obtained from Google Earth was studied in order to get a three dimensional impression of the topography and land use.

2.2 *Literature Survey*

A detailed literature search was undertaken to assess the current status of threatened plants well as faunal species that have been historically known to occur in the Mandini 2931 AB quarter degree grid cell (QDGC) as well as 2905_3120 and 2910_3120 pentads for avifuana/birds (SABAP2). The literature search was undertaken utilising *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina & Rutherford 2006) for the vegetation description as well as *National Red List of Threatened Plants of South Africa* (Raimondo *et al,* 2009) as well as internet using POSA (http://posa.sanbi.org). *The Mammals of the Southern African Subregion* (Skinner & Chimimba 2005) and *The Red Data Book of the Mammals of South Africa: A Conservation Assessment* (Friedmann and Daly (editors) 2004) as well as ADU's MammalMap (http://vmus.adu.org.za/vm_sp_list.php accessed on the 3rd of September 2013) for mammals. Hockey, P.A.R., Dean, W.R.J., Ryan, P.G. (eds). 2005. *Roberts- Birds of Southern Africa VIIth ed.* And BARNES, K.N. (ed.) (2000) *The Escom Red Data Book of Birds of South Africa, Lesotho and Swaziland* for avifauna (birds) as well as internet SABAP2 (http://sabap2.adu.org.za accessed on the 3rd of October 2013).

The *Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland* (Minter *et al.* 2004) for amphibians as well as SAFAP FrogMap (http://vmus.adu.org.za) The *Field Guide to the Snakes and other Reptiles of Southern Africa* (Branch 2001) and *South African Red Data Book-Reptiles and Amphibians* (Branch 1988) as well as SARCA (http://sarca.adu.org.za accessed on the 3rd of October 2013) for reptiles.

A survey of the proposed Beema Bamboo sites site was carried out on foot. As the proposed site 1 is situated within previous and current agricultural areas (old *Eucalyptus* plantations, small scale terraced maize and vegetable crops) and current livestock (cattle and goats) grazing activities the majority of natural comprising of **Kwazulu-Natal Costal Belt (CB 3)** and **Eastern Valley Bushveld (SVs 6)** vegetation has been transformed. The proposed site 2 is situated within fallow historically terraced agricultural lands situated to the east of site 1. The proposed two Beema Bamboo sites are situated to the north-west of Mandeni adjacent to the Tugela River on relatively flat footslopes to undulating hillslopes and steep river embankments. Remnant isolated pockets of indigenous tree species occur around the sites; mainly along perennial and non-perennial drainage lines as well as within the fire-protected gorges and riparian zone of the Tugela River. The sites were visited during daylight hours (8h30-16h30) on the 25th September 2013.

It must be stressed that due to the large sizes as well as time and financial constraints no comprehensive vegetation or faunal surveys were undertaken during the brief ecological survey. Data was heavily supplemented by literature investigations; personal records, historic data and previous surveys conducted in the area. Different habitats were explored to identify any sensitive or specialised species which could possibly occur on the site. Habitats explored included the transformed and degraded Eastern Valley Bushveld on site 1; secondary succession *Aristida junciformis* grasslands (old sugarcane plantations) on the hillslopes as well as isolated pockets of Kwazulu-Natal Coastal Belt vegetation especially within the fire-protected wooded ridges and kloofs as well as the riparian zones of the perennial and non-perennial drainage lines and Tugela River. No surveys were conducted in the dense bush encroached areas within the Tugela floodplain as well as heavily infested alien vegetation thickets and existing and previous homesteads.

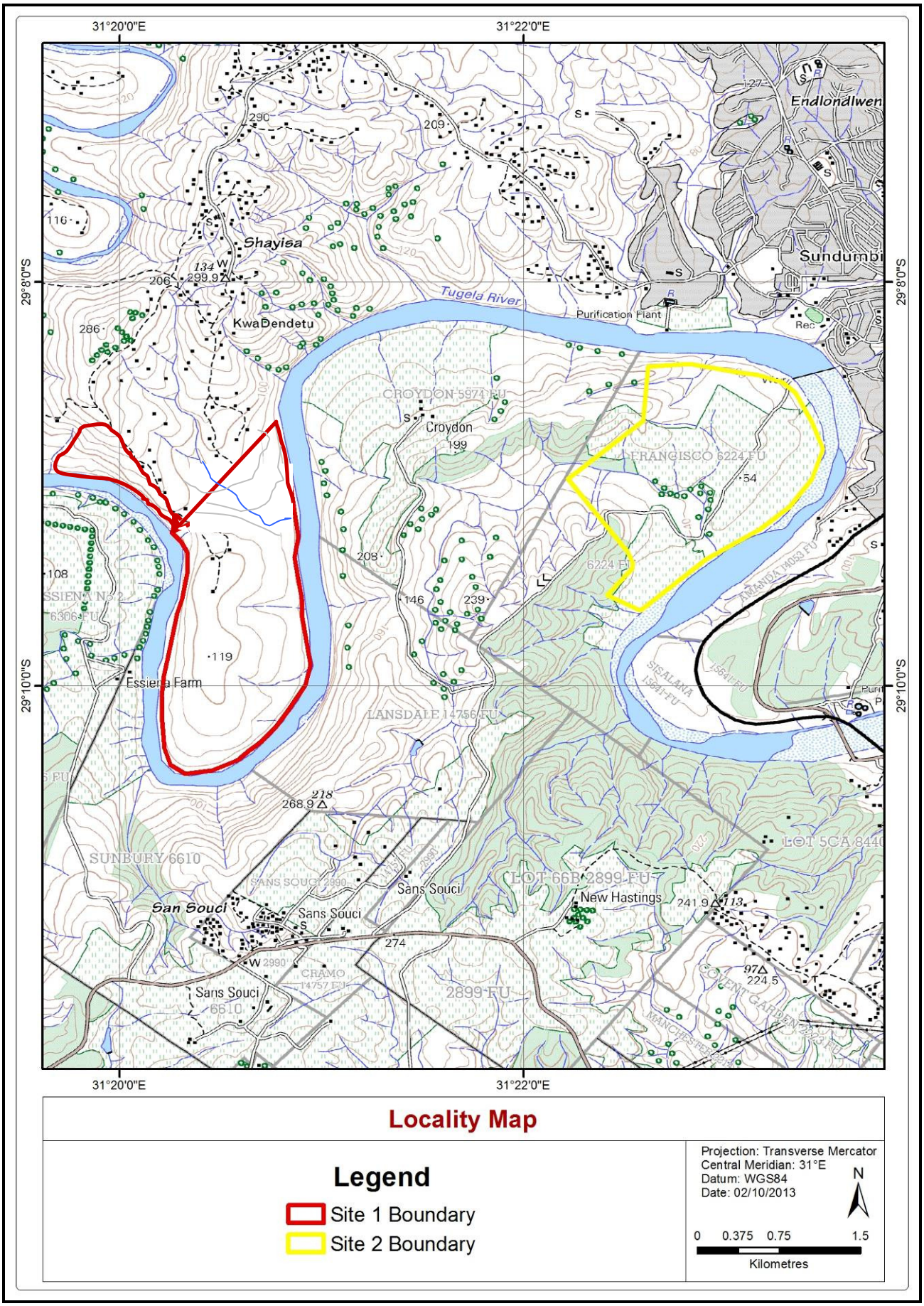

Figure1. Locality map of the proposed Beema Bamboo sites site.

3. LEGISLATIVE FRAMEWORK

The following legislation may have direct or indirect bearing on biodiversity in terms of this development application.

- South African Constitution (No. 108 of 1996), including the Bill of Rights (Chapter 2, Section 24);
- Conservation of Agricultural Resources Act (No. 43 of 1983);
- National Water Act (No. 36 of 1998);
- National Forests Act (No. 84 of 1998);
- Environment Conservation Act (No. 73 of 1976);
- National Environmental Management Act (No. 107 of 1998);
- National Environmental Management: Protected Areas Act (No. 57 of 2003);
- National Environmental Management: Biodiversity Act (No. 10 of 2004); and
- Natal Nature Conservation Ordinance (No. 15 of 1974).

The White Paper on the 'Conservation and Sustainable Use of South Africa's Biological Diversity' was published as South Africa's national policy on biodiversity in 1997. The National Biodiversity Strategy and Action Plan (NBSAP) was prepared by the Department of Environmental Affairs and Tourism (DEAT) in 2005 in order to establish a framework for the conservation and sustainable use of South Africa's biodiversity.

3.1 NATIONAL WATER ACT (ACT 36 OF 1998)

Purpose of the Act

The purpose of this Act is to ensure that the nation's water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors -

(a) meeting the basic human needs of present and future generations;
(b) promoting equitable access to water;
(c) redressing the results of past racial and gender discrimination;
(d) promoting the efficient, sustainable and beneficial use of water in the public interest;
(e) facilitating social and economic development;
(f) providing for growing demand for water use;
(g) protecting aquatic and associated ecosystems and their biological diversity;
(h) reducing and preventing pollution and degradation of water resources;
(i) meeting international obligations;
(j) promoting dam safety;
(k) managing floods and droughts,

and for achieving this purpose, to establish suitable institutions and to ensure that they have appropriate community, racial and gender representation.

The following definitions according to the National Water Act (Act 36 Of 1998) have been used to inform the identification and delineation of the wetlands and riparian areas:

3.2 Wetland

A wetland is land which is transitional between terrestrial and aquatic systems where the water table is at or near the surface, or the land is periodically covered with shallow water, and which in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

3.3 Watercourse means -

(a) a **river** or **spring**;

(b) a **natural channel** in which water flows regularly or intermittently;

(c) a **wetland**, **lake** or **dam** into which, or from which, water flows; and

(d) any **collection** of **water** which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks;

3.4 Riparian Habitat

Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

3.5 The difference between wetlands and riparian areas

Many riparian areas display wetland indicators and should be classified as wetlands. However, other riparian areas are not saturated long enough or often enough to develop wetland characteristics, but also perform a number of important functions, which need to be safeguarded. In these areas alluvial deposits can predominate and/or the water table is too deep for most of the year to produce hydromorphic features in the top 50cm of the soil profile. These conditions do not support vegetation typically adapted to life in saturated soil and it is therefore important to delineate these riparian areas in addition to wetlands. An extensive flood plain or flood bench occurs adjacent to the Tugela River.

Riparian areas commonly reflect the high-energy conditions associated with the water flowing in a water channel, whereas wetlands generally display more diffuse flow and are lower energy environments.

Riparian area indicators

Like wetlands, riparian areas have their own unique set of indicators. It is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators, and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands. If a wetland has been drained, the soil wetness indicators may still be present, but terrestrial plants will replace the hydrophilic plants.

In the case of a riparian area, look for the active channel or the lowest part of the river course. Most likely cues like water with associated emergent vegetation, sedges and reeds or alluvial soil and bedrock will be visible. From this point some topographic units like sandbars, active channel bank, flood benches and macro channel bank with associated riparian vegetation will be identifiable. Proceed upwards towards the macro channel bank, taking note of alluvial soil, topographic units and vegetation indicators. The outer boundary will be the point on the edge of the macro channel bank where there is a distinct difference between the riparian and terrestrial vegetation. In some cases where riparian vegetation is unrecognisable, because of land-use activities, indicators like alluvial material and topographical units can still be used to visualize the edge of a riparian area. If you are adjacent to a watercourse, it is also important to check for the presence of riparian indicators.

Although a specific method for delineating riparian areas has not been defined in the DWAF's **"*A practical field procedure for the identification and delineation of wetlands and riparian areas*"** (2005) manual, the general approach and principles outlined for wetlands can be used, with substitution of riparian indicators for wetland indicators. In order to adequately protect the delineated riparian areas from adjacent land uses, it will also be necessary to include an appropriate buffer zone.

A 32m buffer zone has been demarcated from the outer edge of the riparian zone of the Tugela River and floodplain, the Nembe River and non-perennial drainage lines as well as any palustrine wetlands including seasonally inundated seepage wetlands and seasonally inundated pans or depressions (see Sensitivity Map).

4. THE DELINEATION PROCESS REQUIRES THAT THE FOLLOWING BE TAKEN INTO ACCOUNT:

- topography associated with the watercourses;
- vegetation; and
- alluvial soils and deposited material.

4.1 Topography associated with the watercourse

A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. Flood benches may exist between the active channel and the macro channel bank, and are often covered by alluvial deposits and may have riparian vegetation on them. The macro channel bank often represents a dramatic change in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition. The Tugela River contains a broad active stream channel with several sand bank deposits. A flood bench or floodplain occurs adjacent to the active channel of the Tugela River and has been historically utilised for small-scale agricultural activities as well as a previous homestead on Beema Bamboo site 2. Recent sand deposits occur adjacent to the active channel. The macro channel bank displays hydric indicators as well as hydrophilic vegetation including several large riparian species such as *Ficus sycomorus, Syzigium cordatum, Combretum erythrophyllum, Spirostachys africana*.

4.2 Vegetation

Unlike the delineation of wetland areas, where hydromorphic soils are the primary indicator, the delineation of riparian areas relies primarily on vegetative indicators. Using vegetation, the outer boundary of a riparian area must be adjacent to a watercourse and can be defined as the zone where a distinctive change occurs:

- in species composition relative to the adjacent terrestrial area; and
- in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

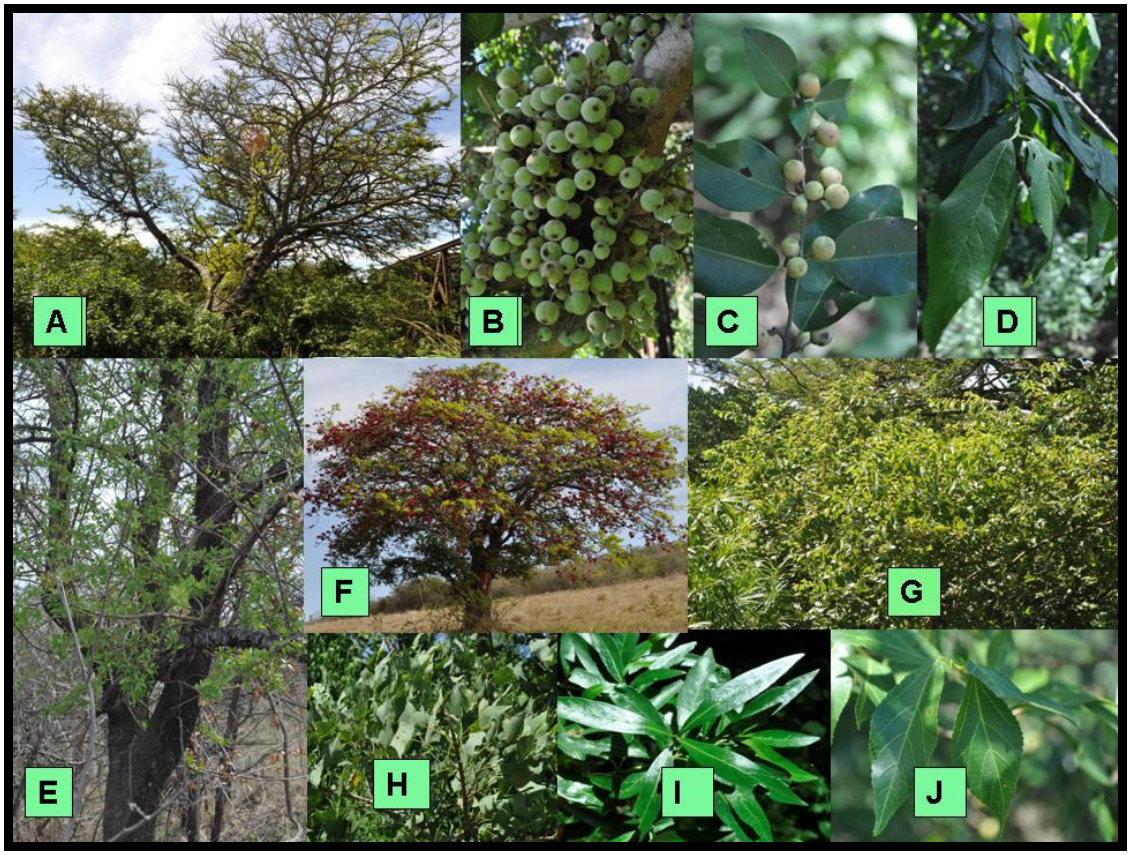

Figure2. A conglomerate of photographs displaying the dominant tree and shrub species observed within the Tugela and associated perennial (Nembe River) and non-perennial drainage lines riparian zones. A: Broad-pod Robust Thorn (*Acacia robusta* subsp. *clavigera*); **B:** Sycamore Fig (*Ficus sycomorus* subsp. *sycomorus*); **C:** Cat Thorn (*Scutia myrtina*); **D:** Brides-bush *Tarrena pavettoides* subsp. *pavettoides;* **E:** Zulu Cabbage-tree (*Cussonia zuluensis*); **E:** Tamboti (*Spirostachys africana*); **F:** Weeping Boer-Bean (*Schotia brachypetala*); **G:** Buffalo-thorn (*Ziziphus mucronata*); **H:** Coastal Coral Tree (*Erythrina caffra*); **I:** Weeping Brides-bush (*Pavetta lanceolata*) and **J:** Cross-berry Raisin (*Grewia occidentalis* var. *occidentalis*)

These differences between riparian and terrestrial vegetation are primarily a result of more water being available to species growing adjacent to watercourses than to those growing further away. It is therefore not necessary to identify species in order to delineate the riparian boundary. All that is needed is to compare relative changes in species composition and growth forms. Where an area has been transformed, or in the absence of natural vegetation, alluvial soils and deposited material will serve as the primary indicators. If a wetland has been drained, the soil wetness indicators may still be present, but terrestrial plants will replace the hydrophilic plants.

4.3 Alluvial soils and deposited material

Alluvial soils can be defined as relatively recent deposits of sand, mud, etc set down by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Deposited material can also be used to delineate the areas where bank stabilisation, provided by the roots of riparian vegetation, is most important. This material may be deposited adjacent to the macro-channel bank during flooding, and can include vegetation debris as well as soil deposits. Evidence of deposited organic material (reeds, branches etc) as well as extensive soil (sand) deposits were observed within the flood bench adjacent to the active channel bank. The increased levels of siltation and sedimentation are from poor soil conservation and vegetation management (over-grazing of livestock) within the adjacent hillslopes due to historic and current sugar-cane plantations as well as subsistence agricultural practices.

4.4 Hydric Soils

Where the iron content of the soil is low, mottles may be scarce throughout the three wetness zones. Nevertheless, the general trend of an increase and then a decrease in mottle abundance, as one move from the temporary zone into the seasonal and then the permanent zone remains true. In riparian areas that are covered in very sandy soil or coarse sediment, organic material and iron oxides are often leached out, giving the soil a white bleached look. In cases such as this, it is not possible to use normal soil wetness indicators for delineation. Reliance should instead be placed on other indicators. Limited hydric indicators were observed in the active channel bank as well as seasonally inundated depressions within the flood bench. Large amount of recently deposited sand occurs within the flood bench due to poor soil conservation within the adjacent sugar-cane plantations.

5. STUDY AREA

The proposed two plantation sites are situated approximately 85km north of Durban within the Kwadukuza (Site 1) and Mandeni (Site 2) Local Municipalities which is located within the Ilembe District Municipality. The proposed sites are situated to the north-west of Mandeni adjacent to the Tugela River. As the proposed site 1 is situated within previous agricultural areas (old *Eucalyptus* plantations, sugar cane plantations. Maize and vegetable crops) and current livestock (cattle and goats) grazing activities the majority of natural comprising of **Kwazulu-Natal Costal Belt (CB 3)** and **Eastern Valley Bushveld (SVs 6)** vegetation has been transformed. The proposed site 2 is situated within fallow historically terraced agricultural lands to the east of site 1. Severe degradation of the remaining vegetation due to surrounding anthropogenic activities including wood harvesting, collection of medicinal plants as well as extensive overgrazing by cattle and goats. Extensive bush encroachment by *Acacia nilotica* subsp. *kraussiana, Acacia tortilis* subsp. *heteracantha* and *Dichrostachys cinerea* within old agricultural lands as well as adjacent to the lower lying areas within the flood bench of the Tugela River on Beema Bamboo site 1 and the non-perennial drainage lines.

Existing impacts occurring within the proposed Beema Bamboo sites and surrounding area include:

- Extensive vegetation transformation around the homesteads, livestock enclosures, grazing pastures and previous agricultural lands.
- Extensive vegetation degradation due to overgrazing by cattle and goats with the grasses grazed to the ground.
- Extensive soil erosion (surface, rill and gully) especially along the non-perennial drainage lines as well as macro-channel banks of the Tugela River. This is due to poor stormwater management as well as uncontrolled livestock drinking activities along the non-perennial drainage lines as well as removal of the riparian vegetation during wood harvesting activities.
- Head cut erosion within the seasonally inundated seepage wetland on site 1 due to uncontrolled livestock grazing and drinking activities.
- Alteration of then natural fire regime. Frequent fires at the incorrect time of year.
- Wood harvesting and tree clear-felling occurs within both sites.
- Thicket formation and severe bush encroachment occurs in the old agricultural lands as well as livestock enclosures as in the lower lying areas of the site by *Acacia spp.* and *Dichrostachys cinera*
- Numerous human and livestock pathways bisecting the site
- Illegal poaching and hunting (dogs, catapults and snares).
- Riparian zone degradation due to removal of majority of tree species for

wood harvesting especially along the perennial and non-perennial drainage lines.

- Reed invasion in certain sections of the Tugela River due to increased phosphates levels due to washing activities as well as siltation and sedimentation due to poor vegetation and soil conservation around the site.
- Bank erosion from vegetation removal for planting of vegetable crops within the flood bench of the Tugela, overgrazing and trampling from cattle.
- Massive siltation and sedimentation accumulates in the perennial and non-perennial drainage lines as well as within the flood bench of the Tugela River mainly through poor soil conservation within the catchment.
- Extensive dumping and littering especially adjacent to existing homesteads.
- Deterioration in water quality due to presence of pit-latrines as well as washing and bathing activities within the Tugela River as well as fertilisers and pesticides from adjacent agricultural lands.
- Alteration of the natural hydrological patterns of the Tugela with artificially created concrete weirs as well as several pumping stations for irrigation of sugar-cane plantations.

Topography and catchment

The proposed Beema Bamboo sites are situated within an undulating environment. The major land features on the site include the lower-lying Tugela River and extremely steep wooded gorges adjacent to site 2. The highest areas on site 1 are situated on the upper hillslopes on the northern boundary and the lowest along the south-eastern boundary adjacent to the Tugela River. The highest lying areas of site 2 are on the upper hillslopes on the north-western boundary and the lowest on the south-eastern boundary. The Tugela River falls within **the Mvoti to Umzimkulu Water Management Area** (WMA) and site 1 including the Nembe River falls within the **V50 C Quaternary Catchment** and site 2 falls within the **V50 D Quaternary Catchment**.

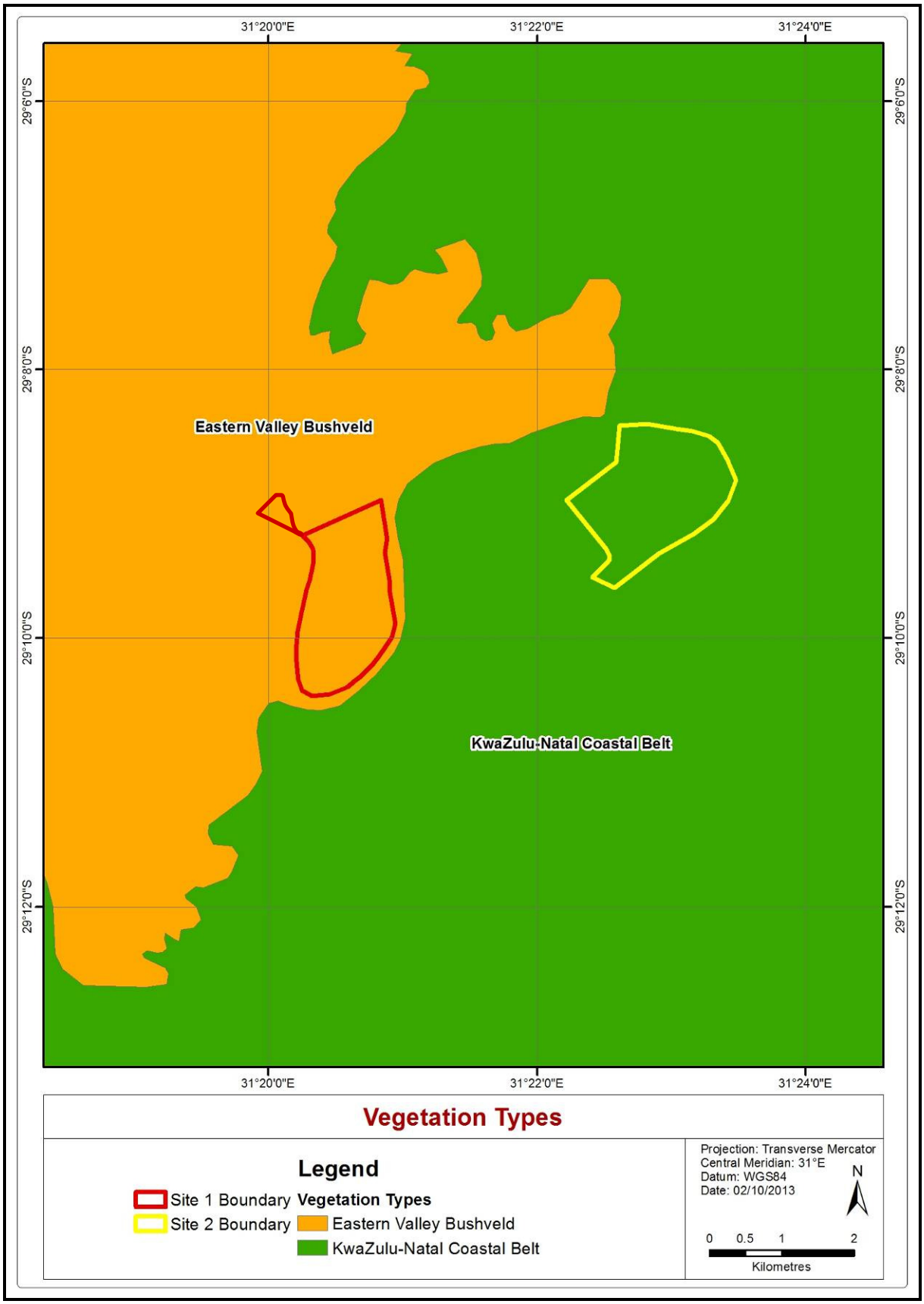

Figure3. Vegetation map of the proposed Beema Bamboo sites situated within the **Kwazulu-Natal Coastal Belt (CB 3) and Eastern Valley Bushveld (SVs 6)** vegetation units (Mucina & Rutherford 2006).

6.1 BEEMA BAMBOO SITE 1

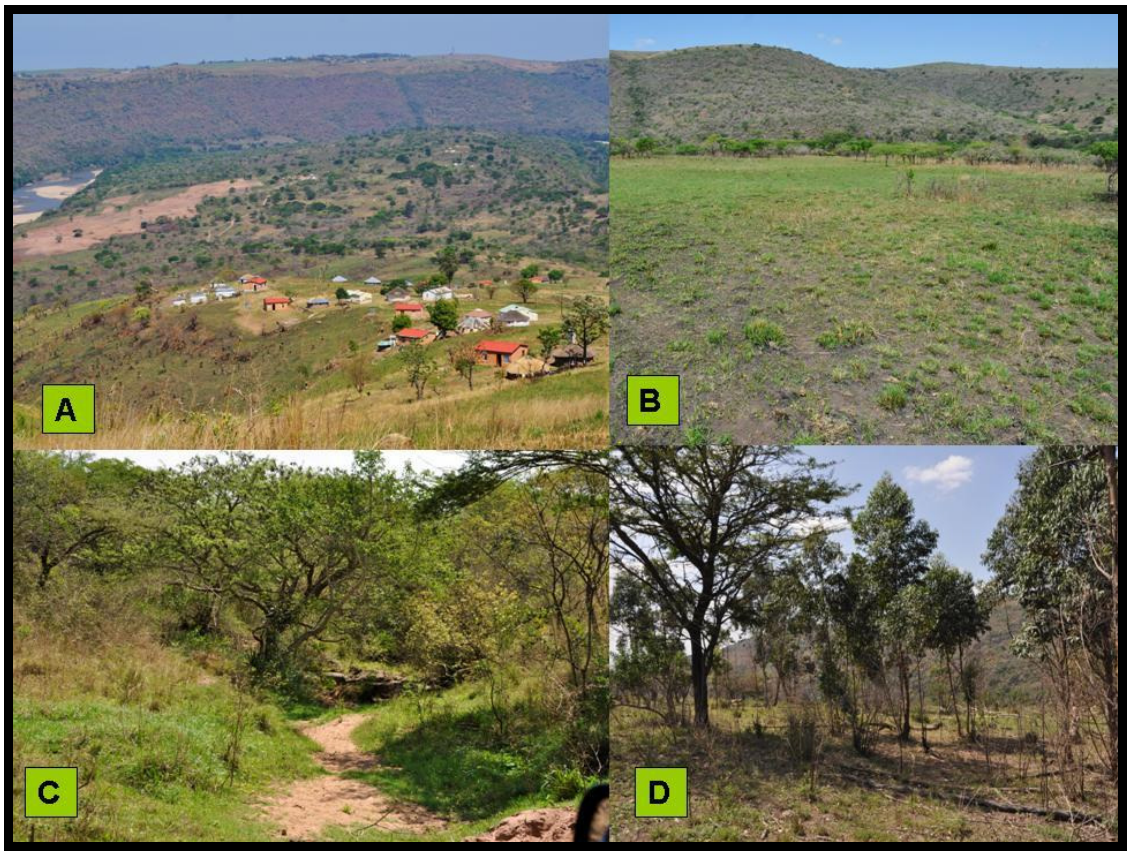

Figure4. A conglomerate of photographs displaying the dominant vegetation units observed on and around the proposed Beema Bamboo site 1. A: The proposed Beema Bamboo site 1 is situated within the footslopes immediately to the west of the Tugela River within a rural-agricultural environme**nt. B:** The majority of the proposed Beema Bamboo site is situated within historical transformed agricultural areas dominated by cleared and overgrazed secondary succession grasslands. **C:** A few scattered pockets of indigenous tree species (mixed bushveld) occur within isolated patches within the central portions of the site; especially along Nembe River and adjacent non-perennial degraded drainage lines which flow into the Tugela River. The tree density increases within closer proximity of the Tugela River and floodplain. Bush encroachment occurs in certain areas of the site. **D:** An old Eucalyptus plantation/woodlot occurs on the southern portion of the site. Several coppicing stumps were observed and utilised for a woodlot.

The proposed Beema Bamboo site 1 is situated within transformed and degraded **Eastern Valley Bushveld (SVs 6)** (Mucina & Rutherford 2006)**.** Acocks (1988) called this vegetation type **Valley Bushveld** whereas Low & Rebelo (1996) called it **Valley Thicket**.

Distribution

It occurs in KwaZulu-Natal and Eastern Cape Provinces, in deeply incised valleys of rivers including the lower reaches of the Thukela, Mvoti, Mgeni, Mlazi, Mkhomazi, Mzimkulu, Mzimkulwana, Mtamvuna, Mtentu, Msikaba, Mzimvubu (and its several tributaries), Mthatha, Mbhashe, Shixini, Qhorha and Great Kei.

Vegetation and Landscape Features

Eastern Valley Bushveld is described by Mucina & Rutherford (2006) as being semi-deciduous savanna woodlands with pockets of thickets in a mosaic pattern, often succulent and dominated by *Euphorbia* and *Aloes*. Most of the river valleys run along a northwest-southeast axis which results in unequal distribution of rainfall on respective north-facing and south-facing slopes since the rain bearing winds blow from the south. The steep north-facing slopes are sheltered from the rain and also receive greater amounts of insolation adding to xerophilous*. The Endemic taxa include the tall shrub *Bauhinia natalensis* and the succulent herb *Huernia pendula* (Mucina and Rutherford 2006).

As the proposed site are situated around rural homesteads and agricultural areas the majority of natural vegetation consisting of Eastern Valley Bushveld (SVs6) has been transformed due to existing rural houses, livestock kraals and small scale agricultural lands on the mid and lower hillslopes. Severe degradation of the remaining vegetation due to surrounding anthropogenic activities including wood harvesting, collection of medicinal plants as well as extensive overgrazing by cattle and goats. Extensive bush encroachment by *Acacia nilotica* subsp. *kraussiana, Acacia tortilis* subsp. *heteracantha* and *Dichrostachys cinerea* within old agricultural lands as well as adjacent to the lower lying areas within the flood bench of the Tugela River and the non-perennial drainage lines. Remnant patches of indigenous riparian vegetation remains along the Tugela River, the Nembe River as well as non-perennial drainage lines. Large areas of the riparian vegetation have been cleared during previous wood harvesting activities. Medium-Low alien vegetation infestations were observed within the riparian zone of the Tugela River as well as scattered throughout the site especially around existing homesteads.

* thriving in or adapted for a hot dry habitat

Vegetation Type	Eastern Valley Bushveld (SVs 6)	**Tree cover**	0-30%
Soil	Gravely-Sandy-Clayey Loams	**Shrub cover**	0-10 %
Topography	Undulating Hillslopes	**Herb cover**	0-50%
Land use	Rural-agricultural homesteads	**Grass cover**	0-80 %
Dominant Tree Species	*Acacia robusta, Sclerocarya birrea subsp. caffra*[δ], *Acacia natalitia, Acacia nilotica, Combretum molle,Spirostachys africana, Cussonia spicata, Dombeya rotundifolia, Strychnos madagascariensis, Schotia brachypetala, Syzigium cordatum, Ziziphus mucronata, Aloe marolthii* subsp. *marlothii*		
Dominant Shrubs	*Dichrostachys cinerea, Elephantorrhiza elephantina, Ehretia rigida subsp. rigida, Euclea crispa subsp. crispa, Grewia occidentalis, Olea eoropea subsp. africana, Euphorbia grandicornis*		
Dominant Gramminoids (Grasses)	*Aristida congesta, Hyparrhenia hirta, Hyparrhenia fillipendula, Panicum maximum, Melinis repens, Eragrostis curvula, Cynodon dactylon, Panicum maximum, Heteropogon contortus, Sporobolus fimbriatus, Tristachya leucothrix, Urochloa mosambicensis*		
Dominant Herbs	*Aloe maculata, Hypoxis argentea, Tagetes minuta, Cirsium vulgare*, Cyanotis speciosa, Thunbergia dregeana, Verbena aristigera*, Pentasia angustifolia, Scadoxus puniceus, Crinum cf. macowanii*[α], *Brunsvigia radulosa, Bekeyha speciosa, Berkheya setifera, Sanseveria hyacinthoides, Hibiscus sp.*		

[δ] Protected Tree Species
[α] Red Listed "Declining" Raimondo *et al.*1997

Alien Invasive Vegetation	*Melia azedarach*, Caesalpinia decapetala*, Chromolaena odorata*, Tithonia diversifolia*, Mimosa pigra*, Tecoma stans*, Eucalyptus grandis*, Opuntia-ficus indica, Lantana camara*, Solanum mauritianum*, Rubus cuneifolius*, Parthenium hyserophorus, Datura strumonium*, Solanum sisymbrifolium, Psidium guajava*,*

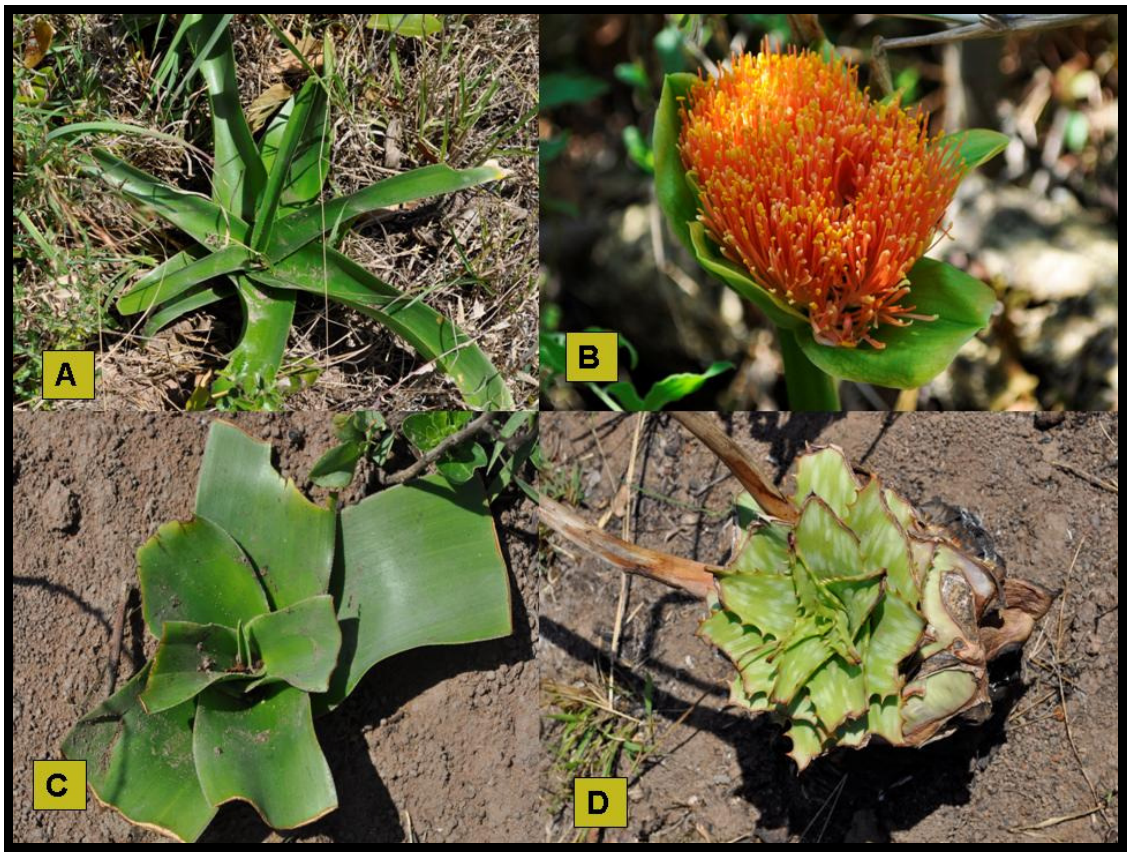

Figure5. A collage of photographs displaying dominant plant species observed on the site A: River Lily (C*rinum cf. macowanii*); **B:** Blood-Lily (*Scadoxus puniceus*), **C:** Candelabra Flower (*Brunsvigia radulosa*) and **D:** Common Soap Aloe (*Aloe maculata*).

Figure6. The geology of the site is dominated by Ordovician Natal Group sandstone. The depth of the soils varied throughout the site. Relatively deep soils (1.2 m) occur within certain areas whilst other areas are situated on a very shallow soil layer (< 50cm). The sandstone layer is evident within eroded areas as well as regularly scraped access roads.

Geology and Soils

The area is underlain by the sediments of the Karoo Supergroup with the mudstones and lesser sandstones of the Adelaide and Tarkastad Subgroups (Beaufort Group) dominant and some Ecca Group Shale. Dominant land type Fa (Mucina and Rutherford 2006). The site is underlain by colluvial and residual soils that overlie weathered bedrock of the Natal Metamorphic Province.

Figure7. Soils within the seasonally inundated seepage wetland were moist and loamy-clay to sandy in character as well as limited organic material (thought to be 'washed-in' from surrounding lands). Evidence of clear red-orange iron concretions (mottling) as well as pore linings (oxidized rhizospheres) within the soil profile, increasing with depth. These are redoximorphic features indicative of hydric soils of seasonal wetness and temporary inundation/ wetness

Climate

Summer rainfall area but with some rain during winter. Mean Annual Precipitation (MAP) is between 550-1 000mm. Frost is infrequent.

Conservation Status

The Eastern Valley Bush currently has the conservation status of being **Least Threatened**. Of the National Conservation Target of 25% only 0.8 % is statutorily conserved in the Luchaba Wildlife Reserve and small patches within the Oribi Gorge Nature Reserve. Approximately 15% has been transformed through cultivation. *Chromolaena odorata, Lantana camara* and *Caesalpinia decapatela* are the most problematic alien invader plants threatening this vegetation type (Mucina and Rutherford 2006).

6.2 BEEMA BAMBOO SITE 2

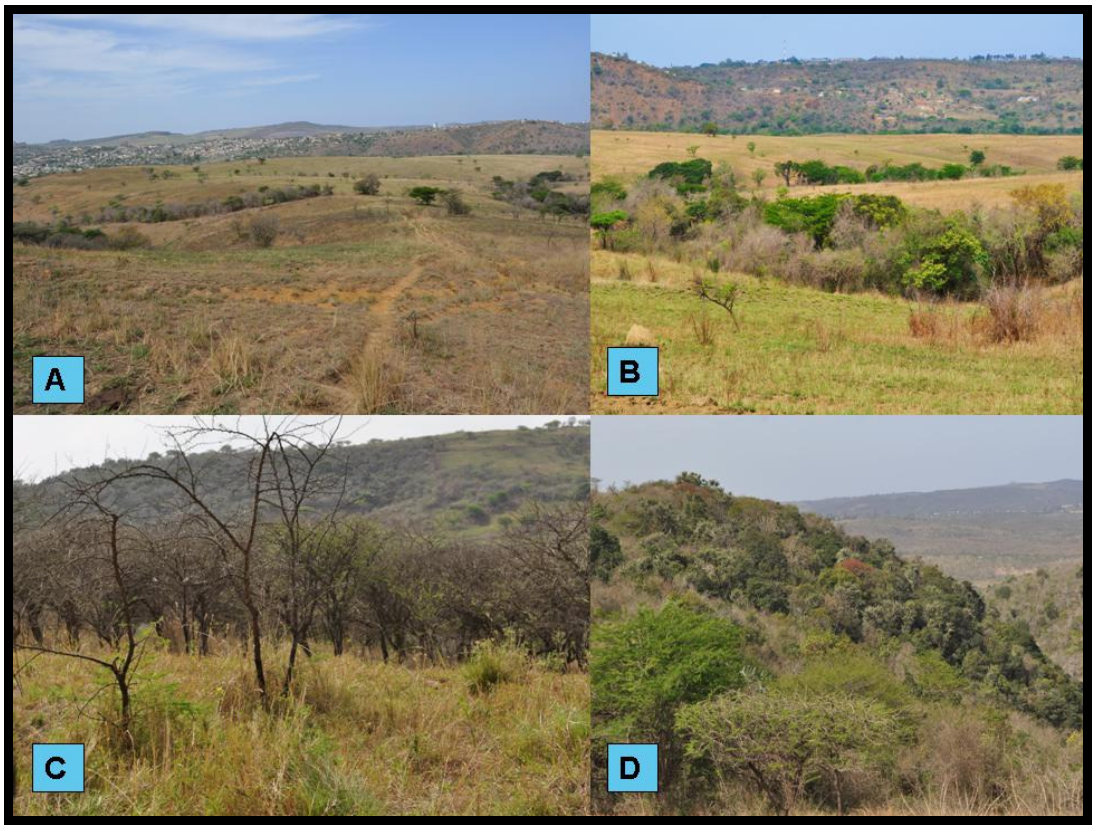

Figure8. A conglomerate of photographs displaying the dominant vegetation units observed on and around the proposed Beema Bamboo site 2. A: The proposed Beema Bamboo site 2 is situated within the footslopes and hillslopes immediately to the north-west of the Tugela River within a rural-agricultural environment. **B:** The majority of the proposed Beema Bamboo site 2 is situated within historical transformed agricultural areas dominated by cleared and overgrazed secondary succession grasslands. A few scattered pockets of indigenous tree species (mixed bushveld) occur within the perennial and non-perennial drainage lines which flow into the Tugela River. The tree density increases within proximity to the Tugela River and floodplain. **C:** Bush encroachment by *Acacia nilotica* subsp. *kraussiana, Acacia tortilis* subsp. *heteracantha* and *Dichrostachys cinerea* occurs in certain areas of the site. **D:** Situated within the fire protected ridges and kloofs usually within the south and east facing slopes as well as the riparian zones of perennial and non-perennial drainage lines is the moist closed woodland unit. Dense understory vegetation as well as abundant climbers occurs within the closed canopy. These areas have been heavily impacted on by wood harvesting activities within the accessible areas as well as alien vegetation invasion.

Vegetation and Landscape Features

Highly dissected undulating coastal plains which presumably used to be covered to a great extent with various types of subtropical coastal forests (Northern Coastal Forest). Some primary grassland dominated by Red Grass (*Themeda triandra*) still occurs in hilly, high-rainfall areas where pressure from natural fire and grazing regimes prevailed. At present the Kwazulu-Natal Coastal Belt is affected by an intricate mosaic of very extensive sugar cane fields, banana plantations, timber plantations and coastal holiday resorts, with interspersed secondary *Aristida* grasslands, thickets and pockets of coastal thornveld (Mucina *et al*. 2006). The vegetation on the site has been heavily degraded due to continual anthropogenic activities including wood harvesting, collection of medicinal plants, frequent fires, overgrazing by cattle and goats. Dense, short grassland overwhelmingly dominated by unpalatable, wiry Ngongoni Grass (*Aristida junciformis*), with this monodominance associated with low species diversity. Wooded areas (thornveld) are found in the fire-protected valleys as well as along the perennial and non-perennial drainage lines. An open and closed woodland riparian zone occurs along the Tugela River as well as scattered moist woodland pockets within the steep rocky ridges and valleys situated outside the western boundary of the site.

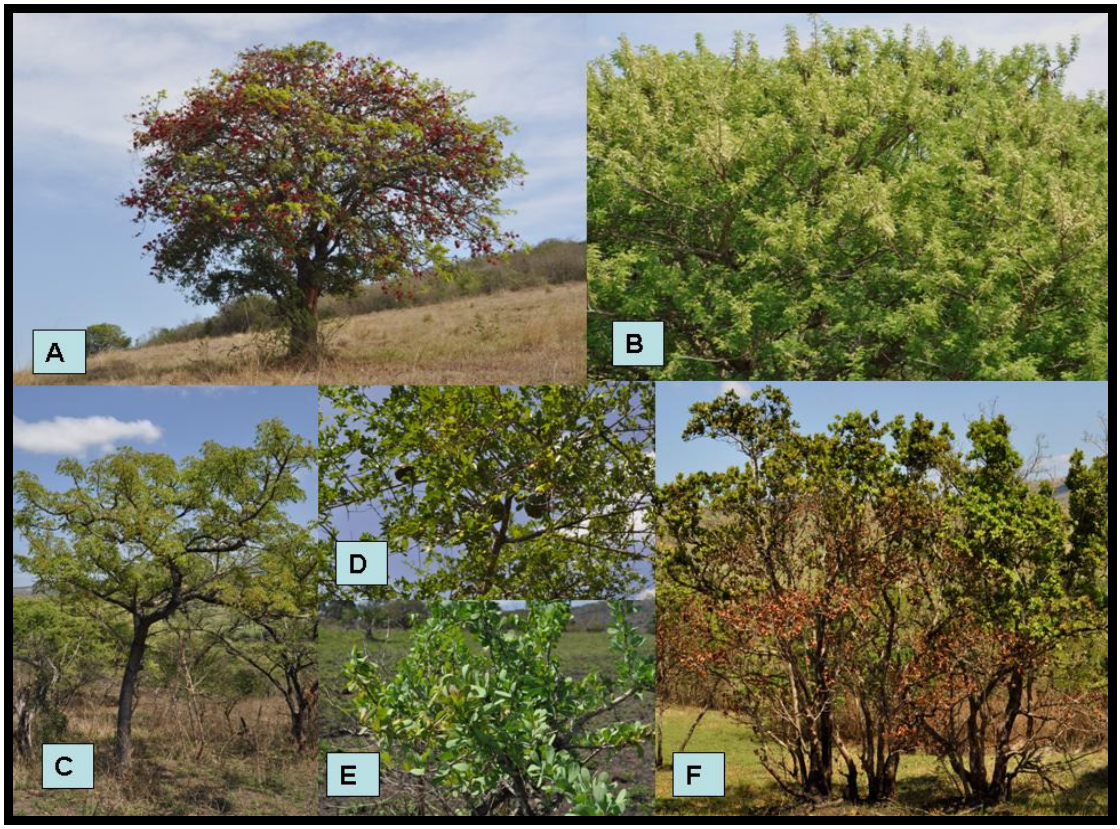

Figure9. A collage of photographs displaying dominant tree species observed. **A:** Weeping Boer-Bean (*Schotia brachypetala*); **B:** Common Hook-Thorn (*Acacia caffra*); **C:** Marula (*Sclerocarya birrea* subsp. *caffra*). **D:** Spiny Monkey Orange (*Strychnos spinosa*), **E:** Common Spikethorn (*Gymnsopsporia buxifolia*) and **F:** Umdoni or Waterberry (*Syzigium cordatum*).

A few isolated pockets of Kwazulu-Natal Coastal Belt occur within the steep non-arable areas of the site 2. These pockets have become severely degraded due to the annual burning of the secondary succession grasslands and adjacent extensive mono-cultured sugar-cane plantations. These remnant pockets or islands of coastal belt vegetation are considered to be of **medium-high** sensitivity as they provide critical habitat for remaining plant and animal species. The remaining indigenous pockets of closed woodland vegetation should be conserved and appropriately rehabilitated with the removal of alien invasive vegetation a priority.

The riparian vegetation along the Tugela River comprises of open and closed canopy consisting of several large Umdoni or Waterberry (*Syzigium cordatum*), Broad-pod Robust Thorn (*Acacia robusta* subsp. *clavigera*), Sycamore Figs (*Ficus sycomorus* subsp. *sycomorus*), Forest Natal Mahogany (*Trichilia dregeana*), Buffalo-thorn (*Ziziphus mucronata*) and Coastal Coral Tree (*Erythrina caffra*). Smaller trees and shrubs observed within the proposed bridge site included Cat Thorn (*Scutia myrtina*); Brides-bush (*Tarrena pavettoides* subsp. *pavettoidesii*); Zulu Cabbage-tree (*Cussonia zuluensis*), Weeping Brides-bush (*Pavetta lanceolata*) and Cross-berry Raisin (*Grewia occidentalis* var. *occidentalis*). The understory vegetation has been transformed and is dominated by pioneer and weedy plant and grass species such as *Setaria megaphylla, Bidens pilosa, Rivinia humilis* as well as dense stands of Parrafin Bush (*Chromolaena odorata**), Leucena (*Leucena leucophela**), Lantana (*Lantana camara**), Bugweed (*Solanum mauritianum**), Red Sesbania (Sesbania punicea*), Castor-Oil Plant (*Ricinus communis**). Extensive macrophyte or *Phragmites mauritianus* reed beds were observed due increased nutrients as well as extensive siltation and sedimentation.

No agricultural activities are proposed adjacent to the Tugela River and associated perennial (Nembe River) and non-perennial drainage lines as well as the proposed 32 m buffer zone from the outer edge of the macrochannel banks or riparian zone. The historic and current agricultural activities observed on Site 1 and Site 2 are situated within the proposed 32 m buffer zone. Future subsistence agricultural activities as well as the extensive Beema Bamboo plantations must be located outside the 32 m buffer zone. The 32m buffer zone should be appropriately rehabilitated and re-vegetated with indigenous plant and tree species and used to monitor the potential invasiveness of the newly introduced Beema Bamboo plantations. Any bamboo invading the 32m buffer zone must be removed and prevented from invading the adjacent riparian zones of mainly the perennial drainage lines as well as Tugela River.

Vegetation Type	Kwazulu-Natal Coastal Belt (CB 3)	**Tree cover**	0-20%
Soil	Gravely-Sandy-Clayey Loams	**Shrub cover**	0-10 %
Topography	Undulating Hillslopes	**Herb cover**	0-80%
Land use	Rural-agricultural homesteads	**Grass cover**	80-90 %
Dominant Tree Species	*Acacia robusta, Sclerocarya birrea subsp. caffra*[δ]*, Acacia natalitia, Acacia nilotica, Combretum molle, Spirostachys africana, Cussonia spicata, Dombeya rotundifolia, Strychnos madagascariensis, Schotia brachypetala, Ziziphus mucronata, Aloe marolthii* subsp*. marlothii, Albizia adianthifolia, Cussonia spicata, Celtis africana, Ecebergia capensis, Vepris lanceolata, Protorhus longifolia, Searsia chiridensis, Dalbergia armata, Chaetachme aristata, Zanthoxylum capense, Trema orientalis, Harpephylum caffrum, Nuxia floribunda, Halleria lucida, Ficus sur, Ficus sycomorus, Ficus natalensis, Bridelia micrantha, Aganthisanthernum bojeri, Gnidia anthylloides, Syzigium cordatum, Trichilia emetica,*		
Dominant Shrubs	*Dichrostachys cinerea, Elephantorrhiza elephantina, Croton sylvaticus, Ehretia rigida subsp. rigida, Euclea crispa subsp. crispa, Grewia occidentalis, Olea eoropea subsp. africana, Euphorbia grandicornis*		
Dominant Gramminoids (Grasses)	*Aristida junciformis, Aristida congesta, Hyparrhenia hirta, Hyparrhenia fillipendula, Panicum maximum, Melinis repens, Eragrostis curvula, Cynodon dactylon, Panicum maximum,*		

[δ] Protected Tree Species

	Heteropogon contortus, Sporobolus fimbriatus, Tristachya leucothrix, Urochloa mosambicensis
Dominant Herbs	*Aloe maculata, Hypoxis argentea, Tagetes minuta, Cirsium vulgare*, Cyanotis speciosa, Thunbergia dregeana, Verbena aristigera*, Pentasia angustifolia, Scadoxus puniceus, Brunsvigia natalensis, Bekeyha speciosa, Berkheya setifera, Sanseveria hyacinthoides, Hibiscus sp.*
Alien Invasive Vegetation	*Melia azedarach*, Caesalpinia decapetala*, Chromolaena odorata*, Tithonia diversifolia*, Mimosa pigra*, Tecoma stans*, Eucalyptus grandis*, Opuntia-ficus indica, Lantana camara*, Solanum mauritianum*, Rubus cuneifolius*, Parthenium hyserophorus, Datura strumonium*, Solanum sisymbrifolium, Psidium guajava*, Ageratum conyzoides*, Ipomoea alba*, Ipomoea indica*, Ipomoea purpurea*, Ricinus communis*, Senna didymobotrya*, Schinus terebinthifolius *,*

Geology and Soils

Ordovician Natal Group sandstone, Dwyka tillite, Ecca shale and Mapumulo gneiss dominate the landscapes of the Kwazulu-Natal Coastal Belt. Weathering of the old dunes has produced the red sand, called the Berea Red Sand in places. The soils supported by the above-mentioned rocks are shallow over hard sandstones and deeper over younger, softer rocks. The soils of the majority of the site are light to dark brown sandy to sandy clay-loams. Hydric soil indicators where observed within the Tugela River and adjacent flood bench or floodplain. Large sections of the flood bench had recent deposits of fine sands from poor soil conservation within the adjacent poorly vegetated hillslopes (sugar-cane) plantations as well as the in-cut development platforms and informal access road within the Mandini township. Hydric soils of temporary inundation were observed within the macro-channel banks of the perennial drainage line.

Figure10. A collage of photographs displaying soil auger samples. The majority of the site comprises well drained brown sandy to sandy clay-loams. No hydric indicators were observed within the majority of soils augers taken from the hillslopes and footslopes. Hydric indicators were observed adjacent to the perennial and non-perennial drainage lines as well as within the flood bench of the Tugela River.

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Climate

Summer rainfall area but with some rain during winter. High air humidity and with no incidence of frost. Mean Annual Precipitation (MAP) is 989 mm.

Conservation

Kwazulu-Natal Coastal Belt (CB 3) is an **Endangered** vegetation unit with only a small part statutorily conserve in Ngoye, Mbumazi and Vernon Crookes Nature Reserves. About 50% is transformed for cultivation, urban sprawl and road-building. Conservation target is 25% conserved.

6.3 ALIEN INVASIVE VEGETATION

Figure11. A conglomerate of photographs displaying the dominant alien invasive vegetation observed within and immediately adjacent to the proposed Beema Bamboo sites. A: Bugweed (*Solanum mauritianum**) Category 1b Weed, **B:** Yellow Oleander (*Thevetia peruviana**) Category 1b Weed; **C:** Redstar Zinnia (*Zinnia peruviana**) Weed; **D:** Peanut Butter Cassia (*Senna didymobotrya**) Category 1b Invader; **E:** Guava (*Psidium guajava**) Category 2 Invader; **F:** Saligna Gum (*Eucalyptus grandis**) Category 1b/2 Invader; **G:** Lantana (Lantana camara*) Category 1b Weed; **H:** Castor-oil Plant (*Ricinus communis**) Category 1b Weed and **I:** Brazilian Peppercorn Tree (*Schinus terebithifolius**) Category 1b Weed.

Exotic and invasive plant species were categorised according to the framework laid out by The Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983). CARA defines weeds as alien plants, with no known useful economic purpose that should be eradicated. Invader plants, also considered by the Act, can also be of alien origin but may serve useful purposes as ornamentals, as sources of timber, or may have other benefits (Henderson, 2001). These plants need to be managed and prevented from spreading.

Alien and invasive plant species can be grouped three categories:

- Category 1 plants are weeds that serve no useful economic purpose and possess characteristics that are harmful to humans, animals or the environment. These plants need to be eradicated using the control methods stipulated in Regulation 15.D of the CARA.
- Category 2 plants are plants that are useful for commercial plant production purposes but are proven plant invaders under uncontrolled conditions outside demarcated areas.
- Category 3 plants are mainly used for ornamental purposes in demarcated areas but are proven plant invaders under uncontrolled conditions outside demarcated areas.

Alien invasive species recorded included *Agave americana* Ageratum conyzoides**, *Caesalpinia decapetala**, *Chromolaena odorata**, *Ipomoea indica**, *Ipomoea purpurea**, *Lantana camara**, *Eucalyptus grandis**, *Sesbania punicea**, *Leucaena leucocephala**, *Montanoa hibiscifolia**, *Rubus cuneifolius**, *Psidium guajava**, *Melia azedarach*, Mimosa pigra*, Ricinus communis*, Senna didymobotrya*, Solanum panduriforme*, Solanum mauritianum*, Tithonia diversifolia*[*] are present.

6.4 RED LISTED PLANT SPECIES

According to the Plants of South Africa (POSA) online check list two threatened species have been recorded from the 2931 AB QDGC. These include the Large-leaf Onionwood *Cassipourea gummiflua* var. *verticillata* which is listed as 'Vulnerable' and *Kniphofia littoralis* listed as 'Near-Threatened'**.** The Large-leaf Onionwood *Cassipourea gummiflua* var. *verticillata* occurs in evergreen forest, riverine and swamp forest as well as Moist scarp forest and coastal lowland forest. Marginally suitable habitat occurs along the riparian zone of the Tugela River and within the fire- protected forest pockets around the proposed Beema Bamboo site 2. *Kniphofia littoralis* is usually found in the seasonal and temporary wet zones of hillslope seepage wetlands and valley bottom wetlands. They seldom occur within the permanently inundated zone. No evidence of the above-mentioned species were observed during the brief field survey but marginally suitable habitat occurs within the seasonally inundated seepage wetland and pan/depression of Beema Bamboo Site1. The wooded gorges on Beema bamboo Site 2 as well as seasonal wetlands on Site 1 are excluded from the proposed Beema Bamboo plantations as well as a 32m grassland buffer zone.

[*] exotic or alien invasive vegetation

One red listed plant species was observed during the brief field survey namely several River Lilies *Crinum macowanii* within the riparian zone of the Tugela River as well as along the Nembe River and perennial drainage lines. The River Lily is classified as 'Declining'[δ] due to over-harvesting for traditional medicine. As it is a long-lived bulb and is constantly appearing in the medicinal plant markets, one can expect an overall continuing decline due to harvesting. It is still common enough not to list it as Near-Threatened (Raimondo *et al.* 2008). More intensive surveys are required in order to ascertain the current conservation status of threatened plant and tree species in these areas

One protected tree species was recorded within the remnant indigenous wooded pockets especially on Beema Bamboo Site1 (>50); namely the Marula *Sclerocarya. birrea* ssp. *caffra*. In terms of the National Forests Act 1998 (Act No 84 of 1998) certain tree species can be identified and declared as protected. The Department of Water Affairs and Forestry (now Department of Forestry and Fisheries) developed a list of protected tree species. In terms of Section 15(1) of the National Forests Act, 1998, no person may cut, disturb, damage or destroy any protected tree or possess, collect, remove, transport, export, purchase, sell, donate or in any other manner acquire or dispose of any protected tree or any forest product derived from a protected tree, except under a licence or exemption granted by the Minister to an applicant and subject to such period and conditions as may be stipulated. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization.

No rare or threatened plants were recorded within the transformed vegetation units proposed from the Beema Bamboo plantations. The proposed Beema Bamboo or renewable energy project if approved should have a **low; short-long term impact on any red listed, rare or protected plant or tree species** if activities are restricted to the currently transformed hillslopes. All remaining pockets of closed woodland, plaustrine wetlands including seasonally inundated seepage wetlands and pan/depression are deemed as sensitive habitats and should ideally be incorporated into the Bamboo plantations ("no-go" areas). All perennial rivers (Tugela and Nembe) and non-perennial drainage lines as well as the proposed 32 m buffer zones from the outer edge of the riparian zone are also considered as sensitive habitats and should be excluded from the proposed Beema Bamboo plantations. An alien invasive removal programme needs to be implemented as well as rehabilitation of the drainage lines and proposed 32 m buffer zones with indigenous (to the area) vegetation (see attached species lists).

[δ] * A taxon is 'Declining' when it does not meet any of the five IUCN criteria and does not qualify for the categories Critically Endangered, Endangered, Vulnerable or Near Threatened, but there are threatening processes causing a continuing decline in the population.

7. PRELIMINARY FAUNAL SURVEY

The preliminary faunal survey focused mainly on mammals, birds, reptiles and amphibians of the study area. The survey focused on the current status of threatened animal species occurring, or likely to occur within the study area, describing the available and sensitive habitats, identifying potential impacts resulting from the two Beema Bamboo sites and providing mitigation measures for the identified impacts. Faunal data was obtained during a single site visit of the proposed development site carried out on foot on the 25th of September 2013. All animals (mammals (larger), birds, reptiles and amphibians) seen or heard; were recorded. Use was also made of indirect evidence such as nests, feathers and animal tracks (footprints, droppings) to identify animals. Previous surveys, literature investigations; personal records and historic data supplemented the initial survey. The literature search was undertaken utilising *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina & Rutherford 2006) for the vegetation description. *The Mammals of the Southern African Subregion* (Skinner & Chimimba 2005) and *The Red Data Book of the Mammals of South Africa: A Conservation Assessment* (Friedmann and Daly (editors) 2004) for mammals. *Roberts-Birds of Southern Africa VIIth ed.* (Hockey, Dean and Ryan (editors); 2005) and *The Escom Red Data Book of Birds of South Africa* (Barnes,2000) for avifauna (birds). A Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers 2009) and the *The Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland* (Minter et al. 2004) for amphibians. *The Field Guide to the Snakes and other Reptiles of Southern Africa* (Branch 2001) and

7.1 AMPHIBIANS

Amphibians are an important component of South Africa's exceptional biodiversity (Siegfried 1989) and are such worthy of both research and conservation effort. This is made additionally relevant by international concern over globally declining amphibian populations, a phenomenon currently undergoing intensive investigation but as yet is poorly understood (Wyman 1990; Wake 1991). Amphibians have declined dramatically in many areas of the world. These declines seem to have worsened over the past 25 years and amphibians are now more threatened than either mammals or birds, though comparisons with other taxa are confounded by a shortage of reliable data.

Most frogs have a biphasic life cycle, where eggs laid in water develop into tadpoles and these live in the water until they metamorphose into juvenile fogs living on the land. This fact, coupled with being covered by a semi-permeable skin makes frogs particularly vulnerable to pollutants and other environmental stresses. Consequently frogs are useful environmental bio-monitors (bio-indicators) and may acts as an early warning system for the quality of the environment.

Breeding in African frogs is strongly dependent on rain, especially in the drier parts of the country where surface water only remains for a short duration. The majority of frog species in the Kwazulu-Natal Province can be classified as explosive breeders. Explosive breeding frogs utilise ephemeral pans or inundated grasslands for their short duration reproductive cycles.

As the survey was undertaken for only 1 day during daylight hours during the early spring period, only a small proportion of species are present. Ideally, a herpetological survey should be undertaken throughout the duration of the wet season (November-Mach) including several nocturnal surveys. It is only during this period that accurate frog species lists can be compiled. During this survey; fieldwork was augmented with species lists compiled from personal records; data from the South African Frog Atlas Project (SAFAP)(1999-2003) and published data, and the list provided below is therefore regarded as likely to be fairly comprehensive. A frog species list recorded from the 231 AB QDGC is presented ion the Appendix (See Table).

The most favourable breeding habitat occurs within the Tugela River and seasonally inundated flood-benches as well as perennial and non-perennial drainage lines. The seasonally inundated footslope seepage wetland on the southern portion of site 1 and the seasonally inundated pan/depression on the northern portions of the site offer the most suitable breeding habitats for remaining frog species. The small seasonal pan has been impacted on from previous clay and sand harvesting activities as well as livestock drinking, grazing and trampling activities. No surface water was present during the brief site visit. Several frog species could potentially utilize the large open sites adjacent to the Tugela River for foraging and exploratory/dispersal areas including Painted Reed Frogs (*Hyperolius marmoratus*), Natal Tree Frog (*Leptopelis natalensis*), Natal Sand Frog (*Tomopterna natalensis*), Guttural Toad (*Amietophrynus gutturalis*) and Raucous Toads (*Amietophrynus rangeri*). Terrestrial breeders which could occur within the isolated indigenous woodland pockets on the Beema Bamboo site 2 include the endemic Bush Squeaker (*Arthroleptis wahlbergi*) as well as Bushveld Rain Frog (*Breviceps adspersus*) on both sites.

Figure12. A conglomerate of photographs displaying frog species likely to occur on the Beema Bamboo sites A: Natal Sand Frog (*Tomopterna natalensis*); **B:** Bushveld Rain Frog (*Breviceps adspersus*); **C:** Painted Reed Frog (*Hyperolius marmoratus marmoratus);* **D:** Water Lily Frog (*Hyperolius pusilus*) and **E:** Natal or Forest Tree Frog (*Leptopelis natalensis*).

Table1. Frog species likely to occur around the site in suitable habitat. Actual species lists for the site will most likely contain far fewer species due to extensive habitat transformation and degradation on and surrounding the site.

Common Name	Scientific Name	Status/ Distribution	Habitat
Guttural Toad	*Amietophrynus* (*Bufo*) *gutturalis*	Common in southern Africa north of Gariep.	Permanent and semi-permanent ponds and backwaters in open grassland.
Raucous Toad	*Amietophrynus rangeri*	Common in the eastern parts of southern Africa	Permanent and semi-permanent ponds and backwaters in open grassland.
Natal Tree Frog	*Leptopelis natalensis*	Common in Kwazulu-Natal	Permanent and Seasonal ponds situated in coastal forest, sand forest or coastal bushveld and occasionally

			grassland
Greater Leaf-Folding Frog	*Afrixalus fornasinii*	Common along the coast of Kwazulu-Natal as far south as Port Edward	Stagnant water bodies containing large stands of saw grass *Cyperus immensus* and bulrushes *Typha capensis* in Coastal Bushveld-Grassland
Painted Reed Frog	*Hyperolius marmoratus marmoratus*	Common along Kwazulu-Natal Coast	Reeds and other emergent vegetation along a wide variety of waterbodies including pans and rivers
Water Lily Frog	*Hyperolius pusillus*	Common in the low-lying coastal areas (Eastern Cape and Kwazulu-Natal) but further inland in the southern parts of Limpopo it is found at higher altitudes.	Shallow pans, ponds, vleis and dams with water lilies (*Nymphaea sp.*) or at least some floating vegetation.
Tinker Reed Frog	*Hyperolius tuberilinguis*	Common in the Eastern parts of Southern Africa from Swaziland up to Port Edward	Reed beds on the periphery of rivers or dense vegetation surrounding seasonal pans
Bubbling Kassina	*Kassina senegalensis*	Common throughout Southern Africa	Grassy margins of seasonally inundated pans as well as dams
Snoring Puddle Frog	*Phrynobatrachus natalensis*	Widely distributed along the eastern sections of Southern Africa	Shallow to fairly deep water in temporary pans and pools, vleis, dams and even slow-flowing streams
Sharp-Nosed Grass Frog	*Ptychadena oxyrynchus*	Eastern Parts of South Africa	Vleis, inundated grassland and sedge pans, temporary roadside pools and rock puddles
Natal Sand Frog	*Tompoterna natalensis*	Common species in Kwazulu-Natal, Mpumalanga,	Streams, rivers or other places where water flows slowly but also in lothic or

		Gauteng.	standing water
Bronze Caco	*Cacosternum nanum*	Common species in Kwazulu-Natal	Vleis, inundated grassland and sedge pans, temporary roadside pools and rock puddles
Bushveld Rain Frog	*Breviceps verrucosus*	Widespread and Common in sandy soils within Bushveld	Terrestrial breeder with eggs laid in a chamber in sandy soils.
Bush Squeaker	*Arthroleptis wahlbergi*	Endemic to the East Coast of South Africa	Terrestrial breeder with eggs laid in moist leaf litter.

Threatened species

Figure13. The Critically Endangered Pickersgill's Reed Frog has been recorded within the 2931 AB QDGC during Southern African Frog Atlas Project (SAFAP).

Geographic Range:

This species is endemic to the coast of KwaZulu-Natal, ranging from Warner Beach in the south to St. Lucia village in the north. It is found within 20 km of the coast up to 380 m a.s.l. Although the extent of occurrence (EOO) is 2 303 km^2, the area of occupation (AOO) has been calculated to be only 9 km^2.

Population:
The spatial distribution of this species is considered to be severely fragmented as >50% of individuals are in small and isolated patches and >50% of subpopulations are considered nonviable. It is secretive and so is under-recorded, but appears to be a rare species.

Habitat and Ecology:
It is a species of coastal mosaic bushland and grassland, breeding in stagnant, usually temporary to semi-permanent water, rarely exceeding 50 cm in depth, surrounded by dense sedges. It is seldom found at the same breeding sites as the abundant *Hyperolius marmoratus*.

Major Threats:
It is confined to a small area subject to urbanisation, habitat fragmentation, afforestation, and drainage for agricultural and urban development. Some breeding sites are being polluted by DDT, which is used for controlling malarial mosquitoes. The spread of alien vegetation, in particular Eucalyptus species, is responsible for the drying out of some breeding sites.

Conservation Actions:
Obtaining accurate information on threats was given the highest priority on conservation research for this species. Determining the status of all sites and estimating population size also receive high research priorities. Research is still required to determine population sizes, life history and ecology (in particular dispersal potential), followed by appropriate monitoring of both population and habitat. In addition, land owner agreements need to be drawn up for protection and management of all sites for conservation management. This species occurs in the iSimangaliso Wetland Park, the Umlalazi Nature Reserve, and the Twinstreams-Mtunzini Natural Heritage Site.

Listed as **Critically Endangered** B2ab (ii,iii) in view of its small AOO of 9 km2, with its distribution being severely fragmented, and a continuing decline in the quality of its habitat and AOO (Measey *et al.* 2011). No suitable habitat occurs within the two Beema Bamboo sites for Pickersgill's Reed Frog. This frog species is restricted to coastal wetlands.

4.2 REPTILES

All reptile species are sensitive to major habitat alteration and fragmentation. As a result of human presence in the area as well as on the site; coupled with the extensive habitat destruction within mono-cultured sugar-cane plantations and high levels of disturbances, alterations to the original reptilian fauna are expected to have already occurred. Removal of large riparian tree species and dead trunks for firewood collection destroys numerous habitats for many arboreal reptile species. Clearing of rock material destroys vital habitat for numerous rupicolous reptile species including the Agamids, Cordylids, Geckonids and Skinks. The majority of snake species hibernate in old tree trunks, termite mounds or under suitable rocks. No major rocky outcrops or rock piles were observed within the proposed Beeema Bamboo sites for rupicolous reptile species; although low-lying mostly embedded rocky outcrops were observed within the steep embankments on the south-western boundary of the site as well as the upper hillslopes around Beema Bamboo site 2. Indiscriminate killing of snake species occur all around human settlements. The indiscriminate killing of all snake species results in the alteration of species composition, with the disappearance of the larger and the more sluggish snake species such as the Southern African Python. Reptile species recorded during the survey included a Spotted Bush Snake (*Philothamnus variegatus*), Southern Tree Agama (*Acanthocercus atricolisi*) *a* juvenile Nile Monitor (*Varanus niloticus*), Variable Skink *Trachylepis* (*Mabuya*) *varia*. A 2.8 m Nile Crocodile (*Crocodylus niloticus*) was killed within the Tugela River on site 1 on the 26th September 2013. According to the current landowner several large adult Southern African Python (*Python natalensis*) have been killed on Site 1. A probable species list is provided in Table2 below as well as a species list from the 2931 AB QDGC in the Appendix (see Table).

Figure14. A conglomerate of photographs displaying the reptile species observed during the brief field survey. A: Flap-necked Chameleon (*Chamaeleo dilepis*), **B:** Spotted Bush Snake (*Philothamnus semivariegatus*) **C:** Juvenile Water Monitor (*Varanus niloticus*) and **D:** Male Southern Tree Agama (*Acanthocercus atricolis*)

Table2: Reptile species that occur or are likely to occur in the study area due to suitable habitat, and may therefore be present. Actual species lists will most likely contain far fewer species due to the high levels of habitat transformation on and surrounding the site.

COMMON NAME	SCIENTIFIC NAME
Cape Skink	*Trachylepis* (*Mabuya*) *capensis*
Striped Skink	*Trachylepis* (*Mabuya*) *punctatissima*
*Variable Skink	*Trachylepis* (*Mabuya*) *varia*
Yellow-throated Plated Lizard	*Gerrhosaurus flavigularis*
Flap-Necked Chameleon	*Chamaeleo dilepis*
Herald or Red-lipped Snake	*Crotaphopeltis hotamboeia*
Green Mamba	*Dendroaspis angusticeps*
Common or Rhombic Night Adder	*Causus rhombeatus*
*Spotted Bush Snake	*Philothamnus senivariegatus*
Common or Rhombic Egg Eater	*Dasypeltis scabra*
Dusky-Bellied Water Snake	*Lycodonomorphus laevissimus*
Brown Water Snake	*Lycodonomorphus rufulus*
Brown House Snake	*Lamprophis fuliginosus*
Green Water Snake	*Philothamnus hoplogaster*
Common Slug-eater	*Duberria lutrix*
Bibron's Blind Snake	*Typhlops bibronii*
Cape and Eastern Thread Snake	*Leptotyphlops conjunctus*
Peters' Thread Snake	*Leptotyphlops scutifrons*

*Nile Monitor	*Varanus niloticus*
**Nile Crocodile	*Crocodylus niloticus*
**Southern African Python	*Python natalensis*

*** recorded during brief field survey**
****killed on Site 1 according to current landowner**

Threatened Species
No threatened reptile species have been recorded from the 2931AB QDGC in which the two Beema Bamboo sites are located and no suitable habitats occurs within the transformed habitats on the site or the immediate surrounding the site for any threatened reptile species.

4.3 AVIFAUNA/BIRDS

Thirty-five (35) bird species were recorded during the brief field survey (total 8 hours). Species recorded during the field survey are common, widespread and typical of a wooded coastal environment. The majority of bird species were recorded from the riparian zones of the Tugela River, perennial drainage lines as well as scattered wooded bushveld areas.

Table 4: Bird species recorded during brief field survey (8hrs).

Roberts' Number	**Common name**	**Scientific Name**
94	Hadedah Ibis	*Bostrychia hagedash*
196	Natal Spurfowl	*Pternistis natalensis*
203	Helmeted Gunieafowl	*Numida meleagris*
297	Spotted Thick-Knee	*Burhinus capensis*
352	Red-Eyed Dove	*Stretopelia semitorquata*
354	Cape Turtle Dove	*Streptopelia capicola*
355	Laughing Dove	*Streptopelia senegalensis*
391	Burchell's Coucal	*Centropus burchellii*
424	Speckled Mousebird	*Colius striatus*
435	Brown-Hooded Kingfisher	*Halycon albiventris*
455	Trumpeter Hornbill	*Bycanistes bucinator*
464	Blackcollared Barbet	*Lybius torquatus*
469	Red-fronted Tinkerbird	*Pogoniulus pusillus*
470	Yellow-Fronted Tinkerbird	*Pogoniulus chrysoconus*
541	Fork-Tailed Drongo	*Dicrurus ludwigii*

545	Black-Headed Oriole	*Oriolus larvatus*
548	Pied Crow	*Corvus albus*
568	Dark-capped (Black-eyed) Bulbul	*Pycnonotus barbatus*
570	Greenbul	*Phyllastrephus flavostriatus*
577	Olive Thrush	*Turdus olivaceus*
600	Natal Robin or Red-Capped Robin-Chat	*Cossypha natalensis*
601	Cape Robin-chat	*Cossypha caffra*
683	Tawny-flanked Prinia	*Prinia subflava*
690	Dusky Flycatcher	*Muscicapa adusta*
710	Paradise Flycatcher	*Tersiphone viridis*
736	Southern Boubou	*Laniarius ferrugineus*
750	Olive Bush-Shrike	*Telophorus olivaceus*
758	*Common Myna	*Acridothermes tristis*
796	Cape White-Eye	*Zosterops pallidus*
801	*House Sparrow	*Passer domesticus*
808	Dark-Backed Weaver	*Ploceus bicolor*
810	Spectacled Weaver	*Ploceus ocularis*
842	Red-billed Firefinch	*Lagonosticta senegala*
846	Common Waxbill	*Estrilda astrild*
857	Bronze Mannikin	*Lonchura culcullata*

Threatened species

One hundred and sixty (160) bird species have been recorded for the 2905_3120 Pentad in which site 2 is situated and one hundred and sixty five (165) from Pentad 2910_3120 in which site 1 is situated. No red listed or threatened bird species have been recorded from the area. The proposed Beema Bamboo sites offer marginally suitable habitat for certain threatened bird species such as the Half-collared Kingfisher or temporary foraging or exploratory areas for Secretarybirds, Martial Eagle and African Crowned Eagle. The high levels of anthropogenic activities on Site 1 and surrounding site 2 (Mandini) however significantly reduces the likelihood of any breeding/nesting activities of the larger raptors such as Secretarybirds. More intensive surveys are required in order to ascertain their possible presence. If any threatened bird species occur it is highly unlikely that the completely transformed areas proposed for the Beema Bamboo sites will form critical habitat for any threatened bird species.

4.4 MAMMALS

No small mammal trapping was conducted. Fieldwork was augmented with previous surveys in similar habitats as well as published data. The area was initially traversed on foot to ascertain the presence of available refuges. Suitable refuges such as burrows and old stumps were observed. The majority of mammal species likely to occur around the existing homesteads are urban exploiters such as the House Rat and House Mouse. A Slender Mongoose was observed crossing over the access road on Site 2. Evidence of Bushbuck, Common Duiker as well as African Porcupine were observed within the flood-bench of the Tugela River. The adjacent Sugar-cane plantations around Site 2 provide suitable habitat for Greater Canerats. Mammal species recorded within the study area as well as those that may occur within the study area, on the basis of available distribution records and known habitat requirement, are included in the Table 5 below.

Table4: Mammal species likely to occur on the site. Species in bold were recorded during the brief survey Identification was determined by visual observations and animal tracks (footprints and droppings).

COMMON NAME	***SCIENTIFIC NAME***
Common Molerat	***Cryptomys hottentotus***
Natal Multimammate Mouse	*Mastomys natalensis*
Greater Canerat	*Thryonomys swinderianus*
*Domestic Dog	*Canis familiaris*
*Feral Cat	*Felis catus*
Common Duiker	***Sylvicapra grimmia***
Blue Duiker	
Red Duiker	*Cephalotus natalensis*
Bushbuck	*Tragelaphus scriptus*

Vervet Monkey	***Cercopithecus aethiops pygerythrus***
Water Mongoose	***Atilax paludinosus***
Slender Mongoose	*Galarella sanguinea*
Large-spotted Genet	*Genetta tigrina*
Porcupine	***Hystrix africaeaustralis***

* introduced species

Threatened species

No sensitive or endangered mammals were recorded within the study area. This is mainly a result of intensive habitat transformation and impoverished habitats within the current and historic agricultural habitats as well as increased human disturbances such as hunting (with dogs) and poaching (wire snares). Smaller mammal species are extremely vulnerable to snares and poaching activities as well as hunting with dogs. Evidence of hunting with dogs was observed on Site 1. The moist closed wooded pockets on the steep gorges surrounding Site 2 could potentially provide important refuges for remaining mammal species due to the inaccessibility of these areas. It is highly unlikely that the two proposed Beema Bamboo sites constitutes significant habitat for any species of threatened mammal species or mammal species In general if restricted to the current transformed and degraded hisllopes.

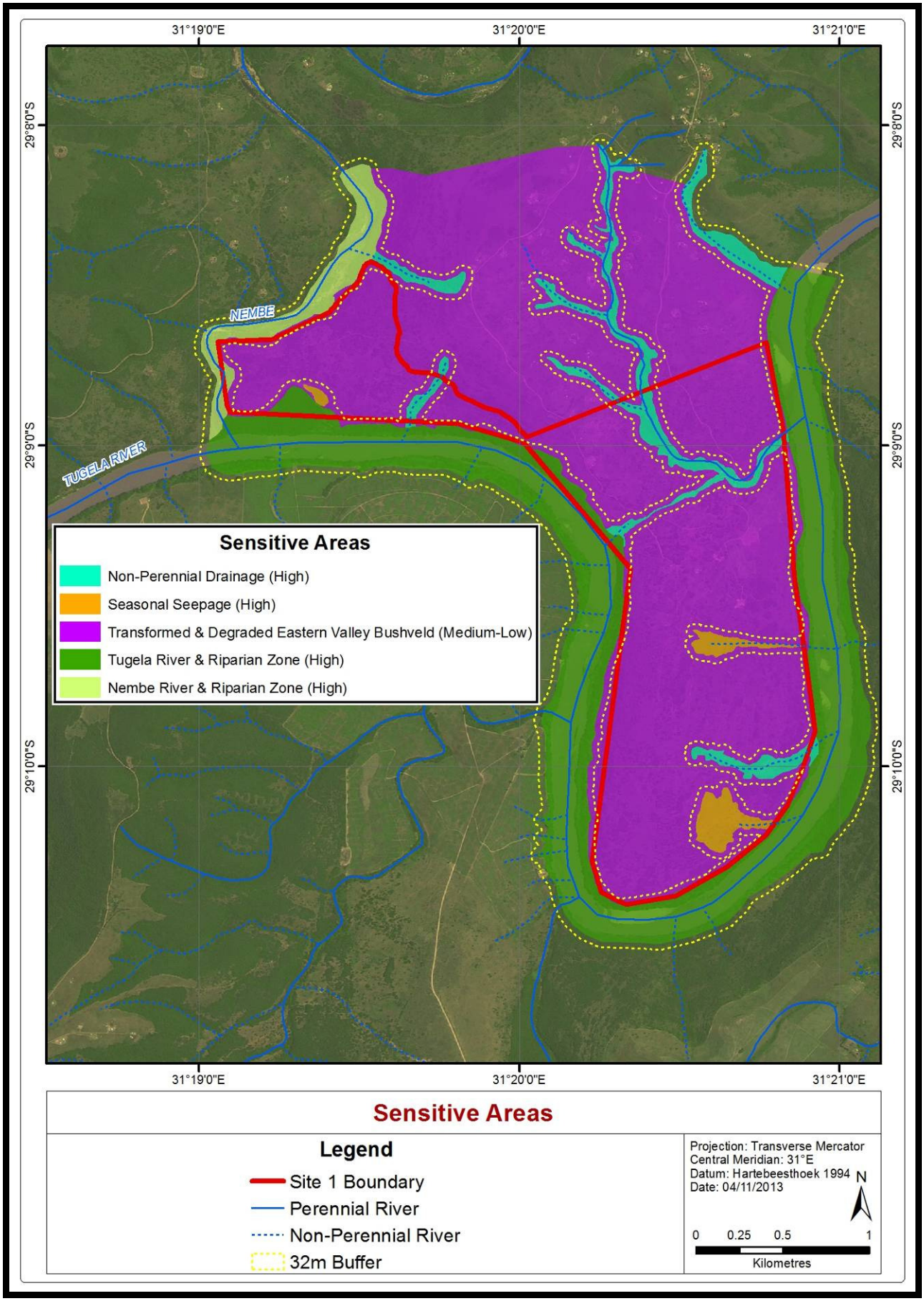

Figure15. Preliminary sensitivity map for the proposed Beema Bamboo site 1.

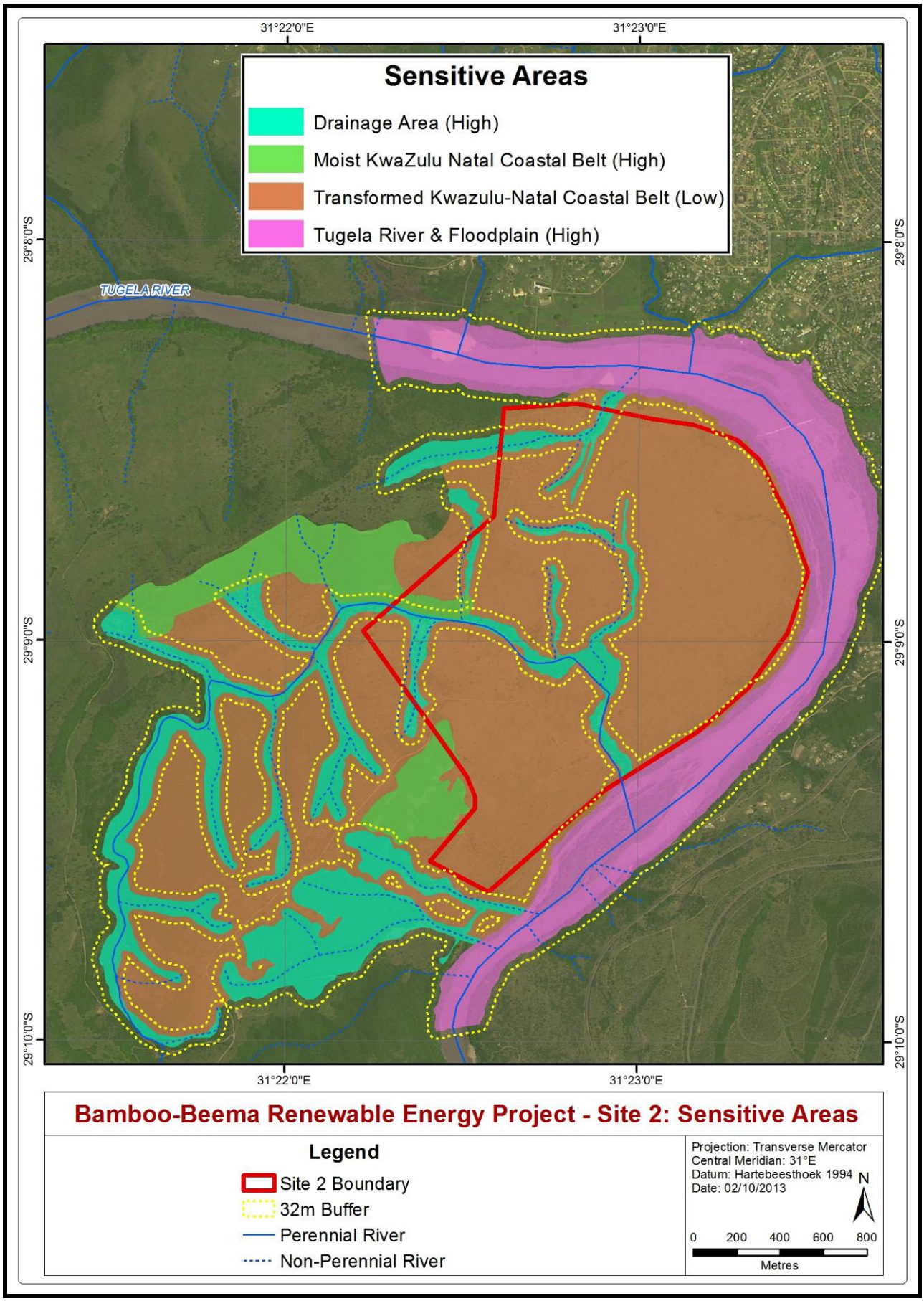

Figure16. Preliminary sensitivity map for the proposed Beema Bamboo site 2.

8. SENSITIVE HABITATS

8.1 TUGELA RIVER, PERENNIAL (NEMBE RIVER) & NON-PERENNIAL DRAINAGE LINES & ASSOCIATED RIPARIAN ZONES

The Tugela River, Nembe River, perennial and non-perennial drainage lines and associated coastal belt/bushveld riparian zones are considered to be of conservation importance for the following reasons:

- The indigenous riparian vegetation along rivers within Kwazulu-Natal, and rivers in general throughout the Kwazulu-Natal coast, are in danger of being completely replaced by alien invasive species. Any remaining areas of indigenous riparian vegetation within Kwazulu-Natal must therefore be regarded as sensitive and of high conservation importance.
- Rivers and drainage lines are longitudinal ecosystems, and their condition at any point is a reflection of not only upstream activities, but also of those within adjacent and upstream parts of the catchment (O'Keefe 1986). Any impact on the riverine area within the study area is therefore also likely to impact on upstream and downstream areas.
- Riparian zones have the capacity to act as biological corridors connecting areas of suitable habitat in birds (Whitaker & Metevecchi, 1997), mammals (Cockle & Richardson 2003) reptiles and amphibians (Maritz & Alexander 2007). Riparian zones may act as potential refugia for certain fauna and could allow for possible re-colonisation of rehabilitated habitats. The riparian vegetation plays a vital role in the re-colonisation of aquatic macro-invertebrates as well as reptiles and

amphibians (Maritz & Alexander 2007). The riparian vegetation provides vital refuge, foraging and migratory passages for species migrating to and away from the rivers. The riparian zone comprises plant communities contiguous to and affected by surface and subsurface hydrological features of perennial or intermittent water bodies (rivers and streams).

- The riparian vegetation is dependant on the river for a number of functions including growth, temperature control, seed dispersal, germination and nutrient enrichment. Riparian vegetation comprises a distinct composition of species, often different from that of the surrounding terrestrial vegetation. Tree species are positioned according to their dependence or affinity for water, with the more mesic species (water-loving) being located closest to the river channel, often with their roots in the water, and the less water-loving terrestrial species further away from the river.

Riparian habitats, also known as riparian areas, include plant communities adjacent to and affected by surface and subsurface hydrologic features, such as rivers, streams, lakes, or drainage ways. These areas may be a few metres wide near streams or more than a kilometre in floodplains. Both perennial and non-perennial streams support riparian vegetation. Because riparian areas represent the interface between aquatic and upland ecosystems, the vegetation in the riparian area may have characteristics of both aquatic and upland habitats. Many of the plants in the riparian area require plenty of water and are adapted to shallow water table conditions. Due to water availability and rich alluvial soils, riparian areas are usually very productive. Tree growth rate is high and the vegetation under the trees is usually lush and includes a wide variety of shrubs, grasses, and wildflowers.

Why are riparian areas important?

Riparian areas perform a variety of functions that are of value to society, especially the protection and enhancement of water resources, and provision of habitat for plant and animal species.

Riparian areas:

- store water and help reduce floods
- stabilize stream banks;
- improve water quality by trapping sediment and nutrients;
- maintain natural water temperature for aquatic species;
- provide shelter and food for birds and other animals;
- provide corridors for movement and migration of different species;
- act as a buffer between aquatic ecosystems and adjacent land uses;
- can be used as recreational sites; and
- provide material for building, medicinal plants, crafts and curios.

Not all riparian areas develop the same way and may not perform these functions to the same extent. It is important that a riparian area's capacity to provide the benefits listed is not reduced. Many of these areas are best managed as natural areas, rather than being converted to other uses. The section of riparian vegetation along the Tugela River has been heavily impacted from surrounding anthropogenic activities. Wood harvesting occurs throughout the area. Several of the large riparian species have been removed in certain sections for wood harvesting; as well as during subsistence agricultural activities. Dominant riparian species included *Acacia natalitia, Acacia robusta* subsp. *clavigera, Ficus sycomorus* subsp. *sycomorus, Pavetta lanceolata, Cussonia zuluensis*, *Trichilia dregeana, Scutia myrtina, Tarrena pavettoides, Gymnosporia buxifolia., Grewia occidentalis, Ficus sycomorus, Ficus natalensis, Ficus sur, Dicrostachys cinerea, Dombeya rotundifolia, Spirostachys africana, Schotia brachypetala, Syzigium cordatum, Celtis africana, Trema orientalis, Erythrina caffra* and *Ziziphus mucronata*.

The riparian zone, of which vegetation is a major component, has a number of important functions including:

- enhancing water quality in the river by the interception and breakdown of pollutants;
- interception and deposition of nutrients and sediments;
- stabilisation of riverbanks and macro-channel floor;
- flood attenuation;
- provision of habitat and migration routes for fauna and flora;
- provision of fuels, building materials and medicines for communities (if done on a sustainable basis); and
- recreational areas (fishing - rod and line not shade or gill nets; bird watching; picnic areas etc.).

The Tugela River, Nembe River and perennial and non-perennial drainage lines and their associated riparian zones are protected under the National Water Act 36 of 1998. The Tugela River, Nembe River and perennial and non-perennial drainage lines and associated riparian zone is considered to be of **High sensitivity** due to their ecological and hydrological functioning as well as providing suitable habitat as well as biological or dispersal corridors for remaining faunal species. A 32 m buffer zone has been placed from the outer edge of the macro-channel bank or riparian zones of the Tugela River, Nembe River and perennial and non-perennial drainage lines (see Sensitivity Maps). No agricultural activities should be allowed within the Tugela River, drainage lines as well as 32 m buffer zone. The current and previous agricultural activities are situated within the 32 m buffer zone. Future Beema Bamboo agricultural activities should be located outside the 32 m buffer zone. The 32 m buffer zone should be appropriately rehabilitated and re-vegetated with indigenous plant and tree species.

8.2 MOIST WOODED KWAZULU-NATAL COASTAL BELT RAVINES AND GORGES

The closed woodland vegetation units found within the fire protected ridges and kloofs usually within the south and east facing slopes usually with elevated levels of soil moisture. Dense understory vegetation as well as abundant climbers occurs within the closed canopy. These areas have been heavily impacted on by wood harvesting activities within the accessible areas as well as alien vegetation invasion. These **highly sensitive** habitats have a diverse floristic component as well as offering favourable habitat for several rupicolous faunal species within the rocky ridges. Due to the dense nature of the closed vegetation unit as well as steep topography access was limited to the lower-lying areas along the Tugela River. No agricultural activities should be allowed within any wooded pocket, ravine or valley.

8.3 SEASONALLY INUNDATED SEEPAGE WETLAND AND PAN/DEPRESSION

Wetlands are characterized by hydric soils and slow flowing water and hygrophilous and hydrophilic grass and sedge dominated vegetation, and provide habitat for many plant and animal species. The conservation status of many of the threatened plant and animal species that are dependant on wetlands reflects the critical status of wetland nationally, with many having already been destroyed. Indigenous marshland vegetation such as that found within the pan on the northern portion of the site as well as seepage wetlands on the southern and central portion of Site 1 comprises a habitat which is restricted in extent, highly productive and which contains a high diversity of plants and animals, many of which are restricted or heavily dependant on such habitat. All remaining wetlands including the remnant patches of seasonally inundated footslope seepage wetland as well as seasonally inundated pan/depression and their associated hydrophilic and hygrophilous sedge and grass dominated vegetation must be considered to be of **High sensitivity**.

A 32 m grassland buffer zone has been placed around the seasonal palustrine wetlands on site 1. Development within the wetland habitats on the site will only be possible if authorised by a Water Use Licence applied for under Section 21 of the National Water Act (Act 36, 1998).

9: POTENTIAL IMPACTS ON THE FAUNA AND PROPOSED ENVIRONMENTAL MANAGEMENT RECOMMENDATIONS

9.1. Destruction of Faunal Habitat

At a local Mandini scale the proposed two Beema Bamboo sites offer limited suitable habitat for remaining faunal species due to extensive habitat transformation and degradation on and surrounding the proposed sites. The Tugela River and seasonally inundated flood bench, perennial and non-perennial drainage lines and wooded riparian zones, footslope seasonally inundated seepage wetlands, seasonally inundated pan/depression and closed wooded ravines and valleys on and adjacent to the proposed Beema Bamboo sites offer the most important habitat (especially for birds) for remaining plant and animal species. As the proposed Beema Bamboo sites are situated within historically transformed agricultural areas as well as degraded areas due to current agricultural activities (livestock grazing); the majority of vegetation is completely transformed and dominated by secondary succession grasslands or degraded due to wood harvesting and bush encroachment. Alteration to the original faunal composition has already occurred within the sites and the secretive or sensitive species have located suitable habitat away from the sites within the remaining wooded coastal pockets along the drainage lines as well as along the Tugela Rive and floodplain. The remaining fauna associated with the site require the conservation of the wooded ravines, seasonally inundated pan/depression, seasonally inundated footslope seepage wetlands on site 1, perennial and non-perennial drainage lines, Tugela River and floodplain with a 32 m rehabilitated natural buffer zone. This could potentially form an appropriate natural biological corridor or green belt connecting the site with similar habitats around the site and should conserve the majority of suitable habitat for faunal species likely to occur on the site and immediate surrounding area.

The proposed development of the degraded and transformed hillslope vegetation (old sugar-cane plantations, Eucalyptus woodlots, maize and vegetable fields) on the two sites will most likely result in a **medium-low**, **short to long-term negative** impact on the affected environment as well as associated faunal species occurring within this habitat. Should the project be approved, it is therefore recommended that the following mitigation measures be implemented:

Mitigation and Recommendations

During the planting or establishment of the Beema Bamboo plantations workers must be limited to areas under cultivation and access to the undeveloped areas, especially along the perennial and non-perennial drainage lines, seasonally inundated pan/depression and seeps; the Tugela River and floodplain must be strictly regulated (ideally fenced off and "no-go" areas during all phases of the agricultural activities). All large indigenous tree species should be conserved wherever possible and incorporated into the Bamboo plantations. Vegetation has been reported to be the single most important habitat component for all species of animals. Linked to this, is the preservation, maintenance and creation of tracts of natural and ornamental vegetation in all stages of ecological succession, interconnected by corridors or green belts for escape, foraging, breeding and exploratory movements needs to be considered. The conservation of the perennial and non-perennial drainage lines, seepage wetlands with a 32 m grassland buffer zone could potentially act as a biological or dispersal corridor towards the Tugela River for remaining faunal species around the transformed mono-cultured Beema Bamboo plantations. No animals should be intentionally killed or destroyed and poaching and hunting should not be permitted on the site. No guns, air rifles or pellet guns should be permitted.

Provision of adequate toilet facilities must be implemented to prevent the possible contamination of surface and ground (borehole) water in the area. All temporary soil stockpiles, litter and rubble must be removed on completion of construction. No dumping of waste material in surrounding open areas. All alien invasive plant and tree species should be removed from the site preventing further invasion especially along the drainage line as well as the Tugela River. Where herbicides are used to clear vegetation, specimen-specific chemicals should be applied to individual plants only. General spraying should be prohibited. All alien vegetation should be eradicated over a five-year period. Invasive species should be given the highest priority and the medium-high infestations along the Tugela River and drainage line as well as within the coastal wooded pockets should be prioritised.

Where the removal of alien species may leave spoil exposed, alternative indigenous species should be established before eradication takes place. The attention of the farm managers must be drawn to the most recent Declared Weeds List (2001) in the *Conservation of Agricultural Resources Act* 43 of 1983 and the associated penalties and prohibitions. Horticultural activities such as fertilisers, herbicide and pesticide runoff, increase in alien vegetation and weedy species, dumping of refuge and building material must be strictly managed and be environmentally sensitive and should meet the following requirements:

- The use of indigenous (to the area) vegetation for proposed 32m buffer zones.
- Limited irrigation by water-wise gardening (use indigenous to the area plants and trees which are adapted to the local conditions).
- Strict fertiliser, pesticide and herbicide control (limited usage for proposed development)
- Invertebrate pests on the site should be controlled in the following manner:
- The least environmentally damaging insecticides must be applied. Pyrethroids and Phenylpyrazoles are preferable to Acetylcholines. Use insecticides that are specific to the pest (species specific) in question. The lowest effective dosages must be applied. Suppliers advice should be sought. Do not irrigate for 24 hours after applying insecticides in areas where there is a chance of contaminating water-courses. Fungal pathogens should be used in preference to chemical insecticides.
- Reduction of weed and erosion by minimum tillage gardening practices (groundcovers and mulching better in all respects).

9.2 Erosion and Surface runoff

Agricultural activities associated with vegetation clearance can lead to massive short term erosion unless adequate measures are implemented to control surface run-off. Sheet erosion occurs when run-off surface water carries away successive thin layers of soil over large patches of bare earth. This type of erosion is most severe on sloping soils, which are weakly structured with low infiltration, which promotes rapid run-off. It occurs on the site where vegetation has been destroyed. Continual erosion in sheet-eroded slopes is a common cause of gully erosion. Gully erosion results from increased flow along a drainage line, especially where protective vegetation has been removed and soils are readily transported. A gully has steep, bare sides and is often narrow and deep. Once formed, a gully usually spreads upstream through continual slumping of soil at the gully head. Gully erosion can be associated with salting as the saline sub-soils are readily eroded. Future soil stockpiling areas must follow environmentally sensitive practices and be situated a sufficient distance away from drainage areas. The careful position of soil piles, and runoff control, during all phases of development, and planting of some vegetative cover after completion (indigenous groundcover, grasses etc.) will limit the extent of erosion occurring on

the site. Sufficient measures must be implemented to prevent the possible contamination of the surface water and surrounding groundwater.

Mitigation and recommendations

Vegetation plays a critical role in the hydrological cycle by influencing both the quantity and quality of surface run-off. It influences the quantity of run-off by intercepting rainfall, promoting infiltration and thus decreasing run-off. Vegetation can influence water quality in two ways: by binding soils thus protecting the surface layer, and by intercepting surface run-off thus buffering the adjacent wetland habitats against suspended and dissolved substances. When the speed of the run-off is reduced, suspended particles can settle out and dissolve substances, such as nutrients, can be assimilated by plants. The vegetation has a filtering effect. It is recommended that the construction programme preferably commence during the dry winter months, when the streams base flow is lower and the risk of soil and bank erosion is lowest. All earthworks as well as vegetation clearance shall be undertaken in such a manner so as to minimize the extent of any impacts. Any erosion channels developed during the Beema Bamboo plantation establishment period should be backfilled and compacted, and the areas restored to a proper condition. The Farm Mangers should ensure that cleared areas are effectively stabilised to prevent and control soil erosion. Ideally the proposed 32m grassland buffer zone should be re-vegetated with an appropriate indigenous grass seed mix preventing further soil erosion and siltation and sedimentation of the perennial and non-perennial drainage lines as well as the lower-lying Tugela River and floodplain. Runoff from the access roads as well as plantations should be channelled through natural grassland buffer areas or directly into the Beema Bamboo plantations reducing the erosional force and the potential risk of contamination and erosion of the drainage lines as well as the Tugela River flood benches and banks.

Figure17. A head cut erosion was observed within the southern seasonally inundated seepage wetland. Adequate gabions and gabion mattresses with sediment trapping geo-textiles should be installed to prevent further erosion up the seepage areas. The eroded area should be fenced off preventing further trampling and disturbances from livestock grazing and drinking activities.

Several rill erosion channels were observed within the run off areas within the Site 1 and Site 2. A head cut erosion was observed within the southern seasonally inundated seepage wetland. Adequate gabion mattresses should be installed to prevent further erosion as well as sediment trapping geo-textiles preventing further siltation and sedimentation. The entire seepage wetland requires fencing off to prevent uncontrolled livestock grazing and trampling activities.

9.3 ALIEN VEGETATION

Alien invasive plant species have become naturalised outside of their normal geographic range. These plants occur in almost every comer of the globe and are known as environmental weeds because they grow, and flourish, where they do not belong. Alien plant infestations progressively invade the natural vegetation of their 'adopted' habitat, taking over from the indigenous plant species and often preventing their regeneration. Problems caused by alien invasive plant species include loss of biodiversity, the loss of topsoil and habitat deterioration. Invasive alien plants can completely alter the functioning of ecosystems and they also reduce the value of land for farming, nature conservation and eco-tourism. Invasions can significantly reduce the productivity of rangelands by out-competing indigenous vegetation.

Generally alien vegetation infestations form dense, monospecific stands which dominate, overtop or replace the natural vegetation of the area, thereby completely altering its nature and functioning. Most of the indigenous wildlife is directly dependent on indigenous vegetation for survival using plants for food, cover, nesting sites and general refuge. Loss of indigenous vegetation and replacement by alien plants can therefore lead to local extinctions or a range of habitat-specific wildlife species, and the domino effects that these losses may cause can have a disastrous effect on ecosystem functioning. Alien invasive plants may be trees, shrubs, creepers, grasses, herbs or even water plants and are called 'invaders' to draw attention to their ability to spread aggressively and cause rapid and often irreversible changes in the landscape.

One of the reasons why many alien plants are such successful invaders is that they produce large amounts of long-lived seed. Many species have seeds that can remain dormant for as long as 50 years or more in the soil under the canopy of the parent plant. Because of the lack of specific seed predators, the seeds of many invasive alien plants are as much as 90% viable. This means that when the dominant parent plant is removed, the large and highly viable soil-stored seed reserve can quickly develop into a dense infestation, consisting of hundreds of plants on a site formerly occupied by a single mature tree. This is especially pertinent to the recently scraped and in-filled platforms. The potential to invade new sites is unfortunately advanced by the seed dispersal activities of fruit- and seed-eating indigenous wildlife especially birds (Bugweed). The seeds of many invasive alien plants are also dispersed by running water, eventually resulting in densely invaded river courses and wetlands. Some invasive plants are wind dispersed and are known to be dispersed for up to 20 km from the selected site. Man is also an inadvertent disperser of invasive plants. Many invasions originated in building sand containing seeds, which was transported to construction sites in un-invaded areas.

OBJECTIVES FOR ALIEN VEGEATION CONTROL PROGRAMME

- To aim, in the short and medium term, for the complete eradication of alien plants is unrealistic. The objective should rather be to prevent the further spread of invasive alien plants into un-infested areas and to isolate the dense infestations within a landscape that is otherwise maintained free of alien plants. The complete eradication of alien plants would be an ideal objective but it is seldom a practical and achievable approach to the alien plant problem.

- Establishing realistic goals for controlling alien plants on the site especially along any pipeline wetland or open natural grassland crossing.

- Sparse infestations or occasional plants on the recently cleared road reserves are the real threat because they can mature, reproduce and increase in number, eventually becoming dense enough to have a negative impact on the surrounding natural vegetation. A practical objective for any area infested with alien plants is therefore to control or clear the plants starting with the least infested areas and working through the various degrees of infestation, starting with light and ending with dense

A long-term alien plant control programme must be implemented for this project and this must include a budget of estimated costs of labour, equipment, transport and chemicals. Alien plant control can be expensive, labour-intensive and time - consuming. It is imperative that the planning and cost estimates are done correctly to ensure that limited funding is effectively used. Alien vegetation control must be viewed as a long-term programme and must also be fully incorporated into the other management practices on the pipeline servitude. This is particularly applicable to the follow-up stages of control. It is almost impossible to totally eradicate invasive alien plants from a property it is more practical rather to think in terms of effective control. The ultimate goal must be to reach a level of control where the annual input is low and the impact of the alien plants on the environment is low or negligible. This is known as the **maintenance level of control**.

There are two levels of control, namely **initial control** and **follow-up control**. Initial control is usually the most costly, with costs reducing progressively through the follow-up controls until a minimal cost is reached at the maintenance level of control. To make any real progress with alien plant control, the follow-up operations must be seen as all-important. If the follow-up control phases are neglected, it is certain that the invasive situation will revert to the original condition, or sometimes worse

CONTROL METHODS

The control of invasive alien plants can be mechanical, chemical or by means of natural biocontrol. Whatever method is used, an important aim must be to kill the plant the first time around ineffective methods or inefficiently applied methods simply necessitate revisiting the site to retreat the plants at double the cost of transport, labour and chemicals. The cheapest control method that effectively kills the alien plants should be used. The use of chemical treatments, for example, is expensive and often the same result can be achieved using a little more time and skill and no chemicals at all. Workers who do the alien control fieldwork should be fully trained, irrespective of the methods used. With adequate training, the application of control methods will be more effective, chemicals will be used more sparingly and efficiently and funds will therefore be spent more effectively.

The ecology of the alien plant concerned must be clearly understood for the control methods to be successful. Some plants readily coppice (including *Eucalyptus*) from the stems when cut down. Others sucker from the roots when the main stem is cut. Many plants have invasive soil-stored seed reserves (Black Wattle *Acacia mearnsii*) which germinate when the parent plant is removed. Many plants, notably cacti such as the Prickly Pear (*Opuntia ficus-indica*), can grow from a small piece that may be left behind after initial control. These are all survival strategies that must be carefully considered when planning a control programme.

To be completely successful, one should always remember that alien invasive plants most often reach habitats by means of seeds which can move over long distances or survive for many years in the soil. So whatever control method is used for mature alien plants, one must not forget the potential for **re-infestation from seed**, which can be soil-stored, wind-transported, water-transported or animal-dispersed. Reducing the potential to re-infest from seed should therefore be an important part of every control method.

METHODOLOGY

The following commonly used methods for controlling a variety of invasive alien plants, but the decision of which method to use for a particular alien plant infestation must be based on, or include, some of the following:

- The method used must be based on the ecology of the plant, the density of the infestation, the terrain, the climate and available resources.
- Use methods that are known, tested and successful.
- The use of unknown methods should first be tested before wider application.
- Train all staff who are to apply the control methods.
- Use the cheapest method that effectively kills the plants.
- Make sure that the plants are killed first time around.

- Ensure that the method can deal with the plants' survival strategies. · Monitor the success of the control method application.
- Monitor the motivation of the staff applying the control method.
- Use only chemicals registered for the plant species or plant type.
- Try to use 'species-specific' chemicals and use sparingly.
- Ensure that the available funding can sustain the chosen method.
- Try to restrict re-infestation from seed with the method used.
- Always incorporate follow-up control methods in the planning phase.

Felling trees

The first option in the control of invasive trees is physically to cut them down. As an alternative to cutting them down, trees can also be killed standing and remain as dead wood features. Dead trunks are utilised for nesting and roosting purposes for several animal species. Felling big alien trees must be done in the most sensitive manner possible. Smaller trees such as the *Dichrostachys cinerea* thickets are more easily cut down with little damage to the surroundings and can be cut up into short sections with the chainsaw for removal for firewood or restoration work. The chainsaw is thus an excellent labour-saving machine that is ideal for the removal of mature trees but operator training, strict safety measures and careful chainsaw maintenance are critical.

Slasher operation:

The slasher is the ideal tool for cutting down the thin trees of many dense alien tree infestations. Stems of up to 80 mm thick can be cut. Even a simple tool like the slasher requires limited but essential basic training. Safety is therefore very important with slasher operation. The operator must first clear away any hanging branches that can interfere with cutting strokes. He must also ensure a safe working distance from other operators - a distance of at least 3 m is recommended. The slasher will cut cleanly if correctly used and kept sharp. Using a blunt slasher will cut less efficiently and cause greater strain on the operator's arms and back as it will require many more cuts to fell the trees. A variety of slasher lengths are available and the one most suited to a particular task will depend on the type of plants to be cleared and the skill of the operators.

Mechanical brush-cutter

An alternative to slashing by hand is to cut the dense branch material away with a petrol-driven mechanical brush-cutter with a toothed disc blade. The brush-cutter is much faster, but runs on petrol and oil and must be well maintained if it is to work effectively. The person who operates the brush-cutter must also be specially trained. Safety aspects are extremely important when using an open mechanical blade and the operator should wear protective clothing. As with hand-slashing, all of the foliage

and branches are removed to gain access to the core stem which is treated in the same way.

This operation is relatively labour intensive and time consuming due to the difficulty in dealing with the dense mat of springy plant material. Once the plant has been treated, it is essential that a follow-up control action be done at the start of the next growing season when the root stock of coppicing species produces new shoots. The re-growth must be sprayed with a contact foliar herbicide. The only alternative to spraying is to dig up the roots, which is not always practical and may lead to soil erosion especially along the banks of the drainage line.

The tree puller

The tree puller, or wrench, is a very simple, yet effective hand tool for the removal of saplings and young alien trees. It is ideal for clearing light, new infestations and for removing new plants during follow-up operations. The tool simply clamps around the tree to be pulled and the clamping pressure is the result of leverage of the footplate against the ground when the long lever is pulled downwards. The sapling is then pulled out of the ground, roots and all, by applying continuous downward pressure on the handle. Trees with a maximum diameter of 25-30 mm can be pulled out of the ground with a heavy-duty puller, but even bigger trees of up to 60 mm in diameter can be lifted in soft soils. Lighter models of puller are available for smaller applications. The real advantage of this tool is that the entire plant, with its roots, is removed so that no coppicing is possible. The tool requires no maintenance, nor does it need fuel or oil to function. It is therefore ideal for use in remote and rugged terrain. It is also relatively easy to use, which obviates the need for any special training. Commercial tree pullers come in a variety of sizes. A heavy-duty puller weighs approximately 8 kg, while a light model weighs about 5 kg. Where soil is very soft or sandy, an additional steel or thick wooden footplate can be used to prevent the puller simply sinking into the ground when leverage is applied. The tree puller is commercially available in most regions but if not, it can be made up by any competent welder or tool maker. Use of the puller is vastly superior to cutting saplings or grubbing them out with a bush-pick or hoe. A real advantage of this method is that the complete root system is removed and follow-up maintenance is not required. The use of the puller is therefore cost-effective and the result is permanent.

FOLLOW-UP CONTROL

Follow-up control should be systematically done according to the control programme schedule and within the system of control blocks that were used for the initial control operation. Follow-up control must not be treated as a haphazard tailing-off of the control operation but rather as a critical component of it. The initial and follow-up phases are equally important and one cannot be done effectively without the other.

Follow-up control should be done before the re-growth or seedlings have the time to develop substantial root systems or dense voluminous foliage, which may require more expensive herbicide treatments. The timing will depend on the type of plant and the climate, but a practical time for follow-up control treatment is when plants are 100-500 mm in height.

Hand-pulling: Follow-up clearing (and initial clearing of seedlings) is most effectively done by hand-pulling. This method is labour intensive but is still cost effective when compared to the cost of herbicide spraying. Pulling should be done when plants are still smaller than 500 mm in height and the best results can be achieved when the ground is wet after rain. When the seedlings are difficult to see in other vegetation, the block should be divided up into strips with tape or line to facilitate systematic searching and pulling to ensure that most of the plants are located and destroyed. Very little skill is required for hand-pulling but workers must be guided by the use of control blocks and the systematic coverage of the control block in strips. Unskilled, temporarily employed workers are ideal for this task and vast numbers of alien plant seedlings can be cleared in a day.

Spraying with herbicide: Plants that re-sprout from cut stems as well as bigger saplings can be treated by spraying with a foliar contact herbicide. The disadvantage of using chemicals is that they are expensive and the spray application can be wasteful. Workers need to be trained in the safe use and application of herbicides for cost-effective and satisfactory results. Herbicide is effectively applied with a knapsack sprayer. There is a great variety of herbicides available for alien plant control. These include foliar-absorbing, bark-absorbing and root-absorbing types. Care must be taken to preferably use selective herbicides that are known to be effective for the plants that must be killed. This approach will save both time and money. Extreme care must be taken to limit the impact of non-selective herbicide treatments on non-target, locally indigenous plants.

REHABILITATION AFTER ALIEN VEGETATION REMOVAL

Clearing away dense infestations of alien plants may leave the soil surface exposed and vulnerable to soil erosion. Dense, alien tree thickets desiccate the soil over time, making it even more vulnerable to water and wind erosion when unprotected. Timeous action is therefore required to prevent the inclusion of the costs of rehabilitating accelerated soil erosion into the alien plant control programme. Rehabilitation is a critically important part of the control programme because it makes little sense to replace an invasive weed problem with a soil erosion problem. The rehabilitation requirements should be estimated when the planning is done because the potential restoration requirements may help to determine the selection of the control methods used.

Rehabilitation after clearing will generally consist of two stages - a **soil surface stabilisation stage** and a **plant cover establishment stage**. The timing of the restoration is extremely important. The forces of nature will not wait until management is ready to do restoration work - the restoration process can therefore proceed even while workers are still cutting down the alien trees. In areas where soil surfaces will become exposed, the restoration process should proceed together with the initial clearing operation.

Nature makes this possible because much of the plant material that is cut down can be used to stabilise the exposed soil surfaces. The branches and foliage of trees and shrubs make an ideal soil surface protecting mulch if cut up into short bits and densely packed over the soil. Alternatively, brush can be reduced to a finer mulch with a wood chipping machine if available.

Exposed soil surfaces can be stabilised in a variety of ways. The best approach for a particular site may require an innovative combination of methods, particularly on slopes and in drainage areas. Whatever method is used, the aim must be to hold the soil surface in place to provide a seedbed for a new and protective vegetation cover. Once stabilised, the cleared site should be seeded with suitable, fast-growing pioneer vegetation. The establishment of grasses is generally most effective. Once the area is stabilised with a vegetation cover, consideration can be given to the re-establishment of elements of the original indigenous vegetation cover. The overall success of grass seed germination is considerably reduced when seeds are planted too deeply. No more than a 1-3 mm soil cover is needed. Once seeded, the area can be covered with a layer of chopped brush. The foliage of the alien plants that are cut down can be used, but care must be taken to avoid the use of material containing seeds. This means that the initial clearing operation should ideally be done before the alien plants set seed. This precaution will ensure that the soil-stored seed bank of the invasive plant will at least be reduced by one season of seed production. The brush should be cut into lengths of no more than 300-400 mm and must be packed across the drainage direction of the site for maximum soil surface protection. Care must be taken to ensure that most of the cut brush lies in close contact with the soil surface. This mulch layer must not completely seal the soil surface from the sun. The brush should be packed to a depth of 100-200 mm, the actual depth depending on the type of material that is available. It is important that light and water can still penetrate the brush or mulch cover to ensure seed germination and seedling growth.

An important part of the rehabilitation of former alien plant infested areas is the continuous follow-up control that will be needed to eradicate the new plants that germinate from the usually considerable soil-stored seed bank. Dedicated and organised follow-up will eventually exhaust the seed bank and rehabilitation will then be almost complete (Coetzee 2005).

9.4 RE-VEGETATION

All geophytes (*Crinum, Brunsvigia, Raphionacmea, Hypoxis*) and Aloes should be relocated from any agricultural areas during vegetation clearance and replanted within the proposed 32 m grassland buffer zones. Grass seed should be collected from the natural grassland areas situated adjacent to the drainage lines as well as Tugela River. This option is labour intensive but once the grasses become established they will self-seed in the rehabilitation area. When available, grass and shrub seeds can be sown into lightly loosened soil that is preferably covered with a layer of mulch or brush. Grass seed must not be buried much more than its own thickness and when sown in mulched areas, need not be buried at all. The only requirement is that the soil surface must be loosened, as the plants will not germinate on a hard, sealed surface

- Where vegetation, especially trees are lost to the alien vegetation removal programme along the perennial and non-perennial drainage lines they should be replaced with suitable indigenous trees such as Umdoni (*Syzigium cordatum*), White Stinkwood *Celtis africana* and River Bushwillow *Combretum erythrophyllum* (see Appendix for recommended species lists).

- Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation. The grass mix should consist of indigenous grasses adapted to the local environmental conditions. The grass seeds should a variety of grass species including several pioneer species.

- The grass mix should consist of indigenous grasses adapted to the local environmental conditions.

- The grass mix should consist of a mix of quick covering grasses (pioneer species), mat-forming grasses (e.g. *Digitaria eriantha, Chloris gayana)* and tufted grasses (e.g. *Eragrostis curvula)* to ensure prompt and adequate coverage of the exposed soil while long term stability of the grass sward is also achieved.

- Re-vegetated areas should be monitored every 3 months for the first 12 months and twice a year thereafter.

- Re-vegetated areas showing inadequate surface coverage (less than 30% within 9 months after re-vegetation) should be prepared and re-vegetated from scratch.

- Damage to re-vegetated areas should be repaired promptly.

- Exotic weeds and invaders that might establish on the re-vegetated areas should be controlled to allow the grasses to properly establish.

- The Beema Bamboo must be closely monitored throughout all stages of the project for any signs of invasiveness and should not be allowed to establish within the 32 m grassland buffer zones. Even as the Beema Bamboo is sterile most bamboos can easily reproduce vegetatively from cuttings etc.

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11. APPENDIX

Table5. Grasses suitable for the re-establishment of vegetation within the proposed 32 m buffer zone along the Tugela River and drainage line (courtesy of S.A.S.A. Experiment Station at Mount Edgecombe).

Botanical name	Common name	Growth	Drought	Frost	Dongas	Seed	Soils	Description	Miscellaneous
Acroceras macrum	Nile Grass		*	*		*		Creeping perennial	Badly affected by cold
Andropogon appendiculatus		*							
Andropogon eucomus	Snowflake grass					*	Heavy clay (ouklip)	Densely tufted, upright, stemmy perennial	Indicator of poorly drained soils
Bothriochloa glabra	Purple-blumed grass							Robust perennial forming large tufts	Occurs where water accumulates
Brachiara serrata	Velvet signal grass		**					Loosely tufted perennial	
Bromus wildenowii	Rescue grass			*		*	Well drained soils	Winter growing perennial	
Chloris gayana	Rhodes grass					*	Loam	Tufted, stoloniferous perennial	Lacks persistence
Cymbopogon validus	Giant turpentine grass							Robust, tufted perennial	
Cynodon dactylon	Couch grass		*	**		*	Sandy	Variable, creeping perennial	
Digitaria eriantha	Smuts finger grass		**			**		Robust, tufted perennial	
Digitaria swazilandensis	Richmond finger-grass		**	**			All soils	Perennial with creeping rhizomes	Easily affected by drought and cold
Echinochloa crusgalli	Barnyard millet		**				Moist, well-drained	Tufted annual	Fully grown in 6 - 8 weeks
Eragrostis capensis	Heartseed love grass		**				Shallow	Loosely tufted perennial	
Eragrostis lappula	Phakwane						Moist, sandy soils	Tufted, variable perennial	
Eragrostis plana	Fan love grass					*	Compact soils	Densely tufted perennial	Occurs on abandoned, arable lands
Hemarthria altissima	Red swamp grass						Wet soils	Perennial, underground rhizomes	Good soil binder, hardy
Imperata cylindrica	Cottonwool grass					*		Perennial, underground runners	Good soil binder, hardy
Ishaemum arcuatum	Hippo grass						All soils	Perennial with creeping	

								rhizomes	
Leersia hexandra	Wild rice grass							Perennial, long underground stems	Good for frogs
Miscanthidium capense	Eastcoast broom grass		**					Robust perennial	Good firebreak
Monocymbium ceresiiforme	Wild oat grass						Leached soils	Loosely tufted perennial	Indicator of acid soils
Paspalum dilatatum	Common paspalum					**	Moist soils	Tufted perennial	Lack of consistently good seed
Paspalum notatum	Lawn paspalum			**			Moist, fertile soil	Sod-forming perennial	Aggressive invader
Paspalum urvillei	Giant paspalum			*			Wet soils	Tall, tufted, upright perennial	Invades naturally
Pennisetum clandestinum	**Kikuyu grass**		**			*		**Creeping, robust perennial**	**Highly Invasive and not recommended**
Poa annua	Annual bluegrass		**				Waterlogged soils	Small, bright green annual	
Setaria megaphylla	Broadleaf actaria					*	Waterlogged soils	Robust perennial	Found in shade
Stenotaphrum dimidiotum	St Augustive grass	*							
Stenotaphrum accundtum	Coastal buffalo grass					*	Sandy	Creeping perennial, extensive runner	Persisting under hard conditions

* Good Characteristics

** Bad Characteristic

Table6. Suggested indigenous trees for rehabilitation around the proposed Beema Bamboo sites site (species indigenous to the area are indicated with an ☺. It is strongly recommended that only these are planted within the 32m buffer zone as far as possible and sourced from a local nursery/source to prevent genetic contamination).

Botanical Name	**Common Name**
Acacia karroo	Sweet Thorn
Acacia caffra	Common Hook Thorn
☺ *Acacia natalitia*	
☺ *Acacia nilotica*	Scented Thorn
☺*Acacia sieberiana* var. *woodii*	Paper Bark
☺ *Albizia adianthifolia*	Flatcrown
☺ *Apodytes dimidiate*	White Pear
☺ *Bridelia micrantha*	Mitzeeri
☺ *Calodendron capense*	Cape Chestnut
Cassia abbreviate	Long-tailed cassia
☺*Celtis africana*	White stinkwood
☺*Combretum erythrophylum*	River Bushwillow
☺*Cussonia spicata*	Common Cabbage
☺*Diospyros lycoides*	Blue bush
☺*Dombeya rotundifolia*	Wild pear
☺ *Ekenbergia capensis*	Cape ash
☺*Erythrina lysistemon*	Corral Tree
☺ *Ficus natalensis*	Natal Fig
☺ *Ficus sur*	Cluster Fig
☺ *Ficus burkei*	Common Wild Fig
Ficus sycomorus	Sycamore fig
☺*Grewia occidentalis*	Cross berry
☺ *Gymnosporia buxifolia*	Common Spikw-Thorn
☺*Halleria lucida*	Tree fuschia
☺*Harpephyllum caffrum*	Wild plum
Kiggelaria africana	Wild peach
☺*Leucosidea serricea*	Ouhout
Olea europaea subsp. africana	Wild olive
Pappea capenis	Jacket plum
☺*Pittosporum viridiflorum*	Cheesewood
Podocarpus henkelli	Henkell's yellowwood
Pterocarpus rotundifolius	Round leaved kiaat
☺*Searsia/Rhus chiridensis*	Red Currant
Searsia/Rhus prunoides	Dogwood
☺*Searsia/Rhus leptodictya*	Mountain karee

☺ *Searsia/Rhus lancea*	Karee
☺ *Searsia/Rhus pyroides*	Common wild currant
Salix mucronata	Safsaf willow
☺ *Schotia brachypetala*	Weeping boer-bean
☺ *Syzigium cordata*	Water berry
☺*Trichilia emetica*	Natal mahogany
☺ *Vepris lanceolata*	White ironwood
☺*Ziziphus mucronata*	Buffalo thorn

Table7. Indigenous shrub species marked with ☺ should be used for rehabilitation activities around the proposed Beema Bamboo sites.

Botanical Name	**Common Name**
☺*Aloe arborescens*	
☺*Aloe maculata*	Common Soap Aloe
☺ *Aloe marlothii*	
Bauhinia species	Pride-of de-Kaap
Buddleja salinga	False olive
☺*Buddleja salvifolia*	Sagewood
Burchellia bubaline	Wild pomegranate
☺*Carissa macrocarpa*	Bird num-num
☺*Dietes species*	Wild iris
☺*Dovyalis caffra*	Kei apple
☺*Ehretia rigida*	Puzzle bush
Erica species	Heaths
Euryops species	Golden daisies
Felicia species	Wild daisy
☺*Grewia flava*	Wild currant
☺*Helichrysum kraussii*	Everlastings
☺*Leonotis leonorus*	Wild dagga
Leucospernum species	Pincushions
☺*Mackaya bella*	Forest bell bush
☺ *Pavetta lanceolata*	Forest's pride bush
☺*Plectranthus species*	Spur flowers
☺*Plumbago auriculata*	Cape leadwort
Protea caffra	Sugarbush
Psychotria capensis	Black birdberry
☺*Rhamnus prinoides*	Dogwood
☺*Strelitzia nicolai*	Natal Wild Banana
Strilitzea reginae	Crane flower
☺*Tecoma capensis*	Cape honeysuckle
☺*Thunbergia natalensis*	Natal bluebell

Table8. Frog species recorded from locus = 2931AB during Southern African Frog Atlas Project (SAFAP).

Family	Genus	Species	Common name	Red list category	Atlas region endemic
Arthroleptidae	*Arthroleptis*	*wahlbergi*	Bush Squeaker	Least Concern	0
Arthroleptidae	*Leptopelis*	*natalensis*	Forest Tree Frog	Least Concern	0
Brevicepitidae	*Breviceps*	*adspersus*	Bushveld Rain Frog	Least Concern	0
Brevicepitidae	*Breviceps*	*mossambicus*	Mozambique Rain Frog	Least Concern	0
Bufonidae	*Amietophrynus*	*gutturalis*	Guttural Toad	Least Concern	0
Bufonidae	*Schismaderma*	*carens*	Red Toad	Least Concern	0
Hyperoliidae	*Afrixalus*	*delicatus*	Delicate Leaf-folding Frog	Least Concern	0
Hyperoliidae	*Afrixalus*	*fornasinii*	Greater Leaf-folding Frog	Least Concern	0
Hyperoliidae	*Hyperolius*	*marmoratus*	Painted Reed Frog	Least Concern	0
Hyperoliidae	***Hyperolius***	***pickersgilli***	**Pickersgill's Reed Frog**	**Endangered**	1
Hyperoliidae	*Hyperolius*	*pusillus*	Water Lily Frog	Least Concern	0
Hyperoliidae	*Hyperolius*	*tuberilinguis*	Tinker Reed Frog	Least Concern	0
Hyperoliidae	*Kassina*	*senegalensis*	Bubbling Kassina	Least Concern	0
Phrynobatrachidae	*Phrynobatrachus*	*mababiensis*	Dwarf Puddle Frog	Least Concern	0
Phrynobatrachidae	*Phrynobatrachus*	*natalensis*	Snoring Puddle Frog	Least Concern	0
Pipidae	*Xenopus*	*laevis*	Common Platanna	Least Concern	0
Ptychadenidae	*Ptychadena*	*anchietae*	Plain Grass Frog	Least Concern	0
Ptychadenidae	*Ptychadena*	*mascareniensis*	Mascarene Grass Frog	Least Concern	0
Ptychadenidae	*Ptychadena*	*oxyrhynchus*	Sharpnosed Grass Frog	Least Concern	0
Pyxicephalidae	*Amietia*	*angolensis*	Common or Angola River Frog	Least Concern	0
Pyxicephalidae	*Cacosternum*	*nanum*	Bronze Caco	Least Concern	0
Pyxicephalidae	*Strongylopus*	*fasciatus*	Striped Stream Frog	Least Concern	0
Pyxicephalidae	*Tomopterna*	*natalensis*	Natal Sand Frog	Least Concern	0

Table9. Reptile species found for locus = 2931AB during South African Reptile Conservation Assessment (SARCA).

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Agamidae	*Acanthocercus*	*atricollis*	*atricollis*	Southern Tree Agama	Not Evaluated	0
Atractaspididae	*Amblyodipsas*	*concolor*		Natal Purple-glossed Snake	Not Evaluated	1
Atractaspididae	*Aparallactus*	*capensis*		Black-headed Centipede-eater	Not Evaluated	0
Atractaspididae	*Atractaspis*	*bibronii*		Bibron's Stiletto Snake	Not Evaluated	0
Boidae	*Python*	*natalensis*		Southern African Python	Not Evaluated	0
Chamaeleonidae	*Bradypodion*	*melanocephalum*		KwaZulu Dwarf Chameleon	Not Evaluated	1
Chamaeleonidae	*Chamaeleo*	*dilepis*	*dilepis*	Common Flap-neck Chameleon	Not Evaluated	0
Colubridae	*Boaedon*	*capensis*		Brown House Snake	Not Evaluated	0
Colubridae	*Crotaphopeltis*	*hotamboeia*		Red-lipped Snake	Not Evaluated	0
Colubridae	*Dasypeltis*	*inornata*		Southern Brown Egg-eater	Not Evaluated	1
Colubridae	*Dispholidus*	*typus*	*typus*	Boomslang	Not Evaluated	0
Colubridae	*Duberria*	*lutrix*	*lutrix*	South African Slug-eater	Not Evaluated	1
Colubridae	*Gonionotophis*	*capensis*	*capensis*	Common File Snake	Not Evaluated	0
Colubridae	*Gonionotophis*	*nyassae*		Black File Snake	Not Evaluated	0
Colubridae	*Lycodonomorphus*	*inornatus*		Olive House Snake	Not Evaluated	1
Colubridae	*Lycodonomorphus*	*rufulus*		Brown Water Snake	Not Evaluated	0
Colubridae	*Lycophidion*	*capense*	*capense*	Cape Wolf Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*hoplogaster*		South Eastern Green Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*natalensis*	*natalensis*	Eastern Natal Green Snake	Not Evaluated	0
Colubridae	*Philothamnus*	*semivariegatus*		Spotted Bush Snake	Not Evaluated	0
Colubridae	*Psammophis*	*brevirostris*		Short-snouted Grass Snake	Not Evaluated	0

Colubridae	*Psammophis*	*mossambicus*		Olive Grass Snake	Not Evaluated	0
Colubridae	*Pseudaspis*	*cana*		Mole Snake	Not Evaluated	0
Colubridae	*Thelotornis*	*capensis*	*capensis*	Southern Twig Snake	Not Evaluated	0
Cordylidae	*Cordylus*	*vittifer*		Common Girdled Lizard	Not Evaluated	0
Elapidae	*Dendroaspis*	*polylepis*		Black Mamba	Not Evaluated	0
Elapidae	*Naja*	*melanoleuca*		Forest Cobra	Not Evaluated	0
Elapidae	*Naja*	*mossambica*		Mozambique Spitting Cobra	Not Evaluated	0
Gekkonidae	*Afroedura*	*pondolia*		Pondo Flat Gecko	Not Evaluated	1
Gekkonidae	*Hemidactylus*	*mabouia*		Common Tropical House Gecko	Not Evaluated	0
Gekkonidae	*Lygodactylus*	*capensis*	*capensis*	Common Dwarf Gecko	Not Evaluated	0
Gerrhosauridae	*Gerrhosaurus*	*flavigularis*		Yellow-throated Plated Lizard	Not Evaluated	0
Leptotyphlopidae	*Leptotyphlops*	*scutifrons*	*scutifrons*	Peters' Thread Snake	Not listed	0
Leptotyphlopidae	*Leptotyphlops*	*sylvicolus*		Forest Thread Snake	Not Evaluated	1
Scincidae	*Acontias*	*plumbeus*		Giant Legless Skink	Not Evaluated	0
Scincidae	*Afroablepharus*	*wahlbergii*		Wahlberg's Snake-eyed Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*striata*		Striped Skink	Not Evaluated	0
Scincidae	*Trachylepis*	*varia*		Variable Skink	Not Evaluated	0
Typhlopidae	*Afrotyphlops*	*bibronii*		Bibron's Blind Snake	Not Evaluated	0
Varanidae	*Varanus*	*niloticus*		Water Monitor	Not Evaluated	0
Viperidae	*Bitis*	*arietans*	*arietans*	Puff Adder	Not Evaluated	0
Viperidae	*Causus*	*defilippii*		Snouted Night Adder	Not Evaluated	0
Viperidae	*Causus*	*rhombeatus*		Rhombic Night Adder	Not Evaluated	0