PRELIMINARY ECOLOGICAL HABITAT ASSESSMENT FOR THE NEWARK QUARRY; MANDENI LOCAL MUNICIPALITY, ILEMBE DISTRICT MUNICIPALITY; KWAZULU-NATAL

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

Triplo4 Sustainable Solutions has been appointed to undertake the environmental authorization for the proposed tillite* quarry situated in Newark in the Mandeni Local Municipality which falls 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 three mining sites and to provide appropriate management recommendations for the proposed quarry development.

The assignment is interpreted as follows: Determine the current ecological status of the vegetation and fauna and the potential ecological impacts of the Newark tillite Quarry 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 developments and adjacent land usage, and information on the natural environment around the proposed quarry sites.
- An initial site investigation (14th January 2014) to assess the current environmental status of the proposed three alternative quarry sites with special emphasis on any remaining natural habitats.
- Identify problematic areas which require immediate attention as well as management, e.g. degraded areas, reclamation areas, alien vegetation.
- Make management recommendations and mitigatory measures for the current as well as potential environmental impacts pertaining to the proposed tillite mining or quarry development.

* Tillite is accumulated glacial debris that has turned into rock comprising a jumbled mix of boulders, pebbles, gravel and sand set in a matrix of glacial flour (Norman & Whitfield 2006)

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 Newark quarry site.
- To provide a description of any threatened plant or animal (mammals, birds, reptiles and amphibians) occurring or likely to occur within Newark quarry 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 presence of any palustrine wetland habitats and the outer edge of the riparian zone of the rivers as associated drainage lines.
- To determine potential impacts of the mining activities on the remaining natural vegetation and associated fauna.
- To provide management recommendations to mitigate negative and enhance positive impacts of the proposed Newark quarry 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 Newark quarry sites.
- Literature investigations with which to augment field data were necessary.
- Identification of potential ecological impacts that could occur as a result of Newark quarry 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 current summer rainfall season (January 2014). Due to financial as well as time constraints no comprehensive vegetation or faunal surveys were conducted but merely a basic ecological/habitat assessment based on the brief one day site visit.
- The majority of habitats on the site are completely transformed due to current agricultural activities (sugar-cane plantations) as well as previous agricultural activities on the site.
- Due to the dense, high sugar-cane (>2m) access was restricted in certain areas along the drainage lines. Due to the steep topography of the wooded south and east facing slopes no access was possible.
- The majority of habitats surrounding the proposed Newark quarry sites have already been completely transformed due to current agricultural activities (sugar-cane plantations) as well as railway lines and Eskom servitudes.
- The majority of animal species are extremely seasonal only emerging after sufficient heavy early summer rainfall (October-November). No comprehensive faunal surveys have been conducted on the site.
- The majority of threatened faunal species are extremely secretive and difficult to observe even during intensive field surveys conducted over several seasons/ years.
- 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 2010-2014).

2. METHODOLOGY

A survey of the proposed three alternative quarry sites was carried out on foot. As the site is situated within current agricultural areas (recently re-planted and established sugar cane plantations) and fallow or old lands dominated by secondary succession grasslands the majority of natural **Kwazulu-Natal Coastal Belt (CB 3)** vegetation has been transformed. The proposed quarry sites are situated on the mid and upper hillslopes dominated by current sugarcane plantations as well as fallow lands and the vegetation is dominated by sugar cane and secondary succession grasslands and pioneer weedy plant species within completely transformed habitats. Remnant isolated pockets of indigenous woodland occur around the sites especially around the proposed quarry sites (2 and 3) as well as within the steep wooded ravine and riparian zone of the perennial and non-perennial rivers. The site was visited during daylight hours (8h30-16h30) on the 14th January 2014.

It must be stressed that due to 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 sugarcane plantations on the lower; mid and upper hillslopes as well as isolated pockets of Kwazulu-Natal Coastal Belt vegetation in various stages of transformation and degradation; especially within the riparian zone of the rivers. No surveys were conducted in the steep wooded slopes due to inaccessibility of the vegetation and slope.

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 Newark quarry sites, e.g. Patches of undisturbed coastal belt 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

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 2910_ pentad 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 23rd of January 2014) 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 23rd of January 2014). 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 23rd of January 2014) for reptiles.

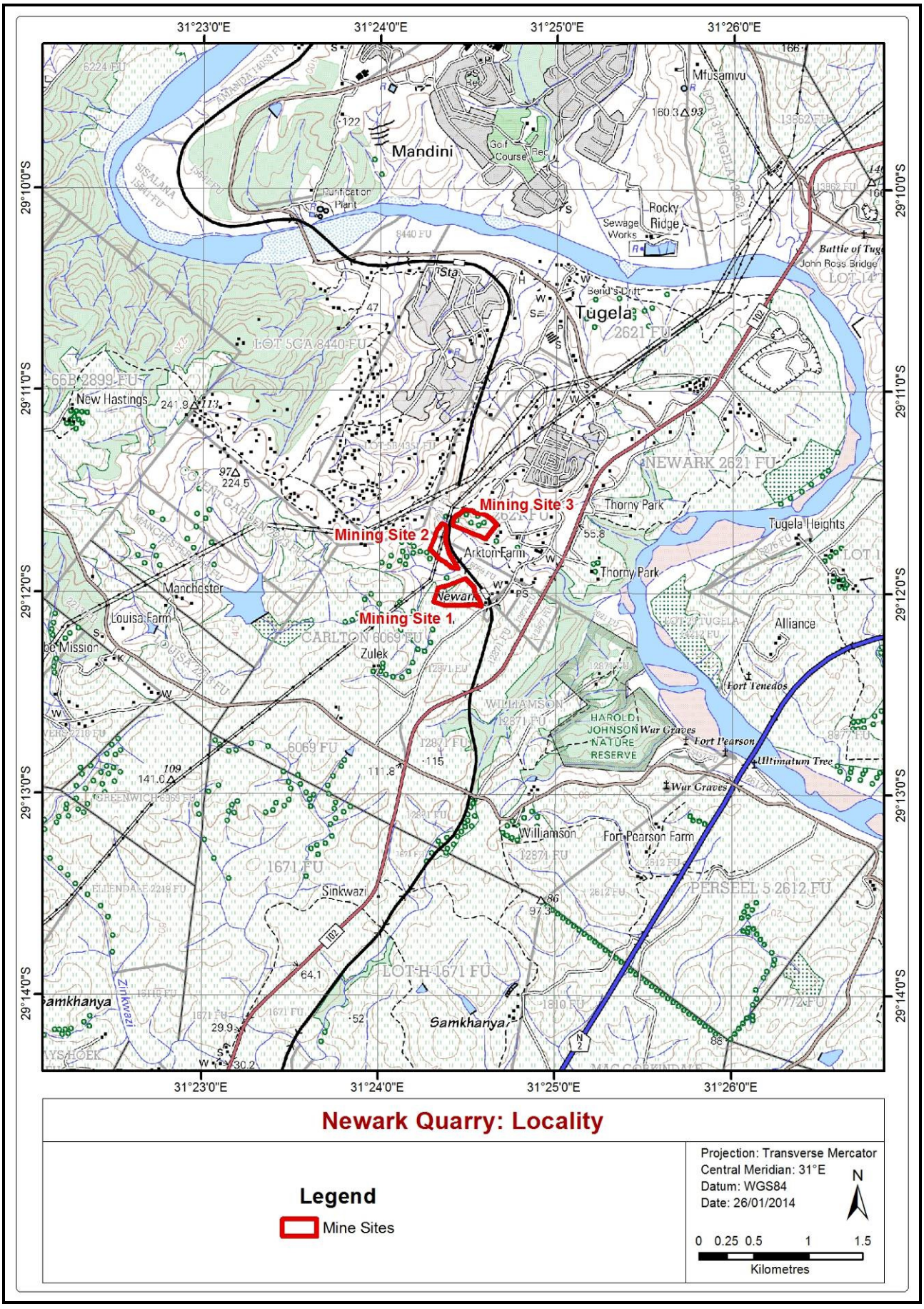

Figure1. Locality map of the proposed Newark quarry sites.

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.

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. This is especially pertinent to the drainage line situated on the eastern boundary of the site. The sugar-cane plantations occur up to the edge of the degraded riparian zone.

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 must be demarcated from the outer edge of the riparian zones of the perennial rivers.

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

- topography associated with the watercourse;
- 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 perennial river on the western and southern boundaries contains an eroded banked active stream channel. Recent sand deposits occur adjacent to the active channel. The macro channel bank displays hydric indicators as well as hydrophilic vegetation as well as exposed tillite bedrock.

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.

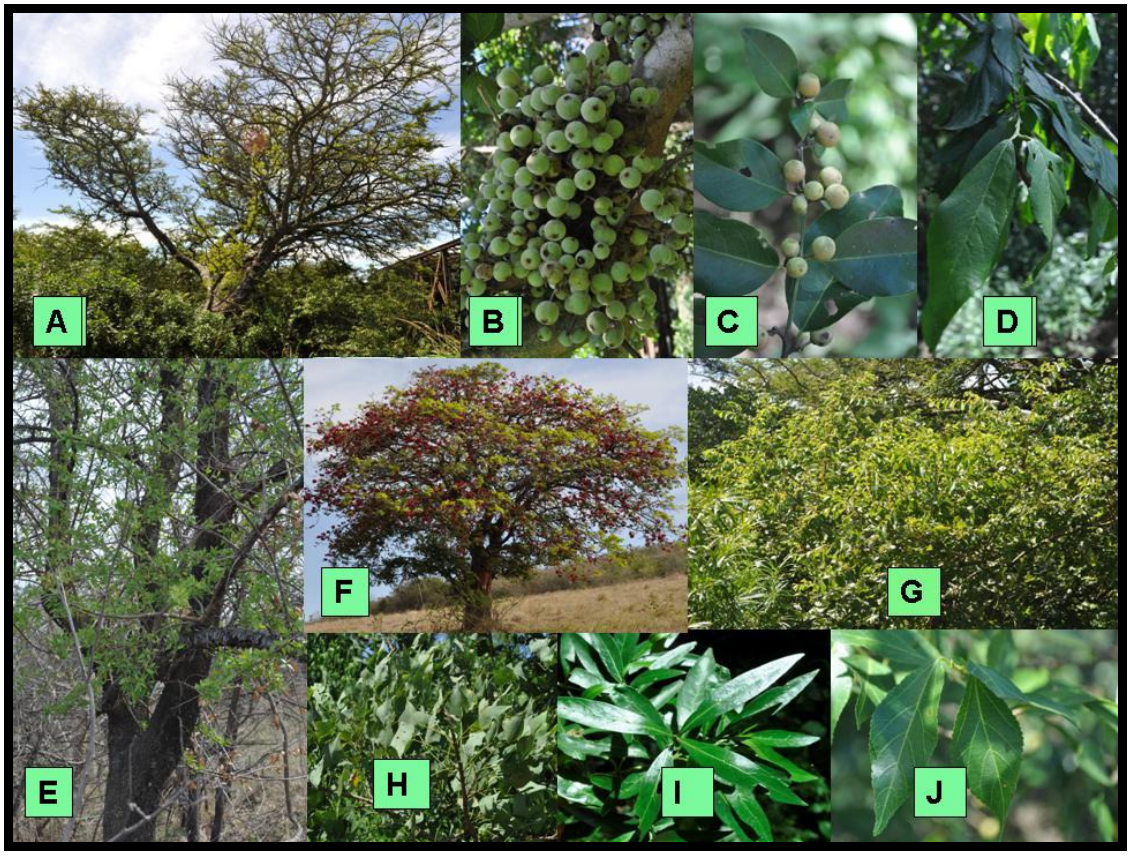

Figure2. A conglomerate of photographs displaying the dominant tree and shrub species observed within the perennial river and associated drainage lines riparian zones. A: Broad-pod Robust Thorn (*Acacia robusta* subsp. *clavigera*); **B:** Sycamore Fig (*Ficus sycomorus* subsp. *sycomorus*); **C:** Cat 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 soil (sand) deposits were observed within the flood bench adjacent to the active channel bank.

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 due to the shallow soils (lithosols) on the tillite bedrock. 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 Newark Quarry sites are situated approximately 1km to the west of the R102 to Mandini on an existing sugar-cane farm approximately 20 km north of Stanger on the North Coast of Kwazulu-Natal. Access is via the R102 and P428 district road. The Newark quarry sites are located under the Mandeni Local Municipality which falls under the Ilembe District Municipality.

The site falls within the **Kwazulu-Natal Coastal Belt (CB 3)** vegetation unit (Mucina & Rutherford 2006). The Kwazulu-Natal Coastal Belt vegetation unit is distributed along the coastal strip of Kwazulu-Natal from near Mtunzini in the north, via Durban to Margate and just short of Port Edward in the south. Altitude ranges from 0-600 m, with the altitude at the sites ranging from 174- 234 m. The major land-use surrounding the site is intensive sugar-cane farming. The majority of the hillslopes and valley bottoms have been transformed into terraced mono-cultured sugar-cane plantations.

Topography and catchment

The proposed Newark quarry is situated within an undulating environment. The major land features on the site include the lower-lying perennial river on the southern and western boundaries of the sites and extremely steep wooded ravines mainly on the south and east facing slopes. The highest areas on the site are situated on the upper hillslopes around the quarry site 1 as well as wooded hillslopes around the quarry site 3 and the lowest along the southern boundary along the perennial river. The perennial river falls within the **Thukela Water Management Area** and the **V50 D Quaternary Catchment**.

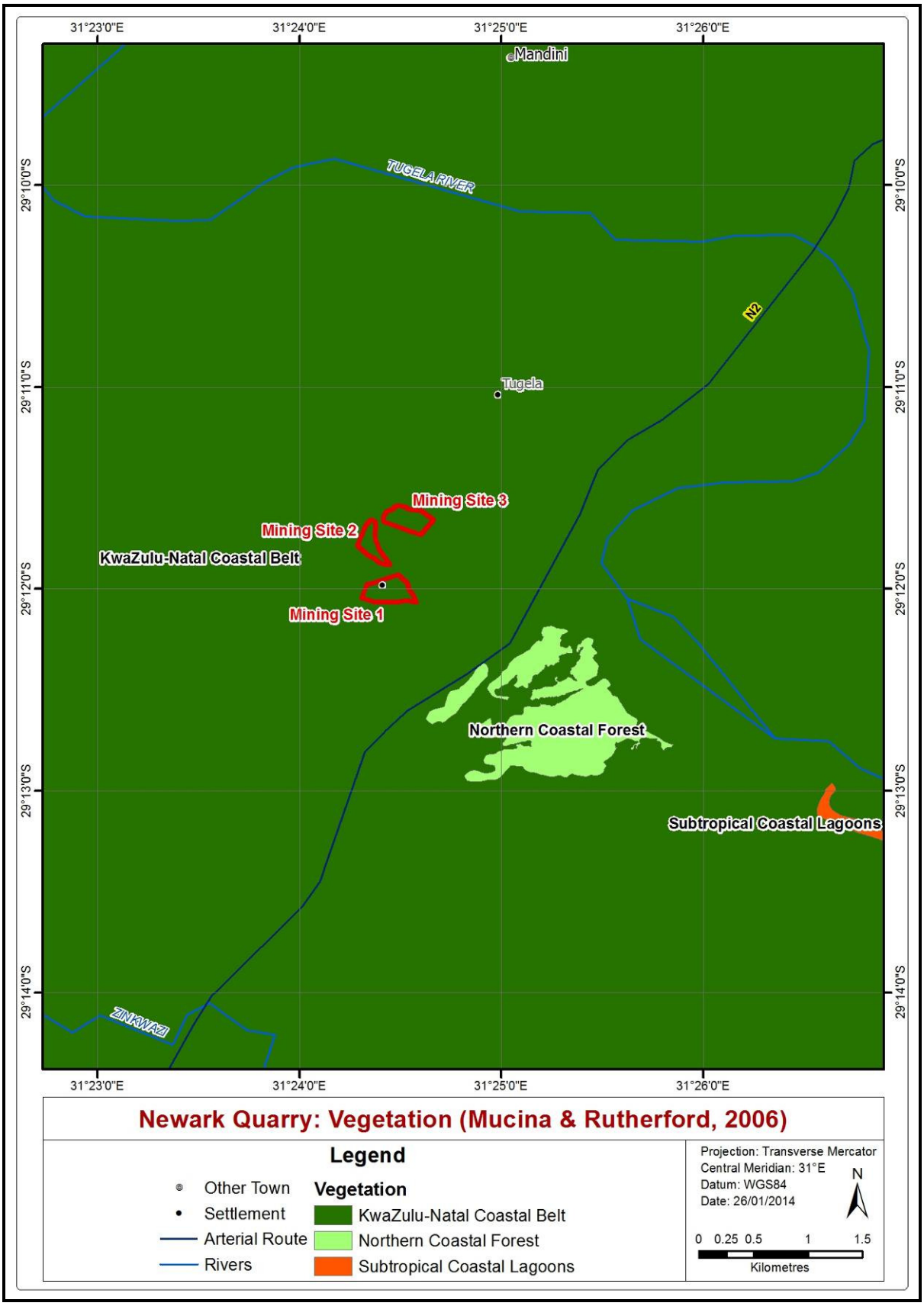

Figure3. Vegetation map of the proposed Newark Quarry sites situated within the Kwazulu-Natal Coastal Belt (CB 3) vegetation unit (Mucina & Rutherford 2006).

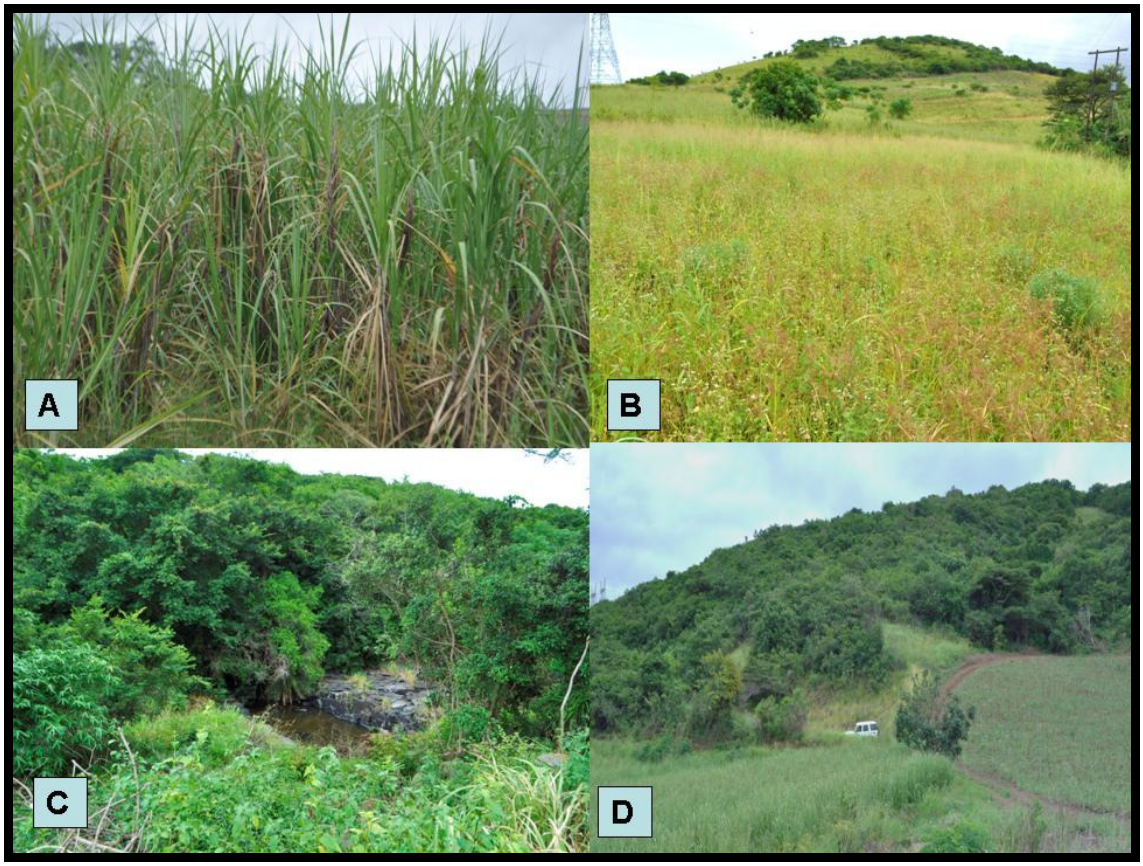

Figure4. A conglomerate of photographs displaying the dominant vegetation units observed around the proposed tillite quarry sites. A: The majority around the proposed mining site 1 is situated within completely transformed terraced hillslopes dominated by mono-cultured sugar cane plantations. An old staff quarters occur on the upper slopes and scattered indigenous trees around the summit. **B:** The mining site 2 is situated within fallow sugar cane fields and is dominated by secondary succession grasslands and weedy pioneers. **C:** A perennial river occurs to the south of mining sites 2 and 3. Remnant pockets of indigenous open and closed woodland occurs within the riparian zone of the river. Evidence of wood harvesting within the riparian zone as well as edge effects of the adjacent sugarcane plantations (increased siltation and sedimentation). **D:** Mining site 3 is situated within a patch of moist woodland on the south facing hillslopes adjacent to extensive sugar cane plantations on the lower slopes towards the river.

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 of the proposed Newark quarry sites are dominated by transformed vegetation units and habitats due to previous and current agricultural activities (sugar-cane *Saccharum officinarum* plantations). The adjacent areas are totally transformed and dominated by sugarcane plantations. Remnant pockets of indigenous tree species occur around quarry site 3 as well as along the perennial river. An open and closed woodland riparian zone occurs along the river as well as steep south and east facing rocky slopes situated outside the western boundary of the quarry site 1. Mining site 3 is situated within a remnant patch of closed woodland on the mid and upper slopes. Several alien invasive plant and tree species occur on the site especially within old agricultural lands and the railway and road reserves.

Existing impacts occurring within the proposed Newark quarry sites and surrounding area include:

- Extensive vegetation transformation around the homesteads, livestock enclosures, grazing pastures and agricultural lands.
- Extensive vegetation degradation due to overgrazing by cattle and goats with the remnant grasses grazed to the ground.
- Extensive soil erosion (surface, rill and gully) especially along the perennial drainage line. This is due to poor stormwater management as well as uncontrolled livestock drinking activities along the perennial drainage lines as well as removal of the riparian vegetation during wood harvesting activities.
- Alteration of then natural fire regime. Frequent fires at the incorrect time of year.
- Wood harvesting and tree clear-felling occurs around the sites.
- Thicket formation and severe bush encroachment occurs in the old agricultural lands as well as livestock enclosures by *Acacia spp.* and *Dichrostachys cinera*
- Numerous human and livestock pathways bisecting the sites.
- 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 rivers/drainage lines.

- Reed invasion in certain sections of the drainage lines 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.
- 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 as well as fertiliser and pesticide runoff from adjacent agricultural lands.
- Alteration of the natural hydrological patterns of the perennial drainage line by artificial embankments as well as access roads.

Figure5. The geology of the site is dominated by Ordovician Natal Group sandstone as well as a Dwyka tillite. The depth of the soils varied throughout the site. Relatively deep soils (1.2m) occur within certain areas whilst other areas are situated on a very shallow soil layer (< 50cm). The tillite is evident within eroded areas as well as the exposed bedrock within the active channel of the perennial river..

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 upper and midslopes of the proposed sites were light brown to grey sandy-loams with clear hydrixc indicators of temporary wetness and are situated on a hard sandstone/tillite layer at around 20-50cm. Hydromorphic melanic clays of seasonal wetness were observed within the eroded drainage line situated outside the southern boundary of the site Large sections of the riparian zone had recent deposits of fine sands from poor soil conservation within the adjacent poorly vegetated hillslopes (sugar-cane) plantations.

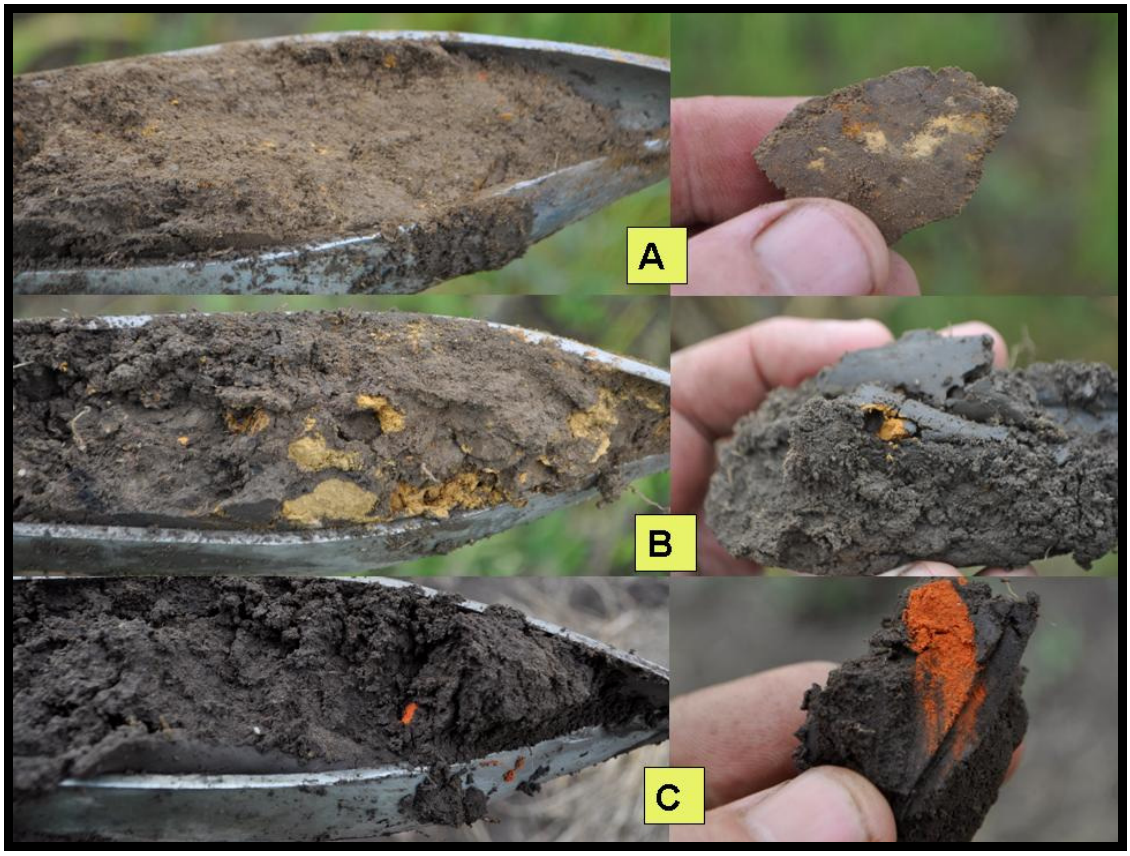

Figure6. A collage of photographs displaying various soil auger samples. A: The majority of the hillslopes on and surrounding the site comprises well drained brown sandy soils. Evidence if iron and manganese concretions (orange and yellow mottling) from ground level to 50cm. These are redoximorphic features indicative of hydric soils of temporary wetness. **B & C:** Soils are grey clays (high in organic matter) as well as distinct large red-orange iron and yellow manganese 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 or inundation.

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. DOMINANT VEGETATION UNITS OBSERVED AROUND PROPOSED QUARRY SITES

6.1 QUARRY SITE 1-TRANSFORMED HILLSLOPES (SUGARCANE)

Vegetation Type	Kwazulu-Natal Coastal Belt (CB3)	**Tree cover**	0-2 %
Soil	Light brown to grey sandy-clay soils as well as sandy-loams	**Shrub cover**	0-1 %
Topography	Undulating Hillslopes	**Herb cover**	0-10 %
Land use	Sugar-Cane Plantations	**Grass cover**	0-10 %
Dominant spp.	*Saccharum officinarum, Bidens pilosa, Cyperus esculentus, Cyperus rotundus subsp. rotundus, Cynodon dactylon, Hyparrhenia fillipendula, Panicum maximum, Panicum shinzii, Pennisetum purpureum, Setaria megaphylla, Melinis repens* subsp. *repens, Gomphrena celosiodes, Veronica persica, Richardia brasiliensis, Panicum ecklonii, Panicum maximum, Imperata cylindrica, Melinis repens, Tecomaria capensis, Leonotis leonorus*		
Alien Invasive Species	*Ageratum conyzoides*, Solanum sisymbrifolium*, Chromolaena odorata*, Ipomoea alba*, Ipomoea indica*, Ipomoea purpurea*, Lantana camara*, Ricinus communis*, Senna didymobotrya*, Solanum mauritianum*, Tithonia diversifolia**		

* alien invasive vegetation

This is the largest vegetation unit in which the proposed quarry sites are situated. The vegetation within the proposed quarry site 1 comprises completely transformed terraced mono-cultured Sugar-Cane (*Saccharum officinarum*) plantations. Pioneer and secondary grass species observed within the crescent around an old housing compound included *Aristida congesta, Aristida junciformis, Cynodon dactylon, Digitaria spp., Chloris virgata, Sporobolus africanus, Panicum maximum, Cymbopogon sp., Eragrostis curvula, Imperata cylindrica, Hyparrhenia hirta* and *Melinis repens*. The grasses (sugarcane) cover varies from bare batches to approximately 0-95% of the site. The forb and herb layers are poorly developed <5%. Forbs were dominated by pioneer weedy plant species such as Peanut-Butter Cassia (*Senna didymobotrya**) Tall Fleabane (*Conyza albida**), Flax-Leaf Fleabane (*Conyza bonariensis**), Common Black jack (*Bidens pilosa*), Castor-Oil Plant (*Ricinus communis*),* Bugweed (*Solanum mauritianum**), Tall Khaki weed (*Tagetes minuta**) Mexican Poppy (*Argemone ochroleuca**), Ambrosia *artemisifolia, Ageratum houstonianum*, Ageratum conyzoides*, Conyza bonariensis** and *Parthenium hyserophorus*.*

Two Marula (*Sclerocarya birre*a subsp. *caffra*) were observed adjacent to the old staff compound on the summit. Trees are protected for a variety of reasons, and some species require strict protection while others require control over harvesting and utilization. The Department of Agriculture, Forestry and Fisheries (DAFF) will have to be approached to obtain the required permits for the removal of the Marula *Sclerocarya. birrea* ssp. *caffra*. No red data plants were observed during the brief field survey or are likely to occur within these totally transformed habitats. These reas are of low sensitivity and conservation potential due to extensive habitat transformation and degradation. Mining activities must be restricted to the transformed hillslopes and no mining activities within 32 m of the wooded river outside the western boundary of the proposed tillite mining area.

6.3 QUARRY SITE 2-SECONDARY SUCCESSION GRASSLANDS

Vegetation Type	Kwazulu-Natal Coastal Belt (CB3)	**Tree cover**	0-5 %
Soil	Light brown to grey sandy-clay soils as well as sandy-loams	**Shrub cover**	0-5 %
Topography	Undulating Hillslopes	**Herb cover**	0-10 %
Land use	Vacant (old/fallow sugar cane lands)	**Grass cover**	0-90 %
Dominant Tree Species	*Acacia robusta, Acacia natalitia, Acacia nilotica, Combretum molle, Spirostachys africana, Cussonia spicata, Dombeya rotundifolia, Strychnos madagascariensis, Schotia brachypetala, Syzigium cordatum, Ziziphus mucronata, Aloe marolthii* subsp. *marlothii, Albizia adianthifolia, Carissa bispinosa, Brachylaena discolor, Bridelia micrantha, Trema orientalis, Erythrina lysistemon, Trichillia emetica, , Ehretia rigida subsp. rigida, Ficus natalensis, Strelitzia nicloai,*		
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	*Hypoxis argentea, Tagetes minuta, Cirsium vulgare*, Cyanotis speciosa, Thunbergia dregeana, Verbena aristigera*, Pentasia*		

	angustifolia, Scadoxus puniceus, Bekeyha speciosa, Berkheya setifera, Hibiscus sp.
Alien Invasive Vegetation	*Arundo donax*, Canna indica*, 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*,*

The majority of the proposed Newark Quarry site 2 is situated within historical transformed agricultural areas (old sugarcane plantations) dominated by secondary succession grasslands and pioneer weedy plant species. A few scattered pockets of indigenous tree species (mixed bushveld) occur on the eastern boundary adjacent to the railway line. The tree density increases within proximity of the lower-lying river.

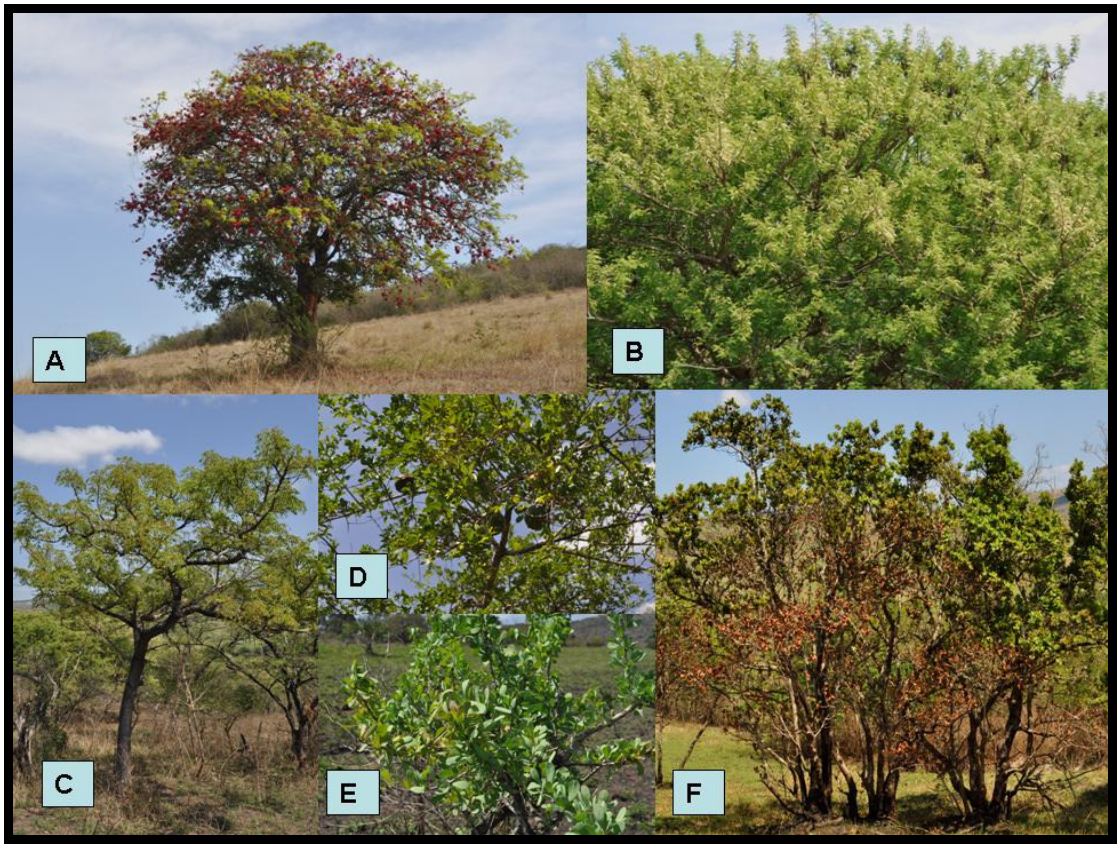

Figure7. A collage of photographs displaying dominant tree species observed within the riparian zone of the perennial river. A: Weeping Boer-Bean (*Schotia brachypetala*); **B:** Common Hook-Thorn (Acacia caffra); **C:** Marula (*Sclerocarya birrea* subsp. *caffra*). **D:** Spiny Monkey Orange (*Strychnos spinosa*), **E:** Common Spikethorn (*Gymnsopsporia buxifolia*) and **F:** Umdoni or Waterberry (*Syzigium cordatum*).

The riparian vegetation along the 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. *pavettoides;* 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**).

No rare or threatened plants were recorded within the transformed vegetation units of the proposed quarry site 2. The proposed site southern boundary is however situated adjacent to a perennial river as well as a remnant patch of indigenous woodland along the railway line reserve on the eastern boundary of the site. All remaining pockets of indigenous tree and shrub species, especially to the west of the site should be conserved as well as the proposed 32 m buffer zones along the perennial and non-perennial drainage lines. This is the 2nd preferred site from an ecological perspective as the majority of vegetation has been historically transformed. The site however is located adjacent to the river as well as bisected by an existing Eskom transmission line as well as a railway line. This will potentially reduce the size of the mining area considerably. The access road to the mining area bisects the perennial river and runs in close proximity to the edge of the riparian zone and could result in increased levels of siltation and sedimentation as well as road fatalities of dispersing animals to and away from the river.

6.3 QUARRY SITE 3- REMNANT POCKETS OF COASTAL BELT VEGETATION ON SOUTH FACING SLOPES

Vegetation Type	Kwazulu-Natal Coastal Belt (CB3)	**Tree cover**	0-60 %
Soil	Light brown sandy soils as well as sandy-loams	**Shrub cover**	0-10 %
Topography	Undulating Hillslopes	**Herb cover**	1-30 %
Land use	Sugar-Cane Plantations (Vacant on upper hillslopes)	**Grass cover**	0-60%
Indigenous Tree species (isolated pockets)	*Albizia adianthifolia, Carissa bispinosa, Brachylaena discolor, Bridelia micrantha, Trema orientalis, Erythrina lysistemon, Trichillia emetica, , Ehretia rigida subsp. rigida, Sclerrocarya birrea subsp. caffra*δ *Ficus natalensis, Acacia natalitia, Acacia nilotica, Strelitzia nicolai, Antidesma venosum,*		
Dominant Grass spp.	*Hyparrhenia hirta, Cynodon dactylon, Panicum ecklonii, Panicum maximum, Aristida junciformis* subsp. *galpinii, Setaria sphacelata, Heteropogon contortus, Imperata cylindrica, Hyparrhenia hirta, Hyparrhenia fillipendula, Panicum maximum, Panicum shinzii, Pennisetum purpureum, Setaria megaphylla, Melinis repens* subsp. *repens, Eragrostis curvula*		
Dominant Forb species	*Tecomaria capensis, Leonotis leonorus, Ledebouria floribunda, Centella sp., Merremia tridentate, Dicerocaryum eriocarpum, Asclepias fruticosa, Solanum panduriforme, Commelina africana, Commelina erecta, Sida cordifolia, Ipomea crassipes, Hibiscus*		

δ protected tree species

	trionum, Schizoglossum cordifolium, Asclepias physocarpa, Turbina oblongata, Evolvulus alsinoides, Aptosimum procumbens, Pterodiscus speciosus, Harpagophytum procumbens, Blepharis subvolubilis, Barleria sp., Cucumis zeyheri, Cucumis metuliferus, Berkheya radula, Senecio coronatus, Senecio venosus, Senecio isatidioides, Vernonia hirsuta, Helichrysum caespititium, Helichrysum aureonitens, Senecio latifolius, Stomatanthes africanus, Geigeria burkei, Indigofera sanguinea, Indigofera zeyheri, Tephrosia grandiflora, Tagetes minuta,*
Alien Invasive Species	*Ageratum conyzoides*, Melia azedarach*, Chromolaena odorata*, Eucalyptus grandis*, Ipomoea alba*, Ipomoea indica*, Ipomoea purpurea*, Lantana camara*, Ricinus communis*, Senna didymobotrya*, Schinus molle*, Solanum mauritianum*, Tecoma stans*, Tithonia diversifolia*, Schinus terebithifolius*, Thevetia peruviana*, ,Tecoma stans, Leucaena leucocephala*, Psidium guajava*,*

* alien invasive vegetation

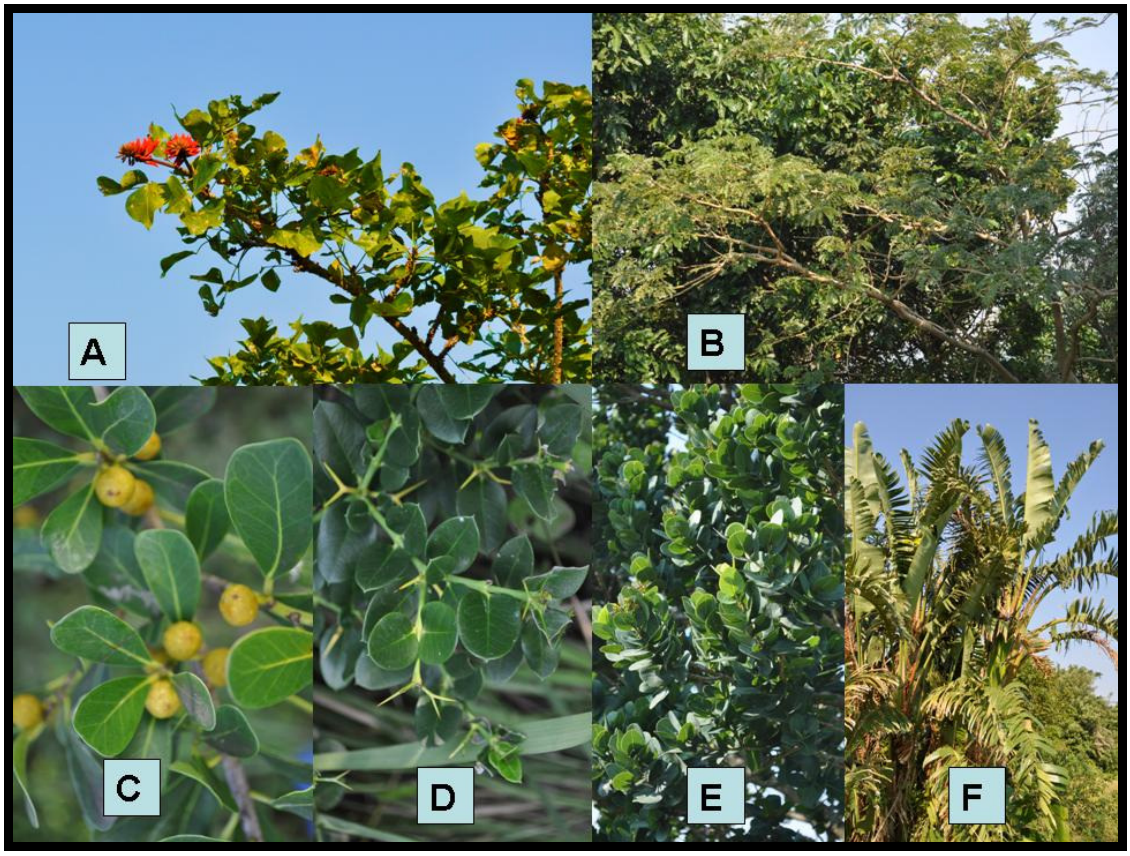

Figure8. A conglomerate of photographs displaying the remnant indigenous tree species observed within the indigenous pockets within and around the site. A: Sacred Coral-Tree (*Erythrina lysistemon*); **B:** Flat-Crown Albizia (*Albizia adiathifolia*); **C:** Coastal Strangler Fig (*Ficus natalensis*); **D:** Forest Num-num (*Carissa bispinosa*); **E:** Umdoni Waterberry (*Syzigium cordatum*); **F:** Coastal Strelitzia (*Strelitzia nicolai*).

The dense Kwazulu-Natal Coastal Belt occur within mainly the non-arable areas of the site including the steep south and east facing rocky slopes. Surveys were severely restricted in these areas due to the steepness of the slopes as well as dense closed vegetation. No red data plants were observed during the brief field survey although suitable habitat occurs for certain red listed species such as the Large-leaf Onionwood *Cassipourea gummiflua* var. *verticillata* which is listed as 'Vulnerable'. 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. More intensive surveys are required in these areas to ascertain the current conservation status of threatened plant species in this area.

These remnant pockets or islands of coastal belt vegetation are considered to be of high sensitivity as they provide critical habitat for remaining plant and animal species. The remaining indigenous pockets of vegetation should be conserved and appropriately rehabilitated with the removal of alien invasive vegetation a priority. The understory vegetation should be re-vegetated with indigenous (to the area) plant and shrub species. This is the least preferred site from an ecological perspective due to the coastal vegetation on the rocky hillslopes as well as proximity to the river approximately 140 m to the south of the proposed quarry site. The access road to the site bisects the perennial river.

6.4 ALIEN INVASIVE VEGETATION

Figure9. A conglomerate of photographs displaying the dominant alien invasive vegetation observed within and immediately adjacent to the proposed Newark quarry 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*, Schinus terebithifolius*, Senna didymobotrya*, Solanum panduriforme*, Solanum mauritianum*, Tithonia diversifolia*∗.

* exotic or alien invasive vegetation

6.5 PROTECTED TREE SPECIES

One protected tree species was recorded adjacent to the old staff compound on the crescent of the hill adjacent to the quarry site namely two 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.

6.6 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 perennial river and within the fire- protected forest pockets mainly on the south and east facing slopes around the proposed sites. *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 or are likely to occur within the completely transformed hillslopes (sugar cane fields). More intensive surveys are required in order to ascertain the presence of threatened plant species within the wooded pockets.

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 tillite mining 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 14th of January 2014. 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 & Chimiba 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.

No suitable breeding habitat in the form of seasonal pools or valley bottom wetlands were observed within the proposed mining sites. The hillslope seepage wetlands have been completely transformed into sugar cane plantations as well as access roads. The most favourable breeding habitat occurs within the perennial river (seasonally inundated pools). The non-perennial drainage lines situated adjacent to mining site 3 is poorly defined and extremely degraded and dominated by sugar cane and offers no suitable breeding habitat for amphibians. Several frog species could potentially uitilise the proposed sites for foraging and exploratory/dispersal areas including Painted Reed Frogs (*Hyperolius marmoratus*), Greater Leaf-folding Frog (*Afrixalus fornasinii*) 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 within mining site 3 and surrounding the sites include the endemic Bush Squeaker (*Arthroleptis wahlbergi*) as well as Plaintive Rain Frog (*Breviceps verrucosus*).

Figure10. A Natal Sand Frog (*Tomopterna natalensis*) was observed on the informal access road to mining site 3.

Table2. 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	Stagnant water bodies containing large stands of saw grass Cyperus immensus and bulrushes

		Edward	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, Gauteng.	Streams, rivers or other places where water flows slowly but also in lothic or standing water
Bronze Caco	*Cacosternum nanum*	Common species in Kwazulu-Natal	Vleis, inundated grassland and sedge pans, temporary roadside pools and rock puddles

Plaintive Rain Frog	*Breviceps verrucosus*	Eastern Parts of South Africa	Terrestrial breeder with eggs laid in moist leaf litter.
Bush Squeaker	*Arthroleptis wahlbergi*	Endemic to the East Coast of South Africa	Terrestrial breeder with eggs laid in moist leaf litter.

Threatened species

No red listed frog species are known from the 2931 BA Quarter Degree Grid Cell (QDGC) or are likely to occur within the proposed mining sites. Site 1 is preferred from an amphibian perspective as the entire area is completely transformed and the furthest from any potential breeding sites along the perennial river.

7.2 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. Several rocky outcrops were observed for rupicolous reptile species especially within the proposed site 3 as well as along the perennial river and riparian zone.

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. Reptile species recorded during the survey included Nile Monitor (*Varanus niloticus*); Spotted Bush Snake (*Philothamnus variegatus*), Southern Tree Agama (*Acanthocercus atricolis*) and a Variable Skink *Trachylepis* (*Mabuya*) varia. All reptiles were recorded from the perennial river and riparian zone. Low reptile diversity is expected in the transformed sugar cane plantations. A probable species list is provided in Table3 below.

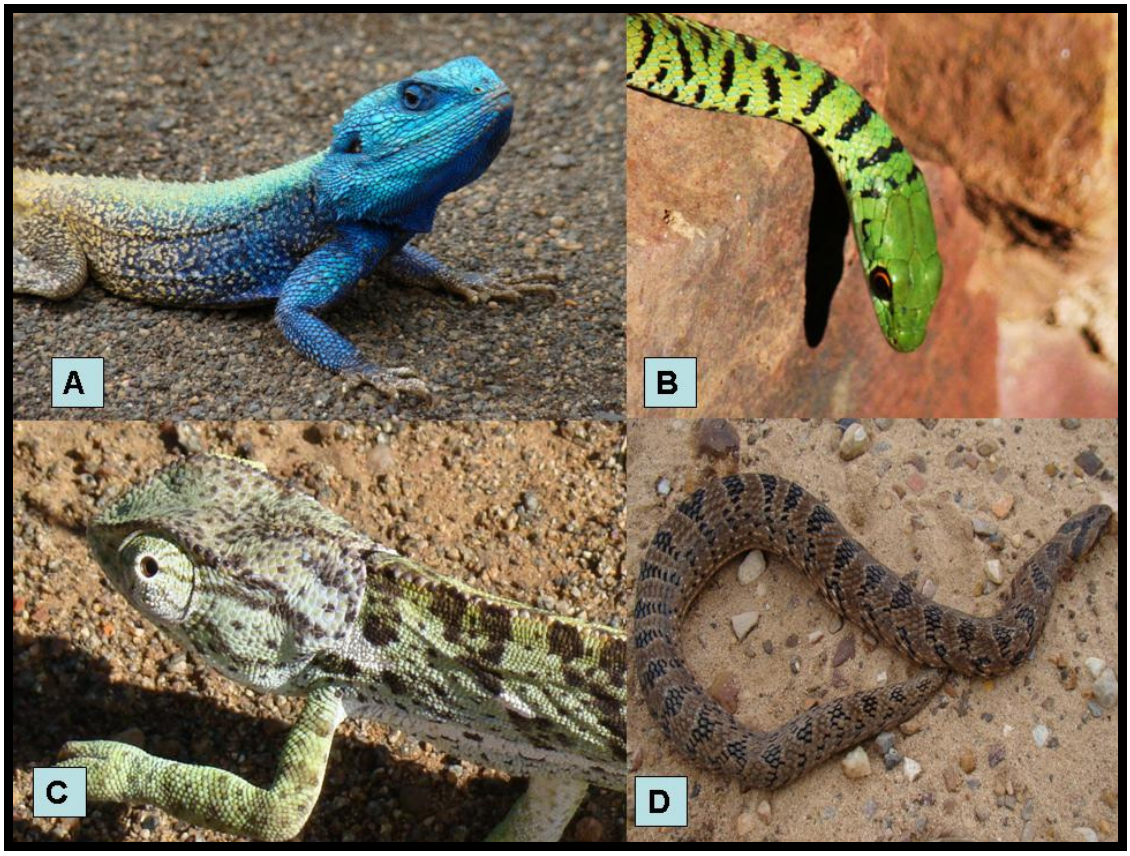

Figure11. A conglomerate of photographs displaying the reptile species likely to occur within the riparian zone of the perennial river. A: Male Southern Tree Agama (*Acanthocercus atricolis*), **B:** Spotted Bush Snake (*Philothamnus semivariegatus* **C:** Flap-necked Chameleon (*Chamaeleo dilepis*) **D:** Rhombic Night Adder (*Causus rhombeatus*).

Table3: 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 from the site 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 semivariegatus*
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*

* recorded during brief field survey

Figure12. The red listed 'Vulnerable' Green Mamba (*Dendroaspis angusticeps*) occurs in coastal, dune and escarpment forests.

Threatened Species

No threatened reptile species are likely to occur on the mining sites 1 and 2. Suitable habitat occurs within mining site 3 within the coastal forest patches to the north, south, east and west for the arboreal red listed 'Vulnerable' Green Mamba (*Dendroaspis angusticeps*).

7.3 AVIFAUNA/BIRDS

Thirty-eight (38) 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 zone of the perennial river as well as several granivorous species within the secondary grasslands.

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

Roberts' Number	Common name	Scientific Name
94	Hadedah Ibis	*Bostrychia hagedash*
149	Steppe Buzard	*Buteo vulpinus*
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*
444	Little Bee-eater	*Merops pusillus*
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

Several threatened bird species have been recorded in the 2931 BA grid square within which the study area is situated including African Broadbill, Wattle-eyed Flycatcher or Black-throated Wattle-Eye, Pied Mannikin, African Finfoot and African Crowned Eagles. No threatened bird species were recorded during the brief survey. The perennial river and riparian zone could potentially provide suitable habitat for Half-collared Kingfishers. 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 mining site 1 and 2 will form critical habitats for any threatened bird species.

7.4 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 stables are urban exploiters such as the House Rat and House Mouse. A Marsh or Water Mongoose was observed crossing over the access road into the sugar-cane fields. Evidence of Common Duiker as well as African Porcupine was observed within the riparian zone of the perennial river. Sugar- cane plantations 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.

Table5: 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

Figure13. Several Vervet Monkeys (*Cercopithecus aethiops pygerythrus*) were observed foraging within a Cluster Fig (*Ficur sur*) within the riparian zone of the perennial river.

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 sugar-cane plantations and 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 and feral cats. It is highly unlikely that the proposed mining sites 1 and 2 constitutes significant habitat for any species of threatened mammal species; or mammal species in general.

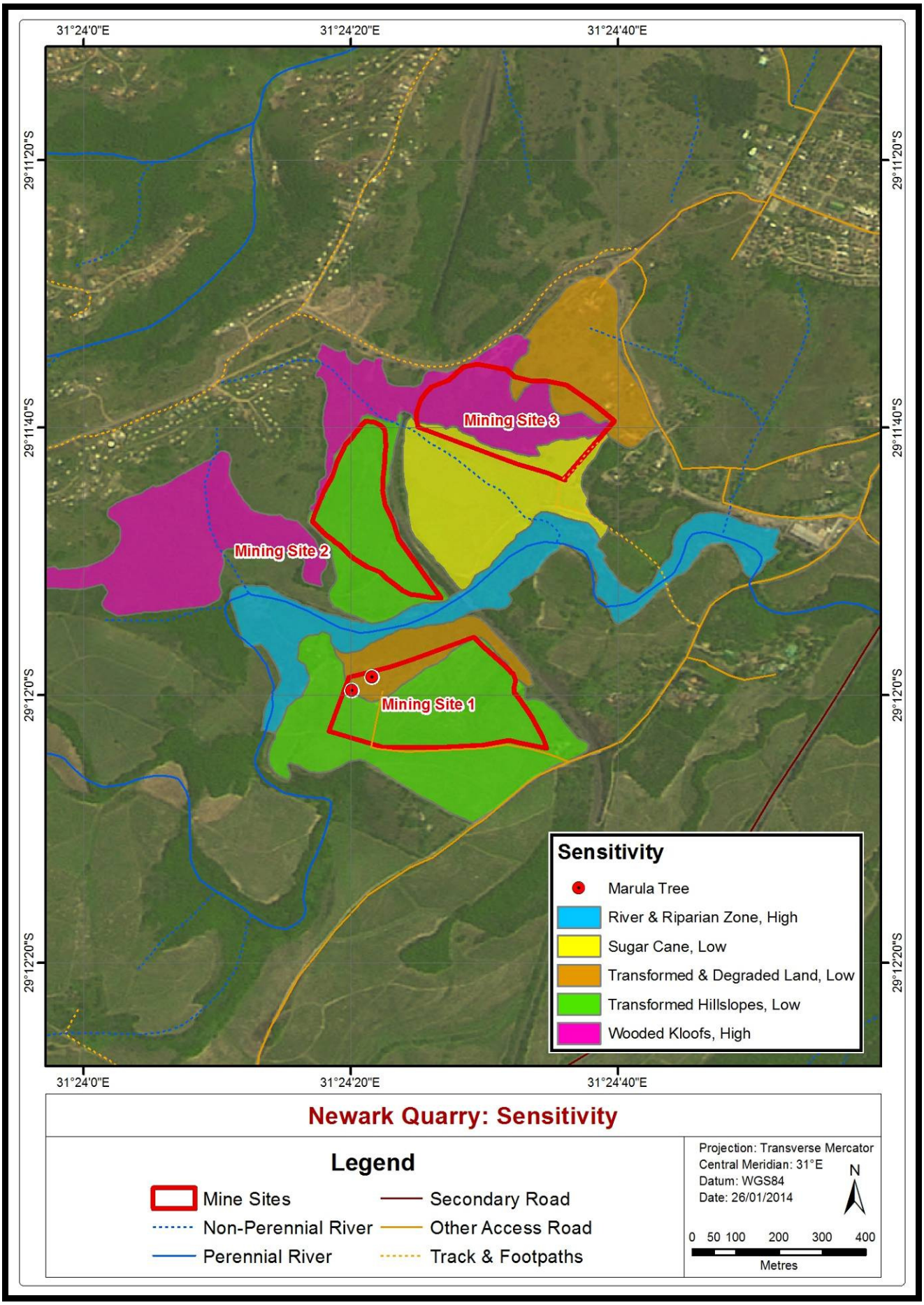

Figure14. Preliminary sensitivity map for the proposed Newark quarry.

8. SENSITIVE HABITATS

8.1 PERENNIAL RIVER and RIPARIAN ZONE

The perennial river and associated coastal belt riparian zone 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 or reach of riparian vegetation along the perennial 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 adjacent agricultural activities. Remnant patches of indigenous closed woodland riparian vegetation occurs along the river. 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 sp., Grewia occidentalis, Ficus sur, Dicrostachys cinerea, Dombeya rotundifolia, 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 perennial river and associated riparian zone is protected under the National Water Act 36 of 1998. The perennial river and associated riparian zone is considered to be of **High sensitivity** due to its **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 must be placed from the outer edge of the macro-channel bank or closed wooded riparian zone. The current sugarcane plantations are situated within the 32 m buffer zone. Future mining and agricultural activities must be located outside the 32 m buffer zone. The 32 m buffer zone should be appropriately rehabilitated and re-vegetated with indigenous grass, shrub, and tree species.

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8.2 WOODED KLOOFS/HILLSLOPES

The closed woodland vegetation units found within the south and east facing rocky hillslopes and ravines and riparian areas of rivers and drainage lines offer important habitat for several animal species especially birds. These highly sensitive habitats have a diverse floristic component as well as offering favourable habitat for several rupicolous faunal species. Due to the dense nature of the closed vegetation unit as well as steep topography access was limited to the lower-lying areas around mining site 3 and along the perennial river. No mining activities should be allowed within the closed woodland areas as around mining sites 1 and 2. Mining site 3 is the least preferred as it will destroy a large section of closed woodland on the mid and upper slopes. These areas should be conserved and incorporated within the privately conserved open space of any future developments and connected with appropriate buffer zones between the lower-lying perennial river and riparian zone. These remaining pockets of indigenous vegetation form important dispersal and refuge habitats around the impoverished sugar-cane plantations. These pockets have become degraded due to the annual burning of the sugar-cane and the understory vegetation has become dominated by pioneer weedy and alien invasive plant species around the fringes adjacent to the sugar-cane fields.

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

9.1. Destruction of Faunal Habitat

At a local Newark scale the proposed mining sites 1 and 2 offers limited suitable habitat for faunal species due to extensive habitat transformation and degradation on and surrounding the site. As a result of the proximity of human settlements in the area and the disturbed nature of the environment, it is unlikely that animal distributions in the area reflect the original state. High levels of human disturbances associated with the existing human settlements and habitat degradation and transformation due to present agricultural activities occur around the proposed quarry site 1 and 2. This has resulted in impoverished habitats with limited faunal diversity. The perennial river and riparian zone and wooded hillslopes adjacent to the proposed quarry sites offers the most important habitat (especially for birds) for remaining plant and animal species.

As the preferred mining site 1 is situated within an existing or working sugar-cane farm as well as old staff compounds the majority of vegetation is completely transformed or heavily degraded. Alteration to the original faunal composition has already occurred within the site and the secretive or sensitive species have located suitable habitat away from the site within the remaining wooded coastal pockets as well as along the river. A detailed map of the exact mining area or quarry site will be required after additional geotechnical surveys have been conducted. A wetland functional assessment will be required for any mining activities within the transformed hillslope seepage areas on mining site 1.

The remaining fauna associated with the site require the conservation of the south and east facing wooded kloofs, the perennial river with a 32 m rehabilitated 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 mining of tillite within the degraded and transformed hillslope vegetation (sugar-cane plantations) on the mining site 1 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

Since the vegetation of the proposed borrow pit is heavily degraded the impact on the vegetation is minimised. There were no sensitive, unique or Red Data species recorded within the mining site 1 and 2. Nevertheless, during mining activities clearance of vegetation should be minimised to the appropriate area. Any remaining geophytes and bulbous plants in the effected areas should be removed and replanted in suitable habitat from the mining site.

During the mining phase or establishment of the quarry workers must be limited to areas under mining and access to the undeveloped areas, especially to the perennial river and riparian zone) must be strictly regulated (ideally fenced off and “no-go” areas during construction activities). 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 river. No animals should be intentionally killed or destroyed and poaching and hunting should not be permitted on the site. No air rifles or pellet guns should be permitted.

9.2 Erosion and Surface runoff

Mining areas are characterised by large cleared areas and soil stockpiles Run-off is generally discharged to surface water systems and often contains pollutants. Pollutants range from organic matter, including sediments, plant materials and sewage, to toxic substances such as heavy metals, oils and hydrocarbons. Mining activities associated with vegetation and soil removal 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.

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. Runoff from the mining areas and access roads should be channelled through natural grassland buffer areas or into artificially created shallow seasonal retention/attenuation ponds reducing the erosional force and the potential risk of contamination and erosion of the lower-lying drainage lines as well as the river. Several rill erosion channels were observed within the run off areas within the sugar-cane plantations.

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.

9.3 REHABILITATION AND RE-VEGETATION

- After the cessation of mining activities the quarry or borrow pit area 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 edges surrounding any pit should be gently sloped preventing possible drowning of animals, livestock and children in the area.
- The use of the exotic invader Kikuyu Grass (*Pennisetum clandestinum*) is not recommended and should be prohibited. The use of an indigenous species such as Couch Grass *Cynodon dactylon* or Buffalo Turf Grass *Stenotaphrum secundatum* is recommended; it occurs naturally in the area as well as being non-invasive and requiring less water than exotic species.
- The grass mix should consist of a mix of quick covering grasses (pioneer species), mat-forming grasses (e.g. *Digitaria eriantha, Cynodon dactylon, Imperata cylindrica, 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.
- Shaping of the borrow pit edges and exposed soil profile to blend in with the gradients of the surrounding landscape.

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

Rehabilitation methods are detailed in Table 6 below.

Table 6: Recommended rehabilitation measures.

Step	1.1.1 Method	1.1.2 Equipment
1	Remove all construction material from the quarry after the completion of mining activities.	To be undertaken by bulldozer.
2	Topsoil that has been stockpiled during construction/mining of the quarry and must be applied to the area to undergo rehabilitation. The depth of the topsoil layer to be applied depends on the natural depth of topsoil in the area, and the amount of topsoil that may have been lost during mining.	Topsoil must be applied from the topsoil stockpiled during construction.
3	The naked ground should be seeded with a stabilising grass mix, suited to the conditions. The quantity of seed used will depend on the slope, with a steeper slope requiring a heavier application of seed. For slopes: • >15º: 25-50 kg/ha • <15º: 15-25 kg/ha The natural seed bank in the topsoil will supplement the seed mix applied	The seed mix should consist of pioneer grass species of the area, and will also depend on what species are commercially available during the season required. A standard seed mix would consist of the following species (in decreasing order of proportion constituting the seed mix): • *Andropogon chinensis* • *Aristida congesta* • *Cynodon dactylon* • *Cymbopogon plurinodes* • *Eragrostis curvula*

		• *Eragrostis gummiflua* • *Themeda triandra* • *Setaria spp.* • *Imperata cylindrica* • *Sporobolus fimbriatus*
4	The areas which have been seeded must be regularly watered directly after seeding until the grass cover becomes established. Watering is to be done in a manner that ensures that no erosion of the topsoil and seed mix takes place.	A hosepipe must be available on site.
5	If the grasses have not established after a period of two months after seeding, the areas should be re-seeded. If necessary, another dressing of topsoil should be applied prior to seeding.	As above.
6	All alien vegetation is to be appropriately removed and disposed of. Alien species that have been encountered in the area included: Black Wattle (*Acacia mearnsii*), Saligna Gum (*Eucalytpus grandis*), Syringa *Melia azedarach,* Scotch Thistle (*Cirsium vulgare*) Castor-Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*), Pom Pom Weed (*Campuloclinium macrocephalum*), Bugweed (*Solanum mauritianum*), Morning Glory (*Ipomoea purpurea*)	Removal will to a large extent be done by hand. Saws may be necessary in certain cases and specific herbicides may be required (if used, the use of these must be strictly controlled)

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11. APPENDIX

Table7. Grasses suitable for the re-establishment of vegetation within the quarry as well as 32 m buffer zone along the perennial river and drainage lines (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

Table8. Suggested indigenous trees for the rehabilitation of the quarry (species indigenous to the area are indicated with an ☺. It is strongly recommended that only these are planted 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

Table9. Indigenous shrub species marked with ☺ should be used for rehabilitation around the proposed Newark quarry.

Botanical Name	**Common Name**
☺*Aloe arborescens*	
Aloe greatheadii	
☺ *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