PRELIMINARY ECOLOGICAL HABITAT ASSESSMENT FOR THE PROPOSED EMERGENCY NONDABULA WATER RETICULATION PROJECT; NDWEDWE LOCAL MUNICIPALITY ILEMBE DISTRICT MUNICIPALITY; KWAZULU-NATAL

Compiled for **Royal Haskoning*DHV*** by:
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Declaration of Independence

I Clayton Cook declare that I have been appointed as an independent consulting ecologist with no affiliation with or vested financial interests in the proponent, other than for work performed under the Environmental Impact Assessment Regulations, 2010. I have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. Remuneration for our services by the proponent is not linked to approval by any decision-making authority responsible for authorising this development.

C.L. Cook *12th of June 2015*

1. INTRODUCTION:

Royal Haskoning*DHV* (RHDHV) as an Independent Environmental Practitioner have been authorised to undertake the environmental authorization of the proposed Emergency Nondabula Water Reticulation Project within the Ndwedwe Local and Ilembe District Municipality. In terms of the National Environmental Management Act, Act 107 of 1998 and the Environmental Impact Assessment Regulations of 2010 published in Government Notice R543 to R546 of August 2010, and promulgated in terms of Chapter 5 of the National Environmental Management Act, a Basic Assessment will be required to obtain environmental authorisation. Royal Haskoning*DHV* (RHDHV) as an Independent Environmental Practitioner appointed Mr. C.L. Cook to provide a basic description of the vegetation and current ecological status/habitat integrity of the and to provide appropriate management recommendations for the proposed Emergency Nondabula Water Reticulation project.

Project Description:

Emergency Nondabula Water Reticulation project proposes that a network of new pipelines are constructed within the Nondabula rural community located in Ward 9 of the Nodwengu Traditional Council in the Ilembe District Municipality, KwaZulu-Natal to link into the existing pipeline network and provide potable water to the community.

The project will consist of the construction of:

- a DN150 Steel / PVC rising main of 4.7 km;
- a borehole with a yield capacity of 15 m³/h at 292 m;
- a 500 kℓ prefabricated steel reservoir;
- a secondary booster pump;
- a 50 kℓ elevated prefabricated steel tank; and
- 110 mm to 32 mm reticulation pipelines of approximately 95 km in length and 1,420 m yard taps.

The proposed infrastructure capacities and dimensions are as follows:

- DN150 steel / PVC pipe 4.7 km long with a throughput of 15 m³/h;
- DN63 HDPE pipe 10 km long;
- DN50 HDPE pipe 10 km long;
- DN32 HDPE pipe 20 km long;
- DN20 HDPE pipe 20 km long;
- 500 kℓ steel tank (16 m diameter x 3.1 m height);
- Borehole with a throughput of 15 m³/h;
- 50 kℓ tank (5 m square x 2 m height)

The assignment is interpreted as follows: Determine the current ecological status of the vegetation and the potential ecological impacts of the Emergency Nondabula Water Reticulation project 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 proposed alignments of the Emergency Nondabula Water Reticulation project and adjacent land usage, and information on the natural environment.
- An initial site investigation (20th- 22nd of May 2015) to assess the current environmental status of the proposed Emergency Nondabula Water Reticulation project alignments with special emphasis on any remaining natural habitats.
- Identify problematic areas which require immediate attention as well as management, e.g. gully erosion, degraded areas, reclamation areas, alien vegetation.
- Make management recommendations and mitigatory measures for the current as well as potential environmental impacts especially pertaining to the Emergency Nondabula Water Reticulation project.

1.1 OBJECTIVES OF THE PRELIMINARY ECOLOGICAL SURVEY/ HABITAT ASSESSMENT

- To provide a basic description of the vegetation and fauna occurring around the proposed Emergency Nondabula Water Reticulation project area.
- To provide a description of any threatened plant or animal (mammals, birds, reptiles and amphibians) occurring or likely to occur within the Emergency Nondabula Water Reticulation project alignments 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 potential impacts of the Emergency Nondabula Water Reticulation project on the vegetation and associated fauna.
- To provide management recommendations to mitigate negative and enhance positive impacts of the proposed Emergency Nondabula Water Reticulation project.

1.2 SCOPE OF STUDY

- An initial ecological survey documenting the dominant vegetation along the proposed Emergency Nondabula Water Reticulation project alignments, reservoir and borehole sites and recording sightings and/or evidence of present fauna within the Emergency Nondabula Water Reticulation project area.
- An assessment of the ecological habitats, evaluating conservation importance and significance with special emphasis on the current status of threatened animal species (Red Data Species), within the proposed Emergency Nondabula Water Reticulation project area.
- Literature investigations with which to augment field data were necessary.
- Identification of potential ecological impacts that could occur as a result of the Emergency Nondabula Water Reticulation project 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.

2. METHODOLOGY

2.1 Predictive methods

A 1:50 000 map of the study area was provided showing existing infrastructure on and around the proposed Emergency Nondabula Water Reticulation project area. This was used as far as possible in order to identify potential "hot-spots" or specialised habitats e.g. Remnant patches of open Sandstone sourveld grassland in various stages of transformation and degradation, scattered closed woodland patches, wooded rocky cliff and ravines, non-perennial rivers, palustrine wetlands, afforested plantations, woodlots and 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 current land use. Aerial photographs were utilised for the sensitivity mapping using Arcview 9.2

2.2 Literature Survey

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) or protected species as listed under the National Forests Act (NFA) (No. 30 of 1998) or the National Environmental Management: Biodiversity Act 'Threatened or Protected Species' (NEMBA ToPS) (No. 10 of 2004) as well as internet using POSA (http://posa.sanbi.org accessed on the 14th of May 2015) for the 2930 BD Quarter Degree Grid Cell. *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 14th of May 2015) 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 Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland* for avifauna (birds) as well as internet SABAP2 pentad 2920_3050 (http://sabap2.adu.org.za accessed on the 14th of May 2015).

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's FrogMAP (http://vmus.adu.org.za accessed on the 14th of May) 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's Reptile MAP (http://sarca.adu.org.za accessed on the 14th of May 2015) for reptiles.

2.3 Site Investigation Methodology

A preliminary assessment of the status, spatial requirements and habitat preferences of all priority plant and faunal species likely to occur in the proposed Emergency Nondabula Water Reticulation project area as well as potential threats to the remaining natural habitats was conducted. For certain species, an estimate of the expected or historical distribution for the area could be extrapolated from published information and unpublished reports, while habitat and spatial requirements were generally derived from the literature. For other species little of this information was readily available and conservation targets remain speculative. Species assessments will be updated when additional data becomes available and where appropriate, proposed conservation targets will be revised.

Three general habitat sensitivity scans were carried out during daylight hours (09h00-17h00) between the 20th- 22nd of May 2015. The site visit did not entail intensive surveying or utilisation of any specific sampling methods and can rather be viewed as being an opportunity to identify any natural vegetation as well as sensitive faunal habitats occurring within and adjacent to the proposed Emergency Nondabula Water Reticulation project area.

2.4 Uncertainties in predicting results

- Limitation to a single season or base-line ecological survey for only 3 days (20 hours) during the late summer early autumn months (May 2015). Observations of plant species flowering during the late summer/autumn months only. It is possible that plants which flower at other times of the year are underrepresented. The majority of threatened plant species are cryptic as well as flower during restricted periods. The present survey was restricted to a basic habitat assessment but due to the transformed nature of the Kwazulu-Natal Sour Grassland as well as degradation of the closed woodland vegetation units adjacent to the non-perennial drainage lines, wooded pockets and wooded cliffs and ravines. As the entire pipeline alignments are situated within existing road reserves and transformed grasslands no additional vegetation surveys need to be conducted. **No red listed plant species were observed adjacent to the proposed pipeline alignments, reservoir sites and Nhlangakazi borehole site or are likely to occur within them due to high levels of habitat transformation and degradation**.
- 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 or will be required along the Emergency Nondabula Water Reticulation alignments due to extensive habitat transformation and high levels of anthropogenic disturbances within the remaining grasslands, degraded closed woodland vegetation units, alien invasive woodlots or afforested plantations. **The Emergency Nondabula Water Reticulation pipeline alignments, reservoir sites and borehole site provide no critical habitat for any threatened faunal species.**

- The majority of threatened faunal species are extremely secretive and difficult to observe even during intensive field surveys conducted over several seasons/ years. One red listed bird species namely a single Southern Bald Ibis was observed foraging in a remnant patch of open sour grassland adjacent to the proposed Emergency Nondabula Water Reticulation project area.
- Due to the steep topography of the wooded ravines and rocky cliffs as well as alien invaded woodlots access was restricted to exiting cattle and human pathways. Due to heavily alien invaded areas especially along the non-perennial drainage lines and wooded pockets visibility and access was severely restricted and certain species may have been overlooked
- Limitation of historic data and available databases for the Nondabula/Bhamshela area.
- 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 the Bhamshela area and similar habitats between 2010-2015).

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.

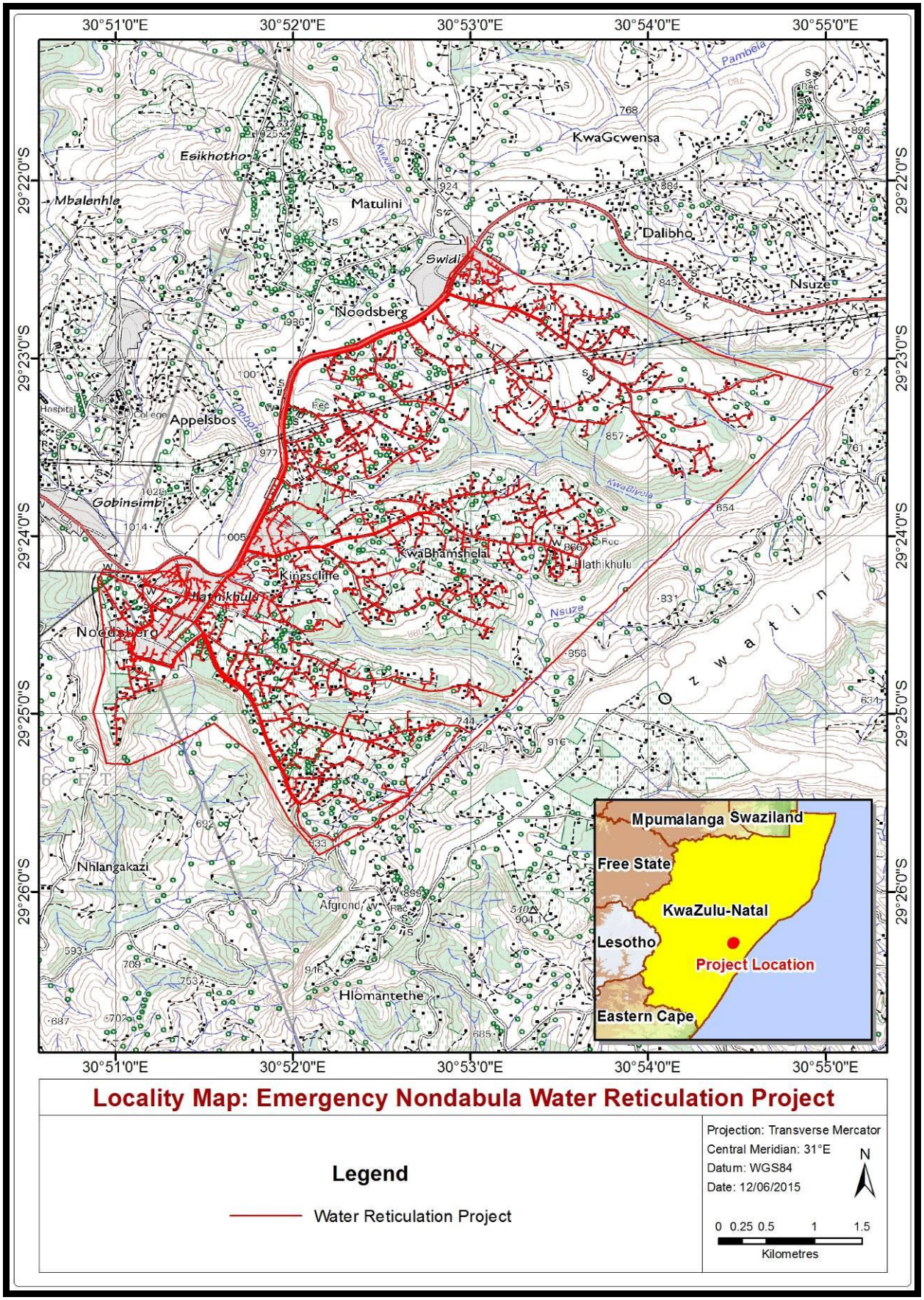


Figure1: Locality map for the Emergency Nondabula Water Reticulation Project.

3.1 STUDY AREA

The proposed Emergency Nondabula Water Reticulation project is situated within the located under the Ndwedwe Local Municipality which falls on the western boundary of the iLembe District Municipality. The proposed site is situated within Bhamshela adjacent to the R614; approximately 40 km to the north of Tongaat and access is via the R614.

The site falls outside the transitional zone or ecotone between **Kwazulu-Natal Sandstone Sourveld (SVs 5)** and **Ngongoni Veld (SVs 4)** vegetation units (Mucina & Rutherford 2006). The majority of the vegetation on the site comprises transformed Kwazulu-Natal Sandstone Sourveld (SVs 5). The southern pipeline alignment situated within the lower-lying hillslopes and valleyare situated within transformed Ngongoni Veld. The Kwazulu-Natal Sandstone Sourveld vegetation unit occurs on the elevated coastal inland sandstone plateaus from Mapumulo near Kranskop in the north to St Faiths near Port Shepstone in the south. Altitude ranges from 1 030 m on the western boundary and 760m around the proposed Nhlangakazi borehole. A remnant patch of **Scarp Forest (FOz 5)** occurs on the steep rocky cliffs and ravine outside the south-western boundary of the Emergency Nondabula Water Reticulation project area.

Vegetation and Landscape Features

Sandstone Sourveld (SVs 5)

Short species-rich grassland with scattered low shrubs and geoxylic suffrutices. Proteaceae trees and shrubs (*Protea, Leucopsermum, Faurea*) can be locally common. The dominant landscape features are flat (or rolling) plateau tops and steep slopes commonly forming table mountains (Mucina *et al*. 2006).

The vegetation of the proposed Emergency Nondabula Water Reticulation project is dominated by completely transformed roads and road reserves, existing residential homesteads, small scale agricultural lands (maize and vegetables), alien invasive *Acacia mearnsii*, Eucalyptus sp.*, Pinus sp.** woodlots, afforested plantations, secondary succession Aristida junciformis grasslands, relic patches of KZN Sandstone sourveld, degraded moist woodland along the drainage lines as well as rocky cliffs and ravines. The recently disturbed areas have been transformed and are dominated by pioneer weedy plant and alien invasive species. Remnant indigenous tree species occur within the moist woodlands including *Vachelia sieberiana* var. *woodii, Halleria lucida, Harpephyllum caffrum, Protorhus longifloia, Burchellia bulbalina, Cussonia spicata and Trema orientalis.* This patch is however heavily infested with alien invasive vegetation. Remnant indigenous riparian species observed along the drainage lines included *Syzigium cordatum, Bridelia micrantha, Ficus sur* and Grassland Tree Fern *Cyanthea dregei*

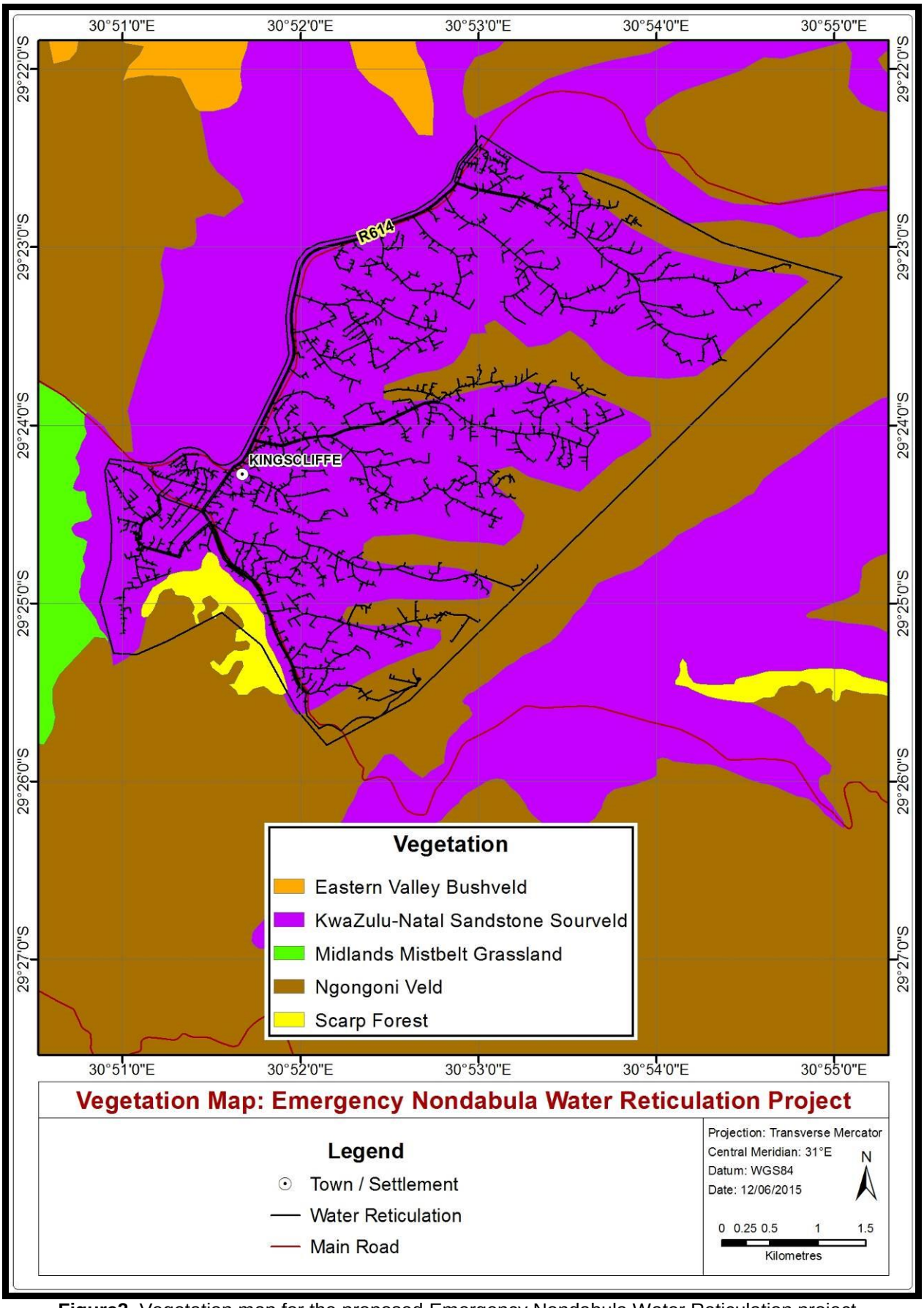


Figure2. Vegetation map for the proposed Emergency Nondabula Water Reticulation project.

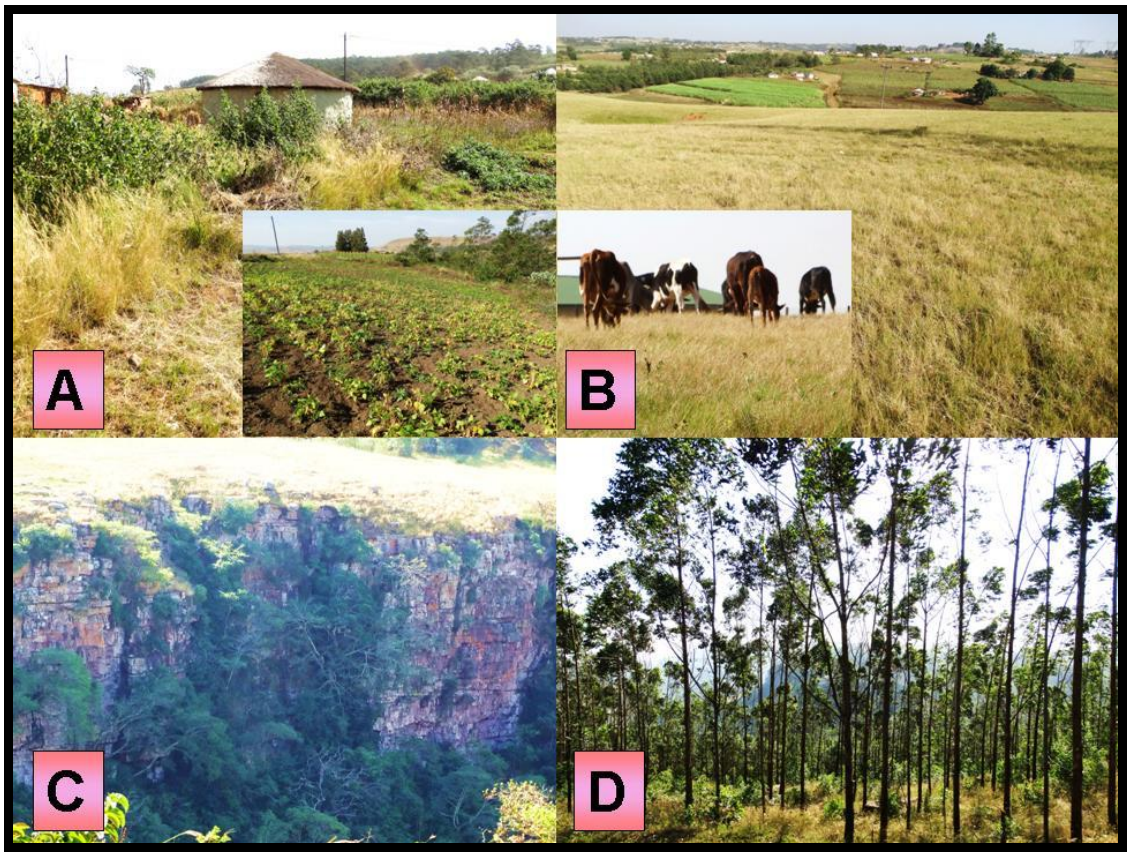


Figure3. A collage of photographs displaying the major vegetation units observed around the Emergency Nondabula Water Reticulation project. A: The entire project area for the proposed water reticulation pipelines comprises transformed plateau grasslands. The natural grasslands have been transformed into existing residential homesteads, formal and informal access roads, small-scale vegetable crops, sugarcane lands and alien invaded woodlots. **B:** Remnant patches of secondary succession *Aristida junciformis* grasslands occur adjacent to the proposed pipeline servitudes. Low forb and herb diversity due to extensive overgrazing and altered fire regimes. **C:** Situated within the fire-protected rocky cliffs and ravines are pockets of closed woodland or scarp forest. These have been impacted on by extensive alien invasive vegetation as well as bark and wood harvesting activities. No activities are proposed within these sensitive areas. **D:** Scattered alien invaded woodlots comprising coppicing *Eucalyptus grandis, Acacia mearnsii*,* and *Pinus patula** occur around the homesteads and agricultural lands as well as along the non-perennial drainage lines and valley bottom wetland. Extensive afforested *Pinus patula** plantations occur adjacent to the proposed Nhlangakazi borehole.

Geology and Soils

Ordovician Natal Group sandstone carry shallow, nutrient poor, skeletal, sandy soils freely drained including **Mispah** and **Glenrosa** soil forms. No hydric indicators were present within the well drained sandy soils observed during random soil augering throughout the proposed pipeline alignments although organically rich clays with hydric indicators were observed in the valley bottom wetland adjacent to the Nhlangakazi borehole site.

Climate

Summer rainfall area but with some rain during winter. Mean Annual Precipitation (MAP) is around 700 – 1 200 mm. Mist common and important in providing additional moisture. Frost is very infrequent.

Conservation

Kwazulu-Natal Sandstone Sourveld (SVs 5) is an **Endangered** vegetation unit with only a small part statutorily conserved (0.2 %) in the Krantzkloof and Vernon Crookes Nature Reserves. About 68% is transformed for cultivation, plantations, urban sprawl and road-building. Conservation target is 25% conserved. This highly transformed vegetation type is a prime agricultural area with mainly sugar cane and timber plantations. The urban sprawl of the eThekwini (Durban) Metropolitan Area and densely populated subsistence farming accounts for most of the remainder. Apart from the critically little conserved areas (a few hundred hectares), most remaining areas are subjected to high levels of grazing and frequent fire which is not conducive to the recruitment of seedlings of many of the shrubs and herbs. Erosion is low although sheet and rill erosion were observed adjacent to the informal access roads as well as severe bank erosion along the non-perennial drainage line due to uncontrolled livestock drinking, trampling and grazing activities.

3.2 TRANSFORMED PLATEAU GRASSLANDS

Vegetation Type	Kwazulu-Natal Sandstone Sourveld (SVs 5)	**Tree cover** (alien invasive species)	0-10 %
Soil	Light brown sandy soils as well as sandy-loams	**Shrub cover**	0-2 %
Topography	Plateau Gently sloping 1-3 %	**Herb cover** (mainly pioneer & weedy species)	0-5 %
Land use	Agricultural, Afforested Plantations, woodlots, livestock grazing and Residential homesteads	**Grass cover**	0-90 %
Dominant Grass spp.	*Aristida junciformis* subsp. *junciformis, Aristida congesta, Hyparrhenia hirta, Cynodon dactylon, Panicum ecklonii, Panicum maximum, Melinis repens, Setaria magaphylla, Digitaria sanguinalis, Eragrostis curvula, Heteropopgon contortus.*		
Dominant Herb spp.	*Tagetes minuta, Chamaechrista mimusoides, Cirsium vulgare*; Hypoxis argentea, Conyza albida, Ceratotheca triloba, Commelina africana, Helichrysum aureum, Kniphofia linearfolia, Solanum sisymbrifolium*, Commelina erecta, Trifolium repens, Centella asiatica, Merremia tridentata, Plectranthus comosus*, Leonotis leonorus, Leonotis intermedia, Dicerocaryum eriocarpum, Lippia javanica, Asclepias fruticosa, Solanum panduriforme*, Lantana rugosum; Ipomoea* spp., *Verbena bonariensis*		

Alien Invasive Species	*Ageratum conyzoides**, *Chromolaena odorata**, *Pennisetum clandestinum**, *Rubus cuneifolius**, *Eucalyptus grandis**, *Pinus patula**, *Psidium guajave**, *Jacaranda mimosifolia**, *Mimosa pigra**, *Acacia dealbata**, *Acacia mearnsii**, *Ipomoea indica**, *Ipomoea purpurea**, *Lantana camara**, *Ricinus communis**, *Senna didymobotrya**, *Solanum mauritianum**, *Tithonia diversifolia*, *Psidium guajava* *
Red Data Species	None were observed or likely to occur within these transformed and degraded habitats.
Conservation Potential/Sensitivity	Low

Figure4. A collage of photographs displaying the dominant vegetation units observed within and immediately adjacent to the proposed Emergency Nondabula Water Reticulation Project. A: The entire pipeline servitudes are situated within existing formal and informal road reserves adjacent to the rural homesteads and schools. **B:** The vegetation around the rural-homesteads has been transformed and is currently utilised for small-scale dry-land vegetable crops including maze (*Zea mays*). C: Several informal alien invaded woodlots occur around the project area. They are dominated by coppicing alien invasive tree species and are used for wood harvesting. **D:** Disturbed areas such as illegal dumping areas, borrow or sand pits, old residential ruins are dominated by dense thickets of alien invasive vegetation dominated by Black Wattle (*Acacia mearnsii**), Lantana (*Lantana camara*), American Bramble (*Rubus cuneifolius**), Bugweed (*Solanum mauritianum**), Woolly Plectranthus (*Plectranthus comosus*) and Paraffin Bush (*Chromolaena discolor*).

* alien invasive vegetation

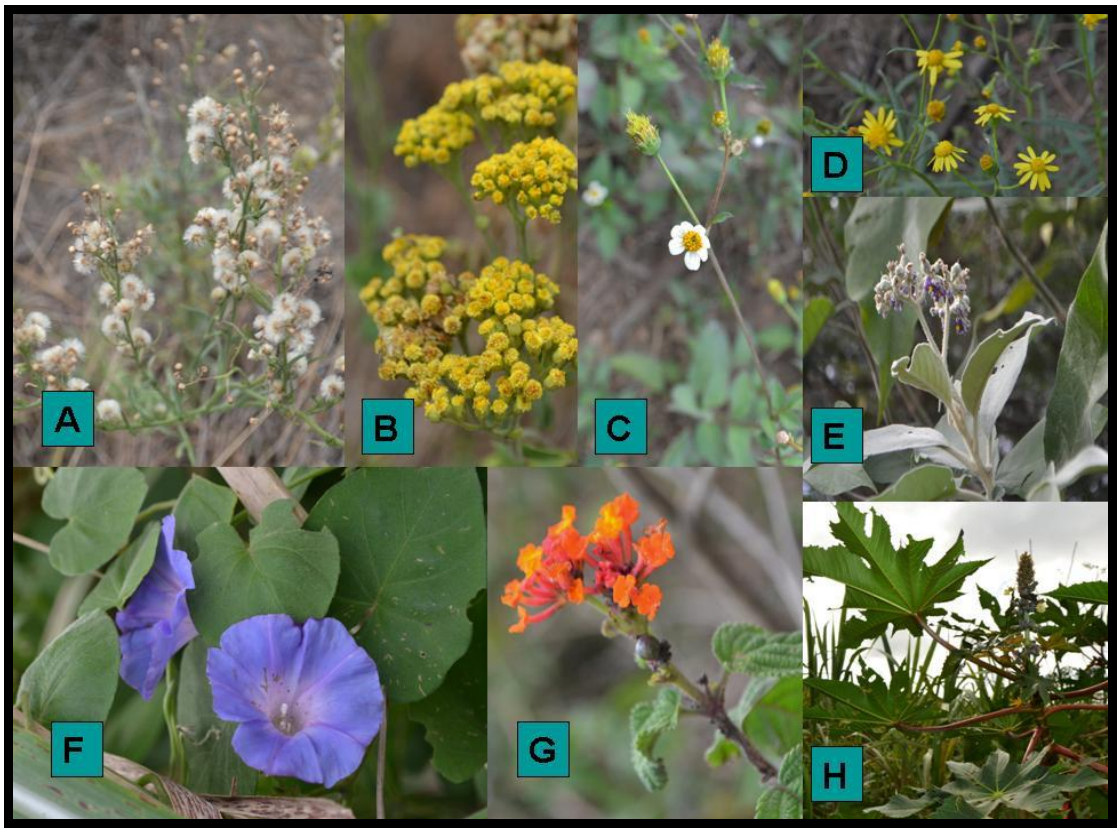


Figure5. Dominant vegetation observed within proposed Emergency Nondabula Water Reticulation pipeline servitudes. The majority of the vegetation consists of weedy pioneers or ruderals such as A: Flax-leaf Fleabane (*Conyza bonariensis**), **B:** Jersey Cudweed (*Pseudognaphalium undulatum**), **C:** Common Blackjack (*Bidens pilosa**) and **D:** Canary Weed (*Senecio madagascariensis**). Alien invasive vegetation included **E:** Bugweed (*Solanum mauritianum**), **F:** Purple Morning Glory (*Ipomoea purpurea**), **G:** Lantana (*Lantana camara**) and **H:** Castor-Oil Plant (*Ricinus communis**)

The secondary succession *Aristida junciformis* plateau grassland unit comprises the largest component of the study area. The area consists of rural homesteads, the small commercial Bhamshela district and agricultural fields (old and current). These areas are utilised in various ways ranging from houses to ploughed maze and vegetable lands, kraals to grassland used for grazing purposes. As a result the natural grassland vegetation has become degraded and is completely transformed.

The grassland areas used for grazing purposes are grazed to approximately 0.5- 1.0 m above ground level and are dominated by the grasses *Aristida junciformis* subsp. *junciformis, Aristida congesta, Cynodon dactylon, Digitaria eriantha, Panicum maximum, Cymbopogon caesius, Eragrostis curvula, Hyparrhernia hirta, Hyparrhenia fillipendula, Imperata cylindrica and Melinis repens.* The grasses cover approximately 70-80% of the area and the forbs 5-10% (mainly alien invasive species). Forbs were dominated by pioneer weedy plant species such as Tall Fleabane (*Conyza albida*), Flax-Leaf Fleabane (*Conyza bonariensis*), Common Black Jack (*Bidens pilosa*), Tall Khaki weed (*Tagetes minuta*), Mexican Poppy (*Argemone ochroleuca*) and *Verbena bonariensis.* On the old agricultural fields and dumping areas the Category 1b Weedy Lantana *Lantana camara** forms extensive thickets.

The majority of tree species observed around the site are Category 2 Invader Black Wattle (*Acacia mearnsii**), Saligna Gums (*Eucalyptus grandis**), Cluster Pine (*Pinus patula**). Several exotic fruit trees have been planted around the rural homesteads including Avocado, Lemon and Peach Trees. Several emerging Guavas (*Psidium guajava**) listed as Category 1b Weeds and the Category 1b American Bramble (*Rubus cuneifolius*[*]) have invaded the disturbed areas on the site adjacent to the roads. The highly invasive Category 1b weed *Ageratum conyzoides* was observed adjacent to the road reserve as well as the Category 1b weedy Common Thorn-Apple (*Datura stramonium**).

The vegetation within the lower-lying southern boundary of the site is dominated by transformed or secondary succession *Aristida junciformis* subsp. *junciformis* grassland with small scale agricultural activities (maize and vegetables). The recently disturbed areas have been transformed and are dominated by pioneer weedy plant and alien invasive species.

No threatened plant species or protected tree species were recorded or likely to occur in the transformed road reserves, degraded secondary succession grasslands (old lands) and agricultural lands in which the Emergency Nondabula Water Reticulation pipeline servitudes and reservoirs are situated.

[*] Alien invasive vegetation according to CARA/NEMBA

3.3 RELIC PATCHES OF KWAZULU-NATAL SANDSTONE SOURVELD

Vegetation Type	Kwazulu-Natal Sandstone Sourveld (SVs 5)	**Tree cover**	0-2 %
Soil	Light brown sandy soils as well as sandy-loams	**Shrub cover**	0-1 %
Topography	Plateau Gently sloping 1-3 %	**Herb cover (mainly pioneer & weedy species)**	0-40 %
Land use	Agricultural, Afforested Plantations, woodlots, livestock grazing and Rural-Residential	**Grass cover**	10-90 %
Indigenous Tree & Shrub species	*Protea caffra, Protea simplex, Protea roupelliae* var. *roupelliae, Erica natalitia. Senecio medley-woodii, Gnidia kraussina*		
Dominant Herbs	*Aster cf. bakerianus, Cyanotis speciosa, Dianthus zeyheri, Watsonia densiflora, Helichrysum cf. alliodes*		
Dominant Grass spp.	*Aristida junciformis subsp. junciformis, Heteropogon contortus, Themeda triandra, Trachypogon spicatus, Digitaria natalensis, Dihetropogon amplectens, Elionurus muticus, Eragrostis plana, Hyparrhenia hirta*		

Alien Invasive Species	*Ageratum conyzoides*, Acacia mearnsii*, Rubus cuneifolius*, , Chromolaena odorata*, Eucalyptus grandis*, Ipomoea alba*, Ipomoea indica*, Ipomoea purpurea*, Lantana camara**
Red Data Species	None were observed but suitable habitat occurs within the relic patches to the east and south of the site.
Conservation Potential/Sensitivity	High

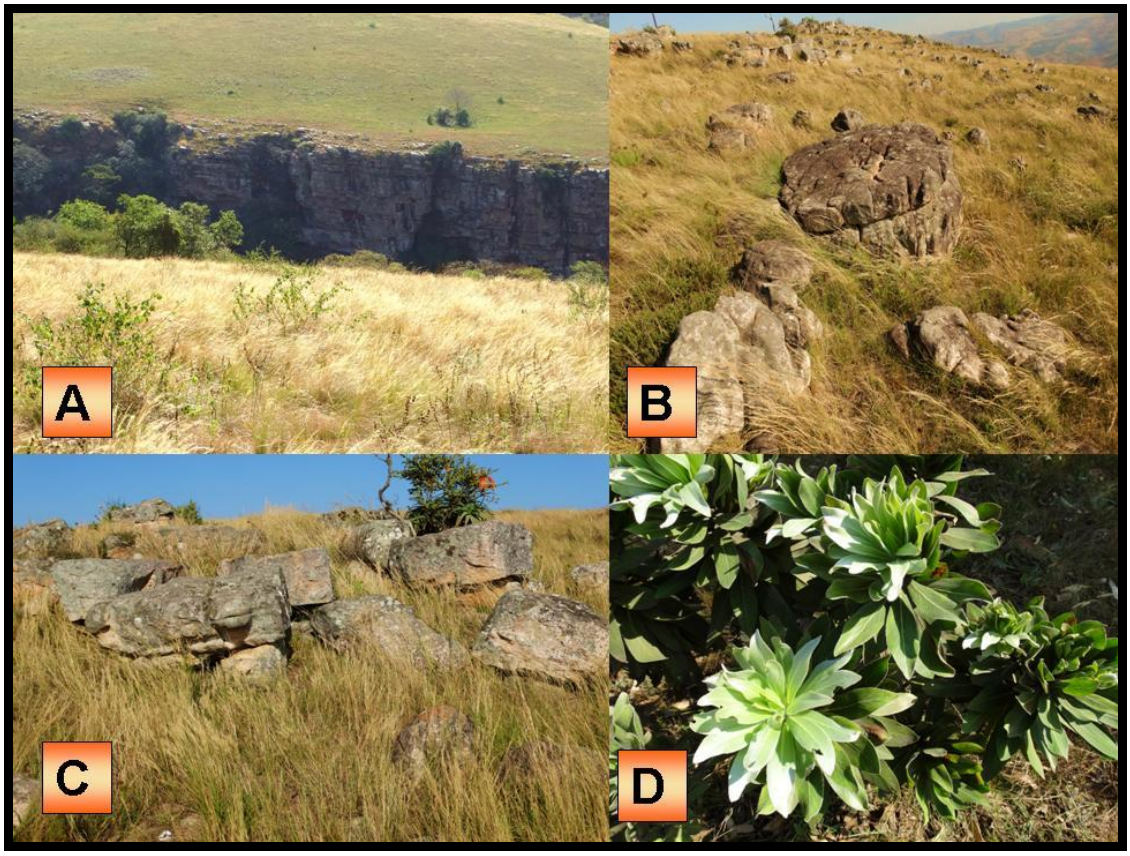


Figure6. A collage of photographs displaying the relic patches of sandstone sourveld observed adjacent to the Emergency Nondabula Water Reticulation Project area. A: Situated on the edge of the plateau are remnant patches of sandstone sourveld. **B**: The exposed and underlying sandstone prevents ploughing of grasslands and provides important habitat for several plant and animal species. **C**: The low-lying sandstone extrusions offer favourable habitat for certain plant species including (**D**) Silver Protea or Sugarbush (*Protea roupelliae* subsp. *roupelliae*. No activities are proposed fro the relic patches of sandstone sourveld on and around the site.

3.4 NON-PERENNIAL DRAINAGE LINES & RIPARIAN ZONE

Vegetation Type	Kwazulu-Natal Sandstone Sourveld (SVs 5)	**Tree cover**	0-80 %
Soil	Large amounts of recently washed in sands within flood-benches.	**Shrub cover**	0-20 %
Topography	Valley Bottom & Sloping Plateau	**Herb cover**	0-20 %
Land use	Rural Residential-Agriculture	**Grass cover**	0-50%
Dominant Grass spp.	*Aristida congesta, Hyparrhenia hirta, Panicum maximum, Panicum schinzii, Melinis repens subsp. repens, Setaria megaphylla, Sporobolus africanus, Eragrostis curvula,*		
Dominant Herbs	*Typha capensis, Merremia tridentate, Dicerocaryum eriocarpum, Asclepias fruticosa, Solanum panduriforme, Commelina africana, Commelina erecta, Sida cordifolia, Ipomea crassipes, Hibiscus 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, Ageratum houstonianum, Helichrysum caespititium, Helichrysum aureonitens, Senecio latifolius, Stomatanthes africanus, Geigeria burkei, Indigofera sanguinea, Indigofera zeyheri, Tephrosia grandiflora, Tagetes*		

	minuta, Ambrosia artemissifolia*, Bidens pilosa*, Ageratina adenophora*, Chamaechrista mimusoides, Cirsium vulgare*; Conyza albida*, Conyza canadensis*, Pteridium aquilinum Ceratotheca triloba*, Rivinia humilis*, Commelina africana, Helichrysum aureum, Datura strumonium*, Solanum sisymbrifolium*, Tithonia diversifolia*, Ageratum conyzoides* *
Dominant Trees and shrubs	*Cyanthea dregei, Vachelia robusta subsp. clavigera, Vachelia nilotica, Vachelia natalitia, Pavetta lanceolata, Cussonia spicata, Cussonia sphaerocephala, Grewia occidentalis, Halleria lucida, Syzigium cordatum, Celtis africana, Trema orientalis, Erythrina caffra, Ziziphus mucronata*
Alien Vegetation	*Acacia mearnsii*, Eucalyptus grandis*, Pinus patula*, Tithonia diversifolia*, Lantana camara*, Solanum mauritianum*, Thevetia peruviana*,Tecoma stans, Ipomoea purpurea*, Ipomoea imndica*, Leucaena leucocephala*, Melia azaderach*, Psidium guajava*, Chromolaena odorata*, Sesbania bispinosa*, Ricinus communis var. communis*
Red Data Species	None were observed within the degraded and transformed riparian zones along the non-perennial drainage lines.
Conservation Potential/Sensitivity	Medium-High

* exotic or alien invasive vegetation

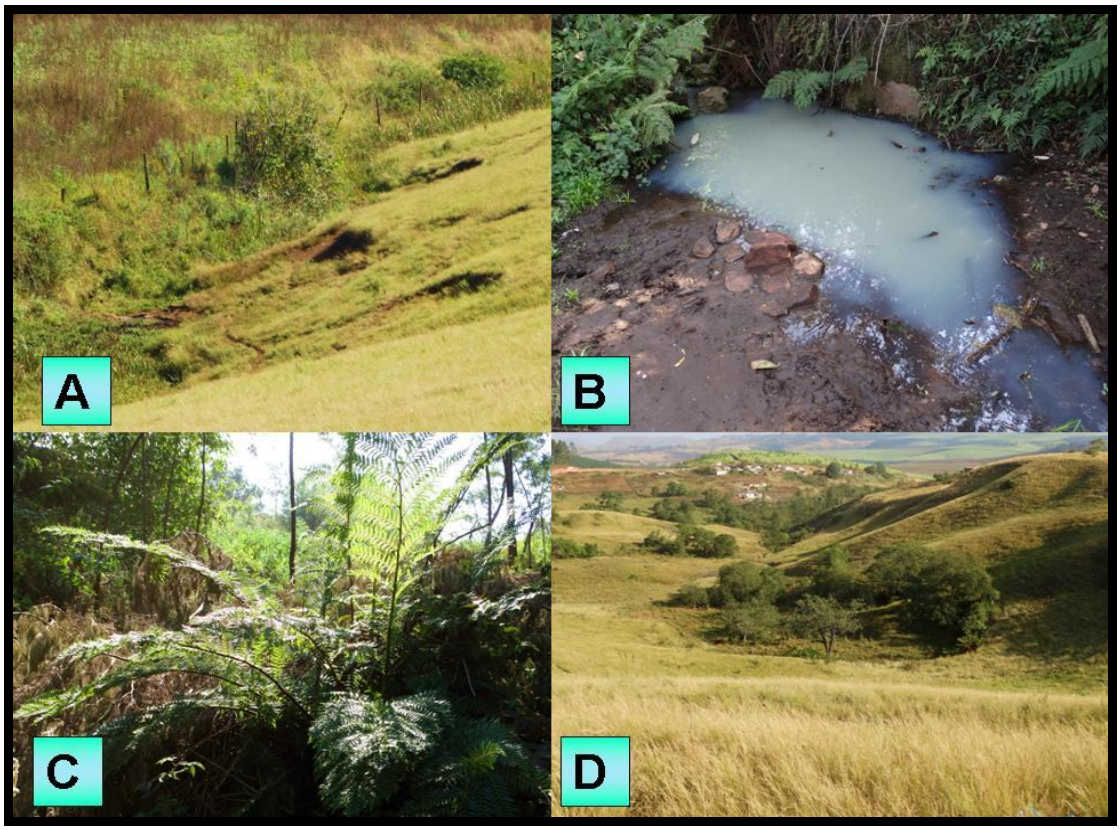


Figure7. A collage of photographs displaying the non-perennial drainage lines observed adjacent to the Emergency Nondabula Water Reticulation Project area. A:The non-perennial drainage lines are heavily degraded with the removal of the majority of natural riparian vegetation as well as extensive alien invasive vegetation along the margins. B: The washing of clothes and bathing activities result in deterioration of water quality. **C**: A few remnant Grassland Tree Ferns (*Cynathea dregei*) were observed within the riparian zone. D: The non-perennial drainage line to the west of the site displays amore natural species composition.

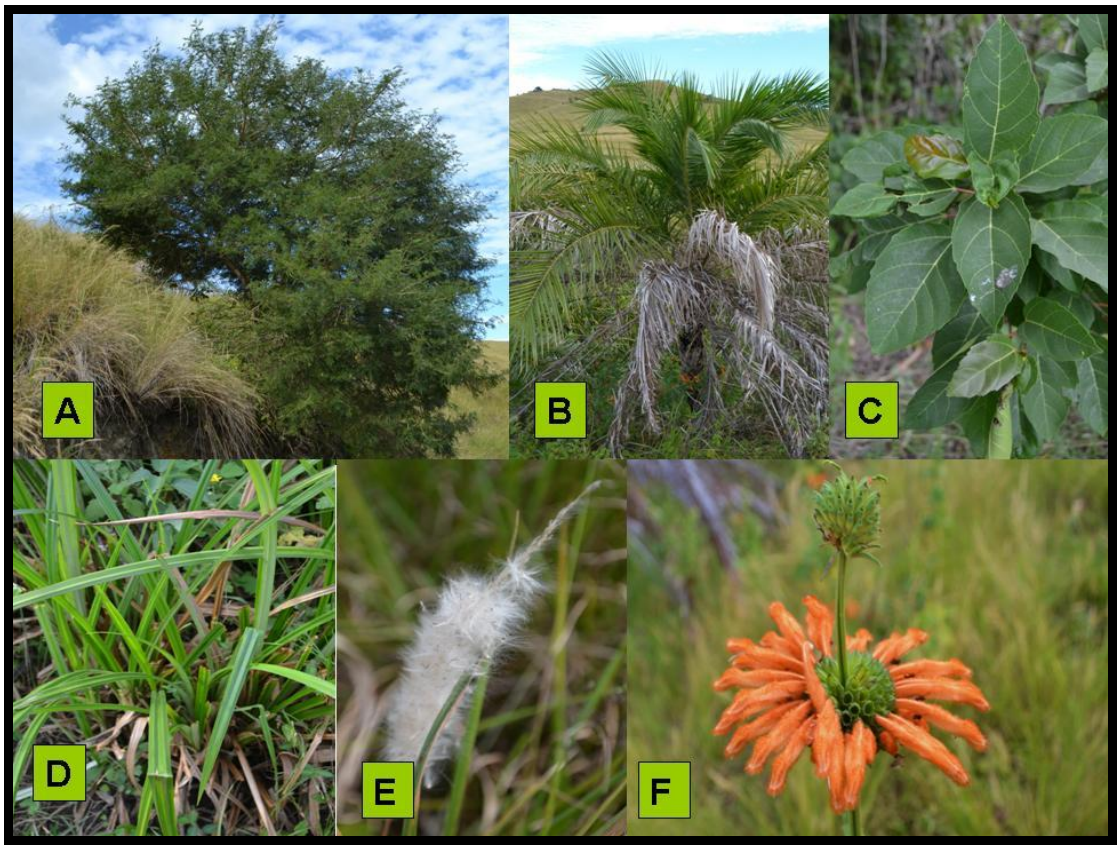


Figure8: A collage of photographs displaying the dominant riparian vegetation observed along the non-perennial drainage line. A: Scented Pod-Thorn (*Vachelia* (*Acacia*) *nilotica* **B:** Several Wild Date-Palm (*Phoenix reclinata*) were observed as well as **C:** Cluster-Broom Fig (*Ficus sur*). **D:** The obligate hygrophyte Giant Sedge (*Cyperus dives*) was observed within the active channel as well as seasonal pools. **E:** The embankments are dominated by the hydrophilic Cottonwool Grass (*Imperata cylindrica*). **F:** Several Wild Dagga (*Leonotis intermedia*) were observed within the macrochannel banks.

No threatened plant species or protected tree species were recorded or likely to occur in the transformed and degraded riparian zones along the non-perennial or seasonal drainage line adjacent to the Emergency Nondabula Water Reticulation Project. A separate aquatic and wetland assessment has been undertaken for the project.

3.5 VALLEY BOTTOM WETLAND

Vegetation Type	Subtropical Freshwater Wetland (AZF 6)	**Tree cover (mainly alien invasive species)**	0-20%
Soil	Soils are waterlogged, clayey soils**,** containing high levels of decomposing organic material, especially in the very productive Giant Sedge *Cyperus dives* beds. Other areas consist of recently "washed in" material which consists of light-brown sandy soils. .	**Shrub cover (mainly alien invasive species)**	0-2%
Topography	Valley Bottom	**Herb cover**	10-40%
Land use	Rural-agricultural (Livestock drinking & small-scale lands)	**Grass cover**	30-80%
Dominant spp. (mainly upstream from bridge crossing site)	*Typha capensis*, *Cyperus dives*, *Cyperus sexangularis, Thelypteris confluens, Cyclosorus interruptus, Cyperus textilis, Mariscus congestus*, *Juncus* spp., *Scirpus ficinoides, Carex* spp., *Eleocharis* spp., *Pycreus nitidus*, *Zantedeschia aethiopica*, *Senecio speciosus, Colocasia esculenta*, Phoenix reclinata, Syzigium cordatum, Monopsis decipiens, Sesbania punicea*, Cirsium vulgare**		

Red Data Species	None were observed within the degraded and transformed areas proposed for the Nhlangakazi borehole site.
Conservation Potential/Sensitivity	Medium-High

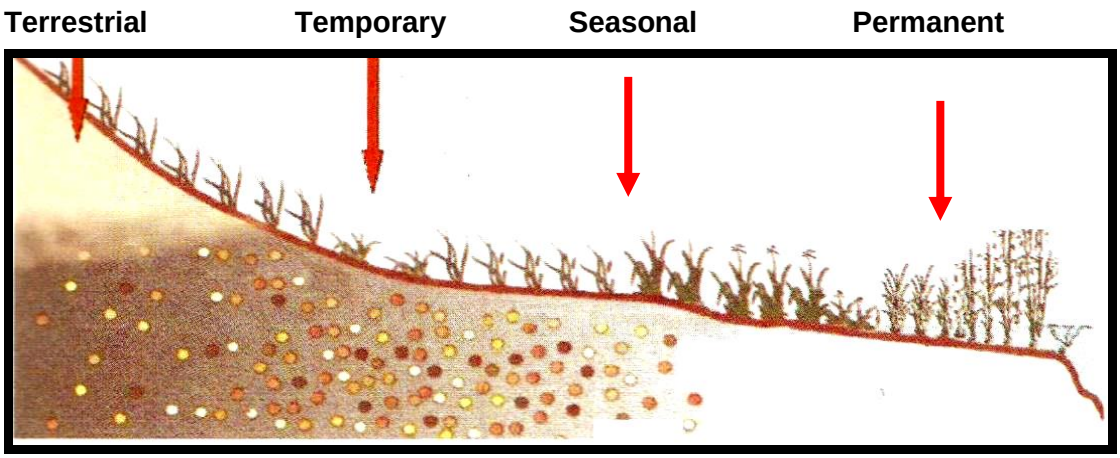


Figure9. Cross section through a valley bottom wetland indicating how soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the permanent wet hydrological zone to the temporarily wet hydrological zone and eventually into the non-wetland or terrestrial zone (Department of Water Affairs and Forestry, 2003 as adapted by Kotze, 1996).

Wetlands can be divided into three zones (DWAF 2005). The permanent zone of wetness is nearly always saturated. The seasonal zone is saturated for a significant part of the rainy season and the temporary zone surrounds the seasonal zone and is only saturated for a short period of the year but is saturated for a sufficient period of time, under normal circumstances, to allow for the formation of hydromorphic soils and the growth of wetland vegetation. The valley bottom wetland is dominated by seasonally inundated soils although permanently inundated soils occur within old sand mining areas as well as artificially embanked areas.

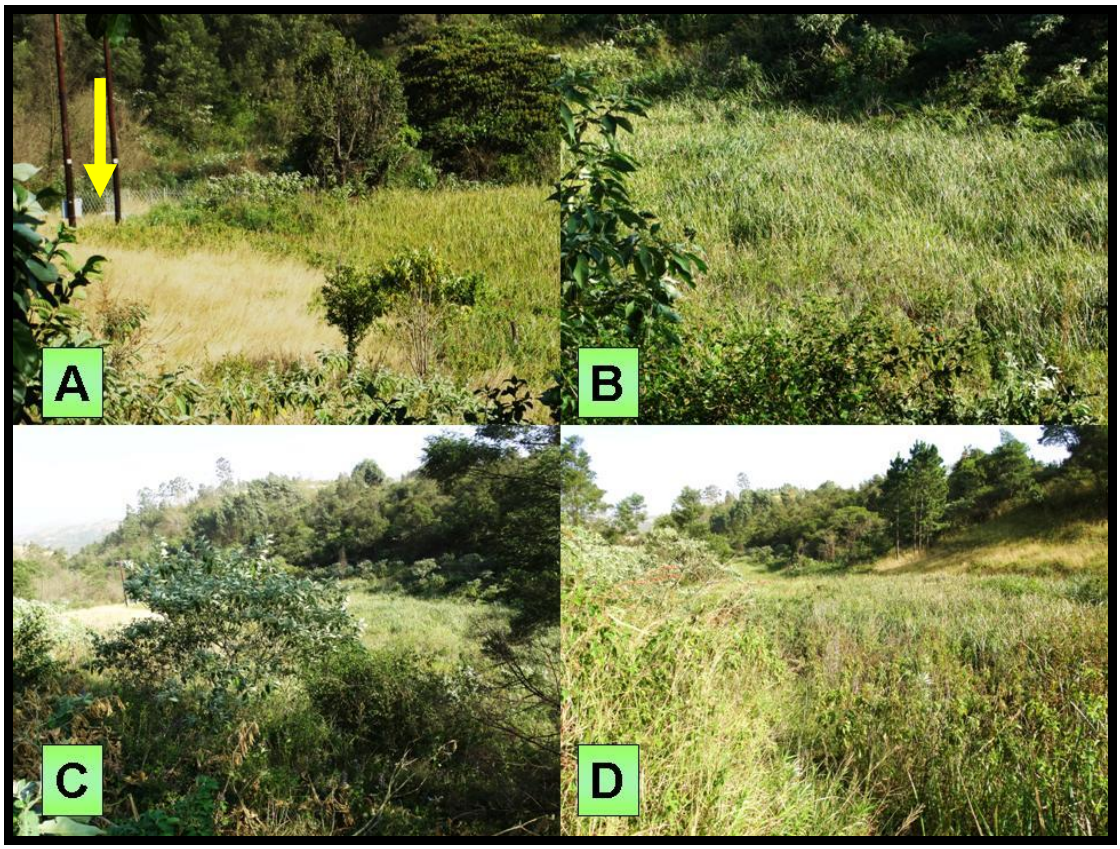


Figure10: A collage of photographs displaying the dominant hygrophilous and hydrophilic vegetation observed along the channelled and un-channelled valley bottom wetland. A: The proposed Nhlangakazi borehole site is situated adjacent to the embanked valley bottom wetland dominated by extensive Giant Sedge (*Cyperus dives*) beds. **B:** The seasonally inundated Giant Sedge bed provides breeding habitat for several frog species as well as nesting and roosting habitat for bird species. **C & D:** Upstream from the proposed borehole site the valley bottom wetland has been negatively impacted on by the edge effects of the forestry activities. Altered fire regimes have resulted in the invasion of alien invasive woody tree and plant species. Medium-high infestations of alien invasive vegetation were observed.

The vegetation of the valley bottom wetland is dominated by hygrophilous sedges and grasses. Species recorded included *Typha capensis*, *Cyperus immensus*, *Cyperus sexangularis, Cyperus textilis, Mariscus congestus*, *Imperata cylindrica, Juncus* spp., *Shoenoplectus spp.*, *Typha capensis*, *Thelypteris confluens, Senecia inornatus, Ranunculus multifidus, Scirpus ficinoides, Carex* spp., *Eleocharis* spp., *Pycreus nitidus*, *Zantedeschia aethiopica* as well as planted *Colocasia esculenta*. The valley bottom has become degraded due to the edge effects of the forestry activities as well as rural-homesteads. Extensive alien invasive vegetation has colonised the edges of the valley bottom wetland.

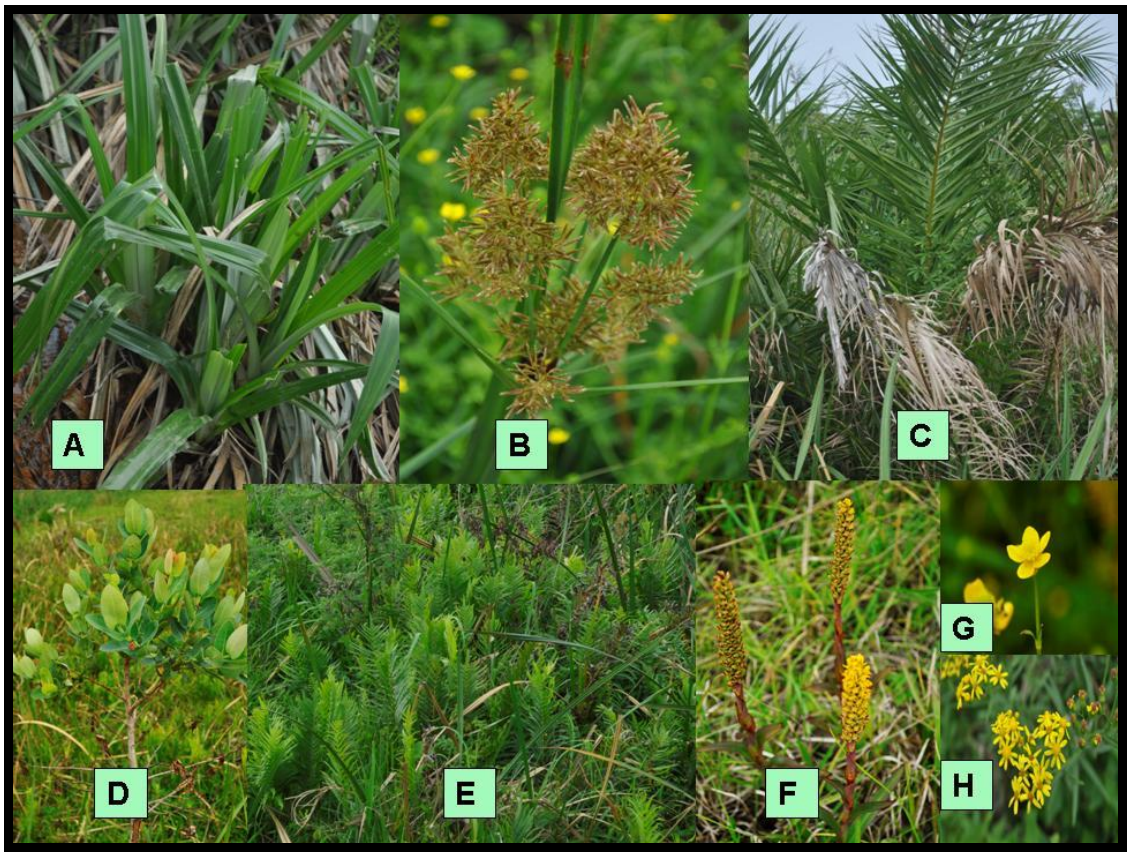


Figure11. A conglomerate of photographs of the dominant plant species located within the permanent, seasonal and temporary wet zones of the valley bottom wetland. **A:** Giant Sedge (*Cyperus dives*) permanent and seasonal wet zone **B:** Winged Sedge (*Cyperus denudatus*) permanent and seasonal wet zone; **C:** Wild Date Palm (*Phoenix reclinata*) temporary wet zones; **D:** Umdoni Waterberry (*Syzigium cordatum*) **E:** Marsh Fern (*Thelypteris confluens*) Seasonal wet zone; **F:** Yellow Candle Orchid (*Disa woodii*) temporary wet zone and **G:** Buttercup (*Ranunculus multifidus*) seasonal and temporary wet zones **H:** *Senecio inornatus* seasonal and temporary wet zones.

The proposed Nhlangakazi borehole site is situated adjacent to an artificially embanked section of the valley bottom wetland adjacent to a *Cyperus dives* dominated section. It is imperative that construction activities are restricted to the borehole footprint within this sensitive wetland habitat and that the area is appropriately rehabilitated/re-vegetated after the completion of construction activities.

No threatened plants were recorded within the proposed Nhlangakazi borehole site or upstream along the valley bottom wetland. A separate aquatic and wetland assessment has been undertaken for the project.

3.6 Afforested plantations/ Woodlots

Vegetation Type	Kwazulu-Natal Sandstone Sourveld (SVs 5)	**Tree cover (alien invasive species)**	0-90 %
Soil	Light brown sandy soils as well as sandy-loams	**Shrub cover**	0-1 %
Topography	Plateau Gently sloping 1-3 %	**Herb cover (mainly pioneer & weedy species)**	0-5 %
Land use	Afforested Plantations and informal alien invaded woodlots,	**Grass cover**	0-60 %
Dominant Tree Species	*Eucalyptus grandis*, Pinus patula*, Acacia dealbata*, Acacia mearnsii**,		
Dominant Grass spp.	*Aristida junciformis* subsp. *junciformis, Aristida congesta, Hyparrhenia hirta, Cynodon dactylon, Panicum ecklonii, Panicum maximum, Melinis repens, Setaria magaphylla, Digitaria sanguinalis, Eragrostis curvula, Heteropopgon contortus.*		
Dominant Herb spp.	*Tagetes minuta, Chamaechrista mimusoides, Cirsium vulgare*; Hypoxis argentea, Conyza albida, Ceratotheca triloba, Commelina africana, Helichrysum aureum, Solanum sisymbrifolium*, Plectranthus comosus*, Lippia javanica, , Solanum panduriforme*, Lantana rugosum; Ipomoea* spp., *Verbena bonariensis*		
Alien Invasive Species	*Ageratum conyzoides*, Chromolaena odorata*, Pennisetum clandestinum*, Rubus cuneifolius*, Eucalyptus grandis*, Pinus patula, Psidium guajave, Acacia dealbata*, Acacia mearnsii**,		

	*Ipomoea indica**, *Ipomoea purpurea**, *Lantana camara**, *Ricinus communis**, *Senna didymobotrya**, *Solanum mauritianum**, *Tithonia diversifolia, Psidium guajava* *
Red Data Species	None were observed or likely to occur within these transformed and degraded habitats.
Conservation Potential/Sensitivity	Low

3.7 ALIEN INVASIVE VEGETATION

Figure12. A conglomerate of photographs displaying the dominant alien invasive vegetation observed within and immediately adjacent to the site. 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.

* alien invasive vegetation

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**, *Arundo donax**, *Caesalpinia decapetala**, *Campuloclinium macrocephalum**, *Chromolaena odorata**, *Ipomoea indica**, *Ipomoea purpurea**, *Lantana camara**, *Leucaena leucocephala**, *Montanoa hibiscifolia**, *Canna indica**, *Jacaranda mimosifolia**, *Rubus fruticosus**, *Rubus cuneifolius**, *Psidium guajava**, *Melia azedarach*, Mimosa pigra*, Ricinus communis*, Senna didymobotrya*, Solanum mauritianum*, Tithonia diversifolia*[*] are present.

3.6 Protected Tree Species

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 protected tree species were recorded within and immediately adjacent to the Emergency Nondabula Water Reticulation project area.** The majority of tree species observed were exotic fruit trees scattered around the homesteads as well as several alien invasive tree species comprising informal woodlots.

[*] alien invasive vegetation

3.7 Red Data Plant Species

An investigation was also carried out on rare and protected plants that might possibly occur in the region. For this investigation the National Red List of Threatened Plants of South Africa, compiled by the Threatened Species Programme, South African National Biodiversity Institute (SANBI) was used.

Table1. Red listed plant species recorded from the 2930 BD QDGC according to POSA (http://posa.sanbi.org/) downloaded on the 14th of May 2015.

FAMILY	SPECIES	RED LIST STATUS	GROWTH FORM	HABITAT	Likelihood Of Occurrence Within Project Area
AMARYLLIDACEAE	*Clivia gardenii* Hook.	VU	Geophyte	Forest	none
AMARYLLIDACEAE	*Clivia miniata* (Lindl.) Regel var. *miniata*	VU	Geophyte	Forest	none
AMARYLLIDACEAE	*Haemanthus deformis* Hook.f.	VU	Geophyte, succulent	Forest margins, sheltered sites under bushes or on moist rocky banks	none
APIACEAE	*Afroligusticum wilmsianum* (H.Wolff) P.J.D.Winter	VU	Herb	Mistbelt and coastal scarp grasslands.	none
ASTERACEAE	*Helichrysum oligopappum* Bolus	VU	Herb	Poor, stony grassland, 915-1675 m.	none
ASTERACEAE	*Senecio dregeanus* DC.	VU	Herb	Open grasslands, often on sandstone plateaus but also recorded from moister mistbelt grassland, 0-1200 m.	none

FABACEAE	*Crotalaria dura* J.M.Wood & M.S.Evans subsp. *dura*	NT	Dwarf shrub, herb	Midlands grassland.	none
GESNERIACEAE	*Streptocarpus molweniensis* Hilliard subsp. *molweniensis*	VU	Herb, lithophyte	Scarp forests in kloofs.	none
IRIDACEAE	*Dierama nixonianum* Hilliard	EN	Geophyte, herb	Open grassland over sandstone, 760-1 500 m.	none
IRIDACEAE	*Dierama pumilum* N.E.Br.	VU	Geophyte, herb	Rocky grasslands, 1000-1200 m.	none
PROTEACEAE	*Leucospermum gerrardii* Stapf	NT	Dwarf shrub	Shallow sandstone-derived soils in Ngongoni and Mistbelt Grassland from 900-1100 m. Associated with serpentine.	none
PROTEACEAE	*Leucospermum innovans* Rourke	EN	Shrub	Most prominent in Pondoland-Natal Sandstone Coastal Sourveld in shallow soils, 100-600 m.	none

No rare or threatened plants were recorded within this transformed vegetation units occurring within the proposed Emergency Nondabula Water Reticulation project area. Marginally suitable habitat occurs within the Sacrp Forest situated within the closed wooded rocky cliffs and ravines as well as relic patches rocky Kwazulu-Natal Sandstone Sourveld on the margins of the plateau for certain red listed species. More intensive surveys conducted over extended periods are required to determine their current conservation status in the area. No pipelines or reservoirs are proposed within these sensitive areas.

4. 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 Emergency Nondabula Water Reticulation project and providing mitigation measures for the identified impacts. Faunal data was obtained during two site visits of the proposed pipeline alignments carried out by car and on foot on the 20th- 22nd May 2015. 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 Eskom 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 *South African Red Data Book- Reptiles and Amphibians* (Branch 1988) for reptiles.

The majority of vegetation adjacent to the proposed Emergency Nondabula Water Reticulation project is completely transformed plateau sandstone sourveld and dominated by secondary succession Aristida junciformis grassland and extensive thickets of alien invasive vegetation. The adjacent plateau grasslands suffer from extensive overgrazing, mostly from goats and cattle. Cattle were observed grazing within the lower-lying non-perennial drainage lines as well as valley bottom wetland. Their grazing and trampling can encourage thicket growth by *Psidium guajave**, *Lantana camara**, *Rubus cuneifolius** and *Caesalpinia decapetala** by reducing grass cover. However, the opportunistic feeding patterns of goats can have a severe impact on both the composition and productivity of this ecoregion. In addition, goats are known to be more destructive than cattle at higher stocking densities (Skead 1988). High livestock densities also pose considerable threat to wildlife, since high numbers of domesticated animals generally cause a displacement of game, as there is less suitable habitat available. Furthermore, wild predators and scavengers such as the Black-backed Jackal, Caracal, Leopard and the Cape vulture have been eradicated by livestock farmers who see these animals as a threat to their livelihoods. Poisoned carcasses are often used for this purpose; this method is indiscriminate and therefore poses considerable threat to all predators and scavengers; especially the threatened Cape Vulture. Poaching and illegal hunting (dogs) are further reducing the remnant faunal populations.

Existing Impacts on the fauna on and surrounding the site included:

- The proposed Emergency Nondabula Water Reticulation project is situated mainly within the reserves of existing formal and informal access roads (driveways) which are dominated by completely transformed vegetation dominated by pioneer and weedy plant and grass species as well as alien invasive vegetation with limited habitat diversity or impoverished habitats.
- High levels of human disturbances associated with the existing villages and habitat degradation and transformation due to present agricultural activities as well as livestock enclosures. This has resulted in impoverished habitats with limited faunal diversity.
- Existing villages, agricultural as well as informal access roads and pedestrian and livestock pathways occur around the site.
- Previous and current agricultural activities (oldlands), afforested plantations have transformed the majority of grassland habitat on the plateau and adjacent hillslopes.
- Extensive overgrazing by livestock (especially cattle and goats) result in limited vegetative or grass cover or refuge habitat for remaining faunal species.
- Littering occurs adjacent to the present access roads as well as schools.
- Frequent burning of remaining patches of secondary succession grasslands severely restricts vegetative cover and potential refuge habitat for remaining faunal species.
- Several dogs as well as feral cats around the existing rural homesteads. Dogs and cats have a high impact on remaining faunal species. Traditional hunting with dogs occurs throughout Kwazulu-Natal.
- Introduction of extensive stands of exotic and alien invasive vegetation throughout the site and along the drainage lines.

Figure13. Several dogs and cats were observed around the rural homesteads. Cats and dogs have a high impact on remaining smaller mammals, bird, reptile and amphibian species.

4.1 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 3 days during the late summer months (May), only a small proportion of species are present. Ideally, a herpetological survey should be undertaken throughout the duration of the wet season (November-Mach). It is only during this period that accurate frog species lists can be compiled.

Three frog species were recorded during the brief survey namely a Guttural Toad (*Amietophrynus gutturalis*), Snoring Puddle Frog (*Phrynobatrachus natalensis*) and a Common River Frog (*Amietia angolensis*). Nine (9) frog species have been recorded from the 2930 BB quarter degree grid square according to Frogmap (http://sarca.adu.org.za/safap/index.php). 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.

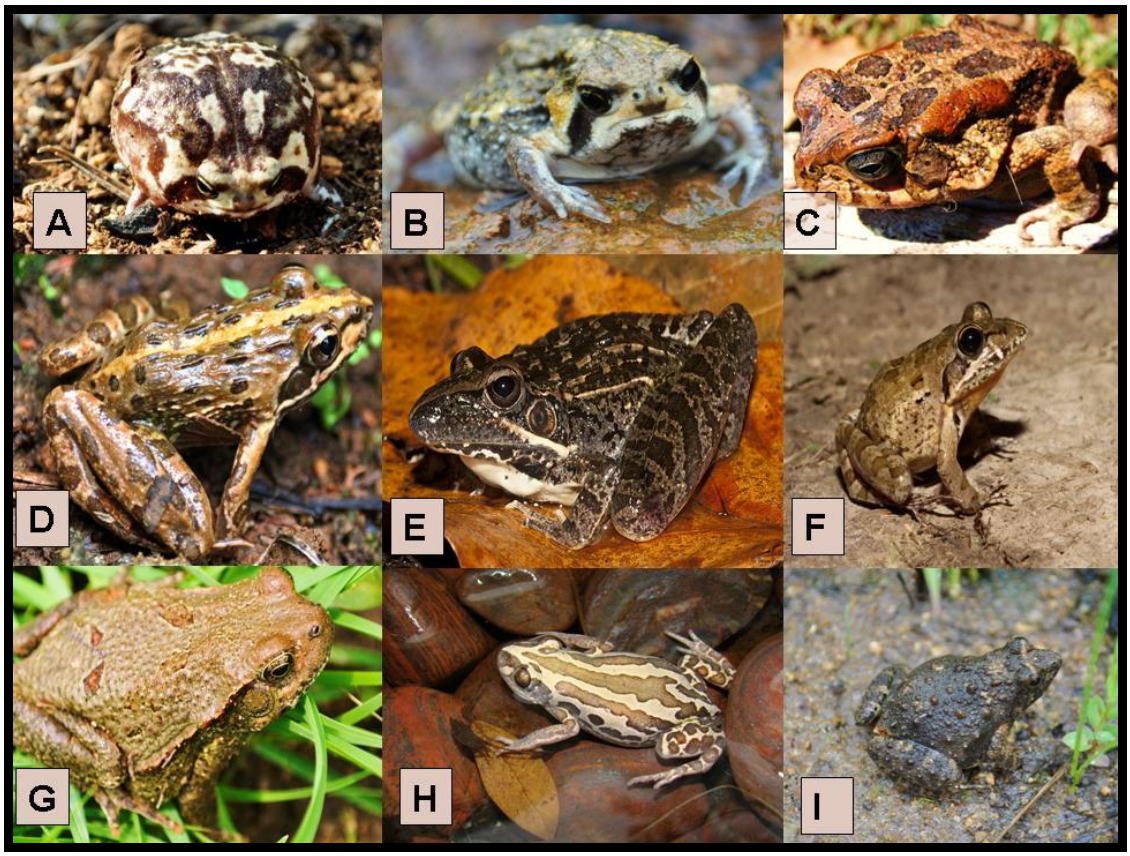


Figure14. A collage of photographs displaying the frog species recorded in the 2930 BD QDGC. A: The terrestrial breeding Bushveld Rain Frog (*Breviceps adspersus*) and **B:** Mozambique Rain Frog (*Breviceps mossambicus*). **C:** The urban exploiting *Guttural Toad (*Amietophrynus gutturalis*). **D:** The *Common River Frog (*Amietia angolensis*) breeds in permanent streams and waterboddies. **E:** The Sharp-nosed Grass Frog (*Ptychadena oxyrynchus*) breeds in seasonally inundated grass pools or depressions. **F:** The Clicking Stream Frog (*Strongylopus grayii*) breeds in a variety of wetland habitats from streams to dams. **G:** The Red Toad (*Schismaderma carens*) favours deeper reed invaded dams for breeding. **H:** The Bubbling Kassina (*Kassina senegalensis*) and (**I**) *Snoring Puddle Frog (*Phrynobatrachus natalensis*) are widespread species.

* observed during current survey

Table2. Frog species recorded on the actual site or are likely to occur on the site.

Genus	Common name	Genus	Species	Red list category	Atlas region endemic
Arthroleptidae	Forest Tree Frog	Leptopelis	natalensis	Least Concern	Yes
Brevicepitidae	Bushveld Rain Frog	*Breviceps*	*adspersus*	Least Concern	No
Brevicepitidae	Mozambique Rain Frog	*Breviceps*	*mossambicus*	Least Concern	No
Bufonidae	*Guttural Toad	*Amietophrynus*	*gutturalis*	Least Concern	No
Bufonidae	Red Toad	*Schismaderma*	*carens*	Least Concern	No
Hyperoliidae	Bubbling Kassina	*Kassina*	*senegalensis*	Least Concern	No
Phrynobatrachidae	*Snoring Puddle Frog	*Phrynobatrachus*	*natalensis*	Least Concern	No
Ptychadenidae	Sharp-nosed Grass Frog	*Ptychadena*	*oxyrhynchus*	Least Concern	No
Pyxicephalidae	*Common or Angola River Frog	*Amietia*	*angolensis*	Least Concern	No

*observed during current survey

Threatened Species

No red listed frog species are known from the 2930 BD Quarter Degree Grid Cell (QDGC) in which the Emergency Nondabula Water Reticulation project site is situated in or are likely to occur within the footprint of the reticulation pipelines. borehole and reservoirs.

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 habitat destruction and high levels of disturbances, alterations to the original reptilian fauna are expected to have already occurred. Removal of indigenous tree species and dead trunks for firewood collection destroys numerous habitats for many arboreal reptile species. Clearing of rock material for terraced agricultural lands 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 rupicolous outcrops or rock sheets were observed within the proposed site. No major termite mounds were observed on the site. Low-lying rocky extrusions and large termite mounds were observed within the remnant patches of sandstone sourveld on the edge of the plateau and steep rocky hillslopes. 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.

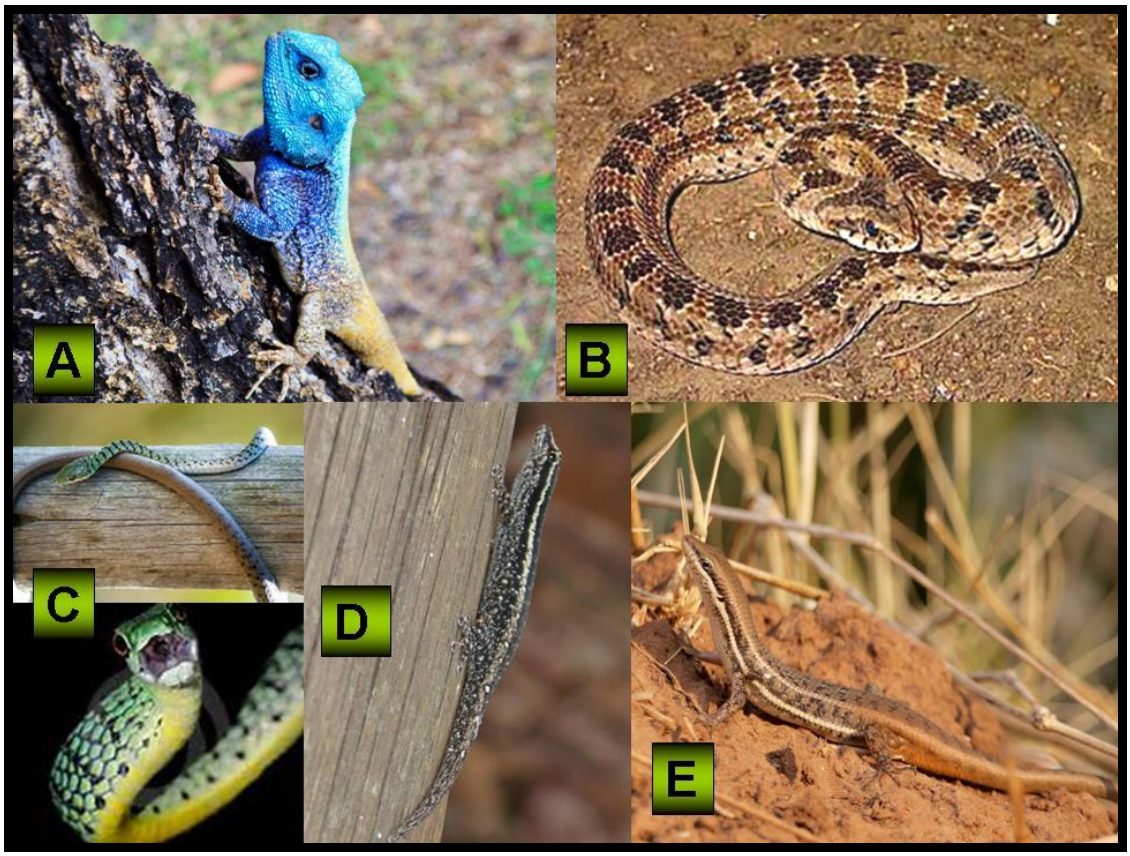


Figure15. **A conglomerate of photographs displaying the reptile species that occur or are likely to occur in the Emergency Nondabula Water Reticulation study area. A:** Male Southern Tree Agama (*Acanthocercus atricolis*); **B:** Rhombic Night Adder (*Causus rhombeatus*); **C:** Spotted Bush-Snake (*Philothamnus semivariegatus*); **D:** Cape Dwarf Gecko (*Lygodactylus capensis*) and **D:** Variable Skink (*Trachylepis varia*).

Table4. Reptile species that have been recorded from the 2930 BD QDGC occur or are likely to occur in the study area due to suitable habitat. Actual species lists will most likely contain far fewer species due to high levels of habitat transformation.

Family	Genus	Species	Subspecies	Common name	Red list category	Atlas region endemic
Agamidae	**Acanthocercus*	*atricollis*	*atricollis*	Southern Tree Agama	Least Concern (SARCA 2014)	No
Colubridae	**Philothamnus*	*semivariegatus*		Spotted Bush Snake	Least Concern (SARCA 2014)	No
Gekkonidae	**Lygodactylus*	*capensis*	*capensis*	Common Dwarf Gecko	Least Concern (SARCA 2014)	No
Scincidae	*Afroablepharus*	*wahlbergii*		Wahlberg's Snake-eyed Skink	Least Concern (SARCA 2014)	No
Scincidae	**Trachylepis*	*varia*		Variable Skink	Least Concern (SARCA 2014)	No
Viperidae	*Causus*	*rhombeatus*		Rhombic Night Adder	Least Concern (SARCA 2014)	No

* observed during brief field survey

Threatened Species

Five reptile species were recorded during the brief field survey including an adult Male Southern Tree Agama (*Acanthocercus atricolis*) on a *Vachelia karroo* trunk. A road fatality of a Spotted Bush-Snake (*Philothamnus semivariegatus*) was observed. Two reptile species were recorded adjacent to the rural homesteads including Variable Skinks (*Trachylepis* (*Mabuya*) *varia*) and Cape Dwarf Geckos (*Lygodactylus capensis*) on the building and fences of kraals on the site. Low reptile diversity is expected from the Emergency Nondabula Water Reticulation project site and immediate adjacent areas. No threatened reptile species are likely to occur on the site or the immediate open areas surrounding the site due to extensive habitat transformation and degradation. Low reptile diversity is expected on the site due to extensive habitat destruction and low diversity within the transformed and heavily degraded *Aristida junciformis* grasslands.

4.3 AVIFAUNA/BIRDS

A comprehensive bird species list requires intensive surveys compiled over several years. One hundred and six (106) bird species have been recorded within the 2920_3050 pentad during the on-going second South African Bird Atlas Project (SABAP2). Due to time constraints and timing of survey no comprehensive bird lists could be compiled. During the site visitation (total of 20 hrs) thirty-four (34) 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 grassland/woodland environment. The majority of bird species were recorded within the scarp forest and closed woodland patches. High levels of human disturbance as well as habitat transformation and degradation on the site and surrounding grassland hillslopes results in the disappearance of the more secretive or sensitive bird species.

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

Roberts' Number	Common name	Scientific Name
92	**Southern Bald Ibis**	***Geronticus calvus***
94	Hadedah Ibis	*Bostrychia hagedash*
126b	Yellow-Billed Kite	*Malvus aegypticus*
148	African Fish-Eagle	*Haliaeetus vocifer*
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*
361	African Green-Pigeon	*Treron calvus*
371	Purple-Crested Turaco	*Gallirex porphyreolophus*
386	Diederick Cuckoo	*Chrysoccocyx caprius*
391	Burchell's Coucal	*Centropus burchellii*
411	Common Swift	*Apus apus*
417	Little Swift	*Apus affinis*
424	Speckled Mousebird	*Colius striatus*
435	Brown-Hooded Kingfisher	*Halycon albiventris*
455	Trumpeter Hornbill	*Bycanistes bucinator*
464	Blackcollared Barbet	*Lybius torquatus*
470	Yellow-Fronted Tinkerbird	*Pogoniulus chrysoconus*
473	Crested Barbet	*Tracchyphonus vailantii*
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*
577	Olive Thrush	*Turdus olivaceus*
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*
814	Masked Weaver	*Ploceus velatus*
815	Lesser Masked Weaver	*Ploceus intermedius*

Figure16. A single Southern Bald Ibis *Geronticus calvus* was observed foraging within the secondary succession *Aristida junciformis* grasslands. The adjacent steep rocky cliffs offer suitable nesting habitat for Southern Bald Ibis.

Threatened species

No threatened bird species have been recorded during the recent South African Bird Atlas Project (SABAP2) from the 2920_3050 pentad in which the Emergency Nondabula Water Reticulation project is situated. One threatened bird species was observed during the brief site visit namely the 'Vulnerable' Southern Bald Ibis. A single adult Southern Bald Ibis was observed foraging in the remnant patches of secondary succession Aristida junciformis grassland. If any threatened bird species occur it is highly unlikely that the Emergency Nondabula Water Reticulation pipeline servitudes, reservoir sites and borehole will form critical habitat for any threatened bird species including the single Southern Bald Ibis. The Southern Bald Ibis is wary of humans and will move away from any disturbances associated with the construction of the reticulation pipelines. No development is proposed within the remnant open secondary succession *Aristida junciformis* grasslands as well as sandstone sourveld adjacent to the Emergency Nondabula Water Reticulation Project.

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. Limited suitable refuges such as burrows, artificially created rock piles, stumps were observed. The majority of mammal species likely to occur around the homesteads are urban exploiters such as the House Rat and House Mouse as well as feral cats. Several mounds of the African Molerat as well as burrows on the Natal Multimammate Mouse were observed in the sandier sections adjacent to the current vegetable gardens on the eastern boundary of the site. 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.

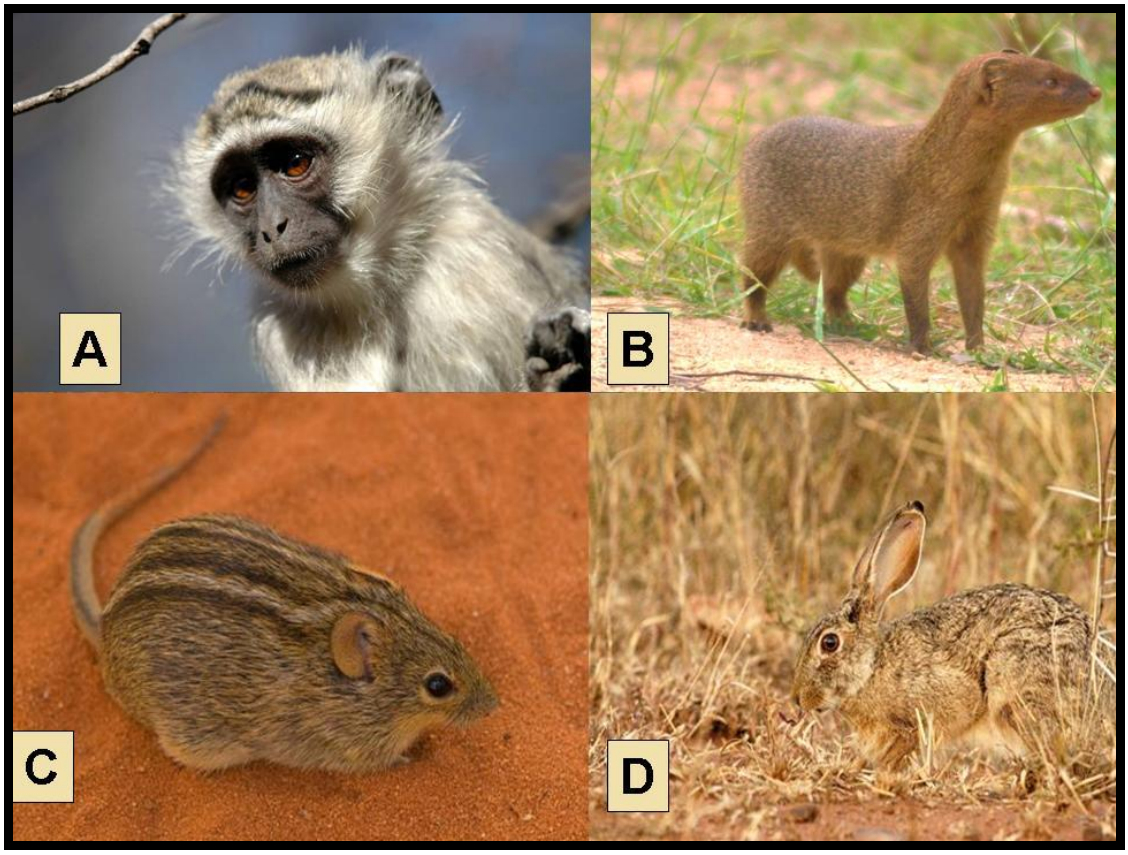


Figure17. A conglomerate of photographs displaying the mammal species recorded from the Emergency Nondabula Water Reticulation project area. A: Vervet Monkey (*Ceropithecus aethiops*)*, **B:** Slender Mongoose (*Galerella sanguinea*); **C**: Four-striped Grass Mouse (*Rhabdomys pumilio*)* and **D:** Savanna or Scrub Hare (*Lepus saxatilis*)*.

* Photographs courtesy of Prof. G.D. Engelbrecht University of Limpopo

Table 5: Mammal species recorded during field survey. 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***
Scrub Hare	*Lepus saxtalis*
Striped Mouse	*Rhabdomys pumilio*
Grey Climbing Mouse	*Dendromus melanotis*
Brant's Climbing Mouse	*Dendromus mesomelas*
Highveld Gerbil	*Tatera brantsii*
***House mouse**	***Mus musculus***
***House Rat**	***Rattus rattus***
***Domestic Dog**	***Canis familiaris***
***Feral Cat**	***Felis catus***
Common Duiker	*Sylvicapra grimmia*
Bushbuck	*Tragelaphus scriptus*
Vervet Monkey	*Cercopithecus aethiops pygerythrus*

Cape Clawless Otter	*Aonyx capensis*
Slender Mongoose	*Galarella sanguinea*
Striped Polecat	*Ictonyx striatus*
Large-spotted Genet	*Genetta tigrina*
Porcupine	*Hystrix africaeaustralis*

* introduced species

THREATENED SPECIES

No sensitive or endangered mammals were recorded within the Emergency Nondabula Water Reticulation study area. The majority of larger mammal species are likely to have been eradicated or have moved away from the area during the previous residential and agricultural developments. This is mainly a result of increased development pressure and human disturbances such as hunting and poaching (wire snares), as well as habitat alteration and degradation by vegetation clearance and frequent fires. Smaller mammal species are extremely vulnerable to snares and poaching activities as well as feral cats. It is highly unlikely that the proposed Emergency Nondabula Water Reticulation project constitutes significant habitat for any threatened mammal species or for mammals in general. The remnant patches of closed woodland and scarp forest provide suitable habitat for certain large mammal species.

5. SENSITIVE ENVIRONMENTS/HABITATS ON AND SURROUNDING THE SITE

From a desktop study using inter alia aerial photographs and Google Earth ™ imagery as well as a preliminary site investigation (20th – 22nd of May 2015) the following four sensitivity categories of areas were identified:

High:	Areas with high species richness and habitat diversity comprising natural indigenous plant species. These areas are ecologically valuable and important for ecosystem functioning.
Medium-High:	An area with a relatively natural species composition; a threatened or unique ecosystem; moderate species and habitat diversity. These areas are ecologically valuable and important for buffering adjacent ecosystem functioning.
Medium-Low:	An area with a relatively natural species composition; not a threatened or unique ecosystem; moderate species and habitat diversity but is currently degraded. Could be developed with mitigation and expected low impact on adjacent ecosystems.
Low:	A totally degraded and transformed area with a low habitat diversity and ecosystem functioning; no viable populations of natural plants. Development could be supported with little to no impact on the adjacent natural vegetation / ecosystem.

5.1 RELIC PATCHES OF KWAZULU-NATAL SANDSTONE SOURVELD

The relic patches of Kwazulu-Natal Sandstone Sourveld (SVs 5) are considered to be of **Medium-High conservation importance** at a local scale for the following reasons:

- Kwazulu-Natal Sandstone Sourveld (SVs 5) is an **Endangered vegetation** (NEMBA 2004 & SANBI & DEAT 2011) unit with only a small part statutorily conserved (0.2 %) in the Krantzkloof and Vernon Crookes Nature Reserves. About 68% is transformed for cultivation, plantations, urban sprawl and road-building. Conservation target is 25% conserved. This highly transformed vegetation type is a prime agricultural area with mainly sugar cane and timber plantations. The urban sprawl of the eThekwini (Durban) Metropolitan Area and densely populated subsistence farming accounts for most of the remainder. Apart from the critically little conserved areas (a few hundred hectares), most remaining areas are subjected to high levels of grazing and frequent fire which is not conducive to the recruitment of seedlings of many of the shrubs and herbs.
- Grasslands in Kwazulu- are highly threatened by afforestation, urbanization and agricultural activities. Only a small fraction of this vital habitat has been formerly conserved. These areas form vital habitats for numerous endemic as well as threatened plant as well as several threatened animal species. All remaining primary sandstone sourveld grasslands and especially within the higher lying rocky hillslopes and plateaus must be considered as a sensitive environment.
- Activities in all remaining open grasslands must be restricted. Access to surrounding open grassland must be strictly managed to prevent possible poaching, harvesting of medicinal plants and disturbances to remaining fauna. No driving of vehicles through open grassland. No new roads or pipelines must be created through primary open grassland.

5.2 PERENNIAL RIVERS & NON-PERENNIAL DRAINAGE LINES

The perennial rivers (Kwabiyela, Nsuze, Mdloti) and non-perennial drainage lines are considered to be of **Medium-High sensitivity and conservation importance** for the following reasons:

- The indigenous vegetation of riverine wetlands within Kwazulu-Natal, and wetlands in general throughout the Grassland and Savanna Biomes, are in danger of being completely replaced by alien invasive species (Henderson & Musil 1997, Rutherford & Westfall 1994). Any remaining areas of indigenous riparian vegetation or marshland vegetation within Kwazulu-Natal must therefore be regarded as 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.

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

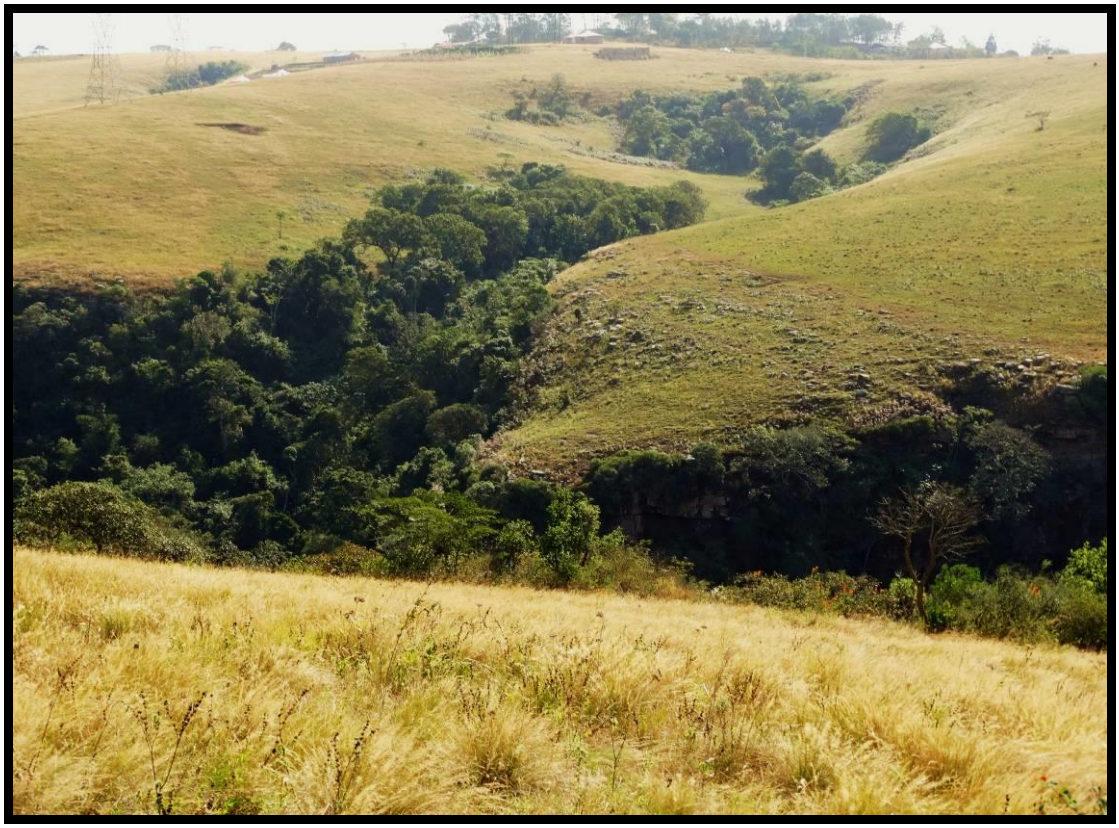
- enhancing water quality in the river by the interception and breakdown of pollutants;
- interception and deposition of nutrients and sediments;
- stabilisation of riverbanks and macro-channel floor;
- flood attenuation;
- provision of habitat and migration routes for fauna and flora;
- provision of 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.).

5.3 PALUSTRINE WETLANDS

Indigenous subtropical freshwater marshland vegetation such as that found within the valley bottom wetland in the Emergency Nondabula Water Reticulation project area 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. The conservation status of many of the faunal species (especially frogs) that are dependant on wetlands reflects the critical status of wetland nationally, with many having already been destroyed. All remaining wetlands (permanent and seasonal) and their associated subtropical hygrophilous vegetation must be considered as a **Medium-High sensitive** habitat.

The proposed Nhlangakazi borehole is situated adjacent to a palustrine valley bottom wetland. The wetland is dominated by hygrophilous grass and sedge species. The wetlands within the study area are heavily impacted on by adjacent forestry activities, livestock grazing and drinking activities as well as small-scale agricultural activities. Extensive overgrazing and trampling of the hygrophilous grass and sedge vegetation within the valley bottom wetland. It has been shown that heavy grazing has a detrimental effect on the hydrological state of wetlands, these include: disruption of flow patterns by paths, gully erosion, silting up of pools, encroachment of marginal vegetation into the wetland area, etc. Soil compaction reduces infiltration, which results in higher surface runoff and more rapid loss of water from the catchment. With increased runoff, stream-flow response is more rapid, flooding increases and recharge of groundwater storage falls with the result that baseflow yields also fall. This can increase the risk of soil loss through surface wash and rill erosion (Kotze & Breen 1994).

5.4 ROCKY RIDGES AND CLIFFS AND CLOSED WOODLAND POCKETS



Ridges are characterized by high spatial heterogeneity due to the range of differing aspects (north, south, east, west and variations thereof), slopes and altitudes all resulting in differing soil (e.g. depth, moisture, temperature, drainage, nutrient content), light and hydrological conditions. The temperature and humidity regimes of microsites vary on both a seasonal and daily basis (Samways & Hatton, 2000). Moist cool aspects are more conducive to leaching of nutrients than warmer drier slopes (Lowrey & Wright, 1987). Variation in aspect, soil drainage (Burnett *et al.*, 1998) and elevation/altitude (Primack, 1995) have been found to be especially important predictors of biodiversity. It follows that ridges will be characterized by a particularly high biodiversity, as such their protection will contribute significantly to the conservation of biodiversity in the area as well as the rest of Mpumalanga Province. For example, a wide variety of bird groups utilize ridges, koppies and hills for feeding, roosting and breeding. These groups include some owls, falcons, nightjars, swifts, swallows, martins, larks, chats, thrushes, cisticolas, pipits, shrikes, starlings, sunbirds, firefinches, waxbills, buntings, canaries, eagles and vultures. Ridges provide important habitat for sensitive species such as bats (roosting sites) and the eastern rock elephant shrew. Ridges and kloofs also form caves, an important habitat for highly specialized animals, e.g. bats. Variable microclimate conditions have resulted in a vast array of invertebrate communities associated with the high plant diversity characterizing ridges. Hills and koppies generally have more insects (both in terms of individuals and species) than the immediate surroundings (Samways & Hatton, 2000). The Scarp Forest and rocky ridge and cliffs must be considered as **Medium-High** sensitive habitat with unique vegetation as well as fauna. No development is proposed within the rocky mountainous slopes, cliffs and summits as well as deeply incised wooded valleys around the Emergency Nondabula Water Reticulation Project.

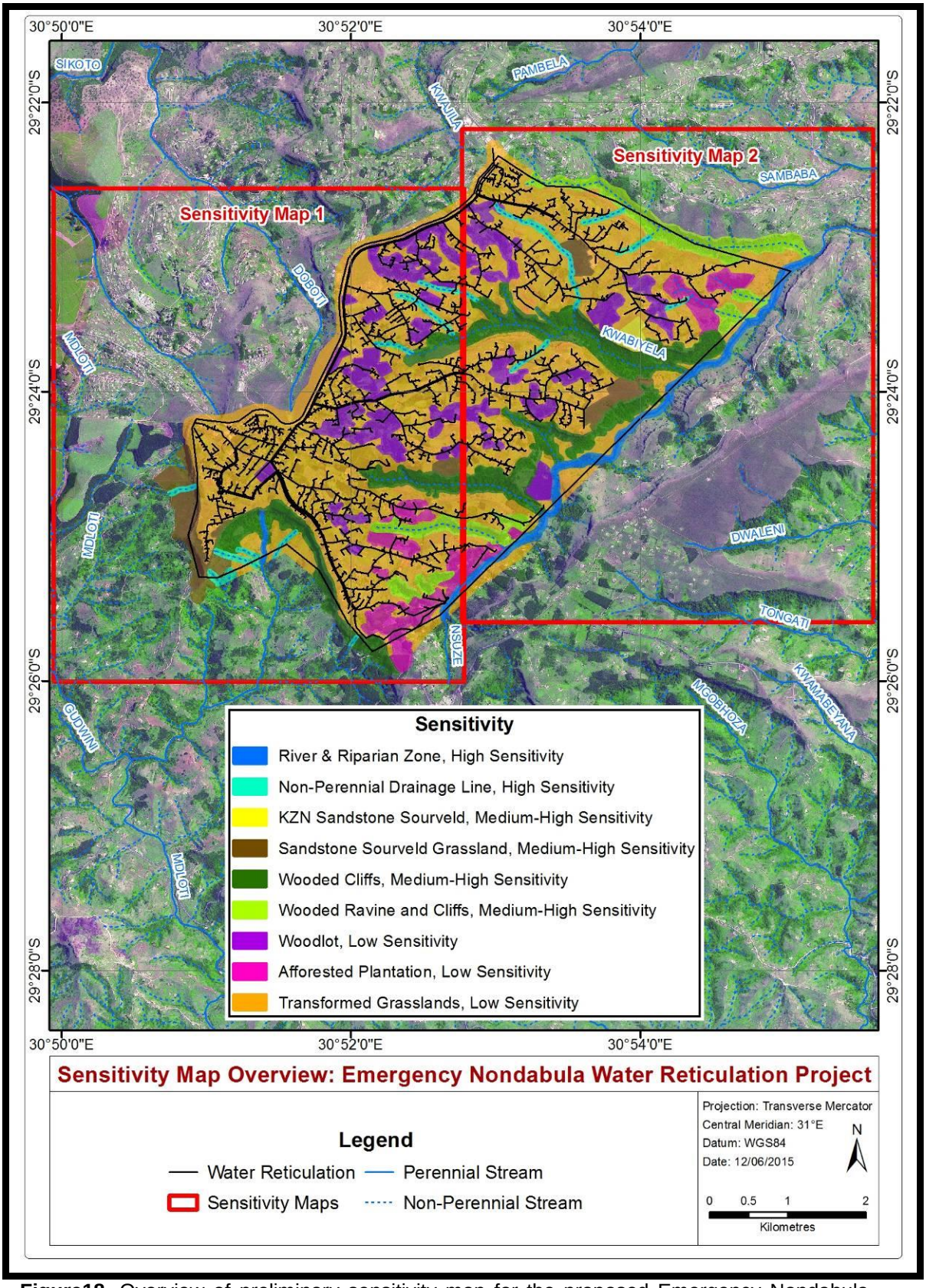


Figure18. Overview of preliminary sensitivity map for the proposed Emergency Nondabula Water Reticulation project.

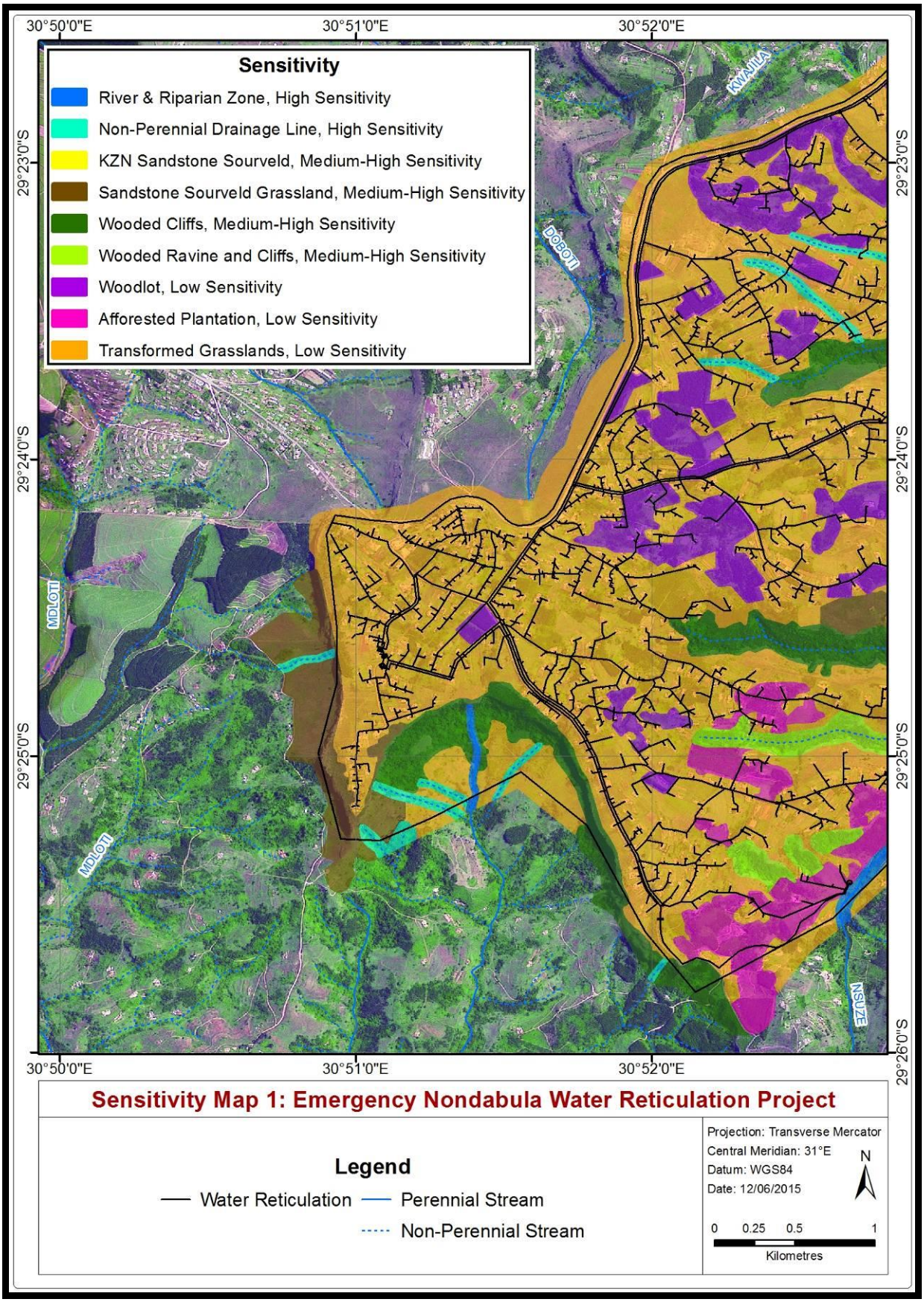


Figure19. Preliminary sensitivity map 1 for the proposed Emergency Nondabula Water Reticulation project

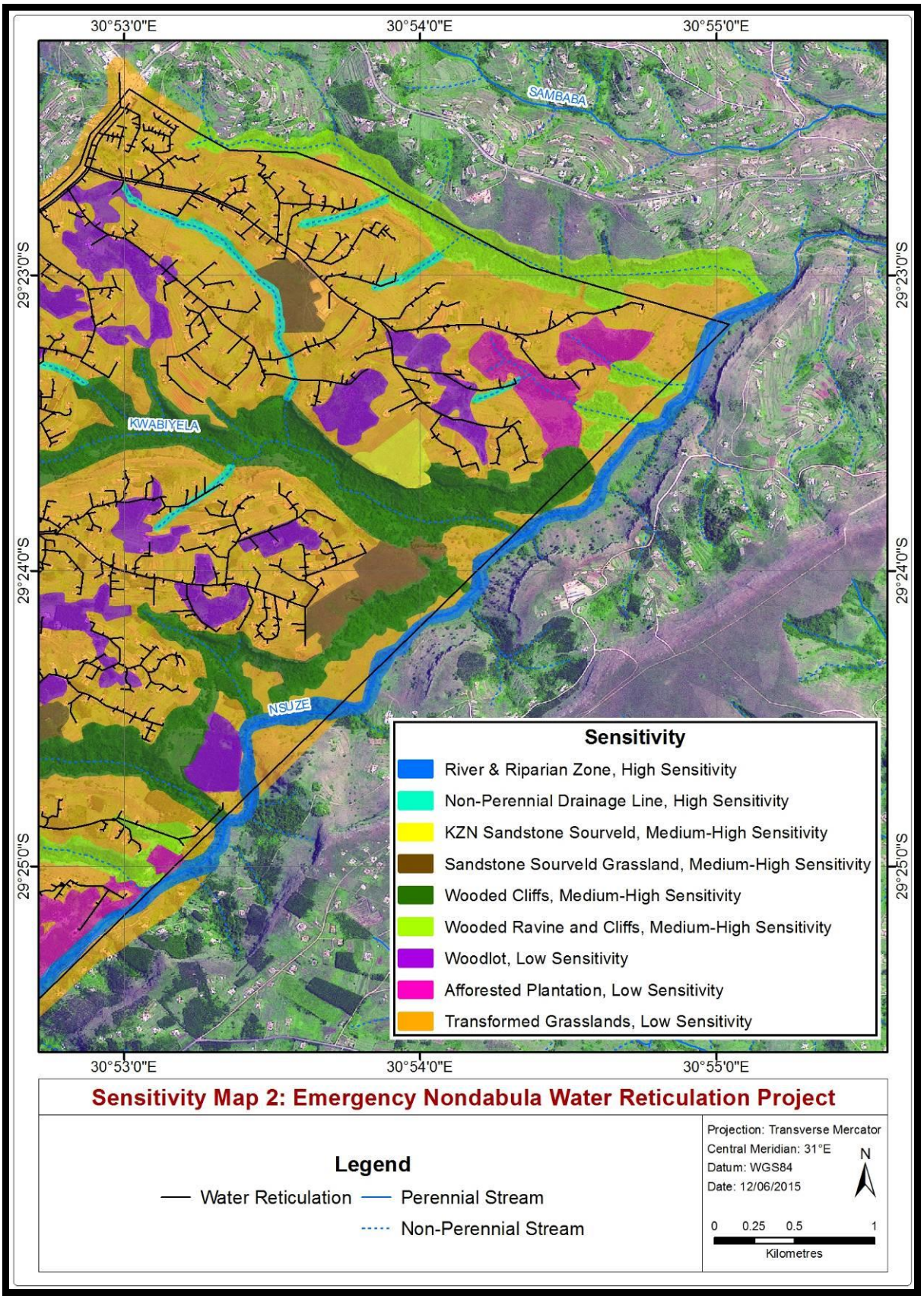


Figure20.Ppreliminary sensitivity map 2 for the proposed Emergency Nondabula Water Reticulation project

6. Impact ranking of potential impacts to associated vegetation and fauna

Table 6. The impact rating criteria used for determining potential impacts of the Emergency Nondabula Water Reticulation project

Descriptive criteria		
Nature	**Include a descriptive sentence**	
Probability	**Categories 1 – 5**	
	1	Improbable (less than 24% chance of occurring)
	2	Probable (25 – 49%)
	3	Likely (50 – 69%)
	4	Very likely (70 – 89%)
	5	Definite (90 – 100%)
Frequency	Categories 1 – 5	
	1	Very rare to remote (once or twice a decade)
	2	Unusual to occasional (once or twice every 5 years)
	3	Frequent (a few times a month)
	4	Very frequent (a few times a week, to daily)
	5	Continuous (daily to a significant percentage of every day)
Extent	Categories 1 – 5	
	1	Footprint / site
	2	Local
	3	Regional
	4	National
	5	International (trans-boundary)
Duration	Categories 1 – 5	
	1	Short (few days to a few months, less than a phase)
	2	Short (few months, or less than a phase in total)
	3	Medium (a few years, significant part of a phase)
	4	Long (lifespan of development (i.e. all of operation)
	5	Permanent
Intensity	Categories 1 – 5	
	1	Very low – natural processes not affected
	2	Low – natural processes slightly affected
	3	Medium – natural processes continue but in a modified manner
	4	Medium-high – natural processes are modified significantly
	5	High – natural processes disturbed significantly so that they cease to occur (temporarily / permanently)
Significance	**Significance = P + F + E + D + I** Minimum value of 5, maximum of 25 Status determines if positive / negative	
	Any positive value	No impact High to low consequence, probability not an issue as positive, **no mitigation required**
	– 5	Low-Low consequence, probably, **minimal mitigation may be required**
	– 6 to 10	Medium-Medium consequence, probably, **mitigation is advised / preferred**
	– 11 to 15	Medium to high-Medium to high consequence, probably to very probable, **mitigation is necessary**
	– 16 to 20	High-High consequence, probably / definite, **mitigation is essential**
	– 21 to 25	Extreme-Very high consequence, definite, **Fatal flaw!**

Table7. Summary table of the potential impacts of the Emergency Nondabula Water Reticulation project

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Nature of Impact	Probability	Frequency	Extent	Duration	Intensity	Significance
Habitat destruction with transformation of natural vegetation and habitats within the proposed Emergency Nondabula Water Reticulation project area.	Improbable (less than 24% chance of occurring)	Very rare to remote (once or twice a decade)	Local Footprint / site	Long (lifespan of development (i.e. all of operation)	Very low – natural processes not affected	Low-Low consequence, probably, **minimal mitigation may be required**
Destruction of suitable habitat for red listed plants and animals.	Improbable (less than 24% chance of occurring)	Very rare to remote (once or twice a decade)	Local Footprint / site	Long (lifespan of development (i.e. all of operation)	Low-Low consequence, probably, **minimal mitigation may be required**	Low-Low consequence, probably, **minimal mitigation may be required**
Erosion and sediment from removed towers.	Likely (50 – 69%)	Very frequent (a few times a week, to daily)	Local Footprint / site, but eroded soil could be washed onto other ecosystems	Long (lifespan of development (i.e. all of operation)	Low – natural processes slightly affected	Medium-Medium consequence, probably, **mitigation is advised / preferred**

7: CONCLUSION AND ENVIRONMENTAL MANAGEMENT RECOMMENDATIONS

The Emergency Nondabula Water Reticulation project is dominated by completely transformed Kwazulu-Natal Sandstone Sourveld and surrounded by old agricultural lands with limited patches of secondary succession grasslands dominated by anthropogenic grasses and pioneer weedy plant species and invaded by alien invasive plant species. The secondary succession grasslands adjacent to the fields provides limited suitable habitat for certain rodent species such as the Highveld Gerbil, House Rats (villages) as well as Multimammate Mouse. Rodents construct burrows in the sandy soils and attract other predators such as the Slender Mongoose. Bird species around the villages are restricted to granivorous or seed eating birds such as Laughing Dove, Cape Turtle Dove. The majority of bird species recorded during the site visit were observed in the remnant pockets of moist closed woodland patches and Scarp Forest within the steep wooded south-western valley. Reptile species are extremely sensitive to habitat destruction and transformation. Low reptile diversity is expected within the Emergency Nondabula Water Reticulation project area. Species recorded during the brief field assessment included Cape Dwarf Gecko (*Lygodactylus capensis*), Southern Tree Agama (*Acanthocercus atricolis*), Spotted Bush-Snake (*Philothamnus semivariegatus*) and Variable Skink (*Trachylepis varia*). Low amphibian diversity is expected along the non-perennial drainage lines due to extensive habitat transformation and deterioration of water quality. Suitable breeding habitat occurs within the non-perennial drainage lines and valley bottom wetland adjacent to the Nhlangakazi borehole for certain frog species including Common River Frogs (*Amietia angolensis*), Painted Reed Frogs (*Hyperolius marmoratus*), Red Toad (*Schismaderma carens*) Raucous Toad (*Amietophrynus rangeri*) and Guttural Toad (*Amietophrynus gutturalis*).

The temporary alteration of vegetation and soil structure in the effected areas of the proposed Emergency Nondabula Water Reticulation project will impact on the fauna and flora directly within the reticulation pipeline alignments, reservoir sites and potentially in the immediate surrounding area. It is imperative that minimal vegetation clearance and disturbances should occur along the proposed pipeline routes. Vegetation clearance should be restricted to the actual pipeline trench (1.5- 2 m) within the 20m pipeline servitudes.

As the pipelines are situated adjacent to seasonal or non-perennial drainage lines usually on a sloping gradient; erosion/siltation preventative measures must be implemented throughout all phases of the project. In addition, the increased human density, heavy construction machinery and vehicles will most likely directly and indirectly result in the short-long term alteration of the faunal composition on the site and surrounding areas. Loss of habitat for foraging, reproduction and shelter will most severely impact on the smaller sedentary species (insects, arachnids, reptiles, amphibians and mammals). Larger more agile birds and mammals will try and locate suitable habitat away from the development. After the completion of the pipeline the newly excavated softer soils could potentially offer favourable habitat for certain burrowing animal species.

7.1 HABITAT DESTRUCTION AND ASSOCIATED DISTURBANCES TO REMAINING FAUNAL SPECIES

During the construction phase of the proposed Emergency Nondabula Water Reticulation project some habitat destruction and alteration inevitably takes place within the proposed pipeline and reservoir project. This happens with the construction of the access roads, and the clearing of the water pipeline servitudes and reservoir sites. As the pipeline alignments are not fixed the preferred alignments should follow existing road servitudes as well as be situated mainly in transformed habitats (old and current agricultural lands) as well as the degraded secondary succession grasslands where extremely limited vegetation clearance will be required during the construction and operational phase of the project. Vegetation clearance will be restricted to road reserves, secondary succession grasslands hillslopes and alien invaded woodlots. These activities will have an impact on the associated fauna especially ground living and fossorial species occurring along or in close proximity of the pipeline servitudes, both through modification of habitat and disturbance caused by human activity. The proposed impact will be of **medium to low; short-long term impact** on remaining (albeit) limited faunal species.

MITIGATION AND RECOMMENDATIONS

The following general recommendations are made to minimise the impacts of proposed Emergency Nondabula Water Reticulation project on the immediate environment and remaining fauna:

- Close site supervision must be maintained during construction activities.
- During the **CONSTRUCTION** phase workers must be limited to areas under construction within the 20 m pipeline servitude and access to the undeveloped areas, especially the relic sandstone sourveld on the edge of the plateau, Scarp Forest and rocky cliff and wooded valleys, permanent and seasonal drainage lines, valley bottom wetland must be strictly regulated (“no-go” areas during construction as well as operational activities).
- Provision of adequate toilet facilities must be implemented to prevent the possible contamination of ground (borehole) and surface water in the area. Mobile toilets must be provided in order to minimize un-authorised traffic of construction workers outside of the designated areas.
- All temporary stockpile areas including litter and dumped material and rubble must be removed on completion of construction. All alien invasive plant should be removed from the pipeline servitude to prevent further invasion.
- Firearms or any other hunting weapons must be prohibited on site.
- Contract employees must be educated about the value of wild animals and the importance of their conservation.
- Severe contractual fines must be imposed and immediate dismissal on any contract employee who is found attempting to snare or otherwise harm remaining faunal species.
- No animals must not be intentionally killed or destroyed and poaching and hunting must not be permitted on the site.

Disturbed areas of natural vegetation as well as cut and fills must be rehabilitated immediately to prevent soil erosion. This is especially relevant adjacent to the Nhlangakazi borehole adjacent to the valley bottom wetland. The use of herbicides shall only be allowed after a proper investigation into the necessity, the type to be used, the long-term effects and the effectiveness of the agent. Application shall be under the direct supervision of a qualified technician. All surplus herbicide shall be disposed of in accordance with the supplier's specifications.

All alien vegetation in the pipeline servitude and densifiers creating a fire hazard shall be cleared and treated with herbicides. 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.

It is recommended that a contractor for vegetation clearing should comply with the following parameters:

- The contractor must have the necessary knowledge to be able to identify indigenous tree species (not interfering with the pipeline servitude.
- The contractor must also be able to identify declared weeds and alien species that must be totally eradicated according to the Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983).
- The contractor must be in possession of a valid herbicide applicators license.

7.2 CONSTRUCTION PHASE

General

- All construction activities must be strictly limited to the construction or pipeline servitude. Vegetation clearance should be restricted to the actual pipeline trench (1.5-2 m) within the pipeline servitude (20m).
- Sufficient chemical toilets and waste bins must be provided in all areas where construction is taking place. These toilets and bins must furthermore be emptied regularly.
- Sanitation facilities shall be located within 100m from any point of work, but not closer than 50 m from any drainage lines or river.
- Construction activities are to be restricted to business hours in order to limit disturbance of surrounding land owners in terms of *inter alia* noise.
- All vehicles associated with the construction activities must be in a serviced condition to prevent oil leaks etc and the possible contamination of the adjacent valley bottom wetlands and streams.

7.3 SOIL CONSERVATION/EROSION CONTROL

- Top soil stripping must be restricted to the pipeline trench (1.5-2 m) and appropriately stored for later use in back-filling. Sub-soil and topsoil (the top +/- 30-50 cm of the soil) should be stored separately.
- Soil stockpiles are to be protected from possible erosion, e.g. through covering of the stockpiles with tarpaulin, and limiting the height and angle of the stockpile. Soil stockpiles must not exceed 1 m in height.
- Soil stockpiling areas must be sufficiently situated away from the drainage areas towards the lower lying non-perennial drainage lines.
- Any erosion channels developed during the construction period or during the vegetation establishment period should be backfilled and compacted, and the areas restored to a proper condition. The Contractor should ensure that cleared areas are effectively stabilised to prevent and control erosion. Disturbed areas of natural vegetation as well as cut and fills must be rehabilitated immediately to prevent further soil erosion.
- Re-seeding shall be done on disturbed areas especially adjacent to any natural bushveld habitat, riverine or wetland crossing
- In accordance with the Conservation of Agricultural Resources Act, No 43 of 1983, slopes in excess of 2% must be contoured and slopes in excess of 12% must be terraced.
- Contour banks shall be spaced according to the original or surrounding topography/slope. The type of soil shall also be taken into consideration.
- Any erosion channels developed during the construction period or during the vegetation establishment period shall be backfilled and compacted, and the areas restored to a proper condition.
- The Contractor shall ensure that cleared areas are effectively stabilised to prevent and control erosion. The method of stabilization shall be determined in consultation with the consultant. Consideration and provision shall be made for the following methods:

- Mulch or chip cover
- Straw stabilizing (at the rate of one bale/m² and rotated into the top 100mm of the completed earthworks)
- Watering
- Planting / sodding
- Hand seeding/ sowing
- Hydroseeding
- Soil binders and anti erosion compounds
- Mechanical cover or packing structures
- Gabions & reno mattresses
- Geofabric
- Hessian cover
- Exposed slopes and/or destabilised areas should be landscaped to blend in with the surrounding areas if possible.

7.4. REHABILITATION

The traditional definition of rehabilitation aims at returning the land in a given area to some degree of its former state after a particular process has resulted in its damage. The pipeline servitude should be appropriately rehabilitated and re-vegetated with indigenous (to the area) shrub, forb and grass species. Rehabilitation methods are detailed in Table 8 below.

Table 8: Recommended rehabilitation measures.

Step	Method	Equipment
1	Remove all construction material from the pipeline servitude where construction has been completed.	To be undertaken by hand.
2	Topsoil that has been stockpiled during construction 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 construction.	Topsoil must be applied from the topsoil stockpiled during construction.
3	The naked ground or new pipeline servitude 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 junciformis* • *Cynodon dactylon* • *Cymbopogon plurinodes* • *Eragrostis curvula* • *Eragrostis gummiflua* • *Themeda triandra* • *Setaria spp.* • *Imperata cylindrica* • *Sporobolus fimbriatus* and sedges such as *Cyperus immensus*, *Schoenoplectus* spp. and *Juncus spp.* should be used.

* see attached species list

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 reseeded. If necessary, another dressing of topsoil should be applied prior to seeding.	As above.
6	Slope stabilisation measures may be necessary in places where grass has not been able to establish and there is an erosion risk. The measures implemented depend on the situation, and can be varied as necessary.	Various slope stabilisation measures are available and vary in effectiveness according to the situation including • Gabion mattresses and baskets adjacent to the non-perennial drainage line. • Logs/bark held in place with pegs • Rows of *Cynodon dactylon*, *Panicum maximum*, *Imperata cylindrica*, *Hyparrhenia filipendula* held in place with pegs. • Soil and rock sausages along contours.
7	All alien vegetation is to be appropriately removed and disposed of. Alien species that have been encountered included Black Wattle (*Acacia mearnsii*), Syringa *Melia azedarach,* Brazilian Glory Pea *or* Red Sesbania *Sesbania punicea*, Castor-Oil Plant (*Ricinus communis*), Lantana (*Lantana camara*), Bugweed (*Solanum mauritianum*), Peanut Butter Cassia (*Senna diymobotrya*), Morning Glory (*Ipomoea purpurea*), Paraffin Bush (*Chromolaena odorata*), Yellow Oleander (*Thevetia peruviana*), Montanoa (*Montanoa hibiscifolia*), Indian Shot (*Canna indica*), *Ageratum conyzoides*, *Caesalpinia decapetala*, *Campuloclinium macrocephalum*, *Chromolaena odorata*, *Ipomoea indica*, *Leucaena leucocephala*, *Psidium guajava*, *Rubus cuneifolius*, *Rubus fruticosus*, *Mimosa pigra, Tithonia diversifolia*.	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)

8	The Emergency Nondabula Water Reticulation project pipeline servitudes must be regularly inspected during the operational phase and alien vegetation that have re-emerged, must be removed and a follow-up treatment applied.	On-going alien vegetation removal programme (beyond the scope of the project)

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9. APPENDIX

Table9. Grass species list (ideally grass species endemic to the area should be used for the re-vegetation of the pipeline servitudes)

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