PRELIMINARY ECOLOGICAL HABITAT ASSESSMENT FOR THE PROPOSED MAYFLOWER BULK SEWERAGE PROJECT; MPUMALANGA PROVINCE

Compiled for **Royal HaskoningDHV** by:
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1. INTRODUCTION:

Royal HaskoningDHV (RHDHV) have been appointed as independent environmental consultants to conduct an EIA Process for the bulk sewerage project for Mayflower situated within the Chief Albert Luthuli Local and Gert Sibande District Municipality. RHDHV as an Independent Environmental Practitioner appointed Mr. C.L. Cook to provide a description of the vegetation and current ecological status/habitat integrity of the Mayflower Bulk Sewerage alignments and to provide appropriate management recommendations for the proposed Mayflower Bulk Sewerage Supply Project.

Project Description:

The proposed project involves the construction of an approximately 6 km bulk outfall sewer line and smaller off-take pipelines. Two alternative alignments have been proposed for the Mayflower bulk sewer project. The proposed Option1 bulk sewer alignment bisects one incised or channelled valley bottom wetland and remnant patch of seasonally inundated seepage wetland. The majority of the alignment is situated within transformed secondary succession grasslands or old lands as well as road reserves. The proposed Option 2 bisects a channelled valley bottom wetland three times and runs adjacent to a channelled valley bottom wetland. The majority of the proposed alignment is situated within transformed secondary succession grasslands and roads reserves but also bisects a granite rocky outcrop. The entire Mayflower township area comprises predominantly of transformed (old agricultural lands) and heavily overgrazed secondary succession grasslands as well as degraded granite outcrops with limited indigenous vegetation. The incised or eroded channelled valley bottom wetlands flows into the perennial Mpuluzi River to the east of the proposed alignments.

Initial preparations:

- Obtain all relevant maps including aerial photographs (Google images) of the proposed Mayflower outfall sewer alignment and adjacent land usage, and information on the natural environment.
- An initial site investigation (24-25th of February 2015) to assess the current environmental status of the proposed Mayflower outfall sewer alignment with special emphasis on remaining natural palustrine wetland habitats and granite outcrops.
- 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 proposed Mayflower Bulk Sewerage 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 two alternative Mayflower Bulk Sewerage alignments.
- To provide a description of any threatened plant or animal (mammals, birds, reptiles and amphibians) occurring or likely to occur within the Mayflower Bulk Sewerage alignments.
- 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 Mayflower Bulk Sewerage pipeline on the remaining natural vegetation and associated fauna.
- To provide management recommendations to mitigate negative and enhance positive impacts of the proposed Mayflower Bulk Sewerage Project.

1.2 SCOPE OF STUDY

- An initial ecological survey documenting the dominant vegetation on the site and recording sightings and/or evidence of present fauna.
- An assessment of the ecological habitats, evaluating conservation importance and significance with special emphasis on the current status of threatened animal species (Red Data Species), within the Mayflower Bulk Sewerage Supply 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 Mayflower Bulk Sewerage Supply 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.

1.3 CONSTRAINTS AND LIMITATIONS OF SHORT DURATION ECOLOGICAL AND FAUNAL SURVEYS

- Limitation to a base-line ecological survey for only 2 days (16 hours) during the late summer months (February 2015). No comprehensive vegetation or faunal surveys conducted but merely a basic ecological/habitat assessment based on a two day site visit.
- The majority of habitats adjacent to the proposed Mayflower Bulk Sewerage Project area have already been completely transformed during establishment of residential platforms, previous and current agricultural activities (kraals, small scale agricultural lands) as well as formal and informal access roads. The vegetation around the existing rural homesteads is completely transformed and dominated by weedy pioneer plants (rurals) as well as alien invasive species. No suitable habitat remains within the proposed pipeline alignments for any red listed plant species.
- 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. Due to the high levels of habitat transformation within the proposed alignments no suitable habitat occurs 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.
- Limitation of historic data and available databases for the Mayflower 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 similar habitats between 2010-2015).

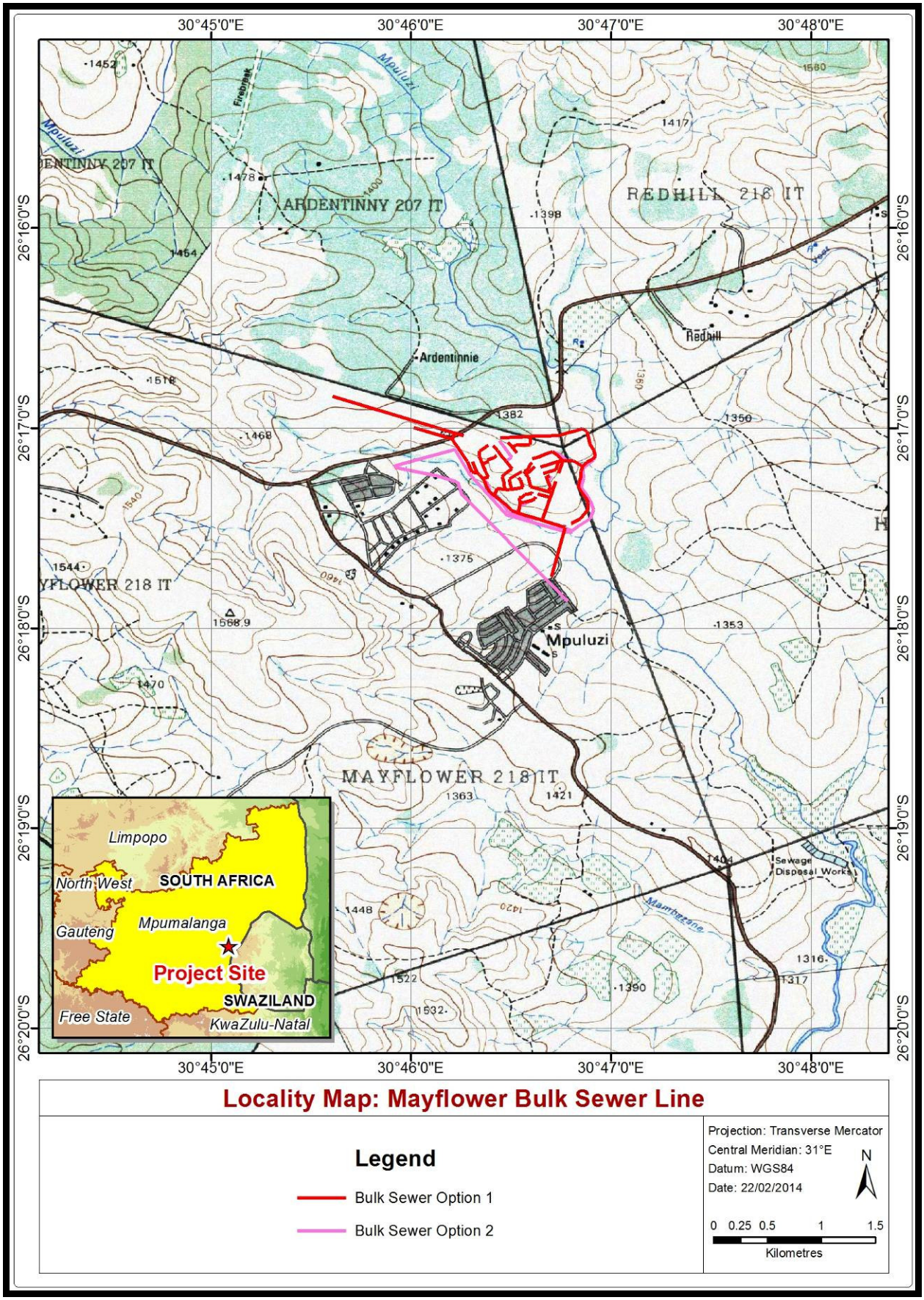

Figure1. Locality map of the proposed Mayflower Bulk Sewerage project.

2. METHODOLOGY

A survey of the proposed Mayflower Bulk Sewerage Supply alignments was carried out by driving around the proposed areas by car and closer inspection of the valley bottom wetland crossings, seasonally inundated seepage wetlands and granite outcrops and remaining natural habitats carried out on foot. As the site is situated around rural homesteads and agricultural areas the majority of natural grassland vegetation consisting of **KaNgwane Montane Grassland (Gm 16)** has been transformed into existing Mayflower residential erven and platforms, commercial areas, schools, small scale agricultural lands as well as livestock enclosures (kraals). The site was visited predominantly during daylight hours (8h30-16h30) on the 24-25th of February 2015.

It must be stressed that due to time and financial constraints no comprehensive vegetation or faunal surveys were undertaken during the brief ecological survey. Due to the high levels of vegetation transformation and habitat degradation within and surrounding the proposed sewer pipeline alignments no suitable habitat remains for any threatened plant or animal species. Data was heavily supplemented by literature investigations; personal records, historic data and previous surveys conducted in the area. Different habitats were explored to identify any sensitive or specialised species which could possibly occur within the proposed alternative alignments. Habitats explored included the KaNgwane Montane Grassland (Gm 16) in various stages of transformation and degradation, eroded channelled valley bottom wetlands, remnant patches of seasonally inundated seepage wetlands, granite outcrops and remnant wooded vegetation as well as a seasonally inundated depression (old borrow pit).

A detailed literature search was undertaken to assess the current status of threatened fauna that have been historically known to occur within the Mayflower (2630 BD) Quarter Degree Grid Cell (QDGC). The literature search was undertaken utilising *The Vegetation of South Africa, Lesotho and Swaziland* (Mucina & Rutherford 2006) for the vegetation description as well as *National Red List of Threatened Plants of South Africa* (Raimondo *et al,* 2009) as well as internet using POSA (http://posa.sanbi.org). *The Mammals of the Southern African Subregion* (Skinner & Chimimba 2005) and *The Red Data Book of the Mammals of South Africa: A Conservation Assessment* (Friedmann and Daly (editors) 2004) as well as ADU's MammalMAP (http://vmus.adu.org.za/vm_sp_list.php accessed on the 20th of February 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 (http://sabap2.adu.org.za accessed on the 20th of February 2015).

A Complete Guide to the Frogs of Southern Africa (du Preez & Carruthers 2009) and The Atlas and Red Data Book of the frogs of South Africa, Lesotho and Swaziland (Minter et al. 2004) for amphibians as well as SAFAP FrogMAP (http://vmus.adu.org.za). The Field Guide to the Snakes and other Reptiles of Southern Africa (Branch 2001) and South African Red Data Book-Reptiles and Amphibians (Branch 1988) as well as SARCA (http://sarca.adu.org.za accessed on the 20th of February 2015 for reptiles.

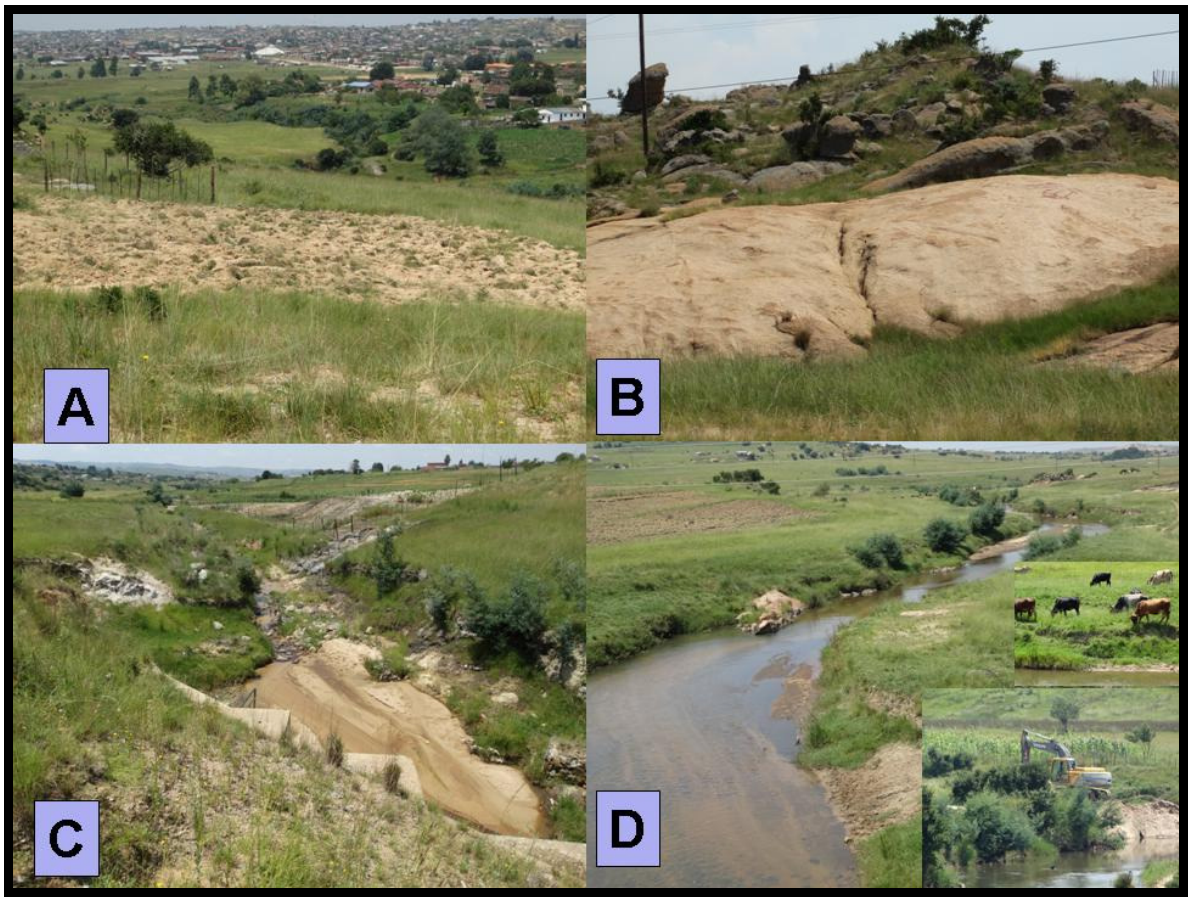

Figure2. A collage of photographs displaying the major habitats surrounding the proposed Mayflower bulk sewer line alignments. A: The majority of the proposed alignments bisects transformed secondary succession grasslands and follow existing access road reserves and livestock pathways. **B:** Scattered low-lying granite outcrops occur adjacent to the alignments. The alignments bisect degraded areas adjacent to a granite rock outcrop. **C:** The proposed alignments bisect a channelled valley bottom wetland which feeds into the Mpuluzi River. Small-scale vegetable (Maze) crops have been planted adjacent to the valley bottom wetlands and have transformed the adjacent footslope seepage wetlands. **D:** The Mpuluzi River and associated riparian zone has become degraded due to uncontrolled livestock grazing and trampling as well as formal and informal sand mining activities. The riparian zone has been invaded by Black Wattle *Acacia mearnsii**.

3.1 STUDY AREA

The study site is situated approximately 39km to the north of Amsterdam in the Mayflower suburb in the Mpuluzi area of Mpumalanga. The Mayflower Bulk Sewerage project falls within the Chief Albert Luthuli Local and Gert Sibande District Municipality. The site falls within the KaNgwane Montane Grassland (Gm 16) vegetation unit (Mucina & Rutherford 2006). The KaNgwane Montane Grassland (Gm 16) vegetation unit is distributed in Mpumlanga and Swaziland, and marginally into northern Kwazulu-Natal. KaNgwane Montane Grassland (Gm 16) occurs along the gentle slopes of the Escarpment, from the Phongolo Valley in the south, northwards to the Usutu Valley and to the uppermost Lomati Valley near Carolina, including the western grassland areas of Swaziland. Altitude varies between 880- 1 740 m with the altitude of the site being 1 338 – 1421 m.

3.2 Vegetation and Landscape Features

Largely comprised of undulating hills and plains that occur on the eastern edge of the Escarpment. This unit is transitional between the Highveld and Escarpment and contains elements of both. The vegetation structure is comprised of a short closed grass layer with many forbs, and a few scattered shrubs on the rocky outcrops. (Mucina *et al*. 2006). The major land-use surrounding the site is residential and commercial and small-scale vegetable crops as well as livestock grazing (cattle and goats) within secondary succession grasslands (old lands).

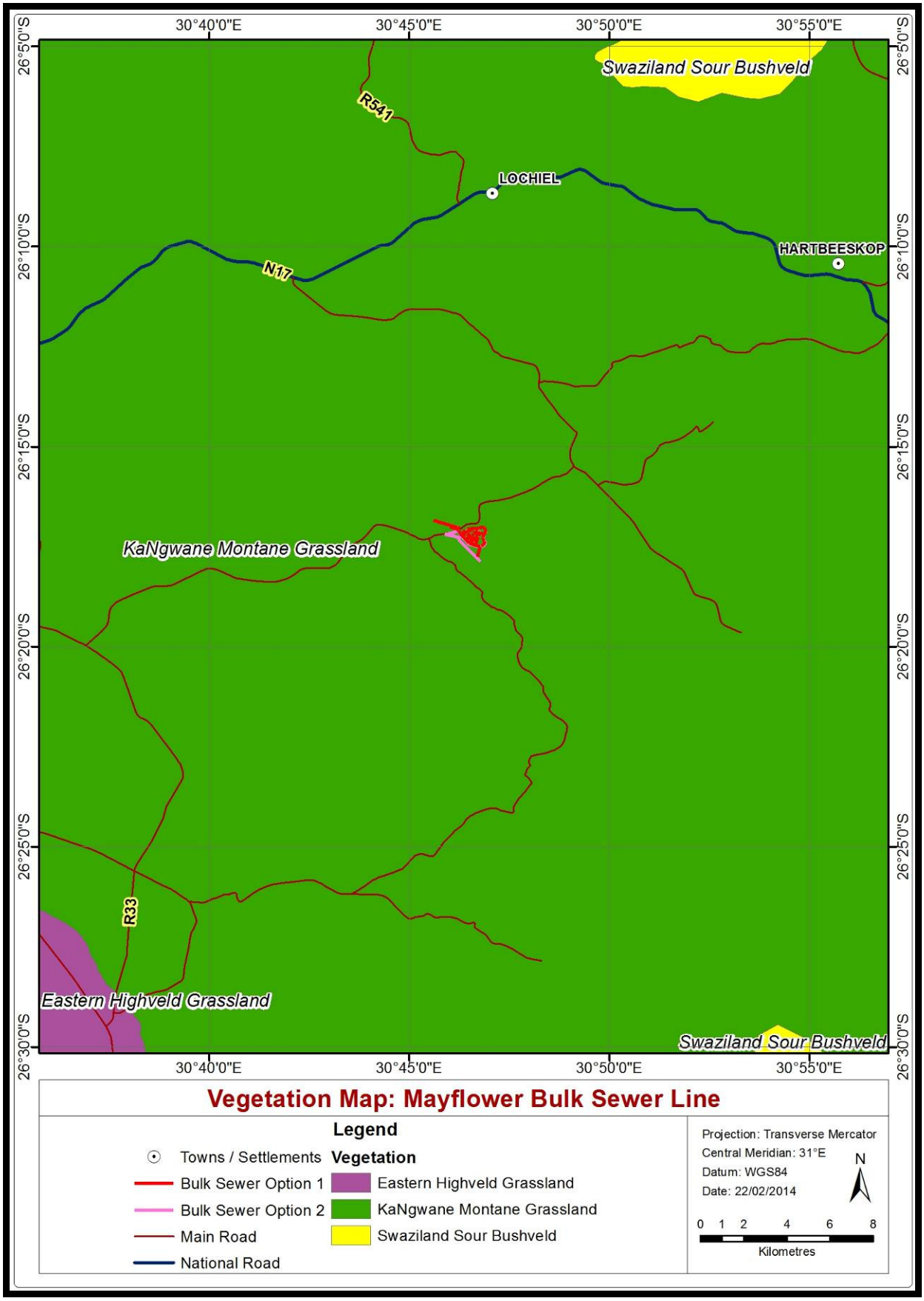

Figure3. Vegetation map for the proposed Mayflower bulk sewerage project (adapted from Mucina *et al.* 2006).

3.3 Geology and Soils

Mostly on granite of the Mpuluzi Granite (Randian Erathem), Archaen gneiss giving rise to melanic soils with diabase intrusions. Land types Ac, Fa and Ba (Mucina & Rutherford 2006).

3.4 Climate

Early summer rainfall area but with some rain during winter. Mean Annual Precipitation (MAP) is around 910mm. This unit has a wide range of frost frequency (3-20 days), with the most frost days occurring in the western region.

3.5 Conservation

KaNgwane Montane Grassland (GM 16) is classified as a **Vulnerable** vegetation unit with only 0.4 % protected within any formally proclaimed nature reserves (Malalotja, Nooitgedacht Dam and Songimvelo). A number of private conservation areas protect small patches of this unit. It is well suited for afforestation and 30% has already been converted to plantations of alien trees. A further 6% is under cultivation. Erosion potential is low except along the channelled valley bottom wetlands. The emnakments are heavily eroded by uncontrolled livestock drinking and grazing activities as well as informal sand mining activities. Conservation target is 27% conserved (Mucina & Rutherford 2006).

3.6. Transformed Secondary Succession Grasslands (Fallow lands)

Vegetation Type	KaNgwane Montane Grassland (Gm 16)	**Tree cover**	< 1%
Soil	Well-drained sandy soils	**Shrub cover**	<2 %
Topography	Undulating Hillslopes	**Herb cover**	20-30 %
Land use	Homesteads and small-scale agricultural activities	**Grass cover**	70-80%
Dominant Tree Species	*Ficus ingens, Cussonia paniculata, Diospyros lycoides, Acacia caffra, Gymnosporia heterophylla, Eucalyptus grandis*, Melia azaderach*, Morus alba*, Jacaranda mimosifolia, Solanum mauritianum*, Psidium guajava*[*]		
Dominant Herbs and Forbs	*Mariscus solidus, Fuirena hirsuta, Eleocharis dregaena, Mariscus solidus, Pycreus polystachyos, Cyperus denudatus, Tagetes minuta, Chamaechrista mimusoides, Cirsium vulgare*; Brunsvigia radulosa, Hypoxis iridifloia, Conyza albida, Ceratotheca triloba, Commelina africana, Helichrysum aureum, Datura strumonium*, Solanum sisymbrifolium*, Lantana*		

[*] Alien invasive vegetation

	camara, Ipomoea purpurea, Commelina erecta, Trifolium repens, Centella asiatica*
Dominant Gramminoids/Grass spp.	*Phragmites australis, Hyparrhenia hirta, Eragrostis chloromelas, Eragrostis plana, Panicum natalense, Trachypogon spicatus, Cynodon dactylon, Imperata cylindrica, Heteropogon contortus, Botrriochloa inscuplta, Digitaria annulatum, Digitaria sanguinalis, Chloris virgata, Hyparrhenia fillipendula, Panicum maximum, Melinis repens, Sporobolus africanus, Eragrostis curvula, Eragrostis teff*

The transformed and degraded secondary succession grasslands comprises the largest component of the vegetation within the Mayflower bulk sewerage project area. The area consists of existing (Mayflower) residential houses, informal shacks and small-scale agricultural fields (old and current) that are mostly located on the mid-slopes as well as grassland plains. As a result the natural vegetation has become degraded and is mostly transformed. The grassland areas are currently used for grazing purposes and are dominated by the anthropogenic grasses *Cynodon dactylon, Digitaria spp., Chloris virgata, Sporobolus africanus, Panicum maximum, Cymbopogon caesius, Eragrostis spp., Imperata cylindrica, Hyparrhenia hirta* and *Melinis repens.* The grasses cover approximately 70-80% of the area and the forbs 20-30% (mainly weedy and 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**), *Verbena bonariensis*, Ambrosia artemisifolia, Ageratum houstonianum*, Conyza bonariensis* and *Parthenium hyserophorus* as well as pioneer grass species such as Rhodes Grass (*Chloris gayana*), Crab finger-Grass (*Digitaria sanguinalis*) Weeping Love Grass (*Eragrostis curvula*), Natal red-Top (*Melinis repens*), Common Buffalo Grass (*Panicum maximum*) and Couch Grass (*Cynodon dactylon*).

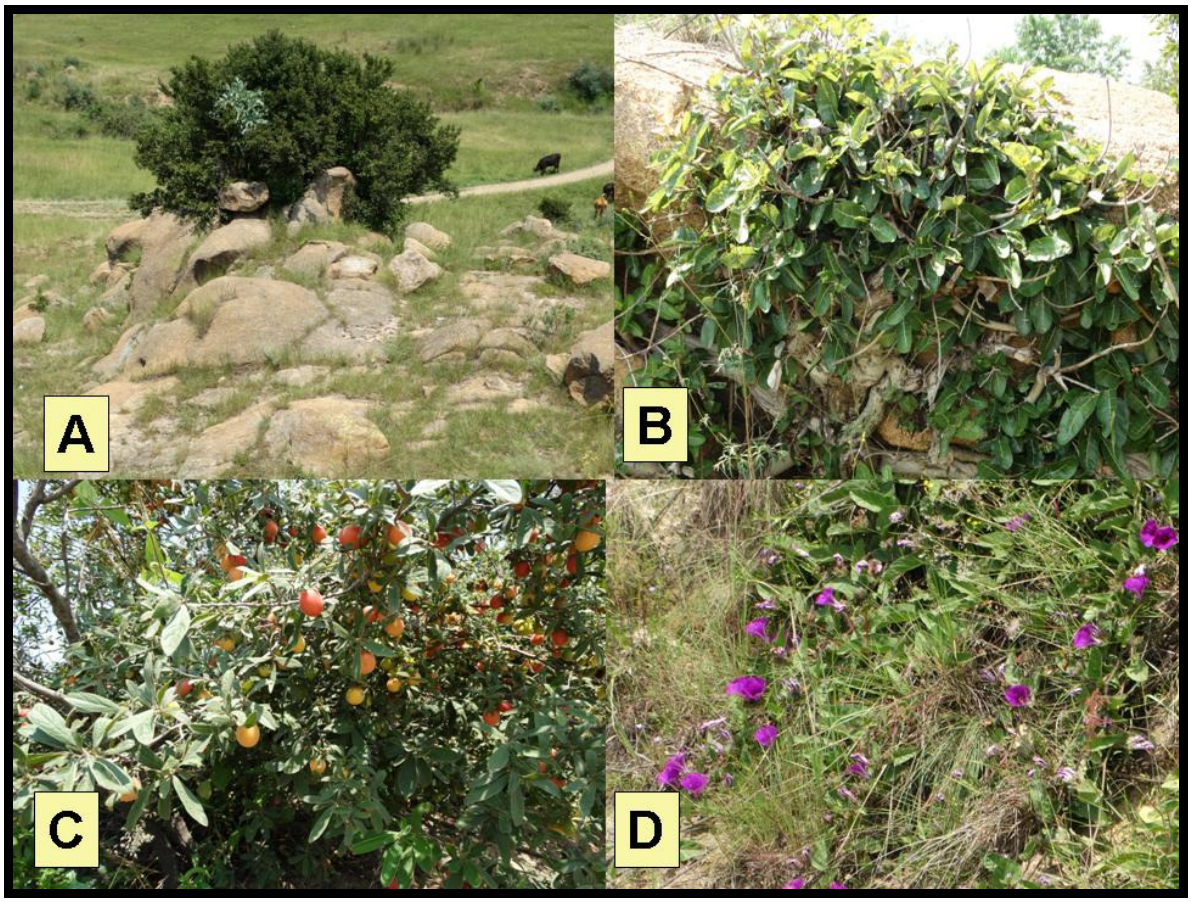

Figure4. A collage of photographs displaying the vegetation observed within the low-lying granite outcrops and hills. A: Scattered granite outcrops occur adjacent to the proposed alignments. Tree species include Highveld Cabbage (*Cussonia paniculata* subsp. *sinuata*) **B:** Red-leaved Rock Fig (*Ficus ingens*); **C:** Karoo Bluebush (*Diospyros lycoides* subsp. *lycoides*) and forbs included **D:** Grassland Ipomoea (*Ipomoea pellita*)

The vegetation within the granite rocky outcrops comprises rupicolous species such as *Acacia caffra, Cussonia paniculata*, *Ficus ingens, Diospyros lycoides, Gymnosporia hetrophylla, Myrsine africana, Searsia discolour, Aloe* sp. and *Asparagus cooperi* and the lithophytic fern *Selaginella dregei*. The proposed sewer alignment bisects a degraded section of a granite rocky outcrop.

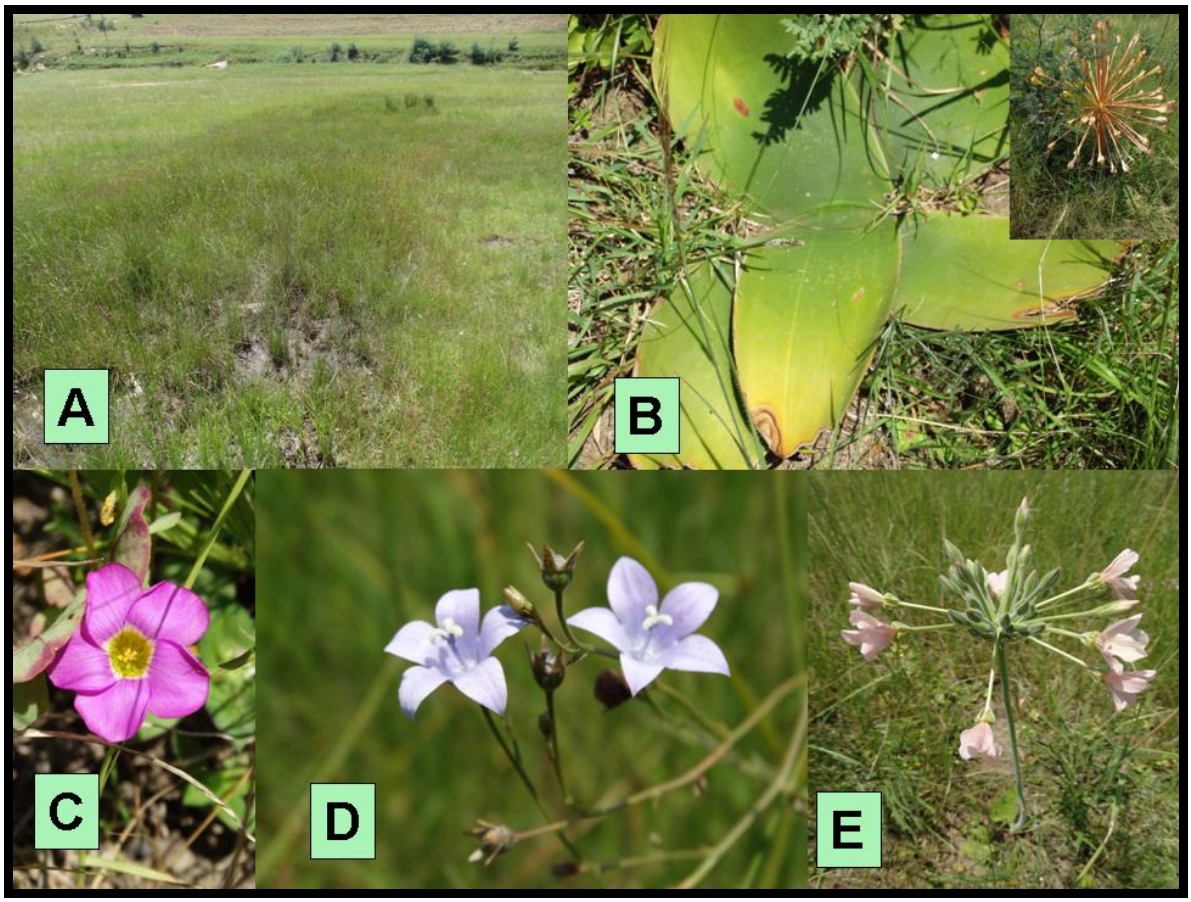

Figure5. A conglomerate of photographs displaying the hydrophilic vegetation observed within the remnant patches of seasonally inundated seepage wetlands. A: Remnant patches of moist grassland occur adjacent to the valley bottom wetlands. The underlying granite forms a hard plinthite and a raised or shallow water-table**. B:** A few geophytic herb Candelabra Flower (*Brunsvigia radulosa*) were observed adjacent to the channelled valley bottom wetland as well as rocky outcrops adjacent to the northern seepage wetland. **C:** Oblique-leaved Sorrel (*Oxalis obliquifolia*); **D:** *Wahlenbergia krebsii* and **E:** Stalk-flowered Pelargonium (*Pelargonium luridum*) were observed within the moist grassland or seepage wetland.

The vegetation within the channelled valley bottom has been historically transformed and degraded due to surrounding anthropogenic activities including increased siltation and sedimentation due to poor soil conservation in the adjacent hillslopes as well as nutrient enrichment (eutrophication) and the removal of vegetation during ploughing of lands within the seasonal and temporary wet zones. The site has been historically annually ploughed and old fallow lands are dominated by secondary succession grasses (Aristida *junciformis* subsp. *junciformis, Imperata cylindrica*, *Cynodon dactylon*, *Cynodon nlemfuensis*, *Eragrostis curvula, Digitaria eriantha*, *Poa annua**) pioneer weedy plant species as well as remnant patches of hygrophilous sedges (*Mariscus solidus, Fuirena hirsuta, Eleocharis dregaena, Mariscus solidus, Pycreus polystachyos, Cyperus denudatus*.).

A few geophytic herbs namely Candelabra Flower (*Brunsvigia radulosa*) were observed adjacent to the channelled valley bottom wetland. Oblique-leaved Sorrel *Oxalis obliquifolia*, *Wahlenbergia krebsii,* Stalk-flowered Pelargonium (*Pelargonium luridum*) were observed within the moist grassland or seepage wetland.

The riparian zone of the adjacent Mpuluzi River has become degraded with alien invasive tree species mainly Black Wattle (*Acacia mearnsii**), Saligna Gum (*Eucalyptus grandis**), Syringa (*Melia azedarach**) White Mulberry (*Morus alba**), Jacaranda (*Jacaranda mimosifolia**) present and signs of extensive bank erosion and slumping evident.

3.7 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.

Extensive alien invasive occurs along the channelled valley bottom wetlands and Mpuluzi River especially within disturbed areas including *Acacia mearnsii**, *Lantana camara**,*Caesalpinia decapetala**, *Cirsium vulgare**, *Ipomoea indica**, *Ipomoea purpurea**, *Psidium guajava**, *Melia azedarach**, *Solanum sisymbrifolium**, *Ricinus communis**, *Sesbania punicea**, *Rubus cuneifolius**, *Senna didymobotrya**, *Solanum mauritianum**, *Tithonia diversifolia** and *Eucalyptis grandis **.

3.8 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. The Department of Agriculture, Forestry and Fisheries (DAFF) will have to be approached to obtain the required permits for the removal of any protected tree species. No protected tree species were recorded within the proposed bulk sewer pipeline alignments.

Figure6. A clump of River Lilies (*Crinum macowanii*) were observed 60 m to the south of Option 2 alignment and 245 m to the south-west of the Option 1 pipeline alignment (GPS locality 26°17'24.86"S 30°46'17.32"E).

3.8 Red Listed Plat Species

A small clump of the Red Listed 'Declining'[δ] River Lilies (*Crinum macowanii*) were observed 60 m to the south of Option 2 alignment and 245 m to the south-west of the Option 1 pipeline alignment. Low numbers remain in the area due to heavy utilization from surrounding settlements. The high levels of human activities on and surrounding the hillslopes including the removal of embedded rock material, harvesting of traditional medicinal plants as well as on-going alien vegetation invasion significantly reduces the likelihood of any significant populations of any rare or threatened plants.

The red listed 'Rare' *Schizochilus cecilii* subsp. *culveri* orchid has been recorded from the 2630 BD QDGC (POSA online checklist). These terrestrial orchids are most commonly found growing on rock ledges, between rocks or on rock faces in high altitude sour grassland. The soils are hydromorphic or damp to wet but always well-drained (McMurtry *et al.* 2008). No suitable habitat occurs within and immediately adjacent to the proposed Mayflower sewer line. The proposed sewer pipeline alignments offer no suitable habitat for any threatened plant species due to extensive habitat transformation and degradation surrounding the proposed alignments. No red listed species were observed during the brief field survey within the proposed pipeline servitudes. From a vegetation perspective Option 1 alignment is preferred due to the fact that the alignments only bisects the channelled valley bottom wetland once compared to the three crossings for Option 2 and the majority of the alignment is in completely transformed vegetation units.

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

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 Mayflower bulk sewer study area, describing the available and sensitive habitats, identifying potential impacts resulting from the development and providing mitigation measures for the identified impacts. Faunal data was obtained during a single site visit of the proposed development site carried out on foot on the 24-25th of February 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 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 Mayflower Bulk Sewerage Project is completely transformed and dominated by secondary succession grasslands as well as alien invasive vegetation within disturbed areas such as road reserves and old livestock enclosures. The adjacent hillslope grasslands suffer from extensive overgrazing, mostly from goats and cattle. Cattle were observed grazing within the valley bottom wetlands. Their grazing and trampling activities result in the compaction and erosion of hydric soils and damage to the hygrophilous vegetation. 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 Mayflower Bulk Sewerage Project is situated within a rural/ agricultural environment which are dominated by completely transformed vegetation (old agricultural lands) dominated by secondary succession grasslands as well as alien invasive vegetation with consist of 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 houses, commercial areas, schools, agricultural lands as well as informal access roads and pedestrian and livestock pathways occur around the site.
- Previous and current agricultural activities (oldlands) have transformed the majority of grassland habitat on the 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 road as well as valley bottom wetlands.
- Frequent burning of remaining patches of grasslands severely restricts vegetative cover and potential refuge habitat for remaining faunal species.
- Hunting with dogs as well as feral cats around the villages. Dogs and cats have a high impact on remaining faunal species.
- Introduction of extensive stands of exotic and alien invasive vegetation.

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 Mpumalanga 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 2 days during daylight hours of the summer wet months (November), only a small proportion of species are present. Ideally, a herpetological survey should be undertaken throughout the duration of the wet season (November-Mach) including several nocturnal surveys. It is only during this period that accurate frog species lists can be compiled. During this survey; fieldwork was augmented with species lists compiled from personal records; data from the South African Frog Atlas Project (SAFAP)(1999-2003) and published data, and the list provided below is therefore regarded as likely to be fairly comprehensive.

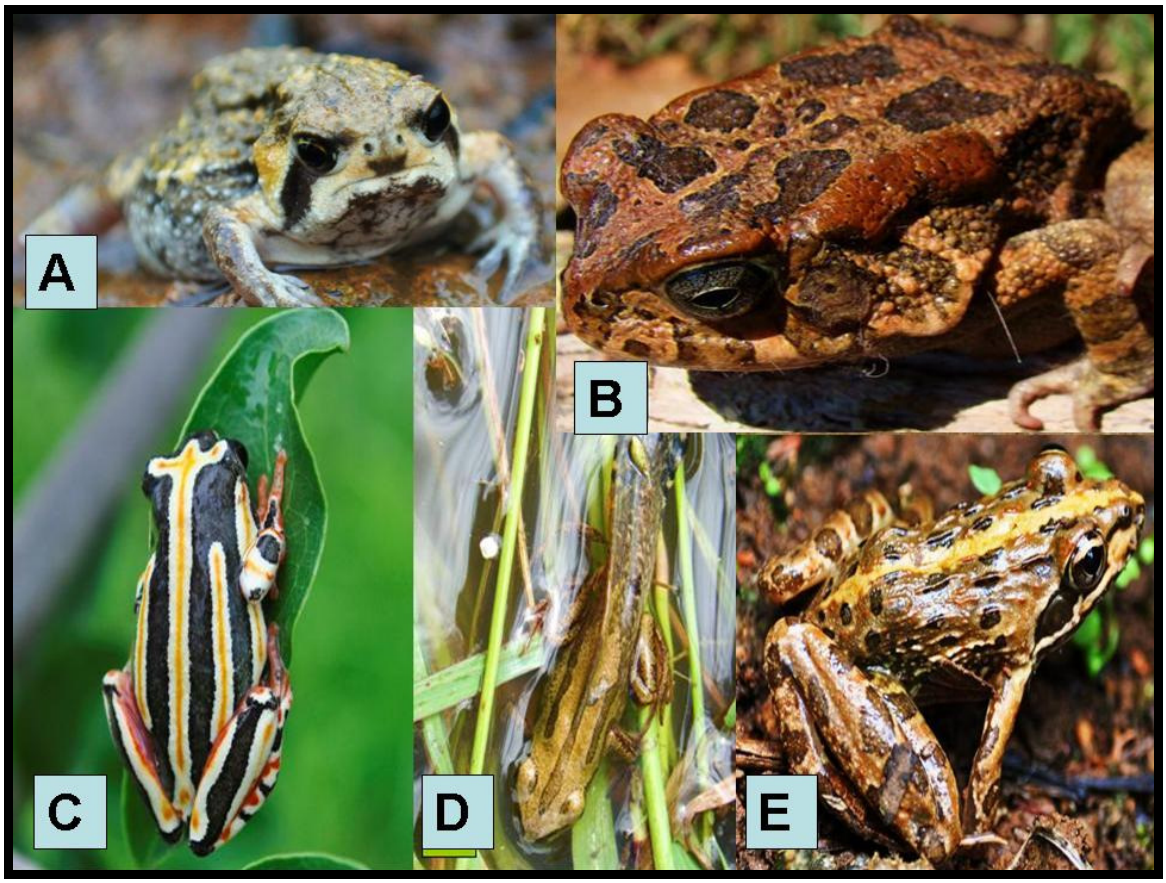

Figure7. **Frog species recorded or likely to occur within the Mayflower Bulk Sewerage Project area include**: **A:** The terrestrial breeding Mozambique Rain Frog (*Breviceps mossambicus*) **B:** Guttural Toad (*Amietophrynus gutturalis*); **C:** Painted Reed Frog (*Hyperolius marmoratus taeniatus*); **D**: Bubbling Kassina (*Kassina senegalensis*) and **E:** Drakensberg River Frog (*Amietia quecketii*) Photographs are not of individuals observed during site visit.

Table1. Frog species recorded on the actual site or are likely to occur on the site according to FrogMAP.

Family	Common name	Genus	Species	Red list category	Atlas region endemic
Brevicepitidae	Mozambique Rain Frog	*Breviceps*	*mossambicus*	Least Concern	
Bufonidae	Guttural Toad	*Amietophrynus*	*gutturalis*	Least Concern	
Bufonidae	Raucous Toad	*Amietophrynus*	*rangeri*	Least Concern	
Hyperoliidae	Painted Reed Frog	*Hyperolius*	*marmoratus*	Least Concern	
Hyperoliidae	Yellowstriped Reed Frog	*Hyperolius*	*semidiscus*	Least Concern	
Hyperoliidae	Bubbling Kassina	*Kassina*	*senegalensis*	Least Concern	
Hyperoliidae	Rattling Frog	*Semnodactylus*	*wealii*	Least Concern	
Phrynobatrachidae	Snoring Puddle Frog	*Phrynobatrachus*	*natalensis*	Least Concern	
Pipidae	Common Platanna	*Xenopus*	*laevis*	Least Concern	
Pyxicephalidae	Drakensberg River Frog	*Amietia*	*quecketti*	Least Concern	Yes
Pyxicephalidae	Bronze Caco	*Cacosternum*	*nanum*	Least Concern	
Pyxicephalidae	Mountain Caco	*Cacosternum*	*parvum*	Least Concern	
Pyxicephalidae	Striped Stream Frog	*Strongylopus*	*fasciatus*	Least Concern	
Pyxicephalidae	Natal Sand Frog	*Tomopterna*	*natalensis*	Least Concern	

Threatened species

No red listed frog species are known from the 2630 BD Quarter Degree Grid Cell (QDGC) in which the Mayflower Bulk Sewerage Project is situated according to the South African Frog Atlas Project (SAFAP). The degraded valley bottom wetlands offer suitable habitat for certain frog species but numbers are expected to be low due to extensive habitat transformation and degradation including deterioration of water quality. The majority of frog species breed in seasonal wetlands with standing water (lothic) and not in flowing (lenthic) wetlands. The excavated pipeline trench must be in-filled as soon as possible as it could potentially act as a pit-fall trap for the majority of amphibian species.

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 large riparian tree species and dead trunks for firewood collection destroys numerous habitats for many arboreal reptile species. Clearing of rock material destroys vital habitat for numerous rupicolous reptile species including the Agamids, Cordylids, Geckonids and Skinks. The majority of snake species hibernate in old tree trunks, termite mounds or under suitable rocks. Several rock piles as well as low-lying rocky outcrops occur on the summit and upper hillslopes and offer suitable habitat for several rupicolous reptile species. A few scattered termite mounds were observed along the proposed alignment increasing in number where agricultural activities have ceased. 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. The frequent burning of the limited overgrazed grassland vegetation has a high impact on remaining reptiles. Fires during the winter months will severely impact on the hibernating species, which are extremely sluggish. Fires during the early summer months destroy the emerging reptiles as well as refuge areas increasing predation risks. Two snake species were recorded during the survey, namely a Mole Snake (*Pseudapsis cana*) as well as a road fatality of a Common Night Adder (*Causus rHombeatus*). Rupicolous reptile species recorded from the low-lying granite outcrops included Striped Skink *Trachylepis* (*Mabuya*) *punctatissima,* Rainbow Skink *(Trachylepis margaritifer*); Distant's Ground Agama (*Agama aculeata distanti*) and Drakensberg Crag Lizard (*Pseudocordylus melanotus melanotus*). A probable species list is provided in Table2 below.

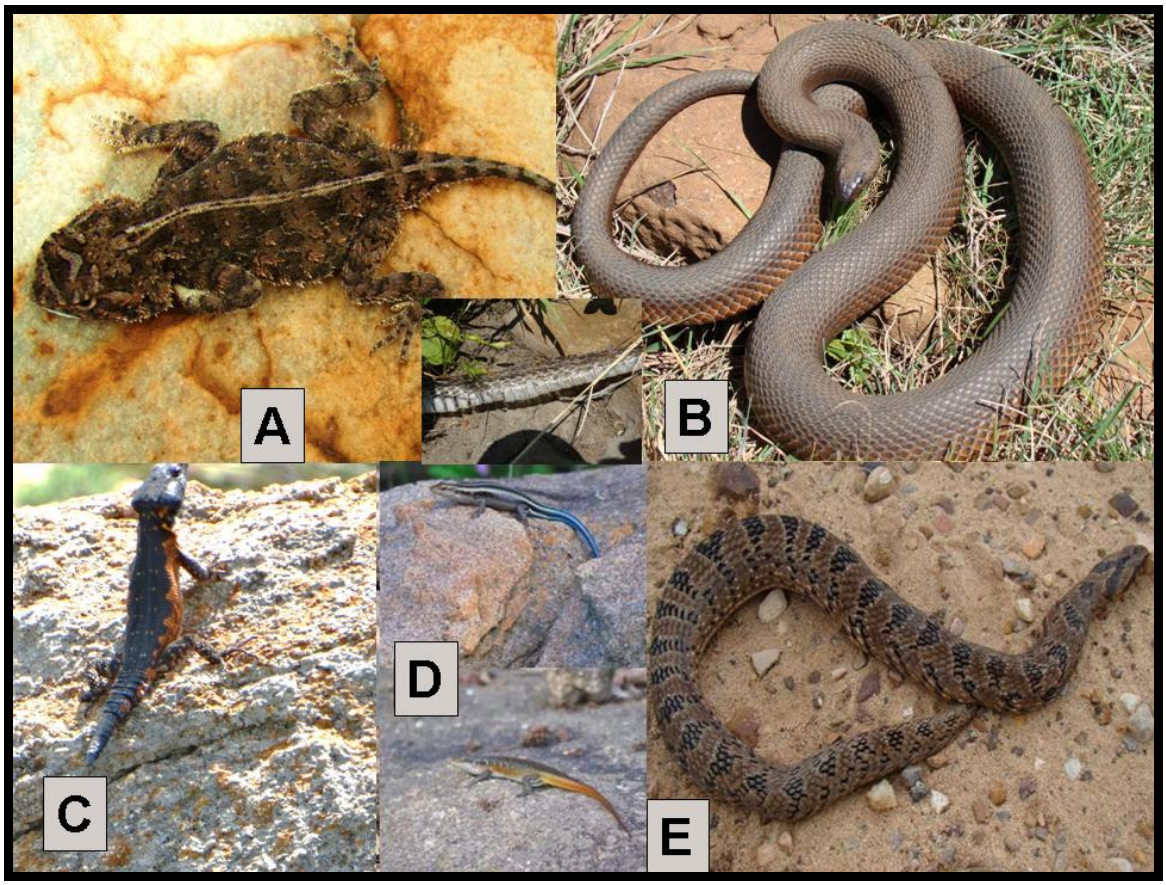

Figure8. A conglomerate of photographs displaying the reptile species observed adjacent to the proposed Mayflower bulk sewer line. A: Distant's Ground Agama (*Agama aculeata distanti*); **B:** Mole Snake (*Pseudapsis cana*); **C:** Drakensberg Crag Lizard (*Pseudocordylus melanotus melanotus*) **D:** Rainbow or Five-lined Skink (*Trachylepis margaritifer*) and **E:** Common Night Adder (*Causus rhombeatus*).

Table 2: Reptile species that occur or are likely to occur in the 2630 BD QDGC according to South African Reptile Conservation Assessment's (SARCA) ReptiMAP and may therefore be present. Actual species lists will most likely contain far fewer species due to high levels of habitat transformation.

Family	Common name	Genus	Species	Subspecies	Red list category	Atlas region endemic
Agamidae	*Distant's Ground Agama	*Agama*	*aculeata*	*distanti*	Least Concern (SARCA 2014)	Yes
Atractaspididae	Black-headed Centipede-eater	*Aparallactus*	*capensis*		Least Concern (SARCA 2014)	
Colubridae	Boomslang	*Dispholidus*	*typus*	*typus*	Least Concern (SARCA 2014)	
Colubridae	Swazi Rock Snake	*Inyoka*	*swazicus*		Least Concern (SARCA 2014)	Yes
Colubridae	Cross-marked Grass Snake	*Psammophis*	*crucifer*		Least Concern (SARCA 2014)	
Elapidae	Rinkhals	*Hemachatus*	*haemachatus*		Least Concern (SARCA 2014)	
Gekkonidae	Van Son's Gecko	*Pachydactylus*	*vansoni*		Least Concern (SARCA 2014)	
Gerrhosauridae	Yellow-throated Plated Lizard	*Gerrhosaurus*	*flavigularis*		Least Concern (SARCA 2014)	
Leptotyphlopidae	Eastern Thread Snake	*Leptotyphlops*	*scutifrons*	*conjunctus*	Not listed	
Scincidae	Wahlberg's Snake-eyed Skink	*Afroablepharus*	*wahlbergii*		Least Concern (SARCA 2014)	
Scincidae	Montane Dwarf Burrowing Skink	*Scelotes*	*mirus*		Least Concern (SARCA 2014)	Yes
Scincidae	Cape Skink	*Trachylepis*	*capensis*		Least Concern (SARCA 2014)	
Scincidae	*Rainbow Skink	*Trachylepis*	*margaritifer*		Least Concern (SARCA 2014)	
Scincidae	*Speckled Rock Skink	*Trachylepis*	*punctatissima*		Least Concern (SARCA 2014)	
Scincidae	Variable Skink	*Trachylepis*	*varia*		Least Concern (SARCA 2014)	
Typhlopidae	Bibron's Blind Snake	*Afrotyphlops*	*bibronii*		Least Concern (SARCA 2014)	

*** recorded during brief field survey**

Threatened Species

No red listed reptile species have been recorded from the 2630 BD QDGC in which the Mayflower Bulk Sewerage Project is situated. No threatened reptile species are likely to occur within the proposed outfall bulk sewer alignment, pumping station and WWTW sites or the immediate open areas surrounding the site due to extensive habitat transformation and degradation. The excavated pipeline trench must be in-filled as soon as possible as it could potentially act as a pit-fall trap for certain reptile species.

4.3 AVIFAUNA/BIRDS

Forty-eight (48) bird species have been recorded from the 2615_3045 pentad acco0rding to SABAP 2. Thirty-four (34) bird species were recorded during the brief field survey (total 14 hours). Species recorded during the field survey are common, widespread and typical of a disturbed grassland and riverine environment. The majority of bird species were recorded along the valley bottom wetlands and Mpuluzi River. High levels of human disturbance as well as habitat transformation and degradation on the site and surrounding valley bottom wetlands and streams results in the disappearance of the more secretive or sensitive bird species. The majority of bird species were recorded from the moist grasslands adjacent to the valley bottom wetlands as well as along the Mpuluzi River.

Table 3: Bird species recorded during brief field survey (14hrs).

Roberts' Number	**Common name**	**Scientific Name**
58	Reed Cormorant	*Phalacrocorax africanus*
62	Grey Heron	*Ardea cinerea*
71	Cattle Egret	*Bubulcus ibis*
81	Hammerkop	*Scopus umbretta*
94	Hadedah Ibis	*Bostrychia hagedash*
102	Egyptian Goose	*Alopochen aegypticus*
126b	Yellow-Billed Kite	*Malvus aegypticus*
127	Black-shouldered Kite	*Elanus caeruleus*
149	Common Bustard	*Buteo buteo vulpinus*
196	Natal Spurfowl	*Pternistis natalensis*
203	Helmeted Gunieafowl	*Numida meleagris*
238	Black-bellied Bustard	*Eupodotis melanogaster*
258	Blacksmith Lapwing	*Vanellus armatus*
297	Spotted Thick-Knee	*Burhinus capensis*
348	Feral Pigeon or Rock Dove	*Columba livia*
352	Red-Eyed Dove	*Stretopelia semitorquata*
354	Cape Turtle Dove	*Streptopelia capicola*

355	Laughing Dove	*Streptopelia senegalensis*
391	Burchell's Coucal	*Centropus burchelii*
411	Common Swift	*Apus apus*
417	Little Swift	*Apus affinis*
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*
672	Rattling Cisticola	*Cisticola chinianus*
677	Levaillant's Cisticola	*Cisticola tinniens*
683	Tawny-flanked Prinia	*Prinia subflava*
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*
846	Common Waxbill	*Estrilda astrild*

Threatened species

No threatened bird species have been recorded in the 2615_3045 pentad during the recent South African Bird Atlas Project (SABAP2). No threatened bird species were recorded during the brief survey within the Mayflower Bulk Sewerage Project area due to high levels of habitat transformation and degradation as well as human disturbances. If any threatened bird species occur it is highly unlikely that the outfall sewer pipeline servitudes will form critical habitat for any threatened bird species.

4.4 MAMMALS

No small mammal trapping was conducted. Fieldwork was augmented with previous surveys in similar habitats as well as published data. The area was initially traversed on foot to ascertain the presence of available refuges. 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 valley bottom wetlands. Evidence of Water Mongoose (Latrine) as well as Cape Clawless Otters were observed along the Mpuluzi River as well as valley bottom wetlands. Vervet Monkeys were observed foraging adjacent to the Mpuluzi River. A single Slender Mongoose was observed crossing the informal dirt access road which bisects the valley bottom wetland. 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 4 below.

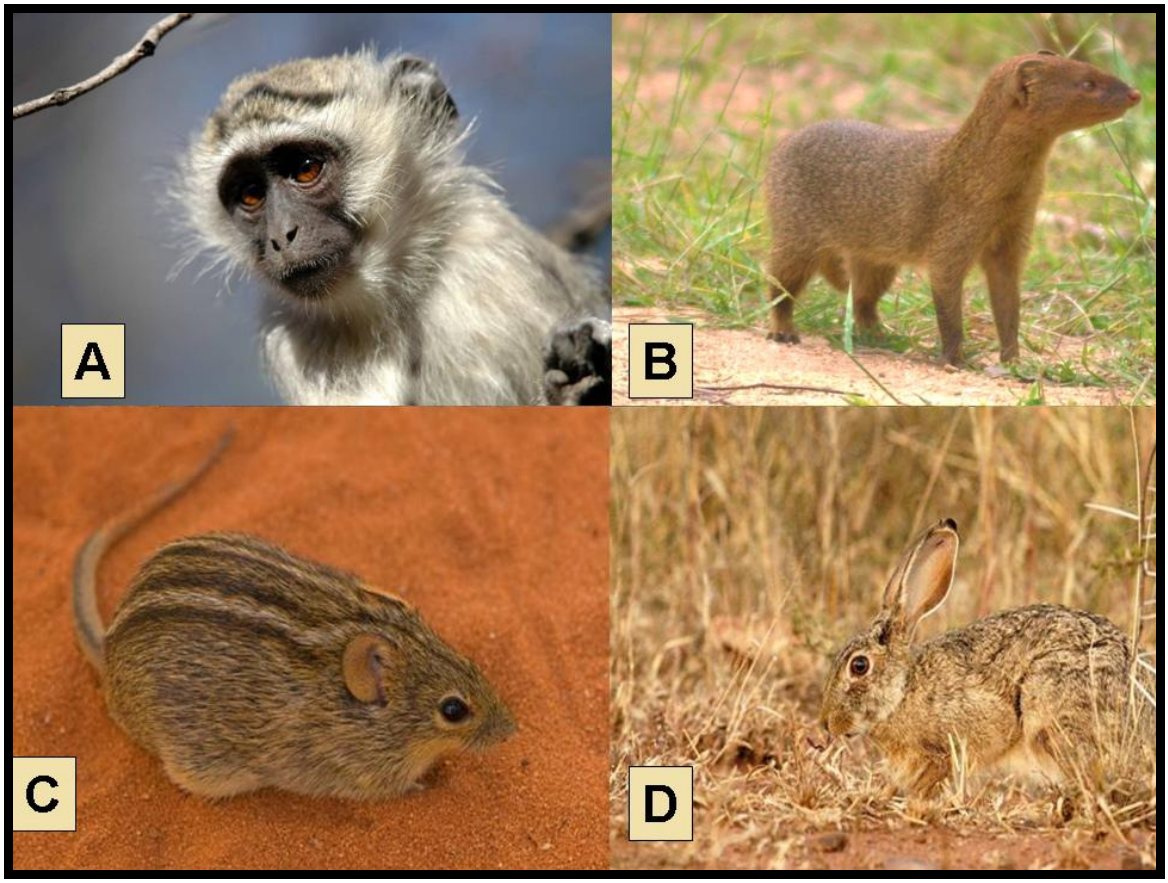

Figure9: A collage of photographs displaying the smaller mammal species observed adjacent to the proposed Mayflower sewer pipeline alignments. A: Vervet Monkeys (*Cercopithecus aethiops pygerythrus*) were observed foraging along the rivers. **B:** Slender Mongooses (*Galerella sanguinea*) were observed darting across the dirt roads. **C:** Four-Striped Grass Mouse (*Rhabdomys pumilio*) were observed in the grassy areas adjacent to the alignments as well as **D:** Scrub Hare (*Lepus sextalis*).

Table 4: 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*
Namaqua Rock Mouse	*Aethomys namaquensis*
*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*

Water Mongoose	*Atilax paludinosus*
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 study area. The majority of larger mammal species are likely to have been eradicated or have moved away from the area during the previous agricultural and residential 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 bulk sewer pipeline alignments constitute significant habitat for any threatened mammal species.

4.5 FAUNAL CONCLUSION

The Mayflower Bulk Sewerage Project area is dominated by old agricultural lands with 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 valley bottom wetlands 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 field 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 indigenous woodland patches within the adjacent granite outcrops and along the Mpuluzi River. Reptile species are extremely sensitive to habitat destruction and transformation. Low reptile diversity is expected within the adjacent degraded road reserves, old lands and current agricultural lands. Two snake species were recorded during the survey, namely a Mole Snake (*Pseudapsis cana*) as well as a road fatality of a Common Night Adder (*Causus rHombeatus*). Rupicolous reptile species recorded from the low-lying granite outcrops included Striped Skink *Trachylepis* (*Mabuya*) *punctatissima,* Rainbow Skink *(Trachylepis margaritifer*); Distant's Ground Agama (*Agama aculeata distanti*) and Drakensberg Crag Lizard (*Pseudocordylus melanotus melanotus*). Medium-low amphibian diversity is expected within the valley bottom wetlands due to extremely limited habitat diversity within the eroded active channels as well as habitat degradation due to deterioration of water quality and alien vegetation invasion. The artificially created seasonally inundated depressions or old borrow pits/sand mining form suitable breeding habitats for certain frog species. The Option 1 alignment is preferred from a faunal perspective as the proposed pipeline servitudes are in close proximity to existing residential erven, access roads, livestock pathways and degraded secondary succession grasslands. The Option 2 bisects the channelled valley bottom wetland three times as well as running adjacent to it and bisecting a granite rocky outcrop. The Mayflower bulk sewer line does not fall within any Critical Biodiversity Areas (CBA) according to the Mpumalanga Conservation Plan (2014).

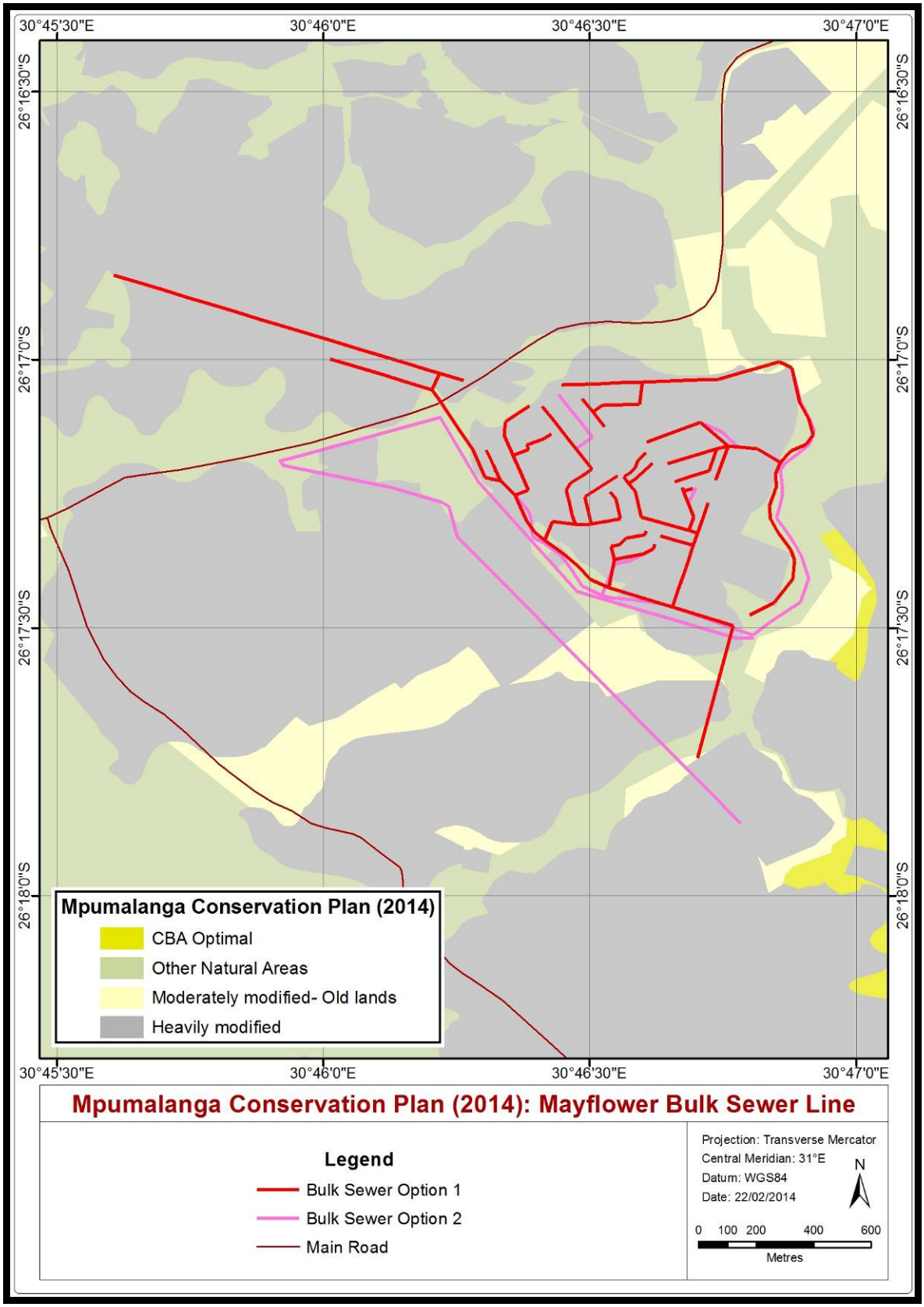

Figure10. Mpumalanga Conservation Plan for the proposed Mayflower bulk sewer line

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5. SENSITIVE HABITATS

5.1 MPULUZI RIVER & RIPARIAN ZONE

The Mpuluzi River is considered to be of conservation importance for the following reasons:

- The indigenous vegetation of riverine wetlands within Mpumalanga Province, and in general throughout the Grassland Biome, is 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 Mpumalanga Province 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.).

All the rivers and streams must be considered as sensitive habitats due to ecological functioning as well as providing suitable habitat as well as biological or dispersal corridors for remaining faunal species. The proposed Mayflower bulk sewer pipeline does not bisect the Mpuluzi River. It does however run adjacent to the river and appropriate soil erosion preventative measures must be implemented during the construction phase of the project in order to prevent further siltation and sedimentation of the river.

5.2 PALUSTRINE WETLANDS (CHANNELED VALLEY BOTTOM & REMNANT SEASONALLY INUNDATED SEEPAGE WETLANDS)

- Wetlands are characterized by hydric soils and slow flowing water and tall emergent vegetation, and provide habitat for many plant and animal species. The conservation status of many of the threatened plant and animal species that are dependant on wetlands reflects the critical status of wetland nationally, with many having already been destroyed.
- Indigenous marshland vegetation such as that found within the valley bottom wetlands and hillslope seepage wetlands in the study 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 that are dependant on wetlands reflects the critical status of wetland nationally, with many having already been destroyed. In this study area wetlands, including seasonal seepage wetlands are important habitats for several faunal species. All remaining wetlands (permanent and seasonal) and their associated indigenous grassland and sedge dominated vegetation must be considered as a sensitive habitat (see separate Wetland Assessment report).

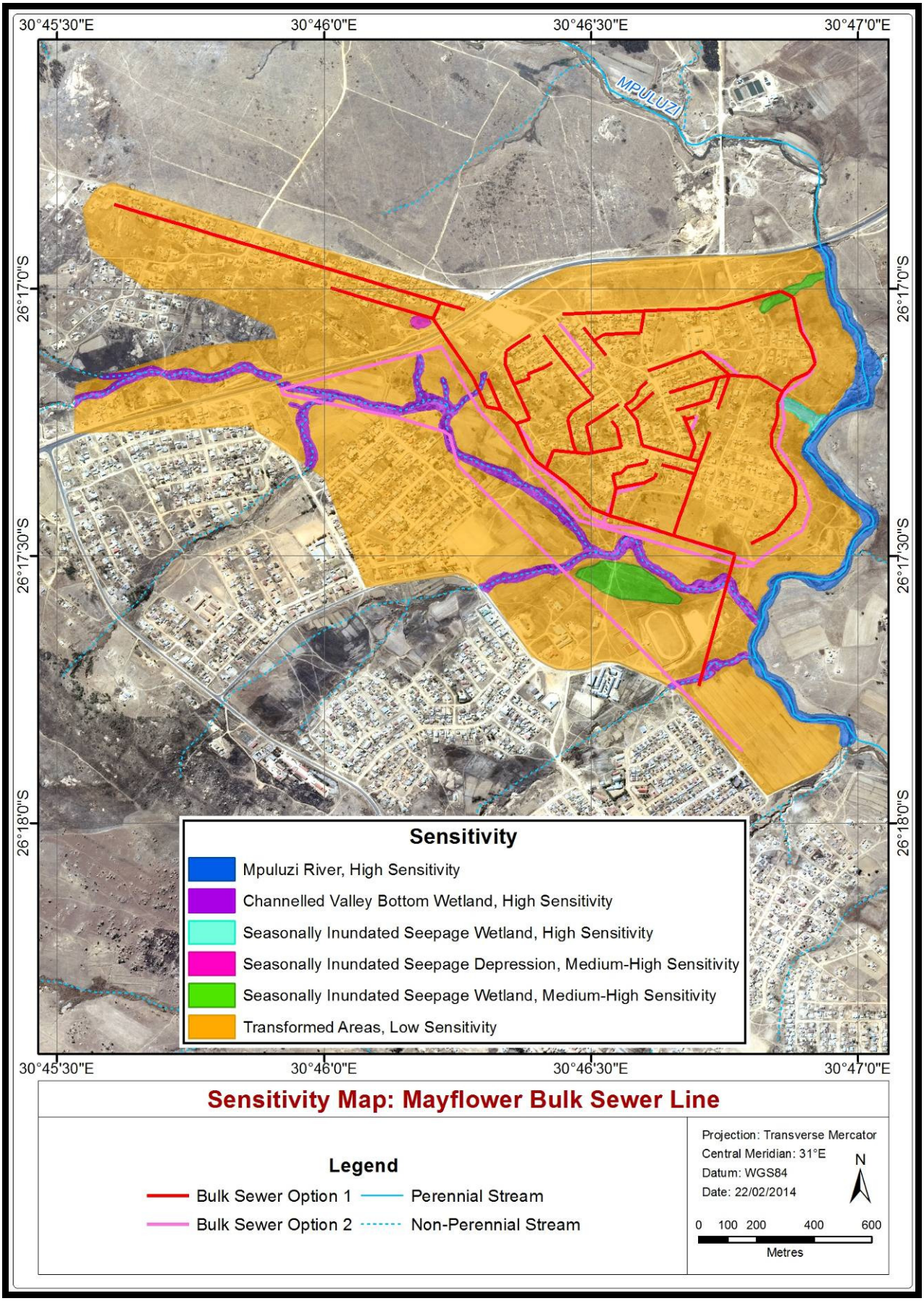

Figure11. Preliminary sensitivity map for the proposed Mayflower Bulk Sewer Line.

6. EVALUATION OF THE PREFERRED ALIGNMENTS

As mentioned previously, two potential alignments have been identified for the Mayflower bulk sewer pipeline. Factors considered in evaluating and determining the order of preference of the two corridors in terms of floral and faunal impacts are listed and discussed below:

Alignment	*Vegetation*	*Fauna*
Option 1	√ Preferred	√ Preferred
Option 2	X Not Preferred	X Not Preferred

6.1 OPTION 1

The majority of the alignment is situated within degraded or transformed vegetation as well as adjacent to existing power line servitudes, access roads and informal tracks and livestock pathways with limited habitat diversity this significantly reduces the level of disturbance and habitat destruction. In addition, fauna in the immediate vicinity of the proposed pipeline would already be relatively tolerant of disturbance as a result of high levels of anthropogenic activities. The alignment bisects one channelled valley bottom wetland as well as the upper sections of a seasonally inundated seepage wetland. The majority of the riparian or hygrophilous vegetation along the channelled valley bottom wetland has already been transformed due to livestock grazing activities. **The Option 1 is the Preferred alignment for the vegetation as well as remaining fauna within the Mayflower area**.

6.2 OPTION 2

The alternative Option 2 bisects the channelled valley bottom wetland three times as well as the remnant seasonally inundated seepage wetlands. The pipeline runs parallel to the valley bottom which increases the potential for further siltation and sedimentation as well as a potential pit-fall trap for remaining faunal species migrating towards the valley bottom wetland. The proposed alignment bisects granite rocky outcrops and will result in additional blasting activities and potential disturbances to remaining faunal species (rupicolous species). The secondary succession grassland vegetation has less anthropogenic disturbances due to limited accessibility compared to the transformed and degraded vegetation towards Mayflower. Fewer tracks and pathways occur in the areas and limited illegal sand mining and wood harvesting activities. A clump of red listed 'Declining' *Crinum macowanii* were observed adjacent to the proposed alignment (within 60m). **This is not preferred from an ecological perspective.**

7: ENVIRONMENTAL MANAGEMENT RECOMMENDATIONS

The temporary alteration of vegetation and soil structure in the effected areas of the proposed Mayflower Bulk Sewer Outfall Pipeline will impact on the fauna and flora directly within the proposed pipeline alignments 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 and servitudes especially within the valley bottom wetland and seepage wetland crossings. As the pipeline is situated adjacent to wetland habitats 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 Mayflower Bulk Sewerage Project, some habitat destruction and alteration inevitably takes place within the proposed pumping station and waste water treatment works site. This happens with the construction of the pumping station and waste water treatment works site, access roads, and the clearing of the bulk outfall sewer pipeline servitudes. 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) where extremely limited vegetation clearance will be required during the construction and operational phase of the project. Vegetation clearance will be restricted to secondary succession grasslands, alien invaded areas and road reserves. 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 Mayflower Bulk Outfall sewerage pipeline construction 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 pipeline servitudes and access to the undeveloped areas, especially the surrounding rocky hills, valley bottom wetlands 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 should be intentionally killed or destroyed and poaching and hunting should not be permitted on the site.

7.2 CONSTRUCTION PHASE

General

- All construction activities should be strictly limited to the construction or pipeline servitude area. Vegetation clearance should be restricted to the actual pipeline trench within the servitude (<4 m) especially within any wetland crossing.
- 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 100 m from any point of work, but not closer than 50 m from the Mpuluzi River.
- It is recommended that the construction programme preferably commence during the dry winter months, when the streams base flow is lower and the risk of soil and bank erosion is lowest. All earthworks shall be undertaken in such a manner so as to minimize the extent of any impacts.
- 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 should 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

- Soil removed from the pipeline trenches is to be 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 should not exceed 1 m in height.
- Soil stockpiling areas must be sufficiently situated away from the drainage areas towards the lower lying valley bottoms and streams.
- 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.

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. **Rehabilitation methods are detailed in Table 5 below**.

Table 5: Recommended rehabilitation measures.

Step	1.1.1 Method	1.1.2 Equipment
1	Remove all construction material from the area 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 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 • Logs/bark held in place with pegs • Rows of *Cynodon dactylon*, *Panicum maximum*, *Imperata cylindrica*, *Hyparrhenia filipendula* held in place with pegs.
7	All alien vegetation is to be appropriately removed and disposed of. Alien species that have been encountered included Black Wattle (*Acacia mearnsii**), Jacaranda (*Jacaranda mimosifolia**) 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*), Yellow Oleander (*Thevetia peruviana*), Oleander (*Nerium oleander*), Montanoa (*Montanoa hibiscifolia*), Indian Shot (*Canna indica*), *Caesalpinia decapetala*, *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 Mayflower 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

Table6. Grass species list (ideally grass species endemic to the area should be used for the re-vegetation of the Mayflower bulk sewer pipeline servitudes)

Botanical name	Common name	Growth	Drought	Frost	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	

Ishaemum arcuatum	Hippo grass				All soils	Perennial with creeping rhizomes	
Leersia hexandra	Wild rice grass					Perennial, long underground stems	
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
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

Table7. Suggested indigenous trees for rehabilitation (species indigenous to the area are indicated with an ☺. It is strongly recommended that only these are planted as far as possible)

Botanical Name	**Common Name**
Acacia karroo	Sweet Thorn
☺*Acacia caffra*	Common Hook Thorn
Accaia natalitia	
Acacia tortilis	Umbrella Thorn
☺*Acacia sieberiana* var. *woodii*	Paper Bark
☺ *Apodytes dimidiate*	White Pear
Calodendron capense	Cape Chestnut
Cassia abbreviata	Long-tailed cassia
☺*Celtis africana*	White stinkwood
☺*Combretum erythrophylum*	River Bushwillow
☺*Cussonia paniculata*	Highveld cabbage
☺*Diospyros lycoides*	Blue bush
☺*Dombeya rotundifolia*	Wild pear
Ekenbergia capensis	Cape ash
☺*Erythrina lysistemon*	Corral Tree
☺ *Ficus ingens*	Red-leaved Rock Fig
☺ *Ficus sur*	Cluster Fig
☺*Ficus sycomorus*	Sycamore fig
☺*Grewia occidentalis*	Cross berry
☺ *Gymnosporia buxifolia*	Common Spikw-Thorn
☺*Halleria lucida*	Tree fuschia
☺*Harpephyllum caffrum*	Wild plum
Kiggelaria Africana	Wild peach
☺*Leucosidea serricea*	Ouhout
☺*Olea europaea subsp. africana*	Wild olive
Pappea capenis	Jacket plum
☺*Pittosporum viridiflorum*	Cheesewood
Podocarpus henkelli	Henkell's yellowwood
Pterocarpus rotundifolius	Round leaved kiaat
Searsia/Rhus chiridensis	Red Currant
Searsia/Rhus prinoides	Dogwood
☺*Searsia/Rhus leptodictya*	Mountain karee
☺ *Searsia/Rhus lancea*	Karee
☺ *Searsia/Rhus pyroides*	Common wild currant
☺ *Schotia brachypetala*	Weeping boer-bean
☺*Trichilia emetica*	Natal mahogany
☺ *Vepris lanceolata*	White ironwood
☺*Ziziphus mucronata*	Buffalo thorn

Table8. Indigenous shrub species marked with ☺ should be used for re-vegetation along the pipeline servitude.

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