STRATEGIC ENVIRONMENTAL ASSESSMENT FOR
GAS PIPELINE DEVELOPMENT IN SOUTH AFRICA

Biodiversity and Ecological Impacts (Terrestrial Ecosystems and Species) - Albany Thicket Biome

STRATEGIC ENVIRONMENTAL ASSESSMENT FOR GAS PIPELINE DEVELOPMENT

Draft v3 Specialist Assessment Report for Stakeholder Review

ALBANY THICKET BIOME

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ABBREVIATIONS AND ACRONYMS

AIP	Alien Invasive Plants
CBA	Critical Biodiversity Area
CR	Critically Endangered
CSIR	Council for Scientific and Industrial Research
EC	Eastern Cape Province
ECBCP	Eastern Cape Biodiversity Conservation Plan
EN	Endangered
ESA	Ecological Support Area
ESI	Environmental sensitivity index
EWT	Endangered Wildlife Trust
GIS	Geographic Information System
H	High (sensitivity)
L	Low (sensitivity)
LCP	Least Cost Path
M	Medium (sensitivity)
NEMBA	National Environmental Management: Biodiversity Act
PU	Planning Unit
SANBI	South African National Biodiversity Institute
SEA	Strategic Environmental Assessment
STEP	Subtropical Thicket Ecosystem Project
VH	Very high (sensitivity)
WC	Western Cape Province
WCBCP	Western Cape Biodiversity Conservation Plan

1 SUMMARY

This assessment aims to identify the potential impacts of constructing and maintaining gas pipeline infrastructure in the Albany Thicket biome of South Africa.

Key environmental attributes of the Albany Thicket biome in the proposed Phased Gas Pipeline study areas include:

- High diversity and endemism for succulents;
- Highly fragmented biome nested in a mosaic of other biomes;
- Extensively degraded due to overgrazing (e.g. goats); and
- Invasion of non-thicket species (e.g. Grassland and Nama-Karoo elements).

The activities associated with gas pipeline construction and maintenance may pose a risk of habitat destruction and degradation, establishment and spread of invasive vegetation, and increased poaching of rare and endangered fauna and flora.

2 INTRODUCTION

The purpose of this assessment is to identify the potential impacts of gas pipeline construction and maintenance to the Albany Thicket biome of South Africa. Furthermore, it recommends management actions and best practice mechanisms to avoid and minimise any potential impacts to sensitive Albany Thicket ecosystems.

This assessment forms part of an overarching Strategic Environmental Assessment (SEA) which ultimately aims to guide sustainable development and environmental decision-making on proposed phased gas pipeline construction and maintenance in South Africa.

The Albany Thicket biome, one of South Africa's nine recognised biomes, and covers an area of nearly 42 000 km^2 in the Eastern Cape and Western Cape provinces (Vlok et al., 2003).

Approximately 60 % of this biome has been severely degraded and the mesic thicket, which has the highest levels of endemism and species richness within the biome, is under the greatest pressure, especially due to overgrazing (Vlok et al., 2003).

The Subtropical Thicket biome provides the resource base for a wide range of economic activities that provide employment for many thousands of people. It provides resource to support extensive commercial and subsistence pastoralism, and growing wildlife-based industries (ecotourism, game breeding, meat and sport hunting).

3 SCOPE OF THIS STRATEGIC ISSUE

3.1 Data Sources

This analysis has made extensive use of data resources arising from the updated, revised Eastern Cape Biodiversity Conservation Plan (ECBCP, 2017) and the Subtropical Thicket Ecosystem Project (STEP) (Pierce & Mader, 2006). Primary data sources used in these projects come from a wide range of organizations and databases compiled by these organizations, including those listed in Table 1.

Table 1: Organizations who provided data used in the Eastern Cape Biodiversity Conservation Plan and used in this study (workshop held in Grahamstown, June 2017).

Organization	Data
South African National Biodiversity Institute (SANBI)	Red listed species data (plants, reptiles, butterflies, bats)
BirdLife South Africa	Important bird areas, and red listed distribution maps
Endangered Wildlife Trust (EWT)	Red listed mammals distribution maps
Geo terra image	Land cover map

In addition to the data sources indicated above, experts for specific taxa were consulted to verify the distribution of and threats to species of special conservation concern within the Eastern Cape (Table 2).

Table 2: Corresponding authors for specific taxa to verify distribution of and threats to species.

Taxa	Experts	Position
Bats	Dr. Werner Marais	Independent consultant
Birds	Jon Smallie	Birdlife Africa
Butterflies	Dr. John Midgely	Academic/Researcher
Frogs	Dr. William Branch	Academic/Researcher
Reptiles	Werner Conradie/ Dr. William Branch	Academic/Researcher
Mammals	Dr Dean Pienke/WWF	Eastern Cape Parks and Tourism Agency
Plants	SANBI data base	SANBI

3.2 Assumptions and Limitations

The scale of input data used in the 2017 ECBCP is variable, however data was integrated at the level of one-hectare pixels, making fine scale analysis possible.

There are a number of assumptions relating to the assignment of subjective sensitivity classes to the various conservation planning categories (Critical Biodiversity Areas (CBAs), and Ecological Support Areas (ESAs)). The main underlying assumption is that biodiversity value, equates to biodiversity sensitivity. In essence, this is implying that for any given activity (like vegetation clearing) the associated impacts will be higher on areas of 'high biodiversity' value than on areas with 'medium' or 'low' value biodiversity. While this is a reasonable assumption, for any one specific area, for this to hold across all gas phases, it requires that the same sensitivity designation will respond to impacts in a similar way. This assumption may not always hold, because there may be different reasons (biodiversity features) for any sensitivity classification, and these biodiversity features may not respond the same to any particular stress (see example in Table 3).

Table 3: Example showing why a biodiversity sensitivity class may not always provide a good indication of a response to an impact.

Biodiversity planning category	Biodiversity sensitivity	Reasons for classification	Response to impact of clearing vegetation for pipes
CBA1	Very high	Red data plants	Very high (direct displacement)
CBA1	Very high	Within home range of Cape vulture	Medium (indirect, noise and dust etc.)

3.3 Relevant Regulations and Legislation

Table 4 lists key legislation, policies and plans pertaining to conservation planning in the Eastern Cape.

Table 4: Key legislation, policies and plans relevant to biodiversity conservation planning in the Eastern Cape.

Year	Document/Act
Legislation	
1934	Townships Ordinance 33 of 1934 (governing urban areas in the former Transkei)
1970	Mountain Catchment Areas Act (No. 63 of 1970)
1970	Subdivision of Agricultural Land Act (No. 70 of 1970)
1974	Cape Nature and Environmental Conservation (Ordinance 19 of 1974)
1987	Ciskei Nature Conservation Act 1987
1987	Land Use Regulation Act (No. 15 of 1987) (governing former Ciskei)
1983	Conservation of Agricultural Resources Act (No. 43 of 1983)
1998	National Forest Act (No. 84 of 1998)
1985	Land Use Planning Ordinance (Ordinance 15 of 1985) (governing former old Cape Province)
1992	Transkei Environmental Conservation Decree (No. 9 of 1992)
1998	National Water Act (No. 36 of 1998)
1999	National Heritage Resources Act (No. 25 of 1999)
2000	Municipal Systems Act (No. 32 of 2000)
2002	Mineral and Petroleum Resources Development Act (No. 28 of 2002)
2003	National Environmental Management: Protected Areas Act (No. 57 of 2003, as amended)
2004	National Environmental Management: Biodiversity Act (No. 10 of 2004)
2004	National Environmental Management: Air Quality Act (No. 39 of 2004)
2008	National Environmental Management: Waste Act (No. 59 of 2008, as amended)
2010	Eastern Cape Parks and Tourism Agency Act (No. 2 of 2010)
2013	Spatial Planning and Land Use Management Act (No. 16 of 2013)
Conventions, Policies and Plans	
1971	Convention on Wetlands (Ramsar Convention)
1973	Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES)
1994	United Nations Framework Convention on Climate Change (UNFCC)
2011	National Freshwater Ecosystem Priority Areas (Nel et al., 2011)
2015	National Biodiversity Strategy and Action Plan (Version 2)
Under revision	Eastern Cape and National Protected Area Expansion Strategy

4 BASELINE DESCRIPTION

4.1 Demarcation of study area

The four Gas Pipeline Phases (study areas) falling within the Albany Thicket biome are shown in Table 5 and **Figure 1** below.

Table 5: Gas Pipeline Phases coinciding with the Albany Thicket biome and intersecting municipalities and STEP map book tile (Pierce & Mader, 2006)

Gas phase and province	Local Municipalities	STEP map book tiles
Gas Phase 1 (WC)	Kannaland, Hessequa, Mosselbay	14
Gas phase: 2 (WC/EC)	Oudsoorn,Baviaans,Ikwesa, Sundays river valley, Kou-kamma, Kouga, Nelson Mandela Bay	18, 17, 16, 10, 9, 15
Gas phase: 7 (EC)	Blue crane Route, Sundays River valley, Nelson Mandela Bay, Makana, Ndlamabe, Nkonkobe,Ngushwa, Buffalo City, Great Kei	6, 13, 12, 19
Gas phase: inland (EC)	Camdaboo, Inkwezi, Bluecrane route	2,3
WC = Western Cape; EC = Eastern Cape		

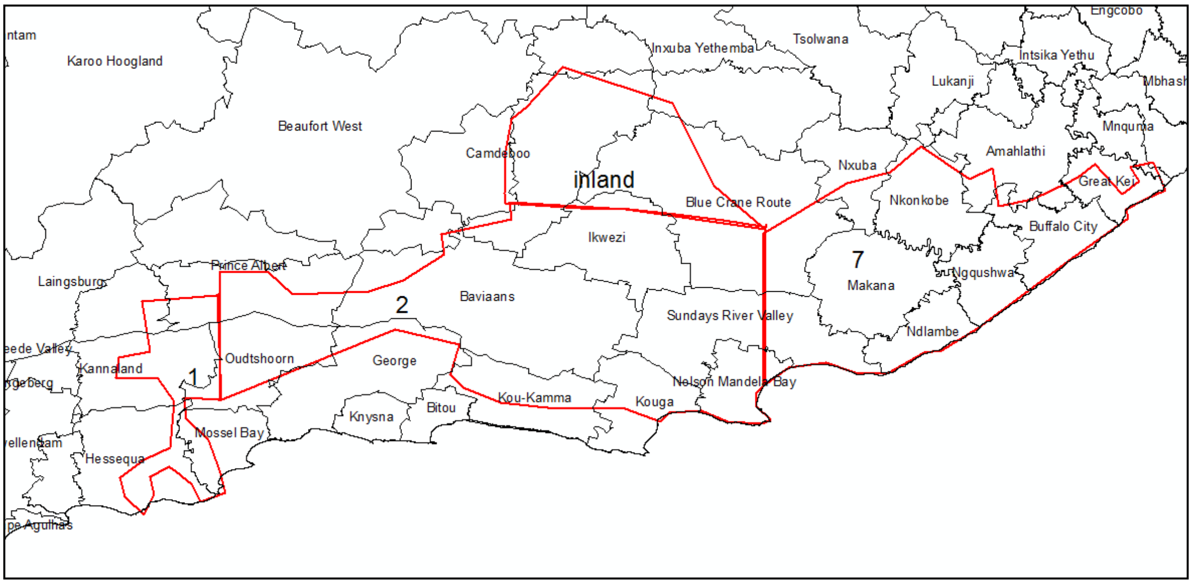

Figure 1: Image of the proposed phased gas pipeline study areas, clipped to a notional buffered extent (25 km) of Albany Thicket biome, showing overlap with local municipalities.

The Albany Thicket biome is a highly fragmented biome, consisting mostly of valleys, embedded within a mosaic of other biomes. For this study, the gas phases occurring within the Albany Thicket biome have been buffered (25 km) as large blocks that include other biomes that surround the Albany Thicket (**Figure 2**).

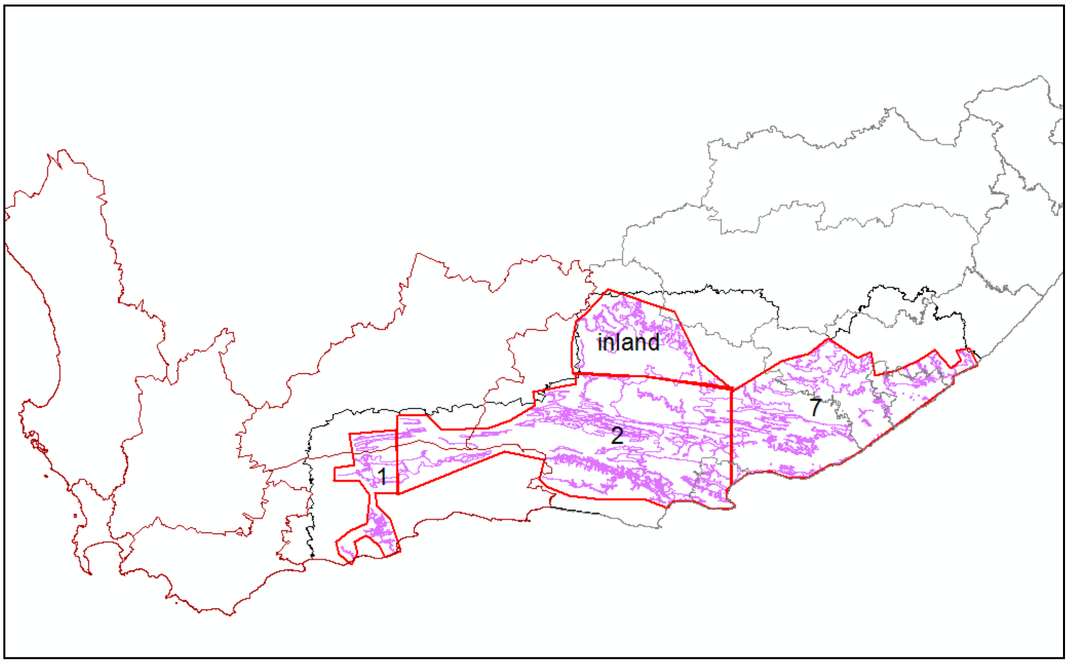

Figure 2: Image of the study areas for Gas Phases 1, 2, 7 and Inland, within a notional buffer around the Albany Thicket biome (Albany Thicket biome extent shown in purple outline, and STEP planning domain in black).

4.2 Baseline Environmental Description of the Albany Thicket Biome

4.2.1 What and where is the Albany Thicket biome in South Africa?

The Albany Thicket biome (also referred to as the 'Thicket biome') is concentrated mainly in the Eastern Cape but also extends into the Western Cape and up the east coast, to a limited degree, as far as the Tugela River basin (**Figure 3**). It is one of South Africa's nine biomes, covering an area of nearly 42 000 km^2 (Vlok et al., 2003).

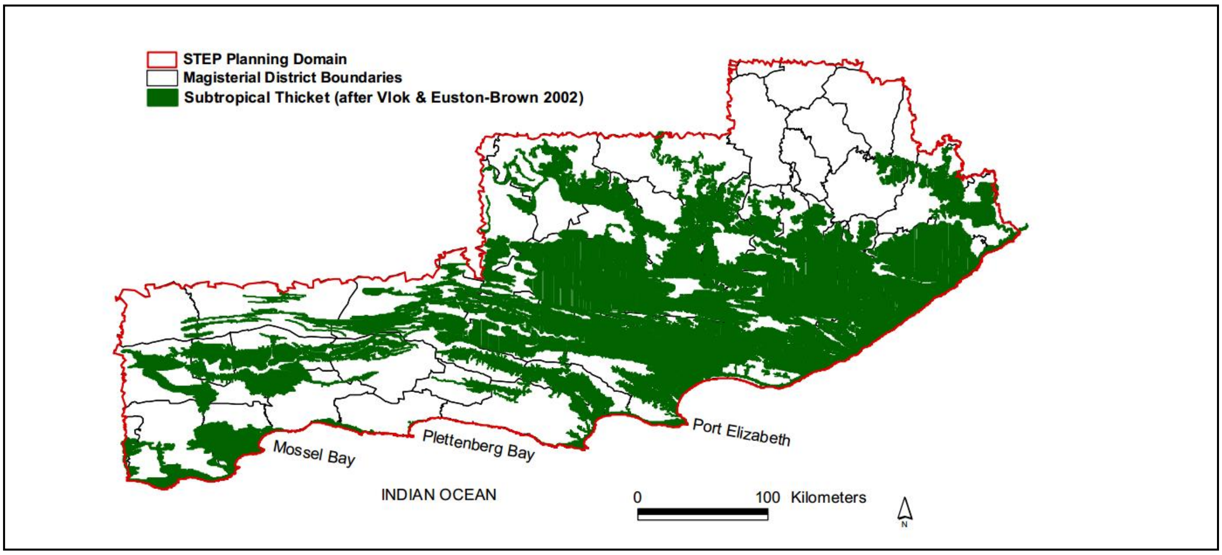

Figure 3: Subtropical Thicket Ecosystem Project (STEP) planning area (Vlok et al., 2003).

Subtropical thicket is a closed shrubland to low forest dominated by evergreen, sclerophyllous or succulent trees, shrubs and vines, many of which have stem spines. It is often almost impenetrable, is generally not divided into strata, and has little herbaceous cover. According to certain definitions subtropical thickets can be considered as a low forest, however this definition is problematic, for several reasons, in that it often occurs in many areas with a rainfall too low to support forests (<800 mm/yr.), does not have the horizontal stratification of forests, and does not have the signature species typical of Southern African afrotemperate forests, (Vlok et al., 2003).

The vegetation of the Albany Thicket can be divided into three eco-regions: the dry, inland areas of the Fish, Sundays, and Gamtoos river valleys; the mesic coastal areas of these river valleys; and the intermontane valleys to the north and west. The vegetation contains a high proportion of both leaf and stem-succulent shrubs such as Spekboom (*Portulacaria afra), Euphorbia bothae* (dominant along the Fish River Valley), *Euphorbia ledienii* and Noorsdoring (*Euphorbia coerulescens*), (Vlok et al., 2003).

The distribution of Albany Thicket communities is determined by a complexity of interrelated factors. The most important of these appears to be soil type. Albany Thicket is restricted to deep, well-drained, fertile sandy loams with the densest thickets occurring on the deepest soils (Cowling, 1983). Soil moisture is another important limiting factor. The vegetation is adapted to grow in hot, dry river valleys where soil moisture is limited for extended periods. Soil moisture increases towards the east, resulting in thickets that are more open, less succulent and less thorny.

The findings a brief field work exercise is captured in Appendix B of this chapter.

4.2.2 Vegetation types of subtropical thicket

This biome was originally described as 'Valley Bushveld' (Acocks, 1953), for good reasons, it typically occurs within the steep slopes of river valleys. This has been a particularly problematic veld type in terms of its delimitation, origins, affinities and dynamics. Tinley (1975) was the first to recognise Valley Bushveld and allied types (Spekboomveld and Noorsveld) as part of a ‘thicket biome’, characterised by a closed-canopy vegetation consisting of an impenetrable tangle of shrubs and low tree. However, Cowling (1984) was the first to formalise the thicket concept in the South African phyto-sociological literature, and Low & Rebelo (1996) recognized the thicket biome in a revised map of Southern Africa vegetation types. The first comprehensive study of the vegetation patterns of diversity was done by Vlok et al., (2003). This yielded 112 unique thicket vegetation types, 78 of which comprised thicket clumps in a matrix of non-thicket vegetation (mosaics) (Figure 4).

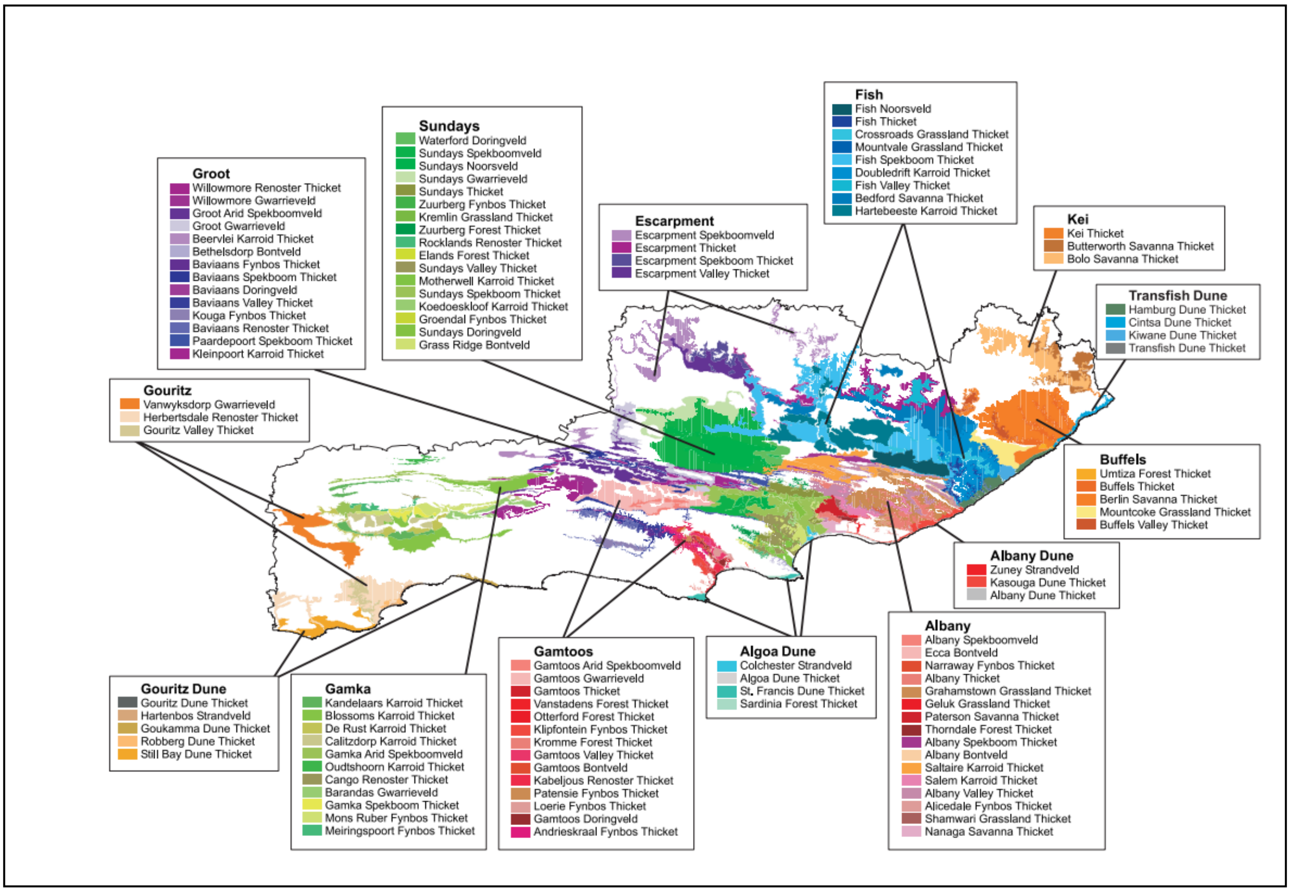

Figure 4: The 112 unique thicket vegetation types for the STEP area (after Vlok *et al.*, 2003).

4.2.3 What is the state of subtropical thicket?

According to Mucina and Rutherford (2006), overall 60 % of this biome has been severely degraded, with only 11 % still in pristine condition, and around 7.3 % totally lost. The mesic thicket, which has the highest levels of endemism and species richness within the Thicket biome, is under the greatest pressure.

A more detailed analysis by Lloyd et al. (2002) and Vlok & Euston-Brown (2002b) provides figures on levels of severely degraded and moderately degraded thicket for each vegetation sub-class. This analysis shows that except for the Mainland Montane Solid (Thicket) and Coastal Dune Solid Thicket, all the vegetation units described show high levels of severe and moderate degradation. Refer to Table 6 below.

Table 6: Proportions (%) of three thicket condition classes (i.e. Pristine Thicket, Moderately Degraded Thicket and Severely Degraded Thicket), and transformed land in the solid thicket types, as a function of the total area of solid thicket (20 730.32 km²) as described by Vlok & Euston-Brown (2002b).

Thicket Type	Other land cover			Thicket condition classes			Total
	Transformed	Water/Sand	Non-Thicket	Pristine Thicket	Moderately degraded Thicket	Severely Degraded Thicket	
Dune thicket	0,13	0.17	0.14	0.3	0.56	0.07	1.40
Valley Thicket	1,85	0.11	0.62	9.97	17.72	14.01	44.28
Arid thicket	0,22	0.11	0.44	3.02	11.58	23.35	38.73
Thicket mainland-montane	0,64	0.11	0.11	5.78	5.87	1.84	14.34
Thicket mainland-basin	0	0.0	0.02	0.53	0.48	0.22	1.25
Totals	2,84	0.51	1.32	19.60	36.21	39.49	100

Forms of thicket vegetation that have been especially ravaged by overgrazing in the past century, are those rich in spekboom or igwanishe, *Portulacaria afra*. There is evidence that even in the short space of a decade, heavy browsing, especially by mohair-producing angora goats, can convert dense shrubland into a desert-like state (Vlok & Euston-Brown, 2002a). Of some 16,000 square km formerly covered in spekboom-rich thicket, some 46 % has undergone severe degradation and 34 % moderate disturbance. This is predominantly from overgrazing, although clearing for crop cultivation is another major threat to the Thicket vegetation. Land has been cleared along the rivers, and lucerne and other crops are grown under irrigation. Land has also been cleared for orange orchards in the Addo region (Vlok & Euston-Brown, 2002b).

The role that indigenous herbivores may have played in determining vegetation boundaries, as do domestic livestock today under certain management regimes has been the subject of much speculation (Hoffman & Cowling, 1990). Several studies have shown that African elephant (*Loxodonta Africana*) has a substantial impact on subtropical thicket composition (Stuart-Hill, 1992), however, these animals as well as black rhinoceros (*Diceros bicornis)*, even under exceptionally high population density (unlike goats) do not convert solid thicket into a mosaic savannah, as Thicket types are probably much more resilient to the impacts of indigenous herbivores. Overgrazing by domestic livestock, in particular goats, has caused dramatic changes in thicket vegetation, with Nama-Karoo shrub like elements invading Arid Thicket types, and subtropical grasses massively increasing in cover in some Valley Thickets, creating savanna-like vegetation that burns at regular intervals, further eliminating succulents and fire-sensitive shrubs (Hoffman & Cowling, 1990).

Unfortunately, removing livestock and resting the veld does not lead to natural recovery of the vegetation, as seedling establishment is constrained by the exposed soil's temperature extremes and reduced water-holding capacity. Essentially, to restore this thicket type requires active interventions (Vlok & Euston-Brown, 2002a).

4.2.4 Value of subtropical thicket

4.2.4.1 Biodiversity Value

- *Flora*

The Albany Centre is a major centre of botanical diversity and endemism for succulents of karroid affinity, especially in the Mesembryanthemeceae, Euphorbiaceae and Crassulaceae, as well as a centre for certain bulb groups.

Subtropical thicket is renowned for its high plants species richness and levels of endemism (i.e. species that grow nowhere else). Vlok & Euston-Brown (2002a) provide a tally of 1 588 subtropical thicket species for the planning domain, 322 (20 %) of which are endemic. Most of these endemics are succulents associated with the vygie, euphorbia, crassula, aloe and stapeliad plant groups (Vlok & Euston-Brown, 2002a).

The subtropical thicket is associated with two globally recognised centres of succulent plant endemism, namely the Little Karoo Centre of the Succulent Karoo in the west and the Albany Centre in the east (van Wyk & Smith, 2001). The Albany Centre encompasses elements of the Cape, Succulent Karoo and Maputaland-Pondoland regions. The Subtropical Thicket biome comprises the south-western sector of the Maputaland-Pondoland hotspot (Figure 5).

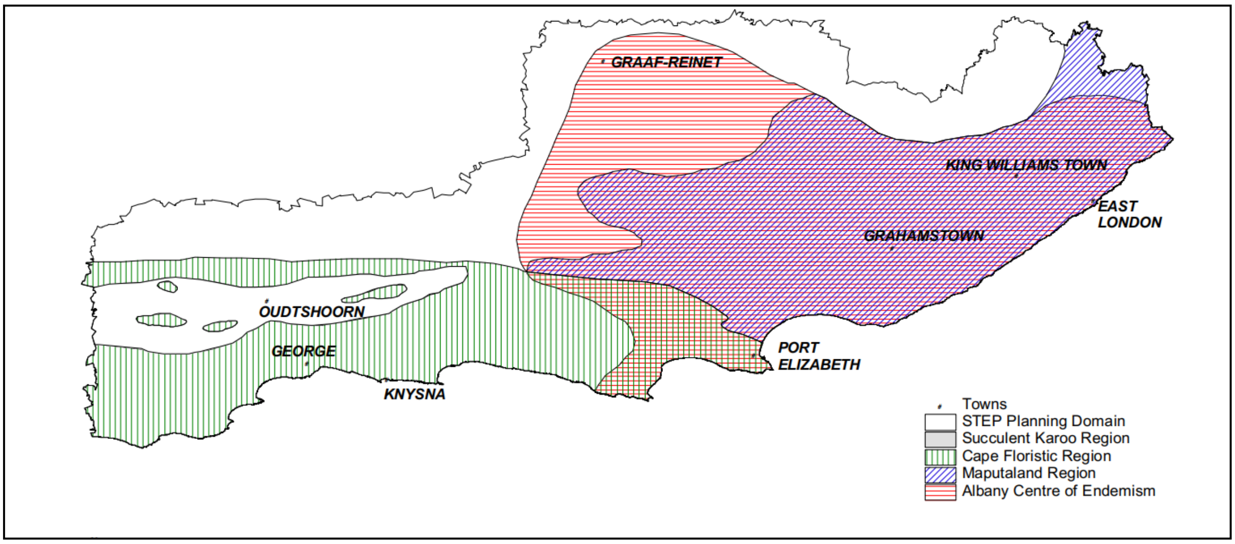

Figure 5: Centres of plant diversity within the STEP planning domain. Boundaries according to van Wyk & Smith (2001).

Subtropical thicket forms mosaics with other South African biomes, namely Fynbos, Forest, Grassland, Nama-Karoo, Savanna and Succulent Karoo. The result is outstanding ecosystem level diversity. Albany Thicket contains at least 125 threatened species, with the mesic thicket vegetation types having the highest number of threatened species (Vlok & Euston-Brown, 2002a).

- *Fauna*

The fauna of the Albany Thicket biome, although diverse, does not demonstrate the level of endemism shown by the flora (Vlok et al., 2002a).

Mammal diversity is relatively high, with 48 species of large and medium-sized mammals, a consequence of the diversity of biomes within the STEP planning domain. Unfortunately, many of these species have been extirpated and all have undergone extensive reductions in their distribution. The smaller mammals include at least two endemic species (long tailed forest shrew and Duthie's golden mole), none of which is restricted to subtropical thicket.

The avifauna is diverse, with 421 species of birds recorded within the planning domain (with no endemics), of which 307 species utilise thicket (Dean, 2002). Birds appear to play an important role in seed dispersal of thicket plants (Dean, 2002). A total of 10 "Important Bird Areas" occur within the planning domain, although only three of these include subtropical thicket (Dean, 2002).

The reptile fauna includes five tortoise species – an exceptional tally - as well as relatively high endemism (six species) among the lizards and snakes (Branch, 1998). The amphibian fauna includes at least three endemic species (Passmore & Carruthers, 1995). Although the invertebrate diversity and endemism is probably high, little is known about this group, other than charismatic species such as the flightless dung beetle (*Circellium bacchus*), which is restricted to subtropical thicket.

4.2.4.2 Socio-economic value

The Subtropical Thicket biome provides the resource base for a wide range of economic activities that provide employment for many thousands of people. It provides resource to support extensive commercial and subsistence pastoralism, and growing wildlife-based industries (ecotourism, game breeding, meat and sport hunting (Sims-Castley, 2002). A detailed analysis of the economic value of this biome was done by Sims-Castley (2002), in which the following economic activities were listed:

Direct consumptive use value:

- Agriculture – Small stock farming (e.g. Angora goats & boer goats);
- Game farming (e.g. trophy hunting, live game sales, venison sales, etc.);
- Horticulture;
- Aloe sap industry;
- Medicinal plants; and
- Fuel wood.

Direct non-consumptive use value:

- Eco-tourism & conservation.

Indirect use value:

- Ecosystem services (e.g. clean air, clean water, soil retention, carbon storage, etc.).

Not all of these forms of land use are sustainable. It is documented that overstocking of small stock, in particular goats, in Thicket areas is ecologically unsustainable (see for example, Hoffman and Cowling, 1990). It leads to loss of phytomass and biodiversity, and an increase in soil erosion and unpalatable plant species – ultimately leading to desertification and loss of natural resources. Game ranching, on the other hand, has been shown to be more ecologically sustainable (Sims-Castley, 2002). Since 1995 there has been a large growth in the game farming industry, with at least 27 additional game farms having been established in the subtropical thicket biome.

Degradation of thicket has negative socio-economic repercussions. Reductions in diversity, soil carbon, soil quality, and plant productivity all lead to lower livestock productivity (Mills & Cowling, 2006).

5 ENVIRONMENTAL SENSITIVITY OF THE ALBANY THICKET BIOME

5.1 Methodological approach to sensitivity mapping

5.1.1 Defining Environmental sensitivity

Environmental Sensitivity Index (ESI) maps are spatial representations of a compilation of information about biodiversity features and their sensitivity to certain specified impacts. In this case the construction of a gas pipeline, where the dominant impacting activity (during construction phase) is clearance of vegetation and the impacts associated with this (erosion, disruption of water flow regimes, fragmentation).

Figure 6 shows how the ESI should be calculated. In a sense it is equivalent to the biodiversity value, but has taken into consideration the vulnerability of the receiving environment to the impact (i.e. the risk of loss). This is in turn determined by the nature of the impact (magnitude, frequency, and likelihood), as well as the ability to mitigate against these impacts, and the inherent fragility of the receiving environment.

The inherent fragility of the receiving environment will vary depending on the specific type of biodiversity feature being considered; however, for any given feature a number of contingent factors will influence fragility, typically these will include the slope and rainfall of the site being impacted. For any given impact, receiving environments on steep slopes (>30 %), and with very high or very low rainfall will be more fragile, and susceptible to cumulative and secondary impacts, such as erosion or poor recovery after rehabilitation. It is believed that this criterion should be considered at finer scales of planning, where for example adjustments to routing paths may be considered based on topography.

Because we are considering a linear structure (gas pipeline), where the associated magnitude, frequency, and likelihood of impacts will be the same throughout the whole study site, we need not include this in the ESI calculations. This is because we are looking at relative and not absolute values.

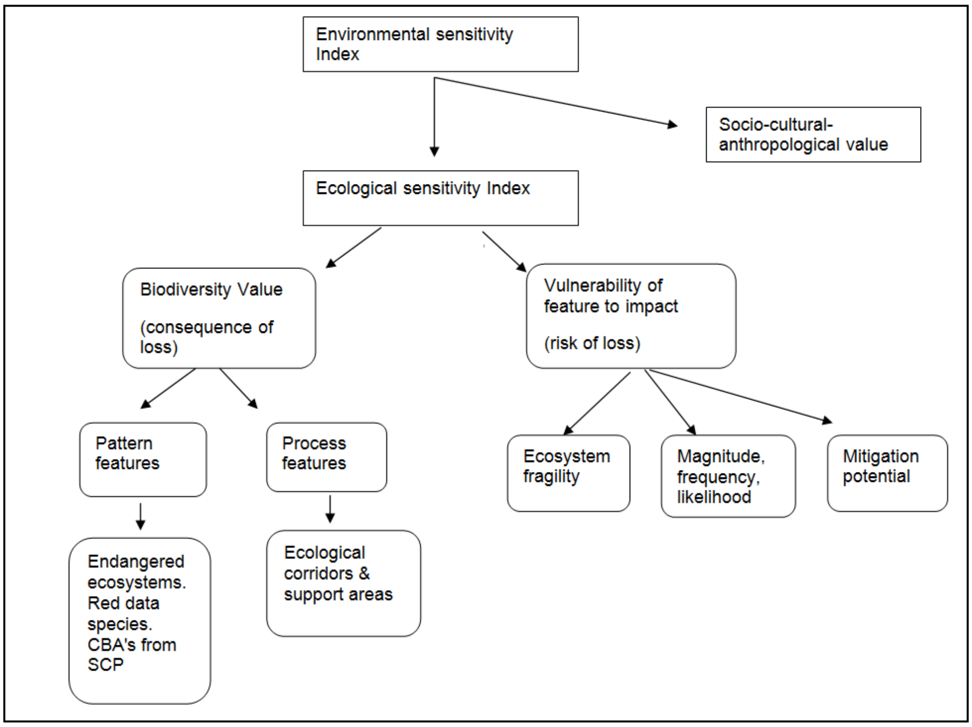

Figure 6: Conceptual outline of the components an Environmental Sensitivity Index

5.1.2 Biodiversity features and sensitivity classification

The biodiversity feature data and critical biodiversity classification rules for Gas Pipeline Phases 7, Inland and part of 2; were adapted from the ECBCP (2017); while the biodiversity feature data and critical biodiversity classification for Gas phases 1 and part of 2 falling into the Western Cape was obtained from the Western Cape Biodiversity Conservation Plan (WCBCP) (2017).

The biodiversity sensitivity values are adapted from the CBA classifications, as based on the provincial systematic conservation plans for the Western and Eastern Cape. This is summarised in Table 7.

Table 7: The biodiversity sensitivity values as derived from the Critical Biodiversity Area classifications.

Conservation Planning Category	Biodiversity sensitivity value
Terrestrial	
PA	Very high
CA	High
CBA1	Very high
CBA2	High
ESA1	Medium
ESA 2	Medium
Protected Area buffers	High
Other Natural Areas	Medium
Non Natural Areas	Low
Aquatic*	
River main stems	Very high
Wetlands	Very high
Estuaries	Very high
*Note: Aquatic ecosystems are considered in detail as a separate topic as part of the SEA.	

Additional detail and data sources, regarding the biodiversity features used and the rules to derive the CBA and ESA classifications are provided in Table 8.

Table 8: Summary table of biodiversity feature data used in this study, to derive biodiversity sensitivity classes based on the Critical Biodiversity and Ecological support areas classification as used in the ECBCP (2017).

Biodiversity feature	Sensitivity class	VH	VH	H	M	M	Data source
	CBA category	PA	CBA 1	CBA 2	ESA 1	ESA 2	
Protected Areas							DEA National Protected and conservation areas data base
Protected Areas (state)	Biosphere Reserves	x					
	World Heritage Sites	x					
	State Owned - SANParks and ECPTA	x					
	Protected Environments	x					
Conservation Areas	Private Nature Reserves			x			
	De Facto Private Nature Reserves			x			
	DAFF forest reserves		x				
Terrestrial							
SA Vegetation Types	Threatened Ecosystems SA vegmap CR and EN Plus with patches >3ha in size		x				From SANBI 2011 data and updated with the ECBCP 2017 analysis. Selected Planning Units (PUs) that are natural and which intersect vegetation type units listed as threatened.
	VU vegetation types needed to meet targets			x			
STEP Vegetation Types	Threatened Ecosystems STEP vegetation CR and EN PUs with remnants						Calculated from STEP vegetation map 2003 against the EC integrated Land Cover 2014
NFI Forests	NFI critically endangered/high priority forest patches (DB)		x				As defined by DAFF, 2006 Report (Derek Berliner)
	Priority clusters (DB)		x				
Other Forests	All other forests (DB)		x				
	CBA1 forest patch 500m buffer				x		
MARXAN analysis	Irreplaceable Sites (selection frequency>80%) - PUs selected to meet targets for: (1) vegetation types, (2) species points, (3) expert areas		x				ECBCP (2017)
	Best Design Sites (selection frequency<80%) - PUs selected to meet targets for: (1) vegetation types, (2) species points, (3) expert areas			x			
	Other sites required to complete the ecological corridor network				x	x	

Biodiversity feature	Sensitivity class	VH	VH	H	M	M	Data source
	CBA category	PA	CBA 1	CBA 2	ESA 1	ESA 2	
Special habitats	Selected cliffs buffered by 100m				x		
	Cliff buffers 500m				x		
	Bat roost sites and 500m radius*		x				
	Vulture breeding sites 5km buffer*		x				
Eastern Cape corridors	Best Design Corridor Sites - PUs selected to meet 60% targets for vegetation types,				x	x	
Ecological infrastructure	Climate change refugia (SANBI 2016 Model)				x		
	Coastal functional zone				x		
	Climate change resilience (SH)				x		
Aquatic*							
	River main stems		x				
	Wetlands		x				
	Estuaries		x				

**Note: Aquatic ecosystems, bats and avifauna are considered in detail as a separate topic as part of the SEA.*

The biodiversity sensitivity designations used in maps are derived from the conservation planning categories as used in ECBCP (2017) (Table 9).

Table 9: Summary of biodiversity features of the Albany Thicket biome assigned a sensitivity to gas pipeline development.

Sensitivity	Reasons
Very High	Protected Areas, CBA1, STEP remnant Endangered and Critically Endangered vegetation types
High	CBA2
Medium	ESA1 and ESA 2
Low	Remaining areas

5.1.3 Threatened ecosystems and vegetation types within study area

The National Environmental Management: Biodiversity Act (NEMBA) provides for the listing of threatened or protected ecosystems in South Africa. A list of Threatened Ecosystems for South Africa has been drawn up (SANBI, 2011). These are threatened ecosystems which require protection and conservation, under NEMBA. Of these only the Albany Alluvial Vegetation (listed as EN) falls within the Albany Thicket biome.

The Threatened Vegetation types for the Eastern Cape province were recalculated for the ECBCP (2017) using the prescribed method of SANBI, but with a revised land cover map that takes into account changes in vegetation cover since the last assessment (i.e. based on the integrated 2014 land cover developed for the Province for this project). In Table 10 and Figure 7 below, the vegetation types occurring within the Albany Thicket biome that were classified as critically Endangered or Endangered are shown.

Table 10: Vegetation types occurring within the Albany Thicket biome that were classified as Critically Endangered or Endangered, with the assigned sensitivity classes used in this study.

Vegetation Type	Status (SANBI, 2011)	Sensitivity (this study)
Buffels Valley Thicket	Critically Endangered	Very high
Escarpment Valley Thicket	Critically Endangered	Very high
Gamtoos Bontveld	Critically Endangered	Very high
Gamtood Doringveld	Critically Endangered	Very high
Paterson Savanna Thicket	Critically Endangered	Very high
Sundays Noorsveld	Critically Endangered	Very high
Sundays Spekboomveld	Critically Endangered	Very high
Zuney Strandveld	Critically Endangered	Very high
Motherwell Karroid Thicket	Endangered	High
Shamwari Grassland Thicket	Endangered	High
Sundays Doringveld	Endangered	High

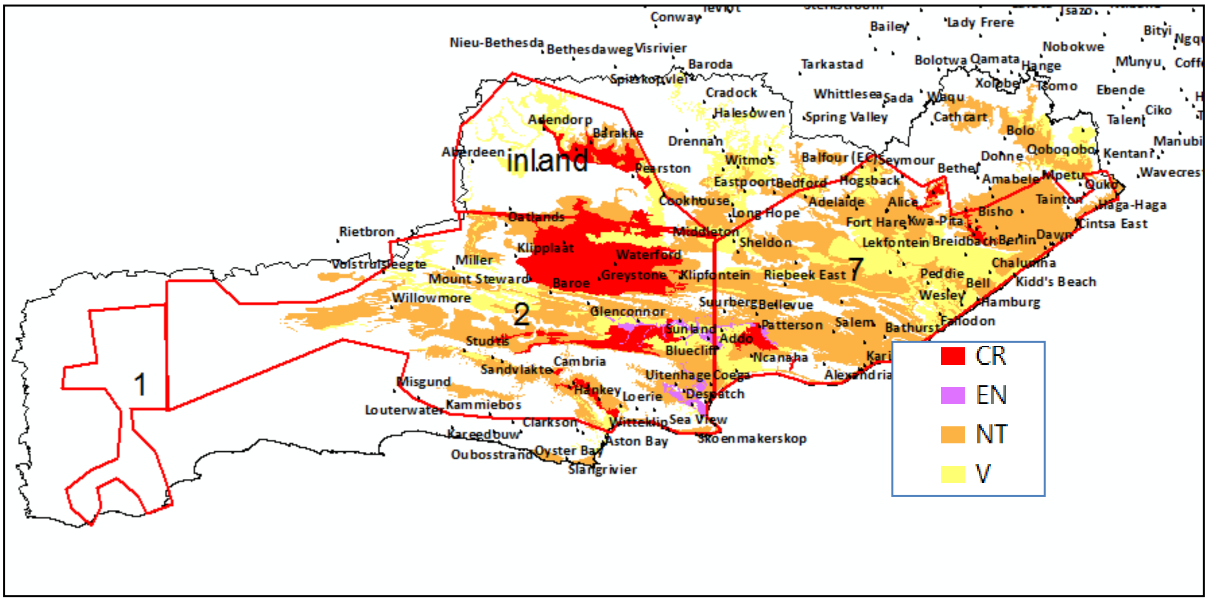

Figure 7: Threatened vegetation types occurring within the Thicket biome.

5.2 Four-tier sensitivity maps

5.2.1 Gas Pipeline Phase 1

This gas phase falls within the Western Cape and covers the local municipalities of Kannaland, Hessequa, and Mossel Bay. It includes a number of important Protected Areas and a section of the Cape Floral World Heritage site (Figure 8). Vegetation is highly diverse with at least four distinct vegetation biomes forming a mosaic with Albany Thicket mostly in river valleys.

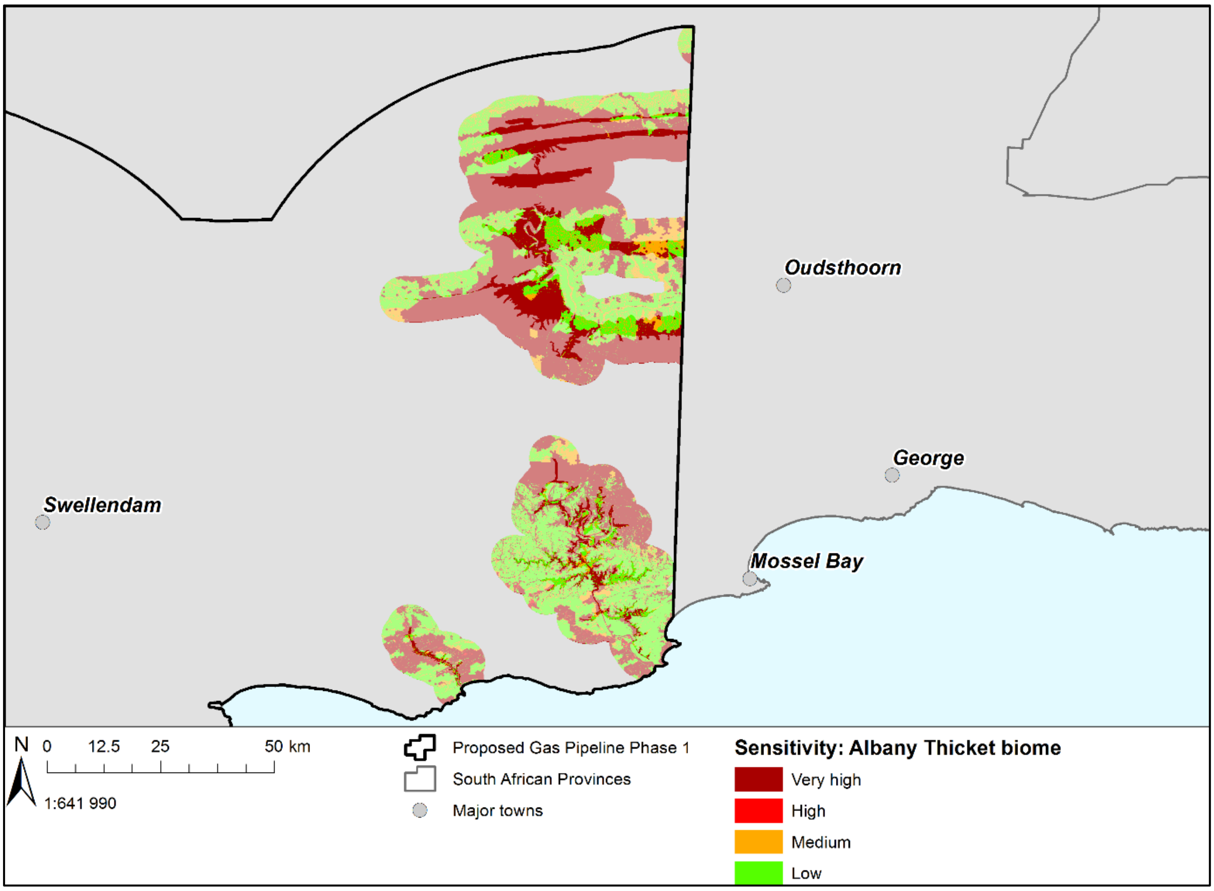

Figure 8: Sensitivity of the Albany Thicket biome in the proposed Gas Pipeline Phase 1 study area. Due to the patchy mosaic nature of the Albany Ticket Biome directly adjacent sensitivities have been masked with a semi-transparent pale buffer for the purposes of this map.

5.2.2 Gas Pipeline Phase 2

This area is rich in high value biodiversity areas as can be seen from the large number of Protected Areas and CBAs. It contains the Baviaanskloof Protected Area, part of the Cape Floral regions World Heritage serial sites, as well as a number critically endangered vegetation types including, Sundays Spekboomveld and Sundays Noorsveld (Figure 9).

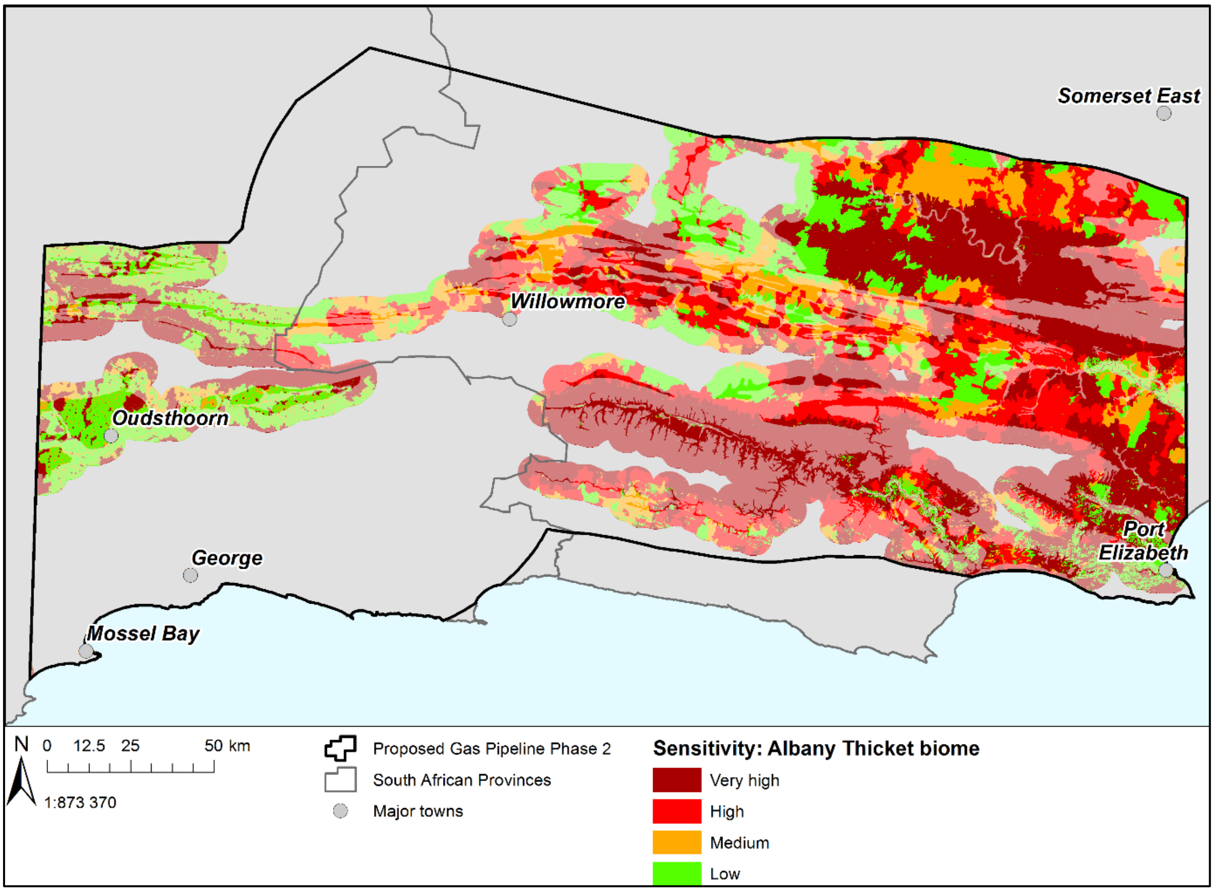

Figure 9: Sensitivity of the Albany Thicket biome in the proposed Gas Pipeline Phase 2 study area. Due to the patchy mosaic nature of the Albany Ticket Biome directly adjacent sensitivities have been masked with a semi-transparent pale buffer for the purposes of this map.

5.2.3 Gas Pipeline Phase 7

This is a large block stretching roughly from Kei Mouth to Coega. It contains a large number of highly sensitive areas mostly due to many state-owned Protected Areas, and private nature reserves and game farms. The coastal areas are incised by deep river valleys often with sensitive and endangered vegetation types. There are numerous sensitive estuaries and wetland areas within the coastal zone, and it is recommended that gas pipelines stay at least 50 km from the coast. It includes important Protected Areas such as Great Fish River and part of Addo Elephant National Park, as well as a number of critically endangered vegetation types including Buffels Valley Thicket, Albany Dune, and Albany Thicket, and one endangered vegetation type, Sundays Valley Thicket (Figure 10).

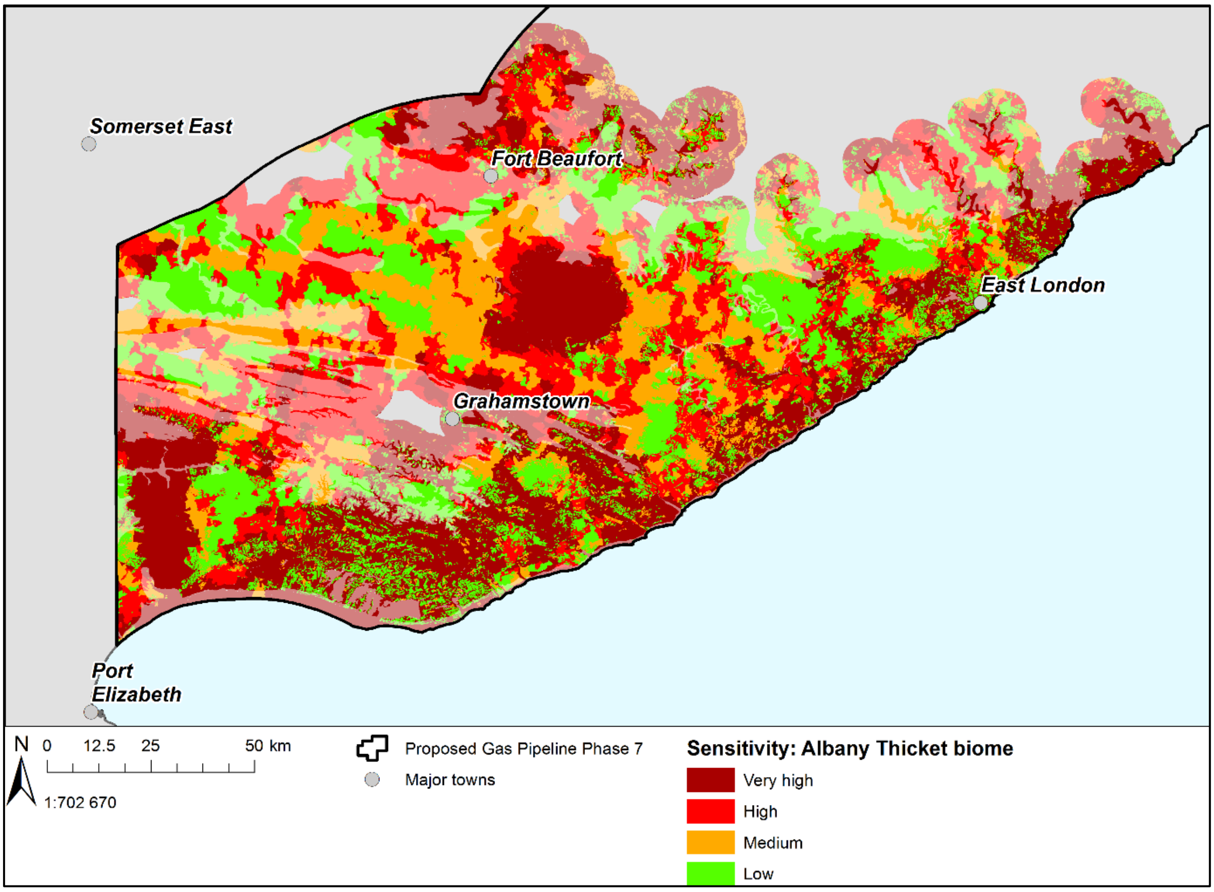

Figure 10: Sensitivity of the Albany Thicket biome in the proposed Gas Pipeline Phase 7 study area. Due to the patchy mosaic nature of the Albany Ticket Biome directly adjacent sensitivities have been masked with a semi-transparent pale buffer for the purposes of this map.

5.2.4 Gas Pipeline Phase Inland

This area contains many highly sensitive areas due to a number of state Protected Areas (Figure 11) including the Camdeboo National Park and part of Mountain Zebra National park. It also contains one Critically Endangered vegetation type, Escarpment Valley Thicket, and part of the Sundays Arid Thicket.

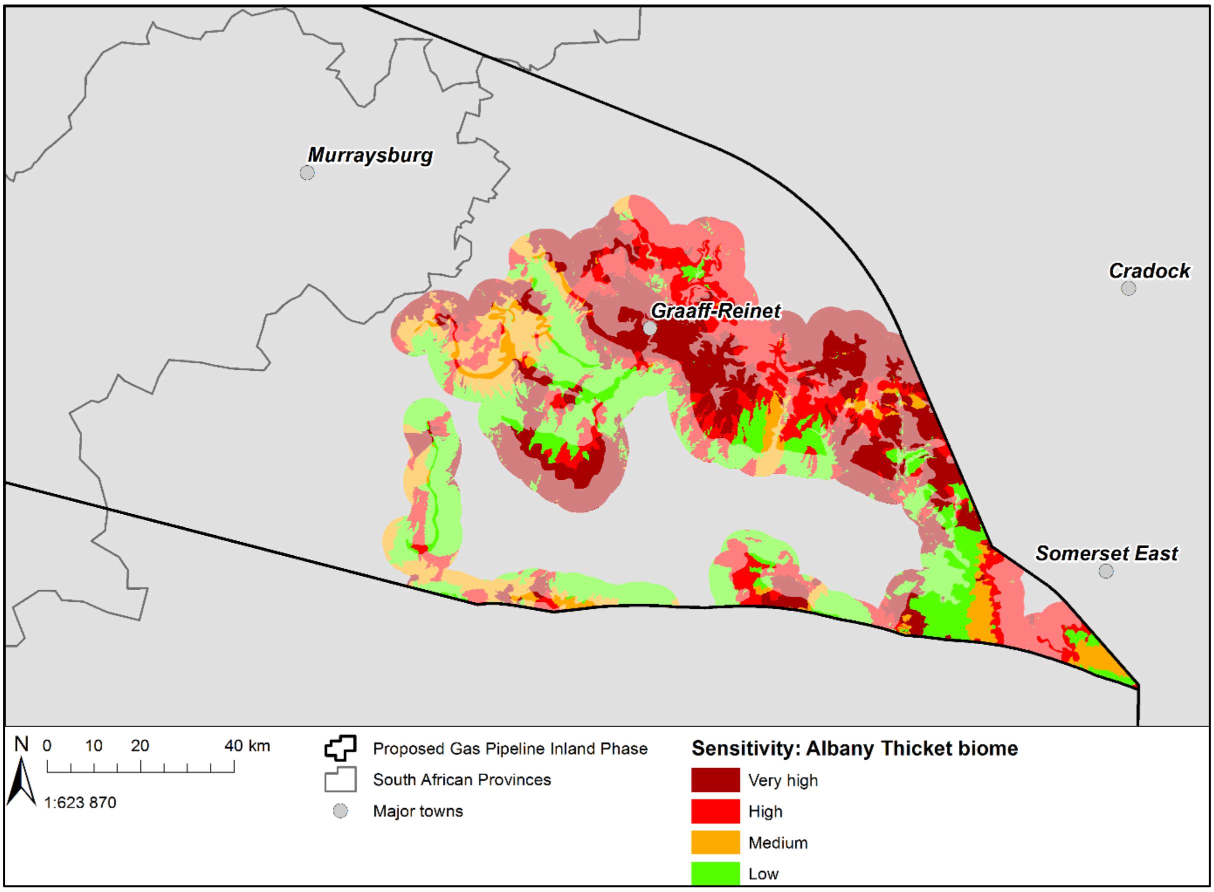

Figure 11: Sensitivity of the Albany Thicket biome in the proposed Gas Pipeline Inland Phase study area. Due to the patchy mosaic nature of the Albany Ticket Biome directly adjacent sensitivities have been masked with a semi-transparent pale buffer for the purposes of this map.

5.3 Environmental suitability of gas corridors

All of the gas phase study areas within the Albany Thicket biome have relatively high proportions of land falling in either, Protected Areas (22 - 10 %), or Critical Biodiversity Areas category 1 (29 - 24 %) (Table 11).

Table 11: Area percentages of biodiversity planning categories for each Gas Pipeline Phase within the Albany Thicket biome

CBA category	% Of Total Area			
	Gas Phase 1	Gas Phase 2	Gas Phase 7	Gas Phase Inland
Protected Areas	22.5	16.8	12.0	10.6
CBA1	29.0	25.8	23.9	26.5
CBA2	1.0	27.6	24.2	20.2
ESA1	9.0	11.7	14.5	12.1
ESA2	2.3	0.5	2.3	0.2
Other	36.22	17.6	23.0	30.3

The biodiversity planning categories can be translated into the four sensitivity classes and expressed as a Percentage of total land area for each gas phase within the Albany Thicket biome. This is visually displayed in Figure 12.

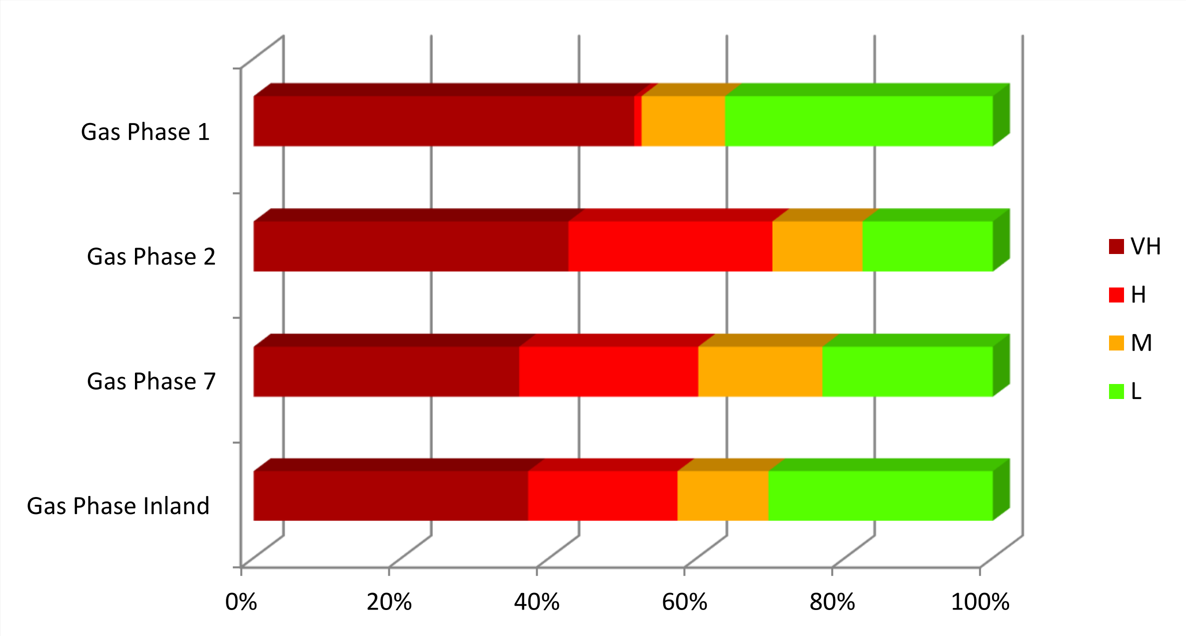

Figure 12: Percentages of each sensitivity class for each gas phase considered within the Thicket biome

To calculate an overall suitability to development score for each of the study areas, each sensitivity class has been weighted, and multiplied by the percentage area of each class. This was then scaled as a score out of ten (Table 12). Refer to Appendix A of this report which provides a description of the methodology used for the calculation of the sensitivity scores.

Table 12: Weighted suitability score for each class for each gas phase (weighting x % area). The higher the score the higher the overall suitability of the gas phase (The following ratings for suitability have been subjectively assigned by the author: 1 – 4 = Poor; 4 – 4.5 = Medium, 4.5 – 5.5 = Fair, >5.5 = Good)

	% Area of Land					Comment
Sensitivity class	**VH**	**H**	**M**	**L**	**Suitability Score (1-10)**	
Suitability Weighting	1	3	6	10		
Gas Phase 1	51.5	1	11.3	36.22	4.8 (fair)	Most H and VH areas can be avoided, Cumulative impact on aquatic systems*.
Gas Phase 2	42.6	27.6	12.2	17.6	3.7 (poor)	Some impact on H and VH sensitive areas.
Gas Phase 7	35.9	24.2	16.8	23	4.4 (medium)	Difficult to avoid the many VH and H sensitive areas.
Gas Phase Inland	37.1	20.2	12.3	30.3	4.7 (fair)	Most H and VH areas can be avoided.

**Note: Aquatic ecosystems are considered in detail as a separate topic as part of the SEA.*

All the gas pipeline phases that fall within the Albany Thicket biome have relatively low suitability ratings, but the Gas Phase 1 pipeline corridor has the highest suitability (most suitable) and Gas phase 2 has the lowest suitability (least suitable) from an environmental perspective compared to the other gas pipeline phases in the Albany Thicket biome.

6 DESCRIPTION OF IMPACTS AND MANAGEMENT ACTIONS

Table 13: Key potential impacts associated with the proposed gas pipeline and recommended management actions. The mitigation hierarchy must be applied for all stages and scales of the project.

Key Impact	Description	Proposed Management Actions
Habitat destruction and degradation	Removal of vegetative cover will result in: • Increased risk of rare species loss • Decline in ecosystem resilience • Decline in ecosystem services • Increased habitat fragmentation • Change in water surface runoff • Increased soil loss • Noise, dust	Avoid • Use of environmental sensitivity maps and least cost in routing design • Design and layout of infrastructure to avoid highly sensitivity areas • Ground assessments and verification before construction • Design to use as much common/shared infrastructure as possible with development in nodes, rather than spread out. • Avoid any construction on steep slopes (> 25 degrees) Minimise • Minimise construction footprint with good planning • Use existing roads as far as possible for access • Construction outside of peak rain season as much as possible • Use dust reduction methods during construction • Use plant rescue to remove rare plants in construction footprint • If roads or structures are fenced, use plain strands and not jackal proof fencing to ensure animals can still move through fences Rehabilitate • During construction maintain top soil for later rehabilitation • Re-vegetate all cleared areas as soon as possible • Stabilise all slopes and embankments, water courses • Where fragmentation of key habitats has occurred use landscape design methods (over and under pass wildlife bridges) to re-establish ecological connectivity
Invasive plant spread	Removal of plant cover and top soil promotes the establishment of pioneers, in particular invasive plants. In addition altered soil structure, moisture availability and light availability can lead to invasion by weeds and invasive alien plants and animals.	Avoid • Unnecessary disturbance of plant cover and top soil. Use existing roads • Do not use sand sources contaminated with invasive alien plant seed for bedding of the pipe or for construction work.

Key Impact	Description	Proposed Management Actions
		Minimise • Where invasive plants occur on or in vicinity of construction site, remove before they set seed. Rehabilitate • Remove all alien vegetation and re-vegetate as soon as possible with perennial fast-growing vegetation • Keep out all livestock • Avoid off road driving
Increased poaching	The pipeline construction activities include opening up remote areas, and developing access roads for construction and maintenance in areas that may have been mostly inaccessible by road or footpaths. Increased road access may promote poaching, in particular if close to communities with a tradition of hunting, medicinal plant collection or illegal harvesting of timber and other valuable plants by collectors (cycads, rare succulents, reptiles etc.). There may also potentially be secondary poaching impacts during construction (and/or maintenance) conducted by the labour teams used in construction.	Avoid • Building access roads into sensitive areas with valuable resources Minimise • Use of surveillance and monitoring of snares, debarking, hunting etc. • Develop community education programs near vulnerable sites

7 RISK ASSESSMENT

7.1 Consequence levels

Table 14: Consequence levels used in risk assessment with thresholds

Impact	Consequence				
	Slight	Moderate	Substantial	Severe	Extreme
Habitat destruction/disturbance (Loss of ecosystem integrity, fragmentation and loss of ecosystem services)	No natural habitat is crossed	Natural habitat impacted is 'LOW' sensitivity	Any impact of 'MEDIUM' sensitive habitat caused by project activities	Any loss of ' 'HIGH' sensitive area caused by project activities	Any loss of 'VERY HIGH' sensitive caused by project activities
Risk of endemic/ rare species loss	No known red data species in footprint and no H or VH sensitive areas	Disturbance of any natural habitat with known red data species: where less than 1 % of this habitat is disturbed	Disturbance of any natural habitat, with known red data species, where up to 5 % of this habitat is disturbed	Disturbance of any natural habitat with known red data species, where more than 5 %, but less than 10 % of habitat is disturbed	Disturbance of any natural habitat with known red data species, where 10 % or more of habitat has been disturbed
Increase risk of spread of alien invasive plants (AIP)	Degree of AIP infestation in catchment of footprint = < 0.5 %	Degree of AIP infestation in catchment of footprint 0.5 to 2% of footprint	Degree of AIP infestation in catchment of footprint = 2-5%	Degree of AIP infestation in catchment of footprint = 5-10 %	Degree of AIP infestation in catchment footprint > 10%
Increased access to sensitive areas (poaching)	Distance to nearest settlement: > 50km	Distance to nearest settlement: 50-30km	Distance to nearest settlement: 30-20km	Distance to nearest settlement: 20-10 km	Distance to nearest settlement: Less than 10 km

7.2 Risk assessment results

Not all biodiversity features share the same potential for mitigation. This may depend on the extent, duration and severity of impact, but also on the sensitivity of the receiving environment. Areas of high biodiversity value, comprising local non-mobile species will be more vulnerable. The success of management actions may be variable (Table 15).

1 Table 15: Impacts and risk assessment with and without mitigation for gas pipeline development for all Phases within the Albany Thicket Biome for each sensitive class category.

Impact	Sensitivity class	Without mitigation			With mitigation		
		Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Habitat destruction/disturbance	VH	Extreme	Very Likely	Very High	Severe	Likely	High
	H	Severe	Very Likely	High	Severe	Likely	High
	M	Severe	Likely	High	Substantial	Likely	Moderate
	L	Moderate	Likely	Low	Moderate	Likely	Low
Risk of endemic/ rare species loss	VH	Severe	Likely	High	Substantial	Not likely	Moderate
	H	Severe	Likely	High	Substantial	Not likely	Moderate
	M	Moderate	Not Likely	Low	Slight	Very unlikely	Very Low
	L	Moderate	Not Likely	Low	Slight	Very unlikely	Very Low
Increase risk of spread of alien invasive plants	VH	Extreme	Very Likely	Very High	Severe	Likely	High
	H	Severe	Very Likely	High	Substantial	Likely	Moderate
	M	Severe	Very Likely	High	Substantial	Likely	Moderate
	L	Substantial	Very Likely	Moderate	Moderate	Very unlikely	Low
Increased access to sensitive areas (poaching)	VH	Severe	Likely	High	Substantial	Likely	Moderate
	H	Severe	Likely	High	Moderate	Not likely	Low
	M	Moderate	Likely	Low	Slight	Very unlikely	Very Low
	L	Slight	Likely	Very Low	Slight	Very unlikely	Very Low

7.3 Limits of Acceptable Change

Limits of acceptable change are defined as the variation that is considered acceptable by experts in the field (Stankey et. al. 1985) of a particular environmental indictor of a component or process of the ecological system in question. Potential limits of acceptable change for the Albany Thicket biome have been suggested by this author and are presented in Table 16.

Table 16: Limits of acceptable change

Impact	Limits of acceptable change
Habitat destruction/disturbance	No more than 2 % loss of VH sensitive habitat polygon
Habitat destruction/disturbance	No more than 5 % loss of any H sensitive habitat polygon
Risk of endemic/ rare species loss	No more than 5% loss of any known population of any known Red data species
Increase risk of spread of alien invasive plants	Any increase over base line conditions
Increased access to sensitive areas (poaching)	No more than 20 % increase in poaching over base line levels

8 BEST PRACTICE GUIDELINES AND MONITORING

Apart from the management actions recommended in Section 6, succulent thicket vegetation has some unique characteristics that need to be considered in a biodiversity vegetation monitoring programme as well as in the restoration of natural habitat following pipeline construction. These include the following:

- High vulnerability to overgrazing by livestock, in particular *Portulacaria* dominated vegetation types. This is particularly relevant when rehabilitating sensitive habitat where livestock may be present.
- High vulnerability of some thicket types to fire damage;
- Invasive alien vegetation, especially rooikrans, (*Acacia cyclops*) poses a real threat to Thicket by increasing the fuel load. This renders it prone to hot fires that will severely damage if not destroy the succulent and tree component; and
- Slow re-growth and recovery after vegetation removal. This is particularly true for arid and some mesic thicket vegetation types.
- Disturbance in arid areas of succulent thickets are prone to invasion of karroid species and arid adapted alien vegetation (Milton, & Dean, 2010). This needs to be considered in restoration plans.

A biodiversity monitoring programme needs to be part of an effective project Environmental Management Programme (EMPr). Objectives of this need to include:

- Speed and progress of vegetation rehabilitation;
- Monitoring of health of rare plant communities/endangered vegetation types within or close to construction;
- Impact of construction activities on changes in water quality and flow, run-off and sedimentation, in particular near watercourses and on steep slopes where erosion is more likely to occur;
- A monitoring programme needs to identify key indicator species that are likely to be impacted within the Thicket biome. These must include both fauna and flora. Species that are relatively abundant as well as easy to monitor. Adaptive management approach must be used to feedback results of monitoring into improving management;
- Fossorial fauna require special attention as these are most likely to be impacted by construction activities; and
- Post construction re-vegetation projects can be combined with carbon sequestration programmes aimed to restore degraded subtropical thicket. This would achieve the combined aims of improving rural livelihoods, restoring biodiversity, and replenishing natural capital/ecosystem services (Mills et al., 2003).

Some best practise guidelines for monitoring of thicket vegetation, and associated fauna, will include:

- Development of a good baseline data by mapping the location of rare and threatened plant species near or within development footprint before any development occurs;
- Make provision for seasonal monitoring, during spring and autumn months, of rare and threatened flora on site;
- Identification of local extinctions caused by construction activities. A plant rescue plan must be developed before construction, and a reintroduction plan must be prepared, once construction has been completed; and
- Management of access into key sensitive areas along construction footprint.

9 GAPS IN KNOWLEDGE

Key gaps in knowledge include:

- Changes in land cover at fine scale;
- Techniques of rehabilitation for degraded thicket types;
- Limit to acceptable change of sensitive ecosystems within succulent thickets
- Extent, stability and distribution of rare and endangered thicket fauna and flora species;
- Differential responses of sensitive biodiversity features to pre- and post-construction activities, and how best to mitigate;
- Impact of climate change on the drivers of changes impacting on rare vegetation types, particularly in transformed and degraded landscapes of the Thicket biome; and
- Uncertainty around long-term fragmentation impacts of long linear structures on terrestrial fauna.

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APPENDIX A: CALCULATION OF SUITABILITY SCORES

Step 1: Calculate Area Percentage of Biodiversity Planning Categories Per Sensitivity

The area percentages of the biodiversity planning categories within the Albany Thicket biome (Table 11) were grouped to determine the percentage of total land area per sensitivity class ranking from Very High to Low, as shown below:

- Very High Sensitivity Class per phase = "% of Total Area of Protected Areas" + "% of Total Area of CBA 1"
- High Sensitivity Class per phase = "% of Total Area of CBA 2"
- Moderate Sensitivity Class per phase = "% of Total Area of ESA 1 + "% of Total Area of ESA 2"
- Low Sensitivity Class per phase = "% of Total Area of Other"

Example for Gas Phase 1:

Very High Sensitivity Class = 22.50 % + 29.00 % = 51.50 %

High Sensitivity Class = 1.00 %

Moderate Sensitivity Class = 9.00 % + 2.30% = 11.30%

Low Sensitivity Class per phase = 36.22%

The percentage of the total area of each sensitivity rating per gas phase is shown below and illustrated in Figure 12:

Sensitivity Class	% Of Total Area			
	Gas Phase 1	Gas Phase 2	Gas Phase 7	Gas Phase Inland
VH	51.50	42.60	35.90	37.10
H	1.00	27.60	24.20	20.20
M	11.30	12.20	16.80	12.30
L	36.22	17.60	23.00	30.30

Step 2: Weight the Sensitivity Class

The following weighting has been assigned to each sensitivity class:

Sensitivity Class	Weighting
VH	1
H	3
M	6
L	10

Step 3: Calculate Overall Suitability Score for each Gas Phase

The following formula has been applied to calculate the overall suitability to development score for **each gas phase**:

Overall Suitability = [(% of Total Area for VH * 1) + (% of Total Area for H * 3) + (% of Total Area for M * 6) + (% of Total Area for L * 10)] / 100

Example for Gas Phase 1:

Overall Suitability = [(51.50 % * 1) + (1 % * 3) + (11.30 % * 6) + (36.22 % * 10)] / 100
= [(51.50 %) + (1 %) + (67.80 %) + (362.20 %)] / 100
= [(484.50 %)] / 100
= <u>**4.8**</u>

Results of the Suitability Scores are shown in Table 12.

APPENDIX B: FIELD TRIP SUMMARY REPORT

Verification of the South Western extent of the Succulent Thicket biome fragments within the Swartberg and Baviaanskloof complex

<u>Objectives</u>

A short field trip was conducted to verify the extent and nature of the mosaic distribution of the Thicket Biome within two highly fragmented regions of the biome, i.e. the Baviaanskloof Wilderness and World Heritage Site, and the Grootswartberg area (specifically Goukamma nature reserve between Calitsdorp and Oudtshoorn).

<u>Approach</u>

Verification of the extent of the Thicket Biome within the complex mosaic of other vegetation types was approximated by comparing KML files of the Thicket Biome extent with Google Earth satellite imagery, as well as taking photographs with a GPS camera. Photographs were taken during a road trip and a four day hike within the Baviaanskloof nature reserve during the month of April 2018. *Portulacaria afra* (Spekboom) was used as an idicator species to astertain the presence of the Thicket Biome.

<u>Study Areas</u>

The map below (Figure B.1) gives the full extent of the Succulent Thicket Biome, as well as the gas phases for this region.

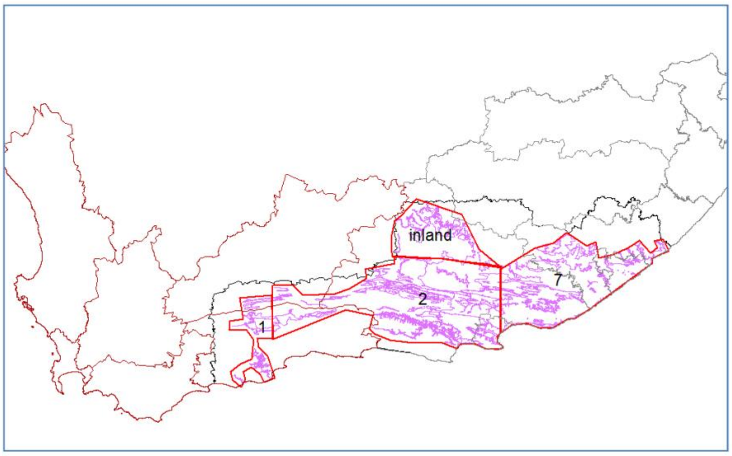

Figure B.1: Extent of the Succulent Thicket Biome. Both study sites fell within the Gas Pipeline Corridor Phase 2

Two areas were visited i.e. Baviaanskloof wilderness area and Gamkaberg nature reserve, which are shown in the maps below (i.e. Figures B.2 and B.3).

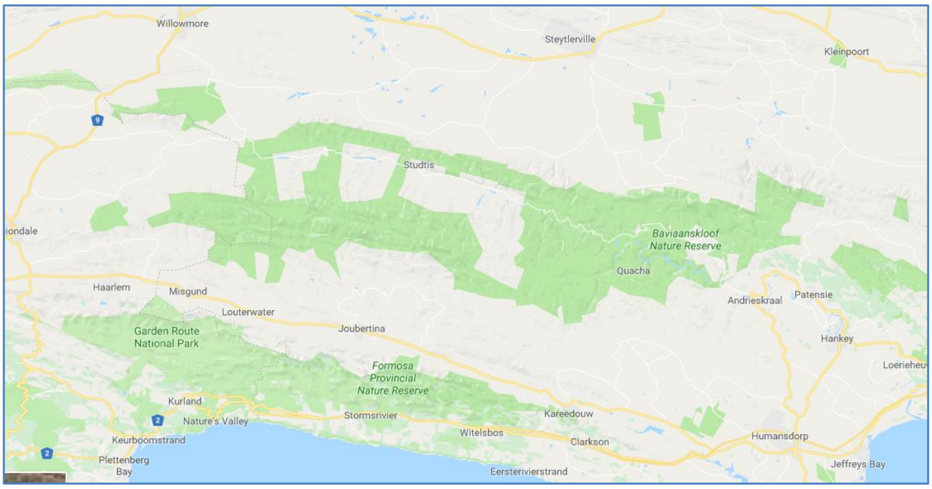

Figure B.2: Baviaanskloof Wilderness Area

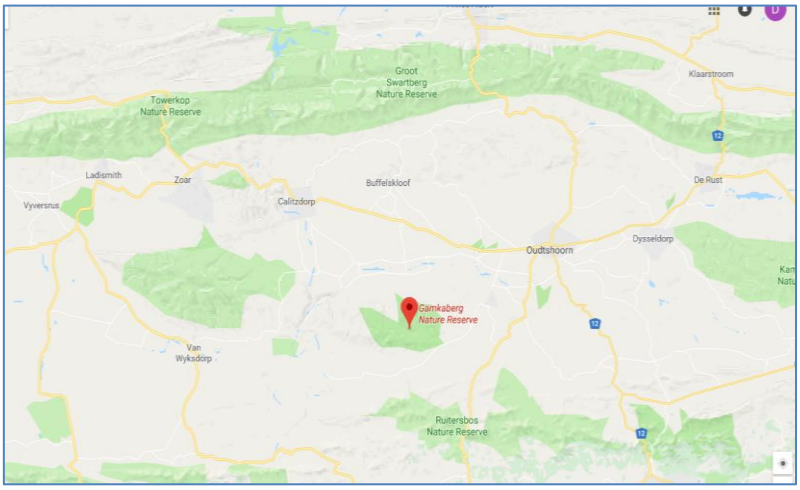

Figure B.3: Gamkaberg Nature Reserve

<u>Findings: Baviaanskloof</u>

Baviaanskloof vegetation is a mix of five diffferent vegetation biomes. Thicket vegetation occurs within the many valleys as mosaics within Fynbos, Succulent Karoo, Forest and Savanna. Typically this is represented as *Portulacaria afra* (Spekboom) clusters on the steep valley slopes. One can recognise it easily on north and east facing mountain slopes where bright green patches occur, usually intermixed with other shrubs. P. afra has an extensive root system which occupies a significant amount of space, and thus keeps loose soil from washing down the steep slopes when it rains. In many areas these Spekboom represents both natural and aided recovery from the overgrazed lands in the early 1900's from the Angora goat wool industry in the Baviaans area.

The Thicket vegetation of the Baviaans is recognised in the National Vegetation map as Gamtoos Thicket. Typical trees include: *Aloe ferox*, *Euphorbia tetragona*, *Boscia albitrunca*, *Cussonia spicata*, *Encephalartos lehmannii*, *Ozoroa mucronata*, *Pappea capensis*, *Schotia afra var. afra*, *Sideroxylon inerme*.

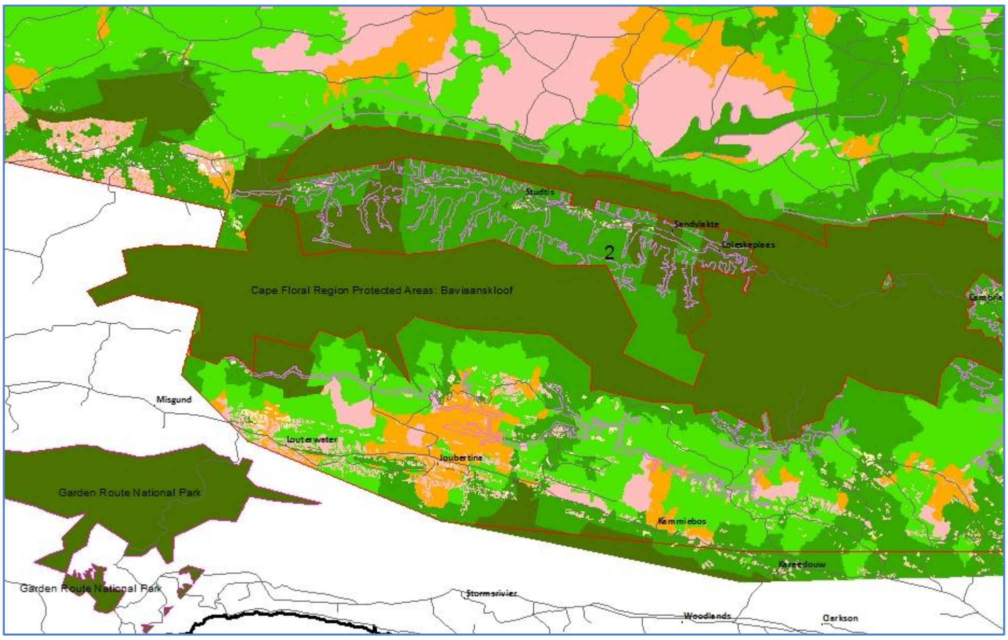

Figure B.4: Thicket vegetation occurs within the deep valley bottoms and north slopes of the Baviaanskloof Wilderness Area (shown by the pink lines)

Figure B.5: Succulent Thicket occurs in the deep valleys and slopes of the Baviaanskloof

Figure B.6: Dry river beds, with *Portulacaria* dominated mountain vegetation on the steep slopes of Baviaanskloof.

Diagnostic plant species seen include a high proportion of both leaf and stem-succulent shrubs such as Spekboom (*Portulacaria afra*), *Aloe africanai*, *Aloe ferox*, *Euphorbia spp. Maytenus procumbens*, and *Polygala myrtifolia*

<u>Conclusion</u>

The national vegetation mapping of Succulent Thicket within the Baviaanskloof complex is relatively accurate. This is mostly because it follows predictable topographic patterns. This region of the biome is characterised by many ecotones with other vegetation types, particularly mountain fynbos and Afromontane forests.

The thicket vegetation of the Baviaanskloof is heavily dominated by *Portulacaria.* It is not clear if this is a natural recovery to its former state, after a long history of overstocking with goats, or represents an intermediate stage of recovery that is a depauperate (species poor) version of mature Succulent Thicket.

Although not a characteristic Thicket species, the Willmore (Baviaans) Cedar occurs in the kloofs of this area. Unfortunately, a fire in 2016 destroyed most trees including many fine old specimens (perhaps as much as 85 % of the population was lost). Very few of the trees seen while on the four-day hike of this region were still alive. This tree occurs within a very limited distribution, known from only 12 locations. It is extremely vulnerable to fire. It is listed as 'Near Threatened' by the IUCN, but in the view of the specialist author, it should receive a higher conservation status of 'Endangered' (Refer to the pictures below i.e. Figures B.7).

Figure B.7: Willomore Cedar Forest destroyed by a fire in the Baviaans

<u>**Gamkaberg Nature Reserve**</u>

The Gamkaberg Nature Reserve is situated in the Little Karoo region of the Western Cape. Four of the Cape biomes occur in the Gamkaberg i.e. Fynbos, Succulent Karoo, Subtropical Thicket, and Evergreen Forest. On top of the mountain, where the last rain falls, there is plenty of fynbos – proteas, restios, ericas and geophytes. In the kloofs there are thick forests, nourished by the natural springs. The Gamkaberg Conservation Area forms part of the even larger UNESCO Gouritz Cluster Biosphere Reserve.

The steep slopes of the valleys are dominated by Thicket vegetation, *Portulacaria afra*. This has been classified in National vegetation maps as Gamka-*Portulacaria*-Thicket. Dense stands of spekboom (*Portulacaria afra*) occur, often with *Euclea undulata*, *Gloveria integrifolia*, *Pappea capensis* and *Rhus glauca*.

Figure B.8: *Portulacaria* dominated slopes.

Figure B.9: The valley bottoms are a mixture of vegetation types.

Figure B.10: It is uncertain if these slopes have been rehabilitated with Spekboom truncheons or represent a natural recovery succession after years of overgrazing from goat farming.

<u>Conclusion</u>

The national vegetation maps depiction of the extent and occurrence of the Thicket Biome for this region are supported by the direct observations made in this field trip.