CRUZ ENVIRONMENTAL

Report No. 12

Vegetation and Wetland Delineation of Priority Habitats in Transnet Capital Projects Richards Bay Port Expansion Project

A report prepared for AECOM SA (Pty) Ltd, Westville, Durban

by

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EXCECUTIVE SUMMARY

Karos Environmental Services CC was sub-contracted by CRUZ Environmental to conduct a vegetation assessment and wetland delineation of the remaining natural ecosystems of the Rail Balloon/Casuarinas area (Figure 1.1)(Site A) and the 600 Series area (Figure 1.2)(Site B) as stipulated by Transnet Capital Projects (TCP), Richards Bay, KwaZulu-Natal.

The following plant communities were identified, described and mapped within the Rail Balloon/Casuarinas area (Site A):
A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests

A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands

A4 *Juncus krausii–Phragmites australis brackish* wetlands

A5 Salt pans

A6 *Imperata cylindrica* seasonal wetlands

A7 Wetlands covered with invasive alien species

A8 Secondary woodlands and shrublands

A9 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands

A10 Seashore vegetation

The following plant communities were identified, described and mapped within the 600 Series area (Site B):
B1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests

B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

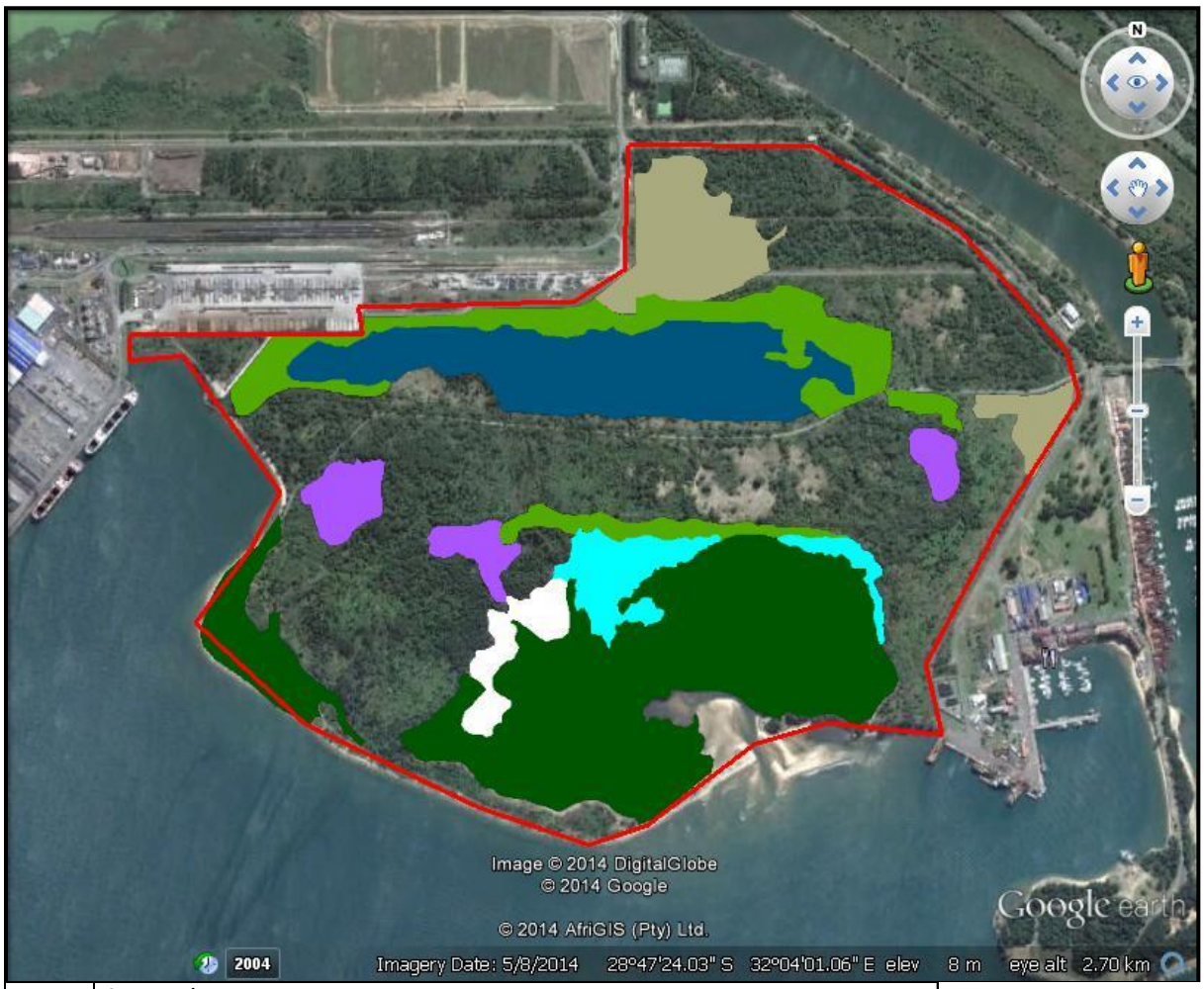
B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands

B4 *Imperata cylindrica* seasonal wetlands

B5 Secondary woodlands and shrublands

B6 Secondary grasslands

The following plant communities and ecosystems are regarded as areas of high conservation value and sensitive to the proposed development:



	Legend
	Study area: Site A
	A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	A4 *Juncus krausii–Phragmites australis brackish* wetlands
	A5 Salt pans
	A6 *Imperata cylindrica* seasonal wetlands
	A7 Wetlands covered with invasive alien species

Figure 8.4 Wetland communities of Site A TCP Richards Bay Port Expansion Project.

	Legend
	Study area: Site B
	B1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	B4 *Imperata cylindrica* seasonal wetlands

Figure 8.5 Wetland communities of Site B TCP Richards Bay Port Expansion Project.

The following plant species of high conservation value were either recorded within the study area or suitable habitats were identified for their existence:

Table 6.2 Assessment of Red Data plants potentially occurring on site

Species	Family	Threat Status	Occurrence Potential	Reason
Adenia gummifera var. gummifera	PASSIFLORACEAE	Declining	High	Species recorded on site
Didymoplexis verrucosa	ORCHIDACEAE	VU	Medium to Low	Limited suitable habitat recorded on site
Dioscorea sylvatica	DIOSCOREACEAE	VU	High	Species recorded on site
Eulophia speciosa	ORCHIDACEAE	Declining	Medium to High	Falls within geographic distribution and suitable, though degraded habitat
Kniphofia leucocephala	ASPHODELACEAE	CR	High	Suitable habitat recorded on site
Kniphofia littoralis	ASPHODELACEAE	NT	High	Suitable habitat recorded on site

Table 6.3 Protected trees recorded on site that require a licence before removal

Species	Common name	Family
Ficus trichopoda	Swamp fig	MORACEAE
Barrintonia racemosa	Powder-puff tree	LECYTHIDACEAE
Bruguiera gymnorrhiza	Black mangrove	RHIZOPHERACEAE
Mimusops caffra	Coastal red milkwood	SAPOTACEAE
Rhizophora mucronata	Red mangrove	RHIZOPHERACEAE
Sideroxylon inerme subsp. *inerme*	White milkwood	SAPOTACEAE

The proposed developments within Site A (Rail Balloon) and Site B (600 Series) of the study area will have far reaching effects on its vegetation and wetland ecosystems. The flat landscape, extremely shallow water table, large bodies of surface water and porous substrates result in very high levels of hydrological interconnectedness between ecosystems. Interference with water drainage, including tidal interchange, will have adverse effects on established and maintenance of mangroves and other wetland ecosystems.

In an attempt to retain the remaining ecosystem processes and to ensure the continuation of current biodiversity patterns, every effort should be made to conserve the remaining wetlands within the study area. This includes managing local and regional catchments. Historical water flow patterns should be reinstated as part of a rehabilitation programme for the wetlands of the study area.

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DECLARATION OF INDEPENDENCE

- I, Theo Mostert, hereby declare that I acted as the independent specialist in this application.
- I do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of NEMA and the Environmental Impact Assessment Regulations, 2010.
- I have and will not have a vested interest in the proposed activity proceeding.

Signed: …… …….. Date: 30 December 2014

ABBREVIATIONS AND ACRONYMS

CARA	Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983)
DWS	Department of Water and Sanitation (formerly known as the Department of Water Affairs and the Department of Water Affairs and Forestry)
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
EMPr	Environmental Management Programme
ESMP	Environmental Services Management Plan
IUCN	International Union for Conservation of Nature
KZN	KwaZulu-Natal
MINSET	Minimum Set Analysis (Ezemvelo KZN Wildlife)
NEMA	National Environmental Management Act, 1998 (Act 107 of 1998)
NEMBA	National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004)
NWA	National Water Act, 1998 (Act 36 of 1998)
PRECIS	Pretoria (PRE) Computerised Information System
SABCA	South African Butterfly Conservation Assessment
SAFAP	South African Frog Atlas Project
SANBI	South African National Biodiversity Institute
SARCA	South African Reptile Conservation Assessment
SDP	Spatial Development Plan
TCP	Transnet Capital Projects

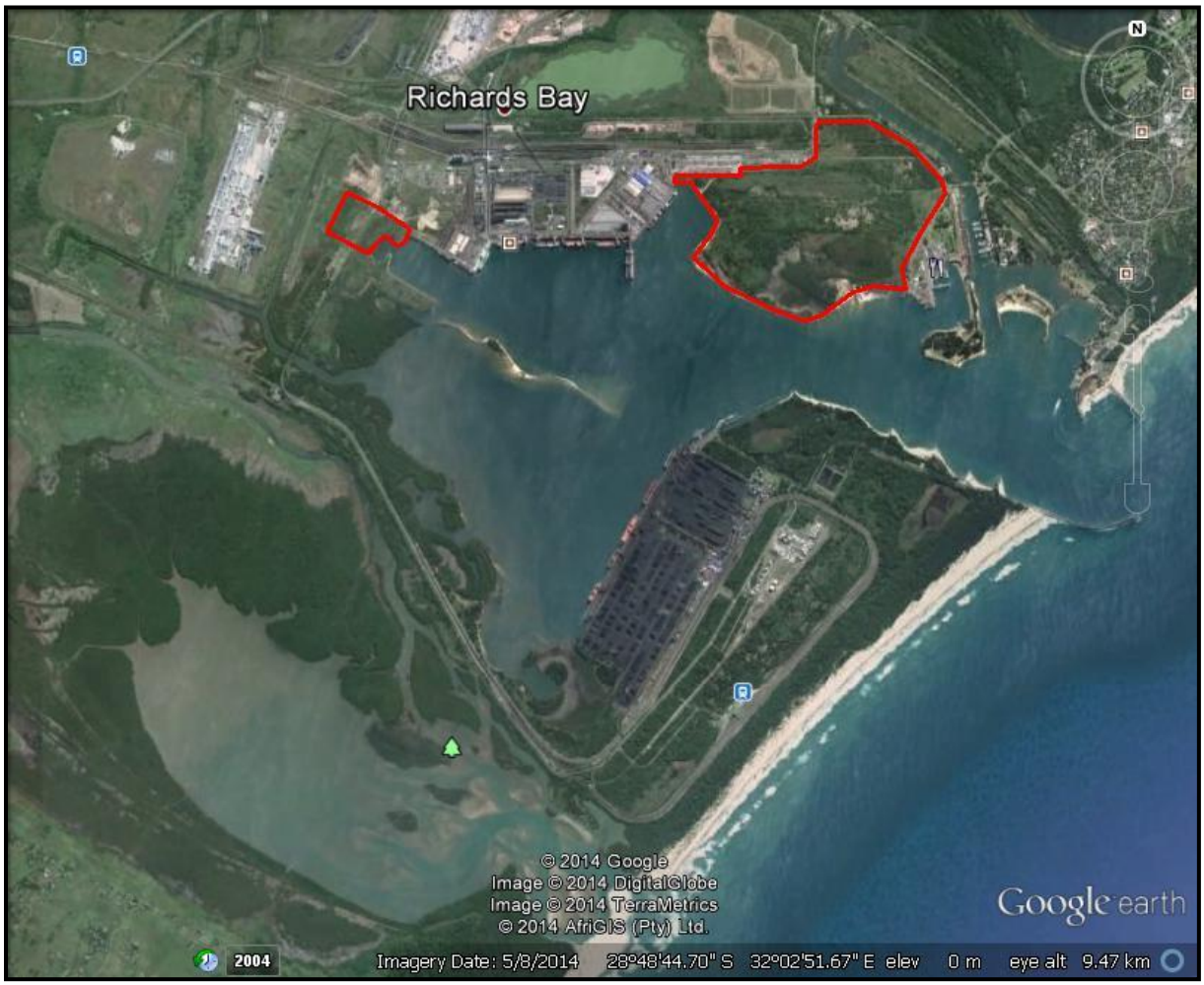
1. INTRODUCTION

1.1 BACKGROUND TO THE STUDY

The ever increasing human demand on natural resources and space are resulting in the degradation and fragmentation of habitat for millions of species. South Africa is no exception, having suffered large scale losses of ecologically functional and pristine ecosystems due to poor regional planning or the implementation of such regional frameworks. When open space systems are rezoned for development, indigenous fauna and flora are replaced by exotic species and converted to sterile landscapes with no dynamic propensity or ecological value (Turner et al., 2001). Additionally, residential and estate development have rarely focussed on decisive planning to conserve natural environments. Little thought was given to the consequences of such development to the ecological processes of highly sensitive systems. Careful regional and local planning of development can help steer human progress in a direction least harmful to the environment, while retaining maximum free ecosystem services such as water purification by natural wetlands. Such planning and conservation of natural ecosystems is not only in the interest of nature conservation but also in the interest of optimum utilisation of renewable resources and free ecosystem services to humans. Sensible planning and the execution of these plans will lead to the effective conservation of fossil fuels, water and soils with high agricultural potential. The conservation of biodiversity and ecosystem patterns and processes is imperative to the well-being of mankind.

In addition to maintaining some ecosystem services for our own well-being, we also have an ethical responsibility to the conservation of ecosystems and their intricate living communities. In 1992, the Convention of Biological Diversity, a landmark convention, was signed by more than 90% of all members of the United Nations. The enactment of the National Environmental Management Biodiversity Act, 2004 (Act No. 10 of 2004), together with the abovementioned treaty, focuses on the preservation of all biological diversity in its totality, including genetic variability, natural populations, communities, ecosystems up to the scale of landscapes. Hence, the local and global focus changed to the sustainable utilisation of biological diversity.

Karos Environmental Services CC was sub-commissioned by CRUZ Environmental to conduct a vegetation assessment and wetland delineation of the remaining natural ecosystems of the Rail Balloon/Casuarinas area (Figure 1.1) and the 600 Series area (Figure 1.2) as stipulated by Transnet Capital Projects (TCP), Richards Bay, KwaZulu-Natal. Collectively the two sites will be referred to as the study area, while respectively they will be referred to as Site A (eastern site) and Site B (western site) throughout this document.



	Legend
	Study area: Site A (eastern terrain)
	Study area: Site B (western terrain)

Figure 1.1 Site A (eastern terrain) and Site B (western terrain) in relation to Richards Bay Harbour

	Legend
	Study area: Site A

Figure 1.2 The Rail Balloon/Casuarinas area (Site A) as stipulated by TCP Richards Bay Port Expansion Project.

	Legend
	Study area: Site B

Figure 1.3 The 600 Series area (Site B) as stipulated by TCP Richards Bay Port Expansion Project.

1.2 TERMS OF REFERENCE

This study forms part of a larger investigation into the proposed expansion of the Port of Richards Bay, initiated by Transnet Capital Projects. The brief of the present study was to:

1. Map and describe all major plant communities within the proposed development area.
2. Delineate all major wetlands.
3. Comment on the ecological status, integrity and disturbances of the different plant communities as an approximation of the status of their underlying ecosystems.
4. Comment on the net effect of the proposed development on the vegetation and wetlands of the study area.

1.3 AIM

The study is aimed at providing, through a once off sampling in spring 2014, an assessment of the ecological importance and status of terrestrial and wetland vegetation in view of the proposed expansion of the Port of Richards Bay.

2. STUDY AREA

2.1 INTRODUCTION

Richards Bay Harbour and the adjacent Sanctuary was originally a large, shallow, estuarine embayment estimated to be some 3000 ha in size (Begg 1978). Extensive reed and papyrus swamps as well as freshwater swamp forests surrounded the original estuary played an important role in filtering water that eventually reached the estuary (Viviers & Cyrus 2009). Sadly, very few habitats within the Richards Bay Harbour have remained unaffected by the relentless development activities over the last half century. Many of the free ecosystem services and ecological functioning provided by the natural ecosystems in and around the harbour's swamps and estuary have been lost. The destruction of these wetland habitats and the canalization of the Mhlathuze River, as well as a number of other perennial streams, resulted in an increase in sediment deposits in the upper reaches of the estuary causing substantial extension of the delta. Furthermore, the water filtering and purification functions of these wetlands were severely impaired due to infilling and drainage practices for sugar cane cultivation (Viviers & Cyrus 2009).

Mangroves are considered to be among the rarest and most threatened of forest types in South Africa (Von Maltitz *et al.* 2003). These forests occur in 38 estuaries in South Africa (Ward and Steinke, 1982). The loss of mangrove habitats was highlighted by Breen and Hill, (1969), Moll *et al.* (1971); Bruton, (1980) and Begg, (1978, 1984). Currently 74% of the total South African mangrove area occurs in this province. In KZN the threats to mangroves have been documented by many authors even prior to 1990 (Breen and Hill, 1969; Moll *et al.* 1971; Begg, 1984; Bruton, 1980). Moll *et al.* (1971) classified the mangrove forests at Richards Bay, Mlalazi, Durban Bay, Sipingo and Beachwood (Mgeni) as threatened.

The importance of mangroves has been described by numerous authors (Begg 1978, 1984, Ward and Steinke 1982, Von Maltitz *et al.* 2003, Mucina & Rutherford 2006). The products and services provided by a hectare of mangrove forest is valued at 200 000 – 900 000 USD (FAO 2003, Gilman *et al.* 2008). Other direct benefits for humans are the numerous medicinal uses of mangrove products (Kathiresan & Bingham, 2001). Indirect benefits include ecological services, screening the solar UV-B radiation, reducing the green house effects, minimizing the impact of cyclones, trapping the sediments, trapping and recycling of nutrients, supporting fish and wildlife populations, and biomass and litter production (Kathiresan & Bingham, 2001).

Blasco *et al.* (1996) noted a radical response by *Bruguiera* and *Rhizophora* to hydrological, salinity, soil and tidal regime changes. Richards Bay Harbour and its surrounding landscapes have been subjected to radical hydrological, salinity, soil and tidal regime changes in the last half century.

2.2 REGIONAL VEGETATION

Terrestrial ecosystem diversity on a regional scale is driven by geology, climate and topography (Barbour et al 1980, Strahler & Strahler 1987), while on a local scale the drivers are altitude, slope, aspect, soil conditions and consumers, whether human or animal (Mucina & Rutherford 2006, De Frey 1999). The vegetation reflects this variation in the landscape with change in species composition and dominance. These changes could be abrupt or gradual depending on the nature of the vegetation or the environmental factors involved (Mucina & Rutherford 2006). This variation in vegetation (plant communities) represents habitat (ecosystems) to a variety of animals at variable spatial and temporal scales (Bothma 1995, Turner et al 2001).

Biodiversity loss is a global issue linked to habitat loss and fragmentation with subsequent loss in species (Lindenmayer & Fischer 2006, Van Andel & Aronson 2006). Transformation (habitat destruction) and the spread of alien invasive species are considered key contributors to biodiversity loss.

Richards Bay Harbour and its surroundings form part of the Maputaland-Pondoland-Albany Centre of Biodiversity, as well as the Maputaland Centre of Plant Endemism (Van Wyk & Smith 2001). It is regarded as Africa's second richest floristic region and contains 80% of South Africa's remaining forests (Van Wyk & Smith 2001).

The immediate surroundings of the study area is a mosaic of regional vegetation types, containing Maputaland Coastal Belt, Northern Coastal Forest, Subtropical Seashore Vegetation, Subtropical Dune Thicket, Subtropical Freshwater Wetlands, Swamp Forest, Subtropical Estuarine Salt marshes and Mangrove Forests, which all form part of the Indian Ocean Coastal Belt Biome (Mucina and Rutherford 2006). The conservation status and value of these vegetation types are summarised as follows:

- CB 1 Maputaland Coastal Belt: Vulnerable to extinction, with only 15% statutorily conserved. Agriculture is one of the main drivers of transformation of this vegetation type
- ZOz 7 Northern Coastal Forest: Under threat on coastal dunes of KZN due to mining
- AZd 4 Subtropical Seashore Vegetation: Least threatened
- AZf 6 Subtropical Freshwater Wetlands: Least threatened (but vital for the health of the nearby mangroves)
- AZs 3 Subtropical Dune Thicket: Least threatened
- FOa 3 Mangrove Forests: Critically endangered
- FOa 2 Swamp Forest: Critically Endangered
- AZe 3 Subtropical Estuarine Salt marshes: Least threatened

Some of these vegetation types were recorded on the study site and will be discussed in detail under the results section.

The National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004) (NEMBA) provides a listing of ecosystems that are threatened and in need of protection. It is required

that impacts should be avoided, minimised, mitigated and/or offset as appropriate (Government Gazette, 9 December 2011).

The National Forests Act, 1998 (Act 84 of 1998), Section 3 states that "… natural forests may not be destroyed save in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social or environmental benefits". This prescribes that no development affecting forests may be allowed unless "exceptional circumstances" can be proven. Section 7 prohibits the cutting, disturbance, destruction or removal of any indigenous living or dead tree in a forest without a licence.

3. METHODS

Schamineé et al. (1995) emphasized the importance of standardized sampling and data analysis for comparative reasons. According to Werger (1974), the following are important requirements to be fulfilled by any ecological classification method concerning total floristic composition:

- The method should be scientifically sound.
- It should fulfil the necessity of classification at an appropriate level or scale.
- It should be efficient and versatile amongst comparable approaches.

For these reasons, it was decided to use the Braun-Blanquet method (Braun-Blanquet 1932; Werger 1973; Mueller-Dombois & Ellenberg 1974; Westhoff and Van Der Maarel 1978) in order to classify and describe the vegetation of the study area.

3.1 PHASE 1 – DESKTOP & LITERATURE REVIEW

During this phase, the specialists involved updated their existing knowledge of the area, using available scientific and popular literature, available datasets from government and academic institutions, the Internet and their extensive network, to ensure that they are aware, which are the current species of concern in terms of international, national and provincial legislation. This information was then used to create a profile of the species of concern with regards to their habitat preference and known areas of distribution. Once the profiles had been generated, this information was used to populate the landscape model derived from small scale datasets with a maximum scale resolution of 1: 50 000 and a pixel or grain resolution of 100 m. Using this information a sensitivity map was created for all plant

species and vegetation types of conservation concern. The following small-scale data sets were used:

1. Geology – 1: 250 000 scale, Council for Geoscience
2. Landforms – 1: 250 000 scale, SANBI, BGIS
3. Land types (soil properties) – 1: 250 000 scale, Institute for Soil, Climate & Water
4. Regional vegetation – 1: 250 000 scale, VEGMAP – SANBI
5. Wetlands – 1: 250 000, National Wetland Inventory – SANBI, BGIS
6. Land Cover – 1: 50 000 scale: 1995, 2000, 2009 – CSIR, DEA, SANBI
7. Topocadastral – 1: 50 000 scale, Surveyor – General
8. EKZNW SEA GIS Datasets (MinSet)

The vegetation of the study area was stratified into homogeneous physiographic–physiognomic units, using aerial photographs (scale 1: 10 000), as well as maps on the topography, geology, soils and Land Types of the study area. Sample plots were placed within each of these stratified units in such a way that habitat was as uniform as possible within each vegetation stand.

3.2 PHASE 2 – FIELDWORK AND DATA COLLECTION

Due to the nature and scale of this study, all emphasis was kept on plants, plant communities and ecosystems, with special emphasis on wetland ecosystems. Data were therefore gathered at landscape and ecosystem scale in order to aid in the description and identification of plant communities and ecosystems of concern. Site A was visited on 25 September, 27 September and 4 October, while Site B was visited on 30 September 2014.

The vegetation structure at each plot was described according to the structural classification system of Edwards (1983). All relevés are stored in the TURBOVEG database (Hennekens 1996) and managed by the Department of Botany, University of Zululand. The taxon names of identified species conform to those of Germishuizen & Meyer (2003) as well as updates from SANBI. Environmental data include soil type, aspect, slope, surface rock cover and disturbance to the soil and vegetation.

The cover-abundance for every species present in a sample plot was assessed according to the Braun-Blanquet cover-abundance scale (Werger 1974, Mueller-Dombois & Ellenberg 1974):

- r Very rare and with a negligible cover (usually a single individual)
- + Present but not abundant, with a small cover value (<1% of the quadrat).
- Numerous but covering less than 1% of the quadrat, or not so abundant but covering 1–5% of the quadrat.
- 2a Covering between 5–12% of the quadrat, independent of abundance
- 2b Covering between 13–25% of the quadrat, independent of abundance
- Covering 25–50% of the quadrat area, independent of abundance
- Covering 50–75% of the quadrat area, independent of abundance
- Covering 75–100 % of the quadrat area, independent of abundance

Due to the small sample size of releves per phytososiological unit obtained in this study, no formal numeric classifications or ordinations were attempted. Instead, all the releves of a given map unit were converted to a synreleve. These synreleves were then used to aid with the floristic descriptions of each plant community. The resulting vegetation units were mapped and described based on their floristic composition, structural composition, ecological functionality and integrity.

A list of red data plant species for the study area and its surroundings was obtained from the South African Biodiversity Institute (SANBI). This list, as well as other listed plants protected and regulated under various provincial ordinances, was used to create a priority species list for the study area.

As stated earlier in this document, the study area is divided into two areas, namely the Rail Balloon/Casuarinas area (Figure 1.2) and the 600 Series area (Figure 1.3) as stipulated by TCP Richards Bay Port Expansion Project. These two areas will be referred to as Site A and Site B respectively throughout this document. For clarity and ease of interpretation by the reader, the plant communities of each site will be discussed separately, even when some communities may occur on both Site A and Site B.

4. PLANT COMMUNITIES OF SITE A: THE RAIL BALLOON/CASUARINAS AREA

The following plant communities were identified, described and mapped within the Rail Balloon/Casuarinas area (Site A):

A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests

A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands

A4 *Juncus krausii–Phragmites australis brackish* wetlands

A5 Salt pans

A6 *Imperata cylindrica* seasonal wetlands

A7 Wetlands covered with invasive alien species

A8 Secondary woodlands and shrublands

A9 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands

A10 Seashore vegetation

	Legend
	Study area: Site A

Figure 4.1 Delineated homogeneous vegetation units as the basis for the plant communities of Site A

	Legend
	Study area
	A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	A4 *Juncus krausii–Phragmites australis brackish* wetlands
	A5 Salt pans
	A6 *Imperata cylindrica* seasonal wetlands
	A7 Wetlands covered with invasive alien species
	A8 Secondary woodlands and shrublands
	A9 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands
	A10 Seashore vegetation

Figure 4.2 Plant communities of Site A TCP Richards Bay Port Expansion Project.

4.1 Plant community A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests

Plant community A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests cover large sections towards the south of Site A. Vegetation structure can be described as tall closed forests with an average tree canopy cover of >80%, ranging from 20% to 95%. Tree height range from 4 m to 14 m depending on habitat suitability for the species involved. No herbaceous layer was recorded within the middle of most mangrove stands, with some herbaceous cover along ecotones with other ecosystems.

Species composition within this plant community is mostly dominated by large dense stands of the mangrove tree species *Avicennia marina*, with smaller stands of *Bruguiera gymnorrhiza* trees along the contact zones of fresh-water and salt-water bodies. Only a few individuals of *Rhizophora mucronata* mangrove trees were recorded along the southern edge of Site A, where surface and subsurface water drain into the harbour. Very few seedlings of the three mangrove tree species were recorded. Other species associated with the fringes of the mangroves include the woody species *Hibiscus tiliaceus* and fern species *Achrostichum aureum*.

Disturbances recorded within this plant community included illegal cutting of *Avicennia marina* and *Bruguiera gymnorrhiza* trees, artificial changes to the natural hydrology of the mangroves and surrounding landscape, siltation, illegal gill net fishing operations, oil pollution and plastic pollution. Very few invasive alien species were noted within this plant community, probably due to the specialised nature of these ecosystems. A number of recently used hippopotamus paths were recorded throughout the area.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type FOa 3 Mangrove Forests classified as Critically Endangered. Although the *Avicennia marina–Bruguiera gymnorrhiza* mangrove forest plant community is relatively species poor with low species diversity levels, it is a highly specialised ecosystem with extremely high functionality value within the surrounding landscape. The low species diversity and richness recorded within the study area is normal for mangrove forests.

The following species were recorded within the *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests:

Woody species

Avicennia marina (Forssk.) Vierh.

Bruguiera gymnorrhiza (L.) Lam.

Hibiscus tiliaceus L.

Rhizophora mucronata Lam.

Herbaceous species

Achrostichum aureum

The following series of photographs were taken as representative elements of the *Avicennia marina–Bruguiera gymnorrhiza* mangrove forest plant community:

A Intertidal mud flats with *Avicennia marina*

B Illegal cutting

C

Channels within mangrove forest

D

Pencil root structure of *Avicennia marina*

E Intertidal sand and mud flats

F *Bruguiera gymnorrhiza* fruit

G *Avicennia marina* stands

H Hippopotamus path within mangrove forest

Photo plate 1 Plant community A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests

4.2 Plant community A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

Plant community A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests currently occur along the fringes of freshwater reed dominated wetlands of Site A. Historically these swamp forests occurred wider spread throughout the study area, with larger unfragmented stands along the eastern sections of Site A. Vegetation structure can be described as medium tall closed forests with an average canopy cover of >80%, ranging from 75% to 100%. Tree height range from 6 m to 8 m depending on habitat suitability for the species involved. Tree canopy cover is very high (90%). A well-developed shrub layer was recorded, with a dense herbaceous layer in most places. The grass layer is relatively sparse due to low light conditions at the forest floor. At the time of the surveys (late dry season), very little free surface water was recorded within the swamp forests.

Plant species dominating the floristic composition of this plant community include the tree species *Ficus trichopoda*, *Syzygium cordatum*, *Bridelia micrantha*, *Hibiscus tiliaceus,* the shrub species *Searsia nebulosa*, *Schinus terebinthifolius*, and the herbaceous species *Chromolaena odorata*, *Cyclosorus interruptus*, *Microsorum scolopendrium*, *Senecio rhomboideus*, *Blechnum attenuatum* and *Stenochlaena tenuifolia*.

Disturbances recorded within this plant community included illegal planting of subsistence crops such as *Colocasia esculenta*, illegal cutting of trees, invasive alien plant species such as *Psidium guajava, Schinus terebinthifolius, Washingtonia robusta, Chromolaena odorata, Casuarina equisetifolia,* historical plantations and stands of *Casuarina equisetifolia*, artificial changes in the drainage of the landscape. Many of the original stands of *Casuarina equisetifolia* have been removed over time, but due to the lack of rehabilitation some of these areas have now become heavily invaded by alien plant species.

Ecosystem functionality is still relatively high. The conservation value of this plant community is therefore regarded as very high. It is highly recommended that this plant community be cleared of all invasive alien species and protected against the disturbances listed above. Special efforts should be made to restore original drainage patterns and to allow stagnant swamp areas to form and persist on site.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type FOa 2 Swamp Forest classified as Critically Endangered.

The following species were recorded within the *Ficus trichopoda–Syzygium cordatum* Swamp forests (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Allophylus natalensis (Sond.) De Winter
Apodytes dimidiata E.Mey. ex Arn.
Barringtonia racemosa
Bridelia micrantha (Hochst.) Baill.
Casuarina equisetifolia L.
Eucalyptus species
Ficus natalensis Hochst.
Ficus sur Forssk.
Ficus trichopoda Baker
Hibiscus tiliaceus L.
Mimusops caffra E.Mey. ex A.DC.
Psidium guajava L.
Searsia nebulosa Schönland
Rubus rigidus Sm.
Schinus terebinthifolius Raddi var. *terebinthifolius*
Smilax anceps Willd.
Strelitzia nicolai Regel & Körn.
Syzygium cordatum Hochst.
Washingtonia robusta H.Wendl.
Sideroxylon inerme L.

Herbaceous species
Acrostichum aureum L.
Blechnum attenuatum (Sw.) Mett.
Chromolaena odorata (L.) R.M.King & H.Rob.
Colocasia esculenta (L.) Schott
Cyclosorus interruptus (Willd.) H.Itô
Ipomoea cairica (L.) Sweet
Microsorum scolopendrium (Burm.f.) Copel.
Mikania natalensis DC.
Senecio rhomboideus Harv.
Stenochlaena tenuifolia (Desv.) T.Moore

Grass species
Setaria megaphylla
Oplusmenis hirtilus

The following series of photographs were taken as representative elements of the *Ficus trichopoda–Syzygium cordatum* Swamp forest plant community:

A *Ficus trichopoda* dominated swamp forest

B Swamp forest rich in *Ficus* spp

C Impenetrable sections along the fringes

D Sections dominated by *Bridelia micrantha*

E

Dense stands of *Hibiscus tiliaceus*

F

Ficus sur as a prominent component

Photo plate 2 Plant community A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

4.3 Plant community A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands

Plant community A3 *Phragmites australis–Cyperus papyrus* freshwater wetland is restricted to the northern half of Site A. It occupies a relatively large percentage of the surface area of the entire site. Vegetation structure can be described as a tall closed reed dominated wetland. No woody species were recorded as part of this plant community, with tall (0.75 to 3 m) reed and sedge species providing the main structure of this community. At the time of the field surveys the soils of this plant community were either inundated with water or waterlogged. Organic content of these sandy soils are very high, with peat formation in large sections.

The community is dominated by emergent species such as *Phragmites australis* and *Cyperus papyrus*, with dense stands of the wetland fern species *Cyclosorus interruptus* along the better drained fringes of the wetland. Like most wetlands, this community is relatively species poor. Although *Cyperus papyrus* as a species is not concidered as being rare or endangered, the ecological function this species performs within wetland ecosystems place *Cyperus papyrus* dominated plant communities in a very high conservation priority category. More detail on the conservation importance of wetland plant communities are provided within “Section 8 Wetlands” of this report.

Disturbances recorded include invasion by the alien species *Schinus terebinthifolius* along the fringes of the wetland. It is recommended that this species be removed from the study area, and that subsequent resprouting and reinfestation be controlled. The surrounding roads and railways have altered the natural drainage into this wetland slightly. It is recommended that drainage culverts be installed and maintained to ensure the free influx of surface and subsurface water into the wetland.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type AZf 6 Subtropical Freshwater Wetlands, with is protected under the National Water Act.

The following species were recorded within the *Phragmites australis–Cyperus papyrus* freshwater wetland (Exotic species highlighted in yellow):

Reed species
Phragmites australis (Cav.) Steud.

Sedge species
Cyperus papyrus L.
Rhynchospora corymbosa (L.) Britton
Bulbostylis species
Carex zuluensis C.B.Clarke
Cyperus esculentus L.
Cyperus papyrus L.
Cyperus prolifer Lam.
Cyperus rotundus L.
Eleocharis limosa (Schrad.) Schult.
Ficinia trichodes (Schrad.) Benth. & Hook.f.
Fimbristylis complanata (Retz.) Link
Pycreus macranthus (Boeck.) C.B.Clarke
Pycreus polystachyos (Rottb.) P.Beauv.
Schoenoplectus senegalensis (Hochst. ex Steud.) Palla ex J.R

Herbaceous species
Berkheya setifera DC.
Canna indica L.
Centella asiatica (L.) Urb.
Cheilanthes viridis (Forssk.) Sw.
Chironia baccifera L.
Dissotis canescens (E.Mey. ex R.A.Graham) Hook.f.
Helichrysum aureonitens Sch.Bip.
Helichrysum kraussii Sch.Bip.
Ludwigia octovalvis (Jacq.) P.H.Raven
Ranunculus multifidus Forssk.

Fern species
Cyclosorus interruptus (Willd.) H.Itô

The following series of photographs were taken as representative elements of the *Phragmites australis–Cyperus papyrus* freshwater wetland plant community:

A *Cyperus* spp dominated edge of wetland

B Fringe of *Phragmites australis* dominated wetland

C *Phragmites australis* stands

D *Cyperus papyrus* dominated edge of wetland

Photo plate 3 Plant community A3 *Phragmites australis–Cyperus papyrus* freshwater wetland

4.4 Plant community A4 *Juncus krausii–Phragmites australis* brackish wetlands

Plant community A4 *Juncus krausii–Phragmites australis* brackish wetlands occur along the northern and eastern edges of the mangrove forests of Site A. This plant community demarcates the main contact zone between tidal salt water and subsurface fresh water moving from the north into the estuary. The fresh water is inherently part of the same water body as that of Plant community A3 *Phragmites australis–Cyperus papyrus* freshwater wetland located towards the north. Before the extensive earthworks done on Site A as part of harbour construction and sediment dumping, plant community A4 extended further to the north, and was probably better connected to community A3, with water moving more freely from the north into the estuary and mangrove forests.

Vegetation structure can be described as a dense to closed sedge land with a sparse tall reed component. The structure is a direct reflection of the salinity of these wetlands, with *Juncus krausii* dominating in more saline conditions and *Phragmites australis* dominating in less saline conditions. Water drainage and hydrology is therefore of critical importance to the maintenance of this plant community.

Dominant species include the sedge *Juncus krausii* and the reed *Phragmites australis*, with large clumps of the mangrove fern *Acrostichum aureum*. This community is naturally extremely species poor due to the harsh natural conditions created by the high salinity and regular physiological drought stress plants have to deal with.

Disturbances recorded during the site visits include cutting of *Juncus krausii* by local communities for the weaving industry, numerous foot paths to and from fishnets and wood harvesting sites within the mangroves, pollution from littering by people passing through, as well as artificial changes to the natural drainage patterns of the landscape directly to the north. Historically planted stands of *Casuarina equisetifolia* have mostly been cut down, but subsequent germination and resprouting cause persistent problems for the natural drainage of the landscape and its wetlands. The surrounding roads and railways have altered the natural drainage into this wetland slightly. It is recommended that drainage culverts be installed and maintained to insure the free influx of surface and subsurface water into the wetland.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type AZe 3 Subtropical Estuarine Salt Marshes.

The following species were recorded within the *Juncus krausii–Phragmites australis* brackish wetlands (Exotic species highlighted in yellow):

Woody species
Casuarina equisetifolia L.
Bruguiera gymnorrhiza (L.) Lam.

Sedge species
Juncus kraussii Hochst.
Scirpus spp

Reed species
Phragmites australis Kunth

Fern species
Acrostichum aureum L.

Herbaceous species
Phymaspermum acerosum (DC.) Källersjö
Salicornia meyeriana Moss

Grass
Odyssea paucinervis (Nees) Stapf
Stenotaphrum secundatum (H.Walter) Kuntze

The following series of photographs were taken as representative elements of the *Juncus krausii–Phragmites australis* brackish wetland plant community:


A Representative vegetation


B Representative vegetation


C Very dense *Juncus krausii* stands


D *Bruguiera gymnorrhiza* along the ecotone


E Representative vegetation


F Representative vegetation


G Representative vegetation


H *Acrostichum aureum* in background

Photo plate 4 Plant community A4 *Juncus krausii–Phragmites australis* brackish wetland

4.5 Plant community A5 Salt pans

Plant community A5 Salt pan occurs to the west of the mangrove forests, where salt water from spring tides is left behind on evaporation pans. Over time a hyper accumulation of sea salts have left this ecosystem extremely saline. Only a very small number of plants can tolerate such high salinity, especially in times when no free water is left on these evaporation pans. Vegetation structure can therefore be described as a very sparse low succulent herbland. Less than 5% of the salt pans are covered with plants, leaving more than 95% bare and salt crusted. The only prominent plant occupying small patches include the halophytic herb *Sarcocornia natalensis* and the halophytic grass *Odyssea paucinervis*. Along the ecotone numerous species from neighbouring plant communities can be recorded in very low numbers with very stunted growth forms.

Disturbances recorded on the salt pans during the site visits include motor vehicle tracks and illegal cutting of mangrove species along the ecotone. This vegetation unit forms part of the

national vegetation type AZe 3 Subtropical Estuarine Salt marshes classified as Least threatened.

The following species were recorded within the Salt pans and along the ecotones (Exotic species highlighted in yellow):

Woody species
Avicennia marina (Forssk.) Vierh.
Casuarina equisetifolia L.

Forb species
Sarcocornia natalensis Bunge ex Ung. -Sternb
Atriplex patula Aellen

Grass species
Odyssea paucinervis (Nees) Stapf
Stenotaphrum secundatum
Paspalum vaginatum

Reed species
Phragmites australis (Cav.) Steud.

Sedge species
Juncus kraussii Hochst.
Pycreus polystachyos

The following series of photographs were taken as representative elements of the Salt pan community:

A Salt pan

B *Avicennia marina* along the edge of the salt pans

C Vehicle tracks on the salt pans

D The halophytic grass species *Odyssea paucinervis* along the edge of the salt pan

E Salt pan

F *Sarcocornia natalensis*

G.*Sarcocornia natalensis* and *Odyssea paucinervis*

H Halophytic species along the edge of salt pans

Photo plate 5 Plant community A5 Salt pans

4.6 Plant community A6 *Imperata cylindrica* seasonal wetlands

Plant community A6 *Imperata cylindrica* seasonal wetlands occur along the eastern most sections and northern most sections of Site A. These seasonal wetland plant communities are the result of seasonally waterlogged sandy soils. Waterlogged conditions develop due to the very shallow water table reaching the surface during the end of the wet season, when aquifer recharge is at its highest for the year. These temporary waterlogged sand soils create unique ecological conditions for which few plant species are well adapted. Vegetation is therefore dominated by a single grass species, the pyrophytic *Imperata cylindrica*. Vegetation structure can be described as medium tall closed grasslands. Grass cover is >95% and 1 m tall.

The regular hot fires that used to maintain the vegetation structure as a grassland are currently being suppressed by the relevant land managers. This is leading to a steady invasion by fire sensitive shrub species such as *Chrysanthemoides monilifera* and *Helichrysum kraussii*. It is highly recommended that these grasslands be treated with hot burns in order to suppress bush encroachment and thickening. Invasive alien species such as *Schinus terebinthifolius*, *Psidium guajava, Lantana camara, Chromolaena odorata* and *Pinus* species are becoming a serious threat to these seasonal wetlands and should be eradicated and controlled. Other disturbances recorded during the site visits included illegal waste disposal. The surrounding roads and railways have altered the natural drainage into this wetland slightly. It is recommended that drainage culverts be installed and maintained to ensure the free influx of surface and subsurface water into the wetland.

These stands of extremely dense stands of grass create habitat for many rodent and bird species (such as the Vulnerable African Grass-Owl). Based on its classification as a wetland and the relatively high ecosystem integrity and functionality, as well as providing habitat for many animals, the conservation value of this plant community should be regarded as high. This vegetation unit forms part of the national vegetation type AZf 6 Subtropical Freshwater Wetlands, which is protected by the National Water Act.

The following species were recorded within the *Imperata cylindrica* seasonal wetlands (Exotic species highlighted in yellow):

Woody species
Chrysanthemoides monilifera (L.) Norl.

Pinus species
Psidium guajava L.
Searsia nebulosa Schönland
Schinus terebinthifolius Raddi var. terebinthifolius
Syzygium cordatum Hochst.
Brachylaena discolor DC.
Casuarina equisetifolia L.
Eugenia capensis (Eckl. & Zeyh.) Harv. ex Sond.
Lantana camara L.
Phoenix reclinata Jacq.

Herbaceous species
Catharanthus roseus (L.) G.Don
Cyperus species
Helichrysum kraussii Sch.Bip.
Helichrysum ruderale Hilliard & B.L.Burtt
Indigofera species
Rhynchosia nitens Benth.
Senecio madagascariensis Poir.
Wahlenbergia undulata (L.f.) A.DC.
Waltheria indica L.
Carpobrotus dimidiatus (Haw.) L.Bolus
Chromolaena odorata (L.) R.M.King & H.Rob.
Conyza bonariensis (L.) Cronquist
Gomphocarpus physocarpus E.Mey.
Lactuca indica L.
Senecio rhomboideus Harv.
Tacazzea apiculata Oliv.

Grass species
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Digitaria eriantha Steud.
Imperata cylindrica (L.) Raeusch.
Melinis repens (Willd.) Zizka
Cynodon dactylon (L.) Pers.
Stenotaphrum secundatum (H.Walter) Kuntze

The following series of photographs were taken as representative elements of the *Imperata cylindrica* seasonal wetlands community:


A Representative vegetation


B Representative vegetation


C Representative vegetation


D Representative vegetation


E Representative vegetation


F Representative vegetation

Photo plate 6 Plant community A6 *Imperata cylindrica* seasonal wetlands

4.7 Plant community A7 Wetlands covered with invasive alien species

Plant community A7 Wetlands covered with invasive alien species occurs mainly in three localities on Site A: east, central and west. However, at a finer scale, this tendency of invasive alien woody plant species invading drained and drying wetlands occurs throughout the study area along the fringes of remaining wetlands. The main reasons for these

invasions are altered hydrology of wetlands and their surrounding landscapes, as well as fire suppression in the study area. The vegetation structure of these wetlands used to be grasslands, sedgelands and reedbeds. Current vegetation structure can be described as dense to closed low shrublands and woodlands. Dominant species include the invasive alien woody species *Schinus terebinthifolius*, *Lantana camara* and *Casuarina equisetifolia*. The herbaceous layer contains species such as the exotics *Chromolaena odorata, Sesbania sesban, Passiflora subpeltata, Ricinus communis* and *Rivina humilis*.

This vegetation unit forms part of the national vegetation type AZf 6 Subtropical Freshwater Wetlands, which is protected by the National Water Act (No.36 of 1998).

The following species were recorded within the wetlands covered with invasive alien species (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Avicennia marina (Forssk.) Vierh.
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Hibiscus tiliaceus L.
Schinus terebinthifolius Raddi var. *terebinthifolius*
Scutia myrtina (Burm.f.) Kurz
Lantana camara L.

Herbaceous species
Acrostichum aureum L.
Chromolaena odorata (L.) R.M.King & H.Rob.
Microsorum scolopendria (Burm.f.) Copel.
Sesbania sesban
Passiflora subpeltata Ortega
Ricinus communis L.
Rivina humilis L.

Grass species
Stenotaphrum secundatum (H.Walter) Kuntze

The following series of photographs were taken as representative elements of the wetlands covered with invasive alien species:

A Representative vegetation

B Representative vegetation

Photo plate 7 Plant community A7 Wetlands covered with invasive alien species

4.8 Plant community A8 Secondary woodlands and shrublands

The Secondary woodlands and shrublands plant community is a mosaic of woodland and shrubland sub-communities which have a secondary origin. The primary vegetation in these areas was removed or severely disturbed in the recent past. Secondary succession followed, resulting in early seral stages of pioneer vegetation. They include Sub-community A8.1 *Acacia kosiensis* secondary woodlands, Sub-community A8.2 Mixed *Cassuarina equisetifolia* secondary woodlands and Sub-community A8.3 *Lantana camara–Schinus terebinthifolius* secondary shrublands. The locality and distribution of the various sub-communities are wide spread wherever severe vegetation disturbances occurred. Due to the mosaic distribution and mixture of these plant sub-communities, no effort was made to map them individually, but instead they were mapped as one vegetation unit.

This vegetation unit forms part of the national vegetation type AZs 3 Subtropical Dune Thicket classified as Least threatened.

4.8.1 Sub-community A8.1 *Acacia kosiensis* secondary woodlands

Sub-community A8.1 *Acacia kosiensis* secondary woodlands are dense tall woodlands dominated by *Acacia kosiensis*. The understory of woody species range from dense impenetrable thickets of young saplings and shrubs of *Acacia kosiensis*, to sparse and open secondary grasslands. The grass layer is dominated by *Stenotaphrum secundatum*, while wetter patches are dominated by *Imperata cylindrica*. The herbaceous layer is dominated by

numerous pioneer species and invasive alien species such as *Desmodium incanum*, *Helichrysum rugulosum*, *Ricinus communis* and *Rivina humilis*.

The following species were recorded within the *Acacia kosiensis* secondary woodlands (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Apodytes dimidiata E.Mey. ex Arn.
Brachylaena discolor DC.
Bridelia micrantha (Hochst.) Baill.
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Clerodendrum glabrum E.Mey.
Ficus natalensis Hochst.
Hibiscus tiliaceus L.
Lantana camara L.
Psidium guajava L.
Rhoicissus digitata (L.f.) Gilg & M.Brandt
Searsia nebulosa Schönland
Schinus terebinthifolius Raddi var. *terebinthifolius*
Tecoma stans Juss.
Trema orientalis (L.) Blume
Gymnosporia senegalensis (Lam.) Loes.
Jasminum multipartitum Hochst.
Scutia myrtina (Burm.f.) Kurz
Strelitzia nicolai Regel & Körn.
Vepris lanceolata (Lam.) G.Don

Herbaceous species
Abrus precatorius L.
Asclepias species
Desmodium incanum DC.
Helichrysum rugulosum Less.
Microsorum scolopendrium (Burm.f.) Copel.
Passiflora subpeltata Ortega
Ricinus communis L.
Rivina humilis L.
Senecio rhomboideus Harv.
Sesbania sesban (L.) Merr.
Asparagus multiflorus Baker

Catharanthus roseus (L.) G.Don
Cheilanthes viridis (Forssk.) Sw.
Chromolaena odorata (L.) R.M.King & H.Rob.
Gomphocarpus physocarpus E.Mey.
Indigofera zeyheri Spreng. ex Eckl. & Zeyh.
Sarcostemma viminale (L.) R.Br.
Secamone filiformis (L.f.) J.H.Ross

Grass species
Imperata cylindrica (L.) Raeusch.
Phragmites australis (Cav.) Steud.
Stenotaphrum secundatum (H.Walter) Kuntze
Cynodon dactylon (L.) Pers.
Digitaria eriantha Steud.
Eragrostis curvula (Schrad.) Nees
Panicum maximum Jacq.

4.8.2 Sub-community A8.2 Mixed *Cassuarina equisetifolia* secondary woodlands

Sub-community A8.2 Mixed *Cassuarina equisetifolia* secondary woodlands occur wherever old stands of *Cassuarina equisetifolia* have been removed, but no follow-up eradication measures were taken. These woodlands are a mixture of pioneer woody species in combination with relatively young *Cassuarina equisetifolia* trees and saplings. Depending on the age of these secondary woodlands, vegetation structure may range from species poor short dense shrublands to species rich tall sparse woodlands. Invariably they are dominated by *Cassuarina equisetifolia*, often with other invasive alien species as co-dominant species, such as *Schinus terebinthifolius*, *Lantana camara* and *Casuarina equisetifolia*. The herbaceous are dominated by exotic species such as *Chromolaena odorata, Sesbania sesban, Passiflora subpeltata, Ricinus communis* and *Rivina humilis*. The grass layer is often very sparse due to needle-fall from the *Casuarina equisetifolia* trees covering the ground.

The following species were recorded within the Mixed *Cassuarina equisetifolia* secondary woodlands (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Brachylaena discolor DC.
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.

Ficus natalensis Hochst.
Gymnosporia senegalensis (Lam.) Loes.
Lantana camara L.
Psidium guajava L.
Rhoicissus digitata (L.f.) Gilg & M.Brandt
Searsia nebulosa Schönland
Schinus terebinthifolius Raddi var. *terebinthifolius*
Scutia myrtina (Burm.f.) Kurz

Herbaceous species
Desmodium incanum DC.
Helichrysum rugulosum Less.
Microsorum scolopendrium (Burm.f.) Copel.
Passiflora subpeltata Ortega
Ricinus communis L.
Rivina humilis L.
Senecio rhomboideus Harv.
Sesbania sesban (L.) Merr.
Catharanthus roseus (L.) G.Don
Chromolaena odorata (L.) R.M.King & H.Rob.
Secamone filiformis (L.f.) J.H.Ross

Grass species
Stenotaphrum secundatum (H.Walter) Kuntze
Cynodon dactylon (L.) Pers.
Eragrostis curvula (Schrad.) Nees
Panicum maximum Jacq.

4.8.3 Sub-community A8.3 *Lantana camara–Schinus terebinthifolius* secondary thickets

Sub-community A8.3 *Lantana camara–Schinus terebinthifolius* secondary thickets occur in the more mesic areas of Site A. These areas are all within the early seral stages of secondary succession after major recent disturbances to the vegetation and / or the underlying soils. The vegetation structure can be described as low closed thickets, ranging between 2 and 4 m in height. The herbaceous and grass layers are generally poorly developed due to low light conditions within the understory. Dominant woody species include *Lantana camara, Schinus terebinthifolius, Psidium guajava, Chrysanthemoides monilifera* and *Trema orientalis*. The herbaceous are dominated by exotic species such as *Chromolaena odorata* and *Rivina humilis*.

The following species were recorded within the *Lantana camara–Schinus terebinthifolius* secondary thickets (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Bridelia micrantha (Hochst.) Baill.
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Lantana camara L.
Psidium guajava L.
Schinus terebinthifolius Raddi var. *terebinthifolius*
Trema orientalis (L.) Blume
Scutia myrtina (Burm.f.) Kurz

Herbaceous species
Abrus precatorius L. subsp. *africanus* Verdc
Adenia gummifera var. *gummifera* (Red Data Declining)
Desmodium incanum DC.
Dioscorea sylvatica (Red Data Vulnerable)
Helichrysum rugulosum Less.
Passiflora subpeltata Ortega
Ricinus communis L.
Rivina humilis L.
Sesbania sesban (L.) Merr.
Catharanthus roseus (L.) G.Don
Chromolaena odorata (L.) R.M.King & H.Rob.
Gomphocarpus physocarpus E.Mey.
Secamone filiformis (L.f.) J.H.Ross
Tecoma stans (L.) Juss. ex Humb., Bonpl. & Kunth var. *stans*

Grass species
Stenotaphrum secundatum (H.Walter) Kuntze
Cynodon dactylon (L.) Pers.
Eragrostis curvula (Schrad.) Nees

The following series of photographs were taken as representative elements of Plant community A8 Secondary woodlands and shrublands:

A Mixed *Cassuarina equisetifolia* secondary woodlands

B Mixed *Cassuarina equisetifolia* secondary woodlands

C Representative vegetation

D *Acacia kosiensis* secondary woodlands

E *Lantana camara–Schinus terebinthifolius* secondary thickets

F *Abrus precatorius*

G *Acacia kosiensis* secondary woodlands

H *Acacia kosiensis* secondary woodlands

I *Acacia kosiensis* secondary woodlands

J *Acacia kosiensis* secondary woodlands

K *Acacia kosiensis* secondary woodlands

L *Chrysanthemoides monilifera*

M *Lantana camara–Schinus terebinthifolius* secondary thickets

N Mixed *Cassuarina equisetifolia* secondary woodlands

O *Tecoma stans* (invasive alien)

P *Acacia kosiensis* secondary woodlands

Photo plate 8 Plant community A8 Secondary woodlands and shrublands

4.9 Plant community A9 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands

Plant community A9: *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands occur in places where sand dredged from the harbour (Begg 1978) was dumped on Site A and levelled off. These artificially created plains of marine deposits resulted in vegetation similar to some of the grasslands occurring along the first dunes along the Zululand coast. Vegetation structure can be described as short sparse bunch grasslands, with very low cover (25–40%).

Dominant species include the grass *Stipagrostis zeyheri*, the herbaceous species *Helichrysum kraussii*, *Carpobrotus dimidiatus* and *Ipomoea pes-caprae*. Prominent, but sparsely distributed woody species include *Passerina rigida, Acacia kosiensis* and *Eugenia capensis*. Species richness and diversity is relatively low.

Due to its artificial nature and secondary status, the conservation value of this plant community is regarded as low. Some areas have been invaded by the alien species *Casuarina equisetifolia*. Before transformation, this vegetation unit used to form part of the national vegetation type CB 1 Maputaland Coastal Belt classified as Vulnerable.

The following species were recorded within the *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Eugenia capensis (Eckl. & Zeyh.) Harv. ex Sond.
Passerina rigida Wikstr.
Rhoicissus digitata (L.f.) Gilg & M.Brandt

Herbaceous species
Canavalia rosea (Sw.) DC.
Carpobrotus dimidiatus (Haw.) L.Bolus
Catharanthus roseus (L.) G.Don
Chironia baccifera L.
Conyza bonariensis (L.) Cronquist
Helichrysum kraussii Sch.Bip.
Ipomoea pes-caprae (L.) R.Br.
Rhynchosia nitens Benth.
Senecio madagascariensis Poir.

Grass species
Stipagrostis zeyheri (Nees) De Winter
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Digitaria eriantha Steud.

The following series of photographs were taken as representative elements of the *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands:


A Representative vegetation


B Representative vegetation


C Representative vegetation


D Representative vegetation


E Representative vegetation

Photo plate 9 Plant community A9 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands

4.10 Plant community A10 Seashore vegetation

Plant community A10: Seashore vegetation occurs along the southern edge of Site A, where a small artificial dune separates part of the estuary from the seawater in the harbour. This plant community is a primary pioneer vegetation type associated with newly colonised

coastal dunes of Zululand. Vegetation structure can be described as a low closed herbland, with average herb and grass height of 300 mm, and a canopy cover of >75%.

This species poor community is dominant by the herbaceous species *Canavalia rosea*, *Carpobrotus dimidiatus*, *Ipomoea pes-caprae* and the grasses *Dactyloctenium aegyptium* and *Stenotaphrum secundatum*. Some sections contain stands of the shrub species *Chrysanthemoides monilifera*, while other sections have been invaded by the alien tree species *Casuarina equisetifolia*.

Currently, these strips of vegetation help to stabilise the edge of the sand mass along the southern edge of the mangrove forests of Site A. Its ecological role is therefore regarded as relatively important, even though its species richness and uniqueness is relatively low. The conservation value of this plant community is regarded as low (i.t.o. species diversity) to medium (based on ecosystem services).

Disturbances recorded during the field surveys include invasive alien species such as *Casuarina equisetifolia*, vehicle tracks and clearings made by fishermen. This vegetation unit forms part of the national vegetation type AZd 4 Subtropical Seashore Vegetation classified as Least threatened.

The following species were recorded within the seashore vegetation plant community (Exotic species highlighted in yellow):

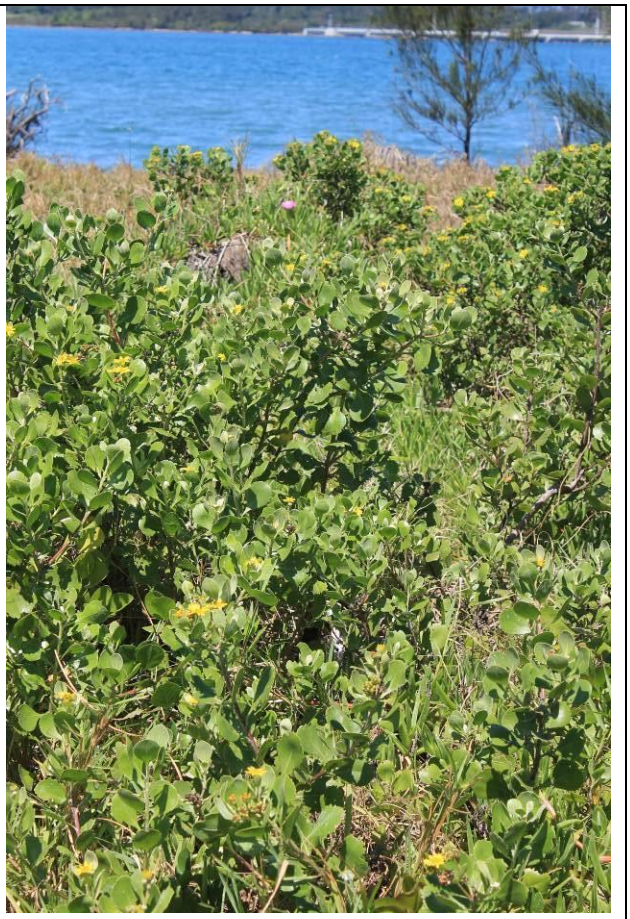
Woody species
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.

Herbaceous species
Canavalia rosea (Sw.) DC.
Carpobrotus dimidiatus (Haw.) L.Bolus
Ipomoea pes-caprae (L.) R.Br.

Grass species
Dactyloctenium aegyptium (L.) Willd.
Stenotaphrum secundatum (H.Walter) Kuntze

The following series of photographs were taken as representative elements of the Seashore vegetation:

A *Stenotaphrum secundatum* banks



B *Chrysanthemoides monilifera*

C *Canavalia rosea*

D *Carpobrotus dimidiatus*

Photo plate 10 Plant community A10 seashore vegetation

5. PLANT COMMUNITIES OF SITE B: THE 600 SERIES AREA

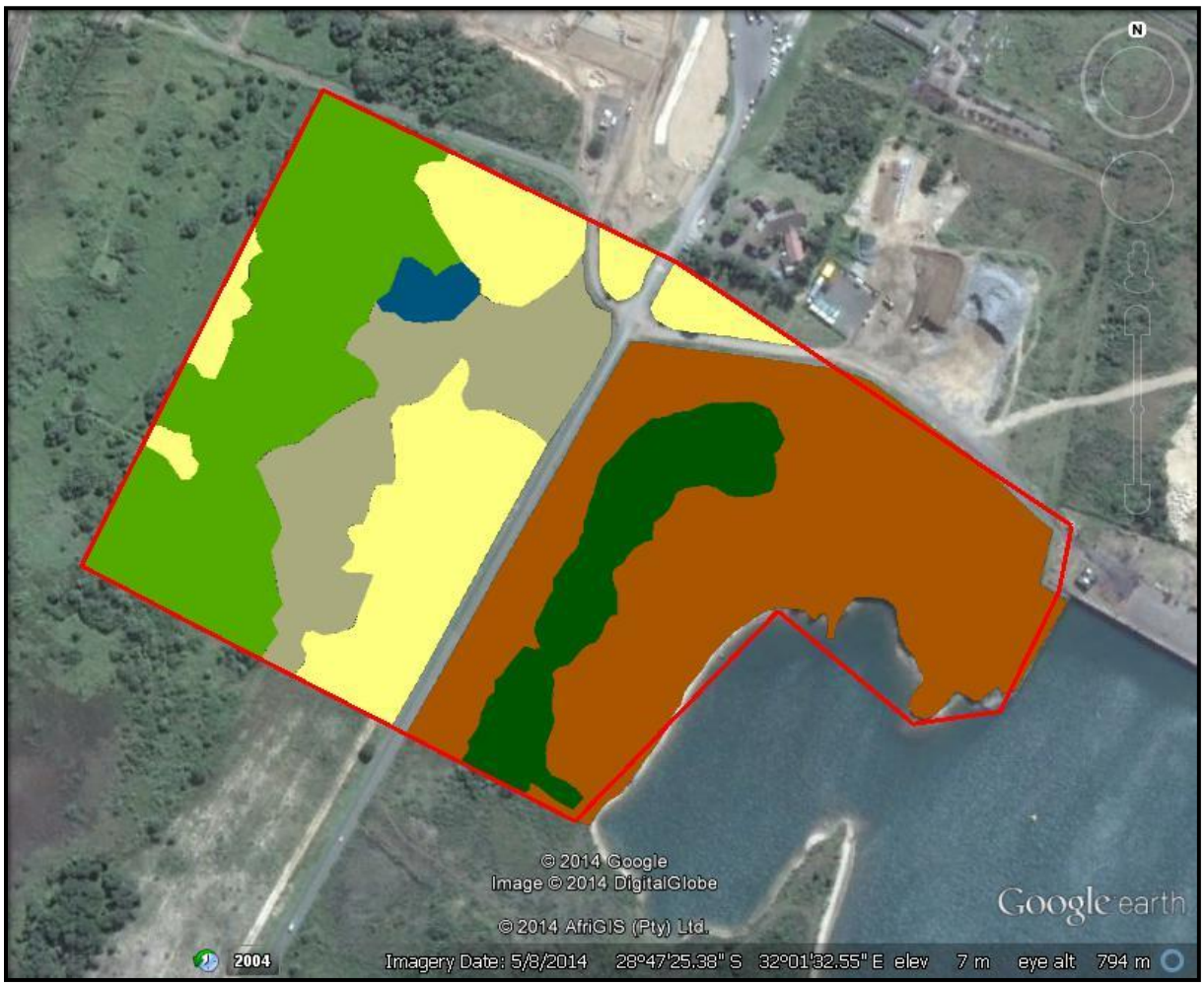
Unfortunately Site B east of Urania road burnt down shortly before the field surveys were conducted. Although the major components contributing to the structure and composition of the site's vegetation could still be identified and described, many of the less common and rarer species could not be recorded. Despite this limitation, the author is confident that all sensitive habitats as well as plant communities with high conservation value were accurately recorded and delineated.

The following plant communities were identified, described and mapped within the 600 Series area (Site B):

B1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
B4 *Imperata cylindrica* seasonal wetlands
B5 Secondary woodlands and shrublands
B6 Secondary grasslands

	Legend
	Study area: Site B

Figure 5.1 Delineated homogeneous vegetation units as the basis for the plant communities of Site B



	Legend
	Study area: Site B
	B1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	B4 *Imperata cylindrica* seasonal wetlands
	B5 Secondary woodlands and shrublands
	B6 Secondary grasslands

Figure 5.2 Plant communities of Site B TCP Richards Bay Port Expansion Project.

5.1 Plant community B1 *Avicennia marina–Phragmites australis* mangrove swamps

Plant community B1 *Avicennia marina–Phragmites australis* mangrove swamps cover a small sections east of Urania road within Site B. Vegetation structure can be described as tall closed woodlands with an average tree canopy cover of 50%, ranging from 20% to 60%. Tree height range from 3 m to 8 m depending on habitat suitability for *Avicennia marina*. No herbaceous layer was recorded within the centre of most mangrove stands, with some herbaceous cover along ecotones with other ecosystems. There is a gradual change from a *Avicennia marina* dominated salt water mangrove forest in the west, to a *Phragmites australis* dominated freshwater wetland towards the east of this map unit. The eastern section is predominantly a freshwater system, fed by surface rainwater and subsurface drainage. The western section is connected to the harbour through a steel pipe that allows tidal inflow and outflow of sea water.

Species composition within this plant community is dominated by *Avicennia marina* and *Hibiscus tiliaceus* trees, the fern *Achrostichum aureum* and the sedge species *Juncus kraussii* within the mangrove sections towards the western sections of the map unit. This freshwater section is dominated by *Phragmites australis, Trema orientalis, Bulbostylis* species, *Eleocharis limosa, Pycreus polystachyos, Berkheya setifera* and *Imperata cylindrica*.

Disturbances recorded within this plant community included severe artificial changes to the landscape and natural hydrology of the landscape.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This specific area contains large numbers of juvenile fish and seems to be an important nursery area for fish populations of the bay. This vegetation unit forms part of the national vegetation type FOa 3 Mangrove Forests classified as Critically Endangered.

5.1.1 Special note

A special note for this ecosystem is the incidental find of a *Zostera capensis* population within permanently inundated sections of Plant community B1 *Avicennia marina–Phragmites australis* mangrove swamps at 28° 47’ 31.39” S and 32° 01’ 29.99” E. This seagrass species (Cape Eelgrass) is classified by the IUCN as vulnerable to extinction and has not been

recorded within the Richards Bay Harbour for three decades (AECOM 2014). Extensive seagrass beds were recorded in the Richards Bay estuary system during the early estuarine surveys of the 1940's (Millard and Harrison 1954). These surveys reported that these habitats supported a rich diversity of marine and estuarine fauna and were believed to be vital to the nursery function of the estuary.

Zostera capensis is a more temperate species that extends into a tropical zone. In South Africa, *Z. capensis* occurs in 17 estuaries in southeast South Africa Coast. The population is severely fragmented and there is also a continuing decline in habitat quality. Major threats are coastal development, flooding, sedimentation and pollution as well as destructive shellfish harvesting for bivalves (Green and Short 2003). Although it is fast growing, it does not colonize quickly. This species has a fluctuating population. The area of occupancy is less than 2 000 km² and therefore meets the threshold for criterion B2 and is therefore listed as Vulnerable.

The following species were recorded within the *Avicennia marina–Phragmites australis* mangrove swamps (Exotic species highlighted in yellow):

Woody species
Avicennia marina (Forssk.) Vierh.
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Hibiscus tiliaceus L.
Trema orientalis L.

Reed species
Phragmites australis (Cav.) Steud.

Sedge species
Bulbostylis species
Cyperus esculentus L.
Eleocharis limosa (Schrad.) Schult.
Ficinia trichodes (Schrad.) Benth. & Hook.f.
Fimbristylis complanata (Retz.) Link
Juncus kraussii Hochst.
Pycreus polystachyos (Rottb.) P.Beauv.

Herbaceous species
Berkheya setifera DC.
Centella asiatica (L.) Urb.

Helichrysum aureonitens Sch.Bip.

Fern species
Achrostichum aureum (Willd.) H.

Grass species
Dactyloctenium aegyptium (L.) Willd.
Stenotaphrum secundatum (H.Walter) Kuntze
Imperata cylindrica (L.) Raeusch.
Cynodon dactylon (L.) Pers.
Zostera capensis L.

The following series of photographs were taken as representative elements of the *Avicennia marina–Phragmites australis* mangrove swamp plant community:


A Freshwater eastern section


B *Phragmites australis* dominated wetland

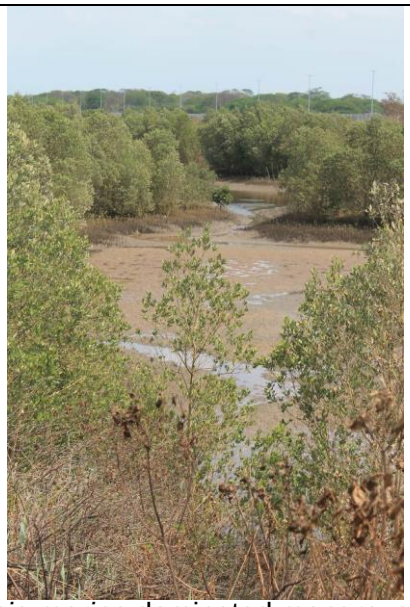

C *Avicennia marina* dominated mangroves


D Freshwater eastern section

E

Pipe allowing tidal movement of sea water

F



Avicennia marina dominated mangroves

G *Zostera capensis* recorded on site

H *Zostera capensis* recorded on site

Photo plate 11 Plant community B1 *Avicennia marina–Phragmites australis* mangrove swamps.

5.2 Plant community B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

Plant community B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests currently occur along the fringes of freshwater reed dominated wetlands of Site B. Historically these swamp forests occurred wider spread throughout the study area, with larger unfragmented stands. Vegetation structure can be described as medium tall closed forests with an average canopy cover of >95%, ranging from 85% to 100%. Tree height range from 6 m to 8 m depending on habitat suitability for the species involved. A poorly well-developed shrub layer was recorded, with an absent herbaceous layer in most places. The grass layer is relatively sparse due to low light conditions at the forest floor. At the time of the surveys (late dry season), very little free surface water was recorded within the swamp forests. Clear indications were recorded of extensive flooding during the wet season.

Plant species dominating the floristic composition of this plant community include the tree species *Ficus trichopoda*, *Ficus sur*, *Ficus natalensis, Syzygium cordatum*, *Bridelia micrantha*, *Hibiscus tiliaceus,* the grass species *Setaria megaphylla* and the herbaceous species *Cyclosorus interruptus*, *Microsorum scolopendrium*, *Senecio rhomboideus*, *Blechnum attenuatum* and *Stenochlaena tenuifolia*.

Disturbances recorded within this plant community included invasive alien plant species such as *Psidium guajava, Schinus terebinthifolius, Washingtonia robusta, Chromolaena odorata, Casuarina equisetifolia,* and artificial changes in the drainage of the landscape.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. It is highly recommended that this plant community be cleared of all invasive alien species and protected against the disturbances listed above. Special efforts should be made to restore original drainage patterns and to allow stagnant swamp areas to form and persist on site.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type FOa 2 Swamp Forest classified as Critically Endangered.

The following species were recorded within the *Ficus trichopoda–Syzygium cordatum* Swamp forests (Exotic species highlighted in yellow):

Woody species
Barringtonia racemosa
Bridelia micrantha (Hochst.) Baill.
Casuarina equisetifolia L.
Ficus sur Forssk.
Ficus trichopoda Baker
Lantana camara L.
Maesa lanceolata Forssk.
Psidium guajava L.
Rubus rigidus Sm.
Schinus terebinthifolius Raddi var. *terebinthifolius*
Strelitzia nicolai Regel & Körn.
Syzygium cordatum Hochst.
Trema orientalis (L.) Blume
Washingtonia robusta H.Wendl.

Herbaceous species
Chromolaena odorata (L.) R.M.King & H.Rob.
Cyclosorus interruptus (Willd.) H.Itô
Ipomoea cairica (L.) Sweet
Momordica foetida Schumach.
Microsorum scolopendrium (Burm.f.) Copel.
Mikania natalensis DC.
Senecio rhomboideus Harv.
Stenochlaena tenuifolia (Desv.) T.Moore

Reed species
Phragmites australis (Cav.) Steud.

Grass species
Setaria megaphylla (Steud.) T.Durand & Schinz
Cynodon nlemfuensis Vanderyst

The following series of photographs were taken as representative elements of the *Ficus trichopoda–Syzygium cordatum* Swamp forest plant community:

A *Ficus trichopoda* dominated swamp forest

B Swamp forest rich in *Ficus* spp

C Impenetrable sections along the fringes

D Sections dominated by *Bridelia micrantha*

E Dense stands of *Hibiscus tiliaceus*

F *Ficus sur* as a prominent component

Photo plate 12 Plant community B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests

5.3 Plant community B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands

Plant community B3 *Phragmites australis–Cyperus papyrus* freshwater wetland is restricted to the north-western section of Site B. It occupies a relatively small percentage of the surface area of the entire site. Vegetation structure can be described as a tall closed reed dominated wetland. No woody species were recorded as part of this plant community, with tall (0.75 to 3 m) reed and sedge species providing the main structure of this community. At the time of the field surveys the soils of this plant community were either inundated with water or waterlogged. Organic content of these sandy soils are very high, with peat formation in some sections.

The community is dominated by emergent species such as *Phragmites australis* and *Cyperus papyrus*, with dense stands of the wetland fern species *Cyclosorus interruptus*

along the better drained fringes of the wetland. Like most wetlands, this community is relatively species poor.

Disturbances recorded include invasion by the alien species *Schinus terebinthifolius* along the fringes of the wetland. It is recommended that this species be removed from the study area, and that subsequent resprouting and reinfestation be controlled. The surrounding embankments, roads and railways have altered the natural drainage into this wetland slightly. It is recommended that drainage culverts be installed and maintained to ensure the free influx of surface and subsurface water into the wetland across human made embankments and infrastructure.

Ecosystem functionality is still very high. The conservation value of this plant community is therefore regarded as very high. This vegetation unit forms part of the national vegetation type AZf 6 Subtropical Freshwater Wetlands, which is protected by the National Water Act.

The following species were recorded within the *Phragmites australis–Cyperus papyrus* freshwater wetland (Exotic species highlighted in yellow):

Reed species
Phragmites australis (Cav.) Steud.

Sedge species
Cyperus papyrus L.
Rhynchospora corymbosa (L.) Britton
Bulbostylis species
Carex zuluensis C.B.Clarke
Cyperus esculentus L.
Cyperus papyrus L.
Cyperus prolifer Lam.
Cyperus rotundus L.
Eleocharis limosa (Schrad.) Schult.
Ficinia trichodes (Schrad.) Benth. & Hook.f.
Fimbristylis complanata (Retz.) Link
Pycreus macranthus (Boeck.) C.B.Clarke
Pycreus polystachyos (Rottb.) P.Beauv.
Schoenoplectus senegalensis (Hochst. ex Steud.) Palla ex J.R

Herbaceous species
Berkheya setifera DC.
Canna indica L.

Centella asiatica (L.) Urb.
Cheilanthes viridis (Forssk.) Sw.
Chironia baccifera L.
Dissotis canescens (E.Mey. ex R.A.Graham) Hook.f.
Helichrysum aureonitens Sch.Bip.
Helichrysum kraussii Sch.Bip.
Ludwigia octovalvis (Jacq.) P.H.Raven
Ranunculus multifidus Forssk.

Fern species
Cyclosorus interruptus (Willd.) H.Itô

The following series of photographs were taken as representative elements of the *Phragmites australis–Cyperus papyrus* freshwater wetland plant community:

A *Cyperus* spp dominated edge of wetland

B *Phragmites australis* stands on Site B

C *Phragmites australis* dominated wetland

Photo plate 13 Plant community B3 *Phragmites australis–Cyperus papyrus* freshwater wetland.

5.4 Plant community B4 *Imperata cylindrica* seasonal wetlands

Plant community B4 *Imperata cylindrica* seasonal wetlands occur along the southern edge of Plant community B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests and Plant community B3 *Phragmites australis–Cyperus papyrus* freshwater wetland of Site A. These seasonal wetland plant communities are the result of seasonally waterlogged sandy soils. Waterlogged conditions develop due to the very shallow water table reaching the surface during the end of the wet season, when aquifer recharge is at its highest for the year. These temporary waterlogged sand soils create unique ecological conditions for which few plant species are well adapted, such as hydrophilic plant species. Vegetation is therefore dominated by a single grass species, the pyrophytic and hydrophilic *Imperata cylindrica*. Vegetation structure can be described as medium tall closed grasslands. Grass cover is >95% and 1 m tall.

The regular hot fires that used to maintain the vegetation structure as a grassland are currently being suppressed. This is leading to a steady invasion by fire sensitive shrub species such as *Chrysanthemoides monilifera* and *Helichrysum kraussii*. It is highly recommended that these grasslands be treated with hot burns in order to suppress bush encroachment and thickening. Invasive alien species such as *Schinus terebinthifolius*, *Psidium guajava, Lantana camara* and *Chromolaena odorata* are becoming a serious threat to these seasonal wetlands and should be eradicated and controlled. Other disturbances recorded during the site visits include historical dumping of marine sediments from dredging operations in the harbour (Begg 1978). Such dumping and some roads and railways have altered the natural drainage into this wetland dramatically.

These stands of extremely dense stands of grass create habitat for many rodent and bird species (such as the Vulnerable African Grass-Owl). Three different family groups of Banded Mongoose were counted, each more than 15 family members strong. Based on its classification as a wetland and the relatively high ecosystem integrity and functionality, as well as providing habitat for many animals, the conservation value of this plant community should be regarded as high. This vegetation unit forms part of the national vegetation type AZf 6 Subtropical Freshwater Wetlands, which is protected by the National Water Act.

The following species were recorded within the *Imperata cylindrica* seasonal wetlands (Exotic species highlighted in yellow):

Woody species
Chrysanthemoides monilifera (L.) Norl.
Pinus species
Psidium guajava L.
Searsia nebulosa Schönland
Schinus terebinthifolius Raddi var. *terebinthifolius*
Syzygium cordatum Hochst.
Brachylaena discolor DC.
Lantana camara L.
Phoenix reclinata Jacq.

Herbaceous species
Cyperus species
Helichrysum kraussii Sch.Bip.
Helichrysum ruderale Hilliard & B.L.Burtt
Indigofera species
Rhynchosia nitens Benth.
Senecio madagascariensis Poir.
Wahlenbergia undulata (L.f.) A.DC.
Waltheria indica L.
Carpobrotus dimidiatus (Haw.) L.Bolus
Chromolaena odorata (L.) R.M.King & H.Rob.
Conyza bonariensis (L.) Cronquist
Gomphocarpus physocarpus E.Mey.
Lactuca indica L.
Senecio rhomboideus Harv.

Grass species
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Digitaria eriantha Steud.
Imperata cylindrica (L.) Raeusch.
Melinis repens (Willd.) Zizka
Cynodon dactylon (L.) Pers.
Stenotaphrum secundatum (H.Walter) Kuntze

The following series of photographs were taken as representative elements of the *Imperata cylindrica* seasonal wetlands community:

A Representative vegetation

B Representative vegetation

C Representative vegetation

D Representative vegetation

E Representative vegetation

D Representative vegetation

Photo plate 14 Plant community B4 *Imperata cylindrica* seasonal wetlands

5.5 Plant community B5 Secondary woodlands and shrublands

Plant community B5: Secondary woodlands and shrublands occur east of Urania road and mostly west of Plant community B1 *Avicennia marina–Phragmites australis* mangrove swamps of Site B. The landscape associated with this map unit is high altered, disturbed and landscaped by harbour activities. Large quantities of marine and other sediments have been dumped on this map unit. The natural drainage patterns have been altered completely. All vegetation of this map unit can be regarded as secondary shrublands resulting from the total removal of the original vegetation and the total disturbance of the natural soils and wetlands. This area has very good potential to be rehabilitated back to its original wetland status. However, such rehabilitation will mean that the planned development of Site B will not be possible.

Unfortunately, this section of Site B burned down shortly before field surveys were conducted. Although the major components contributing to the structure and composition of this vegetation unit could still be identified and described, many of the less common and rarer species, as well as grasses and soft herbaceous species could not be recorded. Despite this limitation, the author is confident that this plant community was accurately recorded and delineated. Vegetation structure can be described as short closed shrubland, with a relatively dense grass layer between stands of shrubs.

Dominant species include the woody shrubs *Chrysanthemoides monilifera*, *Lantana camara* and *Schinus terebinthifolius*. Dominant herbaceous species include *Canavalia rosea*, *Eriosema psoraleoides* and *Helichrysum kraussii*. Dominant grass species include *Imperata cylindrica* and *Dactyloctenium aegyptium*.

Disturbances include the above mentioned landscape alterations and a relatively severe invasion by invasive alien species. It is recommended that these species be eradicated and controlled as stipulated by law. Before transformation, this vegetation unit used to form part of the national vegetation type CB 1 Maputaland Coastal Belt classified as Vulnerable.

The following species were recorded within the Secondary woodlands and shrublands of Site B (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Chrysanthemoides monilifera (L.) Norl.
Lantana camara L.
Psidium guajava L.
Schinus terebinthifolius Raddi var. *terebinthifolius*
Trema orientalis (L.) Blume

Herbaceous species
Arctotheca calendula (L.) Levyns
Canavalia rosea Lindl.
Carpobrotus dimidiatus (Haw.) L.Bolus
Commelina benghalensis L.
Conyza bonariensis (L.) Cronquist
Eriosema psoraleoides (Lam.) G.Don
Gomphocarpus physocarpus E.Mey.
Helichrysum kraussii Sch.Bip.
Helichrysum ruderale Hilliard & B.L.Burtt
Ipomoea pes-caprae (L.) R.Br.
Juncus kraussii Hochst.
Rhynchosia totta (Thunb.) DC.
Sesbania sesban (L.) Merr.
Verbena bonariensis L.

Grass species
Cynodon dactylon (L.) Pers.
Dactyloctenium aegyptium (L.) Willd.
Imperata cylindrica (L.) Raeusch.
Panicum maximum Jacq.

The following series of photographs were taken as representative elements of the Secondary woodlands and shrublands of Site B:

A Open to closed shrublands

B Unburned grass layer

C Mesic sedgeland patch

D Dumped rubble

E Dumped marine sediments

F Altered landscape and soils

G Disturbed soils and burned vegetation

H Excavated harbour edge

I *Eriosema psoraleoides*

J Eroded water edge

Photo plate 15 Plant community B5 Secondary woodlands and shrublands of Site B

5.6 Plant community B6: Secondary grasslands

Plant community B6: Secondary grasslands is a map unit containing two sub-communities of artificial grasslands within Site B. The two sub-communities are the B6.1 *Stipagrostis*

zeyheri–Helichrysum kraussii secondary grasslands and the B6.2 *Cynodon nlemfuensis* secondary grasslands.

Sub-community B6.1 *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands

Plant sub-community B6.1: *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands occur in places where sand dredged from the harbour was dumped on Site B and levelled off. These artificially created plains of marine deposits resulted in vegetation similar to some of the grasslands occurring along the first dunes along the Zululand coast. Vegetation structure can be described as short sparse bunch grasslands, with very low cover (25–40%).

Dominant species include the grass *Stipagrostis zeyheri*, the herbaceous species *Helichrysum kraussii*, *Carpobrotus dimidiatus* and *Ipomoea pes-caprae*. Prominent, but sparsely distributed woody species include *Passerina rigida, Acacia kosiensis* and *Eugenia capensis*. Species richness and diversity is relatively low.

Due to its artificial nature and secondary status, the conservation value of this plant community is regarded as low. Before transformation, this vegetation unit used to form part of the national vegetation type CB 1 Maputaland Coastal Belt classified as Vulnerable.

The following species were recorded within the *Stipagrostis zeyheri–Helichrysum kraussii* secondary grasslands (Exotic species highlighted in yellow):

Woody species
Acacia kosiensis Hayne
Casuarina equisetifolia L.
Chrysanthemoides monilifera (L.) Norl.
Eugenia capensis (Eckl. & Zeyh.) Harv. ex Sond.
Passerina rigida Wikstr.
Rhoicissus digitata (L.f.) Gilg & M.Brandt

Herbaceous species
Canavalia rosea (Sw.) DC.
Carpobrotus dimidiatus (Haw.) L.Bolus
Catharanthus roseus (L.) G.Don
Chironia baccifera L.
Conyza bonariensis (L.) Cronquist
Helichrysum kraussii Sch.Bip.
Ipomoea pes-caprae (L.) R.Br.

Rhynchosia nitens Benth.
Senecio madagascariensis Poir.
Eriosema psoraleoides (Lam.) G.Don
Cuscuta campestris Yunck.
Desmodium incanum DC.
Melilotus alba Desr.
Helichrysum ruderale Hilliard & B.L.Burtt

Grass species
Stipagrostis zeyheri (Nees) De Winter
Cymbopogon excavatus (Hochst.) Stapf ex Burtt Davy
Dactyloctenium aegyptium (L.) Willd.
Digitaria eriantha Steud.

Sub-community B6.2 *Cynodon nlemfuensis* secondary grasslands

Sub-community B6.2 *Cynodon nlemfuensis* secondary grasslands occur scattered throughout Site B wherever dumped marine and other deposits became covered with the exotic grass species *Cynodon nlemfuensis*, or other lawn grass species. The disturbed nature of the underlying soils is ideal for colonisation by monocultures such as lawns. Vegetation structure range from short cut lawns to thick mats (300 mm high) of *Cynodon nlemfuensis* along artificial embankments and roads. Dominant species include *Cynodon nlemfuensis* and *Stenotaphrum secundatum*. The reed species *Phragmites australis* is a codominant wherever enough moisture is retained within the soil.

Disturbances recorded during the site visit include the above mentioned soil disturbances, as well as a steady invasion by the invasive alien species *Lantana camara*. Before transformation, this vegetation unit used to form part of the national vegetation type CB 1 Maputaland Coastal Belt classified as Vulnerable.

The following species were recorded within the *Cynodon nlemfuensis* secondary grasslands (Exotic species highlighted in yellow):

Woody
Lantana camara L.

Herbaceous species

Cissampelos hirta Klotzsch

Grass species
Cynodon nlemfuensis Vanderyst
Stenotaphrum secundatum (H.Walter) Kuntze

Reed species
Phragmites australis (Cav.) Steud.

The following series of photographs were taken as representative elements of the secondary grasslands of Site B:

A Representative vegetation

B Representative vegetation

C *Cynodon nlemfuensis* secondary grasslands in the fore ground

D *Cynodon nlemfuensis* secondary grasslands in the fore ground

Photo plate 16 Plant community B6 of the secondary grasslands of Site B

6. RED DATA PLANT SPECIES AND PROTECTED ECOSYSTEMS

6.1 Red Data species

Red Data plant species that have historically been recorded in the 2832CC quarter degree square (PRECIS data) are provided in Table 6.1 (refer also to Figure 6.1). An assessment of these potentially occurring on site is provided in Table 6.2.

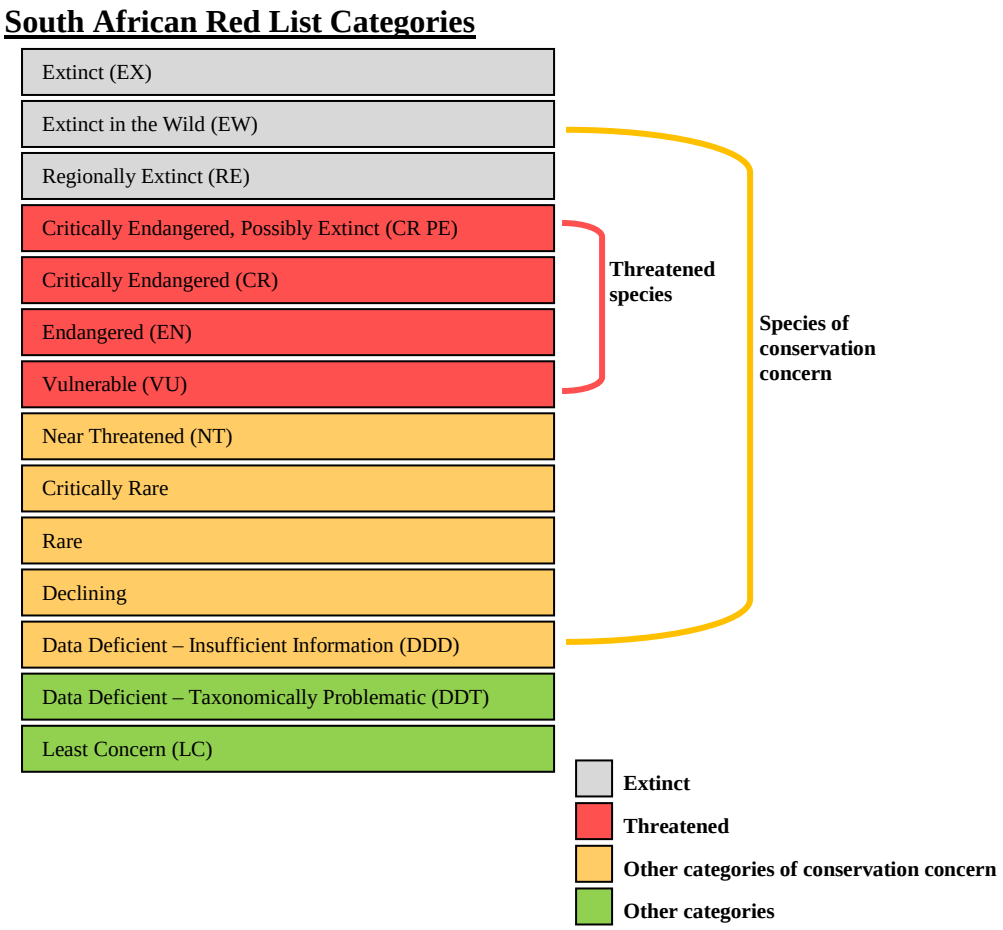


Figure 6.1 Red List Categories (according to the Threatened Species Programme, SANBI)

Adenia gummifera var. *gummifera* (Declining) (Plate 17) and *Dioscorea sylvatica* (VU) (Plate 18) were recorded during the site visits. Overall, the site is suitable for the species of concern recorded in the quarter degree square. It is recommended that a search and rescue operation is undertaken prior to construction to find any Threatened or Protected Species or any other species of concern. Table 6.2 contains the assessment of the likelihood of the Red listed species occurring on the sites.

Table 6.1 **Red list plants recorded in the 2832CC QDS (PRECIS) data**

Species	Family	Threat Status	Habitat and Ecology	Threats
Adenia gummifera var. *gummifera*	PASSIFLORACEAE	Declining	Forested ravines, forest patches and forest margins, forest scrub, miombo woodland, savanna, dune forest, on stony slopes, termitaria and littoral bush	Used medicinally
Bonatea lamprophylla	ORCHIDACEAE	VU	Forest; deeply shaded areas in coastal dune forest	Harvesting/collecting, habitat loss
Didymoplexus verrucosa	ORCHIDACEAE	VU	Coastal dune forest, grows in leaf litter on forest floor	Habitat loss
Dioscorea sylvatica	DIOSCOREACEAE	VU	Wooded and relatively mesic places, such as the moister bushveld areas, coastal bush and wooded mountain kloofs	Over-exploitation due to medicinal use
Disperis johnstonii	ORCHIDACEAE	NT	Forest, savanna; *Brachystegia* woodland, forest patches, usually in shelter of rocks	Potentially threatened by coastal development, subsistence agriculture, informal settlements and alien plant invasion
Elaeodendron croceum	CELASTRACEAE	Declining	Forest; margins of coastal and montane forests	Used medicinally
Eulophia speciosa	ORCHIDACEAE	Declining	Various habitats including sand dunes, bushveld, thornveld and montane grasslands	Harvesting for the medicinal plant trade and habitat loss
Kniphofia leucocephala	ASPHODELACEAE	CR	Wetlands in low lying coastal grassland, in moist, black, sandy clay soil	Transformation of grasslands by urban development, commercial forestry plantations, commercial sugarcane and subsistence farming
Kniphofia littoralis	ASPHODELACEAE	NT	Coastal grassland, moist depressions, not usually in permanently waterlogged soils	Habitat loss due to agriculture, forestry and urban expansion

Table 6.2 Assessment of Red Data plants potentially occurring on site

Species	Family	Threat Status	Occurrence Potential	Reason
Adenia gummifera var. gummifera	PASSIFLORACEAE	Declining	High	Species recorded on site
Bonatea lamprophylla	ORCHIDACEAE	VU	Low	Habitat unsuitable
Didymoplexis verrucosa	ORCHIDACEAE	VU	Medium to Low	Limited suitable habitat recorded on site
Dioscorea sylvatica	DIOSCOREACEAE	VU	High	Species recorded on site
Disperis johnstonii	ORCHIDACEAE	NT	Low	Habitat unsuitable
Elaeodendron croceum	CELASTRACEAE	Declining	Low	Habitat degraded, over-exploitation of medicinal plants in the area
Eulophia speciosa	ORCHIDACEAE	Declining	Medium to High	Falls within geographic distribution and suitable, though degraded habitat
Kniphofia leucocephala	ASPHODELACEAE	CR	High	Suitable habitat recorded on site
Kniphofia littoralis	ASPHODELACEAE	NT	High	Suitable habitat recorded on site

Plate 17 Green-stem (*Adenia gummifera* var. *gummifera*) recorded on site

Plate 18 Elephant's foot (*Dioscorea sylvatica*) recorded on site

6.2 Protected trees

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. Contravention of this declaration is regarded as a first category offence that may result in a person who is found guilty of being sentenced to a fine or imprisonment for a period up to three years, or both a fine and imprisonment.

The following trees species were recorded on site (Table 6.3) and are protected according to the National Forests Act, 1998 (Act 84 of 1998). The removal or damage of these trees would require a licence. In addition, mangrove species are protected under Sections 15(1) and 15(3) of the National Forests Act 1998 (Act no 84 of 1998), which includes *Bruguiera gymnorrhiza* (L.) and *Rhizophora mucronata* Lam.

Table 6.3 Protected trees recorded on site that require a licence before removal

Species	Common name	Family
Ficus trichopoda	Swamp fig	MORACEAE
Barrintonia racemosa	Powder-puff tree	LECYTHIDACEAE
Bruguiera gymnorrhiza	Black mangrove	RHIZOPHERACEAE
Mimusops caffra	Coastal red milkwood	SAPOTACEAE
Rhizophora mucronata	Red mangrove	RHIZOPHERACEAE
Sideroxylon inerme subsp. *inerme*	White milkwood	SAPOTACEAE

A *Ficus trichopoda* (Swamp fig)

B *Bruguiera gymnorrhiza* (Black mangrove)

Plate 19 Examples of protected tree species

6.3 Protected ecosystems

The National Forests Act (No 84 of 1998) controls the management of forestry in the country and aims to promote the sustainable utilisation of forests for environmental, economic and educational purposes. By definition mangroves are classified as natural forests and as such a licence is required for the removal or harvesting of trees. Therefore according to Section 7 of the Act, mangrove harvesting at Richards Bay Harbour and other such forests identified in this study, is taking place illegally. *Bruguiera gymnorrhiza* and *Rhizophora mucronata* are further protected under the Protected Tree List (DWAF, 2010), therefore harvesting should be stopped immediately. However, mangrove forests and associated biota are also protected under the Marine Living Resource Act (18 of 1998) which aims to sustainably utilise any marine resource, preserve marine biodiversity and to conserve marine living resources for future generations. Protection was also given to all estuaries that contained >5 ha of mangrove habitats in the South African National Estuary Conservation Plan (Turpie *et al.* 2010).

Examples and plant communities of the following protected national vegetation types were recorded within the study areas (Site A and Site B), and are summarised as follows (Mucina and Rutherford 2006):

- CB 1 Maputaland Coastal Belt: Vulnerable to extinction, with only 15% statutorily conserved. Agriculture is one of the main drivers of transformation of this vegetation type
- ZOz 7 Northern Coastal Forest: Under threat on coastal dunes of KZN due to mining
- AZf 6 Subtropical Freshwater Wetlands: Least threatened, but protected by the National Water Act, and vital for the health of the nearby mangroves.
- FOa 3 Mangrove Forests: Critically endangered
- FOa 2 Swamp Forest: Critically Endangered

7. INVASIVE ALIEN SPECIES

Weeds and invasive plant species are regulated according to the Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983) (CARA). These regulations were amended in 2001 and are in the process of being revised. According to CARA, plants are divided into three categories. Table 7.1 lists the alien and invasive plants found on site and the type and category in which they fall.

Table 7.1 Problem plants and alien weeds found on site

Species Name	Common Name	Type	Category (CARA)*	Category (NEMBA)†
Achyranthes aspera	Burweed	Weed	1	
Arundo donax	Spanish reed	Weed	1	1b
Casuarina equisetifolia	Horsetail tree	Invader	2	2
Chromolaena odorata	Paraffin weed	Weed	1	1b
Lantana camara	Common lantana	Weed	1	1b
Nephrolepis cordifolia	Tuber sword fern	Weed		1b
Passiflora subpeltata	Wild granadilla	Weed	1	1b
Ricinus communis	Castor-oil plant	Invader	2	2
Rivina humilis	Bloodberry	Weed	1	1b
Schefflera actinophylla	Umbrella tree	Weed		1b
Schinus terebinthifolius	Brazilian pepper tree	Weed	1	1b
Solanum mauritianum	Bugweed	Weed	1	1b

*CARA: Category 1: declared weeds are prohibited invader plants, which must be controlled or eradicated.
Category 2: declared invader plants are allowed in demarcated areas under controlled conditions.
Category 3: mostly ornamental plants having escaped from gardens, but are proven invaders. No further planting allowed.

†NEMBA: Category 1a: immediate compulsory control.
Category 1b: needs to be controlled or contained.
Category 2: permit required.
Category 3: existing plants need to be controlled in wetlands.

Special note: Plant taxa that could not be identified down to species level were left out of the evaluation due to taxonomic uncertainty and the various NEMBA and CARA treatments for different species within each genus.

A weed is defined as a plant that grows in the wrong place at the wrong time. Alien and invasive plants threaten ecosystem functionality, and it is recommended that the alien species found on site be eradicated. The following are recommended methods of control (Bromilow, 2001 & 2010; Henderson, 2001; Te Beest, 2010).

Achyranthes aspera **(Burweed)**

This perennial weed occurs mainly in shady conditions, such as hedges, along streams, at the edge of patches of bush and in overgrown areas of gardens. Burweed can be controlled manually, and mature plants should be pulled out with care.

Arundo donax **(Spanish reed)**

Spanish reed favours moist, but not necessarily wet places. Physical methods of control must include the total removal of the rhizomes, as the plant easily re-grows from pieces left in the soil. The plant should be cut down to ground level and regrowth sprayed with a systemic herbicide. Follow-up treatments are important for long-term control.

Casuarina equisetifolia **(Horsetail tree)**

Horsetail tree is used for dune stabilisation, shelter and ornaments. It is a potential transformer that invades coastal dunes and sandy sea-shores. The most cost effective method of removing the horsetail tree is by felling the tree and treating the stump with herbicide.

Chromolaena odorata **(Paraffin weed)**

Paraffin weed is a transformer species, forming dense, smothering mats over other vegetation. Paraffin weed reduces biodiversity by creating allelopathy and competition. Control of this weed is difficult because it is capable of re-growth from stem coppice, root suckers and seeds. Large plants must be cut down and herbicide applied to the stump. Young plants can be easily uprooted. Older plants can be slashed but quickly coppice unless stumps are dug out or herbicide is applied. Regular burning has been shown to be effective in suppressing infestations in grassland and savanna. However, one should not burn in forest areas, as Paraffin weed is flammable, and can damage fire-sensitive forest plants.

Lantana camara **(Common lantana)**

Lantana is one of the most serious invader species in South Africa. Lantana forms dense, impenetrable thickets, replacing indigenous plants, increasing erosion and seriously interfering with farming and forestry. Cutting the dense bushes and painting or spraying the re-growth with herbicide is the most effective method. Foliar sprays on large, uncut bushes are not very successful. The best results are achieved if the plants are sprayed in summer to autumn. A comprehensive follow-up and maintenance program is essential.

Nephrolepis cordifolia **(Tuber sword fern)**

The tuber sword fern has naturalised widely along the moist eastern seaboard of South Africa and thrives in full sun or light shade, on sandy soils. It invades swamps, forests, coastal bush and roadsides. It is native to Australia, tropical Asia, New Zealand and Japan. Plants can easily be removed by hand-pulling; however, care should be taken that all parts of the plant are removed, as these plants easily re-grow from underground rhizomes and tubers. This fern is susceptible to the glyphosate-based herbicides, but follow-up treatments are essential.

Passiflora subpeltata **(Wild granadilla)**

Wild granadilla was introduced into South Africa for its fruit. They have now become invasive weeds. Systemic chemicals or total physical removal are the best methods of control.

Ricinus communis **(Castor-oil plant)**

The three-lobed fruits of castor-oil plants are extremely toxic to humans and animals. The castor-oil plant is a common pioneer and weed of roadsides, riverbanks, waste places and disturbed habitats. Large plants can easily be controlled by chopping or uprooting them. There are also several registered herbicides that can be used as cut stump treatments.

Rivina humilis **(Bloodberry)**

Bloodberry was introduced to South Africa as an ornamental. It has escaped and can be found growing in the wild in the coastal regions of KwaZulu-Natal. Birds are attracted to the brightly coloured seeds, and disperse the plant as they eat the fruit. Individual plants can easily be hand-pulled and destroyed, ideally before the plants have formed berries and/or flowers.

Schefflera actinophylla **(Umbrella tree)**

Mature umbrella trees are difficult to control with herbicides. It is recommended that the trees are cut and the stumps treated with herbicide to control coppicing. Seedlings can easily be pulled by hand.

Schinus terebinthifolius **(Brazilian pepper tree)**

The Brazilian pepper tree is a vigorous invader and easily replaces indigenous vegetation. It has become well established along the coastal roads and in the coastal bush of KwaZulu-Natal. This plant is easily controlled by physical methods. If mature trees are cut down, care

must be taken not to disperse seed. Triclopyr is registered for application as a basal stem treatment.

Solanum mauritianum **(Bugweed)**

Apart from being poisonous, the fruits of the bugweed act as a host for the fruit fly, which is a serious pest of orchard plants. Birds are attracted to the colourful berries and spread the seeds. Bugweed can be killed easily by cutting, stem painting or soil-applied or foliar herbicides. When mechanically cleared, the clouds of fine hairs that are dislodged contain toxins that can cause respiratory problems in workers clearing the plants. Follow up treatments are essential.

8. WETLANDS

8.1 IMPORTANCE OF WETLANDS (DWAF 2005)

Apart from the many very obvious ecosystem functions and biodiversity related contributions wetland systems have on our natural environment, they also have enormous monetary value and make huge, direct contributions to national economies and human well-being. In 2003 wetlands were worth an estimated $4 trillion per annum (KZN Strategic Environmental Assessment). Based on the higher demand for wetland functions and services to humans, this global value will have grown dramatically. The anthropogenic value of wetlands relates to their primary ability to process water and regulate runoff. In the late 1990's it was estimated that the demand for water in South Africa is likely to meet the economically exploitable supply for the country as a whole by about the year 2030 (Mucina & Rutherford 2006). Current trends and catastrophes suggest we will reach this point sooner (Mucina & Rutherford 2006). Without sufficient water we cannot grow enough crops, support the growth of industry and mining, or develop a growing tourism industry. The South African economy, mainly driven by agriculture, mining, industry and tourism, depend on a continual supply of water of sufficient quality and quantity in order to ensure economic stability.

Wetlands protect and regulate the water resource. Acting like giant sponges, they hold back water during floods and release it during dry periods. In a dry country like South Africa, this is crucial. By regulating water flows during floods, wetlands reduce flood damage and help prevent soil erosion. Wetlands recharge ground water sources, and also remove pollutants from the water. Being natural filters, they help to purify water by trapping many pollutants,

including sediment, heavy metals and pathogens. Some wetlands, such as estuaries, serve as important breeding grounds for oceanic fish. Many wetlands (such as floodplains) can be used as grazing areas, if done on a sustainable basis.

Besides performing these vital functions at very little financial cost, wetlands, in association with appropriate buffer strips, are also natural storehouses of biological diversity, providing life support for a wide variety of species, some totally reliant on wetlands for their survival. Many of these species are used for food, craft manufacture, medicines, building material and fuel, both for subsistence and commercially. Yet wetlands are some of the most threatened habitats in the world today. In numerous catchments in South Africa, over 50% of the wetlands have already been destroyed (Mucina & Rutherford 2006). The main culprits have been the drainage of wetlands for crops and pastures, poorly managed burning and grazing that has resulted in headcut and donga erosion, the planting of alien trees in wetlands, mining, pollution and urban development. All of these impacts alter the water flow and water quality, which kill or damage the wetland. We cannot continue to pollute wetlands, drain them, starve them of water and exploit them unsustainably for food and short-term economic development, without paying a heavy price in the long-term. Continued wetland destruction will result in less pure water, less reliable water supplies, increased severe flooding, lower agricultural productivity, and more endangered species.

8.2 WETLAND DEFINITION (DWAF 2005)

The word “wetland” is a family name given to a variety of ecosystems, ranging from rivers, springs, seeps and mires in the upper catchment, to midlands marshes, pans and floodplains, to coastal lakes, mangrove swamps and estuaries at the bottom of the catchment. These ecosystems all share a common primary driving force: water. Its prolonged presence in wetlands is a fundamental determinant of soil characteristics and plant and animal species composition. Any part of the landscape where water accumulates for long enough and often enough to influence the plants, animals and soils occurring in that area, is thus a wetland.

Wetlands are considered as those ecosystems defined by the National Water Act as: “land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil”.

Wetlands must have one or more of the following attributes:

- Wetland (hydromorphic) soils that display characteristics resulting from prolonged saturation.
- The presence, at least occasionally, of water loving plants (hydrophytes).
- A high water table that results in saturation at or near the surface, leading to anaerobic conditions developing in the top 500 mm of the soil.

8.3 WETLAND DELINEATION (DWAF 2005)

Although the primary driving force behind all wetlands is water, due to its dynamic nature varying daily, seasonally and annually its presence or absence is not a very useful parameter for accurately identifying the outer boundary of a wetland. Long term monitoring is needed to accurately characterize the hydrology of a wetland and the extent of its saturation zones. As a result of this dynamic hydrology within and between wetlands, it is time consuming and expensive to determine the frequency and duration of saturation of wetland soils. Instead, an approach is commonly followed which identifies the indirect indicators of prolonged saturation by water: wetland plants (hydrophytes), wetland (hydromorphic) soils, topography and soil wetness index. The presence of these distinctive indicators in an area implies that the frequency and duration of saturation is sufficient to classify the area as a wetland. Terrain unit help identify those parts of the landscape where wetlands are more likely to occur.

Generally, there are three different zones in a wetland, which are distinguished according to the changing frequency of saturation. These three zones may not be present in all wetlands. The central part of the wetland, which is nearly always saturated, is referred to as the permanent zone of wetness. This is surrounded by the seasonal zone, which is saturated for a significant duration of the rainy season. The temporary zone in turn surrounds the seasonal zone, and is saturated for only a short period of the year that is sufficient, under normal circumstances, for the formation of hydromorphic soils and the growth of wetland vegetation. The object of the delineation procedure is to identify the outer edge of the temporary zone. This outer edge marks the boundary between the wetland and adjacent terrestrial areas.

Finding the outer edge of the temporary zone requires the delineator to give consideration to four specific indicators:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological “signatures developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

Despite hydrology not being one of the four indicators listed above, the delineation procedure is substantially facilitated by an understanding of the broad hydrological processes that drive the frequency of saturation.

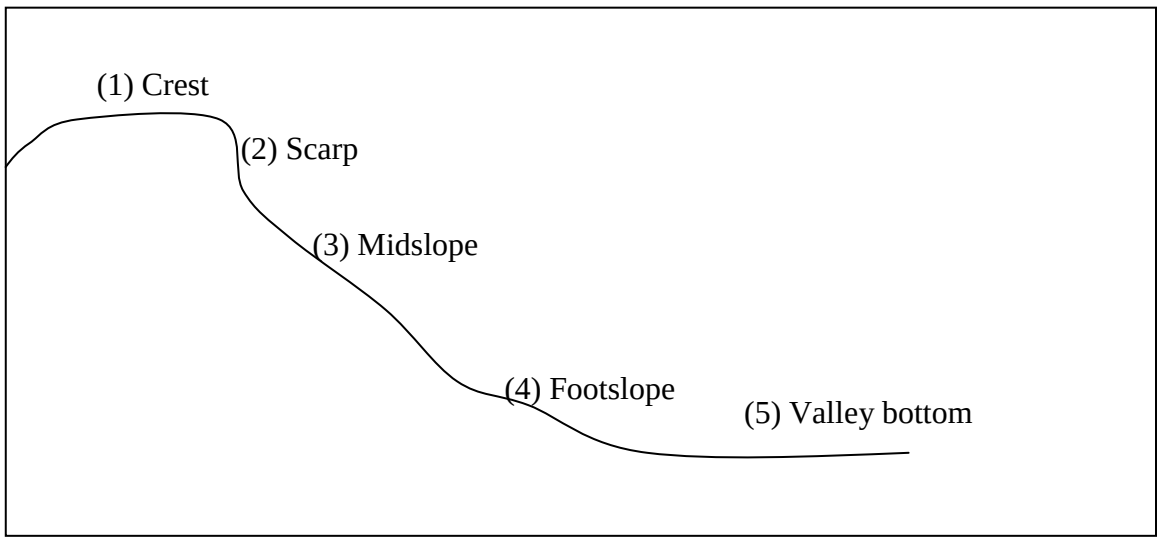


Figure 8.1 Terrain type unit descriptions as recommended by DWAF (2005)

8.4 RIPARIAN AREAS (DWAF 2005)

At this time, quantitative indicators for the delineation of riparian areas have not yet been developed. Determining the boundary of riparian areas therefore relies heavily on professional judgement. This is not necessarily a problem, as delineating riparian areas is generally easier than delineating wetlands. The riparian-terrestrial boundary is often more distinctive than that of a wetland. Where the wetland procedure has adequately protected the riparian area, there is no need to delineate the riparian area and vice versa.

Riparian definition

The National Water Act defines a riparian habitat as follows: “Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.”

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

Riparian areas:

- are associated with a watercourse;
- contain distinctively different plant species than adjacent areas;
- contain species similar to adjacent areas but exhibiting more vigorous or robust growth forms; and
- may have alluvial soils.

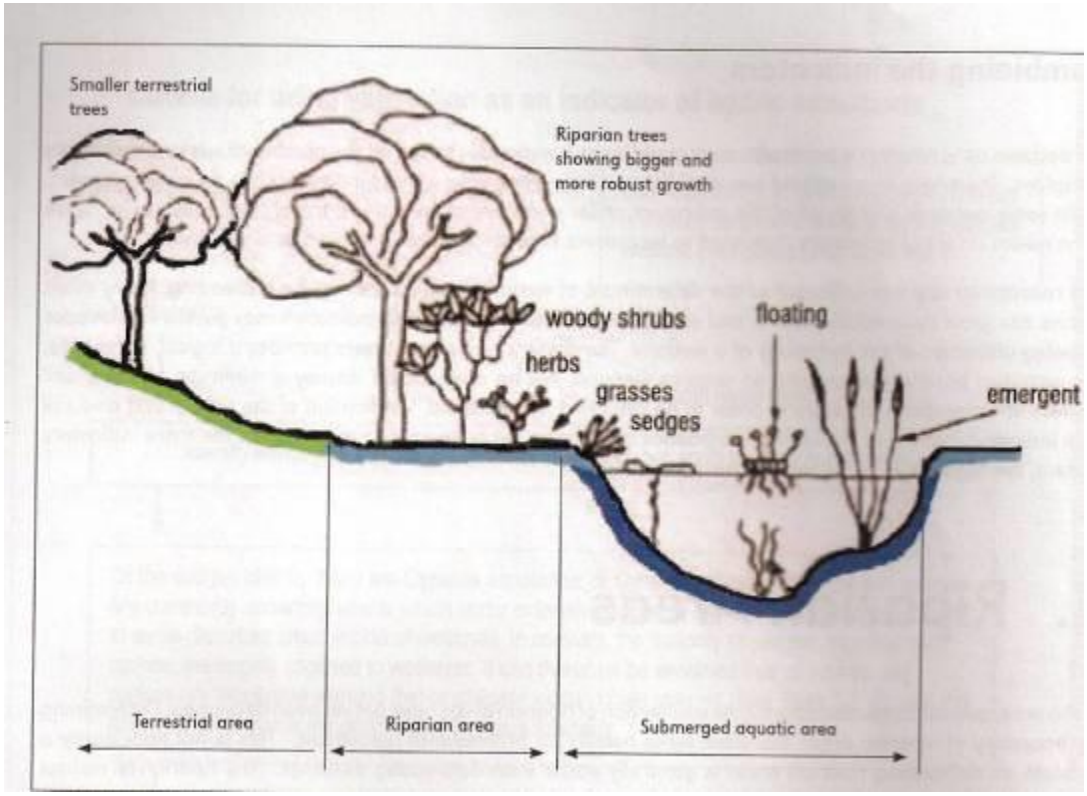


Figure 8.2 Cross sectional cutting of a riparian landscape

The difference between wetlands and riparian areas

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

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

Importance of riparian areas

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

Riparian areas:

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

Not all riparian areas develop the same way and may not perform these functions to the same extent, It is important that a riparian area's capacity to provide the benefits listed is not reduced. Many of these areas are best managed as natural areas, rather than being converted to other uses.

Riparian area indicators

Like wetlands, riparian areas have their own unique set of indicators, it is possible to delineate riparian areas by checking for the presence of these indicators. Some areas may display both wetland and riparian indicators, and can accordingly be classified as both. If you are adjacent to a watercourse, it is important to check for the presence of the riparian indicators described below, in addition to checking for wetland indicators, to detect riparian areas that do not qualify as wetlands.

The delineation process requires that the following be taken into account:

• topography associated with the watercourse;
• vegetation; and
• alluvial soils and deposited material.

Topography associated with the watercourse

A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. Flood benches may exist between the active channel and the macro channel bank, and are often covered by alluvial deposits and may have riparian vegetation on them. The macro channel bank often represents a dramatic

change in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

Vegetation

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

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

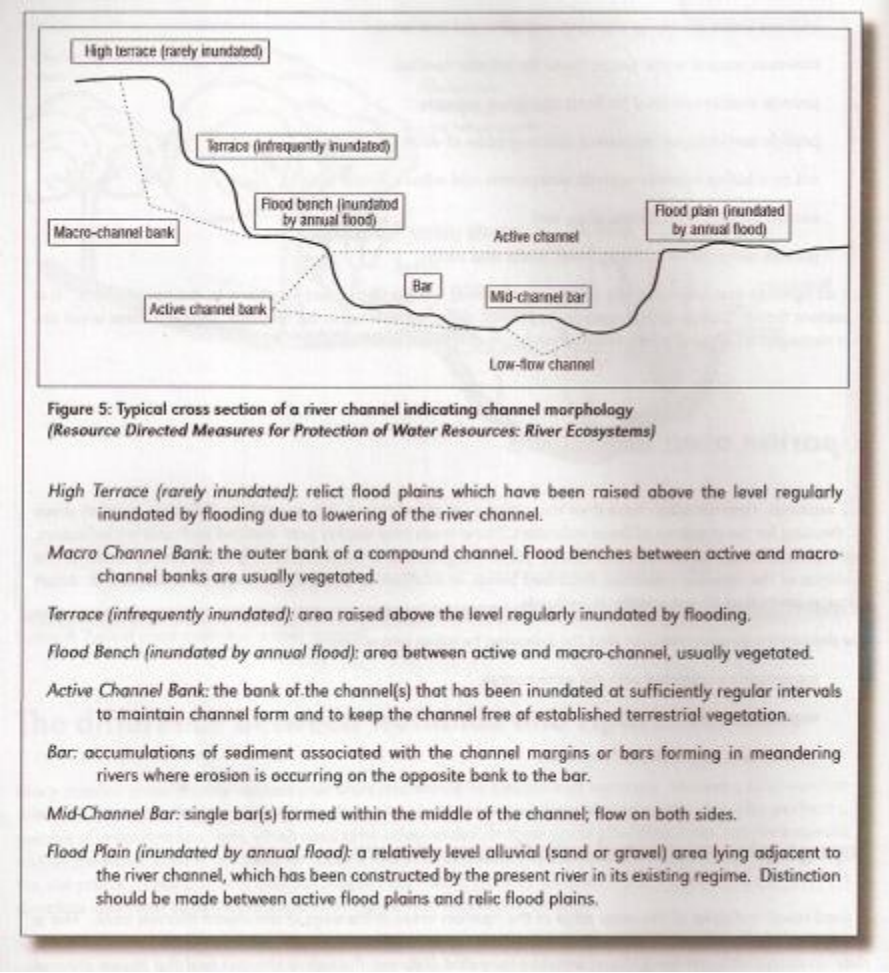


Figure 5: Typical cross section of a river channel indicating channel morphology
(Resource Directed Measures for Protection of Water Resources: River Ecosystems)

High Terrace (rarely inundated): relict flood plains which have been raised above the level regularly inundated by flooding due to lowering of the river channel.

Macro Channel Bank: the outer bank of a compound channel. Flood benches between active and macro-channel banks are usually vegetated.

Terrace (infrequently inundated): area raised above the level regularly inundated by flooding.

Flood Bench (inundated by annual flood): area between active and macro-channel, usually vegetated.

Active Channel Bank: the bank of the channel(s) that has been inundated at sufficiently regular intervals to maintain channel form and to keep the channel free of established terrestrial vegetation.

Bar: accumulations of sediment associated with the channel margins or bars forming in meandering rivers where erosion is occurring on the opposite bank to the bar.

Mid-Channel Bar: single bar(s) formed within the middle of the channel; flow on both sides.

Flood Plain (inundated by annual flood): a relatively level alluvial (sand or gravel) area lying adjacent to the river channel, which has been constructed by the present river in its existing regime. Distinction should be made between active flood plains and relic flood plains.

Figure 8.3 River channel morphology

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

Alluvial soils and deposited material

Alluvial soils can be defined as relatively recent deposits of sand, mud, etc. set down by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators.

Deposited material can also be used to delineate the areas where bank stabilisation, provided by the roots of riparian vegetation, is most important. This material may be deposited adjacent to the macro-channel bank during flooding, and can include vegetation debris as well as soil deposits.

Methods for identification of riparian areas

The general approach for delineating riparian areas in the field is described in section 5. There are a number of sources of information that will assist in the final delineation, and which should be consulted, if available, before going into the field.

Topographical maps

Riparian areas normally occur within the flood area of a river or stream. This is not conclusive and will have to be verified in the field.

Aerial photographs

As a result of alluvial deposits being visible from the air, aerial photography can assist in determining the extent of deposits, as well as the vegetation line indicating a difference in species composition or more vigorous growth.

Aerial videos

As with aerial photographs, aerial videos indicate vegetation transitions and recent alluvial deposits. Aerial videos are usually taken after large flood events, in order to record the extent of flooding and damage. Every major river in South Africa has been covered at least once and these records can assist with the identification of riparian areas.

Vegetation on Recent Alluvial Deposits (with reference to riparian areas)

Note that the procedure for identifying morphological signs of wetness in the soil profile to a depth of 50cm to determine the outer edge of the temporary zone, works in most situations. However, we must consider the situation where recent alluvial deposits (fluvial processes) are too sandy or too young for the morphological signs of wetness to be readily detectable in the profile. In such cases, there may be important types of vegetation that should be protected by the delineation process. In these areas, it is the vegetation factor that is the dominant indicator in the delineation.

The unique nature of a river is in most cases a result of both short-term and long-term fluvial processes. The importance of the river to the floodplain and the floodplain to the river cannot be overemphasized. In the long-term, floodplains result from the combination of the deposition of alluvial materials (aggradations) and down-cutting of surface geology (degradation) over many years. Sometimes this substrate can be described as young fluvial soils with no hydromorphic characteristics. The pedogenetic processes are thus slower than the fluvial processes. This recent alluvial deposit is not a special case and is common throughout catchments.

In cases like this, the hydromorphic characteristics may not always be visible within 50cm of the soil's surface, but the vegetation component still indicates riparian characteristics, and can be used as an indicator to delineate the riparian area. The edge of the macro channel can consist of bank parent material, but the vegetation still depends on the water in the active channel.

Sandy Coastal Aquifers

Aeolian derived, sandy soils associated with sandy coastal aquifers often have grey profile colours, which are not necessarily associated with hydromorphic soil forming processes. The grey profile morphology could be attributed to stripping of sesquioxides off mineral grains via podzolization within the profile. Such grey soils, especially on upland sites and midslope

sites, are thus not associated with zones of saturation and are thus not indicative of riparian or wetland habitats.

Specific soil properties (and thus indicators) on sandy coastal aquifers have been recognized which distinguish wetland habitats from drier sites. The delineation procedure is in essence similar to that described earlier but with refinement to the soil criteria.

The delineation procedure in sandy coastal areas involves.

- Classification of stream channels using hydrology
- Recognition of the terrain morphological unit which must be in a bottom-land site (Section 3)
- Recognition of hydrophilic vegetation (Section 3) if undisturbed
- Recognition of specific soil criteria (detailed below) associated with sandy Aeolian soils in riparian habitats.

(i) Soil properties associated with the temporary zone of wetness in riparian and wetland habitats on sandy coastal aquifers

If the soil form is Fernwood then the profile:

- Has a dark topsoil (moist Munsell values of 4 or less and chroma values of 1 or less)
- Has an extremely high topsoil organic carbon content, amounts which vary but are usually more than 7% throughout the horizon
- Contains accumulation of plant residues which vary from finely divided to predominantly fibrous
- Has a low bulk density (soil material feels ‘light’ and foot stamping on the soil surface often results in vibrations)
- Has a peaty character
- Often exhibits vertical profile cracking in the dry state
- Is susceptible to ground fires

Excluded are layers of organic matter, which in certain cases accumulate on the soil surface e.g. layers of pine needles or leaves under commercial timber plantations.

If the soil form is Katspruit, Kroonstad, Longlands, Wasbank, Lomotte, Westleigh, Dresden, Avalon, Pinedene, Tukulu or Dundee then the profile:

- Has a dark topsoil (moist Munsell values of 4 or less and chromo values of 1 or less)
- Has a very high organic carbon topsoil content, usually more than 4% throughout the horizon
- Has signs of wetness (Section 3.2.3) within 50 cm of the soil surface
- Has a significant textural increase (within 50 cm of the soil surface) from the E or overlying horizon to the underlying soft plinthite, G horizon or unspecified material with signs of wetness, such that sandy profile textures in the E (or overlying horizons) become at least sandy clay loam in the underlying hydromorphic horizons

ii) Soil properties associated with the permanent and/or seasonal zone of wetness in riparian and wetland habitats on sandy coastal aquifers

Pedological criteria are similar as described for the temporary zone of wetness. However, excessively high organic carbon topsoils occur (organic carbon content >10%) and topsoils are typically peaty. Soil form is commonly Champagne. However, the other soil forms (described above) having >10% organic carbon in the topsoil may also occur.

8.5 BUFFER ZONES AROUND WETLANDS AND RIVERS (DWAF 2005)

a. Wetlands

The wetland and a protective buffer zone, beginning from the outer edge of the wetland temporary zone, must be designated as sensitive. Recommendations for buffer zone widths are as follows:

- 32m for wetlands occurring inside the urban edge
- 50m for wetlands occurring outside the urban edge

Note that these buffer zones are essential to ensure healthy functioning and maintenance of wetland ecosystems. Larger buffer zones may be required for wetlands supporting sensitive species.

b. Rivers (non-perennial / perennial)

Riparian zones and buffer zones should be designated as sensitive.

- The riparian zone must be delineated according to DWAF, 2005
- Procedure for the Identification and Delineation of Wetlands and Riparian Zones.
- A 100 m buffer zone from the edge of the riparian zone for rivers/streams outside the urban edge.

- A 32 m buffer zone from the edge of the riparian zone for rivers/streams within the urban edge.

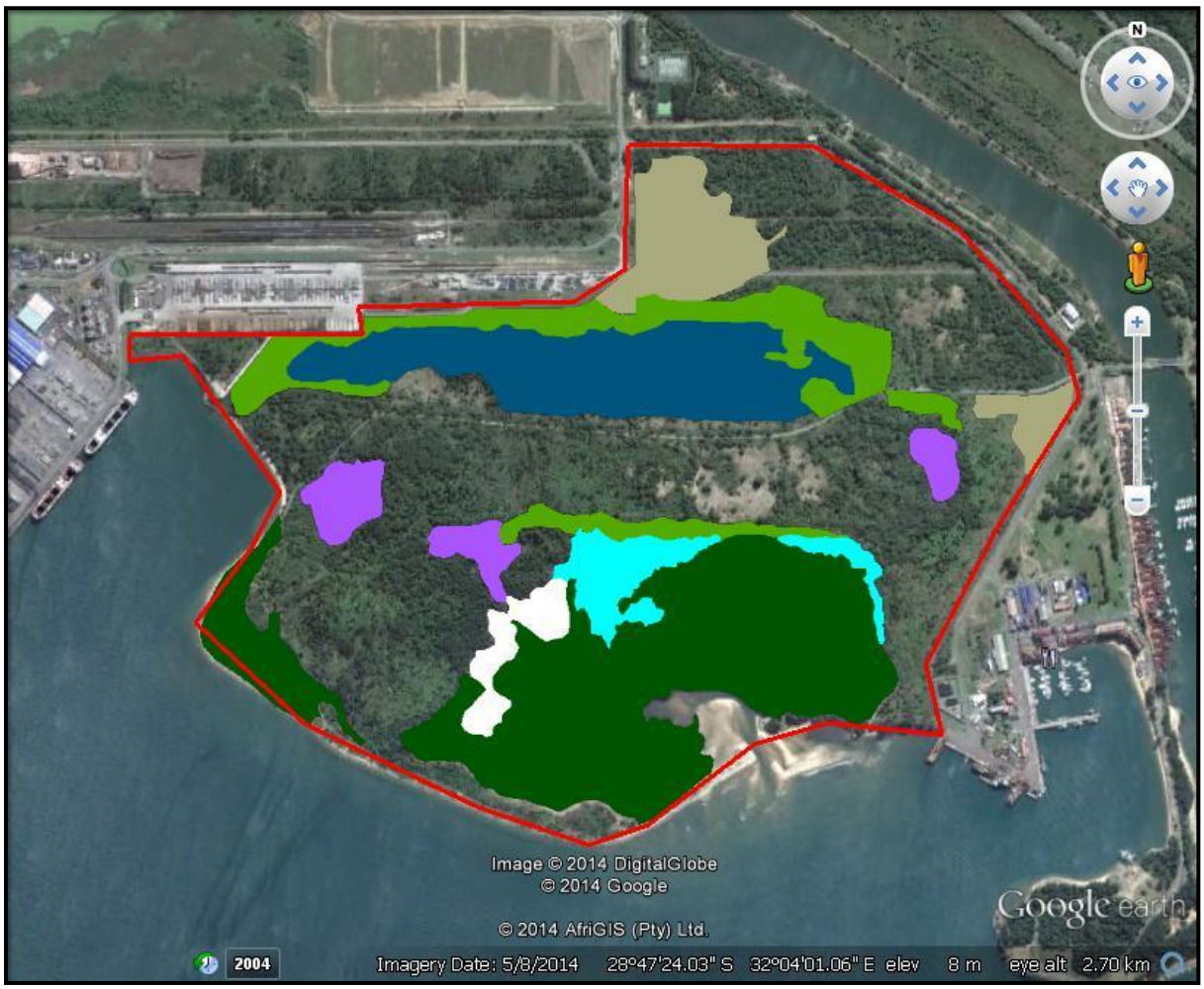
Note that these buffer zones are essential to ensure healthy functioning and maintenance of aquatic ecosystems. Larger buffer zones may be required for aquatic ecosystems supporting sensitive species.

For this specific study information from various data sources were overlain in order to identify potential areas of concern. Information layers included aerial imagery, satellite imagery, topography, land type, soil type, soil potential, soil depth, geology, land-use, infrastructure, vegetation, geohydrology and surface water drainage. Based on these existing information and patterns observed from aerial and satellite imagery, potential wetlands and drainage lines were earmarked for field surveys.

A soil auger was used in order to inspect and described soil forms and diagnostic soil horizons along the landscape catena. Vegetation data was gathered using the Braun-Blanquet technique in order to determine floristic composition and dominance of the various plant communities associated with the different zones of wetlands. Terrain type units were determined based on field observations and topographic models of the study area. This information was used to generate cross sections of the landscape. Data from the field surveys were interpreted and used to confirm the status and extent of wetlands and drainage lines within and adjacent to the study area.

The very flat landscape and the grey leached sandy coastal soils made it more difficult to rely on Terrain Unit Indicators and Soil Form Indicators for the accurate delineation of wetlands and riparian zones. The same applies for the Soil Wetness Indicator, since the study was conducted in September and October at the end of the dry season, when very little groundwater recharge have taken place. The Vegetation Indicator was therefore used as the most reliable indicator for delineation purposes.

Based on all available indicators, the following map of wetlands, seepages, major drainage lines and streams was compiled for the study area:



	Legend
	Study area: Site A
	A1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	A2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	A3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	A4 *Juncus krausii–Phragmites australis brackish* wetlands
	A5 Salt pans
	A6 *Imperata cylindrica* seasonal wetlands
	A7 Wetlands covered with invasive alien species

Figure 8.4 Wetland communities of Site A TCP Richards Bay Port Expansion Project.

	Legend
	Study area: Site B
	B1 *Avicennia marina–Bruguiera gymnorrhiza* mangrove forests
	B2 *Ficus trichopoda–Syzygium cordatum* Swamp forests
	B3 *Phragmites australis–Cyperus papyrus* freshwater wetlands
	B4 *Imperata cylindrica* seasonal wetlands

Figure 8.5 Wetland communities of Site B TCP Richards Bay Port Expansion Project.

Based in the ecological importance of wetlands, and their role within the surrounding landscape, all of the wetlands identified and delineated are regarded as of high conservation value.

9. DISCUSSION & CONCLUSIONS

9.1 EXISTING DISTURBANCES TO PLANT COMMUNITIES AND WETLAND ECOSYSTEMS

Specific disturbances to the various plant communities and wetland ecosystems recorded within the study area have been discussed in detail under the heading of each individual community. The main disturbances can be summarised as the major alterations to the topography and hydrology of both Site A and Site B, as well as the impact caused by invasive alien species.

Mangrove species are highly susceptible to changes in hydrology and salinity (Kathiresan & Bingham 2001). Human induced hydrological changes within the Richards Bay Harbour have altered salinity levels and flooding cycles dramatically. This is most probably the leading cause of the decline of *Bruguiera gymnorrhiza* stands and *Rhizophora mucronata* stands recorded by numerous authors (Begg 1978) within the Richards Bay Harbour. Hydrological changes also include the channelling of basically all major rivers and streams, speeding up drainage, containing floodwater behind earth embankments and preventing the formation of swamps. The very few seedlings of the three mangrove tree species recorded may pose problems for future colonisation and maintenance of the mangrove structure and functionality. This population decline and inability to regenerate are symptoms of the declining health of the harbour's mangroves and wetlands.

In an attempt to retain the remaining ecosystem processes and to ensure the continuation of current biodiversity patterns, every effort should be made to conserve the remaining wetlands within the study area. This includes managing local and regional catchments. Historical water flow patterns should be reinstated as part of a rehabilitation programme for the wetlands of the study area.

9.2 POTENTIAL IMPACTS OF THE PROPOSED DEVELOPMENT ON PLANT COMMUNITIES AND WETLAND ECOSYSTEMS

From a plant community and wetland ecosystem perspective, the proposed development will include the following predicted impacts within Site A (Rail Balloon) and Site B (600 Series) of the study area:

Construction phase

- Removal of vegetation within construction footprint areas
- Reshaping of the landscape to accommodate infrastructure
- Compaction of subsoils and construction of foundations within construction footprint areas
- Diverting and controlling water away from infrastructure
- Changing tidal movement of water
- Changing salinity of local and surrounding water bodies
- Changing the catchment areas of wetlands and mangroves
- Changing recharge regimes of wetlands, aquifers and mangroves

Operational phase

- Long term changes in hydrology of the study area will reduce habitat suitability for species and ecosystems of high conservation value
- Increased turbidity of water with negative implications for intertidal vegetation types
- Increased pollution levels in water due to runoff from developed surfaces
- Increased fragmentation due to linear infrastructure
- Reduced hydrological connectivity
- Restricts movement of plant propagules across barriers may influence population recruitment
- Altered nutrient levels and dynamics of affected wetland and estuarine ecosystems
- Eutrophication of wetland and estuarine ecosystems
- Lowered ecosystem resistance and resilience against natural storms

The proposed developments within Site A (Rail Balloon) and Site B (600 Series) of the study area will have far reaching effects on its vegetation and wetland ecosystems. The flat landscape, extremely shallow water table, large bodies of surface water and porous substrates result in very high levels of hydrological interconnectedness between ecosystems. Interference with water drainage, including tidal interchange, will have adverse effects on established and maintenance of mangroves and other wetland ecosystems. Compaction of the porous substrate under the proposed infrastructure will further restrict the movement of subsurface water, altering the dynamic hydrological patterns within the study

area. Likewise, the use of filling material to stabilise soft soils will impede water movement through these interconnected wetland landscapes.

Construction within mangroves and wetlands will result in the direct loss of nationally protected mangrove and wetland habitat within the foot-print area of the proposed development. Direct loss of plant communities will occur within the footprint of the proposed development. Construction within terrestrial non-wetland plant communities may further have major impacts on the hydrology of nearby wetlands, such as can currently be seen from numerous artificial structures within the study area.

In order to mitigate the potential impact of the proposed development on the vegetation and wetland ecosystems of the study area, construction should be such that no prolonged interference with present hydrological patterns and processes. Historical drainage patterns should be reinstated where possible. Soil erosion along flowing water and siltation of open water systems should be prevented.

9.3 OPPORTUNITIES

The study area has very good potential to be rehabilitated back to highly functional wetland and estuarine status. However, such rehabilitation will mean that the proposed development will not be possible.

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ABRIDGED CURRICULUM VITAE

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