

### 9.3 Geomorphology

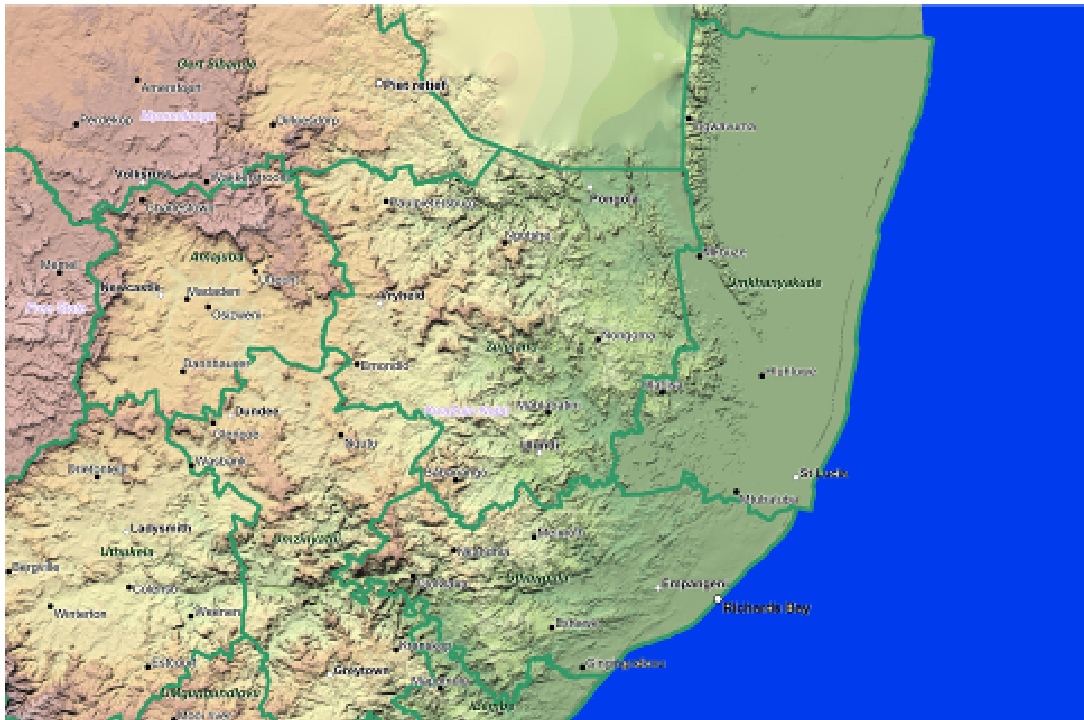
The geology has given rise to geomorphologic features (landforms and landscapes) which in turn define the ground and surface water conditions and the associated ecosystems in the area. NEMA requires that “*the disturbance of landscapes be avoided, or where it cannot be avoided that it be minimised or remedied*”. It therefore becomes evident why the landscape features are important aspects for decision-making.

The nature of the topography in the study area is typical of a coastal plain, which is generally defined as a low-relief area that is bounded by the sea on one side and by a high-relief terrain on the landward side. **Figure 12** illustrates Richards Bay being part of the southern-most tip of a coastal plain, generally known as the Zululand Coastal Plain. It, in turn, forms part of a series of low-lying plains stretching down the east coast of Africa, from Somali in the north to the uMhlathuze plains in the south. In the geological past these plains were part of the ocean floor, and are the result of tectonic activity which raised the ocean floor above sea level, resulting in a unique landscape characterised by sand plains, isolated lakes, dune ridges and a diversity of endemic species<sup>1</sup>. The significance of this landscape is that its character has given rise to a host of ecosystems and high levels of endemism. The southern part of the coastal plain has previously been identified as the Maputaland Centre of

---

<sup>1</sup> Bruton M N and Cooper K H (1980) *Studies on the Ecology of Maputaland*. Rhodes University, Grahamstown and Natal Branch of the Wildlife Society of Southern Africa, Durban.

Endemism and is now part of the Maputaland - Pondoland – Albany Hotspot of biodiversity<sup>2</sup>, a globally recognised area of conservation importance.



**Figure 1: Coastal Plains of Zululand contrasting with mountainous hinterland**

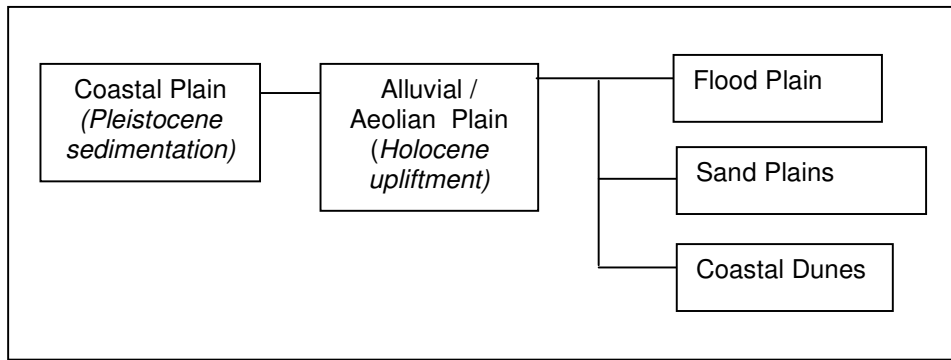
The geomorphology of the study area indicates a Pleistocene history of erosion and sedimentation, comprising boulder beds, old red sands and younger coversands in a sequence of sea-level fluctuations. Continental upliftment during the Holocene age led to the advance of the shoreline to its present position. This resulted in decreased river gradients which reduced their capability of maintaining an outlet to the sea. Smaller river mouths became blocked by littoral and aeolian processes and were permanently sealed by vegetation. Only large rivers and estuaries maintained a semi-permanent outlet. Waters of blocked rivers became dammed up behind dune barriers. Where discharge was relatively small, a freshwater lake would form<sup>3</sup>.

In the EMF study area three distinct topographical features can be identified, as illustrated in **Figure 13**. These are:

- A Flood plain consisting mainly of water bodies (lakes, estuary, river channels);
- Sand plains rising above the flood plain;
- Coastal Dunes.

<sup>2</sup> Van Wyk A E and G F Smith (2001) *Regions of Floristic Endemism in Southern Africa. A review with emphasis on succulents*. Umdaus Press, Pretoria, South Africa.

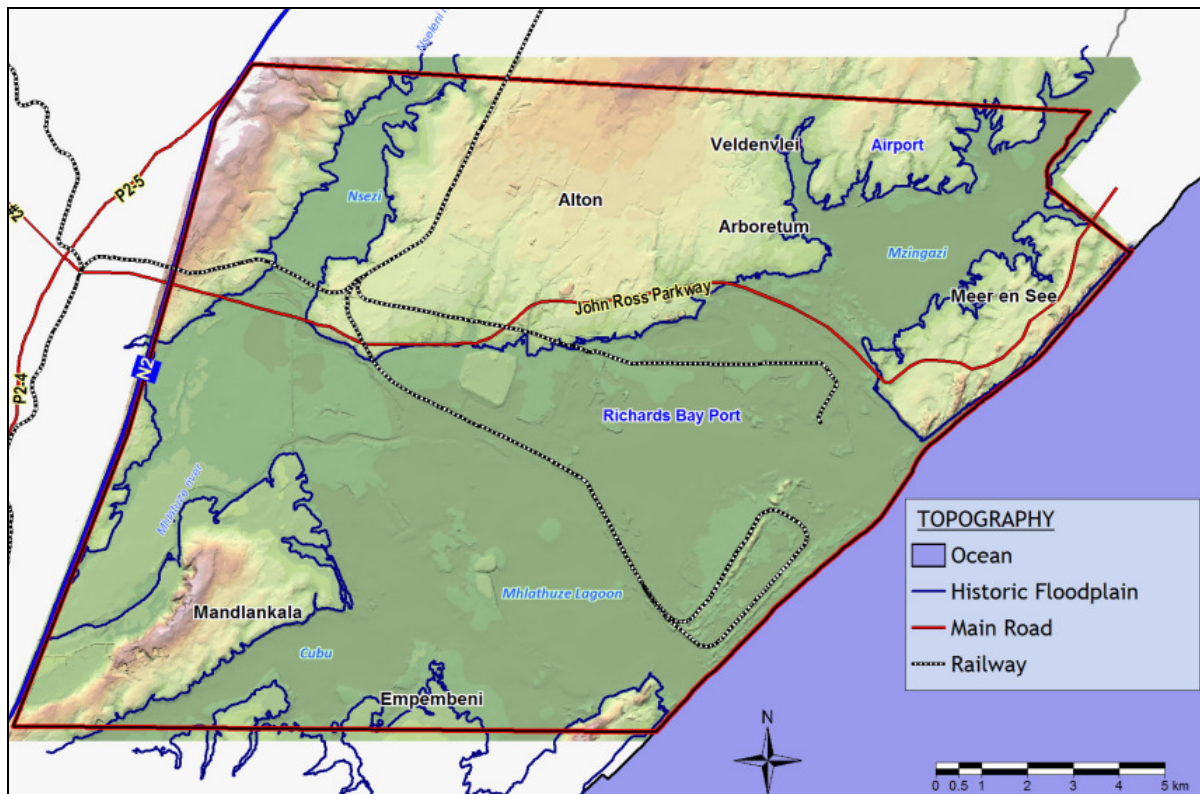
<sup>3</sup> Hobday D K (1979) *Geological evolution and geomorphology of the Zululand coastal plain*. In Allanson B R (Ed) *Lake Sibaya*. Dr. W. Junk bv Publishers. The Hague



**Figure 2: Classification of topographical features in the study area**

**Floodplain**

The floodplain forms part of an alluvial plain that represents the area over which floodplains have shifted over geological time and is characterised by the presence of alluvial soils. The floodplain has been delineated by using the detailed 2m contours of the study area, as is shown on the map in **Figure 14**. The floodplain is characterised by the existence of various hydrological features comprising inflowing rivers, short flowing river streams, wetlands and lakes. A prominent feature is the Mhlathuze estuary. These areas experience occasional or periodic flooding under current circumstances.



**Figure 3: The historical floodplain within the coastal plain**

The interconnected movement of surface water and groundwater is a unique feature of this landscape, and is highly vulnerable to impacts imposed on the associated systems. A large part of this plain has been transformed by human activities through upstream damming, commercial agriculture, diversion of water courses and construction of the port and harbour. These developments resulted in a total transformation of the historical floodplain, including the diversion of the Mhlathuze River and the separation of Lake Cubhu from the original estuary system (**Figure 15**).

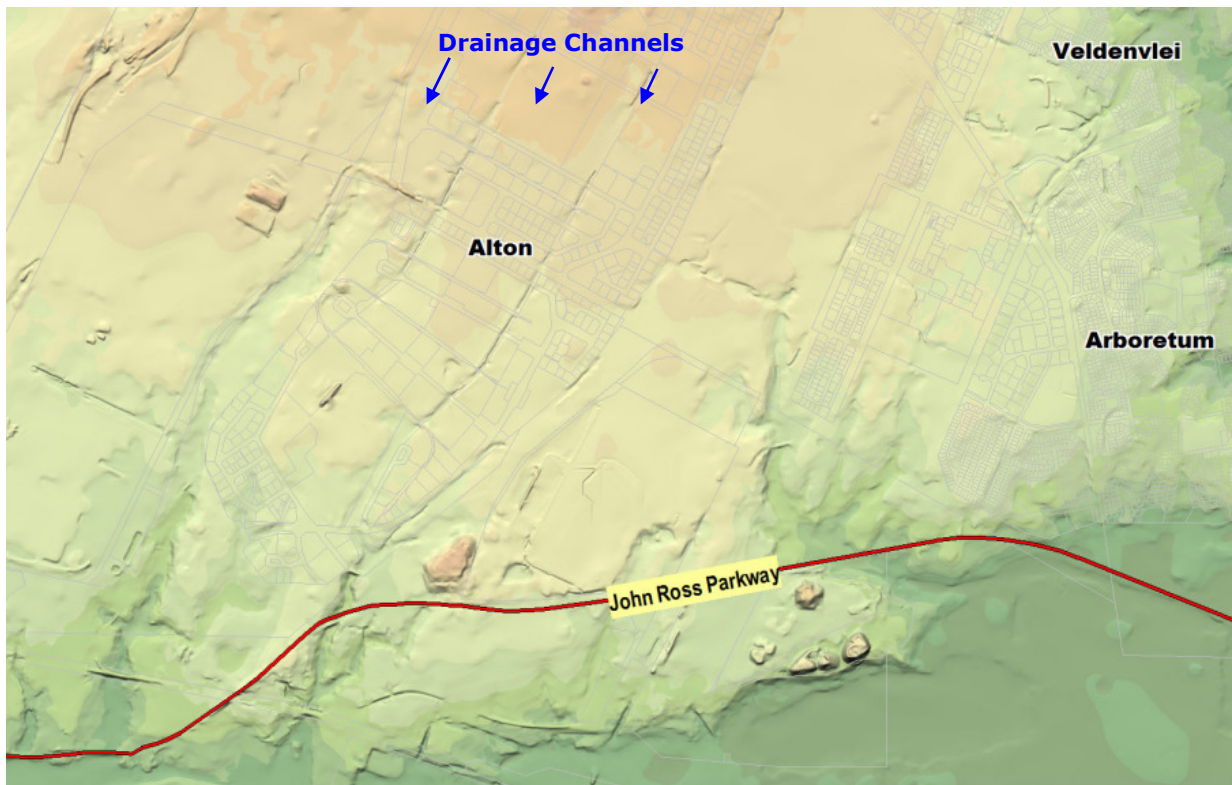


**Figure 4: Photograph of the berm that was constructed to separate the harbour (on the right) and the estuary (on the left)**

### **Sand plains**

The sand plains, consisting of fairly flat land, are intersected by river streams and occasional small wetlands. Where these abut the lakes, incisions of erosion activity created short valleys with relative steep slopes (**Figure 14**).

These areas are generally suitable for development. However, the existence of water-logged areas on the plains has necessitated the construction of drainage channels to mitigate potential flooding in the industrial area of Alton, as indicated on the shaded relief map in **Figure 16**. The interconnected movement of surface water and groundwater, and linkages with the adjacent floodplain, is a unique feature of this landscape, and is highly vulnerable to impacts imposed on the associated systems.

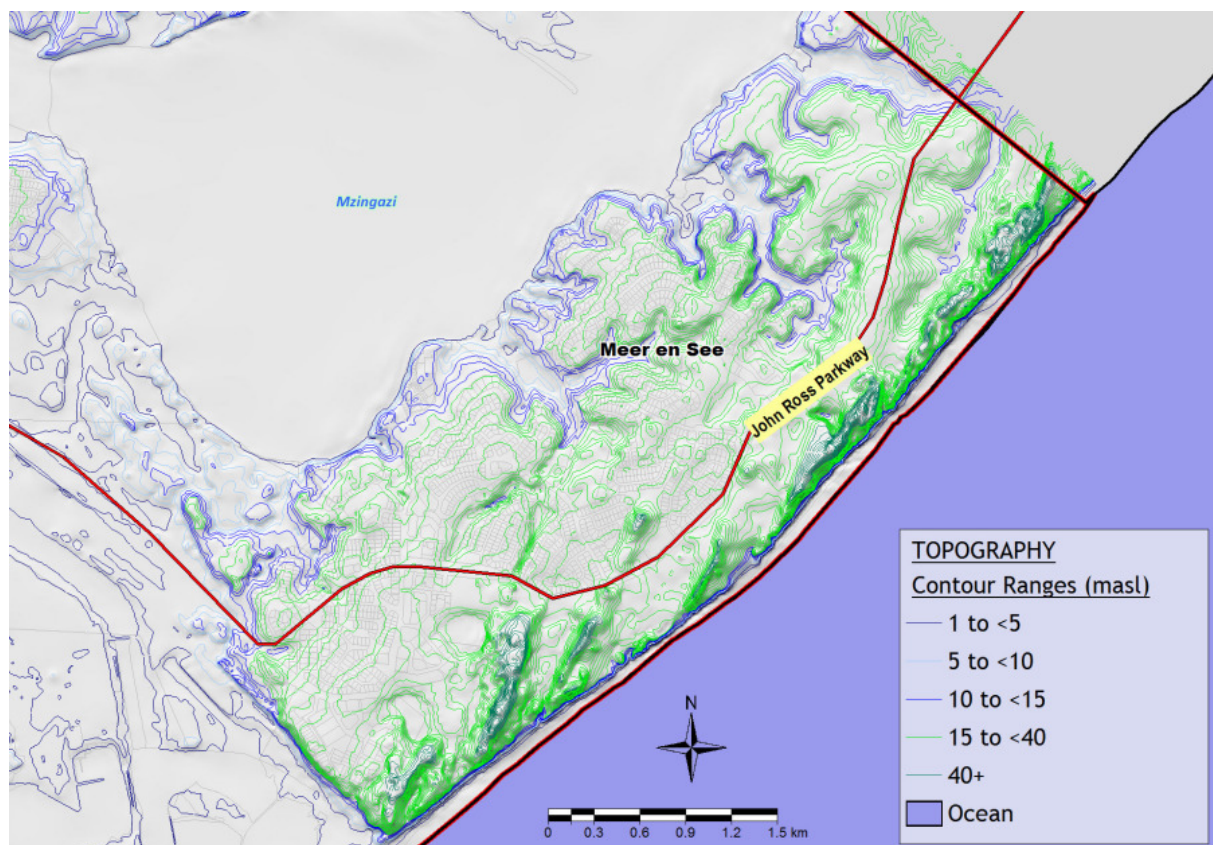


**Figure 5: Drainage channels indicated on shaded relief map**

### **Coastal Dunes**

Prominent dune ridges in a north-south orientation are a noticeable topographic feature of the coastal plain. They are generally composed of reddish sand and are distinguished from younger accumulations of light coloured sand, which are typical of the coastal plain. They occur in a distinct pattern of intermittent rows across the Zululand coastal plain and are more prominent along the coastline where the ridges can be traced from Mtunzini northward into Mozambique

This cordon is one of the largest coastal dune ridges in the world, with heights of almost 200m at places. These dunes are characterised by very steep slopes facing the winds from the ocean. The slopes are extremely vulnerable to any destructive forces, including natural wave action. The retreat and erosion of dunes is a concern in the area as it causes disruption to coastal ecosystems.



**Figure 6: Coastal dunes prominent along the coastline. Erosion of the sand plain evident around Lake Mzingazi.**

The presence of heavy mineral deposits renders these dunes high economical value. Mining of dunes currently occur in the south-west of the study area. Mining of the coastal dunes in the north east of the study ended in 2007. This area is currently being rehabilitated.

Cheniers (old dune ridges and interdunal slacks) occur in the southern part of the study area and has been identified as features worthy of conservation if placed under management even though they are presently under cane cultivation<sup>4</sup>. The origin and character of these land formations are quite distinctive, and their arrangements and composition are taken as evidence of a fluctuation in sea level. The north easterly aspects associated with the identified cheniers in the study area significantly enhances their ecological potential.

### **Coastline topography**

The study area forms a transitional landform zone between the continental and the marine. The significance of this zone lies in its characteristics that control water and sediment yields and how this

<sup>4</sup> Bundy S (2008) *General Concepts and Proposals for Conservation Management and Offsets as part of the Phased Port Expansion Programme*. Report produced for Ilifa Africa Engineers, August 2008. Progress report 2

interacts with near-shore and offshore coastal and marine ecosystems. The coastal geomorphology and sedimentology is well described in the literature<sup>5</sup>. It is not part of the scope of work in this EMF to identify and describe the near-shore and offshore coastal and marine features. However, any large-scale alteration to the features identified on the coastal plain will have an impact on the marine ecosystems. They are therefore briefly introduced here for purposes of ecological significance and to demonstrate that the study area is part of a “metasystem”.

The **KwaZulu-Natal Bight** is an unusually wide part of the continental shelf off south-eastern Africa, bordered on its seaward side by the intense Agulhas Current. The **Thukela Bank** lies seaward of the Bight. It is a section of the coastal shelf that widens along the Bight to a maximum width between Richards Bay and the Thukela River Mouth and supports an important offshore ecosystem.

## **9.4 Soils**

The soils in the area are closely related to the geology and landforms and comprise three main land types, namely deep grey sands, deep alluvial soils and red and yellow apedal soils (**Figure 18**). These land types are described below. The Port Due Diligence Investigations Project has appointed a specialist to undertake an agricultural potential analysis for the area earmarked for port development and for the offset area. The results of this study will be integrated into the EMF baseline upon completion.

### **Deep grey sands**

These soils are generally low in natural fertility because of their high permeability, rapid leaching of nutrient and because they are so thin (maximum of 60cm). Agricultural potential is low but the mild topography, high temperature and good rainfall favours the production of sugar cane. Extensive areas south of the estuary are cultivated with sugarcane. These soils are also suitable for timber production. Some of the inter-dune hollows contain accumulations of peat up to several metres thick.

### **Deep alluvial soils**

Alluvial and estuarine sediments occur on the Mhlathuze River floodplain and channels through which the river flowed at different times. These sediments range in texture from sands to clays. Soft, unconsolidated dark greys characterise the lower course of the Mhlathuze River including the harbour and the broader areas of the flood plain. The depth to suitable foundation material, about 65m in places has significant implications for construction costs. These areas also have an abnormally high

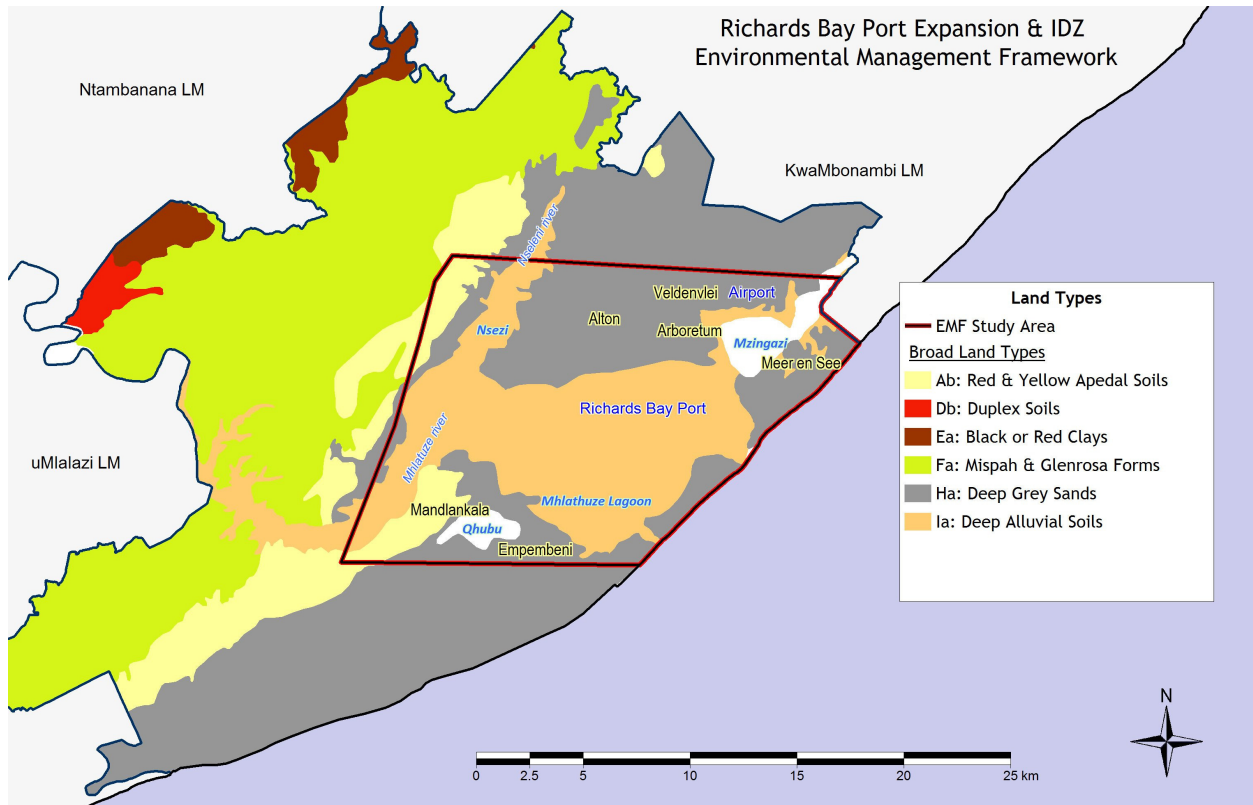
---

<sup>5</sup> Allanson B R and Baird D (1998) *Estuaries of South Africa*. Cambridge University Press, New York.

water table with significant cost and technical implications for the provision of engineering services, waste water and sewerage disposal systems<sup>6</sup>.

### **Red and yellow apedal soils**

Weathered dolerite produces the red and yellow apedal soils. Agricultural potential of these soils are good as they respond well to irrigation.



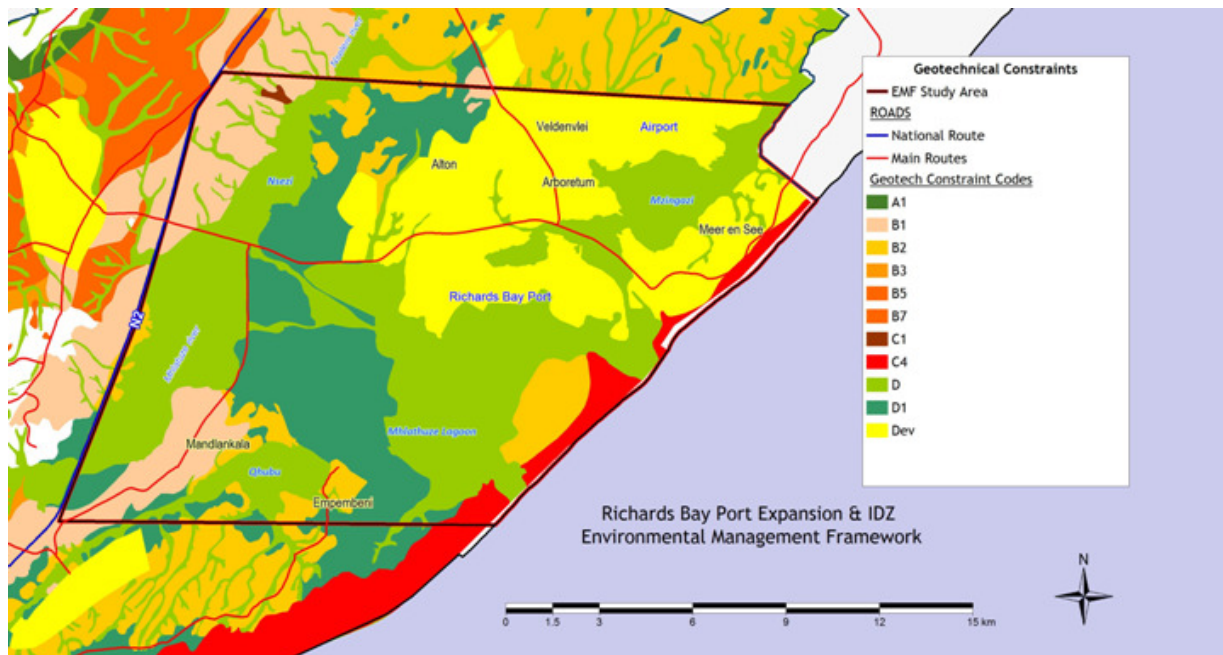
**Figure 7: Land Types**

## **9.5 Geotechnical conditions**

A strategic level assessment of the geotechnical conditions in the uMhlathuze Municipal region was undertaken during 2004<sup>7</sup>. The information was used to classify areas for the purpose of identifying constraints to development as well as difficult founding conditions, or other geotechnical factors affecting urban development. The various zones are illustrated in **Figure 19** below.

<sup>6</sup> City of uMhlathuze (2002) *Integrated Development Plan: Situation Analysis, Environmental Sector*. Report produced by Vuka Town and Regional Planners Inc, April 2002. Report TRP\_449\_N\_Rp169.

<sup>7</sup> Golder (2005) *Report on Engineering Geological Study undertaken for the uMhlathuze Municipal Area, KwaZulu-Natal*, April 2005. Report No: 6223-7059-4-G



**Figure 8: Geotechnical Constraints**

The zonal prefix (A-D) is based on the severity of the geotechnical or development constraints, or a combination of both, for a specific unit. They serve as an early warning for engineers and developers. A summary of the geotechnical and development constraint categories of the environmental sensitive zones have been extracted from the relevant report in **Table 7** below, whereas:

- **A** have no restrictions on development.
- **B** are developable, but with minor geotechnical and/or development constraints
- **C** is developable but with more costly geotechnical and/or development constraints. More detailed geotechnical investigations may be required.
- **D** recommends no development, or more detailed geotechnical investigations required.

**Table 1: Summary of environmentally sensitive geotechnical constraint zones**

ZONE	CONSTRAINTS
<b>C4</b>	Comprises the dune field extending along the coast characterised by windblown sands. These areas are environmentally sensitive, with steep vegetated slopes. Development costs of these areas will be high. Geotechnical constraints are nominal, with conventional foundations suitable for lightly loaded structures. Engineered soil rafts will be suitable for moderately loaded structures, while a piled founding solution will be required for heavily loaded structures.
<b>D</b>	Comprising those areas falling below the 1:100 year floodline, has been identified as unsuitable for development unless reclaimed, and should ideally be zoned for recreational purposes.
<b>D1</b>	Comprises either marshy areas above the 1:100 year floodline or areas susceptible to a perennial perched water table at depths shallower than 0.5m. The study recommended that development of these areas be avoided, unless the areas can be reclaimed.