9.2 Hydrology

In terms of spatial extent the total coverage of all hydrological features comprise approximately 40% of the study area (**Figure 20)**. This is significant bearing in mind the diversity of hydrological features and their functioning to support ecosystems as well as economic activities.

The social and economic activities in the EMF study area, which are extremely diverse in nature, are largely dependant on the availability of water. This section describes the linkages between the hydrological features and the vulnerability of the system in terms of the wider regional context.

9.6.1 Regional Context

Richards Bay lies within the **Usuthu-Mhlatuze Water Management Area** which is one of three large water management units in KwaZulu-Natal. It shares its resources with Mpumalanga, Mozambique and Swaziland. Richards Bay is the economic hub of the Water Management Area with a large number of user sectors including mining, industrial; irrigation and domestic having large water requirements.

Geographically the study area forms part of the **Mhlathuze catchment**. There is sufficient water in the catchment area to meet all requirements at present, but the resource has been over-allocated to users[1].

[1] DWAF (2000a) *Strategic Environmental Assessment for Water Use Mhlathuze Catchment – KNZ*. Report Number SEA-01/2000. Department of Water Affairs, Pretoria.

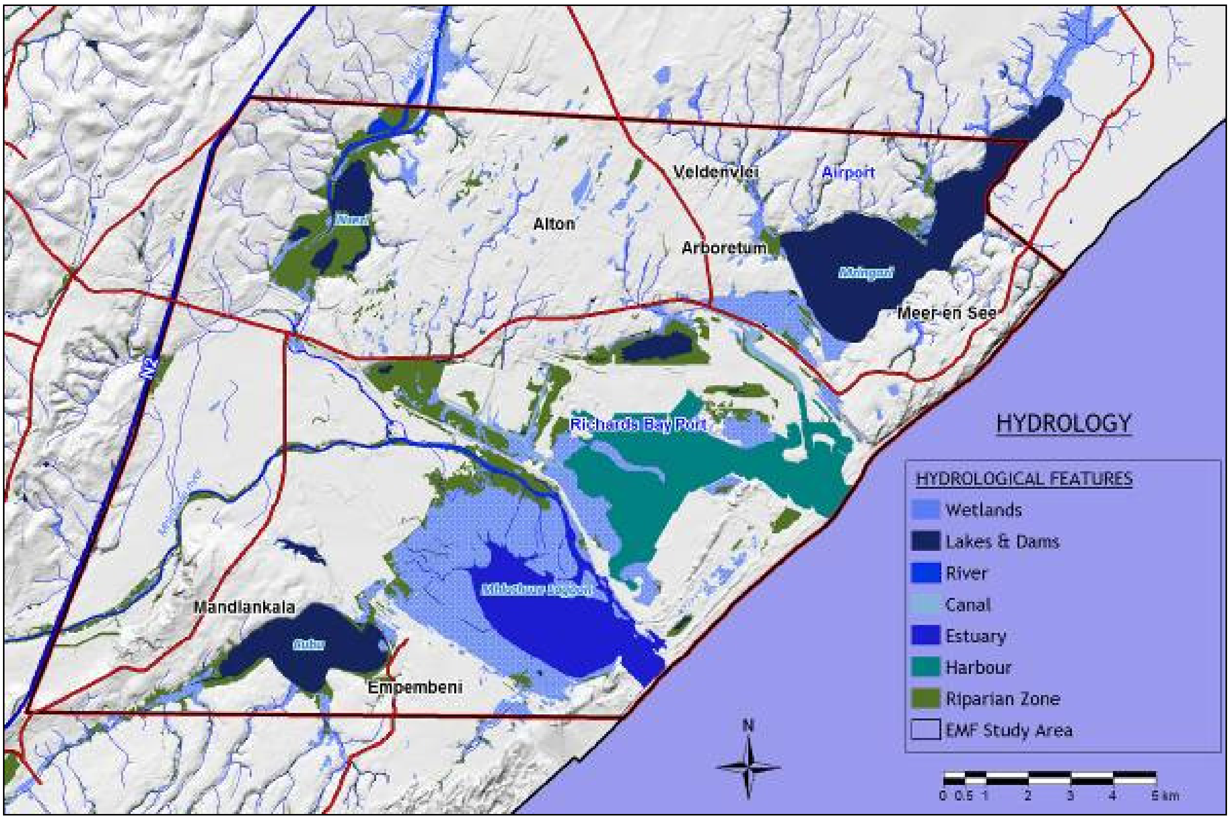

Figure 1: Surface Hydrology within the study area.

The uMhlathuze Municipal Area has also been delineated into **eight spatially distinct hydrological catchment units**[2] (**Figure 21**) which formed the basis for local policy[3] and management planning[4]. A ninth catchment unit has also been added, the **Ocean catchment**, which is the ultimate receiving environment for all run-off from the municipal area. The local studies to define these areas are a rich source of information for the EMF in terms of feature characteristics, environmental service asset descriptions and significance.

Future water use in the Mhlathuze catchment is uncertain and water shortages are projected in the near future[5].

[2] uMhlathuze Municipality (2004) *Strategic Catchment Assessment*. Prepared by the Institute of Natural Resources.
[3] uMhlathuze Municipality (2005) *Environmental Services Management Policy*. Status Unknown
[4] uMhlathuze Municipality (2007) *uMhlathuze Environmental Services Management Plan.* Updated report from the original 2005 Plan, prepared by FutureWorks and dated December 2007
[5] DWAF (2004) *Internal Strategic Perspective: Usutu to Mhlathuze Water Management Area*. Report prepared for the Department of Water Affairs and Forestry (DEAF) by Tlou & Matji (Pty) Ltd and dated March 2004. Report No. PB WMA 06/000/00/0304.

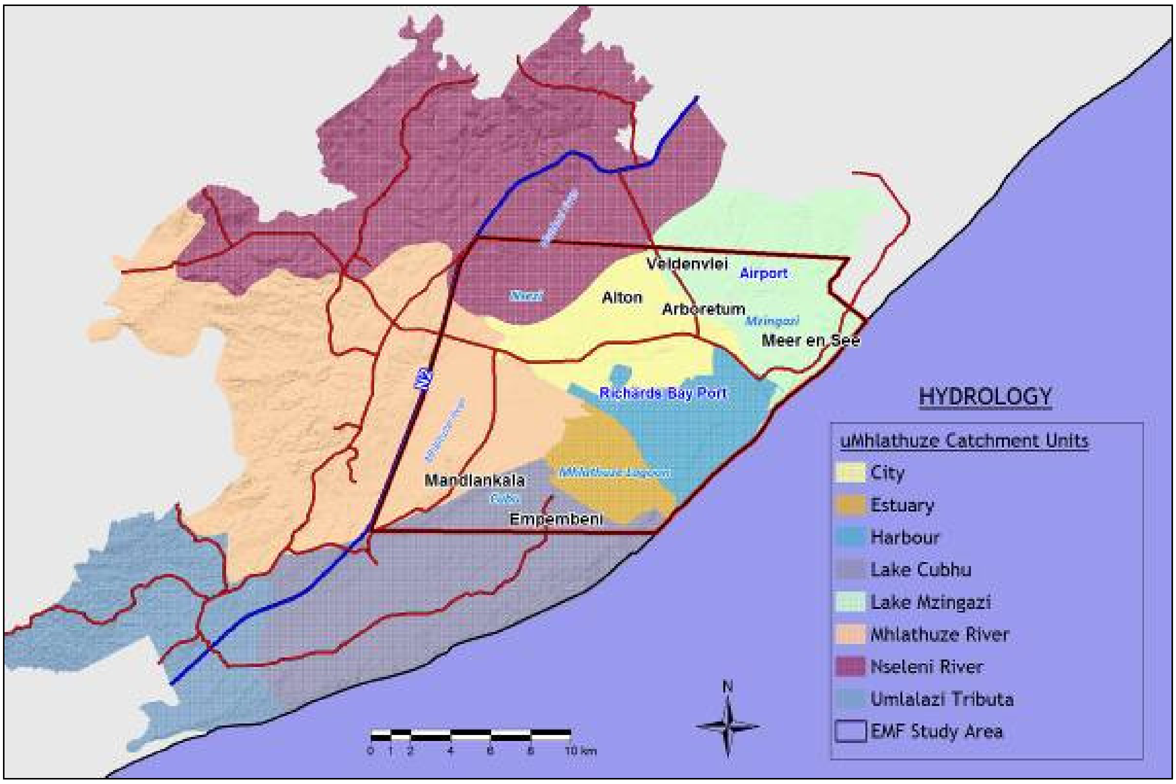

Figure 2: Catchment Units for uMhlathuze Municipality, as defined in the ESMP.

9.6.2 Surface Water Description

The surface water component comprises the following features:

- Estuary;
- Rivers;
- Lakes;
- Wetlands;
- Harbour;
- Canals;

In addition to the above a **Riparian Zone** is also identified, which is associated with the above features. These are briefly described as follows:

9.6.2.1 Mhlathuze Estuary

The original Mhlathuze estuary (**Figure 22**) consisted of a large shallow basin (lake), connected to the Indian Ocean through a narrow mouth north of the basin. Five rivers drained into the original system, the longest being the Mhlathuze River. Nearby lakes Mzingazi and Cubhu drained through the Mzingazi and Mtantatweni rivers respectively into the estuary. Two smaller rivers, the Bhizolo and Manzinyama, opened into the western end of the original estuary.

Richards Bay and Lake Mzingazi at 1:1840 on 5 August 1969

Figure 3: 1969 aerial photo of the Mhlathuze Estuary before development[6]

Substantial changes were made to the original system when the basin was divided in the early 1970s into a southern and a northern section by means of a large dyke to construct the Richards Bay Harbour. The Mhlathuze River was canalised and a new mouth had to be dredged through the dunes. The northern section became a **deep-water harbour**. The southern section became the **estuary** **(Figure 23)**.

Figure 4: Dyke with railway and road separating the harbour (left) from the estuary (right).

[6] Photograph sourced from Van der Walt, J.C (2007). *Zululand True Stories*. Richards Bay Printers. Richards Bay.

Within the context of the topography, with the estuary situated on a floodplain, it must be realised that the estuary is on the receiving end of rivers, streams, canals and diffuse seepage zones of freshwater that drain towards the estuary and the harbour. These streams are all linked hydrologically and ecologically to the surrounding lakes, swamps, and wetlands. The groundwater has strong linkages to all the other water resources that function as drainage boundaries (**Figure 24**). The groundwater is also the main flow component in some of these resources. Consequently the hydrological network forms a very important component of the water resources as it provides the hydraulic linkages, and often the ecological linkages, between the different resources.

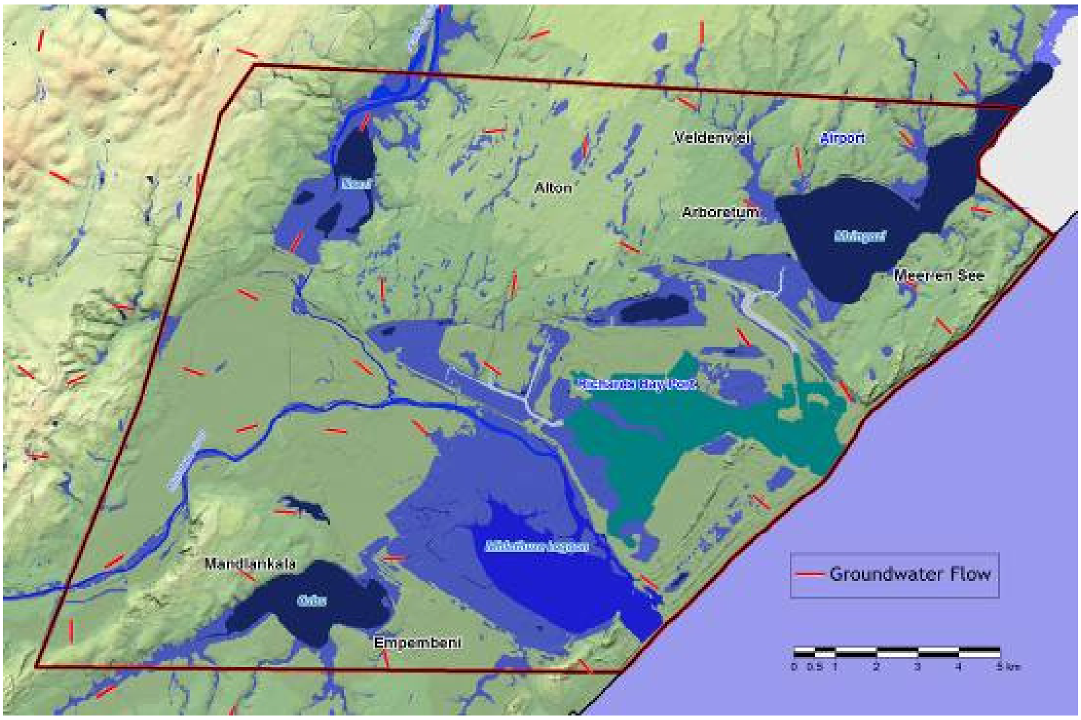

Figure 5: Groundwater flow following the incline of the topography.

The estuary is under increasing pressure as land use activities in the catchment increase in intensity. Major threats include sedimentation, siltation and pollution. The lack of sufficient fresh water in-flow is also regarded as a major concern.

In order to preserve the estuary, it has been declared a nature reserve and is known as the Richards Bay Sanctuary.

9.6.2.2 Harbour

The harbour is associated with a reshaped water body and high developed infrastructure nodes on the northern and eastern edges. Freshwater in-flows into the Port occur via the Bhizolo

Canal, the Manzamnyama Canal and the Mzingazi Canal. The maintenance of these inlets is critical for environmental asset management. The structure of the port and its operations has an influence on the hydrodynamic processes of the harbour and dredge spoils impacts the surf zone (increased turbidity) and have aesthetic and ecological implications. [7]

9.6.2.3 River Systems

Mhlatuze River

The Mhlathuze River, its tributaries and storage features (lakes) have been described in detail in the literature[8]. This is the largest river system in the study area and is characterised by a large flood plain that is exposed to intense exploitation and impacts upstream. The Nseleni tributary feeds the river where it enters the study area in the north-west through Lake Nsezi. From here the Nsezi stream is the freshwater link between Lake Nsezi and the Mhlatuze River.

The Mhlathuze River and its catchment have been substantially modified over the last couple of decades. The extent of local modification has reduced water inputs from the river to surrounding water features affecting hydrological pathways and ecosystem maintenance. The river's significance in terms of environmental service supply has been rated as high[9].

Nseleni River

This tributary of the Mhlathuze River enters the study area in the north-west. Its catchment is primarily rural in character with a predominant land use of commercial and traditional agriculture. There is inflow of treated sewage effluent from the Nseleni Township into the Nseleni River upstream of Lake Nsezi.

Nsezi Stream

This stream is the freshwater link between Lake Nsezi and the Mhlatuze River. It is a highly modified river in which flows are artificially reduced. The only water flowing into the Nsezi Stream under low to normal flow conditions comes from sugar cane drainage canals. The water reaching the Nsezi Stream contains elevated nutrient concentrations and is of poor water quality[10]. The significance of this stream in the aquatic and estuarine ecosystems is further discussed in section 9.3 of this report.

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[7] CSIR (2005) Strategic Environmental Assessment: Port of Richards Bay, State of the Environment Summary Report. CSIR Report No. ENV-D-C 2005-013, Durban, South Africa.

[8] DWAF (2002) *Mhlathuze Operating Rules and Future Phasing.* Report Number PB W120-00 (0199-0999). Department of Water Affairs (DWAF). Pretoria.

[9] uMhlathuze Municipality (2007) *uMhlathuze Environmental Services Management Plan.* Updated report from the original 2005 Plan, prepared by FutureWorks and dated December 2007

[10] Vivier L, Cyrus DP and Owen RK (2009) *Ecological Status of the Nsezi Stream*. A report prepared for Transnet Nnational Port Authority, Richards Bay through Ilifa Africa Engineers Pty (Ltd), *Final Draft*. Coastal Research Unit of Zululand, Investigational Report No 128.

Richards Bay Inner City Streams

All the rivers in the study area flow naturally or have been diverted into the "new" estuary with the exception of the small streams in Richards Bay and those draining the entire Mzingazi catchment which still drain into the harbour. There are three small streams in the central portion of Richards Bay (Alton) that drain directly into the Bhozolo or Ngodweni Canals and then into the deep water harbour. The streams provide many goods and services that depend on their physical characteristics and other attributes, most important of which are the ability to carry pollutants from the industrial area in to the harbour.

9.6.2.4 The Lake System

There are several lakes on the coastal plain that have been formed from an ancient lagoon system that once formed part of the Mhlathuze Estuary during the regression of the sea level. Lakes Mzingazi and Cubhu are classified as **coastal lakes** being supplied from direct rainfall, surface runoff and groundwater. These lakes have a very small stream network and are considered to have a strong, possible dominant groundwater contribution to their sustainable yield. Lake Nsezi formed at junction of the coastal plain and hard rock geological features giving it a different hydrological function to the coastal lakes. It is categorised as a **combination lake** being supplied from both groundwater and surface water (Nseleni River and direct rainfall).

Lake Nsezi

The geohydrological conditions of this lake are unique as it is situated at the edge of the coastal plain. It is the main storage reservoir in the City of Mhlathuze. The Nseleni River is the main source of recharge to the lake. The inflow to Lake Nsezi from the Nseleni River is supplemented by the Thugela transfer scheme via the Mhlathuze River. There is relatively insignificant amount of groundwater contributing to the sustainable yield of the lake.

The uMhlathuze Environmental Services Management Plan recognises Lake Nsezi as a feature of high significant for performing water quality buffering and improvement functions. Its potential to become a RAMSAR site has also been acknowledged.

Lake Cubhu

Lake Cubhu was formed by the siltation of the Mhlathuze flood plain during the rise and fall in sea level. A narrow, low lying flood plain exists between the lake and estuary that is less the 2 mMSL and probably subject to flooding during extreme events. There was no clear channel at the outlet to the lake but a culvert now exists with an overflow at about 2m MSL.

The uMhlathuze Environmental Services Management Plan recognises Lake Cubhu as a key natural feature of national importance because of its surrounding characteristics and ecological processes. The lake is also a key local water supply source.

Lake Mzingazi

The Lake is bounded on the southeast by high aeolian dunes and on the northwest by a much broader band of paleodunes that run parallel to the coast between the Lake Nsezi valley (Mposa river) and Lake Mzingazi. Lake Mzingazi formed during the systematic closure of the estuary by sedimentary deposits across the southwest channel draining onto the Mhlathuze floodplain to form a freshwater lake with a small river network. The stream network feeding into Lake Mzingazi is distinctly dense feeding into the lake through the residential areas of Meerensee, Mzingazi and Arboretum.

Lake Mzingazi is exposed to potential saline intrusion via near surface sand horizons during periods of drought and water table decline. This was recently highlighted when the lake storage capacity was almost depleted during the drought of 2004/5. At present an artificial barrier constructed to restrict the water table decline has reduced saline infiltration.

The uMhlathuze Environmental Services Management Plan rates Lake Mzingazi as a significant feature in terms of its environmental assets and services supply. Water extraction from the lake is for industrial use.

Thulazihleka Pan

This is a man-made pan which owes its origin to the disposal of spoil dredged in 1976. There is no inflow or outflow and it is maintained by rain, seepage and runoff. It lies in an area largely surrounded by industrial sites. Elevated conveyer belts from the nearby fertilizer factory (FOSKOR) transports material over the western end of the pan. The pan is exposed to direct and indirect groundwater pollution. The highly eutrophic state that has resulted is attracting unique bird-life. This has been confirmed by an analysis of water bird trends since the early nineties[11]. The Pan has subsequently become an important conservation feature. It is recognised as an internationally important bird

Long-term sustainability of the Thulazihleka Pan

There is a potential conflict in the current and projected land use and pressures of the Pan and promoting biodiversity conservation as a long-term management objective.

Some say the pan may be 'dying' and would therefore lose its amenity value (bird watching) and biodiversity value (habitat and waste regulation) over the long term. These stakeholders support infill development and the release of the land for optimal land use, i.e. industrial development.

Others believe the pan has resilience and should be managed and maintained for ecological integrity.

The most sustainable management option would need to be informed by a cost-benefit analysis.

[11] CWAC (2009) *Thulazihleka Pan*. Coordinated Waterbird Counts (CWAC). Downloaded from http://cwac.adu.org.za on 6 November 2009.

area[12] and has an ecotourism or an "avitourism" value[13]. The Thulazihleka Pan Complex has been identified as highly significant as it forms part of the functional biodiversity corridor between Lake Mzingazi, harbour estuary complex, Lake Nsezi and Nseleni River[14]. It is under increasing pressure development and forms in its totality the Phase 1E component of the IDZ. Apart from groundwater linkages the pan has no apparent hydrological function.

Figure 6: Aerial view of Thulazihleka Pan

Riparian Zone

The area of land adjacent to a stream or river that is influenced by fluctuations of water levels is the riparian zone. This zone is primarily defined by the geomorphology of the river valley and the nature of the substratum as well as the hydrological features of the waterbody. It normally manifests in distinct longitudinal zones of vegetation associated with wet conditions. The nature of this zone is extremely variable and may range from a narrow grass or sedge dominated stream bank to a permanently flooded reed vlei. The extent of the riparian zone is illustrated in **Figure 26** below.

[12] Birdlife International (2009) Important Bird Area Factsheet: Richards Bay Game Reserve, SA. Downloaded from the Data Zone at http://www.birdlife.org on 7/09/2009.
[13] Allan D G and McInnes A (2002) *Richards Bay Water Bird Survey – January 2002 – Interim Report.* Durban Natural Science Museum Bird Department Research Report 14:1 -40.
[14] uMhlathuze Municipality (2007) *uMhlathuze Environmental Services Management Plan.* Updated report from the original 2005 Plan, prepared by FutureWorks and dated December 2007

Although this zone has no primary hydrological function, changes in water levels, being it surface water or groundwater, will be detected through changes in the associated vegetation.

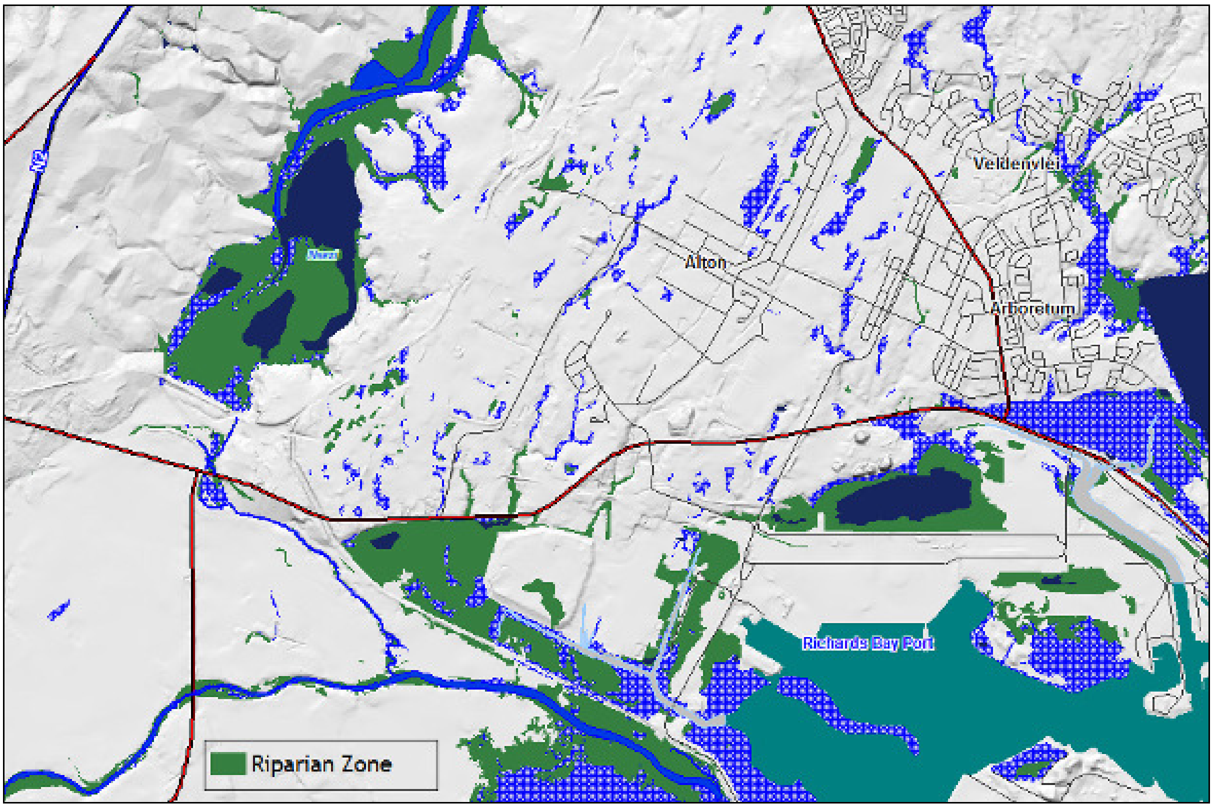

Figure 7: The extent of the riparian zone around Lake Nsezi and the port area.

9.6.3 Ground Water Aquifers

The groundwater associated with the City of Mhlathuze is directly controlled by the underlying geology of the area. The groundwater can be separated into the *primary aquifer* in the unconsolidated sediments (Richards Bay and eSikhawini) from the *secondary aquifers* in the older fractured rock system (Empangeni) as described in the geology section. The rate of recharge to the groundwater and the storage and discharge from the aquifers is hydrologically different for the two aquifer systems. In the primary aquifer the groundwater is stored in the pore spaces (matrix porosity) between the unconsolidated sand particles while it is mainly stored in fractures and fissures in the secondary aquifers with little storage in the pore spaces of the consolidated rock material. Abstraction from the two aquifers and the analysis of hydraulic properties is fundamentally different for the two aquifers. The secondary aquifer does not fall within the study area. The primary aquifer is described below.

Primary aquifer

This aquifer underlies the Richards Bay Region. It was formed by the layers of unconsolidated marine, aeolian and alluvial deposits. It is a shallow aquifer and the water levels are strongly influenced by topography. The aquifer forms extensive lakes and wetlands where the water table is at or immediately below (<1m) the surface. It is also an important source for replenishment of major water bodies in the study area. The development of various vegetation types is controlled by the depth of the saturated zone. Groundwater flow is generally controlled by the presence of main drainage areas such as rivers and lakes. Infrastructure development in the area influences the direction of groundwater flow.

The different hydraulic properties of this aquifer are often treated in a manner that derives a single aquifer while other researchers recognize significant differences in aquifer units. This study draws on local knowledge [15] to derive two aquifers from the primary aquifer: the southern aquifers (eSikhawini to Mhlathuze River) and the northern aquifers (Mhlathuze River to Mzingazi catchment).

eSikhawini Aquifers (southern aquifers)

The main drainage features are the Ocean on the east, the Mhlathuze River in the west, the Umlalazi River in the south and the Mhlathuze estuary in the north. There are two small streams draining to the Ocean but the main internal drainage network is comprised of many small streams that feed into Lake Cubhu. The water table is very close to the topographical surface in the area and is exposed in many areas. The aquifer development potential is low.

Richards Bay Aquifers (northern aquifers)

The aquifer development potential is medium to high. Groundwater is used for irrigation purposes for the sugar cane fields and is abstracted from the Mhlathuze flood plain.

9.6.4 Groundwater-Surface Water Interactions

The groundwater has strong linkages to all the other water resources that function as drainage boundaries. The groundwater is also the main flow component in some of these resources. Consequently the hydrological network forms a very important component of the water resources as it provides the hydraulic linkages, and often the ecological linkages, between the different resources. This situation generates a very sensitive environment in which negative impacts on the groundwater will be reflected in the surface water bodies and vice-versa. Variations in the groundwater and surface water levels during wet and dry periods can also generate changes in the flow direction, further

[15] Kelbe B (2009) *Draft Interim Status Quo Report on the Water Resources of the EMF Study area.* Hydrological Research and Training Specialists, September 2009.

influencing this interconnected system. This complex situation makes the groundwater-surface water interaction highly vulnerable to change. Contamination risks are therefore a key concern in the area.

9.6.5 Water Quality

The quality of water determines its suitability for all uses and to a water-scarce country like South Africa, deteriorating water quality exacerbates an already problematic situation.[16] Water quality tests in the EMF study area indicate pollutants of the water systems emanating from internal as well as external sources. This includes industrial effluents and chemical fall out, sewage spills, mine drainage, agricultural runoff and dust from the mines and the coal terminal.

Deteriorating water quality influences human health, the aquatic ecosystem (aquatic biota, and in-stream and riparian habitats) and has economic implications for various sectors of the economy, including agriculture, industry and recreation. Water quality problems can lead to increased treatment costs of water used for consumption and industrial processes, and decreased agricultural yields. If the carrying capacity of the natural system is exceeded the problems associated with water quality can become exacerbated.

According to DWAF (2002) s16oil conservation or the lack thereof appears to be a major concern, particularly in the Mhlathuze catchment. Land use practises which do not promote soil conservation seem to be a major problem, leading to erosion and sedimentation of the rivers. Evidence of this was detected during an aerial survey in September 2009 (**Figure 27**). Bad management practices, lead to a greater silt and clay load ending up in the rivers and eventually in the estuary. This has been raised as a great concern by Ezemvelo KZN Wildlife.

Figure 8: Evidence of mining operations impacting on the Mhlathuze River (September 2009).

[16] DWAF, (2002). *Water Quality Issues in the Usutu-Mhlathuze: Review of Water Quality Status and Issues in the WMA*. Dwaf/Dfid Strategic Environmental Assessment. August 2002.

Results from tests undertaken by the Water Research Commission (2004) show that most of the physical and chemical values of sampling points in the Mhlathuze River were within the recommended limits specified in the South African Water Quality Guidelines. Water samples from the Mhlathuze Pumping Station, which contained higher concentrations of total nitrogen and phosphate, possessed higher faecal coliform contamination than other sites. This is indicative of point source contamination outside of the EMF study area. Due to the high salt concentration at the Richards Bay Estuary, the bacterial counts were much lower than those at other sites. However, high concentrations of metals (cadmium, lead, aluminium) were detected in the water samples from the estuary.[17] The point source contamination is evidently located within the EMF study area.

The groundwater in Richards Bay has been monitored by various organization for different purpose. While no known groundwater abstraction occurs in the study area the impact of the groundwater quality on human consumption relates to the abstraction via the coastal lakes and streams. However, all indications suggest that a large proportion of the stream flow and lake inflow is directly from groundwater and consequently the groundwater quality must have an impact on the stream and lake water quality.

For the purpose of further analyses into the next phase, the following general issues as identified by DWAF[16] are noted:

- Flows into wetland and lake systems are compromised by up-stream pollution;
- Hazardous waste spillage along the N2 pose a threat along the western boundary of the study area;
- Groundwater – water quality and potential conveyor of pollutants to other resources such as lakes;
- Growth of industrial activities in the EMF study area – increasing impacts on water resources.

9.3 Geohydrological constraints

A strategic level assessment of the geohydrological conditions in the uMhlathuze Municipal region was undertaken during 2004 to better understand and manage the potential geohydrological risks[18]. Three main vulnerability classes were defined and are summarized in **Table 8** below. This study provided recommendations for specific site investigations for each vulnerability class in the event of a proposed development.

[17] Lin J, Biyela PT, Puckree T and Bezuidenhout CC, (2004). *A study of the water quality of the Mhlathuze River, KwaZulu-Natal (RSA): Microbial and physico-chemical factors*. Water Research Commission. January 2004.
[18] Golder (2004) *Strategic Level Assessment of Geohydrological Conditions in the uMhlathuze Municipal Area*. Report No: 6223/6568/1/G, 3 November 2004.

Table 1: Groundwater vulnerability classes (after Golder, 2004)

CLASS	CHARACTERISTICS	RECOMMENDATIONS
HIGH	Indicating shallow groundwater level (< 2m below surface) with a high risk of direct percolation of leachate into groundwater.	These areas will require the most stringent assessment of prevailing groundwater conditions prior to the development and strictly controlled monitoring and management programmes during the operational period of the development.
MODERATE	Indicating groundwater level varying from 2 to 5m below surface and a time delay before potential contamination reaches the saturated zone.	These areas can be considered for development if provision for systematic monitoring is made
LOW	Indicating groundwater level >5m below surface with a reduction in aquifer vulnerability.	These areas are generally suitable for development.

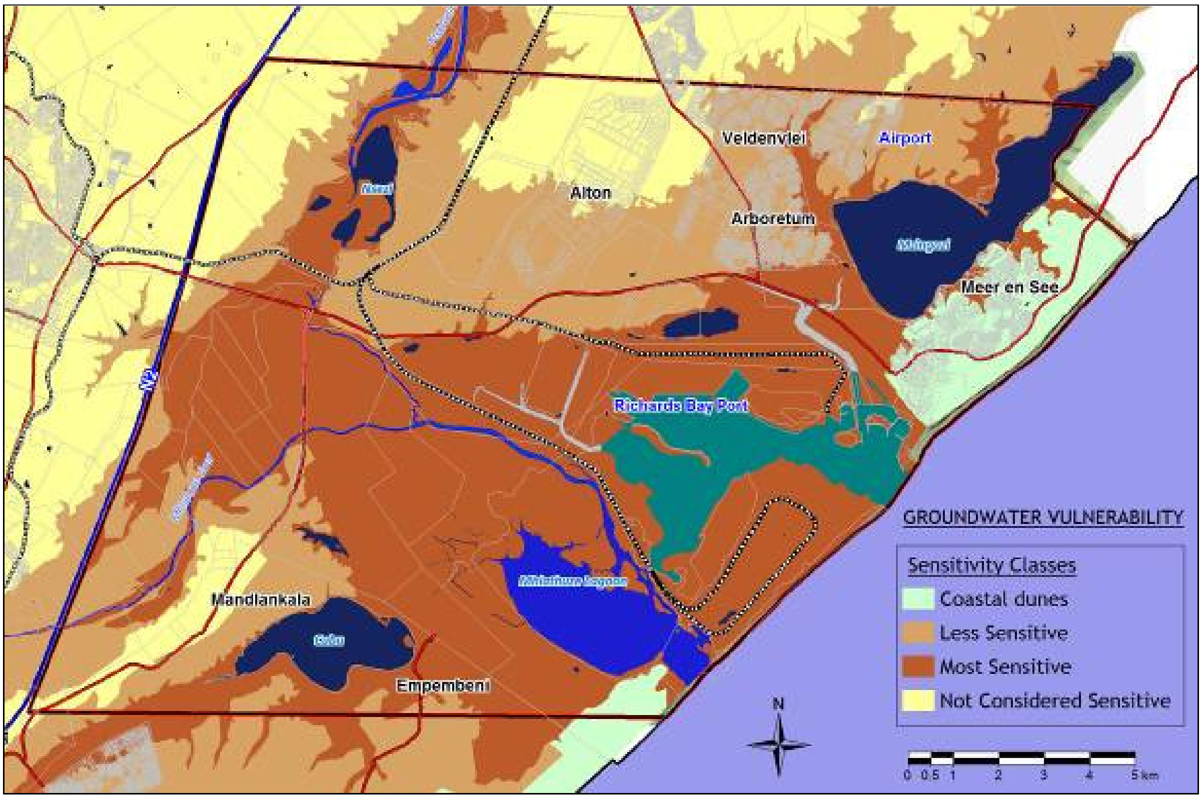

Figure 9: Sensitivity classes of ground water (Refer to Table 4 above)