

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT
SEISMIC REFLECTION SURVEY AND WELL DRILLING,
UMKHANYAKUDE DISTRICT MUNICIPALITY, NORTHERN KZN

Client: SANEDI-SACCCS



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Abbreviations

CCS	carbon capture and storage
CO ₂ (CO ₂)	carbon dioxide
CO ₂ -e	carbon dioxide equivalent, the unit of measurement for greenhouse gases.
GHG	Greenhouse gas
OECD	Organisation for Economic Co-operation and Development
PCSP	Pilot CO ₂ Storage Project
VP	vibroseis source points

Executive Summary

This report describes the proposed geological precursor project to the Pilot CO₂ Storage Project (PCSP) that is being undertaken with funding support from the World Bank to South Africa's Department of Energy and SANEDI-SACCCS. The 2D seismic survey using the "vibroseis" technique, followed by the siting and drilling of deep wells to provide rock core of the proposed CO₂ reservoir lithological units is a critical step in the CCS roadmap that was endorsed by the South African Cabinet. The selection of the most suitable onshore Mesozoic sedimentary succession in the context of either the Zululand or Algoa Basins must be informed by core samples and analytical data that cannot be derived from the existing seismic profiles or lithological drill hole logs that were generated during the 1970's oil search in these basins.

This Environmental and Social Impact Assessment (ESIA) report compiled according to the World Bank guidelines is specific to the preliminary geoscience investigations comprising vibroseis survey and stratigraphic drilling to define the regional lithostratigraphy, geological structure and rock characteristics. Should the geoscience surveys prove the geological succession underlying the study region to be suitable to host the PCSP, a separate ESIA and application for environmental authorisation, including a public participation programme, will be carried out in line with South African legal requirements.

1. Introduction

Fossil fuels supply most of the energy consumed globally and this source of greenhouse gas emissions will continue to rise, contributing to the increase in average global temperature compared with pre-industrial levels. The Global CCS Institute (2013, 2015) stressed the vital need to include CCS in a portfolio of low-carbon technologies to tackle climate change as a low cost mitigation alternative. There is an urgent need for governments to advance CCS by supporting demonstration projects that will build confidence in the technology. Developing countries rely on readily available cheap sources of fossil fuels so the developed nations recognize the need to for CCS technology as part of the low-carbon options portfolio. A summary of the current status of the global CCS industry has been published by the Global CCS Institute (2015).

2. Project description

Approximately 60% of the more than 400 million tons of CO₂ emitted annually in South Africa, is sequestratable, including nearly 30 million tons of ~95% pure CO₂ emitted by the synthetic fuel industry that can be used by any envisaged CCS project in South Africa. Potential storage contexts have been described in the geological storage atlas (Cloete, 2010). Preliminary geological studies have indicated ample capacity associated with deep saline aquifers offshore where the costs are prohibitive for a PCSP.

A small-scale demonstration PCSP (~10,000 tons per year) has been proposed in the context of an onshore extension of a Mesozoic sedimentary succession to prove the technology and develop the skills of local scientists and engineers through first-hand experience. On the basis of the analysis of data and literature from the 1970's oil searches, the Zululand and Algoa Basins have the most suitable geological reservoir characteristics. The proposed PCSP must be sited using high resolution seismic profiling and core drilling to produce a 3D model of the lithological succession to assess the suitability of coarse-grained sandstone units and access the capping/lateral seal strata. Confirmation of these relationships and the physical properties of the lithologies relies on the drilling of up to three deep wells to intersect and obtain intact core from target sandstone units that can be analysed to define the permeability / porosity of both aquifers and lateral/ vertical argillaceous seal units that lie at depths of >800m to >1,200m below the

Maputaland coastal plain of northern KwaZulu-Natal. Should the Zululand Basin lithological context prove to be unsuitable, the focus will turn to the Algoa Basin as a possible alternative site?

2.1 Location and regional context

The onshore Zululand Basin succession underlies uMkhanyakude District Municipality (UKDM) with most of the proposed activities located within uMhlabuyalingana Local Municipality.

2.2 2D seismic reflection survey and well drilling; project description and technical aspects

The World Bank will provide funding through the Department of Energy to finance the PCSP project that will be administered by SANEDI-SACCCS which will appointment of specialist consultants and contractors to undertake the proposed seismic (vibroseis) survey and deep well drilling project.

The terms of reference of the project are;

- (i) Design and execution of a high resolution 2D seismic reflection survey.
- (ii) Design and drilling of deep wells to ~ 2000m depth,
- (iii) Analyses and integration of the data to develop 3D static models of the target stratigraphy.
- (iv) Recommendation of further site(s) for potential use of the SACCCS PCSP.

2.2.1 Seismic survey (vibroseis) process

The high resolution 2D “vibroseis” seismic survey scope of work entails acquisition, processing, interpretation and reservoir modelling phases based on ~500 km of traverse lines, with recommendations for well placement and construction of a 3D static reservoir model. The seismic reflection survey comprises 11 intersecting traverses ranging from ~17 km to 87 km in length using vibroseis vehicles and seismograph array which require a 5m wide access swathe along the traverse line which will be pegged at 15m intervals for alternate geophone plus shot locations. The mean production rate is around 195 VP's (vibroseis source points) or 5.8 line km per day. The traverses are aligned with existing roads and tracks, comprising 160 km of tar roads, 153 km of gravel roads and 169 km of unsurfaced tracks and firebreaks. Trimming/pruning of encroaching vegetation is necessary along sections of some tracks.

2.2.2 Well drilling

Up to three boreholes, up to 2,000 m deep, will be sited at locations identified from the analysis of the intersecting 2D seismic reflection survey profiles. Major activities include well location selection and assessment, well design, site establishment, drilling, coring, logging and core analyses, wireline formation test and leakoff test in the Cenomanian and Aptian sandstone units and site decommissioning.

2.2.3 Data integration, subsurface analysis and reservoir modelling

Major activities include integration of well log data and seismic profile data for regional cross-section correlation, reservoir distribution and quality assessment, construction of 3D reservoir model, capacity estimation, and dynamic reservoir modeling.

3. SOUTH AFRICAN POLICY FRAMEWORK FOR CCS

In 2009, the South African government committed to reduce the country's emissions by 34% from 2020 and 42% by 2025. The projected emissions from coal based electricity generation translates to a 2.04% average increase in emissions per annum between 2010 and 2020, which falls significantly short of the emissions reduction rate of 0.2% required to meet the national commitment. South Africa will face a carbon chasm of 253 million tonnes CO₂-e in 2020 when this gap between the national commitment and

national emissions would constitute approximately half of current estimated emissions in spite of renewable energy programmes and energy efficiency measures. The use of carbon capture and storage (CCS) as a green-house gas emission mitigation measure is being spearheaded by the Centre for Carbon Capture and Storage (SACCCS), a unit of the South Africa National Energy Research Institute (SANEDI).

3.1 South Africa's government commitment to CCS

3.1.1 Cabinet endorsement of CCS plan

South Africa's Cabinet approved a Carbon Capture and Storage (CSS) Roadmap for the storage of carbon dioxide (CO₂) in deep geological formations on 4 May 2012. CCS involves capturing CO₂ from a point source, such as a power station or coal-to-fuel plant, transporting it (usually by pipeline but by tanker for the PCSP) and pumping it down a borehole into porous rock formations deep underground, where it is contained and stored. South Africa's is reliant on foreign financial and technological support to develop its CCS capacity. The government of South Africa has set aside R197-million over a three-year period to support SACCCS in implementing the CCS roadmap. Norway has pledged R28-million to South Africa's CCS activities and the World Bank's CCS Capacity Building Trust Fund is another source of additional funding. At the UN Climate Conference in Paris, known as COP21, 196 countries including South Africa set a goal of limiting global warming and calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. It is likely that the importance of CCS towards meeting these goals will grow if other methods to reduce net greenhouse gas emissions fail to meet targets by specified dates.

3.1.2 CCS Roadmap to be implemented by SANEDI-SACCCS

Analysis by International Energy Agency (IEA) shows that could contribute up to one-sixth of the total CO₂ emission reductions required by 2050. South Africa's abundant coal resources will continue to be exploited as part of an increasingly diversified energy mix.

The strategy of SANEDI-SACCCS to implementing South Africa's CCS plan that could see commercial application of CCS in the future follows a phased "Roadmap" approach. The five phases of the CCS Roadmap implementation strategy are:

1. **Preliminary Potential Investigation;** completed in 2004, this phase showed that on a theoretical level, South Africa had capturable CO₂ emissions and potential geological storage sites.
2. **Geological Storage Atlas;** produced the Carbon Dioxide Geological Storage Atlas (Cloete 2010). This geological inventory of potential storage sites identified priority areas that could be investigated for the location of a storage site suitable for the PCSP. The geological studies proposed here is project is the culmination of the previous investigation phases and will assess the suitability of specific geological formations for the purpose of CO₂ storage as part of a future Pilot CO₂ Storage Project (PCSP).
3. **Pilot CO₂ Storage Project (PCSP) Experiment;** a test of safely injecting CO₂ into rock reservoirs is essential to understand the suitability of South African specific geological contexts for development as a storage medium on a sustained commercial scale. A test injection pilot project of the order of a few ten thousand tons is necessary to ascertain the dispersion and transformation reactions of the carbon dioxide in the storage medium and its effects on the surroundings of the storage aquifer or geological reservoir rock medium.

4. **Demonstration Plant (Planned)**; a demonstration plant will test an integrated operating system under local geological and environmental conditions, as an essential progression from feasibility injection trials and a full scale commercial plant.
5. **Commercial Operation (Planned)**; the magnitude of the commercial scale operation is in the order of millions of tons of carbon dioxide per year.

3.1.3 Progress towards implementing the CCS Roadmap

International Energy Agency (IEA) analysis shows that CCS would remain a critical greenhouse-gas reduction solution. Other demonstration projects were under way in Norway, the US, Australia and Algeria, "There are five projects operating in the world that have stored over five-million tons of CO₂."

Reports based on prior projects, "Toward an effective CO₂ storage capacity assessment of the Zululand Basin, South Africa" (Viljoen et al., 2011), and "Storage potential, capacity estimate and area selection for carbon dioxide storage in the Algoa Basin, South Africa" (Hicks et al., 2013).

Both projects found that insufficient data exist to complete 'full effective storage capacity assessments' according to international criteria and recommended the following;

- Additional 2D seismic reflection surveys to verify both the eastern and western extent of the (Aptian) reservoir and its geometry, thickness and structure.
- Drilling of boreholes to verify rock porosity and permeability of the reservoir cap and seal.
- Investigation of shallower, isolated sandstone bodies which have better porosity and permeability.

The scope of work to be undertaken entails a high resolution seismic survey, preferably a vibrating source (as opposed to dynamite), along linear transects covering ~500 km aligned with remnant exploration cutlines, tracks, firebreaks, and public roads across the Maputaland region and drilling of at least two deep wells to retrieve core for lithological analysis.

4. Legal and administrative framework

During the project planning phase the SANEDI-SACCCS and CGS project team considered the legal context under which the preliminary geological research and the PCSP would need to be authorized. The seismic profiling operations and deep drilling of boreholes to obtain rock core and to conduct *in situ* tests, is a separate project that will determine whether the onshore Zululand Basin succession is suitable for the development of the subsequent PCSP. The techniques to be used are commonly associated with mineral prospecting, groundwater exploitation and even geotechnical site investigations.

The SANEDI-SACCCS and CGS team investigations have revealed that none of the applicable Acts cater specifically for CCS activities, nor associated investigations. Since the project will be funded through the involvement of The World Bank, the ESIA environmental planning and management process will be incorporated as part of the project development proposal and not as a separate process.

4.1 Environmental and Social Risk Assessment (ESIA) process

The Equator Principles have been voluntarily adopted by International Finance Corporation (IFC), part of the World Bank. This risk management framework for determining, assessing and managing environmental and social risk in projects is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. The institutions believe that negative impacts on project-affected ecosystems, communities, and the climate should be avoided where possible, and if these impacts are unavoidable they should be minimised, mitigated, and/or offset. Environmental and

Social Impact Assessment (ESIA) is a documented, systematic assessment of likely environmental, social and economic impacts resulting from the construction, operation and implementation of a proposed project, plan or policy”.

4.1.1 OP 4.01 - Environmental Assessment (The World Bank, 2013a)

The World Bank requires environmental assessment (EA), a process that examines project alternatives, sustainable development as well as technical and economic considerations and identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. The responsibility for carrying out the EA falls on the project implementation organization which must involve the expertise of independent environmental specialists. The scope of EA activities is informed by the nature and scale of the project and associated environmental impacts. The investigations must take into account the biophysical natural environment, human health and safety and social aspects within the project context but also consider possible transboundary and global environmental aspects. The EA process is integrated with environmental management frameworks defined by national legislation or policy, and international treaties and agreements.

Environmental screening and project classification by the World Bank is relative to four Categories (A, B, C, FI), on the basis of its type, scale, location and sensitivity on the basis of its potential environmental impacts. The proposed scope of work for this geological research project can be classified as “**Category C** – minimal or no adverse environmental impacts requiring no more than environmental screening level investigations”.

A project environmental management plan (EMP) consists of the set of mitigation, monitoring, and institutional measures to be taken during implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels.

4.1.2 OP 4.04 – Natural habitats (The World Bank, 2013b)

The Bank policy promotes and supports the protection, maintenance, conservation and rehabilitation of natural habitats and improved land use and does not support projects involving the significant conversion of natural habitats. A precautionary approach is applied to natural resource management to minimize habitat loss, implement mitigation measures and where appropriate, establish and maintain an ecologically similar protected area.

4.1.3 OP 4.11 – Physical Cultural Resources (The World Bank, 2013c)

Physical cultural resources are defined as movable or immovable objects, sites, structures, natural features and landscapes that have archaeological, palaeontological, historical or other cultural significance.

The principles of ESIA are very similar to those advocated by South African legislation that ensures project sustainability as the basis for project planning and implementation. It must be stressed that in South Africa a project planned by following the WB ESIA process does not absolve the proponent from making formal application in relation to legislated environmental authorization processes should the proposed activities trigger that necessity.

4.2 Environmental authorization in the context of South African legislation

The following assessment of the proposed project in the context of South African policies and legislation is not exhaustive but focuses on those Acts which are possibly applicable to the scope of activities and anticipated impacts of the scope of work to be carried out during the vibroseis survey and deep well drilling.

4.2.1 Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002) (MPRDA)

Activities involving the sequestration of CO₂ do not fall within the ambit of “mineral” or “petroleum” as defined by the MPRDA. “Exploration” and “prospecting” means the intentional search for any mineral by means of any method. However, the planned geological investigations are not related to a mineral search but a research exercise designed to provide more lithological detail about the geological succession. Since the proposed geological research activities do not correspond specifically to the requirements for a Prospecting Right (MPRDA, section 18) or an exploration right (section 79) it has been necessary to consider the wider context of environmental legislation.

Additional Regulations under the MPRDA have been added to the existing regulations (GN R 1288, R 1203, R349). Regulation 86 stipulates that exploration activities are subject to the requirements of NEMA and NEMA EIA regulations, 2014. These regulations are specific to petroleum and unconventional gas recovery exploration programmes **where the intention is to extract or exploit these resources**.

4.2.2 National Environmental Management Act (NEMA), 1998 (as amended); National Environmental Management Laws Second Amendment Act, 2013; National Environmental Management Act, EIA Regulations, 2014.

Environmental authorization under NEMA follows the Environmental Impact Assessment Regulations (GN R. 982, 4 December 2014) pertaining to environmental impact assessments under sections 24(5), 24M and 44 of NEMA. Listing Notices GN R. 983, R. 984, R. 985 of 4 December 2014 define activities that could have a negative impact on the environment that must be investigated and reported following either the Basic Assessment report (regulation 19) or Scoping & Environmental Impact Reporting (S&EIR) procedures (regulations 21 to 24).

- Activities requiring a MPRDA Prospecting Right, addressed by Listing Notice 1, Activity 20 is **not applicable as the proposed activities are not being undertaken to explore for minerals but to determine geological structures and confirm lithological characteristics**.
- Listing Notice 2, Activity 18 concerns any activity that requires an exploration right.
- The concept of disposal and sequestration of waste CO₂ is not incorporated within the National Waste Management Strategy 2010 or the NEM: Waste Act, 2008 (Act No 59 of 2008), sections 16 & 19, 20, 21. Not applicable to Phase B activities.
- Listing Notice 3; new roads will not be constructed as part of the seismic survey of drilling operations.
 - Listing Notice 3; addresses the extent “buffer area” extending around the proclaimed boundary of a world heritage site e.g. iSimangaliso Wetland Park WHS (10 km), KEZ Wildlife nature reserve (5 km). Limiting the seismic survey activities to existing roads and tracks will reduce the impact on vegetation to trimming or pruning of shrubs and grass that is encroaching on the margins of existing tracks.
- UMkhanyakude District Municipality has developed an Environmental Management Framework (EMF) covering the proposed study area. It is unlikely that the temporary nature of the geological investigation will be at odds with this plan.

4.2.3 National Water Act (Act No 36 of 1998)

The NWA clearly defines a water-course and resource quality characteristics. According to section 21 (c) and (i) water uses include almost any activity in any catchment has the potential to change the resource quality characteristics (flow regime, water quality, habitat and biota). “The use of water in terms of section 21 (c) and (i) within the 500m radius from the boundary of any wetland” was derived as most construction activities have the potential to change the resource quality characteristics of the wetland and may affect the flow regime of any wetland.

The extensive distribution of freshwater pans, streams and other wetlands in the Maputaland region where the seismic study will be conducted prompted a specialist wetland environmental study (WetRest, 2015) which included a legal interpretation of the study activities in the context of legislation specific to wetland environments.

The vibroseis operations along existing tracks and existing crossings of wetlands and streams will not require specific Water Use licence authorisation. Siting of the drilling pad and probable drilling of shallow wells to supply drilling water and structures to manage drilling fluids may require Water Use licencing.

4.2.4 National Forest Act, 1998 (Act No 84 of 1998)

In terms of section 7(1) of the National Forests Act, 1998, no person may cut, disturb, damage or destroy any indigenous tree in, or remove or receive any such tree from a natural forest except in terms of a license issued under subsection (4) or section 23. The Act is enforced by Department of Agriculture, Forestry and Fisheries (DAFF) <http://www.daff.gov.za/>.

4.2.5 World Heritage Convention Act, 1999 (Act No, 49 of 1999)

This Act incorporates of the World Heritage Convention into South African law. On the 18th April 2011 the Minister of Water and Environmental Affairs approved the Integrated Management Plan of the iSimangaliso Wetland park in terms of section 26(4) of the World heritage Convention Act, 1999 that formalised the Zone of Influence representing a buffer zone around the area.

4.2.6 National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003)

iSimangaliso WP WHS is protected by the National Environmental Management: Protected Areas Act. The Act provides for land outside iSimangaliso to be declared as a Protected Environment and thus regulated as a buffer zone that aims to reduce conflicts between external and internal management objectives, and to protect the core area that is afforded formal protection. GN No. R546 of 2010 defines “buffer area” as an area extending 10 kilometres from the proclaimed boundary of a World Heritage Site or national park and 5 kilometres from the proclaimed boundary of a nature reserve. In the case of the iSimangaliso Wetland Park WHS the current Zone of Influence was accepted as the buffer zone.

4.2.7 Provincial legislation

4.2.7.1 The Kwazulu-Natal Heritage Act, 2008

This Act provides for the conservation, protection and administration of both the physical and the living or intangible heritage resources as administered by Amafa aKwaZulu-Natali Heritage Council.

4.2.7.2 KwaZulu-Natal Provincial Roads Act, 2001 (Act No. 4 of 2001)

The Act provides for the transformation, restructuring, establishment and control of the provincial road network, road policy, norms and road safety standards, maintenance and provision of equitable road access.

4.2.7.3 Buffer zone policies

The iSimangaliso buffer zone, aligning the World Heritage Convention Act and the National Environmental Management: Protected Areas Act is the Zone of Influence adjacent to the protected area and will affect those living and/or using an area within the buffer zone and activities that may have a negative influence on the World Heritage values of iSimangaliso. The development of the Environmental Management Framework, including the Desired State assessment and delineation of thematic Environmental Management Zones, contributed to the publication of a draft Strategic Environmental Management Plan for the district municipal area (EKDM, 2013).

4.2.8 *International conventions and agreements*

4.2.8.1 Lubombo Transfrontier Conservation Areas

In terms of the Lubombo Transfrontier Conservation Area (TFCA), borders separating conservation areas of Swaziland, Mozambique and South Africa came down to support the broader aims and socio-economic upliftment in the southern Africa subcontinent, as well as improving regional ecosystems management. The Lubombo TFCA area covers 4,195 km², of which 317 km² (8%) is in Swaziland, 2,783 km² (66%) is in Mozambique, and 1,095 km² (26%) is in South Africa.

4.2.8.2 UNESCO World Heritage Site; iSimangaliso Wetland Park

The iSimangaliso Wetland Park, covering an area of 239,566 ha, one of the outstanding natural wetland and coastal sites of Africa (<http://whc.unesco.org/en/list/914> ; <http://isimangaliso.com/>) was listed as South Africa's first World Heritage Site in December 1999 in recognition of the following criteria; Criterion (vii): Criterion (ix): Criterion (x).

4.2.8.3 Convention on Wetlands (Ramsar Convention)

This intergovernmental treaty provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (<http://www.ramsar.org/>). South African activities are managed by the national Department of Environmental Affairs.

4.3. *Permission to conduct seismic survey and well drilling*

The lack of specific provision for CCS related activities in the national legislation described above and the purely geological research focus of this precursor to the PCSP, resulted in the SACCCS project consortium making approaches to government departments in the context of Ministerial discretionary powers under MPRDA Section 50(1) to undertake investigations of any geological formation.

The Geoscience Amendment Act, 2010 grants Council for Geoscience additional functions enable it to undertake the vibroseis and lithostratigraphic drilling projects in line with its legal mandate.

4.3.3 *Conclusions and recommendations*

The proposed geophysical and geological research activities do not trigger any specific requirements for a Prospecting Right or Environmental Authorisation. SANEDI-SACCCS has initiated an environmental

assessment with the goal of informing the authorities and interested parties of the proposed PCSP. The SANEDI-SACCCS authority outreach activities have ensured that national, provincial and local government agencies are regularly consulted and informed (see Appendix 6). The geological investigations will confirm whether the onshore Zululand Basin succession has lithological characteristics that meet the minimum requirements for safe development of the proposed PCSP. Failure to meet the reservoir characteristics required will mean that the project must evaluate the Algoa Basin.

5. Project alternatives

The high cost of this proposed precursor to the PCSP and the potential for significant impacts in an area bordering environments of international biodiversity and cultural conservation value and an indigenous population, requires an assessment of potential alternatives that could reduce the potential for negative environmental impacts.

5.1 “No Go” alternative

It is likely that coal and petrol/diesel will power South African industry and business for decades into the future. Fuel from coal production is a major producer of captured industrial CO₂. Most of the coal fired ESKOM power stations and other large emission sources such as the cement industry will not be retrofitted to capture CO₂ emissions. South Africa will remain one of the world and Africa’s major sources of greenhouse gas emissions. The Paris Agreement accepted significant emission reduction targets that will require the South African government endorsement of CCS or face a carbon chasm of 253 million tonnes CO₂-e in 2020. This gap between the national commitment and national emissions would constitute approximately half of current estimated emissions (KPMG, 2011).

5.2 Evaluation of CCS context alternatives

The “Atlas on geological storage of carbon dioxide in South Africa” (Cloete, 2010) found Main Karoo Basin to be unviable for CCS. The potential use of CO₂ injection in enhanced coal bed methane recovery was also evaluated but the possible sterilisation of coal resources for future underground coal gasification negated this option. Therefore it was decided that investigations for a storage location for the PCSP should focus on the onshore Zululand Basin.

The majority of geological storage capacity (98%) is associated with the deep saline formations in thick Mesozoic Basin continental / marine sedimentary packages. Use of CO₂ for enhanced oil and gas recovery in offshore oil and gas fields or the use of depleted reservoirs was considered. After consideration of the logistical and cost implications, the development of a PCSP offshore was rejected in favour of a trial injection into the onshore extension of the Mesozoic formations in the Zululand Basin (Maputaland) or in the Algoa Basin (Nanaga area).

5.2.1 SANEDI-SACCCS rationale for locating the Pilot CO₂ Storage Project Onshore

Locating the PCSP onshore in either the Zululand Basin or the Algoa Basin is the only way to meet the aims of the CCS Roadmap which aims to inject and store 10,000–50,000 metric tons of CO₂ in South Africa. The primary Success Criteria for the overall PCSP are: (1) Demonstrating safe and secure CO₂ handling, injection, storage, and monitoring in South African conditions; (2) Increase local human and technical capacities; (3) Raise awareness of CCS; (4) work with government regarding PSCP within the South African legal and regulatory environment.

5.3 Alternatives considered in the onshore Zululand Basin context

Initial plans considered using the cut lines cleared during the 1970's seismic survey and opening the existing oil exploration boreholes. However, the cutlines has been reclaimed by indigenous vegetation growth and the positions of the old wells could not be located using the available co-ordinates. The siting of new deep wells will only be confirmed on the basis of interpretation of the new digital seismic profile data. Siting of the deep wells will take into consideration the public concerns over shallow groundwater, extensive wetlands, proximity of conservation areas, homesteads and agricultural sites. It will be necessary to obtain landowner permission to site boreholes and use access roads to the sites. If possible the deep wells will be located in disturbed commercial timber plantations that have well maintained road networks.

6. Baseline environmental context

6.1 Legal framework of the environmental investigations

This document outlines the baseline environmental data and specialist studies in the format of the Environmental and Social Impact Assessment (ESIA) content format prescribed by the World Bank (2013a) but also meets the requirements for the Basic Assessment or baseline information component for the Scoping phase of Scoping and Environmental Impact Assessment (ESIA) prescribed by the National Environmental Management Act. The investigations will adopt a risk averse and cautious approach to activities in mainly disturbed areas so that significant negative impacts are avoided or can be effectively mitigated. Public participation or stakeholder engagement is a critical aspect of the integrated environmental management approach embodied in national legislation.

Under each thematic section below, potentially negative environmental aspects that have been identified are described. To ensure that no activities will be undertaken under the project that will lead to the significant conversion or degradation of natural habitat, an environmental management plan has been compiled. This includes action plans for environmental impact monitoring, management and mitigation of significant negative impacts.

6.2 Study area location, infrastructure and EMF/SEMP context

The project is located within the uMkhanyakude District Municipality where the Mozambique border in the north and western boundary of the iSimangaliso Wetland Park World Heritage Site are boundaries of the area. Access is via the N2 freeway, the R22 tar road between Hluhluwe town and KwaNgwanase and the P522 tar road from the Phongola River valley to KwaNgwanase. The highest population densities are in Jozini, Mbazwana and Manguzi towns and surrounding areas.

6.2.1 Umkhanyakude District Municipality EMF, and SEMP

The Desired State report (UKDM, 2013a) and sensitivity analysis (UKDM, 2013b) derived from the UKDM EMF process established an environmental vision for the district and delineated Environmental Management Zones (EMZs) that require active control to ensure that potential is realized. The EMZ areas differentiate the coastal World Heritage Site Zone from "Conserved Terrestrial Biodiversity" nature reserves, "Unconserved Terrestrial Biodiversity", "Surface Freshwater" wetlands EMZ, "Heritage" EMZ the iSimangaliso "Buffer Zone" EMZ.

The Strategic Environmental Management Plan (SEMP) serves to plot the way forward for attaining the desired state by managing the sustainable utilization of land through Management Guidelines and by controlling the activities that may impact on environmental attributes in specific geographical areas.

6.2.2 Environmental aspects associated with the location of seismic survey transects and drilling sites

- i. Aligning the vibroseis survey transect lines along the grid of existing roads and unpaved tracks represents the lowest potential for negative environmental impacts.
- ii. Civil infrastructure along roads must be avoided.
- iii. The slow pace of the vibroseis survey will require effective traffic control.
- iv. Seismic transects along conservation area boundaries are a concern. ion

6.3 Geological and geophysical baseline data

Preliminary investigations found that insufficient data exist to complete 'full effective storage capacity assessments' according to international criteria. High resolution vibroseis seismic surveys are required to position deep boreholes that will sample target reservoir lithologies. The actual storage capacity is, however, constrained by sandstone porosity and the presence and efficiency of cap rock seal beds and lateral seals.

6.3.1 Basin suitability for CO₂ storage

The target lithologies are the Cenomanian Sandstone North (CSN) and Cenomanian Sandstone South (CSS). The Aptian (Lower) Sandstone is an extensive sandstone unit lying deeper than 800 m below surface.

The lithological succession of the Mesozoic Zululand Group comprises alternating sandstone and argillite successions that ought to be ideal for CO₂ storage if the sandstone beds are lensoid with interbedded, less permeable siltstone forming a potential vertical and lateral seal.

6.3.2 Environmental aspects associated with the Zululand- and Maputaland Group successions

Key issues to be addressed;

- i. Confirm the depth and regional gradient of the Neogene/Cretaceous unconformity surface, an important regional groundwater controlling interface.
- ii. Use the intersecting traverses of 2D seismic profiles to define the association between coarse arenaceous units associated siltstone or mudrock units that could form lateral or vertical seals.
- iii. Delineate the dune sand units that host the near surface shallow groundwater aquifer.

6.4 Terrain morphology

The proposed seismic profile lines traverse much of the Maputaland coastal plain, extending as far as the foothills of the Lebombo mountains in the west, the incised Phongolo River valley, ancient dune ridges undulating topography of a stabilised and vegetated Holocene parabolic dunefield.

6.4.1 Environmental aspects associated with the terrain morphology

- i. The non-invasive nature of the vibroseis survey technique limits the potential for terrain related environmental impacts.
- ii. Well-defined stream channels are limited in extent.
- iii. Seasonally inundated wetlands are crossed by road routes and a petrochemical spill response process supported by suitable equipment is available for potential spillages.

6.5 Soil and landtypes

The landtypes are characterised from maps by Soil and Irrigation Research Institute (1986 a,b;1988) and differentiate areas with similar terrain morphology, soil, geology and climate parameters. Much of the land surface is defined by sandy soils of the KwaMbonambi Formation dune sands and interdune wetlands.

6.5.1 Environmental aspects associated with soil associations

The proposed vibroseis transect lines follow established roads that have been built on raised fill where they cross the major wetlands.

- i. The sandy soils are generally cohesion less and can be significantly disturbed along routes by multiple passes of light vehicles.
- ii. Most of the proposed vibroseis activities will occur along existing surfaced roads or tracks.
- iii. Siting of drilling pads on areas of sandy soils will require preparation of lined ponds to store waste water used for drilling or drilling mud storage tanks.

6.6 Groundwater

The groundwater of uMkhanyakude District Municipality region is closely linked to the Zululand Group siltstone/sandstone succession overlain by poorly consolidated Neogene deposits and unconsolidated Quaternary dune sediments described in the groundwater specialist report by Jeffares and Green (2015) included as Appendix 3. Most of the rural settlements are largely or wholly dependent on groundwater for their domestic supplies. Groundwater extraction is shallow, hand dug wells or boreholes drilled for family or communal use and development of groundwater wellfields for agricultural projects. Groundwater plays an extremely important role in water services especially in rural areas where surface water reticulation infrastructure has high cost implications. The Department of Water and Sanitation conducts monitoring of groundwater abstractions, water level fluctuations and chemical quality.

6.6.1 Regional groundwater aquifer characterisation

A confined aquifer is associated with the weathered Neogene deposits that underlie the surficial Pleistocene dune deposits. The shallow unconfined aquifer “perched” above the slightly more clay enriched late Pleistocene dune sands that results in ponding of water within interdune depressions and watercourses. The Cretaceous rocks are associated with higher groundwater EC. Groundwater flow beneath the coastal plain is directed towards the larger coastal lakes. On the basis of drilling and description of the sediment underlying the eastern coastal plain transect, Durham (2012) identified five regional aquifers in a region where previous studies had only described two main aquifers. The numerous freshwater pans and lakes on the coastal plain play an important role in the geohydrology of this area. Recharge of groundwater has been calculated at between 5% and 18% of mean annual rainfall.

6.6.2 Groundwater monitoring

Due to the sensitivity of the shallow groundwater in porous aeolian sands, DWA has drilled groundwater quality monitoring boreholes across the area. Groundwater quality across the project area is generally within the limits set out in SANS 241 (2011) for all determinands except for colour, odour, turbidity, fluoride, iron, manganese and soluble organic carbon. The groundwater is therefore considered of high strategic value due to its suitability for use for human consumption.

6.6.3 Environmental aspects associated with groundwater

- i. The vibroseis survey will be non-invasive and localised on existing disturbed road reserve areas where the potential impact of accidental spillage can be effectively contained.

- ii. Drilling pads require facilities to prevent leakage from waste water into the shallow groundwater table.
- iii. After decommissioning, the deep boreholes can be used for groundwater monitoring.

6.7 Surface water environments and wetlands

The majority of the surface of Maputaland is formed by low parabolic dunes of the KwaMbonambi Formation underlain by the slightly clay-enriched Kosi Bay Formation dune sands. The variably karst weathered Umkwelane/Uloa Formation gravels and sands that form an important aquifer on the Cretaceous bedrock surface. Seasonal perching of shallow groundwater results in surface ponding in interdune swales during the summer wet season. Shallow groundwater seepage feeds incised channels. Permanent interdune lakes have accumulated Holocene freshwater peat deposits. The main freshwater drainage lines are the north-flowing Phongola River channel and floodplain, the northern Muzi/Futi channel, the Sihadla system channels draining into the Kosi lake system. The Mseleni drainage feeds Lake Sibaya, South Africa's largest natural lake. Large areas of wetland are classified as significant wetlands on the National Wetland Database and as Freshwater Ecosystem Priority Areas (FEPA).

A specialist study was undertaken of the full 500 km of proposed seismic survey traverse lines by WetRest (2015) (Appendix 2). 40 wetlands were identified on the basis of their NFEPA wetland status and classified mainly using pedological and geomorphological features.

6.7.1 Environmental aspects associated with surface water drainage systems

- i. The vibroseis activities are temporary, non-invasive and limited mainly to surface roads and will not result in significant damage to wetland substrates, vegetation or compromise surface drainage.
- ii. Mitigation of accidental petrochemical spills is a critical component of the EM Plan.
- iii. Drill pad and associated infrastructure must be sited beyond the legal wetland buffer zone, surface runoff control structures and plastic lined waste water management ponds installed.

6.8 Biodiversity

The specialist biodiversity report (Brousse-James and Associates, 2015, Appendix 1) summarises aspects of the Maputaland-Pondoland-Albany biodiversity hotspot region where there are numerous species having endemic or near endemic status, nine Important Bird Areas, five RAMSAR sites, the iSimangaliso Wetland Park World Heritage Site and a number of important populations of globally threatened species such as the Black Rhinoceros.

The Maputaland Centre (MC) is recognised as an International Centre of Plant Diversity. The complex mosaic of forest types, bushland, thicket, wooded grassland and edaphic grassland is characterised by abrupt changes due to soils, drainage and climate. The area covered by the proposed seismic survey line includes six biomes, the Azonal Forest, Forest, Indian Ocean Coast Belt, Savanna, Grassland and Wetlands Biomes and contains 15 vegetation types with varying degrees of disturbance and statutory protection.

Subtropical Freshwater Wetlands are dominated by reeds, sedges and rushes or waterlogged grassy meadows. Their conservation status is Least Threatened. Inland Saline Wetlands cover 0.025 % of the area traversed by the proposed seismic survey lines, mainly located along alluvial terraces of rivers.

6.8.1 Environmental aspects associated with biodiversity

- i. Activities must not interrupt connections or continuity that maintains ecological processes.
- ii. Species distributions in Maputaland mirror soil landcover types, so protecting surficial soils should automatically conserve most species.
- iii. The biodiversity of Maputaland is relatively well-known, but species distribution data is unreliable.

6.9 Noise, vibration and air quality

The area is characterised by a patchwork of agricultural lands, homesteads and commercial plantations where noise levels are low and air quality is not influenced by industrial emissions. The vibroseis trucks will operate along public roads and unsurfaced tracks at a slow pace of 5.8 km per day. Siting of the drill rig and infrastructure pad will be guided by the availability of disturbed land, located far enough from homesteads to limit noise disturbance.

6.9.1 Environmental aspects associated with noise and vibration

- i. Vibroseis and drilling contractors will follow environmental management action plans to mitigate adverse vibration and noise impacts.
- ii. Equipment operators will wear hearing protection and personal protection gear.
- iii. An exclusion zone will be maintained around active equipment.

6.10 Archaeological and cultural significance

An archaeological and cultural resource assessment was conducted in 2012 as part of the baseline data compilation exercise that contributed to the Environmental Management Framework. The heritage assessment highlighted mollusc fossil assemblages and the long history of human occupation that extends from the Early Stone Age through the Iron Age.

6.10.1 Environmental aspects associated cultural heritage

- (i) A cultural heritage resource assessment will be conducted during the well pad siting exercise.
- (ii) A "chance finds procedure" will be implemented in line with environmental awareness training provided to all personnel working on site.

6.11 Socio-economic framework

The investigations will take place within Umkhanyakude District Municipality where the majority of seismic profiling transects and borehole sites fall within Umhlabuyalingana Local Municipality (KZ271). The Umkhanyakude District Municipality Integrated Development Plan (IDP) Annual Review for 2011/2012 (Final) provides useful information and statistics about the population in the municipal area. Large areas of land are under communal tenure in the District. The key drivers of the local economy are agriculture, services, tourism and retail. The entire coastal strip of uMhlabuyalingana has been designated a district management area, administered by the greater iSimangaliso Wetland Park authority. uMkhanyakude forms part of the Lubombo Trans-frontier Conservation Area. The uMkhanyakude DM IDP provides information regarding the spatial development framework (SDF).

6.12 Stakeholder engagement

SANEDI-SACCCS initiated a Public Engagement Project (CCS PE) in May 2012. National- and Local Stakeholder Engagement Plans were rolled out in a phased manner in consultation with key strategic

stakeholders. The lack of a specific legislative framework governing CCS activities is the major obstacle to be overcome before the SANEDI-SACCCS CCS Roadmap can proceed towards its goals.

It is essential that the CCS PE outreach programme take note of the public outcry surrounding shale gas exploration (fracking) in the Karoo. The differences between unconventional gas exploitation and CCS should be highlighted to ensure that the geological investigations associated with the scope of this research project are not compared directly to the long-term goals of shale gas exploration.

6.12.1 Public participation process (PPP)

The focus of PPP interaction with uMkhanyakude DM should be through their established community liaison network that was engaged during the public participation around the Environmental Management Framework studies (Appendix 6, Nema Consulting, 2010). Public participation is through the ward committee system, meeting the requirements of EIA regulation 54 2(b). The proposed PPP methodology entails the following, in accordance with the EIA Regulations (2014).

6.12.2 Environmental aspects to be addressed by public participation

- i. The uMkhanyakude DM EMF and SEMP must be considered.
- ii. Opposition to the proposed activities from tribal authorities and landowners must be given due consideration due to the large project area.
- iii. Lack of knowledge about CCS amongst the broad public, environmental focus groups and government as well as the lack of any precedents, compounded by lack of direct legislative controls represents a significant risk.
- iv. The main risk from an uninformed public could be triggered by confusion with shale gas exploration.
- v. The CCS PE Project has initiated the public outreach and stakeholder engagement process (Appendix 7).
- vi. An experienced consultant team with prior experience in the uMkhanyakude DM area must be engaged to manage the PPP.
- vii. Public meetings must be chaired by an experienced, independent facilitators.
- viii. An experienced media liaison person must also be engaged to handle reports in the press and respond to queries from investigative reporters.

7. Environmental management plan

The vibroseis operations are regional activities that will utilise existing roads and tracks. The Environmental Management Plan draws on the management and mitigation framework that was implemented during the drilling of groundwater monitoring boreholes in the Umkhanyakude District Municipality area. Additional environmental management actions have been derived from recent scientific drilling of deep boreholes in the Karoo basin that used drilling technology similar to that proposed during the PCSP geological precursor studies.

7.1 Environmental Awareness and Responsibilities

The costs incurred to remedy environmental damage shall be borne by the person responsible for that damage (the “polluter pays” principle). Reasonable measures are prescribed to ensure that the environment is not subjected to pollution or contamination. Environmental education and induction of any contractor staff or visitors to the drilling site are regarded as essential measures to ensure that employees

or visitors understand the environmental risks and potential ramifications of their work activities. The project team hierarchy is; Project Manager, Resident Engineer, ECO and specialist consultants.

7.1.1 Environmental Control Officer (ECO)

The Project Manager will employ an ECO who will report to the Resident Engineer. The ECO responsibilities include monitoring of the EM Plan, reporting and liaison roles.

7.1.2 Contractors

The Contractors will be responsible for implementation, monitoring of compliance and mitigation activities according to the project and activity specific EM Plans.

7.1.3 Environmental Awareness Plan

The awareness plan aims to make employees environmentally conscious of the ramifications of their decisions in the work place and to understand their obligations in line with the EM Plan.

7.1.4 Environmental Awareness Training

The contractor must ensure that adequate environmental awareness training of senior site personnel takes place and that all personnel receive an induction presentation on the importance and implications of the EMP.

7.2 Action plans for environmental impact monitoring, management and mitigation

7.2.1 Biodiversity; animals

No hunting, disturbance, collecting or feeding on wild animals is permitted. Staff may not enter any formal conservation areas without prior approval. The integrity of the Foot-and-Mouth fence along the P522-2 must be maintained. Dangerous equipment or sensitive areas will be cordoned off to reduce the risk to wild animals and livestock.

7.2.2 Surface Water

Disposal of any liquid or solid waste, soil stockpiling, use of water bodies for personal or equipment washing, impeding flow or construction of temporary crossings are among the activities prohibited.

7.2.3 Dust

Actions aimed at reducing the impact of dust on site and adjacent areas include cessation of activities during high winds, reduced vehicle speed, limited disturbance of vegetation, re-vegetation of affected areas and dust suppression.

7.2.4 Noise

The activities occur on existing provincial and district roads will be limited to sunrise-sunset, equipment will be checked and communities/authorities consulted concerning activities on weekends and public holidays.

7.2.5 Visual Aspects

Project structures and activities will maintain a small footprint and are screened where possible.

7.2.6 Community Liaison and Involvement

The project team will liaise with the community through existing municipal committees and the Ward Councillor to disseminate information in relation to operations, timeframes and potential impacts. Local staff will be recruited through the established structures. The ECO will address claims and disputes.

7.2.7 Safety, Health and Environment (SHE)

Project protocols and those specified by specialist consultants or contractors must be adequately communicated during environmental education of communities or contract workers. PPE and First Aid will be available on site. Open flames will only be allowed in facilities or equipment specially constructed for this purpose.

7.2.8 Drill pad and camp access routes

Attention must be given to avoiding damage to informal tracks by high volumes of heavy vehicle traffic. Existing tracks and roads will be used to access borehole sites. Vegetation will not be cleared but minimal trimming or pruning can be carried out. Low speeds will be observed to avoid accidents, excessive noise, dust and injury to livestock.

Long sections of public roads will be used for vibroseis traverses after consultation and approval from provincial Road Traffic Inspectorate authorities. The vibroseis operations must not result in degradation of road surfaces or drainage structures.

7.2.9 Site Clearing

Site clearing must limit disturbance of indigenous vegetation and trimming/pruning is preferable to vegetation clearing that could trigger the need for environmental authorization. Disturbed sites will be used where possible.

7.2.10 Soil Stripping, handling and stockpiling

All topsoil material will be stripped from areas underlying long-term drilling site structures, areas susceptible to contamination, and waste water management structures, and restored during site rehabilitation. To minimise the risk of wind or water runoff erosion, protective structures will be constructed and disturbed areas rehabilitated as soon as possible after completion of activities.

7.2.11 Borehole Siting, Layout and Access

The planned location of borehole sites will be submitted to authorities and community liaison structures in advance for approval. The disturbed area will be minimized, a buffer ensured around wetlands and activities confined to a demarcated area. Accommodation, cooking and potable water structures will be temporary and mobile. Waste receptacles will be supplied at each borehole site to gather all domestic and other refuse and to minimise the occurrence of littering. Where possible and practical, existing facilities will be used after consultation with the Community Representative. Should access to existing ablution facilities not be available, an adequate number of portable chemical toilets will be provided.

7.2.12 Hazardous Materials

All potentially hazardous materials stored or used on site will be handled in such a manner as to prevent soil and water contamination using lockable storage units, impermeable surfaces for maintenance areas, and spill response equipment.

7.2.13 Waste Management

Sites will use waste receptacles, practice waste sorting and disposal at an approved site. Biodegradable refuse will be buried in a pit.

7.2.14 Rehabilitation

All areas disturbed during the vibroseis operations and drilling will be rehabilitated, to the satisfaction of the project Manager, Resident Engineer and ECO on completion of activities. Structures will be removed, voids backfilled, topsoil restored and revegetated.

7.2.15 Environmental Design Criteria

Environmental criteria addressed in the location and siting of the borehole pads must control the flow of water to avoid erosion and/or ponding by planting grass and protecting channels.

7.2.16 Water Quality

Water samples are to be collected from each borehole site and analyzed at a reputable laboratory according to acceptable industry standards to serve as environmental baseline indicators of water quantity and quality.

7.2.17 Monitoring and Reporting

The Project Manager and Environmental Control Officer (ECO) in conjunction with the Contractors, will compile reports for the Funding Agent and the relevant authorities to comply with the requirements stipulated in the EM Plan. Following the completion of activities, the Project Manager will undertake an inspection of the borehole/infrastructure sites to verify that the requirements stipulated above have been incorporated into the design. Long-term maintenance of rehabilitated areas and possible monitoring of groundwater at boreholes will be implemented by the relevant authority after decommissioning.

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

SEISMIC REFLECTION SURVEY AND WELL DRILLING,

UMKHANYAKUDE DISTRICT MUNICIPALITY, NORTHERN KWAZULU-NATAL

GA Botha (PhD, Pr.Sci.Nat)

in association with specialist consultants;

B. James (Brousse-James and Associates) – Biodiversity

P-L. Grundling (WetRest) – Wetland delineation and ecology

M. Schapers (Jeffares & Green) - hydrogeology

S. Allan (The Independent Environmental Advisor – reviewer)

1. INTRODUCTION

Energy is a key input into almost all activity and fundamental to societal wellbeing. Fossil fuels currently supply 81% of energy consumed globally, and energy-related carbon dioxide (CO₂) emissions account for more than two-thirds of total greenhouse gas (GHG) emissions. Continued global economic growth will further increase energy consumption needs.

Consequently, to manage the risks of climate change through significantly reduced GHG emissions will require changes in energy consumption patterns and the technologies used to produce energy (Global CCS Institute, 2013, 2015). All credible climate and economic modelling of responses to manage the risks of climate change demonstrate that this can be done, with continuing steady economic growth. Figures presented by the International Energy Agency (IEA) show that, compared to 1990, primary energy consumption could increase nearly 90 per cent by 2050, while the total value of global output increases nearly seven-fold over the same period (IEA, 2012a).

Increasing quantities of greenhouse gases in the atmosphere, and carbon dioxide (CO₂) in particular, are key contributors to global climate change. Without significantly changing energy use, the scientific evidence suggests the world is heading toward an increase in average global temperature of between 3.6 and 5.3 degrees Celsius (°C), compared with pre-industrial levels, with most of the increase happening this century (IEA 2013).

Forecasts of global energy demand growth indicate the reliance on fossil fuels will continue for many decades to come. Around two-thirds of greenhouse gas emissions are contributed by the energy sector. More than 100 countries have endorsed a goal for deep cuts in global emissions to hold the increase in global temperature to below 2°C (UNFCCC, 2009). To achieve this goal and create a low-carbon future, we should be moving much more quickly to transform the way we generate and use

energy. Energy-related CO₂ emissions continue to rise and, in 2012, reached a record 31.6 gigatonnes (IEA 2013).

The Global CCS Institute (2013, 2015) stressed the vital need to include CCS in a portfolio of low-carbon technologies to tackle climate change at least cost. IPCC's Fifth Assessment Synthesis Report found that most climate models could not meet emissions reduction targets without CCS. Crucially, without CCS, the cost of mitigation would more than double – rising by an average of 138 per cent (Global CCS institute, 2015). There is an urgent need for governments to advance CCS by boosting short-term support for the implementation of demonstration projects around the world as successful demonstration will build confidence by showing the technology in action and, through innovation combined with advances in capture technology, bring down costs. Support from governments worldwide is necessary to implement sustained policy support that includes long-term commitments to climate change mitigation and strong market-based mechanisms that ensure CCS is not disadvantaged. The need to deal with critical legal regulatory uncertainties that were encountered by demonstration projects in Australia, Canada, Europe and the US, is an area that resonates with CCS proponents in South Africa.

A comprehensive description of all aspects of the CCS technology is presented in the report, "What happens when CO₂ is stored underground: Q&A from the IEAGHG Weyburn-Midale CO₂ Monitoring and Storage Project (Global CCS Institute, 2014) which can be downloaded at <https://www.globalccsinstitute.com/publications/what-happens-when-co2-stored-underground-qa-ieaghg-weyburn-midale-co2-monitoring-and-storage-project>

The addition of CCS facilities to existing or new build power plants will increase overall costs, quite often by a considerable margin. However, this must be weighed against the alternatives to CCS as a low-emissions technology in the electricity sector which are more expensive. Failure to implement CCS as a technology option in the electricity sector alone would increase mitigation costs by around US\$2 trillion by 2050 (IEA 2012a). CCS is the only large-scale technology available to make deep emissions cuts in several industrial sectors (such as iron and steel and cement). Industrial sector emissions account for more than 20% of current global CO₂ emissions. It follows that the widespread deployment of CCS in the power and industrial sectors in the coming decades is imperative to achieving a low-carbon energy future at least cost. Much attention is focused on the environmental benefits of fuel switching from coal- to gas-fired power generation. However, natural gas is not carbon free and, to meet longer term emissions reduction goals, both coal- and gas-fired generating capacity will need to be fitted with CCS.

Developing countries are consuming energy at increasing rates as their economies industrialise and standards of living continue to improve. Many of these countries will have access to relatively cheap sources of fossil fuels, so it is likely that CO₂ emissions will increase dramatically without the application of CCS. The developed nations recognize that it is important therefore to work with

developing countries as they further industrialise, by encouraging them to consider CCS technology as part of the low-carbon options portfolio and providing support for its implementation (including the necessary capacity development tools).

CCS is often mistakenly perceived as an unproven or experimental technology. In reality, the technology is generally well understood and has been used for decades at a large scale in certain applications. For example:

- Large-scale CO₂ separation is undertaken as a matter of routine in gas processing and many industrial processes,
- CO₂ pipelines are an established technology, on land and under the sea,
- large-scale injection and geological storage of CO₂ has been safely performed in saline reservoirs for more than 15 years, and in oil and gas reservoirs for decades.

There are currently 12 operational large-scale CCS projects around the world, which have the capacity to prevent 25 million tons a year (Mtpa) of CO₂ from reaching the atmosphere. The key technical challenge for widespread CCS deployment is the integration of component technologies into successful large-scale demonstration projects in new applications such as power generation and additional industrial processes.

There is growing confidence that the technical challenges of integrating CCS at large scale will be overcome through the combination of experiences gained over many years from existing CCS facilities, 'learning-by-doing' benefits that will come from large-scale demonstration projects, and continued investment and collaboration in global research and development (R&D) activities. There has also been increased activity in countries with high levels of CCS interest but less well developed policy frameworks (for example, Malaysia and South Africa).

Further, without CCS, it is unlikely that the 2°C target is achievable. Industrial sector emissions, including from cement, iron and steel, chemical, and refining industries, account for more than 20% of current global emissions. CCS is the only large-scale technology available to make deep emission cuts in these sectors (IEA, 2013c). Without strong action to accelerate CCS activities, the continued industrialisation of non-OECD countries, and the shift in manufacturing output to these countries, will cause industrial emissions to grow.

For this reason, the IEA recently stated that "CCS will be a critical component in a portfolio of low-carbon energy technologies if governments undertake ambitious measures to combat climate change" (IEA, 2013d, p.5). A summary of the current status of the global CCS industry has been published by the Global CCS Institute (2015) which can be downloaded at <file:///F:/CO2%20SEQUESTRATION/global-status-ccs-2015-summary.pdf> . Comment from the Global CCS Institute instate during the recent COP17 meeting in Paris can be sees here; https://www.youtube.com/watch?v=d_O81sA00s

2 PROJECT DESCRIPTION

It has been shown that of the more than 400 million tons of carbon dioxide emitted per year by point- and capturable sources in South Africa approximately 60% is sequestratable (SurrIDGE and Cloete, 2009). This includes nearly 30 million tons per year of ~95% pure carbon dioxide emitted by the synthetic fuel industry. Any envisaged carbon capture and storage project in South Africa is most likely to make use of the almost pure carbon dioxide stream emanating from the synthetic fuel plants where the capture element, comprising approximately half the cost, has already been done.

Preliminary geological studies have indicated that at least 100 gigatonnes of geological storage capacity could be available, more than four times the capacity required to store 240 million tons per year for 100 years. Most of that is associated with deep saline aquifers, with additional prospects of depleted gas fields and enhanced coal-bed methane recovery contexts. Potential storage sites and their characterisation have been published as a carbon geological storage atlas (Cloete, 2010). The majority of CO₂ storage capacity is associated with deep reservoirs offshore where the drilling of storage wells will have to be accomplished in deep water. The costs with offshore drilling and the logistics of maintaining the coupling facility or ocean bed pipelines are prohibitively expensive.

The recommendations from the previous work phases and international review of the projects suggested that the understanding of the geological context of a potential Pilot CO₂ Storage Project (PCSP) project had to be based on recent, high resolution seismic profiling data that could produce a 3D model of the lithological succession. Using the regional lithostratigraphic context of the Zululand Group succession in onshore northern KwaZulu-Natal, the seismic data can be interpreted to distinguish potential coarse-grained sandstone units from the over- and underlying argillaceous strata. The 3D lithological model can also highlight tabular or lensoid relationships between these strata, define faults or capping/ lateral seals and the regional distribution of potential CO₂ storage reservoir formations within the Zululand Group succession. Confirmation of these relationships and the physical properties of the lithologies relies on the drilling of up to three deep wells to intersect and obtain intact core from target sandstone units that can be analysed to define the permeability / porosity of both aquifers and lateral/ vertical argillaceous seal units.

A small-scale demonstration project (~10,000 tons per year) has therefore been proposed to prove the technology in the context of South African geological storage sites and to provide technology transfer that skills local scientists and engineers through first-hand experience in this technology. Analysis of data and literature from the 1970's oil search highlighted parts of the Zululand and Algoa basins for further investigation to locate the most suitable geological reservoir characteristics for the PCSP. The scope of this project includes the geophysical and geological investigations that are required before deep well sites can be sited to drill rock core from the most suitable lithological units at depths of >800m to >1,200m below the Maputaland coastal plain of northern KwaZulu-Natal.

This Environmental and Social Impact Assessment (ESIA) report compiled according to the World Bank guidelines is specific to the preliminary geoscience investigations comprising vibroseis survey and stratigraphic drilling to define the regional lithostratigraphy, geological structure and rock characteristics. Should the geoscience surveys prove the geological succession underlying the study region to be suitable to host the PCSP, a separate ESIA and application for environmental authorisation, including a public participation programme, will be carried out in line with South African legal requirements.

2.1 Location and regional context

The onshore Zululand Basin succession of Mesozoic rocks underlies the Maputaland area of northern KwaZulu-Natal province (Fig. 1). The study area lies within the uMkhanyakude District Municipality (UKDM) (DC27) region which includes the following Local Municipalities; uMhlabuyalingana (KZ271), Jozini (KZ272), The Big 5 False Bay (KZ273), Hlabisa (KZ274) and Mtubatuba (KZ275).

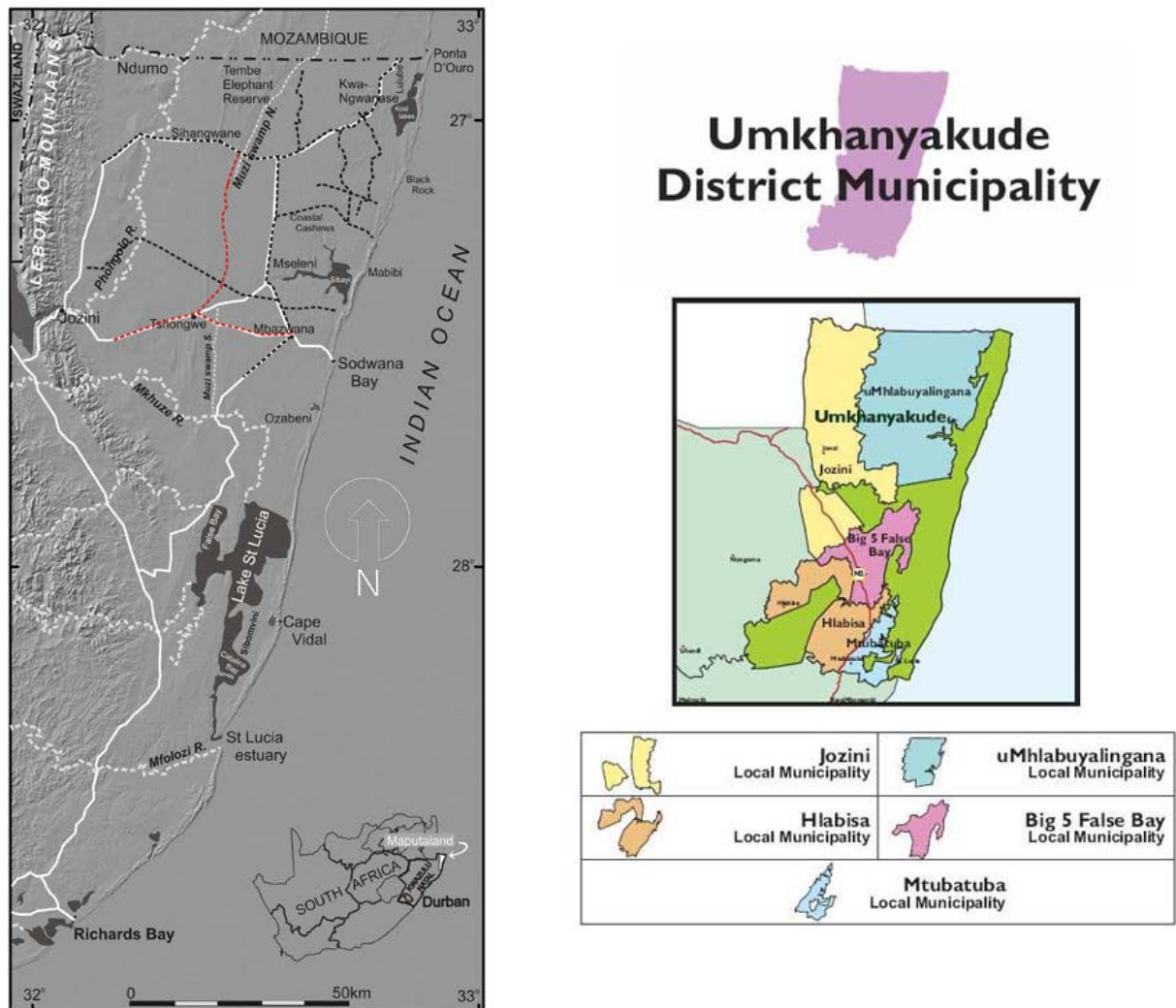


Fig. 1a Location of the Maputaland region of northern KwaZulu-Natal province. The proposed vibroseis transects are depicted as dashed lines (black and red). (b) Map of the Umkhanyakude District Municipality area showing the constituent Local Municipality areas and conservation areas (green) (after <http://led.co.za/municipality/umkhanyakude-district-municipality>)

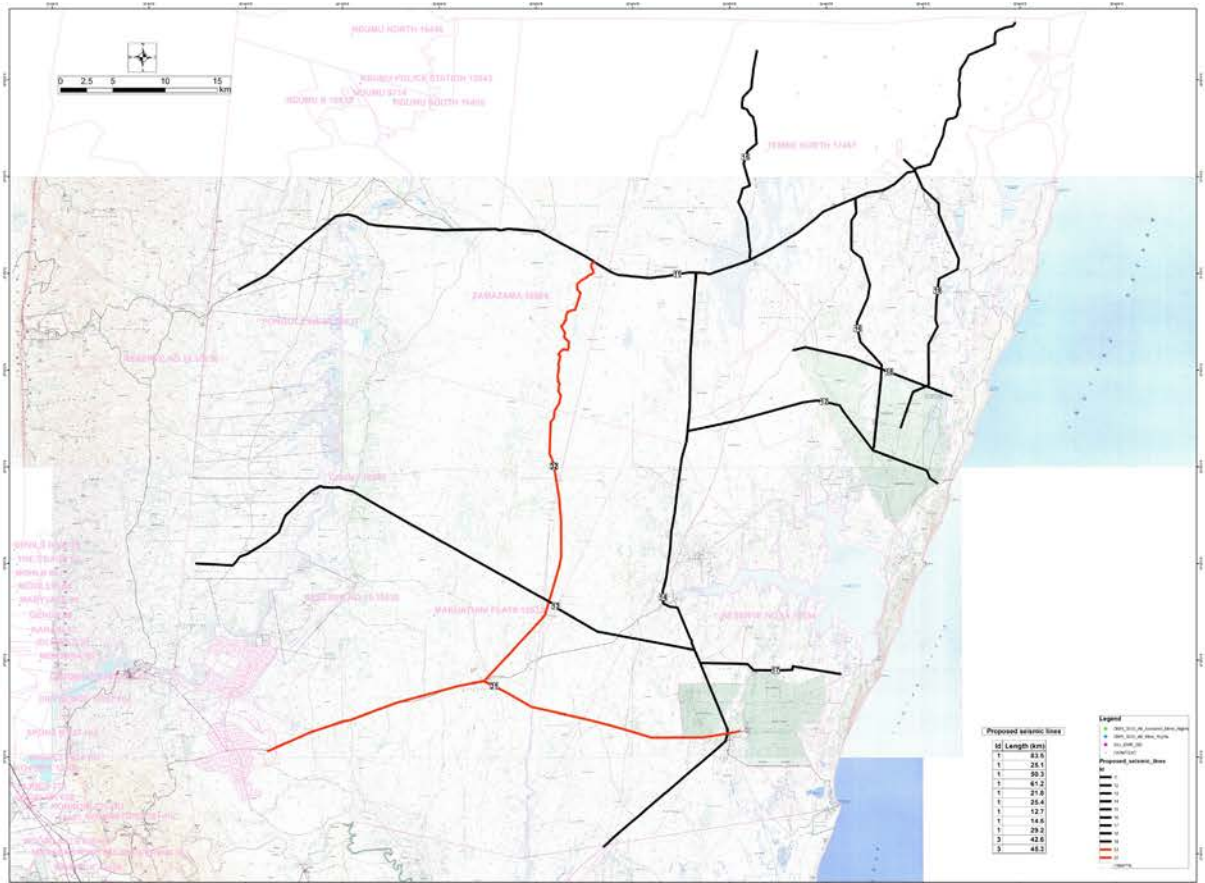


Figure 2 Topocadastral map showing the alignment of the proposed seismic survey transects along main roads and tracks, mainly in the Umhlabuvalinqana Local Municipality area.

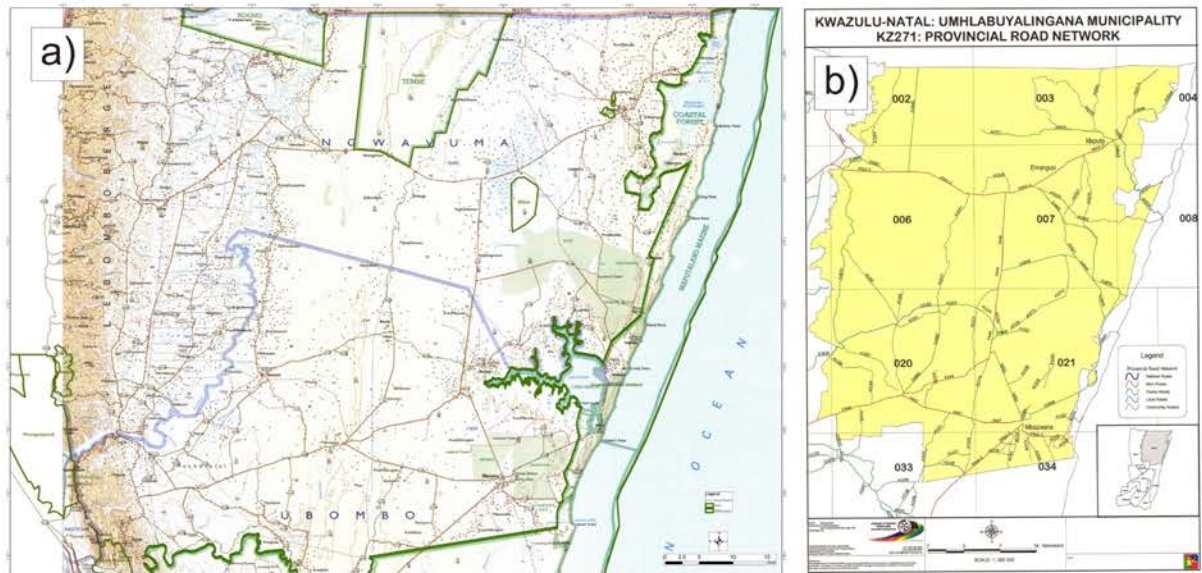


Figure 3 a) Topocadastral base map showing the western boundary of the iSimangaliso Wetland Park, World Heritage Site and the Ndumo/Tembe conservation areas on the Mozambique border in the north.
 b) Provincial road network within Umhlabuvalinqana Municipal area.

2.2 2D seismic reflection survey and well drilling; project description and technical aspects

The World Bank will provide funding through the Department of Energy to finance the PCSP project that will be administered by SANEDI-SACCCS which will appointment of specialist consultants and contractors to undertake the proposed seismic (vibroseis) survey and deep well drilling project. The roles and responsibilities in the South African PCSP are outlined in Appendix 5.

The terms of reference of the project that will be managed by SANEDI-SACCCS includes the following activities;

- (v) Design and execution of a high resolution 2D seismic reflection survey to elucidate the basin structure.
- (vi) Design and drilling of deep wells to ~ 2000m depth, to facilitate well logging, drill-stem and leak-off tests to characterize the strata and assess reservoir characteristics.
- (vii) Analyses and integration of the data from the seismic survey and well tests to develop related 3D static models of the target stratigraphy.
- (viii) Recommendation of further site(s) for characterization for potential use of the SACCCS PCSP.

2.2.1 Seismic survey (vibroseis) process

The seismic surveying scope of work entails acquisition, processing, interpretation and reservoir modelling phases;

- (i) obtain ~500 km of high resolution 2D “vibroseis” seismic survey to generate a high resolution image of the sedimentary succession and regional distribution of potential reservoir lithologies across the sedimentary basin,
- (ii) analysis of the 2D survey with recommendations for well placement,
- (iii) a 3D static reservoir model constructed using existing and newly obtained data, to be supplied with a description, interpretation and discussion of results. The model must be compatible for integration into an industry standard dynamic simulation package. The interpretation & reservoir modelling will be conducted in two phases, before- and after drilling with the outcome of the subsurface analysis.

The proposed survey coverage comprises 11 traverses with individual lengths ranging from ~17 km to 87 km. Tails or line extensions must be added to the ends of each traverse to run on interval of ~ 1

km to ensure well-imaged data at the intersection points. This may not be possible along the eastern extent of E-W lines approaching the coastal/marine reserve within the iSimangaliso Wetland Park.

The mean production rate is expected to be around 195 VP's (vibroseis source points) per day or 5.8 line km per day. The total field survey period will last for up to 100 days. The seasonal rainfall variation in Maputaland dictates the survey be conducted in the dry winter months from June to September.

Equipment typically associated with this seismic reflection survey technique is the high power (Nomad 65) vibroseis units and a 240 channel Sercel 408 seismograph. The vehicles require unimpeded vehicle access over a 5m wide swathe along the traverse line to allow for vibrators, line vehicles and geophone-laying access. The seismic crew comprises up to 26 men, seven 4X4 trucks, one recording truck and two dune-buggy type vibroseis units. Traverses will be pegged at 15m intervals for alternate geophone plus shot locations, and surveyed (xyz) using a differential GPS unit.



Fig. 4 Vehicle of the type proposed for conducting the vibroseis survey. The Nomad 65 Neo depicted is the new all-terrain broadband vibrator. Evolution of the popular Nomad 65 with enhanced mechanical and hydraulic components and shaker redesign, it is capable of delivering stronger low frequency content with full drive achieved from 5.4Hz. <http://www.sercel.com/products/Pages/Nomad-65-Neo.aspx>. A video showing more detail of the vibrator vehicle in operation can be accessed at <http://www.sercel.com/products/Pages/Nomad-65-Neo.aspx>

The 2D seismic survey traverse lines depicted in Fig. 2 are aligned on roads and tracks with varying degrees of surfacing, drainage and shoulder/reserve development. The specialist biodiversity report by Brousse-James and Associates (2015) included in Appendix 1 contains a collection of photographs that show typical road surfaces (see their Appendix 2).

- **160 km of tar roads** where survey works are best carried out along the road reserve where it is accessible and greater than 5m width. Thereafter the choices are to vibrate along the tar road (which introduces insurance concerns) or in adjacent fields (which may require a significant degree of preparation). Vibroseis work along tar and gravel roads will utilize signs and flagmen to advise road traffic of geophone array extents and vibrator locations. Where cables must be laid across roads, the lines will be covered by purpose designed “mats” and warning signs plus flagmen will be placed either side of the crossing pints. If clearing of vegetation is required along the path, it will be conducted under the direction of appropriate environmental monitoring authorities.
- **153 km of gravel roads** may only require some grass- or shrub trimming/pruning along the road reserve margins.
- **169 km of unsurfaced or graveled tracks and firebreaks.** These traverse lines will inevitably require more vegetation trimming/pruning that can leave the root systems intact to clear vegetation extending onto the margins of the existing track or firebreak to create a clear 5m wide swathe.

Data collection and interpretation activities will be conducted both on site and at remote facilities where the interpretation of digital data will result in the export of geological horizons and faults, generation of a digital map, synthetic seismogram and well-seismic tie, seismic facies analysis, seismic inversion for rock properties, reservoir distribution and quality, and building a structural model based on available geophysical and geological information.

2.2.2 Well drilling

During the second phase up to three wells will be drilled at locations identified on the basis of analysis of the intersecting 2D seismic reflection survey transect profiles. It is possible that the drill holes could be 2,000 m deep. The drilling rigs required to drill to such depth are those typically used in the oil and gas industry (Fig. 5) rather than the ‘slim hole’ drill rigs typically used for mineral exploration drilling.

Major activities include well location selection and assessment, well design, site establishment, drilling, coring, logging, and core analyses, followed by establishment of well monitoring equipment (water level etc) and site decommissioning. The Cenomanian and Aptian sandstone units will be perforated for leak off tests. A wireline formation test and leakoff test at each interval will be conducted by sealing off the other using packers.



Figure 5 A drill rig that is capable of drilling to depths of 2,000 m to obtain large diameter core and directional drilling techniques. The drill pad setup of an Atlas Copco Predator drill rigs is used as an example. http://multimedia.atlascopco.com/#1452609579665_16

2.2.3 Data integration, subsurface analysis and reservoir modeling

Major activities include compiling and interpretation seismic and log data on site. This well log data is integrated with the seismic profile data for regional cross-section correlation, reservoir distribution and quality assessment, construction of 3D reservoir model, capacity estimation, and dynamic reservoir modeling.

3 SOUTH AFRICAN POLICY FRAMEWORK FOR CCS

The Intergovernmental Panel on Climate Change (IPCC) recommends that emerging markets substantially reduce in emissions by 2050. In 2009, the South African government committed to reduce the country's emissions by 34% from business as usual levels by 2020 and 42% by 2025. From a carbon perspective, South Africa's electricity mix is currently 90% dependent on coal (KPMG, 2011). The power sector is responsible for 45% of South Africa's emissions, compared to just 26% globally. This high footprint from the power sector means that energy efficiency measures, which can be applied in all businesses, need to play a major role in reducing power usage and in turn, the power sector's high carbon footprint. The projected emissions level from electricity generation in 2020 as compared to 2010 translates to a 2.04% average increase in emissions per annum between 2010 and 2020, which falls significantly short of the emissions reduction rate of 0.2% required to meet the national commitment.

If South Africa continues on its estimated business as usual emissions trajectory, it will face a carbon chasm of 253 million tons CO₂-e in 2020. This gap between the national commitment and national emissions would constitute approximately half of current estimated emissions.

With few other economically exploitable energy resources, such emissions are likely to continue in spite of renewable energy programmes and energy efficiency measures. Consequently, South Africa is investigating the use of carbon capture and storage (CCS) as a green-house gas emission mitigation measure. The Centre for Carbon Capture and Storage (SACCCS) has been established in the South Africa National Energy Research Institute (SANEDI) to take this project forward.

3.1 South Africa's government commitment to CCS

The South African Centre for Carbon Capture and Storage (SACCCS) was initiated in 2009, with CCS studies having been undertaken since 2010 with the publication of the CO₂ Storage Atlas (Cloete, 2010), and Technical document on CCS potential in South Africa (Viljoen et al, 2010). This work (sponsored by PetroSA, Sasol, Eskom, Anglo American, the South African National Energy Development Institute (SANEDI), Council for Geoscience (CGS) and the Petroleum Agency SA (PASA)) identified potential sites for the geological storage of CO₂ as a mitigation measure for the lowering of greenhouse gas emissions from South African industrial sources that primarily utilise coal. The atlas identified Mesozoic sedimentary basins within South Africa that have the necessary storage potential, with the Zululand and Algoa Basins occurring onshore. Subsequent "basin-scale" assessments were undertaken in both basins, with Viljoen et al. (2012) documenting the onshore Zululand basin as part of a project funded by the UK High Commission, whilst Hicks et al., (2013) documented the onshore Algoa Basin as part of the SAfECCS project.

3.1.1 Cabinet endorsement of CCS plan

South Africa's Cabinet approved a Carbon Capture and Storage (CSS) Roadmap for the storage of carbon dioxide (CO₂) in deep geological formations on 4 May 2012. <http://www.esi-africa.com/sa-s-cabinet-endorse-carbon-capture-plan/> ; <http://www.gov.za/minister-energy-mr-dikobe-ben-martins-addressed-south-african-centre-carbon-capture-and-storage>

CCS has been identified in the long-term mitigation scenarios plan as one of the options to reduce CO₂, which is associated with global warming. A Pilot CO₂ Storage Project (PCSP) was announced to further evaluate and build experience around the technology in a South African context. The roles and responsibilities of government departments and agencies in the PCSP are outlined in Appendix 5. Globally, a number of CCS projects have been in operation in excess of fifteen years and are currently safely storing in the order of six million tons per year.

CCS involves capturing CO₂ from a point source, such as a power station or coal-to-fuel plant, transporting it (usually by pipeline) and pumping it down a borehole into porous rock formations deep underground, where it is contained and stored. The geological storage atlas identified potential CCS areas in South Africa (Cloete, 2010). The next step in the CCS roadmap process is expected to be a test injection of CO₂ into a suitable geologic formation, to determine whether such storage can be safely undertaken in South Africa

In an address to the United Nations Climate Change conference in Copenhagen during December 2009, the President acknowledged the need to reach an agreement as being critical for future generations to avoid fundamental and irreversible changes in climate that would affect developing countries most profoundly. His speech highlighted the need, in the long-term, for all nations to reduce emissions, while not retarding the development of developing countries through legally binding emission reduction targets and commitments to nationally appropriate mitigation actions.

The need for developed countries that produce that majority of emissions to provide the lead and contribute finance, technology and capacity building support was stressed in his address. With financial and technological support from developed countries, South Africa should be able to reduce emissions by 34% below 'business as usual' levels by 2020 and by 42% by 2025. <https://www.saica.co.za/Technical/IntegratedReporting/OurSustainabilityServices/News/AddressbyPresidentJacobZumaatUNclimatechan/tabid/1861/language/en-ZA/Default.aspx>

Speaking at South Africa's third CCS conference in Johannesburg, Energy Minister Dikobe Ben Martins reiterated government's support for the technology, as well as for the work being done by the South African Centre for Carbon Capture and Storage (SACCCS). South Africa has indicated that it will continue to explore whether carbon capture and storage (CCS) can play a meaningful role in helping to reduce the country's carbon footprint. The country intended honouring the commitment

made at the United Nations climate negotiations in Copenhagen, Denmark in 2009. This commitment is premised on South Africa receiving financial and technological support from developed countries. The government of South Africa has set aside R197-million over a three-year period to support SACCCS in implementing the CCS roadmap that was endorsed by Cabinet in May 2012.

Under the aegis of South African National Energy Development Institute (SANEDI), the State agency responsible for overseeing energy-related research and development, work is under way on a funding plan, with the financial pledge already made by the South African government said to be providing an important signal to other potential funders of South Africa's commitment to CCS. Norway has pledged R28-million to South Africa's CCS activities and the World Bank's CCS Capacity Building Trust Fund was another likely source of additional funding. <http://www.engineeringnews.co.za/article/sa-pushing-ahead-with-carbon-capture-plans-despite-global-headwinds-2013-10-18>

During the fourth South African Carbon Capture and Storage Conference in Sandton, the Norwegian government renewed its long-term partnership with SA on CCS research through R16m made available to the World Bank's Carbon Capture and Storage Capacity Building Trust that will partly assist in funding a pilot project in SA. SA and Mexico had recently been identified by the World Bank as priority countries for its CCS Fund. <http://www.bdlive.co.za/national/science/2015/10/20/norway-renews-carbon-capture-storage-pact-with-sa>

At the UN Climate Conference in Paris, known as COP21, 196 countries joined together in the Paris Agreement, a universal pact that sets the world on a course to a zero-carbon, resilient, prosperous and fair future. While the Agreement is not enough by itself to solve the problem, it places us clearly on the path to a truly global solution (<http://www.wri.org/blog/2015/12/paris-agreement-turning-point-climate-solution>). A statement by the President of South Africa at the closing plenary of the COP 21 to the United Nations Framework Convention on Climate Change in Paris, France, 12 December 2015, reiterated South Africa's support for the adoption of the Paris Agreement, as reflected in document FCCC/CP/2015/L.9, which President Zuma described as an Agreement that can mark the turning point to a better and safer world.

Paris Agreement set a goal of limiting global warming to less than 2 degrees Celsius (°C) compared to pre-industrial levels. The agreement calls for zero net anthropogenic greenhouse gas emissions to be reached during the second half of the 21st century. In the adopted version of the Paris Agreement, the parties will also "pursue efforts to" limit the temperature increase to 1.5 °C. The 1.5 °C goal will require zero emissions sometime between 2030 and 2050, according to some scientists. It is likely that the importance of CCS towards meeting these goals will grow if other methods to reduce net greenhouse gas emissions fail to meet targets by specified dates.

3.1.2 CCS Roadmap to be implemented by SANEDI-SACCCS

Analysis by International Energy Agency (IEA) shows that CCS would remain a critical greenhouse-gas reduction solution for as long as fossil fuels and carbon-intensive industries continued to occupy a dominant position in the energy mix. The IEA believes CCS could contribute up to one-sixth of the total CO₂ emission reductions required by 2050. The Department of Energy, through Minister Martins, reiterated that government remained of the view that the country's abundant coal resources should continue to be exploited as part of an increasingly diversified energy mix.

The strategy of SANEDI-SACCCS to implementing South Africa's CCS plan that could see commercial application of CCS in the future, follows a phase "Roadmap" approach. Compilation of baseline information during the first and second phases of the roadmap has been completed and the current focus is preparation for the Pilot CO₂ Storage (PCSP) Project. Assessment of the priority geological storage areas on land for the test injection trial has revealed that the geological and geophysical information collected during the search for oil in the 1970's is inadequate to use during the next phase. An additional phase of detailed geological investigations using current seismic profiling and drilling techniques is essential to demonstrate whether the specific injection target aquifer lithologies and their context relative to over- and underlying sedimentary rocks meet the technical specifications for permanent carbon storage. <http://www.sacccs.org.za/roadmap/> . In support of the five phases listed below, research and human capacity development will be performed in parallel to the five phases as shown below.

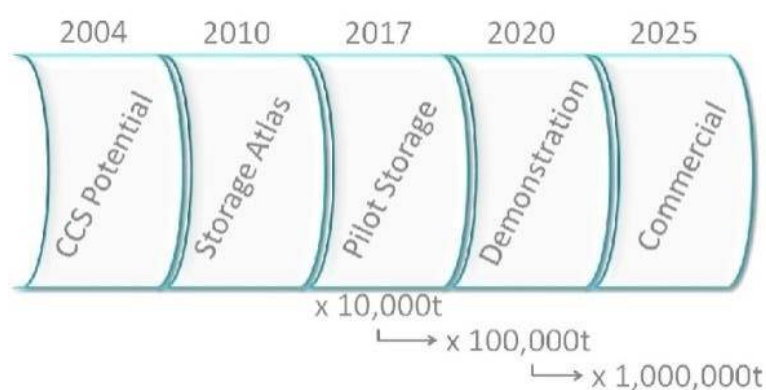


Figure 6 Timeline and anticipated mass of the programmes envisaged as part of the CCS Roadmap implementation.

The five phases of the CCS Roadmap implementation strategy are:

1. **Preliminary Potential Investigation;** completed in 2004 by the CSIR for Department of Minerals and Energy, this phase showed that on a theoretical level, South Africa had capturable CO₂ emissions and potential geological storage sites.

2. **Geological Storage Atlas;** commencing in September 2008, a project to derive more authoritative storage information produced the Carbon Dioxide Geological Storage Atlas (Cloete 2010).

This geological inventory of potential storage sites identified priority areas that could be investigated for the location of a storage site suitable for the PCSP. Existing geological and geophysical information has been the foundation of the advanced investigations towards confirming the physical properties that can support a PCSP.

This project is the culmination of the previous investigation phases and will assess the suitability of specific geological formations for the purpose of CO₂ storage as part of a future Pilot CO₂ Storage Project (PCSP). The 2D seismic reflection survey, data analysis, well drilling, core sampling and analysis, followed by 3D modelling of potential aquifers.

3. **Pilot CO₂ Storage Project (PCSP) Experiment (this project);** following the protocols adopted by other countries, a test of safely injecting carbon dioxide into rock reservoirs is essential to understanding of the suitability of South African specific geological contexts for development as a storage medium on a sustained commercial scale. A test injection pilot project of the order of a few ten thousand tons is necessary to ascertain the dispersion and transformation reactions of the carbon dioxide in the storage medium and its effects on the surroundings of the storage aquifer or geological reservoir rock medium. This experiment will be informed by similar injection activities currently underway internationally. The ultimate purpose of the Experiment is to show to decision makers that carbon capture and storage can be safely undertaken in South Africa.
4. **Demonstration Plant (Planned);** a demonstration plant will test an integrated operating system under local geological and environmental conditions, as an essential progression from feasibility injection trials and a full scale commercial plant. This phase will demonstrate the capture, transport and safe injection of CO₂ into South African geological formations. The magnitude of the demonstration plant is in the order of hundreds of thousands of tons of carbon dioxide per year.
5. **Commercial Operation (Planned);** if the demonstration yields plant positive outcomes, a full scale commercial plant is envisaged. It is expected that this phase will not be conducted by the South African Centre for Carbon Capture & Storage. The magnitude of the commercial scale operation is in the order of millions of tons of carbon dioxide per year.

3.1.3 Progress towards implementing the CCS Roadmap

International Energy Agency (IEA) analysis shows that CCS would remain a critical greenhouse-gas reduction solution for as long as fossil fuels and carbon-intensive industries continued to occupy a dominant position in the energy mix. Other projects were under way in Norway, the US, Australia and Algeria, where the technology was being demonstrated. “There are five projects operating in the world that have stored over five-million tons of CO₂.”

<http://www.engineeringnews.co.za/article/sa-pushing-ahead-with-carbon-capture-plans-despite-global-headwinds-2013-10-18>

3.1.3.1 Findings of the Geological Storage Atlas and Storage Capacity Assessment

In 2010 the South African Centre for Carbon Capture and Storage (SACCCS) commissioned the Council for Geoscience (CGS) to use existing data to assess the effective CO₂ storage capacity of the Zululand Basin (ZB). The project, which was funded by the UK through their High Commission in Pretoria, found there was insufficient data to conclude a basin-scale assessment of full effective storage capacity assessment (CO₂CRC, 2008).

Follow up studies have been carried out;

- “Toward an effective CO₂ storage capacity assessment of the Zululand Basin, South Africa” (Viljoen et al., 2011),
- “Storage potential, capacity estimate and area selection for carbon dioxide storage in the Algoa Basin, South Africa” (Hicks et al., 2013).

Both projects found that insufficient data exist to complete ‘full effective storage capacity assessments’ according to international criteria, e.g. CO₂CRC, 2008 and CSLF, 2008. The data available for the basin studies originated from “legacy data” derived from earlier oil and gas exploration work that was carried-out during the 60’s and 70’s (under licence from PASA).

The literature study made the following recommendations to fill the identified information gaps:

- Additional 2D seismic reflection surveys be obtained to verify both the eastern and western extent of the (Aptian) reservoir and its geometry, thickness and structure.
- Drilling of boreholes to verify rock porosity and permeability of the reservoir cap and seal and various downhole and drillstem tests.
- Investigation of shallower, isolated sandstone bodies which have better porosity and permeability.

In December 2011, SANEDI contracted the CGS to implement “Phase B” which is to develop an ‘Operational Plan’ capable of delivering the additional information required to complete the ‘effective storage capacity assessment of the onland part of the Mesozoic Zululand Basin which lies beneath the Maputaland region.

The scope of work to be undertaken entails a high resolution seismic survey, preferably a vibrating source (as opposed to dynamite), along linear transects covering ~400 km aligned with remnant exploration cutlines, tracks, firebreaks, and public roads across the Maputaland region;

- The 2D seismics along predetermined traverses to image the regional aspect of the sedimentary basin which is known to be about 2 km deep.
- Siting of at least two exploration boreholes/wells that need to be drilled to bedrock beneath the Mesozoic Zululand Group sedimentary succession i.e. depth of about 2 km each based on interpretation of the seismic profiles. There should be at least one well deflection 500 m in extent for each of the two main wells. Full recovery of rock core from top to bottom should be undertaken on at least one of the boreholes as there is no full lithological record for the entire Zululand Group within the onshore portion of the basin.

4 LEGAL AND ADMINISTRATIVE FRAMEWORK

During the project planning phase the SANEDI-SACCCS and CGS project team considered the legal context under which the preliminary geological research and the PCSP would need to be authorized. The seismic profiling operations and deep drilling of boreholes to obtain rock core and to conduct *in situ* tests, and the PCSP which will be sited on the basis of the foregoing investigations, are separate projects.

The techniques to be used during the geological investigations considered here are commonly associated with mineral prospecting but are also used, on different scales, in the context of geophysical exploration for groundwater exploitation and even geotechnical site investigations for infrastructure development.

The SANEDI-SACCCS and CGS team need to ensure that the project is conducted within the scope of applicable environmental legislation. However, as revealed by the extracts below, this is not a simple matter as none of the applicable Acts cater specifically for CCS activities, nor associated investigations.

Since the project will be funded through the involvement of The World Bank, an International Finance Institutions (IFIs) which adheres to the Equator Principles, an additional environmental planning and management process will be imposed on all stages of the project. To be sustainable, a development project must take into consideration the economic, socio-political and environmental implications that will result from the proposed project and all reasonable measures shall be taken to ensure that the negative impacts are minimised and positive impacts maximised to such an extent that there is no net-negative impact resulting from the project. An ESIA should be seen as part of the project development proposal and not as a separate process.

4.1 Environmental and Social Risk Assessment (ESIA) process

The involvement of financial institutions in support of large infrastructure and development projects prompted these organisations to undertake due diligence studies that ensure that project planning and implementation does not impact negatively on the institutional reputation or brand value.

The Equator Principles (<http://www.equator-principles.com/>) is a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk in projects. It is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making. These principles have been voluntarily adopted by International Finance Corporation (IFC), part of the World Bank, and other large financial institutions such as Barclays.

Equator Principles Financial Institutions (EPFIs), have adopted the Equator Principles in order to ensure that advisory involvement or projects financed, are developed in a socially responsible manner that reflects sound environmental management practices (Equator Principles III, 2013). The EP embody explicit commitment to respect human rights, particularly Indigenous Peoples, in the due diligence processes through implementation of robust public consultation standards and enhanced due diligence relating to climate change and biodiversity impacts, including alternatives analysis and revised carbon reporting. The institutions believe that negative impacts on project-affected ecosystems, communities, and the climate should be avoided where possible, and if these impacts are unavoidable they should be minimised, mitigated, and/or offset.

4.1.1 OP 4.01 - Environmental Assessment (The World Bank, 2013a)

The World Bank requires environmental assessment (EA) of projects proposed for Bank financing to help ensure that they are environmentally sound and sustainable, and thus to improve decision making. EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project, evaluating a project's potential environmental risks and impacts in its area of influence (The World Bank, 1999, 2013). The EA process examines project alternatives; identifies ways of improving project selection, siting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA takes an integrated approach to the natural environment (air, water, and land), human health/safety and social aspects (involuntary resettlement, indigenous peoples, and cultural property); and transboundary and global environmental aspects.

Environmental and Social Impact Assessment (ESIA) is a documented, systematic assessment of likely environmental, social and economic impacts resulting from the construction, operation and implementation of a proposed project, plan or policy". It is a tool used to help ensure that issues related to sustainable development are taken into account early in the project planning process, along with the more traditional technical and economic considerations (SAPP, 2010).

The World Bank subscribes to environmental assessment (EA) of projects, based on OP 4.01 – Environmental Assessment Operational Manual (The World Bank. 2013). Project sustainability is enhanced through the evaluation of a project's potential environmental risks and impacts, project alternatives are considered and project implementation (siting, planning, design) is improved by implementing measures to prevent, minimize, mitigate, manage or compensate for adverse environmental

impacts, while enhancing the benefits of positive impacts. Preventative measures are favoured over mitigatory or compensatory measures whenever feasible (The World Bank, 2013).

The scope of EA activities is informed by the nature and scale of the project and associated environmental impacts. The investigations must take into account the biophysical natural environment, human health and safety and social aspects within the project context but also consider possible transboundary and global environmental aspects. The EA process is integrated with environmental management frameworks defined by national legislation or policy, and international treaties and agreements.

The responsibility for carrying out the EA falls on the project implementation organization which must involve the expertise of independent environmental specialists. The World Bank undertakes environmental screening of projects to determine the appropriate extent and type of EA. The World Bank EA requirements can be satisfied by a range of environmental assessment methodologies that are appropriate to the project in line with national legal frameworks. The World Bank reviews EA to ensure consistency with its policy and may indicate the requirement for additional investigations, disclosure or public consultation.

Environmental screening and project classification by the World Bank is relative to four Categories, on the basis of its type, scale, location and sensitivity on the basis of its potential environmental impacts.

(a) **Category A** – significant adverse environmental impacts that are sensitive, diverse or unprecedented across a broader area than the site, facilities or physical works.

(b) **Category B** – potential adverse impacts are less adverse than Category A. Impacts are site specific, few are irreversible or readily mitigated.

For Category A and B projects the World Bank prescribes public consultation requirements with project-affected groups, local NGOs after the environmental screening stage, before the terms of reference for the EA are finalized, after the completion of the draft EA and throughout project implementation. The consultation process includes disclosure through provision of relevant material in format and language that is understandable and accessible to the groups being consulted.

(c) **Category C** – minimal or no adverse environmental impacts requiring no more than environmental screening level investigations.

(d) **Category FI** – use of a financial intermediary vehicle for investment if aspects of the project (or subprojects) may result in adverse environmental impacts. The EA must national and local environmental requirements and be consistent with World Bank policies.

4.1.1.1 Environmental Management Plan

A project environmental management plan (EMP) consists of the set of mitigation, monitoring, and institutional measures to be taken during implementation and operation to eliminate adverse environmental and social impacts, offset them, or reduce them to acceptable levels. The plan also includes the actions needed to implement these measures. Management plans are essential elements of EA reports for Category A projects. For many Category B projects, the EA may result in a management plan only. To prepare a management plan, the borrower and its EA design team (a) identify the set of responses to potentially adverse impacts; (b) determine requirements for ensuring that those responses are made effectively and in a timely manner; and (c) describe the means for meeting those requirements. The EMP identifies feasible and cost-effective measures that may reduce potentially significant adverse environmental impacts to acceptable levels. The plan includes compensatory measures if mitigation measures are not feasible, cost-effective, or sufficient. Environmental monitoring during project implementation provides information about key environmental aspects of the project, particularly the environmental impacts of the project and the effectiveness of mitigation measures.

To support timely and effective implementation of environmental project components and mitigation measures, the EMP provides a specific description of institutional arrangements. This must outline who is responsible for carrying out the mitigatory and monitoring measures (e.g., for operation, supervision, enforcement, monitoring of implementation, remedial action, financing, reporting, and staff training). To strengthen environmental management capability in the agencies responsible for implementation, most EMPs cover one or more of the following additional topics: (a) technical assistance programs, (b) procurement of equipment and supplies, and (c) organizational changes (The World Bank, 1999).

4.1.2 OP 4.04 – Natural habitats (The World Bank, 2013b)

The Bank policy promotes and supports the protection, maintenance, conservation and rehabilitation of natural habitats and improved land use and does not support projects involving the significant conversion of natural habitats. Borrowers (project implementing agencies) are expected to apply a precautionary approach to natural resource management to ensure opportunities for environmentally sustainable development. Project design and implementation must involve environmental expertise to minimize

habitat loss, implement mitigation measure and where appropriate, establish and maintain an ecologically similar protected area.

4.1.3 OP 4.11 – Physical Cultural Resources (The World Bank, 2013c)

Physical cultural resources are defined as movable or immovable objects, sites, structures, natural features and landscapes that have archaeological, palaeontological, historical etc or other cultural significance. Projects financed by the Bank must address impacts on physical cultural resources as part of an EA process and must avoid or mitigate adverse impacts.

The principles of ESIA are very similar to those advocated by South African legislation that ensures project sustainability as the basis for project planning and implementation. Importantly, the scientific collection and reporting of baseline environmental data, public participation in the process of identifying environmental impacts, and implementation of environmental management plans through monitoring, mitigation and rehabilitation also underpin the national legislative requirements.

It must be stressed that in South Africa a project planned by following the WB ESIA process does not absolve the proponent from making formal application in relation to legislated environmental authorization processes should the proposed activities trigger that necessity. Much of the content in this ESIA document would be appropriate for the prescribed content of the documents required under South African environmental assessment processes. Timeframes imposed for the public participation process and submission of documents for review would have to be adhered to.

4.2 Environmental authorization in the context of South African legislation

The following assessment of the proposed project in the context of South African policies and legislation is not exhaustive but focuses on those Acts which are possibly applicable to the scope of activities and anticipated impacts of the scope of work to be carried out during the vibroseis survey and deep well drilling.

4.2.1 Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002) (MPRDA)

The range of activities that would be conducted during geological investigations entailing surface geophysics and deep well boring operations are commonly associated with mineral prospecting or petroleum exploration operations. However, activities involving the sequestration of CO₂ do not fall within the ambit of “mineral” or “petroleum” as defined by the Mineral and Petroleum Resources Development Act, 2002 (Act No 28 of 2002) (MPRDA). The context of “exploration” as used in the MPRDA is in the context of petroleum, and “prospecting” means the intentional search for any mineral by means of any method. An “exploration operation” encompasses “... acquisition and processing of new seismic data or any other related activity to define a trap to be tested by drilling, logging and testing, ...”.

However, the planned geological investigations are not related to a mineral search but a research exercise designed to provide more lithological detail about the geological succession in the area of interest than is currently available from the analogue seismic profiles and deep borehole logs derived from petroleum exploration in the area during the 1970’s.

- Since the proposed geological research activities do not correspond specifically to the requirements for a Prospecting Right (MPRDA, section 18) or an exploration right (section 79) it has been necessary to consider the wider context of environmental legislation. The MPRDA gives effect to section 24 of the Constitution, and acknowledges use of water subject to the National Water Act, 1998 (Act No 36 of 1998) and Chapter 5 and section 24(7) of the National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998, as amended).

4.2.1.1 Regulations for Petroleum Exploration and Production (GN No. R. 466, 3 June 2015)

Additional Regulations under the MPRDA have been added to the existing regulations (GN R 1288, R 1203, R349) after regulation 83.

Regulation 86 stipulates that exploration activities are subject to the requirements of NEMA and any relevant specific environmental management Act and that an Environmental Authorisation is required in terms of the NEMA EIA regulations, 2014. The need for a geological and geohydrological assessment prior to well design is outlined in regulation 87, and specified as being a requisite for the Environmental Authorisation process. These regulations are specific to petroleum and unconventional gas recovery exploration programmes **where the intention is to extract or exploit these resources**.

However, the similarity of the techniques that would be used to plan and implement the PCSP operation, implies that these regulations should be considered as the minimum requirements to be applied to ensure adherence to “best practice” guidelines in the absence of other legislated requirements.

- The scope of work anticipated for this project should form the scientific basis for the report content specified in sub-regulations 87 (2) (a-i) in the context of the broader activities of the PCSP that will require an Environmental Impact Assessment process and Environmental Authorisation.
- The regulations also make provision for additional detail on groundwater and seismicity and specify the well design and construction standards for the protection of soils and aquifers.

4.2.2 National Environmental Management Act (NEMA), 1998 (Act No 107 of 1998, as amended)

National Environmental Management Laws Second Amendment Act, 2013 (Act No 30 of 2013)

National Environmental Management Act (107/1998; Environmental Impact Assessment Regulations, 2014.

Environmental authorization under NEMA follows the Environmental Impact Assessment Regulations (GN R. 982, 4 December 2014) pertaining to environmental impact assessments under sections 24(5), 24M and 44 of NEMA. Listing Notices GN R. 983, R. 984, R. 985 of 4 December 2014 define activities that could have a negative impact on the environment that must be investigated and reported following either the Basic Assessment report (regulation 19) or Scoping & Environmental Impact Reporting (S&EIR) procedures (regulations 21 to 24). Listed activities may not commence without an environmental authorization from the competent authority.

- Activities requiring a MPRDA Prospecting Right are addressed by Listing Notice 1, Activity 20.
 - **This is not applicable as the proposed seismic survey and well drilling is not being undertaken to explore for minerals but to determine geological structures and confirm lithological characteristics.**
- Listing Notice 2, Activity 18 concerns any activity that requires an exploration right.

- The concept of disposal and sequestration of waste CO₂ is not incorporated within the National Waste Management Strategy 2010 or the NEM: Waste Act, 2008 (Act No 59 of 2008), sections 16 & 19, 20, 21. Not applicable to Phase B activities.
- Listing Notice 3 concerns the construction of roads wider than 4m within the 13.5m road reserve in KZN (Activity 4) within National Protected Area Expansion Strategy Focus areas. It is unlikely that new roads will be constructed as part of the seismic survey of drilling operations which will utilise existing sand tracks, forest access tracks or gravelled district roads or.
- Listing Notice 3 addresses the extent of geographic areas in a provincial context and defines the “buffer area” extending around the proclaimed boundary of a world heritage site e.g. iSimangaliso Wetland Park WHS (10 km), KEZ Wildlife nature reserve (5 km).
 - Activity 12, clearing of 330 sq. m indigenous vegetation ... critical biodiversity areas or areas within 10km of national parks or World Heritage Sites or 5km from any other protected area The area of interest is flanked by the iSimangaliso Wetland Park, World Heritage Site eastern boundary and there is more extensive overlap with the 10 km buffer zone around said WHS.
 - **Limiting the seismic survey activities to existing roads and tracks will reduce the impact on vegetation to trimming or pruning of shrubs and grass that is encroaching on the margins of existing tracks.**
- Umkhanyakude District Municipality has developed an Environmental Management Framework (EMF) covering the proposed study area. It is unlikely that the temporary nature of the geological investigation will be at odds with this plan. Care will have to be taken to ensure that trimming/pruning of natural vegetation for the siting of a drilling platform footprint and temporary infrastructure does not exceed legislated area limits.
 - The project description (Section 2) describes the geophysical equipment to be used for the vibroseis profiling operation and the typical areal extent of drilling pad disturbance that is envisaged.
 - It is proposed, where possible, to locate drilling sites within disturbed areas within commercial tree plantations.

4.2.3 National Water Act (Act No 36 of 1998)

The NWA clearly defines a water-course and resource quality characteristics. According to section 21 (c) and (i) water uses include almost any activity in any catchment has the potential to change the resource quality characteristics (flow regime, water quality, habitat and biota) and would require some form of authorization in terms of these water uses. In recognition of this fact the Department published a General Authorisation (GA 1199) for these water uses. However, this GA contains exclusions as part of a risk based approach to ensure that higher risk activities are properly assessed and informed by sound

science and design. Only low risk activities with proper mitigation measures and rehabilitation are being authorised under the GA.

One of these exclusions is “the use of water in terms of section 21 (c) and (i) within the 500m radius from the boundary of any wetland”. This threshold was derived as most construction activities have the potential to change the resource quality characteristics of the wetland and may affect the flow regime if located within the 500m radius from the boundary of any wetland.

A Section 21 (c) and (i) water use authorization is required for any activity within 500 m of the boundary of a wetland.

The extensive distribution of freshwater pans, streams and other wetlands in the Maputaland region where the seismic study will be conducted prompted a specialist wetland environmental study (WetRest, 2015) which included a legal interpretation of the study activities in the context of legislation specific to wetland environments.

Locally, the South African Constitution, various Acts and two international treaties allow for the protection of wetlands and rivers. These systems are protected from destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA) (Act 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act (Act 36 of 1998);
- Conservation of Agricultural Resources Act (Act 43 of 1983);
- Minerals and Petroleum Resources Development Act (Act 28 of 2002);
- KZN Nature Conservation Ordinance (No. 19 of 1974);
- National Forest Act (Act 84 of 1998);
- National Heritage Resources Act (Act 25 of 1999);
- Section 21 (c) and (i) of the National Water Act (NWA) (Act 36 of 1998) GN 1199 - development within 500 meters of a wetland;
- Section 21 (c) and (i) of the NWA (Act 36 of 1998) GN 1198 - Rehabilitation of a wetland area;
- Section 21 of the NWA (Act 36 of 1998); and
- Regulation 983, 984 and 985 of the National Environmental Management Act (Act 107 of 1998).

The vibroseis operations along existing tracks and existing crossings of wetlands and streams will not require specific Water Use licence authorisation. Siting of the drilling pad and probable drilling of shallow wells to supply drilling water and structures to manage drilling fluids may require Water Use licencing.

4.2.4 National Forest Act, 1998 (Act No 84 of 1998)

Natural forests and woodlands form an important part of that environment and need to be conserved and developed according to the principles of sustainable management. In terms of section 7(1) of the National Forests Act, 1998, no person may cut, disturb, damage or destroy any indigenous tree in, or remove or receive any such tree from, a natural forest except in terms of :- (a) license issued under subsection (4) or section 23; or (b) an exemption from the provisions of subsection (4) published by the Minister in the Gazette. Regulations associated with the national Forests Act were published as Government Notice No. R466 (29 April 2009). The Act is enforced by Department of Agriculture, Forestry and Fisheries (DAFF) <http://www.daff.gov.za/>.

4.2.5 World Heritage Convention Act, 1999 (Act No, 49 of 1999)

This Act incorporates of the World Heritage Convention into South African law, providing for enforcement and implementation of the World Heritage Convention in South Africa, the recognition and establishment of World Heritage Sites and the establishment of Authorities and the granting of additional powers to existing organs of state; the powers and duties of such Authorities, especially those safeguarding the integrity of World Heritage Sites. This legislation also defines the procedures for the establishment of Boards and Executive Staff Components of the Authorities, integrated management plans and land matters in relation to World Heritage Sites.

On the 18th April 2011 the Minister of Water and Environmental Affairs approved the Integrated Management Plan of the iSimangaliso Wetland park in terms of section 26(4) of the World heritage Convention Act, 1999 that formalised the Zone of Influence representing a buffer zone around the area.

4.2.6 National Environmental Management: Protected Areas Act, 2003 (Act 57 of 2003)

iSimangaliso is protected by the National Environmental Management: Protected Areas Act. The purpose of this Act is inter alia, to provide for the protection and conservation of ecologically viable areas representative of South Africa's biological biodiversity and its natural landscapes and seascapes. In terms of iSimangaliso as a World Heritage Site, the Act provides for land outside iSimangaliso to be declared as a Protected Environment and thus regulated as a buffer zone. It also provides the Authority with powers

in terms of authorised access, use of aircraft and internal rules as well as commercial and community activities in iSimangaliso and outlines the iSimangaliso Authority's responsibilities in terms of monitoring these activities.

The Buffer Zone Plan in the IMP identifies four levels of influence and contains a map showing the delineation of the buffer zone as three areas around the iSimangaliso Wetland Park:

- Fixed narrow strip falling either side of iSimangaliso's proclaimed boundary.
- Larger area of influence.
- Rivers that enter the park and their catchments.

Buffer zones aim to reduce conflicts between external and internal management objectives, and to protect the core area that is afforded formal protection. According to GN No. R546 of 2010, a "buffer area" means, unless specifically defined, an area extending 10 kilometres from the proclaimed boundary of a World Heritage Site or national park and 5 kilometres from the proclaimed boundary of a nature reserve, respectively. However, in the case of the iSimangaliso Wetland Park WHS the current Zone of Influence was accepted as the buffer zone.

4.2.7 Provincial legislation

4.2.7.1 The Kwazulu-Natal Heritage Act, 2008

This Act provides for the conservation, protection and administration of both the physical and the living or intangible heritage resources of the Province of KwaZulu-Natal. The Amafa aKwaZulu-Natali Heritage Council created for the identification, conservation, protection and the administration of the physical and the living or intangible heritage resources of the Province and, generally, with due regard to national and provincial heritage policy and programmes, to promote and co-ordinate heritage conservation for the benefit of present and future generations.

4.2.7.2 KwaZulu-Natal Provincial Roads Act, 2001 (Act No. 4 of 2001)

The Act provides for the transformation, restructuring, establishment and control of the provincial road network, road policy, norms and road safety standards, maintenance and provision of equitable road access.

4.2.7.3 *Buffer zone policies*

As part of the IMP consultation process, the iSimangaliso Authority finalised the buffer zone, aligning the World Heritage Convention Act and the National Environmental Management: Protected Areas Act requirements (Fig. 7).

The Zone of Influence is an area adjacent to a protected area that is afforded special protection in order to give added protection to the protected area, in this case, a world heritage site. It can also be described as an area of influence in order to protect its world heritage values from external threats. The values for which the iSimangaliso Wetland Park was inscribed are its ecological processes, superlative natural phenomena and scenic beauty and biodiversity and threatened species. The National Environmental Management: Protected Areas Act allows for the Zone of Influence of a world heritage site to be declared a Protected Environment, thus giving it formal protection through law and giving added protection to the world heritage site.

There are three proposed levels of Zone of Influence:

- Level 1: A fixed narrow strip falling either side of iSimangaliso's proclaimed boundary in which no land-use is permitted except for necessary access points and management roads.
- Level 2: A larger area from the Mozambique/South Africa international border southward to the Cape St. Lucia Lighthouse in which the iSimangaliso Authority will exercise its rights and responsibilities in the spirit of co-operative governance.
- Level 3: Rivers (including their catchments) that enter the iSimangaliso Wetland Park. Recognising the strategic importance of rivers, the iSimangaliso Authority needs to have influence from where the rivers enter the iSimangaliso Wetland Park upstream to source. This is defined as a 30 m strip either side of the centre line of rivers to cover both discharge and abstraction. The iSimangaliso Authority will exercise its influence within this 60 m area within the provisions of the Reserve, once the Reserve for each river has been determined by the Department of Water Affairs & Forestry.

The iSimangaliso Authority proposes to influence activities and development in the Zone of Influence mainly through existing legislation and regulations, i.e. through regulated processes such as EIAs, DFAs, water abstraction permit applications and rezoning. Where there is no regulated process concerning a development or activity, provisions under Section 28 of NEMA apply i.e. duty of care and remediation of environmental damage. The iSimangaliso Authority will also co-ordinate with national, provincial and local government in terms of their respective emergency and disaster management plans to deal with events such as floods, droughts, fires, major spillages of hazardous chemical or disease outbreaks.

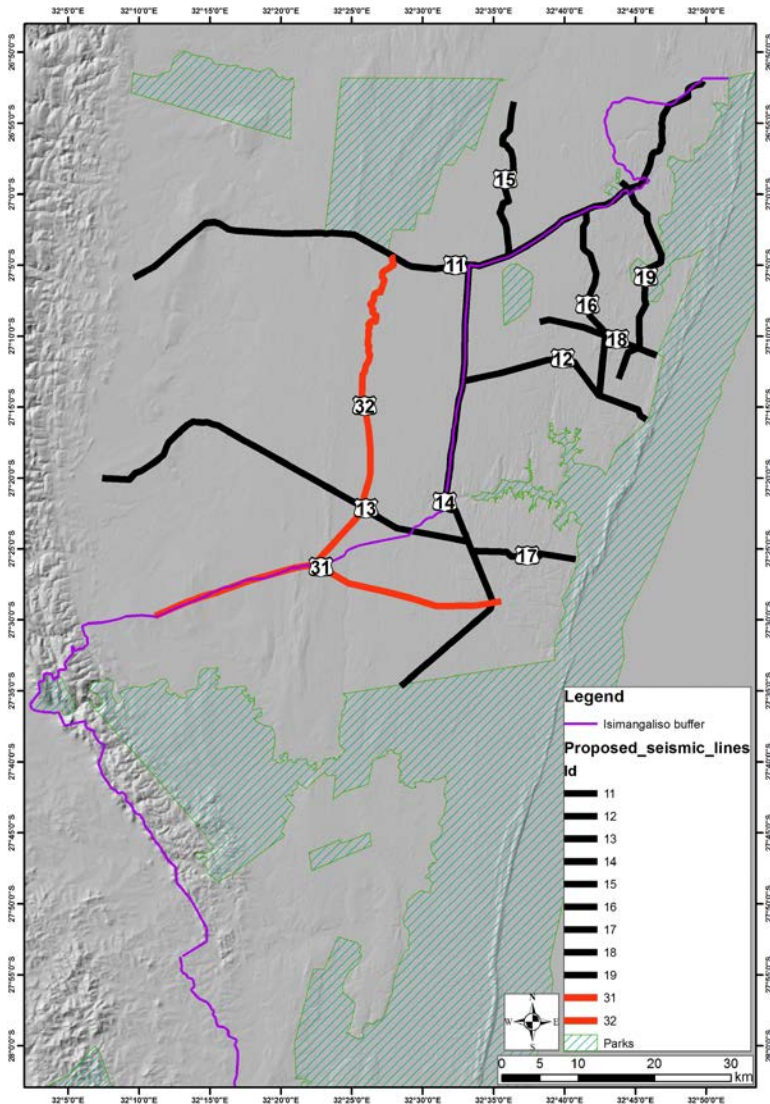


Figure 7 iSimangaliso Wetland Park boundary with the line defining the western Zone of Influence buffer zone (purple). Vibroseis traverse lines follow provincial main and district roads and established public access tracks that cross tribal authority land that is incorporated within the buffer zone.

The responsibilities, obligations and reporting requirements of the iSimangaliso Wetland Park are also contained within its Zone of Influence proposal.

The Zone of Influence was decided after a technical study was conducted using maps and knowledge of the area and relevant legislation. Any area with water (surface and ground water) flowing towards or into iSimangaliso was included in the Zone of Influence. View sheds were also included i.e. any area potentially visible from iSimangaliso.

The Zone of Influence will affect those living and/or using an area within the buffer zone and doing something that may have a negative influence on the World Heritage values of iSimangaliso.

Examples of such inappropriate activities include:

- (i) An activity that uses unacceptable amounts of water that would have otherwise entered the Park e.g. commercial forestry plantations; irrigation for crops; water for cooling in a factory.
- (ii) A development that is very visible or audible from iSimangaliso, thus spoiling iSimangaliso's sense of place e.g. multi-story hotel; a building with strong external lighting; a factory with gas emissions or noisy processes; hunting with loud guns; blasting; loud machinery; high voltage electricity transmission lines; communication towers; commercial forestry plantations.
- (iii) An activity or development that causes unacceptable pollution e.g. uncontrolled chemical spraying of crops; uncontained sewage from a housing development or hotel; discharge of effluent from a factory; discharge of fuel or solid waste from a ship at sea.
- (iv) An activity or development that alters or destroys an area of the natural environment that is an important link to iSimangaliso or performs an important function for iSimangaliso e.g. cultivation on riverbanks; damming of a river; extensive bush clearing of an area that forms an important ecological corridor.
- (v) Depending on the type of activity or development, the iSimangaliso Authority will submit its recommendations or objections through the relevant authority e.g. the DFA Tribunal; the KZN Department of Agriculture and Environmental Affairs; the National Department of Environmental Affairs and Tourism; the Department of Water Affairs and Forestry; uMkhanyakude District Municipality or relevant local municipalities.

Currently, there are no accepted wetland buffer distances provided by the provincial authorities. The NEMA EIA regulations 2015 stipulate a 32m buffer around wetlands. The Ezemvelo KZN Wildlife Biodiversity Impact Assessment Guideline (2013) has compiled criteria for determining the width of wetland buffers based on the biophysical factors and the interactions between them.

Other policies that are relevant include:

- Provincial Nature Conservation Ordinance (PNCO) – Protected Flora;
- KZN Biodiversity Conservation Plan; and
- KZN Vegetation Map (2011).

The development of the Environmental Management Framework, including the Desired State assessment and delineation of thematic Environmental Management Zones, contributed to the publication of a draft Strategic Environmental Management Plan for the district municipal area (EKDM, 2013).

4.2.8 International conventions and agreements

4.2.8.1 Lubombo Transfrontier Conservation Areas

A transfrontier conservation area (TFCA) usually refers to a cross-border region whose different component areas have different forms of conservation status such as national parks, private game reserves, communal natural resource management areas and even hunting concession areas.

The agreement on the Lubombo Transfrontier Conservation Area (TFCA) was signed on 22 June 2000 in Durban at the World Economic Summit by the ministers responsible for the environment in the three countries. Borders separating conservation areas of Swaziland, Mozambique and South Africa came down following a historic trilateral cooperation agreement to promote conservation. The establishment of the Lubombo TFCA supports the broader aims and socio-economic upliftment in the southern Africa subcontinent, as well as improving regional ecosystems management. The Lubombo TFCA area covers 4,195 km², of which 317 km² (8%) is in Swaziland, 2,783 km² (66%) is in Mozambique, and 1,095 km² (26%) is in South Africa. This unique and complex TFCA consists of five mini TFCAs.

The major TFCA objectives are:

- Economic development through natural assets.
- Ecological and financially sustainable use of the natural resource base and the maintenance of ecosystem function through holistic and integrated environmental planning and management.
- The development of joint strategies for transfrontier ecological planning and resource management.

Three of the four specific areas targeted in the protocol are relevant to the proposed geological research programme as they fall partly within the Umkhanyakude District Municipality area. In some instances, the proposed vibroseis route runs along the boundary of part of these areas:

- The Lubombo Ponto do Ouro – Kosi Bay marine and coastal area on the Mozambique-South African borders.
- The Ndumo – Tembe – Futi elephant reserves on the border of Mozambique.
- The Nsubane – Pongolo (Jozini) area on the border with Swaziland.

The area represents a substantial proportion of the core area of the IUCN designated Maputoland Centre of plant endemism and all high level taxonomic groupings e.g. aves, amphibians, reptilians. The diverse landscape is largely intact and hosts functioning geomorphical, hydrological, aquatic,

terrestrial and ecological systems. Established protected areas are: Ndumo Game Reserve, Tembe Elephant Park, Maputo Elephant Reserve and Sileza Nature Reserve.

- Ndumo Game Reserve, listed as a Wetland of International importance in terms of UNESCO's Ramsar Convention.
- The Futi Delta is a unique wetland.
- The region has the potential for reestablishment of the natural movement range for elephant and other species.
- Many tropical biota and unique vegetation communities such as sand forests and woody grasslands exist in the area.
- The iSimangaliso Wetland Park, World Heritage Site forms the eastern coastal zone of the region.

4.2.8.2 UNESCO World Heritage Site; iSimangaliso Wetland Park

The iSimangaliso Wetland Park, covering an area of 239,566 ha, is one of the outstanding natural wetland and coastal sites of Africa (<http://whc.unesco.org/en/list/914> ; <http://isimangaliso.com/>). This area of pristine marine, coastal, wetland, estuarine, and terrestrial environments are scenically beautiful and basically unmodified by people. Natural spectacles include nesting turtles and large aggregations of flamingos and other waterfowl.

The iSimangaliso Wetland Park was listed as South Africa's first World Heritage Site in December 1999 in recognition of its superlative natural beauty and unique global values. The region was incorporated in recognition of the following criteria;

Criterion (vii): iSimangaliso is geographically diverse with superlative scenic vistas along its 220 km coast.

Criterion (ix): The combination of fluvial, marine and aeolian processes initiated in the early Pleistocene in iSimangaliso has resulted in a variety of landforms and continues to the present day. The site is also of sufficient size and retains most of the key elements that are essential for long-term functioning of the ecosystems.

Criterion (x): The five interlinked ecosystems found in iSimangaliso provide habitat for a significant diversity of African biota, including a large number of threatened and/or endemic species. The species lists for iSimangaliso are the lengthiest in the region and population sizes for most of them are viable. Of the over 6,500 plant and animal (including 521 bird) species recorded from the Park, populations of species of conservation importance include 11 species endemic to the park, 108 species endemic to South Africa, while 467 species are listed as threatened in South Africa. The outstanding diversity of habitats (terrestrial, wetland, coastal and aquatic) supports a wide variety of animal species, some at the northern and many at the southern limit of their range.

Ongoing integrity issues include the protection of catchment area and regional development (upstream water abstraction, agricultural practices and road construction); land claims (which may result in further boundary issues); resource harvesting and local community issues; and restoration of degraded habitats.

- The proposed project activities are predominantly temporary and non-invasive in nature and should not have any significant negative environmental impacts within the WHS buffer zone where there are existing roads, homesteads, commercial timber plantations, commercial agricultural practices as well as extensive modification of indigenous vegetation by the agricultural practices of the local population.

4.2.8.3 Convention on Wetlands (Ramsar Convention)

This intergovernmental treaty provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources (<http://www.ramsar.org/>). South African activities are managed by the national Department of Environmental Affairs.

A short section of one vibroseis traverse will pass through a point on the western margin of iSimangaliso Wetland Park although parts of the study area occur within the buffer zone that extends up the watercourses feeding two of the region's four Ramsar sites that recognise the ecological functions of wetlands as well as their importance as resources of economic, cultural, scientific and recreational value;

- Kosi Bay Lake System (Ramsar Site #527),
- Lake Sibaya (Ramsar Site # 528)]
 - The project activities will take place mainly on existing roads and disturbed plantation land. The lack of surface drainage lines that could rapidly transfer any accidental petrochemical spills into drainage systems feeding the Ramsar wetlands will reduce the likelihood of significant adverse impacts beyond a possible spill site and allow for containment and treatment of affected soil.

4.3 Permission to conduct seismic survey and well drilling

The lack of specific provision for CCS related activities in the national legislation described above and the purely geological research focus of this precursor to the PCSP, resulted in the SACCCS project consortium making approaches to government departments in the context of Ministerial discretionary powers and existing authorisations to undertake the scope of work proposed for the seismic survey and deep well drilling.

4.3.1 Ministerial discretionary powers

Given the lack of direct definition in the legislation summarized above of the proposed vibroseis operation or lithostratigraphic drilling operations anticipated, consideration was given to MPRDA Section 50(1) which includes discretionary powers of the Minister of Department: Mineral Resources who may cause an investigation to be conducted on any land to establish if any mineral or geological formation occurs in, or on or under such land and, if so, to establish the nature and extent thereof.

- **The proposed geophysical survey and well drilling would meet these conditions as the aim is not to identify resources that can be extracted or exploited but to confirm lithological characteristics of specific sedimentary units.**

In line with section 50(3) the Minister must publicize the investigation in a Gazette, invite written comments and make contact with the land owner or occupier (section 50(3)(ii)). In terms of the Geoscience Act, 1993 (Act 100 of 1993, as amended), the Council for Geoscience can request the Minister to authorize geological investigations in any area.

From prior experience, the Minister has approved 'scientific drilling' with the condition that an environmental impact assessment (EIA) is conducted. The legal context of such EA will be subject to case specific requirements specified by DMR.

4.3.2 Geoscience Amendment Act, 2010 (Act 16 of 2010)

A letter submitted on 1 July 2015 to the Regional Manager; KZN of Department Mineral Resources requested Ministerial approval for the CGS to conduct the scope of work for the project under a permission granted in line with Section 50(1) of the MPRDA. A DMR official responded to CGS, informing the organization that it was not necessary for the project to be authorized in line with the anticipated Ministerial permission as the Geoscience Amendment Act, 2010 grants Council for Geoscience additional functions, including those listed below:

Section 5 Functions of Council

...

- (e) study the use of the surface and the subsurface of land and the seabed, and from a geoscientific viewpoint advise government institutions and the general public on the judicious and safe use thereof with a view to facilitate sustainable development;

- (g) conduct investigations and render prescribed specialized services to public and private institutions;
- (h) (i) undertake research of its own accord; [or]
- (ii) [undertake] research on behalf of the State or any other government institution, or on behalf of any person or institution, or support such research financially; [and] or
- (iii) any reconnaissance operation, prospecting and other related activities with a view to attracting investment to the mineral resource sector; and
- (i) do anything that is necessary for or conducive to the achievement of the said objects. ...

The interpretation offered by the DMR official pointed to CGS being able to undertake these investigations in line with its legal mandate.

Irrespective of the right of CGS to undertake the proposed geological and geophysical investigations in line with its legal mandate, it remains necessary for the CGS to obtain the appropriate environmental authorization should any activity associated with the proposed investigations fall within the ambit of the legislation outlined above.

4.3.3 Conclusions and recommendations

The proposed geophysical and geological research activities do not trigger any specific requirements for a Prospecting Right or Environmental Authorisation. Despite the lack of formal legal requirements, SANEDI-SACCCS has initiated an environmental assessment with the goal of informing the authorities and interested parties of the proposed PCSP that is being initiated in line with a Cabinet approved CCS Roadmap.

The SANEDI-SACCCS authority outreach activities have ensured that national, provincial and local government agencies are regularly consulted and kept informed about implementation of the CCS Roadmap (see Appendix 6 for a list of consultations). The consultations by SANEDI-SACCCS have also ensured that other stakeholders in the region eg KZN Wildlife and iSimangaliso Wetland Park Authority have been informed of the proposed PCSP and afforded the opportunity to express any concerns that they may have.

The outcome of the geological investigations will confirm whether that the onshore Zululand Basin succession has lithological characteristics that meet the minimum requirements for safe development of the proposed PCSP. Failure to meet the reservoir characteristics required will mean that the project must evaluate the other Mesozoic basin context in the Algoa Basin near Port Elizabeth.

5 PROJECT ALTERNATIVES

The high cost of this proposed precursor to the PCSP and the potential for significant impacts in an area bordering environments of international biodiversity and cultural conservation value and an indigenous population, requires an assessment of potential alternatives that could reduce the potential for negative environmental impacts.

5.1 “No Go” alternative

The Introduction to this report and Section 3 outline the reliance by the economy of South Africa on fossil fuel based energy sources. It is likely that coal and petrol/diesel will power industry and business for decades into the future. The production of fuels from coal is one of the major producers of captured industrial CO₂. However, most of the coal fired power stations that supply the ESKOM electrical distribution grid will not be retrofitted to capture CO₂ emissions. There are no plans to capture CO₂ from other large emission sources such as the cement industry.

Without implementing a carbon capture and sequestration alternative, South Africa will remain one of the world and Africa’s major sources of greenhouse gas emissions unless there is rapid development in the short- to medium-term of renewable energy sources.

In the context of the Paris Agreement that was derived from the COP 21 meeting recently and the acceptance of significant emission reduction targets, it is likely that the South African government will have to emphasise its endorsement of CCS. If South Africa continues on its estimated business as usual emissions trajectory, it will face a carbon chasm of 253 million tons CO₂-e in 2020. This gap between the national commitment and national emissions would constitute approximately half of current estimated emissions (KPMG, 2011).

5.2 Evaluation of CCS context alternatives

The literature review that led to the publication of the “Atlas on geological storage of carbon dioxide in South Africa” (Cloete, 2010) evaluated the spectrum of geological storage contexts and estimated the capacity in South Africa at 150 Gt of CO₂.

The initial considerations of the thick Karoo Supergroup succession of the Main Karoo Basin were found to be unviable due to the low porosity and permeability of the rocks that would pose problems with injectivity.

The potential use of CO₂ injection in enhanced coal bed methane recovery was also evaluated but the possible sterilisation of coal resources that might be utilised by underground coal gasification in future negated this option. With regard to where onshore the PCSP should be located, consideration was initially given to storage in the Zululand and Algoa basins and in the South African coal fields. When considering developing the PCSP with storage in the onshore coal fields, it must be considered that CO₂ injection into coal seams is less advanced than into saline formations, and can have the undesirable consequence of sterilizing the coal fields, preventing future production. Therefore, this option was ruled out for the PCSP. Following further analysis, it was decided that investigations for a storage location for the PCSP should focus on the onshore Zululand Basin.

The majority of geological storage was associated and the Mesozoic basins on the coastal margins were identified as the largest storage volume (98% of capacity). This storage potential is associated with the deep saline formations in thick continental / marine sedimentary packages. The Atlas did caution that the effectiveness of caprock seals needs to be confirmed. An associated possibility is the use of offshore oil and gas fields in these Mesozoic formations including the use of CO₂ for enhanced oil and gas recovery or the use of depleted reservoirs.

After consideration of the logistical and cost implications, the development of a PCSP offshore was rejected in favour of a trial injection into the onshore extension of the Mesozoic formations in the Zululand Basin (Maputaland) or in the Algoa Basin (Nanaga area). A successful PCSP trial will pave the way for a feasibility study of a larger, long-term CCS project offshore.

However, despite a grid of seismic survey profiles and a sparse grid of deep boreholes across both onshore basin areas derived from the 1970's oil search, the level of lithological detail precluded definition of cap and lateral seal successions and confirmation of whether the reservoir host sandstone succession porosity/permeability could facilitate effective CO₂ injection.

The Zululand Basin location was selected ahead of the Algoa Basin context for the initial geological investigations as the site is closer to the industrial production of CO₂ and the less developed rural setting could accommodate the proposed PCSP. However, the short-term goal is to conduct comparative investigations in the Algoa Basin.

5.2.1 SANEDI-SACCCS rationale for locating the Pilot CO₂ Storage Project Onshore

It has been determined by the South African Centre for Carbon Capture and Storage (SACCCS), based on the findings of the Atlas on Geological Storage of Carbon Dioxide in South Africa (hereinafter "the Atlas") and of the Pilot CO₂ Storage Project (PCSP) success criteria, that locating the PCSP onshore in

either the Zululand Basin or the Algoa Basin is the only way to meet the aims of the PCSP. The motivation for this decision can be seen below.

In 2010, the Atlas, which represents the second milestone in the South African Carbon Capture and Storage Roadmap (hereinafter “the Roadmap”), was published. The Atlas provided the results of a nationwide screening of existing geological information, determined the areas in South Africa that are worthy of further investigation for carbon dioxide (CO₂) storage, and gave an indication of the national CO₂ storage capacity. The Atlas concluded that there is a total of 150 billion metric tons in theoretical CO₂ storage capacity in South Africa, 98 percent of which is in three offshore basins—the Orange Basin, the Outeniqua Basin, and the Durban Basin—with the remaining 2 percent located onshore in the Zululand and Algoa basins and in the South African coal fields.

With the completion of the Atlas, the focus of SACCCS moved to the third milestone of the Roadmap: the PCSP. The PCSP involves the injection, storage, and monitoring of 10,000–50,000 metric tons of CO₂ in South Africa. To commence the development of the PCSP, the SACCCS confirmed among participants and stakeholders an agreed set of aims and desired outcomes of the PCSP, referred to as the PCSP Success Criteria.

The primary Success Criteria for the overall PCSP were agreed to as follows:

1. Demonstrating safe and secure CO₂ handling, injection, storage, and monitoring in South African conditions, in particular, South African geology;
2. Increasing the South African human and technical capacities for the development and operation of CO₂ handling, injection, storage, and monitoring;
3. Raising the awareness of the potential importance of CCS to the South African public; and
4. Working with the government to ensure that the development and operation of the PCSP can occur within the South African legal and regulatory environment.

The first and fourth primary PCSP Success Criteria would technically be able to be met with the PCSP located either onshore or offshore. However, the costs of developing a project of this size and nature would be significantly more expensive in an offshore location—potentially orders of magnitude more expensive – thus significantly decreasing the likelihood of the project progressing to operation. The second and third primary PCSP Success Criteria, which aim for capacity building and awareness raising, would largely be unattainable if the PCSP were located offshore. Locating the PCSP offshore would prevent significant involvement and active participation from industry and academia in the project, and would prevent local and national stakeholders from being able to regularly visit the project. Accordingly, locating the PCSP onshore would be the only way to meet the aims of the PCSP.

5.3 Alternatives considered in the onshore Zululand Basin context

The initial site evaluation considered the practicality of conducting the necessary seismic survey on the cut lines that were cleared during the 1970's seismic survey. The possibility of using the existing oil exploration boreholes for down the hole geophysical techniques was also considered.

- Despite being shown on some topocadastral maps, the cut lines could not be located on the ground.
 - The clearing of new cut lines along the old alignments would require far too much bush clearing in an area where there are protected ecosystems.
- The road network in the 1970's was limited to sand tracks whereas the network of surfaced main and district roads has been dramatically improved since the early 1980's.
 - The existing road network offers the potential to conduct the 500 km seismic survey with very limited environmental impact apart from brush trimming on the sides of some existing tracks.
- The positions of old wells could not be traced using the coordinates provided on the well logs. During preliminary site inspections, only one of the holes was located and the structures used to seal the borehole could not be ascertained.
 - Further exploration of these sites could be conducted as an ancillary project when the geophysical consultant teams are operating in the area.
- The siting of new deep wells will only be confirmed on the basis of interpretation of the new digital seismic profile data. Public concerns over siting of deep wells due to the reliance on shallow groundwater in the area, extensive wetlands, proximity of conservation areas, rural population homesteads and agricultural sites need to be considered. There are large areas of commercial timber plantations, both active and abandoned due to the effects of fire that can be used for siting of the drilling pad without triggering legislated limits on clearing of indigenous vegetation. The plantation areas also have well maintained road networks.
- The siting of boreholes, preferably on disturbed land, will be subject to the approval of the landowner or tribal authority. The geological characteristics of the sedimentary succession underlying the region enable sufficient flexibility in the siting of boreholes to accommodate possible concerns over the impact on landuse options or access routes to the drilling site. Permission to drill will be subject to a written agreement between the landowner and PCSP developer to ensure that the rights of both parties are respected.

6 BASELINE ENVIRONMENTAL CONTEXT

6.1 Legal framework of the environmental investigations

A thematic, screening level outline of the biophysical and socio-economic environment in the Maputaland region and uMkhanyakude District Municipality region where the geological research programme is envisaged (Botha, 2012), provided the context for the anticipated (generic) environmental impact assessment process and derivation of an environmental management programme that will be implemented in the event that the geological research activities do not trigger any specific legislated requirements. This document outlines the baseline environmental data and specialist studies in the format of the Environmental and Social Impact Assessment (ESIA) content format prescribed by the World Bank (2013) but also meets the requirements for the Basic Assessment or Scoping phase of Scoping and Environmental Impact Assessment (ESIA) prescribed by the National Environmental Management Act.

Under each thematic section below, potentially negative environmental aspects that have been identified are described. To ensure that no activities will be undertaken under the project that will lead to the significant conversion or degradation of natural habitat, an environmental management plan has been compiled. This includes action plans for environmental impact monitoring, management and mitigation of significant negative impacts.

The investigations will adopt a risk averse and cautious approach to activities in mainly disturbed areas so that significant negative impacts are avoided or can be effectively mitigated. Public participation or stakeholder engagement is a critical aspect of the integrated environmental management approach embodied in national legislation. The scoping and environmental impact assessment approach embodied in the MPRDA and NEMA ensure that environmental matters are considered at all stages of development planning.

The level of detail provided here is sufficient to focus the content of Background Information Documents (BID) or as a basis for Scoping level environmental description. The thematic environmental descriptions undertaken can highlight probable activities or biophysical aspects that would require site specific investigation or specialist input during the environmental planning phase.

The proposed alignment of seismic survey transects was refined during site investigations by the team of consulting specialists. For much of the linear activity the route follows remnant cutlines, cleared firebreaks, existing tracks and public roads that have been disturbed over long periods. Recently water pipeline reticulation schemes have been installed along main roads or following the remnant cut-lines that were cleared of vegetation during geophysical surveys in the 1970's. Other

sections of proposed seismic survey transect follow public roads or forestry tracks where the potential for impact on vegetation or surface water is considerably reduced.

6.2 Study area location, infrastructure and EMF/SEMP context

The uMkhanyakude District Municipality covers more than 12 818 km² in the north eastern part of KwaZulu-Natal province (Figs. 1a, b, 2, 3a, b). The northern boundary is defined by the international border with Mozambique and the eastern boundary by the Indian Ocean shoreline extending southwards to St Lucia estuary. Large areas on the eastern and northern margins of the district municipal area fall within the iSimangaliso Wetland Park conservation area which has World Heritage Site status (Fig. 7).

Access to the Maputaland coastal plain study area is via the N2 freeway between Mtubatuba and Mkhuze on the western side of the Lebombo mountains. The R22 tar road traverses the low-lying coastal plain between Hluhluwe town and KwaNgwanase in the north. The P522 tar road is aligned along the western margin of the Phongola River valley until Lake View where the road turns eastwards towards KwaNgwanase.



Figure 8 The R22/P444 tarred main road in the area of Mbazwana showing the cleared road reserve.



Figure 9 Typical gravelled district road winding through the dense woodland vegetation typical of the central part of the study area.

Although the highest population densities occur within the Jozini municipal area on the Lebombo crest to the west, much of the recent infrastructure development has been directed towards the rural population within the Phongola River valley and nodes such as Mbazwana and Manguzi towns and adjacent areas. The development of a high density network of surfaced roads is limited by the lack of suitable road materials in the coastal plain areas.

6.2.1 Umkhanyakude District Municipality; Environmental Management Framework (EMF), Environmental Management Zones (EMZ) and Strategic Environmental Management Plan (SEMP)

The Environmental Management Framework (EMF) document was the product of an environmental assessment process that compiled baseline biophysical environment reports provided by specialists and engaged in a broad public participation process to ensure that authorities and communities were consulted. An EMF is a study of the biophysical and socio-cultural systems of a geographically defined area to reveal where specific activities may best be undertaken and to offer performance standards for achieving and maintaining the desired state of that area.

The Desired State report (UKDM, 2013a) and sensitivity analysis (UKDM, 2013b) derived from the UKDM EMF process served to build on the status quo evaluation by establishing an environmental vision for the district which is translated into a spatial representation via a mapping exercise. Establishing the desired state includes setting a vision for the district and providing the environmental

management context for the management zones and related requirements for the various environmental features for the SEMP. It also focuses on addressing the imperatives that lead to the instigation of the EMF development process.

- The balanced and broad vision statement for uMkhanyakude is as follows: “To promote economic and social development in the uMkhanyakude district and to harness its tourism potential through the sustainable utilisation and protection of its abundant natural resources”.

The desired State report can be downloaded from;

[http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%203%20-%20SEMP%20\(low%20resolution\)%20-%20Part%201.pdf](http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%203%20-%20SEMP%20(low%20resolution)%20-%20Part%201.pdf)

The Desired State phase of the EMF was concluded with the delineation of Environmental Management Zones (EMZs). Each of these zones represents a specific demarcated area that requires active control to ensure that its potential is realised. The EMZs depicted the assimilated sensitivity maps that were integrated with the development pressures and trends, opportunities, constraints and public aspirations. An Environmental Management Zone (EMZ), which is also regarded as a ‘geographical area’ in terms of section 24 of NEMA, represents a specific demarcated area that requires active control to ensure that its potential is realized and sensitive features are safeguarded. The management zones focus the attention of the relevant authority on critical environmental areas in UKDM and thus ultimately guide and inform decision making within the environmental planning realm. The EMZ areas differentiate the coastal World Heritage Site Zone from the inland KZN Wildlife proclaimed conservation areas that are designated “Conserved Terrestrial Biodiversity”. Large areas in a belt extending parallel to the coast that includes Mbazwana and Emanguzi towns and the land south of the Tembe Elephant Park, are designated “Unconserved Terrestrial Biodiversity”. This area includes critical biodiversity areas, Important Bird Areas, community conservation areas and various vegetation types classified as critically endangered, endangered and vulnerable. The wetland areas shown in Fig. 15 are designated the “Surface Freshwater” EMZ. The Heritage EMZ includes numerous archaeological sites, historical sites and graves. A “Buffer Zone” EMZ was designated according to GN No. R546 of 2010, extending 10 kilometres from the proclaimed boundary of a World Heritage Site or national park and 5 kilometres from the proclaimed boundary of a nature reserve, respectively. This same definition was adopted for the sake of demarcating buffer areas for Protected Areas. However, in the case of the iSimangaliso Wetland Park WHS the current Zone of Influence was accepted as the buffer zone. An absence of data prevented the refinement of vulnerable groundwater zones. Buffer zones aim to reduce conflicts between external and internal management objectives, and to protect the core area that is afforded formal protection. The EMZ report (UKDM, 2013c) can be downloaded from;

[http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%202%20-%20Desired%20State%20\(low%20resolution\)%20-%20Part%203.pdf](http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%202%20-%20Desired%20State%20(low%20resolution)%20-%20Part%203.pdf)

The Strategic Environmental Management Plan (SEMP) derived from the UKDM EMF process serves to plot the way forward for attaining the desired state. In order to address the triggers for sustainable

development in the UKDM and the priority environmental opportunities and constraints, some of the key objectives of the EMF include facilitating environmental decision-making and providing strategic guidance on environmental, economic and social issues in the district. The catalysts for initiating the UKDM EMF fall within the following categories:

- (i) Significant environmental factors (e.g. protection of natural resources to ensure that the associated environmental goods and services are not jeopardised);
- (ii) Development pressures (e.g. unlocking agricultural and tourism potential);
- (iii) Environmental threats (e.g. land use conflicts and incompatible land use practices); and
- (iv) Resource management issues (e.g. risks to sensitive environmental habitat such as the endemic Sand Forest).

The SEMP (UKDM, 2013d) bridges the divide between the current state of the environment in UKDM and the desired state. It aims to achieve this by managing the sustainable utilisation of land through Management Guidelines and by controlling the activities that may impact on environmental attributes in specific geographical areas. The document can be downloaded from;

[http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%203%20-%20SEMP%20\(low%20resolution\)%20-%20Part%201.pdf](http://www.kzndard.gov.za/Portals/0/Environment/Umkhanyakude%20EMF/UKDM%20EMF%20Volume%203%20-%20SEMP%20(low%20resolution)%20-%20Part%201.pdf)

6.2.2 Environmental aspects associated with the location of seismic survey transects and drilling sites

- i. Due to the dense vegetation cover, sandy soils and seasonal shallow water table, aligning the vibroseis survey transect lines along the grid of existing tarred main roads, gravelled secondary district roads and unpaved tracks represents the lowest potential for negative environmental impacts.
- ii. A concern is the siting of civil infrastructure such as powerlines, water pipelines and fence lines along the major main and district road alignments due to the higher density of ribbon development that occurs close to the roads.
- iii. The slow pace of the vibroseis survey will allow effective traffic control on the major routes. Apart from the P444-P447 main road from Jozini to Mbazwana and the section of the P552-2 tarred road from Lake View to KwaNgwanase, the traffic volumes are low.
- iv. The proximity of parts of seismic transects to the EMZ areas marked by the southern boundary fence of the Tembe Elephant Park along road P522-2 and the gravel district road that runs along the unfenced western boundary of the iSimangaliso Wetland Park where it extends up the Sihadla River channel are areas where conservationists could be concerned about the proposed activities.
- v. The UKDM SEMP acknowledges the buffer zone defined in the iSimangaliso Wetland Park IMP and Zone of Influence Policy:
 - a. Comply with IMPs and buffer policies of Protected Areas.

- b. Undertake projects and programmes in a collaborative manner, to meet park objectives.
- c. Satisfy relevant authorities' requirements for development applications in buffer areas.
- d. Manage edge effects for all development applications within –
 - i. 5 km buffer surrounding Protected Areas; and
 - ii. Zone of Influence for iSimangaliso Wetland Park.
- e. Safeguard core protected area from negative impacts.
- f. Enhance the natural functioning of ecosystem(s) within the core areas.
- g. Providing for environmental education, in situ biodiversity and water conservation

6.3 Geological and geophysical baseline data

SACCCS and Council for Geoscience (CGS) have evaluated the onshore Zululand Basins for its effective CO₂ storage capacity as recommended by the CO₂ Storage Atlas of South Africa (Cloete, 2010). Available literature concerning the geological context of the Zululand Basin was collated in a specialist report by Botha and Hicks (2010) and follow up studies “Toward an effective CO₂ storage capacity assessment of the Zululand Basin, South Africa” (Viljoen et al., 2011) and “Storage potential, capacity estimate and area selection for carbon dioxide storage in the Algoa Basin, South Africa” (Hicks et al., 2013).

- Both projects found that insufficient data exist to complete *'full effective storage capacity assessments'* according to international criteria, e.g. CO₂CRC, 2008 and CSLF, 2008. The data available for the basin studies originated from oil and gas exploration work that was carried-out during the 60's and 70's (legacy data). Most of the Zululand Basin borehole material archived at the CGS Core Library comprises degraded chip samples with little continuous drill core sample archived for the potential CCS aquifer units.

In order to provide lithological context data of suitable detail and quality to undertake an 'effective storage capacity assessment' it is necessary to undertake high resolution vibroseis surveys and then position deep boreholes that will optimally sample the target aquifer lithologies.

6.3.1 Basin suitability for CO₂ storage

The national review of geological storage of CO₂ in South Africa by Viljoen et al. (2010) highlighted the CO₂ storage potential of un-mineable coal seams and deep saline aquifers in the onshore Mesozoic Basins. There are no significant coal or organic-rich strata in the Zululand Group so the CO₂ storage potential of the deposits focuses on the thick sandstone units that were intersected during the drilling of ten petroleum exploration boreholes in the area. The review by Viljoen et al. (2010) concluded that the effectiveness of cap rocks and lateral seals must still be determined for the Zululand Basin.

The investigation area focuses on the Mesozoic, Zululand Group rocks that underlie the Maputaland area east of the Lebombo mountains. Regional geological maps published by the Geological Survey (1985a, b) show the regional distribution of geological units. Information on the distribution and thickness of the Pleistocene dune sands can be obtained from research published by Botha and Porat (2007) and Porat and Botha (2008). A dense distribution of shallow groundwater wells across the sandy coastal plain also provide “fill-in” detail on the distribution of the Maputaland Group sedimentary rocks that underlie and form the coastal plain. In most cases these well logs define the regional aquiclude between the Neogene calcareous deposits and the underlying, relatively impervious Mesozoic Zululand Group rocks. Petroleum exploration well logs and analogue seismic profiles in the area provided the geological and lithostratigraphic framework that was used to compile the initial interpretation of the value of the available data in designing the PSCP.

The onshore Zululand Group basin-fill is buried beneath Cretaceous and Cenozoic sediments on the Maputaland coastal plain but covers an area of 7 500 km² with the offshore basin extent totalling 13 500 km² to the 1 500 m isobath (Broad et al., 2006). The Cretaceous succession is up to 2 000 m thick. Differentiation of sandstone dominated units from exploration well logs and records (Hicks and Davids, 2010) identified two potential sandstone areas that lie beyond the minimum depth of >800 m for safe storage of CO₂. The two areas are interconnected by a continuous, albeit thin, sandstone unit that is present throughout the Zululand Basin (Hicks and Davids, 2010).

These target areas in the Cenomanian (Middle) Sandstone are referred to as Cenomanian Sandstone North (CSN) and Cenomanian Sandstone South (CSS). CSN covers 222 km² while the areal extent for CSS is 130 km². Porosity estimations from cores and cuttings vary between 15–25% and the thickness of the sandstone varies between 20 m and 200 m.

The Aptian (Lower) Sandstone is an extensive sandstone unit (Hicks and Davids, 2010) that lies deeper than 800 m below surface. The Aptian Sandstone potentially covers an area of more than 1680 km² with porosity variation of 8-18%.

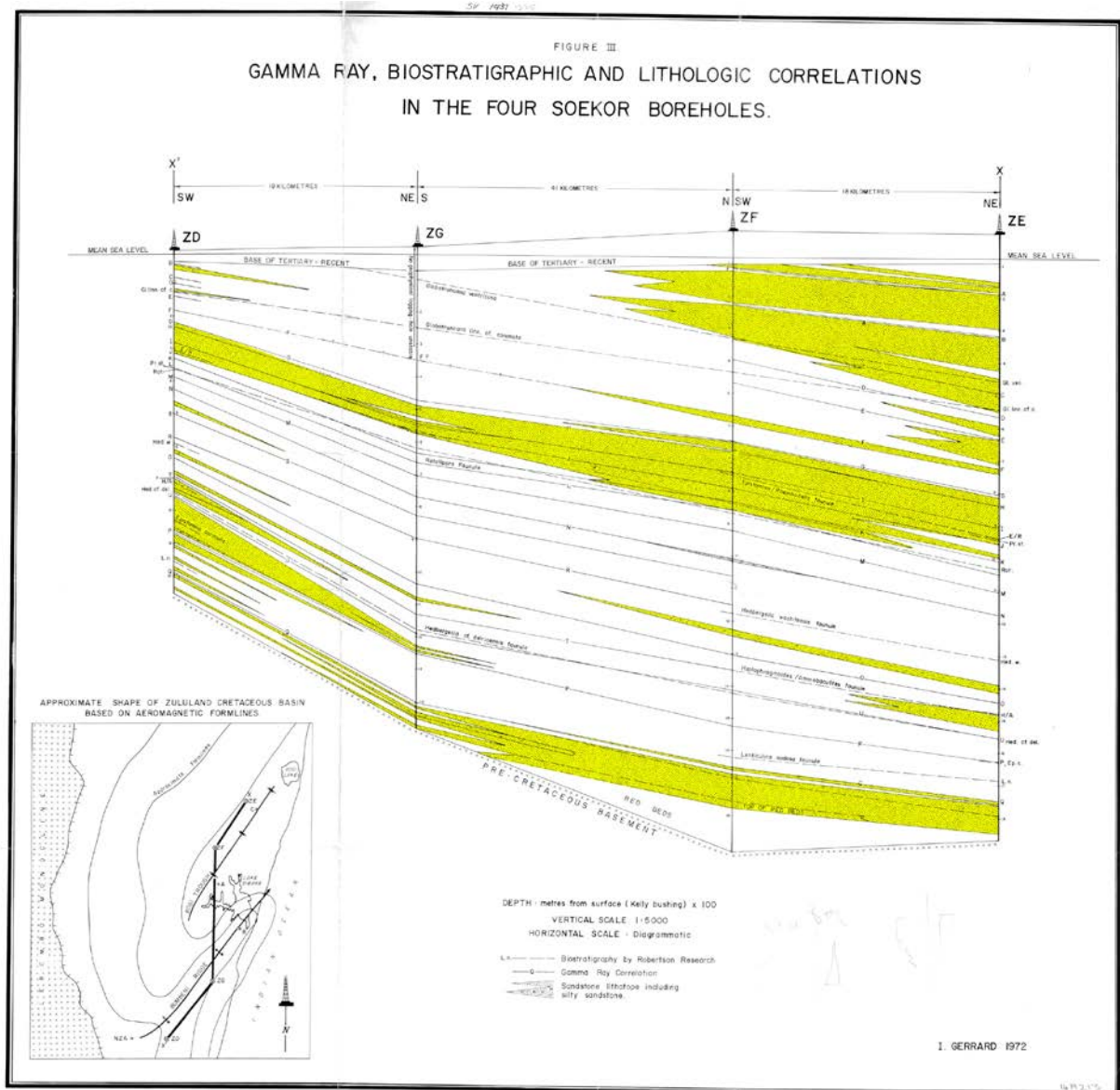


Figure 10 Potential CO₂ storage lithologies identified from the existing seismic profiles and 1970's borehole logs. The network of high resolution 2D digital seismic profile traverses will be integrated to improve the 3D geological records and select the most suitable deep well drilling sites.

The lithological succession of the Mesozoic Zululand Group comprises siltstone and fine-grained sandstone with three laterally continuous sandstone-dominated formations that define major unconformities within the succession. The alternating sandstone and argillite succession ought to be

ideal for CO₂ storage if the sandstone beds are lensoidal with interbedded, less permeable siltstone forming a potential vertical and lateral seal. The actual storage capacity is, however, constrained by sandstone porosity and the presence and efficiency of cap rock seal beds and lateral seals.

6.3.2 Environmental aspects associated with the Zululand- and Maputaland Group successions

Key issues to be addressed using the higher resolution 2D seismic profiles and the detailed lithostratigraphic and aquifer lithological data derived from optimally sited deep boreholes include;

- iv. Confirm the depth and regional gradient of the Neogene/Cretaceous unconformity surface under the Maputaland coastal plain. The eastward dipping Cretaceous surface eroded by transgressive littoral marine Uloa/Umkwelane Formation rocks is an important regional groundwater controlling interface that is at surface along the western margin of the coastal plain but lies at a depth of >80m msl at the present coast.
- v. Use the intersecting traverses of 2D seismic profiles to derive stratigraphic and lithofacies models to define the association between coarse arenaceous units (Cenomanian and Aptian sandstone packages) and associated siltstone or mudrock units that could form lateral or vertical seals. Structural discontinuities such as fault planes and the associated displacement of regional lithostratigraphic units can be derived from detailed seismic profiles.
- vi. Delineate the regional variation in the thickness of mid- to late Pleistocene Kosi Bay Formation dune sands and the surficial KwaMbonambi Formation dunes that host the near surface shallow groundwater aquifer upon which most communities in the region are reliant for their water supply.

6.4 Terrain morphology

The proposed seismic profile lines traverse much of the Maputaland coastal plain, extending as far as the foothills of the Lebombo mountains in the west and Indian Ocean shoreline in the east. The typical low gradient, undulating topography of a stabilised and vegetated Holocene parabolic dunefield is exhibited in Figs 8 and 9.

The seismic transects extend from the Phongola River valley in the west, across the Sihangwane–Tshongwe dune ridge towards the Lake Sibaya basin in the east. North-south aligned transects follow the low lying topography of the Sihadla drainage south of Kosi Bay (Figs. 2, 3)

The Maputaland region within the uMkhanyakude municipal area is characterised by diverse terrain morphology and numerous incised river catchments. The topographic variation can be attributed to the wide range of geological formations and long period of landscape development. The contrasting terrain is characterised by the low lying coastal plain in the east which is flanked by the Lebombo monoclonal mountains and irregular foothills that have been etched by the incised Phongolo River valley.

The 1:250,000 Terrain Morphological Map of South Africa (Kruger, 1983) classifies the uMkhanyakude region into terrain morphological classes based on slope form, relief and drainage density. The low-lying Maputaland coastal plain east of the Lebombo mountains are classified as “plains” with low relief and low drainage density. The eastern Lebombo mountain foothills extending south from Ndumo to Mkhuze are “moderately undulating plains” with variable relief (30-210m) underlain by the Cretaceous siltstones and influenced by the Neogene palaeo-dune ridge along the Phongola River valley. The Lebombo steep mountains are classified as “low mountains” with high relief. The characteristic steep western scarp and lower gradient, hill crest and eastern slopes are defined by the easterly dip of the Jozini rhyolite Formation. A more recent terrain morphological classification by Partridge et al. (2010) only differentiates the “Lebombo Highlands” from the “Maputaland coastal plain”.

The National Aeronautics and Space Administration (NASA) 90 m gridded Shuttle Radar Topography Mission (SRTM) digital elevation data has been modeled using the ESRI ArcMap 9.3 and Spatial Analyst module. This level of terrain modelling will be sufficient for modelling seismic transect gradients and surface water runoff flowpaths and for inter-visibility modelling.

6.4.1 Environmental aspects associated with the terrain morphology

- iv. The non-invasive nature of the vibroseis survey technique limits the potential for terrain related environmental impacts. The undulating dune topography formed by low, extended parabolic dunes and patchwork of woodland and grassland vegetation will shield much of the road routes that are to be followed by the vibroseis vehicles.
- v. The very limited extent of well-defined stream channels limits the potential for distribution of possible accidental petrochemical spills away from the chosen drilling sites.
- vi. The wide expanses of seasonally inundated wetlands that are crossed by road routes dictates that a well-rehearsed petrochemical spill response process supported by suitable equipment is available for potential spillages.

6.5 Soil and landtypes

The landtypes of the uMkhanyakude district municipality span three 1:250,000 Landtype Series maps; 2632 Mkuze, 2730 Vryheid and 2830 Richards Bay (Soil and Irrigation Research Institute, 1986 a, b; 1988). The landtypes differentiate areas with similar terrain morphology, soil, geology and climate parameters (Fig 3). The soil landtypes form a critical component of the development potential assessment of the Umkhanyakude municipal area due to the range of soil types, drainage classes, fertility and geotechnical characteristics that have a significant impact on the indigenous agricultural crops and techniques practiced in the region.

Much of the extent of vibroseis operations is underlain by the KwaMbonambi Formation dune sands that are characterized by deep red/yellow freely drained, sandy soils. The seasonal interdune wetland areas have grey, gleyed sandy profiles, sometimes underlain by palaeo-wetland deposits close to drainage lines such as the Muzi swamps. Clay-enriched or duplex soils with impeded drainage characteristics are closely associated with the main watercourses feeding the Muzi (north and south) wetlands.

6.5.1 Environmental aspects associated with soil associations

The proposed vibroseis transect lines follow established roads that have been built on raised fill where they cross the major wetland areas to avoid seasonal inundation or erosion by flow after major rainfall events. Restriction of the vibroseis equipment to existing roads and tracks will reduce the potential impact on sensitive topsoil layers of the sandy soils.

- iv. The sandy soils are generally cohesionless and can be significantly disturbed along routes by multiple passes of light vehicles. Sections of the vibroseis survey have been located along existing tracks, some of which have utilised the alignment of former cut lines that were created during the seismic surveys of the 1970's. Other vibroseis route alignments follow the tracks used by commercial plantation vehicles or linear tracks kept free of vegetation to serve as fire breaks around the plantations.
- v. Most of the proposed vibroseis activities will occur along existing surfaced roads, the disturbed road shoulder or service tracks parallel to the road reserve.
- vi. Siting of drilling pads on areas of sandy soils will require preparation of lined ponds to store waste water used for drilling or drilling mud storage tanks. The protection of the permeable sandy substrate from spills on the drilling pad is essential in this area of concentrated vehicle activity and storage of industrial petrochemicals and fuel chemicals.

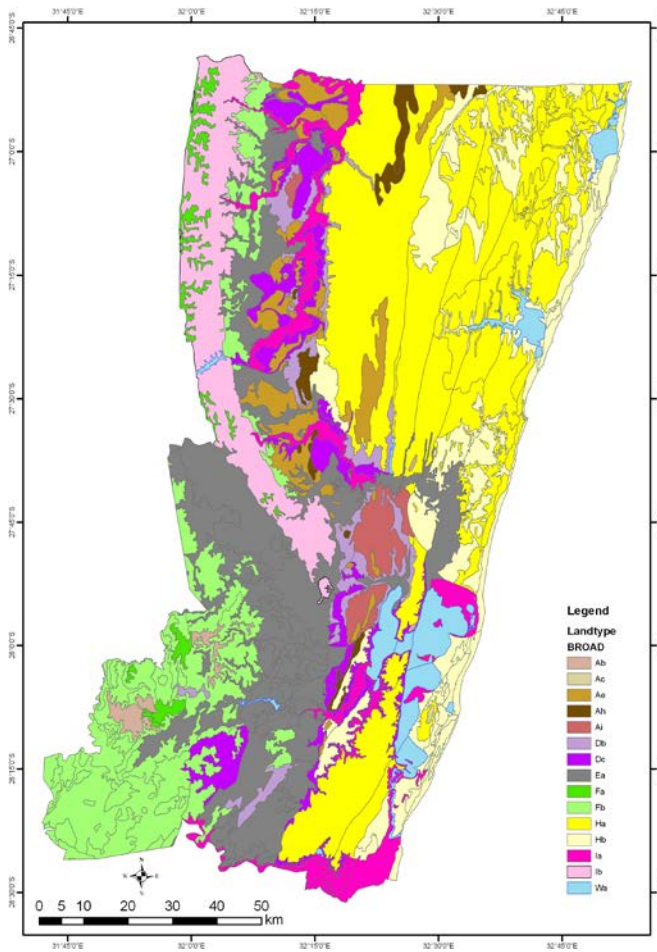


Fig. 11 Soil landtypes of the northern part of uMkhanyakude District Municipality region on the Maputaland coastal plain show the close association of soil distribution with geology and terrain. (After Soil and Irrigation Research Institute, 1986 a, b; 1988; AGIS, 2004).

6.6 Groundwater

The groundwater of uMkhanyakude District Municipality region is closely linked to the Zululand Group siltstone/sandstone succession overlain by poorly consolidated Neogene deposits and unconsolidated Quaternary dune sediments described in the groundwater specialist report by Jeffares and Green (2015) included as Appendix 3. The municipality falls within the “Usuthu to Mhlatuze” Water Management Area 6. The aquifer potential of different rock types is related to the primary porosity of the consolidated rocks or unconsolidated sands and the secondary porosity associated with brittle fracturing or weathering of the bedrock at depth. Regional groundwater assessments of the region, such as the KwaZulu-Natal Geohydrological Mapping Project (EMATEK-CSIR, 1995; Groundwater Development Services, 1995) conducted by consultants on behalf of Department Water Affairs and Forestry (DWAF), have provided a hydrogeological classification of the uMkhanyakude region. Other DWAF publications show the regional context of the lithologically based aquifer assessment. The location of the municipal area straddling the Lebombo mountains and the coastal plain makes the combination of potential groundwater aquifer contexts in this area unique in KZN (Vegter, 1995). Detail has been provided by the regional 1:500,000 groundwater sheets, 2730 Vryheid and 2928 Durban (Department of Water Affairs and Forestry, 1998).

Most of the rural settlements are largely or wholly dependent on groundwater for their domestic supplies and thus represent a large component of the domestic water use sphere. Groundwater utilisation in the area ranges from extraction of seasonal groundwater from shallow, hand dug wells to drilling of boreholes for family or communal use and development of groundwater wellfields for agricultural projects.

In their groundwater reserve determination study of the Usutu-Mhlatuze Water Management Region or 'W' Hydrological Drainage Region (Midgley et al., 1994), Dennis and Dennis (2009) noted that there are numerous databases; WARMS, GRIP and NGDB/NGA. The Department of Water Affairs (DWA) Groundwater Resource Information Project (GRIP) (http://www.dwa.gov.za/Groundwater/GroundwaterOffices/KZN/GRIP_Kwa-ZuluNatal.pdf) was initiated to address a gap in groundwater data available for the management of groundwater resources. Groundwater plays an extremely important role in water services especially in rural areas where surface water reticulation infrastructure has high cost implications. The GRIP project compiled groundwater data generated by water supply projects that were financed and executed by different spheres of government. Groundwater development occurs in a fragmented manner and there is inadequate coordination and cooperation between other organs of state, consultants and developers. The GRIP data serves to identify high yielding aquifers that can support bigger municipal schemes for the augmentation to existing supplies. Fig 12 shows the location of groundwater borehole data points incorporated in the GRIP for the uMkhanyakude region. DWA is also responsible for the compilation of Regional Groundwater Master Plans and Water Use Licence Application: Groundwater Abstraction.

The Comprehensive level Groundwater Reserve Determination Study (Dennis and Dennis, 2009) addressed the rapid population growth and economic development that is leading to rising water demand; agricultural irrigation capacity; the reduction in run-off due to afforestation. The Groundwater Reserve study also defined the water requirements to maintain the status of the wetland systems (rivers, lakes and estuaries) and the natural vegetation on the coastal plain. The report quantifies the groundwater recharge on the basis of geology and landcover/soil types, aquifer vulnerability and groundwater quality. Department Water Affairs (2008) has compiled a KwaZulu-Natal Groundwater Master Plan to address all water functions in the province as defined in the National Water Act, 1998, including development, utilisation, protection, conservation and management. The department also conducted monitoring of groundwater abstractions, water level fluctuations and chemical quality. Most of the study area falls within the Northern Coastal Plain Hydrogeological Region lying east of the Lebombo mountains and comprises the Cretaceous Zululand Group rocks overlain by Pliocene, Pleistocene and Holocene dune deposits.

The specialist report by M Schapers of Jeffares and Green (2015) included in Appendix 3 provides additional detail regarding groundwater quality associated with the different geological aquifers comprising the Maputaland Group.

6.6.1 Regional groundwater aquifer characterisation

Maud (1998) summarised the aquifers in the eastern part of the municipal region. A confined aquifer is associated with the weathered, decalcified and locally karst weathered Uloa/Umkwelane Formation deposits which underlie the surficial Pleistocene dune deposits. The shallow unconfined aquifer is associated with the permeable, porous KwaMbonambi Formation dune sands and seasonally is “perched” above the slightly more clay enriched Kosi Bay Formation. Some lateral groundwater seepage along this unconformity results in ponding of water within interdune depressions and watercourses such as the Sihadla (Kosi system), Lake Sibaya drainages and around pans. The main aquiclude in the region is formed by the argillaceous Cretaceous Zululand Formation rocks, buried under the highly permeable, calcareous Neogene marine sands. The Cretaceous siltstones that underlie the coastal plain at depth are an extremely poor groundwater aquifer, such minimal groundwater as may be found to occur is also generally highly saline.

On the basis of drilling and description of the sediment underlying the eastern coastal plain transect, Durham (2012) identified five regional aquifers in a region where previous studies had only described two main aquifers;

- Localized perched conditions in the Kwambonambi Formation,
- The high yielding, unconfined aquifer within loose sands of the upper Kwambonambi Formation,
- Low yielding silty sands and silts of the Kosi Bay Formation which acts as a confining / semi-confining layer to the underlying geology.
- The confined / semi confined aquifer located in the calcareous sands, clays and gravels of the Umkwelane and Uloa Formations.
- Low yielding and potentially saline waters associated with the Cretaceous sediments.

Two primary porosity aquifers underlie portions of the coastal plain. The nature of the hydraulic continuity between the ‘deep’ and ‘shallow’ aquifers is uncertain. Groundwater abstraction commonly targets the Uloa/Umkwelane Formation calcarenite and calcrete and the shallow Kwambonambi Formation “sugar sands”. Immediately overlying the Cretaceous sediments are the karst-weathered Neogene shelly coquina and calcarenite of variable thickness and erratic areal distribution. This ‘deep’ coastal plain aquifer generally occurs at a depth of 30 to 40 m below the coastal plain surface. Where present, the sandy lower portion of the overlying Kosi Bay Formation can contribute materially to this aquifer (Dennis and Dennis, 2009a, b). By contrast, the ‘shallow’ coastal plain aquifer comprises a saturated fine sand at the base of the surficial Kwambonambi Formation, which occurs at 1 to 6 m below ground level, which is perched on the surface of the much less permeable and more clayey Kosi Bay and Port Durnford Formations, the latter where this ordinarily deeply occurring formation occurs at shallow depth. Under the coastal plain unconsolidated sediments are of the primary porosity

or intergranular type. Springs and seepages, although their flows are very markedly seasonally affected are extensively exploited as a domestic water supply source in the rural residential and agricultural 'hard-rock' portion of the WMA.

The eastern coastal region of the UKDM is predominantly underlain by the Maputaland Group dunes where the principal groundwater occurrence as an "Intergranular Aquifer" with moderate to good borehole yields of $>0.5 - >3$ l/s generally expected (Consulting Groundwater Services, 1995). According to Vegter (1995 a, b, c) borehole yields of these various semi-and unconsolidated coastal deposits are highly variable depending on grain size and thickness and are associated with a drilling depths ranging between 20-50 m below ground level (Vegter, 1995b). In this the coastal region the probability of drilling a successful borehole is $>60\%$ with a 50% probability of a successful borehole yielding >2 l/s (Vegter, 1995a). The groundwater associated with the Maputaland Group "intergranular" aquifer is commonly of hydrochemical class "Type D" where the groundwater is cation-dominated by Na^+ and/or K^+ and anion-dominated by Cl^- and/or SO_4 (Vegter, 1995b).

Groundwater quality characteristic of the area underlain by the Zululand Group is typically shown by the total dissolved solids (TDS) concentrations from < 500 mg/l to >2000 mg/l (Vegter, 1995b). These "weathered and fractured" aquifers have marginal expected borehole yields of $>0- 0.11$ l/s (EMATEK-CSIR, 1995), a predicted storage coefficient of $<0,001$ and drilling depths of $>20\text{m}$ below ground level (Vegter, 1995b).

The numerous freshwater pans and lakes on the coastal plain play an important role in the geohydrology of this area. Recharge of groundwater has been calculated at between 5% and 18% of mean annual rainfall (EMATEK-CSIR, 1995). The porosity of unconsolidated sands is high with a storage coefficient of 0.1. The seasonal fluctuation of groundwater level requires deep drilling to at least 30-50m below the water table (Vegter, 1995a). The unconsolidated dune sand aquifer is

characterised by groundwater with low EC (<50 mS/m) whereas the Cretaceous rocks are associated with higher groundwater EC. Groundwater flow beneath the coastal plain is directed towards the larger coastal lakes.

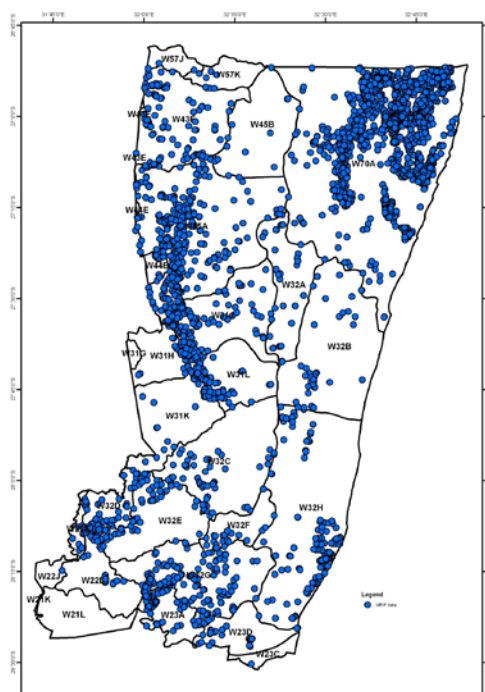


Figure 12 Distribution of groundwater boreholes across the Quaternary sub-catchments for which records are compiled in the Department Water Affairs, GRIP database.

6.6.2 Groundwater monitoring

Due to the sensitivity of the shallow groundwater in porous aeolian sands, DWA has drilled groundwater quality monitoring boreholes across the area, augmented recently with additional sites (Durham, 2012). Monitoring of groundwater fed schemes, ranging from small agricultural water supply initiatives and school water supply (5m³/day), to high production agricultural activities such as the Coastal Cashews Farm are not efficient. The Kwangwanase Water Supply Scheme is an example of a major groundwater fed / augmented water supply schemes for domestic consumption (up to 1000m³/day). However, water level and discharge monitoring throughout the coastal plain is limited to non-existent.

Groundwater quality across the project area is generally within the limits set out in SANS 241 (2011) for all determinands except for colour, odour, turbidity, fluoride, iron, manganese and soluble organic carbon. Whereas colour/odour and turbidity could be related to the drilling/development the complex geology probably influences the localised differences in water chemistry. Based on the analysis carried out, the groundwater in the project area is of good quality and there is no indication of a detrimental effect from historical or existing human and industrial activities in the area. The groundwater is therefore considered of high strategic value due to its suitability for use for human consumption.

6.6.3 Environmental aspects associated with groundwater

- iv. The vibroseis survey along linear transects will be non-invasive and localised on existing disturbed road reserve areas. On surfaced roads the where the infiltration rate is impeded and the potential impact of significant shallow groundwater is reduced provided there is an efficient spillage reaction procedure supported by adequate containment and absorbant equipment.
- v. Due to the high recharge from surface water and the high transmissivity of the intergranular aquifer there is potential of biological and chemical contamination of shallow groundwater. Drilling pads require significant preparation of drilling water supply reservoirs and drilling mud processing sites to prevent leakage into the shallow groundwater table.
- vi. After decommissioning, the deep boreholes will provide an opportunity for monitoring of water table movement at various depths because the groundwater from different aquifers has distinct hydrochemical "fingerprint". During the borehole closure it is possible to install uPVC tube with slotted screens and gravel packs so that the boreholes can be used as long-term

water monitoring wells. Installation of seals between water-bearing horizons can prevent mixing of groundwater.

6.7 Surface water environments and wetlands

The majority of the surface of Maputaland is formed by low parabolic dunes of the KwaMbonambi Formation underlain by the slightly clay-enriched Kosi Bay Formation dune sands. The base of this 20-80m thick dune sand succession is the variably karst weathered residua of the calcified Umkwelane Formation dunes and the remnants of decalcified Uloa Formation gravels and sands that form an important aquifer on the Cretaceous bedrock surface. The high infiltration rate of surficial dune sands and seasonal perching of shallow groundwater on the clayey subsurface dune deposits, results in a rising groundwater table and surface ponding in interdune swales during the summer wet season. Surface runoff in incised channels such as the Sihadla stream is the result of shallow groundwater seepage from the base of high relief dune systems, particularly where the Kosi Bay Formation dunes are near the surface. Permanent interdune lakes are present in dune topography and some have accumulated freshwater peat deposits since the early Holocene (Grundling et al., 1998).

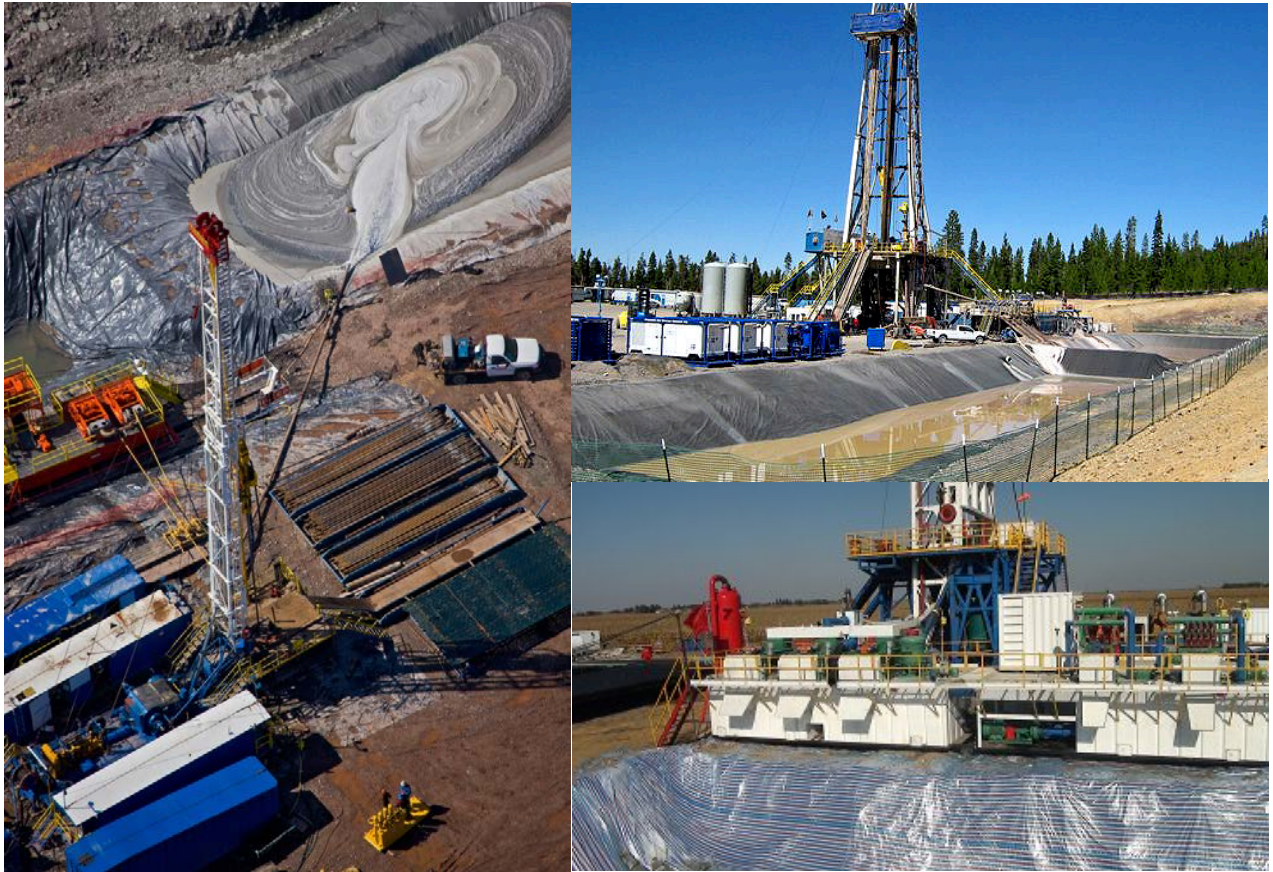


Figure 13 Management of drilling fluids, solids removal equipment and storage of waste water in plastic lined ponds is standard practice at deep drilling well pads. Waste water management can successfully limit any significant negative impacts on surface water and the shallow groundwater table. Photo sources; <http://ehp.niehs.nih.gov/122-a50/> & <http://gnsolidscontrol.blog.com/files/2014/05/drilling-waste-management-3.jpg>; <http://www.btlliners.com/wp-content/uploads/2015/11/Holding-pond-at-Geothermal-drilling-site1-582x400.jpg>.

The main freshwater drainage lines are the north-flowing Phongola River channel and floodplain incised to Cretaceous bedrock along the Lebombo mountain foothills in the west. The Sihangwane-Tshongwe megadune ridge is defined on its eastern flank by the Muzi north wetlands in the Sihangwane/Tembe area that drain north into the Usuthu/Phongola River in Mozambique. The northern Muzi channel becomes the Futi channel in Mozambique. Wide interdune areas on the east of the Muzi channel form seasonal wetlands that drain slowly into the incised channel, resulting in widespread inundation during periods of high rainfall (Fig. 14).



Figure 14 View east over Lake Nhlange in the southern part of the Kosi system showing the interdune wetlands and typical density of homesteads with a gravelled district road traversing the area.

The incised Sihadla system channels draining north towards the Kosi lake system are significant wetlands on the National Wetland Database. Drainage lines feeding the Kosi lakes and Lake Sibaya have been repeatedly incised during the evolution of the lake basins in response to Late Pleistocene sea level fluctuations. The Gesiza/Swamanzi and Siyadla channels feeding the Kosi lakes have incised Pleistocene dunes and receive baseflow seepage feed that sustains flow. Similarly the Mseleni drainage feeding Lake Sibaya and south flowing tributaries rising in the interdune hollows in the Majiji plantation near Mvelabusha, conduct runoff and seepage baseflow contributions into South Africa's largest natural lake.

The Muzi north channel and associated wetlands and interdune wetland areas to the east and the Sihadla catchment draining north towards the Kosi lakes and south into Lake Sibaya represent Freshwater Ecosystem Priority Areas (FEPA) (Nel et al., 2011).

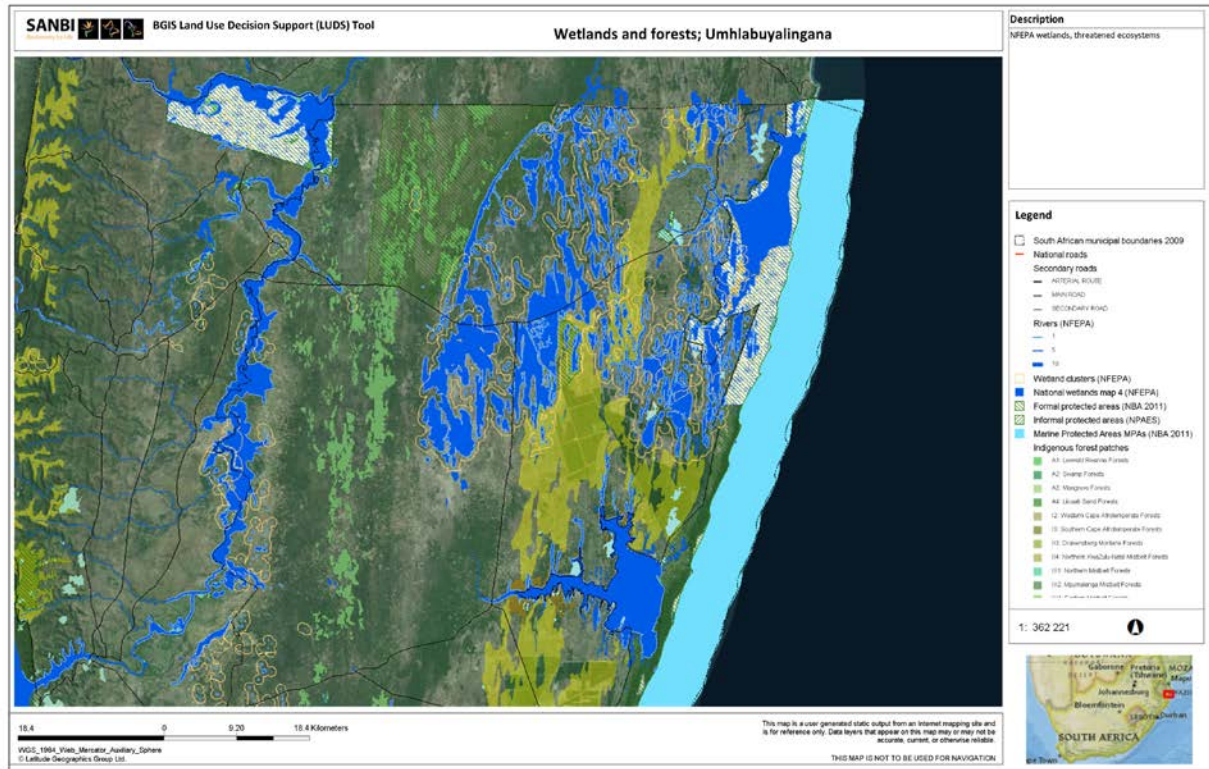


Fig. 15 National Wetlands Database and NFEPA wetlands coverage superimposed on a satellite image basemap also showing the main roads, some of which are vibroseis transect routes. The potential impacts of these alignments is addressed in the wetlands specialist assessment (Appendix 2).

A specialist study was undertaken of the full 500 km of proposed seismic survey traverse lines by Dr P-L. Grundling of WetRest (2015) to assess the potential environmental impact of the 2D seismic reflection survey equipment, support vehicles and staff compliment envisaged for the project (see Appendix 2). The terms of reference for this specialist study were to assess potential impacts on points where the traverse lines intersect the NFEPA wetlands. The wetland functionality and biota are described in detail.

Based on a field inspection conducted in August 2015, 40 wetlands were identified, on the basis of their NFEPA wetland status and classified mainly using pedological and geomorphological features. These wetlands are concentrated towards the northern sections of the study area. Seven drainage systems were traversed by the seismic survey transects with sensitive vegetation identified at some NFEPA wetlands that will be crossed.

6.7.1 Environmental aspects associated with surface water drainage systems

- iv. The seismic survey activities along linear traverses will take place on disturbed roads, road shoulders and existing tracks, parts of which cross important wetland environments. The vibroseis activities are temporary, non-invasive and will not result in significant damage to wetland substrates, vegetation or compromise surface drainage.
- v. Mitigation of the significant impact that accidental petrochemical spills could have is an essential activity that must be prescribed by an environmental management plan and supported by adequate equipment and personnel training.
- vi. Siting of the deep boreholes will take surface drainage into account and the drill pad and associated infrastructure must be sited beyond the legal buffer zone surrounding any wetland. Structures to control surface runoff from disturbed areas must be put in place. Use of plastic lined waste water management ponds on the drill pad will reduce the potential impact of contaminated water reaching wetlands or infiltrating to the shallow water table.

6.8 Biodiversity

The Maputaland-Pondoland-Albany biodiversity hotspot region is characterized by high levels of species richness and endemism and has links with the more tropical parts of Africa to the north and many tropical species reach their southernmost limits here. The specialist biodiversity report (Brousse-James and Associates, 2015) summarises some of the other superlatives of this region; East African Coast Endemic Bird Area with numerous species having endemic or near endemic status, nine Important Bird Areas, five RAMSAR sites. It contains the iSimangaliso Wetland Park World Heritage Site and a number of important populations of globally threatened species such as the Black Rhinoceros. Of the total area of 17,000 km², 21 % of Maputaland (all three countries) has Protected Area status. A summary of the biodiversity status for the Umhlabuyalingana Municipality where much of the research project will be centred (Appendix 1) lists the areal extent of the natural area, conservation areas, Ramsar sites, terrestrial ecosystems, endangered vegetation sites etc. The 2007 vegetation map of South Africa (Mucina et al., 2007) shows much of the study area east of the dune ridge to be low-lying dune landscape characterised by "Maputaland coastal belt (CB1) vegetation with patches of CB2 (Maputaland wooded grassland). The elevated Sihangwane-Tshongwe dune ridge hosts "endemic-rich "sand forest" (FoZ8) with "swamp forest (FOa2)" along drainage lines and "northern coastal forest (FoZ7)" on the elevated coastal barrier dune. The widespread Muzi wetlands and interdune wetlands are classified as "subtropical freshwater wetlands".

The large mammal fauna of the area has been largely displaced by development and agriculture. Well preserved sand- and swamp forest, wooded grassland and wetland patches will host higher small mammal, bird and invertebrate diversity. The data synthesis report by Brousse-James and Associates (2015) provides lists of mammals, birds, reptiles, frogs and invertebrates recorded in the region as well as the Red Data species lists (Appendix 1). The coastal plain's sandy soils are nutrient poor, with

limited areas of and that is highly suitable for agriculture. Local people have traditionally relied on harvesting of natural resources and the region has been relatively ignored by commercial farmers. There is generally a lack of biodiversity distribution data within Maputaland which has hampered conservation planning in the region.

6.8.1 Vegetation communities

The Maputaland Centre (MC) is recognised as an International Centre of Plant Diversity (Matthews, 1998). Phytogeographically, Maputaland is part of the Indian Ocean coastal belt which is both a regional Transitional Zone and a Regional Mosaic having a high proportion of endemics. The complex mosaic of forest types, bushland, thicket, wooded grassland and edaphic grassland is characterised by abrupt changes due to soils, drainage and climate. The area covered by the proposed seismic survey line includes six biomes, the Azonal Forest, Forest, Indian Ocean Coast Belt, Savanna, Grassland and Wetlands Biomes and contains 15 vegetation types (Fig. 16).

- (i) Forests cover a very small part of the total area under consideration; Forest cover 0.5 %, Azonal Forests cover 0.33 %, Lowveld Riverine Forest covers 0.028 % of the area traversed by the proposed seismic survey lines. Swamp Forest (F02a) covers 0.303 % of the area traversed by the proposed seismic survey lines. The conservation status of Swamp Forests is Critically Endangered with some 66 % statutorily conserved in iSimagaliso Wetland Park and other reserves southwards to Mtunzini.
- (ii) KwaZulu-Natal Coastal Forest (Maputaland Moist Coastal Lowlands Forest or Northern Coastal Forest) is well developed on the coastal dunes and covers 0.001 % of the area traversed by the proposed seismic survey lines.

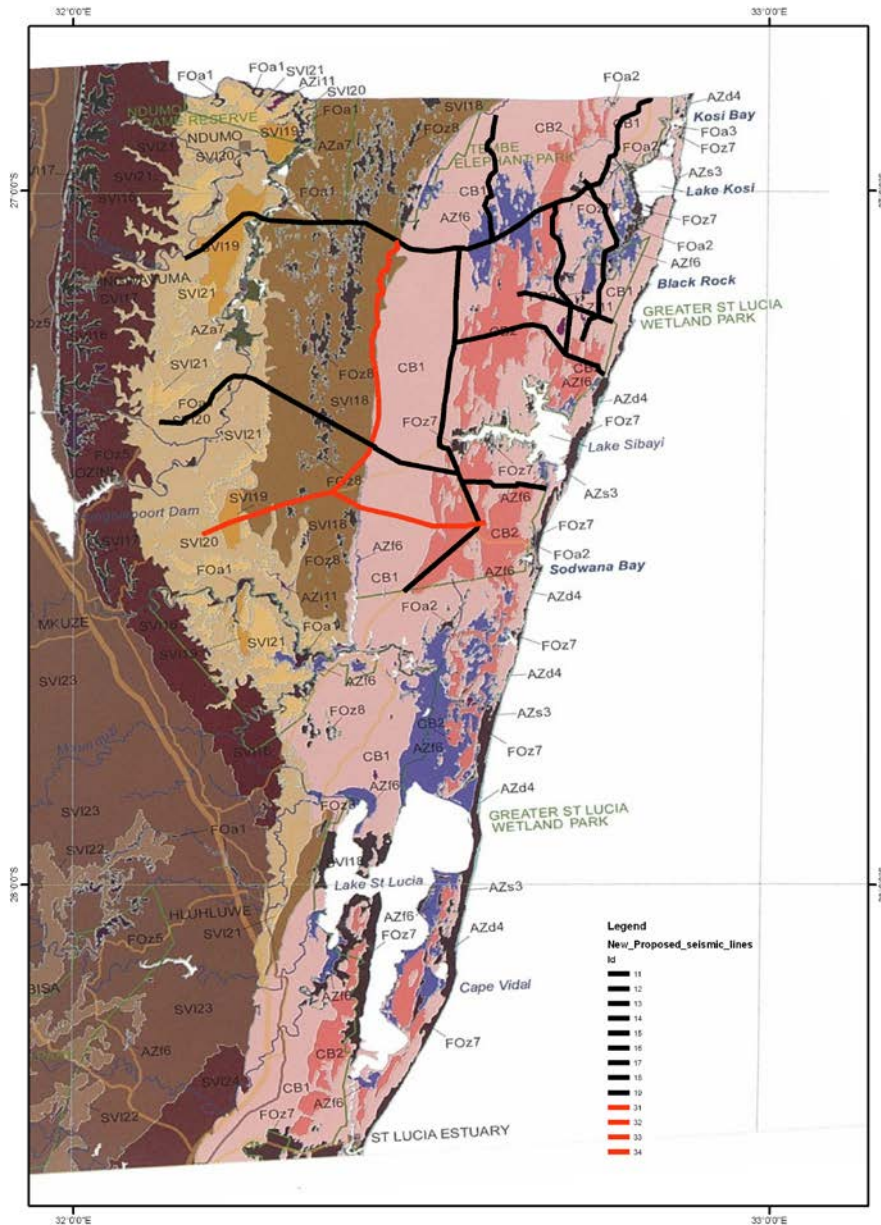


Figure 16 Map showing the main vegetation types in Maputaland relative to the seismic profiling transects. AZf6 – Subtropical Freshwater wetlands; CB1 – Maputaland Coastal Belt; CB2 – Maputaland Wooded grassland; SVI 18 – Tembe Sandy Bushveld; SVI19 – Western Maputaland Sandy Bushveld. (after Mucina and Rutherford, 2006).

(iii) Licuati Sand Forest forests (SVI18, Tembe Sandy Bushveld) are found mainly in Maputaland from False Bay Park in the south to the Tembe Elephant Park and Ndumo Game Reserves on the Mozambique border. It covers 0.50 % of the area traversed by the proposed seismic survey lines.

(iv) Maputaland Coastal Belt covers 16.17 % and Maputaland Wooded Grassland covers 14.10 % of the area traversed by the proposed seismic survey lines.

- (v) In the west on outcrop of Cretaceous rocks, the Makatini Clay Thicket covers 0.11 % of the area to be traversed.



Figure 17 Typical dense woodland vegetation on the dune sands in the central part of the Maputaland project area. Cut lines created during the 1970's geophysical surveys have become overgrown and most are now indiscernible on the ground.

- (vi) Muzi Palm Veld and Wooded Grassland is found on the coastal plain dunes east of the Pongola River. Sandwiched between Tembe Sandy Bushveld, Eastern Maputaland Pallid Sandy Bushveld and Maputaland Coastal Belt, it 11.21 % of the area to be traversed.
- (vii) Tembe Sandy Bushveld is found on extensive flat to undulating plains with sandy, leached soils and covers covers 20.85 % of the area potentially affected.
- (viii) Western Maputaland Clay Bushveld covers 21.8% of the western margin of the study area. It is classified as is Vulnerable with about 11 % statutorily conserved in the iSimangaliso Wetland Park (Mkhuze) and Ndumo Game Reserve, with the target being 19 %. A significant proportion (34 %) has been transformed, mainly by communal agricultural practices.

- (ix) Western Maputaland Sandy Bushveld is Least Threatened with some 18 % statutorily conserved in Mkhuze. Very little of this vegetation type (2 %) is transformed.

6.8.2 Wetland vegetation types

Subtropical Freshwater Wetlands are in areas of flat topography and support low beds dominated by reeds, sedges and rushes or waterlogged meadows dominated by grasses. They occur along the edges depressions in dune topography as seasonal pools and fringe alluvial backwater pans or artificial dams. Their conservation status is Least Threatened. Some 40-50 % is statutorily conserved, and about 4 % has been transformed by cultivation, local grazing and urban sprawl.

Inland Saline Wetlands cover 0.025 % of the area traversed by the proposed seismic survey lines. Subtropical Salt Pans form in shallow depressions, often on old alluvial terraces of rivers. The conservation status is Least Threatened and in the study area more than 40 % is statutorily conserved, much in iSimangaliso and Ndumo Game Reserve.

6.8.3 Environmental aspects associated with biodiversity

- iv. Activities must not interrupt connections that maintain ecological processes and ensure viability of species with large ranges or those that form metapopulations, as well as for maintaining seed dispersal and connecting feeding and breeding grounds.
- v. The conservation planning system developed by Smith and Leader-Williams (2006) determined that distributions of species in Maputaland mirror that of their associated soil landcover types, so protecting surficial soils should automatically conserve most species. The two exceptions to this pattern are, firstly, some species have large ranges and would therefore not be conserved by protecting small or isolated patches of suitable habitat. Secondly, some species have such limited distribution within particular landcover types that protecting portions of those types may not be enough to conserve the species.
- vi. Some landcover types are dependent on traditional fire-burning regimes and therefore it is important that continuity between large patches of these types is maintained.
- vii. The biodiversity of Maputaland is relatively well-known, but species distribution data is unreliable.

6.9 Noise, vibration and air quality

The area is characterised by a patchwork of agricultural lands, homesteads, plantations and commercial forests. Noise is influenced by road traffic and localised agricultural activity. Air quality is not influenced by industrial emissions but smoke from seasonal burning and wind-blown dust do occur.

The vibroseis trucks will operate along public roads and unsurfaced tracks. The progress of the survey vehicles and line laying teams is slow, about 5.8 km per day, but even at this rate there will not be protracted disturbance from equipment vibration, noise or dust generated. The potential impact of vibroseis vehicle operation on municipal infrastructure will be assessed on the basis of operator monitoring and knowledge of the location of potentially sensitive infrastructure.

Siting of the drill rig and infrastructure pad will be guided by the availability of an adequate area of disturbed land. The sustained operations on the drill site, possibly extending for months could represent a significant noise intrusion to homesteads so the site will also take into consideration the potential for disturbance of residents in this quiet rural area.

6.9.1 *Environmental aspects associated with noise and vibration*

- iv. Vibroseis and drilling contractors will compile environmental management action plans to quantify potential adverse vibration and noise impacts.
- v. Equipment operators will wear hearing protection and personal protection gear.
- vi. An exclusion zone will be maintained around active equipment to prevent possible noise or vibration damage.

6.10 Archaeological and cultural significance

An archaeological and cultural resource assessment was conducted in 2012 as part of the baseline data compilation exercise that contributed to the Environmental Management Framework (Nemai Consulting, 2012). The heritage assessment highlighted the occurrence in the Cretaceous bedrock of significant mollusc fossil assemblages associated mainly with the Mzinene and St Lucia Formations. The area has a long history of human occupation that extends from the Early Stone Age through the Iron Age. The area also preserves cultural sites related to the history of the Nguni and Thonga peoples. The proposed non-invasive vibroseis activities will occur on disturbed track and road alignments where any impacts on sites of cultural or historic value will be avoided.

6.10.1 *Environmental aspects associated cultural heritage*

The intention is to site the well drilling pads and infrastructure areas on disturbed, small areas of ~0.2 ha, preferably located close to existing infrastructure sites where the boreholes can be equipped with monitoring equipment with at lessened risk of vandalism.

- (i) A cultural heritage resource assessment will be conducted during the well pad siting exercise to ensure that no negative impacts occur. The permission of the landowner will be necessary to establish a drill pad site.
- (ii) A “chance finds procedure” will be implemented in line with environmental awareness training provided to all personnel working on site. Machine operators must cease work, withdraw equipment, mark the site and refer to the ECO and Resident Engineer who can report the finding. A cultural resource specialist will investigate the finding and advise on actions to be taken. Should the site be of significance it will be reported to Amafa KZN.

6.11 Socio-economic framework

The investigations will take place within Umkhanyakude District Municipality. “uMkhanyakude” refers to the greenish tree with some thorns, *Acacia Xanthophloea* (Fever Tree) that mainly grows in the Umkhanyakude District. The name of the District reflects both the uniqueness of its people and their hospitality, as well as the biodiversity and conservation history that the region is very proud of.

<http://www.kzncogta.gov.za/Municipalities/uMkhanyakudeDistrictMunicipality.aspx>

The majority of seismic profiling transects and borehole sites fall within Umhlabuyalingana Local Municipality (KZ271). The western end of transects enter the eastern boundary of Jozini Local Municipality (KZ272) along the Phongola River valley. The southern boundary of the Mesozoic sandstone is within The Big 5 False Bay Local Municipality (KZ273). The conservation areas and iSimangaliso Wetland Park form a District Management Area (KZDMA 27) which is currently under the jurisdiction of the District, will be geographically split and integrated in the Big 5 False Bay, Mtubatuba and Umhlabuyalingana municipalities.

The Umkhanyakude District Municipality Integrated Development Plan (IDP) Annual Review for 2011/2012 (Final) provides useful information and statistics about the population in the municipal area. Large areas of land are under communal tenure in the District – located in the traditional authority areas under the jurisdiction of the IngonyamaTrust. Traditional councils own 87% of KZ271 land, 70% of KZ272 and 23% of KZ273. The Tribal Authority areas traversed by the proposed vibroseis lines are shown in Fig. 18.

The key drivers of the local economy are agriculture, services, tourism and retail. Agri- processing has potential, but this has yet to be realized as a key driver. One of the most exciting opportunities for generating local large-scale employment lies in the construction of an industrial cluster on communal land on the Makhathini Flats. The construction would include a sugar mill with potential for co-production of ethanol and electricity. The construction of a cold storage facility will also improve access to markets for farmers.

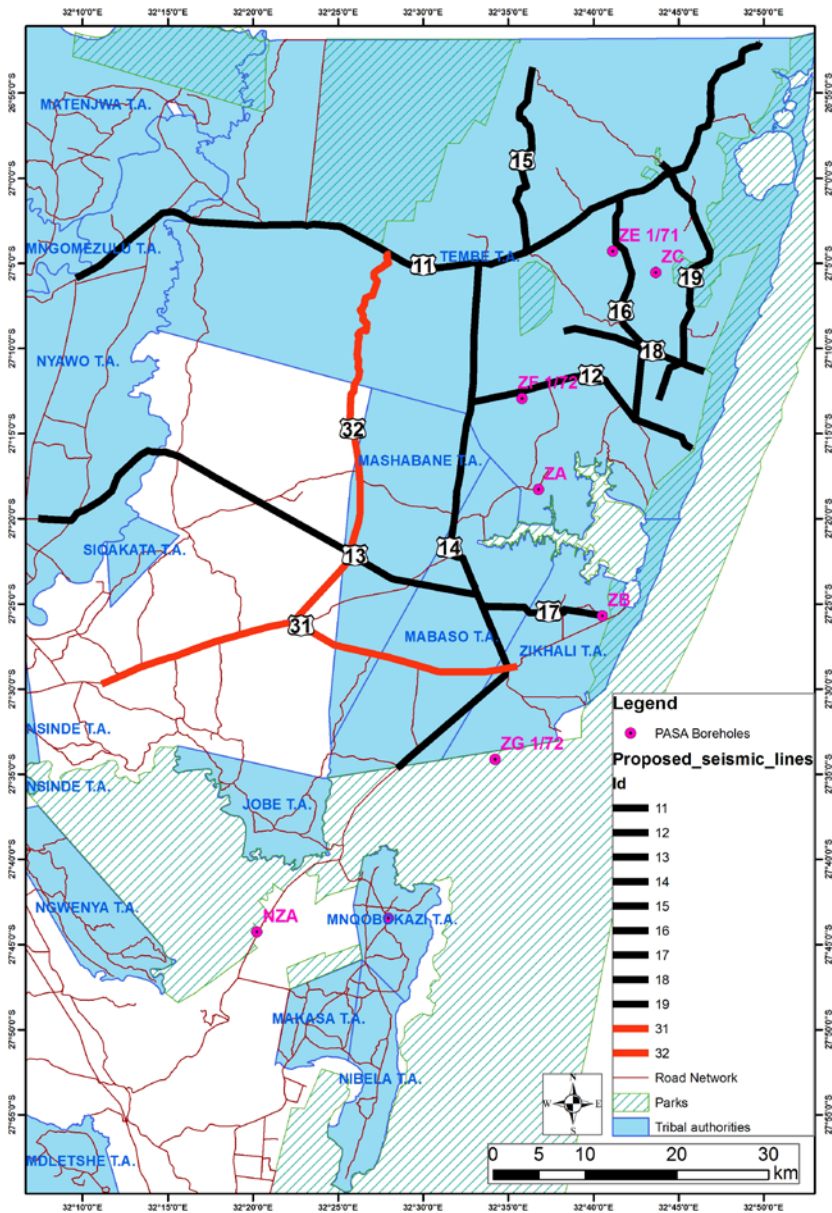


Figure 18 Traditional Authority (TA) areas within the area traversed by vibroseis lines within the Umhlabuyalingana and Jozini Municipality areas.

The entire coastal strip of uMhlabuyalingana which hosts these natural environmental assets has been designated a district management area that is administered by the greater iSimangaliso Wetland Park authority. uMkhanyakude forms part of the Lubombo Trans-frontier Conservation Area. This conservation area includes South Africa, Swaziland and Mozambique. The Tembe-Futi portion of the Lubombo Trans-frontier Conservation Area falls within uMkhanyakude, with Ndumo and Tembe Elephant Park forming major attractions. uMkhanyakude has applied for the entire district to be declared as a Biosphere Reserve, ensuring that all economic development is in line with conservation principles. The IDP proposes that a Strategic Environmental Assessment (SEA) be undertaken as part of the Bio-regional Planning Process. SEA is a process whereby environmental implications are integrated into decision making (forum for economic & environment). The uMkhanyakude DM IDP

provides information regarding the spatial development framework (SDF). Communication of the activities through the municipality should also reach the IDP steering committee, IDP Representative Committees and Development Planning Forum.

Table 2 Summary of socio-economic demographic statistical indicators derived for the uMkhanyakude District Municipality area during Census 2011.

<http://www.localgovernment.co.za/districts/view/21/umkhanyakude-district-municipality>

Population	625 846
Age Structure	
Population under 15	40.30%
Population 15 to 64	55.30%
Population over 65	4.50%
Dependency Ratio	
Per 100 (15-64)	81.00
Sex Ratio	
Males per 100 females	85.60
Population Growth	
Per annum	0.88%
Labour Market	
Unemployment rate (official)	42.80%
Youth unemployment rate (official) 15-34	51.20%
Education (aged 20 +)	
No schooling	25.30%
Higher education	4.90%
Matric	25.40%
Household Dynamics	
Households	128 195
Average household size	4.70
Female headed households	53.90%
Formal dwellings	71.70%
Housing owned	47.70%
Household Services	
Flush toilet connected to sewerage	9.90%
Weekly refuse removal	9.00%
Piped water inside dwelling	13.40%
Electricity for lighting	38.40%

Source: Census 2011 Municipal Fact Sheet, published by Statistics South Africa.

6.12 Stakeholder engagement

SANEDI-SACCCS initiated a Public Engagement Project (CCS PE) in May 2012. The World Bank Group and the Department of Energy appointed a team of experts comprising environmental, social and stakeholder engagement practitioners from South Africa and international experts in CCS from the United States of America, to design public engagement plans for CCS deployment in South Africa. The team consisted of SRK Consulting, the World Resources Institute (WRI) and Finley-Greenberg LLC. The team prepared a National Stakeholder Engagement Plan and Local Stakeholder Engagement Plan to be rolled out in a phased manner in consultation with key strategic stakeholders.

A priority that should be addressed by the CCS PE team is the lack of a specific legislative framework governing CCS activities. SACCCS should request input from the inter-departmental committee comprising representatives of most of the key government departments has an oversight role of SANEDI activities. Input from departmental senior legal representatives should also be requested. Although the initial enquiries should be specific regarding the Phase B project activities, it would be pertinent to request broader legal clarification concerning CO₂ sequestration as it is possible that drafting of new regulations may have to be investigated in the context of NEMA, the EIA regulations and NEM: Waste Management Act.

It is essential that the CCS PE outreach programme take note of the public outcry surrounding shale gas exploration (fracking) in the Karoo. A legal assessment (Havemann Inc, 2012) shows how opponents have drawn widely from the South African legislation in order to justify their standpoint. The differences between unconventional gas exploitation and CCS should be highlighted to ensure that the geological investigations associated with the scope of this research project are not compared directly to the long-term goals of shale gas exploration.

The lack of direct government departmental instruction from the competent authority regarding the permitting approach required to ensure that the geological investigations meet the levels of environmental control that the public expect, rightly or wrongly, is the major obstacle to be overcome before the SANEDI-SACCCS CCS Roadmap can proceed towards its goals.

6.12.1 Public participation process (PPP)

Due to the lack of direct legal precedents, the exact format of a possible environmental impact assessment process for the PCSP will probably be based on negotiation with government

departments that arises from the SANEDI-SACCCS stakeholder engagement process. The NEMA EIA regulations, 2014 outline the public participation process that must be implemented as part of Basic Assessment and S&EIR processes with respect to listed activities. Regulations 54 to 57 outline the process of advertising the activity, inviting interested and affected parties (IAP) to register, submit their comments and feedback after these issues have been addressed in the EIA/EMP. The process entails newspaper and site adverts, background information documents (BID), focus group or public meetings, IAP registration and communication throughout the environmental assessment process.

The focus of PPP interaction with uMkhanyakude DM should be through their established community liaison network that was engaged during the public participation around the Environmental Management Framework studies (Appendix 6, Nema Consulting, 2010).

The Integrated Development Plan for 2014-2015 (UKDM, 2015) states that the Traditional Authorities own about 50% of the land in UKDM with 30% of that area falling within environmentally protected areas. In order to integrate the SEMP the municipality has sought to implement communication strategy as an effort towards ensuring and the improvement of public participation in municipal processes. The main focus of the communication strategy is preparation of procedures for community participation processes including direct communication with Traditional Councils. This is based on one of the Municipality's Key Performance Objectives, that is, *"to build sustainable partnerships with Traditional Authorities to ensure convergence in meeting the developmental needs and challenges in our communities."*

Public participation is through the ward committee system, meeting the requirements of EIA regulation 54 2(b). The proposed PPP methodology entails the following, in accordance with the EIA Regulations (2014);

- i. Prepare I&APs Database.
- ii. Compile public participation material, which will include – (a) Background Information Document (BID); (b) Onsite notice; (c) Newspaper notice.
- iii. Provide written notices to all I&APs by; (a) Fixing a notice board at a place conspicuous to and accessible by the public at the boundary, on the fence or along the corridor of the sites where the activity is to be undertaken. (b) Giving written notice to- (i) The municipal councillor of the ward in which the site or alternative site is situated and any organisation of ratepayers that represent the community in the area; (ii) The municipality which has jurisdiction in the area; and (iii) Any organ of state having jurisdiction in respect of any aspect of the activity. (c) Place advert in the legal section of a local newspaper.
- iv. Provide I&APs 30 days to register as I&APs.
- v. Convene 1 authorities' meeting and 1 public meeting on the same day.
- vi. Compile a Public Participation Report, which provides a full account of the process conducted. Include a Comments and Responses Report. Existing channels of communication to be abided by in rural areas, with the primary form of communication with the community to take place via the Councillor.

6.12.2 Environmental aspects to be addressed by public participation

- i. It is always difficult to predict the development and outcome of the PPP. The uMkhanyakude DM proposal to declare their entire area a Biosphere Reserve could introduce conflicting landuse options at an early stage. Their proposal to conduct a SEA could also result in restrictions being placed on some development options.
- ii. Opposition to the proposed activities can come from many sources. Landowners concerned with loss of land, restricted access to land and water or lack of personal benefits are a risk, particularly when the proposed activity covers such a large, impoverished area.
- iii. Perhaps the more severe risk will be posed by the lack of knowledge about carbon sequestration amongst the broad public, environmental focus groups and government. The lack of any precedents in South Africa will be compounded by the lack of direct legislative controls on the proposed activity.
- iv. The main risk from an uninformed public at this early stage in the process could be triggered by the non-invasive geophysical surveys and the localised well drilling. The public outcry regarding shale gas exploration or “fracking” in the Karoo serves as an example.
- v. The CCS PE Project has initiated the public outreach and stakeholder engagement process (Appendix 7).
- vi. As part of the NEMA Basic Assessment or MPRDA community consultation and Environmental Management Plan (following Prospecting Right guidelines), an experienced consultant team with prior experience in the uMkhanyakude DM area must be engaged to manage the PPP. Their task will be supported considerably if SACCCS undertakes a public education drive in advance of the environmental assessment process.
- vii. Public meetings must be chaired by an experienced, independent facilitator who is capable of handling the potentially emotional and aggressive public and focus group representatives that would attend such meetings.
- viii. An experienced media liaison person must also be engaged to handle reports in the press and respond to queries from investigative reporters.

Table 1 ENVIRONMENTAL RISK ASSESSMENT AND MITIGATION SUMMARY TABLE

SANEDI-SACCCS, 2D Seismic Reflection survey and well drilling, uMkhanyakude District Municipality, KwaZulu-Natal

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ELEMENT	IMPACT DESCRIPTION	DEGREE OF CERTAINTY	EXTENT	DURATION	INTENSITY/MAGNITUDE	NATURE OF IMPACT	SIGNIFICANCE (unmitigated)	ENVIRONMENTAL CROSS-REFERENCE OR TRANSFERRED IMPACT	MITIGATION OF IMPACTS AND RELEVANT ACTION PLANS
Project alternatives considered	"No Go" option – continue generation of GHG from coal powered economy	Definite	Regional	Permanent	High	Negative	High	Air Quality	South Africa's CO2 chasm would increase relative to international commitments. No technology transfer or skills development.
	Focus on Mesozoic basins rather than other rock units	Probable	Regional	Long-term	Low	Positive	High	Groundwater	Technology for CCS in coal seams is poorly developed. Injection into coal seams would sterilise their future use for coal gasification or coal bed methane extraction. Other lithologies with potential have very limited capacity or distribution.
	Location of PCSP in onshore Mesozoic basin	Probable	Localised	Short-term	Low	Positive	High	Air Quality/ groundwater	No "ready made" sites in gas fields exist. Offshore infrastructure development and transport is too expensive for a trial injection project such as the PCSP. Onshore basins have better geological control and represent more accessible sites for seismic profiling and well drilling. Accessibility for skills development for local contractors and academics.
	Onshore project alternatives considered; clearing new cutlines, road network, use of existing wells	Definite	Regional	Short-term	High	Positive	High		No plans to disturb cutlines from 1970's exploration. Focus on existing road network that has developed significantly since 1980's. Road network would facilitate efficient movement of vibroseis equipment and importation of drilling rigs. Old oil exploration wells have been decommissioned but could be investigated as an ancillary project.
Location and infrastructure	Vibroseis trucks active on public roads or road shoulder. Slow moving trucks, long cable arrays and support personnel and vehicles. Potential damage to surfaced roads or civil infrastructure along road corridors.	Definite	Regional	Short-term	Low	Negative	Low	INTERESTED AND AFFECTED PARTIES	Ensure trucks are roadworthy. Communicate with provincial Department of Transport and municipal Road Traffic Inspectorate authorities for permissions. Use Stop/Go signals either side of vibroseis convoy when active on or crossing public roads. Inform provincial, municipal and community structures about schedules for vibroseis in any area in advance during ongoing stakeholder construction.
	Parts of vibroseis activity will be on unsurfaced tracks or public roads that cross the iSimangaliso Wetland Park World Heritage Site '10 km 'buffer zone' boundary. A traverse line crosses one short section of public roads within a short section (<0.5km) on the eastern boundary of iSimangaliso WP. Some traverses also pass along the boundary of provincial nature conservation areas.	Definite	Regional	Short-term	Low	Negative	Low		Consult municipal and provincial conservation authorities to demonstrate the temporary nature of potential disturbance on public roads that are aligned on park boundaries.
	Deep well drilling sites will be selected on the basis of the seismic survey. Drill pad and associated infrastructure will be located on disturbed land close to water and electricity infrastructure where possible.	Definite	Site	Short-term	Low	Negative	Low		Consult with Department Water and Sanitation regarding siting of boreholes and possible use after decommissioning as groundwater monitoring sites.
Geology	Project aims to provide high level of lithostratigraphic detail for onshore Mesozoic Zululand Basin rocks in the uMkhanyakude District Municipality area. Additional detail is necessary to show whether the sandstone aquifer units at >800 m depth have porosity and permeability characteristics that could support a trial injection PCSP project.	Definite	Regional (Vibroseis)	Short-term	High	Positive	High	GROUNDWATER	Vibroseis survey is non-invasive. High level of detail of regional geology over Mafucatlal coastal plain north of Lake Sibaya derived from the seismic survey and lithostratigraphic drilling will provide 3D models of the regional unconformities that define aquiclures and regional groundwater aquifers. This will surpass any existing government groundwater monitoring borehole grid data and be beneficial to authorities and communities. The 3D distribution map of the Neogene/Cretaceous unconformity surface will benefit regional groundwater use planning and monitoring programmes in the future.
	Well drilling will penetrate near surface aquifer and regional unconformity surface that comprises a regional aquiclude separating fresh and saline groundwater zones		Local (well drilling)	Permanent	Low	Negative	Low		Drilling must not interfere with shallow groundwater resource used by surrounding community. Well drilling must not result in contamination of productive Uloa / Umkwelane Fm aquifer at ~50-80m depth. During decommissioning, drilling contractors can place bentonite seals within the well casing to isolate the unconformity interface and prevent potential upward migration of saline groundwater from the Cretaceous siltstones. Existing Department Water and Sanitation groundwater monitoring boreholes will provide long-term monitoring reference baseline. During decommissioning the deep lithostratigraphic wells can be equipped with groundwater monitoring equipment and integrated into the regional groundwater monitoring well network.
Terrain morphology	Vibroseis survey will traverse the low relief dune topography following existing tracks and roads. The seismic survey lines intersect seasonal interdune depression (swale) wetlands locally.	Definite	Site	Short-term	Low	Negative	Low	SURFACE WATER	Vibroseis is a non-invasive survey technique and will be conducted almost exclusively on existing tracks, public roads and road reserve. Specialist wetland survey report defines the points on transects where particular care must be taken to avoid permanent damage to wetland vegetation and surface water flow paths.
Soils	Damage to soils on the routes of the vibroseis survey transects or on the well drilling sites.	Possible	Site	Long-term	Low	Negative	Low	VEGETATION	Vibroseis survey technique is non-invasive. Routes follow remnant cutlines, vehicle tracks, public roads or the road shoulder/reserve zone where vegetation has already been cleared and the topsoil is disturbed. Well drilling sites and the drill should not need to be levelled or extensively disturbed. Where soil disturbance is inevitable, the topsoil must be removed and stockpiled for restoration. An oil spill kit must be kept on site at heavy vehicle parking areas or drill sites to intercept hydrocarbon spills. Contaminated soil must be collected and disposed of at a licenced waste disposal site.
Land	Vibroseis surveyor drilling could permanently alter the	Unlikely	Site	Long-term	Very low	Negative		VEGETATION	The vibroseis traverse routes are entirely disturbed land. The routes will not traverse crop or grazing land.

Capability	land capability of sections of the traverse route or drill pad area.						Very low	BIODIVERSITY	The drilling pads will be sited, when possible, on already disturbed land in commercial plantation areas. Should the 2D seismic profile survey require drilling on undisturbed land, the siting of the drilling platform will be negotiated with the communal landowners through the community hierarchy structure. Vibroseis and drilling contractors have stated their intention to benefit the local community through local employment practices and by making some project infrastructure available to the landowners upon project closure.
Land Use	Project activities could have a negative impact on long-term landuse options on community land or in conservation areas.	Unlikely	Site	Short-term	Low	Negative	Low	VEGETATION	The vibroseis traverse routes will not impact community agriculture or grazing land. Drilling in already disturbed land within the commercial plantations will not permanently alter the land use or land capability for commercial agriculture. Rehabilitation of the project infrastructure site will ensure that vegetation and soil disturbance does not result in long-term erosion by wind or water.
								BIODIVERSITY	
Biodiversity: Vegetation	Vibroseis survey routes could impact indigenous vegetation	Possible	Site	Medium-term	Low	Negative	Low	BIODIVERSITY	Parts of the general area have high vegetation conservation status. Vibroseis routes will be along already disturbed tracks and public road corridors. Most of the traverse routes will be through grassland areas where there has been disturbance and clearing of indigenous grassland either side of the road. On remnant cutlines, firebreaks and tracks it is possible that localised pruning of shrubs or cutting of overhanging branches may be required to clear the 5m wide corridor. On public roads the road shoulder or cleared road reserve will be used.
								LAND CAPABILITY	
Biodiversity: Fauna	Vibroseis survey and drilling could impact fauna in the grasslands, woodlands or wetlands	unlikely	Site	Short-term	Low	Negative	Low	VEGETATION and LAND CAPABILITY	The vibroseis operation is non-invasive and its progression along routes will ensure that the impact is short-lived and restricted to one pass. Disturbance of remnant fauna in this area of communal subsistence agriculture will be limited. Wetland margins are potentially the most disturbance prone areas but the transects will be on disturbed ground. Siting of the drilling operations on disturbed land will reduce the potential impact on ground nesting birds or small mammals. Seasonal wetland margins must be avoided.
Surface water	Activity of heavy machinery and other vehicles could lead to wetland degradation or disturb surface water flow paths in an area with extensive wetlands.	Possible	Site and adjacent	Long-term	Medium	Negative	Medium	VEGETATION	Vibroseis activities will be limited to disturbed road corridors where wetlands are crossed. The activity will be non-invasive, short duration and generally a single pass. No trenching will take place which could divert surface water flow. The specialist wetland study has identified every wetland crossing point and proposed specific environmental management measures. On the drilling pad site care must be taken to isolate potentially contaminated drilling water/fluids by creating plastic lined sumps for temporary storage. Recycling of drilling water will reduce the use of locally sourced water. A downstream surface water monitoring programme must be established to provide baseline water quality guidelines for the site and surrounds. Water quality will be monitored in consultation with department ater and sanitation requirements during the drilling programme at every site.
Ground water	Disturbance of shallow groundwater flow path or possible contamination of vadose zone aquifers by infiltration from disturbed land.	Possible	Site	Long-term	Low	Negative	Low	SURFACE WATER	Shallow vadose zone groundwater resources are used by community members in the areas around wetlands. Most water is used untreated from shallow pits or boreholes. The non-invasive vibroseis equipment must be monitored to ensure that hydrocarbon leaks are detected and the spill contained and cleared. Use of water from drilling should not be from community wells which might have low recharge rates.
Air Quality	Low quality emissions from vehicles and large machinery.	Possible	Site and adjacent downwind	Short term	Low with occasional medium intensity	Negative	Low	VEGETATION	Vehicle activity will be on public road corridors and routes used by community vehicles. Drilling locations will not be sited near community structures or inhabited areas.
								INTERESTED AND AFFECTED PARTIES	
Noise and vibration	Noise and vibration generated by vibroseis trucks and drill rigs could impact community members or infrastructure.	Definite	Site and adjacent downwind	Short-term	Low with occasional high intensity	Negative	Medium, diminishing with distance	INTERESTED AND AFFECTED PARTIES	Vibroseis operations on public roads must be pre-authorized by the provincial Dept Transport to ensure that no damage occurs on gravelled or tar surfaced roads. Consultation with the uMkhanyakude District Municipality must identify potentially sensitive areas along district roads or tracks where there is civil infrastructure such as water reticulation pipelines or buried cables. Community liaison must ensure that all members are aware of the project, its goals and methods employed to reduce suspicion and concern for personal property or crops.
Archaeological / Cultural heritage	Disturbance of unmarked archaeological sites, cultural heritage sites or graves	Unlikely	Site	Permanent	High	Negative	High	INTERESTED AND AFFECTED PARTIES	Community heritage sites have been identified in the uMkhanyakude DM environmental management framework. The non-invasive nature of vibroseis on linear disturbed road corridors reduces the risk of encountering unmarked heritage structures. Any structures that may be pointed out by community members can easily be bypassed to avoid damage. A "chance finds procedure" will be implemented in line with environmental awareness training provided to all personnel working on site. Machine operators must cease work, withdraw equipment, mark the site and refer to the ECO and Resident Engineer who can report the finding. A cultural resource specialist will investigate the finding and advise on actions to be taken. Should the site be of significance it will be reported to Amafa KZN.
Sensitive landscapes	Potential impacts on sensitive environments, community agriculture, conservation areas.	Possible	Site and regional	Short term	Low	Negative	Low	SURFACE WATER	A short section of a proposed traverse is on a surface public road that crosses the iSimangaliso Wetland Park, World Heritage Site boundary for a short distance. Longer lengths of track are located along public roads and tracks within the 10 km "buffer zone" that surrounds the world heritage site. the impact is regarded as being of low significance as the vibroseis activities are non-invasive, short lived, temporary activities. Drilling sites will be located where possible on disturbed agricultural land.
								INTERESTED AND AFFECTED PARTIES	
Visual Aspects	Visual intrusion along routes leading to tourism centres in Maputaland impact of mining activity.	Possible	Site and regional	Short-term	Low	Negative	Low	INTERESTED AND AFFECTED PARTIES	Public outreach and education programmes through appropriate media releases can educate the community and tourists as to the project goals and methods to reduce surprise. The seismic survey activities are mobile and short lived. The drilling sites will be away from tourist road routes.

Socio-economic structure	Community and authority concern about possible negative impacts of the proposed seismic survey and drilling operations. Benefits for community and service suppliers through corporate social outreach programmes.	Possible	Regional	Short-term	Low	Negative	Low	INTERESTED AND AFFECTED PARTIES	Public participation programme will ensure community consultation meets the requirements of authorities through application of legislated requirements. Use existing municipal liaison structures to ensure that all community groups are reached. Short term income and training benefits for local staff employed by vibroseis operator and drilling crews.
		Likely	Regional	Short-term	Medium	Positive	Medium		
Interested and affected parties	uMkhanyakude District Municipality, Umhlabuyalingana Local Municipality, community landowners, Ingonyama Trust, Provincial offices of national government departments; Mineral Resources, Water and Sanitation, Agriculture Forestry Fisheries, Provincial government departments; COGTA (Planning), transport, KZN Wildlife, Economic Development and Environmental Affairs (EDTEA), iSimangaliso Wetland Park Authority. NGOs and other I&APs concerned with limiting negative environmental impacts	Definite	Site and regional	Short-term	Medium	Positive	Medium	SOCIO-ECONOMIC STRUCTURE	Pre-project consultation with authorities to provide detail concerning project activities, timeframes etc. Implementation of a public participation programme that follows the NEMA EIA regulation 2014 guidelines. Community liaison meetings, site visits will be conducted and community feedback documented. Contractors will use locally sourced labour where possible. Some project equipment might be donated for community use. Landowner permission will be required to site drill pads and utilise access roads to the sites.
Waste and Residue deposits	Generation of waste materials that could cause local environmental damage.	Unlikely	Site	Short-term	Low	Negative	Low	SOILS, SURFACE WATER GROUNDWATER	Vibroseis operations do not produce significant waste materials. Site waste management programme will be implemented. Drilling water and fluid management and recycling on the drilling site will reduce the potential for contamination of surface water.

7 ENVIRONMENTAL MANAGEMENT PLAN

The vibroseis operations are regional activities that will utilise existing roads and tracks. The drilling of deep wells is a localised, invasive activity that must be managed to ensure that there are no significant environmental impacts to the site or that potential impacts do not extend beyond the site into possible sensitive environments or receptor areas.

- The Environmental Management Plan proposed here draws on the management and mitigation framework that was implemented during the drilling of a grid of groundwater monitoring boreholes in the Umkhanykude District Municipality area, including some wells sited within and adjacent to wetlands and within the iSimangaliso Wetland Park area (Jeffares and Green, 2011).
- Additional environmental management framework actions have been derived from the recent drilling of deep boreholes in the Karoo basin as part of the scientific programme that will assess the geological and hydrogeological context of the likely lithostratigraphic context of shale gas exploration in the Karoo area. The drilling technology utilised to drill the deep boreholes during the KARIN project was on a similar scale to that proposed during the PCSP geological precursor studies (AGES North West, 2015).

7.1 Environmental Awareness and Responsibilities

The National Environmental Management Act or NEMA (Act No. 107 of 1998) prescribes that any cost incurred to remedy environmental damage shall be borne by the person responsible for that damage (the “polluter pays” principle). It is imperative that the drilling contractor and specialist hydrogeological consultant associated with the drilling programme understand the EMP requirements and prioritise the implementation of environmental management plans and mitigation actions before commencing activities.

Reasonable measures are prescribed to ensure that the environment is not subjected to pollution or contamination. Environmental education and induction of any contractor staff or visitors to the drilling site are regarded as essential measures to ensure that employees or visitors understand the environmental risks and potential ramifications of their work activities. This activity will ensure that they are instructed to operate in an environmentally acceptable manner.

- the Project Manager, Resident Engineer, specialist consultants and ECO will meet with the vibroseis and drilling contractor teams to explain the obligations and action item requirements of this EMP;

- The Project Manager, Resident Engineer and ECO will ensure that environmental awareness is prioritized and where applicable posters will be provided and displayed at the site camp to reinforce the environmental awareness induction training by visually depicting the environmental “do’s and don’ts”.

7.1.1 Environmental Control Officer (ECO)

The Project Manager will employ an ECO who will report to the Resident Engineer. The roles and responsibilities of the ECO must include:

- (i) Ensuring that the necessary environmental authorizations and permits have been obtained.
- (ii) Monitoring and verifying that the EMP is adhered to at all times and taking actions if the specifications are not followed.
- (iii) Monitoring and verifying that environmental impacts are kept to the minimum.
- (iv) Assisting the contractor in finding environmentally responsible solutions to environmental problems.
- (v) Daily report back on the environmental issues.
- (vi) Keeping record of all activities/incidences on site in the site diary concerning the environment.
- (vii) Inspecting the site and surrounding areas regularly with regard to compliance with the EMP.
- (viii) Keeping a register of complaints in the site office and recording and dealing with any community complaints or issues.
- (ix) Monitoring the undertaking by the contractor of environmental awareness training and induction for all new personnel on site or visitors.
- (x) Ensuring that activities on site comply with other relevant environmental legislation if it is applicable.
- (xi) Issuing of warnings for contravention of the EMP.
- (xii) Compile monitoring checklist.
- (xiii) Keep a photographic record of progress on site from an environmental perspective.
- (xiv) Assisting the engineer in finding environmentally responsible solutions to problems.
- (xv) Keeping accurate and detailed records of these inspections.

7.1.2 Contractors

The Contractors shall have the following responsibilities:

- (i) To implement all provisions of the Vibroseis and/or Drilling action items of the EMP. If the Contractor encounters difficulties with specifications, he / she must discuss alternative approaches with the Resident Engineer and/or the ECO prior to proceeding.
- (ii) To ensure that all staff and Sub-Contractors are familiar with the EMP.
- (iii) To make personnel aware of environmental issues and to ensure they show adequate consideration of the environmental aspects of the project.
- (iv) To report any incidents of non-compliance with the EMP to the resident Engineer and/or the ECO.

- (v) To rehabilitate any sensitive environments damaged due to the Contractor's negligence. This shall be done in accordance with the resident engineer and ECO's specifications.

7.1.3 Environmental Awareness Plan

The goal of the awareness plan is to help employees make environmentally conscious decisions in the work place and in their private lives. The environmental awareness induction must educate anyone working on the project to understand their obligation in line with the EM Plan.

- (i) Understand the implications of lack of environmentally sensitive actions,
- (ii) Inform contractors/employees of environmental risks that may result from their work; and
- (iii) Protocols to deal with risks in order to avoid pollution or degradation of the environment.

7.1.4 Environmental Awareness Training

The contractor must ensure that adequate environmental awareness training of senior site personnel takes place and that all personnel receive an induction presentation on the importance and implications of the EMP. It is the contractor's responsibility to provide the site foreman with no less than one hour's environmental training and to ensure that the foreman has sufficient understanding to pass the acquired information on to workers as part of their environmental awareness induction programme.

The contractor must also ensure that all site personnel have a basic level of environmental awareness training topics to personnel should include:

- (i) An explanation of the importance of complying with the EMP.
- (ii) Discussion of the potential impacts of the project on the environment.
- (iii) The benefits of improved personnel performance.
- (iv) Employees' roles and responsibilities, including emergency preparedness
- (v) Explanation of the mitigation measures that must be implemented when carrying out their activities.
- (vi) Explanation of the specifics of the EMP and its specification (no-go areas etc.)
- (vii) Explanation of the management structure of individuals responsible for matters pertaining to the EMP.

7.2 Action plans for environmental impact monitoring, management and mitigation

7.2.1 Biodiversity; animals

No member of the drilling or hydrogeological teams will be permitted to:

- (i) hunt, kill, set devices to trap, tamper with or harass wild animals and livestock or any form of animal shelter;
- (ii) feed native animals;
- (iii) bring his/her own pets to the site.
- (iv) Illegally enter any formal conservation areas without prior approval.
- (v) The integrity of the Foot-and-Mouth fence along the P522-2 road and associated structures must be maintained and all crossing points or gates closed.

Actions must be implemented to ensure that waste disposal or storage facilities do not attract animal pests or indigenous fauna by keeping the site camp and drilling sites free of litter and by providing adequate waste receptacles that can be covered to prevent access by animal pests.

Dangerous equipment or sensitive areas will be cordoned off using stakes or hazard mesh to prevent access by animals and thereby prevent the injury or death of wild animals and livestock.

7.2.2 Surface Water

Members of the project team, contractors or consultants must ensure that the following actions are not permitted:

- (i) disposal of any liquid or solid waste in any watercourse or water body;
- (ii) stockpiling of soil or any other materials within or near a watercourse or water body.
- (iii) use of watercourses or water bodies for domestic purposes including bathing, washing;
- (iv) use of watercourses or water bodies for the cleaning of equipment or containers;
- (v) impeding the flow of any watercourse or water body or permanent diversion of the existing natural alignment of watercourses;
- (vi) wastewater will not be allowed to enter watercourses or water bodies.
- (vii) Abstraction of water from watercourses and water bodies for drilling purposes will be kept within the Department of Water and Sanitation limits.
- (viii) Temporary crossings will be constructed to traverse watercourses. The crossings will be discussed with and be to the satisfaction of the ECO, and will ensure that minimal disruption of the stream bed and surrounding vegetation is caused.

7.2.3 Dust

The operation of large equipment during the vibroseis operations or during drilling pad preparation, waste water management facility excavation, or the handling and transport of erodible sand under windy conditions can generate a visible dust plume. Actions aimed at reducing the impact of dust on site and adjacent areas include the following:

- (i) Activities that could generate dust must be curtailed during high wind speeds that will exacerbate erosion.
- (ii) Exposed surfaces will be re-vegetated with indigenous vegetation as soon as activities at each site are complete.
- (iii) Vehicle speeds will be restricted to a maximum of 40 km/h along gravel (unpaved) roads and 20 km/h when traversing unconsolidated and un-vegetated areas.
- (iv) Only the minimum amount of vegetation necessary to allow activities to take place will be trimmed and pruned.
- (v) Dust suppression measures will be used when dust generation is unavoidable e.g. dampening with water but with caution not to allow muddy conditions to develop due to excessive watering.

7.2.4 Noise

The proposed activities occur on existing provincial and district roads where there is existing traffic and resultant noise. However, the rural surroundings are not subject to high intensity noise.

- (i) Operational hours will be limited to sunrise to sunset (seasonal variation but generally 06h00 to 18h00) to avoid sleep/rest disruption and general disturbance of adjacent land users/residents.
- (ii) Government and community structures will be alerted at least 24 hours before commencing activities; consulted before conducting activities on weekends and Public Holidays.
- (iii) All equipment will be regularly and systematically checked, maintained and repaired (especially exhaust systems) as poorly maintained equipment can generate disturbing and unnecessary noise.
- (iv) Contractors will restrict unnecessary noise such as hooting and shouting.

7.2.5 Visual Aspects

Due to the proximity to conservation areas it is essential that project structures and activities maintain a small footprint and are screened where possible:

- (i) The natural intact vegetation will be used to create a buffer and screen around stationary activities. The vegetation buffer will aid in dissipating the noise and will act as a wind barrier;
- (ii) All areas will be kept neat and tidy at all times.

- (iii) Disturbed sites will be re-vegetated with indigenous material as soon as activities at a site are complete.
- (iv) External lighting for the general illumination of the site camp and borehole sites will be kept to the minimum necessary. Lighting will be directed downwards and shielded to reduce intrusion beyond the site perimeter.

7.2.6 Community Liaison and Involvement

The project team will liaise with the community through existing municipal committees and any community interaction must be directed through the Ward Councillor. This includes the following:

- (i) Permission to site drilling pads and use access tracks to the sites must be negotiated with the landowner of tribal authority, subject to a written agreement that protects the rights of both parties.
- (ii) Information to be disseminated in relation to operations, timeframes and potential impacts on community activities. It is essential to ensure that community members are adequately educated with regard to the project goals and the potential hazards associated with the equipment employed so that inaccurate rumours are not spread.
- (iii) Recruitment of workers to assist the vibroseis or drilling teams.
- (iv) Access to homesteads or should the need arise to cross agricultural lands;
- (v) Addressing nuisance impacts, such as noise, dust or bright lights, which may cause disturbance to the surrounding landowners / land users / residents.
- (vi) All project members must maintain good relations with the surrounding communities by respecting their lifestyles and customs.
- (vii)** Any disputes will be directed to and handled by the Environmental Officer on site who will keep records and follow established protocols to address claims or complaints.

7.2.7 Safety, Health and Environment (SHE)

Project protocols and those specified by specialist consultants or contractors with respect to the requirements associated with their equipment or operations must be adequately communicated during environmental education of communities or contract workers.

- (i) Liaison with the Ward Councillor will endeavour to employ local labour and maintain acceptable levels of gender equity.
- (ii) All workers on site will be supplied with and required to the necessary personal protection equipment (PPE) e.g. hardhats, glasses, dust masks and ear plugs, as prescribed by their job description and proximity to equipment.

- (iii) Contractors will ensure that the team members have access to a first aid kit for medical treatment for minor injuries. Serious injuries must be referred to the nearest clinic/hospital.
- (iv) Workers and visitors will be warned of any dangerous working areas and activities and will be required to wear the necessary PPE.
- (v) Open flames will only be allowed in facilities or equipment specially constructed for this purpose.

7.2.8 Drill pad and camp access routes

The Maputaland coastal plain is criss-crossed by numerous informal tracks that have been developed by the local community to link with the main roads linking towns. These tracks commonly have limited traffic or light vehicles. Use of the roads by higher traffic volumes and heavy vehicles can cause erosion of tracks, rendering these routes inaccessible to the light vehicles used by the community because of thick, loose sand or a high "middelmanneljie".

- (i) Permission to establish drill pads, associated infrastructure and use of access roads will be the subject of an agreement negotiated between the landowner or tribal authority and the project manager.
- (ii) Access roads to the camp or borehole sites will be established or improved in consultation with community representatives. Existing tracks and roads will be used to access borehole sites, where practical and possible.
- (iii) Should tracks need to be upgraded or extended, the following will be adhered to:
 - a. the routes will be planned beforehand to avoid haphazard traversing of the target area;
 - b. routes will be planned to follow the contours of the land where possible;
 - c. the routes will be so selected that minimal vegetation trimming is necessary and if possible no indigenous trees will be felled without the necessary permit from the Department of Agriculture, Forestry and Fisheries (DAFF).
 - d. grassed areas (as opposed to scrub and thicket) will be followed as grasslands recover more rapidly and easily from vehicle tracks;
 - e. watercourses and steep gradients will be avoided as far as is practical;
- (iv) Herbaceous vegetation will not be cleared but minimal trimming or pruning can be carried out to leave the root systems intact.
- (v) All disturbed areas requiring such, will be rehabilitated to the previous condition or better on completion of the works.

7.2.8.1 Use and maintenance of Access Routes

- (i) Reasonable speeds (less than 20 km/h on tracks; less than 40 km/h on gravel roads) will be observed to avoid accidents, excessive noise, dust and injury to livestock.

- (ii) The erection of gates in fence lines and the open/closed status of gates in new and existing positions will be clarified with the landowners/land users/residents and maintained throughout the work period.
- (iii) On temporary access routes to the borehole sites across the sandy substrate in the project area, it is neither practical nor feasible to install extensive runoff and stormwater control measures. The roads will be monitored for erosion and wear, and repaired accordingly.
- (iv) All new and existing access routes will be continually checked for actual or potential erosion sites (especially after rain). Erosion problems will be repaired immediately. Repair may involve backfilling and contouring, seeding and the appropriate placement of sack/rock gabions to control further erosion.

7.2.8.2 Project activities on public roads

Long sections of public roads will be followed by various sections of vibroseis traverses. Use of the equipment on these roads will be after consultation and approval from provincial Road traffic Inspectorate authorities. The vibroseis operations must not result in degradation of road surfaces or drainage structures.

- (i) Project vehicles using public roads must follow the rules of the road and observe all prescribed speeds.
- (ii) Traffic management must be implemented to ensure that road users are alerted to the presence of slow moving vibroseis equipment and support personnel. Flag teams must be sited either side of the operation and through radio contact, maintain traffic flow around the vibroseis operations.
- (iii) Any damage to public roads used during the project must be reported and no repairs carried out without the approval of provincial or municipal authorities.
- (iv) Dust suppression must be carried out with the approval of the relevant authorities and care taken not to create muddy conditions that will further damage road surfaces.

7.2.9 Site Clearing

Site clearing for contractor camps or drill pads limit must disturbance of indigenous vegetation. Where possible, trimming/pruning is preferable to removal of vegetation that could trigger the need for environmental authorization.

- (i) Vegetation will not be unnecessarily disturbed and trees or shrubs will, as far as is practical, not be damaged or felled.
- (ii) Grassland and herbaceous vegetation must be trimmed rather than being removed, and this is only permissible where soil is to be stripped.

- (iii) Invasive alien plants within the active work areas will be removed.
- (iv) For aesthetic and ecological reasons, large trees within the drilling sites will be left intact and the layout of these sites will be planned to accommodate the preservation of large trees for their shade and screening value.
- (v) To minimise the disturbance of vegetation structure and reduce fragmentation of important plant communities, the location of borehole sites and access routes will be planned to avoid traversing directly through these communities and rather circumvent such areas where possible.
- (vi) No trees or shrubs will be felled or damaged for the purpose of obtaining firewood.

7.2.9.1 Soil Stripping, handling and stockpiling

All soil material will be stripped from areas underlying long-term drilling site structures, areas susceptible to contamination, and waste water management structures. This is necessary to ensure the restoration of local soil material during site rehabilitation.

- (i) The topsoil layer (top 100 mm to 200 mm) will be stripped and stockpiled separately to maintain the biological and chemical characteristics of the topsoil which are more suitable for the regeneration of vegetation than the subsoil horizons that must be stored separately.
- (ii) To avoid wastage, soil material that can be used for site backfilling, contouring and rehabilitation, will also be excavated and stockpiled (e.g. during the excavation of waste water sumps).
- (iii) The following soil handling guidelines will apply:
 - a. avoid handling soils when they are wet (causes compaction);
 - b. avoid repeated handling of soils (results in the loss of soil structure and compaction);
 - c. avoid handling soils during windy conditions (exacerbates soil loss through wind erosion).

A suitable site for the stockpiling of soil will be selected, and will meet the following criteria:

- a. away from the working area - so that the stockpiles will not be disrupted by site activities;
- b. away from drainage lines - so that there is no risk of washaway;
- c. away from the base of a bank - so that runoff from the bank does not cause ponding of water alongside the stockpile.

7.2.9.2 Erosion

To minimise the risk of wind or water runoff erosion:

- (i) Sites with potential erosion risk will be protected with sandbags, hay bales, or straw wattles will be placed upslope of borehole sites to divert runoff away and thereby prevent potential erosion of the disturbed area;
- (ii) Disturbed areas will be rehabilitated as soon as possible after completion of activities,
- (iii) Monitoring for actual or potential erosion sites will be undertaken.
- (iv) Should any actual or potential erosion sites develop, repair of such sites will be undertaken immediately by;
 - a. backfilling erosion cavities and seeding with an appropriate seed mix, or, placing loose sack gabions will also be placed within and upslope of such sites, or, utilising both methods (in severe cases).
 - b. Any activity involving the release of large volumes of water or water under pressure (e.g. borehole pump tests) shall be controlled to ensure the minimum amount of disturbance to the surrounding environment. Flow velocity shall be dissipated through the use of sandbags if required to reduce the possibility of erosion.

7.2.10 Borehole Siting, Layout and Access

The location of the borehole sites will be planned in advance and the provisional site submitted to government authorities and community liaison structures for approval. The minimum area necessary to enable the planned tasks be carried out will be selected in a disturbed area where possible. The site should be on previously disturbed ground and if possible close to electricity and water infrastructure.

- (i) The borehole site area will be staked out and demarcated using hazard tape and netting and activities will be confined to the demarcated area.
- (ii) Where possible, borehole sites will be chosen where a buffer distance of 50 m from streams, dams, pans or springs can be maintained.
- (iii) The layout of the borehole sites will be planned beforehand to ensure that the camp is neat and orderly.
- (iv) Where possible, use will be made of existing roads or tracks to avoid creating new access routes.

7.2.10.1 Accommodation

Accommodation structures will be temporary and mobile (e.g. tents or caravans) and will be neatly planned with easy access to amenities to prevent haphazard scattering throughout the area.

7.2.10.2 Services/Facilities

An adequate number of waste receptacles will be supplied at each borehole site to gather all domestic and other refuse and to minimise the occurrence of littering.

Potable water will be supplied and stored at each borehole site for the duration of the contract.

Adequate cooking facilities will be provided. Gas will be used for cooking purposes so that it is not necessary for the surrounding vegetation to be felled for use as a fuel source.

Where possible and practical, existing school or community ablution facilities will be used. The use of existing facilities will be done in consultation with the surrounding landowners/land users/residents and the Community Representative.

Should access to existing ablution facilities not be available, an adequate number of portable chemical toilets will be provided at each borehole site. The toilets are to be used and sited in such a way that they do not cause water or soil pollution. The toilets will be regularly cleaned and properly maintained to prevent odours and health risks. Waybills for the chemical waste haulage must be maintained.

7.2.11 Liquid Effluent Management

- (i) A distinction is made between domestic type wastewater and wastewater that will contain non-biodegradable pollutants such as oil, grease, etc
- (ii) Domestic-type wastewater will preferably be disposed of by linking up with existing facilities at the schools. If the use of existing facilities is not feasible, domestic wastewater will either be:
 - accumulated in a suitable container (e.g. large drum) and periodically carted to an existing facility for disposal; or,
 - released in a controlled manner into the surrounding veld (erosion control practices to be followed; refer to Section 12);
 - Any effluents containing oil, grease or other industrial substances must be collected in a suitable receptacle (e.g. a sunken PVC tank or sump). The contents of the wastewater receptacle will be regularly cleared and removed from the site for appropriate disposal at a permitted disposal facility.
- (iii) When excavating these pits to accommodate the wastewater receptacle, the topsoil and the subsoil will be stripped and stockpiled separately (refer to Section 11).

- (iv) The pits will be surrounded by an earth wall of at least 30 - 50cm in height and be constructed to withstand the impact of heavy rainfall.
- (v) Upon completion of the works the contents of the pits will be disposed of at a waste facility permitted to cater for the waste. The sump/tank will be removed and the disturbed area rehabilitated to previous condition or better.

7.2.12 Hazardous Materials

All potentially hazardous materials stored or used on site will be handled in such a manner as to prevent soil and water contamination. This will include:

- (i) storage of such materials in a lockable, mobile structure that has an impermeable surface¹;
- (ii) maintenance of vehicles and equipment on an impermeable surface (e.g. plastic lining);
- (iii) parking of vehicles that are prone to oil leaks on an impermeable surface (e.g. plastic lining) or through the use of drip pans;
- (iv) use of suitably sized drip pans under equipment that may leak oil, grease or fuel (e.g. drill rigs, generators);
- (v) storage of fuel within a secure, bunded area which has a capacity 2 times the volume of fuel being stored.
- (vi) Any accidental or negligent spills of potentially hazardous materials will be cleaned up immediately. The area of contaminated soil will be removed, stored in a plastic bag or container until it can be disposed of at a permitted disposal site. The affected area will be treated with a suitable absorbent such as Drizit or Peat Sorb or similar, a suitable volume of which is to be kept on site.
- (vii) Used oil will be recovered and recycled.

7.2.13 Waste Management

The borehole sites will be cleared of litter and other waste on completion of the day's work.

- (i) Waste receptacles will be provided at each borehole site for the collection of waste – one for non-biodegradable refuse (glass bottles, plastic bags, metal scrap); the other for biodegradable waste (food, paper).
- (ii) The waste receptacles will be cleared regularly and preferably be covered to prevent access by pest animals. Precautions will be taken to prevent any refuse from spreading from the borehole site.
- (iii) Domestic waste will be disposed of by making use of existing facilities and services at the nearest school(s).

- (iv) If no suitable domestic waste disposal facilities exist at the local schools, then one of following procedure can be followed:
- (v) Biodegradable refuse will be buried in a pit excavated for that purpose. The pit will be covered with a final layer of soil (200 mm to 300 mm thick).
- (vi) Non-biodegradable waste will be accumulated in a suitable container(s) and will be transferred to the nearest permitted waste disposal site.
- (vii) Flammable, toxic or poisonous materials (including the contents of drip trays and sumps/pits) and the containers thereof (including linings) will not be disposed of with the domestic waste. Instead such waste will be transferred to an appropriate, permitted industrial disposal facility. These materials and containers will be appropriately stored to contain contamination until they can be taken to the aforementioned disposal site.
- (viii) Drilling waste (including drill muds, concrete, rock and core material) where applicable can be used to contour the site to limit erosion, otherwise they will be cleared from the sites and disposed of appropriately.

7.2.14 Rehabilitation

All areas disturbed during the drilling, test pumping and installation of the boreholes (including boreholes sites, infrastructure sites and routes, access tracks and roads) will be rehabilitated, to the satisfaction of the Project Manager, Resident Engineer and ECO on completion of activities.

Structures

- All temporary storage, living, ablution structures will be disassembled and removed from the site.
- All concrete structures (e.g. concrete bund slabs) will be broken up and the concrete fragments transferred to a permitted disposal site. Any concrete waste will be disposed of in the same manner.
- All wastewater sumps/pits at the borehole sites will be drained and the liquid and solid waste transferred to a permitted disposal facility. Linings will be removed and disposed of in the same manner.
- After all foreign matter has been removed from the sumps/pits, the excavations will be backfilled with subsoil, compacted and leveled, and capped using the stockpiled topsoil. No foreign matter such as cement or other rubble will be introduced into such backfilling.
- All waste from the borehole sites will be disposed of as documented in Section 15.
- All unused materials, equipment and implements will be packed up and removed from the site.
- If not to be used on a permanent basis, any power, water, sanitation infrastructure on site will be disconnected, disassembled and the components removed from the site.
- All portable chemical toilets will be drained by the chemical waste contractor and removed from site and any voids associated with the ablution facilities will be backfilled, contoured and revegetated.

- Any gate or fence made or erected by the applicant/holder, which is not required by the landowner, will be removed. Fences/gates will be disassembled and the components removed from the site.
- Any private fences/gates that have been disturbed during the project will be repaired.

7.2.14.1 Revegetation of Disturbed Areas

Backfilling and Contouring

- All remaining voids will be backfilled using the stockpiled subsoil material removed during site clearing.
- Wherever backfilling is to take place, rocks will be placed at the bottom of the voids and soil replaced in sequence (subsoil underlying topsoil).
- Site levelling will ensure that no troughs (low points) are created where water could accumulate/pond.
- The site will be contoured and levelled so that it is continuous with the surrounding topography.

Top-soiling

- In all affected areas where topsoil was previously stripped, the topsoil layer will be replaced. Topsoil will be sourced from the stockpiles set aside on site establishment. An even spread of topsoil over all affected areas will be created.
- The topsoil layer must be replaced on top of the subsoil in order to maximise the benefit of the seed-bank present in the topsoil (the seed-bank will accelerate the re-vegetation process).

Physical Substrate Preparation

- The substrate will be physically prepared for re-vegetation. This will involve scarifying compacted areas and tilling affected areas to a depth of 10 cm to loosen clods and prepare a planting/seeding surface. Scarifying and tilling can be done manually by teams of local labour using picks and spades.
- Compacted areas will include all areas underlain by heavy equipment (equipment stores, vehicle parking area) and machinery (drill rig), areas traversed by vehicles (access routes), areas underlying structures (toilets, ablutions).

Chemical Substrate Preparation

- The substrate will be chemically prepared for re-vegetation. This will involve applying a granular chemical fertiliser (30g/m² 2:3:2 NPK slow release granular fertiliser) and working this into the topsoil manually.

Re-vegetating

- The prepared substrate will be re-vegetated to establish a cover of plant material to control erosion, improve the visual quality of the site and control runoff velocity.
- The affected areas will be seeded with an appropriate mix of indigenous plant species. The following mix is recommended:

<i>Eragrostis tef</i> (tufted annual/nurse crop)	Teff @ 8 kg/ha
<i>Cynodon dactylon</i> (stoloniferous perennial)	Kweek @ 5 kg/ha
<i>Chloris gayana</i> (stoloniferous perennial)	Rhodes grass @ 6 kg/ha
<i>Digitaria eriantha</i> (tufted perennial)	Smuts finger @ 5 kg/ha

- The seed mix will be hand broadcast over the prepared substrate.
- All re-vegetated areas will be thoroughly watered after seeding.

Protection Structures

- Erosion protection measures will be installed at sites which may be susceptible to erosion in the long-term.
- Where applicable, a brush mattress (dry branches, preferably thorny) will be placed along the perimeter of rehabilitated sites to prevent access by cattle and goats. This will ensure that the rehabilitated areas are not trampled and overgrazed by livestock and the vegetation cover has an opportunity to become established before being exposed to grazing pressures.

7.2.14.2 Rehabilitation of Access Routes

- Any access road or portion thereof, constructed or upgraded for the purposes of this project and which will no longer be required by the landowner/land user/resident will be rehabilitated according to the procedures documented under Section 16.
- Particular attention will need to be given to the physical amelioration of substrates. The roads will be ripped or ploughed in order to break up compaction and clods and prepare the substrate for seeding.

- Imported road construction materials which may hamper regrowth of vegetation will be removed prior to rehabilitation and disposed of in an approved manner.

7.2.15 Environmental Design Criteria

Environmental criteria addressed in the location and siting of the borehole pads must be implemented by the Borehole Drilling Contractor during construction, operation and decommissioning.

Any borehole water outlet point or storage point (including taps, tanks, pumps) must be designed to;

- (i) cater for and control the flow of water so that runoff is adequately dispersed and/or captured and does not cause erosion;
- (ii) ensure that water does not accumulate or pond at any point where it may stagnate, become contaminated by humans or animals, develop algal blooms or attract animal pests such as mosquitoes.

The design is to include the following features:

- a. grading of the areas surrounding water outlet or storage points to encourage gentle runoff away from the area;
- b. where required, constructing formal channels to carry water away from the outlet/storage point either in the form of a concrete chute or a grassed channel;
- c. re-vegetation of the surrounding areas through rehabilitation (refer to Section 16);
- d. where applicable, planting rows of grass in areas that will be susceptible to erosion;
- e. installation of concrete base around the water outlet or storage point in order to minimize splash erosion;

7.2.16 Water Quality

Water samples are to be collected by the Hydrogeological Consultant from each borehole site to serve as environmental baseline indicators of water quantity and quality. The samples are to be analyzed at a reputable laboratory according to acceptable industry standards.

7.2.17 Monitoring and Reporting

The Project Manager and Environmental Control Officer (ECO) in conjunction with the Contractors, will consolidate Daily Reports and produce a Weekly Report on the activities that have been undertaken during that period. The Weekly Reports are to be synthesized on a monthly basis by the Project Manager and ECO as a Monthly Report for submission to the Funding Agent. On completion,

the Project Manager, ECO and Contractors must compile a Final Report for submission to the Funding Agent.

At any time during the contract, the Funding Agent and the Relevant Authority may carry out an inspection of the site activities to ensure that they are complying with the requirements stipulated in this EMP.

Following the completion of the vibroseis transect lines and decommissioning of boreholes, the Project Manager and Funding Agent may undertake an inspection of the sites to verify that rehabilitation of disturbed areas has been carried out to the satisfaction of the requirements stipulated in this document. Where applicable, the Project Manager and ECO will advise on follow-up and aftercare requirements that need to be carried out in order to meet these requirements.

Following the completion of the boreholes, the Project Manager will undertake an inspection of the borehole/infrastructure sites to verify that the requirements stipulated above have been incorporated into the design.

The long-term maintenance (including re-seeding, erosion control) of the rehabilitated areas will form part of the maintenance plan to be developed and implemented by the Department of Water and Sanitation conjunction with the relevant implementing government department.

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APPENDIX

Appendix 1

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Maputaland seismic survey for geological investigations into
potential underground CO₂ storage.

Biodiversity Report

Maputaland Seismic Survey



For investigations into potential for underground CO₂ storage

Brousse-James & Associates
Ecological and Environmental Services

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This Biodiversity Report on the proposed area within which seismic surveys will take place was completed in October 2015 and was compiled by:

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1 BACKGROUND AND TERMS OF REFERENCE

The Council for Geoscience has contracted Brousse-James & Associates to conduct a regional vegetation, wildlife, ecology and conservation assessment for a proposed seismic survey and borehole drilling exercise in the northern Maputaland area of KwaZulu-Natal.

Based on the findings of the initial desktop assessment, “Geological development of the Zululand Basin; towards an assessment of effective CO₂ storage capacity”, the South African Centre for Carbon Capture and Storage (SACCCS) identified the need for more detailed geological characterisation of the regional stratigraphy of the Mesozoic Zululand Group rocks within the Zululand Basin of northern KwaZulu-Natal.

The need to conduct a seismic profiling survey on a grid across the Maputaland area was defined in order to compile high resolution seismic profile data. This data can be interpreted to identify possible sandstone reservoirs with sufficient porosity/permeability and associated capping and lateral seal lithologies that could support a trial CO₂ pumped storage project. Seismic profile data would assist with the siting of deep boreholes that will sample the potential sandstone reservoir horizons and cap/lateral seal lithologies in order to conduct *in situ* tests and provide core for laboratory testing. The application of a battery of lithological characterisation analyses will determine whether it is feasible to undertake a trial project that will inject CO₂ into the target reservoir rocks, at depths exceeding 800m, to achieve permanent capture and storage. Should the rock characteristics not meet the requirements for injection of CO₂, the trial will not proceed.

SACCCS, represented by South African National Energy Development Institute (SANEDI), signed a Research and Development Agreement with Council for Geoscience (CGS) to undertake environmental planning in support of the project “Phase C – Execution of the Operational Plan”.

A review of the activities involved in the proposed seismic survey and borehole drilling, and national legislation pertaining to geological research undertaken in order to gather information about the rock mass in an area, did not identify any specific requirements of the following Acts and Regulations that would require specific environmental assessments to be undertaken before the proposed seismic survey and borehole drilling could be undertaken:

- Mineral and Petroleum Resources Development Act and Regulations.
- National Environmental Management Act (NEMA) and Regulations.
- NEM: Waste Act.
- National Water Act.

SACCCS has submitted a letter to the Minister, Department Mineral Resources (DMR) requesting authorisation to conduct the seismic survey and borehole drilling, in terms of the MPRDA Section 50(1), which states ...“*Minister may investigate occurrence, nature and extent of mineral resources; 50. (1) The Minister may cause an investigation to be conducted on any land to establish if any mineral or geological formation occurs in, on or under such land and, if so, to establish the nature and extent thereof.*” The Minister usually instructs

appropriate environmental planning to be undertaken as one of the conditions associated with the authorisation.

Due to the appointment of a new Minister, DMR has not yet provided the required authorisation. However, there is abundant environmental baseline data available from which thematic scoping level descriptions of the proposed study area can be derived. The nature of the proposed seismic survey, along a grid of existing main and district roads and established plantation roads and tracks, will limit the extent of potential environmental damage. However, it is essential that government departments and all Interested and Affected Parties be provided with environmental descriptions at an adequate level to inform their decisions regarding the proposed project.

The Scope of Work for the regional vegetation, wildlife, ecology and conservation contract is as follows:

- i. The investigation will be informed by the inception meeting between the client, SACCCS, the lead consultant, CGS, and other consultants. A site investigation of the proposed seismic lines and possible drilling sites will form the basis for interpretation of the potential risks associated with implementing the project.
- ii. The scope of work will include a description of the proposed seismic survey transects and possible drilling sites in the context of a summary of the regional vegetation types, protected vegetation types, ecosystems, conservation areas and conservation priority areas. Where the transects intersect NFEPA wetlands, the potential risks of the seismic survey transects to biota must be assessed.
- iii. The output shall be a report that can be included in a possible environmental impact assessment report and include environmental theme specific recommendations for an environmental management programme relevant to the seismic survey and borehole drilling.

The area within which the proposed seismic surveys and drilling will take place is essentially contained completely within the Umhlabuyalingana Local Municipality (KZN271), which is one of five Local Municipalities contained within the Umkhanyakude District Municipality (DC27). It covers 12 quarter degree squares within that region, as listed in Table 1.

Table 1: Quarter degree squares covered by proposed seismic survey lines

Map Sheet	Map Name	Map Sheet	Map Name
2732 DA	Sodwana Bay	2732 BB	Black Rock
2632 DC	Muzi	2732 AD	Tshongwe
2632 DD	Kosibaai	2732 AC	Jozini
2732 AA	Ingwavuma	2732 CB	Lower Mkuze
2732 AB	Sihangwane	2732 BC & BD	Sibayi
2732 BA	Ngutshana		

From a biodiversity perspective, as opposed to an administrative perspective, the area is contained within Maputaland, as described in Section 2.

2 MAPUTALAND DESCRIPTION

The Maputaland Centre of Endemism is a region of approximately 17,000 km² that falls within Mozambique, South Africa and Swaziland (Figure 1). It is part of the Maputaland-Pondoland-Albany biodiversity hotspot and has high levels of species richness and endemism, which makes its conservation value internationally recognised (Smith & Leader-Williams, 2006). It is part of the East African Coast Endemic Bird Area, of which 230 of the 2,500 species occurring there have endemic or near endemic status (Smith & Leader-Williams, 2006). In addition, it contains the Isimangaliso (previously Greater St Lucia Wetland Park) World Heritage Site, which is contained between Mapelane, just south of St Lucia, and the Mozambique border in the north, five RAMSAR sites, nine Important Bird Areas and a number of important populations of globally threatened species, such as the Black Rhinoceros. Of the total area of 17,000 km², 21 % of Maputaland (all three countries) has Protected Area status.

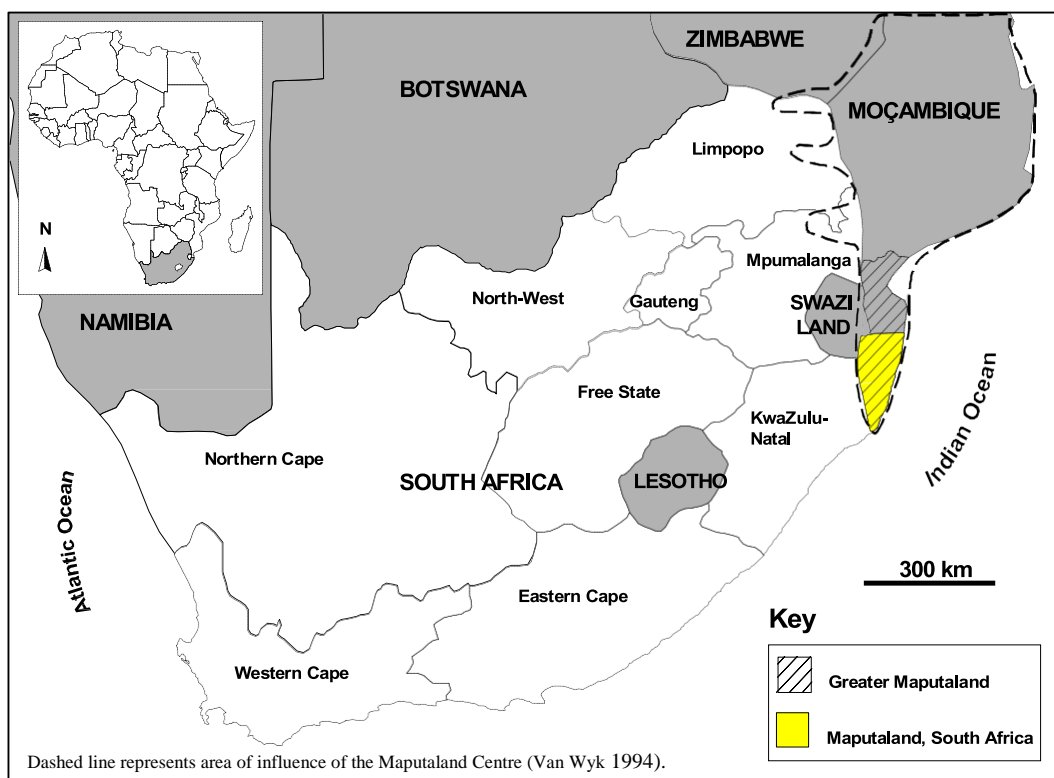


Figure 1: Location of Greater Maputaland and Maputaland, South Africa (from Smith 2001).

The part of Maputaland that is located in South Africa is located within the Indian Ocean Coastal Belt, as defined by Mucina and Rutherford (2006). This is an almost 800 km long coastal strip, between the South African border with Mozambique, extending as far south as the mouth of the Great Kei River, near East London. It is a climatically, ecologically and biogeographically peculiar region that, they have argued, deserves to stand on its own, at the level of a Biome, within the scope of the South African vegetation. The Indian Ocean Coastal Belt is characterised by a regional concentration of endemic species. The northern

landscapes in Maputaland are flat, whilst the southernmost landscapes are characterised by elevated plateaus, separated by deep gorges, associated with major river valleys.

The combination of geology and rainfall patterns largely determines biodiversity levels in Maputaland. Rainfall is relatively high in the Lubombo Mountains, low in the central region and then highest close to the Indian Ocean. The soils in the Lubombo Mountains are ryolitic, the central region has Cretaceous sediments and the eastern section has a large area of coastal sands. There are also a number of river systems that have deposited alluvial soils on top of the underlying geological types. As a result, Maputaland can be divided into five ecological zones, from east to west, namely: Lubombo, Cretaceous, Alluvial, Coastal Plain and Coastal Dune Zones (Smith & Leader-Williams, 2006). These ecological zones have relatively distinct boundaries. For the purposes of the proposed seismic surveys, only the Cretaceous, Alluvial and Coastal Plane have relevance. The other factor that contributes towards species richness is that the region is in the southernmost part of the East African coastal plain and thus contains species found in both East and Southern Africa.

Most of the region's soils are nutrient poor, with only the Cretaceous and Alluvial Zones containing land that is highly suitable for agriculture. This means that local people have traditionally relied on harvesting of natural resources and the region has been relatively ignored by commercial farmers. The result has been that biodiversity levels have largely been maintained, though large mammals are generally restricted to Protected Areas and there is a serious threat from alien plant species. In recent times, there has been an increase in intensive farming and this has implications for the conservation of some habitat types, such as sand forest. Although in the past harvesting rates were sustainable, human population increases, changes in infrastructure and prevailing social conditions have increased instances of over-harvesting of natural resources and this has had impacts on financially valuable species, as well as those with low reproductive rates.

The area has large numbers of very poor people and the Governments of Mozambique, South Africa and Swaziland have realised that economic development on the region should be based on eco-tourism and/or sustainable use of natural resources. The game ranching industry has demonstrated that there can be significant biodiversity and economic benefits by combining photographic tourism, trophy hunting and game harvesting (Goodman, *et al*, 2002; Lindberg *et al*, 2003). The success of these private conservation enterprises is starting to be emulated in some community areas, though success rates have been mixed.

A key part of the development process was the launch of the Lubombo Transfrontier Conservation Area (TFCA) in 2000. It aims to facilitate conservation and sustainable use of biological and cultural resources, whilst promoting regional peace, cooperation and socio-economic development (Smith & Leader-Williams, 2006).

There is generally a lack of biodiversity distribution data within Maputaland (Smith & Leader-Williams, 2006) and this has hampered conservation planning in the region.

3 CONSERVATION RELATED ISSUES OF IMPORTANCE

In terms of the potential impacts of the seismic surveys and possible storage of CO² in the region, there are a number issues of importance (Smith & Leader-Williams, 2006):

- The need to maintain connectivity to maintain ecological processes and ensure viability of species with large ranges or those that form metapopulations, as well as for maintaining seed dispersal and connecting feeding and breeding grounds. In the context of the area within which the proposed seismic surveys will take place, it is important to maintain dry season/wet season connectivity for flora and fauna and to maintain north-south connectivity between the tropics and sub-tropic zones.
- The conservation planning system developed by Smith and Leader-Williams (2006) determined that distributions of species in Maputaland mirror that of their associated landcover types, so protecting each landcover type should automatically conserve most species. There are, however, two exceptions to this pattern. Firstly, some species have large ranges and would therefore not be conserved by protecting small or isolated patches of suitable habitat and, secondly, some species have such limited distribution within particular landcover types that protecting portions of those types may not be enough to conserve the species.
- Some landcover types are dependent on traditional fire-burning regimes and therefore it is important that continuity between large patches of these types is maintained.
- The biodiversity of Maputaland is relatively well-known, but species distribution data is unreliable.

The nature of the proposed seismic survey along a grid of existing main and district roads and established plantation roads and tracks, will limit the extent of potential environmental damage. Since the above-ground spatial impact of the proposed seismic surveys and possible underground storage of CO₂ will be small, the two most important factors to be considered will be possible effects on connectivity and direct, very localised effects on biodiversity elements. The latter will be more of an issue to species with limited distribution and narrow-range endemics than species with wider distribution. It will be particularly important to exercise caution in areas identified as areas with high irreplaceability levels. Those areas that will be covered by the proposed seismic surveys are south of Ndumo Game Reserve and around Tembe Elephant Park, Sileza Nature Reserve and Lake Sibaya. The only area of relevance within the study area that was flagged by Ezemvelo KZN Wildlife (KZN Wildlife) as an “Irreplaceable” Critical Biodiversity Area is the area south-west of Ndumo.

The proposed seismic surveys and test drilling will be extremely short-term activities, with no long-term or cumulative effects anticipated.

4 METHOD AND DATA SOURCES

The investigation consisted of a two-day site visit and a desktop study. During the site visit, from 11-13 March 2015, notes were made about the biophysical environment and key issues. This report, however, is mostly based on a desktop study of available literature and interrogation of GIS data, with the site visit serving to give the professional team an overview of the area.

The information presented and discussed as a result of the desktop study is drawn from the following sources:

1. Available literature (as cited in the individual sections).
2. Modelling (Ezemvelo KZN Wildlife).
3. University of Cape Town Animal Demography Unit (ADU) – verified observations.
4. The Maputaland Conservation Planning System and Conservation Assessment (Smith & Leader-Williams, 2006).
5. Personal knowledge of habitats and distribution.

There are certain deficiencies inherent in each of the data sources and these are discussed in the following section (4.1).

4.1 Deficiencies in data sources

Since there is a lack of biodiversity distribution data within Maputaland, it follows that the available literature cannot give comprehensive descriptions of all species distributions and status.

It is important to note that the KZN Wildlife species database consists of a combination of modelled and actual recorded occurrences of species and that, even within protected areas managed by them, this database does not nearly include all of the species in those areas. The greatest confidence is placed in sampled records; however ironically, sometimes species that are common in a protected area are sometimes not recorded in databases because nobody thought to sample them. It is clear that this database is quite inadequate on its own to predict animal species distributions, particularly because it does not take into account actual conditions on any given site.

The University of Cape Town Animal Demography Unit (ADU) data, which is based on actual observations, is recorded at the coarse resolution of quarter degree squares and thus needs to be interpreted intelligently. The only exception is the latest SA Bird Atlas Project, which is done at the pentad level (see Section 4.4.1). A pentad represents a 5 minute x 5 minute cell (in contrast to the 15 minute x 15 minute cells used previously). There are nine pentads in one quarter degree square.

Within a particular quarter degree square, one needs to determine whether or not the site under discussion has the habitat required by the species in question. Given that the proposed seismic surveys cover a large area, species distributions must be interpreted over the broader

area and are not specific to the actual sites on which seismic surveys or test drilling will take place.

In the early 1990s, David Rowe-Rowe, of the Natal Parks Board, compiled two booklets on the occurrence and distribution of Carnivores (Rowe-Rowe, 1992) and Ungulates (Rowe-Rowe, 1994) in Natal. The data was sourced from Natal Parks Board internal records, as well as from farm data sheets compiled by Zone Officers. At that stage, conservation in the Province was divided between the Natal Parks Board and the KwaZulu Bureau of Natural Resources, so, unfortunately, these booklets do not adequately cover the former KwaZulu homeland areas. Nevertheless, they are a reasonable starting point for determining the distribution of these mammals, and a combination of the knowledge of the animals' habitat requirements and some intelligent extrapolation can give a reasonable idea of what to expect in a given area of the Province. The information from these sources, and species accounts obtained from Skinner and Smithers (1990), were used to interpret and verify data on mammal distribution data obtained from the ADU (MammalMAP).

4.2 Biodiversity Sector Plans

A number of Biodiversity Sector Plans (BSPs) have been developed by KZN Wildlife for District Municipalities throughout KwaZulu-Natal. These BSPs were developed as a precursor to a bioregional plan for the Province. The purpose of a BSP is to provide a map of biodiversity priorities, with accompanying land use planning and decision-making guidelines, to inform land use planning, environmental assessment and authorisations, as well as natural resource management. The biodiversity priorities are identified as Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs). It is important that the BSP maps are consulted by environmental consultants when undertaking the EIA process or compiling biodiversity reports for the process.

Critical Biodiversity Areas, are those areas of natural or near-natural features, habitats or landscapes that include terrestrial, aquatic and marine areas that are considered critical for (i) meeting national and provincial biodiversity targets and thresholds (ii) safeguarding areas required to ensure the persistence and functioning of species and ecosystems, including the delivery of ecosystem services; and/or (iii) conserving important locations for biodiversity features or rare species. Conservation of these areas is crucial, in that if these areas are not maintained in a natural or near-natural state, biodiversity conservation targets cannot be met.

Ecological Support Areas (ESAs) are functional, but not necessarily entirely natural, areas that are required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the Critical Biodiversity Areas.

CBAs can be divided into two subcategories, namely Irreplaceable and Optimal and each of these can be divided up into sub-categories. Irreplaceable areas are those that are considered critical for meeting biodiversity targets and thresholds and which are required to ensure the persistence of viable populations of species and the functionality of ecosystems.

1. The Irreplaceable Areas category consists of:
 - a. Irreplaceable Areas (Strategic Conservation Assessment - SCA).
 - b. Irreplaceable Linkages (Terrestrial and Aquatic).
 - c. Expert Input.
2. The Optimal category consists of:
 - a. Optimal (SCA).
 - b. Expert Input.

The Ecological Support Areas category is made up of four subcategories, namely:

1. ESA (SCA): Functional but not necessarily entirely natural areas that are required to ensure the persistence and maintenance of biodiversity patterns and ecological processes.
2. ESA: Expert input - Areas identified by local experts as areas of functional but not necessarily entirely natural areas that are required to ensure the persistence and maintenance of biodiversity patterns and ecological processes within the Critical Biodiversity Areas (CBA).
3. ESA: Species Specific - Areas required for the persistence of specific species.
4. ESA: Corridors. Corridors created to facilitate linkages in the landscape.

Appendix 1, Map 4 illustrates portions of the study area that falls in each of these categories.

4.3 University of Cape Town Animal Demography Unit (ADU)

The University of Cape Town (UCT) Animal Demography Unit (ADU) runs a Virtual Museum (vmus.adu.org.za), which provides a platform for citizen scientists to contribute to biodiversity projects. The concept was developed by the ADA and members of the public are encouraged to submit digital photographs of various species, along with certain basic information (location being part of that information). The species are identified by observers, but confirmed by a panel of experts. This assists in compiling distribution maps, but also assists in providing species lists for selected areas. In this instance, queries for animal groups were based on the Twelve (12) quarter degree squares, 2732 DA (Sodwana Bay), 2732 BB (Black Rock), 2632 DC (Muzi), 2732 AD (Tshongwe), 2632 DD (Kosibaai), 2732 AC (Jozini), 2732 AA (Ingwavuma), 2732 CB (Lower Mkuze), 2732 AB (Sihangwane), 2732 BC & BD Sibayi and 2732 BA (Ngutshana).

4.3.1 Mammals

The Animal Demography Unit at UCT and the Mammal Research Institute at the University of Pretoria are collaborating to develop the MammalMAP, the Mammal Atlas of Africa. The Cape Leopard Trust was a key catalyst in initiating this project. The objective of MammalMAP is to generate 21st century distribution maps for all of Africa's mammals.

MammalMAP consists of digital photographic records of mammals, along with accurate geographical coordinates of where the pictures were taken.

Species lists for the quarter degree squares covered by the proposed seismic survey lines were generated from MammalMAP. It was found, however, that some of the species listed could not conceivably occur in the area, so some informed culling of the list had to take place. This culling was based on personal knowledge of distribution of species and reference to Rowe-Rowe (1992 & 1994) and Skinner & Smithers (1990).

4.3.2 Birds

The South African Bird Atlas Project 1 (SABAP1) was conducted from 1987 to 1992 and was based on data submitted by citizen scientists, with millions of records submitted for the whole of South Africa, and the data was published in two volumes. This data was submitted per quarter degree square and thus the resolution was quite coarse. This data is now also available electronically. The SA Bird Atlas Project 2 (SABAP2) started in July 2007 and is ongoing. The difference between SABAP1 and SABAP2 is that data is submitted for an area called a pentad – a pentad representing a 5 minute x 5 minute cell (in contrast to the 15 minute x 15 minute cells used during SABAP1). There are nine pentads in one quarter degree square.

The data for SABAP2 are much more recent than SABAP1 and reflect the current situation better than SABAP1 data, but not all of the country has been atlased sufficiently and there are some areas with insufficient data, therefore the use of SABAP1 is still necessary.

Data for the entire area covered by the proposed seismic survey lines was downloaded from the SABAP website, by quarter degree square, and then combined to give an overall list for the area (Section 6.2).

4.3.3 Reptiles

Reptile data (Section 6.3) was downloaded from the Virtual Museum, which has a link to the Southern African Reptile Conservation Assessment (SARCA, 2011) dataset. The distribution database underlying this comprises approximately 120,000 distribution records for reptile taxa that occur in southern Africa, mainly in South Africa, Lesotho and Swaziland. The data was supplied by museums, conservation organisations and private individuals, or was drawn from the literature, or from SARCA field surveys. Approximately 7,000 of the records were submitted by members of the public, via the online Virtual Museum, and have associated reptile photographs to confirm identity of the species.

This data is to be used towards the production of an up-to-date Atlas and Red Data Book of the reptiles of South Africa, Lesotho and Swaziland.

4.3.4 Frogs

Frog records included in this report (Section 6.4) are derived from the Atlas and Red Data Book of the Frogs of South Africa, Lesotho and Swaziland (Minter *et al.*, 2004). This book is based on distribution data collected during seven years of fieldwork (1996-2003), as well

as earlier data compiled from museum records, private collections, available literature and conservation agencies. The actual lists (Section 6.4) were downloaded from the ADU Website (ADU, 2011) and interpreted by means of Minter *et al.* (2004).

4.3.5 Invertebrates

A Butterfly list is contained in Section 6.5.1. The Southern African Butterfly Conservation Assessment (SABCA) was a partnership between the South African National Biodiversity Institute, the Lepidopterists Society of Africa and the Animal Demography Unit (University of Cape Town). SABCA compiled a comprehensive database of records from museum and private collections, field surveys and its own Virtual Museum. About 500,000 records are in existing collections. Field surveys were conducted around South Africa and prioritised to fill in gaps.

SABCA determined the distribution and diversity of butterflies in South Africa, Lesotho and Swaziland and conducted species assessments, according to the IUCN criteria, to produce an updated butterfly Red Data Book and Atlas, with distribution maps for each species at a quarter degree square grid scale.

In addition to the butterfly list, the Virtual Museum also allows downloading of Dragonfly (Section 6.5.2) and Lacewing (Section 6.5.3) lists. These were supplemented with data from the KZN Wildlife species database.

4.4 Red Data Lists

Red Data Lists (Red Lists) and Red Data Books are scientific publications that document the conservation status of species. They are based on a system that categorises species according to their risk of extinction. Red Lists are not in themselves legislation to protect species, but are used to inform threatened species legislation.

Red Data List Categories

- Endangered (E): A taxon is considered to be facing a very high risk of extinction in the wild.
- Vulnerable (V): A taxon is considered to be facing a high risk of extinction in the wild.
- Near Threatened (NT): Does not qualify for Critically Endangered (CR), Endangered (E) or Vulnerable (V) now, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.
- Least Concern (LC): Does not qualify for CR, E, V or NT. Widespread and abundant taxa are included in this category.
- Data Deficient (DD): There is inadequate information to make a direct, or indirect, assessment of the taxon's risk of extinction based on its distribution and/or population status. More information on this taxon is required and acknowledges the possibility that future research will show that threatened classification is appropriate.

5 VEGETATION COMMUNITIES

In this discussion, we refer to the KwaZulu-Natal Vegetation Type Map (KZN VT – Scott-Shaw & Escott, 2011) rather than the National Vegetation Type Map (Mucina and Rutherford, 2006). The reason for this is that the KZN VT map has undergone several changes since the publication of Mucina and Rutherford in 2006. Ezemvelo KZN Wildlife has, in collaboration with various government departments, NGOs, Working Groups and Forums, refined the KZN VT to develop an accurate representation of the pre-transformation extent of the vegetation types present in the Province. As a result of the finer scale mapping and classification, the KZN VT map has, in some cases, identified new vegetation types and/or subtypes within the vegetation types identified at national level. These changes will be incorporated into the revised National Vegetation Type Map (by Mucina and Rutherford). In the discussion, we will refer to the KZN VT and the National equivalent.

The area covered by the proposed seismic survey line includes six biomes; the Azonal Forest, Forest, Indian Ocean Coast Belt, Savanna, Grassland and Wetlands Biomes, and contains fifteen (15) vegetation types, as listed in Table 2 below.

All wetlands and some forest types in the area are considered to be Azonal vegetation types, which means that they are found within a particular vegetation type or biome, but special substrates, such as soil types, bedrock and/or hydrogeological conditions (waterlogging, flooding, tidal influence) exert an overriding influence on floristic composition, structure and dynamics over macroclimate. These Azonal freshwater wetlands and forests thus form a system of archipelagos of small and highly fragmented patches imbedded within all the main biomes of South Africa.

Table 2: KZN Biomes and Vegetation Types in proposed seismic survey area.

KZN Biome	% of Total	Vegetation Type	Area (ha)	% of Total	Target %	% Cons.
Azonal Forest	0.33%	Lowveld Riverine Forest (FOa 1/65)	126	0.028 %	100 %	50 %
		<ul style="list-style-type: none"> • Swamp Forests: <i>Ficus trichopoda</i> Swamp Forest (FOa 2/66.2) • Swamp Forests : <i>Raphia</i> Swamp Forest (FOa 2/66.3) 	1372	0.303 %	100 %	66 %
Forest	0.50%	KwaZulu-Natal Coastal Forests (FOz 7/62.4): Maputaland Moist Coastal Lowlands Forest	5	0.001 %	43 %	68 %
		Licuat Sand Forests (FOz 8/64.1)	2250	0.496 %	100 %	42 %
Indian Ocean Coastal Belt	30.27%	Maputaland Wooded Grassland (CB2/18)	63876	14.095 %	25 %	17 %
		Maputaland Coastal Belt (CB1/19)	73285	16.171 %	25 %	15 %
Savanna	64.90%	Makatini Clay Thicket (SVI 21/39)	508	0.112 %	19 %	42 %
		Maputaland Pallid Sandy Bushveld (SVI 25/40.1)	38497	8.495 %	?	?
		Muzi Palm Veld and Wooded Grassland (SV1 26/40.2)	50823	11.215 %	?	?
		Tembe Sandy Bushveld (SVI 18/47)	94501	20.853 %	19 %	17 %
		Western Maputaland Clay Bushveld (SVI 20/50)	98790	21.800 %	19 %	11 %

		Western Maputaland Sandy Bushveld (SVI 19/51)	10994	2.426 %	19 %	18
Wetland	4.00%	Alluvial Wetlands (Aza 7/75.5): Subtropical Alluvial Vegetation : Lowveld Floodplain Grasslands : Short Grass/ Sedge Wetlands	3591	0.792 %	31 %	?
		<ul style="list-style-type: none"> • Freshwater Wetlands : Subtropical Freshwater Wetlands (AZf 6/76.1) • Freshwater Wetlands : Subtropical Freshwater Wetlands : Short Grass/ Sedge Wetlands (AZf 676.3) • Freshwater Wetlands : Subtropical Freshwater Wetlands : Coastal Lakes & Pans (AZf 676.7) 	14443	3.187 %	24 %	40-50 %
		<ul style="list-style-type: none"> • Inland Saline Wetlands : Subtropical Salt Pans (AZi 11/77.1) • Inland Saline Wetlands : Subtropical Salt Pans : Floodplain Pans (Open) (AZi 11/77.2) 	115	0.025 %	24 %	40 %
		Grand Total	453175	100.00 %		

Notes on Table 2:

- Since the area covered by the proposed seismic survey lines is not a clearly demarcated area, the percentages in the 3rd last column (% of total) are based on the entire patches of different vegetation types that the lines cross over at any point. These percentages are simply presented to give an indication of the relative extent of the different vegetation types within the general area.
- The first part of the code in brackets next to the name is the SANBI code and the second part the KZN code.
- Target and actual conservation percentages within KwaZulu-Natal are given in the last two columns.

5.1 Forests and Azonal Forests

Indigenous forest in South Africa is defined as a generally multilayered vegetation unit dominated by trees (largely evergreen or semi-deciduous), whose combined strata have overlapping crowns (i.e. the crown cover is 75 % or more) and where graminoids in the herbaceous stratum (if present) are generally rare. Forest height ranges from high forest, over 30 m, to scrub forest, with a height of just over 3 m.

Forests are scattered along the eastern and southern margins of South Africa, i.e. the Great Escarpment, mountain ranges and coastal lowlands. They typically occur as a series of scattered small to very small patches (< 10 ha) and most forests are smaller than 100 ha. Most forests occur as an archipelago of forest islands within large -scale patches of biomes, such as Fynbos, Albany Thicket, Grassland and Savanna. Only a few large forest complexes can be found in South Africa and these are widely separated.

In general terms, forests in South Africa show links to two main African forest zones, namely the Afrotropical Forests (part of the Afrotropical Region) and Coastal Forests. The Afrotropical Forests extend into Zimbabwe, Malawi and along the East African mountain ranges, as far north as Ethiopia and Westwards to Cameroon and northern Angola. The coastal forests form part of a mosaic that extends from the Eastern Cape to the Zanzibar-

Inhambane Region. Going south from East Africa, there is a general reduction in species diversity in both forest zones. Montane forests, in general, have fewer species than lowland, coastal and dune forests and drier forests are richer in species than wetter forests.

In historic times, natural forest in South Africa occurred in much the same areas as it does today – almost all in the eastern parts of the country and associated with the slopes of mountain ranges, although it probably once formed a continuous belt along the steps of the escarpment and the Indian Ocean Coastal Belt. This area was probably dominated by subtropical forest, whereas it is now fragmented. Prehistoric fragmentation of forests essentially occurred because of increased aridity in the area and not because of the influence of man and there have been periods of natural forest expansion and contraction in the past, related to cyclical climate changes.

The effect of humans has been more marked along the coastal belt of KwaZulu-Natal and the Eastern Cape, where Iron Age farmers (the Bantu people), migrating southwards along the coast, settled in high density in preferred sites and thus forest and scrub forests were continuously cleared for pastures and exploited for timber, plant foods and medicines over the last 1 400 years. Initially, human numbers were low and the impacts from this clearing only became significant over the last 200 years. The area of indigenous forest has also been reduced overall since the settlement of Europeans in Southern Africa, since 1652 (some 350 years), in some regions more than in others. Sugar cane farming, for example, has been a major cause of forest loss in KwaZulu-Natal.

The initial effects of rotating slash and burn agriculture by the Bantu people were quite small because indigenous forests were able to recover naturally. As human densities increased and nomadic life was no longer possible, impacts started to become irreversible. There was a major difference between the indiscriminate felling by European settlers and the type of utilisation by the Bantu people. The European settlers were looking for large trees of specific species with high timber yield, whereas the Bantu people were (and still are) predominantly using the below canopy trees and shrubs, which are the source of future recruitment for the canopy. This means that, once the indiscriminate timber felling by the settlers ceased, there were many saplings ready to fill the gaps. On the other hand, there are some natural forest patches in South Africa today, surrounded by rural communities, that are completely dominated by senescent and moribund trees and devoid of saplings and shrubs and new plants are quickly eaten by goats. A natural forest in that state is, ultimately, doomed.

Azonal Forests refers to forest which grows outside of typical climatic zones that favour forest development. Forest development, in these instances, is facilitated by the overriding influence of a particular substrate and/or hydrogeological conditions.

Forests cover some 0.5 % of the area over which the proposed seismic survey lines will pass and Azonal Forests cover some 0.33 %, so forests in general cover a very small part of the total area under consideration.

Descriptions of the vegetation types found in the area covered by the proposed seismic survey lines follow.

5.2 Lowveld Riverine Forest (65)

Lowveld Riverine Forest is classified as KZN Veg Type 65 and SANBI Type FOa1. It covers 0.028 % of the area traversed by the proposed seismic survey lines.

Lowveld Riverine Forest is an Azonal Forest type distributed throughout KwaZulu-Natal, Mpumalanga and Limpopo Province. They are tall forests fringing larger rivers (gallery forests) and water pans. When they are dominated by *Ficus sycomorus* or *Diospyros mespiliformis* (alluvial sediments along major rivers), these forests are dense, tall and structured into several tree layers, with a well-developed, dense shrub layer (Mucina & Rutherford, 2006).

The conservation status of Lowveld Riverine Forest is Critically Endangered. About half is statutorily conserved in Kruger and Mapungubwe National Parks, iSimangaliso Wetland Park, Ndumo and Mkuze Game Reserves, Mlawula and Blyde River Canyon National Park in South Africa, as well as in a number of private game and nature reserves. An unknown portion has been irreversibly transformed by clearing for cultivation. Aliens such as *Melia azedarach*, *Lantana camara*, *Chromolaena odorata* and *Caesalpinia decapetala* are serious invaders in places. Agricultural malpractices, building of dams and excessive water extraction for agriculture and mining, as well as exploitation for timber and non-timber forest products, are serious threats to this vegetation type.

5.3 Swamp Forests

Swamp Forests: *Ficus trichopoda* Swamp Forest (66.2) and Swamp Forests : *Raphia* Swamp Forest (66.3) are Azonal Forests and are both incorporated into the SANBI Veg Type - Swamp Forest (F02a). Swamp Forest covers 0.303 % of the area traversed by the proposed seismic survey lines.

Swamp Forests are found in KwaZulu-Natal and the Eastern Cape Provinces, in pockets and narrow ribbons extending in a narrow belt along the Indian Ocean coast, from Maputaland as far south as Port Grosvenor in Pondoland, in low altitudes between 20 and 60 m asl. They have a strong tropical link and reach their southernmost limit in South Africa. Swamp Forests do not reach as far south as Mangrove Forests, which suggests that they are climatically more limited than the mangroves (Mucina & Rutherford, 2006).

Swamp Forests are tall forests reaching 12-15 m and have two main strata, namely the canopy and shrub layer with a poorly developed understory. They are found in muddy, waterlogged soil with organic humus, a peat-like layer and anoxic conditions.

The conservation status of Swamp Forest is Critically Endangered, with some 66 % statutorily conserved in iSimangaliso Wetland Park and other reserves southwards to Mtunzini. An unknown portion has already been transformed, either for plantations or by illegal clearing for fruit and vegetable gardens. The Swamp Forests in the Kosi Bay area are disappearing at a rapid rate. *Chromolaena odorata*, *Lantana camara* and *Pereskia* species

are common invaders in disturbed Swamp Forests. Changes in hydro-geological conditions pose another serious threat to this ecosystem. The endemic *Raphia australis* (Raphia Palm) is limited to Maputaland.

5.3.1 KwaZulu-Natal Coastal Forests: Maputaland Moist Coastal Lowlands Forest

The SANBI vegetation type for KwaZulu-Natal Coastal Forests sub-type Maputaland Moist Coastal Lowlands Forest (62.4) is Northern Coastal Forest (F0z 7). This forest type is distributed in KwaZulu-Natal and, to a very small extent, in the Eastern Cape. It is particularly well developed in Maputaland, on the coastal dunes. KwaZulu-Natal Coastal Forest covers 0.001 % of the area traversed by the proposed seismic survey lines.

These forests are species-rich, tall/medium height and occur on rolling coastal plains and stabilised coastal dunes. The low tree and shrubby understoreys are species-rich and include many subtropical taxa and on the dunes these forests have well-developed tree, shrub and herbaceous layers. Many tropical species reach their southern distribution in these forests (Mucina & Rutherford, 2006).

The conservation status of KZN Coastal Forests, in general, is Least Threatened, whilst that of the Maputaland Moist Coastal Lowlands Forest sub-type is Endangered, mainly due to heavy metal mining, illegal clearing for small-scale agriculture and ongoing coastal development. The original extent of these forests has been diminished by agriculture (mainly sugar cane and fruit gardens), timber plantations, urban sprawl and tourist development. These forests are also sensitive to plant invasion from species such as *Chromolaena odorata*, with species of *Pereskia* and *Acacia* are also posing serious threats. About 68 % is statutorily conserved in and around the Isimangaliso Wetland Park and down the KwaZulu-Natal South Coast, mostly under KZN Wildlife management.

5.3.2 Licuati Sand Forests (64.1)

The SANBI vegetation type for Licuati Sand Forest (64.1) (Scott-Shaw, 2011a) is Sand Forest (F0z 8) (Mucina & Rutherford, 2006). It covers 0.50 % of the area traversed by the proposed seismic survey lines.

These forests are found in KwaZulu-Natal and Mozambique and occur in a broad, highly fragmented belt in South Africa, mainly in Maputaland, from False Bay Park in the south to the Tembe Elephant Park and Ndumo Game Reserves on the Mozambique border.

The vegetation consists of dense thickets of 5-6 m, up to tall forests with the canopy reaching 15 m with a well-developed shrub layer and very poorly developed ground layer. These forests contain a large number of local Maputaland endemics and they form the core of the Maputaland Regional Centre of Endemism. Many other tropical elements have their southernmost distribution here and/or are found in South Africa exclusively here.

The conservation status of Sand Forest is Critically Endangered due to its vulnerability and economic pressure. Some 42 % is statutorily conserved in Tembe Elephant Park, Sileza Nature Reserve, Ndumo and Mkuze Game Reserves, Kruger National Park and the privately owned Phinda Resources Reserve. Large, though unknown, portions were removed for subsistence agriculture and grazing and uncontrolled extraction of wood for fuel and crafts is a problem. The best preserved portion of Sand Forest in South Africa is within Tembe Elephant Park, but the high density of elephants there is a threat to the forests.

5.4 Indian Ocean Coastal Belt

The Indian Ocean Coastal Belt, as defined by Mucina and Rutherford (2006), is an almost 800 km long coastal strip, between the South African border with Mozambique, as far south as the mouth of the Great Kei River, near East London. It is a climatically, ecologically and biogeographically peculiar region that, they have argued, deserves to stand on its own at the level of a Biome within the scope of the South African vegetation. It is characterised by a regional concentration of endemic species. Whilst the northern landscapes are flat, the southernmost landscapes are characterised by elevated plateaus and deep gorges. The Indian Ocean Coastal Belt covers 30.27 % of the area to be traversed by the proposed seismic survey lines.

Two vegetation types over which the proposed seismic survey lines will cross are found within the Indian Ocean Coastal Belt biome, namely Maputaland Coastal Belt and Maputaland Wooded Grassland.

5.4.1 Maputaland Coastal Belt

Maputaland Coastal Belt is classified as KZN Veg Type 19 (Scott-Shaw, 2011a) - SANBI Type CB1 (Mucina & Rutherford, 2006). It covers 16.17 % of the area traversed by the proposed seismic survey lines.

This vegetation type is a broad strip (up to 35 km) along the coast of the Indian Ocean, stretching from the Mozambique border in the north, to Mtunzini in the south. Altitude varies from about 20-120 m. It consists of a flat coastal plain, which was originally probably densely forested in places, with a wide range of interspersed non-forest communities, including dry grasslands, hygrophilous grasslands and thicket groups. Today, the vegetation landscape is composed of pockets of various forest types, thickets, primary and secondary grasslands, wetlands, extensive timber plantations and cane fields (Mucina & Rutherford, 2006).

The belt of the Indian Ocean Coastal Belt immediately inland and parallel to the line of the Northern Coastal Forest has a characteristic appearance of very irregular dunes, with generally open vegetation and *Syzygium cordatum* dotted prominently on the dunes, with many irregular dune slacks interspersed. The soils are nutritionally very poor and leached, except in the interdune depressions, where organic-rich soils are sometimes found.

The conservation status of the Maputaland Coastal Belt is Vulnerable, with 15 % statutorily conserved in the iSimangaliso Wetland Park, as well as in Sileza, Enseleni and Amathikhulu Nature Reserves. More than 30 % is transformed for plantations, by cultivation and by urban sprawl and most of it is agricultural land. Alien plant species include scattered populations of *Chromolaena odorata* and *Lantana camara*. The region has a relatively high number of taxa at the southernmost and northernmost limits of their distribution range and the occurrence of widely disjunct or outlier populations increases its conservation value.

5.4.2 Maputaland Wooded Grassland (18)

Maputaland Wooded Grassland is classified as KZN Veg Type 18 (Scott-Shaw, 2011a) - SANBI Type CB2 (Mucina & Rutherford, 2006). It covers 14.10 % of the area traversed by the proposed seismic survey lines.

Maputaland Wooded Grassland is found in KwaZulu-Natal and Mozambique. In South Africa, it extends from the Mozambique border and as far south as Richards Bay, in altitudes from 20-120 m asl. It is found within the generally flat landscape of the Maputaland coastal plain, supporting coastal sandy grasslands rich in geoxylic suffrutices, dwarf shrubs, small trees and very rich herbaceous flora. The many interdune depression wetlands and hygrophilous grasslands neighbouring the wooded grasslands are excluded (Mucina & Rutherford, 2006).

The conservation status of Maputaland Wooded Grassland is Endangered, with about 17 % statutorily conserved, mainly in the iSimangaliso Wetland Park. Some 46 % is transformed, mostly to pulpwood plantations, sugar cane fields and informal settlements. Alien plant species include scattered populations of *Chromolaena odorata* and *Lantana camara*.

5.5 Savanna

The Savanna Biome consists of vegetation with a grass dominated herbaceous layer and scattered low to tall trees. It includes the gradient, in terms of tree density and height, from “Savanna grasslands” to “tree savanna”, “shrub savanna”, “savanna woodland” or “savanna parkland”. In many savanna areas in Southern Africa, the term Bushveld is more appropriate since the woody component doesn’t form a distinct layer such as tall Miombo vegetation in the north. Bushveld consists of a series of interlocking, often low canopies, with openings and sometimes little distinction between shrubs and small trees.

Savanna covers 64.90 % of the area to be traversed by the proposed seismic survey lines.

5.5.1 Makatini Clay Thicket

Makatini Clay Thicket is classified as KZN Veg Type 39 and SANBI Veg Type SVI 21. It covers 0.11 % of the area traversed by the proposed seismic survey lines.

Makatini Clay Thicket occurs in a number of patches in the Maputaland region, primarily east of the Lubombo Mountains, from Ndumo Game Reserve on the Mozambique border through the Makatini Flats south, to just east of the town of Hluhluwe. It is mostly embedded as varying size patches within Western Maputaland Clay Bushveld, where it occurs in bottomland positions. Small, unmapped fragments of Makatini Clay Thicket also occur west of the Lubombo Mountains, embedded within Zululand Lowveld.

The vegetation of Makatini Clay Thicket comprises a mixed, but mainly simple-leaved short bushland and thicket, with emergent trees up to 10 m and a generally dense dominant shrub layer 1-4 m tall. It occurs on the lower slopes and bottomland areas of gently undulating terrain. Small clay-bottom endorheic pans occur commonly at low points in the terrain.

The conservation status of Makatini Clay Thicket is Least Threatened, with some 42 % statutorily conserved in the iSimangaliso Wetland Park (Mkuze) and Ndumo Game Reserve. About 7 % is already transformed, mainly by cultivation.

5.5.2 Maputaland Pallid Sandy Bushveld

Maputaland Pallid Sandy Bushveld is classified as KZN Veg Type 40_1 and SANBI Type SVI 25, although it is not described in Mucina and Rutherford (2006), but is described in Scott-Shaw (2011). It is found on the coastal plain in Maputaland, east of the Pongola River, north of the Mkuze River and aligned with the Muzi Swamp and its water catchment and southwards to the town of Hluhluwe. It is sandwiched between Tembe Sandy Bushveld and Maputaland Coast Belt and surrounds most of the Muzi Palm Veld and Wooded Grassland. The altitude range is 10-90 m, mostly 40-80 m. It covers 8.49 % of the area traversed by the proposed seismic survey lines.

Maputaland Pallid Sandy Bushveld occurs on ancient coastal dune cordons on gently undulating terrain. It forms open to closed evergreen woodland, with a canopy between 5-10 m tall, as well as bushlands.

It is conserved in the Tembe Elephant Park and the Ozabeni Section of iSimangaliso, as well as in Tshaneni Game Reserve and the Makasa Game Reserve. However, the actual target and percentage conserved are not given as it was not originally described in Mucina and Rutherford (2006).

5.5.3 Muzi Palm Veld and Wooded Grassland

Muzi Palm Veld and Wooded Grassland is classified as KZN Veg Type 40_2 and SANBI Type SVI 26, although it is not described in Mucina and Rutherford (2006), but is described in Scott-Shaw (2011). It is found on the coastal plain in the Maputaland region, east of the Pongola River and sandwiched between Tembe Sandy Bushveld, Eastern Maputaland Pallid Sandy Bushveld and Maputaland Coastal Belt. It occurs in an altitude range of 40 - 90 m asl. It covers 11.21 % of the area traversed by the proposed seismic survey lines.

Muzi Palm Veld and Wooded Grassland is found on ancient coastal dune cordons on gently undulating terrain and dry basins all associated with the Muzi Swamps and Muzi Stream (an ancient shoreline), draining north and south into the Pongola River and Mkuzi River respectively. Two broad plant communities dominate this vegetation type, in a patchwork pattern: *Hyphaene coriacea* dominated seasonally wet Palm Veld, lacking in shrubs and herbs and; wooded grassland, several to many meters above the water table (in average rainfall years), rich in shrubs, dwarf shrubs, geoxylic suffrutices and herbs. It differs from Eastern Maputaland Pallid Sandy Bushveld in the generally higher and very seasonal water table, which is unsuitable for bushveld trees (Scott-Shaw, 2011).

The conservation status of Muzi Palm Veld and Wooded Grassland is Least Threatened and it is statutorily conserved in Tembe Elephant Park, though target and actual percentages are not given.

5.5.4 Tembe Sandy Bushveld (47)

Tembe Sandy Bushveld is classified as KZN Veg Type 47 and SANBI Type SVI 20. It is in part of the Maputaland Lowveld, east of the Pongola River, and is the strip of land between the Mozambique border and Tembe Elephant Park in the north, extending south as far as the surrounds of the confluence of the Mkuze and Msunduzi Rivers. It is sandwiched between Western Maputaland Clay Bushveld in the west and the Maputaland Coastal Belt in the east. It covers 20.85 % of the area traversed by the proposed seismic survey lines.

Tembe Sandy Bushveld is found on extensive flat plains, to slightly undulating in places, on poor, sandy soils that are well leached. It consists of open to closed woodland, with a canopy 5-10 m tall, dominated by leguminous woody species and *Terminalia sericea*, with a species rich shrub layer and grassy undergrowth.

The conservation status of Tembe Sandy Bushveld is Least Threatened, with some 17 % statutorily conserved, almost all in the Tembe Elephant Park.

5.5.5 Western Maputaland Clay Bushveld

Western Maputaland Clay Bushveld is classified as KZN Veg Type 50 and SANBI Type SVI 20. It is found in Maputaland, immediately east of the Lubombo Mountains, eastwards to the edge of the Tembe Sandy Bushveld, from Ndumo Game Reserve on the Mozambique border, through the Makatini Flats south to Mkuze Game Reserve. It covers 21.80 % of the area traversed by the proposed seismic survey lines.

This vegetation type comprises a mixed, but mainly compound-leaved short (5-10 m) woodlands and wooded grassland and occurs on the crests, upper and midslopes of gently undulating terrain.

The conservation status of Western Maputaland Clay Bushveld is Vulnerable, with about 11 % statutorily conserved in the iSimangaliso Wetland Park (Mkhuze) and Ndumo Game

Reserve, the target being 19 %. A significant portion (34 %) has been transformed, mostly by cultivation. Alien plant infestations are locally severe and include *Opuntia* species.

5.5.6 Western Maputaland Sandy Bushveld

Western Maputaland Sandy Bushveld is classified as KZN Veg Type 51 and SANBI Type SVI 19. It is found in isolated patches on the coastal plain in the Maputaland region, east of the Lubombo Mountains, from the Ndumo Game Reserve on the Mozambique border in the north to Mkhuze Game Reserve (part of iSimangaliso), at altitudes between 40-180 m asl. It covers 2.43 % of the area traversed by the proposed seismic survey lines.

The conservation status of Western Maputaland Sandy Bushveld is Least Threatened, with some 18 % statutorily conserved in Mkhuze, the target being 19 %. Very little of this vegetation type (2 %) is transformed, mainly by cultivation.

5.6 Wetlands

Wetlands are valuable for the following reasons:

- In terms of hydrology (water production/retention).
- Habitat for many plant species.
- Habitat for resident and migratory waterfowl.
- Nutrient cycling.
- Grazing.
- Protein for humans – wild fowl and fish.
- Material for building.
- Carbon sequestration.

The principle threats to wetlands include conversion of a wetland from one form to another, reduction in size, or total destruction/ drainage and pollution, urban sprawl and invasion by alien plants. Many invasive alien plants are also wetland species, thus making wetlands particularly vulnerable to infestation. Disturbance of wetlands also increases the likelihood of alien plant invasion on the edges, and aquatic weeds, such as *Eichhornia crassipes* (Water Hyacinth), *Pistia stratiotes* and *Salvinia molesta* (Kariba Weed), within water bodies.

Wetlands cover some 4.00 % of the area covered by the proposed seismic survey lines.

5.6.1 Alluvial Wetlands

Alluvial Wetlands in the region consist of the sub-type: Subtropical Alluvial Vegetation : Lowveld Floodplain Grasslands : Short Grass/ Sedge Wetlands, which is classified as KZN Veg Type 75.5 and SANBI Type AZa 7. They cover 0.78 % of the area traversed by the proposed seismic survey lines.

Alluvial Wetlands are distributed in the Limpopo, Mpumalanga and KwaZulu-Natal provinces in the broad river alluvia and around some river-fed pans in the subtropical regions of South Africa, in particular, the Lowveld, Central Bushveld and northern KZN. They are fully embedded in the Savanna Biome. They consist of flat alluvial terraces supporting an intricate complex of macrophytic vegetation (in the channels of flowing rivers and river-fed pans), marginal reed beds (un-sheltered oxbows and along very slow-flowing water courses), as well as extensive flooded grasslands, ephemeral herblands and riverine thickets.

The conservation target for Alluvial Wetlands is 31 % and large patches are statutorily conserved in a number of protected areas, including Ndumo and Mkhuze Game Reserves, both of which are Ramsar sites. Much of the area has been transformed for cultivation, urban development and road building. Alien woody species commonly occurring in this vegetation type include *Melia azedarach*, *Chromolaena odorata* and the like (Mucina & Rutherford, 2006).

5.6.2 Freshwater Wetlands

There are two KwaZulu-Natal Subtropical Freshwater Wetland types that are incorporated into the SANBI Veg Type: Subtropical Freshwater Wetlands (AZf6), they are:

- Subtropical Freshwater Wetlands (76.1), SANBI Veg Type AZf6.
- Subtropical Freshwater Wetlands: Short Grass/Sedge Wetlands (76.3), SANBI Veg Type AZf6.

In addition, one KwaZulu-Natal Subtropical Freshwater Wetland type, namely Coastal Lakes & Pans (76.7), is classified as the SANBI Veg Type: Freshwater Lakes (W1).

Freshwater Wetlands cover 3.19 % of the area traversed by the proposed seismic survey lines.

Subtropical Freshwater Wetlands are found in most of the eastern part of South Africa and they are characterised by flat topography supporting low beds dominated by reeds, sedges and rushes or waterlogged meadows dominated by grasses. They are found typically along the edges of often seasonal pools in aolian depressions, as well as fringing alluvial backwater pans or artificial dams (Mucina & Rutherford, 2006).

The conservation status of Subtropical Freshwater Wetlands is Least Threatened, with a target of 24 %. Some 40-50 % is statutorily conserved, mostly in Maputaland Protected Areas. About 4 % has been transformed (largely for cultivation), but local grazing and urban sprawl is putting pressure on these wetlands and will continue to do so. Disturbance leads to invasion by aliens, such as *Lantana camara*, *Chromolaena odorata* and *Melia azedarach* on the edges of wetlands and aquatic weeds, such as *Eichhornia crassipes*, *Pistia stratiotes* and *Salvinia molesta* in water bodies.

5.6.3 Inland Saline Wetlands

There are two KwaZulu-Natal Inland Saline wetland types that are incorporated into the SANBI Vegetation Type, Subtropical Salt Pans (AZi 11), they are:

- Inland Saline Wetlands : Subtropical Salt Pans (77.1).
- Inland Saline Wetlands : Subtropical Salt Pans : Floodplain Pans (Open) (77.2).

Inland Saline Wetlands cover 0.025 % of the area traversed by the proposed seismic survey lines. Subtropical Salt Pans are found in the Limpopo, Mpumalanga and KwaZulu-Natal Provinces, as well as in Swaziland, in particular the Lowveld, Maputaland and northern KZN. They are found in shallow depressions, often on old alluvial terraces of rivers, surrounded by zones of bank reeds or low herblands and, in more perennial pans, also filled with a dense carpet of macrophytic floating vegetation.

The conservation status of Subtropical Salt Pans is Least Threatened. The conservation target is 24 %, but more than 40 % is statutorily conserved in a number of protected areas, particularly in iSimangaliso and Ndumo Game Reserve. About 11 % has been transformed for mines, cultivation and plantations.

6 FAUNA

6.1 Mammals

Maputaland covers a large area, with many different habitats, therefore the range of mammal species that inhabit the area will be large. There are a few species that will only be found in the protected areas in the region, whilst others will be ubiquitous. In general, antelope numbers will be lowest in and around rural settlements because of hunting and the presence of dogs.

Table 3 lists mammals recorded for the quarter degree squares covered by the proposed seismic survey lines. It is derived from ADA MammalMap and informed by Rowe (1992 & 1994) and Skinner & Smithers (1990), as well as personal experience of the author.

Table 3: Mammal species recorded for 12 quarter degree squares

Family	Species	Common name	RDB	Endemic	Only PA
Bathyergidae	<i>Cryptomys hottentotus</i>	Southern African Mole-rat	LC	Yes	
Bovidae	<i>Aepyceros melampus</i>	Impala	LC	Yes	
	<i>Cephalophus natalensis</i>	Red Duiker	LC	Yes	
	<i>Connochaetes taurinus taurinus</i>	Blue Wildebeest	LC		Yes
	<i>Kobus ellipsiprymnus ellipsiprymnus</i>	Waterbuck	LC		Yes
	<i>Neotragus moschatus zuluensis</i>	Suni	V		
	<i>Ourebia ourebi</i>	Oribi	E	Yes	
	<i>Raphicerus campestris</i>	Steenbok	LC	Yes	
	<i>Redunca arundinum</i>	Southern Reedbuck	LC	Yes	
	<i>Sylvicapra grimmia</i>	Bush (Grey) Duiker	LC	Yes	
	<i>Syncerus caffer</i>	African Buffalo	LC	Yes	Yes
	<i>Tragelaphus angasii</i>	Nyala	LC	Yes	
	<i>Tragelaphus scriptus</i>	Bushbuck	LC	Yes	
<i>Tragelaphus strepsiceros</i>	Greater Kudu	LC	Yes		
Canidae	<i>Canis adustus</i>	Side-striped Jackal	NT	Yes	
	<i>Canis mesomelas</i>	Black-backed Jackal	LC	Yes	
	<i>Lycaon pictus</i>	African wild dog	E	Yes	
Ceropithecidae	<i>Cercopithecus mitis labiatus</i>	Samango Monkey	V	Yes	
	<i>Cercopithecus pygerythrus pygerythrus</i>	Vervet Monkey	LC		
	<i>Papio ursinus</i>	Chacma Baboon	LC	Yes	
Chrysochloridae	<i>Calcochloris obtusirostris</i>	Yellow Golden Mole	V	Yes	
Elephantidae	<i>Loxodonta africana</i>	African Bush Elephant	LC	Yes	Yes
Equidae	<i>Equus quagga</i>	Plains Zebra	NL	Yes	Yes

Family	Species	Common name	RDB	Endemic	Only PA
Felidae	<i>Acinonyx jubatus</i>	Cheetah	V	Yes	Yes
	<i>Leptailurus serval</i>	Serval	NT	Yes	
	<i>Panthera leo</i>	Lion	V	Yes	
	<i>Panthera pardus</i>	Leopard	LC	Yes	
Galagidae	<i>Galago granti</i>	Grant's Bushbaby	NL	Yes	
	<i>Galago moholi</i>	Moholi Bushbaby	LC	Yes	
	<i>Otolemur crassicaudatus</i>	Brown Greater Galago	LC	Yes	
Girafidae	<i>Giraffa camelopardalis giraffa</i>	The South African Giraffe	LC		Yes
Gliridae	<i>Graphiurus murinus</i>	Forest African Dormouse	LC	Yes	
Herpestidae	<i>Atilax paludinosus</i>	Water/Marsh Mongoose	LC	Yes	
	<i>Herpestes ichneumon</i>	Large Grey/Egyptian Mongoose	LC	Yes	
	<i>Herpestes sanguineus</i>	Slender Mongoose	LC	Yes	
	<i>Ichneumia albicauda</i>	White-tailed Mongoose	LC	Yes	
	<i>Mungos mungo</i>	Banded Mongoose	LC	Yes	
	<i>Paracynictis selousi</i>	Selous' Mongoose	DD	Yes	
Hippopotamidae	<i>Hippopotamus amphibius</i>	Common Hippopotamus	LC	Yes	
Hipposideridae	<i>Cloeotis percivali</i>	Percival's Short-eared Trident Bat	CE	Yes	
Hyaenidae	<i>Crocuta crocuta</i>	Spotted Hyena	NT	Yes	
	<i>Proteles cristata</i>	Aardwolf	LC	Yes	
Leporidae	<i>Lepus saxatilis</i>	Scrub Hare	LC	Yes	
Macroscelididae	<i>Petrodromus</i>	Four-toed Elephant Shrew	NL		
	<i>Petrodromus tetradactylus</i>	Four-toed Elephant Shrew	E	Yes	
Manidae	<i>Smutsia temminckii</i>	Ground Pangolin	V	Yes	
Molossidae	<i>Chaerephon pumilus</i>	Little Free-tailed Bat	LC	Yes	
	<i>Mops condylurus</i>	Angolan Free-tailed Bat	LC	Yes	
Muridae	<i>Aethomys Sp.</i>	Veld rats	NL		
	<i>Aethomys ineptus</i>	Tete Veld Aethomys	LC	Yes	
	<i>Aethomys namaquensis</i>	Namaqua Rock Mouse	LC		
	<i>Gerbilliscus brantsii</i>	Highveld Gerbil	LC		
	<i>Gerbilliscus leucogaster</i>	Bushveld Gerbil	DD		
	<i>Grammomys cometes</i>	Mozambique Grammomys	DD	Yes	
	<i>Grammomys dolichurus</i>	Common Grammomys	DD	Yes	
	<i>Lemniscomys rosalia</i>	Single-Striped Lemniscomys	DD	Yes	
	<i>Mastomys natalensis</i>	Natal Mastomys	LC		
	<i>Mastomys pernanus</i>	Dwarf Mastomys	NL	Yes	
	<i>Mus minutoides</i>	Southern African Pygmy Mouse	LC	Yes	
	<i>Otomys angoniensis</i>	Angoni Vlei Rat	LC	Yes	
	<i>Otomys auratus</i>	Southern African Vlei Rat	NL	Yes	
	<i>Otomys saundersiae</i>	Saunders' Vlei Rat	LC	Yes	
<i>Rattus rattus</i>	Roof Rat	LC			

Family	Species	Common name	RDB	Endemic	Only PA
Mustelidae	<i>Aonyx capensis</i>	Cape Clawless Otter	NT		
	<i>Ictonyx striatus</i>	Striped Polecat	LC	Yes	
	<i>Mellivora capensis</i>	Honey Badger	NT	Yes	
	<i>Poecilogale albinucha</i>	African Striped Weasel	DD	Yes	
Nesomyidae	<i>Dendromus</i>	African Climbing Mice	NL		
	<i>Dendromus melanotis</i>	Gray African Climbing Mouse	LC	Yes	
	<i>Dendromus mesomelas</i>	Brants's African Climbing Mouse	LC	Yes	
	<i>Dendromus mystacalis</i>	Chestnut African Climbing Mouse	LC	Yes	
	<i>Saccostomus campestris</i>	Southern African Pouched Mouse	LC	Yes	
	<i>Steatomys krebsii</i>	Kreb's African Fat Mouse	LC	Yes	
	<i>Steatomys parvus</i>	Tiny African Fat Mouse	NL	Yes	
	<i>Steatomys pratensis</i>	Common African Fat Mouse	LC	Yes	
Nycteridae	<i>Nycteris thebaica</i>	Egyptian Slit-faced Bat	LC	Yes	
Orycteropodidae	<i>Orycteropus afer</i>	Aardvark	LC	Yes	
Pteropodidae	<i>Epomophorus wahlbergi</i>	Epomophorus wahlbergi	LC	Yes	
Rhinolophidae	<i>Rhinolophus clivus</i>	Geoffroy's Horseshoe Bat	NT	Yes	
	<i>Rhinolophus darlingi</i>	Darling's Horseshoe Bat	NT	Yes	
Sciuridae	<i>Paraxerus palliatus</i>	Red Bush Squirrel	NT	Yes	
Soricidae	<i>Crocidura</i>	Shrews	NL		
	<i>Crocidura cyanea</i>	Reddish-gray Musk Shrew	DD	Yes	
	<i>Crocidura flavescens</i>	Greater Red Musk Shrew	DD	Yes	
	<i>Crocidura fuscomurina</i>	Bicolored Musk Shrew	DD	Yes	
	<i>Crocidura hirta</i>	Lesser Red Musk Shrew	DD	Yes	
	<i>Crocidura maquassiensis</i>	Makwassie Musk Shrew	V	Yes	
	<i>Crocidura mariquensis</i>	Swamp Musk Shrew	DD	Yes	
	<i>Crocidura silacea</i>	Lesser Gray-brown Musk Shrew	DD	Yes	
	<i>Myosorex sclateri</i>	Sclater's Mouse Shrew	E	Yes	
	<i>Myosorex varius</i>	Forest Shrew	DD	Yes	
	<i>Suncus infinitesimus</i>	Least Dwarf Shrew	DD	Yes	
	<i>Suncus lixus</i>	Greater Dwarf Shrew	DD	Yes	
Suidae	<i>Phacochoerus africanus</i>	Common Wart-hog	LC	Yes	
	<i>Potamochoerus porcus</i>	Bush Pig	NL	Yes	
Thryomyidae	<i>Thryonomys swinderianus</i>	Greater Cane Rat	LC		
Vespertilionidae	<i>Kerivoula lanosa</i>	Lesser Woolly Bat	NT	Yes	
	<i>Myotis bocagei</i>	Rufous Hairy Bat	DD		
	<i>Neoromicia capensis</i>	Cape Serotine	LC	Yes	
	<i>Neoromicia nanus</i>	Banana Pipistrelle	LC	Yes	
	<i>Nycticeinops schlieffeni</i>	Schlieffen's Twilight Bat	LC	Yes	
	<i>Pipistrellus kuhlii</i>	Kuhl's Pipistrelle	NL		
	<i>Scotophilus</i>	House Bats	NL		

Family	Species	Common name	RDB	Endemic	Only PA
	<i>Scotophilus dinganii</i>	Yellow-bellied House Bat	LC	Yes	
	<i>Scotophilus viridis</i>	Green House Bat	LC	Yes	
Viverridae	<i>Civettictis civetta</i>	African Civet	LC	Yes	
	<i>Genetta tigrina</i>	Cape/Large Spotted Genet	LC	Yes	

6.2 Birds

Birds are the most diverse group of vertebrates in the Maputaland-Albany Hotspot, with more 449 recorded in Maputaland. The hotspot is part of BirdLife International's Southeast African Coast Endemic Bird Area, with four restricted-range species: the Endemic Neergaard's Sunbird (*Nectarinia neergaardi*), the Near Endemic Rudd's Apalis (*Apalis ruddi*), Pink-throated Twinspot (*Hypargos margaritatus*), and Lemon-breasted Seedeater (*Serinus citrinipectus*). One endangered bird species (Saddle-billed Stork) and twenty Vulnerable species are found in the Maputaland.

Red Data codes:

EN = Endangered
V = Vulnerable
NT = Near-threatened

Table 4: Birds recorded for 12 quarter degree squares (449 species)

English Name	Status	End.
Acacia Pied (Pied) Barbet		
African (African Marsh-Warbler) Reed-Warbler		
African (Blue-billed) Firefinch		
African (Common) Stonechat		
African (Ethiopian) Snipe		
African (Grassveld/Grassland) Pipit		
African (Openbilled) Openbill (Stork)	NT	
African Black (Black) Swift		
African Black Duck		
African Black Oystercatcher	NT	
African Broadbill	NT	
African Crowned (Crowned) Eagle	NT	
African Cuckoo		
African Cuckoo Hawk		
African Darter		
African Dusky Flycatcher		
African Emerald (Emerald) Cuckoo		
African Finfoot	VU	
African Fish-Eagle		
House Sparrow		
Icterine Warbler		
Jackal Buzzard		
Jacobin (Pied) Cuckoo		
Jameson's Firefinch		
Kelp Gull		
Kittlitz's Plover		
Klaas's Cuckoo		
Knysna Lourie (pre-split)		
Kurrichane (Small) Buttonquail		
Kurrichane Thrush		
Lanner Falcon	NT	
Lappet-faced Vulture	VU	
Laughing (Palm) Dove		
Lazy Cisticola		
Lemon (Cinnamon) Dove		
Lemon-breasted Canary	NT	NE
Lesser Crested Tern		
Lesser Flamingo	NT	

English Name	Status	End.
African Goshawk (incl. Red-chested)		
African Green-Pigeon		
African Grey Hornbill		
African Harrier-Hawk (Gymnogene)		
African Hawk Eagle		
African Hoopoe		
African Jacana		
African Marsh-Harrier	VU	
African Olive- (Rameron) Pigeon		
African Palm-Swift		
African Paradise-Flycatcher		
African Pied Wagtail		
African Purple (Purple) Swamphen (Gallinule)		
African Pygmy-Goose	NT	
African Pygmy-Kingfisher		
African Quailfinch		
African Rail		
African Sacred (Sacred) Ibis		
African Scops-Owl		
African Skimmer	EX	
African Spoonbill		
African Wattled Lapwing (Plover)		
African Wood-Owl		
African Yellow White-eye		
Allen's (Lesser) Gallinule		
Alpine Swift		
Amethyst (Black) Sunbird		
Amur (Eastern Red-footed) Falcon (Kestrel)		
Arctic Tern		
Arrow-marked Babbler		
Ashy Flycatcher (Alseonax)		
Baillon's Crake		
Banded Martin		
Barn (European) Swallow		
Barn Owl		
Bar-tailed Godwit		
Bar-throated Apalis		
Bateleur	VU	
Bearded Scrub-Robin		
Bearded Woodpecker		
Black & Yellowbilled Kite (pre-split)		
Black Crake		
Black Cuckoo		
Black Cuckooshrike		
Black Heron		
Black Kite		

English Name	Status	End
Lesser Grey Shrike		
Lesser Honeyguide		
Lesser Jacana	NT	
Lesser Masked Weaver		
Lesser Spotted Eagle		
Lesser Striped-Swallow		
Lesser Swamp- (Cape Reed) Warbler		
Lilac-breasted Roller		
Little Bee-eater		
Little Bittern		
Little Egret		
Little Grebe (Dabchick)		
Little Rush- (African Sedge) Warbler		
Little Sparrowhawk		
Little Stint		
Little Swift		
Little Tern		
Lizard Buzzard		
Long-billed (Cape) Crombec		
Long-crested Eagle		
Long-tailed (Paradise) Paradise-Whydah		
Long-toed Lapwing (Plover)		
Magpie (Long-tailed) Shrike		
Malachite Kingfisher		
Mangrove Kingfisher	VU	
Marabou Stork	NT	
Marico Sunbird		
Marsh (European Marsh) Warbler		
Marsh Owl		
Marsh Sandpiper		
Martial Eagle	VU	
Mocking Cliff-Chat		
Montagu's Harrier		
Mountain (Long-tailed) Wagtail		
Namaqua Dove		
Narina Trogon		
Natal Spurfowl (Francolin)		
Neddicky (Piping Cisticola)		
Neergaard's Sunbird	NT	E
Olive Bush-Shrike		
Olive Sunbird		
Olive Woodpecker		
Olive-tree Warbler		
Orange-breasted (Zebra) Waxbill		
Orange-breasted Bush-Shrike		
Osprey		

English Name	Status	End.
Black Saw-wing		
Black Sparrowhawk (Goshawk)		
Black Stork	NT	
Black Tern		
Black-backed (Southern) Puffback		
Blackbacked Cisticola (pre-split)		
Black-bellied Bustard	NT	
Black-bellied Starling		
Black-chested (Breasted) Snake-Eagle		
Black-collared Barbet		
Black-crowned Night-Heron		
Black-crowned Tchagra		
Black-headed (Eastern) Oriole		
Black-headed Heron		
Blackrumped Buttonquail (pre-split)		
Black-shouldered (Winged) Kite		
Blacksmith Lapwing (Plover)		
Black-throated (Wattle-eyed) Wattle-eye (Flycatcher)NT		
Black-winged Lapwing (Plover)	NT	
Black-winged Stilt		
Bleating Warbler (pre-split)		
Blue Waxbill		
Blue-cheeked Bee-eater		
Blue-mantled Crested-Flycatcher		
Booted Eagle		
Brimstone (Bully) Canary		
Broad-billed Prion		
Broad-billed Roller		
Broad-tailed Warbler	NT	
Bronze Mannikin		
Bronze-winged Courser		
Brown Scrub-Robin		
Brown Snake-Eagle		
Brown-backed (Sharp-billed) Honeybird (Honeyguide)		
Brown-crowned (headed) Tchagra		
Brown-headed Parrot		
Brown-hooded Kingfisher		
Brown-throated (Plain) Martin		
Brubru		
Buff-spotted Flufftail		
Burchell's Coucal (pre-split)		
Burnt-necked Eremomela		
Bushveld Pipit		
Cape (Black) Crow		
Cape (Orange-throated) Longclaw		
Cape Batis		

English Name	Status	End
Ovambo Sparrowhawk		
Pale (Mouse-coloured/Pallid) Flycatcher		
Pale-crowned Cisticola		
Palm-nut Vulture		
Pel's Fishing-Owl	VU	
Peregrine Falcon	NT	
Pied (Avocet) Avocet		
Pied Crow		
Pied Kingfisher		
Pink-backed Pelican	VU	
Pink-throated (Rosy) Twinspot	NT	NE
Pin-tailed Whydah		
Plain-backed Pipit		
Purple (Rufous-crowned) Roller		
Purple Heron		
Purple-banded Sunbird		
Purple-crested Turaco		
Rattling Cisticola		
Red Knot		
Red-backed Mannikin		
Red-backed Shrike		
Red-billed Firefinch		
Redbilled Hornbill (pre-split)		
Red-billed Oxpecker	NT	
Red-billed Quelea		
Red-billed Teal (Duck)		
Red-breasted (Rufous-chested) Swallow		
Red-capped (Natal) Robin-Chat		
Red-chested Cuckoo		
Red-chested Flufftail		
Red-collared Widowbird		
Red-crested Korhaan		
Red-eyed Dove		
Red-faced Cisticola		
Red-faced Mousebird		
Red-fronted Tinkerbird		
Red-headed Quelea		
Red-knobbed Coot		
Red-winged Starling		
Reed (Long-tailed) Cormorant		
Retz's (Red-billed) Helmetshrike		
Rock (Feral) Dove (Pigeon)		
Rock Kestrel		
Rock Martin		
Rose-ringed Parakeet		
Rosy-throated (Pink-throated) Longclaw	NT	

English Name	Status	End.
Cape Cormorant	NT	
Cape Gannet	VU	
Cape Glossy (Glossy) Starling		
Cape Robin-Chat		
Cape Rock-Thrush		
Cape Shoveler		
Cape Teal		
Cape Turtle (Ring-necked) Dove		
Cape Vulture (Griffon)	VU	
Cape Wagtail		
Cape White-eye (pre-split)		
Cardinal Woodpecker		
Caspian Tern	NT	
Cattle Egret		
Chestnut-backed Sparrowlark (Finchlark)		
Chestnut-vented Tit-Babbler		
Chin-spot Batis		
Cinnamon-breasted (Rock) Bunting		
Cloud (Tink-tink) Cisticola		
Collared (Red-winged) Pratincole	NT	
Collared Sunbird		
Comb (Knob-billed) Duck		
Common (Eurasian) Cuckoo		
Common (European) Swift		
Common (Whimbrel) Whimbrel		
Common Fiscal		
Common Greenshank		
Common House-Martin		
Common Moorhen		
Common Myna		
Common Quail		
Common Ringed Plover		
Common Sandpiper		
Common Scimitarbill		
Common Tern		
Common Waxbill		
Coqui Francolin		
Corn Crake	VU	
Crested Barbet		
Crested Francolin		
Crested Guinea-fowl		
Croaking (Striped) Cisticola		
Crowned Hornbill		
Crowned Lapwing (Plover)		
Cuckoo Finch (Parasitic Weaver)		
Curlew Sandpiper		
Dark-backed (Forest) Weaver		

English Name	Status	End
Rudd's Apalis	NT	NE
Ruddy Turnstone		
Ruff		
Rufous-bellied Heron		
Rufous-naped Lark		
Sabota Lark		
Saddle-billed Stork	EN	
Sand Martin (Bank Swallow)		
Sanderling		
Sandwich Tern		
Scaly-throated Honeyguide		
Scarlet-chested Sunbird		
Secretarybird	NT	
Sedge Warbler		
Senegal Lapwing (Plover)		
Shelley's Francolin		
Shikra (Little Banded Goshawk)		
Short-tailed Pipit	VU	
Shy Albatross (pre-split)		
Sombre Greenbul (Bulbul)		
Sooty Falcon		
Southern Banded (Fasciated) Snake-Eagle	VU	
Southern Black Tit		
Southern Black-Flycatcher		
Southern Boubou		
Southern Brown-throated Weaver		
Southern Ground-Hornbill	VU	
Southern Masked-Weaver		
Southern Pochard		
Southern Red (Red) Bishop		
Southern Tchagra		
Southern White-faced (Scops-) Owl		
Southern Yellow-billed Hornbill		
Speckled (Rock) Pigeon		
Speckled Mousebird		
Spectacled Weaver		
Spotted Eagle-Owl		
Spotted Flycatcher		
Spotted Thick-knee (Dikkop)		
Spur-winged Goose		
Squacco Heron		
Square-tailed (Mozambique) Nightjar		
Square-tailed Drongo		
Steppe (Common) Buzzard		
Steppe Eagle		
Stierling's Wren-Warbler		
Streaky-headed Seedeater (Canary)		

English Name	Status	End.
Dark-capped (Black-eyed) Bulbul		
Dark-capped Yellow (Yellow) Warbler		
Denham's (Stanley's) Bustard	VU	
Desert Cisticola		
Dideric (Diederik) Cuckoo		
Dusky Indigobird		
Eastern (Yellow-spotted) Nicator		
Egyptian Goose		
Emerald-spotted Wood-Dove		
Eurasian Golden-Oriole		
Eurasian Hobby		
European Bee-eater		
European Nightjar		
European Roller		
Familiar Chat		
Fan-tailed (Red-shouldered) Widowbird		
Fiery-necked Nightjar		
Fiscal Flycatcher		
Flappet Lark		
Fork-tailed Drongo		
Freckled Nightjar		
Fulvous (Whistling) Duck		
Gabar Goshawk		
Garden Warbler		
Giant Kingfisher		
Glossy Ibis		
Golden-breasted Bunting		
Golden-tailed Woodpecker		
Golden-Weaver		
Goliath Heron		
Gorgeous Bush-Shrike		
Great Crested Grebe		
Great Egret		
Great Frigatebird		
Great Reed-Warbler		
Great Spotted Cuckoo		
Great White Pelican	NT	
Greater Flamingo	NT	
Greater Honeyguide		
Greater Painted-snipe	NT	
Greater Sand Plover		
Green (Red-billed) Wood-hoopoe		
Green Malkoha (Coucal)		
Green Twinspot		
Green-backed (Striated) Heron		
Green-capped Eremomela		

English Name	Status	End
Striped Kingfisher		
Striped Pipit		
Swamp (Natal) Nightjar	VU	
Swee (Black-faced) Waxbill (Swee)		
Swift (Great Crested) Tern		
Tambourine Dove		
Tawny Eagle	VU	
Tawny-flanked Prinia		
Temminck's Courser		
Terek Sandpiper		
Terrestrial Brownbul (Bulbul)		
Thick-billed (Grosbeak) Weaver		
Thick-billed Cuckoo		
Three-banded Plover		
Trumpeter Hornbill		
Village (Spotted-backed) Weaver		
Village Indigobird		
Violet-backed (Plum-coloured, Amethyst) Starling		
Wahlberg's Eagle		
Water Thick-knee (Dikkop)		
Wattled Starling		
Whiskered Tern		
White Stork		
White-backed Duck		
White-backed Night-Heron	VU	
White-backed Vulture	VU	
White-bellied (breasted) Sunbird		
White-breasted (Great) Cormorant		
White-browed (Heuglin's) Robin-Chat		
White-browed (Red-backed) Scrub-Robin		
White-crested Helmet-Shrike		
White-eared Barbet		
White-faced (Whistling-) Duck		
White-fronted Bee-eater		
White-fronted Plover		
White-headed Vulture	VU	
White-necked Raven		
White-rumped Swift		
White-starred (Starred) Robin		
White-throated Robin-Chat		
White-throated Swallow		
White-winged Tern		
White-winged Widowbird		
Willow Warbler		
Wing-snapping (Ayre's) Cisticola		
Wire-tailed Swallow		

English Name	Status	End.
Green-winged (Melba) Pytilia (Finch)		
Grey (African) Penduline-Tit		
Grey (Black-bellied) Plover		
Grey (Black-tailed) Waxbill		
Grey (Mouse-coloured) Sunbird		
Grey Cuckooshrike		
Grey Go-away-bird (Lourie)		
Grey Heron		
Grey Tit-Flycatcher		
Grey Wagtail		
Grey-headed Bush-Shrike		
Grey-headed Gull		
Greyheaded Sparrow (pre-split)		
Grey-rumped Swallow		
Groundscraper Thrush		
Hadedda Ibis		
Half-collared Kingfisher	NT	
Hamerkop		
Helmeted Guineafowl		
Horus Swift		
Hottentot Teal		

English Name	Status	End
Wood Sandpiper		
Woodland Kingfisher		
Woodward's Batis	NT	
Woolly-necked Stork	NT	
Yellow (African Golden) Weaver		
Yellow Wagtail		
Yellow-bellied Eremomela		
Yellow-bellied Greenbul (Bulbul)		
Yellow-billed (Intermediate) Egret		
Yellow-billed Duck		
Yellow-billed Kite		
Yellow-billed Stork	NT	
Yellow-breasted Apalis		
Yellow-fronted (eyed) Canary		
Yellow-rumped (Golden-rumped) Tinkerbird (Tinker Barbe)		
Yellow-rumped (Golden-rumped) Tinkerbird (Tinker Barbet)		
Yellow-streaked Greenbul (Bulbul)		
Yellow-throated Longclaw		
Yellow-throated Petronia (Sparrow)		
Zitting (Fan-tailed) Cisticola		

6.3 Reptiles

Table 5 gives a list of reptile species (102 species) actually recorded for the quarter degree squares covered by the proposed seismic survey lines, as downloaded from the Animal Demographic Unit Virtual Museum for Reptiles (SARCA, 2011).

Table 5: Reptiles recorded for 12 quarter degree squares

Family	Species	Common name	Red list category	Endemic
Agamidae	<i>Acanthocercus atricollis atricollis</i>	Southern Tree Agama	LC	
Amphisbaenidae	<i>Monopeltis sphenorhynchus</i>	Slender Worm Lizard	LC	
	<i>Zygaspis vandami arenicola</i>	Maputaland Dwarf Worm Lizard	NL	
Atractaspididae	<i>Amblyodipsas concolor</i>	Natal Purple-glossed Snake	LC	Yes
	<i>Amblyodipsas microphthalma microphthalma</i>	Eastern Purple-glossed Snake	LC	
	<i>Amblyodipsas polylepis polylepis</i>	Common Purple-glossed Snake	LC	
	<i>Aparallactus capensis</i>	Black-headed Centipede-eater	LC	
	<i>Atractaspis bibronii</i>	Bibron's Stiletto Snake	LC	
	<i>Homoroselaps dorsalis</i>	Striped Harlequin Snake	NT	Yes
	<i>Macrelaps microlepidotus</i>	Natal Black Snake	NT	Yes
	<i>Xenocalamus bicolor lineatus</i>	Striped Quill-snouted Snake	LC	
	<i>Xenocalamus transvaalensis</i>	Speckled Quill-snouted Snake	LC	
Boidae	<i>Python natalensis</i>	Southern African Python	LC	
Chamaeleonidae	<i>Bradypodion setaroi</i>	Setaro's Dwarf Chameleon	LC	
	<i>Chamaeleo dilepis dilepis</i>	Common Flap-neck Chameleon	LC	
Cheloniidae	<i>Caretta caretta</i>	Loggerhead Turtle	V	
	<i>Chelonia mydas</i>	Green Turtle	NT	
	<i>Boaedon capensis</i>	Brown House Snake	LC	
	<i>Crotaphopeltis hotamboeia</i>	Red-lipped Snake	LC	
	<i>Dasypeltis inornata</i>	Southern Brown Egg-eater	LC	Yes
	<i>Dasypeltis medici medici</i>	East African Egg-eater	LC	
	<i>Dasypeltis scabra</i>	Rhombic Egg-eater	LC	
	<i>Dipsadoboa aulica</i>	Marbled Tree Snake	LC	
	<i>Dispholidus typus typus</i>	Boomslang	LC	
	<i>Duberria lutrix lutrix</i>	South African Slug-eater	LC	Yes
	<i>Duberria variegata</i>	Variiegated Slug-eater	LC	
	<i>Gonionotophis capensis capensis</i>	Common File Snake	LC	
	<i>Gonionotophis nyassae</i>	Black File Snake	LC	
	<i>Hemirhagerrhis nototaenia</i>	Eastern Bark Snake	LC	
	<i>Lycodonomorphus obscuriventris</i>	Floodplain Water Snake	LC	
	<i>Lycodonomorphus rufulus</i>	Brown Water Snake	LC	
	<i>Lycophidion capense capense</i>	Cape Wolf Snake	LC	
	<i>Lycophidion pygmaeum</i>	Pygmy Wolf Snake	NT	Yes
	<i>Natriciteres olivacea</i>	Olive Marsh Snake	NA	
	<i>Natriciteres sylvatica</i>	Forest Marsh Snake	LC	
<i>Philothamnus hoplogaster</i>	South Eastern Green Snake	LC		
<i>Philothamnus natalensis natalensis</i>	Eastern Natal Green Snake	LC		
<i>Philothamnus semivariiegatus</i>	Spotted Bush Snake	LC		

Family	Species	Common name	Red list category	Endemic
	<i>Prosymna janii</i>	Mozambique Shovel-snout	LC	
	<i>Prosymna stuhlmannii</i>	East African Shovel-snout	LC	
	<i>Psammophis brevirostris</i>	Short-snouted Grass Snake	LC	
	<i>Psammophis mossambicus</i>	Olive Grass Snake	LC	
	<i>Pseudaspis cana</i>	Mole Snake	LC	
	<i>Telescopus semiannulatus semiamulatus</i>	Eastern Tiger Snake	LC	
	<i>Thelotornis capensis capensis</i>	Southern Twig Snake	LC	
	<i>Cordylus jonesii</i>	Jones' Girdled Lizard	LC	
	<i>Cordylus vittifer</i>	Common Girdled Lizard	LC	
	<i>Platysaurus Lubomboensis</i>	Lubombo Flat Lizard	LC	
	<i>Smaug warreni warreni</i>	Warren's Girdled Lizard	LC	
Crocodylidae	<i>Crocodylus niloticus</i>	Nile Crocodile	V	
Dermochelyidae	<i>Dermochelys coriacea</i>	Leatherback Turtle	E	
Elapidae	<i>Aspidelaps scutatus intermedius</i>	Intermediate Shield Cobra	LC	Yes
	<i>Dendroaspis angusticeps</i>	Green Mamba	V	
	<i>Elapsoidea boulengeri</i>	Boulenger's Garter Snake	LC	
	<i>Elapsoidea sundevallii decosteri</i>	De Coster's Garter Snake	NL	
	<i>Hydrophis platurus</i>	Yellow-bellied Sea Snake	LC	
	<i>Naja melanoleuca</i>	Forest Cobra	LC	
	<i>Naja mossambica</i>	Mozambique Spitting Cobra	LC	
Gekkonidae	<i>Afroedura marleyi</i>	Marley's Flat Gecko	LC	Yes
	<i>Hemidactylus mabouia</i>	Common Tropical House Gecko	LC	
	<i>Homopholis wahlbergii</i>	Wahlberg's Velvet Gecko	LC	
	<i>Lygodactylus capensis capensis</i>	Common Dwarf Gecko	LC	
	<i>Pachydactylus maculatus</i>	Spotted Gecko	LC	
	<i>Pachydactylus vansonii</i>	Van Son's Gecko	LC	
Gerrhosauridae	<i>Gerrhosaurus flavigularis</i>	Yellow-throated Plated Lizard	LC	
	<i>Matobosaurus validus</i>	Common Giant Plated Lizard	LC	
	<i>Tetradactylus africanus</i>	Eastern Long-tailed Seps	LC	Yes
Lacertidae	<i>Ichnotropis capensis</i>	Ornate Rough-scaled Lizard	LC	
	<i>Meroles squamulosus</i>	Common Rough-scaled Lizard	LC	
	<i>Nucras intertexta</i>	Spotted Sandveld Lizard	LC	
	<i>Nucras ornata</i>	Ornate Sandveld Lizard	LC	
Leptotyphlopidae	<i>Leptotyphlops</i>		NL	
	<i>Leptotyphlops incognitus</i>	Incognito Thread Snake	LC	
	<i>Leptotyphlops scutifrons conjunctus</i>	Eastern Thread Snake	NL	
	<i>Leptotyphlops scutifrons scutifrons</i>	Peters' Thread Snake	NL	
	<i>Leptotyphlops sylvicolus</i>	Forest Thread Snake	DD	Yes
Pelomedusidae	<i>Pelusios sinuatus</i>	Serrated Hinged Terrapin	LC	
	<i>Pelusios subniger</i>	Black-bellied Hinged Terrapin	LC	
Scincidae	<i>Acontias aurantiacus aurantiacus</i>	Golden Blind Legless Skink	LC	
	<i>Acontias plumbeus</i>	Giant Legless Skink	LC	
	<i>Afroablepharus wahlbergii</i>	Wahlberg's Snake-eyed Skink	LC	
	<i>Cryptoblepharus boutonii</i>	African Coral Rag Skink	E	
	<i>Scelotes arenicolus</i>	Zululand Dwarf Burrowing Skink	LC	
	<i>Scelotes bidigitatus</i>	Lowveld Dwarf Burrowing Skink	LC	Yes

Family	Species	Common name	Red list category	Endemic
	<i>Scelotes fitzsimonsi</i>	FitzSimons' Dwarf Burrowing Skink	LC	Yes
	<i>Scelotes mossambicus</i>	Mozambique Dwarf Burrowing Skink	LC	
	<i>Scelotes vestigifer</i>	Coastal Dwarf Burrowing Skink	LC	
	<i>Trachylepis depressa</i>	Eastern Coastal Skink	LC	
	<i>Trachylepis margaritifer</i>	Rainbow Skink	LC	
	<i>Trachylepis striata</i>	Striped Skink	LC	
	<i>Trachylepis varia</i>	Variable Skink	LC	
Testudinidae	<i>Kinixys natalensis</i>	Natal Hinged Tortoise	LC	
	<i>Kinixys zombensis</i>	Eastern Hinged Tortoise	LC	
	<i>Stigmochelys pardalis</i>	Leopard Tortoise	LC	
Typhlopidae	<i>Afrotyphlops fornasinii</i>	Fornasini's Dwarf Blind Snake	LC	
	<i>Afrotyphlops schlegelii</i>	Schlegel's Beaked Blind Snake	LC	
Varanidae	<i>Varanus albigularis albigularis</i>	Rock Monitor	LC	
	<i>Varanus niloticus</i>	Water Monitor	LC	
Viperidae	<i>Bitis arietans arietans</i>	Puff Adder	LC	
	<i>Bitis gabonica</i>	Gaboon Adder	NT	
	<i>Causus defilippii</i>	Snouted Night Adder	LC	
	<i>Causus rhombeatus</i>	Rhombic Night Adder	LC	

6.4 Amphibians

The amphibian (frog) species list (49 species) in Table 6, for the quarter degree squares covered by the proposed seismic survey lines, was downloaded from ADU (2011) and the Red Listing and descriptive source for frogs was Minter *et al.* (2004).

Frogs are particularly important as indicator species of ecosystem health, but they are also important because it is clear that amphibian populations are declining throughout the world. These declines have not just been in habitats heavily impacted by humans, but have also occurred in pristine habitats, though in South Africa the declines are not as directly evident as in other parts of the world. There are complex factors involved in this general decline and they include habitat loss or modification, global warming, depletion of the stratospheric ozone, chemical pollution, human appetite for frogs, the pet trade, introduced predators and infectious disease.

In South Africa, habitat destruction is the most important factor. For this reason, any loss of frog habitat is important.

Table 6: Frog species list (49) 12 quarter degree squares

Family	Species	Common name	Red list category	Endemic
Arthroleptidae	<i>Arthroleptis</i>		NL	No
	<i>Arthroleptis stenodactylus</i>	Shovel-footed Squeaker	LC	No
	<i>Arthroleptis wahlbergi</i>	Bush Squeaker	LC	No
	<i>Leptopelis mossambicus</i>	Brownbacked Tree Frog	LC	No
	<i>Leptopelis natalensis</i>	Forest Tree Frog	LC	No
Brevicipitidae	<i>Breviceps</i>		NL	No
	<i>Breviceps adspersus</i>	Bushveld Rain Frog	LC	No
	<i>Breviceps mossambicus</i>	Mozambique Rain Frog	LC	No
	<i>Breviceps sopranus</i>	Whistling Rain Frog	DD	Yes
Bufonidae	<i>Amietophrynus garmani</i>	Olive Toad	LC	No
	<i>Amietophrynus gutturalis</i>	Guttural Toad	LC	No
	<i>Amietophrynus maculatus</i>	Flatbacked Toad	LC	No
	<i>Poyntonophrynus fenoulheti</i>	Northern Pygmy Toad	LC	No
	<i>Schismaderma carens</i>	Red Toad	LC	No
Hemisotidae	<i>Hemisis guttatus</i>	Spotted Shovel-nosed Frog	V	Yes
	<i>Hemisis marmoratus</i>	Mottled Shovenosed Frog	LC	No
Hyperoliidae	<i>Afrivalus aureus</i>	Golden Leaf-folding Frog	LC	No
	<i>Afrivalus delicatus</i>	Delicate Leaf-folding Frog	LC	No
	<i>Afrivalus fornasinii</i>	Greater Leaf-folding Frog	LC	No
	<i>Hyperolius</i>		NL	No
	<i>Hyperolius acuticeps</i>	Sharp-nosed Reed Frog	LC	No
	<i>Hyperolius argus</i>	Argus Reed Frog	LC	No
	<i>Hyperolius marmoratus</i>	Painted Reed Frog	LC	No
	<i>Hyperolius pusillus</i>	Water Lily Frog	LC	No
	<i>Hyperolius tuberilinguis</i>	Tinker Reed Frog	LC	No
	<i>Kassina maculata</i>	Redlegged Kassina	LC	No
<i>Kassina senegalensis</i>	Bubbling Kassina	LC	No	
Microhylidae	<i>Phrynomantis bifasciatus</i>	Banded Rubber Frog	LC	No
Phrynobatrachidae	<i>Phrynobatrachus acridoides</i>	East African Puddle Frog	LC	No
	<i>Phrynobatrachus mababiensis</i>	Dwarf Puddle Frog	LC	No
	<i>Phrynobatrachus natalensis</i>	Snoring Puddle Frog	LC	No
Pipidae	<i>Xenopus laevis</i>	Common Platanna	LC	No
	<i>Xenopus muelleri</i>	Tropical Platanna	LC	No
Ptychadenidae	<i>Hildebrandtia ornata</i>	Ornate Frog	LC	No
	<i>Ptychadena anchietae</i>	Plain Grass Frog	LC	No
	<i>Ptychadena mascareniensis</i>	Mascarene Grass Frog	LC	No
	<i>Ptychadena mossambica</i>	Broadbanded Grass Frog	LC	No
	<i>Ptychadena oxyrhynchus</i>	Sharpnosed Grass Frog	LC	No

	<i>Ptychadena porosissima</i>	Striped Grass Frog	LC	No
	<i>Ptychadena taenioscelis</i>	Dwarf Grass Frog	LC	No
Pyxicephalidae	<i>Amietia queckettii</i>	Queckett's River Frog	LC	Yes
	<i>Cacosternum boettgeri</i>	Common Caco	LC	No
	<i>Cacosternum nanum</i>	Bronze Caco	LC	No
	<i>Pyxicephalus edulis</i>	African Bull Frog	LC	No
	<i>Tomopterna</i>		NL	No
	<i>Tomopterna cryptotis</i>	Tremelo Sand Frog	LC	No
	<i>Tomopterna krugerensis</i>	Knocking Sand Frog	LC	No
	<i>Tomopterna natalensis</i>	Natal Sand Frog	LC	No
Rhacophoridae	<i>Chiromantis xerampelina</i>	Southern Foam Nest Frog	LC	No

6.5 Invertebrates

6.5.1 Butterflies

Butterflies are particularly important in terms of their host plant specificity. There is a direct relationship between the variety of indigenous plant species and the variety of butterfly species. In addition, the fact that butterflies are conspicuous makes them easier to record than other species. Butterflies are among the few groups of animals for which there is relatively complete data and this fulfils many of the criteria used to define “indicator” groups. Indicator groups reflect habitat health and are thus important in conservation assessment. Such groups have been regarded as flagship species. Knowing the needs of butterflies, their distribution and biology, enables us to more accurately assess rarity, vulnerability to changes and suchlike. In addition, the fact that butterflies, as a group, are rich in species, as opposed to many vertebrate groups of animals, makes butterflies more easily usable and valuable for assessment of habitat health.

The butterfly list (Table 7), as downloaded from the Animal Demography Unit Virtual Museum (VMU, 2011) for the quarter degree squares covered by the proposed seismic survey lines, gives a total of 320 species.

Following Table 7 is a brief summary of the butterfly species (320 species) that have been recorded for the Maputaland quarter degree squares. It will be noticed that most of the species on the list are quite widespread and there are 15 regional endemics, namely *Alaena amazoula amazoula* (Yellow Zulu), *Aloeides swanepoelii* (Swanepoel's Copper), *Amauris echeria echeria* (Chief, Chief Friar), *Cassionympha cassius* (Rainforest Brown), *Coeliades keithloa* (Red-tab Policeman), *Colotis erone* (Coast Purple Tip), *Eretis umbra umbra* (Small Marbled Elf), *Iolous diametra natalica* (Natal Yellow-banded Sapphire), *Iolous lulua* (White Spotted Sapphire), *Leptomyrina gorgias gorgias* (Common Black-eye), *Ornipholidotos peucetia penningtoni* (Large Glasswing), *Pentila tropicalis tropicalis* (Spotted Pentila), *Pseudacraea lucretia tarquinea* (False Chief), *Sarangesa seineri durbana* (Dark Elfin) and *Teriomima zuluana* (Zulu Buff).

Table 7: Butterfly species list (320 Species) for 12 quarter degree squares

Family	Species	Common name	RDB	Endemic
Arctiidae	<i>Euchromia formosa formosa</i>		NE	
	<i>Nyctemera seychellensis seychellensis</i>		NE	
Hesperiidae	<i>Abantis paradisea</i>	Paradise Skipper	LC	
	<i>Abantis tettensis</i>	Spotted Velvet Skipper	LC	
	<i>Abantis venosa</i>	Veined Skipper	LC	
	<i>Acleros mackenii mackenii</i>	Macken's Dart	LC	
	<i>Andronymus caesar philander</i>	White Dart	NE	
	<i>Andronymus neander neander</i>	Common Dart	LC	
	<i>Artitropa erinnys erinnys</i>	Bush Night-Fighter	LC	
	<i>Borbo</i>		NL	
	<i>Borbo borbonica borbonica</i>	Olive-Haired Swift	LC	
	<i>Borbo detecta</i>	Rusty Swift	LC	
	<i>Borbo fallax</i>	False Swift	LC	
	<i>Borbo fatuellus fatuellus</i>	Long-Horned Swift	LC	
	<i>Borbo ferruginea dondo</i>	Ferrous Swift	DD	
	<i>Borbo gemella</i>	Twin Swift	LC	
	<i>Borbo holtzi</i>	Variable Swift	LC	
	<i>Borbo lugens</i>	Lesser-Horned Swift	LC	
	<i>Borbo micans</i>	Marsh Swift	LC	
	<i>Caprona pillaana</i>	Ragged Skipper	LC	
	<i>Celaenorrhinus mokeezi separata</i>	Christmas Forester	LC	
	<i>Coeliades forestan forestan</i>	Striped Policeman	LC	
	<i>Coeliades keithloa</i>	Red-Tab Policeman	LC	Yes
	<i>Coeliades libeon</i>	Spotless Policeman	DD	
	<i>Coeliades lorenzo</i>	Coastal Red-Tab Policeman	DD	
	<i>Coeliades pisistratus</i>	Two-Pip Policeman	LC	
	<i>Eagris nottoana nottoana</i>	Rufous-Winged Elfin	LC	
	<i>Eretis djaelaelae</i>	Marbled Elf	LC	
	<i>Eretis umbra umbra</i>	Small Marbled Elf	LC	Yes
	<i>Fresna nyassae</i>	Variegated Acraea Hopper	DD	
	<i>Gegenes hottentota</i>	Marsh Hottentot Skipper	LC	
	<i>Gegenes niso niso</i>	Common Hottentot	LC	
	<i>Gegenes pumilio gambica</i>	Dark Hottentot	LC	
	<i>Gomalia elma elma</i>	Green-Marbled Skipper	LC	
<i>Kedestes callicles</i>	Pale Ranger	LC		
<i>Kedestes macomo</i>	Macomo Ranger	LC		
<i>Kedestes mohozutza</i>	Fulvous Ranger	LC		
<i>Kedestes wallengrenii wallengrenii</i>	Wallengren's Ranger	LC		

Family	Species	Common name	RDB	Endemic
	<i>Leucochitonea levubu</i>	White-Cloaked Skipper	LC	
	<i>Metisella orientalis</i>	Eastern Sylph	NL	
	<i>Moltena fiara</i>	Strelitzia Night-Fighter	LC	
	<i>Netrobalane canopus</i>	Buff-Tipped Skipper	LC	
	<i>Parnara monasi</i>	Water Watchman	LC	
	<i>Parosmodes morantii morantii</i>	Morant's Orange	LC	
	<i>Pelopidas</i>		NL	
	<i>Pelopidas mathias</i>	Black-Banded Swift	LC	
	<i>Pelopidas thrax</i>	White-Banded Swift	LC	
	<i>Platylesches</i>		NL	
	<i>Platylesches ayresii</i>	Peppered Hopper	LC	
	<i>Platylesches moritili</i>	Honey Hopper	LC	
	<i>Platylesches neba</i>	Flower-Girl Hopper	LC	
	<i>Pyrrhiades anchises anchises</i>	One-Pip Policeman	DD	
	<i>Sarangesa motozi</i>	Elfin Skipper	LC	
	<i>Sarangesa phidyle</i>	Small Elfin	LC	
	<i>Sarangesa seineri durbana</i>	Dark Elfin	LC	Yes
	<i>Spialia colotes transvaaliae</i>	Bushveld Sandman	LC	
	<i>Spialia confusa confusa</i>	Confusing Sandman	LC	
	<i>Spialia delagoae</i>	Delagoa Sandman	LC	
	<i>Spialia depauperata australis</i>	Wandering Sandman	LC	
	<i>Spialia diomus ferax</i>	Common Sandman	LC	
	<i>Spialia dromus</i>	Forest Sandman	LC	
	<i>Spialia spio</i>	Mountain Sandman	LC	
<i>Tagiades flesus</i>	Clouded Forester	LC		
<i>Tsitana tsita</i>	Dismal Sylph	LC		
<i>Zophopetes dysmephila</i>	Palm-Tree Night-Fighter	LC		
Lycaenidae	<i>Actizera lucida</i>	Rayed Blue	LC	
	<i>Alaena amazoula amazoula</i>	Yellow Zulu	LC	Yes
	<i>Aloeides aranda</i>	Aranda Copper	LC	
	<i>Aloeides damarensis mashona</i>	Damara Copper	LC	
	<i>Aloeides swanepoeli</i>	Swanepoel's Copper	LC	Yes
	<i>Aloeides taikosama</i>	Dusky Copper	LC	
	<i>Aloeides trimeni trimeni</i>	Trimen's Copper	LC	
	<i>Anthene amarah amarah</i>	Black Striped Hairtail	LC	
	<i>Anthene dulcis dulcis</i>	Mashuna Hairtail	LC	
	<i>Anthene larydas</i>	Spotted Hairtail	NL	
	<i>Anthene lemnos lemnos</i>	Large Hairtail	LC	
	<i>Anthene liodes bihe</i>	Liodes Hairtail	LC	
<i>Anthene livida livida</i>	Pale Hairtail	LC		

Family	Species	Common name	RDB	Endemic
	<i>Anthene millari</i>	Millar's Hairtail	LC	
	<i>Anthene princeps</i>	Lubombo Hairtail	LC	
	<i>Axiocerses amanga amanga</i>	Bush Scarlet	LC	
	<i>Axiocerses coalescens</i>	Black-Tipped Scarlet	LC	
	<i>Axiocerses tjoane tjoane</i>	Eastern Scarlet	LC	
	<i>Azanus jesous</i>	Topaz Babul Blue	LC	
	<i>Azanus mirza</i>	Pale Babul Blue	LC	
	<i>Azanus moriqua</i>	Black-Bordered Babul Blue	LC	
	<i>Azanus natalensis</i>	Natal Babul Blue	LC	
	<i>Azanus ubaldus</i>	Velvet-Spotted Babul Blue	LC	
	<i>Baliochila</i>		NL	
	<i>Baliochila aslanga</i>	Natal Buff	LC	
	<i>Baliochila lipara</i>	Lipara Buff	LC	
	<i>Cacyreus lingeus</i>	Bush Bronze	LC	
	<i>Cacyreus marshalli</i>	Common Geranium Bronze	LC	
	<i>Cacyreus virilis</i>	Mocker Bronze	LC	
	<i>Chilades trochylus</i>	Grass Jewel	LC	
	<i>Chloroselas mazoensis</i>	Purple Gem	NE	
	<i>Chloroselas pseudozeritis pseudozeritis</i>	Brilliant Gem	LC	
	<i>Cigaritis apelles</i>	Rusty Bar	NL	
	<i>Cigaritis ella</i>	Ella's Bar	LC	
	<i>Cigaritis mozambica</i>	Mozambique Bar	LC	
	<i>Cigaritis natalensis</i>	Natal Bar	LC	
	<i>Cigaritis phanes</i>	Silvery Bar	LC	
	<i>Cnodontes penningtoni</i>	Pennington's Buff	LC	
	<i>Crudaria leroma</i>	Silver Spotted Grey	LC	
	<i>Cupidopsis cissus cissus</i>	Common Meadow Blue	LC	
	<i>Cupidopsis jobates jobates</i>	Tailed Meadow Blue	LC	
	<i>Deloneura millari millari</i>	Millar's Buff	NL	
	<i>Eicochrysops hippocrates</i>	White-Tipped Blue	LC	
	<i>Eicochrysops messapus mahallakoaena</i>	Cupreous Blue	LC	
	<i>Euchrysops barkeri</i>	Barker's Smoky Blue	LC	
	<i>Euchrysops dolorosa</i>	Sabie Smoky Blue	LC	
	<i>Euchrysops malathana</i>	Common Smoky Blue	LC	
	<i>Euchrysops osiris</i>	Osiris Smoky Blue	LC	
	<i>Euchrysops subpallida</i>	Ashen Smoky Blue	LC	
	<i>Hemiolaus caeculus caeculus</i>	Azure Hairstreak	LC	
	<i>Hypolycaena buxtoni buxtoni</i>	Buxton's Hairstreak	LC	
	<i>Hypolycaena lochmophila</i>	Coastal Hairstreak	LC	

Family	Species	Common name	RDB	Endemic
	<i>Hypolycaena philippus philippus</i>	Purplebrown Hairstreak	LC	
	<i>Iolaus alienus alienus</i>	Brown-Line Sapphire	LC	
	<i>Iolaus diametra natalica</i>	Natal Yellow-Banded Sapphire	LC	Yes
	<i>Iolaus lulua</i>	White Spotted Sapphire	NT	Yes
	<i>Iolaus mimosae rhodosense</i>	Mimosa Sapphire	LC	
	<i>Iolaus pallene</i>	Saffron Sapphire	LC	
	<i>Iolaus sidus</i>	Red-Line Sapphire	LC	
	<i>Iolaus silarus silarus</i>	Straight-Line Sapphire	LC	
	<i>Iolaus trimeni</i>	Trimen's Sapphire	LC	
	<i>Lachnocnema</i>		NL	
	<i>Lachnocnema bibulus</i>	Common Woolly Legs	LC	
	<i>Lachnocnema durbani</i>	D'Urban's Woolly Legs	LC	
	<i>Lachnocnema laches</i>	Southern Pied Woolly Legs	LC	
	<i>Lampides boeticus</i>	Pea Blue	LC	
	<i>Lepidochrysops glauca</i>	Silvery Blue	LC	
	<i>Lepidochrysops patricia</i>	Patricia Blue	LC	
	<i>Lepidochrysops plebeia plebeia</i>	Twin-Spot Blue	LC	
	<i>Leptomyrina gorgias gorgias</i>	Common Black-Eye	LC	Yes
	<i>Leptomyrina hirundo</i>	Tailed Black-Eye	LC	
	<i>Leptotes</i>		NL	
	<i>Leptotes babaulti</i>	Babault's Zebra Blue	LC	
	<i>Leptotes brevidentatus</i>	Short-Toothed Zebra Blue	LC	
	<i>Leptotes jeanneli</i>	Jeannel's Zebra Blue	LC	
	<i>Leptotes pirithous pirithous</i>	Common Zebra Blue	LC	
	<i>Leptotes pulchra pulchra</i>	Sesbania Blue	LC	
	<i>Myrina dermaptera dermaptera</i>	Lesser Fig Tree Blue	LC	
	<i>Myrina silenus ficedula</i>	Common Fig Tree Blue	LC	
	<i>Oraidium barberae</i>	Dwarf Blue	LC	
	<i>Ornipholidotos peucetia penningtoni</i>	Large Glasswing	LC	Yes
	<i>Ornipholidotos peucetia peucetia</i>	Large Glasswing	NL	
	<i>Pentila tropicalis tropicalis</i>	Spotted Pentila	LC	Yes
	<i>Pseudonacaduba sichela sichela</i>	Dusky Line Blue	LC	
	<i>Stugeta bowkeri tearei</i>	Bowker's Marbled Sapphire	LC	
	<i>Tarucus sybaris sybaris</i>	Dotted Blue	LC	
	<i>Teriomima puellaris</i>	Two Dotted Buff	NL	
	<i>Teriomima zuluana</i>	Zulu Buff	LC	Yes
	<i>Tuxentius calice</i>	White Pie	LC	
	<i>Tuxentius melaena melaena</i>	Black Pie	LC	
	<i>Virachola antalus</i>	Brown Playboy	LC	

Family	Species	Common name	RDB	Endemic
	<i>Virachola dariaves</i>	Black-And-Orange Playboy	LC	
	<i>Virachola dinochares</i>	Apricot Playboy	LC	
	<i>Virachola dinomenes dinomenes</i>	Orange Playboy	LC	
	<i>Virachola diocles</i>	Orange-Barred Playboy	LC	
	<i>Virachola vansoni</i>	Van Son's Playboy	LC	
	<i>Zintha hintza hintza</i>	Hintza Pierrot	LC	
	<i>Zizeeria knysna knysna</i>	African Grass Blue	LC	
	<i>Zizina otis antanossa</i>	Dark Grass Blue	LC	
	<i>Zizula hylax</i>	Tiny Grass Blue	LC	
Noctuidae	<i>Egybolis vaillantina vaillantina</i>		NE	
Nymphalidae	<i>Acraea acara acara</i>	Acara Acraea	LC	
	<i>Acraea acrita acrita</i>	Fiery Acraea	LC	
	<i>Acraea aganice aganice</i>	Wanderer	LC	
	<i>Acraea aglaonice</i>	Clear-Spotted Acraea	LC	
	<i>Acraea anemosa</i>	Broad-Bordered Acraea	LC	
	<i>Acraea axina</i>	Little Acraea	LC	
	<i>Acraea boopis boopis</i>	Rainforest Acraea	LC	
	<i>Acraea caldarena caldarena</i>	Black-Tipped Acraea	LC	
	<i>Acraea lygus</i>	Lygus Acraea	LC	
	<i>Acraea machequena</i>	Machequena Acraea	LC	
	<i>Acraea natalica</i>	Natal Acraea	LC	
	<i>Acraea neobule neobule</i>	Wandering Donkey Acraea	LC	
	<i>Acraea oncaea</i>	Window Acraea	LC	
	<i>Acraea petraea</i>	Blood-Red Acraea	LC	
	<i>Acraea rabbaiae perlucida</i>	Clear-Wing Acraea	LC	
	<i>Acraea rabbaiae rabbaiae</i>	Clear-Wing Acraea	NL	
	<i>Acraea satis</i>	East-Coast Acraea	LC	
	<i>Acraea violarum</i>	Speckled Red Acraea	LC	
	<i>Amauris albimaculata albimaculata</i>	Layman; Layman Friar	LC	
	<i>Amauris echeria echeria</i>	Chief, Chief Friar	LC	Yes
	<i>Amauris niavius dominicanus</i>	Friar, Common Friar	LC	
	<i>Amauris ochlea ochlea</i>	Novice, Novice Friar	LC	
	<i>Bicyclus anynana anynana</i>	Squinting Bush Brown	LC	
	<i>Bicyclus ena</i>	Grizzled Bush Brown	LC	
	<i>Bicyclus safitza safitza</i>	Common Bush Brown	LC	
	<i>Byblia</i>		NL	
<i>Byblia anvatara acheloia</i>	Joker	LC		
<i>Byblia ilithyia</i>	Spotted Joker	LC		
<i>Cassionympha cassius</i>	Rainforest Brown	LC	Yes	

Family	Species	Common name	RDB	Endemic
	<i>Catacroptera cloanthe cloanthe</i>	Pirate	LC	
	<i>Charaxes achaemenes achaemenes</i>	Bushveld Charaxes	LC	
	<i>Charaxes brutus natalensis</i>	White-Barred Charaxes	LC	
	<i>Charaxes candiope</i>	Green-Veined Charaxes	LC	
	<i>Charaxes castor flavifasciatus</i>	Giant Charaxes	LC	
	<i>Charaxes cithaeron cithaeron</i>	Blue-Spotted Charaxes	LC	
	<i>Charaxes etesipe tavetensis</i>	Scarce Forest Charaxes	LC	
	<i>Charaxes ethalion ethalion</i>	Coast Charaxes	LC	
	<i>Charaxes jahlunga argynnides</i>	Pearl-Spotted Charaxes	LC	
	<i>Charaxes jasius saturnus</i>	Foxy Charaxes	LC	
	<i>Charaxes phaeus</i>	Demon Charaxes	LC	
	<i>Charaxes protoctea azota</i>	Flame-Bordered Charaxes	LC	
	<i>Charaxes vansoni</i>	Van Son's Charaxes	LC	
	<i>Charaxes varanes varanes</i>	Pearl Charaxes	LC	
	<i>Charaxes varanes vologeses</i>	Pearl Charaxes	NL	
	<i>Charaxes wakefieldi</i>	Forest Queen	LC	
	<i>Charaxes zoolina</i>	Club-Tailed Charaxes	LC	
	<i>Coenyra hebe</i>	Zulu Shade-fly	LC	
	<i>Danaus chrysippus orientis</i>	African Monarch, Plain Tiger	LC	
	<i>Euphaedra neophron neophron</i>	Gold-Banded Forester	LC	
	<i>Euryphura achlys</i>	Mottled-Green Nymph	LC	
	<i>Eurytela dryope angulata</i>	Golden Piper	LC	
	<i>Eurytela hiarbas angustata</i>	Pied Piper	LC	
	<i>Gnophodes betsimena diversa</i>	Yellow-Banded Evening Brown	LC	
	<i>Hamanumida daedalus</i>	Guinea-Fowl Butterfly	LC	
	<i>Heteropsis perspicua perspicua</i>	Eyed Bush Brown	LC	
	<i>Hypolimnas anthedon wahlbergi</i>	Variable Diadem	LC	
	<i>Hypolimnas deceptor deceptor</i>	Deceptive Diadem	LC	
	<i>Hypolimnas misippus</i>	Common Diadem	LC	
	<i>Junonia hierta cebrene</i>	Yellow Pansy	LC	
	<i>Junonia natalica natalica</i>	Brown Commodore	LC	
	<i>Junonia oenone oenone</i>	Blue Pansy	LC	
	<i>Junonia orithya madagascariensis</i>	Eyed Pansy	LC	
	<i>Junonia terea elgiva</i>	Soldier Pansy	LC	
	<i>Lachnoptera ayresii</i>	Blotched Leopard	LC	
	<i>Libythea labdaca laius</i>		NL	
	<i>Melanitis leda</i>	Twilight Brown	LC	
	<i>Neptis goochii</i>	Streaked Sailer	LC	
	<i>Neptis jordani</i>	Jordan's Sailer	LC	
	<i>Neptis kiriakoffi</i>	Kiriakoff's Sailer	LC	

Family	Species	Common name	RDB	Endemic
	<i>Neptis laeta</i>	Common Barred Sailer	LC	
	<i>Neptis penningtoni</i>	Pennington's Sailer	NL	
	<i>Neptis saclava marpessa</i>	Spotted Sailer	LC	
	<i>Neptis serena serena</i>	Serene Sailer	NL	
	<i>Pardopsis punctatissima</i>	Polka Dot	LC	
	<i>Phalanta eurytis eurytis</i>	Forest Leopard	LC	
	<i>Phalanta phalantha aethiopica</i>	African Leopard	LC	
	<i>Physcaeneura panda</i>	Dark-Webbed Ringlet	LC	
	<i>Precis antilope</i>	Darker Commodore	LC	
	<i>Precis archesia archesia</i>	Garden Commodore	LC	
	<i>Precis ceryne ceryne</i>	Marsh Commodore	LC	
	<i>Precis octavia sesamus</i>	Gaudy Commodore	LC	
	<i>Protogoniomorpha anacardii nebulosa</i>	Clouded Mother-Of-Pearl	LC	
	<i>Protogoniomorpha parhassus</i>	Mother-Of-Pearl	LC	
	<i>Pseudacraea boisduvalii trimenii</i>	Trimen's False Acraea	LC	
	<i>Pseudacraea lucretia tarquinea</i>	False Chief	LC	Yes
	<i>Sevenia</i>		NL	
	<i>Sevenia boisduvali boisduvali</i>	Boisduval's Tree Nymph	LC	
	<i>Sevenia morantii</i>	Morant's Tree Nymph	LC	
	<i>Sevenia natalensis</i>	Natal Tree-Nymph	LC	
	<i>Telchinia cabira</i>	Yellow-Banded Acraea	LC	
	<i>Telchinia encedon encedon</i>	White-Barred Acraea	LC	
	<i>Telchinia esebria</i>	Dusky Acraea	LC	
	<i>Telchinia igola</i>	Dusky-Veined Acraea	LC	
	<i>Telchinia rahira rahira</i>	Marsh Acraea	LC	
	<i>Telchinia serena</i>	Dancing Acraea	LC	
	<i>Vanessa cardui</i>	Painted Lady	LC	
	<i>Ypthima</i>		NL	
	<i>Ypthima asterope asterope</i>	African Ringlet	LC	
	<i>Ypthima granulosa</i>	Granular Ringlet	DD	
<i>Ypthima impura paupera</i>	Impure Ringlet	LC		
Papilionidae	<i>Graphium angolanus angolanus</i>	Angola White-Lady Swordtail	LC	
	<i>Graphium antheus</i>	Large Striped Swordtail	LC	
	<i>Graphium colonna</i>	Mamba Swordtail	LC	
	<i>Graphium leonidas leonidas</i>	Veined Swordtail	LC	
	<i>Graphium morania</i>	White Lady	LC	
	<i>Graphium policenes policenes</i>	Small Striped Swordtail	LC	
	<i>Graphium porthaon porthaon</i>	Cream Striped Swordtail	LC	
	<i>Papilio constantinus constantinus</i>	Constantine's Swallowtail	LC	

Family	Species	Common name	RDB	Endemic
	<i>Papilio dardanus cenea</i>	Mocker Swallowtail, Flying Handkerchief	LC	
	<i>Papilio demodocus demodocus</i>	Citrus Swallowtail	LC	
	<i>Papilio nireus lyaeus</i>	Green-Banded Swallowtail	LC	
Pieridae	<i>Afrodryas leda</i>	Autumn Leaf Vagrant	LC	
	<i>Appias epaphia contracta</i>	Diverse Albatross White	LC	
	<i>Appias sabina phoebe</i>	Sabine Albatross White	LC	
	<i>Belenois aurota</i>	Brown-Veined White	LC	
	<i>Belenois creona severina</i>	African Common White	LC	
	<i>Belenois gidica abyssinica</i>	African Veined White	LC	
	<i>Belenois thysa thysa</i>	False Dotted Border	LC	
	<i>Belenois zochalia zochalia</i>	Forest White	LC	
	<i>Catopsilia florella</i>	African Migrant	LC	
	<i>Colotis</i>		NL	
	<i>Colotis annae annae</i>	Scarlet Tip	LC	
	<i>Colotis antevippe gavis</i>	Red Tip	LC	
	<i>Colotis auxo auxo</i>	Sulphur Orange Tip	LC	
	<i>Colotis calais calais</i>	Topaz Arab	LC	
	<i>Colotis celimene amina</i>	Lilac Tip	NL	
	<i>Colotis erone</i>	Coast Purple Tip	LC	Yes
	<i>Colotis euipe mediata</i>	Smoky Orange Tip	NL	
	<i>Colotis euipe omphale</i>	Smoky Orange Tip	LC	
	<i>Colotis evagore antigone</i>	Small Orange Tip	LC	
	<i>Colotis evenina evenina</i>	Orange Tip	LC	
	<i>Colotis ione</i>	Bushveld Purple Tip	LC	
	<i>Colotis pallene</i>	Bushveld Orange Tip	LC	
	<i>Colotis regina</i>	Queen Purple Tip	LC	
	<i>Colotis vesta argillaceus</i>	Veined Tip	LC	
	<i>Dixeia charina charina</i>	African Small White	LC	
	<i>Dixeia doxo parva</i>	Black-Veined Small White	LC	
	<i>Dixeia pigea</i>	Ant-Heap White	LC	
	<i>Dixeia spilleri</i>	Sulphur Small White	LC	
	<i>Eronia cleodora</i>	Vine-Leaf Vagrant	LC	
	<i>Eurema</i>		NL	
	<i>Eurema brigitta brigitta</i>	Broad-Bordered Grass Yellow	LC	
	<i>Eurema desjardinsii regularis</i>	Angled Grass Yellow	LC	
<i>Eurema hecabe solifera</i>	Lowveld Yellow	LC		
<i>Leptosia alcesta inalcesta</i>	African Wood White	LC		
<i>Mylothris agathina agathina</i>	Common Dotted Border	LC		
<i>Mylothris rueppellii haemus</i>	Twin Dotted Border	LC		

Family	Species	Common name	RDB	Endemic
	<i>Nepheronia argia mhondana</i>	Large Vagrant	NL	
	<i>Nepheronia argia variegata</i>	Large Vagrant	LC	
	<i>Nepheronia buquetii buquetii</i>	Buquet's Vagrant	LC	
	<i>Nepheronia thalassina sinalata</i>	Cambridge Vagrant	LC	
	<i>Pinacopteryx eriphia eriphia</i>	Zebra White	LC	
	<i>Teracolus eris eris</i>	Banded Gold Tip	LC	
	<i>Teracolus subfasciatus</i>	Lemon Traveller	LC	

6.5.2 Dragonflies

The Dragonfly list (Table 8), as downloaded from the Animal Demography Unit Virtual Museum (VMU, 2011) for the quarter degree squares covered by the proposed seismic survey lines, gives a total of 46 species.

Table 8: Dragonfly species list (46 species) for 12 quarter degree squares

Family	Species	Common name	RDB	Endemic
Aeshnidae	<i>Anax ephippiger</i>	Vagrant Emperor	NL	No
	<i>Anax imperator</i>	Blue Emperor	NL	No
	<i>Anax tristis</i>	Black Emperor	NL	No
	<i>Gynacantha usambaricus</i>	Usambara Dusk-Hawker	NL	No
Calopterygidae	<i>Phaon iridipennis</i>	Glistening Demoiselle	NL	No
Chlorocyphidae	<i>Platycypha caligata</i>	Dancing Jewel	NL	No
Coenagrionidae		Unidentified Coenagrionidae	NL	No
	<i>Agriocnemis exilis</i>	Little Whisp	NL	No
	<i>Agriocnemis gratiosa</i>	Gracious Whisp	NL	No
	<i>Azuragrion nigradorsum</i>	Black-Tailed Bluet	NL	No
	<i>Ceriagrion</i>		NL	No
	<i>Ceriagrion glabrum</i>	Common Citril	NL	No
	<i>Ischnura senegalensis</i>	African Bluetail	NL	No
	<i>Pseudagrion coeleste</i>	Catshead Sprite	NL	No
	<i>Pseudagrion hageni tropicanum</i>	Hagen's Sprite (sub sp. tropicanum)	NL	No
	<i>Pseudagrion hamoni</i>	Hamon's Sprite	NL	No
	<i>Pseudagrion kersteni</i>	Kersten's Sprite	NL	No
	<i>Pseudagrion massaicum</i>	Masai Sprite	NL	No
Corduliidae	<i>Phyllomacromia contumax</i>	Two-Banded Cruiser	NL	No
Gomphidae	<i>ICTINOGOMPHUS ferox</i>	Common Tigertail	NL	No
Lestidae	<i>Lestes tridens</i>	Spotted Spreadwing	NL	No
Libellulidae	<i>Brachythemis leucosticta</i>	Banded Groundling	NL	No
	<i>Chalcostephia flavifrons</i>	Inspector	NL	No

<i>Crocothemis erythraea</i>	Broad Scarlet	NL	No
<i>Diplacodes</i>		NL	No
<i>Diplacodes lefebvrei</i>	Black Percher	NL	No
<i>Diplacodes pumila</i>	Dwarf Percher	NL	No
<i>Hemistigma albipuncta</i>	Pied-Spot	NL	No
<i>Nesciothemis farinosa</i>	Black-Tailed Skimmer	NL	No
<i>Orthetrum hintzi</i>	Hintz's Skimmer	NL	No
<i>Orthetrum julia falsum</i>	Julia Skimmer (subsp. falsum)	NL	No
<i>Orthetrum stemmale</i>	Strong Skimmer	NL	No
<i>Orthetrum trinacria</i>	Long Skimmer	NL	No
<i>Palpopleura lucia</i>	Lucia Widow	NL	No
<i>Palpopleura portia</i>	Portia Widow	NL	No
<i>Pantala flavescens</i>	Pantala	NL	No
<i>Parazyxomma flavicans</i>	Banded Dusk-Darter	NL	No
<i>Rhyothemis semihyalina</i>	Phantom Flutterer	NL	No
<i>Tramea basilaris</i>	Keyhole Glider	NL	No
<i>Tramea limbata</i>	Ferruginous Glider	NL	No
<i>Trithemis</i>		NL	No
<i>Trithemis annulata</i>	Violet Dropwing	NL	No
<i>Trithemis arteriosa</i>	Red-Veined Dropwing	NL	No
<i>Trithemis stictica</i>	Jaunty Dropwing	NL	No
<i>Urothemis assignata</i>	Red Basker	NL	No
<i>Urothemis edwardsii</i>	Blue Basker	NL	No

6.5.3 Other Invertebrates

The KZN Minset coverage includes another 668 invertebrate species including many species of earthworms, ticks, spiders, scorpions, solifuges, millipedes, coackroaches, beetles, weevils, fruit chafers, robberflies, flies, bees, mosquitoes, cicadas, wasps, sawflies, antlins, grasshoppers, crickets, katydids and snails.

7 DISCUSSION AND RECOMMENDATIONS

This report, which gives an overview of the regional vegetation, wildlife and ecology is, of necessity, not a detailed or site-specific report because the actual drilling sites have not yet been identified. Nevertheless, it has been established that the drilling sites will be on or adjacent to existing roads and tracks, which are mapped in Appendix 1 (Maps 1 to 4), and the sensitivity of those areas can therefore be established, with a reasonable degree of certainty.

The region within which the proposed seismic survey lines are located is enclosed by 12 quarter degree squares within Maputaland in northern KwaZulu-Natal. This area has high levels of species richness and endemism, which makes its conservation value internationally recognised. The ecological zones within the area that will be affected will be, from west to east, the Cretaceous, the Alluvial and the Coastal Plane. The Lubombo Mountains in the east and the Coastal Dunes in the east will not be affected.

The proposed seismic surveys and test drilling will be extremely short-term activities, with no long-term or cumulative effects anticipated. The nature of the proposed seismic survey, along a grid of existing main and district roads and established plantation roads and tracks, will limit the extent of potential environmental damage.

Nevertheless precautions to be taken include the following:

1. Drilling rigs and other plant must stay on existing roads and track at all times. If any big machinery needs to be turned on a road, an opportunity should be awaited to turn in an existing hardened area, so as to avoid disturbing vegetation.
2. Staff involved in the drilling and seismic surveys should be given environmental orientation prior to commencing work and this should include.
 - a. Caution against littering or discarding waste into the veld.
 - b. Warnings of severe penalties if they set snares or attempt to hunt animals or harvest *muthi* plants.
 - c. Guidelines on how to react when confronted by snakes, so that unnecessary killing of snakes does not take place.
 - d. Knowledge of precautions to be taken to avoid pollution of boreholes.
3. Particular care should be taken that boreholes are adequately capped after drilling so that groundwater cannot be contaminated.
4. As far as possible, drilling should keep clear of “Irreplaceable” Critical Biodiversity Areas south west of Ndumo Game Reserve.

Prior to the actual drilling of individual boreholes, an assessment of each site should be made by a biodiversity expert.

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9 APPENDICES

Appendix 1: Maps

Appendix 2: Photos

Appendix 1:

Maps

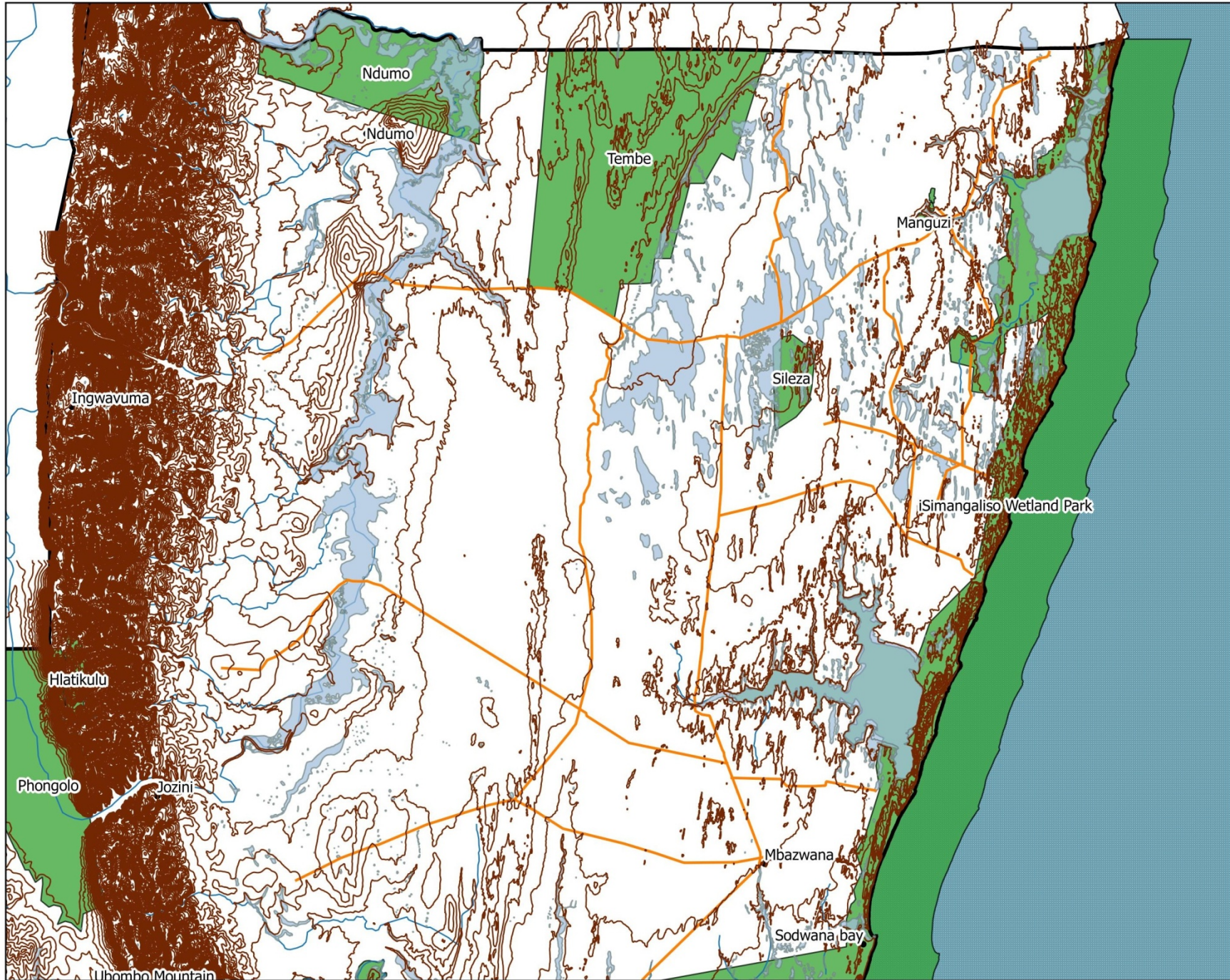
Map 1: Maputaland Proposed Seismic Lines in relation to Protected Areas

Map 2: Maputaland Proposed Seismic Survey Lines on Vegetation Communities

Map 3: Maputaland Proposed Seismic Survey Lines on Infrastructure

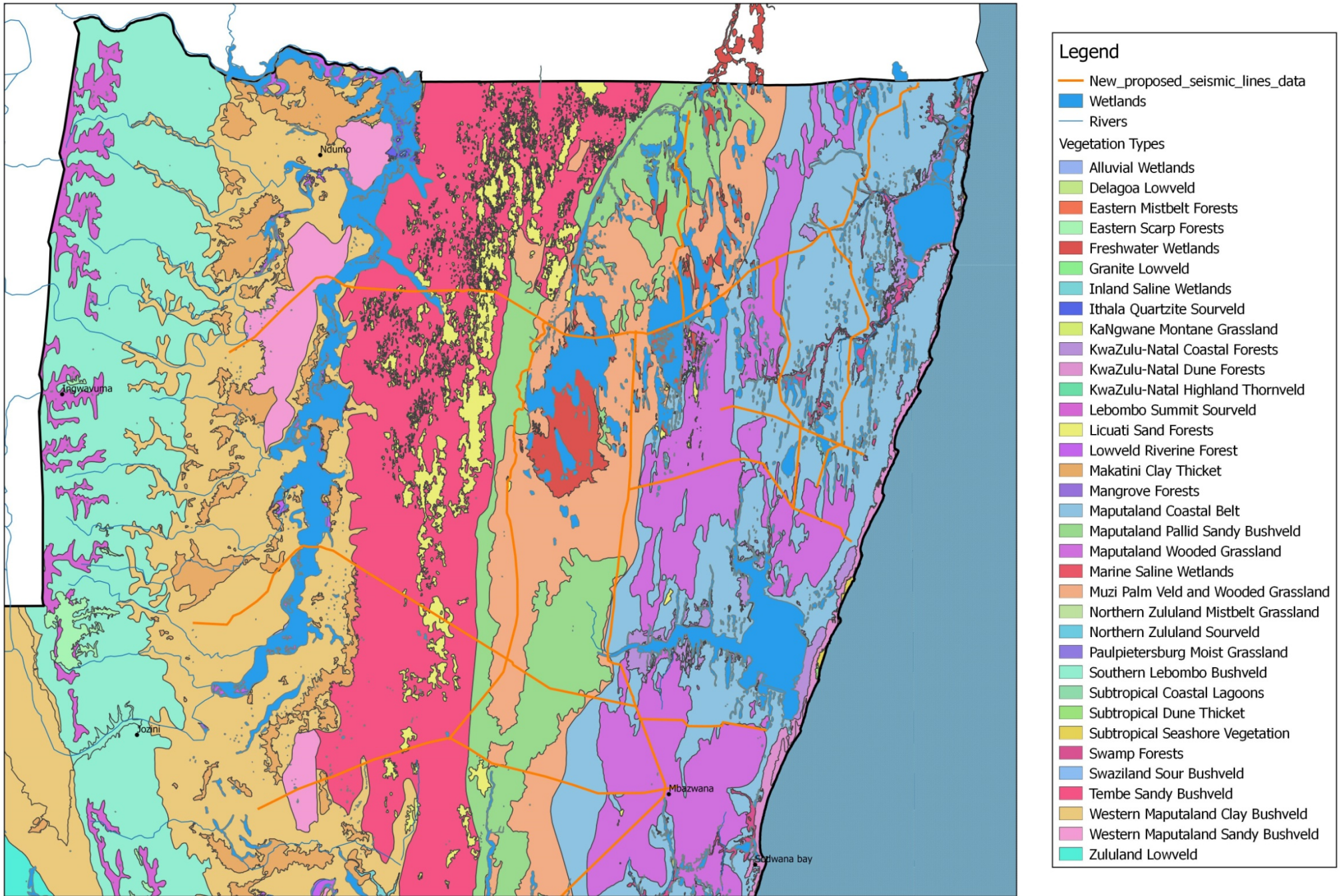
Map 4: Maputaland Proposed seismic lines on Critical Biodiversity Areas

Maputaland Proposed Seismic Lines in relation to Protected Areas



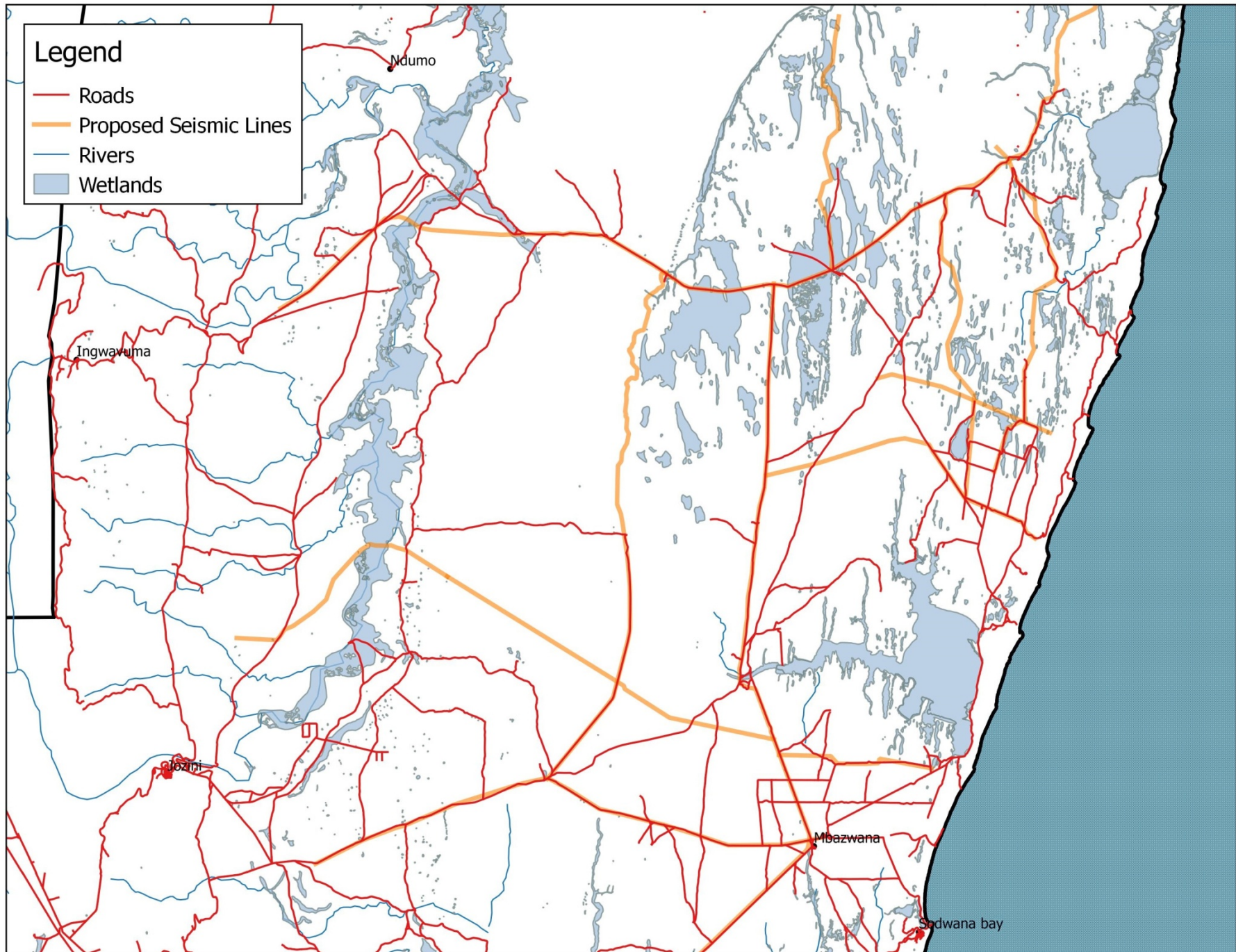
Map 1: Maputaland Proposed Seismic Lines in relation to Protected Areas

Maputaland Proposed Seismic Survey Lines on Vegetation Communities



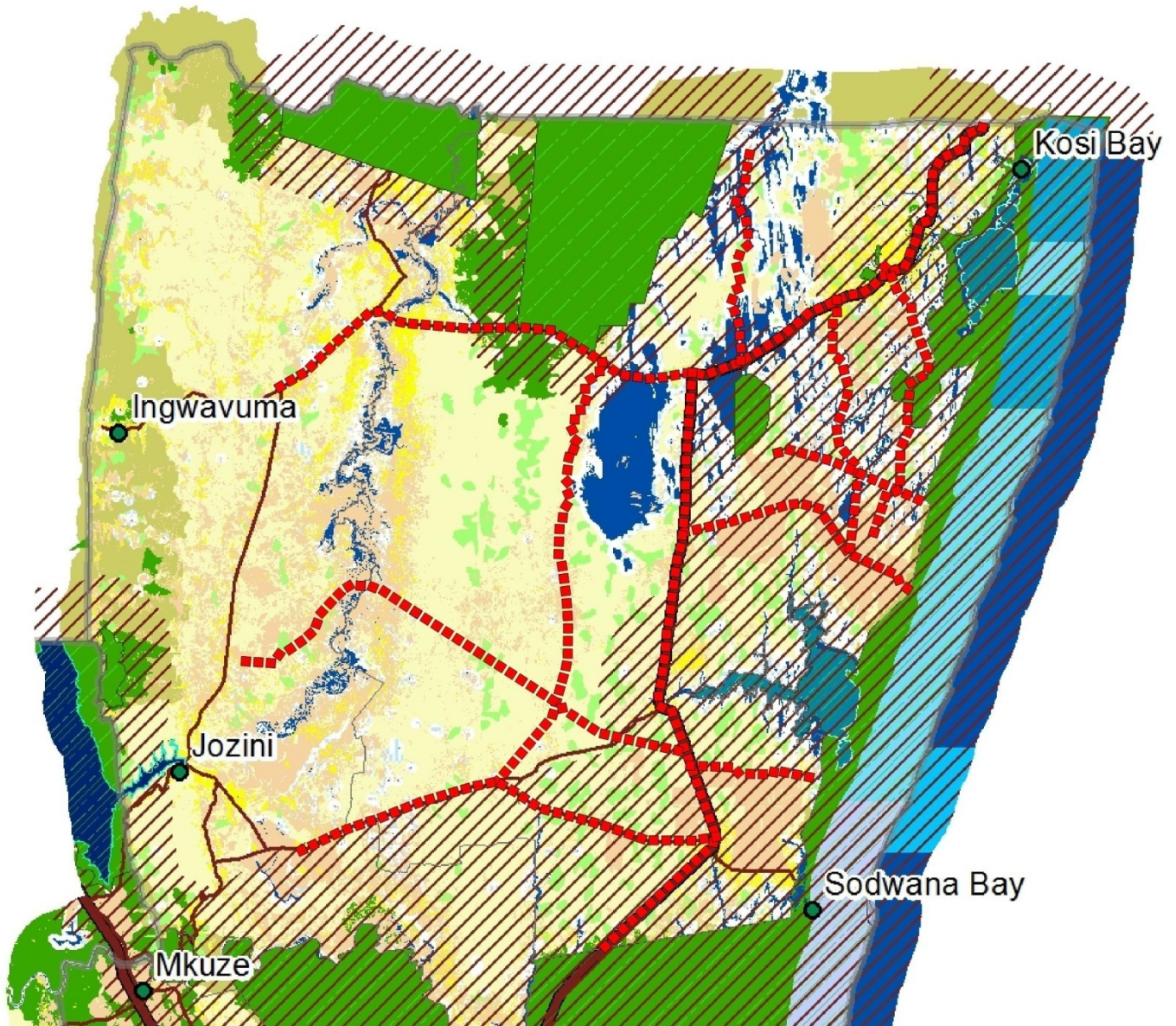
Map 2: Maputaland Proposed Seismic Survey Lines on Vegetation Communities

Maputaland Proposed Seismic Lines on Infrastructure

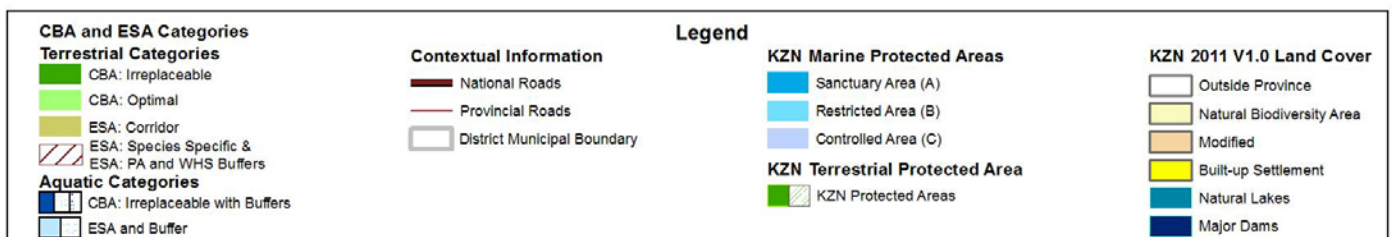


Map 3: Maputaland Proposed Seismic Survey Lines on Infrastructure

Maputaland Propose Seismic Lines on CBAs



Map 4: Maputaland Proposed seismic lines on Critical Biodiversity Areas



Appendix 2:

Photographs



Photo 1: Typical road through plantations in proposed seismic survey area



Photo 2: Palm veld in proposed seismic survey area.



Photo 3: Road through scrub in proposed seismic survey area.



Photo 4: N2 going north through proposed seismic survey area.



Photo 5: Road going through forest in proposed seismic survey area.

Appendix 2

WetRest. 2015. Baseline Environmental and Site specific data for the Proposed Maputaland Seismic Survey.



2015

Council for Geoscience

Baseline Environmental and Site specific data for the Proposed Maputaland Seismic Survey

Submitted to:

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1 September 2015

EXECUTIVE SUMMARY

WetRest was appointed by the CGS to conduct a baseline environmental information and site specific data survey for the proposed Maputaland seismic survey and borehole drilling. There is an abundance of environmental baseline data available for a thematic scoping review of the proposed study.

Based on the provided project description, we are of the opinion that the seismic survey does not require any environmental approvals as per any of the South African pieces of legislation. The proposed drilling of the borehole might be subjected to certain legislative requirements and permitting approvals. However, this can only be ascertained once the site has been confirmed.

The South African Centre for Carbon Capture and Storage (SACCCS) identified the need for a higher level of detail with regards to geological characterisation of the regional stratigraphy of the Mesozoic Zululand Group rocks within the Zululand Basin of northern KZN. In accordance to this, a seismic profiling survey is proposed to be conducted along a grid across the Maputaland area in order to produce a high resolution seismic data profile.

The seismic survey will be confined to the existing roads and therefor the wetland assessment as well. The proposed transects extends approximately 407.2 km along roads across the northern KZN coastal area. The study area is located within the uMkhanyakude District Municipality, towards the eastern side of the Swaziland boundary and towards the south of the Mozambique international boundary.

Based on a site visit done in August 2015, 40 wetlands were identified, based on their NFEPA wetland status. These wetlands are concentrated towards the northern sections of the study area. These wetlands have been classified mainly based on their pedological and geomorphological features by the onsite specialists. There were a total of 7 drainage systems identified along with the sensitive vegetation at the specific NFEPA wetland points:

ABBREVIATIONS USED IN THIS REPORT

CBA	Critical Biodiversity Area
CGS	Council for Geoscience
EIAR	Environmental Impact Assessment Report
EKZNW	Ezemvelo KwaZulu-Natal Wildlife
EMPr	Environmental Management Programme
ESAs	Ecological Support Areas
EGSAs	Ecosystem Goods and Services Areas
KZN	Kwa-Zulu Natal
MPRDA	Mineral and Petroleum Resources Development Act
NEM:PAA	National Environmental Management: Protected Areas Act
NEM:WA	National Environmental Management: Waste Act
NEMA	National Environmental Management Act
NWA	National Water Act
NFEPA	National Freshwater Ecosystems Protection Act
PAs	Protected Areas
SANBI	South African National Biodiversity Institute
SACCCS	South African Centre for Carbon Capture and Storage
SIBIS	SANBI's biodiversity information, and information shared by SANBI partners
WMA	Water Management Area

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1 INTRODUCTION

The Council for Geoscience (CGS) undertook a previous review of the Maputaland area which did not identify any specific requirements within the Mineral and Petroleum Resources Development Act (MPRDA) and regulations, the National Environmental Management Act (NEMA), the National Environmental Management: Waste Act (NEM:WA) or the National Water Act (NWA) with regards to requirements for specific environmental assessments to be undertaken prior to the proposed seismic survey to be undertaken.

Upon a prior occasion, the CGS have submitted a letter to the Department of Mineral Resources requesting authorisation to conduct a seismic survey and borehole drilling in terms of MPRDA Section 50(1) wherein which the Minister usually instructs appropriate environmental planning to be undertaken as a pre-requisite for the associated authorisation. This document is therefore an initiative from the Council of Geoscience to assess the current status quo of the study area, and assess potential impacts from the proposed activities.

It is essential that government departments and all Interested and Affected Parties (I&APs) be provided with adequate environmental descriptions to inform their decision making regarding the proposed project.

2 PROJECT OBJECTIVES

This project aims to provide a concise description of the receiving wetland environment of the proposed seismic surveying initiative of the CGS in Maputaland. Through the study, the various environmental factors will be discussed in the form of the assessment of the wetland ecosystems. The viability of the transect placements will be assessed with regard to these features.

3 SCOPE OF WORK

WetRest was appointed by the CGS to conduct a baseline environmental information and site specific data survey for the proposed Maputaland seismic survey and borehole drilling. There is an abundance of environmental baseline data available for a thematic scoping review of the proposed study. The scope of work had been arranged during a meeting between the client and the lead consultants working on the project.

The framework of this study includes:

- A site investigation of the proposed seismic lines formed the basis for the interpretation of potential risks associated with the advancement of the proposed project.
- The delegation of the borehole sites along the transects will be distinguished based on the a thorough study done of the regional vegetation types, protected vegetation types, the ecosystems, conservation areas and conservation priority areas.
- At any point where the transect intersects an NFEPA wetland the wetland functionality and the biota needs to be addressed.
- To include environmental theme specific recommendations for an Environmental Management Programme (EMPr) which would be relevant to the seismic survey and borehole drilling which can eventually be used as a supplementary document in an Environmental Impact Assessment Report (EIAR).
- Borehole drilling locations will be assessed separately after shortlisting appropriate sites and falls outside the scope of this assessment

4 RELEVANT LEGISLATION

Based on the provided project description, we are of the opinion that the seismic survey does not require any environmental approvals as per any of the South African pieces of legislation. The proposed drilling of the borehole might be subjected to certain legislative requirements and permitting approvals. However, this can only be ascertained once the site has been confirmed.

4.1. Wetland legislation

Locally, the South African Constitution, various Acts and two international treaties allow for the protection of wetlands and rivers. These systems are protected from destruction or pollution by the following:

- Section 24 of The Constitution of the Republic of South Africa;
- Agenda 21 – Action plan for sustainable development of the Department of Environmental Affairs and Tourism (DEAT) 1998;
- The Ramsar Convention, 1971 including the Wetland Conservation Programme (DEAT) and the National Wetland Rehabilitation Initiative (DEAT, 2000);
- National Environmental Management Act (NEMA) (Act 107 of 1998) inclusive of all amendments, as well as the NEM: Biodiversity Act;
- National Water Act (Act 36 of 1998);
- Conservation of Agricultural Resources Act (Act 43 of 1983);
- Minerals and Petroleum Resources Development Act (Act 28 of 2002);
- KZN Nature Conservation Ordinance (No. 19 of 1974);
- National Forest Act (Act 84 of 1998);
- National Heritage Resources Act (Act 25 of 1999);
- Section 21 (c) and (i) of the National Water Act (NWA) (Act 36 of 1998) GN 1199 - development within 500 meters of a wetland;
- Section 21 (c) and (i) of the NWA (Act 36 of 1998) GN 1198 - Rehabilitation of a wetland area;
- Section 21 of the NWA (Act 36 of 1998); and
- Regulation 983, 984 and 985 of the National Environmental Management Act (Act 107 of 1998).

4.1.1. The National Water Act (Act No 36 of 1998)

The NWA clearly defines a water-course and resource quality characteristics. According to section 21 (c) and (i) water uses almost any activity in any catchment has the potential to change the resource quality characteristics (flow regime, water quality, habitat and biota) and would require some form of authorization in terms of these water uses. In recognition of this fact the Department published a General Authorisation (GA 1199) for these water uses. However, this GA contains exclusions as a part of a risk based approach to ensure that higher risk activities are properly assessed and informed by sound science and design. Only low risk activities with proper mitigation measures and rehabilitation are being authorised under the GA.

One of these exclusions is “the use of water in terms of section 21 (c) and (i) within the 500m radius from the boundary of any wetland”. This threshold was derived at in clear recognition of the fact that most construction activities have the potential to change the resource quality characteristics of the wetland and may affect the flow regime if located within the 500m radius from the boundary of any wetland.

A Section 21 (c) and (i) water use authorization must be applied for from DWS for any activity within 500 m of the boundary of a wetland.

4.2. Provincial legislation and policy for buffers

Currently, there are no accepted wetland buffer distances provided by the provincial authorities. Standard practice is to apply a standard 30m buffer to wetlands in the province, disregarding site-specific conditions. The Ezemvelo KZN Wildlife Biodiversity Impact Assessment Guideline (2013) have however compiled criteria for determining the width of wetland buffers based on the biophysical factors and the interactions between them. Other policies that are relevant include:

- Provincial Nature Conservation Ordinance (PNCO) – Protected Flora;
- KZN Biodiversity Conservation Plan; and
- KZN Vegetation Map (2011).

5 LIMITATIONS OF THIS INVESTIGATION

The following limitations were encountered during the progression of the study:

- The GPS which was used for wetland location is at best accurate to within five meters.
- This survey was undertaken early in August, following a dry season.
- Due to the extent of the project, all vegetation analysis was done within 500 m of the proposed seismic transects.

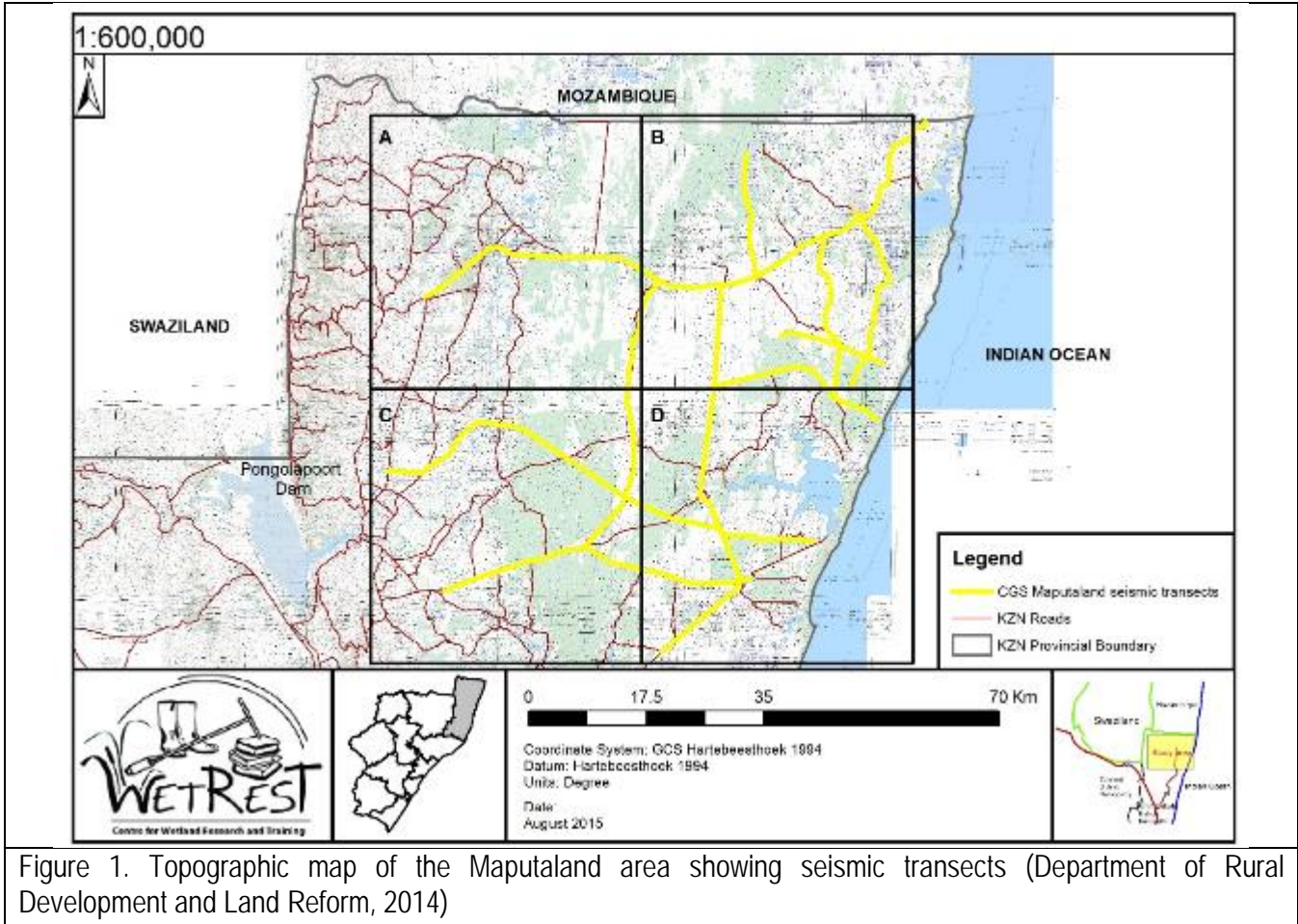
6 PROJECT DESCRIPTION

The South African Centre for Carbon Capture and Storage (SACCCS) identified the need for a higher level of detail with regards to geological characterisation of the regional stratigraphy of the Mesozoic Zululand Group rocks within the Zululand Basin of northern KZN. These findings were built of a desktop assessment, "Geological development of the Zululand Basin; towards the assessment of effective CO₂ storage capacity" (Beck et al 2013).

In accordance to this, a seismic profiling survey is proposed to be conducted along a transects across the Maputaland area in order to produce a high resolution seismic data profile. This data can be interpreted to identify possible sandstone reservoirs with sufficient porosity/permeability and associated capping and lateral seal lithologies that could support a trial CO₂ pumped storage project. Seismic profile data would assist with the siting of deep boreholes that will sample the potential sandstone reservoir horizons and cap/lateral seal lithologies in order to conduct *in situ* tests and provide core for laboratory testing. The application of a battery of lithological characterisation analyses will determine whether it is feasible to undertake a trial project that will inject CO₂ into the target reservoir rocks at depths exceeding 800m, to achieve permanent capture and storage.

Should the characteristics of the rocks be unable to meet the requirements for injection of CO₂ the trail will not proceed.

The proposed transects extends approximately 407.2 km across the northern KZN area, the CGS team has proposed to the existing road network for the purpose of this study. The seismic survey will be confined to the existing roads. Eleven routes will be followed during the proposed seismic survey (Figure 1).



The study area is located within the uMkhanyakude District Municipality, towards the eastern side of the Swaziland boundary and towards the south of the Mozambique international boundary (Figure 2). The project lies within the quarter degree grid cells of 2732 and 2632. The observations were taken alongside the available access routes. Due to the immense size of the receiving environment the study area has been subdivided into 4 sections for descriptive purposes.

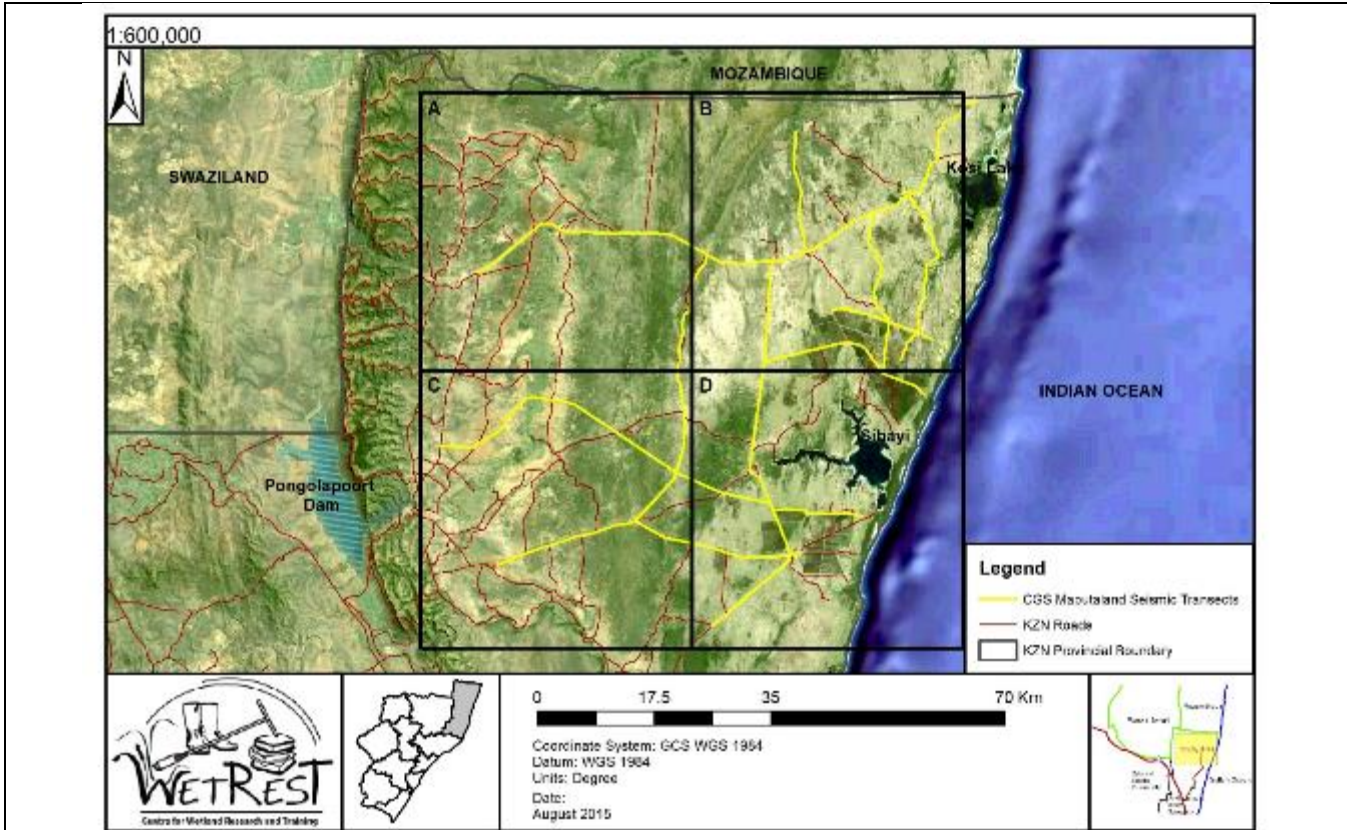


Figure 2. The extent of the project within the uMkanyakhude District Municipality with sectional subdivisions (Department of Rural Development and Land Reform, 2014)

7 RECEIVING ENVIRONMENT

7.1. Climate

The climate observed within the study area, is expected to vary substantially between the coastal areas and the inland areas. Overall climatic conditions are described starting from inland towards the coast (Mucina & Rutherford, 2006). The inland Lebombo Bushveld and Zululand Sourveld areas experience summer rainfall with very little rain in winter. The MAP is approximately 550-1000mm with very infrequent frost occurrences. The central part of the study area experience summer rainfall with some rain in winter and the MAP approximately 550-800mm. The mist of the Indian Ocean contributes to the precipitation, and still no incidences of frost. Closer towards the coast, in the Maputaland Coastal Belt as well as the Wooded Grasslands, the rains comprise generally of a weak rainfall seasonality of annual values up to 1200mm. High humidity and temperature is experienced during summer months with the mean maximum being 35.3°C and a mean winter temperature of 5.5°C. No incidence of frost.

7.2. Geology

The geology of the study area is comprised mainly out of two larger units (Figure 3). The stratigraphic units are those of the Tertiary and Quaternary Periods, which lies beneath most of the study area towards the east of the study area, and the other unit consists of rocks from the Cretaceous Period, towards the west of the study area. These rocks are from the Cenozoic era (Lurie, 1994). The Maputaland Group lies within the east of the study area and the Zululand Group is located towards the west of the study area.

The Zululand Group (Cretaceous Deposits) is comprised out of 3 formations, the St. Lucia Formation, the Mzinene Formation and the Makatini Formation. The possibility of the observation of the St. Lucia Formation within the study area was highly unlikely due to the location of the study area relative to the known extent of the formation. The Makatini Formation lies unconformably over the Lebombo Group and is comprised mostly out of small-pebble conglomerates, sandstones, siltstones and limestones. The limestones and siltstones contain fossils of faunal and floral remnants. The younger Mzinene formation is comprised out of glauconite siltstones and fossiliferous crossbedded sandstones (Shone, 2006)

The eastern section of the study area is comprised out of Cenozoic Deposits. The Maputaland Group has been subdivided into the Uloa, Umkwelane, Port Durnford, Kosi Bay, Isipingo, KwaMbonambi and the Sibayi Formations. The Uloa formation is a spatially large formation which varies between 5 m and 35 m in thickness and consists out of calcified coquina, shelly conglomerates, cobble conglomerates, sandstones, and siltstones which were deposited within the littoral zones of the paleoshorelines of the Lebombo Mountains. The thickest remnants of the formation is found between the Mozambique border and Lake St. Lucia (Roberts *et al*, 2006).

The variation in geology within the study area has a definite effect on the vegetation types found within the study area.

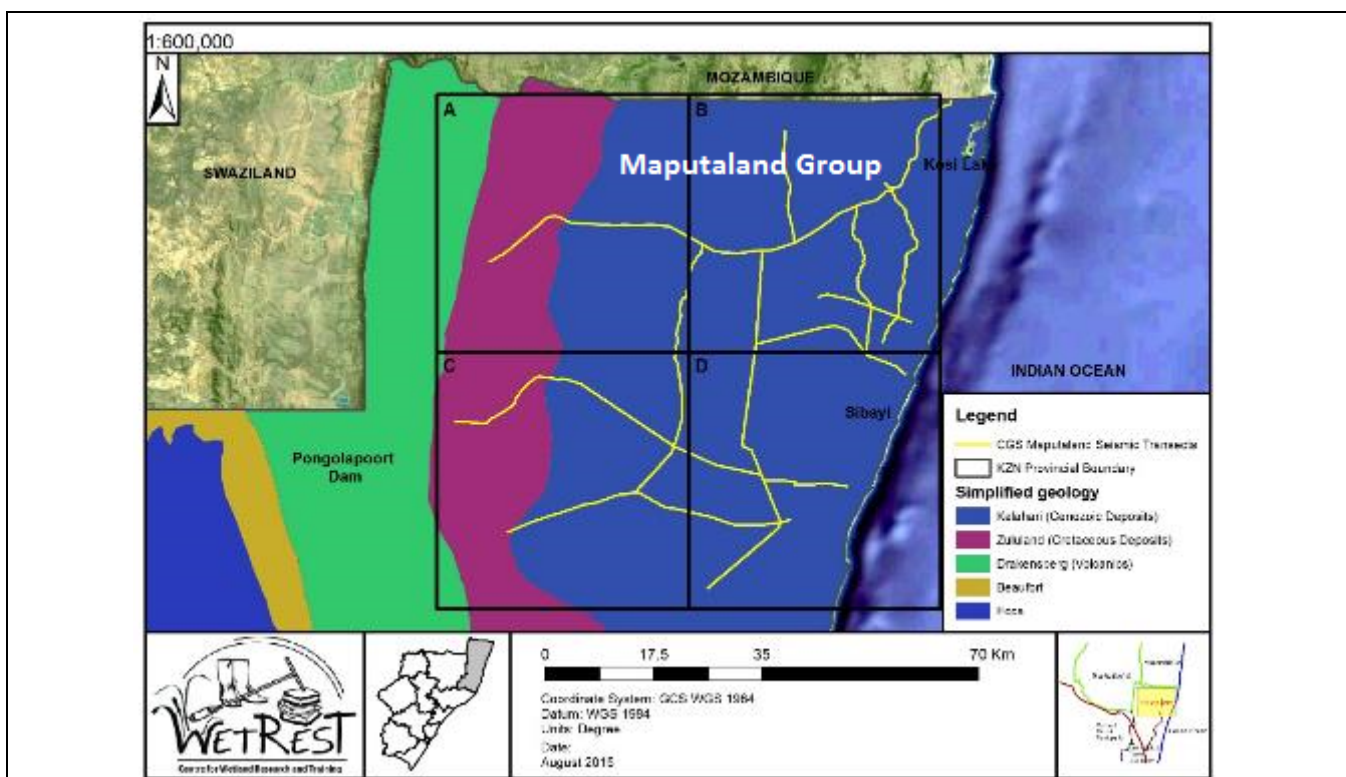


Figure 3. The simplified underlying geology of the study area (AGIS, Accessed on: 25 August 2015)

7.3. Hydrology

The hydrology of the area is confined by the Lebombo Mountains towards the west and the Indian Ocean towards the east of the study area. The study area is located in the Mkuze (W32B), Pongola (W43F, W45A and W45B) and

the Lake Sibaya (W70A) catchments within the Usutu to Mhlathuze Water Management Area (Figure 4) (DWAF, 2004).

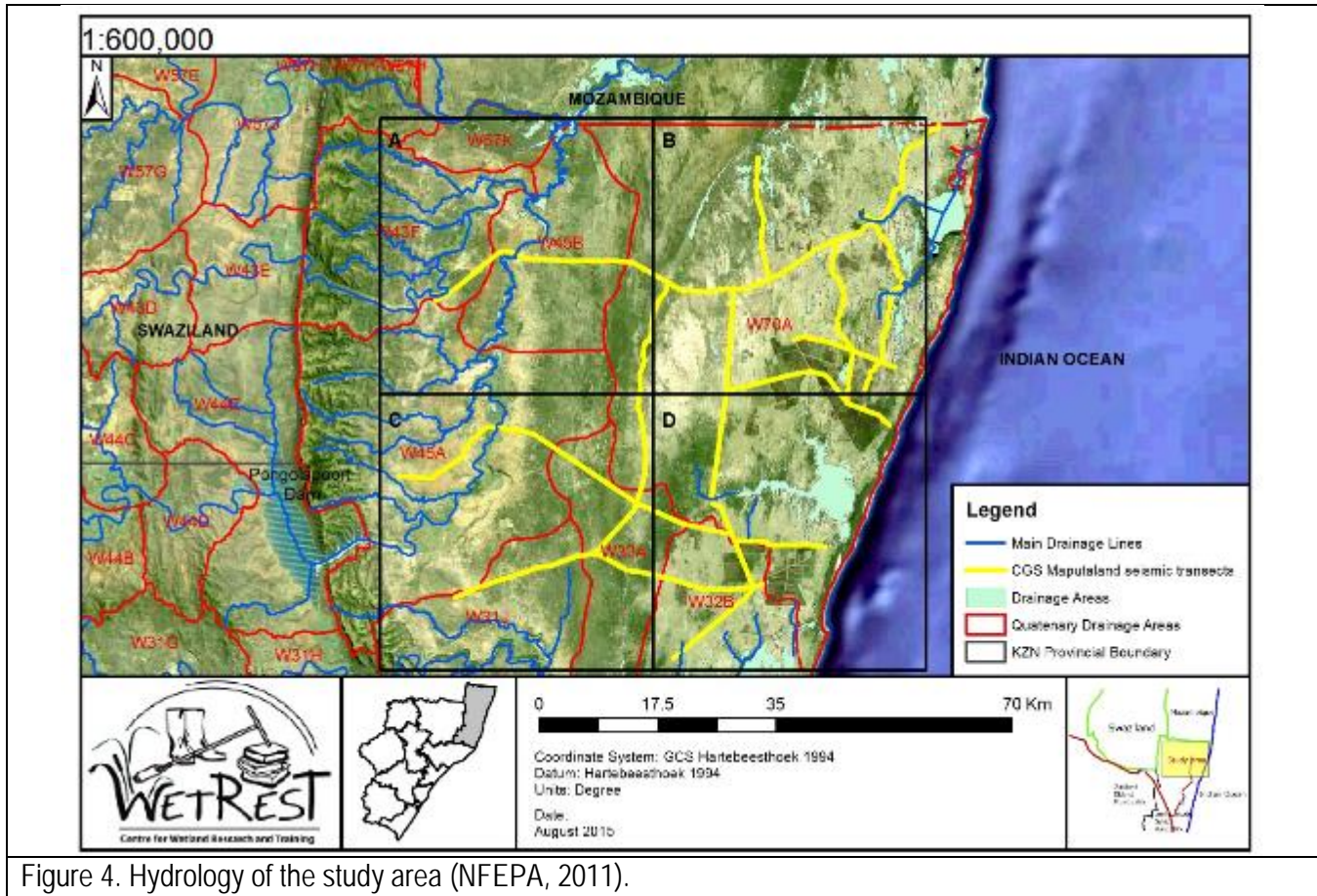


Figure 4. Hydrology of the study area (NFEP, 2011).

7.4. Vegetation

According to DWAF the study area is located within Lowveld and Natal Coastal Plain Ecoregions. The study area mainly falls within the Indian Ocean Coastal Belt and the Savanna Biomes, there are also sporadic occurrences of Azonal vegetation and Forests (NBA, 2011). There are a collective of 11 vegetation types that are situated within 500 m of the seismic transects (Figure 5).

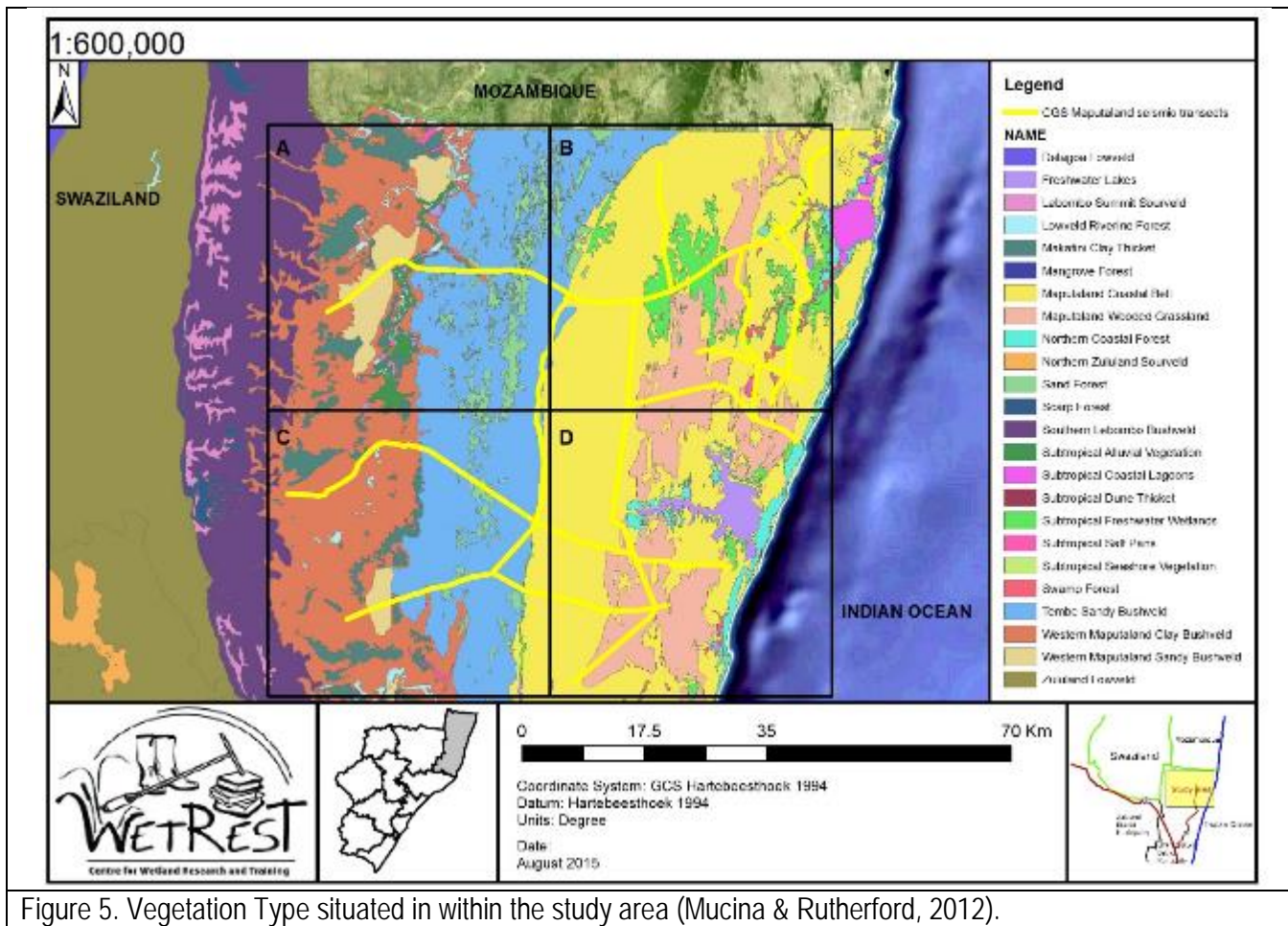


Figure 5. Vegetation Type situated in within the study area (Mucina & Rutherford, 2012).

8 METHODOLOGY

8.1. Wetland Delineation

The wetland delineation was conducted according to the guidelines set out by the Department of Water Affairs and Forestry (DWAF, 2005). Due to the transitional nature of wetland boundaries, they are often not clearly apparent and the delineations should therefore be regarded as of human construct. However, the delineations are based on scientifically defensible criteria, thus providing a tool to facilitate the decision making process regarding the assessment of the significance of impacts on wetlands that may be associated with the proposed developments.

According to DWAF (2005), the following general principles should be applied as the basis of wetland delineation:

"A wetland is defined 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 under normal circumstances supports or would support vegetation typically adapted to life in saturated soil" (Water Act 36 of 1998 in DWAF, 2005).

A wetland can be defined in terms of hydrology (flooded or saturated soils), plants (adapted to saturated soils) and soil (saturated). Due to the variable nature of South Africa's climate, the direct presence of water is often an unreliable indicator of wetland conditions. Prolonged saturation of soil has a characteristic effect on soil morphology, affecting soil matrix chroma and mottling in particular.

The wetlands were delineated by making use of the following wetland indicators (DWAF, 2005):

- Terrain unit indicator helps to identify those parts of the landscape where wetlands are most likely to occur. Wetlands occupy characteristic positions in the landscape and can occur on the following terrain units: crest, midslope, footslope and valley bottom.
- The Soil form indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991) that are associated with prolonged and frequent saturation.
- Soil wetness indicator identifies the morphological signatures developed in the soil profile as a result of prolonged and frequent saturation. Notes were taken on soil chroma to a depth of 50 cm and this was related to hydrological conditions in terms of the criteria for distinguishing different soil saturation zones within a wetland (Kotze et al., 1994).
- The Vegetation indicator identifies hydrophytic vegetation associated with frequently saturated soils.

8.2. Wetland Identification and Classification

Wetlands are described in terms of their position in the landscape, and the classification was done according to their hydro-geomorphic setting (Kotze et al., 2004).

Aerial photos, 1:50 000 topographic maps, satellite photos and GPS points are used to guide onscreen delineation of wetlands in ArcView GIS 10.3. A first estimation of the extent of wet soils can be made from aerial photos, largely based on differences in vegetation and topography, indicating differences in species composition or more vigorous growth. This delineation needs to be verified during field sampling, making use of soil samples and vegetation line transects, as well as spot checks in between transects.

Field verification consisted of several line transect surveys to ensure representative sampling of the area. In each line transect survey soils and vegetation were used to assess the edge of the wetland. Areas between transects were also assessed by doing soil and vegetation spot checks on the perceived wetland marginal zone. It is important to note that, according to the wetland definition used in the South African National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practice the soil wetness indicator tends to be the most important, and the other three indicators have a confirmatory role (DWAF, 2005).

8.3. Literature and Database Survey

A literature study had been conducted to assist the study. The following relevant resources were used in the course of this study:

- The NFEPA VegMap
- The NFEPA Wetlands
- The National Spatial Biodiversity Assessment
- Red Data Plant Lists
- Floral field guides and books
- Ezemvelo KwaZulu-Natal Wildlife (EKZNW) vegetation classifications
- National Geospatial Data
- Mucina and Rutherford (2006) Vegetation types

A detailed description of the resources can be obtained in Section 12 of this report.

8.3.1. Provincial Databases

MINSET

Minset is a feature that is utilized within the C-Plan. This tool uses a minimum amount of study areas in order to optimize the achievement of conservation targets by placing numerous constraints on the users. It presents the most efficient solution to achieving conservation targets and other land use constraints (EKZNW, 2011)

The EKZNW Minset data classifies the major conservation areas into 4 main categories:

- **Critical Biodiversity Area (CBA) Mandatory:** These are areas that have no other options than to meet their required biodiversity targets for both the biodiversity patterns and the ecological process features. This category is subdivided into two sets, depending on the irreplaceability of the area. CBA 1 Mandatory areas have an irreplaceability score that is equal to 1, meaning that the area is highly irreplaceable. CBA 2 Mandatory areas have an irreplaceability score that lies between 0.8 and is smaller than 1.
- **CBA Optimal:** These areas are ideal areas to meet their biodiversity conservation targets whilst aiming to avoid high cost areas. This classification is allocated to areas with an irreplaceability score that lies between 0 and 0.8. This category as well as the CBA Mandatory Areas are determined by the National Threatened Ecosystems, the National and KZN Protected Area Expansion Strategy, the KZN threatened Ecosystems, Forests and macro-ecological corridors that are located in areas that are under great environmental pressures.
- **Ecological Support Areas (ESA):** Areas that are not essential for meeting biodiversity targets directly. However they do play an important role in supporting and sustaining the ecological functioning of the CBAs. These areas are determined by the macro-ecological corridors.
- **Ecosystem Goods and Service Areas (EGSA):** These are areas that are classified as natural/near natural vegetation which has the capability of delivering important ecosystem goods and services to the KZN province and the inhabitants of the land.

Based on the EKZNW Minset data, it was found that the study area as a whole has numerous conservation areas, varying in conservation status.

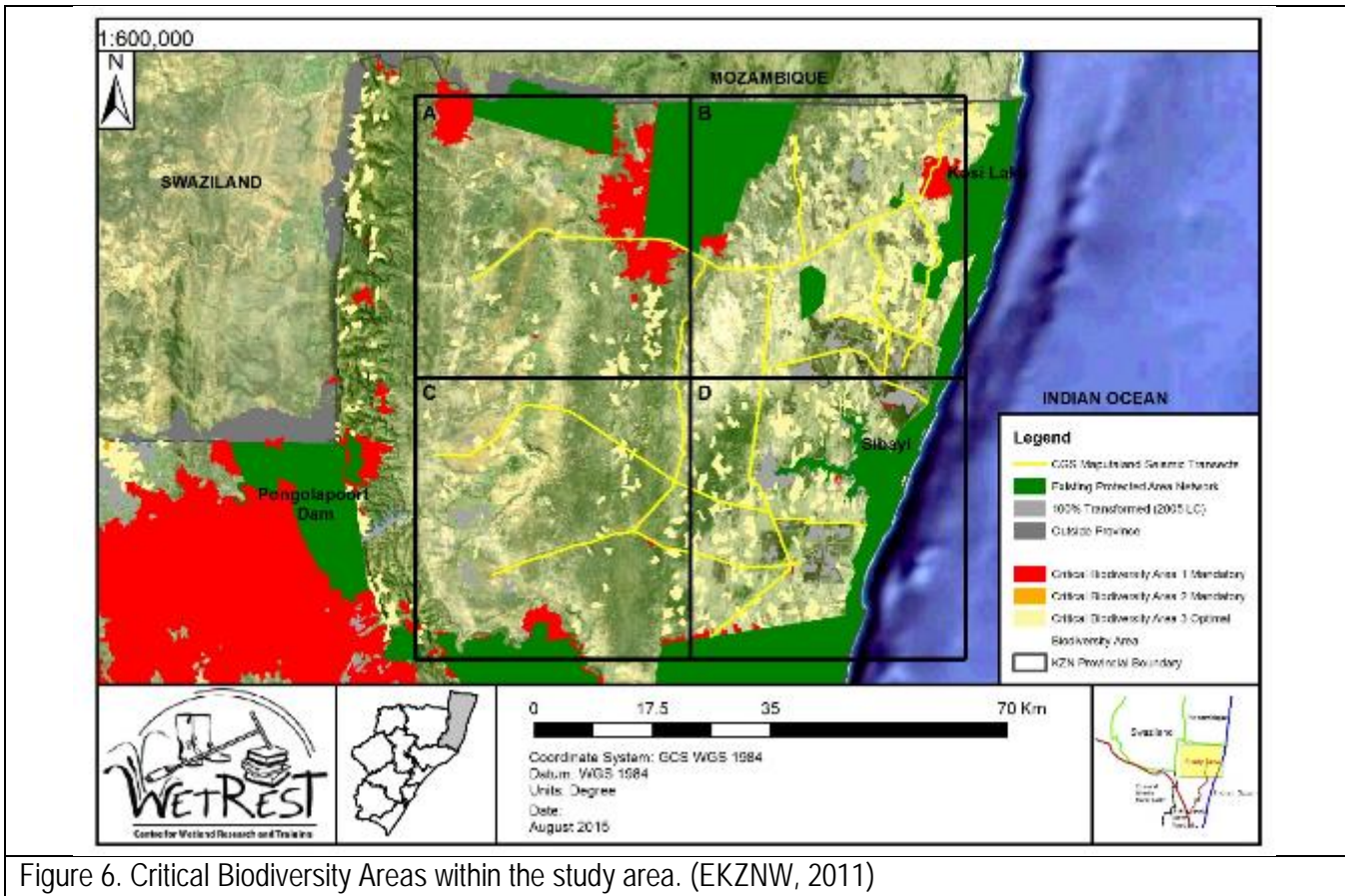
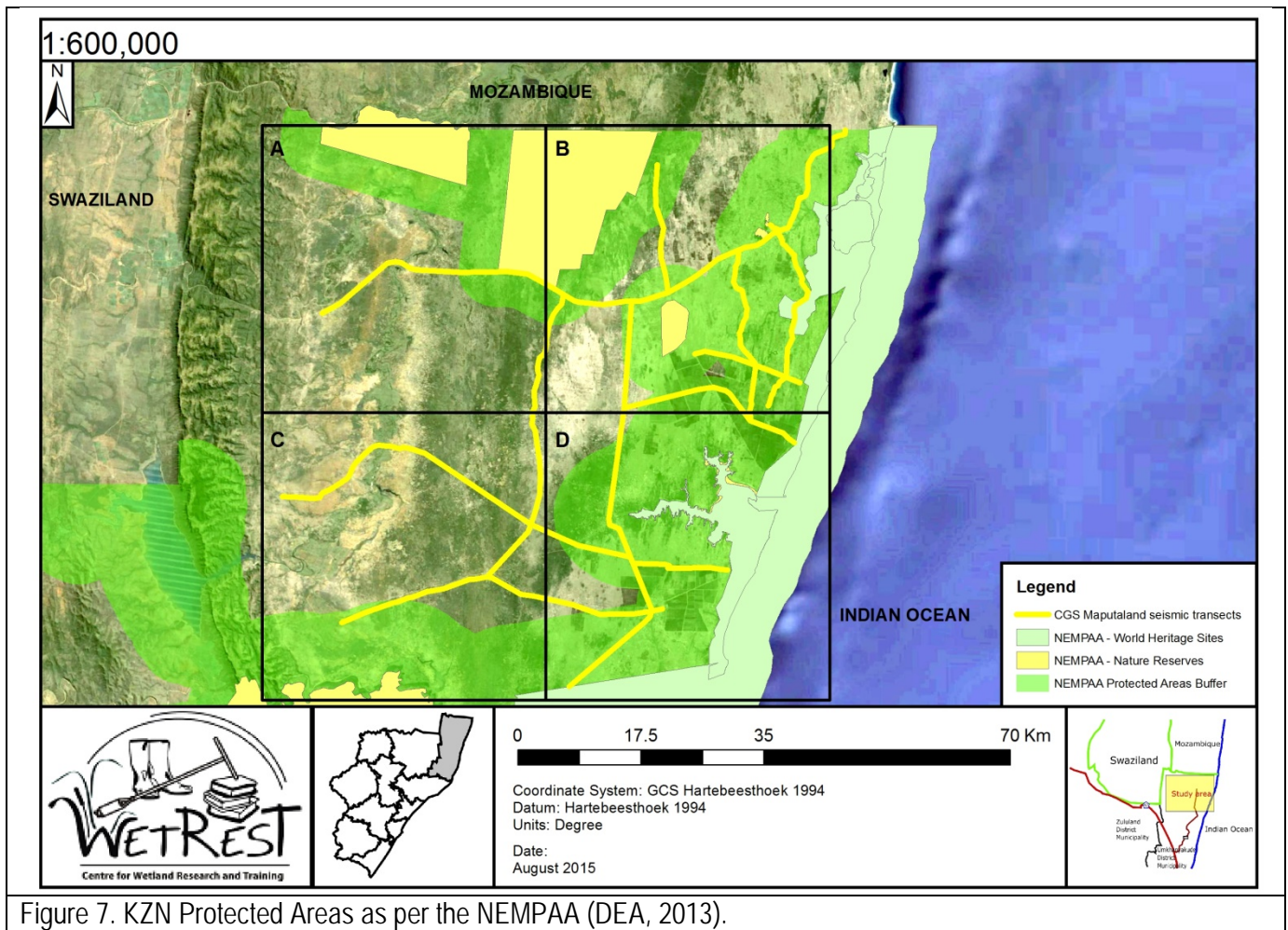


Figure 6. Critical Biodiversity Areas within the study area. (EKZNV, 2011)

NEMPAA

According to the KZN listing notice 3 data (Figure 1) the eastern portion of the study area, adjacent to the ocean, as well as the northern and southern portions of the study area have been classified as protected areas (PAs). In accordance to the regulations a 10 km buffer has been allocated around all PAs. The PAs include:

- Nature reserves;
- Marine PA;
- Mountain catchment areas;
- National parks; and
- World Heritage Sites.



EKZNW

The KZN Vegetation Type Map has undergone several changes since the publication of the Mucina and Rutherford (2006) national Vegmap. Ezemvelo KZN Wildlife has, in collaboration with various government departments, NGOs, Working Groups and Forums e.g. KZN Wetland Forum, IAIA (members of the International Association for Impact Assessment), municipalities and parastatals, refined the KZN VT to develop an accurate representation of the pre-transformation extent of the vegetation types present. As a result of the finer scale mapping and classification, the KZN VT map has in some cases identified new vegetation types and or subtypes within the vegetation types identified at national level. These changes have been peer reviewed and adopted by the National Vegetation Committee, and will be incorporated into the revised SA Vegmap.

The vegetation types identified by EKZNW (2011) have been discussed in an earlier section, dealing with the vegetation of the area. The conservation status of the vegetation types within 500 m of the seismic transects are summarised below (Table 1).

Table 1. Key vegetation types within the study area (EKZNW, 2011 & Mucina & Rutherford, 2006)

VEGETATION TYPE	CODE	STATUS (NSBA)	DESCRIPTION
Tembe Sandy Bushveld	SVI 18	Least threatened	Extensive floodplains to slightly undulating in places with open to closed woodland with a canopy of 5-10m tall, dominated by leguminous woody species and <i>Terminalia sericea</i> with a species-rich shrub layer.
Western Maputaland Sandy Bushveld	SVI 19	Least threatened	The sandy patches of this vegetation type are usually elevated above much of the surrounding clay flats. The vegetation type comprises of mixed, but short bushlands, woodlands, and wooded grasslands. Extreme variations include open-canopy <i>Terminalia sericea</i> sandveld on deeper yellow to orange sands, to <i>Combretum molle</i> -dominated woodlands on the deep red mesotrophic sands.
Western Maputaland Clay Bushveld	SVI 20	Vulnerable	Comprises mainly a compound leaved, short woodland and wooded grasslands. It occurs on the crests, upper and mid-slopes of gently undulating terrain. Two main large alluvial floodplains transect this vegetation type, namely the Mkhuze River and the Pongola River.
Makatini Clay Thicket	SVI 21	Least threatened	The dominant structural vegetation type is wooded grassland, in places pure sour grasslands, and rarely also dense Bushveld thickets. Terrain is mainly low, undulating mountains.
Maputaland Coastal Belt	CB 1	Vulnerable	This vegetation type includes flat coastal plains with patches of non-forest plant communities including dry grasslands, hygrophilous grasslands and thicket groups. Various species of the coastal belt element, Maputaland endemics, species in their northern distribution limit as well as in their southern distribution limit occur within this vegetation type. Most of the vegetation type is agricultural land and very little of this unit remains in a natural state in the South African part of Maputaland.
Maputaland Wooded Grassland	CB 2	Endangered	The generally flat landscape of the Maputaland coastal plain supporting coastal sandy grasslands rich in geoxylic suffrutices, dwarf shrubs, small trees and very rich herbaceous flora. Various species of the Maputaland endemics, species in their northern distribution limit as well as in their southern distribution limit occur within this vegetation type.

VEGETATION TYPE	CODE	STATUS (NSBA)	DESCRIPTION
Lowveld Riverine Forest	FOa 1	Critically endangered	Tall forests fringing larger rivers and water pans. When dominated by <i>Ficus sycomorus</i> or <i>Diospyros mespilliformis</i> , these forests are dense and tall, structured into several tree layers and with a well-developed dense shrub layer.
Swamp Forest	FOa 2	Critically endangered	12-15m tall forests with two main strata (canopy and shrub layer). The dominating trees include <i>Ficus trichopoda</i> , <i>Barringtonia racemosa</i> , <i>Casearia gladiiformis</i> , <i>Cassipourea gummiflua</i> , <i>Syzygium cordatum</i> , <i>Phoenix reclinata</i> and <i>Raphia australis</i> . Understory is poorly developed.
Sand Forest	FOz 8	Critically endangered	Dense thickets of 5-6m up to tall forests with the canopy reaching 15m with well-developed shrub layer and very poorly developed ground layer. This forest houses a large number of local Maputaland endemics and forms the core of the Matutaland Regional Centre of Endemism. Many other tropical elements have their southernmost distribution here, or are found in South Africa exclusively here.
Subtropical Salt Pans	AZi 11	Least threatened	Shallow depressions often found on old alluvial terraces of rivers, surrounded by zones of bank reeds or low herblands and in more perennial pans also filled with a dense carpet of macrophytic floating vegetation.
Subtropical Alluvial Vegetation	AZa 7	Target	Flat alluvial riverine terraces supporting an intricate complex of macrophytic vegetation (channel of flowing rivers and river-fed pans), marginal reed beds and extensive flooded grasslands, ephemeral herblands and riverine thickets.
Subtropical Freshwater Wetlands	AZf 6	Least threatened	Flat topography supporting water-logged meadows dominated by grasses. Found typically along edges of often seasonal pools in aeolian depressions as well as fringing alluvial backwater pans or artificial dams.

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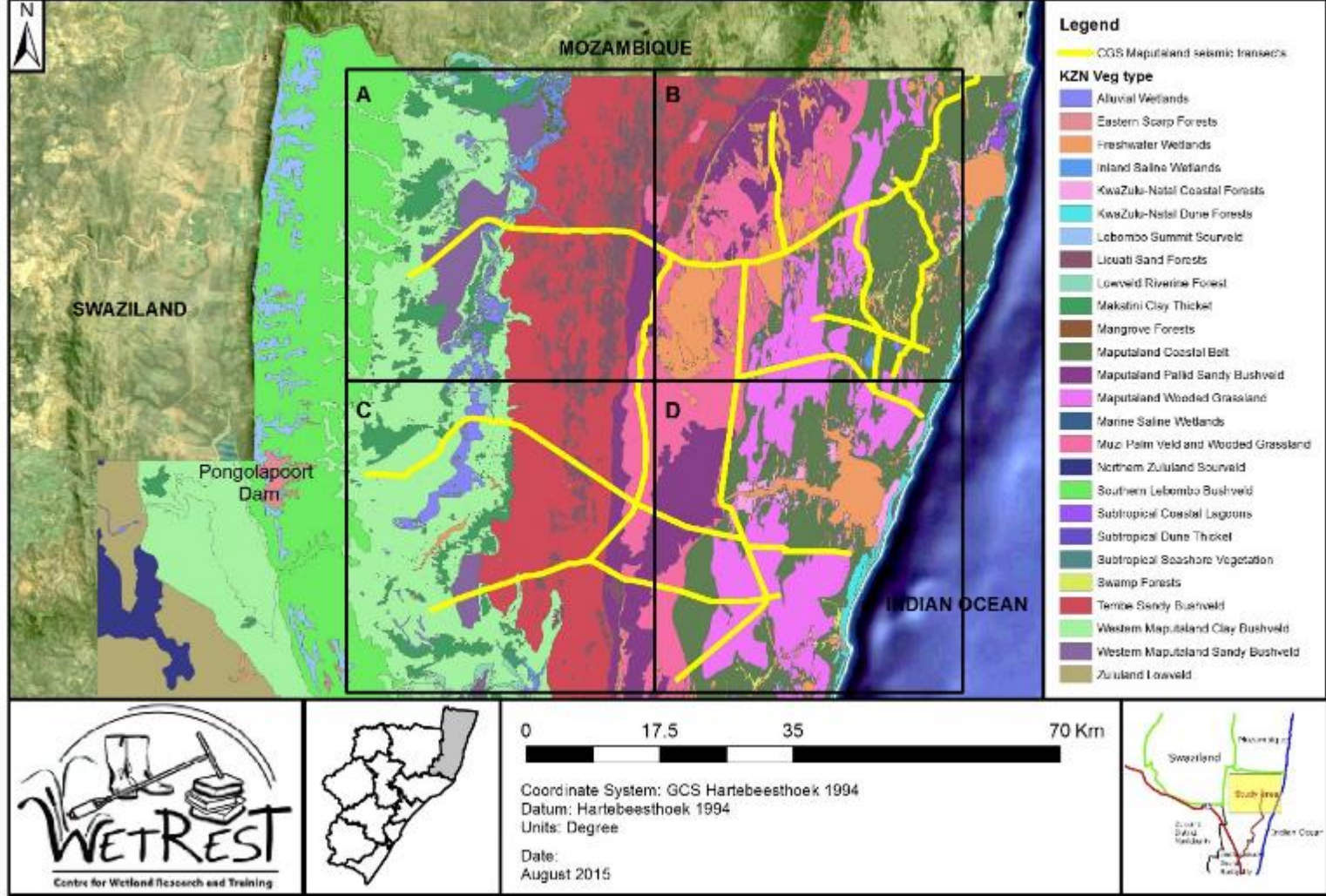


Figure 8. EKZNW Vegetation Type Map for the study area (EKZNW, 2011).

8.3.2. National Databases

The National Databases that were used during the desktop analysis for this project included the NBA's Threatened Ecosystems map and the NFEPA data.

NBA (2011)

The National Biodiversity Assessment provides mapped information for both ecosystems and species, and includes an assessment of the state of South Africa's biodiversity, across terrestrial, freshwater, estuarine and marine environments. The NBA is central to fulfilling SANBI's mandate in terms of the National Environmental Management: Biodiversity Act (Act 10 of 2004) to monitor and report regularly on the state of biodiversity, and includes two headline indicators that are assessed across all environments: ecosystem threat status and ecosystem protection level. The NBA 2011 also deals with species of special concern and invasive alien species, presents new work on geographic areas that contribute to climate change resilience, and provides a summary of spatial biodiversity priority areas that have been identified through systematic biodiversity plans at national, provincial and local scales.

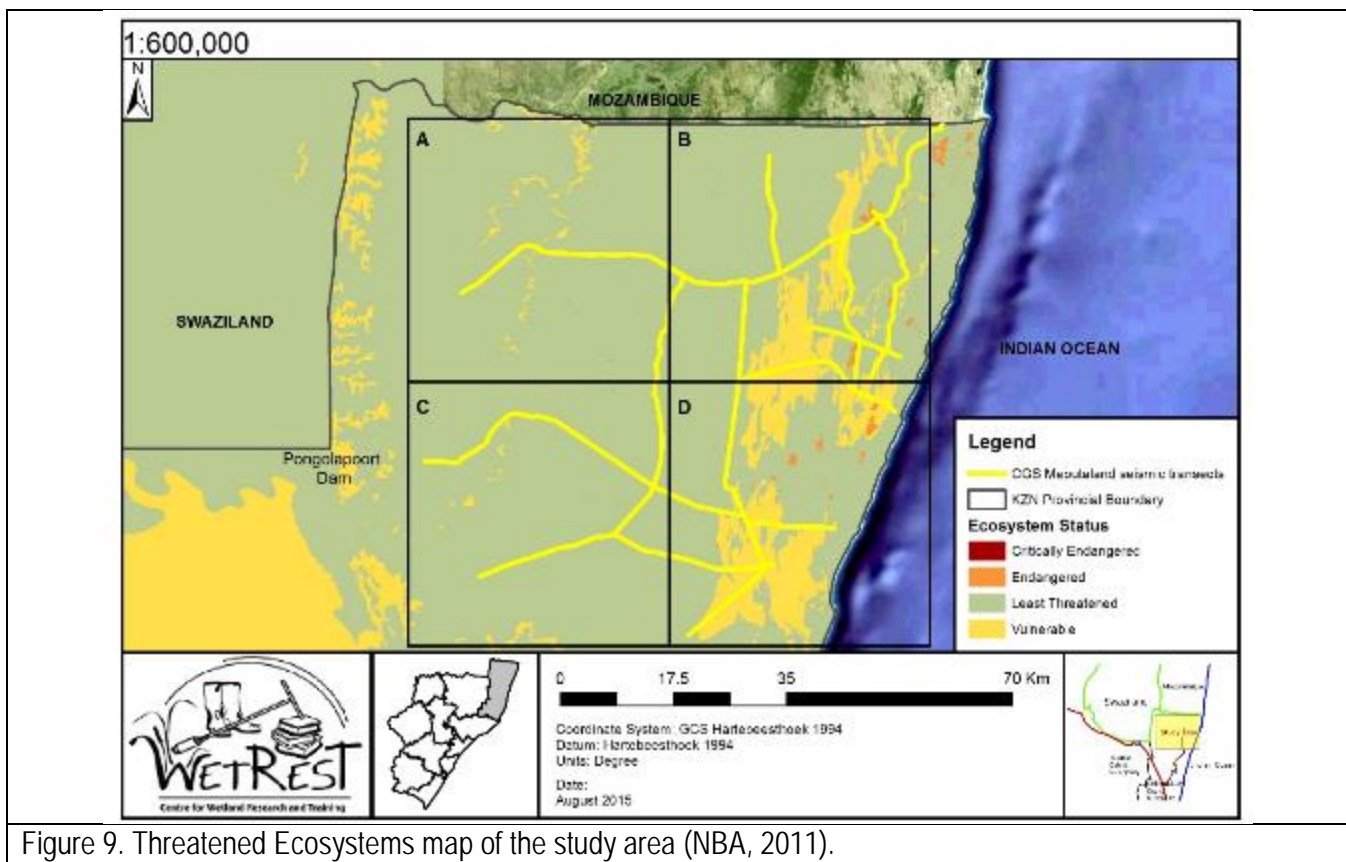


Figure 9. Threatened Ecosystems map of the study area (NBA, 2011).

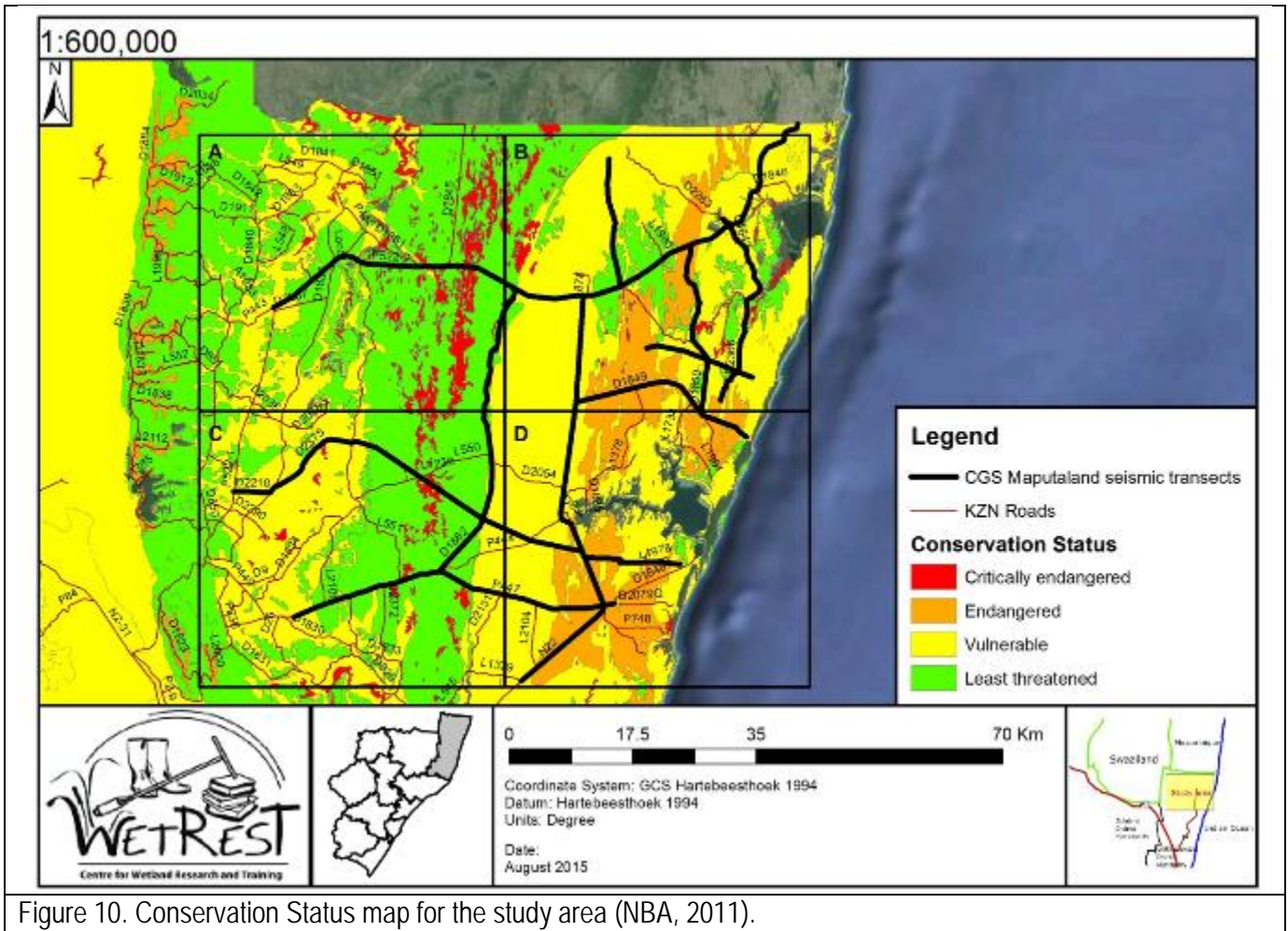


Figure 10. Conservation Status map for the study area (NBA, 2011).

Figure 11 indicates the existing protected areas as defined in NEMPAA, within the study area. As can be seen the roads traverses various protected areas.

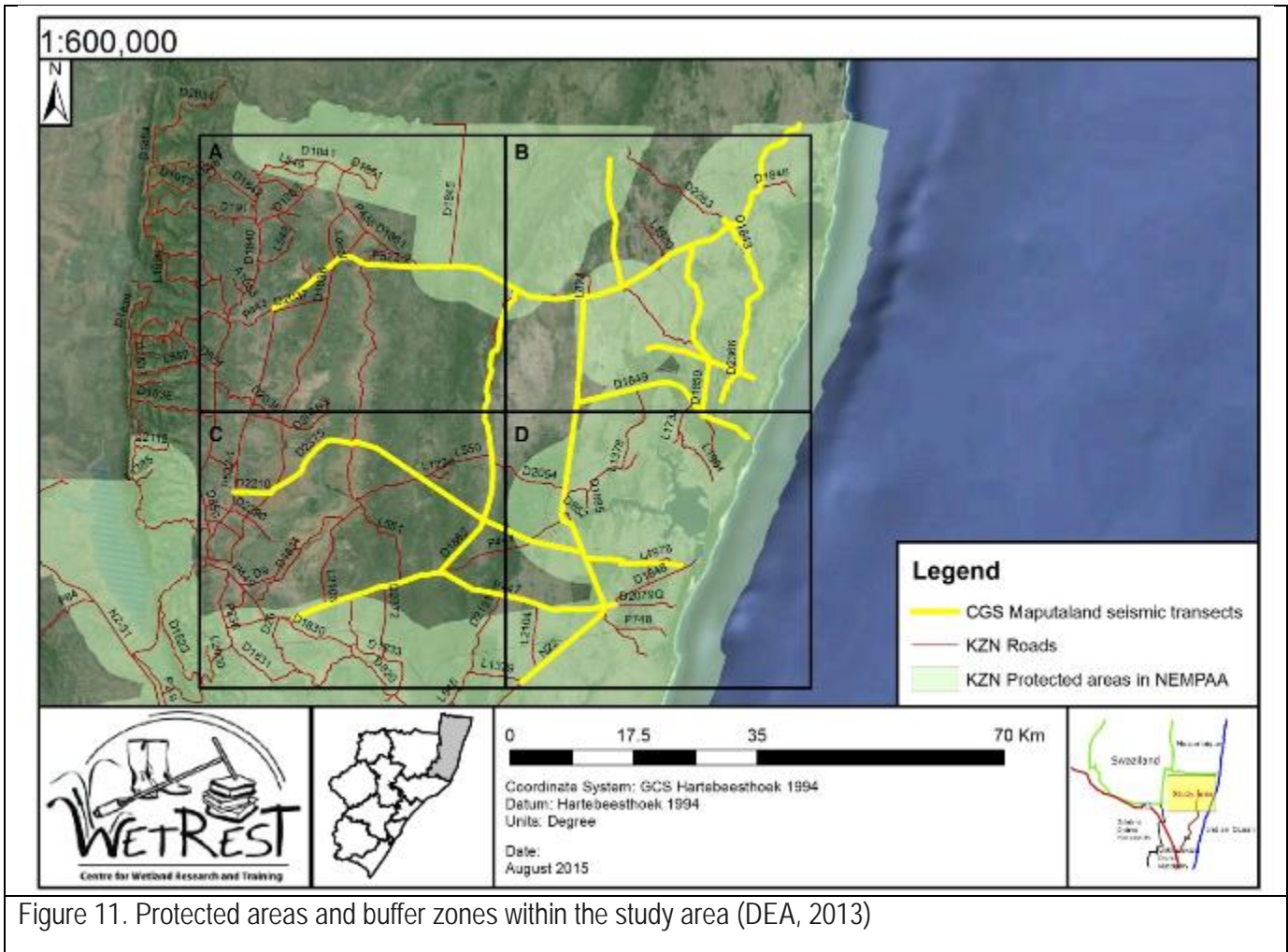
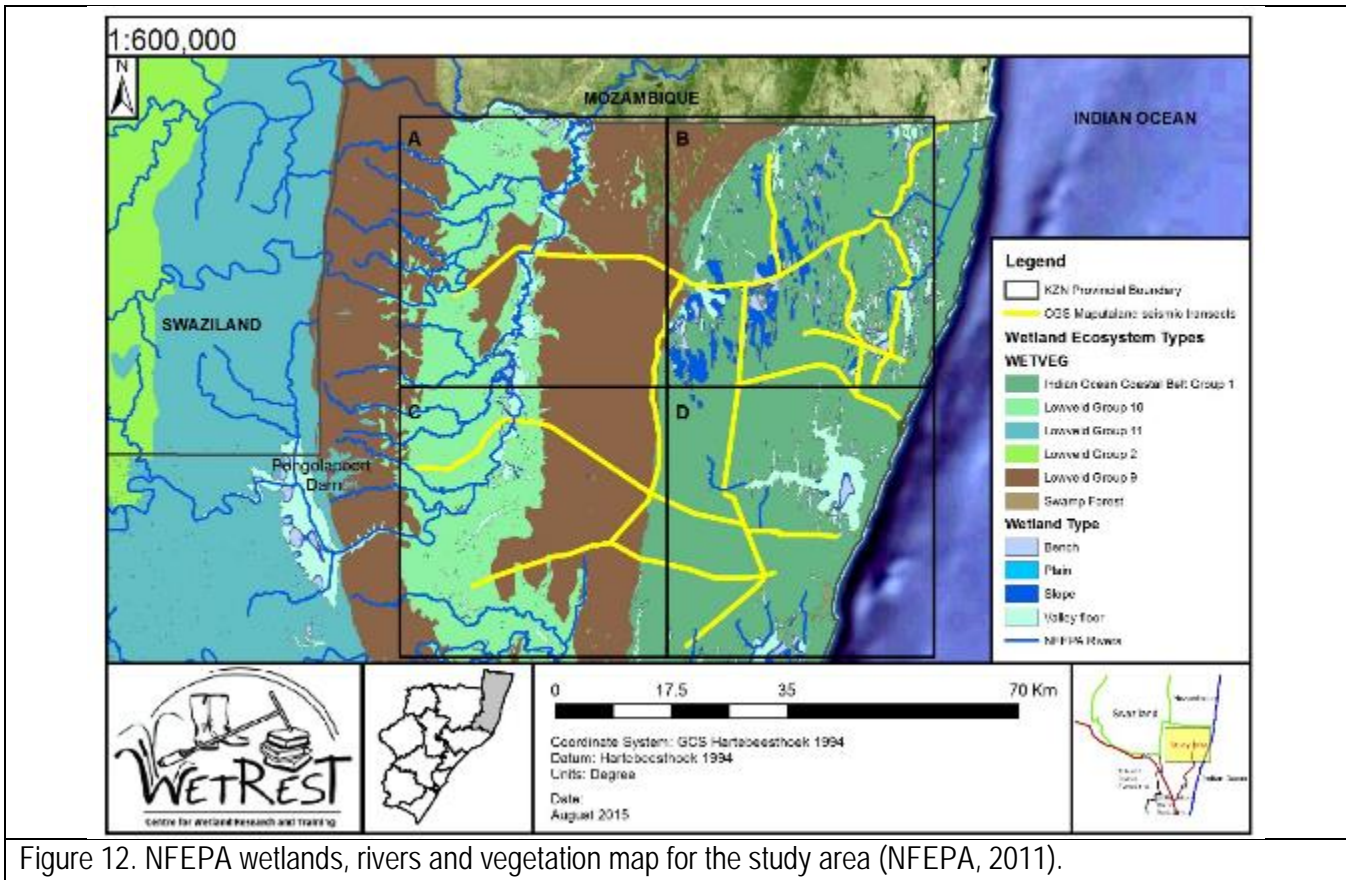


Figure 11. Protected areas and buffer zones within the study area (DEA, 2013)

NFEPA

Through the NFEPA data that is available it is seen that the study area lies within numerous vegetation types. These vegetation types have been discussed in section 7.4. There are an abundance of wetlands located within the study area, ranging between bench, slope, valley bottom wetlands and depression wetlands. It should be noted that NFEPA is a national assessment tool and such several discrepancies exist in the database. The system tends to subdivide wetlands in Maputaland into various smaller sections often classifying these smaller wetland parcels incorrectly. Therefore these wetlands that have been reviewed through a site visit in August 2015 and re-classified in the result and discussion section.

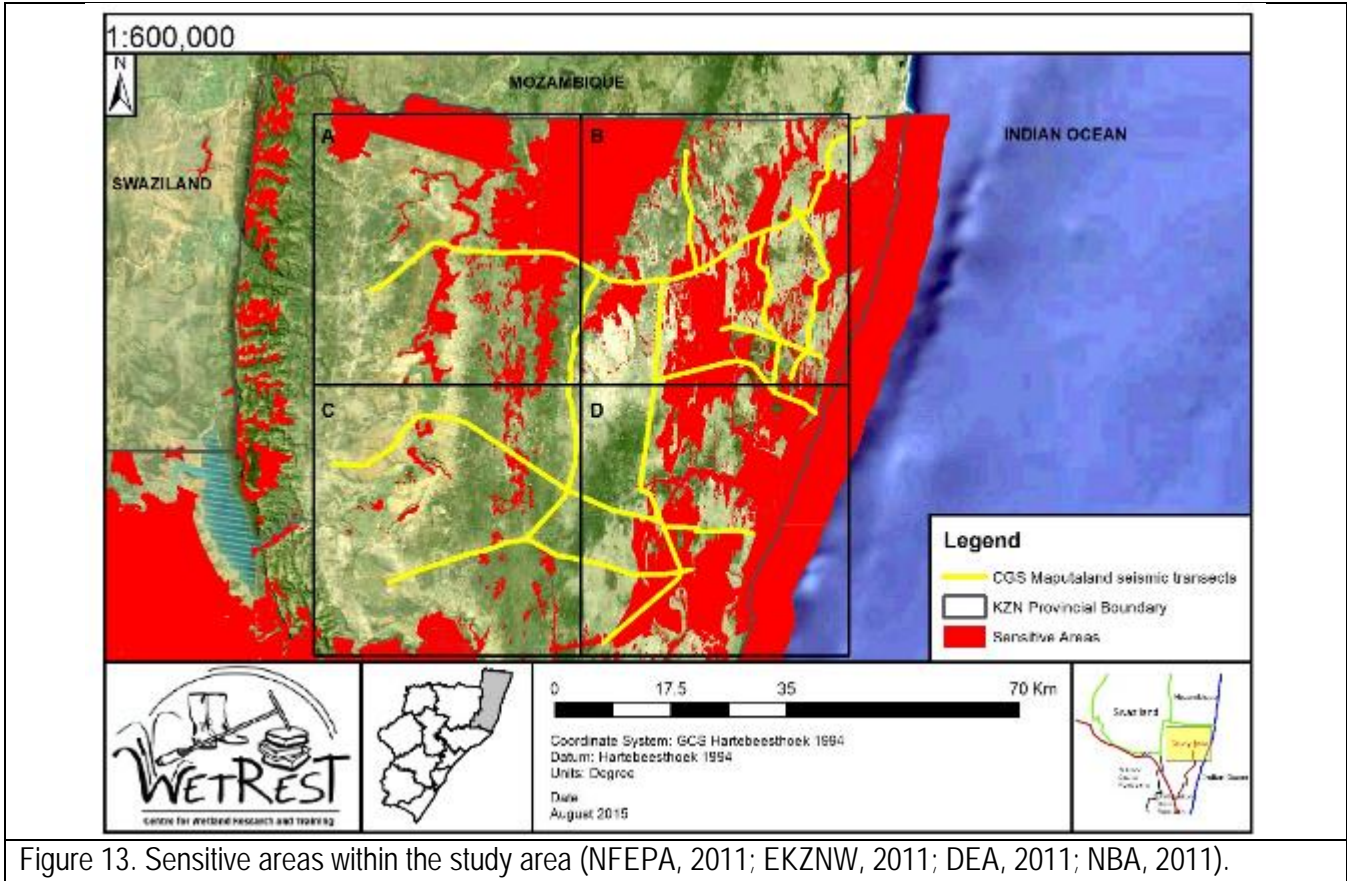
The area has an array of NFEPA Rivers flowing over the landscape. The main NFEPA River found within the study area is the Phongolo River along with its tributaries that lies toward the west of the river, running from the uphill localities of the Lebombo Mountain Range (Section A and C). Towards the far southern portion (Section C) the Mkuze River lies with its tributaries stretching in a northerly direction. In the eastern portion of the study area (Section B) there are NFEPA Rivers, flowing seaward through Kosi Lake.



8.3.3. Sensitivity based on literature

Based on the information gathered through the national and provincial data, the study area's sensitivity was determined. The sensitivity of the area has been defined by the wetlands classified by:

- KZN surveyors;
- EKZNW's CBA 1 Mandatory areas;
- The areas known as Endangered or Critically Endangered
- Protected Areas (As per NEM:PAA)



9 RESULTS AND DISCUSSION

9.1. Wetlands Identified

9.1.1. Study Area

Based on a site visit done in August 2015, 40 wetlands were identified, based on their NFEPa wetland status. These wetlands are concentrated towards the northern sections of the study area.

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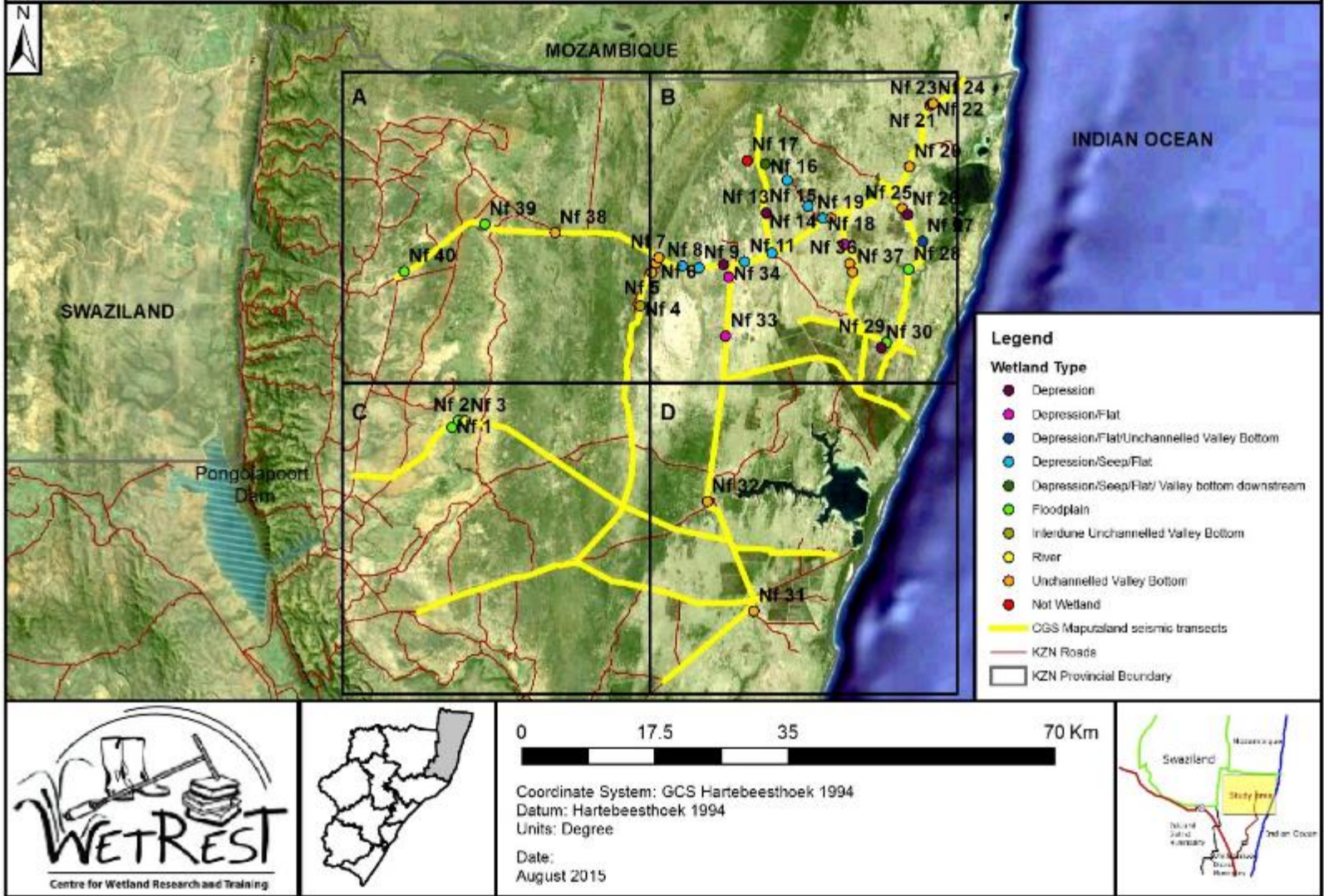
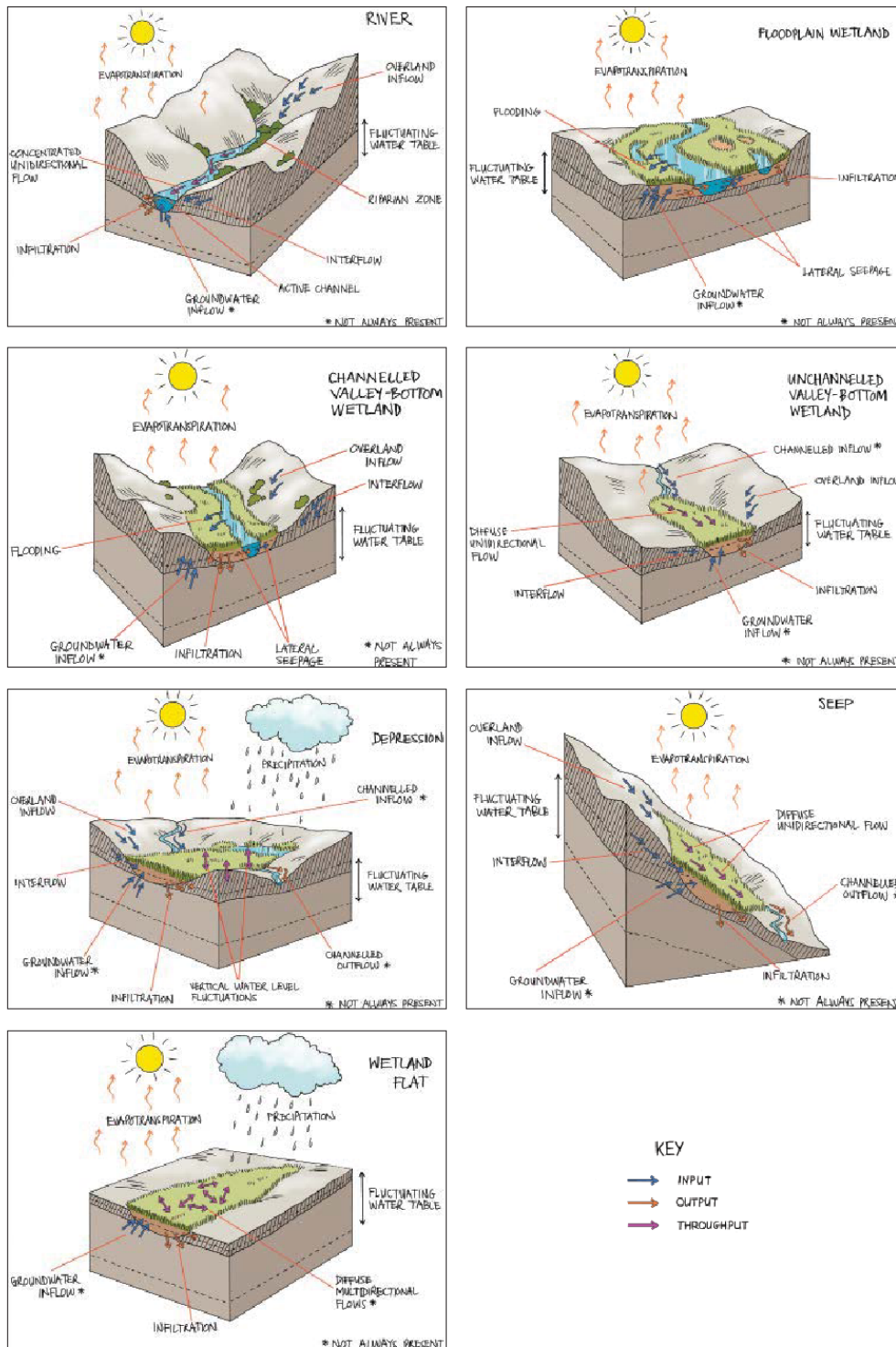


Figure 14. Identified wetlands locations and types according to NFEPA.

These wetlands have been classified mainly based on their pedological and geomorphological features by the onsite specialists. There were a total of 7 drainage systems identified along with the sensitive vegetation at the specific NFEPA wetland points:

Table 2. Hygrogeomorphic units identified in the study area (Extracted from Ollis *et al*, 2013).



9.1.2. Section A

Section A is described in Table 3 and localities marked in Figure 15.

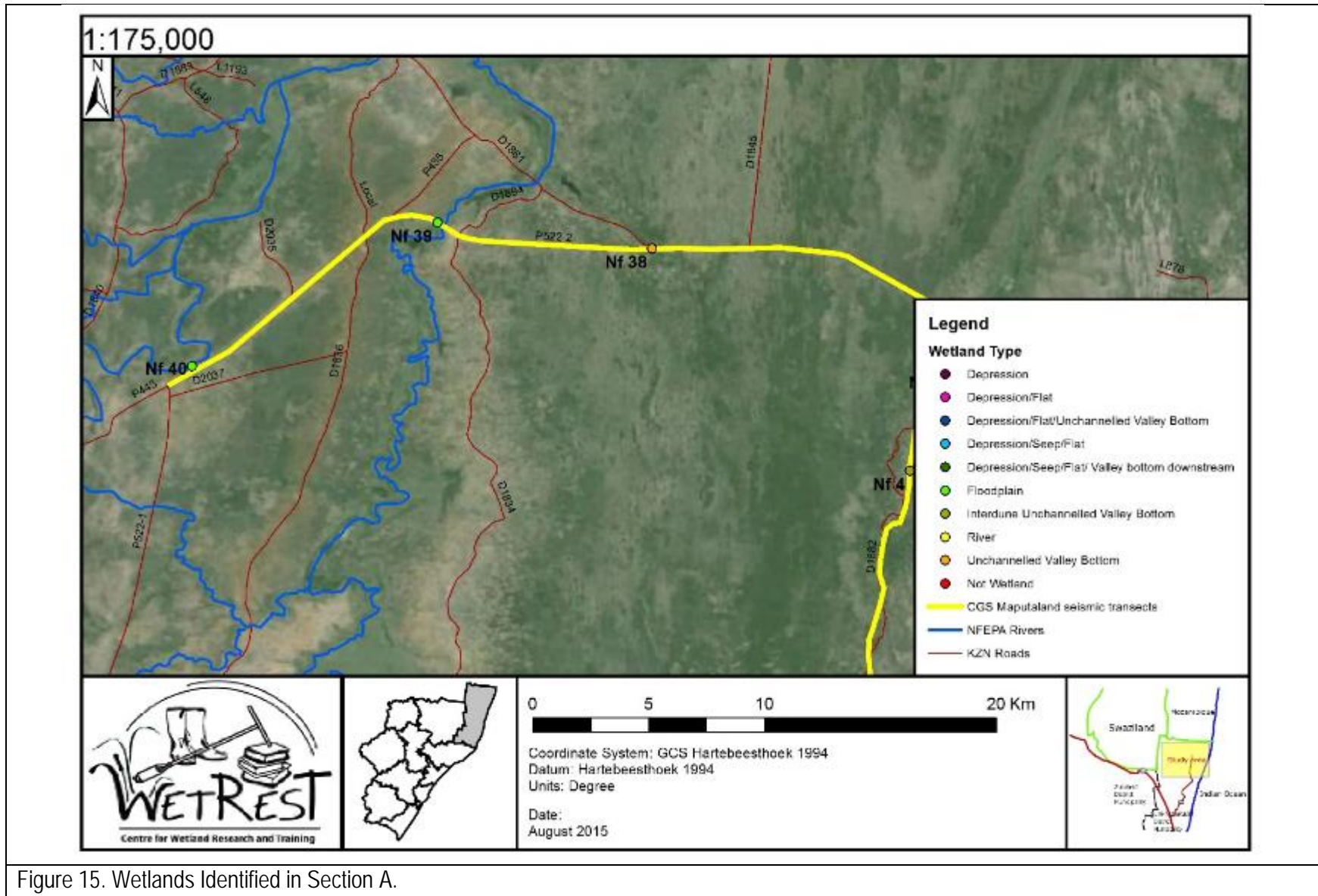


Figure 15. Wetlands Identified in Section A.

Table 3. Description of wetlands identified in Section A.

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 4 (FID 1287, 1307, 1398, 1408, 1534, 1548, 1551, 1661)	27°07'56.10" S 32°26'50.40" E	On Road	Unchannelled Valley Bottom in inter dune setting with small depressions	Muzi north Headwaters	Roads, quarries, tracks, gardens, fences, overgrazing, trampling, soccer fields and AIP.	None, but stay on road
Nf 38 (FID 819)	27°02'45.30" S 32°20'49.70" E	On road	Temporary Unchannelled Valley Bottom	Pongola	Roads, cultivation, over grazing, AIP and Trampling.	None
Nf 39 (FID 160)	27°02'09.20" S 32°15'49.50" E	On road	Floodplain	Pongola	Roads, Bush clearing, cultivation, over grazing, AIP, trampling, veterinary fence, power lines and edge of urban sprawl.	None
Nf 40 (FID 1006, 1010, 1037)	27°05'29.50" S 32°10'06.20" E	200 m from road, however road crosses tributaries	Floodplain, Riparian Zone	Ingwavuma	Roads, tracks, stormwater, riparian zone/ bush clearing cultivation, over grazing, AIP, trampling, veterinary fence, power lines, sand winning in stream and brick making.	None

Table 4. Site-specific information

NF 4



Vegetation description:

This wetland system does have several depression-like features and dominant species occurring are graminoides: *Cynodon dactylon*, *Sporobolus subtilis*, *Panicum maximum*, *Eragrostis curvula*, etc. Sedges such as: *Cyperus longus*, *Cyperus involucratus*, *Pycreus polystachyus*, etc. occur. Woody species such as: *Euclea natalensis*, *Acacia kosiensis*, *Cissus triangularis*, *Hyphaene coriacea*, *Phoenix reclinata*, *Gymnosporia senegalensis*, *Carissa bispinosa*, *Solanum incanum*, etc. are dominant on the fringes.

NF 38



Vegetation description:

Disturbances such as bush clearing have a negative impact on species composition and diversity. In this bushveld environment woody species such as: *Anemia tetraantha*, *Trichilia dregeana*, *Ximenia caffra*, *Gymnosporia senegalensis*, *Dichrostachys cinerea*, *Solanum incanum*, *Parinari capensis*, etc. occur. Diagnostic grasses such as: *Aristida congestus*, *Melinis repens*, *Themeda triandra*, etc. are present. Exotic species found on

this site include: *Psidium guajava*, *Lantana camara*, *Senna didymobotrya*, etc.

NF 39



Active channel of the Pongola River



Macro channel with high flow channels and depressions

Vegetation description:


Diagnostic riparian woody species such as: *Trichilia emetica*, *Landolphia kirkii*, *Ficus sycomorus*, *Diospyros lycioides*, etc. occur. Graminoides such as: *Echinochloa colona*, *Cynodon dactylon*, *Cyperus fastigiatus*, *Typha capensis*, *Phragmites australis*, *Leersia hexandra*, *Stipagrostis aristidea*, *Sporobolus africana*, *Ischaemum fasciculata*, *Urochloa panicoides*. Hydrophytes *Nymphaea nouchali* were found in the open water with the waterweed, *Eichhornia crassipes*. Exotic species such as: *Ageratum conyzoides*, *Ricinus communis*, *Xanthium strumarium*, *Lantana camara*, *Melia azedarach*, etc. were found on the site.

NF 40



Degraded riverine habitat



Subsistence farming	Brick factory in macro channel
	
<p>Sand mining in macro channel</p>	
<p>Vegetation description: In a highly disturbed environment diagnostic species such as: <i>Trichilia emetica</i>, <i>Acacia xanthophloea</i>, <i>Ficus sycomorus</i>, etc. are present. Other prominent species such as grasses: <i>Echinochloa colona</i>, <i>Cynodon dactylon</i>, <i>Melinis repens</i>, <i>Phragmites australis</i>, <i>Stipagrostis aristidea</i>, <i>Sporobolus africana</i>, <i>Urochloa panicoides</i>, etc. occur. The following species commonly occur: <i>Cyperus fastigiatus</i>, <i>Commelina benghalensis</i>, <i>Leonotis sp.</i>, <i>Asclepias fruticosa</i>, etc.. Exotic species found included: <i>Ricinus communis</i>, <i>Tagetes minutes</i>, <i>Senna hirsuta</i>, <i>Xanthium strumarium</i>, <i>Lantana camara</i>, <i>Ageratum conyzoides</i>, etc.</p>	

9.1.3. Section B

Section B is described in Table 5 and localities marked in Figure 16.

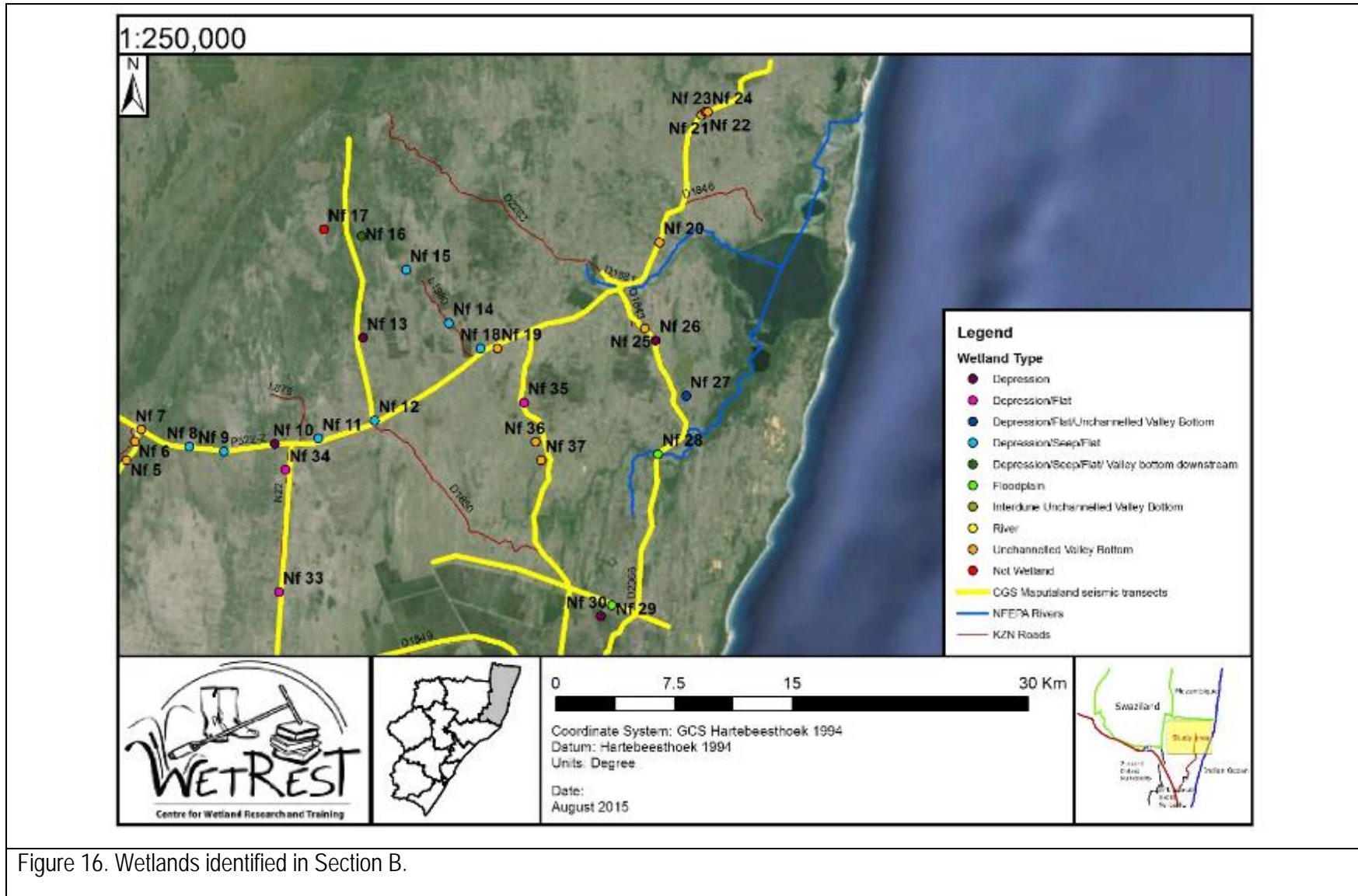


Figure 16. Wetlands identified in Section B.

Table 5. Description of wetlands identified in Section B.

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 5 (FID 1082)	27°05'33.60" S 32°27'40.80" E	On road	Unchannelled Valley Bottom	Muzi north headwaters	Roads bridge, gardens, fences, tracks, over grazing and trampling	None, but stay on road
Nf 6 (FID 1056)	27°04'54.5" S 32°13'58.60" E	On road	Unchannelled Valley Bottom	Muzi north headwaters	Road, school, gardens, fences, tracks, over grazing, trampling and AIP – Blue gum	None, but stay on road
Nf 7 (FID 1015)	27°04'30.40" S 32°28'28.80" E	On road	Unchannelled Valley Bottom	Muzi north headwaters	Road, quarry, gardens, fences, tracks, over grazing, trampling and AIP.	None, but stay on road
Nf 8 (1057)	27°05'05.60" S 32°29'49.80" E	On road	Depression, Seep and Flat	Makhatini palmveld	Road, over grazing, trampling, waterholes, gardening and ploughing in places, power lines and veterinary fence.	None, but stay on road
Nf 9 (FID 903)	27°05'15.0" S 32°31'01.60" E	On road	Depression, Seep and Flat with Peatland (0.8 m peat)	Makhatini palmveld	Road, over grazing, trampling, waterholes, gardening and ploughing in places, power lines and veterinary fence.	None, but stay on road
Nf 10 (FID 1088)	27°04'59.90" S 32°32'46.00" E	On road	Depression	Makhatini palmveld	Road, tracks, over grazing, trampling, quarry, fences, gardening, power lines, veterinary fence.	None, but stay on road
Nf 11 (FID 977)	27°04'48.40" S 32°34'15.60" E	On road	Depression, Seep and Flat	Makhatini palmveld	Road, tracks, school, over grazing, trampling, fences, gardening, power lines and veterinary fence.	None, but stay on road

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 12 (FID 1044)	27°04'11.60" S 32°36'10.00" E	On road	Depression, Seep and Flat	Makhatini palmveld	Road, tracks, over grazing, trampling, fences, gardening, power lines and veterinary fence.	None, but stay on road
Nf 13 (FID 799)	27°01'21.10" S 32°35'47.40" E	300 m from road	Depression	Makhatini palmveld	Tracks, grazing and old gardens. In good condition.	None, but stay on road
Nf 14 (FID 595)	27°00'51.20" S 32°38'44.40" E	On alternative road	Depression, Seep and Flat	Makhatini palmveld	Road, tracks, forestry (bluegum) and waterhole/ quarry.	None, but stay on road
Nf 15 (FID 630)	26°59'01.50" S 32°37'16.00" E	On alternative road	Depression, Seep and Flat	Makhatini palmveld	Road, tracks, grazing, forestry (bluegum), gardens, fences and old gardens.	None, but stay on road
Nf 16 (FID 591, 106)	26°57'52.60" S 32°35'44.00" E	On alternative road (500 m from 'old' route)	Depression, Seep and Channelled Valley Bottom downstream of road	Makhatini palmveld	Road, tracks, grazing, trampling, fences and gardens (downstream)	None, but stay on road
Nf 17 (FID 430)	26°57'38.00" S 32°34'27.00" E	On road	Sand forest, Not wetland	Makhatini palmveld	Road, tracks, grazing, forestry (bluegum) trampling, fences, old gardens and gardens	None, but stay on road
Nf 18 (FID 824, 853)	27°01'42.80" S 32°39'59.80" E	On road	Depression, Seep and Flat	Makhatini palmveld	Road, tracks, construction camp, over grazing, trampling, fences, gardening and power lines.	None, but stay on road
Nf 19 (FID 663)	27°01'42.80" S 32°39'59.80" E	On road	Unchannelled Valley Bottom; Peatland, Raphia palms	Makhatini palmveld	Road, tracks, grazing, trampling, fences, gardening, draining; power lines, housing – in urban sprawl, hardware stores etc. AIP-bluegum and others	None, but stay on road

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 20 (FID 439)	26°58'05.20" S 32°45'57.20" E	On road	Unchannelled Valley Bottom; Peat; Swamp forest	Makhatini palmveld	Road, tracks, grazing, trampling, fences, gardening, draining; power lines, housing – in urban sprawl, hardware stores etc. AIP-bluegum and others	None, but stay on road
Nf 21 (FID 126, 318)	26°53'43.00" S 32°47'23.30" E	On road	Unchannelled Valley Bottom; Peat; Swamp forest	Makhatini palmveld	Road, tracks, grazing, trampling, fences, gardening, draining; power lines, housing – in edge of urban sprawl, AIP-bluegum and others (loading bay south of road for timber)	None, but stay on road
Nf 22 (FID 294)	26°53'36.60" S 32°47'37.10" E	On road	Depression/ Flat	Makhatini palmveld	Road, tracks, grazing, trampling, gardening, draining; power lines, housing and plantation (bluegum)	None, but stay on road
Nf 23 (FID 287, 299)	26°53'36.60" S 32°47'37.10" E	On road	Depression/ Flat	Makhatini palmveld	Road, tracks, grazing, trampling, gardening, draining; power lines, housing and plantation (bluegum)	None, but stay on road
Nf 24 (FID 770)	26°53'36.60" S 32°47'37.10" E	On road	Unchannelled Valley Bottom; Peat; Swamp forest	Makhatini palmveld	Road, tracks, grazing, trampling, gardening, draining; power lines, housing, plantation (bluegum), water abstraction, pipeline and a pump station	None, but stay on road
Nf 25 (FID 752)	27°01'02.10" S 32°45'26.60" E	On road	Unchannelled Valley Bottom; Peat	Makhatini palmveld	Road, tracks, grazing, trampling, gardening, draining; power lines,	None, but stay on road

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
					housing and plantation (bluegum).	
Nf 26 (FID 841)	26°53'36.60" S 32°47'37.10" E	On road	Depression	Makhatini palmveld	Road, tracks, grazing, gardening, draining; power lines, housing, plantation (bluegum) (less degraded than rest, good vegetation cover).	None, but stay on road
Nf 27 (FID 922, 954, 975, 1004, 1022)	27°03'21.00" S 32°46'51.90" E	On road	Depression/ Flat /Unchannelled Valley Bottom; Peatland; Swamp forest	Makhatini palmveld	Road, tracks, grazing, gardening, draining; fences power lines, housing, plantation (bluegum) (less degraded than rest, good vegetation cover) and peat fire (ash) wells.	None, but stay on road
Nf 28 (FID 1125, 1144, 1177, 1463)	27°05'20.80" S 32°45'54.30" E	On road	Floodplain; Peatland; Swamp forest	Makhatini palmveld	Road, tracks, grazing, gardening, draining; power lines, housing, plantation (bluegum) (less degraded than rest, good vegetation cover).	None, but stay on road
Nf 29 (FID 1681, 1725, 1729, 1754, 1760, 1773)	27°10'31.30" S 32°44'19.10" E	On road	Floodplain; Peatland; Swamp forest	Makhatini palmveld	Road, tracks, grazing, plantation (bluegum with pine), gardens, draining, fences. Bracken fern extensive.	None, but stay on road
Nf 30 (FID 1737, 1759, 1761)	27°10'54.60" S 32°43'56.30" E	50 m from road	Depression; Peatland; Swamp forest	Makhatini palmveld	Road, tracks, grazing, plantation (bluegum with pine), gardens, draining and fences. Peat fires - extensive	None

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 33 (FID 1634, 1728)	27°10'04.30" S 32°32'54.60" E	100 m from road	Depression /Flat	Makhatini palmveld	Tracks, over grazing, AIP bluegum, gardens, draining, fences. Housing, power line and fenced	None
Nf 34 (FID 1099, 1310, 1391)	27°05'53.40" S 32°33'07.80" E	On road	Depression/ Flat	Makhatini palmveld	Road, tracks, over grazing, AIP bluegum, gardens, draining, fences. Housing, power line, fenced, waterholes and bush encroachment	None, but stay on road
Nf 35 (FID 1021)	27°03'34.70" S 32°41'18.60" E	On road	Depression/ Flat	Makhatini palmveld	Road, tracks, over grazing, woodlots (bluegum), housing and waterholes.	None, but stay on road
Nf 36 (FID 1059, 1086, 1170, 1240)	27°04'55.90" S 32°41'42.10" E	Road on edge	Unchannelled Valley Bottom	Makhatini palmveld	Road, tracks, over grazing, woodlots (bluegum), housing and waterholes.	None, but stay on road
Nf 37 (FID 1059, 1086, 1170, 1240)	27°05'33.00" S 32°41'54.30" E	Crossing wetland downstream	Unchannelled Valley Bottom; with Peat	Makhatini palmveld	Road, tracks, gardens, fences, over grazing and bush clearing	Non, but stay on road

Table 6. Site-specific information

NF 5



Impacts:



Excavations in wetland areas



Exotic invasive species such as this Queen of the night (*Cereus jamacaru*)

Vegetation description:

The dominant woody species in this wetland are *Acacia burkei*, *Gymnosporia senegalensis*, *Euclea natalensis*, *Terminalia sericea*, *Hyphaene coriacea*, *Phoenix reclinata*, etc. Dominant grass species are *Echinochloa colona*, *Cynodon dactylon*, *Panicum maximum*, etc. Several exotic species such as *Cereus jamacaru*, *Ricinus communis*, *Tagetes minutes*, etc occur.

NF 6



Vegetation description:

Several woody species occur, such as: *Dichrostachys cinerea*, *Phoenix reclinata*, *Hyphaene coriacea*, *Euclea natalensis*, *Acacia kosiensis*, etc. The

herb *Zantedeschia aethiopica* also occurs in places. Graminoides, such as: *Cynodon dactylon*, *Echinochloa holubii*, *Aristida congestus*, etc. occur.

NF 7



Vegetation description:

The dominant woody species include: *Acacia nilotica*, *Euclea natalensis*, *Gymnosporia senegalensis*, *Dichrostachys cinerea*, *Acacia galpinii*, *Acacia kosiensis*, etc. Graminoid species include: *Cynodon dactylon*, *Echinochloa colona*, *Themeda triandra*, *Panicum coloratum*, etc.

NF 8



Vegetation description:

Diagnostic woody species such as *Acacia burkei*, *Phoenix reclinata*, *Gymnosporia markwardii*, *Garcinia livingstonii*, *Annona senegalensis*, *Trichilia dregeana*, *Bridelia cathartica*, etc. occur. The herb *Crinum macowanii* also occurs. Sedges such as: *Pycnus polystachyos*, *Cyperus denudatus*, etc. also occur in places. *Cynodon dactylon*, *Echinochloa colona*, *Themeda triandra* are some of the graminoides that are present. It is important to note that the endemic *Helichrysopsis septentrionale* may occur in-between the sedges and grasses.

NF 9



Vegetation description:

The woody species occur mainly on the fringe of this wetland with species such as: *Acacia nilotica*, *Euclea natalensis*, *Gymnosporia senegalensis*, *Dichrostachys cinerea*, *Acacia galpinii*, *Acacia kosiensis*, etc. Graminoid species include: *Cynodon dactylon*, *Echinochloa colona*, *Themeda triandra*, *Panicum coloratum*, etc. The endemic *Helichrysopsis septentrionale* may also occur in this wetland.

NF 10



Vegetation description:

Mainly woody species such as: *Phoenix reclinata*, *Hyphaene coriacea*, *Acacia kosiensis*, *Dichrostachys cinerea*, and *Acacia burkei* were identified. Graminoides such as: *Cynodon dactylon*, *Aristida congestus*, *Eragrostis curvula*, etc. occur.

NF 11



Vegetation description:

Woody species such as: *Terminalia sericea*, *Acacia nilotica*, *Euclea natalensis*, *Gymnosporia senegalensis*, *Dichrostachys cinerea*, *Acacia galpinii*, *Acacia kosiensis*, etc. occur. *Cynodon dactylon* and *Echinochloa colona* occur with sedges *Cyperus fastigiatus* and *Pycneus polystachyos*.

NF 12



Vegetation description:

This wetland is mostly dominated by graminoides such as: *Eragrostis curvula*, *Dactyloctenium australe*, *Perotis patens*, *Eragrostis lappula*, *Sporobolus subtilis*, etc. Sedges such as: *Cyperus fastigiatus*, *Cyperus natalensis*, *Pycreus polystachyos*, and the forb *Centella asiatica*, occur.

NF 13



Vegetation description:

Graminoides dominate this system and include species such as: *Dactyloctenium geminatum*, *Stenotaphrum secundatum*, *Sporobolus subtilis*, etc. The sedge *Cyperus longus* was also identified. Woody species occur on the fringes with species such as: *Dichrostachys cinerea*, *Phoenix reclinata*, *Hyphaene coriacea*, *Lippia javanica*, etc.

NF 14



Vegetation description:

Herbs such as *Gazania krebsiana*, *Helichrysum krausii*, etc. occur. Graminoid species that are dominant are: *Eragrostis lappula*, *Cynodon dactylon*, *Eragrostis curvula*, *Ischaemum fasciculatum*, *Sporobolus subtilis*, etc. Woody species that occur are: *Phoenix reclinata*, *Hyphaene coriacea*, etc.

NF 15



Vegetation description:

This wetland occurs more in a bushveld environment with woody species such as: *Phoenix reclinata*, *Hyphaene coriacea*, *Ozoroa engleri*, *Syzygium cordatum*, *Dichrostachys cinerea*, sp. evident. The herb *Corchorus junodii* was also identified. The sedge *Pycreus polystachyos* occurs with the following graminoides: *Eragrostis lappula*, *Themeda triandra*, *Cynodon dactylon*, etc.

NF 16



Vegetation description:

Woody species that dominate this system are: *Syzygium cordatum*, *Phoenix reclinata*, *Hyphaene coriacea*, *Rhoicissus revoili*, *Garcinia livingstonii*, *Terminalia sericea*, *Acacia burkei*, *Euclea natalensis*, *Dichrostachys cinerea*, etc. The herb, *Helichrysum krausii* and sedges: *Cyperus fastigiatus*, *Pycnus polystachyos*, etc. occur.

NF 17



Vegetation description:

Syzygium cordatum, *Phoenix reclinata*, *Hyphaene coriacea*, *Rhoicissus revoili*, *Garcinia livingstonii*, *Terminalia sericea*, *Acacia burkei*, *Euclea natalensis*, *Dichrostachys cinerea*, etc. are the dominant woody species. The herb, *Helichrysum krausii* and sedges: *Cyperus fastigiatus* and *Pycnus polystachyos* occur in reasonable numbers. The dominant graminoides are: *Aristida congesta*, *Echinochloa colona* and *Eragrostis gummiflua*.

NF 18



Vegetation description:

This wetland's vegetation consists mainly of graminoides such as: *Stenotaphrum secundatum*, *Echinochloa colona*, *Eragrostis sarmentosa*, *Eragrostis lappula*, etc. The herb, *Gazania krebsiana*, occurs in places. Palm species, *Phoenix reclinata* and *Hyphaene coriacea* were found in places. Isolated clumps of the sedge *Pycnus polystachyos* also occurs.

NF 19**Vegetation description:**

This wetland occurs in a town with many disturbances being evident. Woody species such as: *Clerodendrum glabrum*, *Tecomaria capensis*, *Trichilia dregeana*, *Raphia australis*, etc. occur mainly on the edge of the valley bottom wetland. Graminoides such as: *Phragmites australis*, *Typha capensis*, *Panicum maximum*, *Panicum coloratum* and *Stipagrostis aristidea* occur. The sedges: *Cyperus latifolius*, *Schoenoplectus* sp., *Cyperus fastigiatus*, etc. are also present. Exotic species such as *Psidium guava*, *Senna didymobotrya*, *Citrus lanatus*, etc. are also present.

NF 20



Upstream of road



Downstream of road

Vegetation description:

This swamp forest hosts typical forest species such as: *Ficus trichopoda*, *Voacanga thouarsii*, *Rapanea melanophloeos*, *Typha capensis*, *Imperata cylindrica*, *Mentha aquatica*, *Cynodon dactylon*, *Syzygium cordatum*, *Thelypteris interrupta*, *Cyperus latifolius*, etc. The exotic *Hydrocotyle bonariensis* was found to occur mostly on the forest edges.

NF 21



Vegetation description:

This interdune wetland hosts diagnostic species such as graminoids: *Stenotaphrum secundatum*, *Leptochloa fusca*, *Themeda triandra*, *Digitaria eriantha*, *Sporobolus africanus*, etc. The herb, *Helichrysum krausii* also occurs in reasonable numbers. Sedge species such as: *Schoenoplectus* sp., *Abildgaardia triflora* and *Pycreus polystachyos* also occurs. Exotic species common in the area are *Centella asiatica*, *Psidium guajava*, *Senna didymobotrya*, etc.

NF 22



Vegetation description:

Graminoid species dominate this system with: *Stenotaphrum secundatum*, *Leptochloa fusca*, *Leptochloa fusca*, *Themeda triandra*, *Digitaria eriantha*, *Sporobolus africanus*, etc. present. The herb, *Helichrysum krausii* also occurs. Sedge species that are common include: *Schoenoplectus* sp., *Pycreus polystachyos*, *Abildgaardia triflora*, etc. Exotic species include: *Senna didymobotrya* and *Centella asiatica*.

NF 23



Vegetation description:

The dominate graminoides are: *Leptochloa fusca*, *Stenotaphrum secundatum*, *Leptochloa fusca*, *Digitaria eriantha*, *Themeda triandra*, *Sporobolus africanus*, etc. The sedge species that are in the minority are: *Schoenoplectus* sp., *Pycreus polystachyos* and *Abildgaardia triflora*. Exotic species found on site include: *Senna didymobotrya* and *Centella asiatica*. The herb, *Helichrysum krausii* also occurs.

NF 24



Vegetation description:

The diagnostic grass species are *Stenotaphrum secundatum*, with numerous species such as: *Leptochloa fusca*, *Cynodon dactylon*, *Eragrostis capensis*, *Sporobolus subtilis*, etc. Sedges include: *Schoenoplectus sp.*, *Cyperus involucratus*, etc. Herbs such as: *Helichrysum krausii*, *Centella asiatica* and *Pteridium aquilinum* are also present. The only woody species encountered was *Syzygium cordatum*.

NF 25



Impacts:



Vegetation description:

Diagnostic species include the following grasses: *Stenotaphrum secundatum*, *Sporobolus subtilis*, *Andropogon huillensis*, *Eragrostis lappula*, *Themeda triandra*, *Ischaemum fasciculatum*, *Paspalum virgatum*, *Eragrostis sarmentosa*, *Hyperthelia dissoluta*, etc. in this grass-dominated system.

NF 26



Vegetation description:

The most prominent taxon is the grass, *Stenotaphrum secundatum* while there are other prominent species such as: *Sporobolus subtilis*, *Eragrostis sarmentosa*, etc. Other diagnostic members are the following sedges: *Schoenoplectus maritimus*, *Cuscuta campestris*, *Cyperus natalensis* and the herb, *Helichrysum krausii*.

NF 27



Vegetation description:

Diagnostic grass species include: *Imperata cylindrica*, *Phragmites australis*, *Eragrostis inamoena*, *Ischaemum fasciculatum*, etc. Other consistent species include: *Ozoroa engleri*, *Cyperus prolifer*, *Ludwigia* sp., *Cyclosorus interruptus*, *Pteridium aquilinum*, *Centella asiatica*, *Thelypteris interrupta*, *Hydrocotyle bonariensis*, etc.

NF 28



Vegetation description:

Typical floodplain species occurring here are woody species such as: *Antidesma venosum*, *Ficus trichopoda*, *Psychotria capensis*, *Barringtonia racemosa*, *Bridelia macrantha*, *Phoenix reclinata*, *Hyphaene coriacea*, *Syzygium cordatum*, *Euclea natalensis*, *Ziziphus mucronata*, etc. Other prominent species include: *Panicum maximum*, *Cynodon dactylon*, *Eragrostis sarmentosa*, *Leersia hexandra*, *Phragmites australis*, etc.

NF 29



Degraded wetland habitat as a result of afforestation



Subsistence farming in wetland area



Invasive Bracken fern (*Pteridium aquilinum*)

Vegetation description:

The wetland occurs in a disturbed environment and is dominated by *Pteridium aquilinum*. Other diagnostic species include: *Stenotaphrum secundatum*, *Cynodon dactylon*, *Centella asiatica*, *Themeda triandra*, *Eragrostis sarmentosa*, *Panicum glandulopaniculatum*, and *Dactyloctenium australe*. Remnants of *Syzygium cordatum* still occur in the area.

NF 30





Burnt soil material after uncontrolled fires



Leached iron oxides after uncontrolled fires

Vegetation description:

Diagnostic species that occur in this burnt environment include: *Pycreus polystachyos*, *Eragrostis sarmentosa*, *Cynodon dactylon*, *Ischaemum fasciculatum*, *Diospyros lycioides*, *Cyperus fastigiatus*, *Hydrocotyle bonariensis*, and *Cyperus sphaerospermus*, with scattered *Syzygium cordatum* species.

NF 33



Vegetation description:

Diagnostic species include, grass species: *Stenotaphrum secundatum*, *Paspalum africanum*, *Eragrostis sarmentosa*, *Cynodon dactylon*, etc. Woody species include: *Phoenix reclinata*, *Hyphaene coriacea*, *Syzygium cordatum*, *Dichrostachys cinerea*, etc. Other prominent species in the area: *Hoslundia opposita*, *Pycreus polystachyos* and *Helichrysum krausii*. *Psidium guajava* is the only exotic species found in this wetland.

NF 34



Vegetation description:

The wetland is dominated by the following most prominent taxon, *Stenotaphrum secundatum*. Other prominent species include: *Pycreus polystachyos*, *Melinis repens*, *Sporobolus subtilis*, *Cyperus sp.* *Cynodon dactylon*, *Dichrostachys cinerea*, *Dactyloctenium australe*, etc.

NF 35



Vegetation description:

Diagnostic species of this wetland area are grasses: *Stenotaphrum secundatum*, *Sporobolus subtilis*, *Themeda triandra*, *Eragrostis plana*, etc.

Woody species that occur include: *Strychnos madagascariensis*, *Euclea natalensis subs rotundifolia*, *Parinari curatellifolia*, *Phoenix reclinata*, *Hyphaene coriacea*, *Dichrostachys cinerea*, *Diospyros lycioides*, etc. Other prominent species in the area include: *Helichrysum krausii*, *Cyperus sp.*, *Pycnus polystachyos*, *Cyperus natalensis*, etc.

NF 36



Vegetation description:

Diagnostic to this wetland are grass species such as: *Stenotaphrum secundatum*, *Sporobolus subtilis*, *Cynodon dactylon*, *Themeda triandra*, *Digitaria eriantha*, etc. Other species commonly found include: *Hydrocotyle bonariensis*, *Myrica serrata*, *Cyperus natalensis*, *Phoenix reclinata*, *Hyphaene coriacea*, *Syzygium cordatum*, *Solanum incanum*, etc. The exotic tree *Eucalyptus grandis* also occurs.

NF 37




Vegetation description:

Coccinia cf. adoensis, *Garcinia livingstonii* and *Syzygium guineense* are the woody species, with diagnostic species such as: *Thelypteris interrupta*, *Cyperus prolifera*, *Persicaria serrulata*, *Kyllinga erecta*, *Ischaemum fasciculata*, *Cyperus polystachyos*, etc.

Table 7. Description of wetland identified in Section C

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 1 (FID 1943)	27°16'32.90" S 32°13'29.80" E	300 m SE of the road	Floodplain, seasonal (soil)	Pongola	Roads, cultivation (Sugar cane), overgrazing, AIP and trampling	None
Nf 2 (FID 1916)	27°16'03.8" S 32°13'58.60" E	On road	Floodplain, seasonal (soil)	Pongola	Roads, cultivation (Sugar cane), overgrazing, AIP and trampling	None, but stay on road
Nf 3 (FID 160)	27°16'05.60" S 32°14'27.80" E	On bridge	River, permanent, in floodplain	Pongola	Bridge, roads, cultivation (Sugar cane), overgrazing, AIP and trampling	None, but stay on road

Table 8. Site-specific information

<p>NF 1</p>  <p style="text-align: center;">Cultivation in the Pongola river floodplain</p>
<p>Vegetation description: This site forms part of the Pongola River floodplain and within this disturbed environment diagnostic species such as <i>Acacia xanthophloea</i>, <i>Ficus sycomorus</i>, <i>Cynodon dactylon</i>, <i>Melinis repens</i>, <i>Panicum maximum</i>, etc. occur. The vegetation component is dominated by exotic pioneers such as <i>Argemone mexicana</i>, <i>Tagetes minuta</i>, <i>Bidens bipinnata</i>, <i>Conyza canadensis</i>, <i>Flaveria bidentis</i>, <i>Xanthium strumarium</i>, <i>Melia azedarach</i>, <i>Psidium</i></p>

guajava, etc.

NF 2



Vegetation description:

In this highly disturbed environment in the Pongola floodplain the vegetation component consists mainly of exotic species, such as *Argemone mexicana*, *Tagetes minuta*, *Bidens bipinnata*, *Conyza canadensis*, *Flaveria bidentis*, *Xanthium strumarium*, *Melia azedarach*, *Psidium guajava*, etc.

NF 3



Vegetation description:

The riparian vegetation along the Pongola River is comprised mostly of the following tree species: *Trichilia emetica*, *Ficus sycomorus*, *Ziziphus mucronata*, *Euclea natalensis*, *Acacia xanthophloea*, *Acacia ataxacantha*, etc. The exotic *Melia azedarach* also occurs in places. The dominant graminoides are *Panicum natalensis*, *Setaria sphacelata*, *Cynodon dactylon*, *Phragmites australis*, etc. The waterweed *Eichhornia crassipes* poses a threat to this system.

Table 9. Descriptions of wetlands identified in Section D.

SITE	COORDINATES	LOCATION	TYPE	NAME	CURRENT IMPACTS ON WETLANDS	EXPECTED IMPACT & MITIGATION
Nf 31 (FID 2735, 2731)	27°29'35.00" S 32°34'55.30" E	100 m from the road	Unchannelled Valley Bottom, peatland, swamp forest	Makhatini palmveld, Mbazwana stream	Road, tracks, grazing, plantations, gardens, fences, housing, edge urban sprawl	None
Nf 32 (FID 2279)	27°21'48.70" S 32°31'37.30" E	On road	Unchannelled Valley Bottom, peatland, swamp forest	Makhatini palmveld, Sibayi	Road, tracks, grazing, plantations, gardens, fences, housing, edge urban sprawl	None, but stay on road

Table 10. Site-specific information

<p>NF 31</p> 
<p>Vegetation description: Diagnostic species include: <i>Stenochlaena tenuifolia</i>, <i>Cyperus fastigiatus</i>, <i>Pycreus polystachyos</i>, <i>Cynodon dactylon</i>, <i>Dactyloctenium australe</i> and <i>Pteridium aquilinum</i>. Prominent woody species include: <i>Ficus trichopoda</i>, <i>Syzygium cordatum</i>, <i>Euphorbia tirucalli</i> and <i>Dichrostachys cinerea</i>. Exotic species commonly found in this wetland include: <i>Lantana camara</i>, <i>Solanum mauritianum</i>, <i>Melia azedarach</i> and <i>Psidium guajava</i>.</p>
<p>NF 32</p>



Vegetation description:

The most prominent woody species include: *Apodytes didymata*, *Ficus trichopoda*, *Syzygium cordatum*, *Dichrostachys cinerea*, *Ficus trichopoda*, etc. Common grass species include: *Dactyloctenium australe*, *Cynodon dactylon*, *Typha capensis*, *Panicum maximum*, etc. Other diagnostic species in the area: *Cyperus dives*, *Hydrocotyle bonariensis*, *Commelina benghalensis*, *Persicaria serrulata*, *Cyperus sexangularis*, *Ipomoea purpurea*, *Cyperus fastigiatus*, *Pycnus polystachyos*, and *Pteridium aquilinum*. Exotic species found in this system: *Lantana camara*, *Melia azedarach* and *Psidium guajava*.

10 MITIGATION MEASURES

The following mitigation measures have been proposed for implementing during field work:

- Limit activities to within the existing road network and road reserve,
- Do not impede in wetland areas or their buffers;
- Obtain agreements with the landowners prior to any activities;
- Obtain the necessary approvals for activities within conservation areas and related buffer zones.

11 CONCLUSION

The potential environmental impacts are low due to the seismic surveying transect being laid down to follow the grid of the existing main and district roads. It is proposed that consultation with the relevant regulatory authorities be conducted during the planning of the borehole sites, in order to ensure all their requirements and statutory approvals, if required are obtained.

During the assessment of the proposed area it became apparent that there are numerous sensitive habitat types and wetlands along the transects. Specific care should be taken when conducting the seismic survey. Some mitigation measures have been proposed, which should be implemented during the fieldwork.

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Appendix 3

Jeffares and Green Pty (Ltd). 2015. Geohydrological assessment for uMhlabaylingana Local Municipality, CO₂ storage project. Revision 001, June 2015.

**GEOHYDROLOGICAL ASSESSMENT
FOR UMHLABAYLINGANA LOCAL
MUNICIPALITY
CGS CO₂ STORAGE PROJECT**

JUNE 2015



REVISION 001

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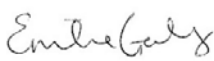


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GEOHYDROLOGICAL ASSESSMENT FOR UMHLABAYLINGANA LOCAL MUNICIPALITY

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GEOHYDROLOGICAL ASSESSMENT FOR UMHLABAYLINGANA LOCAL MUNICIPALITY

1 INTRODUCTION

This report presents the results of a geohydrological investigation for an Environmental Application for potential carbon sequestration in the Umhlabaylingana Local Municipality in northern KwaZulu-Natal. The investigation is at a feasibility stage and the proposed activities associated with the application are as follows:

- Phase 1: Seismic testing
- Phase 2: Deep exploratory drilling

2 INFORMATION SUPPLIED

The following information has been used in the preparation of this report:

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Maps

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- Map Sheet titled, "2732 St Lucia", at a scale of 1:250000, of the Geological Map Series, supplied by the Council for Geoscience
- Map Sheet titled, "Nelspruit 2530", at a scale of 1:500 000, first edition, dated 1998, of the Hydrogeological Map Series of the Republic of South Africa, supplied by the Directorate: Geohydrology, of the Department of Water Affairs and Forestry
- Map Sheet titled, "Vryheid 2730", at a scale of 1:500 000, first edition, dated 1998, of the Hydrogeological Map Series of the Republic of South Africa, supplied by the Directorate: Geohydrology, of the Department of Water Affairs and Forestry
- Aquifer classification, groundwater vulnerability and aquifer contamination susceptibility maps derived from Vegter (1995), by Reynders (1997), and Parsons (1995).

Data

- National Groundwater Archive (NGA) digital information and the Groundwater Resource Information Project (GRIP), as supplied by The Department of Water Affairs (DWA)
- J&G in-house borehole database (recent projects not captured on NGA or GRIP).

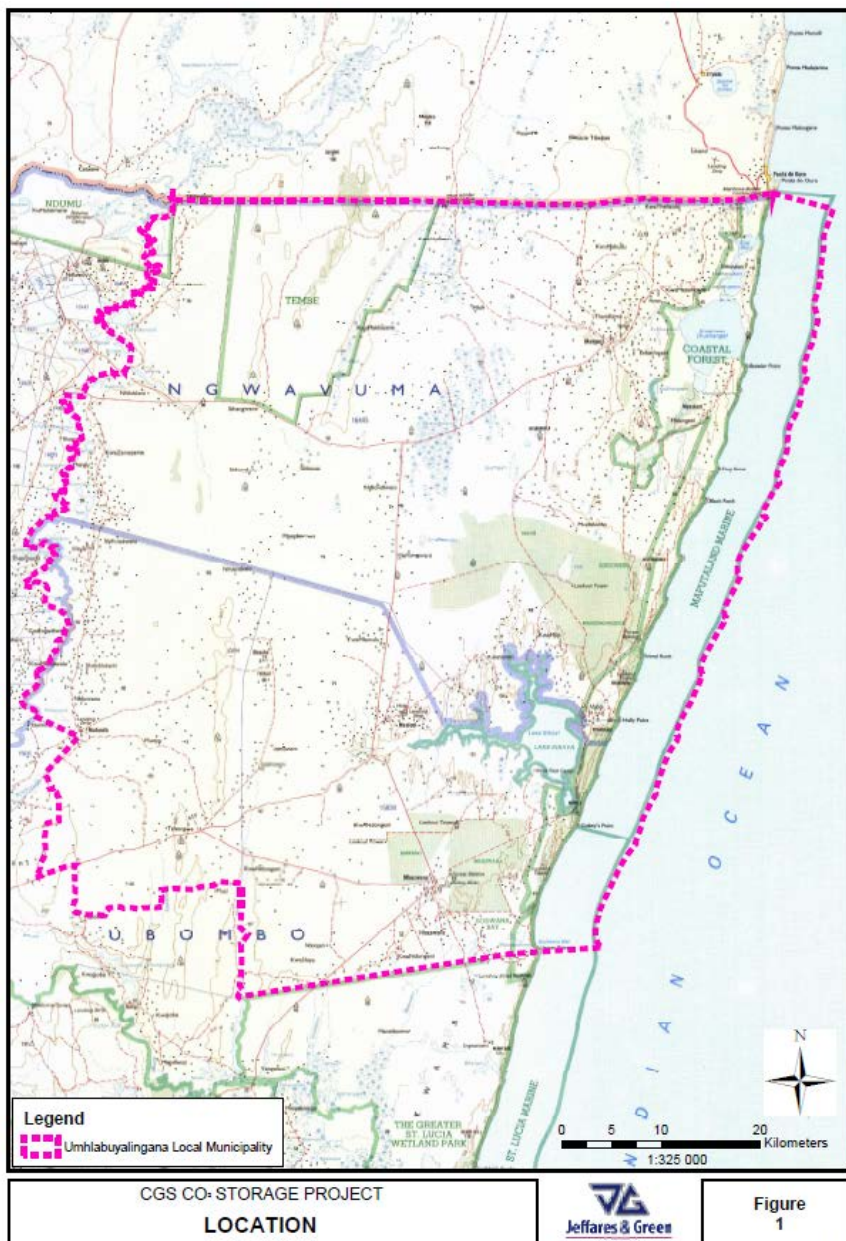
3 DESKTOP AND SITE ASSESSMENT

3.1 Site Description

The Umhlabaylingana Local Municipality is located in northern KwaZulu-Natal and has an area of 4402 square kilometres. The Municipality is predominantly rural, with urban settlements at Mbazwana, Manguzi, Mseleni, Sikhamelele and Mboza.

The Municipality is bordered by Mozambique to the north, the Indian Ocean to the east, the Pongola River to the west, and the St Lucia estuary to the south. The entire area is low-lying, with extensive coastal lakes, notably Lake Sibaya and the Kosi lake system. The land use includes Indian Ocean coastal belt, savannah, pine plantations and protected areas (including Tembe Elephant Park, a small portion of Ndumo Game Reserve, and the Maputland Coastal Forest Reserve).

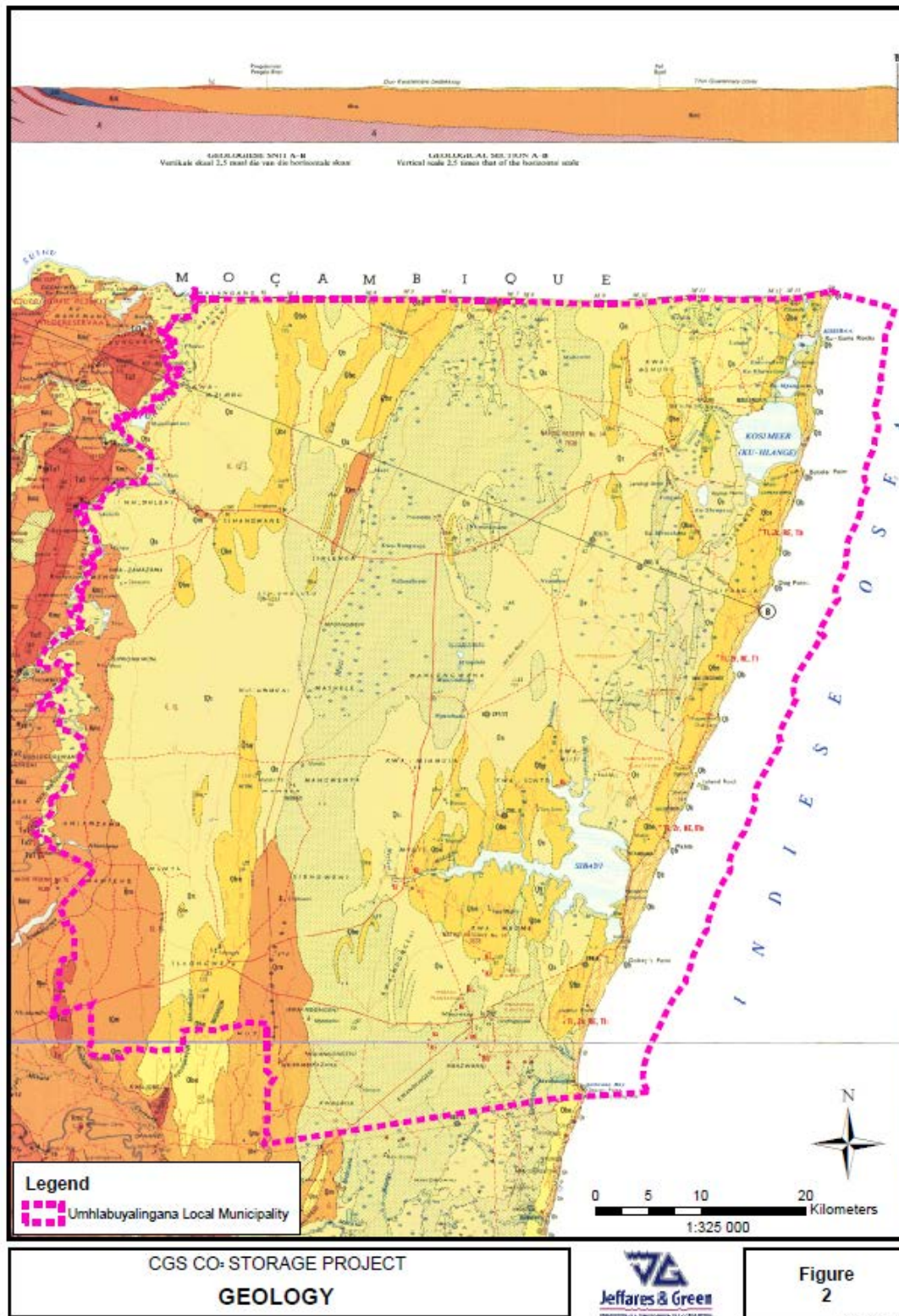
The locality is presented in Figure 1.



3.2 Geology

The geology of the Umhlabaylingana Local Municipality comprises siltstone (with shelly and concretionary horizons) of the Cretaceous aged Mzinene Formation, overlain in all but the most westerly part of the Municipality by a thin Quaternary cover.

The geology is shown in Figure 2:



The lithology is summarised in Table 1.

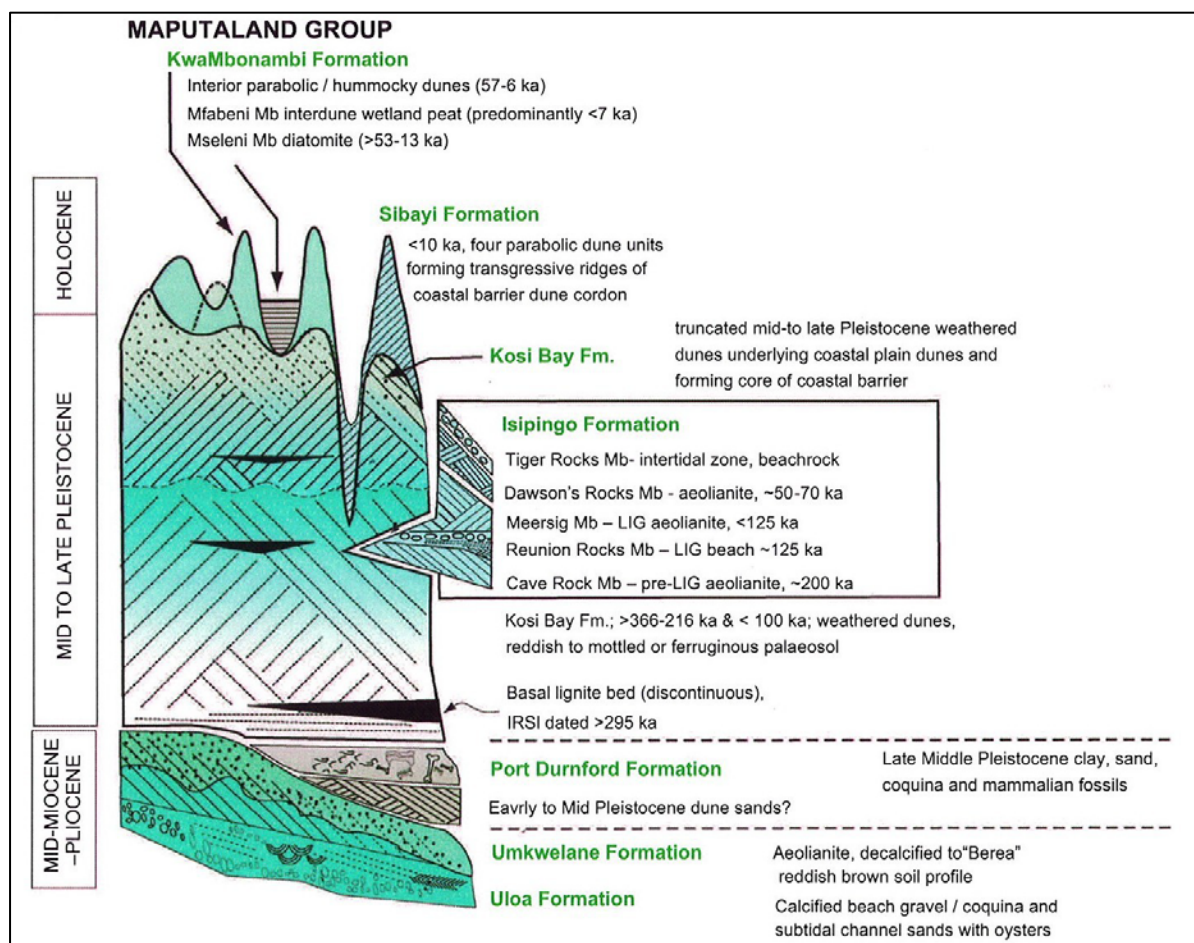
Table 1: summary of lithology

Symbol	Age	Group	Formation	Description
Qs	Quaternary			Alluvium
				Dune and beach sand
				Blown sand
				Yellow redistributed sand
Qbe	Quaternary		Berea	Red dune cordon sand
Qb			Bluff	Calcareous sandstone
Qm			Muzi	Argillaceous sand
Tu2	Tertiary		Uloa	Red sand, red calcarenite, coquina, calcareous sandstone
Kmz	Cretaceous	Zululand	Mzinene	Marine glauconitic siltstone with shelly & concretionary horizons
Jj	Jurassic	Lebombo	Jozini	Rhyodacite and rhyolite

The geological map series describes most of the Municipality to be underlain by yellow redistributed sand.

The surface Quaternary sediments reach up to approximately 100 m thick. The underlying Mzinene Formation has a thickness of approximately 1000 m in the west of the Municipality increasing to over 2000 m at the coast.

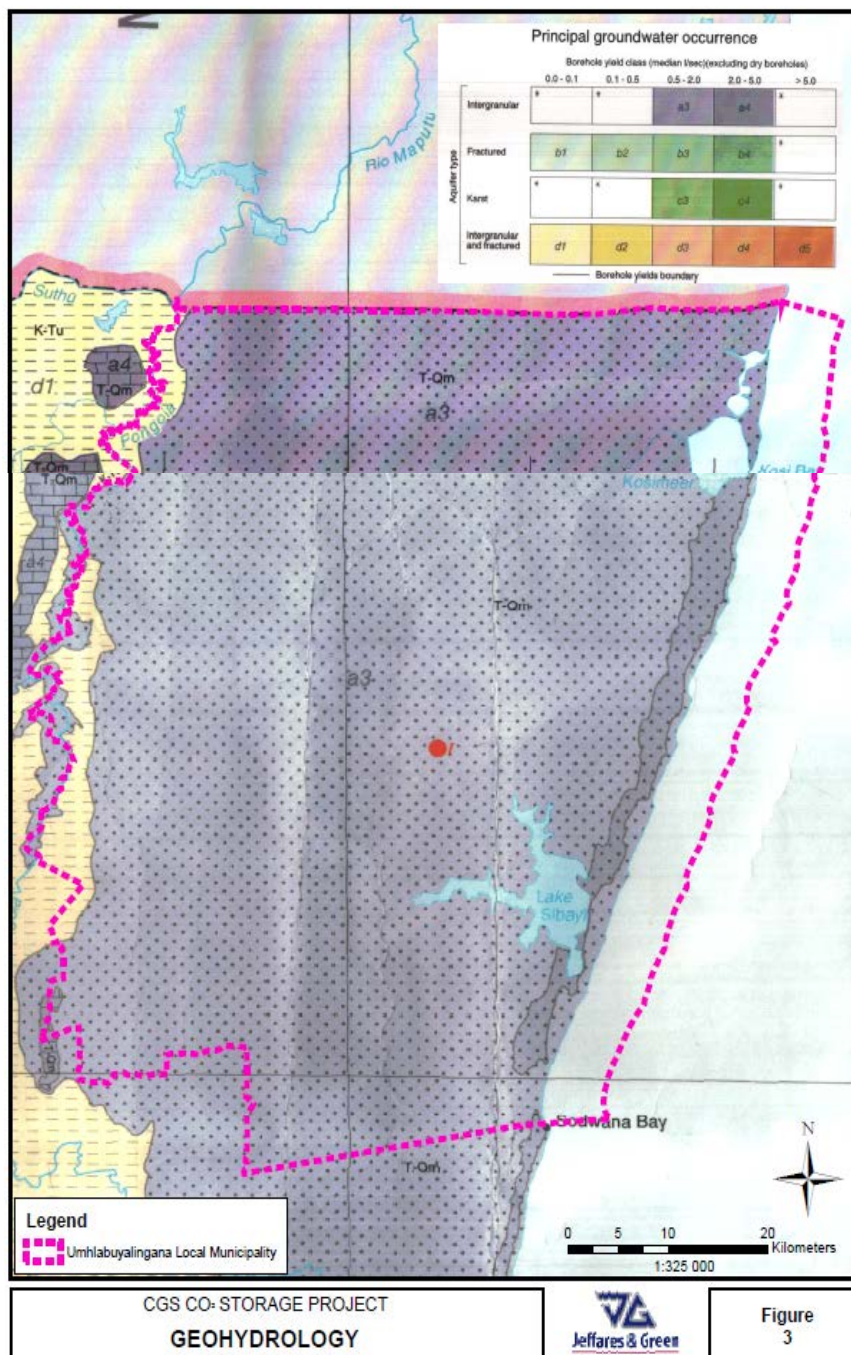
The quaternary and Tertiary sediments, or the Maputaland Group, were updated in 2008, and consist of several stratigraphic units as follows.



The generalized Maputaland Group lithostratigraphic sequence, Botha G.A., and Porat N., 2008.

3.3 Geohydrology

The regional geohydrology of the project area according to the Department of Water Affairs and Forestry published 1:500 000 Hydrogeological Map Series of the Republic of South Africa 1998, is defined as region “a3” which is made up of undifferentiated coastal deposits (unconsolidated to semi-consolidated sediments including sand, calcrete, calc-arenite, aeolianite, conglomerate and clay). The principal groundwater occurrence is noted to be from an intergranular aquifer with an expected median borehole yield in the range 0.5 to 2.0 l/s (43 to 173 Kl/d) from successful boreholes. Groundwater is typically found in the saturated sands. The regional geohydrology of the area is presented in Figure 3.



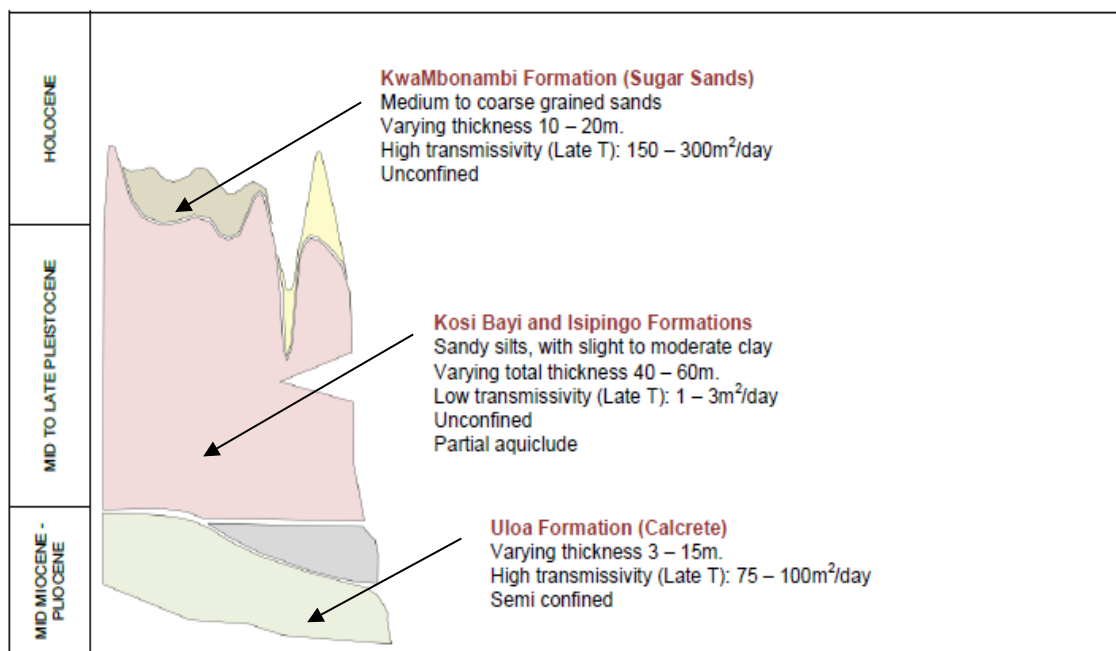
Two areas exist where the geohydrology differs from above, namely:

- the strip of Berea Formation immediately inland of the coast is defined as “a4”, with expected median borehole yield in the range 2 to 5 l/s (173 to 432 Kl/d); and
- the strip of Mzinene Formation in the west of the Municipality is defined as “d1”, which is made up of predominantly argillaceous rocks (shale and siltstone) and with expected median borehole yield in the range 0 to 0.1 l/s (0 to 8.6 Kl/d)

Mean Annual Precipitation is in the region of 600 - 800mm per annum across most of the Municipality, increasing towards the coast, where precipitation is 800 – 1000mm per annum.

Groundwater quality contoured in the above publication indicates the electrical conductivity to be in the range of 0-70 mS/m across most of the Municipality except along the western boundary and in the northwest where electrical conductivity is in the range of 70-300 mS/m.

Geohydrological units within the Quaternary and Tertiary sediments are well defined in accordance with geological Formations of the Maputaland Group, particularly the shallow aquifer relating well to the Kwambonambi Formation, and the deep aquifer relating well to a combination of the Umkwelane and Uloa Formations.



Correlation of stratigraphic units to potential aquifers, Schapers, M., 2011.

It is inferred that the saline aquifer is divorced from the overlying fresh water aquifers via geological controls.

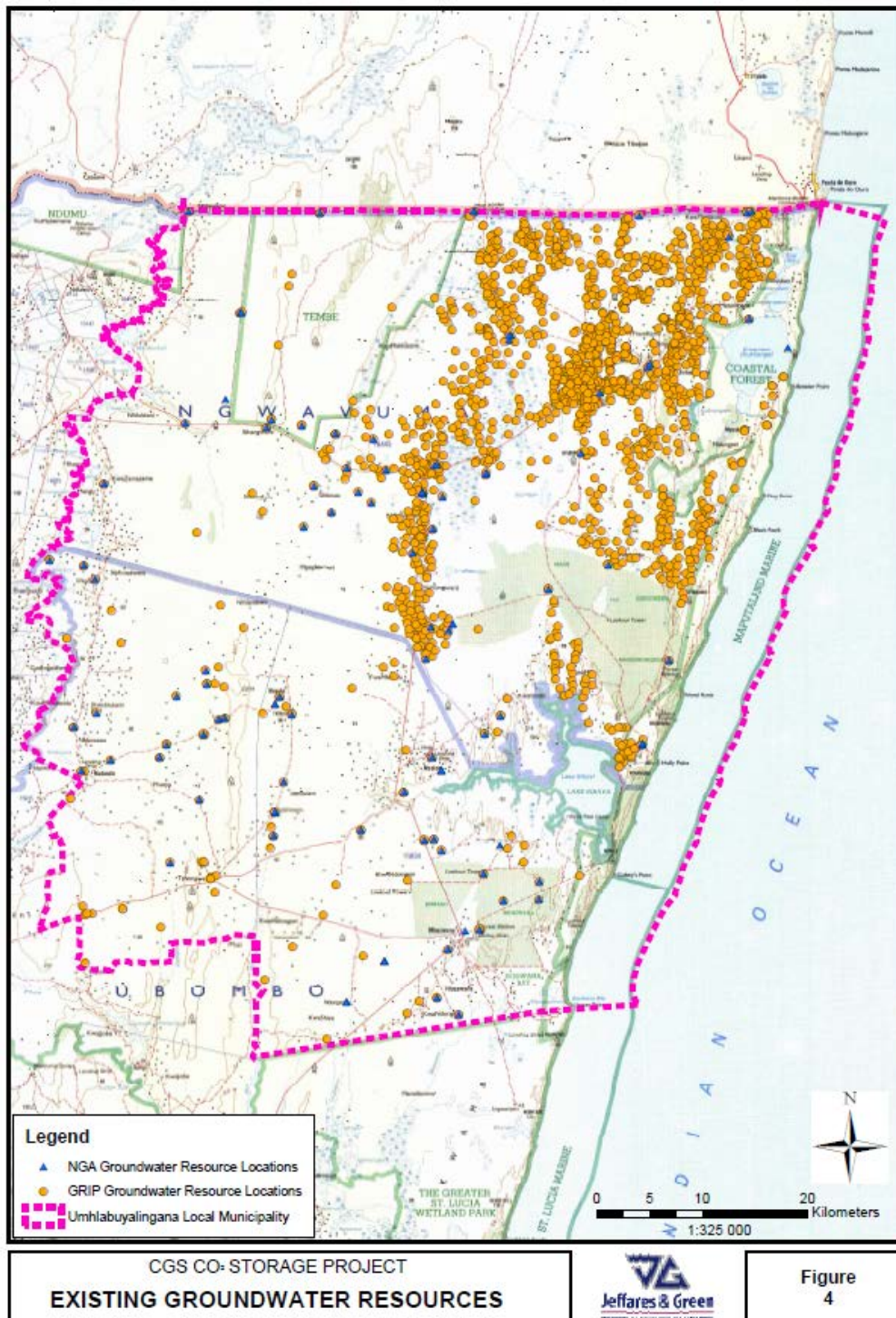
3.4 Existing Groundwater Resources

The Department of Water and Sanitation (DWS) NGA and GRIP databases were interrogated to establish the presence and location of any boreholes, dug wells, wellpoints and springs in the project area. The NGA and GRIP resources are shown in Figure 4.

1759 (No.) groundwater resources are recorded in the GRIP database, with a further 28 boreholes in the NGA database. Boreholes make up 95 % of the GRIP resources but wellpoints, dug wells and springs are also recorded, as follows:

- 1670 (No.) boreholes;

- 54 (No.) wellpoints;
- 10 (No.) dug wells; and
- 25 (No.) springs.



The majority of the groundwater resources are clustered in the northeast of the Municipality, specifically north of the Majiti and Singombisa Plantations and east of the Tembe Elephant Park and particularly in the Manguzi area. Borehole density is also significant along the R22 regional road north of Lake Sibaya, and between Lake Sibaya and Manzamgwenya Plantation.

The boreholes are predominantly equipped with handpumps (98% of pumps are handpumps, where recorded) and are in use (98% of boreholes are in use, where recorded). GRIP borehole data related to borehole depth, water level and aquifer yield is summarised in Table 2. Based on the GRIP records, the average borehole depth is 56 m, with a groundwater level of 3.7 m and a yield of 0.5 l/s.

Table 2: summary of GRIP borehole data

Parameter	Minimum	Maximum	Average	Count
Depth (m)	9	120	56	68
Water level (m)	0.1	44.95	3.67	1495
Aquifer yield (l/s)	0.03	33.3	0.49	1478

It should be noted that there are several groundwater fed water supply schemes throughout the Umhlabayalingana District. Most notable are the two wellfields developed for the Kwangwenase water supply to the south and west of the town of Manguzi, which when combined with the Enkhanyezini boreholes to the north and east of Manguzi, have the potential to supply some 5.7Ml/day from twelve boreholes (refer to figure 5).

Other large schemes supplied with groundwater include Mabibi, Manzamgwenya, KwaSonto, Mvelabusha, Khipimbaso, and Mseleni, with new schemes being proposed at Mbazwane and KwaZibi. Two large agricultural concerns, Coastal Cashews and Sicabazini, both have the ability to utilize over 1Ml/day.

Added to the major schemes, boreholes and shallow wells form the primary source of water for small schemes, industry, commercial initiatives, livestock watering, private residence, schools and clinics, and general community supply throughout the region.

3.5 Ecological Requirements

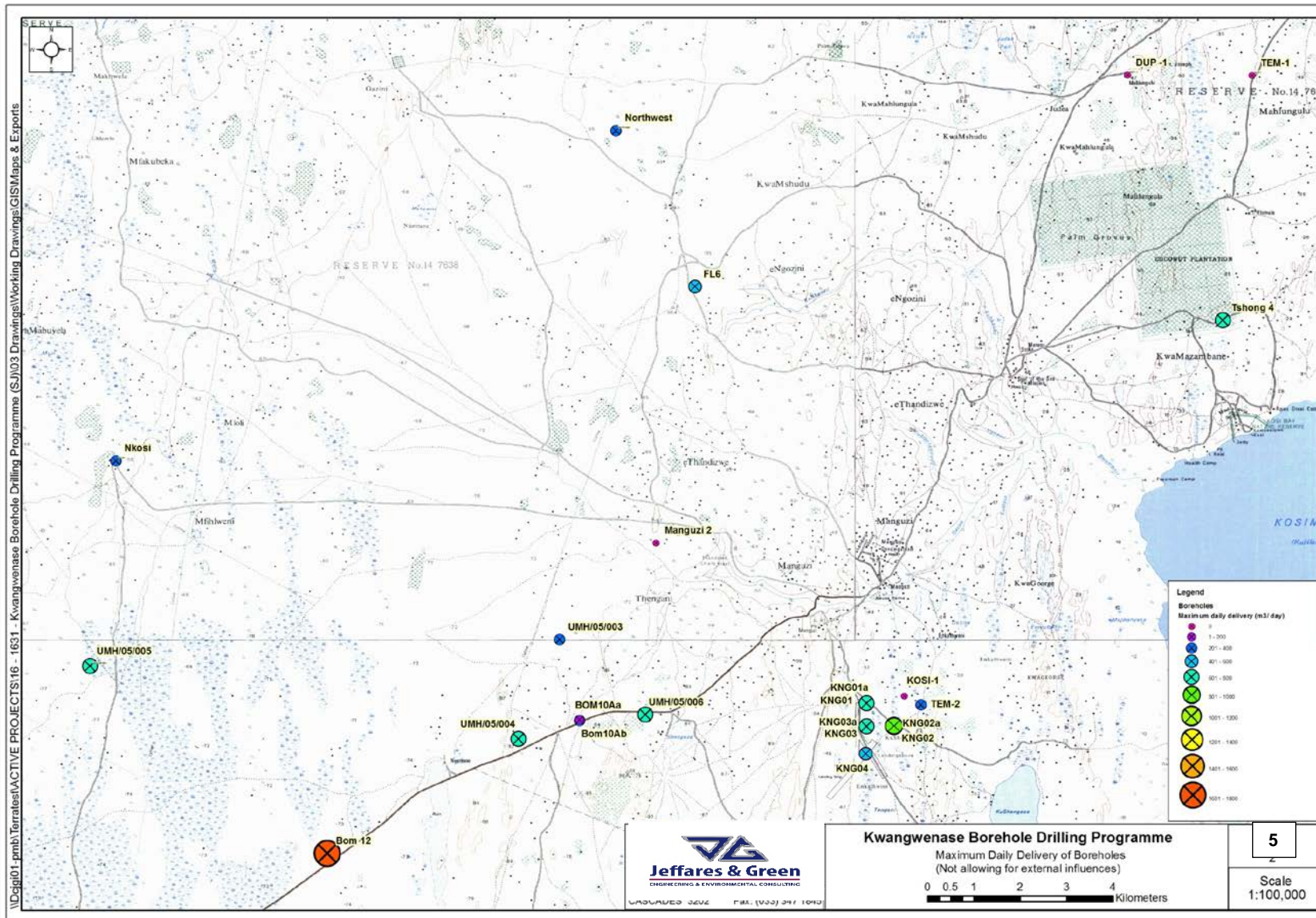
Legislation exists within the National Environmental Management Act and National Water Act to protect Aquifer Dependant Ecosystems (ADE's). The Umhlabayalingana area has a high dependence of ecosystems on groundwater. There is a significant groundwater contribution to baseflow, the numerous wetland systems, and groundwater fed lakes (Lake Shengeza and Lake Sibayi). Over time, the Coastal and eManguze Natural Forest Reserves and the Kosi Lake system may also be adversely affected (indirectly) if groundwater was no longer available.

A proposal to impact or develop a groundwater resource should be subject to three tests:

- Does the development impact on the ecological reserve?
- Does it impact on the Resource Quality Objectives (RQO's)?
- Are environmental standards and goals under NEMA affected?

These measures should safeguard the conservation and ecological requirements of ADE's, if fully implemented.

Successful protection of ADE's requires cooperative governance of land, water and the environment. Aquifers need to be managed on a day to day basis. It is also important to raise public awareness of the role aquifers play in sustaining the surface environment.



I:\digi01_pmb\TerraTest\ACTIVE PROJECTS\16 - 1631 - Kwangwenase Borehole Drilling Programme (S)\03 Drawings\Working Drawings\GIS\Maps & Exports

4 GROUNDWATER QUALITY STATUS QUO

4.1 Ambient Groundwater Quality

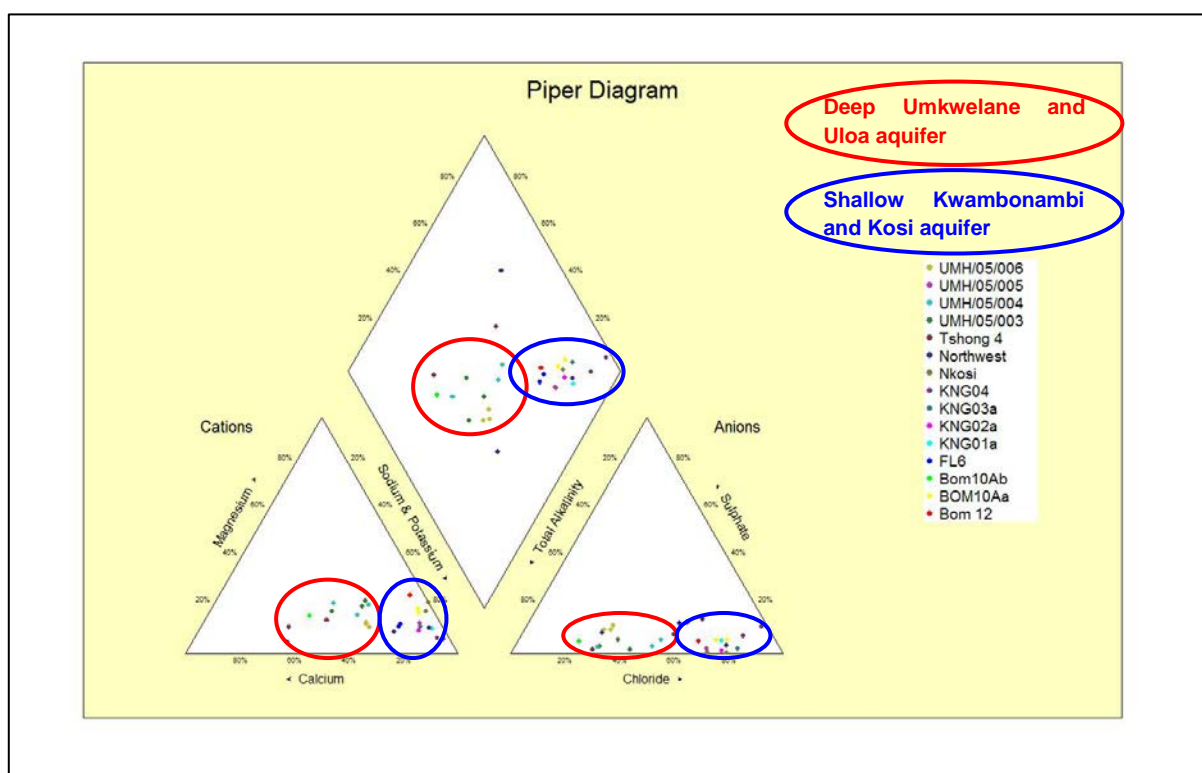
Little is mentioned in previous literature on ambient groundwater conditions specific to the potentially different aquifers within the Maputaland Group. The underlying Cretaceous can be expected to be predominantly saline (Van Wyk, 1963), and there are significantly low pH values associated with shallow peats; and the Uloa formation, due to its carbonate content, behaves like a karstic aquifer (King, 2003). In general, however, the Maputaland Group has been lumped together by many. This is believed to be primarily due to a lack of high confidence information rather than an indifferent understanding of the geohydrological sequence.

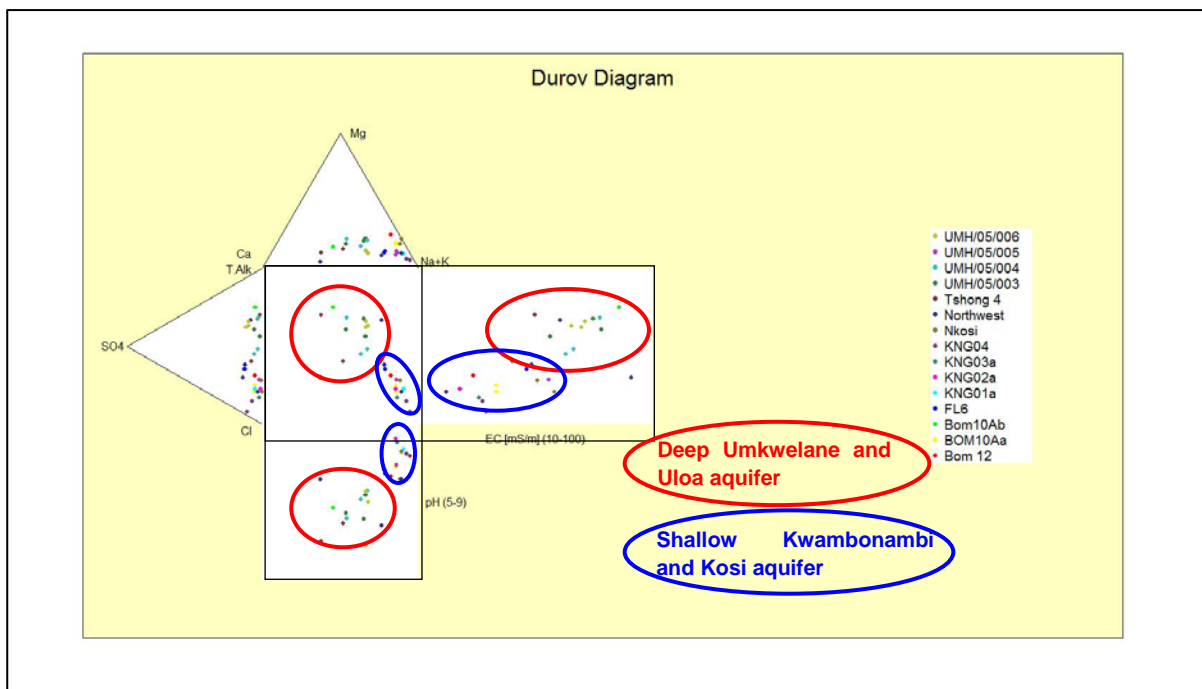
The 1:500 000 Hydrogeological Map Series of the Republic of South Africa, 2730 Vryheid, DWA, 1998, lumps water quality for the Maputaland Group into one unit, and contouring of EC values realizes the range of 0 – 70 mS/m for the greater eManguze Water Supply area.

4.2 Specific Groundwater Quality

The deeper aquifer is undoubtedly controlled by the calcareous nature of the host aquifer, and being deeper in nature, it is probable that the residence time of groundwater in this aquifer is longer than that of the shallow aquifer. Conversely, the shallow aquifer is made of relatively clean sand, which acts as a giant sand filter, in which the water table is generally very shallow (< 5mbgl in low lying areas). High transmissivities, coupled with shallow but significant hydraulic gradients indicate potentially short residence times, with high recharge values.

There is a significantly different groundwater chemistry signature between the shallow and deep aquifers; Piper, and Durov diagrams show very distinct groupings of the shallow and deep aquifers.





5 IMPACT AND VULNERABILITY

5.1 Impact

This investigation is at a feasibility stage and the proposed activities associated with the environmental application are as follows:

- Phase 1: Seismic testing
- Phase 2: Deep exploratory drilling

Typically, neither of these activities would present a significant impact on the underlying aquifer and downstream surface waters, except for where normal environmental concerns are triggered, predominantly associated with the establishment of the seismic testing equipment, and drilling equipment (fauna and flora concerns), and proximity to surface water sources and wetlands. It may be argued that the production of the seismic waves may cause vibrations through the sand mass which may result in settling, but this is highly unlikely, and the potential impact is orders of magnitude less than the natural seismic activity in the area, and thus not considered an impact at all.

Impacts may, however, be associated with mixing of waters between aquifers, of particular significance is the potentially saline waters of the underlying Cretaceous negatively impacting on the fresh water aquifers of the Maputaland Group. As the proposed drilling intends to drill through the Moputoland Group well into the Cretaceous, this presents as a viable impact which will have to be effectively managed, particularly during the placing of screens and the necessary placement of bentonite seals to negate the interaction of these aquifers post drilling.

The same attention to contamination of the groundwater resources from surface sources must also be considered, but may be mitigated by minimising surface water ingress. The surface water impact is associated with runoff and hence rainfall events. Rainfall duration and intensity will control surface water runoff and proper storm water management will mitigate these effects, as will

the placing of sanitary seals at the top of each borehole.

Receiving Environment	Groundwater		
Activity	Seismic testing	Exploratory Drilling	
Significance / Consequence	Aquifer settling	Surface contamination	Mixing of waters between aquifers
Probability	improbable	low	high
Duration	immediate	short to medium	permanent
Scale	site	site to local	site to local
Magnitude	minor	minor to low	moderate to high
Significance	low negative	medium negative	high negative
SP SCORE and RATING	1(1+1+2) = 4	2(2.5+1.5+3) = 14	4(5+1.5+7) = 54
>60 indicates high environmental significance <30 indicates low environmental significance	LOW	LOW	MODERATE

Key

LOW	MODERATE	HIGH
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Formula where SP is defined as significance points.

$$SP = \text{probability} \times (\text{duration} + \text{scale} + \text{magnitude})$$

Groundwater impact is thus considered “**LOW**” for the seismic testing, as is the case of potential surface contamination associated with the exploratory drilling process. The major concern is highlighted as the mixing of fresh and saline aquifers during the exploratory drilling process, which is classed a “**MODERATE**” impact.

5.2 Aquifer Vulnerability

Current sources of potential groundwater contamination include sanitation practices, agricultural activities (forestry), informal cemeteries, light industry (eManguze, Mseleni, Sodwana, and Mbazwana Towns), and Waste Water Treatment Works (WTW).

By far the greatest potential contamination source is on site sanitation, whether it be VIP’s in more rural settings, or soak away in built up areas that are not serviced with waterborne sewage. Significant forestry presents a probable source of groundwater contamination, but is more difficult to quantify due to a certain amount of secrecy surrounding forestry practices in the general area. Thus potential sources of contamination are fertilizers (limited) and chemical treatment (limited).

Shallow permeability is high, indicating the shallow vadose zone will provide a poor barrier to ingress of surface water to the groundwater system. DWA databases, and local knowledge suggest the depth to groundwater in the project area to be variable, but generally shallow <10mbgl. The primary geohydrology is a high yielding primary aquifer and the potential impact is medium to high.

King, 2003, suggests that high filtration capacity of sands results in bacteriological quality being generally very good, with die out of bacteria usually occurring within 5m of a point source such as a pit latrine. Similarly, spatial extent to other potential point sources of pollution / contamination (e.g. informal cemeteries and light industry or the proposed intervention of the project), resulting in little concern being raised.



5.3 Geohydrological Risk

The geohydrological assessment is based on a review of available desktop information and field data obtained during the site assessment. Boreholes are reported by DWA databases throughout the project area, and it is probable to find some groundwater resources within 1km of the exploratory drilling sites. The depth to groundwater is variable and can often be expected to be less than 10mbgl.

Based on desktop information, the Parsons Aquifer Classification System classifies the aquifer as “Major”, with “high susceptibility” and the “most groundwater vulnerability” (refer to figure overleaf). The major impact identified is the potential risk of pollution to the freshwater groundwater resource with the underlying saline aquifer. Umhlabayalingana relies on groundwater from local boreholes.

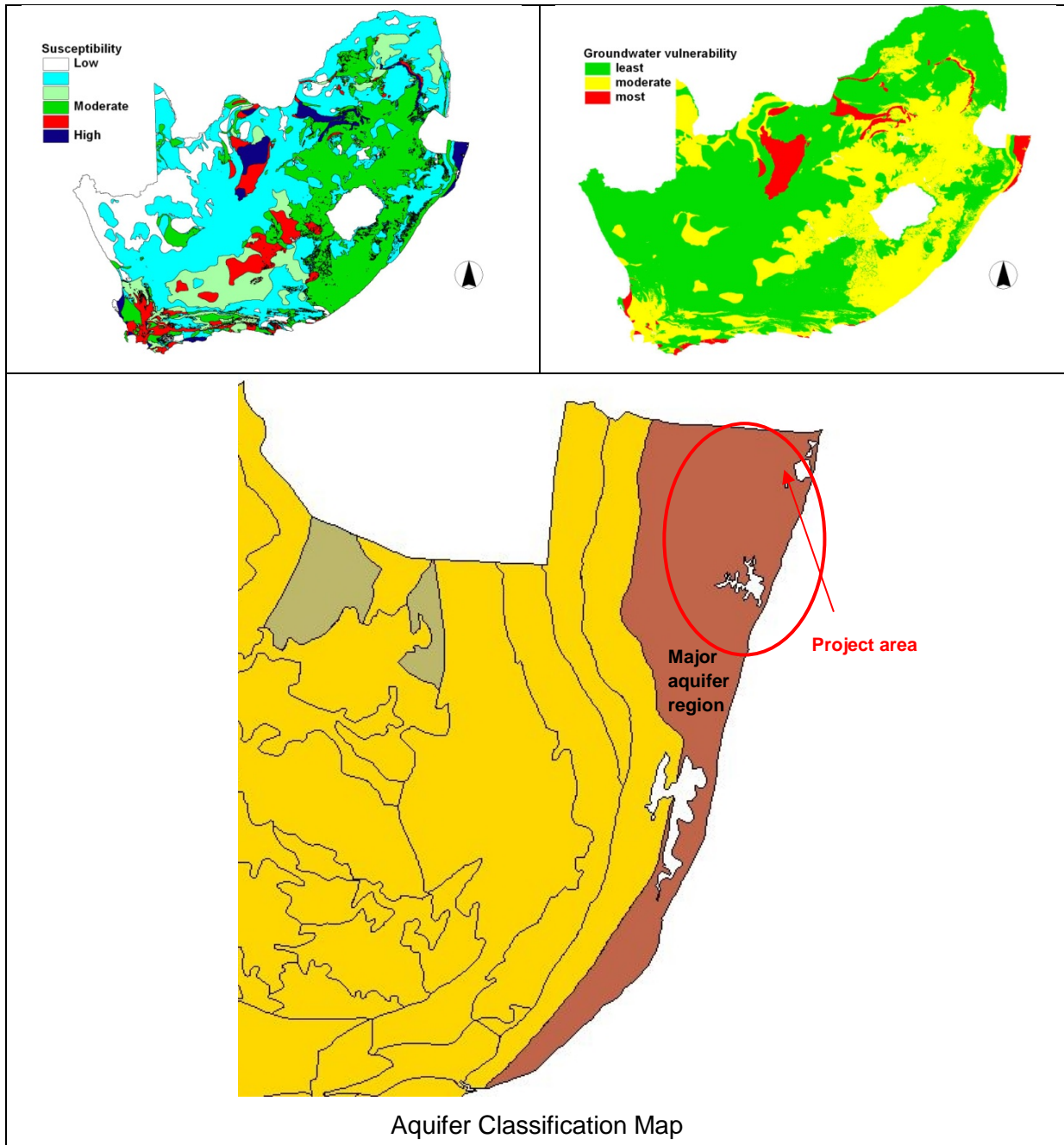


Figure 4.3.5: Aquifer classification, groundwater vulnerability and aquifer contamination susceptibility maps derived from Vegter (1995), by Reynders (1997), and Parsons (1995).

The assessment of risk of aquifer contamination is based on aquifer vulnerability and strategic value:

- Vulnerability is determined based on geohydrological factors and contaminant load. Geohydrological factors are high as the aquifer is classified as *Major*. The aquifer has reasonable protection from the vadose zone, with no structures being confirmed. The contamination load should be negligible if managed and mitigated properly, particularly during the drilling process. The potential impact is therefore very low.
- Strategic value is based on water use in the area. From desktop information, strategic value is high. The area relies heavily on groundwater from local boreholes and the region is noted as being an area of large scale groundwater abstraction.

6 CONCLUSIONS

This report presents a geohydrological assessment for a proposed seismic testing and exploratory drilling of deep boreholes for the purpose of identifying potential deep storage for CO₂. The geohydrological assessment is required as part of the environmental authorisation process and was comprised of a phased approach, as per the guidelines of the Department of Water Affairs and Forestry (now DWS) for waste management facilities.

The regional geology of the area comprises unconsolidated and semi consolidated sediments of the Maputaland Group overlying Cretaceous marine glauconitic siltstone.

The inferred groundwater potential of the Maputaland Group is typically good, and is considered a *Major* aquifer, with borehole median yields between 0.5 and 2.0 l/s. The permeability of the shallow soils was high, providing a limited barrier to infiltration in the vadose zone, however, the clean sands act as filter, and typically limit progression of microbiological contaminants further into the aquifer. Furthermore, there is no anticipated contamination expected from the seismic testing and / or the drilling process, and it is more restricted to existing contamination sources. The depth to groundwater was inferred to be generally less than 10mbgl in the project area. The aquifer vulnerability in general is high, but limited based on the proposed activities.

A total of 1670 (No.) boreholes, 54 (No.) wellpoints, 10 (No.) dug wells, and 25 (No.) springs were identified from DWA databases throughout the proposed project area. There is a reliance on the groundwater resource as much of Umhlabayalingana Local Municipality is supplied by groundwater from local boreholes. The strategic value is therefore medium to high.

The main concern is the impact on the groundwater resource, with impact occurring from the overlying fresh water aquifer being exposed to and mixing with the underlying saline aquifer of the Cretaceous. This interaction will have a high probability with moderate to high magnitude, while surface runoff will have a low probability with minor to low magnitude. Existing activities within the project area may already be impacting on the water quality of the resources.

7 RECOMMENDATIONS

Mitigation techniques may be applied to reduce aquifer vulnerability and risk. We recommend the following:

Seismic Testing:

- Minimize impact on the natural environment by utilizing existing access roads and tracks.
- The seismic testing itself it not likely to impact on groundwater, however, the testing process makes use of large pieces of mechanized equipment. Diesel and oil spills must be



avoided, and should they occur, then recovery of contaminated areas needs to be contained, all affected material collected in spill proof containers, and disposed of at a registered facility.

Exploratory drilling:

- Minimize impact on the natural environment by utilizing existing access roads and tracks.
- The exploratory drilling makes use of large pieces of mechanized equipment. Diesel and oil spills must be avoided, and should they occur, then recovery of contaminated areas needs to be contained, all affected material collected in spill proof containers, and disposed of at a registered facility.
- Surface water drainage should be managed such that ponding and water flow does not occur in the vicinity of the finished borehole.
- A sanitary bentonite seal should be placed below surface at the groundwater interface to limit direct surface contamination down the side of the casing.
- The geological change from the Maputaland Group to the Cretaceous needs to be carefully identified in terms of depth. An extensive (5m) seal needs to be placed over the change to stop waters from the saline aquifer interacting with the fresh water aquifer above.
- No screens should be placed to intersect both fresh and saline aquifers in the same borehole (i.e. a preferential flow path must not be created).
- Careful management and site operations are basic requirements to ensure the impact on groundwater quality in the area is minimised by drilling operations. The success of the exploratory drilling relies on good practice in terms of operation and maintenance, thus reducing contamination generation or surface runoff.

Stage 1 : Assessment of Aquifer Vulnerability		Overall Risk Based on Aquifer Vulnerability and Contaminant Load
Vulnerability of aquifer due to geohydrological conditions	HIGH	LOW to MEDIUM
Vulnerability due to activities proposed	LOW	

Stage 2 : Strategic Classification of the Groundwater		Strategic Risk
Strategic value	HIGH	MEDIUM to HIGH
Relevance of threats of contaminants	MEDIUM	

Risk Assessment Summary	
Aquifer Vulnerability	LOW to MEDIUM
Aquifer Strategic Value	MEDIUM to HIGH



Appendix A: Figures



Operational Guideline: Integrated Water and Waste Management Plan

In terms of a quantitative environmental risk assessment (ERA), the assessment will be based on:

- Probability of occurrence which describes the likelihood of the impact actually occurring and is indicated as:-
 - Improbable, where the likelihood of the impact is very low;
 - Probable, where there is a distinct possibility of the impact to occur;
 - Highly probable, where it very likely that the impact will occur;
 - Definite, where the impact will occur regardless any management measure.
- Consequence of occurrence in terms of:
 - Nature of the impact;
 - Extent of the impact, either local, regional, national or across international borders;
 - Duration of the impact, either short term (0-5 years), medium term (6-15 years) or long-term (the impact will cease after the operational life of the activity) or permanent, where mitigation measures by natural processes or human intervention will not occur;
 - Intensity of the impact, either being low, medium or high effect on the natural, cultural and social functions and processes.
- Significance level of the risk posed by the water use, which is determined through a synthesis of the probability of occurrence and consequence of occurrence.

The applicant will have to rank the risks based on the quantitative assessment as described above into high, medium, or low risks. Management measures need to be identified to mitigate, prevent and /or reduce the risk. These measures will primarily be focussed on the risks identified as high in the ranking matrix, but will also include measures for medium and low risks. The management measures will be taken forward in the IWMP as part of the water use authorisation process.

In order to assess each of the factors for each impact the ranking scales as contained in Table 7-1 could be used. Once the factors had been ranked for each impact, the environmental significance of each impact could be assessed by applying the following formula:

$$SP = (\text{magnitude} + \text{duration} + \text{scale}) \times \text{probability}$$

where SP is defined as significance points.

Table 7-1: Ranking Scales for ERA

<p>PROBABILITY = P</p> <p>5 – Definite / don't know</p> <p>4 – High probable</p> <p>3 – Medium probability</p> <p>2 – low [probability</p> <p>1 – Improbable</p> <p>0 - None</p>	<p>DURATION = D</p> <p>5 – Permanent</p> <p>4 – Long-term ceases with operational life)</p> <p>3 – Medium-term (5 – 15 years)</p> <p>2 – Short-term (0-5 years)</p> <p>1 - Immediate</p>
<p>SCALE = S</p> <p>5 – International</p> <p>4 – National</p> <p>3 – Regional</p> <p>2 – Local</p> <p>1 – Site</p> <p>0 – None</p>	<p>MAGNITUDE = M</p> <p>10 – Very high / Don't know</p> <p>8 – High</p> <p>6 – Moderate</p> <p>4 – Low</p> <p>2 – Minor</p>

The maximum value of significance points (SP) is 100. Environmental effects could therefore be rated as either high (H), moderate (M), or low (L) significance on the following basis:



- More than 60 points indicates high (H) environmental significance
- Between 30 – 60 points indicate moderate (M) environmental significance
- Less than 30 points indicates low (L) environmental significance.



Appendix 4

Specialist contributor CVs

M. Schapers – Jeffares and Green (Hydrogeology)

P-L. Grundling – WetRest (Wetlands)

B. James – Brousse-James and Associates (Biodiversity and vegetation)

S. Allen – Independent

CURRICULUM VITAE



MARK SCHAPERS

NAME OF FIRM : *JEFFARES & GREEN (PTY) LTD*

NAME OF PERSON : *MARK SCHAPERS*

NATIONALITY : *SOUTH AFRICAN*

DATE OF BIRTH : *1968/12/17*

PROFESSION : *HYDROGEOLOGIST / GEOLOGIST*

QUALIFICATION : *Pr.Sci.Nat, MSc (Hydrogeology), BSc (Hons) (Geol), BSc (Geol and Hydro)*

POSITION IN FIRM : *TECHNICAL DIRECTOR / SENIOR HYDROGEOLOGIST*

SPECIALISATION IN FIRM : *HYDROGEOLOGY, GEOLOGY, PROGRAMME / PROJECT MANAGEMENT; GROUNDWATER DEVELOPMENT*

YEARS OF EXPERIENCE : *23 YEARS*

YEARS WITH FIRM : *14 YEARS*

SUMMARY OF EXPERIENCE

Mark Schapers has 23 years' experience, dealing with a wide variety of earth science based projects including hydrogeological, geological, geotechnical, and environmental disciplines.

He obtained an Honors Degree in Structural Geology at the University of Natal - Pietermaritzburg in 1992, and completed an MSc in Geohydrology at the University of the Free State in 2012, completing a dissertation on the Primary Aquifers of the northern KZN Coastal Flats. His dissertation emanates from the wealth of experience gained from 23 years' experience in the KZN Coastal Aquifer, and a passion for the progression and improvement of the conceptual model thereof, such that the Universities of Zululand, KZN, Free State, and North West have honors and masters students either directly or indirectly being supervised in their studies.

He has extensive experience and insight into hydrogeological, geological, hydrological, and geotechnical studies. He has experience in the groundwater supply and sanitation sector (KwaZulu Natal, Eastern Cape, and Mozambique), and groundwater resource management. In addition, he has been involved in numerous institutional studies including groundwater modeling, predictive planning, GIS based planning, backlog studies, and water services development plans.

His current focus is the management of the Durban office. He heads a team of ten individuals conducting works such as hydrogeological inputs (specialist studies) into EIA's, contamination studies, risk assessments, sanitation protocols, groundwater monitoring and modeling, aquifer characterization, rudimentary and production borehole implementation, well-field development, spring protection, geohydrological mapping, and an active involvement in appropriate technology and innovative solutions.

SOCIETY MEMBERSHIP

PrSciNat : South African Council for Natural Scientific Professions - Earth Scientist (2000)
GWD of GSSA : Groundwater Division of the Geological Survey of South Africa (GWD of GSSA)
IAH : International Association of Hydrogeologists
GAKZN : Groundwater Association of KwaZulu Natal – Chairman 2009 - 2012

EDUCATION

1991 : **BSc** – (Geology and Hydrology) - University of Natal, Pietermaritzburg
1992 : **BSc (Hons)** (Geology) - University of Natal, Pietermaritzburg
2012 : **MSc** – (Hydrogeology) - University of the Orange Free State

LANGUAGES

English : *Very Good*
Afrikaans : *Fair*
Zulu : *Limited*
Portuguese : *Limited*



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The **CENTRE FOR WETLAND RESEARCH AND TRAINING (WETREST)** is a non-profit (9204/342/18/3), public benefit organisation (930 037 469) with the objective to establish a world class wetland scientific centre to address the wetland research needs in Africa and to build the capacity of the wetland community in order to secure sustainable management of Africa's wetland resources.

It is currently generating funds by doing consulting and research work in order to generate funds to fulfil its aims and objectives.

Recent projects by WETREST include:

- Maputaland wetland EIA screening for the CGS Seismic assessment
- A research project for the Water Research Commission (WRC Project K5/2346) : Peatland Inventory and Assessment in South Africa
- Appointment by the State Attorney and GDARD as an external specialist team on advising the MEC on peat mining by CULTERRA (PTY) LTD.
- The implementation of a broad scale assessment of the Rugezi Marsh in Rwanda for the International Crane Foundation and the African Crane Conservation Programme.
- Characterising the wetlands on the Vele Colliery for Coal of Africa.
- Research support /advice was rendered in 2011 and 2012 to:
 - SANPARKS (dryland and wetland erosion control)
 - SANBI (Kusile wetland rehab assessment and Mutale wise use project)
 - Tshwane METRO (drainage line rehabilitation)
 - DEA - Specialist support to Green Scorpions
- Student support (mentorship and financial) were rendered to various PDI students

The aims and objectives of WETREST are:

Aim

To fulfil the calling of the Lord Jesus in our daily lives through serving the research and capacity building needs in the wetland community

Objective

The overall objective is to establish a world class wetland scientific centre to address the wetland research needs in Africa and to build the capacity of the wetland community in order to secure sustainable management of Africa's wetland resources.

The specific objectives are to:

1. Identify research gaps/needs in wetland conservation
2. Raise funds to address identified gaps/needs with scientific based research
3. Establish a series of university accredited wetland training modules on under graduate and post graduate level
4. Developed a series of practical/technical training courses to support wetland practitioners
5. Develop a wise-use centre to support sustainable wetland utilization
6. Render free expertise and support to I&AP's where wetlands are threatened by development (mining, infrastructure, damming, pollution, draining etc)

Board Members

J. Adam (ID 740719 0109 082): white female;

P-L. Grundling (ID 660530 5145 088): white male;

L. Gumindega (Passport no: BN655912): black male;

P.H. Muvhenzhe (ID 581019 5662 082): black male;

L. Pretorius (ID 8610150096087): white female;

K. Taruvinga-Middleton (Passport no: BA663460): black female;

Directors

Ms Adam is the director dealing with management and Ms Pretorius is the appointed director for project development. Ms Taruvinga-Middleton is the chairperson of the board.

CURRICULUM VITAE

BARRY JAMES

NAME: Barry Mark James
DATE OF BIRTH / ID NO: 9 January 1961 / 6101095018081
MARITAL STATUS: Married 1986 (2 sons – born 9 Feb 2005; 20 Sep 2007)
LANGUAGES: English, Afrikaans, some Zulu
DRIVER'S LICENCE: Code 14 (Light->extra heavy) & Code 02 (Motorcycle)
ADDRESS: PO Box 1304, Howick, 3290
TEL / FAX / EMAIL: 033-330 4984 / 0862125248 / brousse@sai.co.za

CURRENT STATUS:

Partner in an ecological and environmental consultancy, “Brousse-James & Associates”. Involved in specialist botanical/faunal/ecological surveys, Environmental Impact Assessments, Environmental Management Plans, Rehabilitation and Revegetation Plans, animal rescue and translocation, game ranch/wildlife management planning, game counts, ecological research projects and freelance journalism.

Was until recently the major partner (Managing Member) and founder of Red Ivory Trading, a company specialising in utilisation of indigenous timbers and other indigenous products. Global economic crisis forced the closure of this business at the end of 2009. However, we continue to collect and document indigenous wood under the banner of Brousse-James & Associates and consult with respect to utilization of indigenous wood. Presently writing a book on Southern African wood species - Due for publication early-2016.

EDUCATION:

- PhD Currently registered with the Da Vinci Institute in Johannesburg for a PhD focussed on sustainable use of South African indigenous woods.
- MSc (Agric) (Natal University, 1998) - Plant Ecology.
- BSc (Hons) (Potchefstroom University, 1995) - Plant Ecology.
- BSc (UNISA, 1994) - Majors: Zoology, Botany.
- Diploma in Datametrics (UNISA) - Seven of the required ten modules completed.
- Program languages: Visual Basic, MS Access, SQL Server, Infobasic, Basic, Natural I & II.
- Software knowledge: Coral Office, MS Office, Coral Draw, MapInfo, MapMaker, QGIS.
- Short courses: Soil Classification and Land Capability; Geographic Information Systems (Natal University); Integrated Environmental Management (Natal University); Environmental Auditing; Introduction to Environmental Impact Assessment Procedures (Rhodes University), Structured Systems Design, Productivity, Costs & Profits; Numerous Natal Parks Board & Natal Sharks Board in-service courses.
- Emergency Care Assistant (SA Red Cross, 1995).
- National Certificate in Tourism: Guiding. (2005).
- CMAS registered 2 Star Scuba diver (1986) - Renewed 2014
- NAUI Speciality Rescue Diver (1985) - Renewed 2014

MEMBERSHIPS:

- SA Institute of Ecologists and Environmental Scientists (Professional Member).
- PrSciNat - Professional Natural Scientist (Ecological Science) –Reg. No: 400263/06.
- EAPSA - Certified Environmental Assessment Practitioner.
- International Wood Collectors Society (Associate Editor of Journal).

EMPLOYMENT HISTORY:

ENVIRONMENTAL CONSULTANT (1998 - present)

FULL-TIME MSc STUDENT (1996-1997)

NATAL PARKS BOARD (March 1990 to February 1996)

Positions held:

- i) Zone Officer (District Conservation Officer)
- ii) Rhino Capture Officer
- iii) Trails Officer (2iC)

Experience gained (Natal Parks Board):

Veld management (burning, monitoring, revegetation and erosion control), game management (counting, capture, care, transport and culling), farm extension work, environmental education & wilderness trails, public relations, law enforcement, problem animal control, staff training, administration, equipment maintenance, advanced first aid.

UNIVERSITY OF CAPE TOWN (December 1989 - February 1990)

Contract Senior Analyst Programmer: wrote and maintained programs on Student Records System (Natural Adabas).

GARLICKS (May 1988 - November 1989)

Analyst Programmer in Financial Team (Natural Adabas): maintained financial systems.

SA CONTAINER DEPOTS (July 1987 - April 1988)

Computer Supervisor: network administration, user support, training & documentation.

MASHATU GAME RESERVE (October 1986 - June 1987)

Game Lodge Manager and Ranger: management and maintenance of lodge and equipment, supervision of staff, interpretation for guests.

INFOCUS TRAINING (September 1985 - July 1986)

Lecturer: taught use of micro-computers.

NATAL SHARKS BOARD (August 1984 - June 1985)

Shark Control Officer: maintenance of shark nets & equipment & biological monitoring.

OTHER ACTIVITIES:

- Founder member and past board member of the Dusi-Umgeni conservation Trust (www.duct.org.za).
- Associate Editor of International Wood Collectors Society – write regular articles on South African indigenous woods.

- Freelance photo-journalism: Articles and photographs in the following publications: Out There, Keeping Track, African Wildlife, Runner's World and Open Africa.
- Compiled and produced the Natal Parks Board Trails Officers Training Manual in 1995.
- Wrote an historical/biological/anthropological book (unpublished) on Umfolozi Game Reserve, "Umfolozi, Shaka's Royal Hunting Ground".
- In the process of writing a book about indigenous Southern African woods. Due for publication 2015.

SPECIFIC TALENTS:

Well-developed ability to assimilate, analyse and summarise large amounts of data, i.e. see the "bigger picture" quickly; good administrative skills and proven communication skills, including training and public relations; good technical ability and problem-solving skills; versatility and ability to acquire new skills rapidly; commitment to achievement of goals, energy, enthusiasm and initiative.

INTERESTS:

Conservation (all aspects) with a special interest in sustainable utilisation of natural resources and wildlife products and restoration of degraded land; Zulu history and culture, and its relationship to natural resources; Wilderness management.

Sports: Long-distance running, cycling, canoeing, swimming, horse riding, SCUBA diving. Major events include Comrades Marathon, Dusi Canoe Marathon, Argus Cycle Tour, Midmar Mile, Mt Aux Sources Challenge, Iron Man.

Hobbies: Woodwork and wood turning (specifically indigenous timbers), furniture restoration, leatherwork, music - saxophone and trumpet.

AWARDS/ACHIEVEMENTS

- Captain of school cross-country team. Awarded cross-country scroll.
- Full colours for School Cadet Band.
- Army Gymnasium - Certificate of merit for athletics and marathon.
- Iron Man Triathlon silver medal (1986).
- Natal Parks Board Golden Lion's Head Award for Bravery (1994)
- Admitted to MENSA but not interested in retaining membership.

REFEREES:

Dr Peter Goodman

Cell: +27 (0)762184834

Email: pgoodman@conservation-solutions.org

Professor Tim O'Connor

P.O. Box 379, Hilton, 3245, South Africa

Tel: +27 (0)33-3433491

Email: timoconnor@xsinet.co.za

Professor Kevin Kirkman

University of KwaZulu-Natal

Tel: 033 2605452

kirkmank@ukzn.ac.za

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Assessment**



Profession
Environmental Consultant

Current Positions
Senior Member and Director

Date of Birth
12 May 1963

Established TIEA
Oct 2011

Nationality
South African

Academic Qualifications
Matriculation – Amanzimtoti High School
B Sc (Zoo, Biochem) Univ of Natal
HDE Univ of Natal

Languages
English, Afrikaans

Synopsis Of Employment Experience:

- 1985-1988 educator
- 1989-1993 public relations practitioner
- 1993-2011 environmental regulator
- 2011-present environmental consultant

Contact Details
Mobile: +27 76 578 2941
E-mail : sarah.wine@iuncapped.co.za
Fax: +27 86 242 2646

Sarah Allan (B.Sc, HDE)

Abbreviated Curriculum Vitae

Key Experience as Environmental Regulator

- review of environmental policies, strategy and legislation
- strategic direction for the environmental component of Department
- extensive experience in the Environmental Impact Assessment regulations including:
 - initiating systems to implement EIA regulations from original promulgation in 1997
 - reviewing and evaluating Basic Assessment and Environmental Impact Assessment reports
 - preparing records of decision in the form of Environmental Authorisations.
- experience in the implementation of the Waste Management Regulations and preparation of Waste Management Licences.
- guide staff in the preparation of various environmental compliance documents including:
 - pre-compliance notices,
 - compliance notices, and
 - National Environmental Management Act s24G environmental authorizations for activities commenced without full compliance to EIA or other requirements
- facilitate environmental awareness and education programmes, encourage partnerships with non-governmental organizations
- maintain highest levels of personal honesty and integrity acting in interests of environment and Department

Key Experience as Environmental Consultant (2011 – present)

- provide impartial advice to clients based on knowledge and understanding of environmental prescripts
- external review of draft Scoping Reports and Environmental Impact Assessment Reports
 - prepare Basic Assessment Reports in support of greenfields and brownfields applications for environmental authorization and waste management licenses
 - prepare waste management license S24G submissions seeking condonation for commencing listed activities prior to receiving requisite waste management license.
 - resolve compliance with conditions of authorization between authorization holder and competent authority

Selected Relevant Projects

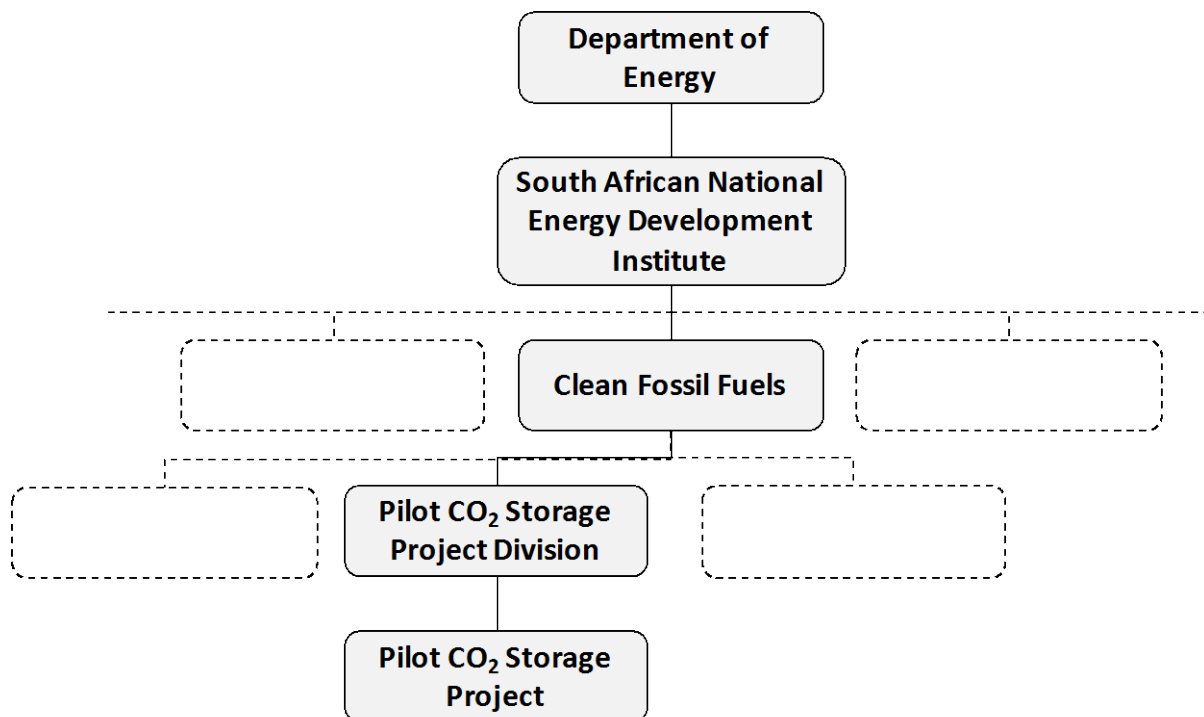
- Agrivesco: change in land use from sugar cane to mixed use development, Camperdown
- Why Waste: waste management and recovery, Ladysmith
- Eskom: external review of power lines, Free State-Northern Cape-Western Cape
- Heavitree: cultivation compliance conditions of authorisation, Estcourt
- Tsogo Sun: refurbishment and extension of Beverly Hills Hotel, Umhlanga Rocks

Appendix 5

Roles and responsibilities for South African PCSP

Department of Energy (DoE) - DoE is the Government of South Africa's (GoSA) department that is responsible for the development of carbon capture and storage (CCS) in South Africa. DoE has a particular focus on the policy, legal and regulatory aspects of CCS and has mandated the South African National Energy Development Institute (SANEDI) to investigate the technical aspects of the technology. The DoE has been involved in CCS since the commencement of CCS development in South Africa, in around 2002. It was engaged in the preparation of the GoSA's *National Climate Change Response White Paper* and is responsible for the implementation of the CCS Flagship Program. The DoE, along with the World Bank, is the major funder of the PCSP having contributed R207 million (USD 14.6 million) to the project. DoE sit on the PCSP Steering Committee.

Organizational Structure for the PCSP in South Africa



The South African National Energy Development Institute (SANEDI) – SANEDI is the PCSP project developer. SANEDI is a Schedule 3A state owned entity, established under Chapter 4 of the South African National Energy Act, No. 34 of 2008, to “direct, monitor and conduct applied energy research and development, demonstration and deployment as well to undertake specific measures to promote the uptake of Green Energy and Energy Efficiency in South Africa.”². SANEDI has six ongoing research programs listed below.

- i. Clean Fossil Fuels
- ii. Clean Energy Solutions
- iii. Energy Efficiency
- iv. Green Transport
- v. Smart Grids, Energy Data and Knowledge Management

² www.sanedi.org.za/background/

vi. Working for Energy.

CCS resides within the Clean Fossil Fuels program. SANEDI has been mandated by the DoE to investigate the technical aspects of CCS development and deployment in South Africa.

Clean Fossil Fuels (CFF) – Within SANEDI, CFF is the program responsible for CCS, for the PCSP, the CCPP, and for this TAP. CFF currently comprises three divisions: the South African Centre for Carbon Capture & Storage, the Pilot CO₂ Storage Project, and the Shale Gas work program.

PCSP Division – The PCSP Division will be the lead division within SANEDI and CFF for the development of the PCSP. The PCSP Division was established, as a dedicated division under CFF, in order to implement the PCSP. The establishment of this division has allowed appropriate governance structures to be established with a focus on project management and execution and with the appropriate technical capabilities. The PCSP Division was established through a Terms of Reference that was approved by the SANEDI Board and is overseen by the PCSP Steering Committee.

Appendix 6

Government Departments, Municipal officials, NGO representatives and community organisation representatives consulted during the compilation of the Environmental Management Framework (EMF) for Umkhanyakude District Municipality by Nema Consulting (2012). This list will form the framework for the Public Participation process to be implemented as part of the Environmental Authorisation process that may be required to undertake the vibroseis survey and lithological drilling ahead of the PCSP

Organisation	Contact	Designation	Number	Email
Amafa AKwaZulu-Natali	Ms W Shabalala		033- 3946543	
Amafa AkwaZulu-Natali/Heritage KZN	Mr B. Marshall	Principal Heritage officer	035-8702054	marshallb@telkomsa.net
Amafa KZN	Sello Mokhanya		033-3946543	sellom@amafapmb.co.za
Amafa KZN	Bernadet Pawandiwa		033-3946543	bernadetp@amafapmb.co.za
Sileza/Tembe Nature Reserve	Barry Revell	Conservation Manager	035-5920009 0767011029	oicembe@kznwildlife.com
eZemvelo KZN Wildlife	Felicity Elliott	Head: Integrated Environmental Management	033-8451437	elliottf@kznwildlife.com
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Thobani Vetsheza	Indigenous Forests	033-3927729	ThobaniV@daff.gov.za
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Wiseman Rozani		033-3927761	WisemanR@daff.gov.za
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Kim Weir		033-3927706	KimW@nda.agri.za
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Mr Mabika		0828094684	
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Mr Mthembu	Mbazwana Plantation	035-5710152	
KZN Department of Agriculture Forestry and Fisheries (DAFF)	Mr Mtenjwa		0736660766	
		Manzengwenya Plantation	035-5748289	
KZN Department of Agriculture & Environmental Services	Mrs Khululiwe Mathenjwa	District Manager, Environmental Services	035-5500210	khululiwe.mathenjwa@kzndae.gov.za
Department of Water Affairs	Ms R.K. Pillay	Senior Water Pollution Control Officer; Water Quality	031-3362823	pillayr@idwa.gov.za
Big 5 False Bay Local Municipality	Ms Annetjie van Zyl	Director: Development Planning	035-5620040	annetjie@big5falsebay.co.za asvanzyl@gmail.com
Big 5 False Bay Local Municipality	Mr Archie M. Mngadi	Municipal Manager	035-5620040 0835167245	archie@big5falsebay.gov.za
Jozini Local Municipality	Ms Samkelisiwe Mkhize	Town Planner	035-5920671	ziphelele@gmail.com
Jozini Local Municipality	Mr N.N.Nkosi	Municipal Manager	035-5721292 0829050465	nnkosi@jozini.org.za thabilecb@webmail.co.za
Jozini Local Municipality	Mr Kobus Marais		0828838146	jakobus.marais@yahoo.com
Jozini Local Municipality	Samke Mkhize	Executive Director: Development Planning	035-5721292	ziphelele@gmail.com

uMhlabuyalingana Local Municipality	Mr S.E. Bukhosini	Town Planner & IDP Manager	035-5920671 0846028657	bukhosinise@gmail.com mahlongwane@gmail.com
uMhlabuyalingana Local Municipality	Mr Mduduzi Qwabe	Municipal Manager Director: Development Planning and Technical Services	035-5920680	msqwabe@webmail.co.za
uMhlabuyalingana Local Municipality	Sifiso Zikhali	Director Planning & Environmental Management	035-5920680 0767115348	zikhalisn@gmail.com
uMhlabuyalingana Local Municipality	Mrs Nokuphila Mthembu	Manager: IDP	0834472229	mthembuhn@gmail.com
uMkhanyakude District Municipality	Mr Lawrence Dlamini	Technical Director	035-5738602	lawrence@ukdm.gov.za
uMkhanyakude District Municipality	Cllr H. Nxumalo	Chairperson: Development Planning & Environmental Management Portfolio Committee	0833420619	nonjabulom@ukdm.gov.za
	Nomathemba Zulu		035-5500069	nomathembazulu24@gmail.com
	Sifiso Zikhali		0767115348	zikhalisn@gmail.com
	Mr Bonga Zamisa	Senior Planner: planning (South)	035-5736700 0715293110	bonga@ukdm.gov.za
	K.M. Moodley	Senior Planner: Development Planning (North)	035-5738613 0837783057	nomfundo@ukmd.gov.za
	Sipho Mathobela	GIS Specialist	0826039476	sipho.mathobela@ukdm.gov.za mathobelas@yahoo.com
	Boxer L. Mpontshane	Municipal Manager	0762438512	boxer@ukdm.gov.za mpontshaneb@yahoo.com
		HOD: Planning; Social and Economic Development Department		
		Chief Planner/Director Development Planning Component		
WESSA KZN Region	Ms Carolyn Schwegman	EIA Co-ordinator	039-9752147	afromatz@telkomsa.net
KZN Department of Agriculture & Environmental Affairs(DAEA)	Mdu Zondo		033-3559532	mdu.zondo@kzndae.gov.za
DAEA- Umkhanyakude	Nqobile Mntambo		035-5500210	samukelo.mtambo@kzndae.gov.za
DAEA-Umkhanyakude	Mrs N.F. Mdamba		035-5500210	felicia.mdamba@kzndae.gov.za
DAEA-Environmental Planning	Dayalin Naidoo	uMkhanyakude District Manager:	035-5500221	Dayalin.Naidoo@kzndae.gov.za

		Environmental Services Directorate: (Environmental Planning)		
DAEA-	Innocent Msibi	Umkhanyakude Acting District Manager:	035-5721280	
Department of Mineral Resources(DMR)	Karoon Moodley	Agricultural Services	031-3359600	karoon.moodley@dmr.gov.za
Department of Mineral Resources(DMR)	Mrs N. Khanyile	Deputy Director	031-3359600	nqobile.khanyile@dmr.gov.za
Department of Energy	Ms Xolile Mtwla	Regional Manager	031-3359609	Xolile.Mtwla@energy.gov.za
Department of Water Affairs (DWA):KZN Region	Norman Ward	Regional Director :KZN	031-3362737	WardN@dwa.gov.za badenhorstT@dwa.gov.za
DWA	Jay Naidoo	Chief Engineer		
Isimangaliso Wetland Park Authority	Thembi Buthelezi	Acting Director: Resources Management and Quality management	035-5901633	thembi@isimangaliso.com
Isimangaliso Wetland Park Authority	Andrew Zaloumis		035-5901633 0827883000 0763982391	andrewa@isimangaliso.com taryn@isimangaliso.com
Isimangaliso Wetland Park Authority	Taryn Bigwood Ivan Scholtz	Environmental Management Officer	033-3556459	ivan.scholtz@kzncogta.gov.za
Department of Cooperative Governance and Traditional Affairs (COGTA) COGTA	Mr S. Zondo	Chief Executive officer	035-5731752 0721126429	skhumbuzo.zondo@kzncogta.gov.za
COGTA	Mr Siphamandla Mkhize	Environmental Management Officer	031-2041881	Siphamandla.mkhize@kzncogta.gov.za
COGTA	Mr Larry Saunders	Chief Planner	033-3556512	larry.saunders@kzncogta.gov.za
COGTA	Ms Lizette Dirker	UMkhanyakude District Manager: COGTA-Traditional Branch	033-3556434	lizette.kzncogta.gov.za
COGTA	Lethu Mkhonza		035-5738800 0795052366	mkhonzale@kznded.gov.za
Department of Economic Development and Tourism		Town and Regional Planner: Spatial Planning	033-2642648	ngcobo@kznded.gov.za
	Sandile Ngcobo			
Department of Economic Development and Tourism	Keshnee Williams	Chief Town and Regional Planner: Spatial Planning	033-2642515	keshnee.williams@kznded.gov.za
Department of Economic Development and Tourism	Gabi Gumbi-Masilela	Chief Town and Regional Planner: Municipal Strategic Planning(IDP)	033-3926425	gabigumbi-masilela@kzndhs.gov.za
Department of Human Settlements	Zithulele Mbonane		035-8742697 0825677419	Zithulele.Mbonane@kzndhs.gov.za
Department of Human Settlements	Peter Woolf	uMkhanyakude District Manager: DEDT	031-3365404	peter.woolf@kzndhs.gov.za
	M.P. Themba		035-5721327 0822207848	Makho.themba@kznhealth.gov.za Zekhethelo.mkhabela@kznhealth.gov.za
Department of Human Settlements		Deputy Manager :LED	0836458463	tholakele.maphumulo@kzntransport.g

Department of Health	T. Maphumulo		035-5620261 0836458463	a
	T. Maphumulo	Secretary to HOD	035-5721370 0826283732	tholakele.maphumulo@kzntransport.g a
Department of Transport	T.M. Mthethwa	HOD		thami.mthethwa@vodamail.co.za
Department of Transport			035-5721370 0823173384	
Department of Transport	G.C. Mabika	Senior Manager: Project Implementation and Management	035-7891035 0763496365	
	Nomvuzo Mjadu	Senior Manager: Planning		PNMjadu@rural development.gov.za
Department of Rural Development and Land Reform		uMkhanyakude District Manager: Health Department		
		Transport Manager		
		Manager: Hluhluwe Cost centre		
		Chief Technician: (Jozini)		
		Roads Superintendent (Jozini)		
		Project Coordinator: uMkhanyakude District Municipality		

Appendix 7

SANEDI-SACCCS consultative meetings with National, Provincial and Local Government Departments, parastatal entities and NGO's with respect to raising the profile of CCS and discussing aspects of the proposed PCSP in KwaZulu-Natal and the Eastern Cape. Consultations specific to the UMkhanyakude seismic survey and drilling project are highlighted in red.

Executive Summary

✓ South Africa has strong requirements for Stakeholder Engagement which are conducted as an integral part of environmental authorisation processes. For CCS, implementing best practices for engagement in addition to complying with public participation and engagement rules is a key recommendation because of the new and complex nature of the CCS process. Stakeholder Engagement activities within SACCCS are informed by the World Resource Institute (WRI) Principles.

✓ A database has been drawn to create a CCS-specific Stakeholder network, comprising of national, provincial, local government and local communities as well as Environmental NGOs (ENGOs). The database includes key stakeholder representatives of all sectors of society such as the Traditional Authorities and Land Administrators in the KZN Zululand Basin and Eastern Cape's Algoa Basin.

✓ As stakeholders are not uniform they require varying levels of consultation, ranging from information sharing to active and in-depth engagement. Thus varying levels of engagement are required for different stakeholders. Therefore, analysis of key stakeholder groupings indicates that government institutions, NGOs and conservation groups, traditional authorities and directly affected communities will require active engagement. The latter two groupings will be especially important at the local level.

✓

✓ The Stakeholder Engagement Work Theme presents the key considerations for Stakeholder Engagement regarding the deployment of CCS in South Africa. For CCS to be fully considered as part of South Africa's energy strategy, and climate change mitigation actions, stakeholders must be engaged and provided with information about the basic principles around the CCS technology as well as benefits and potential risks of its application. This information must be given at a National, Provincial and Local levels including the traditionally excluded stakeholders such as Environmental Non- Governmental Organisations (ENGOs) and Labour Unions.

CCS remains a relatively unknown and poorly understood technology among the publics. Public acceptance is key to successful permitting and the deployment of CCS technology. To this end, ongoing public outreach and education pre-, during and post-PCSP will continue to play a pivotal role. Rapport has been established with the relevant National, Provincial and Local structures. Key messages were developed and supported by a wide variety of communications

materials. Stakeholders are afforded an opportunity to raise concerns/issues and these are captured in the Issues/concerns Logbook.

List of Acronyms

ADDO	ADDO Elephant Park
AgriSA	Federation of Agricultural Organisations in South Africa
Amafa	Amafa KZN Heritage Agency
CCS	Carbon Capture and Storage
CDM	Cacadu District Municipality
CO ₂	Carbon Dioxide
COEGA	COEGA Industrial Development Zone
CoGTA	Cooperative Governance & Traditional Affairs
DAFF	Department of Agriculture, Forestry and Fisheries
DBE	Department of Basic Education
DEDEAT	Department of Economic Development, Environmental Affairs & Tourism
DMR	Department of Mineral Resource
DoE	Department of Energy
DRDLR	Department of Rural Development and Land Reform
DW&S	Department of Water & Sanitation
EC	Eastern Cape
ENGOS	Environmental Non-Government Organisations
EKZN	Ezemvelo KZN Wildlife
ICAP	Integrated Communications Action Plan
IDTT	Interdepartmental Task Team
I&APs	Interested and Affected Parties
ITB	Ingonyama Trust Board
KPAs	Key Performance Areas
KZN	KwaZulu-Natal
MDG	Millennium Development Goals
MDTTT	Multi-Disciplinary Technical Task Team
MoU	Memorandum of Understanding
NatLoc Plans	National and Local Plans (Initiating Stakeholder Engagement)
NMBM	Nelson Mandela Bay Metropolitan Municipality

NUM	National Union for Mineworkers
Orion	Orion Chemical
PCEC	Provincial Committee for Environmental Coordination
PCSP	Pilot CO ₂ Storage Project
PSP	Pilot Schools Project
Pta	Pretoria
SACCCS	South African Centre for Carbon Capture & Storage
SALGA	South African Local Government Authority
SANBI	South African National Biodiversity Institute
SANEDI	South African National Development Institute
SANParks	South African National Parks
SE	Stakeholder Engagement
SRVM	Sundays River Valley Local Municipality
TAs	Traditional Authorities
UKDM	UMkhanyakude District Municipality
UMHLM	UMhlabuyalingana Local Municipality
WESSA	Wildlife and Environmental Society of South Africa
WGB	World Bank Group
WRI	World Resource Institute

✓ **1 April 2013 – 31 March 2014**

Stakeholder Engagement and Communications focused mostly on the SACCCS communications / branding materials, Marketing and Communications Strategy for the CCS Conference, Website updates and revamp, and ad hoc engagement opportunities such as speaking at events and approaches from the media.

To create a more comprehensive CCS engagement and communications strategy SACCCS has worked with the World Bank and Department of Energy to develop an Integrated National and Local Stakeholder Engagement Plan (NatLoc Plans) as part of the World Bank - Department of Energy CCS Study Task 4: Public Engagement. SACCCS has also developed a number of governance documents around Stakeholder Engagement and Communications.

As the PCSP development gets underway the engagement and communications about the PCSP as well as CCS in general will need to increase. To this end, SACCCS needs to move from a responsive mode to a proactive approach. Looking forward SACCCS will need to enhance its website and develop other communications and engagement tools for example, fact sheets, prospectus, posters, FAQs, visual materials and Schools Competitions.

Significant strides were made to support the Presidential and Ministerial Stakeholder Engagement programmes in an endeavour to meet the Millennium Development Goals (MDGs). SACCCS SE programme for the period August 2013 – March 2014 was submitted to the Department of Energy's (DoE) Communications Chief Directorate and Minister's Communications Advisor to keep the Minister abreast on SACCCS' outreach programmes. The SE Lead was part of the Presidential & Ministerial entourage to the Infrastructural launch in the Eastern Cape and the Northern Cape.

SACCCS was represented by the SE Lead at the Minister's first Press Briefing held on 6 August 2013 where he addressed the media, executives of all the DoE SOEs and Regulators on the programmes of the DoE in line with the Budget Vote commitments.

In 2013/14 SACCCS developed an Integrated Communications Action Plan (ICAP) for the Basins focusing on the pre EIA Stakeholder Engagement, pre seismics and drilling as well as during the Basins assessments in alignment with the NatLoc Plans funded by the WBG. Coupled with that, will be the intermittent update of the SACCCS website and other communications material to ensure information is available and easily accessed on SACCCS activities as well as CCS generally. A review of the SACCCS Corporate Identity was undertaken to ensure that SACCCS is clearly branded and that there is consistency. SACCCS arranged media and Stakeholder Engagement training for staff and stakeholders identified as potential SACCCS spokespeople.

1 April 2014 – 31 March 2015

During 2014/15, SE Outreach activities progressed exponentially to an extent that the Integrated Communications Action Plans were split into General CCS & Communications and the Pilot CO₂ Storage Project (PCSP).

The PCSP Stakeholder Engagement Work Theme, continuing with the implementation of the Integrated Communications Action Plan (ICAP), aligned to Nat-Loc Stakeholder Engagement Plans. During this period a Pilot CO₂ Capacity Building Monitoring Project – Bongwana Natural CO₂ Release formed part of the PCSP.

Most of the Stakeholders consulted in the KZN urged SACCCS to consult with the Ingonyama Trust Board (ITB). The ITB is the majority owner of the land in KZN and the Trust Board operates under the KwaZulu Ingonyama Trust Act No 3 of 1994 to hold the land in title for the benefit, material welfare and social well-being of the members of the tribes and communities living on the land and to have a community liaison from that area that the community can relate to.

Stakeholder Engagement continues to be an integral part of the PCSP throughout the project life cycle. Some of the Stakeholders have proven to be more key than others to such an extent that iterative meetings/workshops will be held throughout the project cycle.

The SE activities have focused on identifying and connecting with the local stakeholders as well as the Interested and Affected Parties (I&APs) to ensure that they understand the project. Needless to state, Stakeholders are afforded an opportunity to input into how the project will be implemented. As the PCSP progresses, the focus of SE will shift to maintaining and cementing relationships with these stakeholders. This evolution will also be necessary at a national level with initial efforts being exerted on raising CCS awareness and subsequently to provide project updates.

As the PCSP technical activities unfold, more interactive engagement will be required in order to build and maintain relationships with key Stakeholders. The 2015/16 will see the expansion of SE outreach activities after addition of the stakeholders from Bongwana Natural CO₂ Release sites.

The SE Work Theme will be a continuation of the implementation of the ICAPs provided there are no unexpected objections to the process.

Conclusion

CCS remains a relatively unknown and poorly understood technology among the publics. Public acceptance is key to successful permitting. To this end, ongoing public outreach and education pre-, during and post- Pilot CO₂ Storage Project (PCSP) will continue to play a pivotal role. Rapport has been established with the relevant National, Provincial and Local structures. Key messages were developed and will be supported by a wide variety of communications materials on the concerns/issues Logbook is updated on an ongoing basis.

SANEDI/SACCCS has implemented and will continue to practice the WRI's public engagement guidelines and best practices which include but are not limited to the following:

- An annual review of the PCSP Integrated Communications Action Plan;
- Obtain inputs from the Stakeholders during introductory/iterative consultative sessions at the national, provincial and local levels;
- Incorporate suggestions/ recommendations into the ICAP to ensure Stakeholder buy-in;
- Proactively share information on International CCS and related incidents;
- Manage stakeholder expectations;

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- Timeous dissemination of factual information;
 - Address stakeholder concerns/ issues through dialogue;
 - Promote participatory monitoring by the local communities;
 - Include traditionally excluded stakeholders such as the environmental groups and organised labour; and
 - Adopt international best practices to execute the PCSP.

Needless to say, consultations will take place in accordance with the PCSP schedule which is reviewed on an ongoing basis.

Protocol must be observed at all times. Cultural beliefs must be respected as well.

A list of Stakeholders consultations/meetings held from Q3 2012/13 to-date is set below. In addition files on meeting highlights/minutes and attendance registers form addenda of this report.

Timeframe	Date	Stakeholder Details	Purpose	Outcomes
2012/13 FY				
Q4	2013-02-04	Department of Mineral Resources (DMR) (EC)	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - SACCCS was advised to pursue Section 50. A motivation letter should include scoping report detailing: <ul style="list-style-type: none"> ✓ Where the exploration will take place including Farm Names ✓ What infrastructure would be required ✓ The stages of the exploration (given the exploration will be a four stage process. Emphasis must be placed on first stage and subsequently on the remaining stages at a later stage)
	2013-03-07	Department of Mineral Resources (DMR) (KZN)	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - Deliberations revolved around Section 50 and the meeting resolved that application to that effect must be submitted. - SACCCS urged to consult with RMDEC as a matter of urgency
	2013-03-12	Government Communications Information System (GCIS) (National Office)	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - SACCCS asked to draft a Letter of Intent for submission to Michael Currin, Chief Director: Provincial and Local Liaison who will revert with a way forward after receipt thereof. - GCIS will help to identify relevant provincial structures where SACCCS can present its credentials. GCIS recommended a meeting with the Head of Departments i.e. DEA, DED and DoT
	2013-03-20	South African Local Government Association (SALGA) (National Office)	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - SACCCS requested to draft a Letter of Intent stating SACCCS' expectations from KZN & EC SALGA and the aims for the partnership. - SALGA will initially facilitate meetings with different municipalities and the Traditional leaders in KZN and EC respectively and thereafter nationally should a need arise.
	2013-03-20	Department of Mineral Resources (DMR) (National Office)	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - SACCCS must keep a record of consultations including minutes, pictures and attendance registers. - Public participation should be incorporated into the EMP - The Letter of Intent to apply for exploration permit should include specialist reports.
2013/14 FY				
Q1	2013-04-09	Regional Mining Development &	CCS & PCSP Introduction	<ul style="list-style-type: none"> - RMDEC KZN emphasized that SACCCS must urgently arrange engagement meetings with individual stakeholders

		Environmental Committee (RMDEC) KZN	/Stakeholder Engagement	<p>within RMDEC including the community based organisations (CBO's).</p> <ul style="list-style-type: none"> - RMDEC KZN also recommended that SACCCS should consider Community Social Involvement (CSI) interventions – i.e. to leave a legacy in the affected communities (for example; bursary programmes/internships/skills development on geology, etc.); - Recommendation for public engagement/communications material to be translated in Zulu and Xhosa.
2013-05-07		Regional Mining Development & Environmental Committee (RMDEC) EC	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - A consensus was reached for SACCCS to embark on raising awareness at the universities in addition to the schools; - SACCCS will provide RMDEC with the names of the targeted areas to ensure that consultation takes place with the relevant stakeholders - SACCCS will provide RMDEC with the names of the targeted areas to ensure that consultation takes place with the relevant stakeholders - SACCCS was requested to build capacity of the DMR's officials on CCS and the PCSP. In addition, the Secretariat emphasised the importance of liaising with Mr. T Hani from the Local Government & Traditional Authority (LGTA)
2013-06-19		KZN Department of Water Affairs	CCS & PCSP Introduction /Information sharing	<ul style="list-style-type: none"> - SACCCS must engage with the Head Office in Pretoria - SACCCS must conduct the needs -analysis with regards to the social responsibility programmes – leaving legacy behind for the communities of interest - When engaging with the Traditional Authorities a hand-delivered letter is more appropriate to request for a meeting as opposed to a telephonic call or email. - SACCCS was advised to follow Environmental Best Practice Guidelines when drilling wells. - SACCCS requested to conduct more CCS information sharing sessions so as to assist the relevant officials to have a clearer understanding of CCS as it is a novel technology
2013-06-27		KZN Programme 3	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SACCCS was urged to consider awarding school bursaries as one way of raising CCS awareness in the communities that will be directly affected - SACCCS must consider legacy projects for the affected communities - SACCCS must create a database of all interested parties

				- Prof Timothy Fasheun and Ms Demitra Pillay will invite SACCCS to conduct presentations on CCS, the PCSP and Public Engagement at the next meeting of the Provincial Committee for Environment Co-ordination (PCEC) to ensure that they understand the processes at an early stage as they can also advice on how to handle certain issues
Q2	2013-08-07	Department of Agriculture, Forestry & Fisheries, PTA	CCS & PCSP Introductions/ Information sharing	<ul style="list-style-type: none"> - SACCCS was encouraged to utilise DAFF's existing structures such as Land Use Soil Management, and National Agrarian Committee, the Agricultural Resource Council (ARC) to inform them about the SACCCS, the Carbon Capture & Storage (CCS) and public engagement ethos when dealing with the local communities and other relevant government structures. - SACCCS must liaise with the Agricultural Labour unions - SACCCS must emphasise and allude to Climate Change in its presentations in an endeavour to raise awareness in the farming communities - SACCCS invited to attend/ participate in the Sectoral Disaster Risk Management Plan and Climate Change Sector Plan Provincial Workshop scheduled to take place on 21-22 August 2013 in Limpopo
	2013-08-07	South African National Parks	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SANParks will furnish SACCCS with the database of stakeholders and contact details of the following: <ul style="list-style-type: none"> ✓ South African National Biodiversity Institute (SANBI); ✓ ADDO Provincial/Regional Offices; ✓ MINTEK; ✓ MINMEK; ✓ Eastern Cape Park Tourism Board.
	2013-08-30	DMR EC CCS 101 Workshop	CCS Training – Information sharing	<ul style="list-style-type: none"> - The permitting authority must be on site to ensure that the engineers do the job accurately and the site is well protected. - South African Heritage Resources Agency (SAHRA) must be involved or consulted especially when doing the drilling and seismic. - DMR requested to be advised what skills or courses are needed for explorations.
	2013-09-27	KZN SALGA: Climate Change Summit	Stakeholder Engagement/ Capacity Building	- SACCCS team conducted a presentation and fielded questions

	2013-09-29	EC SALGA: Climate Change Summit	Stakeholder Engagement/ Capacity Building	<ul style="list-style-type: none"> - SACCCS must conduct a presentation to the Provincial Executive Committee (PEC) in order to lobby for CCS to be incorporated in the school's curriculum - SACCCS must give priority to the municipalities throughout its engagement / outreach program
Q3	2013-10-16	KZN DAEA: PCEC	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - Conducted presentation and fielded questions.
	2013-10-21	Cooperation Government & Traditional Affairs (COGTA) Provincial Municipalities	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - SACCCS must engage with Ingonyama Trust Board (a land-owner of the most parts in KZN) - SACCCS must consult the Provincial Officials of the Local Government and Tradition leaders
	2013-11-05	KZN UMkhanyakude District Municipality	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - Mr Boxer Mpontshane will assist SACCCS by coordinating sessions with the identified Stakeholders and the community. - The District is a highly sensitive protected Biodiversity area, therefore it was recommended that SACCCS engage with the following stakeholders: <ul style="list-style-type: none"> ✓ ISimangaliso Wetland Park (owns more than 65% of the land); ✓ Traditional Authorities (own about 75% land within the District); ✓ Ingonyama Trust Board (a land Administrator) etc. - SACCCS must engage with the Schools to assist with career guidance
	2013-11-06	KZN DAEA: Empowerment Unit	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - Bore-holes must be considered for domestic use as a legacy for the community; - SACCCS must consider awarding bursaries to primary and secondary schools; - The Empowerment Unit has requested more follow-up presentations on CCS and the PCSP respectively to ensure that the technology is understood before reaching out to the communities
	2013-11-19	EC SALGA Working Group: Eastern Cape	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SACCCS is allowed to use the municipalities existing structures when engaging with the communities - CCS was adopted as a standing item on the agenda of the SALGA Climate Change & Sustainability Working Group meetings which take place quarterly

				- Engagement with the schools in the Eastern Cape to include CCS/Climate Change as part of the curriculum.
	2013-11-28	EC DEDEAT Environmental Management	Stakeholder Engagement/ CCS & PCSP Introductory meeting	- SACCCS presented and fielded questions on CCS and the PCSP in South Africa
Q4	2014-01-31	Department of Water Affairs (National Office)	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SACCCS must submit a letter to the Department of Water & Sanitation (DW&S): Director General of Policy & Regulations requesting to present SACCCS credentials (CCS, PCSP and PE); - DW&S Chief Engineers and Hydrologists will be invited to the SACCCS presentation; - SACCCS must investigate impact of CCS on Water quality. - SACCCS must engage with the department at the strategic level before consulting other relevant stakeholders such as Water Boards and so forth.
	2014-02-25	Cacadu District Municipality	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SACCCS should forge collaborative partnerships with the following structures: <ul style="list-style-type: none"> ✓ Provincial Government – HOD: Economic Development ✓ Mayoral Committees, and ✓ Councillors' Committee - CDM recommended that SACCCS has to consider benefits that will improve the quality of the lives of the communities that might be affected by the deployment of the PCSP
	2014-02-26	Nelson Mandela Bay Municipality	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - SACCCS must consider capturing CO₂ from the Eastern Cape industrial sites to garner support from the government structures and the communities. - More research needs to be done with regards to the CO₂ emissions in the Eastern Cape (in particular Port Elizabeth and East London industrial zones) - SACCCS encouraged to establish a Sub-Committee drawn from the MDTTT officials to deal with Climate Change and CCS issues within the EC province;
	2014-02-28	Eastern Cape Local Government and Traditional Affairs	Stakeholder Engagement/ CCS & PCSP Introductory meeting	- SACCCS must consider engaging with the officials of the Spatial Planning Land-Use Management Act (SPLUMA) in the EC province;

			meeting	<ul style="list-style-type: none"> - Iterative engagements must be pursued - The Centre should consider capacitating the municipalities with regards to the roles they will assume in the project - The communities must benefit equally in the same way as the GHG emitting industries.
	2014-03-05	UMhlabuyalingana Local Municipality	Stakeholder Engagement/ CCS & PCSP Introductory meeting	<ul style="list-style-type: none"> - Consensus that SACCCS must present to the Mayor, Municipal Manager, EXCO, Technical Directors as well as Senior Managers - UMHLM indicated that some of the Big 5 False Bay Local Municipality (BFBLM) villages fall within UMHLM including areas cited below <ul style="list-style-type: none"> ✓ Jozini, ✓ BFBLM, and ✓ UMHLM - SACCCS must strike the balance - preserve the conservation in its pristine state and industrial developments to create jobs for the communities
	2014-03-27	iSimangaliso Wetland Park Authority	CCS & PCSP Introduction /Stakeholder Engagement	<ul style="list-style-type: none"> - The project prohibited within 10kms radius of the world heritage sites and national parks - iSimangaliso requested the Technical Report and other relevant reports - SACCCS must give assurance that iSimangaliso will not be considered for the PCSP - SACCCS must send a conformation in writing that iSimangaliso will not be considered for the PCSP
2014/15 FY				
Q1	2014-04-07	Sundays River Valley Municipality (SRVM)	Stakeholder Engagement/ CCS & PCSP Iterative meeting	<ul style="list-style-type: none"> - SACCCS must prepare an Item Report (IR) which will be circulated to the Management and Ward Committee for information before commencing with a formal consultation with the communities in the SRVM area. - The IR must outline the background information on SACCCS, CCS, PCSP (including the potential sites and municipalities) and public participation. - SACCCS will be invited to conduct a presentation to the Councilors after the National Elections.
	2014-04-08	Nelson Mandela Bay Metropolitan Municipality – Multi-Disciplinary Task Team.	Introductory meeting	<ul style="list-style-type: none"> - Deliberations revolved on safety issues. SACCCS allayed fears by providing facts on safety. - The MDTT was not satisfied with the handling of safety issues.

				<ul style="list-style-type: none"> - SACCCS was requested to come back with convincing responses
	2014-04-10	Department of Economic Development, Environmental Affairs & Tourism (DEDEAT) (EC)	Iterative meeting referral by Cacadu District Municipality.	<ul style="list-style-type: none"> - Fielded questions and concerns raised after the presentation. - SACCCS urged to raise CCS awareness at schools
	2014-04-14	South African Local Government Association	Iterative/Feedback Meeting	<ul style="list-style-type: none"> - SALGA expressed keen interest to formalise the collaboration with SACCCS - SACCCS must consider using schools to raise awareness on Carbon Capture and Storage (CCS) as one of the solutions addressing Climate Change challenges;
	2014-05-14	Department of Agriculture, Forestry and Fisheries (DAFF) (KZN)	Introductory meeting/referral by the DAFF National Office	<ul style="list-style-type: none"> - SACCCS must consider iterative engagement as stakeholders cannot grasp the technology at one sitting. - As an Interested party/stakeholder, DEDEAT requested to be kept abreast on the project development
	2014-05-20	National Union of Mineworkers	Introductory meeting/the Stakeholder reached out to SACCCS.	<p>SACCCS was urged to approach:</p> <ul style="list-style-type: none"> - Steel and smelters industries - Technology Innovation Agency - Chamber of Mines - Mining Qualifications Authority - Involve previously disadvantaged academic institutions - SACCCS urged to engage with the Department of Transport (DoT) and Transnet for the transportation of CO₂
Q2	2014-07-09	South African National Biodiversity Institute (SANBI) (National Office)	Introductory meeting	<ul style="list-style-type: none"> - SANBI will provide SACCCS with: <ul style="list-style-type: none"> ✓ Contact details of the SANBI Education Centre Manager for SACCCS to leverage on its existing structures; ✓ The South African Biodiversity information on protected areas; and ✓ National Biodiversity Assessment Document (2011).
	2014-07-11	Eastern Cape Department of Water & Sanitation (DWS) (EC)	Introductory meeting	<ul style="list-style-type: none"> - SACCCS was advised that the department is exploring the option of using the saline aquifers for desalination - SACCCS was urged to be familiar with the no-go areas which fall within the potential sites during the exploration phase.
	2014-07-15	Wildlife & Environmental Society of South Africa (WESSA) (KZN)	Introductory meeting	<ul style="list-style-type: none"> - WESSA accepted SACCCS request to leverage on its Eco-Schools Programmes.

	2014-07-17	AgriSA (National Office)	Introductory meeting	<ul style="list-style-type: none"> - SACCCS cautioned to be sensitive when dealing with the farmers because of the Shale Gas debates, especially in the Eastern Cape (EC). - SACCCS urged to develop and customize a CCS protocol based on the principles of the AgriSA shale gas protocol which deals with beneficiation
	2014-07-23	Department of Environment Affairs: Intergovernmental Committee on Climate Change (IGCCC) (National Office)	Introductory meeting	<ul style="list-style-type: none"> - SANEDI/SACCCS participated at the Climate Change Dialogue as CCS is one of DEA's Eight Flagship Programmes in the Climate Change Response White Paper - Fielded questions after presentations to the delegates - The IGCCC Chairperson confirmed the Committee's support of CCS
	2014-08-22	Department of Water & Sanitation (DW&S) (NATIONAL OFFICE)	Iterative meeting with DG and team.	<ul style="list-style-type: none"> - SACCCS must be transparent in sharing information so as to enable DW&S to make informed decisions on the CCS technology. - The DoE which was in attendance confirmed that DW&S is part of the IDTT - DW&S will pursue the Control Activity route because of uncertainties around the CCS technology
	2014-09-05	Greenpeace Africa (National Office)	Introductory meeting	<ul style="list-style-type: none"> - Greenpeace reiterated its anti-coal stance and its opposition to new investment in initiatives that prolong coal usage as an energy source - Greenpeace has requested to be kept abreast.
	2014-09-16	Ezemvelo KZN Wildlife (EKZNW) (KZN)	Introductory meeting	<ul style="list-style-type: none"> - EKZNW will provide SACCCS with contacts/leads of the key stakeholders in the Province that might be directly and indirectly affected by the PCSP. - SACCCS must consider establishing a Provincial Technical Task Team. Dr Timothy Fasheun highly recommended to lead the task team. <p>SACCCS will be guided about where the biodiversity hot-spots are located in the KZN.</p>
Q3	2014-10-20	Department of Agriculture, Forestry and Fisheries: Land-Use & Soil Management (KZN)	Introductory meeting	<ul style="list-style-type: none"> - SACCCS must be familiar with the Conservation of Agricultural Resources Act (CARA) and other relevant legislations. - Once the site has been positively identified, SACCCS will need to intensify consultations with the most relevant stakeholders; - SACCCS must arrange a workshop/meeting with all key

				stakeholders in the KZN Province to agree on the siting of the PCSP
2014-10-20	KwaZulu-Natal Department of Rural Development and Land Reform (DRDLR) (KZN)	Introductory meeting		- Consultation with the Ingonyama Trust Board must take precedence as they own the majority of the land within UMkhanyakude District
2014-10-21	AMAFA KZN Heritage	Introductory meeting		- The PCSP must be at least ten (10) Kilometres away from the National Heritage Sites and five (5) kilometres away from Cultural/Local Heritages Sites - SACCCS must also be aware of and respect the general local cultural landscapes and indigenous belief systems - SACCCS must work closely with local Amakhosi, Indunas, and the Councillors;
2014-11-10 to 13	Department of Environmental Affairs: Dialogue on Climate Change	Near-Term Flagship Programmes Expos		- Info dissemination at the Expo - A number of people visited the stand to seek clarity on CCS and the PCSP
2014-11-12	Earthlife Africa (National Office)	Introductory meeting		- Earthlife Africa does not support CCS technology as they believe that it is unrealistic and it prolongs the use of coal. - Earthlife requested to be kept up to date with new developments
2014-11-18	GroundWork & South Durban Environmental Community Alliance	Introductory meeting		- GroundWork and SDCEA reiterated that they do not support CCS technology because they believe it will prolong the use of coal. - They are more interested in the commercial phase of CCS in South Africa - Both recommended that the residents near the power plants where the CO ₂ is in high concentration need to be consulted as a matter of urgency because they will be somehow affected. - Groundwork took the SACCCS SE team on a tour of areas located in close proximity to the Oil refineries
2014-11-20	Water Research Commission (National Office)	Introductory meeting referral by National DWS.		- WRC raised a concern about the possibility that CCS could activate earthquakes during the injection phase. - WRC stated that due to water scarcity in the country, desalination of groundwater (like deep saline aquifers) will be considered for future use similar to countries such as India and Israel. - WRC expressed willingness to be involved with any

				groundwater-related matters during the PCSP.
	2014-12-17	Ingonyama Trust Board (KZN)	Introductory meeting	- Met with the officials who will escalate SACCCS request to the CEO and his team
Q4	2015-01-27	SANBI: Environmental Education Centre	Iterative meeting	- Met with the Education Centre Manager and we agreed on collaborative relations including usage of SANBI's existing structures to raise CCS & PCSP awareness to the teachers, learners and the public at large, initially at the head office and subsequently to the provinces.
	2015-02-13	Department of Cooperative Governance for Traditional Authorities (KZN)	Introductory meeting – a referral by the Ingonyama Trust Board because SACCCS needed to be orientated by the Senior manager who is the Ingonyama's Advisor	- In essence Protocol has to be observed at all times when dealing with the Amakhosi - SACCCS must place emphasis on developmental legacy issues and Climate Change when conducting presentations to the ExCo, the Portfolio Committees. - SACCCS must consider to change the name Zululand Basin as it has political connotations. - SACCCS was urged to meet with Dr William Mngoma, the Chair of Programme 7 dealing with the Provincial Growth Development Strategy - SACCCS to liaise with Mandisa of SPLUMA for the Traditional Settlement Master Plans as well as Boxer Mpontshane of UMKhanyakude and the Ndumo Education Centre for advise in charting way forward - SACCCS must reach out to the Provincial House of Traditional Affairs
	2015-03-05	Ugu District Municipality: Environmental Services	Introductory meeting (CCS/PCSP/Monitoring)	- Presented SACCCS' credentials, shared information on the Bongwana Natural CO ₂ Release (BNCR) Pilot CO ₂ Capacity Building Monitoring Project (PMP). - We established rapport with the Municipality before the commencement of the PMP. - Ugu District Municipality (UDM) expressed willingness to work with SACCCS in understanding the impact the BNCR might have in the district. - SACCCS was urged by the UDM to familiarise itself with and to understand the land issues including the administration thereof before commencing with the monitoring activities
	2015-03-06	Umuziwabantu Local Municipality (KZN)	Introductory meeting (CCS/PCSP/Monitoring)	- Umuziwabantu gave SACCCS an in-principle support which is key before the project can take off - Umuziwabantu will introduce SACCCS to the Local Inkudla

				<ul style="list-style-type: none"> - before the commencement of the project - SACCCS must be transparent and must consider legacy issues
	2015-03-17	Mbizana Local Municipality	Introductory meeting (CCS/PCSP/Monitoring)	<ul style="list-style-type: none"> - SACCCS shared on a monitoring programme at the Bongwana (Harding) near Umzimkulwana River and in Mbizana near Umtamvuna River. - SACCCS was urged to consider transfer of skills during the two projects (PCSP & PMP) and to work closely with the Municipality in particular on matters addressing Climate Change issues - SACCCS was urged to be transparent and must update the municipality on a regular basis
2015/16 FY				
Q1	2015-05-07	Mbizana Climate Change Response Strategy Meeting (EC)	Information Sharing and follow-up meeting (CCS/PCSP/Monitoring)	<ul style="list-style-type: none"> - SANEDI/SACCCS shared information on the Pilot CO₂ Monitoring Capacity Building Project at the Bongwana Natural CO₂ Release. - Establish working relations as SACCCS will be serving on Mbizana climate change Committee
	2015-05-12	Mbizana Climate Change Workshop (EC)	Information Sharing and Iterative meeting	<ul style="list-style-type: none"> - SACCCS conducted a presentation on CCS, PCSP and Pilot CO₂ Monitoring Capacity Building Project. - Concern was raised by Inkosi Jali that SACCCS had a site visit in September 2014 without seeking permission and he took an exception to SACCCS conduct - The presiding Chairperson sought the Mayor's intervention on behalf of SACCCS - SACCCS was accompanied by the Municipal entourage to pay Inkosi Jali a courtesy call to apologise and chart way-forward - SACCCS must respect the Cultural and traditional beliefs upheld by Inkosi and his communities.
	2015-05-14	Ugu District Municipality (KZN): Environmental Services	Iterative meeting	<ul style="list-style-type: none"> - A site visit was postponed until consultations were held with the Amakhosi in the area. - The discussions revolved around the structures to be consulted before the sample-taking begins in September 2015. The structures recommended included: <ul style="list-style-type: none"> ✓ Ugu Infrastructure and Development Plan Forum. ✓ Ugu's Portfolio Committee on Economic Development. - Ugu requested to be involved in the Pilot Monitoring Project as part of capacity building.

				<ul style="list-style-type: none"> - SACCCS was invited to present at the next meeting of the Portfolio Committee scheduled for 10 June 2015.
	2015-05-28	SANBI: Environmental Education Centre (National Office)	Plenary session	<ul style="list-style-type: none"> - Plenary session on <ul style="list-style-type: none"> ✓ Teachers Workshops ✓ Learners Workshops ✓ MoU between SACCCS & SANBI
	2015-06-06	Council for Scientific Industrial Research (CSIR)	Introductory meeting (CCS/PCSP/Monitoring)	<ul style="list-style-type: none"> - Thulani Maupa (TM) drafted a proposal outlining CSIR's involvement in the Monitoring Project, including the breakdown for manpower, equipment and cost. - SACCCS will engage with the following institutions for capacity building component: <ul style="list-style-type: none"> ✓ UKZN; and ✓ UFS. - CSIR will engage an intern to assist with long term monitoring especially the CO₂ observation at the Bongwana - Environmental Impact Assessment (EIA) will be required, especially if the CSIR is to set-up a monitoring station. Doing this on privately-owned land might be quicker than on state-owned land. - A site visit to familiarise the CSIR with the site will be undertaken once all access issues have been complied with.
	2015-06-08 to 09	SANBI: Environmental Education Centre (National Office)	Workshop for Assistant Educators Officers	<ul style="list-style-type: none"> - Workshop took place as planned for the head office and the Walter Sisulu AEOs
	2015-06-12	Ugu District Municipality Infrastructure and Development Plan (IDP) Forum (KZN)	Iterative meeting (CCS/PCSP/Monitoring) Referral by the Ugu Environmental Manager	<ul style="list-style-type: none"> - The IDP Forum Chairperson indicated that the AmaKhosi are represented at the IDP Forum. - A recommendation was made that SACCCS must liaise with AmaKhosi directly to arrange meetings to discuss more about the Bongwana Pilot Monitoring Project. - UGU IDP Forum supports the monitoring project in principle provided that all protocol is observed.
Q2	2015-07-02	National House of Traditional Leaders (Parliament)	Introductory meeting	<ul style="list-style-type: none"> - The NHTL is a body composed of delegates from the Provincial Houses of Traditional Leaders (PHTL) of South Africa, representing the Provincial Houses at national level. - Inkosi Mavundla informed SACCCS that the Bongwana area falls within his area of jurisdiction. - He cautioned that his Traditional Council, which represents the community has to be consulted first before any work can

				<p>be undertaken on the site.</p> <ul style="list-style-type: none"> - Polly Modiko assured Inkosi Mavundla that all protocol will be observed. The SE team has already commenced with the process of engaging the Local Municipalities who will in turn guide SACCCS on protocol. - Inkosikazi Mhlauli commended SACCCS for showing respect and acknowledging the cultural beliefs and norms of the Bongwana communities. - She conceded that Isinuka/herbal spring at Bongwana is believed to heal all types of ailments and is regarded as a sacred place. - SACCCS was urged to use vernacular when engaging the communities. This will assist in ensuring that the affected communities get a better understanding of what the project entails well before its commencement.
2015-07-09	Department of Cooperative Governance and Traditional Authorities Executive Committee (EXCO) (KZN Ugu District)	Introductory meeting	<ul style="list-style-type: none"> - AmaKhosi representatives felt strongly about organisations that use the District as guinea pigs and requested SACCCS to consider leaving a legacy. - SACCCS was requested to submit a letter outlining how will the District benefit from the Pilot Monitoring Project. - It was recommended that SACCCS arrange a meeting with AmaKhosi that might be affected by the project in one seating to solicit support. - SACCCS was requested to share the results of the samples gathered during the Pilot Monitoring study. - SACCCS was asked to engage with the local municipalities before the commencement of the project 	
2015-07-10	Sundays River Valley Local Municipality: Executive Committee (EXCO)	Iterative meeting	<ul style="list-style-type: none"> - The Municipal Manager: Lonwabo Ngoqo requested that the meeting should not be used to tick the box. - Sundays River Valley Local Municipality (SRVLM) mentioned that there's a Professor from Rhodes University who conducted a study at a thousand (1000) metres in the subsurface and found that the Kirkwood baseline is shallow and contains fresh water. - SACCCS assured the Councillors that the PCSP will not be sited in the no-go areas. SACCCS will steer clear of fresh water. - SACCCS should keep the municipality abreast of the developments wrt the project. 	

				<ul style="list-style-type: none"> - SACCCS will update the SRVM about the outcomes of the meeting with the EC Education District once it has taken place
2015-07-22	Cooperative Governance for Traditional Authorities (CoGTA): Disaster Management Division (Provincial)	Introductory meeting		<ul style="list-style-type: none"> - Ms Lindokuhle Ngubane (LN) reached out to SACCCS - She gave a brief background of the Provincial Disaster Management Directorate which was established under the Disaster Management Act, Section 29. - LN attended a World Conference in Canada and heard that South Africa is looking at Carbon Capture and Storage (CCS) during one of the presentations. - She approached SACCCS during the Sustainability Week in Pretoria, CSIR. - SACCCS in turn provided information on the CCS, PCSP and Bongwana. - Gauteng CoGTA – Disaster Management Directorate envisage to enter into partnership with SACCCS especially around issues of risks reduction and community participation should a need arise - It was emphasised that capacity building for the municipality needs be a priority as the CO₂ will be transported via roads and fields within the jurisdiction of the municipalities
2015-07-22	SANBI: Environmental Education Centre	Plenary for Teachers' Workshop		<ul style="list-style-type: none"> - Both parties reached consensus on the format of the workshops.
2015-07-27 to 30	SANBI: Environmental Education Centre	Teachers' Workshop		<ul style="list-style-type: none"> - Facilitated workshops for teachers for the Nkangala Education District constituted by Nokaneng and Mametlhake to raise awareness on Climate Change, CCS and the PCSP - The District HoD has asked SACCCS to facilitate more workshops as Climate Change forms part of the curriculum
2015-07-29	Mthimude Tribal Council	Introductory meeting referral by NHTL.		<ul style="list-style-type: none"> - Nkosi Mavundla and the community leaders support the Pilot Monitoring Project in his area of jurisdiction. - He requested that a feedback session must be scheduled to keep the community leaders abreast of the sample takings
2015-08-11 to 14	SANBI: Environmental Education Centre	Climate Change Workshop		<ul style="list-style-type: none"> - The workshop was held at the SANBI Environmental Education Centre in Pretoria as part of SANBI/SACCCS collaboration on climate change, environmental education and CCS awareness. - The purpose of the Climate Change Week was to capacitate the learners on environmental education, energy sources and

				the role of CCS in mitigating against climate change
2015-08-15	Jali Tribal Council	Introductory meeting	<ul style="list-style-type: none"> - Nkosi Jali and the Headmen requested a site visit to the Umtamvuna River to enable them to make an informed decision regarding granting permission to SACCCS' Pilot Monitoring Project. - SACCCS apologized to the Inkosi for the site visit conducted in September 2014 without informing him - SACCCS must respect that the community use Isinuka for cleansing purposes and skin problems amongst others. - Nkosi Jali mentioned that he was taken aback by the presentation conducted at the Wild Coast Casino when his area of jurisdiction was named after Bongwana. He requested that the name Bongwana Pilot CO2 Monitoring Project be reviewed. - SANEDI/SACCCS will consider changing the name and will work closely with the affected community (including the Mbizana Local Municipality and Kwa-Jali Tribal Office) to avert having more than one name for the project. 	
2015-08-29	Ndumo Community Centre	Teachers' Workshop	<ul style="list-style-type: none"> - Ndumo Environmental Education Centre is within close proximity to the potential CO₂ storage sites as it is within UMkhanyakude District Municipality. SACCCS association with Ndumo Environmental Education Centre will be used to increase of CCS and climate change in relation to Science, Technology, and Engineering and Maths (STEM) fields. - 30 participants, constituted by the teachers, Tshwane University of Technology Students doing practical training at the Environmental Education Centre and representatives from the Game Reserve. - The SACCCS raised awareness on the CCS, PCSP and Bongwana Monitoring project - The Centre Manager, Ms Cheryl Ogilvie has undertaken to introduce SACCCS to the Schools within the Ndumo area. 	
2015-09-03	National House of Traditional Leaders (EXCO) and KZN Provincial House of Traditional Leaders	Bongwana Site Visit	<ul style="list-style-type: none"> - SACCCS will be monitoring the sites for a minimum of two years, Phase one for the year 2015/16 will commence on the 19th – 25th September 2015 in Collaboration with the Council for Scientific and Industrial Research (CSIR), Council for Geoscience (CGS), UKZN, the two Municipalities namely Mbizana Local (EC) and Ugu District (KZN) and British Geological Survey (BGS) Phase two will be conducted in the 	

				<p>year 2016/17 year will be a build up from phase one.</p> <ul style="list-style-type: none"> - The DoE's Mr Landi Themba pointed out that stakeholders, Amakhosi, culture and indigenisation should be respected, citing a case of the late Sara Baartman whose inappropriate photo was taken without her consent..
2015-09-15	Ugu District Municipality: Portfolio Committee		Iterative meeting (CCS/PCSP/Monitoring)	<ul style="list-style-type: none"> - SANEDI/SACCCS was given a go-ahead to continue with the Pilot Monitoring project -SANEDI/SACCCS must provide Ugu PCED with project time frames
2015-09-18	SANEDI/SACCCS, Local & International Organisations		Bongwana Study Visit	<ul style="list-style-type: none"> - It was decided that the field excursion will focus on 3 known sites which were also visited during the 2014 workshop. These sites cited below were also visited by the NHTL ExCo: <ul style="list-style-type: none"> ✓ Farm Baker; ✓ Farm Umzimkulwana Lot 7; and ✓ Umtamvuna River. - The purpose of the field excursion was among othes to determine the long-term monitoring requirements and also set up protocols for CO₂ monitoring and capacity building in South Africa. The skills learned from the Bongwana Pilot Monitoring Project will be applied to the PCSP. - SE provided support service for the entire duration - All relevant constituents will be informed about the sample results once available.
2015-09-23	Portfolio Committee on Environment		Climate Change Public hearings	<ul style="list-style-type: none"> - The purpose of the public hearings are to afford interested parties an opportunity to make inputs on the South Africa's Climate Change Negotiating Position in the lead up to the 21st session of the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris, France, in December 2015. - Dr T Surridge and Polly Modiko co-presented in Parliament after submission of SANEDI's stance on Climate Change
2015-09-28	Izibonda Tribal Council		Introductory meeting	<ul style="list-style-type: none"> - Inkosi Machi is in charge of the Izibonda Tribal Council and he was not present at this meeting. A request was made to SACCCS to avail itself for the benefit of the Inkosi at a date to be communicated later - SACCCS can only be granted an audience if Umuziwabantu Local Municipality is involved in the research project as the areas on interest fall under their jurisdiction. - SACCCS must respect the areas of interest as they are

				<p>regarded sacred by the community and are affectionately known as Uggomo.</p> <ul style="list-style-type: none"> - SANEDI/SACCCS was urged to observe protocol at all times. - The tribal council requested a more detailed plan including images and information on what needs to be undertaken in the area.
	2015-09-30	Department of Water & Sanitation (National Office)	Iterative meeting with DG and Technical team.	<ul style="list-style-type: none"> - The DDG indicated that DWS has entered into a transboundary agreements with the neighbouring countries regarding aquifers. - Aquifer maps will be provided to SACCCS so that they can take note of the water buffer zones when planning for the PCSP. - SACCCS was commended by the DWS for working hand in glove with regional departments as they are the ones on the ground. - DWS reiterated that monitoring should be integral to the PCSP - The DWS emphasised that the PCSP will be a Control activity similar to Shale Gas.
Q3	2015-10-28	Izibonda Tribal Council	Iterative meeting with Nkosi Machi	<ul style="list-style-type: none"> - Inkosi Machi was present and he chaired the meeting. - He asked questions around skills development and job creation and reiterated what was agreed upon at the meeting held on 28-09-2015
	2015-10-29	KZN Department of Mineral Resources	Iterative meeting for progress in the permitting application	<ul style="list-style-type: none"> - The KZN DMR indicated that a follow-up on the Section 50 (1) application made by CGS on behalf of SANEDI/SACCCS will be made up. - The DMR promised to revert to SANEDI/SACCCS within two weeks (16 November 2015). - On the whole the relations are cordial and the officials have requested to be kept abreast of the project after clarifications were sought by the DMR and SACCCS handled the queries to the DMR's satisfaction
	2015-11-10	Isibusiso Esihle Science Discovery Centre	Introductory meeting	<ul style="list-style-type: none"> - The Centre offers environmental education work to schools and communities in the surrounds of Manguzi which falls within the Municipal District of UMkhanyakude. - The Centre has offered to host SANEDI/SACCCS display stand and requested to be capacitated on CCS in order for them to be able share information with the locals about the technology
	2015-11-11	KZN Department of Environmental Affairs	Iterative meeting with the newly appointed	<ul style="list-style-type: none"> - The purpose of the meeting was to provide feedback to the KZN DEA and to introduce SANEDI/SACCCS to the new

			Regional Manager: DEA (Mtubatuba)	officials. - The Regional Manager pointed out that he still need to conduct more research internally in order for them to advice on how CCS will be regulated.
2015-11-12	UMkhanyakude District Municipality: Planning and Economic Development		Iterative meeting with the Acting General Manager: Planning and Economic Development	<ul style="list-style-type: none"> - Meeting was chaired by Mr Boxer Mpontshane - SACCCS was urged to familiarize itself with the IDP which focuses mainly on developmental challenges and priorities of UMkhanyakude. - Areas mostly affected by drought include Jozini, Umfolozi and Hluhluwe - SACCCS was advised to focus on how CCS skills will be developed as well as job opportunities - SACCCS was urged to give regular updates on the project - SACCCS must peruse the adopted UMkhanyakude Environmental Management Framework - SACCCS was invited to present to the ExCo at a meeting scheduled for 17 November 2015
2015-11-17	UMkhanyakude District Municipality (UKDM): Planning and Economic Development Portfolio Committee		Iterative meeting with UMkhanyakude DM EXCO	
2015-11-18	Ingonyama Trust Board		Iterative meeting with Real Estate Deputy Manager	
2015-11-19	KZN Department of Economic Development and Environmental Affairs		Iterative meeting with Dr. Fasheun	
2015-11-20	KZN South African Local Government Association		Iterative meeting	
2015-12-15	Cooperative Governance for Traditional Authorities (CoGTA) Regional Office		Iterative meeting with Disaster Management Committee	

