March 2011

DRAFT SUMMARY REPORT

PASA Reference No. 12/3/219

For public comment from Monday, 07 March to Tuesday, 05 April 2011

Report Number. 12800-10362-3

Golder Associates

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1.0 OVERVIEW

Shell Exploration Company B.V.(Shell), a registered company of Royal Dutch Shell plc, has submitted an application to explore for gas in the South Western Karoo Basin (Western Precinct). The Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002) (MPRDA) requires that an application for an exploration right should be accompanied by an environmental management plan (EMP).

The Draft EMP has been compiled by Golder Associates Africa (Pty) Ltd (Golder), an independent environmental consultant; this document is a summary of the contents of the Draft Environmental Management Plan (EMP) for the Western Precinct. Stakeholders may access the full EMP and supporting documents on the Golder website (www.golder.co.za).

The Draft EMP is available for public review from Monday, 07 March to Tuesday, 05 April 2011. Subsequent to the public review period, the EMP will be updated and submitted to the Petroleum Agency of South Africa (PASA), the designated authority in terms of the MPRDA, as part of an application for a gas exploration right.

Should the exploration right be granted, it will be valid for a period of three years, but may be extended three times for a total exploration period of nine years. It is assumed that this process of review and decision-making will take place during 2011. The proposed exploration is expected to commence from late 2012, should an exploration right be granted and all other regulatory approvals and permits have been obtained.

Shell cannot begin exploration without undertaking necessary environmental impact assessments required by the National Environmental Management Act, 1998 (Act 107 of 1998). An Environmental Authorisation is required for activities, such as land clearing, and extraction of gas. *Note*: Other regulatory approvals, over and above an Environmental Authorisation, will need to be obtained prior to commencing certain activities.

Structure of the Draft EMP Report

The Draft Environmental Management Plan Report is structured as follows:

Chapter 1 is the introduction and amongst other gives a quick overview of the proposed project, highlighting key aspects and new information;

Chapter 2 provides the international and national context for and history to the proposed project, outlining the role of gas in an energy context, South Africa's energy situation, and previous exploration in the Karoo by Soekor;

Chapter 3 sets the legal context for gas exploration in South Africa and lists the key laws and regulations applicable ;

Chapter 4 describes the existing environment – the Karoo. It summarises knowledge about the existing physical, biological, social and cultural environment upon which the proposed project may impact;

Chapter 5 describes the applicant and proposed exploration project, outlining Shell as a company, and describing the intended steps in and project requirements for gas exploration;

Chapter 6 outlines how the assessment for the EMP was conducted, both technical assessment and public consultation. It summarises stakeholder issues contributed during the process, and outlines the requirement for an Environmental Impact Assessment under the National Environmental Management Act (NEMA) prior to drilling and hydraulic fracturing;

Chapter 7 describes the project alternatives, including selection of drill sites should the application be approved by PASA, and the 'no project' alternative;

Chapter 8 describes the potential impacts of the proposed project in terms of a range of environmental and social aspects;

Chapter 9 contains the Environmental Management Plan which will become legally binding on the applicant should the exploration right be granted;

Chapter 10 contains an undertaking by the applicant, required by the Mineral and Petroleum Resources Development Act;

Chapter 11 states the consultants' conclusion and recommendations pertaining to the proposed project and includes the environmental consultants' statement of independence; and

Chapter 12 lists the references cited in the report and technical assessment studies.

The key elements of the above-listed chapters have been summarised below.

2.0 PROJECT LOCATION

This draft summary report relates to the exploration right application referred to as the *Western Precinct* (PASA Reference No. 12/3/219). The application area intersects the Western and Northern Cape, and covers the Cape Winelands, Central Karoo, Namakwa, and Pixley ka Seme District Municipalities. A list of properties in this application area is available in Volume 2 of the Draft EMP.

Shell has also submitted two other applications for consideration by PASA, with Reference numbers 12/3/220 (Central Precinct); and 12/3/221 (Eastern Precinct) respectively (Figure 1). Separate EMPs (and draft summary reports) are available for these applications.

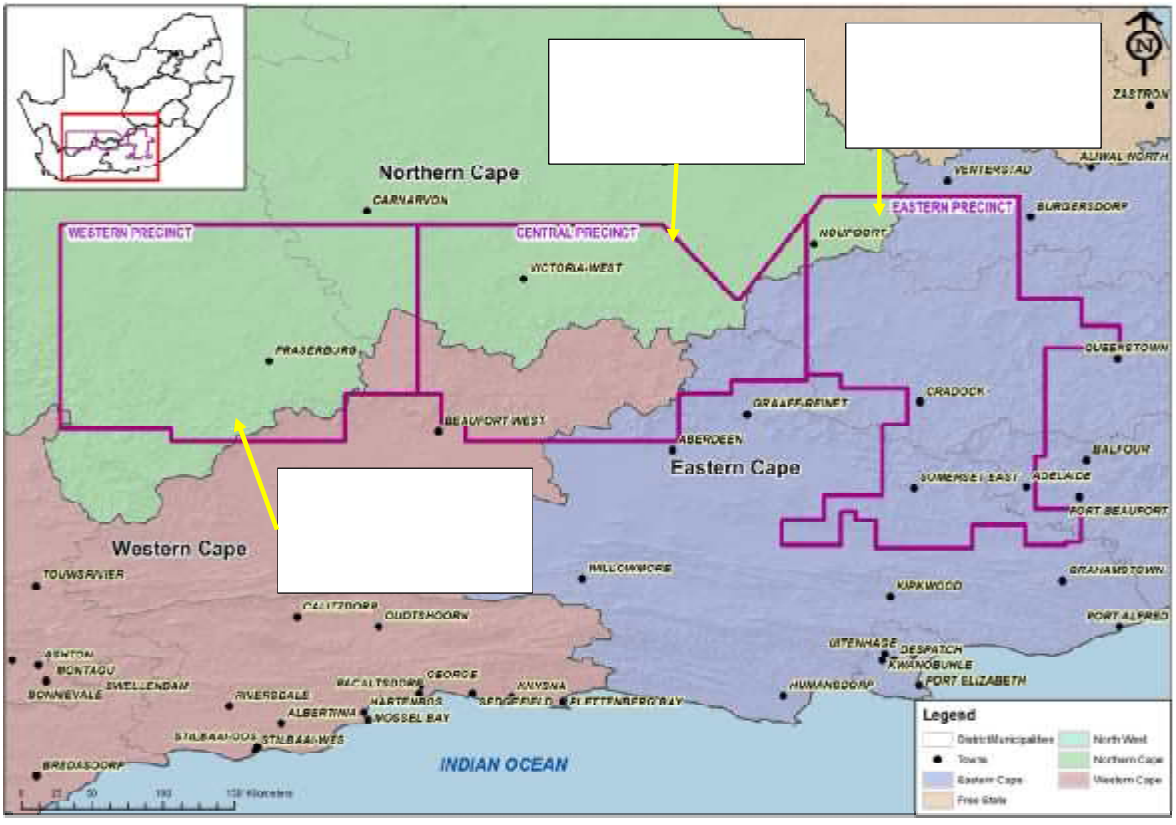

Figure 1: Proposed shale gas exploration right applications at a glance

3.0 CONTEXT AND HISTORY

The global outlook for energy and the role of natural gas

The world's greatest present challenge is meeting the needs of the developing world, and especially the achievement of the Millennium Development Goals while simultaneously mitigating the effects of greenhouse

gas (GHG) emissions on the world's climate. The Energy Outlook Scenarios of the International Energy Agency (IEA)) anticipate total world consumption of energy to increase by 49 percent from 2007 to 2035. The largest projected increase in energy demand is in non-OECD economies like South Africa. The IEA World Energy Outlook (WEO) 2010 Factsheet states: "*Natural gas is set to play a central role in meeting the world's energy needs for at least the next two-and-a-half decades*."

Natural gas, little exploited until the 1950s, is set to become a valuable part of the global energy mix.

Natural gas is the cleanest burning of all the fossil fuels (gas, oil and coal). By contrast, combustion of coal and oil emits high levels of harmful emissions as well as ash particles that are carried into the atmosphere and contribute to pollution. Natural gas-fired power plants can be built relatively quickly. Transport fleets can be converted to run on gas. Natural gas holds a further strategic advantage, since gas-fired power plants can supplement the intermittent electricity supplies from renewable sources. In this way it would facilitate the expansion of the renewables sector.

Natural gas in the combustion phase is a clean energy option, and this offers an important potential national benefit to South Africa. In addition, natural gas has marked advantages over coal in terms of life-cycle GHG emissions (Figure 2).

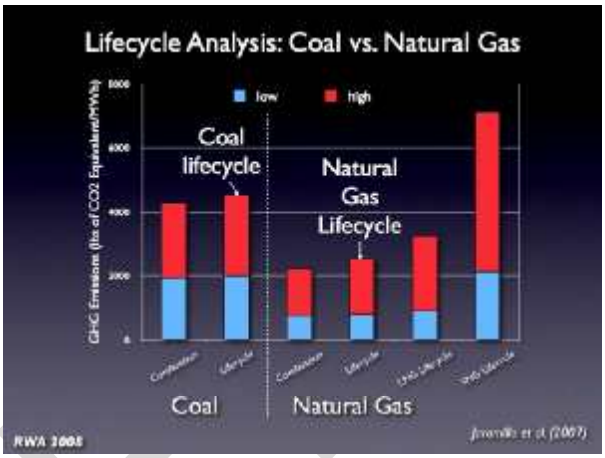

Figure 2: Comparative life-cycle GHG emissions for coal, natural gas, and synthetic natural gas life-cycle in electricity generation as well as in the combustion phase for coal and natural gas. From Jaramillo and co-authors, as posted by Allmendinger

South Africa's energy outlook

There is a direct link between energy and the achievement of the Millennium Development Goals (MDG) (these goals arose from the World Summit on Sustainable Development in Johannesburg in 2002). South Africa is committed to lift people out of poverty and support progress in health (especially among children) and education. Providing access to safe, clean modern energy for all South Africans means increased electricity generation.

The National Climate Change Response Green Paper (National Climate Change Response Green Paper 2010) indicates how South Africa will address the energy sector in its response to climate change. The SA Government regards climate change as one of the greatest threats to sustainable development.

The energy sector is the largest contributor to GGE emissions in South Africa: successful climate change mitigation in South Africa must focus on the energy sector. Government will integrate a climate constraint into its energy planning tools, including the Integrated Energy Plan (IEP) and the Integrated Resource Plan for Electricity Generation (IRP).

The IRP, which is part of the IEP, presents the plan for electricity for South Africa over the next 20 years, saying that about 52,000 MW is needed over the next 20 years to meet the country's future economic growth, despite a 35% offset through improved energy efficiency. The potential offered by natural gas is clear from the global trends outlined earlier.

Previous exploration in the Karoo

The first organised search for hydrocarbons in South Africa was undertaken by the Geological Survey of South Africa in the 1940's. In 1965 Soekor (Pty) Ltd was formed by the government and began its search in the onshore areas of the Karoo, Algoa and Zululand Basins (http://www.petroleumagencysa.com/Promotion/ExplorationHistory.aspx).

In the 1960s, Soekor undertook hydrocarbon exploration activities across the Karoo but was unsuccessful in their exploration for oil. However, the potential for gas being held within geological formations at depths down to nearly five kilometres was noted in a few exploration wells that were drilled.

In only one of the ten (deep) wells drilled did gas actually flow, and then only for one day before gas flow stopped and monitoring ceased. This particular well is located south of Shell's Eastern exploration right application area.

Figure 3: Well cores from the 1960s drilling for oil exploration are still being kept at the National Core Library at Donkerhoek outside Pretoria, managed by the Council for Geoscience

As no oil was discovered at that time, and in light of the economic climate, it was not technically-commercially feasible to continue to explore to try to extract gas. Therefore, exploration activities ceased, and the Soekor wells were decommissioned. However, well cores from the 1960s drilling for oil exploration are stored at the National Core Library Donkerhoek, managed by the Council for Geoscience (Figure 3).

How this links to the proposed Karoo shale gas exploration

Technological improvements in drilling techniques make it possible to stimulate gas to flow from these "'tight" rock formations, such as those found in the Karoo. However, there is inadequate information to evaluate whether the shale formations present within the Karoo hold potential as a viable gas resource. Consequently, early level exploration is necessary to confirm whether South Africa potentially has viable unconventional natural gas resources which may be of strategic value in the future as an energy source to meet the growing demand for electricity within the country.

Shell, a company with considerable experience in exploration, has thus made application for exploration rights to initiate an early level exploration programme in three broad areas to confirm whether the deep shale strata in the Karoo contain unconventional natural gas and, if so, to evaluate the potential to extract unconventional natural gas.

4.0 APPLICATION AND ENVIRONMENTAL PROCESS

The shale gas exploration right application process, and the environmental processes required are shown in Figure 4.

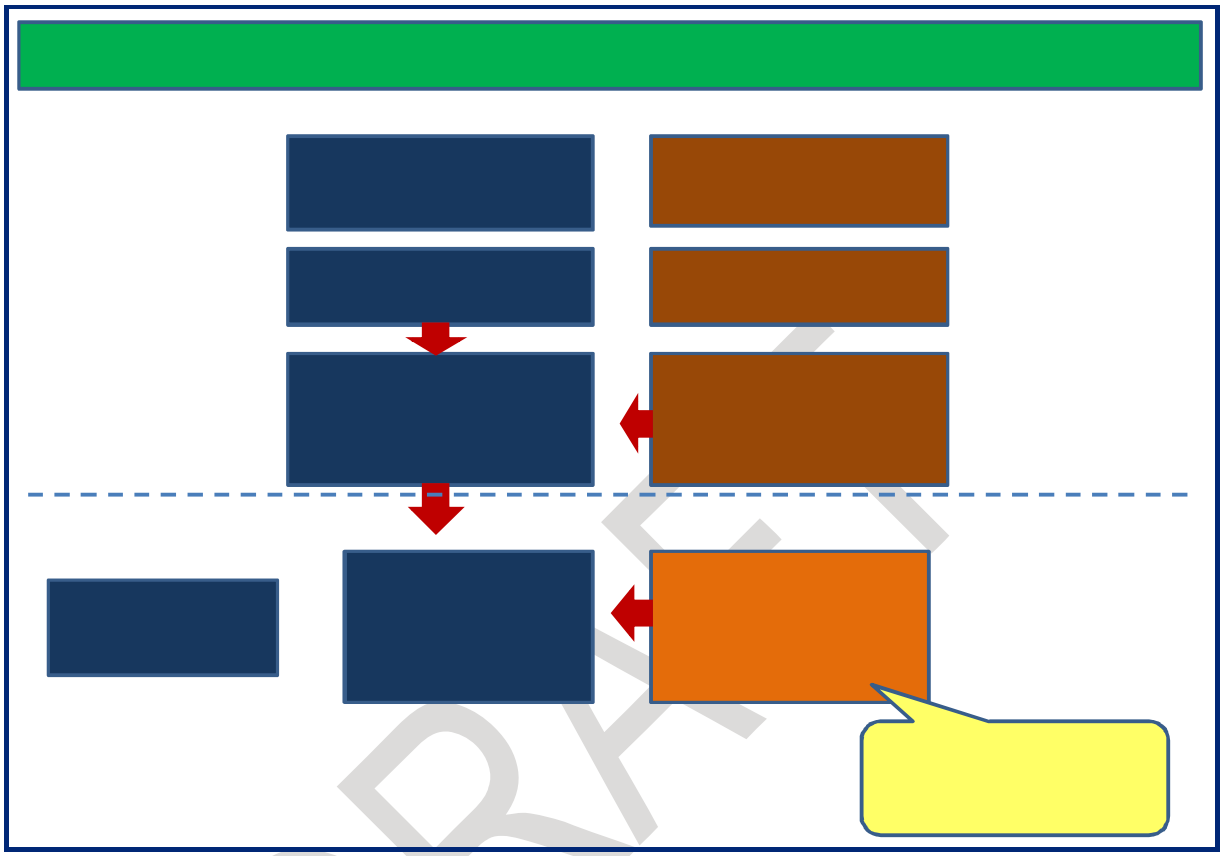

Figure 4: The application process for shale gas exploration rights and environmental processes required

Shell had a Technical Co-operation Agreement with PASA for 12 months (December 2009 to Dec 2010). No field work or environmental baseline studies were permitted during this period. In December 2010, Shell made a decision to apply for an exploration right, which was accepted by PASA on 14 December 2010. PASA instructed Shell, in accordance with MPRDA (article 39 (2)) to develop an Environmental Management Plan, and submit this to PASA in 120 days, on or before 14 April 2011. This requirement under the MPRDA leaves limited time for the applicant to undertake site specific environmental baseline studies to help narrow down and prioritise precise coordinates for drilling locations.

The consultants met with PASA to verify this instruction, and in particular as a result of the concerns raised by stakeholder during the initial consultation period in January-February 2011. PASA re-confirmed that, the EMP should, in the absence of specific drilling sites, as a minimum assess and make recommendations for mitigation in respect of the types of activities to be conducted somewhere within the regional areas.

The current process to compile the required EMP consequently comprises assessment of available information covering the application areas supported by broad based field verification for certain studies. The EMP process has also seen widespread consultation with interested and affected parties through a multi-stage consultation process affording stakeholders opportunity to engage with proponent and consultant teams early on in the process, and again during the period of stakeholder review of the draft documents.

The approach followed in compiling this draft EMP document has been to identify and assess potential impacts in a broad, regional context, as well as to assess specific exploration activities generically but not in

a site-specific context. A typical gas exploration well was used to assess potential impacts and to develop indicative mitigation measures. The content of and recommendations made in the EMP document should, to a large extent, also be viewed as critical input to a later scoping phase, where the required NEMA EIA will be performed.

The EMP report has been compiled to meet the requirements of the MPRDA Regulations (R527 of 2004) section 52(2) as well as section 39(3) of the Act.

The EMP needs to be submitted within 120 days of the application having been accepted.

However, should an exploration right be granted, the applicant may proceed only with those gas exploration activities that do not trigger a listed activity under the National Environmental Management Act, 1998 (Act 107 of 1998) (NEMA). **Drilling and hydraulic fracturing will trigger listed activities under the NEMA (see *Chapter 3, Legal Context of the EMP for details*). Thus, an Environmental Impact Assessment under the NEMA will be required before drilling and hydraulic fracturing can commence, including a rigorous process to determine drill sites in consultation with landowners.**

In addition, the applicant may also need to apply for various other licenses such as an Integrated Water Use Licence or individual Water Use Licenses in terms of the National Water Act (NWA), and possibly the National Heritage Resources Act 25 of 1999, depending on location of drilling sites and site specific technical requirements such as water sources which cannot be determined at this time in the absence of known drilling site locations.

5.0 THE EXISTING ENVIRONMENT - THE KAROO

The 30,000-ha Western Precinct includes parts of the Western and Northern Cape Provinces, and covers the Cape Winelands, Central Karoo, Namakwa, and Pixley ka Seme District Municipalities.

The natural environment

The Precinct is located on the great westward sloping plateau of South Africa, at elevations between 900 and 1 000 m above mean sea level, on the Beaufort and Ecca Groups of sedimentary rocks. These sedimentary rocks lie in nearly horizontal strata; thus it is a landscape dominated by wide plains and broad depressions (Dean, W J and Milton, S. (eds) 1999), interrupted by koppies formed by criss-crossing dolerite intrusions (Figure 5). Large doleratie sills cap mountains and form great scarps, such as that ovelooking Beaufort West. The Ecca Group contains potentially gas-bearing shales.

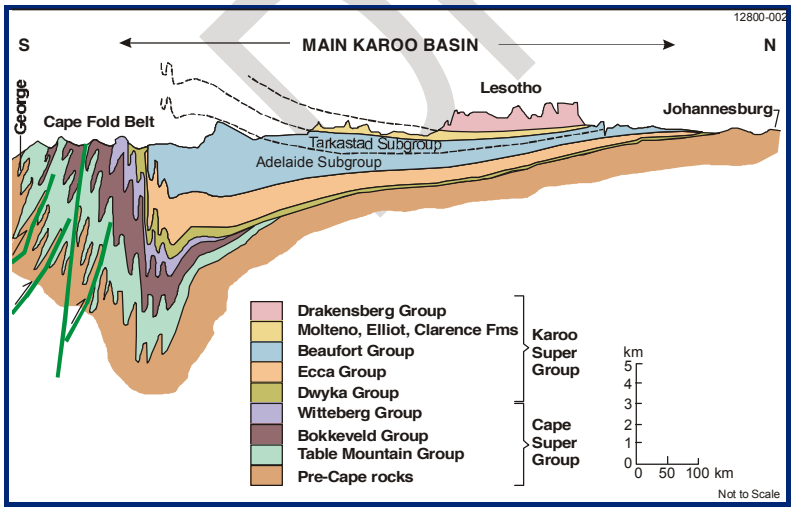

Figure 5: Section of the Main Karoo Basin (reproduced from Woodford, 2002

Soils are alkaline with a high base status in the subsoil, while the topsoil is sandy with low base status. These soils have little agricultural potential. Poorly drained structured soils occur on the Beaufort and dolerite parent materials; these are susceptible to compaction, and generally have a moderate to high erosion index.

The Western Precinct lies in and on the margins of the winter rainfall region of South Africa, in an arid zone seldom penetrated by the rain-bearing frontal weather that marks the climate further south. In summer, high-pressure cells over the region cause persistent hot, dry conditions. Summer days are hot and dry, and winters cold (mean annual maximum temperature about 30°C, and minimum, 0°C and less). Rainfall is low and erratic; mean annual rainfall ranges between about 150 mm and 285 mm.

The prevailing wind directions are SE to S, and W to NW winds prevail. Highest wind speeds will frequently exceed 10 metres per second; winds of this velocity form dust storms (Van Jaarsveld, F, 2008).The air is clean; at worst, farming generates dust. Air concentrations of the industrial pollutants such as sulphur dioxide and nitrogen dioxide would currently be very low. However, during periods of high wind, local or larger dust storms would bring elevated levels of airborne particulates (Van Jaarsveld, F, 2008).

Biodiversity

The Western Precinct is an important region of biodiversity. It includes portions of the Nama Karoo, Fynbos, and Succulent Karoo Biomes. These in turn include seven vegetation types: of these types, none has been listed as threatened, endangered or vulnerable in the national lists (SANBI). These ecosystems are assessed to be especially vulnerable to anticipated climate change (SANBI). Of the available (SANBI) inventory list 917 plant species, 45 are considered rare or are listed as Red Data species. Well over 400 animal species are known to occur in the Western Precinct; of these species four are of particular concern due to their Red Data status and limited distribution ranges, namely:

Blue Crane, *Grus paradiseus*

Mountain Zebra, *Equus zebra*;

Riverine Rabbit *Bunolagus monticularis*; and

Karoo Rock Sengi, *Elephantulus pilicaudus (*Figure 6*).*

There are many opinions that Karoo ecosystems are especially vulnerable to disturbance, and slow to recover thereafter. The ecology in this respect is not well understood, requiring further research (Dean, W J and Milton, S. (eds) 1999).

Figure 6: Karoo Rock Sengi (Elephantulus pilicaudus)

Water

The Precinct falls in the secondary drainage area D5 in the Orange River Catchment; the major rivers that drain the area are the Vis, Sak, Riet and Renoster Rivers, all of which are perennial.

Karoo rock strata have tight and cemented strata with very low primary porosity and permeability; accessible aquifers are found in weathered and fractured zones. Records from 20 027 boreholes in the Precinct show that groundwater is shallow: about 92% had water at depths of less than 30m. This indicates that sustainable groundwater exploitation relies mainly on recharge from rainfall and the storage potential of the aquifer at shallow depths. Quality is variable but 81% of the groundwater is potable.

The Department of Water Affairs water use registration database shows two water use sectors, agriculture (stock watering and irrigation) and domestic to comprise the main water users in the Precinct. Registered annual water use amounts to 4.571 million cubic metres, among 147 users.

Aesthetics and heritage

The Western Precinct has high levels of aesthetic appeal, being characterised by vast landscapes, and distinct topography and low sparse vegetation. Thus, the visual absorption capacity of the landscape is almost universally low, meaning that development will be highly intrusive. Within this Precinct, the noise climate is dominated by natural sounds of birds, insects and the rustling of vegetation in the wind (in the absence of traffic).

The Precinct houses diverse cultural heritage resources, for example, Late Stone Age archaeological sites dating to the last 4 000 years and San rock art/engravings. Declared Provincial Heritage Sites include the corbelled houses, and historic buildings in Fraserburg. The Karoo Basin is one of the few places worldwide with exposures of the fossil record for the 45-million-year interval spanning the Permian/Triassic (P/Tr) Boundary.

Sensitive landscapes

The 80 000 ha Tankwa Karoo National Park is the most important Protected Area in the Precinct.

The MeerKAT radio telescope is currently under construction in the Northern Cape of South Africa adjacent to the site proposed for the Square Kilometre Array (SKA) near the small town of Carnarvon. The telescope will be used for research into cosmic magnetism, galactic evolution, and the large-scale structure of the cosmos, dark matter and the nature of transient radio sources. It will also serve as a technology demonstrator for South Africa's bid to host the Square Kilometre Array (SKA). The MeerKAT and SKA telescope sites are located some 38 km north of the Western Precinct boundary.

If South Africa wins the SKA bid, the core of this giant telescope will be also be constructed near the towns of Carnarvon and Williston, linked to a computing facility in Cape Town. The SKA will have a core of several hundred antennae and outlying stations of 30 to 40 antennae spiralling out of the core. These stations will be spread over a vast area of up to 3 000 km.

In terms of the Astronomy Geographic Advantage Act, 2007 (Act 21 of 2007) the SALT, MeerKAT radio telescope and the core of the planned SKA sites have been declared as core astronomy advantage areas and are subject to a 3 km buffer on development.

Figure 7: South African Large Telescope

Socio-economic conditions

The Northern Cape Province is the largest, but also least and most sparsely populated Province in the country. The Precinct falls mostly in the Karoo Hoogland Local Municipality. The estimated population in this municipality is about 12,000, less than 0.5 people per km², and has declined by 0.9% between 2001 and 2007. Agriculture employs 23% of the workforce, while community, social and personal services employ 26% of the workforce. Unemployment rates at 34%.

6.0 DESCRIPTION OF APPLICANT AND PROPOSED EXPLORATION PROJECT

Shell Exploration Company B.V. is a registered company of Royal Dutch Shell plc, a public limited company registered in England and Wales and headquartered in The Hague, the Netherlands (see www.shell.com).

The purpose of exploration will be to assess whether there is viable shale gas within the proposed 30 000 km^2 exploration area. The proposed exploration may involve up to eight exploration wells, expected to commence from late 2012 if an exploration right is granted and all other approvals and permits have been obtained. The precise drilling locations have not yet been identified. Potential areas been identified based on high level desktop studies; these are indicated in Figure 8.

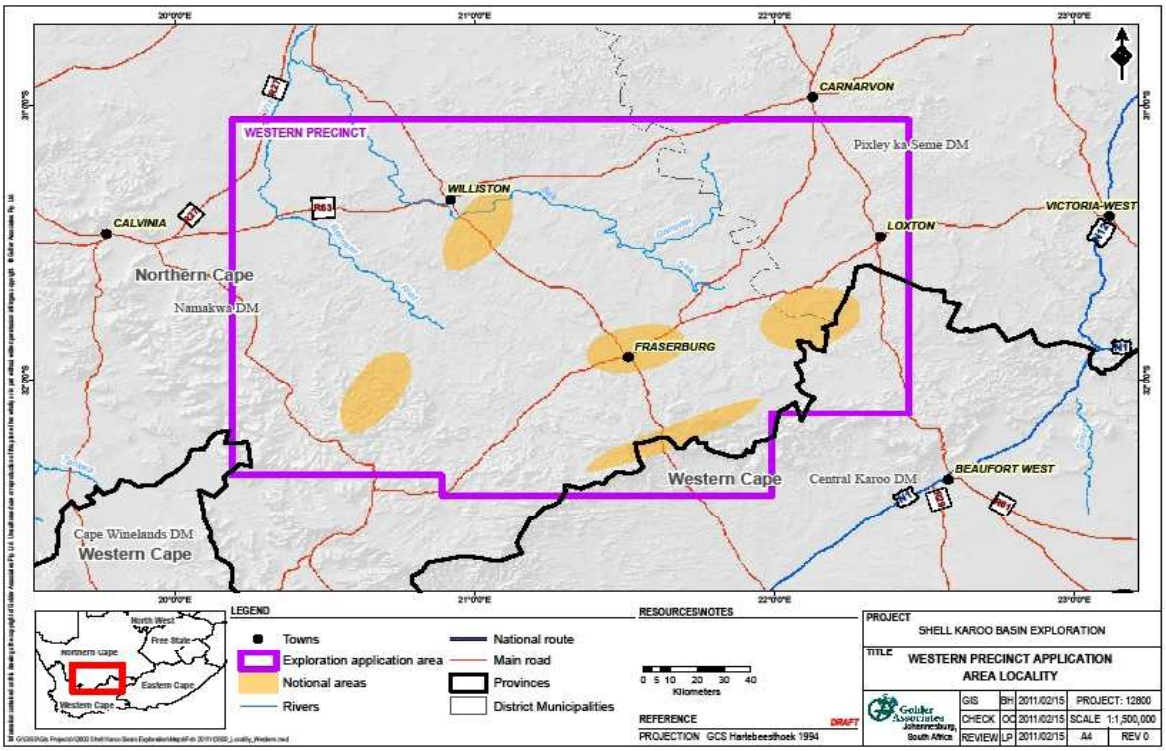

Figure 8: Illustration of possible areas within which a suitable well site may be identified for future exploration drilling activities

Proposed exploration activities at such sites would typically include:

Non-invasive gathering of geophysical data. **Magneto-Tellurics** involves positioning of small receiving sensors in the cleared areas; the equipment will typically be set up during the day on a site with five small clearings of 0.2 m^2 each. **Seismic acquisition** methods may be employed; these include shallow seismic (to assess the shallow rock composition) and micro-seismic techniques (to understand the conditions around the well bore).

Drilling of vertical exploration wells of up to depths of 5 000 m to identify the shale layers. Well sites will be approximately 100 m x 100 m. Additional land may be required for access roads, supply base, and accommodation. This is not likely to exceed a maximum of 20 ha within the 30 000 sq km (3 million ha) application area. A well may require between 0.3 and 6 megalitres of water.

The steps in the process would involve several activities:

Well site preparation: establishment of a level, compact and secure area

Drilling: mobilsation and erection of the drilling rig; drilling a vertical well; inserting the steel casing into the well; cement grouting of the casing in place; pumping drilling fluid (drilling mud) down the well during drilling; analysing and subsequent disposal/recycling of rock cuttings; and of rock cores that may be taken; regular pressure testing of the cased well for its integrity.

Gas stimulation: if hydrocarbons are detected during the drilling of vertical exploration wells, possibly hydraulically fracturing of a part of the vertical hole through the shale layer to test whether gas can be stimulated to flow and/ or drilling another vertical well from a nearby location which will have a horizontal section from the base of the vertical hole that extends into the shale layer and hydraulically

fracturing the exploratory horizontal hole in order to stimulate gas flow for the purposes of gas yield testing.

Transport of specialist hydraulic fracturing equipment to a well site;

Preparation of the fracturing fluid: blending of water and additives off site, maintenance on site with a truck mounted blending unit, with hoses to transfer liquid additives from storage containers to the blending unit or well directly from blending truck. The blended solution will be immediately fed into the wellbore as required. Examples of additives used in fracturing fluids used by Industry for unconventional gas operation are provided in the Draft EMP, Chapter 5; the examples provided are, however, not specific to the Karoo. The choice of additives that may be used in the Karoo will depend on a number of location specific factors. Shell has committed to undertake toxicity screening, the results of which will be publically shared, prior to developing the final hydraulic fracture design for an Exploration well. In addition, more generally, Shell supports disclosure by Contractors and Suppliers of chemicals that may be used during the hydraulic fracturing process. and

Pumping of hydraulic fracturing fluids under pressure into the shale formation.

Hydrocarbons surfacing from the well will either be flared; or captured for combustion in power generation units on site; or liquefied.

Capture and settling of any liquid hydrocarbons in a settling tank in preparation for export by truck to an existing processing facility.

Decommissioning: wells will be decommissioned if no gas is found or deemed not to be viable; where the well is decommissioned, it will be sealed off below the level of the upper aquifer and capped.

What happens if gas is found?

If the presence of gas is indicated during the initial three year exploration period, Shell can make a formal application to PASA to renew its exploration rights and to undertake additional exploration activities. This request for a licence renewal can be made three times, which if granted each time, could allow Shell to explore for up to nine years.

During later stages of exploration, if Shell successfully discovers gas which can be stimulated to flow to the surface, the next step would typically be to drill additional wells, to establish whether similar geological characteristics exist.

Once an area had been established that did have produce-able, sizeable volumes of gas, then the likely engineering concept would be to drill several wells from a single, existing site, to touch the greatest area of rock from a single point on the surface.

The guiding principles for the conceptual development are reduced surface footprint modularity and scale-ability At this stage, due to large uncertainties (e.g.: where gas may be located, how much, how much each well might flow etc) the concept is based upon using a modular, on (or near) well site mobile gas plants to process the gas and generate electricity to then be distributed into the existing national electricity grid. In this scenario additional infrastructure would be required to ”connect” the sites so that the gas can be distributed or used to generate energy locally, feeding into existing infrastructure.

Shell is also considering other engineering concepts that could take gas that is discovered and generate energy for the people of South Africa.

7.0 CONSIDERATION OF PROJECT ALTERNATIVES

In the event that Shell is granted a gas exploration license by PASA, the company will undertake further planning for gas exploration in a number of steps. These are briefly summarised here for the purposes of a discussion on alternatives.

Also as background to this discussion, Figure 9 shows the environmental process to the stage of completion of a NEMA Environmental Impact Assessment prior to drilling and hydraulic fracturing of wells, as discussed in earlier chapters.

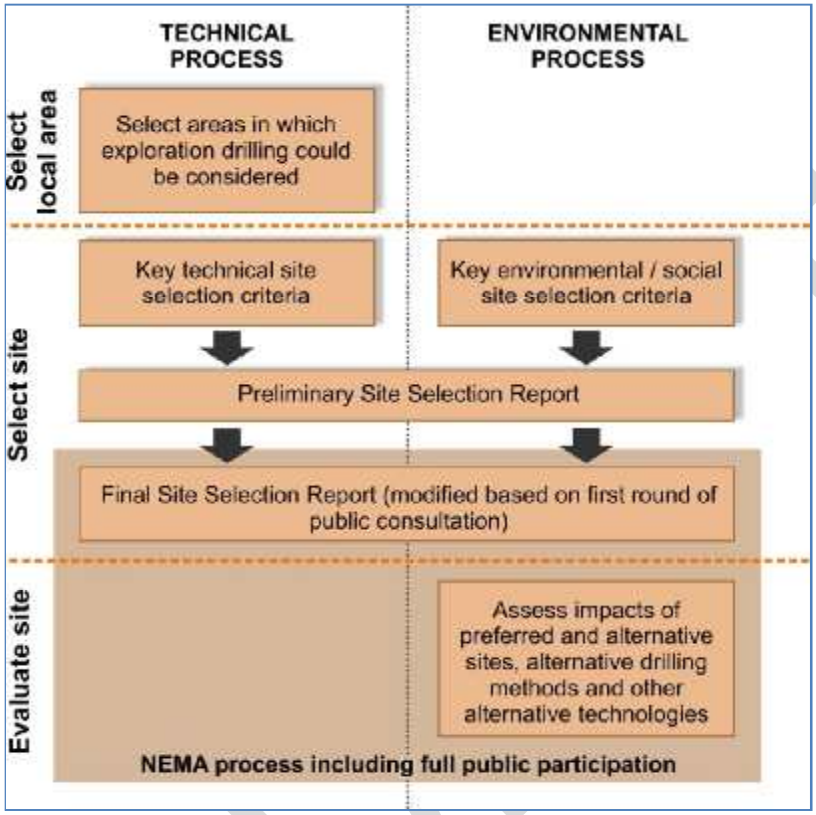

Figure 9: Environmental process to the stage of completion of a NEMA Environmental Impact Assessment prior to hydraulic fracturing of wells

Based on previous Soekor data from the 1960s and desktop work, Shell has defined notational drilling areas (Figure 8). These notional areas were based on a desktop study and high level considerations such as topography, road access, etc. The precise locations where exploration drilling activities may take place have not yet been identified. This will be done with inputs from environmental specialists and in consultation with stakeholders, including land owners through the following steps:

Step 1: Refine the areas within which drilling could be considered

Step 2: Determine the specific location of proposed drilling sites in the licence area, on the basis of integrated technical and environmental analysis and in consultation with the landowners. Prepare a preliminary Site Selection Report. This step will be undertaken jointly by Shell and independent environmental consultants.

Step 3: Prepare an Environmental Impact Assessment (EIA) in accordance with the requirements of the National Environmental Management Act (NEMA). The preliminary Site Selection Report will be subject

to public review and will only be finalized during the Scoping Phase of the EIA. The EIA will be prepared, as required by the NEMA, by independent environmental consultants.

The alternatives that will be considered will consist of various options that could avoid or minimise the potential impacts or enhance the benefits of the proposed exploration activities.

The EMP and future EIA studies will not include a comparison of shale gas with alternative energy forms, which is beyond the terms of reference of this and future EIA investigations. Given the general nature of this PASA application, it is not possible to consider specific alternatives in detail in the EMP.

The alternatives that are likely to be open for consideration in the EIA, if the exploration project is approved by PASA, are as follows:

Project alternatives

Location alternatives: The selection of drilling sites within the application area will be determined by integrated technical and environmental analysis; in this selection process, the optimum site will be chosen among several alternatives. Preliminary criteria which will be used to identify drilling sites are provided in the Draft EMP; these will, however, will be further defined during the subsequent EIA process and with input from the subject matter specialists.

Technology alternatives: Various technology and infrastructure alternatives exist which will be considered during the course of the EIA for each of the wells.

Access roads: A route selection process will be undertaken to determine the alignment of the access roads to the well sites.

Water supply: The following water supply options will be investigated and assessed during the EIA: deep groundwater aquifers (>100 m); raw (untreated) water from a local municipality; treated wastewater from a local municipality, mine or any other facility generating wastewater; surface water from large perennial rivers or dams; and seawater. Water conservation measures will mitigate the demand for water.

Water storage alternatives: There are various options to store water on site, such as using metal tanks, pillow tanks or geotextile-lined bunded-wall containment.

Transport routes for water supply: Water supplied from remote sources may be initially by train in the case of sea water, and then by truck.

Waste disposal alternatives: Fluid used for drilling and fracturing will be recovered, treated, and the treated wastes will be temporarily stored in containers on site, and then disposed to licensed sites.

Capturing hydrocarbons on surface: Hydrocarbons surfacing from the well will either be flared or captured for use.

The 'no go' alternative

The intention of the 'No go' alternative as an option in environmental analysis is to provide the decision maker with a view of *what will be foregone in the event that the proposal does not go ahead*. The current project is an application is for an *exploration right*, and not for the *development of shale gas fields*. The desirability of developing a production well field and the positive and negative issues associated with this must be undertaken at the appropriate time, if and when such authorisation is sought.

In the absence of a license granted for exploration, the potential of these shales to supply economically recoverable supplies of gas will remain unknown (unless another exploration company were to conduct the work in future).

8.0 TECHNICAL ASSESSMENT

The location of drilling sites is not yet available. Consequently, assessment of environmental issues, mitigation and management for a typical exploration site has been adopted for the technical assessment. Environmental issues were identified for the geophysical data acquisition activities (i.e. Magneto-Telluric and

Seismic Survey techniques), for well site preparation for drilling activities, for vertical drilling, for hydraulic fracturing, and for decommissioning.

A standard impact ranking system (DEAT, 1998) has been applied to assess the significance of the identified possible impacts. It is, however, important to note that impact significance ratings provided in the EMP are *estimates* of likely significance of these activities, as the impact is dependent upon the site and the characteristics of that site. No site clearing for drilling or subsequent hydraulic fracturing may commence before an environmental impact assessment (EIA) has been completed under the requirements of the NEMA, and authorisation to proceed with these activities has been received from the regulator (in this case Department of Environmental Affairs (DEA), not PASA). Impact significance will be confirmed during the EIA.

The results of the technical assessment for the purposes of the draft EMP are summarised below:

Geophysical data collection

Magneto-Tellurics

The geophysical data collection is largely a non-invasive process. Nominal excavation of approximately four short trenches (40 cm deep, 20 cm wide, 100 cm long) in the field is necessary. The survey team will consist of three to four members accessing the relevant property via vehicle (in one to two vehicles on existing roads) and then by foot. The equipment will typically be set up during the day; record data overnight, and then will be moved to a new location (3 to 10 km away) the following day. Should the controls outlined in the EMP be implemented, negligible impacts on land use, soil, vegetation and sensitive landscapes are expected. Such controls include the the field survey team making use of established farm roads and tracks, notification of landowners in advance that access to the site is required, and avoiding watercourses, identifiable gravesites and cultivated land.

Seismic acquisition

Shallow seismic

As with the Magneto-Telluric Surveys, shallow seismic techniques are largely a non-invasive process. The surface area required by the equipment is relatively small in size. The shot used to create the acoustic signals will be a short once-off occurrence per site. The survey team will consist of a few members accessing the relevant property(ies) via vehicle (in one to two vehicles on existing roads) and then by foot. The equipment will typically be set up during the day; will record the acoustic signal created by the shot, and then will be moved to a new location. Should the relevant controls be implemented, negligible impacts on land use, soil, vegetation, sensitive landscapes are expected.

Micro-seismic

No additional footprint or land disturbance is required as a result of recording micro-seismic data. No impacts are therefore anticipated as a result of these activities.

Well site preparation

The following potential impacts of moderate significance were identified:

Loss of soil resource due to well site preparation and construction of access road;

Loss of soil integrity due to well site preparation and construction of access roads;

Heavy vehicle movement, excavation exploration and soil removal will potentially result in soil compaction;

Approximately 1 ha will need to be cleared around the well; this will influence the existing land use on that site. In the event that soil contamination occurs, and it is not treated and managed effectively, this could influence the capability of that land in the future;

Clearing of vegetation during the well site preparation phase may result in the destruction of Red Data or Protected plant species, or may result in loss or fragmentation of habitat for Red Data faunal species;

Vehicle collisions with Red Data faunal species, especially smaller, slower moving terrestrial species, on road networks;

Impacts on fauna may result due to localised increases in noise, light and dust levels;

Various activities during well site preparation require disturbing the soil to some degree through the use of construction machinery. Fugitive dust will be released as well as exhaust emissions;

Excessive vegetation removal, dust and night lighting could result in visual impacts;

Construction of access roads and the well site may damage heritage sites and features in the immediate environs of the well site. The generation of dust could pose a threat to rock paintings in close proximity to the site;

There is a potential for impacts associated with site clearance on identified or unknown potentially sensitive features, such as Red Data species habitat types and paleontological sites;

Local employment opportunities; and

Exploration activities will entail additional traffic on local roads. Additional traffic will increase wear and tear on the roads, increase risk of accidents, and increase noise and fugitive dust levels.

Should appropriate mitigation measures (outlined in Chapter 9 of the EMP) be implemented effectively, it is anticipated that most impacts can be mitigated to low, except for impacts on soil loss and integrity, land use and capability, and access, traffic and transport, which remain moderate, subsequent to mitigation.

Exploration drilling

The following impacts of moderate to high significance were identified:

The drill rig will penetrate geological layers up to a depth of 1 to 5 km (depending on site conditions), at each drilling site. Core (soil, unconsolidated material and rock) will be removed. Core or drill chippings could possibly contain naturally occurring radioactive materials (NORMs) which could contaminate the environment;

Potential spillages from heavy machinery, vehicles, generators, chemical storage areas, drilling muds, hydraulic fracturing fluids, etc could contaminate soils and surface water;

The gas exploration well will drill through the potential water bearing zones present at the well site. The well could therefore provide a pathway for groundwater loss and potential contamination;

Inflow of groundwater into the well causing a lowering of water levels;

Poorly managed abstraction of groundwater from the boreholes can lead to excessive lowering of the water table, failure of the borehole and possible lowering of the water level in water supply boreholes located within the area of influence of the wellsite borehole(s);

Routine emissions are expected from power generators. Fugitive emissions may occur at drill rig and open air fluid impoundments, if these are used to hold drill cuttings and fluid; and

Drilling, pumps, compressors and generators, and vehicles importing and exporting materials and staff could increase ambient noise levels between ±150 m and 1.6 km from the centre of the site, at night.

Should appropriate mitigation measures (outlined in Chapter 9 of the EMP) be implemented effectively, it is anticipated that these impacts can be mitigated to low.

Hydraulic fracturing

The following impacts of moderate significance were identified:

- Potential spillages from hydraulic fracturing fluids, etc could contaminate soils, and surface water;
- Failure of steel casing to provide complete seal with hydraulic fracturing zone and leakage of gas and chemicals into the well annulus and subsequently into the overlying aquifers;
- Hydraulic fracturing of the well leading to invasion of chemicals from the target shale horizon into the overlying aquifers via unknown fracture zones;
- Larger volume of return water from the gas exploration well than expected resulting in the return water storage dam filling and overflowing and/or spillage of saline/brackish return water from the well causing contamination of the underlying groundwater;
- Gas may be flared. Fugitive emissions may occur at open air fluid impoundments, if these are used to store hydraulic fracturing flowback water; and
- An operational flare at the well site will result in visual impacts.

Should appropriate mitigation measures (outlined in Chapter 9 of the EMP) be implemented effectively, it is anticipated that most impacts can be mitigated to low, except for potential impacts on visual aspects associated with flaring, which remain moderate, subsequent to mitigation.

Decommissioning

The following impacts of moderate significance were identified:

- During decommissioning, infrastructure will be removed and the site will be rehabilitated. This may result in the colonisation of the site by invasive alien plant species; and
- Inadequate sealing of well resulting in poor sealing of gas and contaminated hydraulic fracturing water and subsequent invasion of the well and contamination to groundwater aquifers.

Should appropriate mitigation measures (outlined in Chapter 9 of the EMP) be implemented effectively, it is anticipated that these impacts can be mitigated to low.

Potential risks to human health

Chapter 8 of the draft EMP provides a brief overview of some of the key potential risks to human health associated with exploration drilling any hydraulic fracturing. The description is based on reviewing literature that is available in the public domain (specialist reports from projects in the USA and a position statement from Europe), while considering the specific process that Shell will adopt. Potential risks include:

- The bulk of the hydraulic fracturing fluid comprises water and sand which acts as a proppant to keep fractures open. Fracturing fluids do, however, contain quantities of chemicals (about 1-2% by volume). The type and concentration of the chemicals used depends on the conditions of the specific well. While many of the chemical additives are relatively benign, some chemicals that a company may select to use are known to have acute (from acids and bases) and more chronic effects (ethylene glycol, glutaraldehyde, and n,n-dimethyl formamide), if an exposure path exists;
- Risks to public safety associated with potential chemical spills, well blowouts and transportation of hydraulic fracturing fluids and waste water; and
- Acute loud noise and chronic low level noise is associated with a variety of negative health effects. These can include hearing loss but also psychological and physical health effects due to noise annoyance.

As part of the site specific EIA, a human health impact assessment will be conducted to confirm potential risks to human health, as well as to provide measures to manage and mitigate identified risks.

9.0 THE ENVIRONMENTAL MANAGEMENT PLAN

Key objectives of the EMP are to:

- Recognise that social responsibility and environmental management are among the highest corporate priorities;
- Ensure that applicable acts, regulations and guidelines are met;
- Assign clear accountability and responsibility for environmental protection and social responsibility to management and employees;
- Facilitate environmental planning through Project life cycle;
- Provide a process for achieving targeted performance levels;
- Provide appropriate and sufficient resources, including training, to achieve targeted performance levels on an ongoing basis; and
- Evaluate environmental performance and social responsibility against Shell's environmental and other policies, objectives and targets and seek improvement where appropriate.

The EMP has the sections indicated in Table 1.

This section includes brief summaries of Shell Policies and Procedures, Location and Design Methods, the Environmental Management Plans and Mitigation Measures, and the Monitoring Plans.

Shell Policies and Procedures

Shell will comply with all legal requirements prior to, and during, any field activity in the Project.

The company has set business principles and standards for health, safety, security, environment and social performance (http://www.shell.com/home/content/aboutshell/who_we_are/our_values/sgbp/), to which every employee must abide by. Briefly, these principles include:

- Contribution to sustainable development;
- A systematic approach to health, safety, security and environmental management; and
- Being a good neighbour.

All activities will be carried out in accordance with Shell's General Business Principles, Sustainable Development Principles and HSE Commitment and Policy which is supported by a full suite of Shell HSE standards (unless there is a conflict with legislation, in which case legislation takes precedence).

Location and Design Methods

Project location and design methods are standards employed to avoid environmental impacts. The project will follow location and design criteria based on applicable local and national laws and regulations; applicable technical design codes; and applicable national environmental criteria and standards.

Examples of the environmental criteria include avoidance of terrestrial and archaeological sites; avoidance of direct project footprint effects to nearby protected areas and avoidance or minimisation of indirect effects; avoidance of direct mortality, destruction of habitats and indirect effects to species with conservation status; establish project design parameters to help minimise environmental and public health and safety impacts from natural and industrial hazards.

Environmental Management Plans and Mitigation Measures

The section outlines the individual EMPs and mitigation measures that will be implemented during the duration of the Project. The section is categorised based on primary project activities that will require specific mitigation measures that are unique to that activity, such as well installation and drilling and hydraulic fracturing. These are discussed in Table 1 below.

There is an additional subsection that provides individual EMPs that are likely to be applicable throughout the project life cycle in a more general sense. These individual EMPs include the following:

Air Quality Management Plan;

Noise Management Plan;

Sediment and Erosion Control Plan;

Hazardous Materials Management Plan;

Non-Hazardous Solid Waste and Domestic Wastewater Management Plan;

Petroleum Management Plan;

Fish and Fish Habitat Management Plan;

Soils and Vegetation Management Plan;

Wildlife and Wildlife Habitat Management Plan;

Spill Prevention and Response Plan;

Transportation Management Plan;

Archaeological/Cultural Resources Management Plan; and

Occupational Health and Safety Plan.

Table 1: Summary of components of the EMP

Project activity	Mitigation measures
Drilling and Well Installation	Casing: The casing must be able to withstand the various compressive, tensional, and bending forces that are exerted while running in the hole, as well as the collapse and burst pressures that it might be subjected to during different phases of the well's life. Cementing: Selected cements, additives, and mixing fluid should be laboratory tested in advance to ensure they meet the requirements of the well design. Standard operating practices for cementing are recommended in order to ensure that isolation is achieved.
Hydraulic Fracturing	Prior to beginning this process, all equipment should be tested to make sure it is in good operating condition. All high-pressure lines leading from the pump trucks to the wellhead should be pressure tested to the maximum treating pressure. Any leaks must be eliminated prior to initiation of the hydraulic fracture treatment.
Water Management	Water management during drilling and hydraulic fracturing is to ensure the reliability of water supply; and control, collect, and treat wastewater during fracturing process.
Water Supply	Detailed evaluations will be carried out during the EIA that will focus on specific drilling locations. The intention is to identify the most suitable water source on a

Project activity	Mitigation measures
	per-well site basis.
Water and Fluids Disposal	Drilling fluids returning to surface will contain chemicals and subsurface contaminants mobilised during the drilling process. These elements will be removed from the fluids prior to reuse. If wells are hydraulically fractured, fluids used in this process return to the surface once the well is back produced. These fluids will be recycled, and mostly re-used for other drilling activities as much as possible.

Monitoring Plans

The objectives of environmental monitoring is to verify the accuracy of predicted environmental effects that will be identified in the EIA, to determine the effectiveness of the measures taken to mitigate environmental effects of the project and to promote compliance by Shell with applicable regulatory requirements and internal policies.

Detailed monitoring plans will be developed once the EIA is completed and project design has been finalised. These plans will outline the rationale for monitoring, the parameters to be monitored, monitoring programme details and follow-up actions to be taken as appropriate.

Preliminary recommended monitoring include the following:

Noise during construction and operation at nearby noise sensitive receptors;

Surface water quality monitoring at streams near well pad sites;

Monitoring of source water supplies for well production and hydraulic fracturing. Depending on the nature and location of the source water, this may include water quality, water quantity and flow and biomonitoring; and

Monitoring of nearby groundwater wells to measure groundwater quantity and quality during well installation and testing and hydraulic fracturing, if conducted.

Technical monitoring will also be conducted during well installation, including pressure monitoring throughout hydraulic fracturing so that any unexplained deviation from the design can be immediately identified and analysed before operations continue.

An independent environmental monitor (EM) will be onsite during operations.

10.0 PUBLIC CONSULTATION

The MPRDA is brief on public consultation during the development of an EMP. Section 79 (4) of the Act states: *If the designated agency accepts the application, the designated agency must …notify the applicant in writing (a) To notify and consult with any affected party.*

However, good practice principles reflected in the NEMA guide consultation, and these have been applied.

Process

The process is shown in Figure 10 and summarised below.

Identifying landowners and other stakeholders

A total of 2 213 stakeholders have registered as stakeholders across all three of Shell's exploration application processes of which 1 280 stakeholders, including 348 landowners, are currently registered for the Western Precinct EMP process.

They represent various sectors of society: national, provincial and local government, landowners, agriculture, conservation, cultural heritage, education, research, NGOs, research organisations, and many others.

Landowners were identified through the Surveyor General's title deeds database. Other stakeholders were identified through networking and referral and in response to media advertisements. When stakeholders were registered by a spokesperson, their permission for registration was obtained telephonically. Information on potential land claimants is being awaited from the Northern Cape Department of Rural Development and Land Reform.

Announcing the opportunity to comment and providing information (January 2011 – February 2011)

The first document for comment, a Background Information Document (BID), was distributed in the week of 03 January 2011. The comment period on the BID ran up to 18 February 2011. The process was announced as follows:

- Telephone calls to organisations and other bodies alerting them to documents being mailed;
- Paid advertisements, in English and Afrikaans, in two national, two regional and four local newspapers;
- Announcements on two national and three community radio stations; and
- Distributing a BID accompanied by a letter notifying stakeholders of the proposed project, and EMP and consultation processes, in English, Afrikaans and Xhosa.

Providing information on the proposed project and EMP process took place as follows:

- Distributing the BID mentioned above, and making available lists of affected properties on Golder's website (www.golder.com), at 15 public places, at open houses and public meetings and sending copies to Stakeholders upon request;

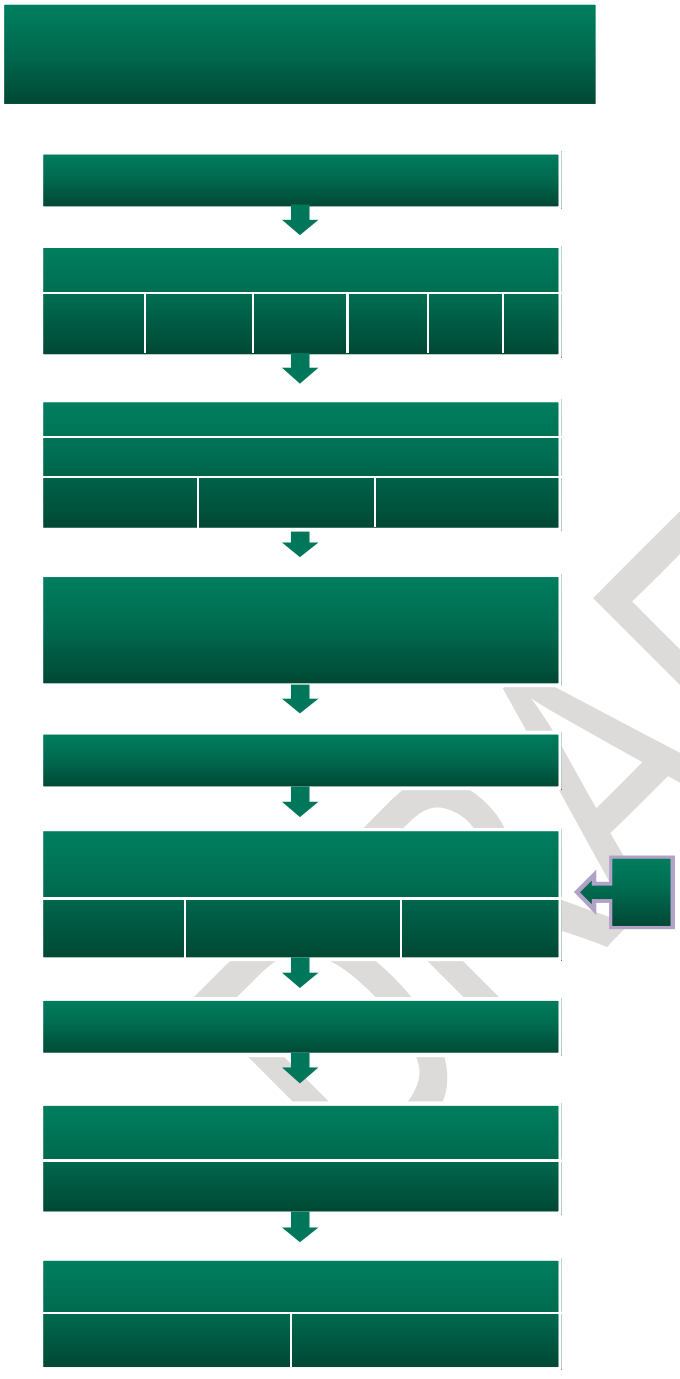

Figure 10: Public Consultation Process towards the development of the EMP - Western Precinct

Telephone calls to key stakeholders, e.g., farmer's unions, local communities, NGOs, CBOs to confirm their attendance at the open houses and public meetings; and

Convening open houses in Loxton, Sutherland and Cape Town where the project and process were visually displayed and/or presented. At the request of stakeholders some open houses were run as public meetings in which the proposed exploration project was presented and there was collective discussion.

Obtaining comments

Comments were obtained in various ways, as follows:

During the open houses/public meetings mentioned above, where stakeholders commented directly to members of the EMP team;

Meetings with three national and three provincial authorities; and

Comment sheets were returned by Stakeholders after having read the BID or having attended meetings, written submissions were received by email or mail and telephonic comments were captured.

Next steps

The next steps in the process are:

Announcing the availability of the Draft EMP for comment. This will be done by way of letters addressed to stakeholders personally, advertisements in the printed media, email, and announcements on the Golder website;

Convene public and other meetings with stakeholders and organisations in March/April 2011;

Collating comments on the Draft EMP into a Comments and Response Report on the draft EMP; and

Once the PASA decision is available later this year, notify stakeholders.

Key issues raised by landowners and other I&APs

I&APs raised several kinds of issues, summarised below (the Comment and Response Report is appended in Volume 2): see Table 2.

Table 2: Comprehensive list of key questions that emerged during the consultation process

Thematic key question	Illustrative questions
Groundwater	How can the potential impacts of hydraulic fracturing on groundwater be determined given the limited groundwater information for the Karoo? What can we learn from how this is done in other parts of the world?
Surface water	Are groundwater sources linked to surface water sources? If so, what is the possibility of contaminated aquifers polluting surface water sources?
Air quality	What quantities of shale gas will be released per well during exploration?
Archaeology and history	Will any archaeological and historic sites be disturbed and if so, what will be the impacts of this?
Astronomy	Drill sites for exploration will operate 24 hours per day. What light at night will be needed, and how far will this light project?
Soils	Will high-potential agricultural soils be sterilized by establishment of drill sites, access roads and other project infrastructure?
Seismicity	Will the depth of proposed drilling have effects on seismicity in the Karoo?
Waste	What types of wastes will be generated from the exploration activities?
Terrestrial ecosystems (flora)	What proportion of different vegetation types will be affected by land clearing?
Animals (Fauna)	What animals (mammals, birds, reptiles, amphibians, insects, arachnids etc) are likely to be affected by land clearing and how?
Biodiversity	Will the high biodiversity in the Karoo be affected by land clearing, drill site operations, waste water storage and other project activities?
Rehabilitation	Given the low ecological resilience of Karoo ecosystems, what measures will be taken to rehabilitate disturbed areas?
Aesthetics/visual	What visual impacts will be caused during the day and at night by the proposed gas exploration activities, and to whom?
Health	What is the likelihood of health impacts to humans, their stock or wild animals as a result of any of the exploration activities?
Property value	Will the gas exploration project cause a negative impact to property values?
Safety and security	How and where will construction workers be accommodated and for how long?
Traffic	What will be the increase in traffic as a result of construction of project elements?
Socio-economic issues	Will the proposed gas exploration cause negative impacts to the economy of the Karoo, e.g. income earned from sheep farming, other agricultural practices, tourism etc?
Cumulative assessment and Risk Assessment	Will be cumulative impact of the project be assessed?

11.0 UNDERTAKING AND COMMITMENTS

Shell's undertakings as set out in the Draft EMP include financial provisions for decommissioning, indemnities and other requirements of this kind, as well a number of commitments to the people of South Africa. Shell's commitments include:

General

We will set up an independent advisory committee for this project to provide expert steers and advice on environmental and social impacts (hydraulic fracturing, water, etc) to ensure we reduce and mitigate impacts as far as possible, take into account people's concerns and reflect them in the project design/execution.

This committee will also look particularly into development of the region and provide Shell suggestions for contributing to economic and social growth over and above its commitments to social investment, local content of suppliers, contractors and job creation.

We will create citizen advisory groups – made up of a broad cross-section of community leaders and elected officials – who will work alongside Shell's management team to identify and provide advice regarding concerns related to operations, such as truck movements, noise, etc.

Shell will provide full compensation to any landowner with evidenced direct negative impact or loss on their land as a result of their activities.

Utilising best practices, we will work with impacted communities and landowners to address how the can receive direct benefits from UCG development.

We are committed to lead in setting of global best practices and operational standards for unconventional gas development in the Karoo.

Water

In the Karoo, we commit to analysing and implementing relevant recommendations arising from the USEPA study[1] currently underway through 2014 into the project.

We also commit to incorporate any new best practices from Provincial and/or States with existing well design and HF regulatory primacy - especially recognizing these jurisdictions may have similar geologic, water, etc conditions more consistent with the Karoo.

We commit not to compete with the people of the Karoo for their water needs. Nobody will go short of fresh water because of our operations; either in the exploration phase, or if there is any further development.

We will commit to establishing mutually acceptable protocols for the independent monitoring of the water quality in existing water wells and surface water surrounding our activities.

We will conserve and recycle water where ever possible. We will commission an independent study in our licence area of water resources using third party experts to ensure that we get a better understanding, also providing information that may be useful in further development of water supplies for the region.

When we develop plans to source water in our operations we will make sure we understand local community needs and see how we can help meet community shortages in addition to project needs.

[1] The USEPA's announcement in March 2010 that they would prepare a detailed, peer reviewed, investigation of the impacts of hydraulic fracturing on human health and the environment. It is expected that this study will take two years to complete (Reuters, March 18, 2010)

We will commit to make available any recovered and unwanted clean water for community use – along with the transfer of water boreholes which are no longer required by the project.

Prior to drilling any exploration well, local experts will be consulted to identify the most suitable water source for development areas. We will develop a water plan for each well or pad (multiple wells at same location) site.

Impacted landowners, the relevant water authorities, local stakeholders and environmental advisors will be consulted throughout the water source selection process.

We will share our well design and aquifer protection plans which will adopt best practices from around the world. Best practices include the use of standards and guidelines around multiple barriers and cementing, casing integrity testing and annuli monitoring.

Any well that is permanently plugged and abandoned will meet best practice internationally

Hydraulic Fracturing

We commit to disclose fracturing fluids at each drilling location, and consult with communities as part of the development of hydraulic fracturing plans. The information will be available on our website.

We will recycle the flow back water as much as possible and dispose of remaining fluids responsibly.

We will not use BTEX in any hydraulic fracturing operations.

We will support the development of 'best-in-class" regulatory standards for hydraulic fracturing in South Africa.

Based on the results of the water study, we will ensure a suitable natural physical barrier exist between target gas-bearing formations and any potable water aquifers used by communities/industry.

Our well design, drilling, completions and operations standards require multiple physical barriers and procedures to control well operations – including the fracturing process, and prevents the migration of gas and any fluids into underground drinking water sources.

We will publish well completion reports publicly.

Shell will monitor the integrity of its wells.

12.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Shell propose to conduct an unconventional natural gas exploration drilling programme in the Karoo to confirm whether tight shale bands located between 1000 and 5000 m below ground contain unconventional natural gas and, if present, whether this gas can be stimulated to flow. This exploration programme will entail the drilling of up to 8 deep level exploration boreholes in the 30,000 km² exploration rights application area. It may be necessary to hydraulically fracture the deep tight-shale gas bearing layer.

The technology of hydraulic fracturing has been in use for many years, but only recently has it been rapidly developed and improved for shale-gas development. It offers promise, should worthwhile natural gas reserves be proven in the Karoo. However, the volume of recoverable gas stored in Karoo shales is unknown at present.

The process of deep level exploration drilling and hydraulic fracturing involves fair numbers of traffic and freight to/from each exploration well, the consumption of substantial quantities of water, and the use of quantities of materials in the drilling and fracturing process. The traffic and the onsite development could have marked aesthetic impacts at a local scale, while drilling and hydraulic fracturing takes place, but these impacts will be of relatively short duration and reversible. The volume of wastewater generated will need to be addressed in accordance with legislation, but this is not beyond what would be reasonable to manage at

an exploration site of this nature. Potential risk to groundwater resources is mitigated through installation of well casing and thorough integrity testing of the installed casing prior to commencement of hydraulic fracturing. The footprint of each exploration well site is roughly 1 ha in extent and will be cleared of vegetation, stabilised and used for the duration of the exploration drilling activity on the site. There will be up to eight such sites in each exploration licence application area (30,000 km²). There is flexibility in choosing each drill site and the EMP document describes criteria that will govern the site selection process. Should these be applied, the real impact of this land clearance on biota, habitat, heritage resources will be low. Moreover, with proper siting of drill sites direct impact on landowners can be considerably reduced.

Soekor's exploration in the 1960s was focused on drilling to find oil, not natural gas. In only one borehole did gas flow, and then only for one day. Soekor did not make provision for hydraulic fracturing of the wells, which is the critical technological development that has facilitated gas recovery from 'tight shale formations'. There still remains some evidence of gas presence in shale core samples retained in the National core archive from this early exploration programme.

In the absence of a license granted for exploration, the potential of these shales to supply economically recoverable supplies of gas will remain unknown.

In Golder's opinion, such an approach would be unnecessarily conservative. It would prevent (or delay) the determination of the resource potential of the Karoo shale gas formations and the benefits that South Africa could derive from this - in the absence of any material evidence that a small number of exploration wells could result in an unacceptable level of environmental impact.

While such a determination can only be finalised once the exploration wells have been sited, it is unlikely, in our view, that the construction of a small number of wells could, in itself, result in environmental damage that is unacceptable, as long as the siting and management of these wells is controlled through a rigorous, scientific, EIA process.

Although the Karoo may never see shale-gas development as intense as under way and foreseen in the Northern Hemisphere, any development in the Karoo would require stringent risk assessment and risk management strategies, as part of environmental impact assessment, before it could proceed. Such risk assessment would need to be based on rigorously formulated shale-gas development risk scenarios, and informed by high quality evidence, especially on the Karoo stratigraphy. The risk scenarios would necessarily be based on careful specifications for the fracturing and production technologies appropriate to the Karoo development, and scaled for a feasible development, and not simply transferred from experience elsewhere. A benefit will be, that by the time such production scenario becomes imminent (which could be nine years from today), the findings of current research in the Northern Hemisphere will be available to inform the process.

Recommendations

It is acknowledged that there are concerns about the risks associated with hydraulic fracturing in shale gas production well fields. These concerns have typically emerged in relation to shale gas production operations. The current review of the risk to water resources posed by hydraulic fracturing, being conducted by the USEPA bears testimony to this. However, Shell's application does not involve production – it is for exploration wells only and is of a much smaller scale compared to production phase operations.

While we would support the current applications for exploration rights submitted by Shell, we believe it would be wise for decision-makers to await and consider the findings of the USEPA review[1], before any licensing of a production well field is considered.

Environmental recommendations made in the EMP

The principal recommendations from the Environmental Management Plan are summarised here:

[1] Draft Plan to Study to address the Potential Impacts of Hydraulic Fracturing on Drinking Water Resources, Office of Research and Development US Environmental Protection Agency, Washington DC, February 7, 2011

The site selection criteria presented in the EMP report should be applied to best position identified drilling sites in order to avoid impact to the environment and to landowners where ever possible and, where this is not possible to minimise the operational impact of the exploration drilling site.

The environmental management plan (EMP) presented in chapter 9 must be updated for each drilling site to reflect site-specific conditions, drawing upon the findings and recommendations of the detailed technical studies which will underpin the site-specific environmental impact assessment. This must happen prior to commencement of site clearing and deep level drilling and hydraulic fracturing.

An environmental impact assessment (EIA) supported by detailed technical study will need to be conducted prior to the commencement of drill site establishment, deep level drilling and hydraulic fracturing.

Environmental Impact Assessment (EIA) in terms of NEMA

Should an exploration right be granted, the applicant may proceed with *only* those gas exploration activities that do not trigger a listed activity under the National Environmental Management Act (NEMA). Drilling (drill site establishment) and hydraulic fracturing will trigger listed activities under the NEMA.

The following two listed activities as a minimum will trigger a NEMA EIA, but there are others too, and will need to be confirmed once drill sites have been identified and there is greater finality regarding the associated supporting infrastructure at each drill site.

Activity 24 of Notice 1, GN 544, requiring a basic assessment: *The transformation of land bigger than 1 000 m^2 in size, to residential, retail, commercial, industrial or institutional use ….* (Drill sites will be approximately 100 x 100 m, thus 10 000 sq m).

Activity 4 of Notice 2, GN 545, requiring a full EIA: *The construction of facilities or infrastructure for the refining, extraction or processing of gas, oil or petroleum products with an installed capacity of 50 cubic meters or more per day…* (It is assumed that hydraulic fracturing during exploration drilling could stimulate 50 cubic meters or more of gas per day).

Thus, an Environmental Impact Assessment for drilling and hydraulic fracturing will be required in terms of the NEMA.

Key questions to be considered in EIA

In anticipation of a future EIA, the consultants have developed initial criteria for drill site selection (see *Chapter 7, Alternatives* of the EMP report), and a preliminary list of key questions to be considered by the EIA. The questions are based on stakeholder and authority comments, and input from technical specialist who conducted assessments to inform the current EMP.

The key questions will guide the terms of reference for Specialist Studies to be conducted during the EIA. Importantly also, these key questions largely reflect concerns raised by stakeholders and landowners and have been drafted to ensure that these concerns get carried forward into subsequent detailed EIA.

The EIA will thus need to address these questions during EIA scoping and reflect competent scopes of work during the EIA scoping phase for inclusion into the EIA Draft Scoping Report which will be available to stakeholders for comment and review prior to the initiation of detailed specialist study to inform site-specific impact assessment.

The key questions pertain to the physical, biological and social environment. In considering these key questions during the EIA, applicable laws, regulations, conventions, standards, guidelines and other legal instruments or guidelines will need to be considered in the assessments.

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