

CHAPTER 18

Impacts on Integrated Spatial and Infrastructure Planning

CHAPTER 18: IMPACTS ON INTEGRATED SPATIAL AND INFRASTRUCTURE PLANNING

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Executive Summary

Shale gas development (SGD) is expected to have the following impacts:

- Highly likely to be an incremental increase in the construction, upgrading and maintenance of road infrastructure with an associated increase in demand for scarce construction materials (including high quality gravel and water) and increased on-going road maintenance.
- Highly likely to be increased volumes of heavy vehicles on district and local roads, and a subsequent impact on major through routes (logistical corridors) in the wider region leading to 1) the deterioration of roads, and 2) necessitating higher levels of law enforcement and traffic management, to prevent vehicle overloading, traffic accidents and congestion.
- A high likelihood of formal and informal town growth and subsequent demand on housing, services and infrastructure in main towns, with resultant pressures on municipal capacity, financial viability resources and management, to ensure effective delivery.
- Site-specific land development will require the granting of land use and land development approvals in terms of the regulatory framework (being) put in place by the Spatial Planning and Land Use Management Act, 2013 (SPLUMA), the Western Cape Land Use Planning Act, 2014 (LUPA) (where applicable) and Municipal Land Use Planning Bylaws. The institutional governance capacity of municipalities and other organs of the state to consider land use and land development applications and provide inputs to applications in terms of other regulatory requirements where required will most likely need to be enhanced in order to plan for, guide and monitor SGD.
- The governance capacity of local and district municipalities in the region for coordinated, integrated, aligned and sequenced spatial and infrastructure investment planning and management is limited (see Western Cape Government, 2009; 2012; The Presidency, 2014). There is thus a high likelihood that these authorities will be challenged to successfully implement mitigation measures relating to any new activity in their individual and overlapping areas of jurisdiction.
- With the roll-out of the recently promulgated SPLUMA and the Western Cape LUPA, new institutions are being established and new procedures for spatial planning and land use management introduced, so there is high likelihood that even the slightest change in current land use will pose significant challenges in the context of land use regulation and spatial planning.

- While SGD might be beneficial for the relevant operators, and possibly the regional and national energy mix and the national fiscus, the indirect costs of the planned exploration and operation phases will most likely have the biggest impact on the already resource-constrained municipalities in the area, notwithstanding any potential municipal rates increase.
- The uncertainty of the outcomes of the exploration phase, the sustained incremental approach of the operation, and the ongoing exploration activities will require timeous and synchronised intergovernmental prioritisation, budgeting and implementation (within relevant integrated planning, spatial planning and infrastructure investment processes and frameworks), which will pose significant challenges to local, as well as provincial, spheres of government.

CHAPTER 18: IMPACTS ON INTEGRATED INFRASTRUCTURE AND SPATIAL PLANNING

18.1 Introduction and scope

18.1.1 Sustainable towns and infrastructure development as indispensable for shale gas development (SGD)

In this chapter the implications of shale gas development (SGD) in the Karoo are explored in the context of 1) local development realities, 2) legal requirements and associated development pressures related to land development and land-use change, 3) local and regional road infrastructure requirements, 4) settlement development, and 5) associated municipal service delivery and implications for spatial planning and land use management.

Short and longer-term implications, risks and possibilities for mitigation are outlined within the context of 1) the set development principles and priorities, as well as, 2) the institutional realities of the relevant provincial and national spatial planning and integrated development planning and transport planning governance system, which is primarily aimed at supporting intergovernmental alignment to facilitate effective service delivery, job creation, transformation of apartheid legacies and long term sustainability. While the latter represents a set of national challenges, merely escalated within the arid and semi-arid

Definitions

Regional infrastructure: This includes all national, provincial and district roads, railway lines used to access the area and passing through the area, as well as pipelines that could potentially be required for local and regional gas distribution.

Local access roads: These are any direct access roads (other than the above) used to access the wellpads and related service sites. It also includes any roads built in any formal settlements which are developed to accommodate workers, or to access informal settlements resulting from in-migration of aspirant job seekers.

Spatial planning: This is the term used to describe the planning for future patterns of development in an area, typically reflected in a municipal spatial development framework, but now also possible in provincial, regional and national Spatial Development Frameworks (SDFs) in terms of Spatial Planning and Land Use Management Act, 2013 (SPLUMA).

Land use management: This is the activity, typically carried out by a municipality, of regulating and facilitating land use change.

Sustainable settlement development: This term refers to the processes of planning for, investing in, and governing of human settlements in such a way that they are economically vibrant, spatially and socially integrated, self-generating, safe and overall good places to live in. It also includes the use of resources to achieve these characteristics that is cognisant of the cumulative needs of current and future generations.

Municipal service delivery: Delivery of housing, electricity and basic services such as water and sanitation, to which South African citizens have a constitutional right.

Karoo landscapes, resource-scarce municipalities and low-growth regional economies, it also represents challenges that form part of current initiatives in South Africa to support regional and local development through 1) large-scale catalytic investments, 2) the identification of alternative energy sources, and 3) a developmental ethos that requires national investment decisions to be rooted in local contextual and institutional realities.

In exploring the possible implications of SGD in the Karoo, it is important to recognise that land, infrastructure and settlement development often are merely the result and spatial footprint of complex socio-economic and socio-ecological systems. As such, the Chapter should be read in association with the chapters highlighting details regarding the social fabric and population and migration dynamics (Atkinson et al., 2016), economic development (Van Zyl et al., 2016), agriculture (Oettle et al., 2016) and tourism (Toerien et al., 2016). In terms of the implications SGD, it should also be noted that the Chapter addresses transportation implications in terms of road infrastructure and land-development implications in the context of the spatial planning and land-use management system and impacts on settlement development, while specific implications for water resources (Hobbs

Definitions

Integrated development. The planning instrument and process set in place by the Municipal Systems Act, 2000 (MSA), to enable coordinated service delivery and development between the three spheres of government and other role players within a municipal area, to 1) improve quality of life, 2) support sustainable development and transformation, and 3) facilitate democratic and multi-sector planning processes. The municipal Integrated Development Plan (IDP) addresses current and future societal needs within the context social and ecological systems in which they exist. All project and activities related to infrastructure, land development, service delivery, as well as land and environmental management within any area needs to form part of the relevant IDP and associated sector plans and infrastructure investment frameworks.

Regional Spatial Development Framework. SPLUMA makes provision for the establishment of a planning instrument to enable focused temporal and spatial coordination of governance and investment actions in and between different spheres of government, within areas with unique, but interrelated, attributes or development challenges that span more than one municipality and/or province.

Land development. SPLUMA defines land development as the erection of buildings or structures on land, or the change of use of land, including township establishment, the subdivision or consolidation of land or any deviation from the land use or uses permitted in terms of an applicable land use scheme.

Land use. SPLUMA defines land use as the purpose for which land is or may be used lawfully in terms of a land use scheme, existing scheme or in terms of any other authorisation, permit or consent issued by a competent authority, and includes any conditions related to such land use purposes. This could be related to “zoning” in the traditional sense of the word.

NOTE: No distinction is made between ‘Land use application’ and ‘Land development application’ in SPLUMA, however the Western Cape LUPA identifies conditions where land development applications would require provincial approval and SPLUMA makes provision for ministerial approval in cases where land development applications are deemed of national interest.

et al., 2016), transportation of hazardous waste (Oelofse et al., 2016) and all other biodiversity (Holness et al., 2016) and visual (Oberholzer et al., 2016) impacts are dealt with in a series of issue specific Chapters of this scientific assessment.

18.1.2 Pointers from international and regional infrastructure and town growth experiences

Risks associated with infrastructure and land development will most likely be central to opportunities and challenges associated with SGD in South Africa. Experience in the United States (US) points to how 1) the ability to source and access cheap and commoditised equipment and services, 2) the large scale availability of road and even pipeline infrastructure, as well as, 3) the private ownership of land and mineral rights assisted (amongst other things) in creating a set of specific circumstances that supported rapid commercial SGD in that country (Fakir, 2015).

Site visits to the Middle East and US have shown the geographically scattered patterns of on-surface infrastructure development associated with the establishments of wellpads for SGD, and the direct implications with regards to regional and local road infrastructure and settlement development that manifest as a result of it (Paige-Green, 2015; 2016).

Evidence from the Sultanate of Oman and Pennsylvania indicates that even before shale gas production phases, wellpad construction and use (for exploration as well as extraction) and associated activities result in significant stresses on the existing road network due to increased heavy vehicle traffic. While the stresses on road networks and infrastructure are primarily influenced by the mode of transport of the gas (i.e. pipeline or road) in the production phases, the preparation of wellpads and access roads, import of heavy equipment and transportation of construction materials during the exploration phases, as indicated in Burns et al. (2016), can also result in a significant increase in heavy traffic on regional road networks. Due to heavy vehicle loads of equipment and construction material, local roads also deteriorate rapidly and require significantly increased maintenance, if not severe rehabilitation or even total reconstruction. This is obviously more applicable to paved roads than unpaved roads, although deterioration of the latter and the need for re-gravelling does increase significantly (Paige-Green, 2015; 2016). The deterioration of unpaved roads is not only attributable to increased traffic, as climatic effects such as flash flooding can also play an enormous part in their deterioration. In the case of the less developed rural areas of the Sultanate of Oman (Paige-Green, 2016) where the inspections were carried out, unpaved roads make up a considerable proportion of the network. This necessitated an increase in the structural capacity of certain access roads in Oman, and significant resource-implications associated with the upgrading/improvement and maintenance of such roads. In the case of the unconventional gas exploration in the US (i.e. Pennsylvania), improving

structural capacity for example required applying expensive asphalt overlays and new crushed stone bases on existing paved roads, with mitigation measures associated with the sustainability of the road infrastructure resulting in substantial resource implications related to construction, and the resultant introduction of concepts such as “bonded roads requiring exploration and extraction companies to maintain the road in at least as good a condition as they were at the start of gas extraction operations” (Paige-Green, 2015).

International experiences related to unconventional gas exploration seem to not only place significant focus on the benefits of unconventional gas as an energy resource, but also on implications for such large-scale regional investment to address unemployment and developmental challenges within regions and local towns, as in the case of Washington County Pennsylvania (Paige-Green, 2015; Williamson and Kolb, 2011), where unemployment in the region was said to have dropped to zero during the shale production phase. Settlement development in the case of Pennsylvania (as also projected in Burns et al. (2016) for the Karoo), was associated firstly, with the on-site provision of housing for security guards and engineers, and to support staff rotating for shifts (which are dependent on the range of activities within active periods of development); and, secondly, with temporary accommodation (i.e. construction camps) aimed at accommodation for construction workers and road labourers. In addition to providing housing on-site and in construction camps, more permanent/formal settlement provision is also required for the local or in-migrating set of largely high skilled staff supporting the activities related to the respective phases and scenarios of exploration and production.

While the experiences related to unconventional gas exploration and production internationally do not seem to highlight large scale in-migration of unsuccessful jobseekers into “host” regions and nearby towns, South African experiences of resource-related development and large scale infrastructure investment clearly highlight the implications and unintended consequences associated with the in-migration of unsuccessful jobseekers (Oranje, 2013a; 2013b; 2013c). Given the context of South Africa’s large scale unemployment and highly mobile and dynamic population (Van Huyssteen, 2013; 2015), many examples exist of the implication of in-migration, i.e. “the Platinum Belt” (see Van Huyssteen et al., 2014) and of towns that have actually doubled in size in resource rich regions associated with new mining or extraction activities, i.e. Lephalale in Limpopo and Postmasburg in the Northern Cape (see Van Huyssteen et al, 2013b). Realities and implications of such in-migration and resultant boom and bust towns internationally (Argent, 2013; Jacquet, 2009; Jacquet et al. 2014) and locally (van der Berg et al., 2010) on already struggling local authorities (Oranje, 2013a; 2013b; 2013c), as well as on mining companies in terms of social responsibility and local investment (Oranje, 2013a; 2013b; 2013c) cannot be ignored in the case of considering the possible implications of unconventional gas exploration and production on settlement development and the pressures it could

place on municipal service delivery. In the study area, possible developments (and even discussions about possible developments) related to shale gas, renewable energy and uranium mining will most likely have a cumulative impact on settlement development and associated pressures on governance capacity and service delivery.

18.1.3 The backbone of settlement and road infrastructure in the Karoo region

Given the above context, it is useful to note that the study area is largely characterised by the arid and sparsely populated Karoo landscape. For example, the area around Beaufort West that is likely to be the central logistical hub or production centre if full scale production is realised is a sparsely populated area. The Central Karoo District Municipality of which Beaufort West is the administrative centre had an estimated total population of just more than 70 000 people in 2011, of whom almost half (46%) lived in the town of Beaufort West (stepSA Regional Profiler, 2016). A more detailed description of urban development and spatial dynamics in the area, including a spatial representation of population distribution and concentration in the various towns in the study area is set out in Burns et al. (2016). Beaufort West is also the biggest and most accessible town in the region, providing a range of government and private sector services to the broader region. Unemployment in the region is exacerbated by the unavailability of jobs for school leavers and matriculants, and the fact that many of the jobs that are available, are actually of a temporary and seasonal nature (Western Cape Government, 2012).

With regards to existing settlement development, the area is characterised by an average population density (outside of towns) of less than 0.5 persons per km² (stepSA Regional Profiler, 2016). Settlement outside towns is limited (and ‘discouraged’) owing to a range of factors including 1) the Karoo’s arid landscape and temperature extremes, 2) restrictions on the subdivision of farm land, 3) cost implications, and 4) the sustainability of service delivery. Within the wider study area, 475 319 people or 32% of the population, are concentrated in the towns of Queenstown, Graaff-Reinet, Cradock, Beaufort West, Fort Beaufort, Middelburg and Somerset East (stepSA Regional Profiler, 2016; stepSA Town Growth Profiler, 2015; Burns et al., 2016). The town of Murraysburg, at the centre of the possible ‘sweet spot’ for exploration, is a minor settlement of about 5 000 people (stepSA Town Growth Profiler, 2015).

In terms of regional connectivity and access to the area (see Figure 18.3), the N1 national road that bisects the Central Karoo is a key national transport corridor for road-based freight transport, passenger services and private vehicles. Running parallel to the N1 is the long-distance main railway line connecting Cape Town to Johannesburg and other main urban centres (see Figure 18.3) highlighting main regional routes to Port Elizabeth/Nelson Mandela Bay Metropolitan Municipality,

Mossel Bay and George as well as the key internal routes N12, R61, R63, R75, R338 and R407 to Prince Albert, Murraysburg and Aberdeen. The routes to and from the coast traverse several scenic passes, some of which will need to have restrictions on use placed on them for heavy vehicle traffic, i.e. Swartberg, Montague (no-go gravel passes) and Robinson Pass (steep dangerous and misty), Meirings Poort and Outiniqua Pass (scenic, dangerous, but essential freight routes).

Road corridors, such as the N1 and N12, and important rail links which pass through the region are of critical importance to the country and must be maintained for the good of the economy of the country as a whole. However, the resultant heavy road traffic generated by SGD will significantly impact on local towns and regional roads. Minor roads currently provide access for individual farms, but are unlikely to be sufficient to support the establishment of the numerous wellpads required and more roads will need to be constructed for this purpose, mainly on private land.

The current coverage of the road network is considerable, given the sheer size of the Karoo. For example in the Central Karoo District there is 1 km of road per 5 km². Taking account of the low population total, the road network length per person is high and the maintenance of these roads presents an on-going problem; this is exacerbated by flash floods and dwindling local levels of the right quality of gravel to suitably maintain the unpaved roads and the import of construction material is already required. Capacity to maintain roads in the area is constrained (Theron, 2016).

18.1.4 Integrated spatial and development planning

Largely in response to Apartheid planning practices and outcomes, but also fuelled by similar sentiments in international planning circles, a primary objective of the post-1994 South African planning system has been the coordinated pursuit of shared development objectives in 1) the plans, 2) the budgets, and 3) the implementation of the plans of the three spheres of government and the sectors in each of these spheres (Pieterse, 2016; Oranje and Van Huyssteen, 2007; Oranje, 2013). Within the South African context, the importance of considering the spatial impact of development and spatial planning is not only strongly linked to current needs and priorities, but also to past legacies and challenges in creating a future for South Africans to thrive. Over the course of the last two decades, a range of plans and investment instruments have been put in place to guide development and bring about more effective intergovernmental and spatial alignment within the planning system, spearheaded initially by the Development Facilitation Act (1996) and embodied by the Intergovernmental Relations Framework Act, 2005 (IGRFA), and the SPLUMA.

Despite the necessity and desire for such an integrated and well-coordinated system of planning, budgeting and implementation in South Africa, its establishment has been a slow, uneven and arduous

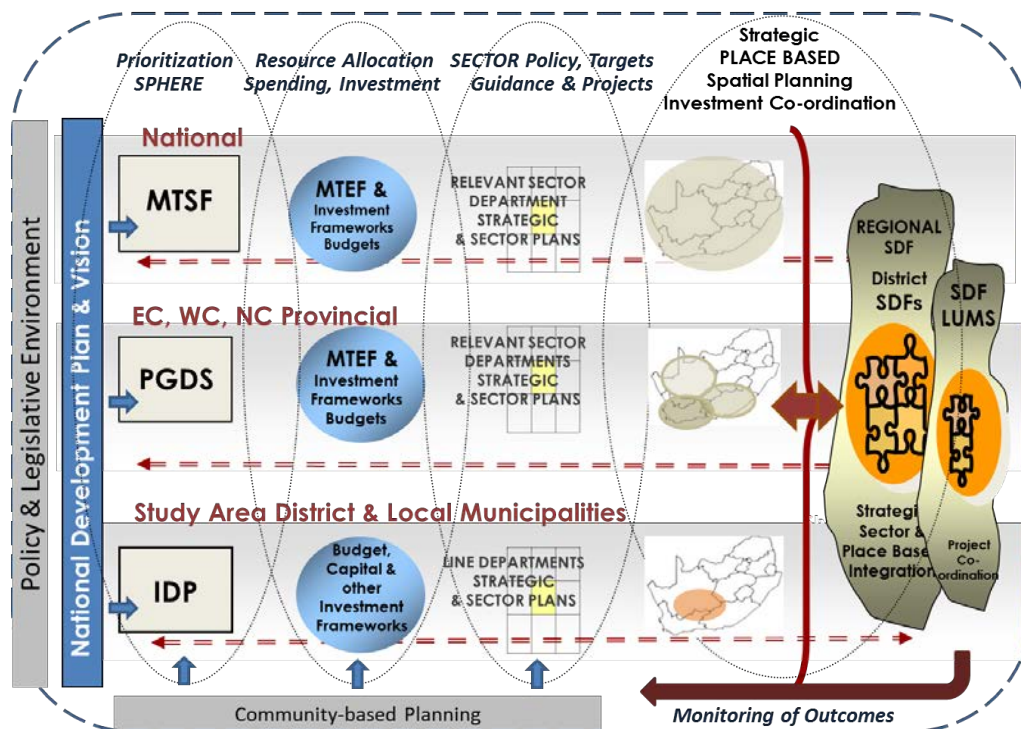
process (Pieterse et al., 2016; Oranje and Van Huyssteen, 2011; Western Cape Intra-Governmental Shale Gas Task Team, 2012). Within this context, the need for a new integrated approach to planning aimed at overcoming the challenges associated with distance, inaccessibility and lack of choice is perhaps greatest for 1) historically disadvantaged members of society who had lived in settlements marred by Apartheid planning in pre-1994 South Africa, 2) the more rural, less capacitated and lesser resourced municipalities where state expenditure in most cases is the key driver of the local economy, and 3) ecologically sensitive areas.

The region in which SGD may most likely take place, is exactly such a region - not only ecologically sensitive (Hobbs et al., 2016; Holness et al., 2016), but also a largely rural area characterised by high levels of socio-economic inequality and vulnerabilities (Van Zyl et al., 2016) and a diverse but significant number of under-capacitated and under-resourced municipalities (Department of Cooperative Governance and Traditional Affairs, 2009a; 2009 b; The Presidency, 2014; Van Wyk and Oranje, 2014). It is thus imperative that, irrespective of whether SGD is to take place in the area or not, careful, coordinated and integrated planning must take place.

The opportunities and challenges for coordinated inter-governmental planning becomes even more evident when considering the wide range of spatial and integrated development planning and governance instruments (see Figure 18.1), all requiring annual review, adaptation and alignment, relevant to the study area, i.e.:

- Spatial outcomes and principles as set out by SPLUMA and the National Development Plan (NDP) 2011, merely broadly defined and regional interpretation still to be defined;
- Integrated and strategic national, local and regional plans i.e. the NDP, the IDPs developed for every local and district municipality in the study area, and the Provincial Growth and Development Strategies (PGDSs) and equivalent plans within the Western Cape, Eastern Cape and Northern Cape Provinces;

Place based intergovernmental co-ordination



Adapted from Oranje & Van Huyssteen 2010

Figure 18.1: Overview of relevant integrated spatial and development planning instruments.

- Integrated Spatial Development Frameworks (SDFs) to guide spatial development within national, provincial, regional, local and precinct scales (see SPLUMA and the Department of Rural Development and Land Reform’s (DRDLR) SDF Guidelines (2014), as well as the Western Cape LUPA). While plans are in place for all three provinces as well as relevant district and local municipalities (given that transitional requirements deem SDFs drafted in terms of the old legislation as SDFs in terms of new legislation), most of the local and district plans require an update to ensure that they can fulfil the functions and purposes as set out by recent legal developments and regulations;
- Integrated provincial and municipal sector plans i.e. integrated housing plans, integrated transportation plans and integrated disaster management plans;
- Integrated investment frameworks i.e. Integrated Infrastructure Investment Framework (provincial and municipal), Capital Investment Framework (municipal) and spatially targeted budgeting instruments introduced by National Treasury; and
- Land use management schemes which are largely in place for towns, and in most cases require support to develop for the full extent of the municipal area, need support to ensure alignment with SDFs and support with the preparation of relevant by-laws to guide

development. In the Western Cape, the Laingsburg, Prince Albert and Beaufort West Local Municipalities (amongst others) have all adopted municipal by-laws enabling LUPA.

Governance capacity of local and district municipalities in the Karoo region for coordinated and aligned spatial and infrastructure investment planning and management, including mitigation of any new activity in their areas of jurisdiction, is already limited, with high levels of differentiation between provinces in terms of legislative requirements and institutional readiness. This is worsened by the incremental approach often taken by mining companies in mining areas and towns which stands in stark contrast to the need for well-considered, multi-stakeholder planning (Oranje, 2013a; 2013b; 2013c). The complex institutional context for service delivery, and the associated roles and responsibilities, often negotiated at local and district municipal areas, adds a further challenge (Oranje & Berrisford, 2012) and requires dedicated capacity and support for relevant municipalities. With regards to the Western Cape Province, the Province for example plays an active role in the monitoring, support and regulating function within the Central Karoo District Municipality, as it is one of the least capacitated compared to the other district municipalities in the Province.

While it is both 1) legally mandated and 2) evident from the situation on the ground that government needs to create an enabling and guiding context for development and investment in the region through ensuring effective pro-active and coordinated planning, budgeting and targeted investment and governance, the risks and mitigations associated with the possible impact of SGD on land, infrastructure and settlements could in many respects also be addressed through such pro-active planning.

18.1.5 Regulatory and practice context for land development and land use management

The realisation, timelines, scale, location, cost and possible impacts of SGD (as outlined in Burns et al., 2016) are highly dependent on a complex regulatory framework and associated processes of obtainment of rights, the latter are addressed in this Chapter.

There are a wide range of development activities directly and indirectly related to SGD throughout the foreseen phases and possible scenarios that would potentially impact on existing land uses and future development of the area. A number of the proposed activities and developments directly related to SGD (Burns et al., 2016) will most likely require land use change and land development applications (See Figure 18.2) in terms of the relevant regulatory frameworks. While the focus of this Chapter is specifically in highlighting implications related to urban development, road infrastructure and spatial planning, the compatibility of SGD with respect to existing agriculture, mining, game farming, tourism and conservation remains a major consideration. The implications of SGD on these respective

land uses are addressed in detail within the relevant Chapters of the study, including i.e. biodiversity and ecology (Holness et al., 2016); agriculture (Oettle et al., 2016); tourism (Toerien et al., 2016); economics (Van Zyl et al., 2016); human health (Genthe et al., 2016) and water resources, both on the surface and underground (Hobbs et al., 2016).

While the Environmental Authorisation (EA) issued by the provincial or national government in terms of the National Environmental Management Act (NEMA), Act 107 of 1998 and prospecting or mining rights issued in terms of the Mineral and Petroleum Resources Development Act (MPRDA), Act 28 of 2002, are both legal determinants, they are issued in parallel to the relevant municipal applications for 1) changes in the applicable land use rights, and 2) land development required for both the exploration and production phases of SGD.

Since the advent of the SPLUMA in 2013, and in line with a series of pronouncements by the Constitutional Court since 2010, the locus of land use change approvals

is the municipality. The decisions of other national or provincial departments may not overturn that of the municipality. Based on the above, it is emphasised that an applicant can only successfully commence with a development when all the required regulatory approvals has been granted.

Zoning for Agricultural Purposes

Historically, land use management in the study area was regulated through the provisions of the former Cape Province's Land Use Planning Ordinance, 15 of 1985 (commonly known as "LUPO"). With the division of the old Cape Province into the Eastern Cape, Northern Cape and Western Cape provinces in 1994, LUPO remained in place. Municipalities in these provinces all have zoning schemes approved in terms of LUPO, and these zoning schemes prescribe the extent of permissible land uses, particularly in the town/urban/built-up areas. Outside the built-up areas, and thus outside of the application of the zoning schemes, LUPO prescribed that the applicable land use would be deemed to be the most restrictive zoning that matched the current lawful land use. Thus, for most of the rural areas the land was deemed to be zoned for "agricultural purposes".

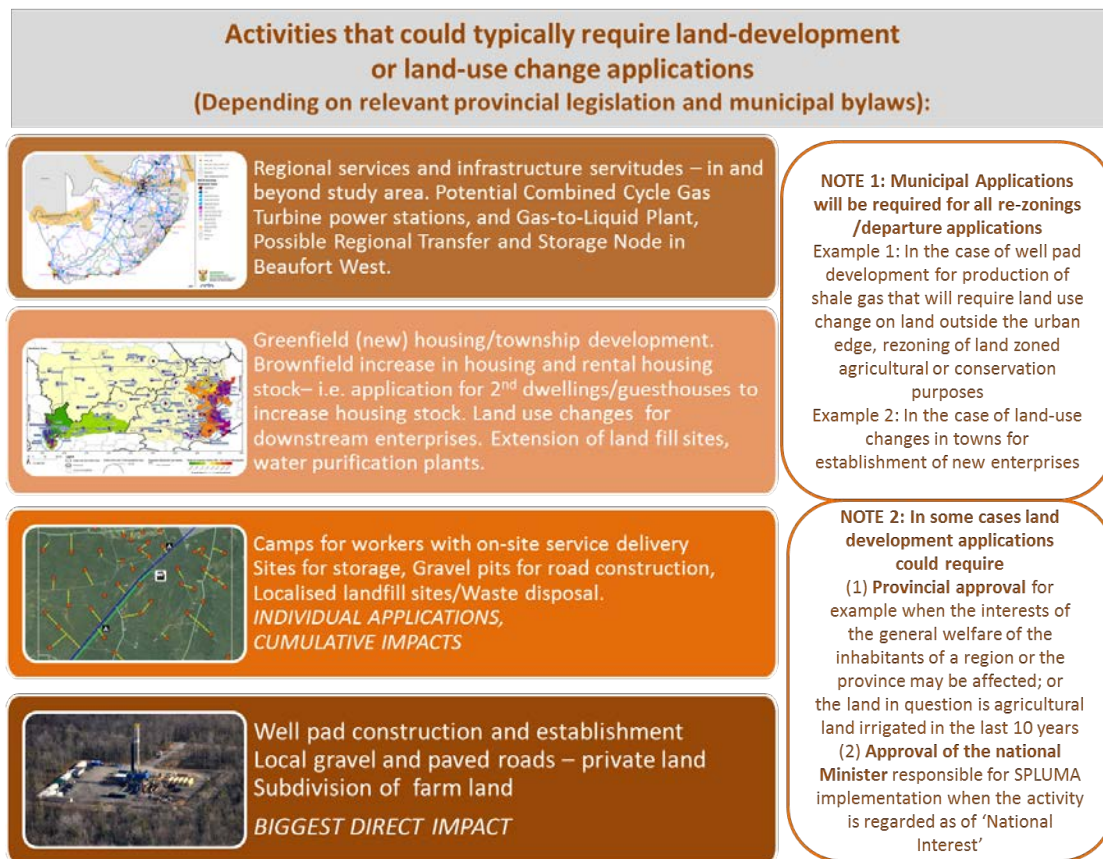


Figure 18.2: Activities that could typically require land development and land use change applications in the study area.

Prior to SPLUMA, the land use planning dispensation for the former Cape Province (now forming part of the Western, Northern and Eastern Cape) was governed by the Land Use Planning Ordinance, 15 of 1985 ('LUPO'). In the Northern Cape, the Northern Cape Planning and Development Act (NCPDA), Act 7 of 1998 was promulgated. The three affected provinces are, however, each at different stages in evolving from a legal position based on LUPO to one that is in line with SPLUMA. The Western Cape already has new legislation in place (LUPA and an accompanying set of Land Use Planning Regulations (2015)), while the Northern and Eastern Cape provinces have draft legislation that is being considered in each of the respective provinces. In the absence of new provincial legislation and until such time as the municipalities have municipal planning bylaws in place, the former LUPO-based (or NCPDA-based in the case of the Northern Cape) system stays in effect until repealed by provincial governments as set out in the Guideline on Transitional Measures (DRDLR, 2015). This results in significant challenges:

- Firstly, SPLUMA is a new act, which together with its set of regulations and guidelines, is still being rolled out, however effectuated differently between the provinces in the study area.

- Secondly, in order to extend Land Use Management Schemes (LUMS) required in terms of SPLUMA and LUPA beyond ‘town/urban areas’ (for which areas town planning schemes were originally developed for) large portions of ‘rural land’ in municipalities in the study area have ‘inherited’ a zoning for agricultural purposes. This implies that land use change applications will be required for any use outside agriculture zoning and existing provisions on such land portions, typically the portions on which SGD is envisaged.
- Thirdly, considerable support to municipalities with regards to capacity and resources are required to effectuate the institutional arrangements and processes to support municipal orientated land use decision-making required within SPLUMA, for example the appointment of Municipal Planning Tribunals in each municipality which are not yet in place.
- Fourthly, approval processes could be negatively impacted upon by the fact that SPLUMA is a new piece of legislation not yet tested and tried by courts. Legally, decisions taken in terms of this system, where SPLUMA and former Ordinances may in all likelihood have to be considered, are of dubious validity. A range of aspects, especially related to the lack of clarity regarding definitions and procedures related to a “land development application”; “land use application” and “land use of national interest” are also not clarified in SPLUMA, which

Interrelated Regulatory Context

It terms of NEMA, petroleum exploration and production activities trigger the need for an EA prior to the commencement of such activities. In terms of NEMA and the Environmental Impact Assessment (EIA) Regulations, 2014, the Minister of Mineral Resources is the competent authority for deciding on applications for EA, with the Minister of Environmental Affairs being the relevant authority to consider appeals against any EA granted/refused.

The statutes to be considered in this regard are: 1) the EIA Regulations 2014; 2) NEMA; 3) the Regulations for Petroleum Exploration and Production, 2015; 4) the Regulations pertaining to the financial provision for prospecting, exploration, mining or production operations, 2015, issued under NEMA; 6) the Regulations regarding the planning and management of residue stockpiles and residue deposits from a prospecting, mining, exploration or production operation, 2015, issued under the NEM: Waste Act; 7) the Disaster Management Act, 2002; 8) the National Heritage Act; and 9) the Hazardous Waste Act, 2008.

The Minister of Water and Sanitation also declared “The exploration and or production of onshore naturally occurring hydrocarbons that requires stimulation, including but not limited to hydraulic fracturing and or underground gasification, to extract, and any activity incidental thereto that may impact detrimentally on the water resource”, to be a controlled activity (Government Gazette 39299, Notice 999, dated 16 Oct 2015). Following the declaration of the above-mentioned controlled activity, a water use licence for this particular category of activity is required under the National Water Act (NWA), 1998 (Act No. 36 of 1998). The Department of Water and Sanitation (DWS) is in the process of drafting water use licence application regulations, which will seek to align such applications in accordance with the so-called “One Environmental System”.

could be problematic for application processes, as well as valid decision-making. These aspects are highlighted for timeous clarification as part of mitigation proposals in Section 18.4.

- Fifthly, a challenge to both SPLUMA and LUPA is that there are no precedents for land use approvals related to SGD in South Africa. The clarity provided in LUPA (thus Western Cape Province only at this stage) for land developments and uses related to unconventional SGD (Figure 18.2) might result in unintended consequences of potential exploration and production being initially focussed within the Western Cape Province's area of jurisdiction.
- Lastly, the challenges related to possible procedural uncertainties and capacity within the complex regulatory system is well recognised. While the relevant sector regulatory requirements are discussed in detail in the respective chapters of this scientific assessment, the cumulative need that these generate for integrated and coordinated planning and governance between different authorities, streamlined and aligned processes and the potential burden this places on human capacity and specific high-level expertise in already stretched municipalities is the focus of this discussion.

Most of the district and local municipalities in the Karoo Region have restricted financial, planning, technical (road construction/ maintenance) and administrative capacity (see study conducted by the Western Cape Intra-Governmental Shale Gas Task Team, 2012). Experience in the roll-out of renewable energy projects in this region has shown that municipal capacity is not up to the task of processing land use applications of this scale and impact, and thus it may even be necessary to create a 'shared capacity', which might include appointing the necessary experts and consultants to train officials and/or provide professional support to municipalities (Berrisford, 2015). The challenge implicit in gearing up these municipalities to be in a position to process the land use applications for SGD to fulfil their regulatory functions associated with these applications needs urgent attention. The need for municipalities to acquire additional capacity has been foreseen and can be facilitated through legislation, namely SPLUMA (Section 39(1)), or at a regional level through SPLUMA (Sections 18 and 19). The Infrastructure Development Act, Act 23 of 2014, could possibly strengthen integrated infrastructure development.

SPLUMA prescribes a system for municipal decision-making that is premised on the appointment of Municipal Planning Tribunals. Municipalities have relatively wide powers to elaborate on the provisions of SPLUMA (and LUPA in the case of the Western Cape), by adopting municipal planning by-laws. The authority for municipalities to adopt municipal planning bylaws lies in the provisions of the Constitution (see Section 156 (2)), which authority is reflected in the provisions of Section 2 of LUPA.

In addition to the need to enhance and strengthen the capacity to manage a system of land use approvals, municipalities will also have to gear up their development planning, financial management and infrastructure delivery capacities. This has to be done to provide the overall organisational capacity to anticipate and manage the increase in economic activity, infrastructure provision, population growth and related demographic shifts that will inevitably follow the scaling up of SGD.

18.2 Key potential impacts and their mitigation

The various exploration and production scenarios will have wide-ranging impacts on regional and local infrastructure (especially road infrastructure), land development, town growth and sustainable regional and settlement development in the area. In the next Section, 1) the key potential impact areas under the different scenarios are highlighted, 2) measures and limits of change are identified, and 3) high-level risks assessed (without and with mitigation). The Section is concluded with proposals around the most critical mitigation measures.

18.2.1 Local road construction and resource requirements

SGD will require significant road access. During exploration, seismic surveys are usually carried out by vehicles that travel off-road across local farmlands and do not impact significantly on the road infrastructure, other than to get to their points of departure for testing. The establishment of exploration wells (including those that involve the use of hydraulic fracturing (“fracking”)), however, require proper access, usually along unpaved access roads. During exploration movement (Paige-Green, 2015; 2016) activities include regular movement of staff, equipment, fuel and provisions and maintenance vehicles, generally requiring all-weather access for the most part (also see Burns et al. (2016) outlining the activities for the respective Scenarios). This is probably the busiest period in terms of road construction and utilisation. Once the wells are established, the intensity of vehicular movement will be linked to the respective campaigns. Access roads to wells that have been approved for production will require necessary upgrade and maintenance. It should be noted however, that while exploration and well development (for both exploration and production purposes) in a local area may be incremental it may also take place with increased intensity during the various phases and possible scenarios of SGD (see Burns et al. (2016) for estimated numbers of vehicles and time frames).

Exactly what percentage of the local access roads will need to be paved will be dependent on how the vehicle loading is distributed, and is highly dependent on how the drilling campaigns are distributed/clustered. If the vehicle loading is distributed among a number of different roads, and if the total

volume of vehicles on any single stretch of road does not exceed 60 heavy vehicles per day (acceptable industry standard), it may be possible to continue to use unpaved roads but these then have to be of a high standard. While the paving of roads may have some benefit for improved ride quality for the local community during and after production (decommissioning), and hold benefit for other industries in the area, i.e. agriculture and possibly tourism, the risk of having to maintain a greater length of paved roads into the future without the economic income stream, means that the paving of public roads should be limited as far as possible as it also holds additional costs implications for municipalities and a financial burden on government as a whole (Technical Recommendations for Highways (TRH) 20, 1999). Any paving of private access roads on farms will have resource implications. Their impact on the land owners will vary dependent on the length, nature of paving and the use the farmers can derive after decommissioning should they wish to maintain the road.

Although current local access roads provide a relatively good level of connectivity for current use when maintained, the current financial burden of road maintenance per capita is high (Central Karoo District Municipality, 2013) and can potentially increase with the advent of exploration. The development, maintenance and upgrading of roads requires significant resources in terms of materials and cost. The typical material usage on roads, based on a standard 8 m wide road is as follows:

- **Unpaved road:** Wearing course layer of about 1 200 m³/km that needs to be replaced every seven to ten years; and
- **Paved roads:** At least two, sometimes three, layers of material each of about 1 200 m³/km that should last 15 to 20 years. These also require routine (patching, crack-sealing, edge-break repair, etc.) and periodic maintenance (resealing).

The implications of increased traffic are difficult to estimate, and depend on existing traffic volumes. In the main, the heavy vehicle traffic volume is currently estimated to be below 25 heavy vehicles per day on the unpaved roads with an additional 25 vehicles per day for Scenarios 1: Exploration Only and 2: Small Gas over the whole network of roads and 160 heavy vehicles per day for Scenario 3: Big Gas, although this will be distributed among four separate campaigns and thus not on the same stretch of road (see Burns et al., 2016). Given that the vehicles are likely to be distributed over several different stretches of road it is thus estimated that not more than 40 additional vehicles a day will travel on any stretch of unpaved road. This is, however, highly dependent on the distribution of the campaigns and wellpads. The increase in traffic volume of heavy vehicles will not be assessed in terms of a percentage increase over existing traffic, but a fixed traffic volume. In other words, a local gravel road currently carrying 30 vehicles per day may experience an increase of 25 to 50 vehicles

depending on 1) the scenario and 2) the distribution of traffic, which is difficult to predict. This will probably reduce the interval between re-gravelling from ten years to six years or less, the latter interval being relevant to the Big Gas scenario with less impact for the Exploration Only and Small Gas scenarios. The impact of the same increase of 30 to 50 vehicles on a road already carrying 200 vehicles per day may decrease the re-gravelling interval from six to perhaps four or five years. The 2012 traffic volume map (Central Karoo District Municipality, 2013) indicates that the majority of unpaved roads at that time carried less than 100 vehicles per day, but there is no information on the lower class roads, which probably carry less than 50 vehicles per day with the total usage unlikely to exceed 100 heavy vehicles per day even for the Big Gas scenario. An estimate of the increased traffic in each scenario and the impact on the maintenance costs are given in Table 18.1 and Table 18.2 below, based on the information as set out in Burns et al. (2016).

Not all of the unpaved roads will carry extra traffic, with the assumptions in the case of each scenario being as follows:

1. **Scenario 0 (Reference Case):** No roads impacted. Routine and periodic maintenance with resealing every ten years and regravelling every seven to ten years continues at normal frequency - excludes any portion resealed as mitigation.
2. **Exploration Only:** All paved roads impacted (excluding the Fraserberg and Hofmeyer links) and 25% of all gravel roads in the 'sweet spot'. Routine and periodic maintenance of paved roads with resealing continues with increase in frequency to nine years – pro-rated for portion rehabilitated.
3. **Small Gas:** All paved roads impacted plus 50% of gravel roads in the 'sweet spot' and 12.5% of other gravel roads in immediate vicinity of the Fraserberg and Hofmeyer routes for campaigns identified in areas. Routine and periodic maintenance with resealing continues with increase in frequency to nine years – pro-rated for portion rehabilitated.
4. **Big Gas:** All paved roads impacted plus 100% of gravel roads in the 'sweet spot; and 25% of other gravel roads in the immediate vicinity of the Fraserberg and Hofmeyer routes. Routine and periodic maintenance with resealing continues with increase in frequency to seven years – pro-rated for portion rehabilitated

Extra traffic on unpaved roads will lead to more frequent grader blading and re-gravelling; depending on the increase in traffic (see Table 18.2 for changing frequency of re-gravelling). Extra traffic on paved roads will lead to additional routine maintenance (potholes, cracking and edge-break) and a small increase in resealing frequency.

Costs for maintenance are based on current costs (not adjusted for inflation as this is common to all of the roads), using the 2012 Central Karoo Integrated Transport Plan (Central Karoo District Municipality, 2013) as a bench mark.

Table 18.1: Traffic and network requirements for the four scenarios.

Road type	Road length (km)	Percentage Roads Impacted			
		Reference Case	Exploration Only	Small Gas	Big Gas
Paved roads					
Port Elizabeth - Victoria West	442	0	100	100	100
Victoria West - Three Sisters	61	0	100	100	100
Beaufort West (R61 via Aberdeen)- to Junction of R75 near Kleinpoort	288	0	100	100	100
Fraserburg - Beaufort West	30	0	0	100	100
Graaff-Reinet - Hofmeyer via R421	169	0	0	100	100
Unpaved roads					
Fraserburg - Beaufort West	120	0	0	100	100
Unpaved 'sweet spot" roads	1273.61	0	25	50	100
All roads in 30 km buffer of Beaufort West-Fraserburg (excluding main route above)	1624	0	0	12.5	25
All roads in 30 km buffer Graaff-Reinet -Hofmeyer (R421)	2512	0	0	12.5	25
Private access roads					
Exploration Only: 1 km road per wellpad for 30 wellpads	30	0	100	100	100
Small Gas: 0.5 km per wellpad for 55 wellpads	27.5			100	100
Big Gas: 0.5 km per wellpad for 410 wellpads	205				100

Indicative costs will depend on the exact extent of the network affected (see Table 18.2 for summary of likely increase in costs and gravel required and Digital Addendum 18A for guideline cost details per road segment).

Table 18.2: Summary of costs and additional gravel required for roads impacted.

Paved roads								
	Reference Case		Exploration Only		Small Gas		Big Gas	
Routine maintenance cost per km (Rand)	R100 000.00		R 110 000.00		R 110 000.00		R 125 000.00	
Reseal frequency in years	10 years		9 years		9 years		7 years	
Cost to rehabilitate to required base	R 1.82 bn							
Total annual maintenance cost	R 150.1 mil							
Additional annual cost: Paved roads			R 12.2 mil		R 15.7 mil		R 49.8 mil	
Unpaved roads								
	Routine	Gravel/ m ³ /year)	Routine	Gravel/ m ³ /year)	Routine	Gravel/ m ³ /year)	Routine	Gravel/ m ³ /year)
Periodic maintenance cost per km (Rand)	R 300 000.00		R 300 000.00		R 300 000.00		R 300 000.00	
Routine maintenance cost per km (Rand)	R 750.00		R 825.00		R 825.00		R 1000.00	
Regravel frequency	7 years		6 years		6 years		4 years	
Total annual maintenance cost	R 241.1 mil							
Additional annual cost: Unpaved roads			R 3 mil		R 59.4 mil		R 177.6 mil	
Total gravel lost per year (m ³)		947 933		955 730		976 556		1 119 676
Change in gravel lost (m ³ /year)		0		7 797		28 623		171 743
<i>Note: All costs exclude inflation and are based on current cost.</i>								

Paved roads will typically require about 1200 m³ of construction material per layer per kilometre of road. Depending on the existing site conditions, anything from one to three layers of material could be required for different areas of road. This would normally be expected to last 20 years before rehabilitation. Unpaved roads typically require re-gravelling with one wearing course layer on the existing pavement structure. Under normal operating conditions, this upper 150 mm of material would be lost as dust, eroded and whipped-off material, requiring a replacement every six to ten years.

The acquisition of this construction material is usually from borrow pits which 1) needs to provide access to appropriate quality material in close proximity to the road construction site, 2) has to go through the necessary regulatory approval processes, 3) has to be expropriated (if required), 4) have to be managed (including continuous rehabilitation), and 5) finally, be commissioned. It is already increasingly difficult to source the appropriate quality and quantity of construction materials within the region. The regulatory processes for commissioning new gravel pits requires effective project planning to avoid delays in the implementation of construction and maintenance programmes. In order to ensure longer lasting roads, better quality material increasingly needs to be sourced from further afield, resulting in significant project cost implications. For more than ten years, the access to gravel in the region has hampered maintenance on the gravel road network, due to the limited availability of (legally) approved gravel pits. For example, after several years, upgrading of the Swartberg Pass has recently commenced with material brought in at great expense from outside the district from commercial sources (Theron, 2016). The same challenges apply to paved roads, although the increased road width and the material quality requirements for the upper layers and bituminous surfacing is significantly higher (usually crushed stone), making the location of the materials more difficult, processing more expensive, the haulage somewhat longer and the actual cost of the materials significantly higher. One issue that is normally not considered adequately, especially in arid areas, is the availability of water for construction. Large quantities of water (especially during construction in dry and hot seasons) are required. These typically would be about 84 m³ (i.e. 84 000ℓ) per layer per km. This water needs to be sourced and hauled to the construction site. The strength of local boreholes is likely to support construction of at least 1 km of road per well per week for the duration of construction (Hobs, 2016). Currently no additional import of water for this purpose is envisaged. In the following Sections, the demand for road maintenance is discussed in relation to each of the four scenarios:

Reference Case: Even if no SGD takes place, the demand for local access road maintenance is already high in the region (Central Karoo District Municipality, 2012) and thus, either with or without mitigation (using a better grade of gravel and/or water wise construction and a possible longer term switch to new/ alternative materials), there already is a relatively high demand on raw materials for

road maintenance in the area. Given the lead time for such activities including licencing/approval of gravel pits, this needs to be planned and budgeted for, well in advance of the planned date for commencement of maintenance activities.

Exploration Only: Exploration-related activities will require expansion of the existing road network to enable drilling of wells and the establishment of wellpads and associated infrastructure in and around the SGD areas. The seismic surveys are usually carried out by vehicles that travel off-road across local farmlands and do not impact significantly on the road infrastructure, other than to get to their points of departure for testing. Exploration wells, on the other hand will require proper access, usually along unpaved access roads. During exploration activities, the regular movement of staff, equipment, fuel and provisions and maintenance vehicles occur, generally require road access of a quality to handle all weather conditions. This is probably the busiest period as once the wells have been established and ready (and approved) for production, access roads only require limited maintenance. While a concerted effort should be made to optimise the use of the existing road network, it is inevitable that new access roads will be required. Based on the assumption that new access roads will on average not exceed 0.5 km per well (see Burns et al., 2016) an additional 30 km, 27,5 km and 205 km of access roads will be required for the Exploration Only, Small- and Big Gas scenarios, respectively. The construction of these access roads is expected to be financed by the mining companies and to be constructed on private land. The main limitation will be the acquisition of gravel and other raw materials (Theron, 2016). There is a risk that severe pressure will be placed on local materials such as gravel and that steep price rises may price out the government-funded road sector. A strategy may be required to protect local gravel pits for the maintenance use of district and provincial managed and maintained roads. Although these new access roads will initially be used only for access to exploration areas and possibly later to production areas, their presence will invariably attract local traffic and most probably generate new traffic. For roads carrying less than about 150 to 200 vehicles per day, unpaved riding surfaces will usually be adequate, provided that the local materials are suitable, given current industry standards. For roads carrying more traffic than this or more than about 60 heavy vehicles per day, paved roads are generally more appropriate and cost-effective and sustainable over the long term. These have much greater material requirements and higher environmental impact (TRH 20, 1990). Private roads are unlikely to ever be decommissioned; however, should the roads not be required for local use, such roads must at least be scarified to allow for recolonisation of the natural flora (See Holness et al., 2016).

Public access roads should however be restored to at least the same level as when exploration commenced. In order to ensure that this is achieved, the baseline monitoring must clearly define the condition of the various segments of road prior to any exploration-associated traffic using the road.

This must include photographic/video evidence of defects and poor quality sections as well as a full condition survey over the entire road, agreed on by the relevant road authority.

Small Gas: Given the approach of expanding exploration while production is under way, the biggest impact under the Big Gas scenario for local roads would be the establishment of additional exploration and extraction wells, with a resultant increase in the construction of local access roads (27.5 km additional road) and road use (i.e. traffic volumes). In this scenario, due to increased use of roads the demand for upgrading continues but as new access roads to the wells are built the demand for raw material for road making will increase significantly even with the use of better construction techniques and innovative materials. This will also result in an increase in regulatory applications associated with sourcing material from new gravel pits or the expansion of existing pits (NEMA, Regulations 765, Schedule 3). To improve the durability of roads, the use of better quality gravel and stone sourced from more distant pits may be required. An increase in construction will also result in an increase in the amount of water required to support construction (water could be just below potable level in terms of quality but cannot be too salty, with the salinity of the water wells in the area often being too high). Under this scenario the increased intensity of shale gas activities (related to both exploration and production) will increase the heavy vehicle load to approximately 25 heavy vehicles per day (see Burns et al. (2016) for total trips generated; where calculations are based on estimated total vehicle trip per scenario and estimated duration of scenario), placing greater strain on the roads and the maintenance thereof. This will in turn place limited resources (i.e. water, crushed stone, bitumen and the right quality of gravel), as well as existing strained institutional, financial and technical capabilities (e.g. the construction of new roads, expansion of existing roads, establishment of borrow pits, or expansion of existing pits will require increased project planning and management, as well as regulatory approval processes).

There are no specific actions required for decommissioning. Any new roads on private farms can either be left untended or continue to be used at the land owners discretion. Public access roads should be restored to at least the same level as when exploration commenced. This supports the importance of baseline monitoring from the outset.

Big Gas: With increased and full scale production, as well as the possible extension of wells, the impact of new ‘private’ road construction and heavy vehicle impact (increasing to 166 additional heavy vehicles per day – see Burns et al., 2016) on existing local access roads will become much more extensive with, firstly, paving of some local access roads to support increased activities in the production phase and, secondly, the specific need to ensure easy access to the local distribution and logistics hub (which will most probably be located in Beaufort West - see Burns et al., 2016). Due to

uncertainty as to the scale and specific location of operations, no specific routes are identified for paving and any paving will be the responsibility of, and be financed by, the mining companies should this become necessary. This will have implication for gravel and other construction materials. Upgrading of unpaved roads to paved standard would have significant benefits in terms of road user costs, but these would accrue mostly to the exploration and production companies, as well as local road users, but would have no direct benefits to the local road authorities.

Paving of roads will be associated with even more planning, management, construction, tendering and project management requirements, with major implications for an increased demand for water and high quality construction material and their transport into the region. In addition to the above, side-effects of the sudden increases in traffic such as increased dust from unpaved roads, noise and vibration can have negative impacts on agriculture, tourism and even in the northern area on the Square Kilometre Array (SKA). Together with the increased heavy traffic volumes (i.e. those that damage the roads), there will be a corresponding, but larger, increase in light and medium traffic. This traffic, however, while having a negligible impact on the road performance, has implications in terms of traffic congestion, dust generation on unpaved roads and potential road safety.

As for the Small Gas scenario; there are no specific actions required for decommissioning. Any new roads on private farms can either be left untended or continue to be used at the land owners discretion. Public access roads should be restored to at least the same level as when exploration commenced. This supports the importance of baseline monitoring from the outset.

18.2.2 Pressures on regional road infrastructure and logistic networks

As the gas containing shale is at great depths (3 000 to 4 000 m in the Beaufort West area and deeper towards the east), large rigs will be required for the exploratory (and later production) drilling to such depths. These will comprise various components, some of which will definitely be abnormal loads, both in terms of dimensions and masses. The normal traffic ordinances will need to be followed during conveyance of these loads. The abnormal loads would have limited impact on the roads in comparison with the large numbers of other conventional heavy vehicles delivering the necessary provisions and resources (see vehicle trips as set out in Burns et al., 2016). Where possible, use should be made of the existing rail infrastructure to transport the abnormal loads (see Digital Addendum 18B). It should perhaps be noted that the size of loads carried by rail is limited by the height of the overhead power lines on electrified tracks as well as by the dimensions of bridges and tunnels. Any rail transport of material and equipment required for SGD will require a mode change in Beaufort West and distribution from that point to the wellpads by suitable trucks. This will imply the availability of suitable rigs to transport the equipment from rail head to the wellpads.

Any rapid economic or infrastructure development can place enormous challenges on existing road systems (pavements and bridges), as well as require significant investments in new systems. In addition to the traffic associated with SGD activities of gas fields (i.e. the transportation of heavy equipment, drilling rigs, etc.), other transportation issues must also be considered in the case of the Karoo. One of these is the importation of potable/fresh water and this is more fully considered in Hobbs et al. (2016). Based on local experience many of the local Karoo groundwater sources may have high salinities and may be unsuitable for the support of local staff and even for the fracking operations, or may not be able to provide the adequate quantities required for sustaining the operations (Hobbs et al., 2016). The current proposal is to identify suitable additional water sources outside the areas, e.g. desalinated water from Mossel Bay, and to transport it into the area.

The exact location and direction of travel has yet to be determined and traffic for this has not been factored in to the transport impact. However, should this become necessary, this will place significant extra stress on the existing regional road infrastructure. Similarly, the removal of wastes from the study area to either Port Elizabeth or Vissershoeck (Cape Town) will add to the existing traffic volumes and will require attention (Oelofse et al., 2016). Many of these wastes (including waste water) could be hazardous or toxic, and this will involve special authorisation and the development of a fluid transportation management plan in terms of the regulations (Regulation 466; clause 117) under the MPRDA. Given the uncertainties regarding the exact volume and frequency, this is not covered in this part of the document. The re-use of material and construction of pipelines for transport of waste, use of rail, or even the establishment of a Hazardous Waste site in or close to the study area can be considered in mitigation. In addition to the impacts of the extra traffic, certain sections of road could be perilous to the movement of such heavy vehicles (slippery road surface, misty conditions, tight bends or steep grades) and could thus require improvement (re-alignment in some cases), avoidance strategies, especially of tourist-related routes or at least additional sign-posting and guard-railing.

The significant increase in traffic associated with SGD could have a severe impact on existing roads systems, especially ageing ones currently prevalent over most of South Africa. Figure 18.3 indicates local and regional roads in areas that will most probably be affected by the respective SGD scenarios as set out in Burns et al. (2016). The study area is already subject to flash flooding and extensive damage to key road infrastructure due to extreme rainfall patterns, increasingly associated with climate change, which is expected to get worse (Verhaege, 2016).

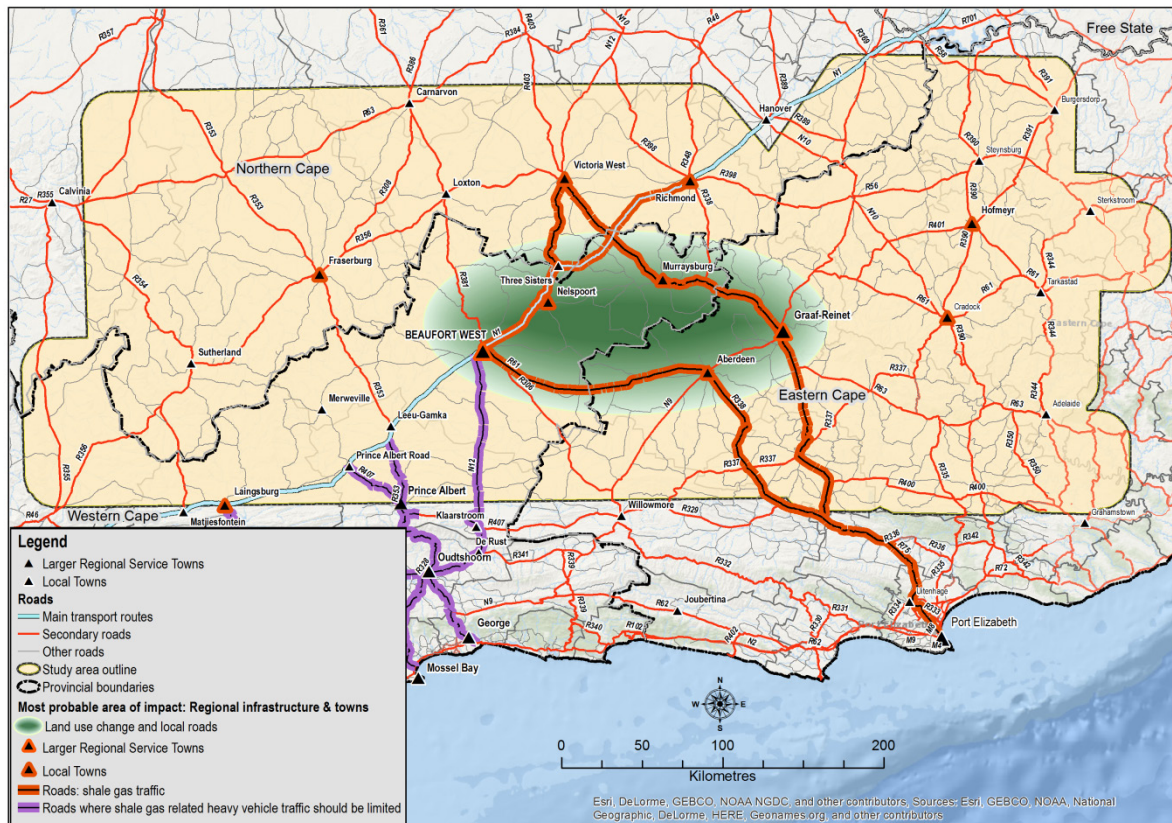


Figure 18.3: Towns and main routes likely to be impacted by potential SGD.

Reference Case: Currently, many of the roads in the area are already in a poor condition, although some of the key national and regional routes like the N1 have recently been upgraded. Many of the existing roads in the area are relatively old (more than 50 years) and nearly 30 years beyond their design lives. Existing demand for road maintenance is already high and either with or without mitigation (the former implying preventative rehabilitation and the use of higher grade gravel and other materials to extend road life, water-wise construction and application of new materials) there still is a high demand for raw materials (Central Karoo District Municipality, 2013; Theron, 2016). The application of new materials would be a more long-term option. Major implications related to the impact of regional and national corridors such as the N1 in the Karoo and surroundings, under the existing Reference Case can be summarised as heavy road freight traffic passing through the region (this currently makes up almost 40% of total traffic on the N1; see Central Karoo District Municipality, 2013). While such through-traffic, especially in Beaufort West, contributes significantly to high street traffic, but also to the local economy. This raises issues regarding ways to handle through-traffic, the need for better traffic controls, and emergency incident response by the local authorities, currently and in the future.

Exploration Only: While exploration and testing will result in the drilling of wells and establishment of wellpads and associated infrastructure and development in and around the exploration areas, the movement of equipment, materials and resources along the existing primary and secondary road networks (mostly national and provincial) into the area from ports of entry and major hubs can be expected to have a significant influence on the existing regional road networks as set out in the following Section. It is estimated that approximately 25 additional heavy vehicles per day will be traveling on the routes in question over a period of five years (Burns et al., 2016). The N1 especially is a key road freight route for South Africa, and the impact of large construction vehicles, equipment and the like on this road can increase the risk of accidents, spillage of hazardous materials, the deterioration of the road infrastructure and congestion. Likewise, the N12 is envisaged as a key route for the transport of water needed for fracking from Mossel Bay and is currently in a poor state of repair (more than half of the roads in the Eastern Cape are considered to be in a fair to very poor condition) (Kannemeyer, 2014). The R61 provides access between Beaufort West to Aberdeen/Graaff-Reinet, as well as Port Elizabeth Harbour/Coega and the inland areas of the Eastern Cape. This route will probably attract much of the equipment transport as Port Elizabeth is the nearest port to the area (this is also the most likely route for the transport of hazardous waste out of the area), with the N2 to Cape Town being the other alternative route likely to be used.

Construction material already has to be trucked in from outside the area (Theron, 2016). The ongoing identification and permitting of approved gravel pits will start to increase significantly during this stage. The road network provides a good level of connectivity when maintained. During this phase it is not expected that any significant deterioration of roads will be noticeable. However, to mitigate against any rapid decline in the subsequent phases, it is likely that greater emphasis will need to be placed on upgrading and the rehabilitation of specific routes, the N12 being of particular concern, as well as regular high quality maintenance of the existing road network (Central Karoo District Municipality, 2013). Demands on the prevention of overloading and general traffic enforcement are likely to increase in line with greater heavy vehicle traffic volumes.

Action required with respect to decommissioning will entail ensuring that roads are in at least the same or better state than in the Reference Case; pointing once again to the importance of baseline surveys to establish current state in order to apportion cost and responsibility for repair should roads be damaged. No additional regional roads are expected to be built.

Small Gas: As exploration is extended and more equipment is brought into the area, the heavy vehicle load will increase, increase somewhat with an estimated further 25 additional vehicles per day for a 35- 40 year period, thereby placing even greater strain on the roads, and with that an increased

requirement for maintenance (see Burns et al. (2016) for estimated vehicle and trip volumes). This increased demand on financial resources, as well as natural resources in terms of water, crushed stone, concrete and asphalt and the right quality of natural gravel will require increased applications for new gravel pits and quarries. This process is already quite time consuming and expensive, leading to maintenance delays. As a key freight route for South Africa the impact of large construction vehicles and equipment on the N1 road can increase the risk of accidents, spillage of hazardous materials and congestion. A further concern is the pressure on key routes to the coast (Port Elizabeth, George, and Mossel Bay), especially so the pressure on several mountain passes with sharp bends and steep grades along the route. This will all contribute to rapid deterioration of the aging road infrastructure and increased congestion on the national and regional routes with limited opportunity to divert any freight to rail, due to the a) size of equipment, and b) the relatively poor location of the main rail lines in relation to the identified likely extraction areas.

Actions required with respect to decommissioning will be to ensure that roads are in at least the same or better state than in the Reference Case; pointing to the importance of baseline surveys to establish cost and responsibility for repair should roads be damaged. No additional regional roads are expected to be built (based on Burns et al., 2016).

Big Gas: With full SGD, the impact will continue to increase due to production phase requirements, together with the extension of wells and wellpads. It is expected that there will be an addition of 160 heavy vehicles per day on the regional network for the period of 35- 40 years (Burns et al., 2016). Regional roads will be under more pressure and deteriorate rapidly under these large increases in heavy traffic, requiring significant maintenance at best but, more likely, because of their ages, extensive rehabilitation and improvement. At this stage, the age of the road network will also become critical and substantial road reconstruction will be required. This will be associated with greater planning, management, construction, tendering and project management requirements, the majority of these being outsourced. This will also increase the demand for water and construction material. The development, maintenance and upgrading of roads to address increased traffic will also require increased financial and human resources. The more traffic generated, the shorter the lifespans of certain roads within the existing regional road network will become, and the more funding will need to be dedicated to maintenance and repairs. Invariably, as the major routes deteriorate and are not adequately maintained (commonly noted in South Africa as a result of constrained budgets), traffic will move to alternative (but longer) routes, enlarging the network that will suffer increased deterioration.

Actions required with respect to decommissioning entail that roads are left in at least the same or better state than in the Reference Case; pointing to the importance of baseline surveys to establish cost

and responsibility for repair should roads be damaged. No additional regional roads are expected to be built.

18.2.3 Settlement development and service delivery implications

Within the study area, the towns of Beaufort West, Graaff-Reinet, Middelburg, Colesberg and Cradock provide different regional service functions in the broader study area, housing the bulk of the population (Burns et al., 2016; stepSA Town Growth Profiler, 2013) and acting as regional hubs in relation to retail, manufacturing, as well as community and government services economic activities (stepSA Town Growth Profiler, 2013; Burns et al., 2016) in the region. As in the rest of the country, these type of towns are also experiencing the impact of increased concentration of population in rural areas, marked with the highest growth rates in terms of population and households during the 1996-2011 era both due to natural growth, as well as townward movement – a trend which is most likely to continue (Van Huyssteen et al., 2013b). Given that more than one fifth of the population in these towns are households living in poverty and that these towns are facing 1) a relative decline in working age population, 2) a decline in formal economic production (stepSA Regional Profiler, 2016), 3) increased levels of socio-economic vulnerability (Atkinson et al., 2016), and 4) the constitutional provision of the right to municipal services, municipalities are under increasing pressure for sustainable basic and social service delivery while straddled with limited human and financial resources. While the average population growth rate for all towns in the area was quite low (calculated at a mere 1% between the 1996 and 2011 census years), the bigger towns in the area have experienced a 1.6% growth average during this time (stepSA Town Growth Profiler, 2016). While this growth is not high compared to the average population growth (1.8%) in similarly-sized towns in the country as a whole (Van Huyssteen et al., 2013b) it still has subsequent implications on the increase in demand for housing, access to water, electricity and sanitation, as well as resultant implications for local amenities (parks, sports and recreation), social services (health care, education, home affairs offices, etc.) and associated facilities.

Based on calculations in Burns et al. (2016), the estimation of staffing requirements and resultant potential population increase and settlement implications for households under various unconventional gas exploration and production scenarios is set out in Table 18.3. The required staffing includes local staff and estimates for construction and on-site security staff (Van Zyl et al., 2016).

Table 18.3: Estimated direct settlement implications associated with SGD in the study area/Karoo Region.

Scenario	Highly Skilled Professionals (mostly non-local)	*Skilled and Unskilled – Direct and Indirect (Construction, Security and other) (mostly national skilled and local unskilled)	** Associated Migration Pressures	Town-based settlement implications	On-site settlement implications
Exploration Only 8 years	1 025 professionals (725 expat and 300 national experts estimated). Not necessarily permanent residents within the area, around 50% might commute in on weekly basis, on average small household sizes (single professionals, and or experienced expats not relocating families). Indirect job and enterprise opportunity could extend the number of professionals/highly skilled jobs.	675 direct jobs and a total of 1 100 direct and indirect jobs. Assuming that job opportunities will mostly be filled by existing residents and that provision for on-site and/or construction camp accommodation will be for certain percentage of local staff, while families and extended households of local staff will remain in existing housing in towns.	While jobs are highly limited and local job creation is prioritised, historic examples of in-migration associated with mining and other development (i.e. Saldanha Steel) in Northern and Western Cape towns, show that in-migration can be expected to increase the pressures on housing and service delivery especially in the so-called Service Towns (See Figure 18B(ii) in Digital Addendum).	High income households: Increase demand for rental accommodation in Service Towns. Limited high-income property development. Increased need for lower-income and subsidy housing. Increase bulk and basic service provision, which is primarily a municipal responsibility.	Construction of temporary and semi-temporary accommodation and sustainable on-site service provision. Largely a developer-responsibility.
Small Gas 25 Years	90 ore permanent residents within the area (60 expat and 30 national experts). Estimated that around 20% of the workers might commute in, on average small household sizes (single professionals, and or experienced expats not relocating families).	210 direct jobs and total of 420 direct and indirect jobs. Challenge will be the reduction in on-site and/or construction camp accommodation with resultant pressures on local towns. Families and extended households of local staff will remain in	While jobs are highly limited and local job creation is prioritised, the “word” of production and historic examples of in-migration associated with mining and other development (i.e. Saldanha Steel) in Northern and Western Cape towns, show	High income households: decrease demand for rental. Increase but limited high income property development (possible high security and alternative energy clusters for longer term accommodation need). Increased need for lower-income and subsidy housing	On-site development limited to staff required to stay on the wellpad i.e. security staff, or staff in temporary camp. Maintenance of temporary and semi-temporary accommodation, and sustainable on-site service provision.

Scenario	Highly Skilled Professionals (mostly non-local)	*Skilled and Unskilled – Direct and Indirect (Construction, Security and other) (mostly national skilled and local unskilled)	** Associated Migration Pressures	Town-based settlement implications	On-site settlement implications
	Indirect job and enterprise opportunity could extend the number of professionals/highly skilled jobs.	existing housing in towns and staff will most likely be sourced from existing residents in area.	that in-migration can be expected to increase the pressures on housing and service delivery especially in the so-called Service Towns (See Figure 18B(ii) in Digital Addendum).	with reduction in on-site housing. Increase bulk and basic service provision, which is primarily a municipal responsibility.	Largely developer-responsibility.
Big Gas 30 Years	600 more permanent residents within the area, (400 expat and 200 national experts). Around 20% might commute in, on average small household sizes (single professionals, and possible increase in higher income households in region). Travel modes might have impacted on ease of commuting.	1 400 direct jobs and total of 2 800 direct and indirect jobs. Challenge will be the reduction in on-site and/or construction camp accommodation with resultant pressures on local towns. Families and extended households of local staff will remain in existing residents in towns and staff sourced most likely from existing residents in area.	The increase in jobs and the “word” of more extensive production together with the network attraction of people already in the area in Northern and Western Cape Town show that in-migration can be expected to increase the pressures on housing and service delivery especially in the so-called Service Towns (See Figure 18B(ii) in Digital Addendum).	High income households: substantial increase demand for rental. Increased need for high income property development (possible high security and alternative energy clusters). Increased need for lower income and subsidy housing with reduction in on-site housing. Increase bulk and basic service provision. Largely municipal responsibility.	On-site development limited to staff required to stay on the wellpad i.e. security staff, or staff in temporary camp. Maintenance of temporary and semi-temporary accommodation, sustainable on-site service provision. Largely developer responsibility. Given higher levels of activity this could imply more temporary camps.

* Given the complexities regarding road maintenance and upgrading in the Karoo region as set out above, the number of construction related staff might be underestimated. It should be noted also that most road construction companies bring their own temporary construction crews.

** The table provides an estimation of direct need and does not include a calculation of possible in-migration.

Reference Case: Existing growth in towns will most probably continue with resultant increased demands on land, housing and municipal service delivery due to normal population growth. There might be fluctuations and an increase in in-migration to the area as experienced in many other towns in resource rich areas (Van Huyssteen et al., 2013b), even before exploration phases begin given the publicity and expectations with regard to possible unconventional shale gas and uranium mining and possible Green Energy Projects in the area (see indication of current green energy project applications across the country and concentrated in the region in Digital Addendum 18B).

Exploration Only: Land development associated with SGD will largely be associated with road construction, drilling wells and wellpad construction (Burns et al., 2016), with limited on-site housing provision, as well as housing for construction workers in temporary road-side construction camps, which is likely to move around the area. A limited number of people entering with high skills levels will most likely have options to reside in larger towns such as Graaff-Reinet or Beaufort West. A percentage of these might also opt to reside in nearby centres such as George/Mossel Bay, Nelson Mandela Bay Metropolitan Municipality, or even Cape Town – travelling in and out on a weekly basis to the area, an experience well noted in exploring regional town growth drivers in the Gamagara Mining Region in the Northern Cape (Van Huyssteen et al., 2014).

Even though low-skilled employment is expected to be limited to road and on-site construction as well as security and transport activities and exploration activities are expected to take place in an incremental way, expectations regarding possible opportunities will most probably give rise to influx to the area. Especially given the high levels of unemployment, increased mobility of the South African population (Mans et al, 2014; Maritz and Kok, 2014), as well as mine closures and job losses in other parts of the country. South African experience, i.e. in the case of in-migration being associated with developments in Saldanha and various mining towns in South Africa such as Kuruman and Lephalale (Van Huyssteen et al., 2013b) echoes experiences of the international boomtown phenomena (Jacquet, 2014). Implications of possible informal settlement and increased service demand could be expected in towns in the area. Given the proposed incremental approach to exploration, the number of people and households to accommodate in surrounding towns will most probably pick up over the exploration phase.

An increase (as well as an expected increase) in the demand for rental accommodation for specialists associated with SGD activities and/or associated services as in the cases of Lephalale (North West) and Postmasburg (Northern Cape) could give rise to an increase in property values, which in turn could lead to an increase in the conversion of existing housing stock to rental accommodation and guest houses. Given the uncertainty in the exploration phase; opportunities for ‘quick wins’ in the

property market through gated community developments, land use changes or illegal sub-letting will probably arise. Associated with the above, an increase in land and other resources to cater for township extension and possible informal settlement upgrading, as well as timeous provision of social and basic services, and upgrading capacity of bulk services (especially considering water availability and land fill sites) can be expected.

While this scenario refers to a case of limited resource find and an exit after the exploration phase, it would most probably not have a huge effect on the highly skilled professionals and skilled (expat and national employment) workforce who would have been commuting and largely making use of rental accommodation. Many local employees and people that might have migrated to the area in the 'hope' of work will most probably not have alternative options. While town economies might experience fluctuation of growth and then decline during this time, the footprint of town growth (private sector and government), as well as the expected increase in the indigent population associated with migration will most likely remain. This scenario might entail that local economies and enterprises use the opportunity for growth and diversification, or that municipalities are left with an unsustainable service delivery and financial burden.

Small Gas: Growing demand for service delivery in service towns due to influx of job-seekers, a growth in formal activities, and an additional influx in Beaufort West which will most likely be developed as a local logistic hub to support operations. Expansion of wells, wellpads and thus on-site settlement could be expected. Continued exploration, as well as the increased need for higher quality road construction to address the needs within a production scenario, and the likely need for resurfacing, sealing and on-going maintenance will also sustain the need for construction related activities and camps in the area. While job creation in the construction sector and on-site on wellpads could contribute to local economic development, it is foreseen that large portions of households in towns will still be dependent on government grants and local economies will still be largely dependent on the government service sector, with subsequent spatial implications of growing informal settlements, coupled with an increased demands for social facilities and 'boomtown' characteristics without the market-related development that necessarily accompanies it. The prospect of dual economies in these towns of 1) grant-dependent and 2) shale and associated industry workers is likely. Given limited production activities in the Small Gas scenario and decommissioning without extensive production, the implication for small towns of 'losing' high skilled residents and experiencing a semi-permanent professional in-flux on a regular basis during the time period, and out-migration afterwards, might actually result in an over-supply of housing, rental accommodation and services, with severe implications for property prices and the municipal rates base.

Big Gas: Growing demand for service delivery in service towns due to an influx of job-seekers, a growth in formal activities and an additional influx in Beaufort West, which will most likely act as logistical hub in support of production is foreseen. This will have implications of informal settlement growth, service demand and associated unintended consequences, especially within larger service towns. The impact of demand for water and sanitation, landfill facilities, social facilities, etc. resulting from scattered settlement on the wellpads during the production phase will most likely continue. In this scenario, a larger impact on town growth can be expected with household growth and associated demand due to longer-term job opportunities for higher skilled workers and less uncertainty in the property market associated with production versus exploration phases. While job creation in the construction sector and on-site on wellpads could contribute to local economic development, it is foreseen that large portions of households in towns will still be dependent on government grants and local economies will still be largely dependent on the government service sector, with subsequent spatial implications of growing informal settlements, an increased demands for social facilities and ‘boomtown’ characteristics without the market-related development that necessarily accompanies it. The prospect of dual economies in these towns of 1) grant-dependent and 2) shale and associated industry workers is likely.

Given the extensive production activities in the Big Gas scenario and decommissioning taking place only after extensive production, the implication will most probably be severe. With decommissioning after the time period of extensive production it is quite probable that towns will be ‘losing’ highly skilled residents and semi-permanent professionals. Given the longevity of this scenario and the most likely influx of employed, entrepreneurs and job-seekers into the area during the time, as well as the establishment of a more diversified economy, the impact of decommissioning will most likely be felt not just locally, but also in direct and indirect ways in the regional economy. The cost of managing the towns and infrastructure will remain with the municipality (as also set out in the other scenarios), with mitigation only being possible in sustainable ongoing settlement development, which may be problematic should there be significant declines in the local economy

18.2.4 Spatial and development planning, land use management and governance implications

Integrated development planning and spatial coordination and alignment has proven difficult in South Africa, despite the Constitution and legislation such as the Municipal Systems Act 32, 2000, and SPLUMA expressly calling for it. The culmination of many small-scale and scattered land use applications, development and incremental operations will most likely have major impacts on towns and municipal governments. Municipalities and government as a whole needs to be prepared to consider and guide potential SGD and associated downstream developments.

The South African planning system provides for a range of planning instruments and processes to enable multi-agent coordinated prioritisation, budgeting and implementation in regional and municipal SDFs, IDPs as well as service delivery and infrastructure plans within the five year municipal planning cycles (Figure 18.4) and resultant annual investment and implementation priorities. The possibility of SGD, as well as other potential regional development activities such as uranium mining and renewable energy resource developments in the study area, would require timeous planning for various development scenarios within the range of relevant medium term spatial and integrated planning instruments. Such spatial planning instruments create the conditions conducive for municipal preparedness to consider formal private sector driven applications for land use change (i.e. by mining companies, and/or private land developers in towns) but also to be prepared to address potential increase in service demands due to increased traffic and activities in the area, and/or potential in-migration and increase in population numbers in towns and associated service delivery needs.

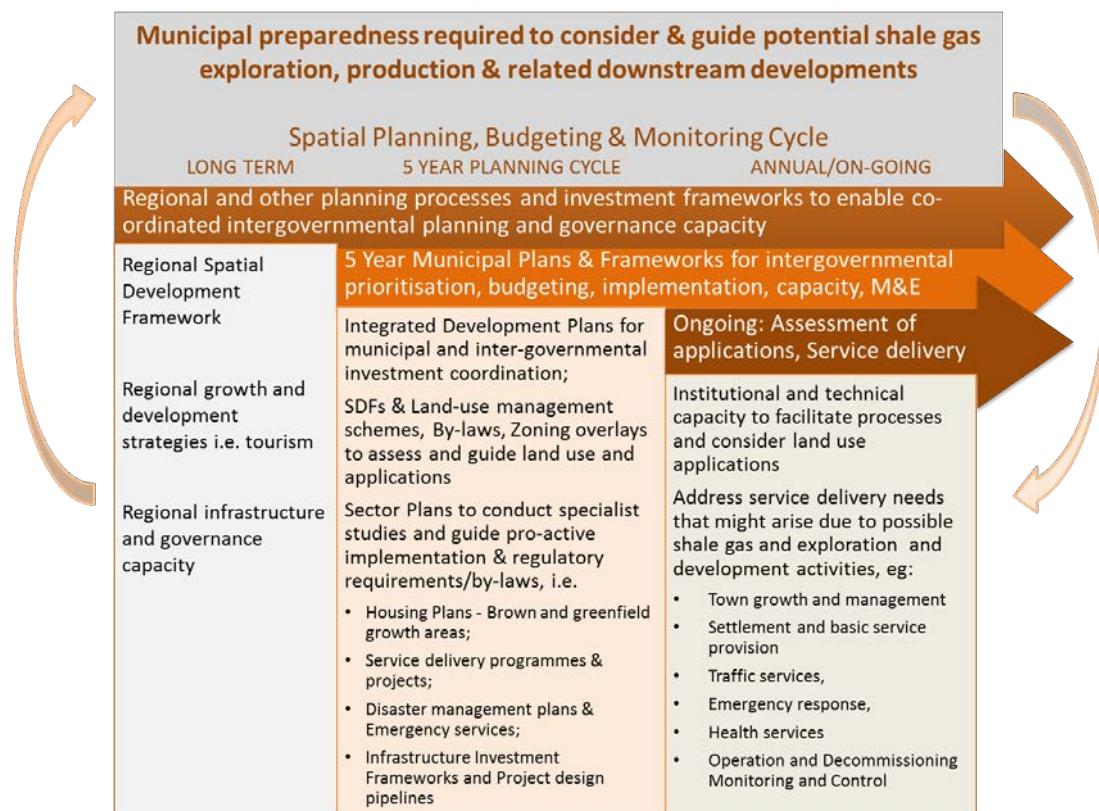


Figure 18.4: Municipal preparedness required to consider and guide land use applications and impacts related to potential SGD, and related downstream land developments and service needs.

While the envisaged SGD activities may have a positive impact on municipal and provincial financial viability and capacity and add money to the national fiscus, it will also have impact on investment, upgrading, expansion and maintenance service costs. An example of municipal services that are directly and indirectly impacted upon due to possible unconventional SGD campaigns under the

respective scenarios would be investment, upgrading, expansion, maintenance and regulation of roads, and a need for expanded emergency services and environmental management (as noted in the Central Karoo Integrated Transport Plans of 2005, 2009 and again in 2013). The need for enforcement to enhance traffic safety especially on the N1 and reduce damage to roads through overloading has been identified as an issue in need of attention. While emergency incident response is critical and demands are far in excess of that required by the local population and locally generated traffic, the movement and parking of heavy freight vehicles passing-through towns, already creates traffic management demand in towns such as Beaufort West that largely act as a regional gateway. Development contributions related to impact on infrastructure and services will need to be considered.

In the same vein, the expected incremental but on-going land use and land development applications associated with well establishment through the different phases of SGD as represented by the respective scenarios for exploration and production will require additional resources and capacity in terms of the administration of regulatory processes – placing severe strain on authorities in all spheres of government.

In relation to each of the scenarios described below, it is important to recognise, as noted in Section 18.1.5 above, that the entire land use regulatory system is in a process of change, new laws are being developed, new institutions established and new regulatory instruments are being developed. Consequently, even the slightest change in current resource and land use patterns will pose significant challenges in the context of regulatory processes and environmental and spatial planning.

Exploration Only: The exploration activities will require various types of land use change applications. It will also require applications for mining to the Department of Minerals and Resources (DMR) after consultation with the competent authorities including the Department of Environmental Affairs (DEA). In the case of the applications for exploration infrastructure, primarily on farmland, this entails both a municipal decision to be taken by the Municipal Planning Tribunal regarding a land use within a land use zone that is probably zoned for “Agriculture”. Decisions will also have to be taken around mining rights and environmental aspects in relation to mining and environmental legislation. Within the built-up areas, there may be some limited land use changes which are unlikely in this scenario to represent significant challenges. It is in the more rural areas where the capacity constraints in government are most deeply felt and where the deepest challenges lie. There might be difficulties in processing land use applications in a reasonable time period, as well as enforcing and monitoring decisions. The need to support municipalities in their adaptation to the new regulatory environment will be stronger in the Eastern and Northern Cape Provinces, given that LUPA provides more legal clarity in terms of land use and land development application processes, and that the Western Cape Province currently seem to have more capacity to support municipalities in this process.

With decommissioning, the relevant obtained land use rights will remain in place and wellpads will be rehabilitated as far as possible, adhering to relevant regulations pertaining to the sealing of drill heads (Burns et al., 2016). Unpaved and paved local access roads on private land will most probably just remain inactive as rehabilitation of road surfaces in the Karoo is problematic. Monitoring and control of sealed drill heads and wellpads (as in the case of derelict mining land) will require ongoing expertise and resources.

Small Gas: The intensity of the SGD activities described in relation to the Exploration Only scenario obviously increases in the Small Gas scenario. The pressures on municipal systems and processes become more pronounced. The processing of land use applications will very likely become complex and more challenging, with culminating implications of the incremental processes. While government has to respond to the needs of the private sector through policy development and the administration of regulatory processes (embedded), government must retain its independence (autonomy) and must not be captured by the vested interests of private sector. Care must therefore be taken in ensuring that governance systems assign accountability to decision-makers as required in terms of the relevant legislation and are open and transparent. The need for national and provincial government to support municipalities in their adaptation to the new regulatory environment will become stronger in this scenario.

With decommissioning, the relevant obtained land use rights will remain in place and wellpads will be rehabilitated as far as possible, adhering to relevant regulations pertaining to the sealing of drill heads (Burns et al., 2016). Unpaved and paved local access roads on private land will most probably just remain inactive as rehabilitation of road surfaces in arid regions such as the Karoo is problematic. Monitoring and control of sealed drill heads and wellpads (as in the case of derelict mining land) will require ongoing expertise and resources. Possible fluctuations in the economy might result in excess housing stock or out-migration of people and enterprises.

Big Gas: This scenario will be characterised by increased exploration activities (i.e. a higher intensity of exploration), the establishment of production wells and significant downstream developments. The intensification of these development activities will result in a significant increase in regulatory applications and demands for services (and service delivery) in all spheres of government. In particular, the ongoing and cumulative impact of increased land use and land development applications will put significant strain on the less capacitated municipalities (Department of Cooperative Governance and Traditional Affairs (CoGTA), 2014). Without the support from national and provincial authorities, it is anticipated that these under-capacitated local municipalities will struggle to adequately deal with the regulatory decision-making burden associated with this scenario. The challenge in this scenario lies in the work that the municipalities will need to do to scale up their

overall planning and management capacity to guide and coordinate the development that will flow from the now significantly increased economic activity, and related social and environmental changes in their municipal areas.

It is expected that after the first five to eight years of exploration activities, in the course of this scenario, land use management within the Western, Eastern and Northern Cape Provinces will become aligned and that experience on the one hand, and more legal clarity in terms of land use and land development application processes on the other, will eventually support more streamlined approval processes. It will be critical in this scenario to plan for and manage the cumulative impact of site specific land developments and land uses associated with SGD. Given that the Big Gas scenario will result in a significant increase in regulatory applications it will require additional resources at all spheres of government.

With decommissioning, the relevant obtained land use rights will remain in place and wellpads will be rehabilitated as far as possible, adhering to relevant regulations pertaining to the sealing of drill heads (Burns et al., 2016). Unpaved and paved local access roads on private land will most probably just remain inactive as rehabilitation of road surfaces in the Karoo is problematic. Monitoring and control of sealed drill heads and wellpads (as in the case of derelict mining land) will require ongoing expertise and resources.

Possible fluctuations in the economy through or at the end of the production phase might at some stages result in excess housing stock or out-migration of people and enterprises. Evidence from the Northern Cape suggests the danger in complete ‘draining’ of population and enterprises in smaller local towns (Van Huyssteen et al., 2014) and the role of bigger towns in providing access to government services to communities that are dependent on government grants and faced with high rates of unemployment.

18.3 Risk assessment

Risks and opportunities are usually measured against a baseline or at least considering what is ‘normal’. While some risks and opportunities are measurable to an extent, others might be more qualitative and probabilistic in nature. The wide range of aspects addressed in the Chapter on land, infrastructure and settlement development imply that key risks and opportunities are measured and explored in highly diverse ways, as summarised in Table 18.4 and set out in more detail for key impact areas below.

18.3.1 Measuring and highlighting key areas of risk

Table 18.4: Measures of risks, opportunities and limits of acceptable change.

Key risk area	Measuring risks	Limits of acceptable change
Local road construction and resource implication.	<ul style="list-style-type: none"> • Traffic volumes: Vehicle use per day. • Longevity – Intervals for upgrading/maintenance/reconstruction. • Construction material requirements and costs. • Maintenance requirements and costs. • Water requirements and standards regarding salinity. 	<p>Experience is that resources and capacity to maintain and build roads are currently constrained and thus any further increase in maintenance requirement would be unacceptable unless fully financed by the developers- the latter could be difficult to apportion fairly and must be negotiated prior to development.</p> <ul style="list-style-type: none"> • Increase in normal maintenance cycle for a gravel or paved road to less than six to ten years (little water required here). Any change in this norm is the limit of acceptable change. • Increase in the maintenance costs beyond the existing cycle. • Reconstruction (significant water required here) occurs every 20-30 years and change in this norm is the limit of acceptable change. • More finance required than available in relative provincial and local budgets (through proportional contributions by developers).
Regional road infrastructure and networks.	<ul style="list-style-type: none"> • Freight volumes: Vehicle and tonnage per day. • Longevity – Intervals for upgrading/ maintenance/ reconstruction. • Distance to haul hazardous waste and fracking liquid. • Road safety. 	<ul style="list-style-type: none"> • Increase in current maintenance budget requirement and cycle. • Increase in the maintenance costs beyond the existing cycle. • Reconstruction (significant water required here) occurs every 20-30 years and change in this norm is the limit of change since water is a scares resource in the area (Hobbs et al., 2016). • Any additional budget requirements as budgets are already constrained. • Increase in accidents and road deaths above current levels.
Settlement development and service delivery needs.	<ul style="list-style-type: none"> • Households in need of housing and free basic services (backlog). • Demand for (alternative) housing – rental, high income. • Resource availability: Sustainable service delivery (availability, cost, access to and resource 	<ul style="list-style-type: none"> • Average town growth over last two census periods is the norm; an increase in town growth has major implications for land, service delivery and resources. • Increase in housing and service delivery backlog. • Above average growth in informal – green fields or ‘backyard’ settlement.

Key risk area	Measuring risks	Limits of acceptable change
	<p>implications for water/sanitation/energy provision/spatial form & maintenance).</p> <ul style="list-style-type: none"> • Capacity and accessibility to social and municipal services such as education, health, sport facilities, land fill sites, etc. respond to number and location of users. • Number of indigent population, and percentage of indigent population to total population. • Rates and taxes, service payments. • Increase in service delivery needs in the region. • Number and growth in enterprises, employment, GDP/capita, inequality. • Sustainable Development Goals (where relevant). 	<ul style="list-style-type: none"> • Increase in operation and service cost, with increase in budget deficits (Increase in percentage indigent population within the municipality; increase in service delivery needs in the region; decrease in municipal revenue due to rates and taxes; limited access to grant and other funding; limited mitigation measures for alternative resourcing). • Increase in the demand for water and other bulk services beyond the planned delivery targets, or when the demand exceeds the projected resource availability and bulk infrastructure capacity. • Capacity and accessibility to social services and municipal services such as education, health social services and sport facilities, land fill sites, etc. respond to existing and projected demand. • Increase in inequality as measured by the average for the Gini-coefficient in the relevant regional and provincial context.
<p>Spatial and development planning, land use management and governance capacity implications.</p>	<ul style="list-style-type: none"> • Relevant and well capacitated role players involved in key planning processes. • Governance capacity for planning, implementation, monitoring, control. • Long term plans with scenarios, projections and alternative mitigation options. • National government project specific investment considering local realities and future. • Number and size of applications for land use change; EIAs, etc. • Capacity to facilitate administrative & decision-making processes. 	<ul style="list-style-type: none"> • Forward planning (IDP/SDFs) – the existence of a credible SDF (based on existing growth rates) must be seen as the norm, and any anticipated demands for development and services not catered for in the SDF must be regarded as beyond the limits of acceptable change. • Regulatory framework and administration – legal certainty must be regarded as the acceptable norm (i.e. the existence of an appropriate regulatory regime and the capacity to implement it). The minimum municipal planning bylaws needed for most municipalities should be expected to be promulgated. • Consideration of projected and cumulative impact of separate but inter-related land use changes and developments should be standard practice at a regional level. • Skills development for municipalities must be seen as the norm, e.g. as required to fulfil their mandates, do long-term planning and give expression to their plans.

Local road construction and resource implications: The exact implications of increased traffic are difficult to estimate, as they depend on the level of existing traffic and base line traffic volumes are not available for all unpaved roads. It is unlikely that any predetermined limit can be set on the construction of infrastructure reconstruction volumes or indeed traffic volumes as it is always possible to maintain and build roads and increase road volume and safety features of a network in this sparse environment. It is currently not restricted by development or availability of undeveloped land for construction. The real limiting factors will be the availability of the financial and management resources available, as well as access to raw materials. The increase that will be measured will thus not be in terms of a percentage increase over existing traffic but a fixed traffic volume. In other words, as indicated in the previous Section, the traffic on a local gravel road currently carrying 30 heavy vehicles per day may increase by 30 to 50 heavy vehicles, probably reducing the interval between re-gravelling from ten years to six years. The impact of the same 30 to 50 vehicle increase on a road currently carrying 200 vehicles per day may decrease the re-gravelling interval from six years to perhaps four or five years.

It is essential that the status quo on the existing roads is identified, i.e. remaining life, problem areas, bridge conditions and problems, and that the status quo is maintained or improved. Any rapid deterioration of road quality above the current trend would not be acceptable. Neither would an increase in overloading, speeding or accidents be tolerated. Currently identification of the status quo of assets is a national requirement in terms of the Road Infrastructure Asset Management Policy that has been implemented down to provincial level, and is being implemented at local government level. This information will provide a base scenario (perhaps with some additional data collection related to specific areas or problems), which can be used to evaluate any accelerated deterioration, particularly if the assessment records extend back for a few years. Where pavement condition data is not available or up to date, this should be collected prior to initiation of any exploration or production.

Capacity and lifespan of regional through-routes/logistic corridors: The reduction in lifespan of any road by more than three to five years will significantly increase the demand on the national and provincial fiscus and burden the already over-burdened and onerous maintenance and upgrading programme.

The majority of damage to roads is done by vehicles with axle loads in excess of 80 kilonewtons (kN). However, there is evidence to indicate that this varies with the type of pavement structure – deep natural gravel pavements undergo less damage, for instance, than a shallow pavement with stabilised upper layers. The increase in legally loaded vehicles (i.e. those with individual single axle masses of less than 80 kN, the current legal axle limit is 90 kN, which results in 64% more damage than an 80

kN axle) will reduce the pavement life by approximately the same percentage as the increase in traffic, i.e. if the heavy traffic (in terms of number of standard axles) increases by 10%, the road life will be reduced by 10%. However, if the number of axles heavier than 90 kN increases by 10% the reduction in life is reduced by considerably more than 10% (typically the ratio of the actual mass to the standard design mass (80 kN) to the power 4.2).

Settlement development and service delivery needs: Growth and development of towns and settlements is a natural and generally progressive phenomenon which should not be limited unduly if well planned, executed and sustainable. Given the small size of towns and the current availability of vacant land, it would be difficult to set a limit on any well planned growth. The key limiting factor would be to ensure that informal growth and development is limited and that township and settlement formation is restricted to areas directly adjacent to the current built-up area. The major restriction on development can only be seen to come in the form of the availability of the financial and management resources to develop and service new human settlements. Limits on available water supply to support increased settlement formation will need to be considered in implications on water resources.

Construction material and resources: Unpaved roads will typically require about 1 200 m³ of construction material per layer per kilometre of road and depending on the existing site conditions, anything from one to three layers of material may be required for a new road. Under normal use the upper 150 mm of this material would require replacement every six to ten years. As long as raw materials can be sourced from local borrow pits, etc. at a reasonable cost, it is unlikely that any limits to change can be imposed.

The same applies to paved roads, where similar volumes and layers are required. However, the width is normally a little larger and the material quality in the upper layers and bituminous surfacing is significantly higher (usually crushed stone), making the location of the materials more difficult but not limiting, the haulage somewhat longer, and the actual cost of the materials significantly higher. Access to water for construction may be a limiting factor, as typically 84 m³ (84 000ℓ) per layer per km will be required and needs to be sourced and hauled to site. Unpaved roads will typically cost about R 350 000 to R 500 000/km to construct and about R 40 000 to R 75 000 /km per year to maintain while paved roads are most likely to cost from R 2.5 million to about R 5 million/km to construct. The road authority would need to prepare budgets and procure funding for this. If the national and provincial budget allocations can be increased though, for example, taxes on shale gas, and loans, it would not pose a technical limitation.

Land use management regulatory bottlenecks: In the absence of comprehensive mitigation measures to develop land use management and spatial planning instruments, relevant institutional and municipal capacity (including for example Municipal Planning Tribunals) there will most likely be severe regulatory bottlenecks and challenges with effective assessment of applications.

Legal clarity and inter-governmental collaboration: SGD is new in South Africa. It was only recently that the courts pronounced on the legal channels that had to be followed and satisfied when applying for mining rights. In *Maccsand (Pty) Ltd versus City of Cape Town and Others*, Case No.: CCT 103/11 [2012] ZACC 7 (12 April 2012), the Constitutional Court made a clear distinction between 1) mining and 2) land use and spatial planning legislation, and ruled as follows: While the MPRDA is concerned with mining, the LUPO (1985) in the Western Cape Province (subsequently replaced by SPLUMA and LUPA) governs the control and regulation of the use of all land. These laws (mining-related on the one hand, and spatial planning and land-use related on the other) serve different purposes within the competence of the spheres of government charged with the responsibility of administering them: While the MPRDA governs mining, LUPO (now SPLUMA and LUPA) regulate(s) the use of land. However, the exercise of a mining right granted in terms of the MPRDA is subject to LUPO. An overlap between the two functions occurs due to the fact that mining takes place on land. This overlap does not constitute an impermissible intrusion by one sphere into the area of another, because spheres of government do not operate in sealed compartments.

There is nothing in the MPRDA suggesting that LUPO ceases to apply to land upon the granting of a mining right or permit. By contrast, Section 23(6) of the MPRDA proclaims that a mining right granted in terms of that Act is subject to it (i.e. LUPO) and other relevant laws. The implication of this pronouncement is that, while permission may be granted to mine, mining cannot take place until the land in question is appropriately rezoned. The South African constitutional order provides that one sphere of government or organ of state may take a decision whose implementation may not take place until consent is granted by another sphere of government or organ of state within whose area of jurisdiction the decision is to be executed. Each organ/actor and/or piece of legislation is concerned with different subject matter. If consent is refused in the case of a rezoning, it does not mean that the approval granted in the first decision (the granting of a mining right) is vetoed.

The authority from whom consent was sought would have exercised its power, which (power) does not extend to the power of the other functionary. This is the case, despite the fact that the effect of the refusal in those circumstances would be that the first decision cannot be put into operation. This difficulty may be resolved through cooperation between the two spheres of government or organs of state from the beginning of the desire to mine and lodge an application regarding the use of land. The

option of course also exists to challenge the refusal through an appeal process or by taking it on review. The preferred option would of course be that of intergovernmental collaboration. In the second case, *The Minister for Mineral Resources versus Swartland Municipality* (12 April 2012), which was heard together with *Maccsand versus The City of Cape Town*, the judge concurred that a party who is granted a mining right or permit in terms of the MPRDA may start mining operations only if the zoning of the land in terms of LUPO permits it (*Maccsand (Pty) Ltd versus City of Cape Town and Others* [2012] ZACC 7, CCT 103/11). Whatever course of action is followed, functioning intergovernmental relations and/or time are required.

Clarity of legal and implementation practices with regards to land use application for SGD phases: Notwithstanding the ongoing development of regulations and guidelines to support the transition to a SPLUMA-based system for land use regulation, SPLUMA does not provide a clear picture of how exploration and production are to be dealt with in terms of land use and land development applications and no clear implementation practices have yet been established. In general, municipal planning by-laws or LUPO (where it is still in effect) will have to guide land use applications at municipal level, taking cognisance that municipalities' zoning schemes and definitions may differ. Two major aspects that pose risks are:

- Within the current legislative context as a general guide, SGD actions could possibly be covered by a temporary departure which may have a time limit of five years depending on the municipality's planning by-laws. When production is envisaged, suitable rezoning will have to be applied for, over and above other regulatory approvals. It has to be considered that other than other mining activities, in the case of SGD, the exploration phase is actually the phase that entails the most severe land use impact in terms of wellpad establishment, as well as all the activities associated with the process of fracking (Burns et al., 2016); and
- Clarification is required as SPLUMA defines land development as the erection of buildings or structures on land, or the change of use of land, including township establishment, the subdivision or consolidation of land or any deviation from the land use or uses permitted in terms of an applicable land use scheme. A land development application could thus be interpreted as a land use application in the traditional sense of the word. SPLUMA defines land use as the purpose for which land is or may be used lawfully in terms of a land use scheme, existing scheme or in terms of any other authorisation, permit or consent issued by a competent authority, and includes any conditions related to such land use purposes. This could be related to "zoning" in the traditional sense of the word. SPLUMA appears to be using the terms "land use application" or "land development application" indiscriminately. Whereas SPLUMA as framework legislation is not clear in its distinction between "land use" and "land development", clarity can however be provided in provincial planning legislation (as in the case of LUPA) and in municipal by-laws, which implies provincial capacity, intervention and collaboration in the study area.

Legal clarity is required in SPLUMA regarding matters of National Interest: SGD be an issue of national interest. Section 52 of SPLUMA requires that a land development application which impacts materially on matters within the exclusive functional area of the national sphere in terms of the Constitution; or strategic national policy objectives, principles or priorities, including food security, international relations and co-operation, defence and economic unity; or is a land use 1) of which the purpose may fall within the functional area of the national sphere of government; 2) may be prejudicial to the economic, health or security interests of one or more provinces or the Republic as a whole; or 3) may impede the effective performance of the functions by one or more municipalities or provinces relating to matters within their functional area of legislative competence, then it may be dealt with on national level.

- In such cases where the above applies, SPLUMA states that an application should be referred to the national Minister, should an applicant believe the above to be the case in relation to his/her application, or when the Municipal Planning Tribunal is of such an opinion. When this happens the Minister has two options, he/she can either join as a party to the application (thereby in subjecting him/herself to the municipal decision in this regard) or may direct that the application be referred to him/her to decide. There is no precedent of this yet and most likely implies that an additional process and decision is required to be taken.
- Lastly on SPLUMA and National Interest, before the Minister exercises a power in terms of Section 52 dealing with national interest, he/she must prescribe a set of criteria after public consultation. This has not yet been done and it is not known when this will be done. As a result of the involvement in the SPLUMA regulations process, it appears to be a matter for later regulation and not a matter that would need to be regulated for, as a prerequisite for SPLUMA implementation.
- The above aspects could have significant implications for municipal processes, institutional capacity and expertise and collaboration between the relevant organs of the state.

Spatial and development planning and governance capacity: In the area of sustainable development planning and settlement construction and management, there are a number of key risks associated with the lack of timeous planning and institutional readiness. Should processing of mining-related applications be slow and/or be seen as being inconsistent with the principles of fair administration (i.e. fair, open and transparent), there is an increased risk of decisions being challenged (and taken on review), or even unlawful commencement of development activities. The capacity constraints with regards to planning may result in the post-1994 ideals of integration and harmonisation not materialising, leading to social instability in the towns and social cohesion suffering. The lack of long-term environmental and development planning may also result in crises management becoming the norm in government, resulting in unsustainable development outcomes.

While effective environmental and development planning frameworks are essential, the risk of avoiding unsustainable outcomes can only be avoided if government has the capacity (i.e. funding, human resources, skills) to implement these strategic frameworks and the associated regulatory processes. To avoid unfavourable investment conditions especially for local economic development, long-term planning for shale and the after-shale phase will have to pro-actively consider land use needs and spatial planning implications of, for example, more heavy vehicle through traffic, as well as potential enterprises that are typically associated with SGD such as manufacturing, vehicle and equipment repair and services, and even guest house accommodation.

Mediation of benefits from mining rights and precedent for land applications: The regulation of mining rights, the mediation between mining and other economic, social, cultural and natural activities, and the process of ensuring that affected communities benefit from mining operations in post-Apartheid South Africa is still evolving. SGD steps into this ‘still evolving and contested terrain’ as both a generically labelled “extractive industry/activity”, but also as a ‘novel/new extractive industry/activity’. Officials and elected decision-makers that will be called upon to decide on 1) land use change and land development applications for SGD, 2) considering the implications of SGD on adjacent and nearby land uses, 3) the impacts on potential/future spatial development in surrounding areas, 4) the involvement by communities in mining operations, 5) contributions to be paid to municipalities for municipal services, and 6) the possible provision of bulk infrastructure etc. will not have local precedent to tap into, and will only have international experience to turn to. The relevance of such international precedent extends beyond the (more generic) technical experience, and extends into the locally-specific/unique aspects of spatial and land use planning legislation, powers and functions of organs of state, provision, maintenance and upgrading of infrastructure, etc.

Appeals processes: Under the pre-SPLUMA systems land use decisions of municipalities could be taken on appeal to the provincial government. This option has now fallen away and each municipality needs to design and implement its own system (to the extent that this is consistent with SPLUMA and LUPA in the Western Cape Province) for hearing appeals against the decisions of its Municipal Planning Tribunal. Municipalities in the Karoo region and especially towards the eastern parts of the area, in general, have technical and professional capacity constraints. The task in supporting these municipalities to be in a position to process the land use applications that will be needed for SGD is a challenge that must be addressed by provincial governments as a matter of priority. Experience in the roll-out of renewable energy projects in this region has shown that municipal capacity is not always up to the task of processing land use applications of this scale and impact (Berrisford, 2015).

18.3.2 Risk assessment summary

Table 18.5: Risk assessment matrix

Impact	Scenario	Location (See Figure 18.3)	Without mitigation			With mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Local road construction and resource implications	Reference Case	Local access roads in the central Karoo area.	Low	Very likely	Low	Low	Very likely	Low
	Exploration Only	Most probable impact area.	Substantial	Very likely	Moderate	Moderate	Very likely	Moderate
	Small Gas	Most probable impact area with localised impact in medium probability area with likely access road linkages to Beaufort West as logistics hub.	Substantial	Very likely	Moderate	Moderate	Very likely	Moderate
	Big Gas	Most probable impact area with localised impact in medium probability area, with likely access road linkages to Beaufort West as logistics hub.	Severe	Very likely	High	Substantial	Very likely	Moderate
<p>Low – No additional increase in traffic and thus no additional maintenance required (See Table 18.3). Moderate – Increase in local road use, maintaining the frequency of maintenance at higher cost. With mitigation (i.e. better construction) the maintenance period can be maintained at the current level. Substantial – Substantial increase in traffic of heavy vehicles per day, resulting in more frequent maintenance and thus implies increased cost. Severe – In production scenario, increase in heavy traffic of up to 160 vehicles per day, increases the regularity and cost of maintenance.</p>								

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Impact	Scenario	Location (See Figure 18.3)	Without mitigation			With mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
Pressure on regional road infrastructure	Reference Case	Along major regional transport corridors with most probable impact.	Low	Very likely	Low	Low	Very likely	Low
	Exploration Only		Substantial	Very likely	Moderate	Moderate	Very likely	Moderate
	Small Gas		Substantial	Very likely	Moderate	Moderate	Very likely	Moderate
	Big Gas		Extreme	Very likely	Very high	Moderate	Very likely	Moderate
<p>Low – No additional increase in traffic and thus no additional maintenance required (See Table 18.3). Moderate – Increase in local road use, maintaining the frequency of maintenance at higher cost. With mitigation (i.e. better construction) the maintenance period can be maintained at the current level. Substantial – Substantial increase in traffic of heavy vehicles per day, resulting in more frequent maintenance and thus imply increased cost. Extreme – In production scenario, increase in heavy traffic of up to 160 vehicles per day concentrated on a few key roads which are currently in a poor condition, increases the regularity and cost of maintenance.</p>								
Demand for new settlement development and associated local service delivery implications in towns and for on-site settlements	Reference Case	Existing larger regional service towns.	Low	Likely	Moderate	Low	Likely	Low
	Exploration Only	Larger regional service towns in area with most probable impact.	Moderate	Very likely	Moderate	Moderate	Very likely	Low
	Small Gas	Larger regional service towns in the area with most probable impact and Beaufort West as logistics hub. Scattered settlement impact.	Substantial	Very likely	Moderate	Moderate	Very likely	Moderate
	Big Gas	Larger regional service towns in the	Severe	Very likely	High	Moderate	Very likely	Moderate

CHAPTER 18: IMPACTS ON INTEGRATED SPATIAL AND INFRASTRUCTURE PLANNING

Impact	Scenario	Location (See Figure 18.3)	Without mitigation			With mitigation		
			Consequence	Likelihood	Risk	Consequence	Likelihood	Risk
		most likely study area, with Beaufort West as logistics hub. Scattered settlement impact.						
<p>Reference Case: Low – Related to current growth rates and no SGD, the pressures on regional centres are low.</p> <p>Exploration Only: Moderate – Increased migration and limited job growth will imply higher than normal growth rates of regional centre.</p> <p>Small Gas: Substantial – Increased number of wellpads, construction related jobs and camps with increased in-migration expected will imply more scattered settlements through the area, increased direct and indirect activities related to SGD and associated logistics expected to impact growth in settlement and housing demand in Beaufort West specifically. Moderate with appropriate mitigation.</p> <p>Big Gas: Severe – As above with increased indirect settlement and land use implications for housing, enterprise development and informal growth. Moderate with appropriate mitigation.</p>								
Spatial and development planning, land use management and governance capacity	Reference Case	Within all relevant municipalities, provinces and national departments in the study area	Moderate	Very likely	High	Low	Very likely	Low
	Exploration Only		Extreme	Very likely	High	Moderate	Very likely	Moderate
	Small Gas		Severe	Very likely	High	Moderate	Very likely	Moderate
	Big Gas		Severe	Very likely	High	Moderate	Very likely	Moderate
<p>Reference Case: no additional pressure for land use applications, however given current lack of capacity the consequences are expected to be moderate without mitigation and low with mitigation applied.</p> <p>Exploration Only: pressure for land use applications will increase, not only in terms of numbers, but also in terms of the complexity and the number of decision-makers involved. The consequences are expected to be extreme as there is no precedent, complexity of regulatory framework and current capacity constraints. The consequences are expected to be moderate with mitigation.</p> <p>Small Gas: pressure for land use applications will also increase but given that the time period is longer, the larger numbers and complexity as above is expected but can benefit from lessons learned and adapting regulatory challenges. Thus, the consequences are expected to be severe. The consequences are expected to be moderate with mitigation.</p> <p>Big Gas: the pressure for land use applications will increase exponentially due to production requirements, as well as expected land use change and growth in settlements. Thus, the consequences are expected to be severe. The consequences are expected to be moderate with mitigation.</p>								

18.4 Mitigation guidelines and monitoring requirements

18.4.1 Pro-active and integrated planning, prioritisation and budgeting

Inter-governmental Regional Planning: When considering the unique and cumulative (positive and negative) implications of the growing renewable energy market, the potential establishment of an uranium mine and SGD in the study area and the wider Karoo Region, it is proposed that the IGRFA, and the SPLUMA be used to enable the preparation of a Regional Spatial Development Framework (RSDF) for the area. It will also facilitate pro-active, coordinated intergovernmental planning between the respective local and district municipalities, provinces and relevant provincial, national sector departments, communities and business (including the Karoo Parliament), as well as other relevant institutions and state owned enterprises (such as ESKOM, the South African National Roads Agency Limited (SANRAL), SANRAIL, the South African National Biodiversity Institute (SANBI)) active in the area. Such an RSDF should 1) be aligned with the relevant Provincial Spatial Development Frameworks (PSDFs) and Municipal Spatial Development Frameworks (MSDFs), 2) systematically consider the status quo and existing guides and proposals for the area, as set out in relevant national, provincial and municipal plans, strategies, policies and frameworks, 3) make provision for a variety of futures, 4) craft a desirable future for the region, 5) allocate roles and responsibilities to the different spheres and sectors of government active in the area, and 6) be prepared in a consultative and collaborative manner under the auspices of the forum. It is expected that the forum will actively pursue continuous and meaningful engagement with civil society representatives, including representatives from existing and potential business interests in the area.

The RSDF and associated processes will address highly diverse, specialised and possible fluctuating governance, service delivery and capacity needs and challenges, as well as enable ‘inter-governmentally aligned’ responses from the magnitude of targets, plans, budgets, investment frameworks and projects driven by various sector departments and spheres of government in the area (see Figure 18.4). The development of a RSDF will provide a relevant medium term planning framework for five year municipal planning cycles, as well as timeous planning for projected demands and implications to ensure preparedness in terms of settlement, infrastructure and land development pipelines. In this way, government will be able to provide clear and consistent guidance and the required investment support to private sector and other development agents with regards to development for which very little if any president and/or capacity exist within the Karoo (and the rest of South Africa). The RSDF can inform national infrastructure investment and development spending programmes and schedules, the PSDFs of the affected provinces, and the MSDFs of the affected municipalities.

Essential long term spatial and integrated planning: The challenges and potential opportunities posed by activities related to potential SGD, as well as associated downstream development, clearly illustrate the

need for sound IDP and SDF at municipal level. All spheres of government should participate in municipal IDP processes with SDFs providing guidance, as well as a spatial reflection on how, when and where all organs of state are to dispose of their budgets (i.e. planning led budgeting).

- Municipal IDPs and SDFs should be developed within the context of the RSDF, where the implications of demand modelling and projections of potential regional development, as well as likely town growth and decline and possible associated downstream development implications within the respective municipalities should be determined. For SDFs to play this role, it is critical that municipal SDFs be updated to cater for large scale development (such as SGD, uranium mining or expanded renewable electricity developments) and to inform the reprioritisation of budget allocations where and if required. In order to mitigate for this, provincial support to municipalities is essential. For coordinated spatial and delivery planning, local projects have to be planned in the context of regional and local SDFs and IDPs, as well as relevant sector plans (i.e. Plans for Housing; Disaster Management Plans; Integrated Transport Plans, etc.) to ensure timely provision for upgrading of the roads, as well as other infrastructure (rail and gas pipelines), housing, social services, etc. See also implications of potential SGD as identified within this assessment for example on tourism (Toerien et al., 2016), economic development (Van Zyl et al., 2016), enterprise development and social fabric (Atkinson et al., 2016).
- Given the infrastructure pipeline and associated time lines, the adaptation of sector plans is a crucial mitigation factor required for the planning, environmental clearance, land expropriation where necessary, design and procurement of new infrastructure, before construction starts. Examples include the need for applicants for unconventional shale gas exploration to develop a fluid transportation management plan to at least ensure planning to minimise fluid transport movements and distances, and the implementation of management procedures to address the risks associated with fluid transport – i.e. any transport of fluids must be in accordance with relevant legislation and national standards in a manner designed to prevent spillage.

18.4.2 Regional infrastructure network options

Mitigation and avoidance: One of the problems with road planning and maintenance in South Africa is that the jurisdiction over roads falls under several different authorities, each with its own competence, resources and prioritised budgets and implementation plans. For example, the N1 national route is managed by SANRAL, the N12 section within the Western Cape is managed by that province, R routes are managed by the respective provinces which they traverse, provincial authorities in various degrees provide support for local municipalities or even undertake road maintenance on their behalf especially of inter-town district and regional roads, district roads in the Western Cape are managed by the district municipalities' technical roads departments, and local roads are the responsibility of the respective local municipalities.

Railway: Continued use of a rehabilitated rail network, necessary rolling stock and improved logistics management for rail will be to benefit of the country as a whole (see Digital Addendum 18B). Given that size of loads carried by rail is limited by the height of the overhead power lines on electrified tracks as well as by the dimensions of bridges and tunnels rail transport of material and equipment required for SGD will require pro-active design, planning and implementation of a mode change and distribution facility in Beaufort West.

Pipelines: The potential use of pipelines for transport of gas for distribution or processing, for removal of waste and the import of fresh water will reduce the pressure on the road network. These pipelines can be developed alongside the road within the road reserve. After decommissioning pipelines can be flushed clean and used for alternative purpose. Pipeline use for transport of water can continue to be of use to the local community.

18.4.3 Maintenance of road infrastructure

Planning, resources and partnerships: One of the problems with determining the impact of the ‘shale gas’ heavy vehicles on the roads is to differentiate between the damage done by these vehicles and the normal deterioration that would have taken place without them. In most cases no historical rates of deterioration are available as a baseline for comparative purposes on specific roads. It may thus be necessary to identify similar roads in the area which do not carry any development vehicles and use these as a comparative basis. The alternative is to make use of the “social consciousness” of the developers to ensure that the local communities are constantly provided with high quality and well-maintained roads. It should be noted that, although road provision is expensive, the cost is infinitesimal compared with the overall cost of SGD and the presence of good roads has significant benefits in terms of reducing road user costs.

Baseline: To ensure efficient monitoring and checking of the impacts of the road traffic a baseline study to determine the current state of all roads is essential. A traffic count of heavy vehicles (together with their axle loadings) is also required in order to attribute responsibility for damage effectively if the shale gas companies are made responsible for maintaining roads in the current state. It is also expected that any critically poor roads be upgraded/rehabilitated or limitations placed on their use prior to being used for SGD activities.

Resources and materials: Mitigation of material loss from unpaved roads and high maintenance costs on paved roads requires careful road design and construction. For unpaved roads, selection of the best locally available material is essential to reduce maintenance and replacement costs. Although specifications for these materials are available, local materials may not always comply with these requirements and the

corresponding performance will be poorer. It should be noted, however, that even with the best materials, construction must be of the highest quality to ensure good performance.

Similarly, with paved roads, the best available materials must be sourced and high construction standards (together with good drainage and overload control of vehicles) are essential. Because of the normal environmental requirements associated with the sourcing of the material required for road construction (often taking in excess of 18 months for a full approval by the Departments of Minerals and Energy (DME) and DEA), it is best that the initial material locations are identified and that such locations makes provision for sufficient material for replacement purposes as well.

One issue regarding resources is that natural gravels and construction materials are finite and their continued use is not sustainable. To mitigate this latter effect, more application/research is required with regard to less water-intensive building methods and the use of alternative materials. A possible alternative to consider is to locate and make use of industrial and mining wastes. Materials such as slag, fly-ash, bottom ash, waste foundry sands, etc. can often be used in roads, but these materials are probably only located in the Port Elizabeth area – there is little industrial or mining activity in the central Karoo areas. Haulage of these materials in the quantities required into the area under consideration would be both costly and time-consuming and would inevitably lead to additional deterioration of the regional road network. The use of local natural materials in the area, although neither environmentally nor socially sustainable, thus appears to be immutable. It can also be stated that it is possible to reduce water usage with careful construction practices, more expensive equipment, use of recycling machines and a skilled work force.

Partnerships for co-funding: In terms of local and regional roads, normal maintenance and construction procedures should be followed. It will be important, however, to identify which authorities are responsible for the various maintenance and upgrading operations. These could be national (SANRAL, Department of Transport or even Department of Public Works), provincial or municipal agencies. The relevant authorities need to be made aware of the possible developments that could affect their roads and their maintenance budgets. With regards to mitigating impact on roads, the concept of bonded roads has been set up in Pennsylvania where gas operators are required to maintain the road in at least as good a condition as they were at the start of SGD operations and maintain any damage induced by local traffic. Established best practice (similar to the concept of “bonded roads” used in Pennsylvania (Paige-Green, 2015)) in South African mining regions are partnerships where mining companies play a key role in maintaining municipal roads, i.e. in the case of Eskom in Ermelo (Hes, 2013). Given that extra traffic will lead to more frequent grader blading and re-gravelling on unpaved roads and to additional routine maintenance (potholes, cracking and edge-break) and a small increase in resealing frequency on paved roads necessary reconstruction will need to be negotiated with by SGD companies in a ‘maintenance co-funding

agreement' similar to that between Mpumalanga Province and Eskom due to road damage from the transport of coal (SAnews.gov.za, 2013).

18.4.4 Monitoring and control of road use

In terms of mitigation, it will be essential to identify and document (with photographic evidence) the status quo of existing roads, including i.e. current traffic and road and bridge conditions, remaining life of roads, as well as problem areas, to be used as reference or datum points that can be used to allocate responsibility for any increased damage. This information will provide a base case scenario, which can be used to evaluate any accelerated deterioration, particularly if the assessment records extend back for a few years. Where pavement condition data is not available or up to date, this should be collected prior to initiation of any exploration or production, with photographs, videos and condition measurements (riding quality, pavement deflections, etc.) where appropriate. EIA requirements at the time of production will need to assess the specific impact on regional and local road and other infrastructure.

During the initial base line characterisation of the regional road infrastructure, certain roads may be in the latter stages of their effective lives and prone to rapid deterioration under the increased traffic. These will need to be identified and certain shale gas related traffic (say more than 3500 kg axle loads) excluded from using them (i.e. 'out of bounds'). The number of overloaded axles will need to be minimised and controlled – this is usually done by the need to obtain abnormal load permits for any vehicles with unusually heavy loads.

There is minimal overload control on non-SANRAL roads in South Africa. As the primary access to the area will be from the south on non-SANRAL roads, including the N12 which is already in an advanced state of deterioration, periodic checking of axle loads on these roads should be carried out. This should make use of at least Weigh-In-Motion (WIM) sensors but preferably portable scales or specially installed weighbridges. Portable scales are probably better as they can be procured from contractors on tender (not requiring much in-house capacity) and also can be randomly used on different roads to take into account intentional avoidance of routes with known overload control. WIM control is usually not sufficient to ensure effective prosecution, but requires the vehicles to be diverted to conventional weigh bridges. Calibrated portable weigh stations can usually be used for prosecution.

As indicated, tendering for vehicle-weighing systems requires minimal in-house capacity in the road authorities and is well within the ambits of the local road authorities. Prosecution of overloading offenders will require capacity among the traffic departments which probably exists already.

Weighbridges can be temporary/periodically implemented, especially when heavy equipment is coming in – possibly on the N12 somewhere and the R175.

Detailed evaluation of the risks of heavy vehicle traffic through the many mountain passes between the SGD area and coast at Mossel Bay and Port Elizabeth may be required and mitigation may include avoidance of certain passes and scenic routes which may be vulnerable.

18.4.5 Sustainable settlements and service delivery

Social services, facilities and bulk infrastructure: Given foreseen direct and possible migratory growth of towns, as well as foreseen growth in regional population and through-traffic, the demand for and access to social services (e.g. health, emergency services and education) and services amenities (sports and recreation facilities, education, libraries, home affairs offices) and utilities such as landfill sites, water treatment plants, energy and especially water resource demand will have to be considered over and above mere town extension. Projected growth of towns and regional service demands will be critical to support planning, budgeting, construction and/or upgrading of existing facilities and required service delivery. Implications of production on bulk infrastructure will need to be considered in relevant EIA closer to the time of production.

Sustainable on-site housing and service delivery: Minimising resource implications and risks with on-site development within the arid Karoo landscape will require making use of alternative technologies, environmentally sensitive and sustainable design of accommodation and buildings, utilisation of grey water and methodologies to enable sustainability, as well as on-site generation and use of renewable energy and food production where possible. EIA requirements will need to assess this in detail.

18.4.6 Effective and efficient land use management and regulatory environment

Regulatory uncertainty: Clarity and consistency of processes related to “land use applications” and “land use development applications” for SGD within the jurisdiction and legal contexts of the three affected provinces is critical and requires further legal input and assessment. As set out in Section 18.3 of this chapter, several risks with regards to the uncertainty of the regulatory framework to facilitate, guide and assess relevant land use change applications highlights the need to create regulatory certainty, which will imply setting in place the required institutional capacity (regulatory frameworks, strategies, human resources, skills, collaboration etc.). This particularly relates to the implementation of SPLUMA, especially at municipal level. It is proposed that an intergovernmental task team addresses this as a matter of urgency.

Municipal regulatory environment: The following steps will be needed to mitigate the risks arising out of the regulatory environment:

- It is proposed that the Northern and Eastern Cape Provincial Governments must take a leading role in rolling out municipal land use planning bylaws, and repealing old order provincial legislation (e.g. LUPO and the Northern Cape Planning and Development Act, Act 7 of 1998). They must also promulgate their own provincial planning and development legislation to ensure that SPLUMA can operate effectively.
- Support to provincial governments, especially in the Eastern and Northern Cape Provinces, to develop and/or model municipal planning bylaws that can be used to effectively regulate and manage land use change associated with potential SGD. This could possibly include the use of ‘zoning layers’ that can support municipal decision-making;
- Support to municipalities to establish Municipal Planning Tribunals, as required in terms of SPLUMA, either individually per municipality or jointly or at a district level (see Section 34 of SPLUMA). These tribunals can be set up to operate in more than one municipality, e.g. for a whole district, provided that the affected municipalities all agree to it;
- Support to municipalities to develop wall to wall land use management schemes (SPLUMA, Section 24(2)(a)), including land use zones that take into account the range of land uses likely to arise from SGD; and
- Support to municipalities to develop municipal spatial development frameworks (Section 20 of SPLUMA) and, where appropriate, regional spatial development frameworks (Sections 18 and 19 of SPLUMA).

In relation to each of the steps outlined above, coordinated capacity building and expansion of existing capacity (i.e. additional staff) will be needed (see Section 18.4.7).

While government should understand the needs of the private sector and be responsible in terms of policy development and the administration regulatory processes (embedded), government must retain its independence and must not be captured by the vested interests of private sector. Care must therefore be taken in ensuring that governance systems assign accountability to decision-makers and are open and transparent.

18.4.7 Creating shared capacity to address regional service demands

The cost of improving the state of readiness of all spheres of government, especially municipalities, to deal with the implementation of potential SGD must be considered when evaluating the net economic impact of SGD on South Africa. It is anticipated that all spheres of government (especially municipalities) will struggle to handle the increased strategic planning and regulatory challenges without creating additional

capacity. When referring to regulatory capacity, special mention should be made to the need for compliance monitoring and enforcement, as this will be one of the cornerstones for successful implementation of any SGD scenario. Unfortunately, local government in South Africa has a poor track record insofar as compliance monitoring and enforcement of legislation is concerned (See CoGTA, 2009a; 2009b). International best practice guidelines should be considered to address this challenge.

To achieve the above, it is recommended that 1) coordinated capacity building, and 2) the expansion of existing human recourse capacity (i.e. additional staff, shared skills and experience, capacity building) be addressed through the establishment of a ‘shared services specialised unit’. Such a shared service unit is probably also more feasible given the anticipated extended timeframes and phased approach to potential SGD activities. An example of such a “shared specialised service” is the Planning Implementation Management Service (PIMS) centres that played a key role in providing a shared specialised service to support local and district municipalities with the development and institutionalisation of IDPs and IDP processes. Centres were staffed by consultants that reported to the former Department of Provincial and Local Government, or in some cases centres were hosted in district municipalities (Meiklejohn, 2003). Capacity building to support communities and local decision-makers to engage in relevant processes will be invaluable.



Figure 18.5: The critical role pro-active long term and regional planning instruments and capacity.

Managing increased traffic volumes and need for emergency services: Some of the critical key issues to be resolved are 1) how through traffic in towns such as Beaufort West will be addressed, i.e. by building a bypass or upgrading of internal roads; 2) the need to increase enforcement capacity to enhance traffic safety to improve safety especially on the N1 and to reduce damage to roads through overloading as well as to manage passing traffic within main towns; 3) the need to provide emergency incident response in the Karoo area, which is already far in excess of that required by the local population and locally generated traffic; 4) the need to further increase emergency response capacity in order to improve incident response capability to reduce fatalities at accident sites; and 5) the movement and parking of heavy freight vehicles passing, which is already creating traffic management demand in main towns such as Laingsburg, Beaufort West and Graaff-Reinet and which also requires the enhancement of local transport planning capacity to better serve existing community needs. Mechanisms such as development contributions to recover and mitigate for direct and indirect costs to municipalities will need to be considered, especially given the incremental approach within activities associated with the Exploration Only and Small Gas scenarios. International case examples and proposals are addressed in Van Zyl et al. (2016).

Capacity development, training and empowerment: One of the major mitigation factors critical to planning, implementation, monitoring and adaptation will be the capacity of the relevant settlement planning, service delivery, integrated planning and other authorities in the area. Building capacity and expanding numbers of planners in municipalities could address this, but this requires resources, may not be done to the extent to which it has to be due to funding constraints and skills availability, and takes time to ensure the desired results. In addition to this, data on shale activities and mining output is hard to come by, and will be need to be sourced, supplied and regularly updated. In order to deliver on this mandate, local planning officials will have to be capacitated and informed to provide the necessary enabling and regulatory services. The role and support of the South African Local Government Association (SALGA), Department of Cooperative Government and Traditional Affairs (DCOG), research councils, academia and local civil society led initiatives such as the Karoo Parliament can be solicited in support of the respective provincial governments. The important role of Non-profit Organisations (NPOs) in social collaboration initiatives in facilitating certain processes are dealt with in Atkinson et al. (2016) which outlines the social context and addresses the impacts on the social fabric. “Sister” agreements with municipalities that have experience of SGD could also be considered in support for municipal preparedness.

Regional specialist capacity: The following will be required:

- specialist support for baseline studies;

- specialist studies and dedicated capacity to support SDF and land use management scheme development, with possible appropriate zoning layers for multiple purposes (considering a variety of legal considerations);
- specialist studies and advice in considering land use applications. There is scope in terms of SPLUMA for a municipality to appoint technical advisers to a municipal or ‘shared’ planning tribunal to assist with more complex decision-making;
- special studies to determine relevant development contributions related to impact on infrastructure and services;
- specialist support with adaptation of sector plans and strategies;
- monitoring and control, which includes support and control of land use practices;
- processes to be followed with decommissioning; and
- the establishment of a dedicated task team.

Details regarding specialist capacity requirements should be provided for in relevant environmental impact assessment processes and management plans.

A regional specialist capacity can also be considered to provide specialist services that will be required to assess applications, assist with pro-active planning, monitoring and control of impacts on land uses and activities within areas to be effected by SGD, including for example specialists related to air quality (Winkler et al., 2016), waste planning and management (Oelofse et al., 2016), heritage (Orton et al., 2016), noise pollution (Wade et al., 2016).

Transportation of hazardous material: In addition to appropriate emergency services and the development of a fluid transport management plan, it will be critical that the general workforce, including drivers, must receive appropriate training and be equipped to respond to emergencies and implement clean-up measures, as required by-law (see MPRDA and relevant regulations regarding transportation of fluids). The possibility to make use of a regional landfill site instead of long distance hauling of fracking liquid could also be considered.

18.5 Gaps in knowledge

There is a need for a baseline study and set of findings regarding road conditions and impact. Baseline road condition data and on-going traffic volume studies are essential to attribute responsibility for negative road impacts. This may prove highly contentious if several different companies are granted mining rights in the area.

There are substantial information gaps as to the state of land use management instruments, such as land use management schemes, in the region. Similarly, there are few, if any, strategic environmental assessments on which decision-makers can rely for decision-making. The quality of many MSDFs is very weak, especially in the smaller municipalities. There is thus in general; 1) a shortage of information on which decision-makers can rely when making land use and spatial planning decisions, and 2) a lack of clarity regarding the regulatory implications of incremental exploration and associated wellpad development and local access road construction.

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18.8 Digital Addenda 18A – 18B

SEPARATE DIGITAL DOCUMENT

Digital Addendum 18A: Tabulated detailed information

Digital Addendum 18B: Maps