Acknowledgements

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CPCS also expresses its special thanks to all stakeholders consulted during the writing of this report. All mistakes and inaccuracies are ours.

CPCS Transcom International Limited
Alpha and Omega Chambers
Bridgetown, Barbados
+1 613 237 2500
bridgetown@cpcstrans.com

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Acronyms / Abbreviation

BR	Botswana Railway
B	Beam
Capex	Capital Expenditure
CD	Chart Datum
CG	Cape Gauge
CIF	Cash, Insurance, Freight
CSD	Cutter Suction Dredger
CV	Caloric Value
DRC	Democratic Republic of Congo
DTM	Digital Terrain Model
Dwg	Drawing
DWT	Dead Weight Tonnage
E	East
EIA	Environmental Impact Assessment
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
ENPV	Economic Net Present Value
EPC	Engineering, Procurement and Construction
ERITDA	Earnings before Interest, Taxes, Depreciation, and Amortization
EU	European Union
FEED	Front End Engineering and Design
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
FOB	Free on Board
GBN	Government of Botswana and Namibia
GRT	Gross Register Tonnage
GT	Gross Tonnage
HAT	Highest Astronomical Tide Level
IPCC	Intergovernmental Panel on Climate Change
JICA	Japanese International Cooperation Agency
LAT	Lowest Astronomical Tide Level
LLD	Land Leveling Datum
LOA	Length Over All
LPG	Liquefied Petroleum Gas
LWOST	Low Water of Ordinary Spring Tides
M & R	Maintenance and Repairs
MEP	Mmamabula Energy Project
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MIRR	Modified Internal Rate of Return
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs

MoU	Memorandum of Understanding
MSL	Mean Sea Level
Mtpa	Million tons per annum
N	North
NAD	Namibian Dollar
Namport	Namibian Ports Authority
NG	Narrow Gauge
OECD	Organisation for Economic Co-operation and Development
Opex	Operational Expenditure
PFS	Pre-Feasibility Study
PIANC	Permanent International Association of Navigation Congresses
RBCT	Richards Bay Coal Terminal
S	South
SADC	Southern African Development Community
SAN	South African Navy
SG	Standard Gauge
SOC	Social Opportunity Cost
SPT	Standard Penetration Test
SRTP	Social Rate of Time Preference
SWAN	Simulating Waves Nearshore
T	Draft of Vessel
TEU	Twenty-foot Equivalent Units
TKR	Trans-Kalahari Railway
TNPA	Transnet National Port Authority
TOR	Terms of Reference
TPT	Transnet Port Terminals
TSHD	Trailer Suction Hopper Dredger
UNCTAD	United Nations Conference on Trade and Development
USD	United States Dollar
USGS	United States Geological Survey
VAT	Value Added Tax
VTS	Vessel Traffic Service
W	West
WACC	Weighted Average Cost of Capital

Executive Summary

The Pre-Feasibility Study (PFS) Report for the Trans-Kalahari Railway (TKR) has been undertaken against a background of the Terms of Reference (TOR), the Inception Report, the Technical Report as well as the Traffic Studies report and provides a clear and objective assessment that aims to support both Governments' decision on whether or not to proceed on a multinational basis with a new rail link from a suitable location in Botswana, connecting directly to a port on the Namibian coast.

The report has examined the railway alignments and port location options as well as carrying out a railway, ports, shipping and terminal assessment, together with examining the costs that pertain to their operations. An Initial Environmental and Social Assessment were carried out together with the human resources and training needs assessment for the new infrastructure operations. Public-Private Partnership options were examined in depth together with the existing railway and port legislation and the cross border issues. A Risk Assessment has been carried out in concert with the plans for the future project preparation.

Due to the complexity of the traffic assignment model build, 720 scenarios were identified and tested. These were, however, screened and cut down to a manageable number of 'short listed' options. These options have been reviewed in the Traffic Studies Report and Mmamabula has been identified as a good choice for being the rail option starting point due to the vast coal reserves in the area.

The Traffic Studies report findings refined the rail route options to be assessed to the following three options:

- Mmamabula to Walvis Bay, via Gobabis (Option 1);
- Mmamabula to Walvis Bay, via Mariental (Option 2); and
- Mmamabula to Lüderitz (Option 3).
- In terms of port options the following were developed:
- Lüderitz port; and
- Walvis Bay port.

Railway Assessment

The existing railway network in Botswana and Namibia was assessed, and the possibility of linking into these networks was taken into account. Investigation of the existing network's geometrical standards indicated that generally the horizontal curvature and ruling grades did not fall within the design criteria requirements for a high volume haul line. The utilisation of the existing rail infrastructure as a heavy haul line for the transport of coal and general freight is therefore not recommended.

Potential rail route corridors to link the Ports identified in the Traffic Studies Report, and the coal mining development planned at Mmamabula, were assessed using design criteria typically required for heavy haul railway lines carrying the tonnages envisaged, as per the Traffic Studies Report. The geometrical standards and rolling stock standards played a vital role in selecting a preferred rail corridor. This was especially the case on the Namibian side where the rail corridor crossed mountainous terrain. Both Cape Gauge (CG) and Standard Gauge (SG) design criteria were contemplated.

One of the challenges facing Africa is how to adapt its rail infrastructure systems in order to respond to and integrate with the emerging trading systems. The choice of gauge was investigated and the pros and cons were identified. This was done against the background of the AU resolution of 2007, the perception that the region's railways are in need of major improvements in efficiency and performance and the perceived advantages of SG.

Dual gauge was identified as a possibility, however the cost saving that one may realise from constructing a dual gauge system of the scale and magnitude required for the TKR is largely be nullified by the many constraints that such a system brings with it. These constraints were highlighted and various examples of dual gauge systems around the world were discussed.

The design criteria which included grade limitations, track lengths and minimum horizontal curvature, were used as the basis of the macro route location. Rail alignments were developed for the three route corridors identified from the Traffic Study. The software programmes used for the route determination were Global Mapper, Google Earth, Map Source, and Micro station In Rail Design Suite.

The method for determination of the routes was as follows:

- Visual information, including topographical information was used to determine possible routes;
- Digital Terrain Model (DTM) strips in the specific LO bands were exported to an ASCII file to form a platform for the geometric design;
- Contours were generated in Microstation InRail to determine the optimum route for each option by analysing the terrain in order to achieve specific grade requirements; and
- Alignments were adjusted to follow existing infrastructure (railway lines, roads, transmission lines, property boundaries, etc.) where it was possible to do so without resulting in unreasonable earthworks quantities.

The three route options were compared in terms of route length, earthworks required, highest route elevation, number of structures required and tunnel length (if required). These comparisons included SG and CG options. The results of the analysis were summarised and tabulated. The summary showed that Option 2 was the shortest route in terms of track kilometres, it had the least escarpment elevation to overcome, the least amount of earthworks, and no tunnelling was required along its route, as opposed to the other two routes. Option 3, however, had the least amount of bridge area. Fill earthworks for CG were more than for SG, but this was due to less fill being required on SG formation due to the thicker layer works required.

Shipping, Ports and Terminal Assessment

The Capesize vessel was recommended as the average vessel size for this study pending a detailed study of vessel size distribution (shipping schedule) at the proposed port.

The technical assessment highlighted boundary conditions for the sites, inclusive of meteorological, marine environmental metadata and physical information (e.g. bathymetry and geotechnical data) of the sites as well as a discussion on the suitable sites for the coal terminal locations.

The assessment of the two port locations, Lüderitz and Walvis Bay included typical arrangements for the stock yards, based on previously tested configurations for similar projects. Although a two staged phase was assumed, being Phase I (16.8 Mtpa) and Phase

II (65 Mtpa), some of the infrastructure is required to be put in place for the initial phase, such as the trestle for the conveyors.

The Walvis Bay port terminal does have higher input costs in terms of directly related infrastructure, e.g. longer conveyor length, longer trestle length, more dredging. However, the Lüderitz terminal will require more investigations into the off-site infrastructure investments, such as electricity provision and access from major roads.

The non-coal cargo terminal in Luderitz requires a new wharf to be developed to the south of Angra point to house the storage facilities and provide berthing for the vessels shipping non-coal cargo. However, in Walvis Bay, the non-coal cargo has been routed to existing terminals where possible. In both scenarios, the container traffic has been assumed to be accommodated in the future Walvis Bay Container terminal expansion.

Human Resources and Training

The primary areas of operation for a railway organisation were identified and explained in detail. Training for critical staff, such as the train drivers was identified and briefly discussed.

A summary of the number of two-person crews that are required for each of the three alignment options, and the comparatives between SG and CG were tabulated and briefly discussed.

Employee numbers have been benchmarked against other terminals around the world and for some of the operations (such as off-shore) employee numbers have been compared to first principle examples of similar magnitude projects.

Scope and Cost of Investment

The railway Capex was been divided into two broad groups, namely 'Above' Rail and 'Below' Rail.

'Below' Rail costs covered all the infrastructure costs that relate to the railway alignment. These costs typically include earthworks, drainage, trackwork, bridges, tunnels, etc.

Above Rail costs covered all the rolling stock requirements necessary to initiate operations of the railway. Yard facilities for rolling stock were covered too. The Above Rail costs also took into account requirements for intermodal operations. These were factored into the calculation. However, it is important to note that the full cost of the intermodal rolling stock requirements will not be as high as the figures indicated due to the fact that some existing rolling stock may be utilized for intermodal transport.

For both 'Above' and 'Below' Rail costs, Option 2 was the lowest.

The contributions of higher capital input costs at Walvis Bay were due to natural features and strategic town planning issues of the area thus requiring that the stock yard and berth be separated much further apart than for Lüderitz, where the site is almost green field. It must however be noted that the port costing differences must be viewed in combination with several other factors in addition to the rail cost components.

Cost of Rail, Port & Terminal Operations

The annual operating costs for the coal and intermodal operations, for all three alignment options were estimated on a year-to-year basis over a period of 30 years. The total for the 2016 to 2045 period operating costs is summarised and it indicated that Option 2 had the least operating cost.

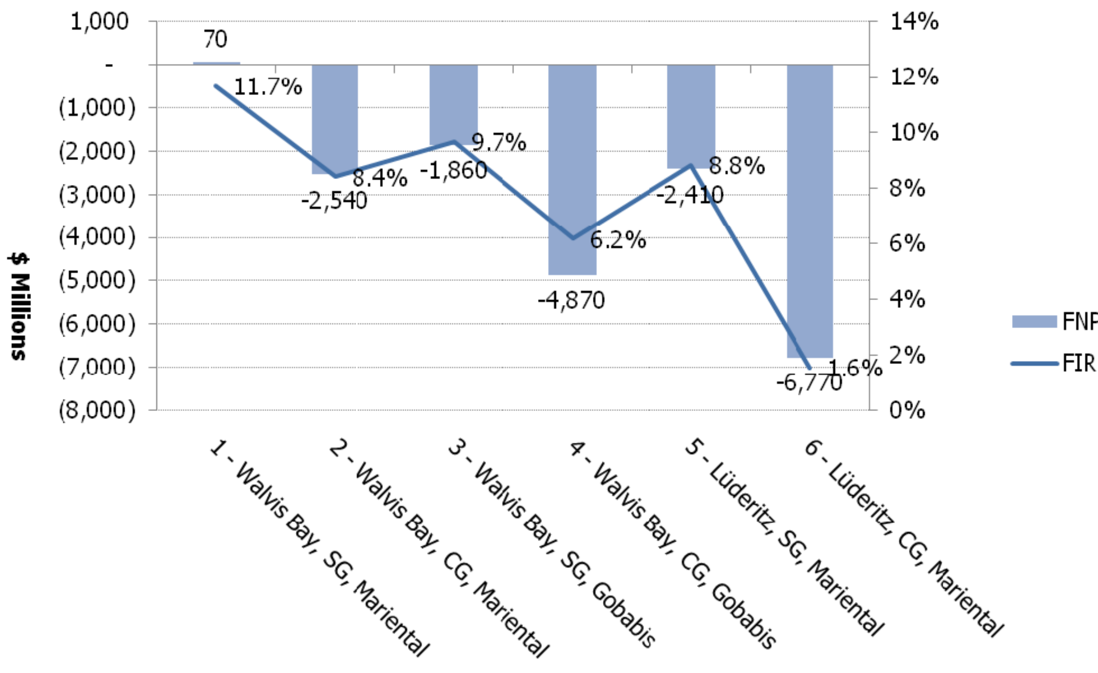
The port options operational costs were estimated based on known operational data from other examples, and these were then proportionally allocated to the proposed infrastructure. This resulted in the slightly higher cost to maintain Walvis, due to longer conveyer, longer trestle and more dredging required.

Results of Preliminary Financial and Economic Analysis

The financial and economic attractiveness of the port, rail alignment and gauge options were assessed using standard discounted cash flow analysis, assuming a 30-year economic life. The financial analysis was based on a capital structure appropriate to a PPP infrastructure transaction, including 70/30 debt/equity ratio, 8% cost of debt and required return on equity of 20%, leading to a Weighted Average Cost of Capital of 11.6%.

The financial analysis indicated that apart from Option Route 2 (Scenario 1 Standard Gauge-Mmamabula to Walvis Bay via Mariental) none of the options were commercially feasible without some government financial support, as indicated in the figure below.

Figure 1: Financial Results of Integrated Options



Source: CPCS Analysis

The most financially attractive option is Scenario 1, the standard gauge routing via Mariental to Walvis Bay. Under the default assumptions, it is projected to achieve a Financial Net Present Value (FNPV) of 70 million, and a Financial Internal Rate of Return (FIRR) of 11.7%, slightly above the estimated cost of capital. There would be no requirement for a Capex subsidy for this option.

Sensitivity analysis, focusing on Capex and revenue estimates indicated that these financial results were quite sensitive. Under a pessimistic case, of the type typically required by private investors in major infrastructure projects, in which we tested a 20% Capex cost overrun and revenues at 80% of forecast, the projected IRR of the preferred option fell from 11.7% to 4.5%. This highlights the importance of ensuring that the Capex estimates are based on rigorous feasibility studies and that revenue forecasts, particularly for coal, are locked in through mechanisms such as take-or-pay contracts.

The economic analysis, carried out conservatively in accordance with best international practice, confirmed that the project is economically beneficial. In addition to the transport benefits that, among other factors lead to projected Economic Internal Rate of Return (EIRR) of 12.8% for the preferred option compared to a social discount rate of 6.4%, the increased coal production is estimated to contribute approximately 1.5% to Botswana GDP.

Initial Environmental and Social Assessments

Initial (Scoping) Environmental and Social Assessments were carried out mainly as desktop assessments complimented by field visits and limited consultations. Each of the proposed three routes for the TKR in Namibia presents its own unique set of environmental and socio-economic concerns. An appraisal ranking system was developed for the three route options based on the likely magnitude of the potential environmental and socio-economic impacts.

Some of the key environmental issues for Botswana will include current settlements along the corridor, wildlife migration between the Central Kalahari Game Reserve and the Kgalagadi Trans Frontier Park, mining areas/concessions, and historical sites. Similarly for Namibia, major concerns include the sand dunes (shifting and static), mining areas/concessions, and historical sites. The full impact on these issues will be addressed in a full environmental impact assessment.

A critical issue of concern at the port terminals is the potential impact of coal handling facilities and the dredging of port terminals to enable them to handle the large vessels required to move large quantities of coal. The potential physical, biological and socio-economic impacts of these activities that have been identified in this report will need further study at the feasibility stage.

The initial environmental assessment of the TKR project has shown that option Route 1 will have less negative environmental and socio-economic impacts, followed by Route 2 option.

Private Sector Interventions

The report has undertaken an analysis of the various options that are available under Public-Private Partnership (PPP) schemes to finance the TKR and the port terminal. These were evaluated considering a background of the challenges and opportunities that face both Botswana and Namibia in terms of attracting private sector participation in such a major infrastructure development initiative.

The advantages and disadvantages of each options were examined and our preliminary recommendation is for a **Design Build Operate and Transfer option-"**Design and build civil works, rolling stock, rail and port terminal systems and provide operation and maintenance (O&M)" as a public-private financing option. The private sector design-builds the fixed infrastructure, procures the rolling stock and related systems, and operates the system. The design/build/operator bids on a fixed price basis. Tariffs may be collected by the public agency or shifted to the private operator who receives an interest in the operating profits of the enterprise. Government provides defined financial assistance, this could include development period cost-sharing, loans, or credit enhancement. Private financing may secured by the government agency's obligation to make scheduled payments under the contract to cover loan obligations.

Risk Assessment

A Risk Assessment has been carried out for the scheme and a Risk Register developed with Mitigation Measures recommended. A Risk Assessment Workshop, facilitated by an independent facilitator, has been recommended to be held before the end of Phase 2 of the Study.

Plan for Further Project Preparation

Recommendations have been made following the rail and port assessments. In terms of rail, based on the technical and financial conclusions, CPCS recommends that the **Option 2** (Mmamabula to Walvis Bay Port, via Mariental) alignment is preferred from a Capex and Operational Expenditure (Opex) point of view. Route 1 is preferred from an Environmental and Socio-economic points of view and both options could be taken to full feasibility study.

The study has shown that Lüderitz port is preferred over Walvis Bay port as a location for coal terminal and coal shipping facility. However, the high cost due to length of railway, tunnelling, and environmental constraints, of a TKR railway line to Lüderitz nullify any benefits of expanding the Lüderitz port and hence Walvis Bay is being recommended.

A PPP Action Plan has been drawn up which gives a privatisation timeline of 36 months. Equally, an overall Implementation Plan which takes into account the necessary PPP processes and actions has been developed.

1 Background

1. In September 2010, CPCS Transcom submitted the Traffic Studies Report for Prefeasibility Study of Three Rail Links: Trans-Kalahari Railway, Mmamabula-Ellisras and Mosetse-Kazungula – Phase 1.

2. The report, prepared for the Ministry of Transport and Telecommunications of the Republic of Botswana, was centred upon the review of historical traffic data, coal production and markets, movement of other commodities, rail routing and traffic projections.

3. In terms of coal production, both countries have reserves to meet the projected demand. Botswana has in excess of 200 billion tons of coal reserves. Most of these coal reserves are in the Mmamabula and Morupule areas.

4. Regarding total commodities, including coal, to be transported, there would be an increase from 5.9 million tons in the Base Year (2016) to 64.8 million tons by the Forecast Year (2035). The peak of 75 million tons will occur between years 2025 and 2029. It is very important to note that coal volumes will constitute between 80% and 95% of the traffic, thus it cannot be stressed enough the importance of coal in determining the economic feasibility of the TKR. With a relatively small population in Botswana, consumer goods will not be a major factor.

5. The Traffic Studies Report has established that there is a significant demand for coal in China and India. It is forecast that demand for coal in Asia would be 484 million tons in 2010, rising to 661 million tons by 2019. In China, the 2010 demand of 100 million tons would rise to 132 million tons by 2019 and in India the corresponding figures would be 73 million tons in 2010 and 131 million tons in 2019.

1.1 Define Port Location & Railway Alignment

6. Due to the complexity of the traffic assignment model build, 720 scenarios were identified and tested. These were, however, screened and cut down to a manageable number of 'short listed' options.

7. The 'short listed' options have been reviewed in the Traffic Studies Report and Mmamabula has been identified as a good choice for being the rail option starting point due to the vast coal reserves in the area.

8. The analysis has recommended that the following rail route options be omitted from further work and have therefore not been included in this report:
   - Mmamabula to St Francis Bay railway line;
   - Mmamabula to Elizabeth Bay railway line;
   - Mmamabula to Walvis Bay via Salzbrum and Windhoek; and
   - Mmamabula to Cape Fria/Angra Fria.

9. The above options have been discounted mainly due to the Capital and Operational Costs basis as well as environmental restrictions in some cases.

10. The Traffic Studies report findings have refined the rail route options to be assessed to the following three options:

- Mmamabula to Walvis Bay, via Gobabis;
- Mmamabula to Walvis Bay, via Mariental; and
- Mmamabula to Lüderitz.

11. The following options have been discounted:

- Elizabeth Bay;
- St Francis Bay;
- Cape Fria/Angra Fria;
- Mowe Point;
- Cape Cross; and
- Sandwich Harbour.

12. As in the case of rail options, the above port options have mainly been excluded because of the high cost and adverse environmental implications.

13. Findings from the traffic assignment model have resulted in the following ports being assessed as part of the final model runs:

- Lüderitz port; and
- Walvis Bay port.

14. The modelled traffic flows were used to inform the choice of the technically viable port sites and the associated rail alignment options. The two ports and three alignment options are assessed further in this report in terms of engineering, costing, risk assessment and environmental screening.

2 Railway Assessment

2.1 Methodology

15. The following tasks were identified and completed during the execution of the *Preparation of Pre-feasibility Study of TKR: Phase 1*. They relate to Subtask 4.2 of the Inception Report which was submitted in June 2010:

- Information collection on route locations;
- Assessment of existing rail infrastructure
- Set parameters and design criteria for SG and CG scenarios;
- Preliminary route investigations;
- Compare the alternative alignments;
- Operational modelling for inputs into Capex and Opex model; and
- Compile draft scenarios.

2.2 List of assumptions

16. The main assumptions applicable to this study are shown below:

Figure 2-1: List of assumptions: Rail

No	Assumption Description
1	The three routes to be investigated are Mmamabula to Walvis Bay port via Mariental, Mmamabula to Walvis Bay port via Gobabis and Mmamabula to Lüderitz port.
2	The design volume is 75 Mtpa (65 Mtpa Coal and 10 Mtpa General Freight).
3	The traction energizing mode will be diesel-electrical.
4	The gauge scenarios to be analysed will be 1,067 mm CG and 1,435 mm SG
5	The design required for the track superstructure will be for 26 t per axle for CG, and 30 t per axle for SG. This axle loading will also apply to the sub-structure, bridges and culverts.
6	Route alignments were selected to try and follow existing infrastructure (railway lines, roads, transmission lines, farm boundaries, etc.) without operational constraints as far as possible.
7	For this study, the cut and fill slopes were taken as 1:1.5 for earthworks quantity determination.
8	Alignment options were evaluated using SRTM data sets and Global Mapper software

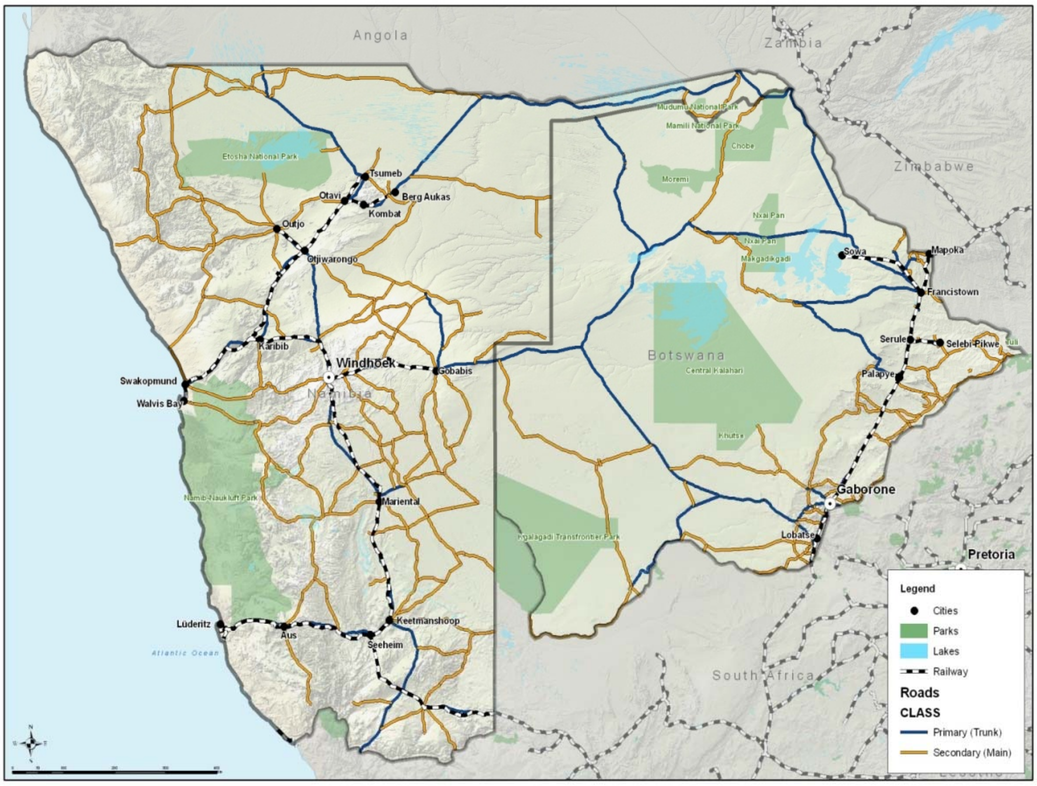
2.3 Existing Railway Network

2.3.1 Railway network in Namibia

17. The construction of railway lines in Namibia commenced in 1897 when the first 600 mm gauge track was laid inland from Swakopmund to Rossing. Namibia's current rail network is shown in Figure 2-2. The total current length is 2,628 km,

all of which is CG. The main line runs in a south-north direction from the border town at Ariamsvlei. A branch line goes to the port of Lüderitz, of which the Aus to Lüderitz section is under upgrading, while the main line continues northwards from Keetmanshoop to Windhoek. The main line then continues westward via Kranzberg to the port of Walvis Bay. From Kranzberg the railway line runs north through Otjiwarongo via Otavi to Tsumeb where it connects with the northern railway line to Ondangwa. A branch line goes from Otavi to Grootfontein.

Figure 2-2: Existing railway network



18. The railway lines were built to relatively light standards with allowable main line axle loads of 16.5 tons and restrictions of 11.5 tons on the branch lines. The main line is laid with 30-57 kg/m rails on steel and concrete sleepers and a ballasted bed. Branch lines have 22-30 kg/m rails on steel sleepers and generally no ballast.

19. Upgrading of various sections and subsections of the railway lines is required in order to comply with the required 18.5 ton axle loads of wagons and higher speeds[1]. Permanent Way materials are very old, worn out and in many instances have reached the end of their useful service life. Much money and energy is required to maintain these railway lines to a standard safe for the transit of trains. As a result of the condition of the material, it is not possible to run trains at speeds of 60 km/h or higher to compete against road transporters. The result of this is that more maintenance is required on the National road network due to damaging effect the increased numbers of heavy vehicles are causing to the roads.

20. To increase the operational speed from 60 km/h to 100 km/h requires upgrading of the railway lines to accommodate 20.0 ton axle loads. In order to achieve this,

[1] The National Development Plan (Plan3) for railway infrastructure in Namibia

the existing wagon rigid bogies must be replaced with bogies that can operate at higher speeds (above 60 km/h) with a safe design speed of 120 km/h. A total of 1,800 bogies from the existing wagons must be replaced to comply with the new strategy for higher speed and axle loads[1].

21. In order to cater for the higher operational speed and axle loads, upgrading of existing bridges on the rail track is required. An engineering study is required to determine the load-carrying capacity of the bridges.

22. For the purpose of effective maintenance on the upgraded railway lines and new railway lines, a tamping machine is required for the ballast. The geometry of the track must be kept to a required standard for the safe passage of trains at 100 km/h.

2.3.2 Railway network in Botswana

23. Botswana Rail is a government owned company responsible for the operation of the railways in Botswana. It provides rail transport within the country and has rail links to South Africa and Zimbabwe.

24. The north-south main railway line in Botswana was constructed by the Bechuanaland Railway Company, from Vryburg to Bulawayo as part of Cecil Rhodes's expansion policy into Africa in the 1890s.

25. BR's network maintains 890 km of 1,067 kms of Cape Gauge track that runs along its south-east section connecting the border of Zimbabwe-Francistown-Gaborone-border of South Africa. In addition, three branch lines exist, namely Francistown to Sowa (Sua Pan), Palapye to Morupule Colliery and Serule to Selebipikwe.

26. The opening of the Beitbridge-Bulawayo railway in Zimbabwe in 1999 resulted in a major drop in the volume of freight transit and income.

27. The existing railway between Mmamabula and Gaborone is generally straight with minimal horizontal curves. Gradients are flat (approx. 0.2% - 1.0%). No major issues were identified in terms of geometrical standards of the existing line segment comparing with proposed geometrical standards.

2.4 Current Condition of Existing Railway Infrastructure

28. The railway infrastructure of the sections that could possibly be influenced by the transport of coal through the existing rail network is as follows:

2.4.1 Gobabis to Windhoek (225 km)

29. The track gradient from Windhoek towards the Hosea Kutako Airport is at some places 1:50 (2%) due to the mountainous area near Windhoek through which the track is running.

30. The rails consist mainly of 30 kg/m rails for 130 km and 95 km of 22 kg/m rails, all laid on steel sleepers. Ballast is provided on the track from Windhoek to the airport but is of poor quality, whilst the remainder of the line is on ground (muck ballast). The entire rail section of 22 kg/m is subject to a speed restriction of 40 km/h and can only carry loads of 13.5 tons per axle. The allowable axle load

from Windhoek to the Airport is 16.5 tons per axle. Due to the narrow cuttings of approximate 20 km in total lengths, the sharpest curve radius is 111 m.

31. The embankment is very narrow and during the rainy season there are geometrical problems due to the very high clay content at some places. Surface water drainage poses a problem since there are places where the fill was not raised high enough to accommodate culverts.

32. The rail reserve is 60 metres wide, but at curves the width to the reserve is as narrow as 10 metres.

33. There are 11 rivers that are crossed by means of bridges and these do not include culverts. The longest bridge on this section has a total length of 136 m.

34. The major problems are corrosion of the steel sleepers on the muck ballast and the fact that, with the exception of the section from Windhoek to the Airport, the line cannot be tamped.

2.4.2 Windhoek to Walvis Bay (420 km)

35. The maximum gradient is 1:66 (1.5%) on various sections of the track. The rails consist of 57 kg/m rails for 8 km, 48 kg/m rails for 382 km and 30 kg/m rails for 31 km. About 222 km of the track has steel sleepers, whilst the remainder of the track (199 km) from Usakos to Walvis Bay has concrete sleepers. Ballast is provided on the entire line. The heavier rails originated mostly from the South African Coal Line during the time when the railways in Namibia were under the control of South Africa Railway and Harbours (SAR & H) where the rails became obsolete for the heavy axle loads the rails were then refurbished and sent to the then South West Africa (now Namibia) for installation.

36. As a result of the poor condition of the track material for the first 31 km from Windhoek and the cracking of the concrete sleepers between Swakopmund and Walvis Bay due to rusting of the reinforcement, FIST clips and rails, the axle loading is limited to 16.5 tons per axle.

37. As a result of the high cost to widen the cuttings, the sharpest curve radius is 149 metres. Fishplate joints are provided at these curves and would need to be eliminated to reduce maintenance cost.

38. There are 77 steel bridges with allowable axle loading of 16.5 tons per axle. These bridges require evaluation before higher axle loadings can be accommodated. The bridge over the Swakopmund River near Swakopmund town is under severe stress due to rust and will need reconditioning in the near future.

39. The main railway line between Windhoek and Walvis Bay is regarded as the most important line in Namibia because it links the port of Walvis Bay with the rest of the country, and strategically important commodities, such as fuel and coal, are therefore transported over this railway line. The railway line also carries commodities for the newly established Trans Kalahari corridor. This section of the railway infrastructure carries 33% of the total bruto tons transported by rail in Namibia.

40. Over the years TransNamib has upgraded about 300 km of this railway line section. About 100 km track of various short sections are in urgent need of upgrading in order to comply with the required 18.5 ton axle loads of wagons. The rail materials of these sections are very old and worn out. A lot of money and energy is required to maintain these railway lines to a standard for the safe passage of trains. As a result of the conditions of the material it is not possible to run trains at speeds of 80 km/h to compete with the road transporters. Rolling stock limitations also play a factor towards running trains at speeds mentioned above.

2.4.3 Windhoek to Mariental (274 km)

41. On the section between Windhoek and Aris, the maximum gradient is 1:36 (2.8%) and two locomotives are required for each train southwards. The rails consist of 57 kg/m rails for 82 km and 48 kg/m rails for 192 km. About 138 km of the track has steel sleepers while on the remainder of the track (136 km) concrete sleepers are provided. Ballast is provided on the entire line, but due to the ingress of the Kalahari sand from the east, the ballast between Rehoboth and Kalkrand stations is fouled.

42. Because of the embankment material's poor condition due to its clay content for the first 30 km from Mariental, the axle loading is limited to 16.5 tons per axle.

43. As a result of the high cost to widen the cuttings from Windhoek to Aris, the sharpest curve radius is 135 metres. Fishplate joints are provided at these curves. To reduce maintenance costs these would need to be eliminated.

44. There are 23 steel bridges with allowable axle loading of 16.5 tons per axle. These bridges require evaluation before higher axle loadings can be accommodated.

45. In general the track is regarded as in good condition for the current traffic, with permanent speed restrictions at the sharp curves.

46. Apart from the mountainous area south of Windhoek and the descent to the Fish River valley near Mariental, the track runs in a straight line with a 60 metre wide reserve and can therefore accommodate a second line.

2.4.4 Mariental to Keetmanshoop (231 km)

47. This section of the track runs over a flat area and therefore the gradients are flat. The rails consist of 57 kg/m rails for 19 km, 48 kg/m rails for 188 km and 30 kg/m rails for 24 km. About 138 km of the track has steel sleepers while the remainder of the track (93 km) has concrete sleepers. Ballast is provided on the entire line.

48. Because of the embankment material's poor condition due to its clay content for about 30 km south of Mariental, the axle loading is limited to 16.5 tons per axle.

49. The track can be regarded as continuously welded with exception of the 23 steel bridges and over the 30 kg/m rail sections and it is in a good condition for the current traffic. The bridges must be evaluated before higher axle loading than 16.5 ton can be allowed.

50. The sharpest curve has a radius of 300 metres. The reserve is 60 metres wide and can accommodate a second line. The only problem will be putting an additional line through Mariental and Keetmanshoop stations because the rail lines tracks are used for shunting.

2.4.5 Keetmanshoop to Seeheim (46 km)

51. This section of track runs along a flat area adjacent to a river and is therefore prone to washaways. The rail consists of 48 kg/m rails on concrete sleepers. Ballast is provided along the entire line. The maximum axle loading is 16.5 tons due to the unknown load capacity of the bridges.

52. The sharpest curve has a radius of 366 m. The rail reserve is 60 m wide and can accommodate a second line provided it is situated on the trackside away from the river.

2.4.6 Aus to Lüderitz (139 km)

53. The first 24 km from Aus is built on tubular track beams with 30 kg/m rails, while the remainder of the track will be conventional track with 40 kg/m rails on steel sleepers for 50 km. An amount of 368 million Namibian dollar has been spent to date and an estimated additional amount of 323 million Namibian dollar is still required to complete the rehabilitation work by 2010. To date only 75 km of the track has been completed.

54. The main outstanding works to complete the rehabilitation by 2010 includes:

- Construction of earthworks for Phase 2 (64 km)
- Procurement of rails for which tenders have yet to be called due to lack of funds, Construction of track work for Phase 2, which would require procurement of rails to stay on schedule
- Lüderitz station and harbour connection.

55. A new marshalling yard and a goods depot are planned for construction outside the town (2 km) next to the lagoon area of Lüderitz bay. The existing Lüderitz station can only accommodate trains of 340 m in length, while the standard requirement is 640 m clear between clearance markers. With the potential freight envisaged through the port, it would be impossible to handle these tonnages within the restricted space available at the existing station area which cannot accommodate such trains.

56. It is planned that the existing Lüderitz station be used predominantly for tourist traffic, and as locomotive maintenance/repair workshop.

57. Another challenge for the Consultants is to develop an entrance railway line into the harbour. The new station yard will be connected with the old station yard with a single railway line running through the town within a cutting. The vertical level difference between the old station and the harbour is 8 metres over a very short distance as it must also cross the street feeding the harbour. A further problem is that the rail route is crossing a public parking area. It may be that the only solution would be to build a bridge to cross the parking area and the street, and to ease out the track gradient.

58. From Aus to the desert plain, the route gradient is 1:44 (2.3%) over 24 km, which makes it very steep in the upward direction (eastwards), and frequent creep of the rails was experienced in the past. The existing railway route runs mainly over Government land and therefore a second line can be built on the reserve. However, through the town of Lüderitz it will be a problem to get a new route to the harbour because of the town location between the rocky outcrops in the area.

2.4.7 Utilising existing rail infrastructure for haulage of coal

59. With reference to the benefits and constraints for the transport of coal by means of rail transport, it is clear that:

60. Subject to Section 13(11) of the Act[2], which governs the rail transport in Namibia, it will be possible for a private company to build a railway line with the written approval of the Minister of Works and Transport. The approval must include the conditions relating to the financing, operation and maintenance of such line, as well as the rights, including proprietary rights. Should such a line be connected to the existing railway network, the approval must include the requirements of TransNamib as the appointed rail operator through Act 28.

61. The railway line from Windhoek to Gobabis is inadequate. The first section of approximately 30 kms from Windhoek has severe grades limiting train loads to 540 ton. Thereafter the grade is adequate, but the line is laid with 22 kg/m rail, which would have to be completely rebuilt with new rail, sleepers, ballast, proper drainage and embankment. The suitability of the alignment and the strength of all structures would also need careful evaluation before higher axle loads can be accommodated.

62. The condition of the existing railway infrastructure in Namibia is not to standard for transporting huge volumes of coal at a high frequency with a number of trains. A dedicated railway line for coal transport is preferred for this purpose. The most favourable route is a direct line from Mmamabula coal mine in Botswana, to Walvis Bay port or Lüderitz port, as discussed in the Traffic Study. An independent train-control system for this coal line should be provided. Such a route will have the least influence on TransNamib rail services after the upgrading of the rail infrastructure has been carried out, to accommodate the corridor traffic.

63. The proposed rail alignments will stay within the existing rail reserves, where possible, in order to facilitate interconnection between the proposed and existing network in Botswana and Namibia, provided the CG option is adopted.

64. For the SG option, the route has deviated from the rail reserve near Gaborone to allow for a transhipment facility north of Gaborone.

65. The sand dune encroachment and entrance constraints to possible harbours near Lüderitz will have the most severe effect on the construction cost of such a railway line to the Lüderitz area. These dynamic sand dunes occur approximately 10 km east of Lüderitz. This area experiences predominantly coastal southerly winds which drives the movement of these dunes. The sand-laden winds are able to form dunes that are 30 m high and move northwards at a rate of 50 m to 300 m per year. The movement of these sand dunes traverses the existing railway

[2] National Transport Services Holding Company Act (Act No. 28 of 1998)

running from east to west. The provision of tunnels and several cuttings *en route* and limited harbour facilities makes this route for coal transport not favourable. This, however, is further assessed under Chapter 3 of this report.

66. Further investigation of the existing network's geometrical standards indicates that generally the horizontal curvature and ruling grades do not fall within the design criteria requirements for a high volume haul line. The utilisation of the existing rail infrastructure as a heavy haul line for the transport of coal and general freight is therefore not recommended.

2.5 Conceptual Design Criteria

67. Potential rail route corridors to link the Ports identified in the Traffic Studies Report, and the coal mining development planned at Mmamabula, was assessed using design criteria typically required for heavy haul railway lines carrying the tonnages envisaged, as per the Traffic Studies Report. The geometrical standards and rolling stock standards will play an important role in selecting a preferred rail corridor. This is especially the case on the Namibian portion where the rail corridor crosses mountainous terrain.

68. The basis of the norms and standards listed below is mainly those generally used by heavy haul railways elsewhere in the world. In some instances, internally developed guidelines have been included as part of the criteria. Both NG and SG design criteria is contemplated.

69. Economies of scale dictate that using the maximum allowable axle loads for the length and volumes of coal haulage envisaged, will obtain a cost advantage. The maximum allowable axle loads for NG lines are 26 t, and 30 t for SG lines. The envisaged export coal traffic will be approximately 65 Mtpa, with other commodities and general freight making up an additional 10 Mtpa. The base case will thus be for 75 Mtpa.

70. The track alignment specifications (design parameters) that will be used for the new track alignment infrastructure are set out in Figure 2-3.

Figure 2-3: Design parameters for track work

No	Design Parameter Description	Cape Gauge	Standard Gauge
1	**DESIGN VEHICLES (ROLLING STOCK)**		
1.1	Locomotives		
	Locomotive Type	GE Dash 9-40CW Diesel Electric Locomotive	SD70ACe Diesel Electric Locomotive
	Horse power	4,000 hp	4,300 hp
	Minimum continuous speed	25.3 km/h	14.0 km/h
	Locomotive Mass	160 tonne	195 tonne
	Locomotive length	22.25 m	22.63 m
1.2	Wagons		
	Wagon type	Cape Gauge coal	Standard Gauge coal, eg. NHYH

No	Design Parameter Description	Cape Gauge	Standard Gauge
	Wagon Payload	82 tonne	108 tonne
	Wagon length	15 m	15 m
2	**TRAFFIC**		
2.1	Maximum line speed	80 km/h	80 km/h
2.2	Speed limit of grades in loaded direction	44 km/h for 1:100, 35 km/h for 1:80, and 25 km/h for 1:60 on long downgrades where there is a risk of trains running away	44 km/h for 1:100, 35 km/h for 1:80, and 25 km/h for 1:60 on long downgrades where there is a risk of trains running away
2.3	Maximum permissible axle loading		
	All Superstructure	26 t	30 t
	New Substructure	26 t	30 t
	New Culverts and Bridges	26 t	30 t
2.4	Gross tonnage per annum	75 Mtpa	75 Mtpa
3	**TRACK GEOMETRY: HORIZONTAL ALIGNMENT**		
3.1	Minimum radius	800 m	800 m
3.2	Crossing loops lengths	To be determined	To be determined
4	**TRACK GEOMETRY: VERTICAL ALIGNMENT**		
4.1	Grades		
	Towards port (loaded train): Maximum Grade on straights	1:100 (1.000%)	1:100 (1.000%)
	Towards mine (empty train): Maximum Grade on straights	1:100 (1.000%)	1:100 (1.000%)
	Staging yards	1:800 (0.125%)	1:800 (0.125%)
	Crossing loops: departure grade for air braked trains	1:200 (0.5%)	1:200 (0.5%)
	Crossing loops: departure grade for all other trains	0.75 x RG (%) – 0.06 where RG = Ruling Grade	0.75 x RG (%) – 0.06 where RG = Ruling Grade
	Minimum length between grade changes	800 m	800 m
5	**CLEARANCES**		
5.1	Horizontal Clearances		
	Minimum distance between centres of parallel tracks	4.5 m	4.5 m
	Minimum distance between centres of parallel tracks with traction masts and signal poles	6.0 m	6.0 m
	Centres of tracks at clearance markers	4.0 m	4.0 m

No	Design Parameter Description	Cape Gauge	Standard Gauge
5.2	Vertical Clearances	As per Table 2 of Annexure A for Dash 9 Clearance Report, Rev A	As per Table 2 of Annexure A for Dash 9 Clearance Report, Rev A
6	**TRACK GEOMETRY: CROSS-SECTIONAL**		
6.1	Super elevation / cant	As per Sheet 4 of 4 of Annexure 9 of the Manual for Track Maintenance, Spoornet June 2000	As per Sheet 4 of 4 of Annexure 9 of the Manual for Track Maintenance, Spoornet June 2000
6.2	Minimum ballast depth below sleeper	280 mm	280 mm
6.3	Formation width from track centre to shoulder		
	Cuts and fills lower than 2 m	3.0 m	3.0 m
	Fills higher than 2 m	3.5 m	3.5 m
6.4	Formation Slope		
	On straights and curves	1:25 towards one side allowing for future expansion	1:25 towards one side allowing for future expansion
	Length transition from -1:25 to 1:25 cross-fall	80 m	80 m
	Fill slopes	1:1.5	1:1.5
	Cut slopes	1:1.5	1:1.5
7	**TRACK SUPERSTRUCTURE**		
7.1	Rails	60 kg/PY/650/280	60 kg/PY/650/300
7.2	Sleepers	Concrete Pandrol PY - new	Concrete Pandrol PY – new
7.3	Sleeper spacing	650 mm	650 mm
7.4	Ballast depth below sleeper	Ballast thickness of 280 mm minimum under sleepers	Ballast thickness of 280 mm minimum under sleepers
7.5	Turnouts		
	Mainline crossing loops	1:12 Electrical sets centrally controlled on concrete sleepers	1:12 Electrical sets centrally controlled on concrete sleepers
	Mainline other	1:12 Electrical sets centrally controlled on concrete sleepers	1:12 Electrical sets centrally controlled on concrete sleepers

2.6 Gauge Selection

2.6.1 Background

71. The rapidly changing international environment is characterised by economic integration. One of the challenges facing Africa is how to adapt its rail infrastructure systems in order to respond to and integrate with the emerging trading systems[3].

72. The most prominent gauge in Southern Africa is 1,067 mm between rails and is commonly known as **Cape Gauge (CG)**. It is classified as part of the **Narrow Gauge (NG)** or meter gauge group which accounts for less than 17% of the world's railways. The dominant gauge in the world is 1,435 mm (> 60%). It is classified as **Standard Gauge (SG)** and has various advantages over NG. Stability is better and may permit higher speeds as well as higher and wider rolling stock. Sheer economies of scale provide advantages in research and development and availability of rolling stock.

73. Railways in Africa are mostly of the narrowing variety (85%) and account for less than 7% of the world's railways by kilometres. Excluding South Africa and some countries in the extreme north of Africa, these railways are generally in a very poor condition with no cross border networks worth mentioning, apart from the Southern African Development Community (SADC) network. In 2007 the African Union together with the Union of African Railways resolved that SG should be adopted for the construction of new railway lines on the continent.

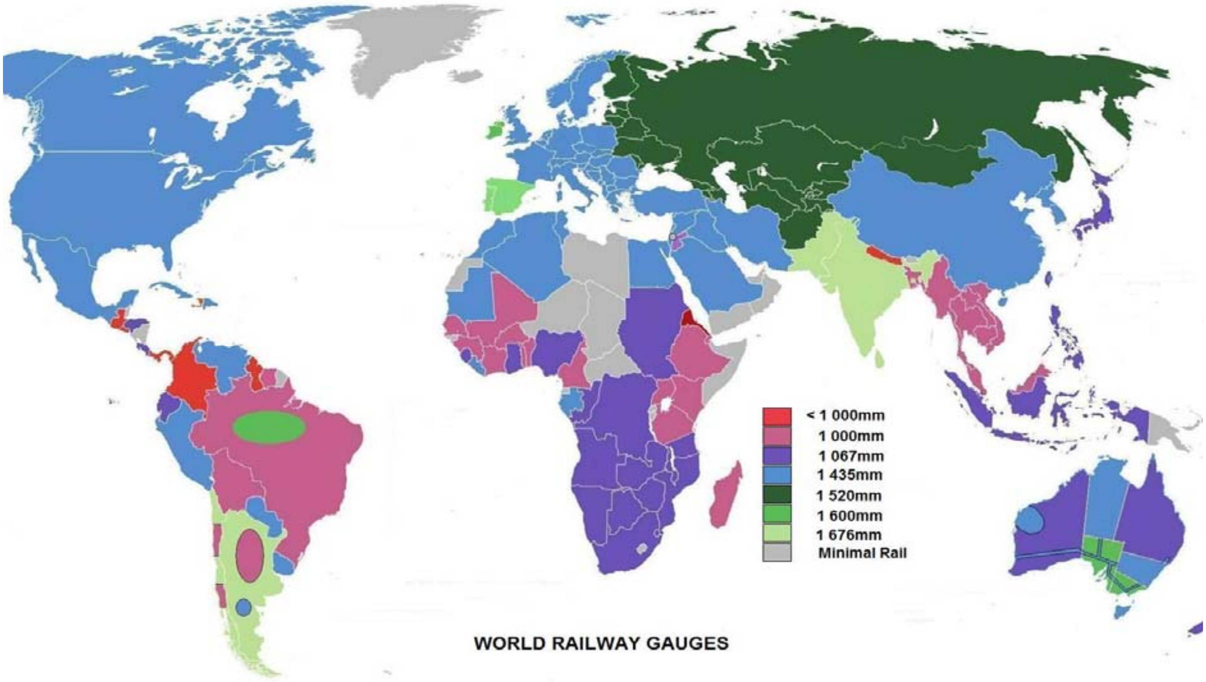
74. Against the background of the AU resolution, the perception that Namibia's and Botswana's railways are in need of major improvements in efficiency and performance and the perceived advantages of SG, it is essential to investigate the value and the pros and cons of a change of gauge.

2.6.2 Features of Rail Gauges in the World

75. The world's existing railway track inventory comprises 1,144,000 route kilometres, of which narrow or meter gauge (914 to 1,067 mm) accounts for 16.6%, standard gauge (1,435 mm) for 60.2%, and broad gauge (1,520 to 1,676 mm) for 23.2%.

[3] East African Railways Master Plan Study, CPCS, January 2009

Figure 2-4: World rail gauge distribution



76. In many parts of the world diversity in gauge arose and, often, persists to this day. Although this is recognised as a costly hindrance to national and international commerce, several countries each make extensive use of two or even three track gauges.

77. Among the common elements to different regional histories was the mix of incentives governing the choice of gauge:

- Firstly, railway builders, operators, and in some cases regulators have had preferences for specific gauges, based on perceptions of the technical performance characteristics of different gauges.
- Secondly, agents have nearly always valued compatibility with neighbouring railways, adopting established gauges where they existed.

78. Early choices of gauge were generally made by individual local railway companies or governments, with little regard for the effects of their choices on others. Later, cooperation and the formation of interregional railway systems led to increased coordination of choices, often facilitating the resolution of earlier diversity.

79. The gauge that happened to be chosen by the first line built tended, on average, to be adopted by nearly two-thirds of all the lines built thereafter in that region. Historically, newly preferred gauges have been able to get a foothold only where previous railways were sparse.

80. The conversion cost relative to network integration benefits has a substantial effect on the likelihood that early diversity will be resolved. In recent decades, Australia and India have made substantial progress in reducing their diversity of gauge. Experience has shown broader gauges to be generally better than narrower, causing regret in regions where NG emerged as standards.

81. More often, experience has caused regret over the emergence of diversity, which has generated costs first of coping with breaks-of-gauge and then, sometimes, of converting whole regions.

2.6.3 Break of Gauge Issue

82. *"Breaks-of-gauge"* hinders through-service across numerous international borders. The multitude of gauges becomes an operational impediment at various international border crossings as well as internally in many countries. To name a few of the more important ones:

- The contiguous networks of the Commonwealth of Independent States and the Baltic States (all 1,520 mm) to Western Europe, China, the Korean Peninsula, and the Middle East (all 1,435 mm);
- The Iberian Peninsula (Spain and Portugal) (1,668 mm) to Western Europe (1,435 mm);
- China (1,435 mm) to Vietnam (1,000 mm);
- Internally in India, Australia, South America and Africa;

83. Break-of-gauge can be a major operational impediment. There are a number ways this is handled around the world notably:

- Transshipment,
- Bogie changing,
- Variable gauge wheel sets (notably for smaller differences, such as Western Europe to the Iberian Peninsula to the west, and the Commonwealth of Independent states and the Baltic States to the east), and
- Dual gauge track.

84. All of these add to operational costs and origin to destination transit times.

2.6.4 Technical Advantages and Disadvantages of SG vs CG[4]

85. The SG technology has one disadvantage compared to its CG counterpart, and that is the additional Capex needed for initial construction due to the longer sleeper, wider formation and additional ballast requirements. This premium is however fairly small for a new railway line.

86. For the rest, the SG technology has a number of important advantages:

Speed

87. Having a± 32% wider wheel base, it is only logical that SG will provide more stability enabling higher safe speeds on both straights and curves. Minimum curve radii on NG lines are seldom set above 1,000m as this will not restrict speeds around curves for the conventional CG speed range of up to 130 km/h. SG rolling stock can safely negotiate these curves at 15% higher speeds than similar CG rolling stock.

[4] Engineering News. 25 November 2007. (Rail industry needs to step up efficiency, performance - Radebe)

88. Best practices in advanced CG lines, such as the JR Freight (Japan), QR (Australia) and Transnet Freight Rail (TFR), operate or have operated specially equipped light to medium freight traffic at speeds of 100 – 120 km/h. QR and TFR operate their world class heavy haul trains at speeds of up to 80 km/h (similar to SG heavy haul).

89. The current maximum speeds on CG for passenger traffic is 160 km/h on QR (tilt trains), 130 km/h on the networks of the six Japanese passenger railway companies, and 100 km/h on TFR. During the 1980s Spoornet operated a regular 150 km/h service between Pretoria and Johannesburg (known as the Metroblitz).

90. Best practices in SG operations employ speeds that are way ahead of the current CG technologies. Notable are Japan and Europe where intercity trains operate in the 200 to 300 km/h bracket and beyond. Most of these lines are very modern and beautifully engineered with extremely flat curves (4,000 to 7,000m radii compared to CG where 800 to 1,000m radii are considered flat).

91. Freight traffic operations are much more dependent on price and service delivery (predictability of time of arrival at the destination) than on actual speed between stations. The extra speed capabilities of SG therefore provide limited advantage over a CG operation except in double stack container train operations where the norm is generally to operate up to about 120 km/h.

Stability (Double stacking of containers)

92. As discussed above, the higher stability of SG also enables the option of double stacking containers to enable heavy intermodal freight train traffic. This is extensively used in the USA and Canada where electrification is sparsely used. The 32% wider wheel base permits a 32% higher centre of gravity for a wagon travelling around curves of the same radius on SG compared to CG. Double stacking of containers will be possible for the TKR if the SG option is chosen. Allowance has been made in the CAPEX for bridges and tunnels (bigger structural gauge) to accommodate for double stacking. Advantages of double stacking of containers includes:

- The number of trains can be reduced by 48%, for the same throughput.
- The payload capacity of the container train will be increased from 1500 MT to 2500 MT to match the carrying capacity of locomotives.
- Congestion at terminals will be minimized. Dwell time of containers at terminals and ports will reduce.
- Matching of throughput for larger ships can be fulfilled in lesser time.
- Cost of unit transportation will reduce. Up to 20% in some cases around the world.
- Rolling stock requirement of locos and rail flats will reduce substantially.
- Rail share will increase with the same rolling stock.
- Will encourage direct service of larger ships to Ports.
- Overall transit time of containers will reduce.

Vehicle Profiles

93. SG operations allow wider and higher vehicle profiles than CG. This is also a result of the better stability. SG profiles are 200mm wider and at least 600mm higher than CG profiles[4]. CG standards can arguably be widened to similar dimensions as for SG, but on existing lines such endeavours will more often than not be thwarted by a multitude of existing structures along the lines that were built to the original permissible structure profiles.

Availability of Research and Development (R&D)[5]

94. Globalisation changed the railway industry. R&D became concentrated in a number of centres of excellence which are generally based in the standard and broad gauge countries. No new developments which fundamentally raised the competitiveness of CG have emerged for a long time.

Wagons and Coaching Stock[5]

95. With manufacturing capacity and R&D primarily residing in the SG countries, global sourcing is likely to gain momentum as the most competitive way to acquire trailing stock.

96. Volumetric size of wagons is important as far as light density commodities such as coal are concerned. Pursuing world's best practice in axle load terms, SG has an important advantage in dramatically reducing the wagon fleet size required for a large coal transportation operation[6]. This comes with associated Capex and Opex savings.

Locomotives[5]

97. The power and tractive effort of CG locomotives are limited by the back-to-back wheel-set dimensions of a motored bogie. SG locomotives are way ahead of their CG counterparts in terms of cost per kN tractive effort. It would be fair to say that there is no indication that CG will be able to catch up or overcome this handicap[5 & 6].

98. The capital costs of SG and CG locomotives are best compared on a cost per tractive effort basis. Inspection of available offerings point at USD 7,500 to USD 10,000 per kN for CG locomotives and USD 3,500 to USD 7,500 for SG locomotives[5 & 6]. So even if there is limited difference in total price per locomotive, the fleet size is substantially decreased with associated Capex and Opex savings.

99. The lower cost of SG rolling stock (wagons and locomotives) as well as the lower cost of operations (less rolling stock to maintain and fewer trains to operate) can generate substantial savings compared to a CG operation. Depending on the traffic volume, this should normally be sufficient to offset the higher cost of SG track and to provide real economic gain.

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[5] Transnet Integrated Port and Rail Masterplan, April 2007

[6] Railroad Association of South Africa. 2007; Position Paper on Track Gauge

Formation Stresses

100. Although the longer sleeper of the SG should reduce formation stresses due to the larger footprint, the actual gain is judged to be limited to omissible. Due to the nature of ballast tamping machines the centre portion of the sleeper does not contribute much to bearing[6]. The wider base does however reduce the effect of differential settlement on cross levels. This is advantageous for riding quality and reduces track maintenance.

Track Maintenance (and Tolerances)

101. As a composite beam the SG track structure provides better resistance to lateral displacement compared to the NG track structure. In terms of riding quality the SG track is also more tolerant to errors of twist in the running top (a 5 mm error in twist on SG will have the same effect as a 3.7 mm error on CG). The cost of track maintenance should therefore be marginally in favour of SG.

102. Modern day track maintenance machines restore errors in alignment and running top to the same absolute limits with equal ease on CG and SG.

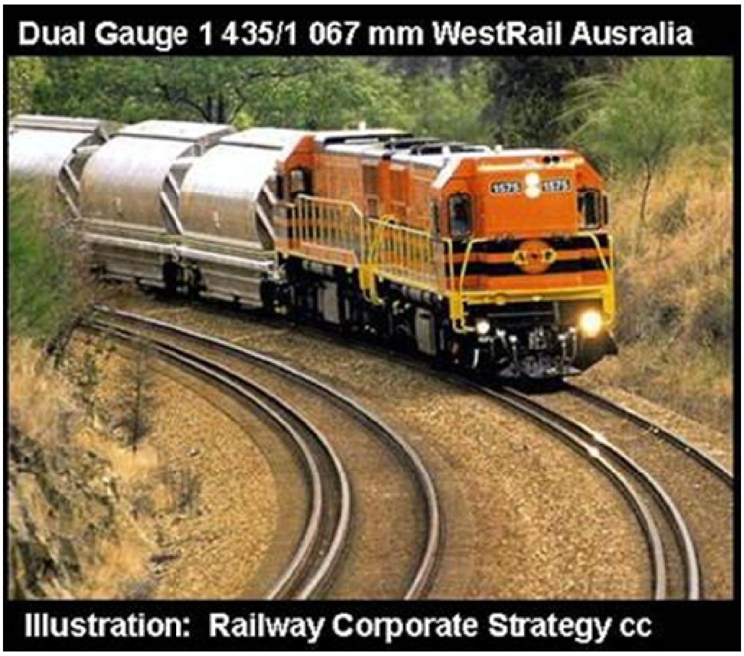
103. The literature revealed no reports comparing the actual maintenance costs of CG and SG track operations. For similar axle loads and traffic volumes it would be realistic to expect similar levels of life cycle costs for rails and sleepers. SG operations would have some advantage regarding ballast life cycle costs and a substantial advantage regarding track geometric maintenance (running top and alignment).

104. SG thus has a maintenance cost advantages over CG. Although it is difficult to quantify, it is not expected to be substantial.

2.6.5 Dual Gauge

105. A dual-gauge railway has railway track that allows trains of different gauges to use the same track. Generally dual-gauge railway consists of three rails, rather than the standard two rails. The two outer rails give the wider gauge, while one of the outer rails and the inner rail give a narrower gauge. Thus one of the three rails is common to all traffic. (This configuration is not to be confused with the electric third rail.)

Figure 2-5: A typical Dual-Gauge Railway



106. In allowing railway tracks of different gauges to share the same alignment, costs can be reduced. Dual gauge can replace two separate tracks, having two rails each, with one track with three rails. This allows one rail fewer for the stretch of the dual gauge line, but there are complications and costs that may offset the savings. Many studies have been conducted to show the financial impact of adopting a dual gauge system as opposed to gauge conversion. Dual gauge has been adopted in several counties on a small scale but nowhere on a large scale like the TKR. Examples of its use around the world include:

- **Britain:** The Great Western Railway was initially broad gauge (2,140 mm). After the "gauge war", it was decided to re-gauge the GWR. As the broad gauge was sufficiently dissimilar from standard gauge and used wooden sleepers, dual gauge was easily introduced. The Metropolitan Railway, now part of the London Underground system, started as dual gauge: its present third and fourth rails are for electricity supply, not dual gauge.
- **Western Australia:** There is a double-track dual-gauge (1,067 mm & 1,435 mm) main line from East Perth to Northam, about 120 km.
- **Australia:** In Brisbane, shorter stretches of dual-gauge track (1,067 mm & 1,435 mm) exist between the rail freight yards at Acacia Ridge and the Port of Brisbane, for freight trains. A dual-gauge line branches off at Park Road Station to run alongside the electric suburban NGCitytrain line over the Merivale Bridge into Platform 1 at Roma Street Station. This is used by standard-gauge interstate CountryLink XPT services to Sydney.
- **Belgium:** Some sections of tram track in Brussels combined 1,000 mm NG for the interurban trams with 1,435 mm SG for the urban trams. Since the closure of the former, these have been replaced with SG track.
- **Germany:** In Stuttgart, the tram lines were 1,000 mm NG. In the 1970s it was decided to convert the streetcar system to a modern Stadtbahn and re-gauge it to SG to increase capacity. Inner-city tunnels replacing street-level

sections in busy streets were built with a cross-section suitable for standard-gauge cars. After the conversion started in 1981 with the commissioning of the first three class Stadtbahn cars, the tunnels and all other sections used by multiple lines were fitted with 1,435 mm /1,000 mm dual-gauge track, to allow both old-style streetcars and new Stadtbahn cars to share those sections while lines were converted one by one over the next decades. In 2006, conversion of line 15 (the last line to be converted) was under way and was completed in 2008, although some sections will retain their dual-gauge track indefinitely as a courtesy to the streetcar museum of Stuttgart, which will operate old 1,000 mm NG streetcars on weekends and special occasions.

- **Indonesia:** Dual-gauge track was installed in 1899 between Yogyakarta and Solo. The track was owned by the Nederlandsch-Indische Spoorweg Maatschappij, a private company, which built the 1,435 mm SG line in 1867. The third rail was installed to allow passengers and goods travelling over the 1,067 mm CG State Railway a direct connection without requiring transfer at both cities. Later, a separate pair of tracks was installed at the government's cost to allow greater capacity and higher speeds.
- **India:** A short section of dual-gauge 1,067 mm and 750 mm line existed in North Sumatra on a joint line of the Deli Railway and the Aceh Tramway. This line survived up to the 1970s.
- **Sweden and Finland**: There is 2 km of dual gauge, 1,435 mm and 1,524 mm, between Haparanda and Tornio across the bridges over the border. At each end of the dual-gauge section there are yards with standard and Finnish gauge areas to allow for transhipment. The four-rail method is used because the gauges are close together. The bridge structure needs to be wider than normal to allow for the offset from the centreline by each gauge. At the Tornio yard is a Rafil gauge changer.

107. It is evident that most of the world’s dual gauge examples occur over short distances (under 500 km), and nowhere in the world is dual gauge being utilised on lines requiring heavy haulage of coal over long distances.

108. The cost saving that one may realise from constructing a dual gauge system of the scale and magnitude required for the TKR will be cancelled by the many constraints that such a system will bring with it. The speed advantage of SG will not be realised as the geometrical standards of the existing CG network will remain due to the fact that horizontal and vertical alignments of the dual gauge system will follow the CG alignment. Bridge structures will have to be widened to accommodate the wider dual gauge system. The bridges will have to be upgraded in terms of axle loading if the advantages of increased SG axle loads are to be realised.

109. Dual gauge also brings with it the complexity of dual-gauge turnouts. Dual-gauge turnouts (also known as switches or points), where both gauges have a choice of routes, are quite complicated, with more moving parts than single-gauge turnouts. They impose very low speed limits. Third-rail was proposed around 1900 as a solution for the break of gauge problems in Australia, but there was a problem with the design of turnouts due to the closeness of SG and Irish gauge of only 160

mm. After one or two decades on increased resentment, the dual gauge option was rejected as unacceptable. Dual-gauge turnouts are complicated, expensive, and suitable for low speeds only.

110. Another point to consider when opting for a dual gauge system is the impact of running trains over long distances at different speeds. The clashes in terms of services patterns and the increased overall waiting time incurred by differential train speed profiles will cause a cumbersome and inefficient service programme, thus compromising the full benefit of a single gauge option.

111. Signalling may also be complicated somewhat, as all three rails must be connected to track circuits or mechanical interlocking arrangements. Mixed gauge is simpler to signal with electric signals than with mechanical signals. Since rails wear very slowly, the extra tonnage on the common rail is generally not a problem.

112. It is clear that all the advantages that SG has over CG are substantially reduced when a dual gauge system is adopted over a long distance and with the capacities that are required of the system.

2.6.6 Africa Union Rail Development Guidelines and the 2007 Gauge Resolution[7]

113. In 2007 the Africa Union together with the Union of African Railways resolved that SG should be adopted for the construction of new railway lines on the continent[7].

114. It was worded:

> *"To this end and to facilitate interoperability of rail transport networks in Africa, standard 1,435mm gauges should be adopted and retained for construction of new rail lines in the Continent"*

And it concluded that:

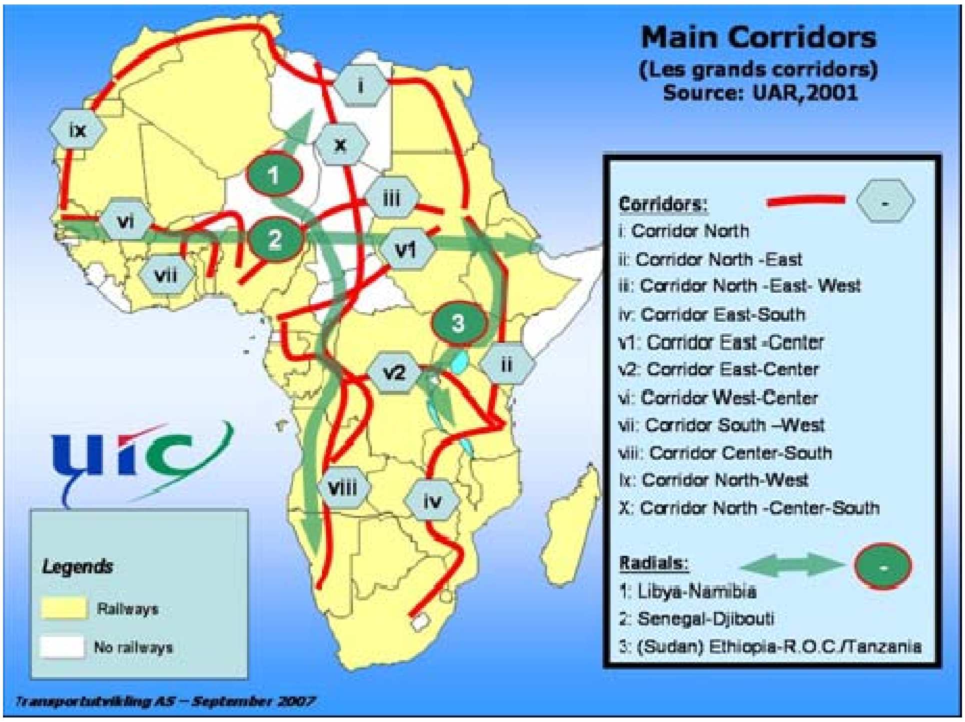
> *"The conversion to standard gauge (1,435mm) for new railway lines should enable African railways to benefit further from the wide range of material and equipment at global level, and will contribute significantly to resolving the problem of interoperability in the future Pan-African railway network."*

115. Ten Corridors and three Radials feature in the vision of the Union of African railways (Figure 2-6) and member states are encouraged to keep these in mind for future integration whenever new lines are considered.

116. Viewed from the background of general poor rail conditions and lack of rail networks in Africa, this resolution makes complete sense.

7 Railways Africa. 31 May 2008 (DOT to run SA Branch Lines)

Figure 2-6: Major African Railway Corridors



117. Apart from construction in Libya, actual activities on the ground do not as yet provide any support to this resolution. There are nevertheless a fair number of positive intentions under consideration in a number of countries. Notable ones are:

- As far back as 2003, Nigeria decided to rebuild and remodel its total 1,067 mm CG network to SG specifications. Progress to date has been slow due to contractual and funding difficulties but contractor has been appointed for the new work
- Algeria and Morocco who are already predominantly SG countries are both planning substantial extensions to their networks inclusive of a SG high-speed line in Morocco to European standards.
- In 2008 both Kenya and Uganda announced their intentions at Ministerial level to replace their current 1,000 mm NG networks with SG technologies.
- Burundi and Rwanda, also at ministerial level, announced their intention to build a 700 km line to connect their landlocked countries to Tanzania. This will obviously be influenced by the Tanzanian intention to rebuild in SG.

2.7 Route Analysis

2.7.1 Description of routes

118. The three railway routes to be analysed are as follows:

- Mmamabula to Walvis Bay port via Gobabis (Option 1);
- Mmamabula to Walvis Bay port via Mariental (Option 2); and
- Mmamabula to Lüderitz port (Option 3).

119. As Mmamabula is the common terminal point for the alignment options, it will be taken as the starting point, and chainages will increase in the "down" direction. Note should be taken that the chainage at Mmamabula is minus km 139. The zero point is near Pilane (Gaborone). The reason for this is that the actual start point at Mmamabula is not yet known, so to amend the entire alignment's chainages due to the actual Mmamabula start point being amended does not make sense. This way, it is possible to amend the start point and only affect the chainages up to Pilane, without having to change entire alignment chainages.

120. The route to Mmamabula from Gaborone follows the existing BR line and A1 road northwards towards Dinokwe. About 12 km south of Dinokwe the alignment turns eastwards for approximately 20 km to a point near the Mmamabula concession. This section of the route follows an existing registered servitude near to the Capricorn road.

121. The route between Gaborone and Sekoma (km 230) runs mostly adjacent to the A2 main road, making a small deviation to the south of Jwaneng town to bypass the town. The route deviates away from Thamaga heading westwards until it joins the A2 at Jwaneng.

Figure 2-7: Rail Alignment at Jwaneng

122. All three route options have the same alignment up to Mabutsane (km 270) in Botswana, where Option 1 splits from the other two alignments and follows a northerly direction then turns westwards towards Gobabis in Namibia. From there

the route continues towards Windhoek and then westwards to Swakopmund ending at Walvis Bay port.

123. Deviations from the road are due to constrains such as ruling grades and curves. Additionally, the route deviates from the road in locations where the road route would not be the most economical route in terms of earthworks and additional length of track. Finally, deviations occur when the road goes through a town or village as the track cannot follow the same route without encroaching on dwellings.

124. Option 2 and Option 3 continue to have the same alignment up to Strampriet (km 817) near Mariental in Namibia. From there Option 2 follows a north-westerly route towards Walvis Bay port, and Option 3 follows a south-westerly route towards Lüderitz port.

125. All three of the routes have tried to follow existing infrastructure like major roads, farm boundaries or existing rail infrastructure. The common route from Mmamabula to Gaborone has predominantly followed the AI highway.

126. Option 1 alignment runs adjacent to road A2 as it spurs off northwards at Mabutsane. The road is closely followed, where possible, all the way to the border where it becomes road B6 until Windhoek, then the line follows road B1 northwards, until Okahanja where it follows road B2 westwards until Walvis Bay. See Figure 2-8.

127. Option 2 alignment follows the common alignment until Mabutsane. From Mabutsane there are no roads westward to follow until the alignment crosses the border and follows very closely to a secondary road, road C20 from Aranos until Mariental. It then veers away from roads until it meets up with road C14 near Nomtsas. The rail alignment follows this road as much as is possible within the ruling grade specifications but does veer off from the alignment at times, mostly through the escarpment where it cannot follow the road alignment due to its steepness. See Figure 2-9.

128. Option 3 alignment follows the common alignment until Mabutsane. From Mabutsane there are no roads westward to follow until the alignment crosses the border and follows very closely to a secondary road, road C20 from Aranos until Mariental. From Mariental it does not follow any roads until 22 km outside Aus where it runs adjacent to the B4 freeway, at times veering away from the road, until Lüderitz. See Figure 2-10-10.

129. In addition to the maps below, a set of 1:250,000 maps are included as Annexure to this report. The maps show major roads, towns, villages, rivers and other topographical information as underlay to the three proposed alignments.

Figure 2-8: Rail Alignment (Option 1)

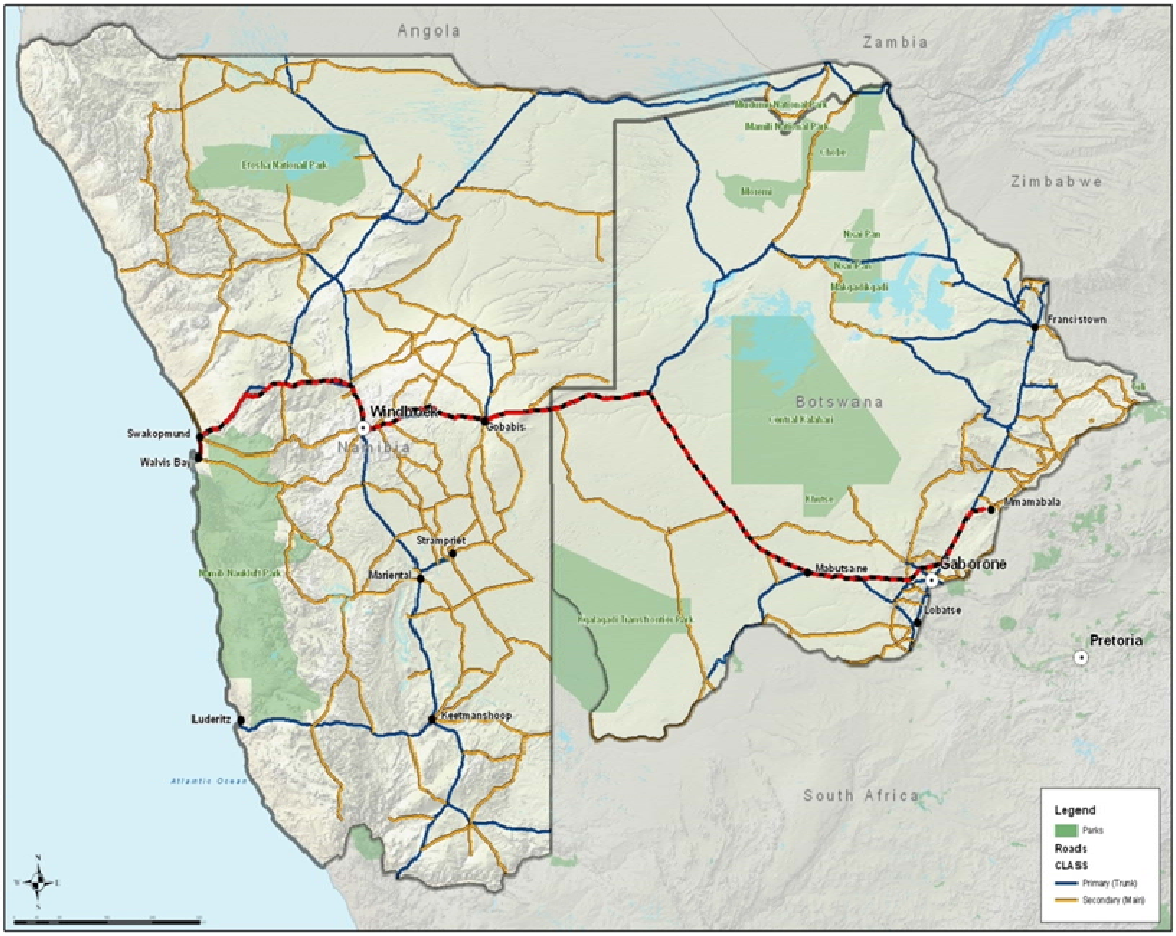


Figure 2-9: Rail Alignment (Option 2)

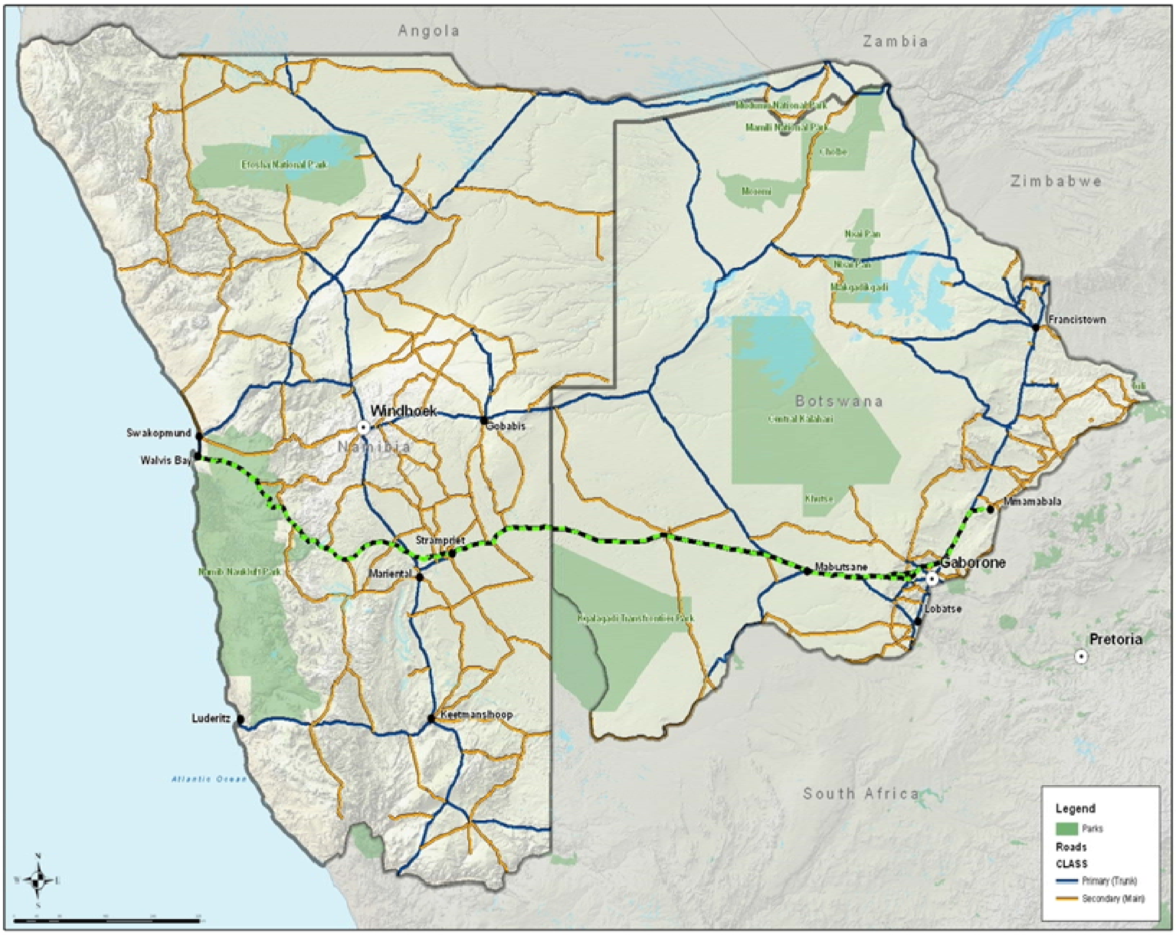


Figure 2-10: Rail Alignment (Option 3)

2.7.2 Topography

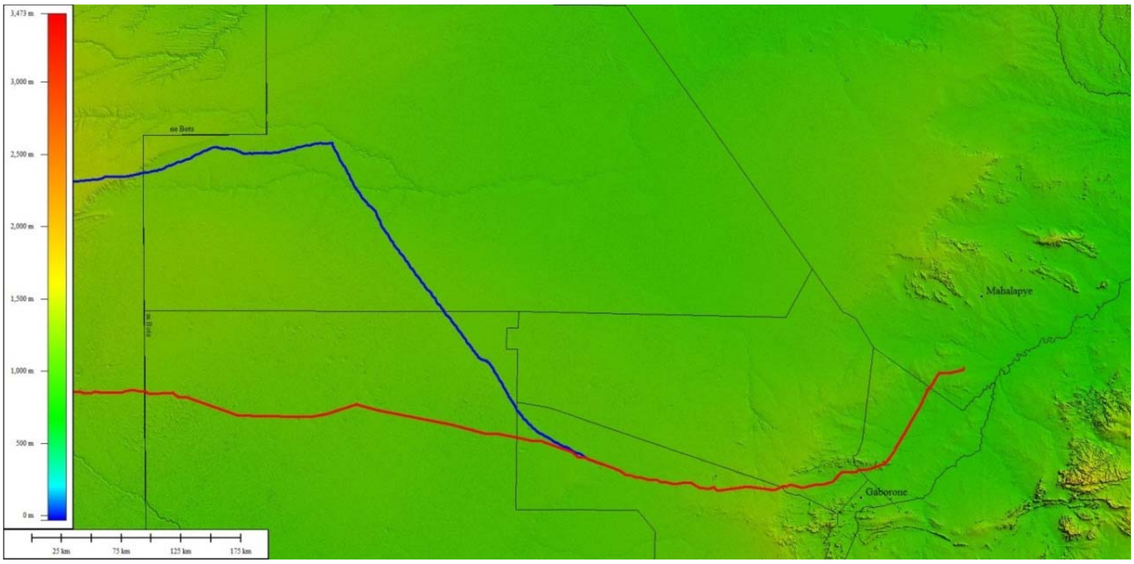
130. The sections of the proposed alignments that traverse through Botswana and the eastern section through Namibia (east of Mariental) are covered by sandy soil that is expected to be collapsible. This section of the proposed alignment is fairly flat compared to the Namib Naukluft mountainous sections in Namibia. Deep cuttings or high fills are not expected here. The provision of water is generally expected to be problematic and sources of rock aggregate are only present in the section between Mochudi and Jwaneng.

131. The general description of the topography of the route alignments can be divided into 3 sections, namely:

- Section 1: Mmamabula to Botswana Border;
- Section 2: Botswana Border to just before escarpment in Namibia; and
- Section 3: Escarpment to ports.

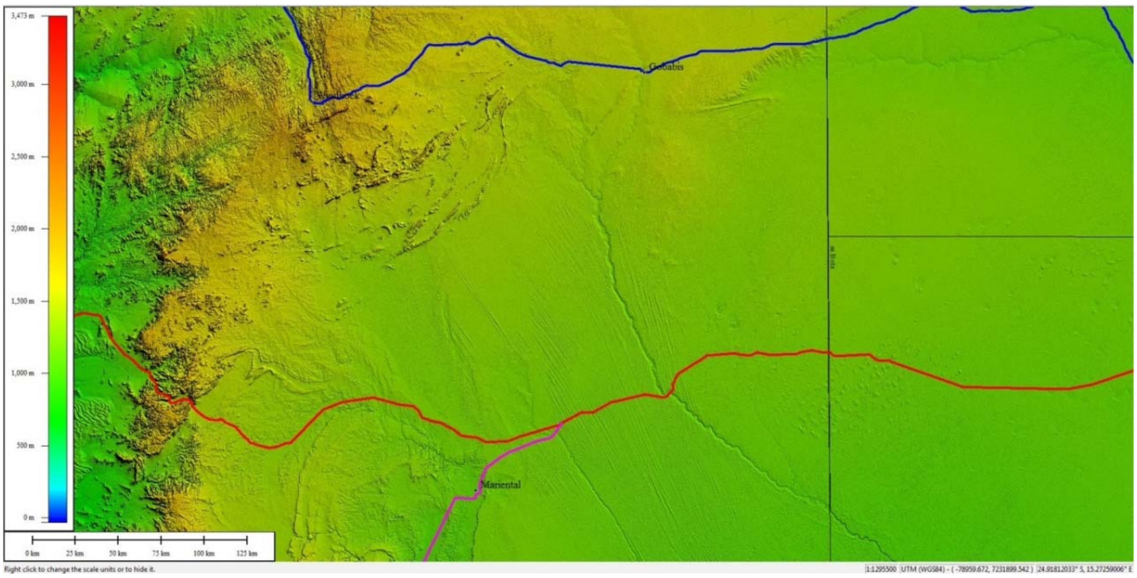
132. **Section 1: Mmamabula to Botswana Border** - The topography in this section is relatively flat compared with Section 3, with rolling topography close to Gaborone. There is some sections in this section that require some snaking of the route, but other than this the flat route is mostly straight following existing infrastructure and farm boundaries. See extract from Global Mapper in Figure 2-11 bellow.

Figure 2-11: Topography, Section 1



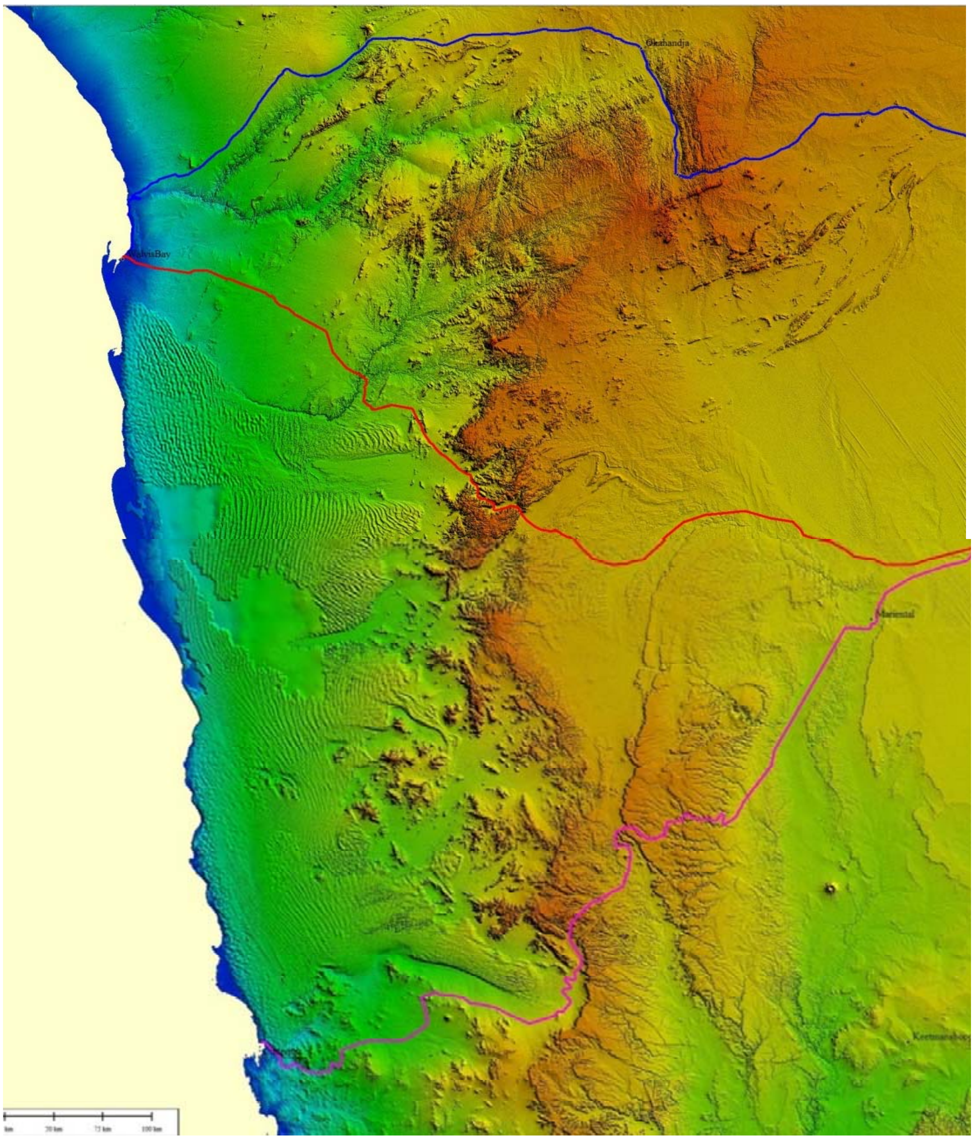
133. **Section 2: Botswana Border to just before escarpment in Namibia** - The topography in this section is relatively flat with rolling topography approaching the mountainous area. The general vegetation ranges from lightly bushed savannah to desert. After Aronos the topography changes to hilly with dunes running perpendicular across the route. The routes cross the Nossob River, with Option 3 crossing the Fish River after Mariental. See extract from Global Mapper in Figure 2-12 below.

Figure 2-12: Topography, Section 2



134. **Section 3: Escarpment to ports** - The topography in this section is mountainous and characteristic of steep gradients, with the topography changing to rolling terrain when approaching the coast. Sand dunes are found on all the alternatives when approaching the coast. Where possible all routes through the escarpment have followed passes. However there is the need for tunnelling on Option 1 and 3. See extract from Global Mapper in Figure 2-13 below.

Figure 2-13: Topography, Section 3



2.7.3 Geotechnical considerations

135. The purpose of the pre-feasibility investigation was to provide a broad overview of the proposed project and outline obvious constraints. The following geotechnical considerations may have an influence on the design and implementation of the project:

- Collapsible/compressible soils;
- Expansive soils;
- Soft soils;
- Groundwater;
- Erodible soil profiles;
- Instability of areas of soluble rock;
- Steep slopes;
- Excavatibility;
- Areas subject to flooding; and

- Construction materials.

136. Each of the abovementioned constraints and its applicability to this project is discussed in the sections that follow.

137. The main geotechnical considerations have been identified for the geotechnical zones of the three route options. It is therefore recommended that the detailed geotechnical investigations envisaged for the Feasibility stage be tailored to investigate these considerations. This will typically comprise test pitting investigations, combined with laboratory testing. Drilling investigations are envisaged for the deep cuttings and tunnel sections.

Collapsible/compressible soil profile

138. More than half of the proposed railway will be constructed on windblown sands of the Kalahari and Namib deserts. These deposits are potentially collapsible soil profiles (with a loose consistency or pin holed structure). Signs of extensive biotic reworking (termites and moles) were also noted along the roads in Botswana. Published reports indicate that the collapse potential of the Kalahari deposits can be remediated by impact compaction (rolling), even in a fairly dry condition. In addition, the granite bedrock in the Gaborone region can also weather to a potentially collapsible soil profile.

Expansive soil profile

139. The area to the west of Mariental is underlain by shale and siltstone bedrock, which can weather to an expansive clayey soil profile. This is, however, an arid region and residual soils are not expected to be developed to a significant extent. Playa lakes may be covered by clayey deposits, which may be highly expansive. Heaving of the coastal sands of Namibia due to crystallising gypsum is also a known phenomenon.

Soft soil

140. Portions of the Walvis Bay seabed are covered by a highly organic diatomaceous ooze that is essentially diatom rich silt with variable sand content. The consistency of this material varies from soft to stiff and it consequently generally has a low shear strength and high compressibility. The ooze contains a high level of H2S and creates highly corrosive conditions. This material has low bearing capacity and will result in consolidation settlement when fills or structures are placed on it.

Groundwater

141. The proposed railway will be constructed in an arid region, which depends mainly on groundwater resources for drinking and stock watering purposes. It is expected that a considerable amount of water will be required during the construction phase of the project. A detailed geo-hydrological investigation of the route will therefore be necessary together with the drilling of water boreholes for groundwater abstraction purposes. As replenishment of the source will be both low and slow in this low rainfall area, such abstraction needs to take place with care.

Erodibility of soil profile

142. The bulk of the proposed routes are covered by windblown sands, which are highly erodible by wind and water. In addition, shifting dunes in the Kalahari and in the Namib Desert can cover the railway line and will require continued maintenance. Specialised catch fences have been used in the past and the near proximity of the railway line can be covered with stone to mediate the problem.

Instability of areas with soluble rock

143. Sections of the proposed routes will traverse areas which are underlain by potentially soluble (dolomite) bedrock. Due to the arid climate, the risk of sinkhole or doline formation is, however, expected to be low, but this is not to say that cavities will not be present below the future railroad. Extensive investigation will be required.

Steep slopes

144. The proposed routes will traverse the Great Escarpment in Namibia, which may result in steep slopes in the longitudinal and transverse direction of the railway line. Construction of tunnels at these locations will reduce the need for long passes. Slope stabilization measures may also be required for sections in deep cuttings, particularly where these are cut into the colluvial and alluvial gravel fans and bajadas below the ridges and mountain chains.

Excavatibility

145. The region has an arid climate, which generally results in the development of thin weathered soil horizons. Shallow bedrock can therefore be expected in the sections not covered by transported soil (from Mariental to the Namib Desert). Deep cuttings and tunnel excavations will require the use of explosives.

Areas subject to flooding

146. The proposed routes are located in an arid region, which is subject to periodic flash floods. In addition, pans along the route will also be flooded periodically.

Construction materials

147. The re-use potential of the in-situ materials along the railway route and the availability of borrow pits, quarries and commercial sources of aggregate will have a major influence on the proposed project. The calcrete deposits along the route are expected to often produce suitable material for construction of embankment fills, some roads pavement layer works and for the construction of platforms. Rock will be required for ballast, concrete aggregate, embankment erosion protection works, harbour protection works, etc.

2.7.4 Curves

148. The curve radius of the majority of the horizontal curves (aprroximately32 %) for the three routes is 1,000 m. Of the three routes, Option 2 and 3 had more than 98 % of their curves with radii's of 800 m or more. There were, however, places where the use of curves with smaller radii was required. The smallest curve radius

occurred mostly on Option 1. It was the 200 m curve (3.72 %), which was used in an area where the topography made it difficult to use larger radii's. Except for these areas, the remainder of the curves are all within the design criteria limits.

Figure 2-14: Summary of horizontal curves

Mmamabula to Walvis Bay port via Gobabis											
Radius (m)	200	400	500	600	700	800	900	1000	1500	2000	>2000
Number	13	5	6	3	0	25	0	197	4	33	193
Percentage	2.71%	1.04%	1.25%	0.63%	0.00%	5.22%	0.00%	41.1%	0.84%	6.89%	40.3%
Mmamabula to Walvis Bay port via Mariental											
Radius (m)	200	400	500	600	700	800	900	1000	1500	2000	>2000
Number	0	0	0	4	0	164	0	76	2	10	4
Percentage	0%	0%	0%	1.54%	0%	63.1%	0%	29.2%	0.77%	3.85%	1.54%
Mmamabula to Lüderitz port											
Radius (m)	200	400	500	600	700	800	900	1000	1500	2000	>2000
Number	0	0	0	1	0	176	0	70	6	22	9
Percentage	0.00%	0.00%	0.00%	0.35%	0.00%	62.0%	0.0%	24.7%	2.11%	7.75%	3.17%

2.7.5 Grades

149. The grades of the vertical PI's are generally flat because the topography is predominantly flat. As can be seen in the tables below, grades steeper than the ruling grade of 1.00 % make for a small percentage of the total grade spectrum. The percentage of positive to negative grades are equally shared, indicating a saw tooth profile, which is expected for flat terrain such that earthworks is minimised with average PI spacing between 2.5 km to 3.0 km. A summary of grades for all three options is shown below. Route Option 3 has the highest percentage of grades outside of the 1.00% grade specified as the ruling grade – 7.55 %.

Figure 2-15: Summary of vertical PI's

Mmamabula to Walvis Bay port via Gobabis						
Slope (%)	<-1.00	-1.00 to -0.50	-0.50 to 0	0 to 0.50	0.50 to 1.00	>1.00
Number	10	82	190	220	83	4
Avg. Length (m)	5758	3023	2708	2591	2467	3656
Percentage	3.58%	15.4%	13.97%	35.42%	12.72%	0.91%
Mmamabula to Walvis Bay port via Mariental						
Slope (%)	<-1.00	-1.00 to -0.50	-0.50 to 0	0 to 0.50	0.50 to 1.00	>1.00
Number	8	102	269	280	86	2
Avg. Length (m)	4734	2069	2002	1795	1673	1402
Percentage	2.64%	14.69%	37.49%	34.98%	10.01%	0.2%
Mmamabula to Lüderitz port						
Slope (%)	<-1.00	-1.00 to -0.50	-0.50 to 0	0 to 0.50	0.50 to 1.00	>1.00
Number	15	88	255	275	75	10
Avg. Length (m)	5155	2339	2118	1852	1932	3690
Percentage	5.11%	13.59%	35.66%	33.63%	9.57%	2.44%

2.7.6 Bridges

150. Google Earth was used as the basis for the determination of bridges. The proposed routes were overlaid onto the images and with the help of the visual information on Google Earth, all bridge locations were identified. Where clearly defined and visible watercourses could be seen, the positions of bridges were identified. The majority of bridges are 10 to 20 m in length.

151. The rail bridge width is assumed to be 7.8m wide and consist of a 6m clearance for the single track, a 650mm wide walkway on each side of the tracks outside the clearance area and a 250mm wide plinth for the steel railing. The length of bridges varied depending on the type of bridge crossing encountered. This was calculated using Google Earth to visually determine the approximate length of each bridge.

152. The road over rail bridge width comprise of 2 x 3.7m wide lanes, 2 x 1.5m wide shoulders and 2 x 450mm additional width for NJ balustrades. This gives a total bridge width of 11.3m. The bridge must span a clear opening of at least 9m consisting of 6m for the rail track and drainage and an additional 3m for the maintenance road. This, however, may vary depending on the topography. The effective bridge area is therefore 102m^2. Both gravel and surfaced roads fall within this width category.

153. The actual bridge length for rail over river bridges depends on the particular river. These bridge lengths were determined from the longitudinal sections. The rivers were classified in three groups:

- Small River – The assumed clear opening is less than 20m. The area was calculated with a 10m span giving a bridge plan area of 78m^2.

- Medium River – The assumed clear opening is between 20m and 500m. The area was calculated with a 300m long bridge giving a bridge plan area of 2340m^2
- Large River – The assumed clear opening is more than 500m. The area was calculated with a 1500m long bridge giving a bridge plan area of 11700m^2.

154. Detailed flood determination was not carried out at this stage. The bridge structures were identified for estimate purposes and will be reviewed in the next stage.

Figure 2-16: Summary of proposed bridges

Mmamabula to Walvis Bay port via Gobabis			
Description	**Type**	**Total Number**	**Total length (m)**
Road over rail	Gravel	15	300
Road over rail	Surfaced	68	2,040
River bridge	Small	178	3,560
River bridge	Medium	44	13,200
River bridge	Large	1	3,110
Mmamabula to Walvis Bay port			
Description	**Type**	**Total Number**	**Total length (m)**
Road over rail	Gravel	35	660
Road over rail	Surfaced	22	700
River bridge	Small	152	3,040
River bridge	Medium	40	12,000
River bridge	Large	2	1,860
Mmamabula to Lüderitz port			
Description	**Type**	**Total Number**	**Total length (m)**
Road over rail	Gravel	8	240
Road over rail	Surfaced	8	240
River bridge	Small	157	3,140
River bridge	Medium	30	9,000
River bridge	Large	4	3,600

155. The large bridges that were identified, were as follows:

156. Mmamabula to Walvis Bay port via Gobabis:

- Ch 1,094,000 to ch 1,097,110 with a bridge length of approximately 3,110 m and a height of approximately 25 m.

157. Mmamabula to Walvis Bay port via Mariental:

- Ch 749,000 to ch 750,200 with a bridge length of approximately 1,200 m and a height of approximately 40 m.

- Ch 1,185,140 to ch 1,185,802 with a bridge length of approximately 660 m and a height of approximately 140 m.

158. Mmamabula to Lüderitz port:

- Ch 749,000 to ch 750,200 with a bridge length of approximately 1,200 m and a height of approximately 40 m.
- Ch 823,200 to ch 750,200 with a bridge length of approximately 1,340 m and a height of approximately 20 m.
- Ch 1,032,140 to ch 1,032,140 with a bridge length of approximately 500 m and a height of approximately 45 m.
- Ch 1,059,920to ch 1,060,489 with a bridge length of approximately 560 m and a height of approximately 20 m.

2.7.7 Tunnels

159. There were no tunnels identified for Option 2, however, various deep cuttings occurred on both Option 1 and Option 3. These deep cuttings have been identified as potential tunnels.

160. There are three tunnels on the proposed Option 1 route with an estimated length of 15,695 m. This equates to approximately 0.91% of the route length. The deepest of these is 100 m deep.

161. There are five tunnels on the proposed Option 3 route with an estimated length of 12,778 m. This equates to approximately 1.05% of the route length.

162. These tunnels are all required to shorten the respective routes. Although this will have the same construction cost as the alternative to the tunnelling, the impact of a shorter route on the long-term operational cost will be less.

163. On Option 1 alignment, the tunnel at Ch 783 is needed to overcome the very steep gradients near the town of Buitepos. Other alternatives were investigated but the longer routes and divergence from current road reserves makes this tunnel the most feasible. The long tunnel at Ch 1,080, is needed to overcome the ridge between Okahandja and Wilhelmstal. The steepness of the terrain in this area does not allow for a 1% rail gradient to traverse around this ridge. The short tunnel at Ch 1,097 is situated just before the small town of Usakos. It is necessary because of the steep ridge that needs to be traversed. These ridges could also be traversed by using cutting, however a cutting of 15 m and more brings with it problems related to toe lines and space constraints, together with drainage problems.

164. On Option 3 alignment, all the tunnels occur on the approach to and from the Fish River. This area is very rugged terrain with many deeply cut valleys. Where possible the alignment has kept very close to these valleys, but in some instances has made the use of tunnels to traverse the severe terrain. These tunnels occur between the towns of Gibeon and Helmeringhausen.

Figure 2-17: Summary of proposed tunnels

Mmamabula to Walvis Bay port via Gobabis		
Chainage of tunnel start (KM)	**Length (m)**	**Max Depth below surface (m)**
Ch 783	3,885	30
Ch 1,080	11,408	100
Ch 1,097	402	30
Mmamabula to Walvis Bay port		
Chainage of tunnel start (KM)	**Length (m)**	**Max Depth below surface (m)**
N/A	N/A	N/A
Mmamabula to Lüderitz port		
Chainage of tunnel start (KM)	**Length (m)**	**Max Depth below surface (m)**
Ch 1,029	2,730	72
Ch 1,033	1,205	47
Ch 1,080	3,010	82
Ch 1,097	473	30
Ch 1,147	5,360	94

2.7.8 Earthworks quantities

165. The volumes of fill exceed the volumes of cut for Options 1 and 2 because of the predominantly flatter topography and due to the fact that fill conditions are preferred in design. Cut volumes for Option 3 are four times more than its fill volumes. The reason for this is the very steep and rugged terrain encountered on this route, especially at the crossing of the Fish River valley.

166. The cut and fill slopes were taken as being 1:1.5. A detailed geotechnical study may indicate a different cut slope depending on the type of material. Without the input from a detailed geotechnical study, the commonly used cut and fill slopes were applied throughout.

167. Earthworks and layer-works were determined according to the typical cross sections shown below. The difference in layer-works thickness between the two gauge options is as a result of the axle loadings being 26 tons (CG) and 30 tons (SG). The difference in formation width is as a result of the longer sleepers used for SG. The additional width is needed to provide the lateral track resistance necessary of the ballast crib.

Figure 2-18: Typical cross-section for CG (26 T axle loading)

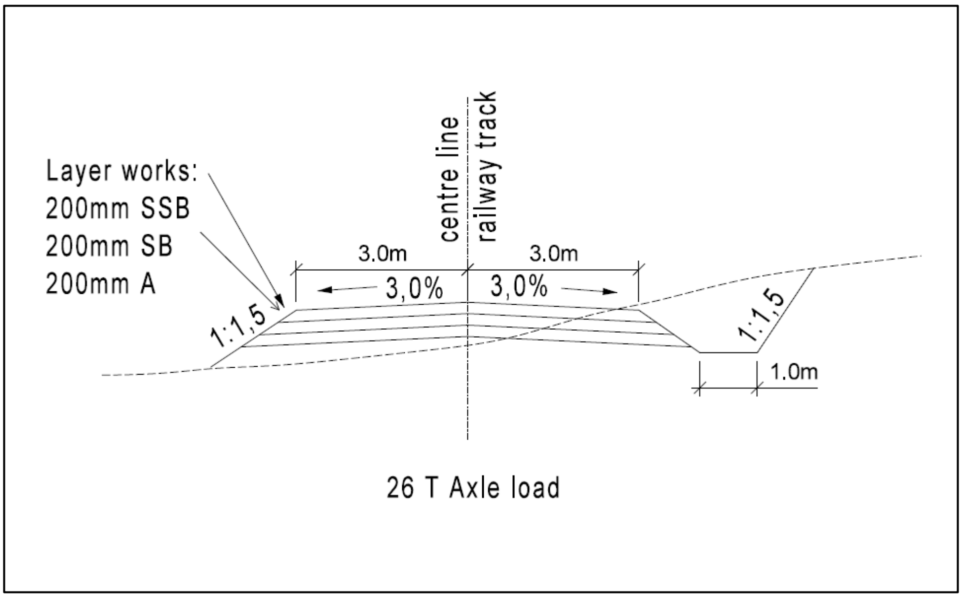
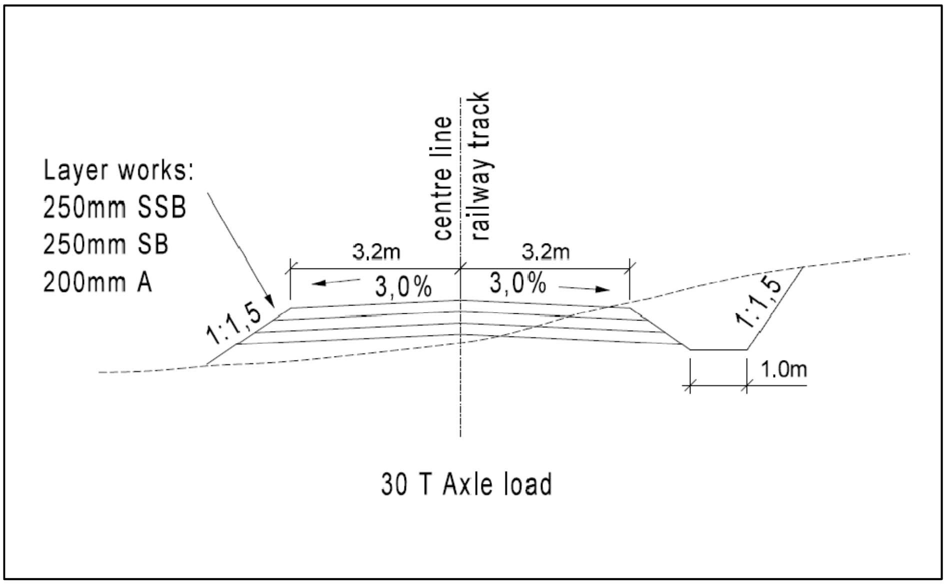


Figure 2-19: Typical cross-section for SG (30 T axle loading)



168. The earthworks summary for the three alignment options is shown in Figure 2-20, with the comparative volumes of SG vs CG.

169. In all normal cut situations, CG has lower volumes of cut than SG. The difference is attributed mainly due to the wider formation required for longer sleepers.

170. The opposite situation occurs in the normal fill situation. The SG as lower volumes of fill than the CG option. The reason for this is that there is less fill required in the SG option to construct the alignment to the same final track level due to the thicker selected layer-works. Although the earthworks are wider, the height of normal fill required to achieve the same track level is lower.

171. Overall, for the three alignments, the total volume moved for each of the alignments indicates marginally more volume is moved for the SG option than for the CG option.

172. Out of the three route options, Option 2 has the least volume to be moved. The difference is 23.6 % less than Option 1, and 54.5 % less than Option 3.

Figure 2-20: Summary of earthworks

Mmamabula to Walvis Bay port via Gobabis				
Earthworks Type	Cape gauge		Standard gauge	
	Volume (Mil m^3)	Ave/km (m^3)	Volume (Mil m^3)	Ave/km (m^3)
Normal cut	15,07	10,100	16,55	11,100
Normal fill	44,58	28,300	41,21	27,400
SSB	2,06	1,400	2,55	1,700
SB	2,27	1,500	2,84	1,900
A	2,49	1,600	2,63	1,700
Total	**66.47**		**65.78**	
Mmamabula to Walvis Bay port via Mariental				
Earthworks Type	Cape gauge		Standard gauge	
	Volume (Mil m^3)	Ave/km (m^3)	Volume (Mil m^3)	Ave/km (m^3)
Normal cut	20,29	15,300	21,97	16,600
Normal fill	23,78	17,800	22,99	17,200
SSB	2,32	1,700	3,10	2,300
SB	2,54	1,900	3,10	2,300
A	2,77	2,000	3,37	2,500
Total	**51.70**		**54.53**	
Mmamabula to Lüderitz port				
Earthworks Type	Cape gauge		Standard gauge	
	Volume (Mil m^3)	Ave/km (m^3)	Volume (Mil m^3)	Ave/km (m^3)
Normal cut	77,46	55,200	78,88	56,300
Normal fill	19,14	13,500	18,93	13,300
SSB	2,04	1,400	2,63	1,800
SB	2,23	1,600	2,76	1,900
A	2,20	1,500	2,69	1,900
Total	**103.07**		**105.89**	

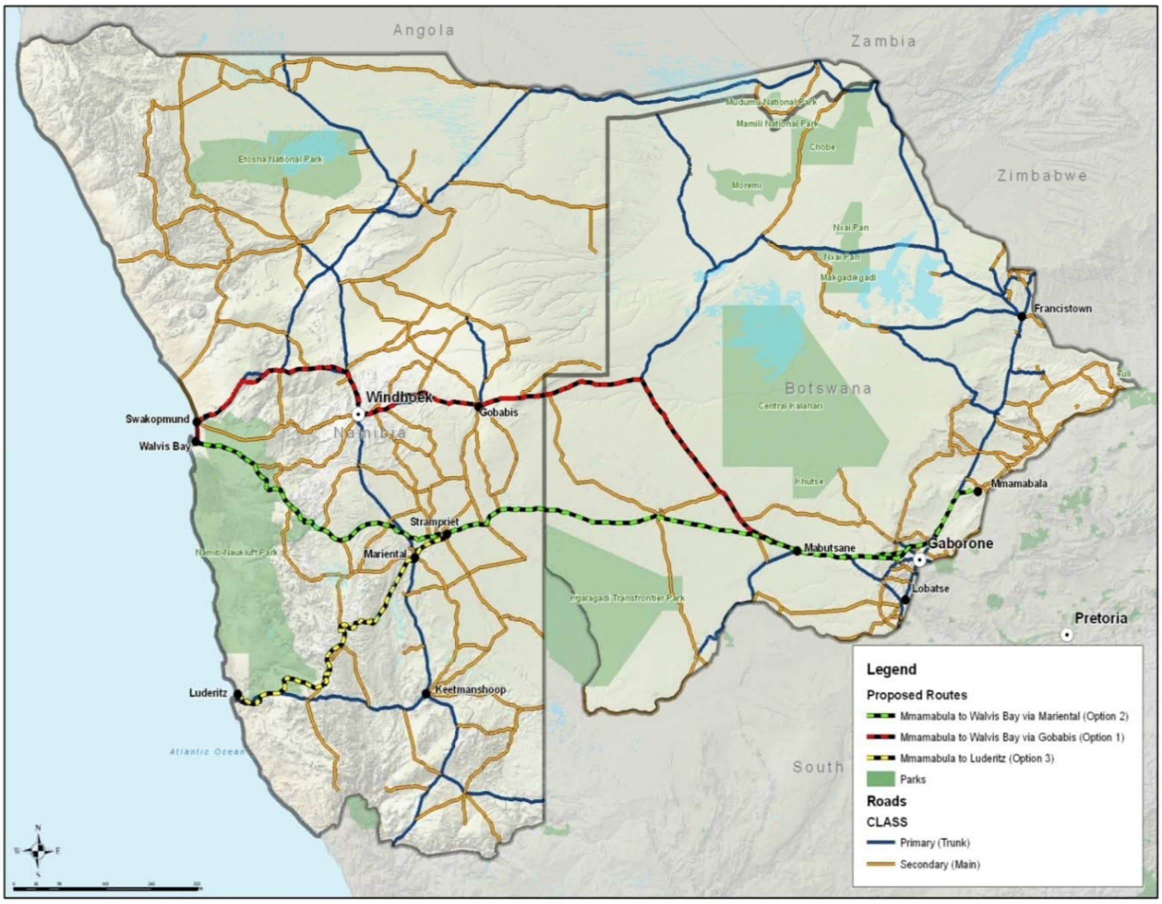
2.8 Route Comparison

173. The final route alignments to Lüderitz and Walvis Bay are shown in Figure 2-21. Global Mapper software together with Google Earth was used to determine the routing of the alignments.

174. All DTMs were created from the data exported from Global Mapper. The NASA Shuttle Radar Topographic Mission elevation data was downloaded from the Consortium for Spatial Information (CGIAR-CSI) database and was used for the DTM surfaces. The alignments were adjusted to follow existing infrastructure (roads, railways, transmission lines, etc.) as far as possible, keeping the topography in mind, without resulting in unreasonable earthworks quantities. Therefore, the alignments may not necessarily be the most optimum alignments in terms of earthworks quantities and hence cost. Further optimization studies, on certain sections using the latest software programs should be carried out during the next stage.

175. Railway design is more restrictive than road design in terms of grade and curve design standards. Although every attempt was made to follow the existing infrastructure, the final route alignments do deviate away from the existing infrastructure at times due to the differing design standards between the proposed railway and the existing infrastructure.

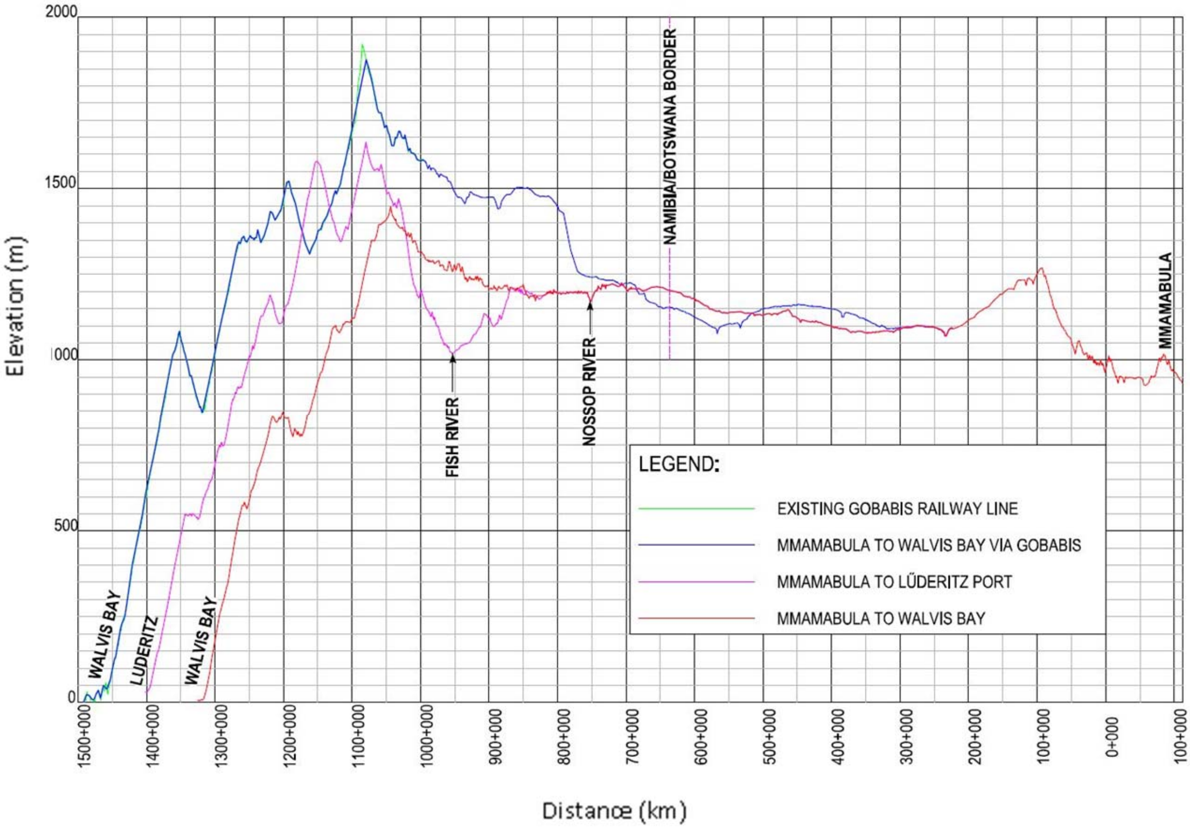
Figure 2-21: Locality plan of final route alignments



176. The longitudinal profiles of the three proposed route alignments, together with the nearest matching existing alignment (in green) is shown in Figure 2-22 below.

177. Note should be taken that the km chainage at Mmamabula is minus km 112. The zero point is near Pilane (Gaborone). The reason for this is that the actual start point at Mmamabula is not yet known, so to amend the entire alignment's chainages due to the actual Mmamabula start point being amended does not make sense. This way, it is possible to amend the start point and only affect the chainages up to Pilane.

Figure 2-22: Profile of final route alignments



178. All three of the proposed routes have a common start point, namely Mmamabula. The elevation at Mmamabula is 940 m above Mean Sea Level (MSL). The routes gradually rise to an elevation of 1,270 m above MSL near Gaborone. From Gaborone, the gradient decreases over a distance of approximately 150 km onto the Kalahari plains which occur at roughly 1,100 m above MSL. The alignment splits at two points; firstly at approximately km 270 at Mabutsane where the line veers off towards Gobabis to the north; then another split further eastwards into Namibia at approximately km 817, at Strampriet near Mariental the line heads south westerly towards Lüderitz and north westerly towards Walvis Bay. The area between km 750 and km 820 is the area where the well-known red dunes of western Namibia occur.

179. The Namibian escarpment is clearly visible on all three options. The highest elevation reached is 1,864 m above MSL and occurs on the Gobabis route (Option 1). The rate of descent from the escarpment of the three alignments is greatest on the Lüderitz (Option 3) route. The lowest route over the escarpment is Option 2, which rises to 1,448 m above MSL

180. Option 1 has more elevation changes and descends over a higher escarpment compared with the other two routes. Apart from being the longest route, it will be

more energy intensive due to the elevation changes than the other two routes. It also has 15.7 km of tunnelling along its route.

181. Option 2 is the shortest route of the three. It is also the route that crosses the escarpment at the lowest elevation, and without utilizing any tunnels along the way.

182. The table below compares the final route alignment characteristics of the three alignment options.

Figure 2-23: Summary of route characteristics of the three proposed alignments

Route Characteristics		Mmamabula to Walvis Bay port via Gobabis (Option 1)	Mmamabula to Walvis Bay port via Mariental (Option 2)	Mmamabula to Lüderitz port (Option 3)
Distance (km)		1,525	1,352	1,430
Highest route elevation MSL (m)		1,864	1,448	1,635
Number of bridge crossings	Large river	1	2	4
	Medium river	44	40	30
	Small river	178	152	157
	Road over rail	83	57	16
	Total bridges area (m^2)	173,200	142,400	126,500
Earthworks CG	Cut volumes (Mil m^3)	15,07	20,29	77,46
	Fill volumes (Mil m^3)	44,58	23,78	19,14
Earthworks SG	Cut volumes (Mil m^3)	16,55	21,97	78,88
	Fill volumes (Mil m^3)	41,21	22,99	18,93
Total tunnel length (m)		15,700	0	12,800

183. The information summarized in Figure 2-23 will be used as base information into the Capex model to provide a high level cost estimate of the alignments, with both SG and CG options assessed. This is dealt with further in the section below.

3 Shipping, Port and Terminal Assessment

3.1 Methodology and Design Criteria

184. This section presents an overview of the technical criteria for the port site selection as well as the design assumptions that inform further planning.

185. Both of the preferred port locations are assessed in terms of their existing port & Dry Port infrastructure & land use, marine environment, including marine metadata, meteorology, geophysical, geotechnical characteristics and proximity to the landside terminal.

186. Navigational infrastructure components are presented for each site. These include:

- Minimum draft assumptions;
- Channel dimensions; and
- Dredging depth.

187. The main components for the bulk material handling are outlined at a conceptual level, and a proposed phasing is presented according to the ramp up of the trade volume forecast.

188. The following design criteria was used to conceptualise the terminal requirements for coal:

Figure 3-1: Design criteria – Coal Exports

Criteria	Considerations
Port Location	• Heavy-haul rail connectivity • Natural Embayment/Existing infrastructure • Hinterland topography and marine environment
Maritime	• Metocean conditions (wave and wind exposure) • Natural depth/Minimal dredging • Berth requirements (operation, number, occupancy, future development) • Navigation Requirements (access channel, turning basin) • Geophysical conditions • Vessel requirements (average and maximum vessel) requirements, and future vessel sizes) • Connection to landside terminal • Coastal and harbour structure requirements (breakwaters, quay walls, causeways, access trestles) • Health and safety requirements
Landside Terminal	• Minimal earthworks/minimal disruption to existing port operations • Throughput ramp-up • Stockyard configuration requirements (location, capacity criteria, material handling and equipment requirements, layout requirements, future development requirements) • Health and safety requirements (dust control, fire requirements,
Utilities	• Availability of existing infrastructure

Criteria	Considerations
	• Planned infrastructure for region
Future Expansion	• Satisfy water, landside, material handling requirements as well as impact on surrounding

189. The following design criteria was used to conceptualise the terminal requirements for non-coal commodities:

Figure 3-2: Design criteria – Non-coal Exports

Criteria	Non-coal
Port Location	• Existing land connection as far as possible • Existing facilities suitable to design vessels
Maritime	• Ability to handle increased traffic
Landside Terminal	• Utilise existing infrastructure where possible
Material Handling	• Avoid double handling • Re-use of facilities
Future Expansion	• Satisfy water, landside, material handling requirements as well as impact on surroundings

3.2 List of assumptions

190. The following list of assumptions needs to be considered with the shipping, port, and terminal assessment.

Figure 3-3: List of Assumptions

No	Assumption Description
1	Two sites for a coal terminal are investigated, being Lüderitz and Walvis Bay
2	The design volume considered is 65 Mtpa for the coal terminal. As this is the core of the feasibility study, the other commodities (approximately 10 Mtpa) are considered as supplementary cargo in this stage of the study.
3	Only previous reports and existing information was utilised for this assessment. No additional analyses or designs were conducted as this is assumed to form part of future study phases. No costing was correlated with contractors at this stage.
4	The ramp up in trade forecast volumes for the coal cargo as per the Traffic Studies Report allows for two production horizons and therefore only two stages, being 16.8 Mtpa (Phase I) and 65 Mtpa (Phase II) are addressed. For non-coal commodities, the maximum forecasted volumes were used to plan required facilities.
5	For both locations, a new port terminal was conceptualised for the coal terminal due to the existing facilities not being adequate for expansion to a deep water port and large land side terminal. Where possible, non-coal traffic has been routed to existing facilities.

3.3 Design Vessel

191. The Capesize vessel is recommended as the average vessel size for coal export for this stage of the study pending detailed studies of vessel size distribution (shipping schedule) at the proposed port. The dimensions of the average Capesize vessel recommended in this study is summarised in Figure 3-4 below.

Figure 3-4: Capesize vessel (Average Vessel Size): Coal Exports

Capesize Average Size	
Length Over All	279.9 m
Beam	44.6m
Draft	17.0m
Dead Weight Tonnage (DWT)	170,211 Mt
Speed	14.3knots

192. Based on a preliminary assessment of vessel statistics from previous similar studies, the following dimensions for the design vessel are recommended, pending detailed studies of future vessel sizes:

Figure 3-5: Design Vessel: Coal Exports

Design Vessel	
Dead Weight (DWT)	250,000
Length Over All (m)	330
Beam (m)	55
Loaded Draft (m)	19.8

193. Navigation requirements for non-coal commodities were based on smaller vessel sizes (see Figure 3-6); therefore the calculated navigation requirements for coal are assumed to be adequate for the non-coal terminal.

194. The following dimensions for design vessels for the non-coal commodities are recommended, pending detailed studies of future vessel sizes:

Figure 3-6: Design Vessels: Non-Coal Exports

	Projected Annual Throughput (MT)	Weekly Parcel Size (tonnes)	Selected Vessel Size	Vessel DWT (tonnes)	LOA (m)	Beam (m)	Depth (m)	Draft (m)
Through Traffic	0.43	8270	Mini Bulk Carrier	10,000	138	20	11	8
Soda Ash	0.32	6154	Mini Bulk Carrier	7,000	124	18	10	7
Salt	0.21	4039	Mini Bulk Carrier	5,000	113	16	9	7
Ni/Cu Matte	0.14	2693	Mini Bulk Carrier	5,000	113	16	9	7
Fuel	0.46	8847	Mini Bulk Carrier	10,000	138	20	11	8
Grains	0.15	2885	Mini Bulk Carrier	5,000	113	16	9	7
Cement	0.35	6731	Mini Bulk Carrier	7,000	124	18	10	7

	Projected Annual Throughput (MT)	Weekly Parcel Size (tonnes)	Selected Vessel Size	Vessel DWT (tonnes)	LOA (m)	Beam (m)	Depth (m)	Draft (m)
Containers	3.61	69424	Panamax	70,000	255	36	20	14
Copper	1.5	28847	Handy-Sized	30,000	195	27	15	11

195. For the purpose of the PFS all dredging for channels and beams, and depth of the structural designs will be based on the bulk coal carrier design vessel.

3.4 Site Selection of proposed Port Terminal locations

196. The Inception Study included various initial candidate port sites in Namibia. The original choices were Elizabeth Bay, St Francis Bay, Cape Fria, Mowe Point, Cape Cross Port, Sandwich Harbour Port, Lüderitz and Walvis Bay.

197. However, previous traffic studies, based on an initial railway assessment, recommended that only Lüderitz and Walvis are to be investigated further as preferred locations. The other locations were thus determined to be unfeasible and eliminated from further stages.

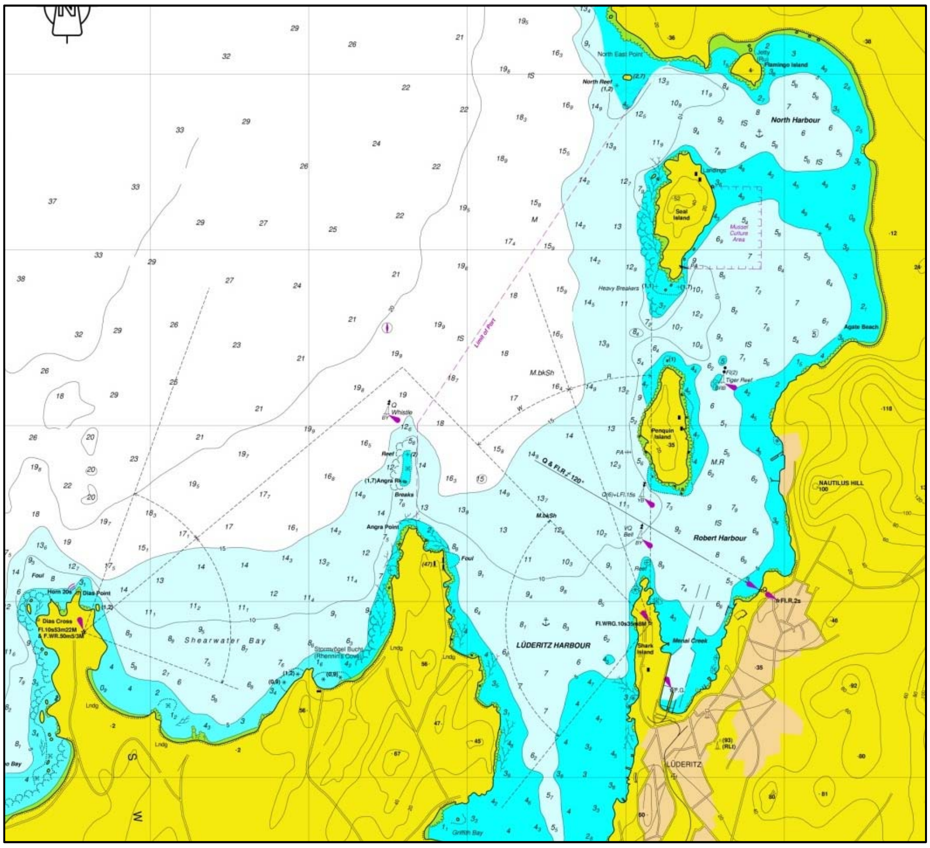
198. Information on the preferred locations of potential ports at Lüderitz and Walvis Bay are presented below, with a Technical Assessment of the sites addressed in the following sections.

3.4.1 Lüderitz

199. Lüderitz Bay is a large indentation lying between North East Point and Dias Point, which is 7.3 km to the South West (SW). Lüderitz has five natural harbour basins and bays. Most parts of these bays are always exposed to a swell which, being refracted by the isobaths of the coast, sweeps in from the South West (SW). Strong SSW to SW winds blow almost continuously for about ten months of the year.

200. An existing commercial port managed by Namport exists in Robert Harbour, inclusive of a Fishing Industry. The proposed terminal locations for Lüderitz Bay are Lüderitz Harbour, Robert Harbour, Middle and North Harbour, and Shearwater Bay. An ongoing PFS for Lüderitz indicated the current port (within Robert Harbour) is constrained for large future development. This is taken into account in separate sections on site selection.

Figure 3-7: Admiralty Chart showing proposed terminal locations (Luderitz)



3.4.2 Walvis Bay

201. Walvis Bay Town and harbour are situated in a bay on the leeward side to the North of Pelican Point. Walvis Bay currently has an operating commercial and fishing harbour. The current draft for the channel and Berth 1-3 is -14.0m CD. Walvis Bay has deep sand layers offshore. Namibian Ports Authority (Namport) is also currently planning expansion of the existing harbour which would necessitate deepening of the harbour basin and navigation channels. Although the bay is relatively shallow, dredging seems to be feasible.

202. It is envisaged that NAMPORT will dredge to -16.0mCD for the container terminal expansion.

203. Potential harbour sites were previously located within the port limits. Potential options for a deep sea port location were considered north of the existing port for coal, so as to minimise dredging and also to create a connection with a terminal that would not interfere with the town's planning limits.

204. For the non-coal commodities, the following site were identified:

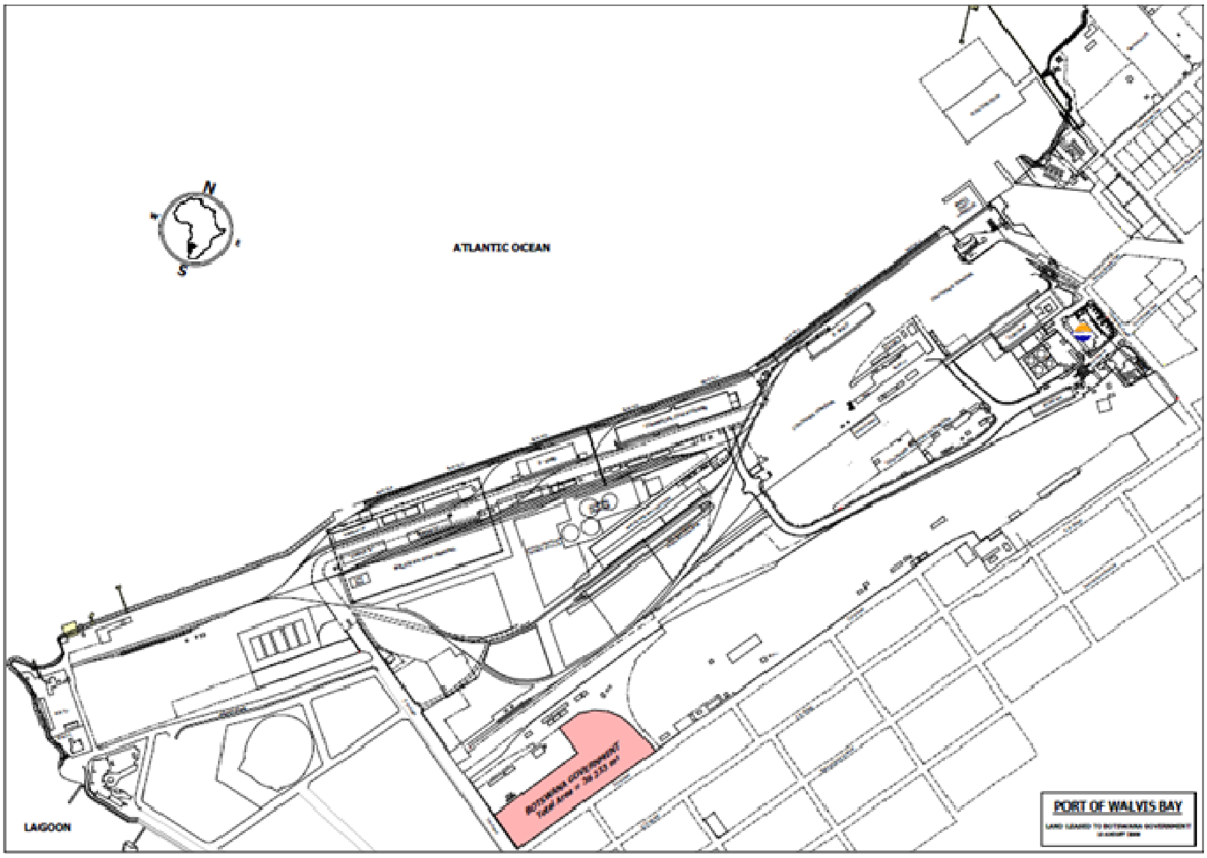
Figure 3-8: Non-Coal Commodities Site Selection

Commodity	Proposed Site Location
Soda Ash	Botswana Dry Port. New storage shed
Salt	Existing salt terminal
Ni/Cu Matte	Refer to Figure 3-9. Botswana Dry Port
Fuel	Existing liquid bulk terminal

Grains	Proposed future grain facility as planned by Namport
Cement	Botswana Dry Port New storage shed
Containers	Existing container terminal and future container terminal expansion by Namport
Copper	Refer to Figure 3-9 for Botswana Dry Port.

205. The proposed Botswana Dry Port is to be located in the Walvis Bay Port (see shaded area in Figure 3-9 below).

Figure 3-9: Botswana Dry Port in the Port of Walvis Bay



206. The premise for the non-coal commodities being located at the Botswana Dry Port is that the current connectivity issues are addressed. Namport is planning to include & connect the Dry Port within the Commercial Port of Walvis Bay. From the layout, it can also be seen that apart from the nearby railway line, there is no current road connectivity other than via municipal access roads.

3.5 Technical Assessment of Lüderitz site

207. The technical assessment highlights boundary conditions for the sites, inclusive of meteorological, marine environmental metadata and physical information (e.g. bathymetry and geotechnical data) of the sites as well as a discussion on the suitable sites for the coal terminal locations.

3.5.1 Bathymetry

208. The bathymetry of Lüderitz is shown on Naval ChartSAN 1002 (see Figure 3-7). The bathymetry of the various embayments displays a far more complex nature of the seafloor with several areas of blinders, outcroppings and islands.

209. The various embayments behind the islands are typically not deeper than -12 m CD. Between the islands in an alignment south north, a ridge is evident. This ridge is most likely to consist of rocky material. Shearwater Bay bathymetry shows relative deep water offshore to the North of the bay between Dias and Angra (see Figure 3-11).

210. Considering future land and water space required, the Shearwater bay site has been selected.

3.5.2 Cadastral

211. The nautical extent of the Port of Lüderitz is shown on the Naval Chart SAN 1002 (see Figure 3-7). The nautical port limits are under the jurisdiction of Namport.

212. The commercial port, owned and controlled by Namport, has a very short waterfront of approximately 800 m. The remainder of the shoreline is owned by various fishing, ship repair and diamond mining entities and falls under the jurisdiction of the Municipality. Further to the north, the areas are mostly owned by the State.

3.5.3 Topography

213. The hinterland to Lüderitz is hilly and rocky. This will have an impact on the transportation network and location of stockpile area.

3.5.4 Waves

214. From previous wave studies for Lüderitz, the following summary can be drawn:

215. Wave energy can only reach the entrance to the Port of Lüderitz from a restricted direction due to the geometric shape of the Lüderitz and Robert Harbour bays. The major significant wave energy that can affect the project site is from a window extending from west to north-west (see Figure 3-10).

Figure 3-10: Orientation of Lüderitz and Robert Harbour

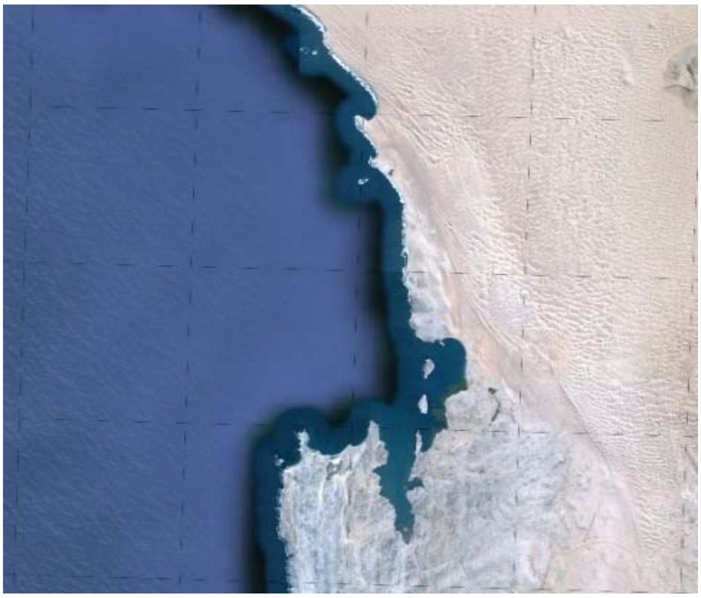
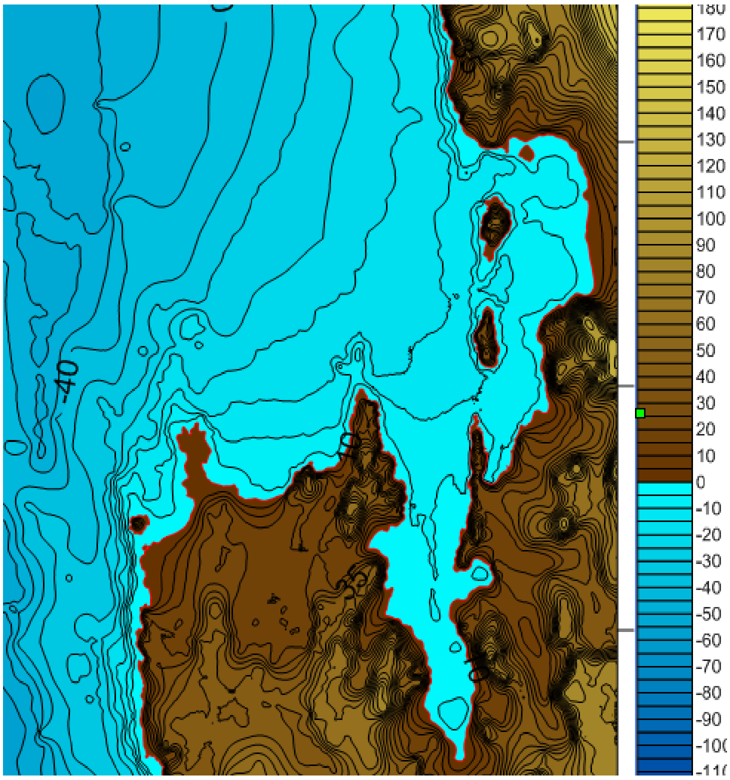
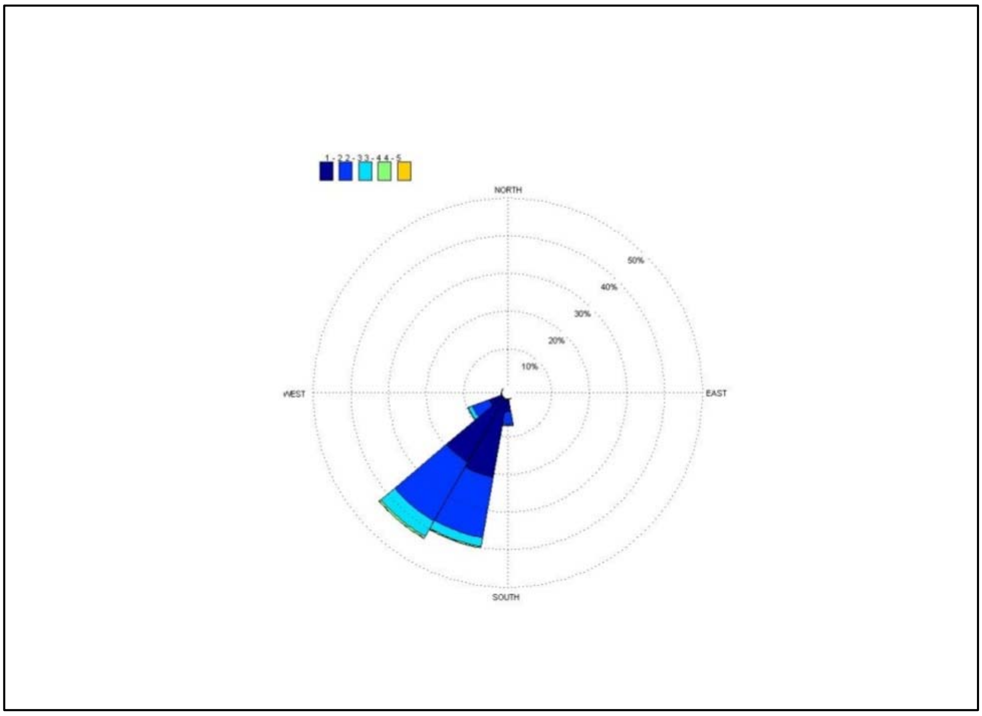


Figure 3-11: Bathymetry of Lüderitz Bay



216. Predominant wave direction lies in the 200°–215° window (see Figure 3-12 below).

Figure 3-12: Offshore wave rose at the Port of Lüderitz



217. The results of the offshore extreme analysis for the significant wave heights for return periods 1, 5, 10, 20, 50 and 100 years are summarised in Figure 3-13.

Figure 3-13: Extreme offshore wave analysis for various Return Periods

Return Period (years)	Significant Wave Height (metres)
1	3.70
5	5.25
10	5.70
20	6.00
50	6.50

218. From a previous wave transformation study the wave statistics at five locations in Lüderitz Bay (see Figure 3-14) for significant wave heights ranging from 1 to 7 metres, wave periods from 7.5 to 25.5 seconds and wave directions from 0 to 120 degrees were determined. The results are summarised in Figure 3-15.

Figure 3-14: Location of near-shore positions where wave climate will be determined

Figure 3-15: Extreme Significant Wave Heights (metres) for various Return Periods (years)

Wave height (Hs in m) exceedence frequency					
Return Period (years)	**B**	**C**	**D**	**RH**	**E**
1	1.38	1.40	1.70	0.97	2.61
5	2.09	1.95	2.14	1.27	3.89
10	2.26	2.06	2.26	1.32	4.20
20	2.38	2.16	2.41	1.39	4.46
50	2.58	2.27	2.55	1.50	4.80
100	2.74	2.38	2.65	1.55	5.09

3.5.5 Wind

219. The Lüderitz and Robert harbour bays are characterised by strong, predominantly South South-East (SSE) winds throughout the year with speeds in excess of 30 km/hr. The SSE wind direction has a 77% frequency during summer and 57% frequency during winter. The North East winds prevail during the winter months, and can reach wind speeds of 50 km/hr.

3.5.6 Tides

220. The tidal data, sourced from The International Admiralty Chart Series Reference INT 2631 SAN 1002, is summarised in Figure 3-16.

Figure 3-16: Tidal Planes for Robert Harbour

Tidal designation	Relative to Chart Datum (mCD)
HAT (Highest Astronomical Tide)	1.99
MHWS (Mean High Water Spring)	1.65
MHWN (Mean High Water Neap)	1.22
MSL (Mean Sea Level)	0.94
MLWN (Mean Low Water Neap)	0.65
MLWS (Mean Low Water Spring)	0.23
LAT (Lowest Astronomical Tide)	0.00

3.5.7 Currents

221. The Benguela Current system, running along the western coast of Namibia, will have little effect on vessels calling to the Port of Lüderitz. The only current which may have an impact on vessels entering or exiting the port is the current running along Seal and Penguin Islands, which will be mainly wind-driven. Typical current velocities in Robert Harbour have been measured at 0.1m/s.

3.5.8 Geophysical

222. A geophysical investigation was conducted by the CSIR-DEMCO JV in 2009. The seabed in the existing port is comprised predominantly of a layer of silty sediment overlaying hard gneiss bedrock. This geophysical layering is characteristic of both Lüderitz Bay and Robert Harbour.

3.5.9 Geotechnical data

223. Geotechnical parameters for concept development have been derived based on the borehole data from a previous investigation.

224. The following soil characteristics were deduced from the geophysical and geotechnical investigation and data respectively.

Figure 3-17: Characteristics of soil

Soil Type	Broad Characteristics
Harbour Bay Sediment Deposits	Predominantly silt and clay deposits with traces of heavy metals and polyaromatic components underlain by discontinuous layers of coarse sand and gravel.
Namaqualand Metamorphic Complex	Below the sediment deposits the basement rocks consist primarily of Gneisses, Schists and Granite rock formations.
Entrapped Gas	Based on sub-bottom profiling a later of impenetrable acoustic basement layer which suggests that there could be gas (H_2S) trapped within the sediment succession.

3.5.10 Navigation requirements

225. The minimum loaded draft requirement depends on the design vessel specification and application of safe navigational criteria. Paragraph 192 indicates for the design vessel, loaded draft require is 19.8m for the required Bulk Carrier. .

Channel Dimensions

Figure 3-18: Navigation Channel Calculations for Lüderitz

Navigation Channel Characteristics		
Vessel Characteristics	**Coal Bulk Carrier**	
Length Over All (LOA)	330	M
Capacity/ Dead Weight (DWT)	250,000	Mt
Beam (B)	55	M
Draft (T)	19.8	M
Vessel speed v_s	8	Kn
Amplification factor	**Open Sea**	**Sheltered areas**
Manoeuvrability	1.5B	1.5B
Vessel speed	0.1B	0.1B
Lateral wind	1.0B	1.0B
Lateral current	0.7B	0.1B
Longitudinal current	0.0B	0.0B
Wave conditions	2.2B	1.0B
Navigational aids	0.2B	0.2B
Bed characteristics	0.2B	0.2B
Water depth	0.2B	0.4B
Hazardousness of cargo	0.0B	0.0B
Embankment characteristics x2	0.5B	0.5B
Subtotal one way traffic	7.1B	5.5B
	319.5	247.5
Rounded Channel Width	320 m	250 m

226. The navigation channel widths for Lüderitz, the widths are 320 m for the outer channel (Open Sea) and 250 m for the inner channel (Sheltered Area).

227. The above calculated navigation requirements (see Figure 3-18) will be adequate for the non-coal commodities.

Dredging depth

228. Water depths shown on naval charts together and other available bathymetric information were used to calculate dredging. All levels indicated on naval charts and bathymetric information is referenced to Chart Datum (CD).

229. Permanent International Association of Navigation Congresses (PIANC) 'Approach Channels: Preliminary Guidelines' was used to calculate the depth and width for straight channel sections:

- Lüderitz Approach Channel Widths: Inner = 250 m, Outer = 320 m
- Only -13 m CD is necessary for empty vessels in Lüderitz

230. The required dredging depth for channels, berths and basins is shown in Figure 3-19.

231. The Lüderitz approach channel will be dredged to a minimum dredged level of -21.78 m CD; however, the outer channel should not require dredging due to sufficient water depth.

Figure 3-19: Calculation of dredging depth for 19.8 m vessel

Dredging depth for channels with 19.8 m Design Vessel according to PIANC				
Site	**Formula (function of T)**	**Sheltered (m)**	**Formula (function of T)**	**Open Sea (m)**
Lüderitz	1.10	21.78	1.17	23.17
Draft (T)	19.8	m		

Port Structures

232. This section will contain the remaining general assumptions required for the PFS work on the coal port options.

233. Assumptions: Minimum sizes for structures for coal terminal

- Quay/Pier
- Minimum length per berth is 350 m (inclusive of mooring facilities); and
- Shiploader and conveyor parameters will determine width.
- Causeway
- Width for piled causeway = 10m (5m for road and 5m for three conveyors).

234. Assumptions: Minimum sizes for structures for non-coal terminal

Quay/Pier

- Minimum length per berth is 200m (inclusive of mooring facilities)
- Shiploader and conveyor parameters will determine width

Offset from existing channel

235. The offset is determined by the berthing layout. For a longitudinal berthing layout (vessels berth bow to stern along the quay) the offset from the navigation channel

needs to allow a vessel, with tugs in attendance, to pass a berthed vessel with adequate clearance.

236. When a vessel starts un-berthing at a longitudinal quay in proximity to a navigation area, the offsets needed are shown in Figure 3-20.

Figure 3-20: Offsets next to longitudinal berth

Offsets needed next to quay	
Description	**Offset (m)**
Beam of coal vessel	45
Tug line	50
Tug length	35
Safety offset	20
Total	**150**

237. This value of 150 m coincides with the safety offset of 150 m, between channel and berth, which Namport has deemed to be necessary for a liquid bulk berth alongside the navigation channel.

238. When a vessel is berthed on opposite sides of a pier structure, the basin width or offset value can be reduced to 100 m (this is sufficient for the pull-off and manoeuvring area needed). Also note that tugs can operate in shallow water (- 5 m CD) and therefore no dredging is required to allow tugs to operate.

239. Dredged Material Utilisation for Reclamation: Initial Assumptions

- Lüderitz – The first assumptions about the geotechnical profile is that top layers (around 2 m) cannot be used due to high organic content. The balance being rock, can be used, but is not preferred due to difficulty of handling. (Further description is given in section 4.3 Geotechnical information.)

240. Berthing structures will be designed to allow a future deepening of the basin to depths as indicated in Figure 3-20.

241. Navigation requirements determined for the bulk coal carriers are considered adequate for the non-coal cargo carriers.

Maintenance Dredging

242. From discussions with Namport, it was noted that minimal maintenance dredging occurs at Lüderitz i.e. no maintenance dredging records were present. However, an allowance has been made for 100 000 m^3 to be dredged every five (5) years.

3.6 Technical Assessment of Walvis Bay site

243. The technical assessment highlights boundary conditions for the sites, inclusive of meteorological, marine environmental metadata and physical information (e.g.

bathymetry and geotechnical data) of the sites as well as a discussion on the suitable sites for the coal terminal locations.

3.6.1 Bathymetry

244. The bathymetry of Walvis Bay is shown on Naval Chart SAN 1001. The bathymetry of the bay displays a gradual increase in depth from the south (lagoon mouth) to the north into the open ocean. There are no signs of rock outcropping i.e. sudden changes in depth or pinnacles. The first outcropping is Bird Island to the north west of the bay.

3.6.2 Topography

245. The immediate hinterland to Walvis Bay is typically relatively flat. To the north east are high dunes but with sufficient space for a variety of options to develop rail or conveyor corridors and stockpile locations.

3.6.3 Cadastral

246. The nautical extent of the Port of Walvis Bay is shown on Naval Chart SAN 1001. It is clear from this chart that the port limits cover an extensive area and include the entire embayment within Pelican Point peninsula. There are private owners of landside areas along the northern borders with the Namibian Navy occupying the extreme northern extents of the embayment.

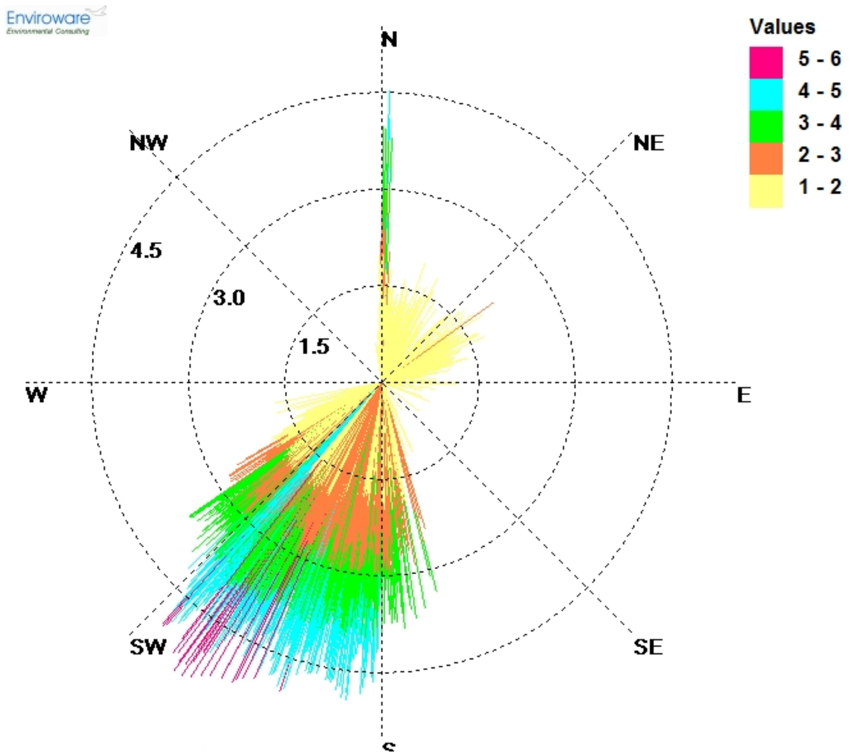
247. Beyond the breakwater to the north the land area is primarily under the jurisdiction of the Municipality and partly owned by private or state enterprises. The distance from the breakwater to the northern port limit along this shoreline is approximately 8 km.

3.6.4 Wave data

248. From a previous wave study (for Namport) the following summary can be drawn:

- Deep sea waves originate predominantly from sector S to SW with 60 % of waves from SSW (see Figure 3-21)

Figure 3-21: Offshore significant wave height distribution (shown as storm swell)

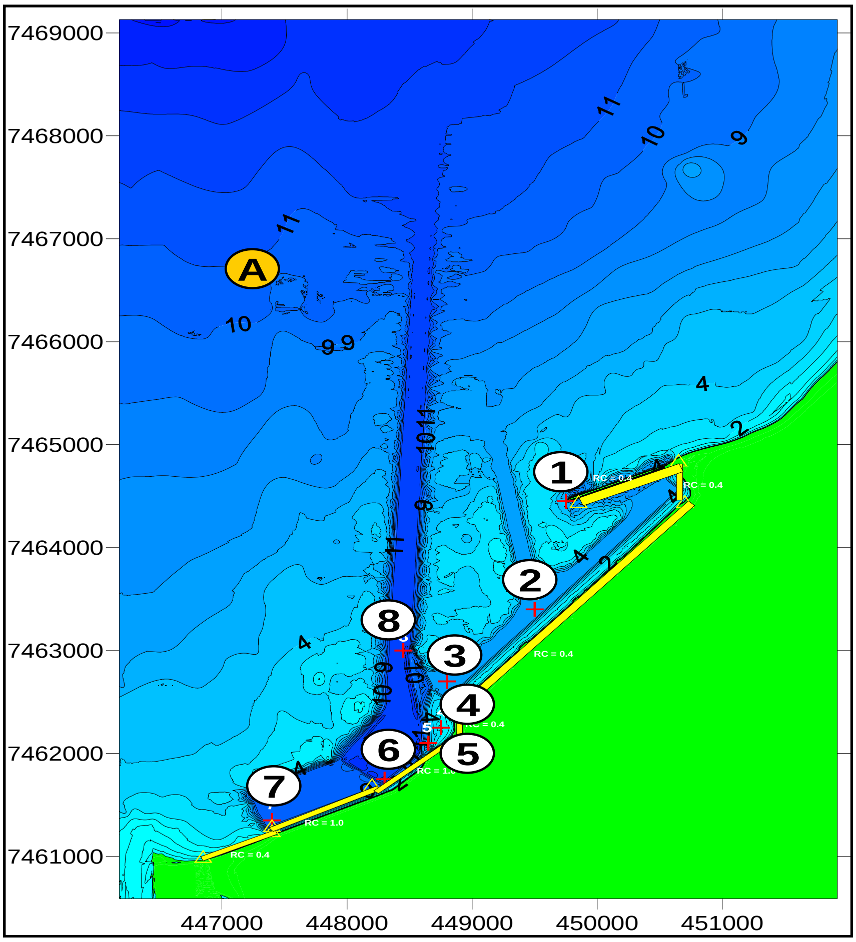


249. From a previous wave transformation study wave statistics for locations inside the embayment were determined (see Figure 3-22 and Figure 3-23)

Figure 3-22: Summary of wave height exceedance frequency at Points 1, 2, 3, 4, 5, 7 & 8

Wave height (Hs in m) exceedance frequency						
Point No	**1/year**	**1:5 years**	**1:10 years**	**1:20 years**	**1:50 years**	**1:100 years**
1	1.7	2.9	3.2	3.4	3.5	3.7
2	1.0	1.6	1.7	1.8	2.0	2.2
3	0.8	1.3	1.4	1.5	1.7	1.8
4	0.9	1.6	1.7	1.8	2.0	2.2
5	0.9	1.4	1.6	1.7	1.8	1.9
7	1.5	2.4	2.6	2.7	2.8	3.0
8	1.7	2.5	2.7	2.8	3.0	3.2

Figure 3-23: Port of Walvis Bay near-shore wave reference locations



3.6.5 Wind data

250. At the offshore location the wind direction is predominant from the sector SSE to SSW (79%). The 1 in 1 year average, 3 s gust is 19.2 m/s, the 1 in 10 year average, 3 s gust is 21.4 m/s and the 1 in 100 year average, 3 s gust is 23.9 m/s

251. It is considered that the actual wind conditions at Walvis Bay Harbour are more extreme than at the offshore measurement location, due to local interface between land and sea.

3.6.6 Tides

252. The tidal regime is given in the SAN publication for Walvis Bay as follows (see Figure 3-24):

Figure 3-24: Characteristic tidal water levels at Walvis Bay

Tidal designation	Relative to Chart Datum (mCD)
HAT	1.97
MHWS	1.69
MHWN	1.29
MSL	0.98
MLWN	0.67
MLWS	0.27
LAT	0.00

3.6.7 Currents

253. Tidal currents in the bay can be estimated as generally low. Following the South African Navy Charts (SAN 1001) the tide induced coastal currents are in the order of 0.5 m/s to 1.0 m/s. However, local deviations on the shallow flats and the deeper access channel to the port are to be expected. At the entrance to the shallow lagoon currents may reach two to four knots.

3.6.8 Geophysical

254. No geophysical investigation or information was obtained to be able to assess the subsea conditions of the Walvis Bay site.

3.6.9 Geotechnical

255. The Walvis Bay area is underlain by Holocene to Late Quaternary sediments with the upper seabed consisting of highly organic diatomaceous ooze, which overlies clean sandy sediments with a low organic content.

256. The quartzitic sands that are present below the diatomaceous ooze vary from medium dense to dense. They occur down to elevations of approximately -10 m CD to -18 m CD and are granular, non-plastic to slightly plastic and non-cohesive, with moderate compressibility and strength.

3.6.10 Navigation requirements

257. The minimum loaded draft requirement depends on design vessel specification and the application of safe navigational criteria. Paragraph 192 indicates for the design vessel loaded draft required is 19.8m for the required Bulk Carrier.

Channel dimensions

258. The navigation channel widths are calculated for Walvis Bay in Figure 3-25.

Figure 3-25: Navigation Channel Calculation for Walvis Bay

Navigation Channel Characteristics		
Vessel Characteristics	**Coal Bulk Carrier**	
Length Over All (LOA)	330	m
Capacity (Dead Weight Tonnage)	250,000	mt
Beam (B)	55	m
Draft (T)	19.8	m
Vessel speed v_s	8	kn
Amplification factor	**Open Sea**	**Sheltered areas**
Manoeuvrability	1.5B	1.5B
Vessel speed	0.0B	0.0B
Lateral wind	0.4B	0.8B*
Lateral current	0.2B	0.1B
Longitudinal current	0.0B	0.0B
Wave conditions	1.0B	0.0B
Navigational aids	0.2B	0.2B
Bed characteristics	0.1B	0.1B
Water depth	0.2B	0.4B
Hazardousness of cargo	0.0B	0.0B
Embankment characteristics x2	0.5B	0.5B
Subtotal one way traffic	**4.6B**	**4.1B**
	207	184.5
Rounded Channel Width	**210 m**	**185 m**

259. As a practical check the width needed for a slowly moving ship, with a tug on each side, just starting to navigate out to sea (from the existing harbour basin) and steered at angle of 10 degrees into the crosswind was calculated. An extra value of 0.6B (Beam) was added to the lateral wind factor to account for this. ($\Delta = 71/\cos 10° - 45 = 27 = 0.6B$) This factor is only added for sheltered areas as the ship will be moving at a high speed and the impact will therefore be much less.

260. The navigation channel widths in Walvis Bay, according to PIANC are shown in Figure 3-25.

261. The current draft of the channel and Berth 1 – 3 is -14.0m CD.

Port Structures

262. This section will contain the remaining general assumptions required for the PFS work on the coal port options.

263. Assumptions: Minimum sizes for structures for coal terminal

- Quay/Pier
- Minimum length per berth is 350 m (inclusive of mooring facilities)
- Shiploader and conveyor parameters will determine width
- Causeway

- Width for piled causeway = 10m (5m for road and 5m for three conveyors)

264. Assumptions: Minimum sizes for structures for non-coal terminal

- Quay/Pier
- Minimum length per berth is 200 m (inclusive of mooring facilities)
- Parameters will determine new facilities versus existing port infrastructure (e.g. shiploaders and conveyors required).

Dredging

265. Water depths shown on naval charts together with available bathymetric information provided by Namport are used to calculate dredging. All levels indicated on naval charts and bathymetric information is referenced to CD.

266. PIANC 'Approach Channels: Preliminary Guidelines' was used to calculate the depth and width for straight channel sections:

- Walvis Bay Approach Channel Width: Inner = 185 m, Outer = 210 m

Offset from existing channel

267. The offset is determined by the berthing layout. For a longitudinal berthing layout (vessels berth bow to stern along the quay) the offset from the navigation channel needs to allow a vessel, with tugs in attendance, to pass a berthed vessel with adequate clearance.

268. When a vessel starts un-berthing at a longitudinal quay in proximity to a navigation area, the offsets needed are shown in Figure 3-26.

Figure 3-26: Offsets next to longitudinal berth

Offsets needed next to quay	
Description	**Offset (m)**
Beam of coal vessel	45
Tug line	50
Tug length	35
Safety offset	20
Total	**150**

269. This value of 150 m coincides with the safety offset of 150 m, between channel and berth, which is deemed to be necessary for a liquid bulk berth alongside the navigation channel.

270. When a vessel is berthed on opposite sides of a pier structure, the basin width or offset value can be reduced to 100 m (this is sufficient for the pull-off and manoeuvring area needed). Also note that tugs can operate in shallow water (- 5 m CD) and therefore no dredging is required to allow tugs to operate.

271. Dredged Material Utilisation for Reclamation: Initial Assumption

- Top 3 m to spoil due to high organic percentage. Balance of material can be used for reclamation material.

272. Navigation requirements determined for the bulk coal carriers are considered adequate for the non-coal cargo carriers.

Maintenance Dredging

273. From discussions with Namport, it was noted that approximately 250 000 m³ is dredged every five (5) years.

3.7 Technical Comparison of Potential sites

Figure 3-27: Technical comparison of the potential sites

Description	Lüderitz	Walvis Bay
Site Access	Difficult due to the uneven landscape	Close to existing road and rail for the coal and non-coal
Enabling works	Earthworks expected in order to create laydown area and land terminal on rock	To be built up from natural ground level on sand
Utilities	Locally, little or no capacity. A new power and desalination plant required	Existing plans in the region to increase capacity
Maritime factors	• More wave exposure • Strong gusting wind • Dredging: dredging is in rock new channel and turning basin to be dredged • Deep water • Known for navigational challenges, however, larger vessels can be accommodated	• Protected bay • Dredging: dredging in sand, channel and turning basin to be dredged •
Rail operational conditions	• Wind-blown sand on track and terminal • Less vessel traffic	• Wind-blown sand on track and terminal • More vessel traffic
Connectivity	• Hinterland connections inadequate	• Hinterland connections adequate
Rank	2	1

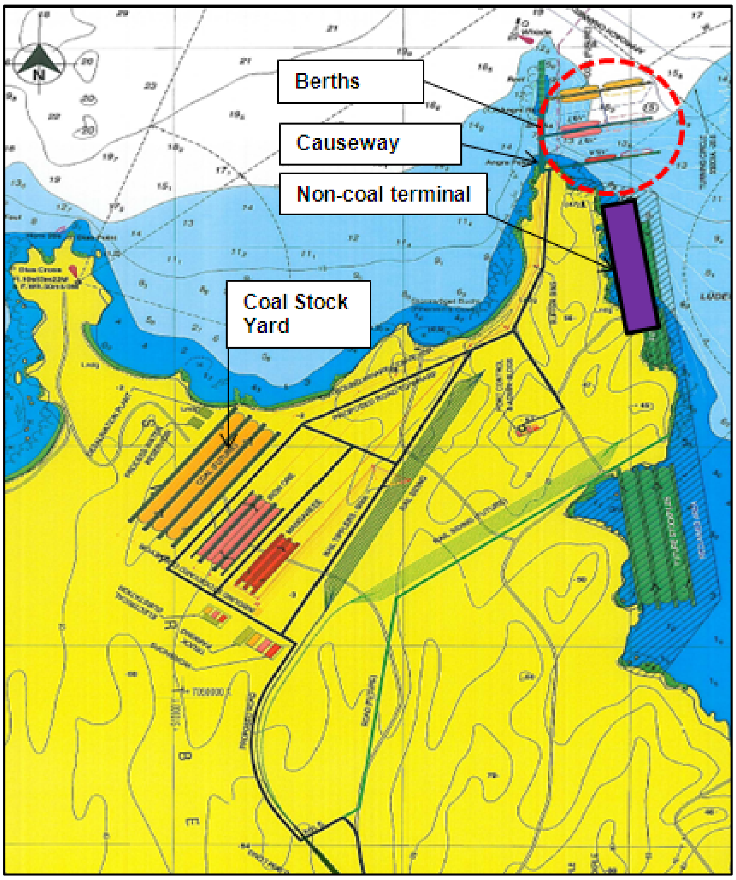
274. The likely competitiveness of the candidate ports is a function of the overall logistic solution.

3.8 Coal Terminal Development for Lüderitz and Walvis Bay sites

3.8.1 Coal Terminal Development: Conceptual Layouts

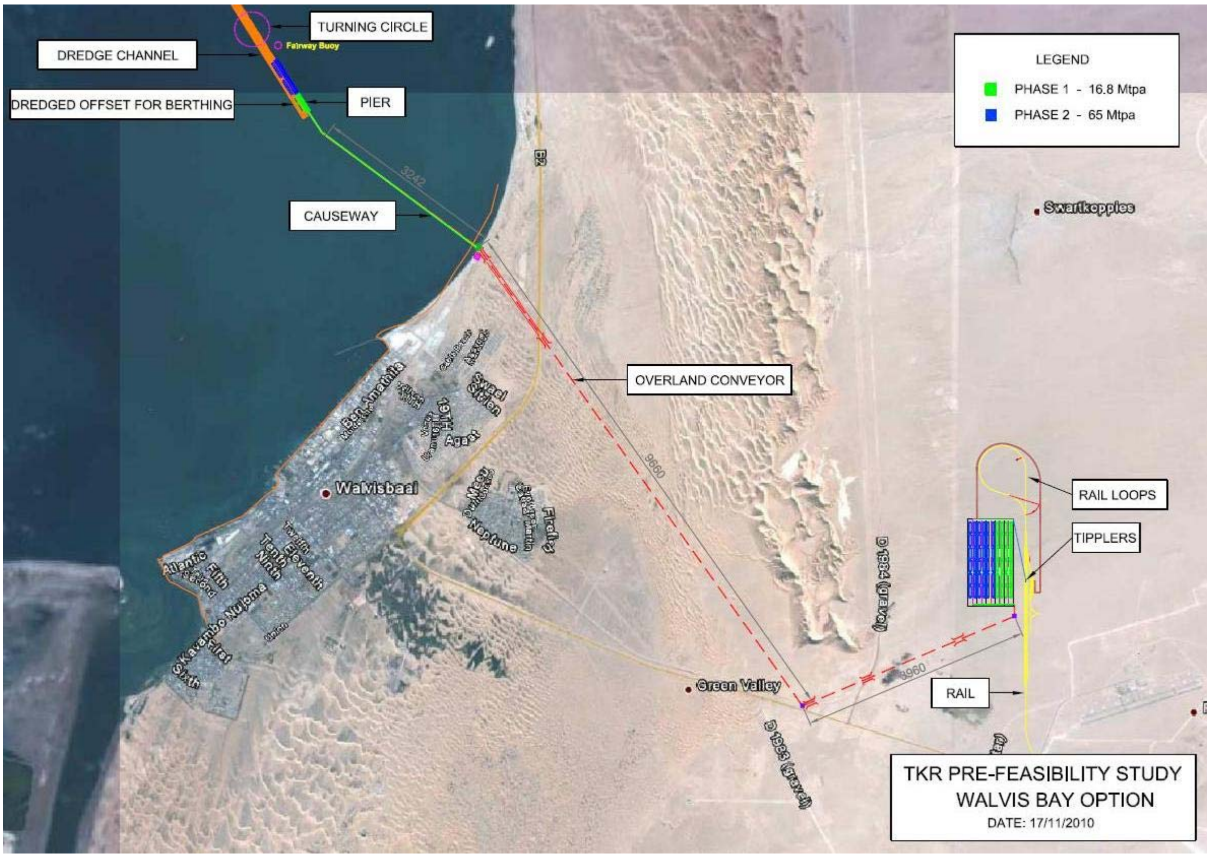
275. The proposed coal terminal development conceptual layout (developed from other studies) for the Port of Lüderitz at Angra Fria is shown below:

Figure 3-28: Proposed Deepwater Port at Angra Fria (Coal and non-coal terminals)



276. The proposed coal terminal development conceptual layout for the Port of Walvis Bay is shown below:

Figure 3-29: Proposed Coal Terminal Development at Port of Walvis Bay



3.8.2 Berthing requirements

277. Due to the cost of operating the dry bulk vessels, the turn-around time is an important cost-saver. Therefore, these vessels generally call into a port where the service times are low i.e. where there are low berth occupancies with high loading rates.

278. From a preliminary assessment of similar projects in South Africa, Mozambique, Australia and Brazil, for the study it is recommended that the following berths will be required for each of the phases Figure 3-30:

Figure 3-30: Berth requirements

Phase	Required no. of berths
I	1
II	3

279. A first estimate of the optimal number of berths is based on a sensitivity test of the berth occupancy and congestion factor.

280. A sensitivity test of the berth occupancy and congestion factor is shown below:

Figure 3-31: Sensitivity analysis of the berth requirements on berth occupancy and congestion factor

Phase	No. of Berths	Berth occupancy	Congestion factor
I	1	0.10	0.08
		0.30	0.32
		0.50	0.75
		0.60	1.13
II	3	0.10	0.00
		0.30	0.03
		0.50	0.12
		0.60	0.23

281. It can be seen from Figure 3-31 above, for a berth, as the berth occupancy increases, the congestion factor increases i.e. the waiting time increases.

282. For this study optimal berth occupancy will have to satisfy not only the initial phase but any subsequent phases thereafter. The chosen berth occupancy is **0.60**, which entails a congestion factor of 0.32 and 0.23 for Phase I and II respectively.

3.8.3 Development of Bulk Materials Handling Concepts

Rail Receival Systems

283. Tippler Station and Rail Loop: Initially two loops are required for up to 16.8 Mtpa. However, additional rail loops are envisaged to accommodate the creation of additional capacity, as follows:

Figure 3-32: Summary of Additional Rail Loop Requirements

Capacity Increment	No. Rail Loops
16.8 Mtpa	2
65 Mtpa	5

284. Tippler and indexer: Based upon the performances detailed in separate studies, tippler stations are proposed to suit the target capacities as summarised below. Figure 3-33 is based on conservative assumption that smaller trains will be used and that decoupling of wagon consists will be required (this proposal has been used as the basis for cost estimation).

Figure 3-33: Number of Tippler Stations Required to Suit Decoupling and 112 X 63 t Wagons

Capacity Increment	No. tippler Rail unloading stations
16.8 Mtpa	2
65 Mtpa	5

3.8.4 Stockyard

Assumed Rail and Storage Operating Philosophy

285. It has been assumed that there will be several grades of coal that need to be stored at the stockyard facilities.

286. It has been assumed that the terminal stockyards will operate as the main buffer between the mining operation and the ship-loading with minimal storage provided at the mine site. It is further assumed that the coal will be railed to the port on a regular basis to generally match a steady mining production rate.

287. For this type of operation it is most efficient to store each coal type in dedicated areas within the stockyard, especially when there are minimal coal types.

288. This form of operation (as opposed to a cargo assembly operation) is the most efficient method when there is a long railway and relatively few product types that are each shipped on a reasonably regular basis. It is also the best method, when railing delays are possible as it allows the whole buffer volume to be stored at the terminal at the earliest possible time.

289. Coal would be stored in typically large stockpiles of each grade in dedicated areas that are allocated in the stockyard. The stockpiles grow and contract depending upon the shipping schedule. When there is a gap in shipping for a particular coal grade, that pile grows to maximum. When there are many ships for that coal grade, the stockpile reduces.

Required Storage Volume

290. Based on the operating philosophy as described above, the stockyard space that should be made available for each coal grade should be determined according to two criteria:

Criterion A: 2 to 3 Ships per Product Type

291. For this criterion, the volume required is set by the level of variability in the shipping schedule. If the shipping schedule was perfectly matched to the mining rate, then no more storage would be required than 1 X the largest ship. However, this can never be practically achieved in practice and additional storage volume is required to match the actual variability in the shipping arrivals and ship sizes. The shipping arrivals for the different products may have very different frequencies but usually have very similar levels of variability. In the absence of any detailed knowledge of the applicable shipping schedules, it can usually be assumed that about 2 to 3 ships per product will provide enough buffer storage. Therefore,

under this criterion, the overall stockyard volume will be determined according to number of products rather than according to annual throughput.

Criterion B: % of Annual Throughput

292. This second criterion is usually applied to allow for sufficient storage of high throughput products to withstand some reasonable delays in rail supply, especially for long railways where loss of rail supply is more likely. A check is usually made of the volume provided as a percentage (%) of throughput to ensure that typical delays in railing may be accommodated. This criterion is usually applied to limit the stored volume to no less than about 6 to 10% of throughput. Considering an average fill of 50% of maximum stockyard capacity at any point in time, there is a reasonable likelihood that a 6% capacity allowance will contain 3% of throughput at any point in time. Therefore, a 6% allowance would provide a 50% probability that an unexpected 10 days loss of supply would be covered. There would then be a high likelihood that up to 5 days loss is covered. Therefore a 6% allowance appears to be a suitable.

Stockyard Options

293. Stockyard options have been determined to suit the volumetric requirements described above and to integrate with the required loading and unloading systems.

294. The methodology was to first consider the proposed configuration of the bulk material handling and infrastructure in a preliminary assessment, which would enable a comparison of the CAPEX and OPEX to be done, and from this preliminary design, recommendations would be made.

Dual Purpose Stacker-Reclaimer Machines

295. This configuration is based upon use of dual purpose Stacker/Reclaimer machines of similar capacity to those proposed in similar operations.

296. In this arrangement, two reclaim machines would operate together to achieve sufficient reclaim rate to match the required ship-loading rate. In this respect, the operation is similar to that adopted at the Dalrymple Bay Coal Terminal located near Mackay in Australia. The use of two machines also allows for 50/50 blending to be achieved on outloading in the event that this might offer some advantage at some future time.

297. The machine capacities included are also of similar capacities to the Mitsubishi S/R machines that were supplied to the DBCT terminal. This size machine will therefore be readily sourced from Asian equipment designer/manufacturers.

298. Since this configuration can also accommodate dual inloading systems, each inloading system need only yield a throughput of 13 Mtpa. There is therefore no requirement to necessarily avoid wagon decoupling or to use the larger 80 t capacity wagons.

Stockyard Layouts

299. In determining space requirement for these stockpiles, a mean bulk density of 0.9t/m³ has been assumed along with 6 separate piles per row.

300. 6 x separate stockpiles per stockpile row have been allowed to suit the possibility that a large number of brands will be required to be handled. A separation of 10 m between piles in the same row has been allowed. Additional space between piles has also been allowed to accommodate cross drainage.

301. Stockpile widths have been selected to allow efficient recovery using a typical bucketwheel reclaimer boom of 62.5 m length. The selected stockpile widths are such that a small volume of coal (approximately 1.5%) will not be able to be automatically recovered by the bucketwheel without some assistance by a dozer to move this small volume of coal into the area where it can be recovered by the bucketwheel. The benefit of using these wider piles with some "dead" space is that a much larger live volume is able to be stored in a given stockyard length and reclaim efficiencies are significantly improved.

302. Yard machine runways have been positioned on top of elevated machine bunds. These elevated bunds serve to protect the yard machines and yard conveyors from burying in case of stockpile slumping as can occur as a result of heavy rains during flash floods. Suitable allowances have also been made for longitudinal open drains alongside these machine bunds.

303. In the case of this configuration, when the stockyard is expanded beyond 16.8 Mtpa and additional stockyard rows are added, additional space is proposed to be allowed between the initial stockyard row pair and future stockyard row pair to accommodate the possible future addition of stackers and stacker bunds. This may be found useful should it later be decided to convert the terminal to a high throughput cargo assembly type operation. Such a conversion might be desirable should the number of mines and product types increase substantially beyond current levels at some future stage.

Incremental Developments for 16.8 and 65 Mtpa

304. As explained earlier, the philosophy was to develop the export facility in stages, i.e. for 16.8 Mtpa and 65 Mtpa. The following schematics show the typical development for this configuration of terminal configuration; however, these values do not correlate to TKR.

Figure 3-34: Schematic Layout of Development Steps for Bulk Materials Handling

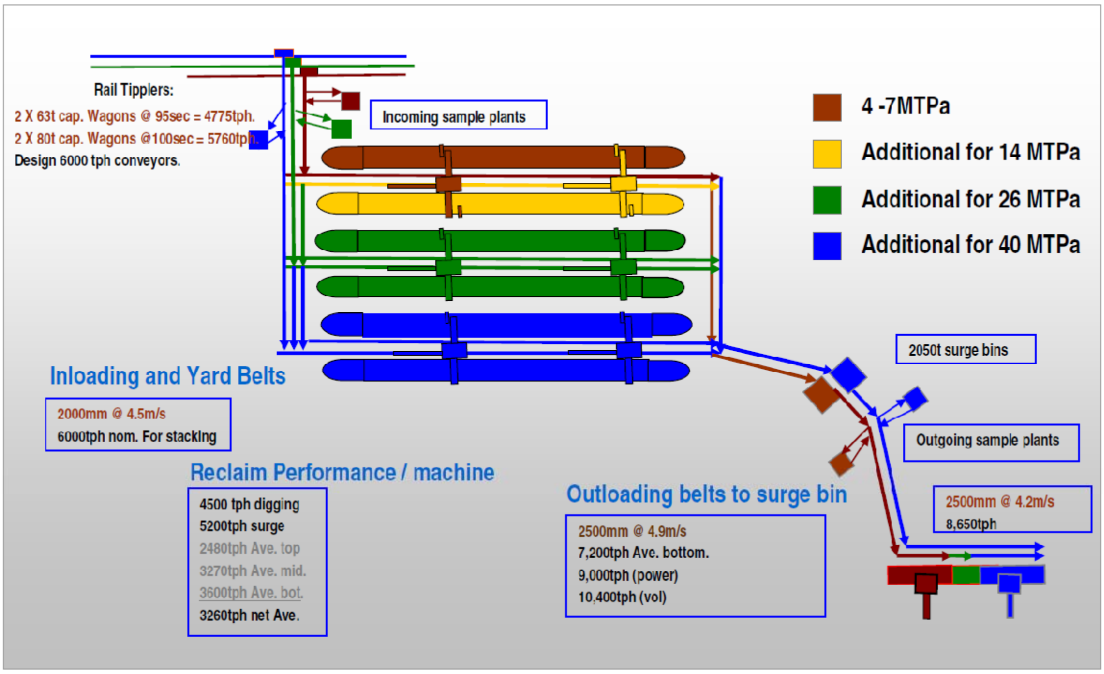
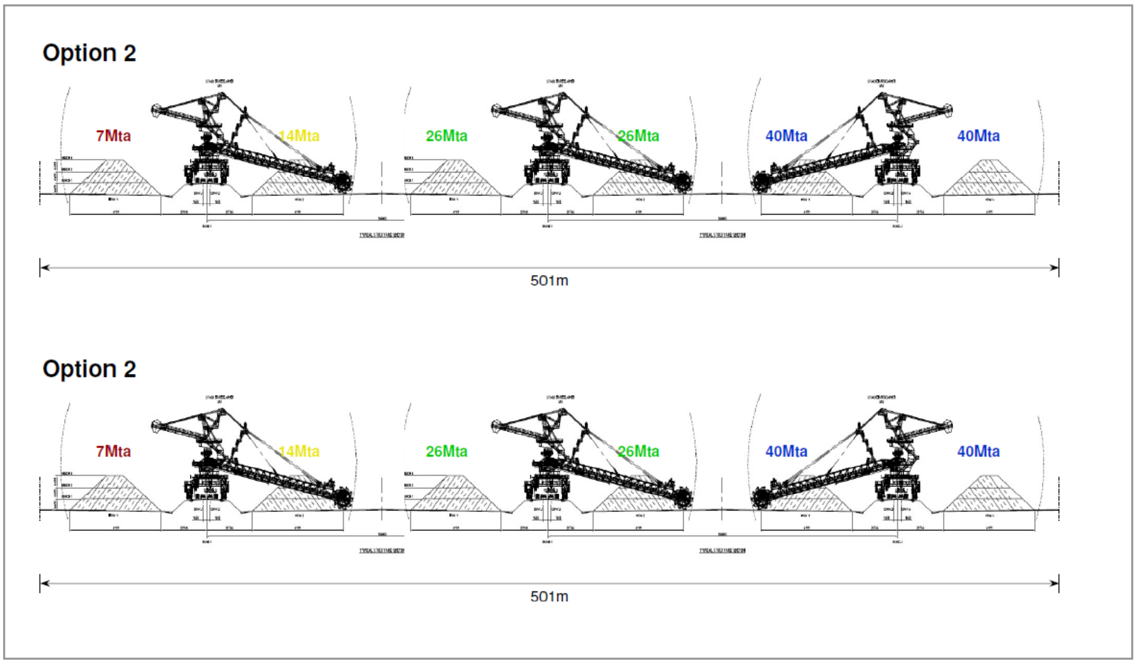


Figure 3-35: Schematic Cross-section of Stockyard Layout



Yard Machines

305. Yard machine capacities have been determined to meet throughput requirements as detailed in preceding sections, as well as to meet specifications of machines which may be readily sourced from typical Asian designer/suppliers. Boom length of 62.5 m has been selected to match typical machines previously supplied to other major coal terminals.

306. Additional yard machines are required to serve the additional stockpile rows as described earlier, as follows:

Figure 3-36: Summary of Yard Machines Required

	Option 2
16.8 Mtpa	4 X Stacker/Reclaimers total
65 Mtpa	10 X Stacker /Reclaimers total

307. It is intended that two reclaim machines will reclaim in unison to serve one single loading system while one single stacking machine is required to handle the complete capacity from a single unloading station.

308. Yard machine capacities have been selected to target throughput capacities as follows:

Figure 3-37: Summary of Machine Capacities

Function	Productivity rate (tons per hour)	
Stacking	6000	
Reclaiming	Target digging rate Typical surges to Weighted average bench reclaim rate	4,500 5200 3260

309. In order to achieve these capacities, all yard machines including Stacker/Reclaimers are proposed to be fitted with 2,000 mm wide boom conveyors operating at approximately 4.6 m/s.

Inloading Systems

310. Inloading conveyor systems have been arranged to allow transfer to the stockyard conveyors as shown schematically on Figure 3-34.

Inloading Conveyor Systems

311. Inloading conveyors have been selected to suit the capacities as described in previous sections and have been sized conservatively as follows:

Figure 3-38: Summary of Conveyor Sizing

Conveyor Specification	Measure
Capacity	6,000 tph (to match nominal 5760 tph peak tippler rate)
Belt width	2,000 mm
Belt speed	4.6 m/s
Trough angle	35°

312. Additional inloading conveyor systems would be provided to serve each new tippler for expansion from 16.8 Mtpa to 65 Mtpa, i.e. increase from 2 tandem tipplers to 5 tandem tipplers. The initial inloading systems would also be expanded to feed additional stockyard conveyors. Additional conveyors would have the same

capacities and design parameters as determined for the initial inloading system at 16.8 Mtpa.

Inloading Sample Plant

313. Additional sample plants are required for each new inloading system as described in the previous paragraph.

3.8.5 Outloading and Shiploading Systems

314. As described in separate studies, the 16.8 Mtpa (even up to 26 Mtpa) capacity might be achieved using a single outloading string with one shiploader on a single berth. Separate studies of existing facilities suggest that this should be easily achievable.

315. Expansions to outloading systems are summarized as follows:

Figure 3-39: Summary of Required Outloading Systems

Capacity Increment (Mtpa)	No. of outloading systems required
16.8 Mtpa	1 X system total
65 Mtpa	Add 2 new outloading systems. 3 X outloading systems total. Extend Berth to provide 3 X full length berths and provide 2 additional shiploaders. .

316. All conveyor systems, surge bin capacities, sample plant requirements for the additional systems are identical to the requirements as for the initial outloading system:

Figure 3-40: Summary of Capacity Determination

Capacity Measures	Productivity (tons per hour)
Average Bench Reclaim Rate	6,500 tph
Bottom Bench Reclaim Rate	7,200 tph
Surge Bin Volume	2,050 t (Comprised of 1,750 t working capacity plus 300 t upper and lower control buffers.)
Shiploading Rate	8,650 tph

Outloading Conveyor Systems

317. Outloading conveyor design capacities and sizes, that have determined to suit the 16.8 Mtpa capacity via a single outloading string, have been selected as follows:

Figure 3-41: Summary of Capacity of Conveyors Upstream of Surge Bin

Capacity Measures	Productivity (tons per hour)
Volumetric Capacity (Surge rate)	10,400 tph
Capacity for Power Demand Calculation (Combined digging rate)	9,000 tph

Capacity Measures	Productivity (tons per hour)
Typical Max Average Capacity (Reclaiming bottom stockpile bench)	7,200 tph
Belt Width	2,500 mm
Belt Speed	4.9 m/s
Trough Angle	35°

Figure 3-42: Summary of Capacity of Shiploading Conveyors Downstream of Surge Bin

Conveyor Specification	Measure
Capacity	8,650 tph
Belt width	2,500 mm
Belt speed	4.2 m/s
Trough angle	35°

Surge Bin Belt Feeders

318. The ship-loading rate is proposed to be fed from the surge bin utilising 3 X 2,500 mm wide belt feeders each with maximum capacity 4,500 tph.

Weigher Conveyor

319. A short weigher conveyor receives product from the surge bins and delivers the coal to the jetty conveyor.

320. This conveyor incorporates dual high accuracy belt weighers and is deliberately made short to allow for ease of calibration. The weighers allow accurate monitoring of batch pours from the surge bin.

321. The provision of this conveyor minimises draft survey delays by allowing completion of pours to be immediately determined according to belt weigher readings. Draft survey is then only required upon completion of loading to confirm final tonnages for payment purposes.

322. Note that dual weigh systems with continuous cross-checking features to nominal accuracy +/- 0.25% are proposed to provide high accuracy and high reliability.

323. The weigher conveyor is also proposed to incorporate a belt plough system that provides a means of discharging the surge bin to ground in case of accidental reclaiming of a coal volume in excess of the required volume to be loaded in a given batch.

324. It is expected that this feature would be rarely used provided care is taken in determining reclaimed tonnages to match required tonnages to be ship-loaded.

Jetty Conveyor

325. The ramp up from 16.8 Mtpa to 65 Mtpa requires the addition of 2 new jetty conveyors, increasing the total to 3 jetty conveyors.

Outloading Sample Plant

326. As mentioned in the above paragraph, the increase in annual throughput requires the addition of 2 new outloading sample plants.

Shiploader

327. A single travelling, luffing shiploader is proposed to be constructed to allow ship-loading at up to 8650 tph for 16.8 Mtpa.

328. For 65 Mtpa capacity, the berth needs to be extended to provide (3 X full length berths in total) and 2 additional shiploaders will be required.

3.8.6 Development of On-Shore Facilities for 16.8 and 65 Mtpa

Development of Off-site Infrastructure

329. The following off-site infrastructure development s need to be considered for Lüderitz and Walvis Bay:

Figure 3-43: Off-site infrastructure developments

Description	Lüderitz	Walvis Bay
Electricity	Power plant required (Power from NAMPOWER)	Power plant at Swap (Power from NAMPOWER)
Water supply	Desalination plant required (Water from NAMWATER)	Desalination plant at Swakopmund proposed (Water from NAMWATER)
Sewer Treatment Plant	Sewer Treatment Plant required	Sewer Treatment Plant required

Description of on-site improvements

Main civil works

330. The overall scope of the main civil works for the coal stockyard facilities include the following items:

- Earthworks for Stockyard;
- Bunds for the stacker /reclaimer machines which incorporate drainage of the stockyard;
- Support structure for stacker/reclaimer machines which incorporate the rail tracks for the machines;
- Drainage channels and pollution control dam;
- Water pump stations;
- Miscellaneous foundations including water storage tanks, water treatment plant, electrical sub-stations and pumping stations; and
- Bridges.

Coal stockyard area

331. The stockyard will be constructed to meet the final capacity of 65 Mtpa as well as allow for extra tonnages.

Rail tippler, weighbridges, train positioner, etc.

332. Additional foundations and conveyor tunnels will be constructed for additional tipplers required for the increase from 16.8 Mtpa to 65 Mtpa development phase.

Water reservoirs, pump stations and reticulation

333. The water reticulation for the stockyard and along the conveyors (for fire and dust suppression) will be extended for ramp up from 16.8 Mtpa to 65 Mtpa development phase.

334. The reservoirs and pump stations which will be installed initially will be modular for extension from 16.8 Mtpa to 65 Mtpa development phase.

Drainage and Storm water control

335. Pollution control dams will be constructed for the development of the stockyard. Additional concrete-lined drains which run along the stacker and reclaimer bunds, will be required to drain the incremental development of the stockyard.

Electrical reticulation

336. The extension of the electrical reticulation will also be done for the increased capacity.

Mobile equipment

337. Allowance has been made in the CAPEX calculations for additional mobile equipment, as summarized in the table below:

Figure 3-44: Summary of Mobile Equipment Requirements

Description	Mobile Equipment Required	
	16.8 Mtpa	65 Mtpa
Dozers	2	3
Cranes	2	2
Bobcat	3	4
Front End Loader	3	4
Vac-Al	1	1
Water Cart	2	2
Truck (7 t)	2	3
Light Delivery Vehicles	8	10
Sedans	4	4
Personnel Carrier	3	4
Fire Tender	1	1
Ambulance	1	1

3.9 Terminal Development for Walvis Bay site for non-coal cargo

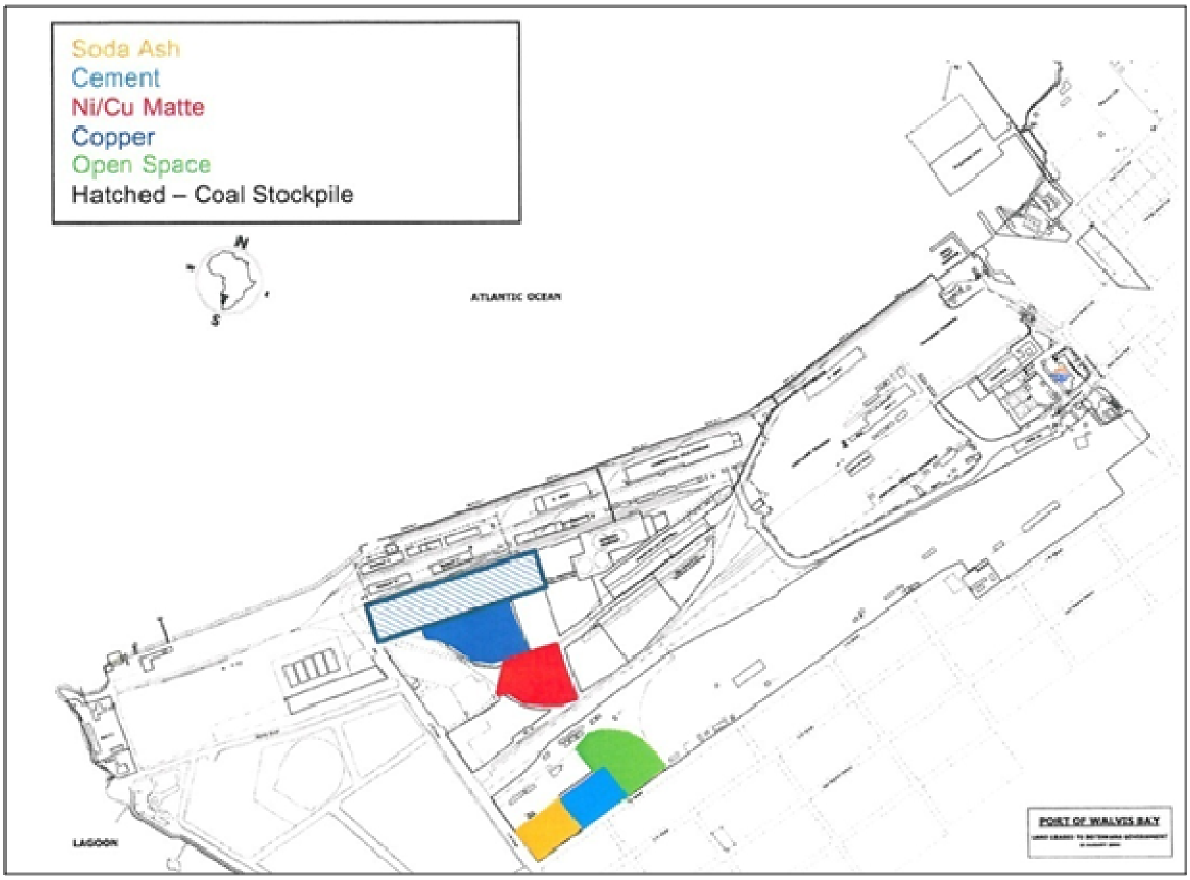
338. The following assumptions regarding the handling and transfer of the non-coal commodities apply:

- Non-coal commodities utilise the Botswana Dry Port unless mentioned otherwise. Bulk commodities are Grain, Fuel, Salt and Soda Ash (both exports), whilst
- Break-bulk commodities are Nickel-Copper Matte, Copper and Cement
- Liquid Bulk consist of fuel
- Grain, fuel and containers will utilise the existing and planned new facilities, which form part of a different study.

339. All preliminary assessments are based on the 2036 final commodities due to the slight ramp up in the commodities through the phase.

340. The proposed potential layout and location of the different commodities is shown in Figure 3-45.

Figure 3-45: Proposed Stockyard Layout for the Non-Coal Commodities



3.9.1 Berthing Requirements

341. Due to the low volumes being loaded, for economic viability, the turn-around time is an important cost-save. Therefore, vessels will call into a port where the service times are low i.e. where there are low berth occupancies with high loading rates.

342. It is assumed that with the commissioning of the new large scale coal terminal that the current coal imports through Walvis Bay would cease. Therefore, the land currently hosting the existing coal terminal will become available for new use. Further studies are required to determine the total impact on Walvis Bay.

3.9.2 Development of Materials Handling Concepts: Bulk and Break-Bulk

343. Internal port rail network is assumed to be as is and any future rail connections are assumed to be to this internal rail network.

344. For non-coal cargo, the stockyard sizes have been determined from desktop level study of material properties as shown in Figure 3-46

Figure 3-46: Non-coal Material Properties

Commodity	Density (t/m^3)	Stowage Factor	Angle of Repose
Soda Ash (bulk)	1.97	1.13 – 1.27	40
Salt (bulk)	1.15	1.98 (fine -1.27)	30
Copper (break-bulk)	1.173	0.90	35
Ni/Cu Matte (break-bulk)	~1.173	0.45	-
Grain (wheat) (bulk)	0.80	1.27 – 1.42	28
Cement (bagged)	1.00	2.85	30
Fuel (bulk)	0.80	-	-

345. Stockyard sizes have taken into account irregular shipments and therefore any variation in cargo and shipping traffic.

346. Stockyard facility volumes and sizes have been determined to suit the volumetric requirements as indicated in the traffic study and also based on rule of thumb.

Dry Bulk Handling

347. The soda ash will require a wagon station and conveyor system to transport the dry bulk to the designated new storage shed. Dust control measures need to be taken due to the fine particle size of the soda ash. The movement of the soda ash from the shed to the vessel will require an outbound conveyor system from the shed to the assigned terminal where the vessel will be loaded using a mobile shiploader. Figure 3-47 below illustrates the type of shiploader that could be used.

Figure 3-47: Typical Mobile Shiploader

348. The imported grain will require a conveyor system transferring the commodity tot eh proposed future grain facility.

349. Both fuel and salt will make use of the existing material handling facilities and equipment.

Stockyard Sizes and Handling Equipment

350. The storage requirements and material handling equipment assumed for salt and soda ash is summarised in Figure 3-48.

Figure 3-48: Walvis Bay Storage Requirement and Material Handling Equipment

Commodity	Facility	Area (m^2) Required	Equipment Required
Soda Ash	Stockpiled in new shed	70m x 70m	1 x Overhead shuttling conveyor 1 x Overhead tipper conveyor 1 x Front end loader
Salt	Stocked on existing salt stockpile facility	Existing facilities	Existing equipment
Grain	Stockpiled in the proposed new grain facility	-	-

351. The inbound conveyor system will have the following properties:

Figure 3-49: Summary of Conveyor Sizing

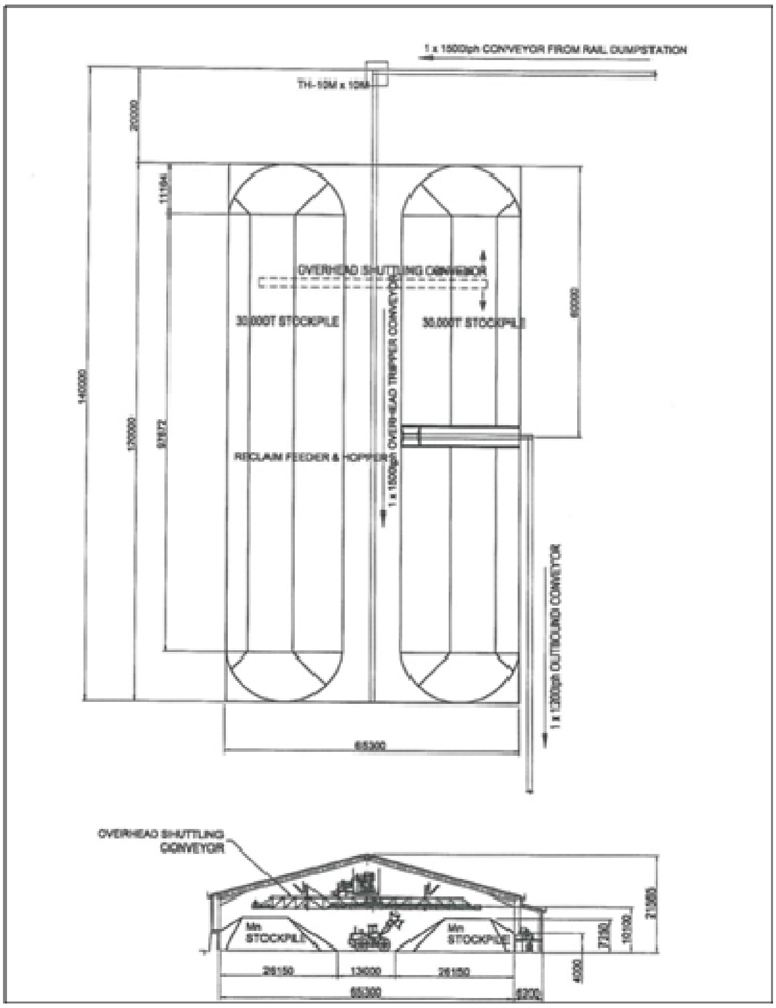
Conveyor Specification	Measure
Capacity	1,500 tph

352. The proposed overhead shuttling conveyor system, which will stack the material, has been adopted from previous similar facilities.

353. Front End Loaders will be used to reclaim the material into outbound transfer stations.

354. A typical process flow diagram for the soda ash is as shown in Figure 3-50.

Figure 3-50: Process Flow Diagram for a typical Shed Operation



Break-Bulk Handling

355. The loading and handling of the break-bulk materials will involve forklifts and tractor trailer transportation to and from storage locations along the terminal where mobile cranes will load the vessels.

356. It is assumed that both copper and Ni/Cu matte are transported in break-bulk and therefore the transfer of the commodities from the rail to the allocated storage sites can be performed by forklifts and tractor-trailer transport modes. A tractor and trailer will be used for the movement of the commodities from the storage area to the terminal where mobile cranes will be used for the loading of the vessel.

357. Imported bagged cement is assumed to be offloaded from the vessels using the vessel's own offloading equipment onto tractors and trailers and transported to the storage shed.

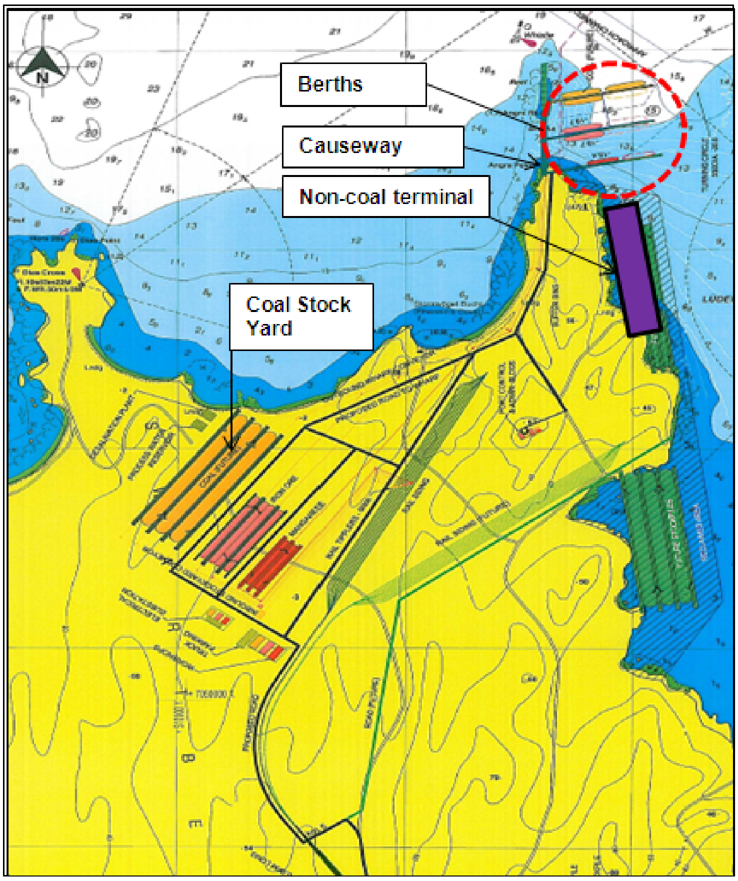
3.10 Terminal Development for Lüderitz site for non-coal cargo

358. The following assumptions regarding the handling and transfer of the non-coal commodities apply:

- Non-coal commodities utilise the proposed new Deep Water Port at Angra Fria unless mentioned otherwise (Figure 3-51).
- Bulk commodities are Grain, Fuel, Salt and Soda Ash (both exports), whilst
- Break-bulk commodities are Nickel-Copper Matte, Copper and Cement
- Liquid Bulk consists of the fuel
- Containers will utilise the existing and planned new facilities at Walvis Bay, which form part of a separate study.
- All preliminary assessments are based on the 2036 final commodities based on the insignificant ramp up in the commodities through the phase.

359. The proposed storage area for the above storage facilities will be located on land to be reclaimed in Luderitz Harbour. The location of the proposed storage area is illustrated in Figure 3-51.

Figure 3-51: Proposed Angra Fria Deep Water Port Layout (Potential Layouts from recent studies)



3.10.1 Berthing Requirements

360. Due to the low volumes being loaded, for economic viability, the turn-around time is an important cost-saver. Therefore, vessels will call into a port where the service times are low i.e. where there are low berth occupancies with high loading rates.

361. In order for vessels with DWT's of 30,000 to 40,000 capacities the estimated alongside depth next to the proposed terminal is 13m. In order to achieve this depth a volume of 250,000m3 needs to be dredged along the terminal whilst 30,000m3 will need to be dredged along the approach channel.

3.10.2 Development of Materials Handling Concepts: Bulk and Break-Bulk

362. The future port rail network is assumed to be as determined by the coal terminal design and that any future rail connections will be to this internal rail network.

363. Stockyard sizes have been adopted from desktop level study of material properties as shown in Figure 3-52.

Figure 3-52: Non-coal material properties

Commodity	Density (t/m^3)	Stowage Factor	Angle of Repose
Soda Ash (bulk)	1.97	1.13 – 1.27	40
Salt (bulk)	1.15	1.98 (fine -1.27)	30
Copper (break-bulk)	1.173	0.90	35
Ni/Cu Matte (break-bulk)	~1.173	0.45	-
Grain (wheat) (bulk)	0.80	1.27 – 1.42	28
Cement (bagged)	1.00	2.85	30
Fuel (bulk)	0.80	-	-

364. Stockyard sizes have taken into account irregular shipments and therefore any variation in cargo and shipping traffic.

365. Stockyard facility volumes and sizes have been determined to suit the volumetric requirements as indicated in the traffic study and also based on rule of thumb.

Bulk Handling

366. The export of dry bulk materials will require an outbound conveyor system and dedicated shiploader per commodity to load the vessels.

367. Inbound soda ash will require a wagon dump station and conveyor system to transport the dry bulk to the designated new storage shed. Dust control measures need to be taken due to the fine particle size of the soda ash. The movement of the soda ash from the shed to the vessel will require an outbound conveyor system from the shed to the assigned terminal where the vessel will be loaded using a mobile shiploader. Figure 3-53 below illustrates the type of shiploader that is required.

Figure 3-53: Typical Mobile Shiploader

368. The imported grain will require a conveyor system transferring the commodity to the proposed future grain facility.

369. Both fuel and salt will make use of the existing material handling facilities and equipment.

370. Stockyard Sizes and Handling Equipment

371. Based on previous studies of similar projects and best practices guidelines, the storage requirements and material handling equipment for the salt and soda ash is summarised in Figure 3-54.

Figure 3-54: Walvis Bay Storage Requirement and Material Handling Equipment

Commodity	Facility	Area (m^2) Required	Equipment Required
Soda Ash (dry bulk)	Botswana Dry Port, stockpiled in new shed	70mx70m	1xOverhead shuttling conveyor 1xOverhead tipper conveyor 1xFront end loader
Salt (dry bulk)	Existing salt terminal, open stockpiles	70mx70m	2xFront end loader 2xTractor & trailer
Fuel	New facility	-	-
Ni/Cu Matte (break bulk)	Botswana Dry Port, stockpiled in new shed (assumed pallets)	40mx40m	2xForklifts 1xTractor & trailer
Grain (dry bulk)	New grain terminal planned by Namport, stockpiled in new shed	70mx70m	1xOverhead shuttling conveyor 1xOverhead tipper conveyor 1xFront end loader
Copper (Ingots – break bulk)	Botswana Dry Port, open stockpiles (assumed pallets)	100mx100m	8xForklifts 2xTractor & trailer
Cement (break bulk)	Botswana Dry Port, bagged and stored in a new shed	70mx70m	2xForklifts 2xTractor & trailer
Containers	Existing Port	-	-

372. The inbound conveyor system will have the following properties:

Figure 3-55: Summary of Conveyor Sizing

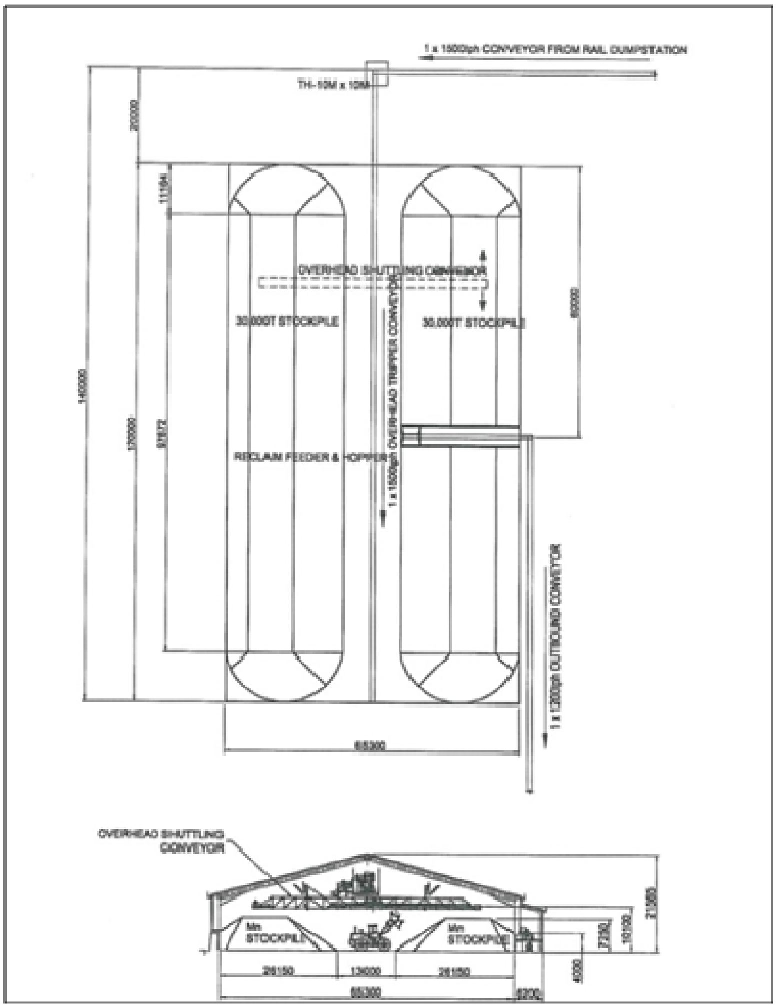
Conveyor Specification	Measure
Capacity	1,500 tph

373. The proposed overhead shuttling conveyor system, which will stack the material, has been adopted from similar projects with enclosed sheds.

374. Front End Loaders will be used to reclaim the material into outbound transfer stations.

375. A typical process flow diagram for the soda ash is shown in Figure 3-56

Figure 3-56: Process Flow Diagram for a typical Shed Operation



376. Outloading conveyor design capacities and sizes, that have been determined to suit the 16.8 Mtpa capacity via a single outloading string, have been selected as follows:

Figure 3-57: Summary of Capacity of Conveyors Upstream of Surge Bin

Capacity Measure	Productivity (tons per hour)
Typical Max Average Capacity (Reclaiming bottom stockpile bench)	1,200 tph

Break-bulk Handling

377. Loading and handling of the break bulk materials will involve forklifts and tractor-trailer transportation to locations along the terminal where mobile cranes will load the vessels.

378. It is assumed that both copper and Ni/Cu matte are transported in break bulk and therefore the transfer of the commodities from the rail to the allocated storage sites can be performed by forklifts and tractor-trailer transport modes. A tractor and trailer will be used for the movement of the commodities from the storage area to the terminal where mobile cranes will be used for the loading of the vessels.

379. Imported bagged cement is assumed to be offloaded from the vessels using the vessel's own offloading equipment onto tractors and trailers and transported to the storage shed.

3.11 Implementation schedule for the Port Terminal

3.11.1 Specialist and enabling studies

380. Allowance has to be made in the schedule for Environmental and Social processes, as well as several specialist studies.

381. Allowance has to also be made for a number of studies and investigations which will be required before the completion of the detail engineering for the different disciplines. These include:

- Full Environmental and Social Impact Assessment (ESIA);
- Resettlement Action Plan (RAP);
- Aerodrome investigation;
- Topographical Survey;
- Bathymetrical and Geophysical Survey;
- Update of hydrodynamic studies (wind, wave and tidal);
- Ship Motion Study;
- Geotechnical Investigation (on- and off-shore);
- Geohydrology Study;
- Traffic Impact Assessment; and
- Accommodation Investigation.

3.11.2 Resettlement

382. It was further assumed that all construction work will commence half way through the resettlement process, and there may be some risk attached to that.

3.11.3 Project Scheduling – Bulk Materials Handling

383. Typical durations for the activities have been obtained from similar projects (previous Aurecon projects).

Procurement

384. The early procurement of the bulk material handling equipment is important, as sufficient allowance has to be made for the manufacturing of the equipment (long lead items).

Engineering

385. It is envisaged that the tenders for bulk materials handling equipment, will call for the design and manufacturing of the equipment. Therefore, initially, only an update of the design parameters will be done, while the detail engineering will only be done after the procurement process has been completed.

Manufacturing, Fabrication and Transport

386. Manufacturing and fabrication of equipment are all considered to be long-lead items, and therefore should be procured as soon as possible, to be able to be done simultaneously with the ESIA and RAP, while construction on site cannot be commenced with. .

Erection

387. Erection and assembly of equipment are also considered to be long-lead items. Each of the equipment required, are to a large extent dependent on the completion of a portion of the infrastructure:

- Stacker and reclaiming machines: sections of the bunds with rail (track beam) completed.
- Surge bin, sample plants, transfer stations and yard conveyors: terraces with support bases.
- Tipplers: reinforced concrete base structure.
- Jetty conveyors: sufficient access onto trestle structure.
- Shiploader: access to the loading platform and section of rails (track beams) completed.

Commissioning

388. It is recommended that a Commissioning Manager be appointed as part of the Project Management Team, to co-ordinate and supervise the total commissioning activities for the Complete Project Works to ensure that the Overall Project Resources are utilised as beneficially as possible.

389. The Commissioning Manager will have under his direct control a dedicated Project-Wide Commissioning Team comprised of Consultants and Contractors in addition to a full complement of the Owners Team's operating and maintenance personnel who will make-up the core elements of the commissioning team.

390. The Project-Wide Commissioning Team's primary function is collectively to assist all of the individual Suppliers in completing their particular machinery/equipment commissioning activities in order to meet the Overall Critical Commissioning Milestones of the Complete Project Works.

391. Machines will all have to safely and successfully complete full running tests under no-external-load conditions for a predetermined duration to ensure the structural, mechanical, electrical and control integrity (cold commissioning).

392. Subsequently, machines shall safely and successfully complete full running tests, under load conditions at half the Nominal Capacity in all of the operating and control configurations of the machines for a pre-determined duration (hot commissioning).

393. The Contractors will typically be required to guarantee performance of the machines, i.e. that the machines will achieve the Nominal Capacity as specified (Operating Performance Guarantee).

3.11.4 Project Scheduling – On-Shore Facilities

Engineering

394. Allowances have been made for detail engineering for each of the various sub-sections in the schedule. Allowance has been made in the durations for a consultation process with the client.

395. In some instances, detail engineering is dependent on completion of the investigations and studies (e.g. geotechnical investigations). However, in all instances, the investigations and detail engineering were scheduled to be implemented concurrently with the ESIA and RAP processes.

Procurement

396. As with detail engineering the procurement process shall be implemented concurrently with the ESIA and RAP processes.

Construction

397. As explained above, the detail = engineering and procurement processes need to be completed, as construction needs to commence as soon as the EISA and RAP processes have been completed.

Early works

398. Early works which are required before the actual construction of the infrastructure can commence, are the construction of terraces (required for site offices, laydown areas, pre-cast yard etc.), access road, temporary water, sanitation and temporary electricity supply.

Off-site Infrastructure

399. Construction of off-site infrastructure includes the construction of approximately 30km of electricity supply, a desalination plant, a sewer treatment plant and permanent access road.

On-site Infrastructure

400. Construction of on-site infrastructure includes the construction of all civil and earthworks associated with the terminal (stock yard, rail loop, drainage structures, pollution control dam, water-, sewer- and electrical reticulation, buildings, internal roads, etc.). These are in certain instances scheduled to be sufficiently completed in order to provide access to the suppliers of bulk materials handling equipment for assembly and erection.

Testing, commissioning and hand-over

401. Where necessary, allowance was made for testing and commissioning before a final hand-over to the client. This is preceded by the updating and recording of record drawings.

4 Human Resources & Training

4.1 Railway Human Resource Requirements

4.1.1 Operational Human Resource and Training suggestions

402. The preferred TKR Operator must have a vigorous recruitment drive to obtain the organisational resources required. The first source of staff must be from Namibia and Botswana. Recruitment drives must then broaden to the rest of the Southern African Development Community. Finally, if the skill set is still not satisfied, international applicants should be considered, especially to fill critical management positions.

403. Seeking the skills locally is beneficial for many reasons. Local staff will cost less, and local people are familiar with the working conditions and particular cultural nuances of Namibia and Botswana. Additionally, local population will benefit economically and socially.

404. The preferred TKR Operator must introduce a system of career path planning to ensure that talented individuals are identified at junior grades and developed to more senior grades. This should be applied particularly to filling the critical grades of Train Drivers, Train Controllers and Train Planners.

405. The feeder grades to Train Drivers, Controllers and Planners are the Train Driver Assistants. The Train Driver Assistant should be viewed as an entry level grade for unskilled, local people. With minimal initial training, followed by "on-the-job" training under the supervision of a Train Driver, these local people can be promoted up to Train Planners and, in exceptional cases, to more senior operational positions.

406. The career path planning system must include a training register, such that each step of the path is achieved by completion of specific training courses (combined with pre-requisite "on-the-job" experience). For operational positions, the training courses should, wherever possible, be offered in-house by the TKR Operator staff who have already achieved proficiency in the specific area. Certain generic skills training such as computer skills are usually cost-effectively outsourced to institutions focused on providing such training.

407. The key aspect with providing Organisational Resources is to plan well ahead and view the recruitment and development of staff holistically in terms of the organisation's goals. The planning must avoid short term crises/shortages in skills and, in so doing, avoid the safety risks associated with over-worked staff or deployment of inadequately trained or inexperienced staff, especially in safety critical grades.

408. The most safety critical grade is the grade of Train Driver. It is essential that Train Drivers, especially of the long coal trains are well trained. In this regard, a mobile train simulator that is deployed at various locations along the corridor throughout the year is highly recommended. This mobility will ensure that the Namibia and Botswana Train Drivers will all spend time on the simulator.

409. The depots will be staffed with dual trade diesel electrical technicians. The educational level is typically ten to 12 years formal schooling followed by an apprenticeship of three to four years. Further on-the-job training in various fields, such as fuel injection equipment, electrical control systems and brake systems, is provided.

410. It is the technician's duty to perform all maintenance tasks prescribed and to report on defects observed and the condition of the equipment. The technicians are assisted by unskilled labour units who perform only menial tasks such as cleaning, fetching tools, etc.

411. In addition, a small corps of semi-skilled workers is employed to perform battery maintenance, traction motor cleaning, bogie maintenance, painting and heavy degreasing. There is also a small supporting group comprising technicians such as welders, boilermakers and turners/machinists.

412. The prime responsibility of the maintenance engineer is to continually monitor the performance of his locomotives from the point of view of reliability and cost, to investigate and report on component failures and to continually examine and evaluate the service lives of each component on the locomotives to ascertain the optimum maintenance cycle and/or procedure for that particular item. Situated at the main depot, his responsibilities include:

- Liaison with the locomotive manufacturers;
- Control of the supply and quality of spare parts;
- Design and implementation of modifications;
- Prescribe and control maintenance philosophy;
- Facilitate interface between depots and operations staff; and
- Control rolling stock maintenance budgets.

4.1.2 Primary areas of operation

413. The primary areas of operation of the rail organisation comprise:

- Operating (also referred to as transportation or logistics);
- Traction and rolling stock (also referred to as mechanical operations or motive power);
- Infrastructure (trackwork, buildings, bridges, structures, power, signals and telecommunication);
- Financial administration;
- Human Resources; and
- Support and information management.

414. The operating division constitutes the operating of train services and delivering of time and place utility in the form of transporting coal from Mmamabula to the port in a predictable manner.

415. The traction and rolling stock division is responsible for the maintenance of locomotives and rail wagons. These assets need to have a high level of availability and utilization.

416. The infrastructure division is responsible for the maintenance of the entire infrastructure.

417. The financial, human resources and support and information management divisions render support services to the other departments and to management.

4.1.3 Executive Management Board of the Organisation

418. The executive management board of the private railway company will comprise the functional heads of each section of the company namely:

- Executive manager (infrastructure);
- Executive manager (traction & rolling stock);
- Executive manager (transportation);
- Executive manager (human resources);
- Executive manager (finances); and
- Company secretary (support services).

419. The executive board will be supported by the support services section namely:

- Company secretary (head);
- Public relations and communications;
- Legal;
- Planning;
- Audit and internal control; and
- Organisation information.

420. Each member shall be an employee of the private railway company and will therefore function in terms of the provisions in the employee contract with the company.

4.1.4 Infrastructure Division

421. The infrastructure functions comprise the management of the fixed assets operated by the private railway company on a demand-driven basis in terms of the commercial objectives of the company, as well as the asset availability in terms of quality and safety norms as set out in its technical plan.

422. The sub-divisions of the infrastructure division will consist of:

- Trackwork;
- Buildings and structures;
- Signals and telecommunications;
- Civil work, and
- Plant and equipment.

423. The above sub-divisions will be managed by possibly two infrastructure managers who will focus on the managing of fixed assets in Botswana and Namibia.

424. The infrastructure division will be responsible for correlating the commercial and transportation demand of the business, with short, medium and long term

planning and managing the input of resources to meet the demand in terms of quality of infrastructure availability.

425. The infrastructure division will also be responsible for managing all contractors for maintenance works during the period of rail operations.

4.1.5 Traction and Rolling Stock Division

426. The division responsible for the sourcing of traction and rolling stock will be responsible for meeting the traffic demands of the company.

427. In the above regard, the traffic demands will be interpreted by the division in terms of the commercial plan on the short, medium and long-term and the sourcing of locomotives and rolling stock will be coordinated and deployed to match the demand.

428. The availability, reliability and utilization of the locomotives and rolling stock will be monitored and managed by this division.

429. The following sub-divisions will form part of this division namely:

- Procurement of parts and consumables;
- Managing rehabilitation works and maintenance in depots;
- Managing all aspects of sourcing and availability of the rolling stock;
- Managing all train crews; and
- Making available to train operation divisions during the count-down and execution process, the locomotives and crew, complete with train worthiness.

430. This division will be responsible for ensuring the effective and efficient deployment of the movable assets of the company.

4.1.6 Operating Division

431. The operating division is responsible for managing on a freight reservation basis, the freight trains and for working through trains on a pre-scheduled train plan on a predictable basis as part of a rail supply chain focus.

432. The operating division comprises the following sub-divisions:

- Train planning and execution;
- Freight reservation;
- Train expediting; and
- Wagon distribution.

433. Train planning and execution will be monitored with the mine and the port as well as General Freight clients on an annual, quarterly, monthly, weekly and daily planning system.

434. A system similar to "Pit to Port" will be implemented and operated by this division. This will ensure the management of train operations from Mmamabula mine to the port in order to participate in the scheduling of freight from the mines to the stockpiles in the port.

435. The commercial sub-division of this division will comprise:

- Marketing of General Freight;
- Tariffs and contracts;
- Logistical services; and
- Port and mine interfacing.

436. The above commercial sub-divisions will focus on integrating the client's demands with the General Freight services of the company and its primary focus to transport coal.

4.1.7 Human Resources Division

437. This division is responsible for sourcing a motivated worker corps for the activities of the private railway company and to handle all salary and benefits aspects of human resources.

438. Recruitment will need to be attended to. This aspect will be based on a requirement system in which the various sub-divisions will work closely with the recruiting sub-division to recruit the most suitable staff for the future activities of the company.

439. The medical sub-division will handle all medical benefits of company staff members as well as their dependants and family members. The sub-division handling all internal communications will be in charge of all communications that have to be made to the staff of the company.

440. It will be of paramount importance that the staff be informed of targets, achievements and cultural aspects in which the company is functioning as a private railway organisation with commercial objectives. The staff will need to participate to give effect to the realisation of the objectives of the company.

441. The training sub-division of the company will assist in the development of the skills and knowledge of the staff of the company in order to make the company function at the highest level of efficiency. A training school will need to be introduced to give effect to the training focus of the company.

442. The labour relations sub-division of the company will need to assist management in handling all aspects of labour relations and the role of the unions in the railway industry in Botswana and Namibia.

4.1.8 Financial Division

443. The finance division will manage all financial functions of the company. The sub-divisions of the finance division comprise:

- The treasury and cash management sub-division which will handle all cash related aspects of the company as well as all remittance of cash payments made by clients. Cash-flow projections and cash management will be of utmost importance to the company;
- The creditor sub-division of the company will ensure that favourable payment terms are negotiated and agreed upon between the company and its

creditors and that the payment of creditors are in line with the cash-flow planning of the company;

- The debtor sub-division will manage the debtor or collectable payments from clients of the company. This division will also monitor debtor-ageing reports and shall be responsible for minimizing the bridging funds for debtors;
- The sub-division of the company, that will handle all financial statements including management reports, will ensure that all results at each month-end and year-end are compiled on time for the board to control the company effectively;
- The sub-division handling the capital investment programmes will be responsible for compiling the feasibility reports relating to capital investment requirements, progress and follow up reports on the return on investment achieved, on the capital investments; and
- Asset management will be handled by a sub-division which will ensure that an asset register is kept of all assets acquired by the company and report on the return on assets achieved by the company in all financial reporting.

4.1.9 Support Services Division

444. The division of the company secretary will assist the management of the railway company in obtaining managerial information concerning the performance of the organisation.

445. The company secretary will also provide the board of directors with the required company documents for statutory meetings.

446. The various functions concentrated in the company secretary's division, will render direct specialist management services to the managing executive management and the board namely:

- Company secretarial services;
- Public relations and external communications;
- Legal matters;
- Planning activities of the company;
- Organisational information technology; and
- Audit and internal control.

447. The above support services of the company will ensure that the board and executive management obtain clear communications in order to affect good corporate governance.

4.1.10 Critical Staff

448. Train crews are considered critical staff in a railway system. The training required for train crews entails development of skills and maintenance of best practice in terms of creating a health and safety regime. The candidate train drivers will have to be recruited in the first quarter of year 3. Training manuals will need to be prepared by the third quarter of year 2. Training of drivers will have to commence after recruitment in the second quarter of year 3.

449. Expatriate train drivers will have to be deployed at the outset to handle material construction trains and assist in the training of the new recruits.

450. The critical staff component has been included in the costing of the rail Opex. The estimates are based on previous experience from similar projects. The staff numbers are based on several criteria. These are listed as, for a two-person crew:

- Maximum shift length (active driving): 9 hours
- Maximum shift length (total hours): 10 hours
- Shifts worked per week: 5 off
- Annual leave: 25 days
- Sick leave: 10 days
- Training: 5 days
- Public holidays: 10 days
- Labour component of annual crew costs: 90 %
- Cost of two-person crew per annum: approx. USD 120,00

451. The table below summarises the number of two-person crews that are required for each of the three alignment options, and the comparative between SG and CG.

Figure 4-1: Summary of Crew Requirements (Coal and Intermodal)

	Standard Gauge	Cape Gauge
	From start-up (2016) to fully operational (2019)	Start-up (2016) Fully operational (2019)
To Walvis Bay via Gobabis (Option 1)	100 to 240	150 to 420
To Walvis Bay (Option 2)	70 to 170	110 to 290
To Lüderitz (Option 3)	110 to 260	200 to 520

4.1.11 Railway resource requirements during construction

452. As important as it may be to utilise resources from Botswana and Namibia for the operation of the TKR, it will be equally important to utilise local resources for the construction of the TKR. A project of this magnitude must make every effort to inject the local economies by creating jobs and income for the people of Namibia and Botswana.

453. The number of jobs that can be created from such a project is very difficult to quantify, mainly due to some unknowns that exist at present. These include the type PPP model and type of construction methods to be used and number, type and duration of construction contracts to be implemented.

454. Based on other projects of similar type, we have broadly categorised the type of work force requirements that may be necessary to implement construction of such a project.

455. A band of between 13% and 24% has been used as the construction cost vs. labour cost ratio. This is fairly broad but research shows that civil engineering projects of this magnitude utilise approximately 13% to 24% of the construction cost for labour. The upper limit being typical of labour intensive projects.

456. The table below summarises the split between the different work categories and the proportional split between local and foreign labour. The proportional split between local and foreign labour takes into account foreign specialist contractors and assumes lesser availability of local labour in remote areas. However, one can see from the table that on average about 63% of the total labour cost can be allocated to local labour. This translates to a range of approximately between **USD 300 mil** and **USD 600 mil** cost for labour.

Figure 4-2: Summary of labour cost allocation for construction of the railway

	Local Labour Allocation (million USD)	Foreign Labour Allocation (million USD)	Total Labour Allocation (million USD)
Management	15 – 30	15 - 30	30 - 60
Supervisors	10 – 20	30 - 60	40 - 80
Specialists	5 – 10	60 - 100	65 - 110
Operators	40 – 70	70 - 130	110 - 200
Skilled labour	90 – 160	20 - 40	110 - 200
Unskilled labour	180 – 330	5 - 10	185 - 340
TOTAL	**340 – 620**	**200 - 370**	**540 - 990**

4.1.12 Citing similar railway construction projects in Africa

457. Various rail projects in Africa have been researched in terms of scope of construction effort to try and draw similarities with TKR. It is impossible to find a project that one may compare holistically with TKR in terms of resource figures i.e. number of construction workers. However, one project that comes fairly close to TKR in terms of track length, bilateral integration between two countries, demographics and time of construction, is the TAZARA line. Its utilisation of resources may be used as a broad benchmark for TKR.

458. The TAZARA Railway is 1860 km in length and was built between 1970 and 1975 by the Tanzania-Zambia Railway Authority to give landlocked Zambia a link to the Tanzanian port of Dar es Salaam, as an alternative to export routes via rail lines to Zimbabwe, South Africa and Mozambique.

459. Work on TAZARA was carried out by both foreign and local workers. The foreign contingent was made up of about 10,000 workers, while the locals (Tanzanians and Zambians) were about 35,000 strong. Of the 10,000 foreigners about 5,000 were technical experts. Many of the 35,000 locals went on to become the railway's first operators. So, in total, a workforce of about 45,000 was employed to construct the TAZARA Railway in five years.

4.1.13 Port and Terminal: On-shore Operation

460. Employee numbers have been benchmarked against other terminals around the world. Below is a summary of the figures obtained from other coal terminals and those proposed for TKR are highlighted.

Figure 4-3: Benchmarking of Employee Numbers

Mtpa	No. of employees	Employees/MTpa	Country
100	743	7.4	Australia
76	500	6.6	South Africa
68	265	3.9	Australia
45	163	3.6	Australia
75	600	8.0	Australia
25	190	7.6	Canada
16	**88**	**5.5**	**TKR**
65	**250**	**3.8**	**TKR**

Note: Assumed figures for TKR are indicated in bold.

461. From the above it may be concluded that:

- initially, manpower levels are comparatively high, due to under-utilisation of the facilities;
- manpower utilisation can be improved with machine automation; and
- manpower utilisation can be improved with outsourcing of various functions.

462. A staff compliment of 246 is considered for the port coal terminal (on-shore). It is believed that with attractive employment conditions, including the provision of housing and timely recruitment and training in the early stages of the project, these HR objectives can be met.

4.1.14 Port and Terminal: Off-shore Operation

463. Employee numbers for the marine operation of the terminal were developed from first principals. Human resources required on this project include crews for the tugs and line handling boats, berthing gangs and management personnel.

464. For each tug, a crew of six is required (tugmaster, tugmaster's mate, two engineers, two deck hands). As the terminal would be operated on a 24-hour basis, this requirement would equate to three crews per tug, thus 18 people per tug, resulting in 54 people in total for tug crews.

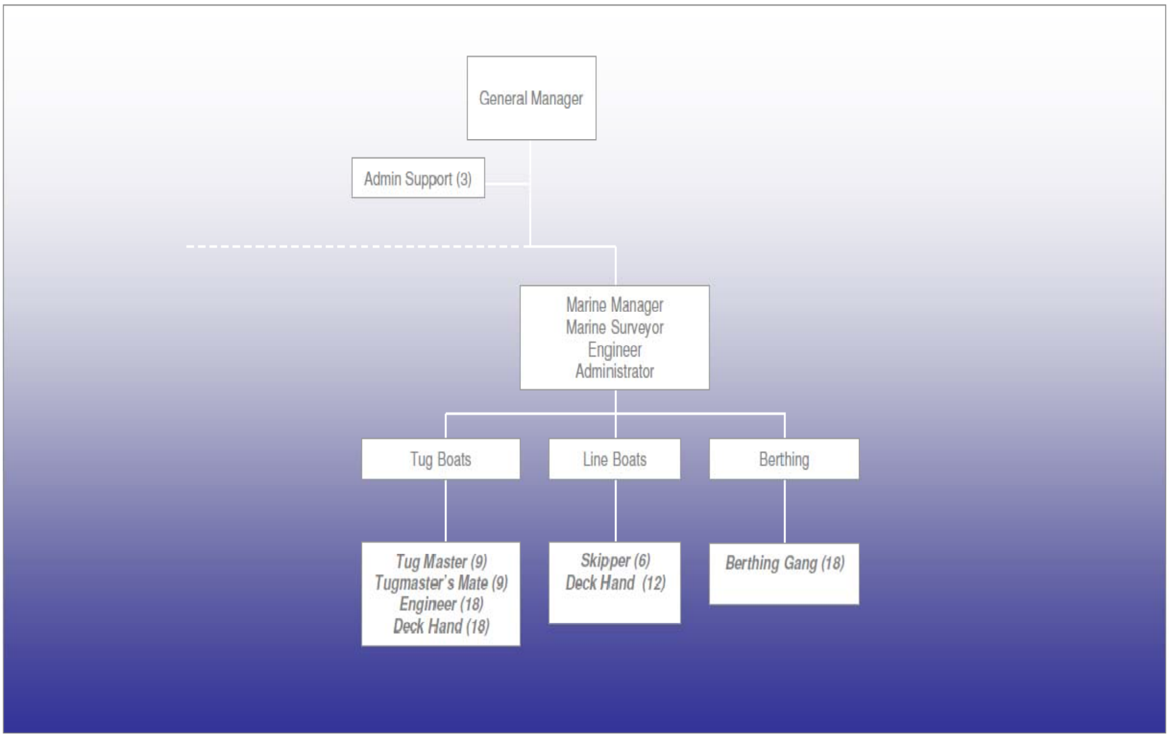
465. For each line handling boat, a crew of three is required (skipper and two deck hands). For a 24-hour operation, three crews per boat is required, thus a total of 18 people for the two line handling boats.

466. To berth a vessel, two berth gangs of six people each are required for each shift and with three shifts, a total of 18 people is required as berth gangs.

467. For proper management of all the marine operations and maintenance of the equipment a management team comprising of four people (Marine Manager, Marine Surveyor, Engineer and Administrator) would be required.

468. Based on the above principles, the following organisational structure is proposed for the marine operations (off-shore):

Figure 4-4: Proposed Organisational Structure (off-shore)



Note: The figures shown in bold/italics are shift workers (3 x 8 hr shifts, 24 hrs/day, 7 days per week, 365 days/annum).

469. A staff compliment of 76 is considered for the marine operations (off-shore). It is believed that with attractive employment conditions, including the provision of housing and timely recruitment and training in the early stages of the project, these HR objectives can be met.

5 Scope & Cost of Investment

5.1 Capital Investment Expenditure - Rail

5.1.1 Rail Infrastructure (Below Rail)

470. The rail infrastructure capital cost for each alignment option has been estimated using our experience in costing similar rail projects. In addition to the rail infrastructure, train control costs and other 'below' rail infrastructure operating costs were estimated.

471. The maximum grade determined from the alignment studies was 1.063% for the Mmamabula to Walvis Bay options and 1.468% for the Mmamabula to Lüderitz option. The ruling gradient is simply the steepest gradient on a line where the gradient varies and will determine the weight of train for a given locomotive or the power requirements for a given weight of train.

472. In addition to the main rail line between the Mmamabula and the port, the following additional rail infrastructure was assumed and cost estimates developed for all three alignment options:

- Passing loops to allow crossing of trains; and
- Train crew facilities along the route to allow for crew changes.

473. One can see from the Earthworks item that SG earthworks cost more than CG earthworks. This cost takes into account the volumes of both normal cut and fill material as well as the selected material that is used in the substructure up to the top of sub-ballast. While one would expect there to be a higher SG Track Works cost than CG, the CG is only marginally higher. The reason for this is that there are more passing loops required on the CG scenario. Although CG is still less than SG in terms of total Capex, the margin is much less.

474. We have estimated the construction cost to a 26 - 27 tonne axle load for the CG options, and 32 - 33 tonne axle load for the SG options. These are summarised in Figure 5-1.

Figure 5-1: Below Rail Construction Cost Estimates

	Standard Gauge (Millions USD)			Cape Gauge (Millions USD)		
	Mmamabula to Walvis Bay via Mariental	Mmamabula to Walvis Bay via Gobabis	Mmamabula to Lüderitz	Mmamabula to Walvis Bay via Mariental	Mmamabula to Walvis Bay via Gobabis	Mmamabula to Lüderitz
Earthworks	724.5	820.7	798.1	652.4	726.2	718.6
Bridge Structures and Culverts	672.9	828.1	714.2	585.1	720.1	621.1
Tunnel Costs	-	502.2	408.9	-	473.8	385.8
Track Works	1,144.6	1,300.7	1,264.0	1,167.5	1,303.7	1,289.5
Drainages and Environmental Controls	217.8	246.2	230.6	217.8	246.2	230.6
Fencing, Road Signage and Road Furniture	32.1	36.2	33.9	32.1	36.2	33.9
Passing Loops	61.6	75.8	99.4	109.4	111.5	166.2
Level Crossings	28.1	28.1	28.1	24.7	24.7	24.7
Control Centre (allocation)	1.0	1.0	1.0	1.0	1.0	1.0
Wayside Equipment	9.6	10.9	10.2	9.6	10.9	10.2
Telecommunications	129.8	146.4	137.3	129.8	146.4	137.3
Signal, Coms, Power and Others	230.1	261.9	275.9	274.6	294.2	339.3
Construction Sub-Total	3,022.0	3,996.3	3,725.8	2,929.4	3,800.8	3,618.9
Access Track	23.1	26.1	24.4	23.1	26.1	24.4
Property	47.5	53.7	50.3	47.5	53.7	50.3
Construction Camp (share of total)	76.8	91.2	110.4	76.8	91.2	110.4
Sub-Total	**3,169.3**	**4,167.2**	**3,910.9**	**3,076.8**	**3,971.8**	**3,804.0**
Contractor Indirect Costs	1,109.3	1,458.5	1,368.8	1,076.9	1,390.1	1,331.4
Sub-Total	**4,278.6**	**5,625.8**	**5,279.7**	**4,153.6**	**5,361.9**	**5,135.4**
Contingency	641.8	843.9	792.0	623.0	804.3	770.3
Total Section Below Rail Capital Costs	**4,920.3**	**6,469.6**	**6,071.6**	**4,776.7**	**6,166.1**	**5,905.7**
Capitalised Interest	426.9	561.3	526.7	414.4	534.9	512.3
Total Below Rail Capital Cost (incl. capitalised interest)	**5,347.2**	**7,030.9**	**6,598.4**	**5,191.1**	**6,701.1**	**6,418.0**

5.1.2 Signalling and Telecommunications Systems

475. Signalling and telecommunication systems will be designed and installed strictly in accordance with defined user needs. The solution will conform to the requirements of referenced industry standards, applicable sections and will be compliant with local requirements, local regulations and code requirements of authorities having jurisdiction in the applicable area. Cognisance will also be taken of the technologies installed on the existing railway and communications network to which the TKR will link and compatibility will be ensured, in the case of the NG option.

Telecommunications network components

476. Telecommunication solution makes provision for a microwave backhaul with point-to-point radio links to provide communication links to all line-side signalling and train condition monitoring systems. The microwave backhaul can also serves as a communication medium between trains consists and the Central Train Control centre.

477. Voice communication can also be provided to serve as a backup in case of train control system failure and also as a communication medium with maintenance staff along the line. A VSAT communication system can be provided for commercial application between the coal loading and offloading points, and can will also serve as a fall-back system for the microwave backhaul should it fail.

478. A proposed solution for level crossing protection includes the installation of half-arm barriers combined with flashlights to warn users of approaching trains or rail vehicles. The protection system is automatically activated prior to the arrival of the train at the crossing by using fail-safe track vacancy detection equipment.

479. A Yard Technique solution is proposed at the Walvis Bay yard consisting of electrical point sets controlled remotely via a radio network from a central control panel by yard personnel.

480. If required, state of the art digital exchange switching equipment will be designed and implemented to secure access to available communication network. This system can also provide voice communications between stations by using the access network.

Signalling network components

481. The proposed line-side signalling will include the provision of electrical point sets with electrical indicators on the main line to increase the capacity of the line and contribute to the safe running of trains over turnouts. In addition, track vacancy detection will be installed over point sets to keep the sets electrically locked while trains are occupying the particular track section over the point set. The control and indication of each set is interfaced with the train control system.

482. The proposed train condition monitoring systems will consist of Hot Bearing Detector systems, Derailment Detector systems and Earthquake Detector systems. The alarms generated by the mentioned systems will be interfaced into the train control system to prevent possible derailments and subsequent damage to rail infrastructure. An in-motion weighbridge system is proposed at the port yard for the weighing of both loaded and empty wagons.

483. All line-side signalling equipment, telecommunication equipment and train condition monitoring equipment will be supplied by using a combination of either mains power or solar power. Provision will also be made for a backup power supply system to provide power in the case of a main supply failure.

484. The total signalling system shall be monitored and if need be, controlled from a centralised traffic control office.

5.1.3 Rail Operations Capital Expenditure

485. The rolling stock fleet requirements and the rail yard requirements have been estimated for both the coal and the intermodal operations.

Fleet Determination

486. Using OpenTrackTM rail simulation software, each alignment was modelled to determine achievable power to weight ratio (number of wagons per locomotive). The following figures show the resulting performance of each train-consist over each alignment in the loaded direction for coal.

487. Each of these figures shows the speed [km/h] vs. distance [km] in the top graph and the corresponding vertical alignment in the bottom graph. The black line on the top graph indicates the maximum track speed.

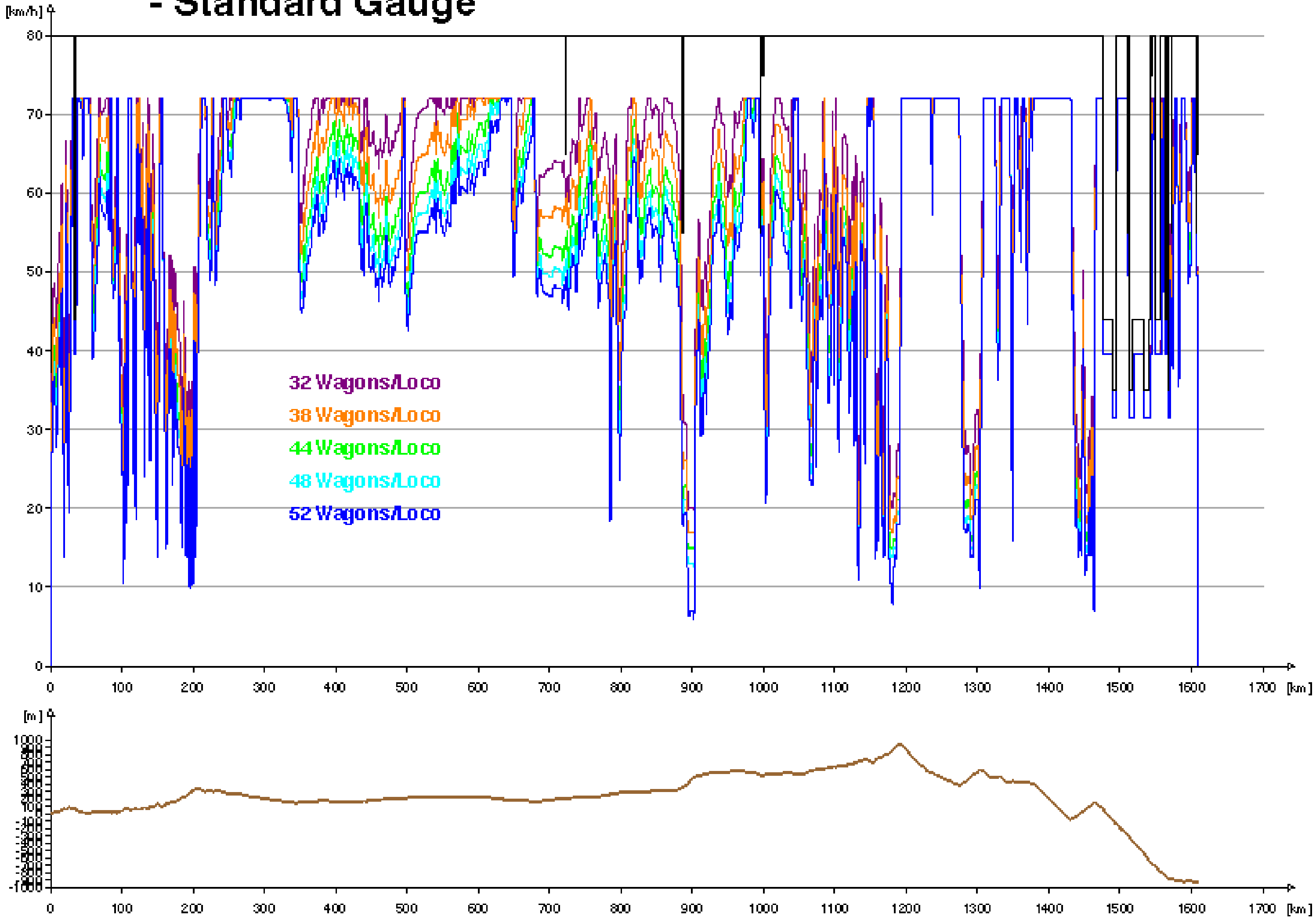
488. Several different wagons/locomotive consists were tested for each alignment and each gauge option. These are indicated in different colours on the graphs so that one may differentiate the different consists.

489. It is clearly visible from the speed vs. distance graph that at steep sections along the alignment, the speed drops well below the minimum continuous speed that is realistically possible for that consist. It is generally not advisable to allow locomotives to run for periods at speeds below their specified minimum continuous speed limit. The reason for this is that running at speeds below minimum continuous speed causes the traction motors to overheat and hence may cause irreparable damage to the locomotives.

490. For this reason, the number of wagons/locomotive shown in Figure 5-2: Number of Coal Wagons per Locomotive and Figure 5-3: Number of Intermodal Wagons per Locomotive do not correspond with the wagons/locomotive consists shown on the graphs. The numbers in the tables indicate the realistic number of wagons per locomotive that may be used without allowing the locomotives to dip below the minimum continuous speeds allowed. It is these numbers in Figure 5-2: Number of Coal Wagons per Locomotive and Figure 5-3: Number of Intermodal Wagons per Locomotive that have been used in the Capex calculations.

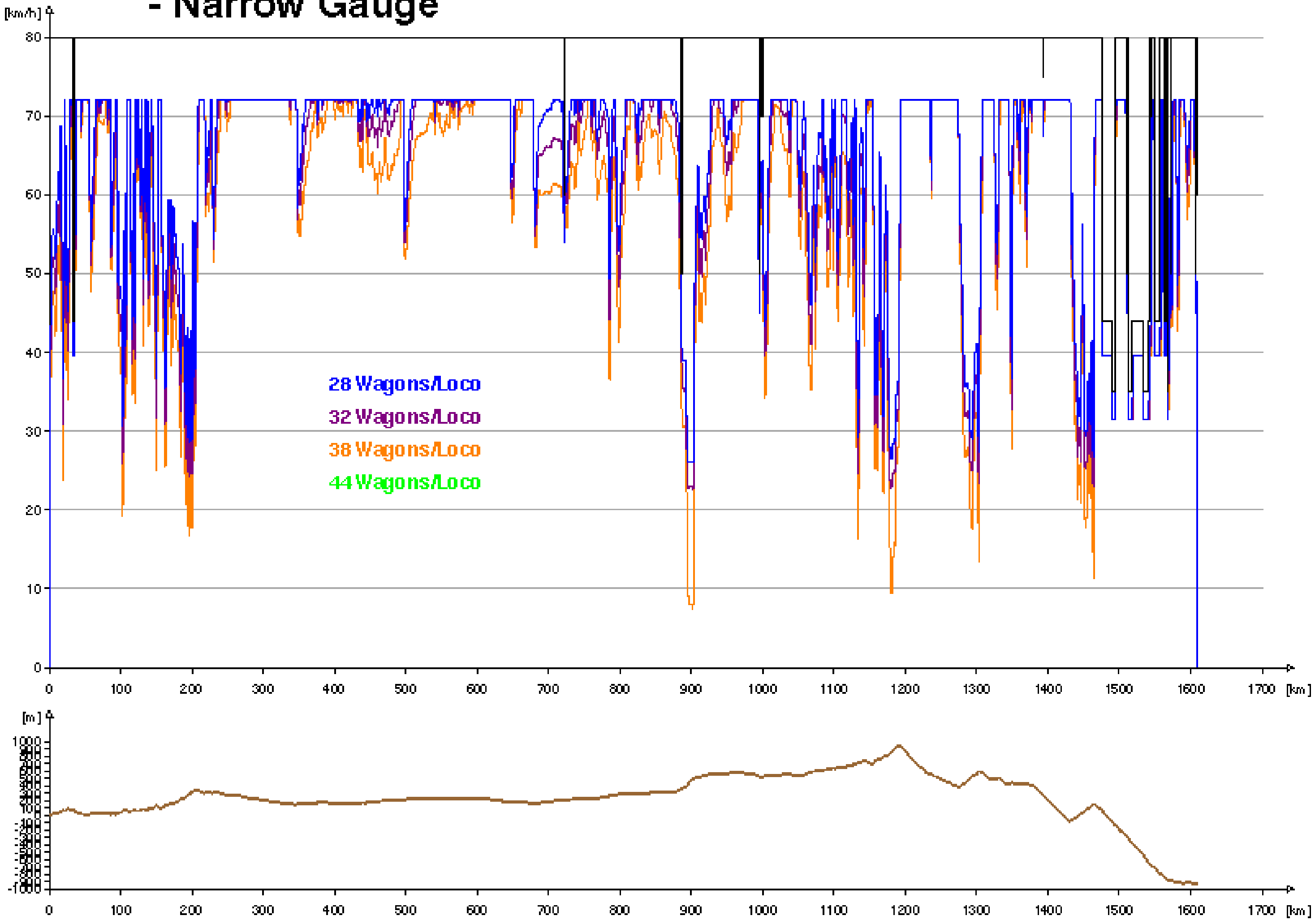
Mmamabula to Walvis Bay via Gobabis

- Standard Gauge

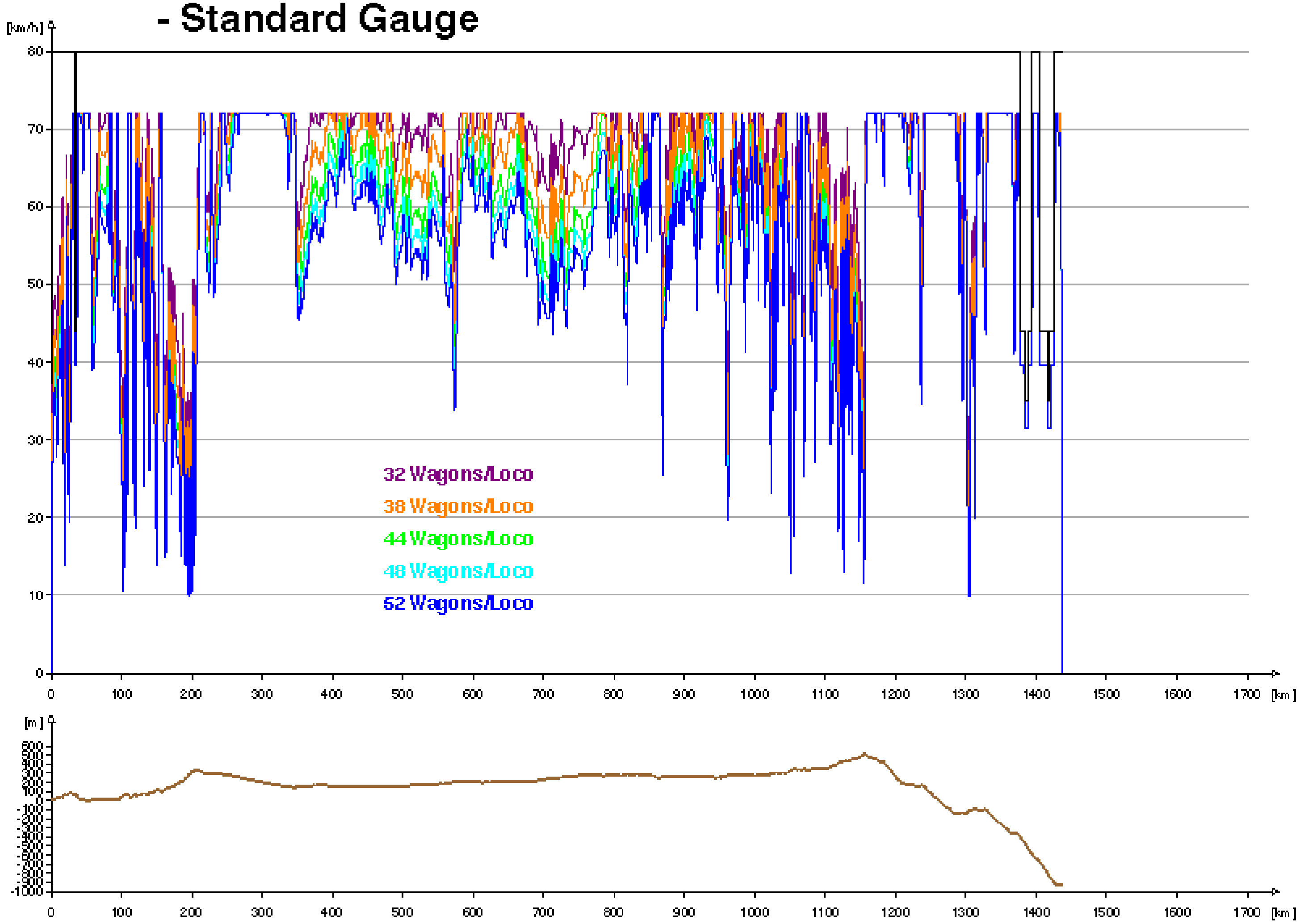


Mmamabula to Walvis Bay via Gobabis

- Narrow Gauge

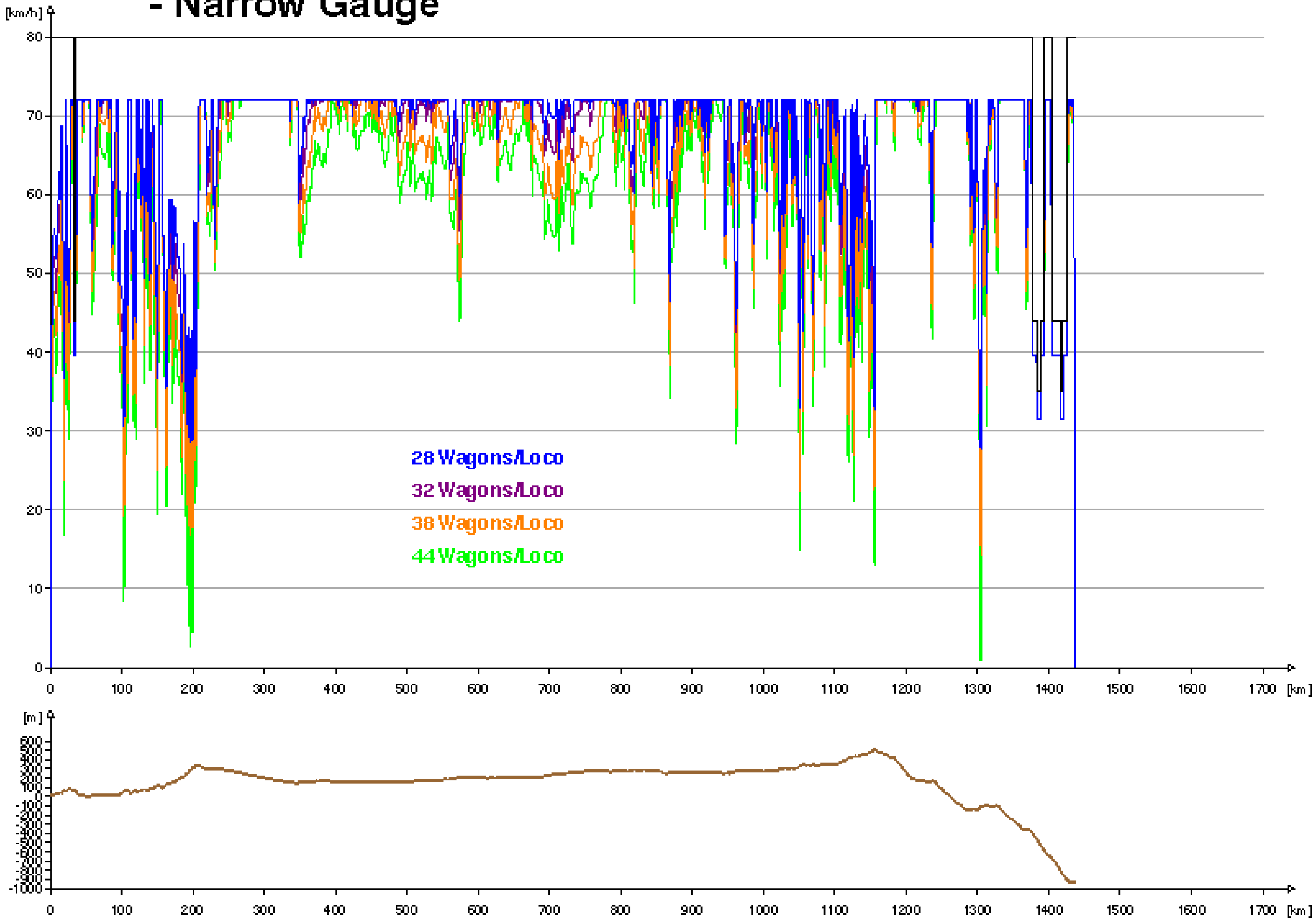


Mmamabula to Walvis Bay via Mariental
- Standard Gauge

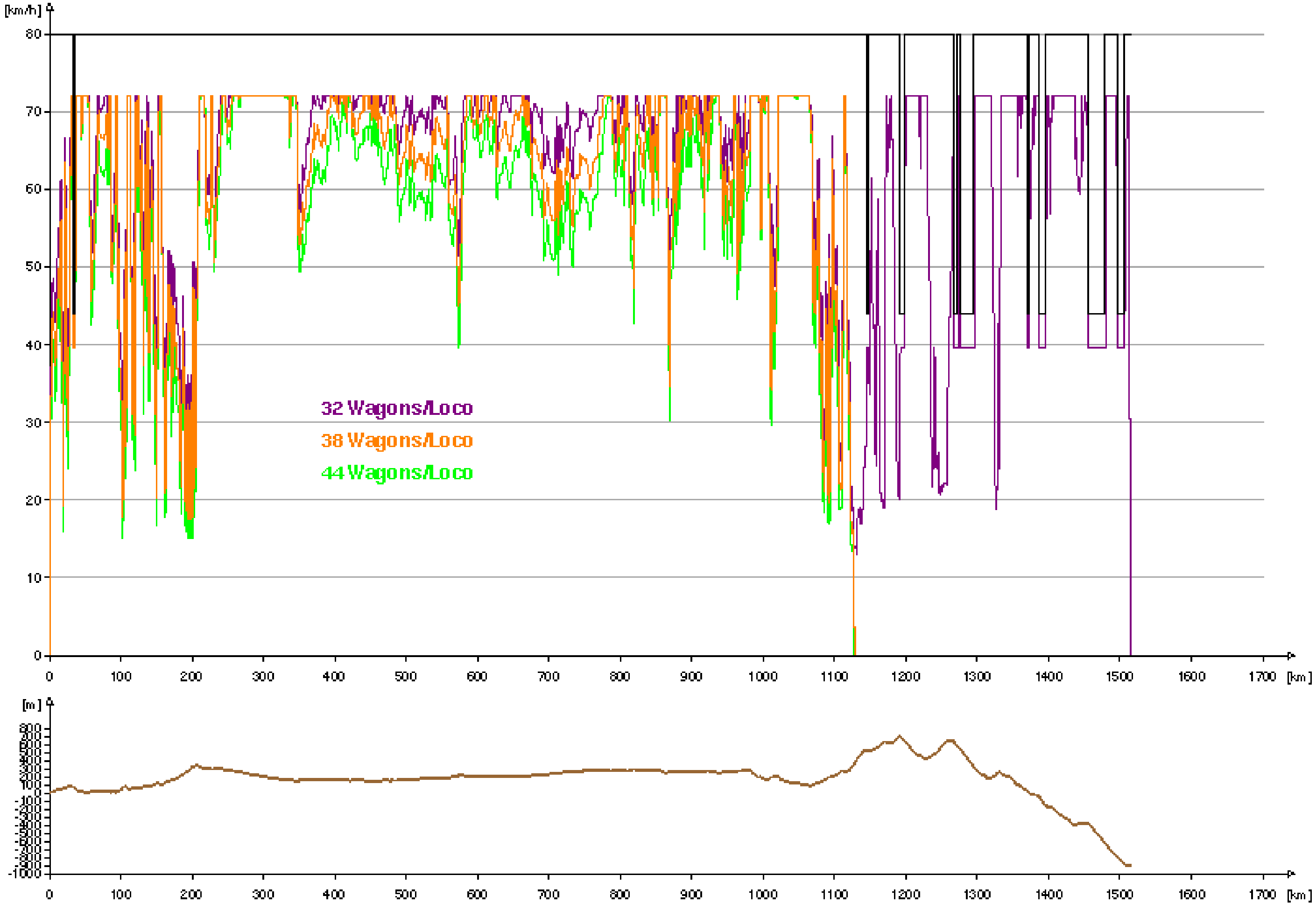


Mmamabula to Walvis Bay via Mariental

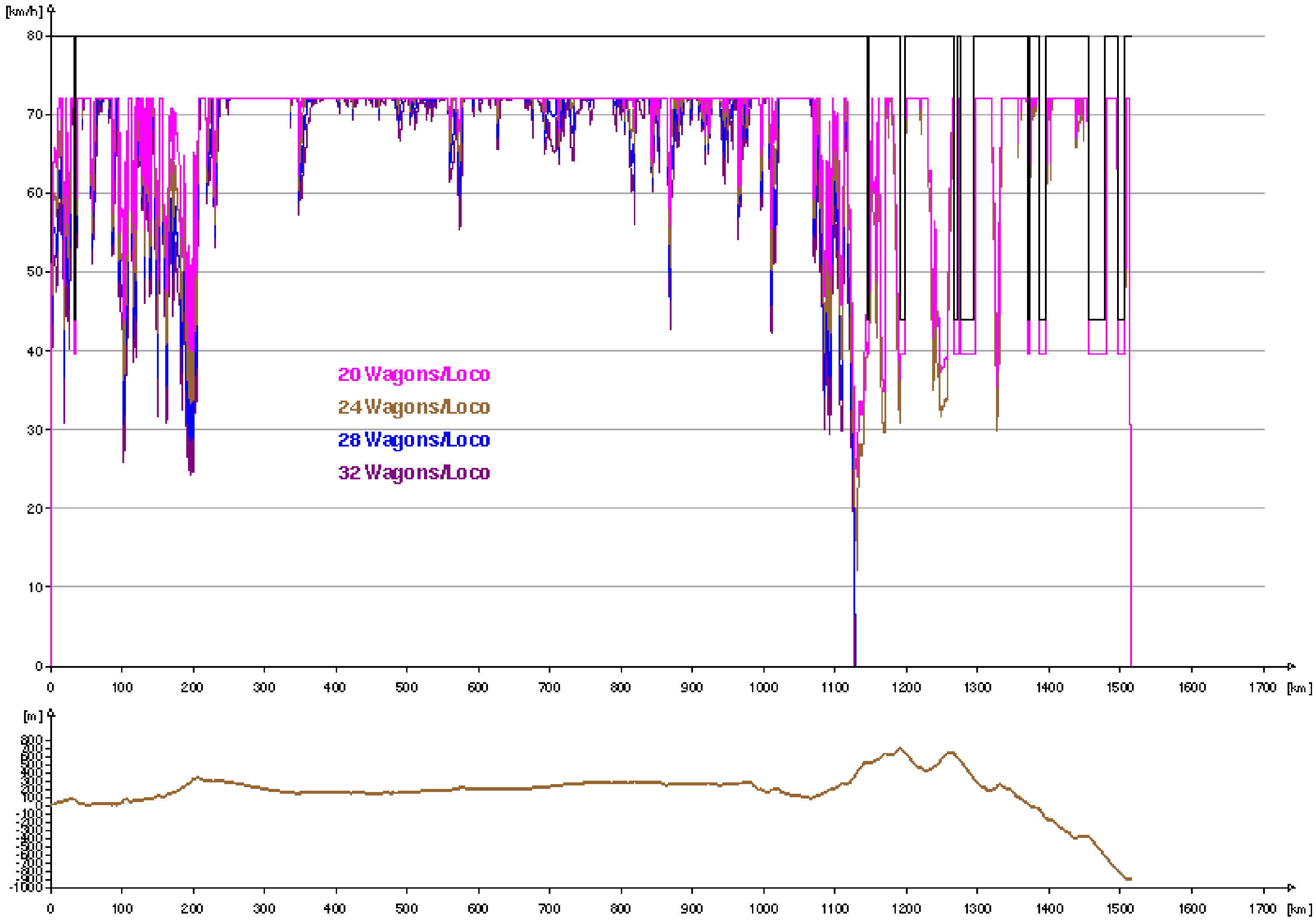
- Narrow Gauge



Mmamabula to Ludritz - Standard Gauge



Mmamabula to Ludritz - Narrow Gauge



491. As can be seen by the above figures, the model allows the trains to travel at very low speed (under the locomotives minimum continuous speed). However, in reality, if a locomotive travels under its minimum continuous speed for prolonged periods of time, its traction motor will overheat due to operating at speeds (RPMs) in excess of design, eventually resulting in failure of the traction motor.

492. By analysing the results from the modelling we were able to determine the maximum number of wagons per locomotive for each alignment.

Figure 5-2: Number of Coal Wagons per Locomotive

Alignment	Number of Coal Wagons per Locomotive	
	Cape Gauge	Standard Gauge
Mmamabula to Walvis Bay port via Gobabis	32	44
Mmamabula to Walvis Bay port via Mariental	32	48
Mmamabula to Lüderitz port	20	32

493. It has been assumed in determining the number of intermodal wagons per locomotive, that all services will be required to achieve the coal traffic runtimes. In addition, there will be two slots per day per direction allocated to the train service plan to accommodate intermodal traffic. To achieve the same runtimes, assuming the same locomotives, the power to weight ratio will be the same. Thus the numbers of intermodal wagons for each alignment have been calculated as shown in the following table:

Figure 5-3: Number of Intermodal Wagons per Locomotive

Alignment	Number of Intermodal Wagons per Locomotive	
	Cape Gauge	Standard Gauge
Mmamabula to Walvis Bay port via Gobabis	25	37
Mmamabula to Walvis Bay port via Mariental	25	41
Mmamabula to Lüderitz port	15	27

494. The analysis undertaken shows a four locomotive train pulling the appropriate number of wagons as per the tables above was a reasonable operation minimising overall rail operating and capital costs on this corridor. The resultant fleet sizes (at full operations) for the coal operations are summarised below.

Figure 5-4: Fleet size for coal operations

Alignment	Cape Gauge			Standard Gauge		
	Train Sets	Loco-motives	Wagons	Train Sets	Loco-motives	Wagons
Mmamabula to Walvis Bay port via Gobabis	99	397	12672	55	221	9680
Mmamabula to Walvis Bay port via Mariental	70	281	8960	39	157	7488
Mmamabula to Lüderitz port	124	497	9920	60	241	7680

495. Similarly, the resultant fleet sizes (at full operations) for the intermodal operations are summarised below.

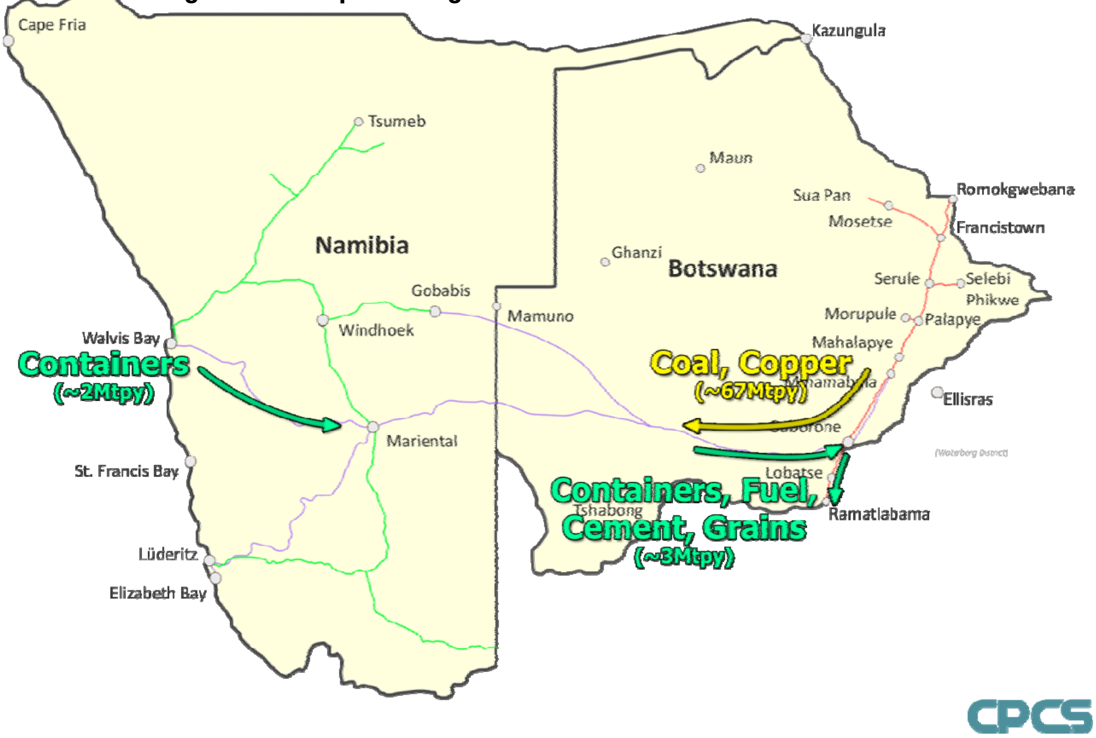
Figure 5-5: Fleet sizes for intermodal operations

Alignment	Cape Gauge			Standard Gauge		
	Train Sets	Loco-motives	Wagons	Train Sets	Loco-motives	Wagons
Gaborone to Walvis Bay port via Gobabis	24	97	2400	19	77	2812
Gaborone to Walvis Bay port via Mariental	21	85	2100	16	65	2624
Gaborone to Lüderitz port	37	149	2220	24	97	2592

5.1.4 Intermodal operations

496. Figure 5-6 highlights the key traffic flows used in consideration of the transhipment nodes. Containers are assumed to be handled through Walvis Bay regardless of the route selection, while bulk commodities are expected to flow through the selected port location. Coal and Nickel are the major commodities travelling westward on the TKR, while containers, fuel, cement, and grains are the major commodities anticipated to flow inbound to Gaborone and RSA.

Figure 5-6: Map showing traffic flow distribution

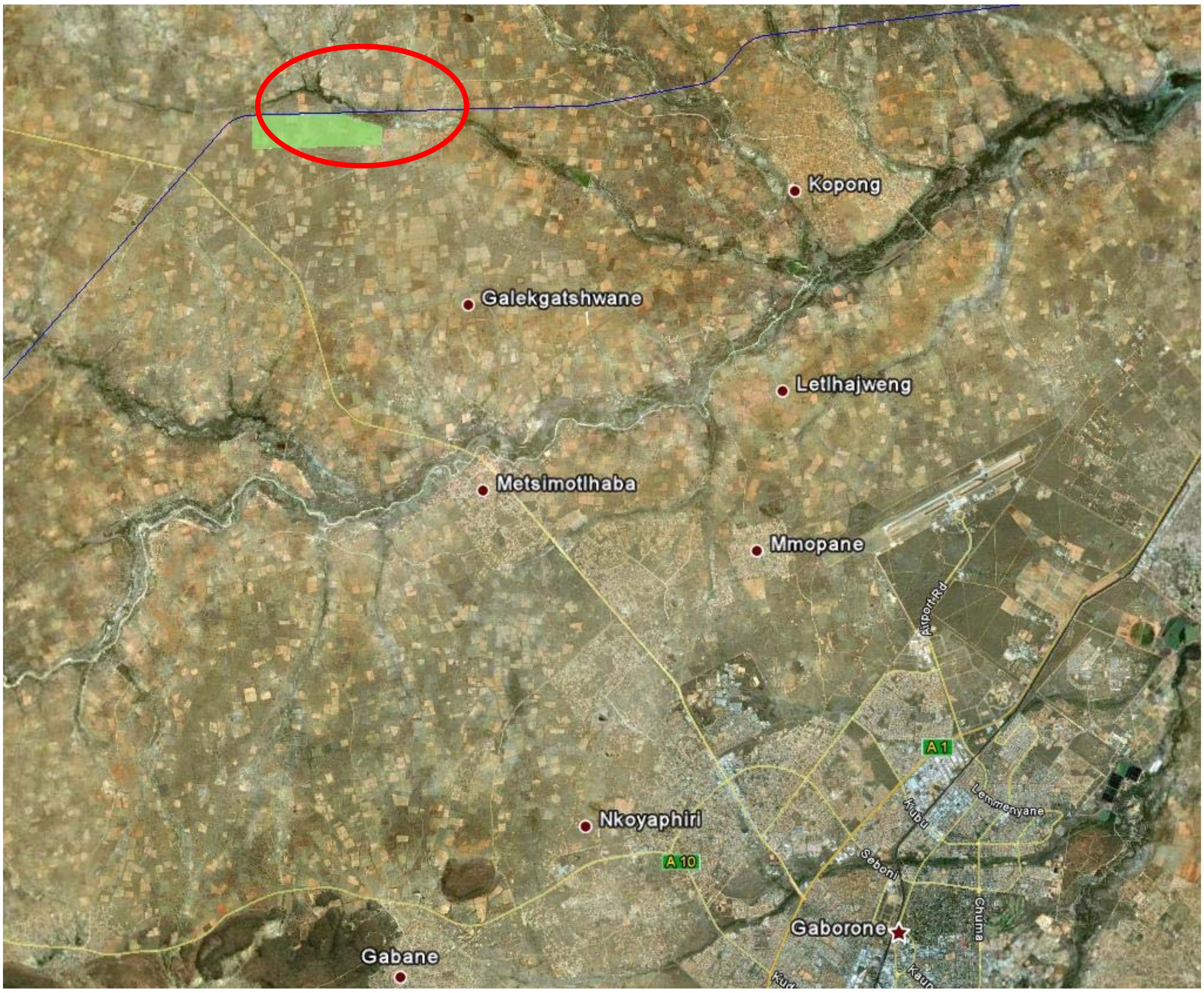


Source: CPCS

497. In the case of Mariental as a transhipment node: if the SG option is chosen for Option 3 (Mmamabula to Lüderitz), then transhipment may be required from SG and CG, using TransNamib to transport containers to Walvis Bay or Lüderitz. If the CG option to Lüderitz is chosen then no transhipment will be necessary assuming the containers will head to Walvis Bay on the same wagons.

498. The Traffic Study report shows that intermodal operations justify Gaborone as a transhipment node. The node will provide a transit route between Gaborone and Walvis Bay port or Lüderitz port, and vice versa. General freight traffic will make use of a new proposed transhipment facility at Gaborone, which will most likely be situated near Kopong where the rail alignment and the Molepolole road converge, as shown in Figure 5-7. This area has been provisionally identified as potential for the transhipment and maintenance facility due to the flat terrain and the fact that the proposed area is undeveloped with land available for the initial and future rail and other associated infrastructure requirements. This makes the site more suitable than a development in Gaborone. The size of the facility would be approximately 400 ha (this includes a maintenance yard). This will be the hub for transhipment from road to rail, and from rail to rail if the SG option is chosen.

Figure 5-7: Possible site for maintenance and transhipment facility



Source: Google Earth

499. For a Standard Gauge TKR system, transhipment facilities, where gantry cranes allow for an efficient transhipment of containers between different freight trains, are important and facilitate the general shift from point-to-point transport to hub-and-spoke railway systems. A rail to rail transhipment facility at Gaborone will accelerate container handling, so that multiple smaller trains with equal destination can be consolidated to a reduced number of trains without hampering on time delivery of goods.

5.1.5 Open access operations

500. Operations with open access allowance will be possible on the TKR, allowing for third party operators to make use of the system. Allowance has been made for two slots per day per direction to allow for a system of open access. This allowance is for the period when coal production is envisaged to be at its peak (year 2021 to 2036). More non-coal slots may be included leading up to the peak coal production period.

501. For the CG option, open access will be possible by way of cross-overs between the existing railway network and the TKR. Wherever possible, the TKR has been aligned to run adjacent to the existing rail network in part for this reason. Special operational "rules" will have to be adhered to by the third party operators wanting

to utilise the TKR including scheduled departure and arrival times, operating speeds, train configurations, etc. The third party operators will undergo a clearance process to use the line before gaining clearance to the TKR.

5.1.6 Supporting train technology

502. Mainline locomotive and wagon capacities are a function of the capability of the locomotive or wagon which determines the gross train mass that a specific locomotive consist can haul over its whole route of application and the maximum permissible payload that the specific wagon type can carry.

503. The magnitude of the utilization parameter known as turnaround time or cycle time of the available fleet - namely the time it takes, from the time that a loaded wagon was dispatched; through the whole process from the loading site, movement to the off-loading point, off-loading, empty movement to the next loading site, loading, until it is once again dispatched after the time of being loaded.

504. The choice of which technology to implement, be it tractive power supply system, or train configuration, is influenced by a multitude of factors such as availability, regulatory compliance, system compatibility, capital and operating cost, as well as safety. All these factors have to be taken into account when selecting the appropriate system and due consideration must be given to each to ensure that the best solution is chosen to suit all the commuter rail system requirements.

505. The prime benefit of utilizing diesel equipment instead of electrical is that there is no overhead contact (catenary) or contact rail system to construct. Electric traction is a very costly capital investment. An additional benefit to using diesel service is that the safety issues revolving around an exposed electrical conductor, either third rail or wire, are eliminated. The drawbacks to using diesel-powered equipment are firstly, the high cost of fuel, secondly, the need to fill fuel tanks regularly, and thirdly, the air polluting emissions generated by the diesel engines. Generally, diesel equipment does not have acceleration and deceleration properties that are comparable to electric equipment. Therefore, operations may require some additional infrastructure improvements to increase capacity that would not be required for electric rolling stock.

5.1.7 Workshop infrastructure requirements

506. A diesel electric locomotive consists of a multiplicity of separate systems, of which the failure of any one would result in that locomotive being unable to operate reliably. A maintenance philosophy which addresses reliability whilst minimising down-time and costs is required. A similar approach is required for wagon maintenance.

507. The maintenance philosophy to be applied may be described as condition-based, preventive maintenance with certain elements of reliability-centred maintenance. It may perhaps be best understood by examining it in terms of a) schedule, b) content, and c) procedure – the "when", the "what", and the "how".

508. ***Where:*** Maintenance is scheduled on a time or mileage basis, with each locomotive receiving a trip inspection or roadworthiness examination daily and

more comprehensive services and examinations at intervals specified by the Original Equipment Manufacturer (OEM) or owner.

509. ***What:*** The content of the examinations, at the prescribed intervals, is flexible and determined according to the perceived maintenance requirements of the particular fleet of locomotives. This is to be specified by TKR Operator or, failing that, each component on the locomotive is assessed and a maintenance cycle, based on intervals of 24 hours, 30 days or 18 months (or multiples thereof) is determined. The inputs to this decision are:

- the manufacturer's recommendation,
- practical observations, failure and trend analysis,
- experience with similar components on other equipment or at other centres,
- condition versus age of the component as determined from spot-checks and statistical sampling techniques.

510. ***How:*** The detailed instructions on how each job is to be performed, the clearances to be maintained, the torques to be applied etc., are contained in the maintenance instruction manuals and a lot of time and effort should be expended at the design and purchasing stage to force the manufacturer to provide suitable documentation with the locomotives. These manuals must be carefully maintained throughout the life of the locomotives, being updated regularly with all relevant modifications and modernisations which may have been implemented during the entire life cycle. They are also used as the basis for training courses and programmes.

Main rolling stock depot

511. The main depot will be capable of undertaking all maintenance tasks required throughout the life of the locomotive, including tyre re-profiling, major bodywork and/or wreck repairs.

512. In order to rationalise stores stock holding of high value components and to maximise utilisation of expensive tooling, repair of certain components is centralised at the main depot. To this end, all turbocharger rotor rework and certain power assembly rework is undertaken at the workshops.

513. The main depot layout must consist of an area equipped with 5-10 t overhead travelling cranes, platforms and pits, allowing multi-level access to the locomotive, an area known as the component repair bay and the back shop, equipped with two 40-60 t overhead travelling cranes, where wheel and bogie changes and heavy component change-outs are undertaken. The main depot area also consists of the wagon repair yard with synchronised floor jacks and pits.

514. The locomotive platform area will be designed for rapid throughput. All examinations, including non-scheduled or running repairs but excluding daily inspections, will be carried out here. Components requiring repair will be removed and transferred to the component repair bay where they will be repaired and exchanged for repaired items in the appropriate bay.

515. Activities in the component repair bay will include:

- Diesel engine overhaul;

- Turbocharger overhaul excluding rotor balancing;
- Fuel injection equipment overhaul and calibration;
- Engine control governor overhaul and calibration;
- Repair and overhaul of fans, blowers etc.;
- Compressors and exhauster overhaul;
- Repair and testing of electrical small parts and electronic panels;
- Complete routine maintenance on all electrical rotating machines excluding rewinds, and
- Overhaul and testing of all airbrake equipment.

516. By the nature of the work which will be done in the back shop, and by virtue of its design, it will be obvious that the throughput or production rate is fairly limited. Locomotives are therefore, kept away from the back shop unless it is absolutely unavoidable or for planned major overhauls.

517. Associated with the main depot, is a large storage area for spare parts and consumables. Fuelling facilities and a laboratory whose primary function is to monitor engine lubrication oil condition, engine coolant quality and depot effluent control are also provided.

Rolling Stock Sub-Depot

518. A sub-depot will be used to perform only daily maintenance and minor running repairs. The mainline diesel locomotive shed will be equipped with a pit and a platform, but no overhead cranes. The wagon repair siding has a shed providing cover for minor repairs and wheel changes using floor-standing synchronised jacks. A small shed to maintain the shunting locomotives utilised for shunting and loading operations, is also provided. An infrastructure maintenance depot can also be situated here.

519. Future operational simulations will determine whether fuelling and sanding infrastructure is required, however, it is considered prudent to allow space for such facilities if required.

Infrastructure depots

520. Infrastructure Depots will be centrally located from where the track and signal maintenance of the particular section can be undertaken. The staff report here every day for duty, all the different items of maintenance spares, material and equipment are stored here and there are facilities for the emergency gang to sleep and stay during the night and over weekends.

Train Driver Book-off facilities

521. Train driver book-off facilities must enable train drivers to change shifts. The train driver coming off duty signs off and the train driver coming on duty signs on at the roster clerk’s desk. Near the book-off facilities, there must be accommodation for the train drivers to sleep before their next shift begins. This should preferably be on the property or within walking distance to negate the need for vehicle transfers between sleeping quarters and book-off facilities.

5.1.8 Electrification of TKR

522. The debate on whether to electrify the entire main line between Mmamabula and a port location in Namibia is not a debate that is suitable for exhaustive discussion at this stage. A detailed study would be required to discuss all the implications related to electrifying the TKR.

523. The detailed study would look at the existing infrastructure's capacity and reliability in delivering power to the line in both Namibia and Botswana. This would include power generation, power distribution, capacity and institutional structures, amongst other issues such as environmental impacts.

524. Before conducting an exhaustive study on the feasibility of electrifying the TKR, it is recommended that the following points be considered by both Namibia and Botswana:

- Current regional supply capacity of supplying the line with the required power (min 50 kV AC);
- Several power plants will have to be constructed to supply the required power necessary at a huge capital investment.
- Difficulty in extending power lines due to length and remoteness of the railway line;
- The power plants infrastructure would have to be in place prior to railway electrification. The two cannot occur simultaneously;
- Investment in the type of locomotives made (electric or diesel) needs to be carefully considered because it will be very costly to exchange the one type for the other;
- Capex cost of electrification may make TKR less economically feasible;
- Additional maintenance costs linked to OHTE;
- Electricity has in the past been considered cheaper than diesel, however this notion is quickly changing as electricity demand is increasing worldwide;
- Third party operators will require a shift from diesel operations to electrified operations; and
- Connectivity issues between two sovereign countries will need to be considered.

5.1.9 Capital Cost (Above Rail)

525. In addition to the rolling stock fleet capital the following additional capital items were assumed and costed for all three alignment options:

- Yard facilities and workshops at both ends to maintain the rolling stock fleet
- Provisioning facilities at these yards
- Sub-depot facilities at a suitable centralised point along the routes (near Mariental for Options 2 and 3, or near Gobabis for Option 1)

526. We have estimated the capital cost for the CG and SG operations. The Rail Yards (facilities and workshops) and Rollin stock capital investment estimates are based on fleet size as determined by Open Track simulations. These estimates are summarised below.

Figure 5-8: Above Rail Capital cost estimates

	Mmamabula to Walvis Bay (Millions USD)			Mmamabula to Walvis Bay (via Gobabis) (Millions USD)			Mmamabula to Lüderitz (Millions USD)		
	Coal	Inter-modal	Total	Coal	Inter-modal	Total	Coal	Inter-modal	Total
Standard Gauge									
Rolling stock capital investment	1,826.1	523.4	2,349.5	2,432.8	590.3	3,023.1	2,192.8	648.2	2,841.0
Rail Yards (including facilities and workshops)	458.8	210.6	669.3	592.1	222.9	815.0	496.1	213.8	709.9
Total Above Rail Capital Cost	**2,284.8**	**734.0**	**3,018.9**	**3,024.9**	**813.2**	**3,838.1**	**2,688.9**	**862.1**	**3,550.9**
Capitalised Interest	184.1	59.3	243.5	243.7	65.7	309.4	216.6	69.6	286.2
Total Above Rail Capital Cost	**2,469.0**	**793.4**	**3,262.3**	**3,268.7**	**878.9**	**4,147.6**	**2,905.5**	**931.7**	**3,837.1**
Cape Gauge									
Rolling stock capital investment	2,242.9	455.6	2,698.5	3,170.9	520.3	3,691.2	3,018.6	652.0	3,670.6
Rail Yards (including facilities and workshops)	578.6	182.8	761.4	813.8	202.0	1,015.9	716.8	214.1	930.9
Total Above Rail Capital Cost	**2,821.5**	**638.5**	**3,459.9**	**3,984.7**	**722.4**	**4,707.1**	**3,735.4**	**866.1**	**4,601.5**
Capitalised Interest	227.4	51.6	279.0	321.2	58.4	379.6	300.9	69.9	370.9
Total Above Rail Capital Cost (incl. capitalised interest)	**3,048.9**	**690.1**	**3,739.0**	**4,305.9**	**780.7**	**5,086.6**	**4,036.3**	**936.0**	**4,972.3**

527. To summarise, the railway Capex has been divided into two broad groups, namely 'Above' Rail and 'Below' Rail. Note that for the purposes of the financial model, the capitalised interest was not including included in the Capex, but rather amortized over a realistic period.

528. Below Rail costs cover all the infrastructure costs that relate to the railway alignment. These costs typically include earthworks, drainage, trackwork, bridges, tunnels, etc.

529. It appears from the high level assessment that CG has lower Below Rail cost compared with SG. Of the three route alignments, Option 2 (Mmamabula to Walvis Bay via Mariental) is the lowest at **USD 5,191 Mil**.

Figure 5-9: Summary of Below Rail Costs

	Standard Gauge Cost (Millions USD)	Cape Gauge Cost (Millions USD)
Mmamabula to Walvis Bay via Gobabis (Option 1)	7,031	6,701
Mmamabula to Walvis Bay (Option 2)	5,347	5,191
Mmamabula to Lüderitz (Option 3)	6,598	6,418

530. Above Rail costs cover all the rolling stock requirements necessary to initiate operations of the railway. Yard facilities for rolling stock are covered here. It can be seen that the advantage that CG has over SG regarding infrastructure costs is

cancelled by the fact that the Above Rail costs of a SG scenario are much less than the CG counterpart. The reason for this is that SG operations require less rolling stock to move the same volumes.

531. The Above Rail costs also take into account requirements for intermodal operations which have been factored into the calculation. However, it is important to note that the full cost of the intermodal rolling stock requirements will not be as high as the figures indicate due to the fact that some existing rolling stock may be utilized for intermodal transport.

532. It appears from the high level assessment that out of the three route alignments, Option 2's Above Rail Cost is the lowest at **USD 3,262 Mil**.

Figure 5-10: Summary of Above Rail Costs (Coal and Intermodal)

	Standard Gauge Cost (Millions USD)	Cape Gauge Cost (Millions USD)
Mmamabula to Walvis Bay via Gobabis (Option 1)	4,148	5,087
Mmamabula to Walvis Bay via Mariental (Option 2)	3,262	3,739
Mmamabula to Lüderitz (Option 3)	3,837	4,972

5.2 Capital Investment Expenditure – Ports and Terminal

5.2.1 Project Cost: CAPEX

533. The capital cost is based on rates obtained from previous studies in the region and the rates are escalated to November 2010.

534. The estimated capital costs are exclusive of operation cost and any enabling studies that fall outside the scope of this report as well as taxes, permits, land cost and professional fees, and have been based on the following:

- All capital expenditure (Capex) were calculated for year 0 and adjusted as needed to model the construction periods
- Project Timeline: Phase I – 2016 and Phase II – 2019, as per Traffic forecast
- For non-coal, all capital cost occurs in year 1

535. The capital costs are estimated for as current cost for both scenarios at 16.8 Mtpa and 65 Mtpa for Phase 1 and Phase II respectively.

536. It is assumed that capital cost for Phase I includes the costs for some of the Phase II components due to the relative short period in between the Phases as per the Traffic Studies Forecast. Therefore, items such as the causeway have been included in Phase I costing.

537. Due to the slight ramp-up for non-coal cargo, the capital cost includes the equipment required for the maximum throughput capacity. All container cargo has been assumed to be handled by the future Walvis Bay Container Terminal. Therefore no costs have been included in the ports capital costs for container cargo. However, it would be required to investigate the requirements to reroute

the container traffic to Walvis Bay in the case where coal is being hauled to Ludertiz.

538. The following major cost factors must be considered in more detailed studies:

- Diesel fuel cost
- Labour recruiting and training strategy
- Volatile rates of material, such as cement and structural steel
- Provision of Utility plants, especially at Lüderitz
- The capital cost has been evenly distributed over the phases with a lead time of 4 – 5 years.

539. The following summaries of the capital costs for the coal exports for each of the Phases and potential port sites are presented as order of magnitude costs, which will have to be refined in future study phases:

Lüderitz

	Phase 1 – 16.8 Mtpa USD Mil	Phase 4 – 65 Mtpa USD Mil
ON-SHORE CAPEX		
Engineering Infrastructure		
Total – Infrastructure	557	532
Bulk Materials Handling Equipment		
Total - Bulk Material Handling	305	479
Operational Capital		
Total - Operational Capital	11	26
TOTAL – ON-SHORE CAPEX	873	1,038
OFFSHORE CAPEX		
Offshore Infrastructure		
Pier		
Total – Pier	195	387
Causeway		
Total – Causeway	66	0
Dredging		
Total – Dredging	60	0
Offshore Bulk Handling Material		
Shiploader		
Total – Shiploader	37	58
Conveyor		
Total – Conveyor	17	49

TOTAL – OFFSHORE CAPEX	376	493
GRAND TOTAL (for each phase)	1,248	1,531
GRAND TOTAL (project completion)	2,779	

Walvis Bay

	Phase 1 – 16.8 Mtpa USD Mil	Phase 4 – 65 Mtpa USD Mil
ON-SHORE CAPEX		
Engineering Infrastructure		
Total – Infrastructure	406	513
Bulk Materials Handling Equipment		
Total - Bulk Material Handling	533	934
Operational Capital		
Total - Operational Capital	11	26
TOTAL – ON-SHORE CAPEX	**949**	**1,473**
OFFSHORE CAPEX		
Offshore Infrastructure		
Pier		
Total – Pier	195	387
Causeway		
Total – Causeway	236	0
Dredging		
Total – Dredging	137	0
Offshore Bulk Handling Material		
Shiploader		
Total – Shiploader	37	58
Conveyor		
Total – Conveyor	51	115
TOTAL – OFFSHORE CAPEX	**656**	**560**
GRAND TOTAL (for each phase)	**1,604**	**2,034**
GRAND TOTAL (project completion)	**3,638**	

540. It must be noted for the small difference in volumes of non-coal for Phase 1 and 4, the CAPEX is assumed to be in during the first phase to provide the required facilities.

541. The following summaries of the capital costs for the non-coal exports for each of the Phases and potential port sites are presented as order of magnitude costs, which will have to be refined in future study phases:

Lüderitz

Commodity	Material Handling USD Mill	Storage Area USD Mill	Equipment USD Mill	Electrical & Controls USD Mill	Mechanical services & Environment USD Mill
Soda Ash	29	3.7	5.9	9.5	2.2
Salt	26	0	0.5	4.8	2.2
Ni/Cu Matte	0	1.2	5.7	4.8	2.2
Grain	13	3.7	0.5	9.5	2.2
Copper	0	0	11.4	0	2.2
Cement	0	3.7	0	0	2.2
Fuel	0	0	0	0	0
Subtotal	**69**	**12.1**	**24**	**28.6**	**13.2**
Grand Subtotal	**147**				
Grand Total (incl. P&G's and Contingencies)	**219**				

Walvis Bay

Commodity	Material Handling USD Mill	Storage Area USD Mill	Equipment USD Mill	Electrical & Controls USD Mill	Mechanical services & Environment USD Mill
Soda Ash	14.8	3.7	5.9	9.5	2.2
Salt	0	0	0	0	0
Ni/Cu Matte	0	1.2	5.7	4.8	2.2
Grain	0	0	0	0	0
Copper	0	0	11.4	4.8	2.2
Cement	0	3.7	0	0	2.2
Fuel	0	0	0	0	0
Subtotal	**14.8**	**8.6**	**23**	**19.1**	**8.8**
Grand Subtotal	**74.3**				

6 Cost of Rail, Port & Terminal Operations

6.1 Above Rail Operating Cost Estimate

542. Annual estimates of operating costs for the coal and intermodal operations, for all three alignment options have been calculated. The total for the 2016 to 2045 period operating costs is summarised below. Appendix C contains the annual operating costs.

543. From the tables below, it is clear that the major cost driver for operating costs is fuel price as it accounts for approximately 45% of the total operating costs. Variations in the fuel price will impact negatively on the accuracy of the operating costs of the rail project during the project period.

544. The basis of the Opex estimate for the three options entails the process of activity demand in the form of volumes of coal to be hauled per annum, together with intermodal volumes as per the Traffic Study report.

545. Annual volumes were translated into trainloads per year and the required train consists and number of trains per day.

546. The train crew strengths required will be determined by the number of trains and the lengths of track.

547. The number of locomotives and wagons were used to determine the size of maintenance depots, equipment and yard sizes in terms of staging and building facilities.

548. For SG operations over a period of 30 years, it can be seen that the total cost of operations including intermodal operations is the lowest for Mmamabula to Walvis Bay port via Mariental (Option 2).

549. For CG operations over a period of 30 years, it can be seen that the total cost of operations including intermodal operations is the lowest for Mmamabula to Walvis Bay port via Mariental (Option 2).

550. The comparative operating cost between SG and CG indicates that SG operating costs are lower than CG for the 30 year period.

Figure 6-1: Total Operating Cost Estimate for Standard Gauge

	Mmamabula to Walvis Bay via Mariental (Millions USD)			Mmamabula to Walvis Bay via Gobabis (Millions USD)			Mmamabula to Lüderitz (Millions USD)		
	Coal	Inter-modal	Total	Coal	Inter-modal	Total	Coal	Inter-modal	Total
Standard Gauge									
Locomotive Maintenance	2,920.9	610.2	3,531.1	3,635.4	761.0	4,396.3	4,600.6	972.2	5,572.8
Wagon Maintenance	3,997.7	377.9	4,375.7	4,530.6	427.0	4,957.6	4,204.1	398.5	4,602.6
General Yard Maintenance NES (e.g. track & signal)	256.1	110.3	366.4	331.8	120.6	452.4	266.1	113.3	379.5
Building Maintenance	29.2	12.8	42.0	40.3	14.5	54.8	43.8	18.0	61.8
Crew Quarters	2.8	1.4	4.2	3.6	1.9	5.6	3.6	1.9	5.6
Locomotive Maintenance Facility	41.0	19.4	60.5	51.8	21.6	73.4	51.8	21.6	73.4
Underfloor Wheel Lathe	7.8	7.8	15.6	7.8	7.8	15.6	7.8	7.8	15.6
Wagon Maintenance Facility	63.8	23.5	87.4	80.1	25.2	105.3	63.8	24.6	88.5
Provisioning Facility	20.5	9.7	30.2	25.9	10.8	36.7	25.9	10.8	36.7
Yard & Facilities Maintenance Sub-Total	421.2	185.0	606.2	541.4	202.3	743.7	462.9	198.1	661.1
Yard Electric Energy Use	2.6	1.6	4.1	3.3	1.7	5.1	2.7	1.6	4.3
Fuel Cost	8,159.2	1,278.9	9,438.1	10,279.2	1,434.7	11,713.9	10,621.2	1,751.5	12,372.7
Crew Cost	413.9	173.5	587.4	619.0	216.6	835.5	619.0	279.2	898.1
Business Overheads	1,163.1	202.0	1,365.0	1,398.9	241.0	1,640.0	1,483.0	277.2	1,760.2
Total Above Rail Operating Costs	17,078.6	2,829.0	19,907.6	21,007.8	3,284.4	24,292.2	21,993.4	3,878.4	25,871.8

Figure 6-2: Total Operating Cost Estimate for Cape Gauge

	Mmamabula to Walvis Bay via Mariental (Millions USD)			Mmamabula to Walvis Bay via Gobabis (Millions USD)			Mmamabula to Lüderitz (Millions USD)		
	Coal	Inter-modal	Total	Coal	Inter-modal	Total	Coal	Inter-modal	Total
Cape Gauge									
Locomotive Maintenance	5,491.9	954.5	6,446.5	6,338.4	1,087.4	7,425.9	9,312.7	1,687.5	11,000.2
Wagon Maintenance	5,024.7	366.8	5,391.5	5,735.8	417.6	6,153.5	5,314.7	389.4	5,704.1
General Yard Maintenance NES (e.g. track & signal)	310.6	89.7	400.4	439.2	103.3	542.5	352.3	98.0	450.3
Building Maintenance	51.2	16.4	67.6	73.0	17.8	90.8	91.4	27.3	118.7
Crew Quarters	4.6	1.9	6.5	7.3	1.9	9.2	8.3	2.8	11.0
Locomotive Maintenance Facility	61.9	21.6	83.5	82.1	21.6	103.7	103.0	32.4	135.4
Underfloor Wheel Lathe	7.8	7.8	15.6	7.8	7.8	15.6	7.8	7.8	15.6
Wagon Maintenance Facility	72.2	19.6	91.8	104.2	22.1	126.3	80.1	21.0	101.1
Provisioning Facility	31.0	10.8	41.8	41.0	10.8	51.8	51.5	16.2	67.7
Yard & Facilities Maintenance Sub-Total	539.4	167.8	707.2	754.5	185.3	939.8	694.2	205.4	899.6
Yard Electric Energy Use	3.1	1.3	4.4	4.4	1.5	5.9	3.5	1.4	4.9

Fuel Cost	10,046.2	1,395.7	11,441.8	12,089.5	1,464.7	13,554.2	12,679.8	2,024.8	14,704.6
Crew Cost	781.1	231.7	1,012.7	1,168.5	266.2	1,434.6	1,403.4	413.6	1,817.0
Business Overheads	1,775.6	258.1	2,033.7	2,099.6	293.5	2,393.1	2,508.7	404.4	2,913.1
Total Above Rail Operating Costs	23,661.9	3,375.9	27,037.8	28,190.7	3,716.2	31,906.9	31,917.0	5,126.6	37,043.7

6.2 Below Rail Operating Cost Estimate

551. We have estimated the annual operating costs for the 'Below Rail' components for all three alignment options. The total operating cost for the period 2016 to 2045 is summarised in Figure 6-3.

552. From the table below, one can see the major components that require annual maintenance. These components include structure and track, facilities, communications and trackside systems. We have also made provision for business overheads and train control.

553. The model assumes an incremental increase on the year-to-year 'Below Rail' maintenance costs as the infrastructure ages with time for the first 5 to 7 years. In addition to this annual maintenance cost, a yearly recurring capital allowance of 1.5% of the 'Below Rail' capital would be required to allow for rail renewals, turnout renewals, signal upgrades etc. done at regular intervals when these items reach the end of the their physical life.

554. The 1.5% effectively allows for rail renewals, which at high transit volumes, could require replacement after approximately 15 years, however the use of head hardened rail, an appropriate rail grinding programme as well as wheel profiling will extend the life of the rail. Major overhauls for rail mainly reflect the renewal of rails. The figure of 1.5% used means that the components of rail infrastructure other than formation (which requires very little recapitalization) is replaced on average every 50 years, and thus keeps up with the expected depreciation of these assets. In simple terms, spending 1.5% on average every year recapitalising the rail assets will result in an asset substantially the same in 50 years as it is today, i.e. able to service the required task.

Figure 6-3: Summary of Below Rail Operating Costs

	Mmamabula to Walvis Bay via Mariental (Millions USD)	Mmamabula to Walvis Bay via Gobabis (Millions USD)	Mmamabula to Lüderitz via Mariental (Millions USD)
Standard Gauge			
Structures & Track Maintenance	876	997	965
Facilities Maintenance	5	6	6
Comms & Trackside Systems Maint.	163	186	180
Business Overheads	157	178	173
Train Control	126	155	200
Recurring Capital Costs	799	1,052	987
Total Below Rail Operating Costs	**2,126**	**2,321**	**2,322**
Cape Gauge			
Structures & Track Maintenance	892	999	985
Facilities Maintenance	5	6	6
Comms & Trackside Systems Maint.	166	186	184
Business Overheads	159	179	176
Train Control	234	263	398
Recurring Capital Costs	798	1,037	989
Total Below Rail Operating Costs	**2,256**	**2,431**	**2,547**

6.2.1 Train Operations Philosophy framework

555. The Operations Philosophy describes the most common operational frameworks. The recommended philosophy for operations on the TKR is the planned or traffic pull philosophy.

556. The planned or traffic pull process leaves nothing to chance as far as traffic flow is concerned. Each and every event that has to take place during the transportation process is meticulously planned in advance. Service operation/execution takes place by physically working the plan. All envisaged train movements across the entire railway network are planned and scheduled in advance.

557. Provision is also made for volume fluctuations by planning and scheduling additional capacity. This also allows for some flexibility within the plan. The complete scheduled train plan is referred to as the Master Train Schedule and all train movements are dictated by it. The Master Train Schedule is normally divided into a mainline or direct origin to destination movement schedule and, in the case of general freight and passengers, a local short haul pick-up and delivery plan to and from junctions with the mainline as well as a client siding shunting plan (which will be applicable to general freight only).

558. The total train plan, as given by the Master Train Schedule, is not executed every day. A daily train plan reflecting the train requirements for a particular day is derived from the Master Train Schedule for execution on the particular day. Once the daily train plan for the remaining general freight slots is finalised (2 slots per day), each and every consignment is linked to a particular wagon. Each wagon is then linked to a train and each train to a scheduled slot chosen from the Master Train Schedule.

559. The Master Train Schedule makes allowance for a daily train slot in both directions between the two end points. Depending on traffic demand, the daily train plan

can allocate this slot to a goods train destined for the mines or, on other days for example, three days per week, to other commodities. The Master Train Schedule also shows slots blocked out for daily track maintenance which, in abnormal circumstances, may be used for train slots (as part of a contingency plan in the case of lost production due to a derailment).

560. The planned process of traffic movement requires sophisticated information systems, excellent communications between all the relevant role players facilitating consignment and train movements. It furthermore requires strict discipline as far as execution is concerned, making central planning and control a pre-requisite, as well as documented and implemented operating procedures and execution countdown processes.

561. Guarantees as far as delivery times of consignments can be offered to clients because of the predictability of the service. Provision for eventualities such as equipment failure, etc., is internally absorbed by allowing for dwell times, normally at intermediate destinations or marshalling yards.

562. A planned service gives clients the obvious advantages of predictability, enabling them to perform accurate transportation planning. From a railway perspective, the level of asset utilisation is as high as practically possible which, in turn, reduces overall capex and operating cost.

6.3 Operating Cost Estimate – Ports and Terminal

6.3.1 Project cost: OPEX

563. The operating cost is based on rates obtained from previous studies in the region and the rates are escalated to November 2010.

564. The estimated operating cost are exclusive of capex, contingencies, taxes, permits, land cost and professional fees, and have been based on the following:

- All capital expenditure occurs in a construction prior to implementation
- All operating cost occur in years thereafter
- Project Timeline: Phase I – 2016 and Phase II – 2019, as per Traffic forecast
- Costs were escalated from base year by a factor of 2, as a conservative approach, pending proper financial analysis.
- The annual operating costs are estimated for a ramp up scenario from 16.8 Mtpa to an ultimate 65 Mtpa production scenario for Phase I and II respectively.

565. The operating cost analysis shows a high proportion of fixed operating cost and a low proportion of variable cost component. The following major cost factors were considered in the analysis:

- Product transportation, handling and storage costs
- Port-side handling (transfer) costs inclusive of port tariffs
- Human resource costs e.g. salaries
- Utilities demand

- For non-coal cost, there are several areas that require more detail to determine the final costing for the project operation lifetime, such as:
  - Costing strategy for equipment servicing the Botswana Dry Port within the Namport port limits
  - Any dues payable by Botswana to Namport for the Dry Port land and regular servicing
  - Dues and tariffs for routing cargo to existing terminals in Walvis Bay and Luderitz (fuel only)
  - Tariffs payable to Namport for use of the future container terminal for throughput of container cargo
  - Maintenance dredging payable by Namport, which includes mobilisation and demobilisation of dredgers, to meet navigation requirements.

566. The following summaries the operating costs for the coal exports for each of the Phases and potential port sites are presented as order of magnitude costs, that will have to be refined in future study phases:

Lüderitz

	Phase 1 – 16.8 Mtpa USD Mil	**Phase 2– 65 Mtpa USD Mil**
ON-SHORE OPEX		
Fixed OPEX	29	112
Variable OPEX	4	16
TOTAL – ON-SHORE OPEX	**33**	**128**
OFFSHORE OPEX		
Fixed OPEX	12	36
Variable OPEX	0.1	0.2
TOTAL – OFFSHORE OPEX	**12**	**36**
GRAND TOTAL (for each phase)	**45**	**164**

Walvis Bay

	Phase 1 – 16.8 Mtpa USD Mil	Phase 2 – 65 Mtpa USD Mil
ON-SHORE OPEX		
Fixed OPEX	29	112
Variable OPEX	4	15
TOTAL – ON-SHORE OPEX	**33**	**128**
OFFSHORE OPEX		
Fixed OPEX	24	73
Variable OPEX	0.1	0.2
TOTAL – OFFSHORE OPEX	**24**	**73**
GRAND TOTAL (for each phase)	**57**	**200**

567. The following summaries the operating costs for the non-coal exports for each of the Phases and potential port sites are presented as order of magnitude costs, that will have to be refined in future study phases:

Lüderitz

	Phase 1: 3.26 Mtpa* USD Mill	Phase 2: 3.56 Mtpa* USD Mill
ON-SHORE OPEX		
Fixed OPEX	5.6	7.0
Variable OPEX	0.8	1.0
TOTAL – ON-SHORE OPEX	**6.4**	**8.0**
OFFSHORE OPEX		
Fixed OPEX	21.6	64.4
Variable OPEX	0.1	0.2
TOTAL – OFFSHORE OPEX	**21.7**	**64.6**
GRAND TOTAL	**28.1**	**72.6**

*Excluding container volumes

Walvis Bay

	Phase 1: 5.26 Mtpa* USD Mill	Phase 2: 7.17 Mtpa* USD Mill
ON-SHORE OPEX		
Fixed OPEX	9.1	12.4
Variable OPEX	1.3	1.7
TOTAL – ON-SHORE OPEX	**10.4**	**14.1**
OFFSHORE OPEX		
Fixed OPEX	24.3	72.6
Variable OPEX	0.1	0.2
TOTAL – OFFSHORE OPEX	**24.4**	**72.8**
GRAND TOTAL	**34.8**	**86.9**

*Excluding container volumes

7 Initial Environmental Assessment

7.1 Introduction

7.1.1 Objectives and Terms of Reference

568. The TOR call for, "an initial assessment [to] ... provide sufficient information to allow an assessment of the appropriateness of developing a new railway, port and other facilities in Botswana and Namibia ... [and] recommend measures to be adopted to minimise the social and environmental impacts of the proposed rail lines." It is not the purpose of this study to develop a full Environmental Impact Assessment (EIA). Throughout the development this Initial Environmental Assessment the World Bank's Guidelines on the development of Environmental Impact Assessments and the mitigation associated with those impacts were used. In addition the relevant legislation and policies in the two countries has been used.

569. The purpose of this chapter is to provide a preliminary assessment of the likely environmental impacts of the project. The chapter also sets out the process for an environmental appraisal compliant with the applicable legislation. Chapter 8 addresses the social impacts and provides a Summary Appraisal Matrix for the Environmental and Social Impacts.

7.1.2 Project Description

570. The Trans Kalahari Railway project potentially consists of the following elements, depending on the results of the analysis:

- the Mmamabula-Mariental-Walvis Bay railway line link to Namibia's Atlantic coast;
- the Mmamabula-Gobabis-Windhoek-Walvis Bay railway line link;
- the Mmamabula-Luderitz railway link;
- the Mmamabula-Mosetse-Kazungula railway link to the north (to be addressed in Phase 2); and
- the Mmamabula-Ellisras railway link (also to be addressed in Phase 2).

7.1.3 Description of Route Options

571. The three railway routes to be analysed are as follows:

- Mmamabula to Walvis Bay port via Gobabis (Option 1);
- Mmamabula to Walvis Bay port via Mariental (Option 2); and
- Mmamabula to Lüderitz port (Option 3).

572. In Botswana all the three proposed routes share the same alignment from Mmamabula to Mabutsane. From Mmamabula, the proposed Trans Kalahari Railway follows the current Francistown-Gaborone A1 railway line and Highway route at Mahalapye up to Pilane Village which is about forty kilometres north of Gaborone. At Pilane village the proposed line follows a westerly alignment along a route which lies north of Bokaa Village, the City of Gaborone, Kopong, and Thamaga villages. After Thamaga village, the line route follows a south-westerly

orientation and by-passes Jwaneng Town and Mine to the south before turning north-westwards to follow the Trans Kalahari Highway through to Mabutsane village (See Alignment Drawings in Appendix B). This alignment avoids potential conflicts between the proposed line and both Jwaneng Town Planning area and the mine lease area. The proposed three route options then follow different alignments from this point upwards along the coast, as discussed below.

573. Every effort has been made with all three routes to follow existing infrastructure like major roads, farm boundaries or existing rail infrastructure. Where there are no farm boundaries or existing linear infrastructure, the route is aligned with the aim of avoiding conflicts with land uses of high economic value, such as settlements and mining establishments, so as to avoid the potential for high compensation claims. A case in point is the alignment of the proposed route away from the Jwaneng Mine in Botswana.

574. **Option 1:** The alignment of Route Option 1 runs adjacent to the A2 road as it spurs off northwards at Mabutsane. The route is aligned to follow the Trans Kalahari Highway, crossing the Namibia-Botswana Border and connecting to the railhead at Gobabis in Omaheke region of Namibia. From Gobabis the line follows the current railway line to Windhoek and on to Walvis Bay. Most of the route is extensive ranch land through which a railway line currently requiring upgrading already exists.

575. **Option 2:** The alignment follows the common alignment until Mabutsane. From Mabutsane there are no roads westward to follow until the alignment crosses the border and follows very closely to a secondary road, road C20 from Aranos until Mariental. It then veers away from roads until it meets up with road C14 near Nomtsas. The rail alignment follows this road as much as is possible within the ruling grade specifications but does veer off from the alignment at times, mostly through the escarpment, where it cannot follow the road alignment due to its steepness.

576. **Option 3:** The alignment follows the common alignment until Mabutsane. From Mabutsane the line to Luderitz follows a south westerly route to Mariental in Namibia. The line then continues southwards to skirt around the Sperrgebiet National Park to connect to the port of Luderitz in southern Namibia. In both Botswana and Namibia, this route is designed to avoid the main protected area systems thereby reducing its potential impacts on the rich wildlife resources in the parks. Some concerns might still arise in Botswana where the proposed route traverses an area of salt pans called the Schwelle that lies between the Central Kalahari Game Reserve and the Kgalagadi-Gemsbok Transfrontier Park. Ungulates such as hartebeest and wildebeest concentrate in this area to calve in the wet season before dispersing throughout the Kalahari in the dry season. A further concern with this alignment is that it traverses areas of unique scenic value in southern Namibia characterised by the Fish River Canyon and the desert landscape of the region.

577. The potential impacts of these three railway line options will be evaluated for the construction and operational phases.

578. The chapter also reviews the impacts of the associated terminal ports, the options under consideration being Walvis Bay and Lüderitz. The port of Walvis Bay is situated at the north-west coast of Namibia. Luderitz on the other hand is located

on Namibia's south west coast. Specific attention will be paid to the ecological impact of coal dust on marine ecology, and human settlements at each of the ports (Chapter 8), in both the construction and the operational phases. Specific attention will also be paid to impacts of dredging on the unique marine environments in the two locations and impacts on the tourism industry. The environmental assessment will also consider the coal loading terminal at Mmamabula and propose mitigation measures against unwarranted pollution in the vicinity of the mine.

7.2 Policy and Legislative Framework for Environmental Impact Assessment

579. Botswana and Namibia have legislative and administrative frameworks that govern environmental conservation and management as well as the requirements for the conduct of Environmental Impact Assessments on projects. These were reviewed as part of this initial assessment of the potential environmental and socio-economic impacts of the proposed Trans Kalahari Railway project.

7.2.1 Botswana Policy and Legislative Framework

580. In Botswana the Ministry of Environment, Wildlife and Tourism, represented by the Department of Environmental Affairs (DEA) is the competent authority that regulates Environmental Impact Assessments. In addition to the newly enacted Botswana EIA Act of May 2005, there are other pieces of legislation and policies that are relevant to the proposed development project. A review of legal compliance requirements was undertaken to provide an analysis of those applicable laws and regulations that are relevant to the proposed TKR project. In ensuring that a legal and regulatory framework review process is consistent with the baseline and resource inventory and covers relevant institutional activities that will take place on site, focus was placed on the following legislation, regulations, policies, and strategic plans that were found relevant and applicable to the proposed development project.

Figure 7-1: Botswana Legislative Framework

Act/Policy	Applicability/Comment
Land Use Related Laws:	
Land Control Act	This Act controls land allocation and use. The allocation of land for the proposed railway line development should meet the requirements of this Act.
Monuments and Relics Act (59:03 of 1970 revised 2001)	This Act is particularly important in regard to the notification of discoveries (Section 12 and Section 19) concerning the pre-development impact assessment, with the penalties for non-compliance detailed in Section 23.
National Museum Monuments and Art Gallery Act, 201	This act protects objects or artefacts that are part of Botswana's cultural, social and political heritage.
National Agricultural Master Plan on Arable Agriculture and Dairy Development (NAMPAAD)	Through this Policy, the Ministry of Agriculture hopes to promote the agricultural sector.
Resource Specific Laws:	
Rural Development Policy (1972)	The primary aims of the policy are: to increase sustained

	production from land and from wildlife through research, coordinated extension work, and conservation planning leading to the introduction of sound land management practices; to improve marketing and credit facilities in the rural areas and to create new employment opportunities where feasible and thereby reduce the numbers of those without any means of support; and, to promote industries, services and crafts in the rural areas.
Forest Act (Cap 45:08)	The Act provides for the conservation and utilization of forest resources. Under this Act, the Contractor is expected to protect forests that have been gazetted as forest reserves, to construct works for the mitigation and prevention of soil erosion, correct disposal and control of water including storm water and drainage water, protection of catchments, source, course, banks or feeders of any stream, etc.
Water Act (Cap 34:01 of 1968)	The Act defines ownership rights and use of public water. It also prohibits the pollution, fouling or poisoning of, interference with, or flow alteration of public water.
The Tourism Act (1992)	The Act provides for the development of tourism and related activities in the country. The Act defines tourism as enterprises that include "operations that offer facilities on and off site, such as tourist camps, lodges, caravans, hunting camps and tented tourists camps which also operate tours which require the services of professional guides or professional hunters licensed under the Wildlife Conservation and National Parks Act, 1992.
Agricultural Resources (Conservation) Act (Cap 35:06)	The Act provides for the conservation and improvement of the agricultural resources, such as water, soil, flora and fauna.
Wildlife Conservation Policy (1986)	The overall aim of the policy is that a better return be gained on land allocated to wildlife while at the same time ensuring the continuity of this resource. Rational and effective conservation and management programmes are therefore considered to be the essence of the policy. Specific objectives include the need to; realize the full potential of the wildlife resource; develop a commercial wildlife industry in order to create economic opportunities, jobs and incomes for the rural population; and to increase the supply of game meat as a consequence of the further development of commercial wildlife utilisation.
Wildlife Conservation and National Parks Act No. 28 (1992)	This Act makes provision for the conservation and management of wildlife in the country, giving effect to CITES and any other international convention for protection of fauna and flora to which Botswana is, from time to time, party; to provide for the establishment, control and management of national parks and game reserves; and for matters incidental thereto or connected therewith. Also, the Act provides for the conservation of wildlife in buffer zones called Wildlife Management Areas (WMAs) outside national parks and game reserves. Although grazing and other developments are allowed in these areas, it is of limited

	nature especially due to lack of services and water resources.
Herbage Preservation (Prevention of Fires) Act (Cap 38:02)	The Act provides for the prevention of bush fires, in order to conserve herbage resources with Sections 4, 6 and 9 concerning fire control and firebreaks, and the penalties for contravention (Section 14) pertinent to the current project.
National HIV/AIDS Strategy (2003 to 2009)	The Government of Botswana has declared HIV/AIDS a national emergency and is committed to an aggressive, comprehensive, and expanded multi-sectoral and multi-level response to fight the epidemic and to curb its impact on society. Not only has it become the most important public health challenge facing the country but it also poses the most serious challenge to future socio-economic development. As a result, the proponent of this project must be aware of these challenges and approach it proactively.
Pollution Control Laws:	
Public Health Act (Cap. 63:01) of 1981	The Act provides for a wide range of public health measures, including the regulation of sanitation and camping. The proposed bridge development and operations would be affected by this Act since the workforce will have to be provided with sanitation and camping facilities.
Mines, Quarries, Works and Machinery Act (Cap.44.02 of 1978)	The project involves sourcing materials from borrow pits and other works which will have to be in accordance with this Act. The Act provides for the safety, health and welfare of persons engages in prospecting, mining and quarrying operations including any works, which are part of, and ancillary to, mining and quarrying operations (excavation of gravel).
Atmospheric (Prevention) Pollution Act (Cap 65:03 of 1971)	The Act provides for the prevention of the pollution of the atmosphere caused by industrial processes. The Act seeks to control the emission of 'objectionable matter', which is defined in Section 2 as 'smoke, gases including noxious or offensive gases, vapours, fumes, grit, dust or other matter capable of being dispersed or suspended in the atmosphere, which is likely to be produced by any industrial process'. The Act intends amongst other things to guide and prevent atmospheric pollution. It outlines a number of measures intended to be undertaken to regulate and control levels of atmospheric emissions.
EIA Act (2005)	The Act provides for environmental impact assessment to be used to assess the potential effects of planned developmental activities, to determine and to provide mitigation measures for effects of such activities, as they may have a significant adverse impact on the environment, to put in place a monitoring process and evaluation of the environmental impacts of implemented activities. Section 9 (2) states that an environmental assessment shall identify and evaluate the environmental impact of an activity with particular reference to the: • Health, safety or quality of life of people; • Archaeological, aesthetic, cultural or sanitary conditions of the environment, and

	• Configuration, quality and diversity of natural resources
Botswana Strategy for Waste Management, 1998	The activities associated with the proposed development project are bound to generate both hazardous and non-hazardous waste; therefore the developer should adhere to the waste management guidelines as stipulated in this document.
Guidelines for the disposal of waste by landfill, 1997	Chapter 9, landfill restoration and aftercare: this is applicable during disposal of different types of waste generated during the construction of the proposed railway line.
Waste Management Act (1998)	This Act provides for proper waste handling and disposal.
Road Traffic Act (Cap 69:01)	Many Sections of this Act are relevant to the proposed development just as they are to everyday life on the roads of Botswana, with general compliance clearly essential to the health and safety of all road users.
Town and Country Planning Act	General development of land in rural and urban areas.

7.2.2 Namibia Legislative and Policy Framework

581. Namibia has a comprehensive set of policies and laws guiding the practice of project implementation, which were developed immediately following independence. The conservation of natural resources and environmental quality is enshrined in the constitution.

582. The Ministry of Environment and Tourism (MET) is the custodian of Namibia's natural environment and discharges this duty via environmental regulations, policies and legislation. The Environmental Management Act 7 of 2007 seeks to prevent and mitigate the significant effects of development activities through the EIA process. The management of marine and coastal environments in Namibia is the responsibility of Namport and the Ministry of Sea Fisheries and Marine Resources. These institutions are mandated to protect the environment under their jurisdiction in terms of Namibian Ports Authority Act 2 of 1994 and the Marine Resources Act 27 of 2000. In both countries there is legislation that regulates air quality, water resources, minerals, land management, agriculture, local governance and heritage.

583. The Table below shows the main policies and pieces of legislation in Namibia that provide for EIA.

Figure 7-2: Namibia Policy and Legislative Framework

Legislation/Policy	Applicability/Comment
Environmental Management Act No. 7 of 2007 (EMA)	The EMA is the principal legislation that guides environmental management in Namibia. It provides for stakeholder participation.
Environmental Assessment Policy for Sustainable Development and	This was the initial policy that made the need for EIA mandatory in Namibia. Needs to be read with the EMA.

Legislation / Policy	Applicability / Comment
Environmental Conservation	
Local Authorities Act No.23 of 1992	The Act provides for the establishment of local authorities and bestowed administrative powers on such institutions. EIAs are a requirement under the Act.
Namibian Ports Authority Act No. 2 of 1994	Provides for the management and administration of ports in Namibia through the Ports Authority. Any developments at ports are to be subjected to comprehensive EIA according to this Act.
National Heritage Act No. 27 of 2004	Provides for the preservation and protection of national heritage. Development projects are to be subjected to Archaeological impact assessments
Atmospheric Pollution Prevention Ordinance No. 11 of 1976	Provides for the prevention of air and atmospheric pollution. Sets standards to be met by all projects with potential impacts.
Water Resources Management Act No 24 of 2004	Provides for management and protection of water resources. Any potential adverse impacts on water emanating from the project will be managed under this Act.

7.3 Environmental Baseline

7.3.1 Biophysical Environment

Climate

584. **Botswana** is semi-arid with four seasons, which have significant effect on the vegetation. Annual rainfall is low, ranging along a gradient from less than 200 mm in the extreme south-west to 650 mm in the north-east. Drought is endemic and eighteen year cycles of drought and wet conditions exist (Tyson, 1986). The summer season (November – January) is generally hot with maximum rainfall. Autumn (February – April) is slightly hot with some rain. Winter (May – July) is very cold and dry. The spring season (August – October) is hot and often dry. The nearest main weather stations to the project area are located at Jwaneng, Gaborone, Ghantsi, and Charleshill.

585. Most of **Namibia** is classified as an arid to semi-arid region; the line being crossed from semi-arid to arid when evaporation exceeds rainfall. Most of it has a sub-tropical 'desert' climate, characterized by a wide range in temperature, from day to night and from summer to winter, and by low rainfall and humidity. The northern strip follows the same pattern, but has a more moderate, less dry climate. Temperature ranges widely from very hot to very cold, depending on altitude and the time of the year. From April to September, in the 'dry season', it is generally cool, pleasant, clear and dry. Temperatures average around 25°C during the day, but nights are much colder. Frost is possible in the higher areas and deserts. October and November are still within the 'dry season' but then the temperatures are higher, especially in the lower-lying and more northerly areas.

586. Rainfall is low and variable and can occur at any time from October to May. Namibia is the driest country in sub-Saharan Africa. The country's mean annual rainfall varies from less than 50 mm at the coast to over 600 mm in the north-east and is variable in both time and space. This inherent variability in precipitation has direct impacts on vegetation growth, the duration and frequency of river flows and the amount of groundwater recharge (Weaver, 2002).

Topography

587. **Botswana** is a broad tableland landlocked country with a mean altitude of 1000 m. The country is a vast plateau about 1 200 m above sea level extending near Kanye north to the Zimbabwean border that divides the country into two distinct topographical regions. The eastern region is hilly bush country and grassland (veld). To the north-west lie the Okavango Delta occupying a vast area and to the west is the Kalahari Desert.

588. The topography of **Namibia** can be divided into four regions. At 2000 m above sea level, the highest area is the central plateau that runs roughly from Keetmanshoop in the south to Otjiwarongo in the north. This is hilly, verdant country where most of Namibia's best farmland is concentrated. To the west of this plateau, the land falls off in a dramatic escarpment down to the Namib Desert, one of the oldest deserts which stretches for 1 600 km along the Atlantic Ocean. The escarpment and the incisions that have been cut through it by river action over the years provides some spectacular scenery. To the west of the escarpment the Namib is a flat coastal plain whose profile is broken only by shifting dunes and the odd towering Isenberg.

Geology and Minerals

589. The rock formations of **Botswana** have formed over a period of 3 000 million years (Government of Botswana, 2001). The geology of Botswana is largely obscured by Cretaceous of Recent Kalahari Beds, consisting mainly of Aeolian Sands. Achaean and paleoprorozoic rocks occupy parts of eastern Botswana. Sequences of Mesoproterozoic, north-east striking rocks, are continuation of proterozoic rocks from Namibia, cross into western Botswana (Kampunzu et al. 2000). Karoo sediments, mainly of continental –fluvial origin, and thick basaltic lavas overlie Precambrian rocks in the east of the country. The geomorphology of Botswana is divided into the Okavango Delta, the Sandveld or Kalahari Desert.

590. The Kalahari Sandveld shows evidence of having been a barren sand desert in periods of the geological past. Dune patterns are still visible from the air, but not from the ground as the dunes have been covered by grass and trees or bush vegetation. The alluvial soils of the ancient lake beds range from grey loamy soils in the wetlands and gray-green saline soils on the pans, to gray clayish soils and yellowish sandy soils around the wetlands and very chalky light gray soils around the pans.

591. Diamonds, exploited since 1970, are mined from some of the world's largest diamond pipes at Orapa and Letlhakane south of the Makgadikgadi Pans, and at Jwaneng in the south-eastern Sandveld (Parsons, 1999). Other mineral potential includes manganese and platinum in Basement rocks which may intrude further west deep under the Kalahari, and natural gas potential geological basins in the western Sandveld.

592. Information obtained from the Botswana Geological survey indicates that mining or exploration rights have been issued to mining companies covering almost the entire country. A distinction is made between diamonds and other minerals in the allocation of these rights. This very extensive allocation of rights does not reflect on the known distribution of mineral deposits, which is sparser than that of Namibia.

593. The geology of **Namibia** can be divided into several geotectonic and lithologic domains. The oldest domain belongs to the Paleoproterozoic Vaalian to lower Mokolian, followed by the Mesoproterozoic middle to upper Mokolian rocks (Republic of Namibia – Ministry of Mines and Energy, 1992). The sedimentary and volcanogenic succession of the Neoproterozoic Damara Belt comprises more than 60% of Namibia's rock outcrops. The north-east south-west striking belt is folded and metamorphosed with metamorphic grade progressively increasing towards the axial centre of the fold belt. Granites occur in the central part of the Damara Belt (Martin, 1965; Martin and Porada, 1977). The terrestrial Kalahari Beds of Tertiary to Recent age are predominantly unconsolidated Aeolian sand dunes and occupy large parts of eastern Namibia.

594. The southern regions of Namibia are characterized by extensive mineral deposits with uranium and diamonds being the predominant minerals. Extensive mineral exploration activities have resulted in large tracts of land in the south being expropriated for mining purposes and excluded from public use. Notable in this respect is the Sperregebit National Park which is a reserved mining area excluded from public access. The proposed route to Lüderitz traverses part of this area.

Hydrology and Water

595. Because of its semi arid climatic conditions, most rivers in **Botswana** are ephemeral and even during the wet season stream flow is not continuous, with internal rivers only flowing for 10-75 days a year. Hence valleys are usually dry except during the rainy seasons. The only sources of year–round surface water are the Chobe in the north, the Limpopo River in the south-east and the Okavango River in the north–west. In seasons of heavy rainfall, floodwaters flow into the Makgadikgadi Salt Pans, Lake Ngami and Lake Xau.

596. Groundwater resources are used throughout the country for livestock and domestic watering and for small areas of irrigation. These resources are geologically old and quality can be affected by salinity and concentrations of fluorides, nitrates and other elements. Due to low rates of surface runoff groundwater recharge is typically slow. Although the groundwater potential is large, abstraction levels are low due to the relatively high exploitation cost and salinity (Shahin, 2002).

597. **Namibia's** climatic conditions result in a scarcity of surface water. With the exception of the border rivers: Orange River (219 249 km^2) in the south and the Kunene (17 549 km^2), Okavango (106 798 km^2) and Zambezi rivers (17 426 km^2) in the north, there are only dry rivers in Namibia. They only flow periodically during the rainy season, sometimes just for a few days or even hours. The percentage of mean annual precipitation that ends up as river flow in ephemeral systems in Namibia varies from as little as < 1% up to around 12.5% for parts of the Fish River basin. The remainder goes to direct evaporation and Evapotranspiration, with the latter being by far the greatest component (Shahin, 2002).

598. Runoff into the ephemeral rivers of the interior occurs as a direct response to heavy rainfall events and these determine the duration, volume and timing of river flow. There is little or no delayed surface or subsurface runoff and definitely no surface base-flow. The main reasons for this, other than the erratic rainfall, are high riverbed losses, impermeable surfaces with little or no topsoil, scarce

vegetation and hilly or mountainous terrain. Any flow in these rivers is referred to as flood (Weaver, 2002).

599. Most rainwater evaporates immediately or is channelled away as sheet flow without being absorbed by the vegetation. Due to impermeable layers of clay and stone, the groundwater is collected and is eventually used by the surrounding settlements and farms. Namibia's groundwater occurs in a wide range of rock types making groundwater management a complex process. It provides a buffer against drought in many regions of the country, but it does remain inherently vulnerable to over abstraction and pollution. Part of the annual rainfall is collected in dams, the biggest being Hardap Dam near Mariental, with a capacity of 300 million m^3. On account of the growing population, water supply remains a major problem for Namibia.

600. In Namibia, the alternative routes traverse a number of ephemeral rivers, including: Auob, Brackwater, Black Noossop, Fish, Khan, Konkiep, Kuiseb Swakop, Olifants, Okahandja and White Nossop.

Vegetation

601. In **Botswana** most plant life is seasonal. The entire landscape changes with the arrival of the rainy season, with it being transformed from arid landscape of Kalahari Desert, into one dotted by waterholes and new growth. The vegetation of the Kalahari Desert, described as a 'thirstland', is unlike that found in most deserts. It is more characteristic of dry steppe than desert, characterized by savannah grasslands with thorny scrubs, covering most of Botswana's Kalahari sandsheet, or Sandveld, while in the eastern Hardveld the rocky hills are covered in tree savannah. The north and eastern third of the country is covered by Mopane woodland.

602. From Mmamabula to Gaborone and to about 50 km west of the city, the new railroad route will pass through Hardveld. The vegetation here is described as Peltophorum africanum Acacia tortilis associated with Terminalia sericea (Bekker and de Wit, 1991). Other woody species associated with this vegetation type are Combretum apiculatum and Acacia erubescens, with the grasses Aristida congesta, Digitaria eriantha, Eragrotis rigidior and Stipagrotis uniplumis. Although the literature makes no mention of any rare or endangered plants, a number of Aloe species are known to occur in the area (Van Wyk and Smith, 1996).

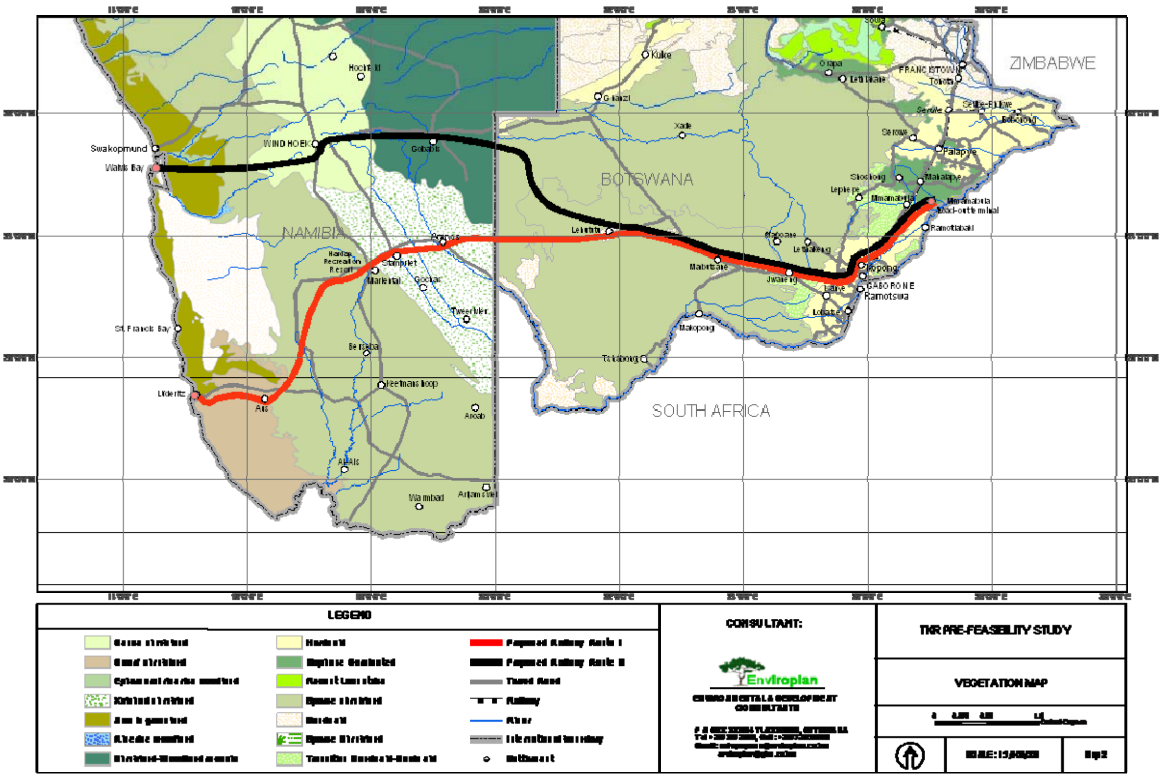
603. Towards the west, the landscape changes to become part of the Kalahari Sand basin (Mendelsohn et al, 2002) or Sandveld (de Wit and Bekker, 1990). Here two related vegetation types are crossed, being the Acacia mellifera, A. luederitzi, Boscia albitrunca shrubveld to the south between Kang and Jwaneng and the Acacia erioloba variant of the Terminalia sericea, Lonchocarpus nelsii bushlands. The southern Acacia mellifera, A. luederitzi, Boscia albitrunca shrubveld contains also acacia erioloba (camelthorn) trees, as well as occasional Terminalia sericea shrubs. These plains are interspersed with pans, which feature Catophractes alexandri, Dichrostachys cinerea and Ziziphus mucronata along their fringes. From similar systems in Namibia it is known that in these pan fringes often smaller succulent species occur. These pans are often used as a source for calcretes (for animals), which are likely to be used for the construction of the railway line.

604. The more northerly Terminalia sericea, Lonchocarpus nelsii bushland has a very similar composition, with Terminalia sericea dominating. Some Grewia species occur here as well. The grass layer, depending on the closeness to settlements, is well developed, with Anthephora pubescences, Eragrotis lehmanniana, Schmidtia pappophoroides, Stipagrotis uniplumis and Digitaria spp. This grass layer forms an important fodder resource for extensive cattle ranching in the area. Being a typical rainfall area, these grasses will be dry and easy to burn during the winter and early spring months before the onset of the rainy season.

605. These vegetation types are fairly wide-spread in both countries. Thus, no major impact is anticipated by the construction of a railroad, with the exception of limited and very localized plant communities around the pans (Strohbach, 2008).

606. Figure 7-3 shows the vegetation of Botswana within the proposed project.

Figure 7-3: Botswana Vegetation



607. Veld Products are an important aspect of the vegetation over the project area. In Botswana, the districts in the project area as a whole have a fair amount of veld products, which include Grewia flava (Moretlwa), Grewia retinervis (Motsotsojane), Grewia bicolor (Mogwana), Grewia flavascenes (Mokgomphatha).

608. Over the rest of the project area, veld products that occur there and are collected less frequently for home consumption include Grewia flava (Moretlwa), Grewia retinervis (Motsotsojane), and gemsbok cucumber (Acanthosicyos naudiamus – Legabala) when it is their season. Tsama melon (Citrullus lanantus - Kgengwa). Gonimbrases belina, Corchorus asplenifolin (Delele), and Amaranthus (Thepe) are traditional vegetables found during the rainy season.

609. While much of the **Namibian** landscape is characterised by deserts and mountains, the country extends far enough north to have a varied range of plant life. Namibia can be split into four distinct vegetation zones which together support more than 4 000 seed bearing vascular plants, 120 different species of tree, over 200 endemic plant species and 100 varieties of lichen. The zones are defined as follows: the tropical forests and wetlands along the banks of the perennial rivers in the Kavango and Caprivi regions, the savannah plains with occasional trees in the Kalahari Desert, the mountainous escarpment regions such as the Kaokoland and Damaraland, and the low altitude coastlands and Namib Desert. Savannah covers 64% of Namibia, dry woodlands and forests account for 20%, while desert vegetation covers 16% of the country.

610. The arid south and the Namib Desert generally appear devoid of plant life; however, lichens grow in great diversity on west facing slopes and surfaces where they are able to draw moisture from the sea fogs. The plants are now recognized as a vital component of the Namib Desert environment, and most areas are now protected as many animals rely on the lichen as an important source of water. In Central Namibia, thornbush savannah is dominant with extensive grasslands and acacia bush. The horizon is marked sporadically by the occasional camelthorn tree and other kinds of Acacia which often grow near dry riverbeds. Toward the north-east, where there is a higher rainfall, the thornbush savannah slowly turns into Mopane savannah and there are a great number of trees. In the relatively humid Caprivi the dominant vegetation form is the Woodland savannah, interspersed with single Baobabs, Wild figs and Makalani Palms.

Wildlife Conservation

611. In **Botswana** a wide range of ecosystems contained within the country's borders translates into an equally wide range of animal species. More than 30 species of large mammals are found, including herds of zebra, wildebeest, elephant and large antelope. The animals generally congregate around water-filled pans in areas like Makgadikgadi Pans in the wet season and around areas of permanent water, such as the Okavango Delta and the Chobe river system, in the dry season.

612. As a result of varying rainfall patterns, mobility is the key to survival for most animal species through Botswana, with herds of many thousands of animals travelling long distances in search of water. In Gantsi district, areas such as Schwelle are important to the integrity of the Kalahari Desert system because many Kalahari ungulate species, such as gemsbok, springbok and wildebeest are dependent upon the numerous pans and fossil river valleys (DHV, 1980). With its high concentration of mineral pans, together with open woodlands, the Schwelle constitutes a 'core area' in the wet season , when calving takes place, with the wildebeest dispersing, often along dry river valleys as the dry season progresses (Williamson and Williamson, 1985b; Lindsay, 1992). Botswana is also home to many different bird species and reptiles.

613. **Namibia** is the only country in the world to specifically address conservation and protection of natural resources in its constitution. The country has a wide variety of wildlife, with over 114 mammal species, eight of which are endemic. The Namib Desert is well known for its large number of endemic dune dwellers, especially lizards, of which there are 30 endemic species. Namibia is also home to many bird species.

614. Wildlife resources of high importance for tourism occur in the less densely settled north-western and north eastern communal lands, with gemsbok scattered throughout the country. The large Ludwig's Bustard (Neotis ludwigii) are endemic to the Succulent Karoo, Nama Karoo and desert biomes, where they feed on insects, small vertebrates, seeds and plant material. They undertake large scale seasonal migrations to and fro the winter rainfall Succulent Karoo biome, migrating from the summer rainfall parts of Nam Karoo, especially in the south, to the Succulent Karoo during winter, to take advantage of the better vegetation quality and increased insectivore population (Lovegrove, 1993). It is a movement that is paralleled only by springbok (Antidorcas marsupialis). As in the case of the Kalahari Desert in Botswana, mobility is key to the survival of animals in the Namib Desert resulting in large-scale roaming of gemsbok, springbok, ostriches and Hartmann's mountain zebra.

Wildlife Crossings

615. Wildlife migration corridors should be considered when reviewing possible alignments. As a rail line would risk fragmenting wildlife populations and increased mortality due to train/animal collisions, options to mitigate these issues should be reviewed. One method of dealing with wildlife migration is presented in Figure 7-4. By developing a simple wildlife bridge over the alignment, animals would still be able to migrate over the rail tracks. In the example provided, the road was allowed to stay at grade while animals passed overhead. This is one such example and it should be revisited during a more detailed study.

Figure 7-4: Wildlife Crossing

Source: Dutch Wikipedia

7.4 Assessment of Environmental Impacts

7.4.1 Methodology of this Study

616. Based on the requirements of the TOR and the available resources, this was not a full EIA, but a Scoping study designed to identify major issues and propose solutions. The identified environmental impacts are grouped into: biophysical environmental impacts, environmental health, occupational health/safety/public health, and are discussed in turn. We also make some observations about heritage resource impacts and provide a preliminary assessment of the port options.

617. In both Botswana and Namibia the proposed TKR route will traverse some of the following environmentally sensitive areas:

618. Botswana:

- Areas where there are settlements (towns/villages/settlements) near the railway corridor.
- Wildlife management areas – these are buffer zones between game reserves and communal areas. These areas are rich in wildlife resources and biodiversity in general.
- Game reserves and national parks wildlife corridors (wildlife seasonal migration between the Central Kalahari Game Reserve (CKGR) and the Kgalagadi Trans Frontier Park (KTFP)).
- Ecologically sensitive Kalahari Desert sandy soils (dune topography comprising sand of variable consistency) poses potential problems for the construction and operation of the railroad. Compaction will be required along large distances and migrating dune sand will necessitate special track design and/or stabilization of windblown sand.
- Archaeological / historic sites (near Kanye village – Livingstone Resting Place); hills near Molepolole and Thamaga villages.
- State-protected concession areas such as mining areas – Jwaneng Mine.

619. Namibia:

- The sand dunes in the Aranos, Stampriet and Mariental areas. There are also shifting dunes further south towards Luderitz which will cause problems for railway operations.
- The Namib-Naukluf Park and the southern edge of Sperrgebiet Park.
- The spectacular landscapes dominated by the Fish River Canyon in the south.
- Steep escarpment zone stretching north-south separating the Namibian highland and coastal plain areas.
- Mining lease areas.
- Archaeological and historic sites/rock paintings.
- Marine and coastal areas.

620. Depending on the route alternative chosen, the tracks rise to about 2000m altitude in the Namibian Central Plateau before reaching the escarpment dropping down to the Namib Desert and the coast line. In the escarpment, slopes are generally steep, often reaching more than 25%. The shorter railroad route alternatives pass through the steepest parts of the escarpment, likely descending through the Boussua Pass or the Us Pass into the Namib plains.

7.4.2 Biophysical Environment

621. Preliminary concerns are loss of habitat, habitat fragmentation, and change in drainage conditions, disturbance of species and the effects of construction activities on animal communities along the proposed TKR project corridor in both Botswana and Namibia.

622. Environmental issues that relate to impacts on geology and soils include:

- Erosion and its consequences; and
- Loss of soil fertility.

623. The **soils** in the project area, especially the stretch across the Kalahari Desert in Botswana and the Namib Desert in Namibia, are predominantly Kalahari sands, which are naturally vulnerable to soil erosion. The removal of vegetation will expose the soil to the agents of soil erosion. Heavy vehicles that will be used during the construction of the proposed railway line, construction and operation activities of the proposed TKR project will compact soils, thereby resulting in the reduction of the soils infiltration capacities. Increased soil compaction will promote overland flows or run off which in turn can cause increased soil erosion along water channels and tracks. However, due to the general flatness of the topography especially in Botswana, severe soil erosion resulting from rain water will be reduced.

624. Soil fertility can also be lost through removal of topsoil, compaction, and disruption of soil structure. Although many of the effects can in principle be modelled mathematically, some of the effects can be complex, and as a result impact prediction will be qualitative in this regard.

625. Heavy machinery (drilling and blasting) and other heavy vehicles are invariably associated with high consumption rates of fuel lubricants. These lubricants are normally bought in bulk and moved to construction sites. Dumping and accidental spillages may occur in such sites, and this may lead to the contamination of soils on the surface and subsequently underground water sources. The heavy construction vehicles are also likely to induce a lot of dust and erosion (similar to what has already been discussed) during the transportation of materials.

626. **Flora:** The predominant vegetation type over the first two hundred kilometres of the proposed route in Botswana (Mmamabula to Lehututu) is of the Terminalia species, Combretum apiculatum and various Acacia species which are well represented in the area. There are no rare or endangered vegetation species in the area so impacts will be limited. Further to the west and into Namibia, the landscape is dominated by Kalahari sands with fairly well represented vegetation types. The critical impact to vegetation is the destruction during clearing to pave way for railway line surveys, opening camp sites for the construction crews, and the creation of access roads. In implementation phase, predicted impacts will mainly emanate from coal dust clogging leaves and reducing evapotranspiration.

627. Widespread clearing of large areas results in a complete change of the vegetation structure (physiognomy) of the area, with the cleared areas tending to support grasses almost immediately. This has the effect of fragmenting the habitat into distinct pieces that tend to support only small populations of animals and insects. These small populations in turn tend to become increasingly vulnerable to environmental threats and disturbances. This type of disturbance is permanent and should be avoided.

628. The project area is located in a high risk area for veldt fires especially during the dry season. The Contractor will need to be educated on activities that have the potential to cause veldt fires and thus be able to reduce those activities. During the operational phase, fires can also be caused by diesel electric engines. Fire

management strategies including fire guards will need to be put in place along the TKR route.

629. **Fauna:** Construction activities and the movement of vehicles have the potential to disturb or displace individual wildlife species through the noise that will be generated, habitat destruction and even kill certain animal species through road accidents. In particular, the effect of noise produced during the construction activities, presence of construction crew and heavy trucks has the potential to disturb wildlife. In the operational phase trains will also generate noise which could disturb wildlife. The magnitude of this potential problem will however depend upon the frequency of trains along the route.

630. In both Botswana and Namibia, Route Option 1, after the common section, traverses an area that has been opened up through the development of the Trans Kalahari Highway. This area is also already used for game ranching and wildlife management in fenced off ranches. As stated earlier, care will be taken to ensure that the proposed railway follows existing infrastructure and farm boundaries, so as to minimize potential conflict with present land uses. It is therefore estimated that potential impacts on fauna along this proposed route will be minimal with the exception of those stretches where such conflicts are unavoidable. Such situations will be identified during detailed investigations during the feasibility study stage of this project.

631. Route Options 2 and 3 however pose threats to wildlife habitat as they are aligned to traverse the schwele area in Botswana which is both a breeding area for ungulates in Botswana and part of the migration corridor between the Kgalagadi Gemsbok Transfrontier Park and the Central Kalahari Game Reserve. Serious potential impacts on wildlife are therefore predicted over this area. This will have direct negative impacts on the country's tourism sector which is heavily dependent upon wildlife resources. Route Option 2 has the proposed railway line traversing the Namib-Naukluf Park in Namibia. Although previous studies of similar projects have indicated that there will not be any "fatal conflicts" between the proposed railway line and wildlife in the park, this assessment concludes that there is potentially some conflict and recommends that this option be subjected to further analysis as the park is characterised by unique visual vistas which would be disturbed by trains carrying coal traversing the area.

632. Route Option 3 traverses some of Namibia's most attractive countryside. While no flagship faunal species are found in this area, there are cases of localised endemism which could be permanently destroyed by coal dust being spread over the area.

633. An environmental issue of great concern along all three proposed routes is that of poaching cases which might increase as a result of the presence of railway line construction workforce as well as in the operational phase. The participation of the workforce in illegal hunting of wildlife will be an adverse and direct impact on project development. The construction and operation of the railway line through new areas will also improve access and open up wildlife areas to increased poaching. The magnitude of this issue will be investigated, and will depend on the controls that will be put in place during the construction and operation of the railway line.

634. Railway line construction activities involve the transportation of materials, drilling blasting of rocks and the digging of borrow pits, which if not covered or protected often pose safety risks to both livestock and wild animals. .

635. As discussed earlier under vegetation impacts, the removal or clearing of vegetation will also result in the loss of grazing resources for wildlife and livestock.

636. **Water Resources/Hydrology**: Both Botswana and Namibia are semi-arid to arid with rainfall decreasing from east to west. Most rivers in the two countries are at best seasonal with the majority of them being ephemeral. Both countries therefore depend upon ground water for their water requirements. The limited potential underground recharge of the study area has already been alluded to. Given the scarcity of water in both countries, it is vital that pollution of water resources be prevented or mitigated. Pollution of underground water may result from accidental spillage of fuel and other hydrocarbon products. This normally occurs when such fuels are brought to the site for fuelling the machinery or when the machinery breaks down and necessitates emergency repairs on site. An additional potential source of pollution of groundwater resources is through contamination from sanitation facilitation for workers. This should be controlled through the use of potable sanitation facilitation that can be emptied at designated points along the preferred route.

637. With respect to surface water, the pollution pathway is similar to the one described above for underground water resources. For surface water however, pollution is much easier given that the rains may wash away the said hydrocarbons and deposit them in a surface water point. A few major rivers will be crossed by the proposed line in eastern Botswana. These include Mhalatswe near Mahalapye, the Bonwapitse, the Notwane, and the tributaries of the Metsimotlabe near Thamaga village. The west of Botswana and most of Namibia are characterised by ephemeral river systems which reduces the potential threat of surface water pollution. Potential for the pollution of surface water is however higher along Option Route 3 in the vicinity of the Fish River and its tributaries.

7.4.3 Environmental Health

638. The key environmental health concerns relate to waste management and sanitation. Waste generated in the towns and villages within the project area is collected by the respective authorities and transported for disposal at designated landfill sites. In Botswana there are also dumpsites located at all the villages/towns within the project area where domestic waste is disposed. The sanitation in the villages is mainly provided by pit latrines while in the towns there are sewer systems or septic tanks. In the institutional buildings and the most modern residential areas sanitation is provided by septic tanks. Clinical waste is disposed at the district hospitals where there is a diesel/electric incinerator facility for all clinical and medical hazardous waste. The clinical waste from the clinics in the villages is collected once a week or when need arise. Route Option 1 has a number of settlements that would be affected and would need mitigation. These include Kang, Tswane and Charleshill from Mabutsane to the Botswana-Namibia border. There are very few settlements along Option Routes 2 and 3.

639. The development of the proposed TKR project with its associated activities such as construction camps for the workers, fuelling and servicing of vehicles will generate waste, and this waste would need to be managed in an environmentally-

friendly manner. This study will have to assess the current waste management practices that are employed by the community, in a view to asses if it will accommodate the increased volumes and types of waste that will be generated by the proposed TKR project.

7.4.4 Occupational Health and Safety

640. Rock drilling & blasting, excavations, transportation and emissions from operating equipment might cause some form of air pollution along the three routes during the Construction and Operation phases. This will lead to degradation of air quality and lowering of visibility from air borne particulates. While this can largely be mitigated for the project workers by ensuring that they use protective clothing, the same cannot be said for the members of the public in the villages and towns to be traversed by the railway line. There are concentrations of population in the Pilane area of Kgatleng district, Thamaga Village, Jwaneng Town, Sekoma and Mabutsane villages in Botswna. The detailed EIA will need to explore possible ways in which air pollution by emissions and particulate matter will be reduced to ensure that the health of people in these villages is not compromised. The major settlements along Option Route 1 from Mabutsane to the Botswana-Namibia border are Kang, Tswane and Charleshill. Air pollution control measures, as will be identified at the feasibility study stage, will need to be implemented over this section. Similar measures will also be needed over the stretch of the line from Gobabis to Walvis Bay although this is not expected to be a serious threat since the proposed line is following an already existing railway servitude for most of this distance. There are very few settlements along Option Routes 2 and 3. The major concern along these routes is the dissipation of coal dust over areas of specific floral endemism which will need to be mitigated during the operational phase of the project.

641. Ambient noise levels around the proposed TKR project development site would be very low in the absence of construction activities, considering that some parts of the area are remotely located. Some of these areas are exclusively used for farming and livestock/wildlife grazing. In the post-construction phase, sources of noise would be limited to vehicle and human traffic along the main roads such as the Trans Kalahari Railway and Highway all the way to Windhoek, Namibia. However, during railway construction the major sources of noise and vibration would come from blasting and drilling (where the terrain is rock such as in Namibia), heavy duty vehicles, and trucks transporting materials. Noise generated by trains in the operational phase will also need to be assessed. The study will have to assess the sources of noise, the effects thereof, with a view to make recommendations in terms of what sources of noise can be allowed on site and what cannot, as well as how the effects of noise can be mitigated.

642. The effects of these increased noise and vibration levels would differ from one receptor to another, and with the period of exposure, as well as with the type of noise, i.e. continuous noise versus intermittent noise versus impulsive noise. Assessment and evaluation of this issue where machinery operators are concerned would render occupational health exposure risks. Where the general environment is concerned, noise and vibrations would be assessed to determine their effect on the community (public) or environment. Environmental or community noise is commonly described in terms of "ambient" noise level, which is defined as the all-encompassing noise level associated with a given noise environment.

7.4.5 Heritage Resources

643. Botswana and Namibia have rich cultural and archaeological histories dating back thousands of years. The preservation of this heritage is not only important from cultural and historical perspectives, but is required by legislation in both countries and in terms of the IFC Performance Standards.

644. This assessment has not included the conduct of a thorough Archaeological Impact Study. Instead, a review of previous studies conducted for other projects along the proposed routes has been conducted. A detailed archaeological study will therefore need to be carried out to cover the entire corridor as part of the industry requirements when a full EIA is being carried out. This study will be undertaken by a registered and duly authorised Archaeologist and will be submitted to the Governments of Botswana and Namibia, Departments of National Museum and Monuments for approval. The absence of archaeological material does not suggest that there are no artefacts within and/or in the vicinity of the project area. The following sections provide an indication of the sites of potential archaeological importance along the proposed route in Botswana and Namibia. .

Botswana

645. All cultural heritage and archaeology in Botswana is governed by the Monuments and Relics Act of 2001, in terms of which it is illegal for any unauthorised person to alter, destroy or damage ancient sites or monuments, or to remove archaeological materials from sites of discovery.

646. Archaeological data collected indicates that archaeological sites dating back as far as two million years ago have been reported within the environs of the proposed TKR corridor. In areas where archaeological sites have not been reported, this is probably attributed to the fact that there has been limited research done in the area. Archaeology in eastern Botswana is better known as a result of the greater amount of research linked to generally higher levels of development concentrated in this part of the country. Figure 7-5 below provides a summary of archaeological potential for each broad section of the TKR route in Botswana while Figure 7-6 provides a listing of potential archaeological sites.

Figure 7-5: Archaeological sites declared by the Botswana National Museum

Site No.	Site name	Type
45-A4-41	Dithejwane	Walling
45-A4-42	Magagarape	Ancient working
45-D2-5	Moritsane, Gabane	Archaeological site
	Baobab tree	Natural History
	Kopong site	Rock Engravings
	Gakgatla	Ancient Mining
	Maokagane hills	Ancient Mining
	Livingstone's cave	Natural workings
	Ntsweng	Ancient historic workings
	Dithejwane	Ancient ruins
	Taung Valley	Iron Age settlement
	Manyana	Rock paintings
	Motlhatsa tree	Livingstone Memorial

	Go-kodisa	Ancient mining
	Kanye	Ancient Rock Engravings
	Dimawe hills	Ancient ruins
45-D3-1	Dimawe	Historic
20-A1-14	Kangumene near Charles Hill	Rock engravings
21-B4-15	Okwa Valley near Tswaane	Rock Art
21-B4-16	Okwa Valley near Kalkfontain	Rock Art
21-B4-17	Olifantskloof farm, Xanagas	Rock Art
	Mmamuno engravings 1 near (near Border Post)	Rock Art
	Mmamuno engravings 2 (behind Customs and Immigration hoiuses)	Rock Art

Figure 7-6: Archaeological Potential along Sections of TKR Route in Botswana

Route Options	Route Section	Archaeological Potential
Route 1 Route 2 Route 3	Mine to Mmamabula Station	The Botswana National Museum has recorded no sites in this area. However, a recent study by Digby Wells and Associates (2007) indicates that this is very rich in archaeological resources.
Route 1 Route 2 Route 3	Pilane –Jwaneng	This section of the route passes through many major villages that are rich in archaeology, history and culture. Many sites, including those declared national monuments, are found along this route.
Route 1 Route 2 Route 3	Jwaneng- Tshane	This route traverses the deep Kalahari (Kgalagadi) sands which cover archaeological sites. Research in this area, including surveys conducted along the Trans Kalahari Highway indicates potentially rich archaeological material.

(Source: Adapted from Arms, 2008)

Namibia

647. Cultural heritage and archaeological sites in Namibia are governed by the National Heritage Act No.27 of 2007 which makes provision for archaeological assessment of large projects such as the TKR Project. Namibia has an exceptionally rich and well-preserved archaeological record, with firmly dated sites spanning much of the last 700 000 years and beyond (Kinahan, 2000). Some of the most important features of the archaeological record include a very large number of rock art sites dating to within the last 20 000 years. A number of significant local concentrations of Holocene to Recent rock art exist, and one of these, Twyfelfontein rock engraving site, has recently been added to the World Heritage List.

648. Figure 7-7 presents the archaeology along the alternative routes connecting with the port options on the Namibian coast. It indicates areas of high and low sensitivity.

Figure 7-7: Archaeology along Alternative Railroad Routes in Namibia

	Railroad Route Sections	Archaeological Characteristics
1	Option 1: Gobabis to Walvis Bay through Karibib and Okahandja	The immediate vicinity of the port at Walvis Bay is considered to be of no archaeological importance; it is mainly reclaimed land, and the remaining natural land is extensively disturbed. Between Arandis and Usakos a series of archaeological surveys have identified significant local concentrations of Later Stone Age sites. There are also a number of historical sites, including Commonwealth War Graves and sites of various skirmishes that took place during the World war 1. The area between Usakos and Karibib has a low apparent site density but may contain important late pre-colonial era sites including ancestral graves belonging to communities that were displaced during the colonial era. No detailed survey has been carried out in this area. The area between Okahandja and Windhoek has a number of later Stone Age and pastoral sites, but survey cover is patchy. Detailed archaeological surveys in the Khomas Hochland area immediately west of Windhoek have located dense local distributions of late pre-colonial sites mainly related to mining and smelting of copper ores from Matchless deposits. The same area was the scene of considerable military activity from the late 19th century until the final pacification of indigenous resistance in 1904. There are numerous historical sites relating to this period, as well as early settler farming which immediately followed. Below the escarpment , on the central Namib gravel plains, there is a patchy distribution of Holocene to Recent archaeological sites, as well as a major group of 2nd millennium AD sites clustered around the Tumas Mountain. This group is bisected by this route section.
2	Option Route 2: Link between Mariental – Walvis Bay	There are no significant archaeological features on the Swakop River part of the route and the dry western escarpment zone is similarly poor. The gravel plains have patchy distribution of archaeological sites, generally clustered at water sources and isolated rock outcrops or inselbergen. The western parts of this route section are not well known, and the presence of major site concentrations at the Tumas Mountain have recently been reported just to the south of this route.
3	Option Route 1: Rail corridor between Windhoek and Gobabis	This section has very few known archaeological sites, most of the area being archaeologically unexplored. The vicinity of Gobabis has several large springs and pans that were important foci of hunter-gatherer settlement until the late 19th century.
4	Option Route 1: Link between Gobabis	This section has few known archaeological sites.

	and Buitepos / Mmamuno	Surveys of adjacent areas in the Omaheke Region suggest that archaeological sites would be preferentially associated with calcrete fault scarps on the margins of Omuramba drainage lines. Areas of deep sand cover have been found to have virtually no archaeological sites in this region, although inter-dune valleys that formed semi-permanent wetlands during the last interglacial (approx. 5000b.p) may have some archaeological sites.
5	Option Route 2: Link between Mariental and Botswana border	The archaeology of this area has not been surveyed.
6	Option Route 3: Rail corridor between Windhoek and Luderitz, via Keetmanshoop and Goageb	This area has been the subject of two major archaeological surveys for new power-lines. The surveys yielded low site densities but indicated rather specific terrain associations. These included very extensive mid-Pleistocene to late Holocene stone artefact sites as lag deposits in areas of dense gravel and talus cover; burial mounds, including what are evidently elite grave sites in major river valleys; large rock shelter sites with stratified deposits; and rock art in the escarpment area immediately west of Aus. A historical feature of this section is the large number of sites relating to the early anti-colonial uprisings and the 1915 South African invasion. These sites include minor fortifications, trenches and what are probably the only surviving aerial bombardment craters from World War 1.
7	Option Route 3: Link between Mariental and Luderitz	This route section covers similar terrain to route section 7, and is expected to yield some important sites, mainly in the valleys of the Fish and Konkiep Rivers.
8	Option Route 2: Link between Mariental and Walvis Bay	This route section has some very extensive mid-Pleistocene to Holocene stone artefact sites in the form of surface lags in areas of dense gravel and talus cover. Major river crossings and isolated outcrops can be expected to have high local site densities. Although accurate survey cover is only available for small parts of this section, the data suggests that there would be high impact areas and that these would probably occasion the need for extensive mitigation work.

(Source: Adapted from Kinahan, 2008)

649. Should there be any cultural heritage and archaeological sites within the vicinity of the study area, proper mitigation measures should be put in place to salvage as much information as possible from the study area.

7.4.6 Preliminary Port Assessment

650. This study focuses on Walvis Bay Port which is the terminal for the preferred Route Option 1. The port of Lüderitz is also assessed as it is a potential alternative.

Potential Environmental Issues at the Ports

651. The development of infrastructure at either Walvis Bay or Lüderitz Ports to accommodate the handling of coal and non-coal traffic will need to be further investigated for potential environmental and social impacts at full feasibility study stage. These developments will include the construction of cargo storage facilities the size of which will be determined by the possible scheduling of ships at either port. Walvis Bay already handles more traffic than Lüderitz indicating that more traffic would be directed through there. It is therefore expected that more attention will need to be paid to possible environmental impacts at the former port location.

652. In addition to the development of cargo handling facilities there will be the need for periodic dredging of the harbour to maintain the depth of the navigation channel. The port of Walvis Bay poses greater challenges from a sand deposit perspective than Lüderitz which is located in an area that is characterised by more rugged terrain. There will therefore be more dredging at Walvis Bay. Details of the frequency of this dredging will be established at feasibility stage.

653. The construction of cargo handling facilities and the dredging schedules at the ports will have considerable environmental and social impacts which will need to be ascertained and assessed at full feasibility stage. These impacts relate to:

- Impacts on the physical environment which relate to changes in local bathymetry resulting in changes in the flow of the sea and the velocity of the currents and waves in the harbour. Associated with these are elements such as sediment transportation and the exposure of new geological materials which might lead to saline intrusion;
- The impacts of sediment transport and dredging on marine ecology in the harbour;
- Habitats for birds and other migratory species might also be adversely affected. The extent of the impact will depend upon the frequency of dredging;.
- Potential for resettlement of resident communities, especially at Luderitz where a large section of the port's population lives in informal settlements;
- Impacts on the local economy especially where coastal areas are important for fishing as an economic activity. Positive impacts might also result from the introduction of new economic activities to the area;
- Impacts of the quality of life of coastal populations. Port developments and extensions will impact on service provision to local populations through increased employment opportunities, intrusion by outsiders, increased pollution especially from facilities developed to handle cargo such as coal, cement and soda ash;
- The impacts of increased rail and road traffic.

Walvis Bay

654. Walvis Bay is characterised by its rich ecological heritage made up of the lagoon, the unique salt pans which are home to huge populations of greater and lesser flamingo. The area is also an integral part of the highly productive Benguela

Current Large Marine Ecosystem which has formed the basis of a thriving fishing industry. Oyster farming is also becoming an increasingly important economic activity in the area. Finally, because of the rich marine biological diversity in the Bay, tourism is a major source of employment and income at Walvis Bay.

655. The extension of use of the Walvis Bay harbour to include handling of coal and other cargo will need to be closely evaluated to establish the potential impacts of coal dust on the marine environment as well as the human environment. This study has only highlighted the potential for impacts at a scoping level and is therefore not comprehensive. The ecological significance of Walvis Bay makes it imperative that an in-depth environmental impact study of the proposed dredging and construction of coal handling facilities at the harbour be commissioned before any construction work commences. The proposed study will not be a baseline study as there have been other EIA of potential Walvis Bay developments conducted as recently as the beginning of 2010 which provide very comprehensive data for use in the proposed focused study.

656. The continued ecological integrity of the Walvis Bay system is important for the growing mariculture industry (oyster farming and fish farming) that is on-going in the area, as well as eco-tourism and recreation. Oyster farming using suspended baskets on long lines is currently conducted on the leeward side of Pelican Point. This area is under the jurisdiction of Namport and is within the boundary of the Walvis Bay nature reserve. It is anticipated that the site (1 250 ha) can accommodate 10 oyster farms. Further to this there are two land sites zoned for mariculture development between Walvis Bay and Swakopmund (Carter, 2008).

Lüderitz

657. Lüderitz port is located in an area that is topographically broken. This limits the extent to which the port can be developed, unlike the situation at Walvis Bay. The harbour at Lüderitz and the islands that lie off-shore hold ecologically significant bird and fish populations which will require further study to augment this environmental study.

658. The coastal area near Lüderitz is very species rich, with a relative high number of endemics occurring along this highly fog-dependent vegetation (Fanroth, 1991). Agate Beach to the north of the town of Lüderitz has been identified as a potential site for the coal terminal and ship-loading facility. The desert vegetation in this area is described as the "Augea capensis" community by Fanroth 1991, but its sensitivity is not known.

659. Lüderitz Bay (26^{o} 39' S) is a primarily rocky bay. There are three islands in the system (excluding Shark Island which is now permanently connected to the mainland); Penguin, seal and the relatively small Flamingo Island in the north. Other important components are the lagoon which extends southwards from Lüderitz Harbour and Shearwater Bay located between Angra and Diaz Points. Shorelines are predominantly rocky with the exceptions of pocket type coarse sand beaches at Flamingo and Agate Beach and in Shearwater Bay. The Port of Lüderitz lies in the inner bay with Lüderitz lagoon extending southwards. Halifax Island is located just off the open sea coast south west of Diaz point with Shearwater Bay located east of this.

660. The embayment is exclusively marine as there are no significant fresh water streams that flow into the system. Lüderitz lies adjacent to the Lüderitz upwelling cell in the Benguela current system. This is the largest cell in this ecosystem and a major supplier of nutrients to the area adjacent to the continental shelf and areas towards Walvis Bay. This cell produces diverse populations of algae and animal life that inhabit the rocky inter-tidal shores and the sand and rocky sub-tidal shores of the region.

661. Lüderitz is important for the commercially viable lobster harvests although various species of fish such as galjoen, steenbras. Kob and Hottentot bream are also common. Biogeographically the region is part of the Namaqua South Temperate Zone and comprises the northernmost limit of intertidal and reef species including the kelp, Chaetopleura (mollusc) and echinoderms such as Patira. It is therefore important from a biodiversity conservation perspective.

662. Colonies of coastal seabirds also utilize the offshore islands in the system for roosting and breeding. The important seabirds that use these islands are:

- Halifax-African penguin, crowned cormorant, kelp gull, Hartlaub's gull and African black oystercatcher;
- Penguin – African penguin, Bank Cormorant, Crowned cormorant, Cape cormorant, white breasted cormorant, Kelp gull, Hartlaub's gull and African black oystercatcher and;
- Seal – Crowned cormorant, Cape cormorant, Kelp gull and African black oystercatcher. (Simmons et al (1999), BCLME (1999) and NACOMA (2007).

7.5 Environmental Scoping Conclusion

663. Each of the proposed three routes for the TKR in Namibia presents its own unique set of environmental concerns. The region between Mariental and Lüderitz in Namibia is characterised by scenic vistas that have become the basis of a growing tourism industry in the specialty protected areas of this region. Further, large parts of the region enjoy special protection on account of the presence of diamonds. The Sperrgebiet National Park is a case in point. Finally, the dune formations and the marine ecology in the Lüderitz harbour itself will require specially focused attention as the project proceeds to construction to ensure against unwarranted ecological impacts.

664. The route option between Mariental and Walvis Bay traverses the Namib-Naukluft Park, one of Namibia's prime desert parks. Potential impacts of the proposed TKR include disturbance of ecosystem processes including wildlife movements as well as the disruption of the burgeoning tourism industry especially around Lüderitz and in the coastal dune area. Various mitigation measures are proposed for these potential impacts. These include judicious orientation of the railway line to avoid cutting across ecosystems, education programmes for construction and operational staff to avoid poaching and the involvement of local community groups in management arrangements.

665. The region between Gobabis and Walvis Bay is characterised by cattle ranches and conservancies established for the management of wildlife. The major potential impacts over this area will be the division of currently contiguous land areas by a linear development that requires a dedicated way leave. This could introduce

adverse impacts through improved access, the edge effect and increased wildlife and livestock mortalities due to accidents. These impacts can be mitigated if the proposed railway route is developed along the already existent Gobabis-Windhoek-Walvis Bay railway line.

666. Namibia's coastal zone will soon be managed under a specific management plan emanating from the Namibia Coastal Zone Management project that is being implemented with support from the World Bank. There is a need for linkages between the EIA experts under this initiative and the NACOMA project to ensure that all the recommendations being made for the management and mitigation of potential impacts of developments from the TKR at Walvis Bay and Lüderitz are made and implemented, within the provisions and framework of this management plan.

667. An issue of concern in Botswana is the potential for the railway line route cutting across the Schwelle, which is a wildlife breeding and migration zone, between the Kalahari Gemsbok Transfrontier Park and the Central Kalahari Game Reserve. This potential impact can however be mitigated through ensuring that the proposed railway line is confined to the same route as the Trans Kalahari Highway. That way, no new impacts additional to those of the highway will be introduced by the development.

668. No threatened vegetation types are found along the Mmamabula to Gobabis or Mariental routes, therefore no special mitigation measures will be required over this stretch with the exception of the need to minimise clearance of woodland.

669. No major surface hydrological features characterise the proposed routes. However, both Botswana and Namibia depend on ground water for their water supplies. Care should therefore be taken to avoid pollution of these valuable sources of water along the proposed routes especially through oil and fuel spillages during the project operational phase.

670. Most projects involving excavation usually result in adverse impacts on heritage resources such as archaeological sites. Literature reviews indicate the presence of some important archaeological sites along the proposed routes. The Namibian coastal area is also important for heritage sites as indicated by recent discoveries of ship wrecks loaded with artefacts which are culturally significant in the Lüderitz bay area. The detailed environmental and socio-economic studies on the proposed project should therefore include a comprehensive archaeological impact assessment.

671. There are no conflicts between the proposed railway line and developments at Jwaneng Town Council and the Jwaneng mine as the proposed route lies outside both the Town Council planning area and the mining lease area. A review of the Jwaneng Town Council development plan indicated that the area to be traversed by the railway line will not be required for the expansion of the town over the next twenty years.

672. The findings from this initial/scoping environmental assessment are that there are less fatal environmental flaws with Route Option 1. Route Option 2 will have potential impacts on wildlife breeding in the Schwelle area of western Botswana and migration patterns between the Kgalagadi Transfrontier Park and the Central Kahalari Game Reserve. Further, the route also traverses the Namib-Naukluft Park

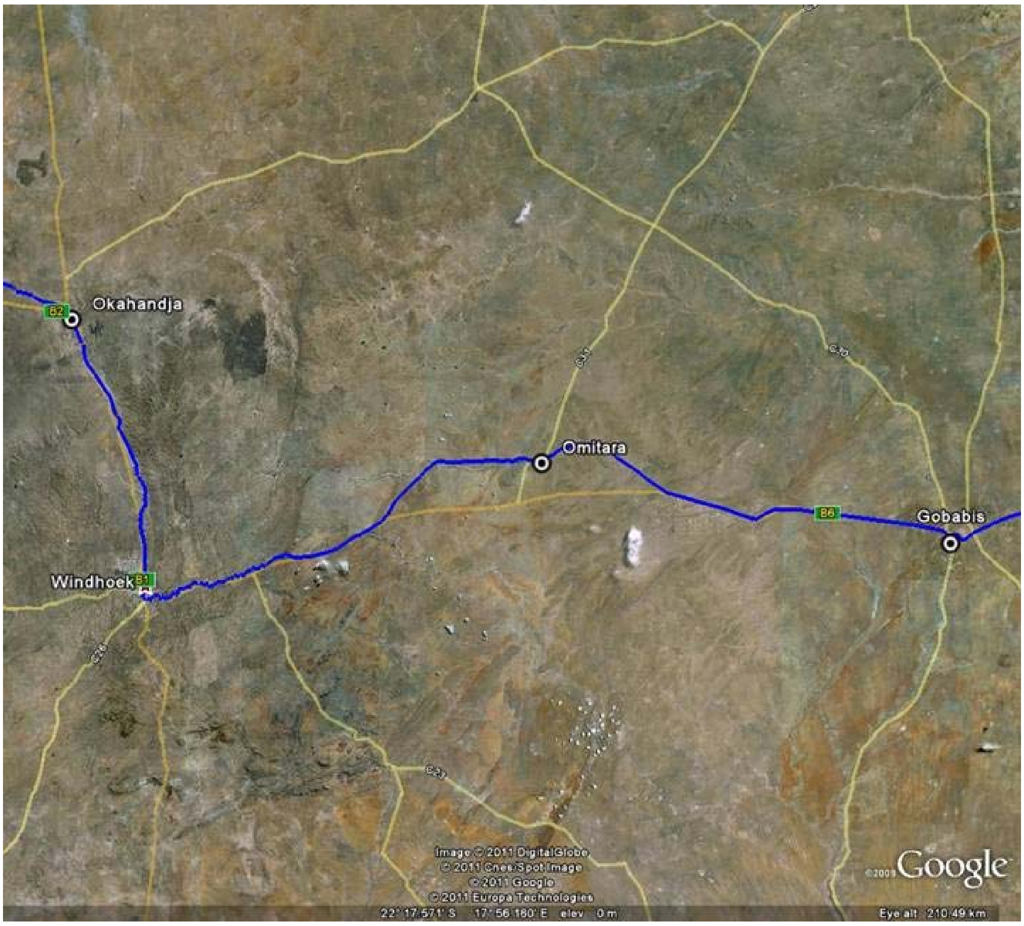
in Namibia which is important for tourism in the country. It might also not be possible to find a suitable route around the sand dunes along the coast of Namibia. These dunes, especially dune 7, are a major tourist attraction in Namibia which the Government of Namibia would like to be protected from undue damage. The potential pollution of these features from coal dust is also of special concern to the Government in Namibia. However this route is attractive from an engineering, financial and economic perspective. It is therefore necessary that more comprehensive environmental analyses be conducted to generate enough information to enable an assessment of whether these engineering and financial benefits are higher than the environmental costs that will be incurred if the line is built through this area.

673. The recommendation from this initial study is therefore that both Options 1 and 2 be taken forward for further analysis at the full feasibility study stage. There were suggestions that Route 1 be re-oriented to follow the Trans-Kalahari Highway to Gobabis with a diversion from Omitara to Okahandja and on to Walvis Bay. To divert the route directly between Omitara and Okahandja is not possible due to the terrain. The route has to clear the escarpment and it does so by following the B1 road from Windhoek to Okahandja and then from Okahandja to Wilhelmstal it follows the B2 road (as illustrated in Figure 7-8). The diversion from the B2 road occurs due to the alignment not being able to maintain the required 1% gradient. It is at this diversion that the two tunnels occur. Apart from this diversion, the route follows the B2 road all the way to Walvis Bay.

674. A critical issue of concern at the port terminals is the potential impact of coal handling facilities and the dredging of port terminals to enable them to handle the large vessels required to move large quantities of coal. The potential physical, biological and socio-economic impacts of these activities that have been identified in this report will need further study at the feasibility stage. The initial environmental assessment of the TKR project has shown that Route 1 option will have less negative environmental and socio-economic impacts while Route 2 option is attractive from the engineering and financial perspectives. These two options could therefore be taken forward for in-depth study in the next phase of the study to ascertain their feasibility on the basis of all considerations (technical, financial, social, economic and environmental).

675. A Draft Environmental and Social Management Plan is given at the end of Section 8.

Figure 7-8: Gobabis-Omitara-Okahndja Corridor



8 Social Assessment

8.1 Introduction

676. The purpose of this chapter is to provide a preliminary assessment of the likely social impacts of the proposed coal loading facilities, railway and port facilities, both positive and negative, as per the requirements set out in the TOR. It must be pointed out here that this report is not a record of a comprehensive Social Impact Assessment including a full stakeholder assessment but is a Scoping Social Impact Assessment study. However, some limited Stakeholder consultation has been carried out as part of the exercise. This section of the report therefore presents the issues that will need to be addressed in the follow-up full feasibility study of the TKR project.

8.2 Consultation process

Stakeholders Identification

677. The linear nature of the TKR project means that a large range of stakeholders (e.g. government and regulatory authorities, communities, landowners, nongovernmental organisations, special interest groups and business) will be directly affected by and interested in the development. . A review of relevant documents and initial meetings with key representatives from number government departments in Botswana and Namibia assisted in the identification of possible key stakeholders that would be consulted during the implementation of the project.

678. As stated earlier, the current study involved limited stakeholder consultations as it was an initial environmental and socio-economic assessment study. Critical stakeholders that have potential interest in the project were identified and consulted through direct interviews in Botswana. Similar consultations were planned for Namibia but did not take place due to difficulties experienced with arranging the process; specifically the consultants arrived in Namibia but were unable to meet with the stakeholders. Stakeholder consultation in Namibia will therefore need to be revisited in Phase II of the project. The names of the stakeholders consulted in Botswana and the findings of the consultations are highlighted in Figure 8-1.

Figure 8-1: Key Stakeholders Consulted: February 28 – March 8, 2011

Name / Position	Organization	Issues Raised
Ms Masego Thebe, *District Physical Planner* Mr. Keaikitse Tladi, *District Physical Planner*	Kgatleng District Council, Dept of Physical Planning, Mochudi *Tel: +267 5777411* *Mobile: + 267 73179938*	• The proposed TKR Route Options at Pilane turnoff from the existing railway line before the fly over bridge will affect planned developments within the village. According to the Development Plans the planned developments in the area include a bus rank, a hospital, a senior secondary school and a recreational area. • The proposed TKR route options should branch before Rasesa village and then

		proceed to bypass Bokaa village to the north to avoid potential land use conflicts with the village development plan. • The major land use along the proposed route is zone for tribal agricultural use (both arable (crops) and non arable (livestock) farming area). In this area there are many cattle posts especially along border between Kgatleng and Kweneng districts. • Compensation would be required along the proposed TKR corridor in this area. Compensation is done by Department of Lands through the Land Board (Kgatleng Land Board). The compensation is based on development structures on the land. Botswana has Guidelines that are followed during consideration for land compensation related issues. • The New Land Policy in Botswana talks mostly of issues related to equitable distribution of land. Recording keeping and identification of locations such street names and plot numbers are also emphasized. The control over the sale of land is also addressed.
Michael Kitembele *Chief Physical Planner* Mr. Mmoloki Poloko *Physical Planner* Mr. Losika Mosarwa *Economic Planner* Mr. Robert Maabong *Physical Planner* Ms Tsepo Nkarabang *Licensing Officer*	Southern District Council, Dept of Physical Planning, Kanye Kweneng District Kweneng District Council, Dept of physical planning, Molepolole Tel: +267 5920981	• The proposed TKR route will pass over the North of Thamaga village in Southern District. • The District land use plans show that the area where the proposed TKR corridor will be developed is mostly agricultural land where there are arable (cropland) and non arable (livestock grazing areas: private ranches, cattle posts, etc). • The future growth of the villages near the proposed TKR route should be taken into consideration. • Some of the villages along the proposed TKR corridor have Development Plans e.g. Mabutsane and Thamaga. . The future expansion of Thamaga village should take into consideration the implementation of the project. Sekoma village has no Development Plan. • The District Planners asked how wide the TKR reserve will be and also how much land will be required to accommodate the railway line along the existing Trans Kalahari High way road reserves. • The proposed TKR will affect different land uses such as private ranches and they will need to be compensated for land lost. • The negotiations for compensation on lands that have Title Deeds take a long time. The Change of Deed process is

		extensive and is difficult because commercial land values are taken into consideration. • In some cases the Title Deeds for the land where the proposed TKR would be constructed could be used as security for mortgages for bank loans. In this regard the issue becomes complicated. • An alternative route should be considered for the TKR from Gaborone to go through Lobatse, Pioneer Gate. This route would have a large volume of goods that are currently coming from South Africa by road. There is currently a proposal to develop a Container Depot at Pioneer Gate. • Consideration should be made to ensure that the TKR gauge is standardized. • The proposed TKR should also take on board other goods (either than coal) and services that could use rail transport.
Mr. G.B. Radisebo, *Physical Planner*	Jwaneng Town Council, Dept of Physical Planning	• Jwaneng Town Council (JTC) has a 24 year Development Plan for the town. The proposed expansion of the town will not be affected by the proposed route for the TKR. • The proposed expansion of the town is going to be on state land and the expansion can only be to the east, west or south of the town.
Ms N. Digkomo- Goulden *Public & Corporate Affairs Manager* Mr. Joseph Matlhare *Wildlife Manager* Mr. Jambo Gababotse *Mineral Resources Manager*	DEBSWANA, Jwaneng Mine Tel: +267 588 4013 Fax: +267 588 0143 Email: ndigkomo-goulden@debswana.bw	• The proposed Route Option for the TKR is not going to affect Jwaneng mine and future mining lease area. The proposed TKR by passes Jwaneng Mine and town to the south which lies outside the Town Council planning area and also outside the mine lease area. • Jwaneng Mine is an open pit mine. As part of the mining methodology, blasting is done after every two days. The impact of blasting is felt even in town but there have not been any cases where structures (buildings) have been affected by the tremors & vibrations. • Jwaneng Mine has a game park that cover an area of 17 000 ha. The game park is used for conservation of different wildlife especially endangered species such as White Rhino, Cheetah), educational (school children tour the park) and research purposes. There are no predators found at the park except Cheetahs. Jwaneng Park is used for recreational purposes and not for tourism. • Jwaneng Mine does not foresee an immediate benefit of the proposed TKR that they could use it for the transportation

		of their goods. However, the Mine indicated that depending on the source of their goods maybe they could also utilize the railway. • Jwaneng Mine may close down in 2035; a mine closure plan is being developed.

8.3 Socio-Economic Baseline

8.3.1 Land Use

679. In **Botswana**, the major land uses in the corridor project area are settlements (rural and urban), mining concession areas such Jwaneng Mine, Wildlife Management Areas (WMAs), game reserves/national parks, forest reserves such as Sibuya and Kazuma, communal grazing area (cattle posts), arable and non arable farming. There are also some commercial farming areas (freehold farms), lease hold farms, especially at Pandamatenga in Botswana along the proposed Mosetse – Kazungula railway route (Phase 2 Study). The types of crops grown in the Pandamatenga farms include cotton, maize, sorghum, fruits and vegetables.

680. The predominant land use along the proposed rail routes in Namibia are cattle ranching and wildlife management. An elaborate network of wildlife based conservancies has been established in both communal areas and commercial farming areas especially in the area to be traversed by the Mmamabula-Gobabis-Walvis Bay route. Most of the land to be traversed by the proposed Mmamabula to Lüderitz route is probably the country’s most sensitive ecological zone and has therefore been designated as predominantly conservation areas. The Fish River Canyon, Sperrgebiet and Naufluk National Parks are important conservation areas in this southern area of the country.

8.3.2 Socio-Economic Context of Corridor Catchment Area

Botswana

681. Over the past three decades Botswana has achieved an average annual growth of over 8% making it one of the most successful economies in Africa. This growth has been heavily dependent on revenues from mining, and diamond mining in particular. Diamonds contribute between 80% and 86% to the total value of exports. This revenue has been channelled into the provision of social services such as education and healthcare. Despite this public expenditure, there is an uneven distribution of wealth in Botswana, with many households still living in poverty; an estimated 30% of the population lives in extreme poverty (ERM, 2008a). Income levels are low and unevenly distributed between urban and rural areas (ERM, 2008a).

682. Botswana’s long term socio-economic planning perspective is outlined in her “Vision 2016” and National Development 9/10 (NDP 9 & 10). For example the underlying policy objectives of NDP 9 incorporate economic diversification, employment creation, rural development, poverty alleviation, environmental protection and the fight against HIV/AIDS. Furthermore, a number of initiatives have been undertaken to attract Foreign Direct Investment (FDI), such as the review and enactment of new laws, regulations and policies with a view to

promote investment, employment generation and wealth creation. As the economy of Botswana is highly dependent on mining and diamonds in particular, the Government has embarked on an economic diversification agenda.

683. The population of Botswana as a whole has been increasing tremendously over the past several years. In 2001, the population was estimated at 1,678,981 (GoB, 2001a). During the period 1991-2001 the population growth rate was 2.4%. This population growth was mainly due to a fairly low mortality, until recently and a high but declining fertility rate. In 2005 the population was estimated to be around 1.8 million people. . Given the current growth scenario, Botswana's population should double in size every 21 years. The Population of Botswana along the proposed TKR is given in Figure 8-2.

Figure 8-2: Botswana Population Data for TKR Catchment Area (2001)

Locality	Males	Females	Total
Gaborone	91 823	94 184	186 007
Kanye	18 020	22 608	40 628
Jwaneng	7 613	7 566	15 179
Moshaneng	601	735	1 336
Thamaga	7 884	10 233	18 117
Gabane	4 704	5 695	10 399
Kumakwane			
Moshupa	7 468	9 454	16 922
Kang	1 877	1 867	3 744
Tswane	146	195	341
Lehututu	767	952	1 719
Charles Hill			

Source: Population and Housing Census (CSO, 2001)

684. The country's dominant ethnic group is the Tswana (Batswana), comprising approximately 80% of the population, with eight principal tribes, each assigned tribal territories within the country. The population is a young one, with 38% under the age of 15. National education and literacy levels have been improving over the last 30 years, with around 81% literacy level in 2004.

685. While population densities in most districts increased between 1991 and 2001, areas that are experiencing rapid population increase are located in the south-eastern part of the country, where only 5% of the land is suitable for agriculture. The continual flow of people out of the rural subsistence agricultural sector is contributing to rapid urban migration. This is reflected in land scarcity and increased demand for infrastructure, housing and basic services.

686. The land along the proposed railway routes (corridor) through the Botswana side of the Kalahari Desert is used for a range of purposes including; commercial, freehold, and communal farming, game farming, conservation (in the form of national parks/game reserves), pastoral areas and wildlife management areas. The vast majority of this area consists of sparsely inhabited wildlife management areas on tribal land administered by Kgalagadi Land Board.

687. The population in the Kalahari Desert is low and sparsely distributed, with the largest number of people living in rural areas. Major settlements are Jwaneng (a

mining town), Sekoma (1200 inhabitants), Mabutsane (2000 inhabitants), Morwamusu (750) and Hukuntsi and Tshane.

688. In Botswana, under the traditional system, a village is considered the central place of residence with other land uses such as commercial, industrial and educational. Most villages are surrounded by communal grazing areas which are mostly used for livestock grazing, non intensive small scale arable farming, trek routes and other non commercial activities. The communal grazing lands occupy a radius between 3 and 10 km from the village. According to Conservation International, Western Kalahari Conservation Project (2008), most communities living along the proposed railway route have low levels of education. The area further counts a high proportion of female–headed households due to male out-migration in search of employment and security. This makes homesteads more vulnerable to change (ERM, 2008).

689. The majority of homesteads are linked, to some degree, to traditional agricultural and pastoral activities, and/or businesses that are dependent on natural resources (e.g. thatching grass, selling firewood and the sale of veld and wildlife products). Many are dependent on wood as a source of energy. Small-scale industrial projects are limited to brick moulding, skin tanning, and leather production and dress making.

690. Although not very well developed, tourism is one of the most important services being promoted in the area and focuses on the wildlife. Most of these activities are concentrated around Sekoma, Zutshwa – Ngwatle and take the form of Community Based Natural Resources Management (CBNRM). Projects have been created in some Wildlife Management Areas to promote wildlife conservation allied to tangible community benefits. Community Trusts have been set up in a large number of communities in order to facilitate these projects, and are supported by the Botswana Government and NGOs and other donors. These try to undertake income-generating activities based on natural resources, such as craft making, the selling of veld products, subsistence hunting and the selling of hunting quotas. On a small scale there are also ecotourism initiatives, such as the construction of cultural villages, setting up of campsites and dance groups (Conservation International, Western Kalahari Conservation Project, 2008).

691. The proposed railway route through Botswana follows the alignment of the Trans Kalahari Highway, which is a critical transit route between South Africa and Namibia and allows traditionally isolated, remote and underdeveloped district of Western Botswana to access towns and cities. This is also the most densely populated part of the Kalahari (Hund, 2008).

692. There are a large number of cattle posts throughout the area, comprising a borehole, fenced enclosures where the cattle can be kept at night and adjoining huts for herders. Many are concentrated along or near transport routes including the Trans Kalahari Highway. The unemployment rate in the Kgalagadi district was recorded at 18.2% in 2004.

Namibia

693. The Namibian economy is concentrated on a few industries, namely agriculture, fishing and mining, with the tertiary sector contributing almost 58% to the country's Gross Domestic Product (GDP). The country is the fourth largest

exporter of non-fuel minerals in Africa and the world's fifth largest producer of uranium. Currently the economy depends mainly on the export of primary goods; unprocessed or partially processed mining, agricultural and marine products. Despite efforts to encourage value adding to primary products, the manufacturing industry in Namibia remains fairly small and is also concentrated in a few industries (e.g. meat and fish processing, beverages and smelting) contributing only 11% to GDP.

694. Despite rapid urbanisation, Namibia is still a mainly rural society. This is anticipated to change considerably and by 2010 it is expected that 50% of the population will be urbanised (Office of the President, 2004).

695. Namibia's population was 1.8 million in 2001 and spread over an area of 824,116 km^2 and 13 regions. The growth rate is estimated at 2.6% (Namibia Household Income and Expenditure Survey, 2003-2004). However, according to UNICEF, the HIV prevalence rate in Namibia amongst the population aged 14-64 was estimated at approximately 19.6% at the end of 2005. To temper growth-related expectations, these figures as well as decreasing fertility (UNDP, 2008) has to be factored into the population growth rate figures, which are projected at 2.61 million by 2011 (Office of the President, 2004).

696. Namibia is sparsely populated. In Namibia the majority of the population (60%) lives in the northern regions of the country. Khomas Region is home to 14% of the Namibian population, and is the most populated area in Namibia. The growth rates for the various regions in Namibia are given in Figure 8-3.

697. The population density in the basin is 0.01 to 1.1 people per km2. Whilst 33% of the population lived in urban centres in 2001, the urban population is currently growing at a much higher rate (over 5% per annum), than the rural population. It is one of world's most sparsely populated countries, with only 30% living in urban centres. The rural economy has two different tenure systems: 43% of the country, mostly in the drier parts, contains private, medium scale, commercial ranches on freehold land, and 39% of the area serves as communal land. . The remaining 18% is owned by Government, comprising mainly environmentally protected areas and areas set aside for mining and exploration.

698. The vision is for Namibia to be a "highly urbanised country with 75% of the population residing in the designated urban areas" (Office of the President, 2004: Vision 2030, quoted in ORASECOM, 2008).

Figure 8-3: Recent Population Growth Trends in Namibia

Region	Population (2001)	Population (2007)	Growth
Karas	**69 321**	**71 701**	**3.4%**
Keetmashoop Rural	6 349		
Karasburg	14 693		
Omaheke	**68 041**	**75 620**	**11.1%**
Aminuis	12 343		
Gobabis			
Kalahari			
Hardap	**68 246**	**70 584**	**3.4%**
Mariental	13 596		
Khomas	**250 260**	**304 341**	**21.6%**
Windhoek Rural	19 908		

Source: Central Bureau of Statistics

8.3.3 HIV/AIDS Issues in the Corridor Catchment Area

699. The HIV/AIDS epidemic in Botswana is the biggest social and economic crisis facing the country today. HIV/ AIDS prevalence is higher or worse than those found in most southern African countries such as Zimbabwe and Zambia (GoB, 2000c). Data from sentinel surveillance show that the number of antenatal clinic attendees tested in the major urban areas (Gaborone, Francistown and Selibe – Phikwe) increased from 6% in 1990 to 43% in 1998.

700. HIV/AIDS threatens the continued economic growth mostly because of its impact on the labour force and its possible impacts on savings and investment (GoB, 2000e). HIV/AIDS are the major health threat to women and adolescents. By mid-1993 one in every five pregnant women in Gaborone and one in every three in Francistown were infected with HIV. Population increase, urbanisation, poverty and HIV/AIDS are identified as critical factors that put pressure on the environment.

701. The National Statistics on HIV/AIDS in Namibia according to the Human Development Report of UNDP (2002) are summarized in Figure 8-4.

Figure 8-4: Summary of the Effects of Aids on the Namibian Population

Indicator	1991	1995	2001	2006
Total Population (million)	1.4	1.6	1.9	2.1
Population growth rate (%)	3.6	3.1	2.1	1.5
Annual Number of deaths from AIDS	390	1,440	13,880	23,220
Life expectancy at birth	60.0	58.3	43.8	40.2
Orphans due to AIDS (<15 yrs)	50	1,630	31,290	118,050

Source: Human Development Report, UNDP 2002.

702. From the national statistics it is clear that HIV/AIDS will have a devastating impact on the Namibian population. Firstly, the population growth rates will decline as indicated in Figure 8-4 8-4 from 3.6% per annum to a mere 1.5%. Secondly, HIV/AIDS will play havoc with quality of life indicators in Namibia as depicted in the table. Life expectancy decreased from 60 years in 1991 to 40 years in 2006. The number of people dying as a result of HIV/AIDS increased significantly from

390 in 1991 to 23 220 in 2006. HIV/AIDS orphans have increased from 50 in 1991 to 118 000 in 2006.

703. In the Hardap Regional Development Plan (2001/2002 – 2005/2006) it is contemplated that the total population of 68,249 (2001) will decrease to approximately 52,300 by 2010. The expected population decrease is mainly attributed to the increased mortality as a result of HIV/AIDS and increased, migration from Hardap Region to larger urban centres in Namibia. If this scenario is realized, it implies relatively low or possible declining growth in water demand.

8.3.4 Preliminary Assessment of Social Impacts at the Ports

Port of Luderitz

704. The port of Luderitz is located on the southern coast of Namibia in the Karas Region. Luderitz has a population of approximately 300,000 people of which 65% live in informal areas (Encyclopedia Britannica, 2008). Luderitz town has a large fishing and boat building industry. It is estimated that about 60% of the total employed population is occupied in the fishing industry. Recently the port has also catered for the needs of the offshore diamond industry (Namport Handbook, 2007). The mining activities are centred around Elizabeth Bay, where most of the people in the mining industry are employed, and offshore diamond mining from the port of Luderitz itself. An aquaculture industry is also in the process of being established in Luderitz. The cultivation of shellfish species such as oysters, abalone and mussels has increased significantly in the past 10 years (Straubach Planning, 2004). The area also includes the Kudu Gas field in the Atlantic Ocean near Luderitz and small scale industries in Luderitz and Keetmanshoop.

705. In recent years tourism has become one of the main sources of income for the town, with the main attractions being the ghost mining town of Kolmanskop, the German colonial architecture, the desert scenery and the unspoiled coastline.

Socio Economic Issues

706. Namibia's economic growth largely depends on its ability to engineer export-led industrialization by taking advantage of its strategic location and superb economic infrastructure. The Government of Namibia through the Ministry of Trade and Industry aims to promote the port of Luderitz as a strategic and important gateway and logistic base for various mineral operations as well as the petroleum industry. They have also made considerable effort to put competitive tax and non-tax incentive in place in order to attract foreign investment to the Export Processing Zones (EPZ) of the town and to encourage both foreigners and locals to invest in the local manufacturing sector.

Port of Walvis Bay

707. Walvis Bay is located within Erongo region. The town has an estimated population of nearly 44,000 (double the number of 20 years ago). It is the principal port of Namibia, one of only two navigable natural harbours on the coastline and is the terminus of the Trans-Kalahari Highway. Walvis Bay is the centre of Namibia's fishing industry, which accounts for at least 5% of the Gross Domestic Product (GDP).

708. The fishing industry provides approximately 40% of the employment in Walvis Bay. Despite periods of decline, the fishing industry continues to play an important role in the development of Walvis Bay and has developed into a leading force in the world's fish supply market.

Socio Economic Issues

- The economy of Walvis Bay is fairly diversified. The 3,500 hectare Walvis Bay salt field is one of the largest solar evaporation facilities in Africa, processing 24 million tonnes of sea water each year to produce more than 70,000 tonnes of high quality salt which is shipped to markets in Africa. Walvis Bay also produces high quality oysters for sale to customers throughout southern Africa.
- With the need for ship repair and maintenance, well-equipped engineering firms have emerged to provide a wide range of services to the fishing and other industries. This has encouraged the growth of support industries such as shipping insurance, construction and cargo transport and retail services. In the third quarter of 2007 more than N$200 million were invested in developments within Walvis Bay. The investments include the establishment of an assembly plant by West Coast Truck Exports and the refurbishment of the BP fuel tank storage facility. The Walvis Bay fuel depot is the largest fuel storage facility on the African west coast.
- Tourism is Namibia's fastest growing industry and is also an important provider of employment and incomes, as more and more visitors come to experience the confluence of desert and seashore. Walvis Bay hosts a number of premier eco-tourism sites, such as Sandwich Harbour and the Walvis Bay Lagoon, an important wetland and a Ramsar site which is the oldest lagoon on the Namibian Coast. Tourism in Walvis Bay increased by an estimated 15-20% in the period 2005/2006.
- To enhance development in the area, infrastructure and economic growth, the Walvis Bay Corridor Group (WBCG) was established in 2000 to engage in business development activities , thereby increasing cargo for ports and corridors linked to it. The Walvis Bay Corridors are an integrated system of well maintained, tarred roads and rail networks linking Walvis Bay to key financial and business centres, such as Gaborone and Johannesburg. Not only has the initiative provided jobs to many people, it has also resulted in Walvis Bay becoming a thriving port, linking many land-locked SADC countries to the transatlantic markets (A Guide to the Walvis Bay Corridors, 2000).

8.4 Assessment of Potential Socio-Economic Impacts

709. The following summary outlines socio-economic issues that will be evaluated in full detail during the feasibility stage of the project. Details of these impacts are given in Figure 8-5.

8.4.1 Land Use Conflicts

710. Land Use conflicts are a potential impact of the proposed project. The proposed TKR corridor will traverse different land uses with the predominant ones being cattle ranching and wildlife management. While the likelihood of displacement of current land uses is reduced on account of the nature of primary activities, in the event that the proposed railway line alignment and maintenance are located on one's farm or plot and affects it, they have to be compensated. The consultations conducted with stakeholders in Botswana indicated that the whole route from Mmamabula to Mabutsane traverses tribal land which is mainly used for pastoral and agro-pastoral purposes. There are usually no structural developments on pastoral land therefore it is not expected that there will be many cases of community members asking for compensation for loss of use of structures. In the event that the need for this arises, the Government of Botswana has developed comprehensive guidelines for estimating the levels of compensation to be paid to land users.

711. The proposed route options have also been chosen to follow already existing servitudes and farm boundaries in both Botswana and Namibia. This will reduce land use conflicts. Potential land use conflicts at the two port options will be mitigated through ensuring that any requirements for land for the project and its associated infrastructure are accommodated within the development plans for the settlements. Town planning authorities as well as NAMPORT will be consulted during Phase II of the project to ascertain the availability of land to meet the needs of the project.

8.4.2 Traffic Accidents

712. Traffic accidents are usually a major concern when large projects such as the TKR are developed in settled areas and along major transportation routes. As discussed in the description of the proposed route options the only areas where potential conflicts with on-going activities are along the A1 road and railway line from Mahalapye to Pilane. The proposed route then traverses land areas that are not settled or used for transportation. This same situation also characterises Route Options 2 and 3 while route Option 1 will follow already developed servitudes. It is therefore not envisioned that there will be major traffic conflicts resulting in traffic accidents along all three proposed routes. Therefore the impact on traffic accidents would be neutral.

713. The proposed railway line will introduce an additional mode of overland transportation to Luderitz thereby introducing a potential traffic hazard. This is more so given Namibia's plans to develop the town into a mining and tourism hub for the southern region of Namibia. Planning for the port terminal for the railway line will therefore need to be managed to ensure this hazard is minimized. Walvis Bay on the other hand is an already developed port with a railway terminal. It is therefore recommended that this new development be integrated into the already existent infrastructure. Should this not be possible, similar mitigation measures to those proposed for Luderitz above will need to be considered to manage any adverse impacts.

714. The other source of accidents is during the construction phase. Clear traffic management measures need to be in place to mitigate against these eventualities.

The impact for all three route options and two port options would be similar and therefore the impact would be neutral.

8.4.3 Public Health and Safety Issues

715. Issues that need to be assessed in the impact stage of the EIA relating to public health and safety issues will include the effects of dust emissions on the workers as well as public, the effects of noise generated by the excavation activities, potential spread of communicable diseases, including HIV/AIDS by the migrant labour and the effects of improper waste and sewage disposal practices by the workforce at the construction and camp sites. While the proposed line routes do not go through major settlements, appropriate mitigation measures will need to be put in place to avoid unduly impacting local communities.

716. Pollution control measures will need to be identified and applied and public health education programmes introduced to raise the awareness of local residents about the potential health risks inherent in unsafe social contact with workers coming from outside. The potential for introducing health risks from outside the region could be managed through preferential hiring of locals to do the bulk of unskilled work required during construction phase. Public Health and Safety concerns are higher in areas with higher population concentrations. It is therefore expected that there will be more issues at the two alternative port sites. These effects arise from a variety of sources including the proposed cargo handling facilities, the interaction between local populations and those brought in from outside the two towns during both construction and implementation of the project. Of particular significance is the potential for the spread of HIV and other communicable diseases which will need to be managed through extensive awareness campaigns.

8.4.4 Creation of employment (enhancement of the local economy)

717. Employment opportunities are limited especially for rural communities in both countries. It is therefore anticipated that local populations will realise new, albeit transitory opportunities for employment during the construction of the proposed railway routes. Project implementers will need to ensure that there is preferential engagement of local populations for general labour during this phase. Needless to say, the limited employment created by the project will help in the improvement of the livelihoods of the people as well as create buying power for the population. The created buying power will be instrumental in forging backward and forward linkages in the economy and thus contribute positively to economic growth in the area. The developments of coal handling facilities at both Lüderitz and Walvis Bay will increase potential employment opportunities for the communities in these two towns.

718. There are potential developments that normally follow the introduction of new transportation infrastructure. These are likely to generate positive socioeconomic benefits. These developments will occur at different phases of the proposed development project both along the routes and at the two ports. These include the following:

Construction Phase

719. Temporary Employment Opportunities: During the construction phase, there will be temporary employment opportunities that will be generated along the railway

line route as well as at the port terminals. The different contractors should be encouraged to recruit casual and unskilled/semi-skilled labour from the nearby communities so that the local people can also benefit from the project development activities. If possible, the contractor can use labour intensive approaches when doing some jobs instead of using machinery. The wages earned through this temporary employment will inject financial resources into the project area with primarily positive spin-offs.

720. Economic Boom: Business communities (general dealers and vendors) will temporarily experience a business boom from the contractors buying goods and foodstuffs from them. It is also expected that the railway line will generate opportunities for transporting additional goods to coal which might inject new business opportunities to the area. Southern District Council in Botswana has indicated that a new container terminal is proposed for the South African side of the Pioneer Gate Border Post. If a similar facility is developed on the Botswana side and integrated into the proposed TKR. A new lease of life might be injected into dying towns like Lobatse. Business entities at the two ports will also be similarly benefitted.

Operational Phase

721. While it is not expected that the railway project will maintain jobs along its route in the operational phase it will improve access into previously inaccessible territories thereby making it possible for the movement of goods and services through and into these areas. Because of this, there will be access to the railway by third party operators during the operational phase of the railway. There will be some business opportunities that will be developed during this phase of the proposed TKR project. The specific details will be determined in the next phase of the feasibility study.

722. Economic Development: The completion of the TKR will facilitate the movement of coal to international markets as well as the movement of goods from the coast into the region. The major beneficiary will be the coal industry which will be able to transport coal from Botswana for export through Namibian ports. Regional benefits will be expected from this opening up of the region’s hinterland to international markets with significant impacts on the socio-economic map of the region.

723. Some of the businesses will be reliant on railway as an improved means of moving goods and services. Local industries will benefit from reliable and affordable mode of transport. There is a potential for different agricultural and tourism-related business to develop and tap from the rail transport as a service provider. Farming supplies such as agricultural inputs (fertilizers / animal feeds and other products) can be transported by rail. Agricultural products can also be transported by rail to relevant markets. The general dealers and other industries can transport their goods by rail. The other benefits will be in the form of taxes paid by the different users.

8.4.5 Summary of Major Socio Economic Impacts and Constraints

724. Figure 8-5 presents a summary of the key environmental and social impacts and constraints to the TKR Project and includes the findings of the specialist desktop studies. To inform initial planning and design of the project , impacts and

constraints are categorised by environmental aspect and related to a specific area in the study such as the proposed TKR Route Options (either Option 1, 2 or 3). The project component where the constraint and / impact occur is also presented. These key findings in turn inform the assessment of impacts and the comparison of alternative railroad routes and port options presented in Figure 8-6 and Figure 8-7.

Figure 8-5: Summary of Major Socio Economic Impacts and Constraints

ASPECT	Potential Impact and Constraint		PROJECT COMPONENT – Route Options
	Type	Characteristics and/ or location	
Social			
	Human settlement	• High concentration of human settlement around Gaborone, Windhoek, Mariental, Walvis Bay and Luderitz which increases potential for project related nuisance and health and safety issues. • Railroad alignment through Pilane area north of Gaborone is likely to require large scale resettlements. • Higher number of sensitive receptors and economic activities in sizeable urban areas such as Gaborone, Windhoek, Walvis Bay and Luderitz • Walvis Bay and Luderitz comprise sizeable populations.	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) Coal terminal and associated infrastructure **Route Options 1 & 2 & 3**
	Community Conservancies / traditional land /indigenous groupings	• Community conservancies and traditional land occur in areas between Mariental and Keetmanshoop as well as between Gobabis and Windhoek and Okahandja. • Topnaar settlements are located along the Kuiseb River, including to the south of Walvis Bay.	Railroad (Namibia) **Route Options 1 & 2 & 3**
	Domestic animals	• Large numbers of domestic animals (e.g. Cattle and donkeys) in Botswana; cattle posts along the Trans Kalahari High way. • Cattle and sheep farming occur across large areas of central Namibia (mainly related to large scale farming practices)	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) **Route Options 1 & 2 & 3**
	Small –scale farming on tribal land and /or agricultural schemes	• Subsistence agriculture occurs on the land occupied by the Mmamabula mine concession. • Cultivated land is found in the areas around Gaborone, along the proposed route from Pilane, Mabutsane and up to Namibia Border at Mmamuno. • The Hadarp agricultural scheme	Load out terminal (Mmamabula Mine) **Route Options 1 & 2 & 3** **Route Option 1.**

		is situated north of Mariental. • Small-scale farming is located on the traditional lands between Mariental and Keetmanshoop and in the Windhoek district.	Railroad (Namibia) **Route Options 1 & 2 & 3**
	Large farmlands and wildlife conservancies/ Wildlife Management Areas (WMA) in Botswana	• Large farms are located in the highlands areas (e.g. east of Gaub Pass and south of Mariental heading down to Spitskop) • Commercial Ranches to the west of Jwaneng Mine in Botswana. • Farmers are involved in the ranching of cattle and sheep farming. • A large number of private farms fall within wildlife conservancies (e.g. significant proportion of these conservancies are located in the Windhoek District and surrounds. • There are wildlife management areas that are located across the proposed TKR especially the Route Option 2 / 3 after Lehututu village.	Railroad (Namibia) Railroad (Botswana) **Route Options 2 & 3**
Economic			
Tourism	Conservation	• Schwelle area between the Kgalagadi Transfrontier National park and the Central Kalahari Game Reserve (CKGR) has been designated as a wildlife conservation / tourism priority area (on-going collaboration between Botswana Government, Conservation International and the European Union). • In Namibia, tourism potential increases westward from Windhoek and Mariental to coastal dunes, with increasing number of tourism establishments (e.g. lodges and camp sites) • The C14 road between Mariental and Walvis bay is a major tourist route and traverses the Namib – Naukluft National Park and includes key tourist attractions such as the Kuiseb Canyon • There are plans to declare the whole of the Namibia coastal area a National park, with different zones (this has obtained in principle support from the Namibian Cabinet) • Soussousvlei is major tourist	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) **Route Options 1 & 2 & 3** Coal terminal and associated infrastructure

		attraction • Swakopmund, Walvis Bay and Luderitz are major tourist centres given their historic German colonial architecture. • The Walvis Bay lagoon is a key attraction for ornithologists and bird watchers.	
Mining		• Large numbers of mining and mineral concessions are found along the routes of the project especially in Botswana. • Diamond concessions are located southwards from Luderitz to Oranjemund (i.e. Sperregebiet) • Elizabeth Bay is the site of an active on-land diamond mine. • Samicor hold rights for mining the seafloor around the offshore islands except for penguin and seal which are within the port limits.	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) **Route Option 3**
Infrastructure		• There is a network of roads through the Western Kalahari in Botswana which are difficult to traverse. • There is a good network of tar and gravel roads in Namibia. • Luderitz and Walvis Bay have established port facilities with container terminal situated at Walvis Bay	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) **Route Options 1 & 2 & 3**
Heritage			
	Iron Age and Stone Age archaeological deposits and historic sites	• Archaeological deposits are situated around Thamaga and Molepolole, west of Gaborone. • Artifacts have been identified across central Namibia • Nomadic pastoral sites and metal workings have been discovered from skirmishes between the Witbooi Clan and Germans are located at Gideon in the Namib – Naukluft National Park. • Rock art sites between Omaruru and Richtersveld National Park	Railroad (Botswana) **Route Options 1 & 2 & 3** Railroad (Namibia) **Route Options 1 & 2 & 3**
	Cultural sites	• Diaz Cross overlooking Shearwater Bay southwest of Luderitz is a key cultural site. • Luderitz has many historic buildings	Coal terminal and associated infrastructure **Route Option 3**

725. Consultations with planning authorities in the three districts that the proposed TKR railway will traverse indicated no projected conflicts with expected growth patterns of the villages and towns that lie in close proximity to the line. Development planning horizons in both Botswana and Namibia range from five (5)

to twenty (20) years. It is the view of the assessment team that projections of growth of settlements over periods longer than twenty years would be difficult as these are influenced by a myriad of factors. A good example of the difficulties with projecting growth patterns of settlements is the observation made at Jwaneng Town Council. The town's growth was said to be dependent upon the lifespan of the mine which is estimated to be up to 2035 as well as where and whether new diamond deposits are discovered in future. Consultations with District Planning Authorities at Kanye were also inconclusive as to the extent to which villages that will be traversed by the proposed railway line would grow beyond standard planning horizons. Because of these difficulties the assessment team is of the opinion that projecting the potential impacts of the project over periods longer than twenty years would not be possible or practical. The team therefore opted to project impacts within the conventional planning horizons used by both governments. .

8.4.6 Costs of Environmental Mitigation

726. This initial environmental assessment of the TKR was conducted with limited field visits and stakeholder consultations. The identification of these measures and the costs associated with them will require that extensive field surveys as part of a full feasibility exercise be conducted on the ground to identify communities that will potentially be affected by the project. The comprehensive EIA proposed for the feasibility stage will have to include an assessment of costs of mitigation to be included in the overall project costs. A number of approaches to estimating costs of projected environmental impacts will be used to compute these costs. These include:

- Estimating the potential losses to the economies of both countries caused by disruption of nature based economic activities such as tourism;
- Computation of costs of compensating communities for loss of use and access to resources such as agricultural land;
- Computing the costs of compensating affected communities for loss of resource utility-relocations, relocation of burial sites etc;
- Computing costs of physical works that might be required to mitigate against impacts such as disruption of wildlife migration routes;
- Costs of stakeholder/community mobilization and training.

727. These costs will be assessed in the feasibility study and factored into total project costs. This will cover costs of measures such as compensation for loss of access to land, fencing off the servitude to avoid conflicts with humans and animals, etc. This will however need to be confirmed during the feasibility study stage of the project when the exact routing on the ground has been identified. The Capex costing that has been done under the Railway and Ports Sections for all three options include some of the mitigation measure such as Fencing, Road Signage and Road Furniture, and Property. These items cover some of the cost of mitigation impacts. They make up approximately 2.5% of the cost of construction. For planning purposes, and in the absence of an estimate of mitigation costs it is proposed that, as per standard practice, a generic average proportion of 10%-20% of total project costs be allocated to overall costs of mitigation of environmental and socio-economic impacts.

8.4.7 Comparative Assessment of Impacts of Proposed Route Options

728. The environmental and socio-economic analysis is part of a broader study intended to assist the client to decide on which of the three route options to take forward to full feasibility study. To assist with this, a comparative analysis was conducted of the potential environmental and socioeconomic impacts of the TKR project along each of the proposed routes. The analysis covered both the construction and operational phases of the project. Each expected impact was assessed for its severity and significance on a scale of 1 to 5 with a score of 1 signifying lowest impact and 5 signifying highest impact. The total scores for each impact were collated and used to rank the proposed route options based on their environmental and socio-economic impacts. At this preliminary stage the scoring system used positive values for both negative and positive impacts. Figure 8-6 and Figure 8-7 below summarises the results of the comparative analysis. From an environmental and socio-economic perspective, the preliminary findings indicate that Route Option 1 will have the least environmental and socio-economic impacts. However, Route Option 2 has been identified as a feasible option on account of its positive cost benefit analysis and engineering feasibility. It is therefore recommended that both Route Options 1 and 2 be taken forward for further analysis during the full feasibility study for the proposed TKR line.

Figure 8-6: Construction Phase

Environmental and Social Impact	ROUTE OPTIONS		
	Option 1	Option 2	Option 3
Socio Economy			
Positive impacts			
• Enhanced local economy	2	2	2
• Temporary employment creation opportunities	5	5	5
Negative impacts			
• Transmission of disease / spread of HIV/ AIDS	3	3	3
• Social disruption	2	2	2
• Increased animal mortality (livestock / wildlife)	2	3	3
• Threat to public health	2	2	2
• Aesthetics and visual disturbance (impact on tourism/ environment)	2	3	2
Environmental and Public Health			
Negative impacts			
• Improper waste management and disposal	2	2	2
• Contamination from pit latrines	2	2	2
Land Use			
Negative impacts			
• Potential land use conflict (human settlement / farming activities)	1	2	2
• Change in land use	1	2	2
• Loss of land	1	2	2
• Presence (location) of minerals	2	3	3
Flora (vegetation) impacts			
Negative impacts			

• Destruction of vegetation	2	3	3
Impact on soils			
Negative impacts			
• Increased soil erosion	2	2	2
• Soil contamination	2	2	2
Fauna (animal communities) impacts			
Negative impacts			
• Wildlife disturbance and displacement	2	4	4
• Increased wildlife poaching incidents	2	4	4
• Reduced grazing resources for animals	2	2	3
Impact Water resources / hydrology			
Negative impacts			
• Potential impact of underground and surface water resources	2	2	2
• Impacts of river crossings			
Impact on Marine ecology			
Negative impacts			
• Disturbance of ecosystems	3	3	3
Impact of dredging activities at the Ports			
Negative impacts			
• Disturbance of ecosystems	4	4	4
Impact on Archaeology and Heritage			
Negative impacts			
• Disturbance and destruction of archaeological sites & heritage	2	3	3
TOTAL SCORE	**50**	**62**	**62**

Key:
Option 1 = Mmamabula –Walvis Bay via Gobabis (Variation route: follow TKR to Gobabis then diversion from Omitara to Okahandja and on to Walvis Bay).
Option 2 = Mmamabula – Walvis Bay via Mariental
Option 3 = Mmamabula to Luderitz via Mariental.

SCORES
1 = low
3 = Moderate
5 = High

Figure 8-7: Operation Phase

Environmental and Social Impact	ROUTE OPTIONS		
	Option 1	Option 2	Option 3
Socio Economy			
Positive impacts			
• Improved transportation of goods and services	4	4	4
• Enhancement of regional (SADC) economy	3	3	3
• Enhancement of local economy	2	2	2
• Employment creation opportunities	2	2	2
Negative impacts			
• Transmission of disease / spread of HIV/ AIDS during maintenance of	2	2	2

railway line and facilities			
• Social disruption during maintenance of railway line and facilities	1	1	1
• Increased animal mortality (livestock / wildlife)	2	3	3
• Aesthetics and visual disturbance(tourism /environment)	2	2	3
Environmental and Public Health/ Safety			
Negative impacts			
• Improper waste management and disposal at railway stations	1	1	1
• Air and noise pollution from diesel locomotives	2	2	2
• Effect of coal dust pollution on people and the environment at the shiploading terminal- Port.	3	3	3
• Effect of coal dust pollution on people and the environment at the loading terminal at Mmamabula	3	3	3
• Coal dust pollution during transportation	2	4	3
Land Use			
Negative impacts			
• Change in land use	1	1	1
Positive impacts			
• Presence of development infrastructure (road / existing rail)	1	3	3
• Improved accessibility of areas that used to be inaccessible	1	2	3
Impact on soils			
Negative impacts			
• Increased soil erosion	1	1	1
• Soil contamination from fuel spillages	2	2	2
Fauna (animal communities) impacts			
Negative impacts			
• Wildlife disturbance and displacement	2	4	4
• Increased wildlife poaching incidents	2	4	4
• Increased animal mortality through accidents	2	3	3
Impact Water resources			
Negative impacts			
• Potential impact of underground and surface water resources	1	1	1
Impact on Marine ecology			
Negative impacts			
• Disturbance of ecosystems	2	2	2
• Impact of coal dust on marine ecosystem	2	2	2
Impact of dredging activities at the Ports			
Negative impacts			
• Disturbance of ecosystems	3	3	3
Impact on Archaeology and Heritage			
Negative impacts			
• Disturbance and destruction of	2	3	3

archaeological sites & heritage			
TOTAL SCORE	**54**	**60**	**64**
GRAND TOTAL SCORE (Construction and Operational Phases)	**104**	**122**	**126**

Key:
Option 1 = Mmamabula –Walvis Bay via Gobabis (Variation -follow TKR to Gobabis then diversion from Omitara to Okahandja and on to Walvis Bay).
Option 2 = Mmamabula – Walvis Bay via Mariental
Option 3 = Mmamabula to Luderitz via Mariental

SCORES:
1 = Low
3 = Moderate
5 = High

NB: The above results are from an Initial Environmental Assessment study. More specific and detailed assessment would need to be undertaken during the full feasibility study. The lower the total score, the lower the environmental impacts.

8.5 Preliminary Environmental and Social Management Plan

8.5.1 Basic Principles

729. Pulling together the material from the last two chapters, we present below a preliminary Environmental and Social Management Plan.

730. An Environmental and Social Management Plan (ESMP) is a tool for proactive management of the environmental aspects of a proposed project so as to minimise the significance of negative impacts. The ESMP enhances the positive impacts by moderating the spatial extent and duration of an impact. During project construction and operation, proactive management is vital for avoiding or minimising environmental effects. This requires commitment from a project proponent and close cooperation with government agencies with responsibilities for environmental management. The ways in which construction and operation procedures are planned can have impacts or benefits for the environment. The ESMP serves as a guide for ensuring that the environmental and social issues discussed above are taken into consideration during the construction and operation phases of the proposed TKR development project. The ESMP must clearly specify the actions required of Governments to avoid or minimise impacts and which agencies are responsible for ensuring that the proposed actions are implemented. Figure 8-8 shows the TKR proposed Draft ESMP.

731. As a way of promoting transparency in the development of projects such as the TKR, it is recommended that the ESMP be shared with all stakeholders that might be potentially impacted by the construction and implementation of activities associated with this project.

732. The ESMP for this proposed project basically seeks to achieve proactive management of environmental impacts associated with the construction of the

TKR during the construction and operation phases. The ESMP will achieve this through the following:

- Defining the strategies needed to implement these mitigations; and
- Defining specific measures needed to implement these mitigations.

733. Feasible mitigation measures outlined below will help reduce the severity of some negative impacts identified. The positive impacts will be enhanced. It is important to note that Ministry of Transport and Communication (Botswana) and the Ministry of Works and Transport (Namibia), along with the Namport and the Department of Environmental Affairs (DEA), will have the overall responsibility to ensure that the mitigation measures are implemented.

734. A preliminary ESMP for the TKR project is presented at the end of this Chapter. It should be interpreted together with a code of conduct that will be developed for purposes of guiding the contractor during the implementation of the project.

8.5.2 Monitoring and Evaluation Procedures

735. During the Construction Phase, it is necessary to monitor and evaluate the details of the ESMP. It is recommended that the contractor, during routine visits to the site should make an evaluation of the listed requirements and ensure the implementation of mitigation and recommendations suggested. This approach will result in cost savings and smoother progress in the project implementation activities.

736. The contractor must monitor the environmental and social issues to ensure that the predicted impacts are not greater than expected during the project implementation. Occasional environmental auditing or inspections by the Ministry of Transport and Communication and officers from Botswana and Namibia will also be necessary to ensure that the contractor implements the ESMP accordingly. Through this approach the actual impacts that exceed the predicted impacts will be avoided and any new negative ones will be identified for prompt mitigation.

737. An additional issue for monitoring is that of the commitments made by both countries to climate change mitigation through the various international protocols and instruments that they have acceded to. It is recommended that the monitoring programme include tracking of potential contributions of the operations of the project to carbon dioxide emissions. This should be done with a view to ensuring that the two countries remain within the limits of their obligations under these various agreements as well as the limits set in their respective national climate change strategies. It should be noted however that both countries possess considerable net carbon credits which they can trade to take care of any potential increases in emissions from the project. .

8.5.3 Organisational Structure and Responsibility

738. The responsibilities in an ESMP should be allocated to an existing organisational structure. In the case of the TKR project, there are three main organisations that are of great importance in the implementation of the project, these are the Contractor and the two governments of Botswana and Namibia (Ministries of Transport). The latter are key Government institutions which have the legal mandate to oversee certain aspects that will be included in this ESMP. Detailed

below are key responsibilities necessary for the implementation measures suggested through the ESMP.

739. The **Contractor** would be responsible for the following, amongst other things:

- Ensuring that the project is constructed and operated in accordance with the ESMP and accepted standards of transport operation;
- Ensuring that environmental mitigations, procedures and operational controls that are recommended are put in place within the project implementation schedule and are complied with on a daily basis;
- Reporting to the Project Engineer on performance of ESMP as a means to facilitate continual improvement in environmental management;
- To remain conversant with the requirements of the ESMP and other requirements applicable to the environmental aspects of the project;
- To have a working knowledge of ESMP and new developments in the field of environmental management;
- To identify, establish and maintain appropriate links with interested and affected parties; and
- Ensure that the workforce and sub-contractors are environmentally aware and perform their duties in an environmental friendly manner.

740. The **Ministries of Transport** in the two countries are mandated to oversee all transport related activities in the respective countries, to ensure that they are operated in accordance with the requirements of the relevant Acts pertaining to transport. As a result of these responsibilities and in its role as the client for the TKR project, the Ministry representatives are supposed to make routine visits to the project site to check whether the construction and operations are complying to the requirements of the above mentioned Acts, and also with recommendations of the EIA study. It should be noted that the carrying out of the EIA is one of the conditions upon which the construction license (or permit) is awarded. Therefore, the two Ministries are equally mandated to ensure that the proposed TKR project is carried out in accordance with the recommendations of a full EIA study.

8.6 Socio-Economic Conclusions

741. Railway lines, unlike roads, have generally not caused major adverse social changes in their catchment areas. It is therefore not expected that there will be major shifts in population distribution in the districts that the proposed lines will pass through. The main impacts that can be expected out of the proposed projects will be through the creation of employment during the construction phase. To maximise this positive impact, it is recommended that, as much as possible, the recruitment of general labour be concentrated in the project catchment area.

742. The potential for the spread of communicable diseases as construction crews interface with local communities is a major threat especially given the generally high incidence of conditions such as HIV and AIDS. Extensive educational campaigns, especially targeting the youth should be conducted throughout the construction of the project.

743. Construction and implementation of linear transportation projects generate dust and noise and increased accidents which could adversely impact on local populations. The appropriate mitigation against these impacts is judicious location of the railway lines in relation to settlements as well as effective management of operation of the transport systems. .

744. The development of the coal handling facilities at either port will generate employment for the general populations in the preferred town. Care will need to be taken to ensure that local residents receive priority when employment is offered to work on this project.

745. It is important to note that the socio-economic impacts discussed in this report are only at Scoping stage as their identification was informed by a limited comprehensive stakeholder consultation process. A full Environmental and Socio-Economic Impact Assessment would need to be carried out during the full Feasibility study and this would include comprehensive Stakeholder and Public/Community Consultation ad Exhibitions.

DRAFT ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN (ESMP)

Figure 8-8: Construction Phase ESMP

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
Socio-economy								
Negative Impacts:								
Transmission of disease and spread of HIV/ AIDS	**Objective:** To reduce transmission and spread of HIV/AIDS infections **Mitigations:** Sex education for both the community and construction crew (Refer to section 4.3.1)	• Few cases of new diseases and HIV infections • Number of seminars held to sensitize the people	Contractor and Project Engineer/ Min of Health Unit/ NACA	Social workers and local authority and nurses		Condoms, Educational posters, pamphlets, transport	Throughout the Construction phase	Contractor and Project Engineer
Social disruption	**Objective:** To reduce disruptions on the social setting of the area. **Mitigations:** • Public meetings to raise awareness of the project community on pros and cons of the development such as this one. • Workshops and meetings to raise awareness of employees on matters of social and cultural attrition. • Observation of local etiquette/code of conduct.	• Record of all Kgotla meetings to sensitize the community. • Record of meetings with employees • Existence of a cordial working relationship between village leaders and the contractors.	Contractor and Project Engineer/ Dept of Social Welfare, VDC	Social welfare educators, Social workers etc		Educational posters, pamphlets	Prior and throughout the project.	Contractor and Project Engineer
Threat to Public	**Objective:** Minimise the	• Minimal cases of health	Contractor and	Contractor		Salvage or	Before	Contractor

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
Health	risk to public health **Mitigation Measures:** • Setup on-site system to collect and sort waste for recycling and re-use • Select products and materials with minimal packaging or no packaging to reduce waste • Provision of adequate on site sanitation facilities. • Strict adherence to Waste Management Act (1998), Guidelines for the Disposal of Waste by Landfill (1997) and Botswana Strategy for Waste Management (1997).	problems associated with poor waste handling and improper sanitation practices • Reduction in the amount of waste generated over time. • Increase in the amount of waste recycled and re-used. • Compliance with the relevant legislation	Project Engineer	and Project Engineer		bins/ skips, on site mobile sanitation units or construction of pit latrines,	Construction starts	and Project Engineer
Livestock mortality	**Objective;** To avoid livestock mortality due to accidents **Mitigations:** • Drivers to adhere to speed limits. • Encourage community participation • Educating drivers on road safety.	• Number of reported accidents involving livestock.	Contractor and Project Engineer	Contractor and Project Engineer		Pamphlets and posters on road safety	Throughout the project period	Contractor and Project Engineer
Road Safety	**Objective:** To avoid accidents involving Construction vehicles **Mitigation:** • Drivers to be conscious when driving through	• Number of accidents involving Construction project vehicles. • Number of traffic offences involving drivers.	Contractor and Project Engineer	Contractor and Project Engineer		Pamphlets and posters on road safety	Throughout the project period.	Contractor and Project Engineer

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
	the village. • Speed limits to be adhered to by drivers. • Heavy trucks to drive with beacons and headlights on when driving on dusty roads • Community to be educated on the traffic hazards.							
Aesthetics and visual disturbance	**Objective:** To minimise visual impacts of the project **Mitigation:** • Rehabilitate construction sites, encourage natural revegetation using indigenous vegetation. • Backfill the trenches and disturbed sites. • Avoid haphazard trenching and other activities.	• Sites at the proposed TKR line construction that have not been rehabilitated or backfilled.	Contractor and Project Engineer	Contractor and Project Engineer		Shovels and JCBs	Throughout the project period	Contractor and Project Engineer
Positive Impacts:								
Enhancement of the local economy	**Objective:** To grow the local economy **Recommendations:** • Promotion of investment project area. • The contractor to be encouraged to buy products locally	• The number of locals setting up new businesses as a result of the project.	Local authorities.	Local authorities		Pamphlets to encourage contractor to buy goods locally if available.	Throughout the project phase	Contractor and Project Engineer
Employment Creation	**Objective:** To enhance employment benefits within the project area **Recommendations:** • Railway line	• The number of locals employed in unskilled and semi skilled jobs.	Contractor and Project Engineer	Contractor and Project Engineer and Recruiting	Dependen t on the Labor guidelines and	Employment guidelines from Labour Dept.	At the beginning of construction. phase	Contractor and Project Engineer

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
	construction should be made labour intensive • Source semi/unskilled labour locally • Job advertisement at the kgotla • Recruitment to be undertaken at all the project villages • Adherence to Botswana labour law.			officers from Labour Dept.	company policy			
Environmental Health								
Negative Impact:								
Improper waste management and disposal	**Objective:** To avoid environmental pollution from improper waste management. **Mitigation:** • Put in place a proper waste management system. • Encourage contractor to dispose waste at designated sites. • Dispose waste in an environmentally sound manner	• Proper waste management practice • Recycling and reuse of waste generated	Contractor and Project Engineer	Contractor and Project Engineer		Litter bags/ bins	Throughout the project cycle	Contractor and Project Engineer. KDC Environm ental Health officer
Occupational Health and Safety & Public Health								
Negative Impacts:								
Air pollution	**Objective:** To minimise air pollution in the project area. **Mitigation:** • Sprinkle the dust roads and working areas with water.	• Minimal air pollutants emitted into the atmosphere.	Contractor and Project Engineer	Contractor and Project Engineer. District Environme		Water Bowers/ workshop facilities for vehicle service	Throughout the project period	Contractor and Project Engineer District Environm

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
	• Service machinery and vehicles regularly			ntal Health officer				ental Health officer
Noise pollution and vibration	**Objective:** To control noise pollution and impacts of vibrations **Mitigation:** • Confine train operations to daytime. • Use personal protective equipment. • Conduct visitor safety induction • Contractor to practice diligence in operations	• Low noise levels experienced. • No explosives.	Contractor and Project Engineer	Contractor and Project Engineer		Ear plugs and protective clothing	Throughout the project period	Contractor and Project Engineer
Contamination from pit latrines	**Objective:** To minimise contamination from pit latrines at the construction camps. **Mitigation:** • Use lined pit latrines or mobile toilets. • Locate pit latrines away from the shallow water table.	• No pollution incident noted.	Contractor and Project Engineer	Contractor and Project Engineer		Mobile toilets/ Educational pamphlets	At the start of the project and throughout the project life.	Contractor and Project Engineer
Land-Use								
Negative impact:								
Potential land use conflict	**Objective:** To avoid potential land use conflict **Mitigations:** • Conflict resolution. Discussion among the responsible authorities/ affected parties • Rehabilitate and landscape the disturbed sites.	• Very few cases of reported incidents of conflict.	Contractor and Project Engineer	Contractor and Project Engineer/ Land Board		Fence off the railway servitude area.	At the start of the project	Contractor and Project Engineer

Impact	Objectives and Mitigation measures:	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
Changes in Land use (direct and induced)	**Objective:** To manage and control change in land use **Recommendation:** • Ensure that the land get rehabilitated as close as possible to its original state so that it can revert back to its original use	• Change of land use managed properly • Land rehabilitated	Contractor and Project Engineer.	Contractor and Project Engineer /Land Board		Managemen t Plans	Throughout the project	Land Board, Departme nt
Loss of Land	**Objective;** To minimise loss of land **Recommendations** Ensure that the TKR works are confined to the railway corridor	• No pieces of land are opened up and not used.	Contractor and Project Engineer	Contractor and Project Engineer		Managemen t Plans	Throughout the project	Contractor and Project Engineer. Land Board
Flora Impacts (vegetation)								
Negative impacts:								
Loss of woody and herbaceous vegetation cover.	**Objective:** To minimise vegetation loss **Mitigations:** • Keep a small ecological foot print • Leave mature trees uncut where possible • Reduce trampling by machinery • Rehabilitate to allow natural revegetating of disturbed areas	• Only areas required for TKR railway are cleared • Mature trees left standing.	Contractor and Project Engineer.	Contractor and Project Engineer		Machinery	Before operations start	Contractor and Project Engineer.

Impact	Mitigation measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		

Impact	Mitigation measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
Soils								
Negative impacts:								
Soil Erosion and its consequences	**Objective:** To reduce soil erosion at the project site **Mitigation:** • Contractor to construct storm water drainage system to control runoff. • Landscaping of the area • Dressing disturbed sites with top soil during rehabilitation and mulches to control water runoff	• Storm water drainage or control system constructed • Site landscaped • Disturbed areas dressed with top soil and mulched to control runoff •	Contractor and Project Engineer	Contractor and Project Engineer		Shovels	Throughout the project	Contractor and Project Engineer
Loss of soil fertility	**Objective:** To minimise loss of soil fertility **Mitigation:** • Topsoil to be stockpiled for reuse during rehabilitation • Ripping and scarifying of surface on compacted areas	• Topsoil stockpiled at the pipeline construction and rehabilitation sites. • Compacted areas ripped and scarified	Contractor and Project Engineer	Contractor and Project Engineer.		Machinery/ shovels	Throughout the project	Contractor and Project Engineer
Soil contamination	**Objective:** To avoid soil pollution **Mitigation:** • Store fuel on bunded areas or impervious surfaces, • Avoid spillages, • Clean up immediately any oil spillages. • Proper waste disposal methods to be applied.	• No oil spillages on the soil at the site. • Amount of waste transported to landfill site. • Effective waste management practice	Contractor and Project Engineer	Contractor and Project Engineer		Machinery/ shovels	Throughout the project	Contractor and Project Engineer.

Impact	Mitigation measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
Fauna (animal communities)								
Negative impacts:								
Wildlife disturbance and displacement	**Objective:** To minimise wildlife disturbance **Mitigation:** • Educate the contractors about activities that can affect wildlife. • Avoid poaching	• Wildlife observed roaming in the area. • No incidences of wildlife poaching.	Contractor and Project Engineer DWNP	Contractor and Project Engineer DWNP		Posters and pamphlets	Throughout the project	Contractor and Project Engineer.
Increased incidents of poaching due to improved access to previously remote and inaccessible areas.	**Objective:** To discourage poaching at all costs **Mitigations:** • Educate construction workers and operational staff about the impact of poaching • Anti poaching efforts to be intensified in collaboration with local authorities.	• No incidences of poaching reported. • Trained work force	Contractor and Project Engineer DWNP Police	Contractor and Project Engineer DWNP Police		Educational posters and pamphlets	Throughout the project	Contractor and Project Engineer
Reduced grazing resources for livestock and wildlife	**Objective:** To minimise clearance of land used for grazing livestock and wildlife. **Recommendation:** • 1. Disturbance of the ecosystem to be confined to the proposed TKR line corridor	• No clearance of vegetation in areas that are not going to be used for TKR construction activities.	Contractor and Project Engineer.	Contractor and Project Engineer		Managemen t Plans	Throughout the project	Contractor and Project Engineer.
Water Resources and Hydrology								
Negative impacts:								
Potential pollution of underground and	**Objective:** To avoid pollution of underground and surface water resources.	• No incidence of water pollution found in the vicinity of the Project site.	Contractor and Project Engineer.	Contractor and Project		Water quality monitoring	Throughout the project	Contractor and Project

Impact	Mitigation measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment/ Materials		
surface water resources.	**Mitigation:** • Clean up immediately any oil spillages. • All fuel lubricants must be stored in bunded areas or impervious surfaces. • Proper waste disposal methods to be applied. • Contractors' pit latrines should be lined to avoid contamination of ground water.	• Effective waste management practices in place	Dept of Water Affairs	Engineer / DWA.		kits		Engineer
Impact on Marine Ecology								
Impact of noise on aquatic birds and people during construction and	**Objective:** To reduce the impact of noise on aquatic birds. **Mitigation:** Control and monitor noise levels during construction	• Effective noise control measures in place.	Port Companies and Min of Health					Contractor / Project Engineer/ Railway Authorities

Figure 8-9: Operations Phase ESMP

Impact	Mitigation Measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment and Materials		
Environmental Issue								
Socio economy								
Positive Impacts:								
Improved transportations of goods and	**Objective**: To have efficient and affordable mode of transportation of	• No complaints about from customers and service users.	Ministry of Transport	Ministry of Transport staff		Educational materials/ Transport	Throughout the project	Min of Transport

Impact	Mitigation Measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment and Materials		
services	goods. **Enhancement** • Ensure that the locomotives are in perfect working conditions.	• No delays in the delivery of goods.						
Enhancement of local economy	**Objective**: To encourage growth of the local economy **Recommendations:** • Encourage potential investors to invest along the TKR corridor. • Efficient operation of WTP and available/ reliable water supply in both villages.	• The number of new businesses opened up along the TKR corridor. • The number of locals employed in the new businesses in both villages.	/ Department of Industry and Commerce / Dept of Labour	Staff from the identified department s		Brochures/ pamphlets and Employment Guidelines from Dept of Labour	Throughout the project	Min of Transport
Negative impacts:								
Transmission of diseases and spread of HIV/ AIDS during maintenance of the railway line and facilities.	**Objective**: To reduce the transmission and spread of HIV/AIDS infections. **Mitigation** • Sex education for both community and maintenance crew. • Issuing of condoms.	• Few cases of new diseases and HIV infections. • Number of seminars/ meetings held to educate the people.	District Health Units / NACA of Botswana	Social workers and local authority nurses		Educational posters/ pamphlets, condoms / transport	Throughout the project	KGDC Health Unit / NACA
Environmental Health								
Negative impacts:								
Improper solid waste disposal from railway stations	**Objective**: To avoid environmental pollution from improper solid waste disposal. **Mitigation:** • Put in place a proper waste management	• Proper waste management practice • Recycling and reuse of waste generated	District Health Unit/ Dept of Waste Management and Pollution Control	Staff from the District Health Unit / Dept of Sanitation and Waste Manageme		Brochures/ pamphlets and Employment Guidelines from Dept of Waste	Throughout the project	District Council staff

Impact	Mitigation Measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment and Materials		
	system. • Dispose waste in an environmental friendly manner			nt		Management and Pollution Control		
Occupational Health and Safety & Public Health								
Negative impacts:								
Air pollution from diesel engine locomotives	**Objective:** To minimise air pollution from the diesel engine locomotives. **Mitigation**: • Regular service of the locomotives • Use eco friendly fuels • Introduce electric engine locomotives. • Introduce electric trains	• Minimal air pollutants emitted into the atmosphere	Min of Transport/ National Environmental Laboratory	Staff from Min of Transport		Transport / relevant measuring equipment	Throughout the project	Min of Transport / National Environmental Laboratory
Land Use								
Negative impact:								
Change in land use	**Objective:** To manage and control change in land use **Mitigation:** • Ensure compatibility of land use within the TKR corridor.	• Change in land use managed properly.	Lands authorities in both countries.	Lands authorities in both countries		Transport and equipment	Once and as need arise	Lands authorities in both countries
Fauna (Animal Communities)								
Negative impacts:								
Increased animal mortality through accidents	**Objective:** To reduce incidents of accidents involving animals **Mitigations:** • Secure the railway servitude but provide animal corridors for potential migrations e.g. Underpasses.	• Reduced number of animal mortality reported	Railway management authorities	Railway management authority				Railway management authority

Impact	Mitigation Measure: objective and target	Key Performance Indicator (KPI)	Responsibility	Resources			Deadline	Sign off
				Personnel	Financial	Equipment and Materials		
Soil Erosion and its consequences	**Objective:** To reduce soil erosion at the project site **Mitigation:** • Contractor to construct storm water drainage system to control runoff. • Landscaping of the area • Dressing disturbed sites with top soil during rehabilitation and mulches to control water runoff	• Storm water drainage or control system constructed • Site landscaped • Disturbed areas dressed with top soil and mulched to control runoff	Railway management authorities	Staff from Min of Transport		Transport / equipment	Throughout the project	Railway management authorities
Impact of coal dust on marine ecology and people	**Objective:** To reduce the impact of coal dust on people and marine ecology **Mitigation:** Dust suppression systems in place.	• Reduced number of pollution cases reported.	Port companies/ Min of Health					Railway Authority Project Engineer

9 PPP Participation, Regulatory and Cross Border Aspects

9.1 Public Private Partnerships (PPP)

9.1.1 Introduction

746. The Terms of Reference provide that the Consultant identify requirements of a regulatory nature in Botswana and Namibia that would need to be in place to ensure the success of the project and maximise its development impact, including whether to provide for open access, interoperability, interconnection, and cross-border operation by a single operator.[8] This section focuses on the legal framework of the railway sector in both Botswana and Namibia.

747. The section also examines the public-private partnership (PPP) in both Botswana and Namibia although information on the latter is very limited. It further explores the various PPP options and outlines the advantages and disadvantages associated with each option. The section gives an outline of the railway concessions in Africa as well as port privatisation schemes, including the lessons to be learnt from each sector.

748. This section is also linked to Section 12 on Plan for Further Project Preparation which gives the Privatisation Action Plan with the project timeline.

9.1.2 PPP Defined

749. Public-Private Partnerships (PPP) are **one of the most attractive but also misunderstood and misused tools** being used to address developments, both infrastructure and efficiency, in the railway and port sectors. Their use is based on the recognition that both the public and private sectors can benefit by pooling their resources to improve the delivery of railway and port services. PPP Definitions in the context of Botswana PPP Framework and South African Law are given below.

> **PPP Defined:**
>
> Public-Private Partnership (PPP) describes a spectrum of possible relationships between public and private actors for the co-operative provision of infrastructure services. The PPP spectrum runs the gamut from the services being offered solely by the public sector to full privatisation (through divestiture of government assets).

750. The terms of the PPP arrangement are generally set forth in a concession agreement setting out the rights **and responsibilities** of the public and private partners. Three basic conditions of the concession agreement are: (1) ownership of the railways' and ports' infrastructure is retained by the government; (2) railway and port operations are performed as commercial activities at the concessionaire's risk; and (3) the concessionaire, with the agreement of the

[8] See section 5(i)(iii) of the Terms of Reference.

government, has flexibility to change tariffs, staff, or equipment according to market conditions.

751. Typically, concession arrangements are (a) a mixture of a strict concession in which the required investments are financed by the concessionaire; or (b) a franchise or leasing arrangement in which new investments are financed by the government. Railway concessioning differs from railway privatisation in that under a concession arrangement there usually is no sale of immoveable assets. In most cases, the concessionaire is given the option to purchase or lease the rolling stock and the government is then given the right of first refusal should the concessionaire decide to sell these movable assets before the end of the concession contract period.

752. While provisions of the concession can vary, in most cases the concessionaire will have the option of deciding what level, if any, of existing plus new railway and port equipment and staff it wishes to retain, subject to provisions to protect the "public interest".

753. PPP involves a **contract** between a public sector authority and a private party, in which **the private party provides a public service or project** and assumes substantial financial, technical and operational risk in the project.

754. **Agreement** between government and the private sector regarding the **provision of public services or infrastructure**. It is a means of bringing together social priorities with the managerial skills of the private sector, relieving government of the burden of large capital expenditure, and transferring the risk of cost overruns to the private sector

755. South African law defines a PPP as a **contract** between a public sector institution/municipality and a private party, in which the private party assumes substantial financial, technical and operational risk in the design, financing, building and operation of a **project**.

756. Botswana PPP Frame work defines that PPP involves a **contractual arrangement** between a governmental institution and a private party whereby the private sector party provides **public infrastructure and/or infrastructure related services**

9.1.3 Critical Challenges for Introducing PPP

757. Efforts to implement these partnerships face many challenges. **For the Governments of Botswana and Namibia**, the challenge is to find ways to fulfil its responsibility for providing access to competitively priced railway and port services, while recognizing the legitimacy and meeting the needs of private investors. This implies a new and often difficult transition for any government, from provider and manager of railway and port services, to enabler and regulator, a transition that requires a different mentality and skill set.

758. **For private firms**, the challenge is to be convinced that investing in any particular project offers more attractive returns than other available investment

opportunities, particularly in the challenging new global financial environment[9]. Drawing that conclusion depends on the firm's comparison of the potential returns against the potential risks, including both country risk (reflecting the general private investment framework established by government) and project risk (reflecting the specific characteristics of the investment opportunity offered by government).

759. Overcoming these challenges is further complicated, however, by a range of gaps in the capacity of both public and private actors. Major gaps include:

- Mistrust and lack of understanding of the reciprocal party's interests and needs;
- The absence of locally available information on, and experience with, arranging sustainable partnerships; and
- The underlying legal, political, social and institutional obstacles to forming public-private relationships.

760. These gaps often lead to lengthy negotiations and increased transaction costs. In addition, these conditions make smaller projects much less attractive to potential international and national investors.

9.1.4 Lessons Learnt

Forces Resisting Change

761. Initial resistance usually comes from employees who fear their jobs or security will be harmed. This valid concern needs to be assuaged through social safety net programs for employees. Related concerns include the selection process for retained employees, respect for their seniority, and retraining. Resistance from current management can be a concern. Of course, experience suggests that the better managers have little to fear from privatisation simply because the new railway will need them as much as the old one.

762. Competitors (especially trucking companies) are often a strong opponent of rail restructuring and private sector involvement. The reason is simple: it is better to have a financially weak, inefficient, and low quality rail competitor than an efficient market oriented railway and port network. The public in Botswana and Namibia must see the entire process as being transparent and equitable. It is after all their rail network. Should the assets be sold to private interests, the employees, private citizens and Botswana/Namibia businesses should have the opportunity to buy shares in the new venture.

763. The regulatory and legal environment should be "surprise free" and include:

- A well-defined mechanism to resolve disagreements and conduct contract renegotiations.

[9] See, inter alia, World Bank-ICA-PPIAF, Attracting Investors to African Public-Private Partnerships: A Project Preparation Guide (2009); Leighland, J. And H. Russell, "Another Lost Decade? Effects of the Financial Crisis on Project Finance for Infrastructure", GridLines: Note No. 48, June 2009 (available from PPIAF website); and, for a good private sector perspective, even though it is a little dated, Bombardier, "Implementing and Financing Transport & Infrastructure Projects: A Question of Fair Allocation of Risks", 2nd Middle East Rail Projects conference, September 2005.

- A formalised procedure to price services provided at government request (through Public Service Obligations-PSOs).
- Regulation by contract the influence of the free market. The concession agreement can serve as the de facto regulatory authority between state and concessionaire, defining the terms and conditions under which the Concessionaire may invest, maintain, and market services. In negative concessions, the agreement is even more important because it is the "purchase of services" contract (PSOs) between state and Concessionaire.
- Perhaps most critically a stable financial environment where dividends may be paid to residents and non-residents and some protection be afforded against foreign exchange fluctuations.

Obstacles to Private Investment in TKR

764. There are a few factors that inhibit private sector and foreign investment in privatisation projects in both Botswana and Namibia. The major factors include the following.

765. **Availability of Concessional Finance. .** In many cases concessional financing from donors and export credits is available to the Government and private investment appears to be considered as a last resort if other funds are not available. Although the level of both countries' risk is not that high, the perceived risk for Africa as a whole would weigh negatively on any investor's analysis of the investment environment.

766. **Investor fatigue.** Another obstacle to attracting railway operators to Botswana and Namibia lies in the fact that the actual number of qualified and financially stable investors is limited. Investment trend in railways in Africa has been fluctuating since 1990 as demonstrated below. The restricted pool of investors is faced with privatisation of several projects throughout Africa: Senegal, Mali, Ghana, Congo – Brazzaville, Zambia and Tanzania. Governments will have to overcome this challenge as the number of projects in the market continues to grow.

767. The following table shows the investment in rail projects with private sector participation in developing countries.

Figure 9-1: Private Participation Investment in Rail Projects (1990 – 2000)

Year	Investment (US $ million)
1990	833
1991	271
1992	1,000
1993	1,378
1994	670
1995	3,507
1996	6,555
1997	4,924
1998	3,445
1999	2,734
2000	1,121

Source: WB PPI Database.

Factors Favouring Private Investments in Botswana and Namibia

768. There are factors that are favourable to justifying investment in both countries. These are:

- **Image**. On international basis both countries are viewed as politically and economically very stable. These attributes are attractive to investors. The table below illustrates how both countries fair alongside some selected African countries.

Figure 9-2: Risk Analysis of Selected Southern African Countries

Country	Sovereign Risk	Economic Risk	Political Risk	Country Risk
Namibia	BBB[10]	BBB	BB	BBB
Botswana	BBB	BB	A	BBB
Angola	BB	B	B	B
South Africa	BBB	BB	BBB	BBB
Zambia	BB	B	BB	BB
Malawi	B	CC	B	B

Source: Economist Intelligence Unit, November 2010.

- **Corruption**. In 2010, Transparency International, which publishes an annual Corruption Perceptions Index, rated Botswana (5.8 out of 10) as the country within Sub Saharan Africa with the lowest levels of corruption and Namibia

[10] The ranking used above represent: (A – An obligor has **strong capacity** to meet its financial commitments but is somewhat more susceptible to the adverse effects of changes in circumstances and economic conditions than obligors in higher-rated categories; BBB – An obligor has **adequate capacity** to meet its financial commitments. However, adverse economic conditions or changing circumstances are more likely to lead to a weakened capacity of the obligor to meet its financial commitments; BB – An obligor is **less vulnerable** in the near term than other lower-rated obligors. However, it faces major ongoing uncertainties and exposure to adverse business, financial, or economic conditions which could lead to the obligor's inadequate capacity to meet its financial commitments; CC – An obligor is **currently highly-vulnerable**.)

(4.4 out of 10) was rated as the second least corrupt country. Within the region other countries had the following scores: South Africa 4.4; Angola 1.9; Malawi 3.4; Mozambique 2.7; Zambia 3.0; and Zimbabwe 2.4. Worldwide, Sweden and Finland had the highest scores of 9.2.

- **Risk**. According to the Economist Intelligence Unit as indicated above, Botswana has a Country Risk Score of BBB and Namibia BBB which portends good investment climate. These scores are based on risks such as political risk, market risk and foreign exchange risk.
- **Growing Economies.** Both Botswana and Namibia have growing economies, especially in the mining sectors. The growing economy is likely to continue providing a growing demand for consumer goods and for industrial production.
- **Public Procurement Procedures**. Both countries have had significant reforms in public procurement practices.

9.2 Overview of Africa Railways

769. With few exceptions, the railways in Africa have fallen on hard times, with track in bad condition, many locomotives out of service (locomotive availability ratios below 50%), and freight and passenger traffic locked in a downward spiral. With deficits and government subsidies high and growing, and public funds limited, there was little reason to believe that much could be done about the *railway problem* in Africa. Within the SADC region the picture is less gloomy with South Africa leading the way in terms of having a viable railway system.

9.3 Railway Privatisation in Africa

770. International donors have been assisting African railways since the 1950s in an effort to improve their operations and financial condition. Until 1980, these efforts focused primarily on providing training and capital investments, including locomotives, track rehabilitation and spare parts. The results were often disappointing. Most African railways continued to lose traffic to road haulers and incur annual deficits that required state subsidies.

771. As the traffic levels, financial condition, and operational performance of the railways continued to deteriorate with poor availability and utilisation of locomotives and rolling stock, many African governments sought external assistance to restructure their railways to reverse the decline. Competition from the mostly private trucking sector in these countries highlighted the railways' problems and indicated the importance of market-driven business operations.

772. Since the late 1980s and early 1990s, however, the emphasis pursued by multilateral and bilateral donors shifted toward institutional reform to improve the operational efficiency of the railways. Most of these railways were government owned parastatals characterised by poor service, limited tariff flexibility, and surplus staff.

773. The new strategy tried to lessen the dependency of the railways on state subsidies and establish the railways as autonomous commercial enterprises

through "restructuring". These initial efforts to restructure African railways into becoming commercially viable transportation enterprises were met with mixed success. The restructuring initiatives were often too timid and incremental. The Governments found it difficult to act as shareholders and ensure commercially sound behaviour. The railways found it either too difficult or impossible to shed excess staff and unprofitable operations.

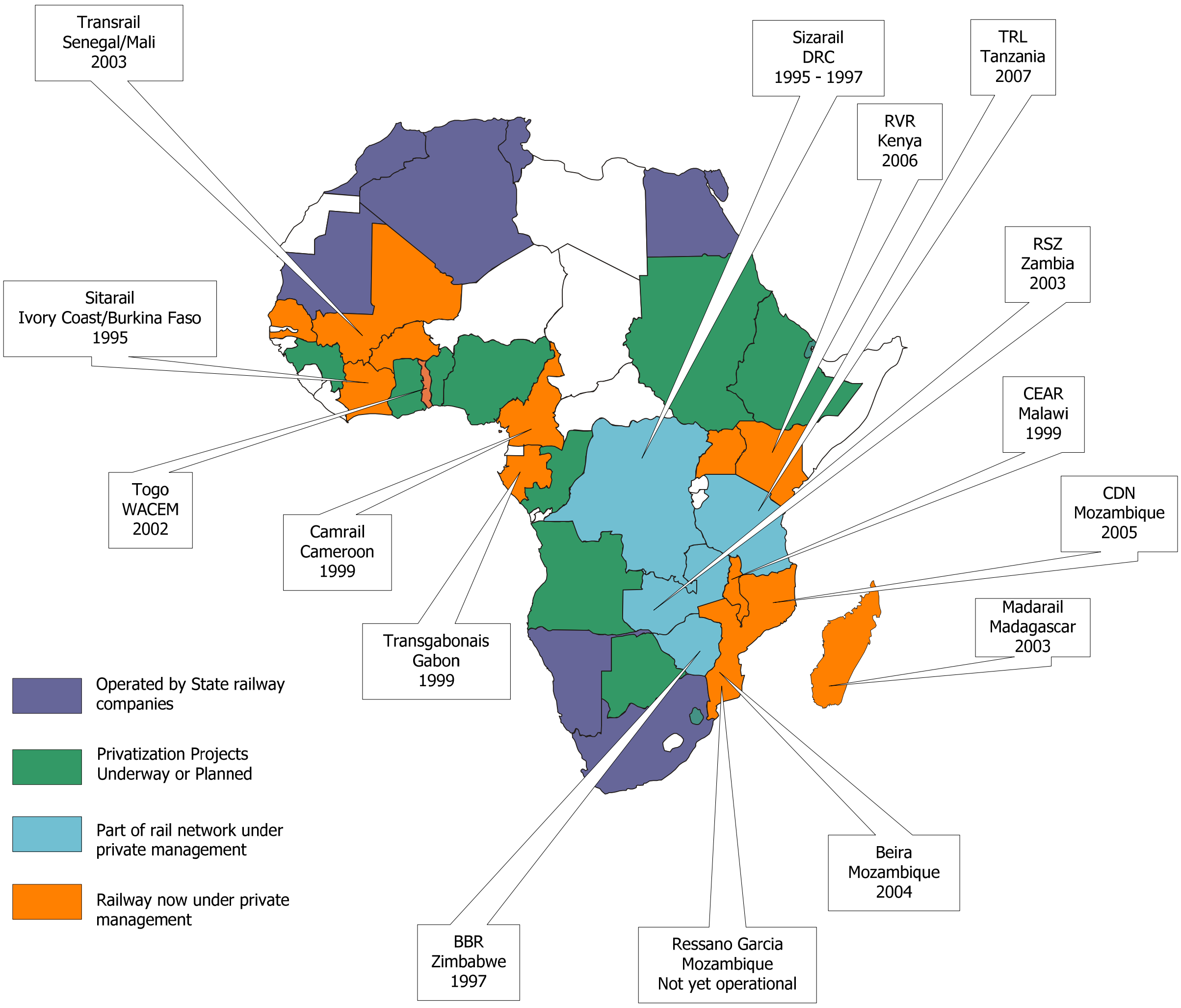
774. These problems fostered new approaches to railway restructuring. Current World Bank and donor efforts for revitalising African railways are now focusing on public-private partnerships (mostly through concessioning). Figure 9-3 below presents key indicators of select African railways that have been privatised, are undergoing privatisation or are being considered for privatisation. Figure 9-3 shows the countries concerned in Sub Saharan Africa and the dates on which privatisation took effect.

Figure 9-3: Comparative African Railway Statistics

Description	Nigeria	Ivory Cost / Burkina Faso	Kenya	Mozambique	South Africa	Tanzania	Uganda	Zambia	Zimbabwe
Major Gauge (mm)	1,067; 1435	1,067	1,000	1,067	1,067	1,000	1,000	1,067	1,067
Route Length (km)	3,557	1,167	3,034	2,988	21,303	2,982	1,241	1,273	2,759
Locomotives	165	20	243	171	3,845	113	73	60	316
Diesel	-	-	243	111	1,479	113	73	60	206
Electric	-	-	-	-	2,235	-	-	-	30
Freight (000 tons)	110	876	3,086	400	162,000	1,000	Unknown	3,450	14,377
Ton-kms. (million)	52	523	772	400	93,020	660	74	1,074	5,384
Passenger (000)	2,600	300	2,414	6,800	3,500	2,500	Unknown	1,134	2,100
Pass. Kms (million)	479	126	674	183	1,205	1,194	172	326	571

Source: World Bank Railway Database – latest year available

Figure 9-4: Railway Concessions Awarded in Africa since 1990



775. While it would be satisfying to think that this shift in approach was the product of years of careful reflection upon the railway problem, the reality is that economic crises forced the reform agenda. Most Government's were no longer able to pay their railway losses. Far from being able to afford continuing financial drains, national treasuries wanted to bring some money in for a change, not pay it out, and they looked to private sector involvement as a way to reverse (or at least stem) the outflow. Many of the governments also recognised that the massive losses were due to inefficiency and poor response to competition (loss of market share), neither of which seemed particularly deserving of public support. The political rationale for rail subsidies was further undermined by the inevitably poor service of capital starved public sector enterprises.

776. Other forces that have acted as drivers for reform of the railway problem include:

- Growth of competition from trucks, automobiles, barges and airlines.
- Railways can help to address pollution and energy consumption problems that tend to be aggravated by an increasing reliance on road transport.
- Growing need to provide economic transport to individuals who need mobility, but cannot afford automobiles and air transport.
- Economic development hinges on access to markets outside their borders. Countries which lack effective linkages with the world will suffer.

777. Since 1993, there have been at about fifteen rail concessions in Africa, with some in progress. Two of these have been cancelled, one has been badly affected by war and one has suffered from natural disasters and procedural delays. Four have operated for five years or more but only one of these without a significant dislocation of some sort.[11]

9.4 Ports Privatisation in Africa

778. Over the past two decades, there have been in excess of 200 transactions in the port sector in developing countries, including Africa. The transactions have ranged from "Greenfield" development of port facilities, outright divestitures, management or lease contracts and concessions. These 200 transactions have resulted in over $20 billion worth of investments in the port sector, in addition to an influx of private sector management expertise, efficiency and profit orientation.

779. The intervention of the private sector in the port sector across the developing world can be considered a successful Work in Progress. Although in some instances privatisation has fallen short of expectations (such as in Ghana, where admittedly privatisation has taken an unusual hybrid format), results have been overwhelming, (such as in Colombia or Nigeria) and most Port Authorities and Governments in developing nations are in agreement on the net benefit of private sector participation in the port sector.

780. This sub-section presents a brief overview of the introduction of private sector participation initiatives in the port sector in Nigeria, Ghana, Tanzania and Israel.

9.4.1 Nigeria

781. The Federal Government of Nigeria (FGN) concessioned its port terminals and facilities through a privatisation process that commenced in 2004 and was concluded in 2006. The concessioning was a consequence of a decision of the Federal Government to reform the Nigerian Port Authority (NPA) from the service port model into a landlord port. Previous to the reforms, the Nigerian ports were characterised by a high degree of inefficiency, theft, corruption and public sector subsidization. Figure 9-5 presents some key indicators of port performance (at the Container Terminal) pre and post concessioning.

Figure 9-5: Nigerian Port Performance Indicators, Pre- and Post-Concessioning

Performance Indicator	Pre-Concession	Post-Concession
Average time at anchorage	20 + days	1.5 days
Berth productivity	9 moves per hour	17 moves per hour
Dwell time (Direct Delivery)	31 days	22 days

Source: Nigerian Port Authority

782. Since the concessioning at the Nigerian ports, there has been a dramatic improvement in port services, with cargo clearing times falling significantly from their pre-concession levels. The only problems outstanding at the Nigerian ports have to do with the continued non-performance/interference of the public sector

[11] See Richard Bullock, *Results of Railway Privatisation in Africa* (The World Bank, Washington DC, 2005)

bodies at the ports. For instance, the Nigerian Customs still works a five-day work week whereas the terminal operators operate 24 hours a day and seven days a week.

783. The Nigeria ports' concessioning is considered one of the most successful port transactions in Africa. In one transaction alone, the Apapa Container Terminal Transaction, the Federal Government of Nigeria realised $1 billion in upfront concession fees paid by the selected terminal operator (paid in two instalments). In addition, many of the terminal operators in the other 24 transactions have invested significant sums into the Nigeria ports infrastructure including investments to attain ISO certification at port facilities.

784. The concession framework also allows the Port Authority to regulate the port concessions in the interest of consumers. Port tariffs, performance levels and other critical aspects of the concession are regulated through the concession agreements. This has enabled the ongoing success of the concessions despite the lack of a transport sector regulator in Nigeria.

9.4.2 Ghana

785. Ghana has adopted a tentative approach in its private sector participation policy for the port sector, and as such has not embarked on the full scale privatisation observed in Nigeria. Nevertheless, Ghana began introducing private sector participation in its port sector as far back as the early 1970s. Back then, the Port Authority allocated 25 percent of break bulk cargo handling activities to a private firm. This was to be followed a few years later with the appointment of another private stevedore to handle 10 percent of break bulk cargo stevedoring services. By 2007, 9 private stevedoring companies had been established and were handling 75 percent of break bulk cargo stevedoring for the Port Authority. Each firm was allocated 8.33 percent of the cargo.

786. Container traffic stevedoring, since 2007, has been handled by a private Container Terminal Operator. The terminal operator is set-up as a joint venture between the Port Authority and a private sector firm. The Port Authority has a 30 percent stake in the Container Terminal firm. All cargo handling, however, is carried out by the private employees of the terminal operator.

787. The impact of the private sector participation initiatives implemented at the Ghana Ports has been mixed. Whereas port performance has improved dramatically for container handling, general and bulk cargo handling is still below expectations. Figure 9-6 shows the performance achievements for the Port for containerised, general and bulk cargo.

Figure 9-6: Ghana Port Performance Indicators, Pre- and Post-Concessioning

Activity	GPHA Performance	Private Operator Performance	Internationally accepted standard
Container handling	300 movies per ship day	600 moves per ship day	1,200 moves per ship day
Conventional cargo handling	50 tonnes per ship hour at berth	80 tonnes per ship hour at berth	150 tonnes per ship hour per berth
Dry bulk handling	150 tonnes per ship hour at berth	250 tonnes per ship hour at berth	600 tonnes per ship hour at berth

Source: Ghana Ports and Harbours Authority

788. A study commissioned by the Ghana Ports and Harbours Authority (GPHA) in 2006 suggested that the lacklustre performance of private stevedores was because of the quota system in allocating traffic. Each of the nine licensed stevedores is essentially guaranteed 8.33 percent of non-containerized cargo, irrespective of the level of performance. This practice has virtually eliminated the need for any of the operators to be efficient or improve their productivity.

789. In 2006, the GPHA initiated a public tender for the development of a Container Freight Station at the Port of Tema. The CFS was to have been developed on a BOT basis. However, the preferred bidders for the project could not raise the funding required for the project, and the Port Authority had to take over the project and finance its development.

9.4.3 Tanzania

790. The container terminal at Dar es Salaam, Tanzania, was privatised in 2000. Since then it has transformed itself from one of the least efficient container ports to the most efficient container port in East Africa. In fact, its success has eventually worked against it, since the additional traffic the improved efficiency has attracted has led to congestion at the approaches to the port, and to overcrowding of the container stacking yard – much like the present case at Mombasa. As a result, the Tanzanian Ports Authority is now embarking on the development of a new container terminal that will at least double the port's existing capacity. This new terminal will be developed and operated as a BOT concession.

9.4.4 Israel

791. Israel's Shipping and Port Authority Act of 2004 introduced a new port management structure with the objective of introducing more competition in the country's port sector. The existing Israel Ports Authority, owner and operator of Israel's three commercial ports, was disbanded and various new port authorities were established. The main elements of the new law included:

- All Israel port authority assets were returned to the government (including ownership of port land, financial assets, equipment, materials, and superstructure).
- All existing employees were transferred to newly created government companies (see below), with existing salary and working conditions guaranteed.

- Port property rights were transferred to the Israel Ports Company (100 percent owned by the government), which would lease or concession port land to port operators while the legal ownership remains with the government.
- All movable assets, facilities, outstanding obligations and liabilities were transferred to the appropriate companies in the various ports.

792. The new government-owned (limited liability) port operating companies, one for each port (Haifa, Ashdod, and Eilat), were tasked with the management of the existing terminals as well as the maritime services, including traffic control, pilotage, and towage.

793. The law also created a Shipping and Port Authority as a governmental unit within the Transport Ministry. Its responsibilities include advising the minister on port service levels, infrastructure planning and development, systems and port facilities and the drafting of port regulations.

794. In addition to the above, the legislation and subsequent ministerial regulations created the position of port manager with harbourmaster's responsibilities such as vessel traffic control, port clearance, aids to navigation, and marine works.

795. An analysis of this port management structure by the World Bank has concluded that:

- The various port companies in Haifa, Ashdod, and Eilat are virtually monopolists within their respective port areas, and in practice they will allow only limited intra-port competition.
- The development of the ports still is a national issue under the Israel Ports Company, which acts as a national landlord.
- The port companies are also responsible for marine operations, which may give rise to a conflict of interest in the event that more intra-port competition is allowed in the future.
- The functioning of the port manager is highly impaired as the marine department's activities are part of the respective port companies.
- The entire structure will generate many competence problems.
- Fair competition within this structure is limited.

9.4.5 Lessons Learnt from Past Port Privatisation

796. A major lesson learned in port privatisations is the need for transparency and open competition through a structured international tendering process. Many examples can be given of attempted port privatisations that have bogged down due to legal challenges to the selection of the company to be awarded a concession contract. Some of these are described in the following paragraphs:

797. Montevideo, Uruguay is a prominent example of how things can go wrong in a privatisation process. Attempts at privatizing a container terminal at the port had failed four times due to court challenges before a successful round was completed. At a later stage, the government announced plans to auction off the terminal on the stock market.

798. The Malaysian experience at Port Klang has shown that the failure to have an adequate legal framework in place prior to the privatisation effort can impose substantial delays as legislators debate legislative actions to facilitate the privatisation process.

799. The continuing refusal of the Sri Lankan government to corporatize or privatise its publicly owned container terminal in Colombo has delayed the necessary port expansion for years.

800. Colombia's failure to properly define anti-competitive behaviour before entering into a privatisation agreement has led to the need for the regulator to constantly solicit legal opinions before intervening.

801. In many countries, the broad regulatory framework may not adequately support a private sector arrangement. Private sector ownership of port assets may be prohibited by the legal system. Tariff setting responsibility may reside within an operating port authority that would compete with the private operator. But governments can make private sector participation in ports work by allowing tariff flexibility in the concessioning agreements with private operators.

802. Conflicts and legal challenges can be minimised by clearly presenting the bidding rules and selection process in the bid documents. Criteria to be used for selecting the successful bidder should be stated and a pro forma contract provided with the bid documents so that everyone is competing for the same contract. The role of the port administration after the privatisation and any limits on the contractor's ability to operate should be stated in the bid package. Bidders should be requested to provide a business plan that will become part of the final contract. The bidders should be requested to state quantifiable targets for productivity gains and market development. This business plan should be accorded significant weighting in the selection process. Incentives and penalties should be provided in the contract should there be a significant deviation from targets in the business plan.

803. It is important to develop beforehand a well-reasoned plan for transitioning to private operation and have a clear understanding of how the port will function after the various port services are privatized. A number of important questions should be addressed:

- How much management and operational autonomy will be granted to the private operators?
- What will be the role of the port authority in regulating the rates and practices of private operators in the port?
- Who will be responsible for common area maintenance and upgrades, and how will the cost of these activities be recovered from port users?
- Will the port continue to have a marketing and planning function after privatisation, or will this be left to the individual service providers?
- What resources will be required to carry out the functions that remain with the port authority?
- What type of retraining program and severance package will be created to address the issue of redundant personnel?

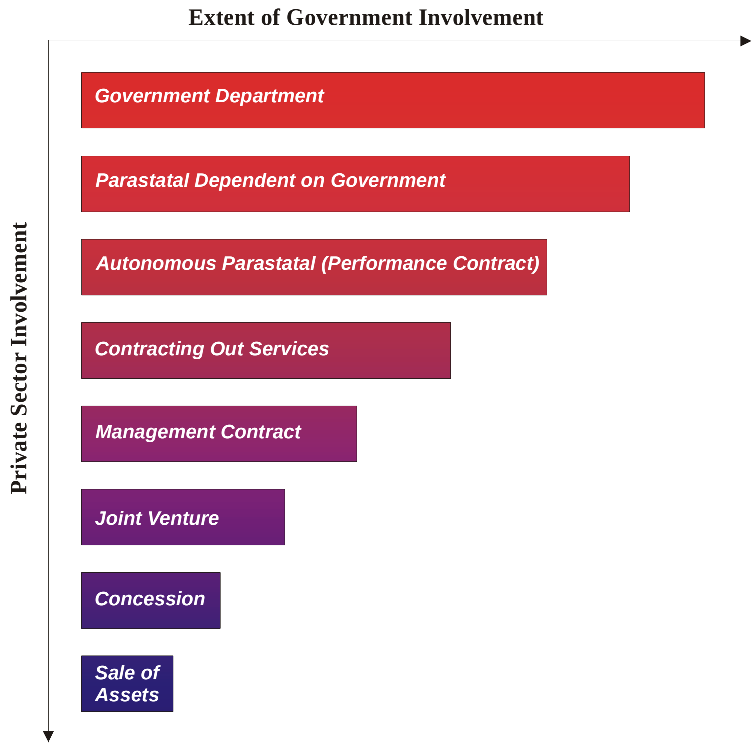
9.5 Options for Introducing Private Sector Participation for the TKR

804. The Governments of Botswana and Namibia have several options at their disposal to further develop their railway and port sectors. There is a continuum of options for involving the private sector in the provision of infrastructure services, as illustrated by Figure 9-7 below.

805. In the middle of the spectrum are supply and service contracts, which tend to be of short duration and require less private commitment than the options higher up in the continuum. The private contractor is not directly responsible for providing the service, but instead for performing specified tasks, such as supplying inputs, constructing works, maintaining facilities, or billing customers. In this first category, private sector involvement is highest in management contracts.

806. At the other end of the spectrum lies the sale of assets. This divestiture of assets involves transferring ownership of existing assets and responsibility for future expansion and upkeep to the private sector.

Figure 9-7: The Continuum of Privatisation / Restructuring Options



807. The full range of options is explored below.

9.5.1 Restructuring / Commercialisation

808. Restructuring/commercialisation is defined as the process of transforming troubled state-owned transport organisations into stand-alone (financially self-sufficient) enterprises operating on commercial principles (even though the government may retain ownership). This activity has been led by the World Bank in collaboration with USAID, CIDA, and other donor agencies.

809. The principle behind restructuring is that a railway or port terminal should, as should other transport enterprises, be able to operate as commercial enterprises. They should also be able to finance their operations and capital assets replacement without subsidies from their national governments or grants from donors. Subsidies should only be necessary if national governments insist on the railways or other transport enterprises carrying uneconomical traffic (i.e. passenger traffic or government freight).

810. This public control can be devolved in several areas through outsourcing certain services such as locomotive maintenance, coach washing, and security. The most significant reform is the introduction of a management contract.

811. A **management contract** provides for the day-to-day management function of the railway to be placed in the hands of a private contractor/ manager for a limited duration (typically 1-3 years). Management contract payments are normally made on a monthly period for a fixed amount for the services rendered. Payment often includes a bonus for reaching set targets or a percentage of revenue or profit.

812. The **advantages** of this type of arrangement for Botswana and Namibia are:

- Opportunity to introduce new management skills/techniques/culture.
- Can be highly effective as a transitional arrangement during restructuring and/or prior to privatisation.

813. The **disadvantages** for this arrangement for Botswana and Namibia Railways/Ports Authority are:

- Does not guarantee to eliminate or reduce public sector financial obligations.
- Does not ease investment in railways and ports.
- Does not transfer any risk from Government(s) to contractor and generally provides limited incentive to ensure the organisation's increased performance.
- Does not reduce the potential for undue government interference, particularly in staffing and financial decisions.

9.5.2 Public Private Partnerships for Rail and Ports

814. The trend in Africa and elsewhere is for Railways and Ports to explore partnerships between governments and the private sector. The most common partnerships have been concessions or franchises.

Concessioning

815. Concessioning is defined as the outcome of reaching an agreement between two contracting parties (the national Government and the private operator or concessionaire) to transfer railway and port operations to a private operator. . The concession agreement provides the exclusive (or non-exclusive) right to operate on track, (normally 20+ years duration, plus optional renewal) involving the purchase or lease of movable assets. .

816. The other key features of this arrangement include:

- Government retains ownership of infrastructure assets, such as buildings, land and permanent way. Movable equipment such as wagons and locomotives can be sold or leased to the concessionaire.
- Concessionaire normally has responsibility for management and regular maintenance of all fixed assets.
- Payment normally consists of a combination of initial lump sum, an annual lease payment and an annual fee based on revenue or profit levels.
- All regulatory issues can be contained in the Concession Agreement.

Privatisation of Malawi Railways

- First privatised railways in Anglophone Africa
- 797 km of main line track with freight and passenger traffic serving port of Nacala in Mozambique privatised
- In November 1999, GOM concluded a 20-year concession agreement with SDCN Consortium which includes the Railroad Development Corporation of Pittsburgh, USA.

817. A well designed concession agreement is central to the implementation of any of the various BOT schemes, and many of the disadvantages noted above may be mitigated by judicial design of the agreement. The roles of the concessionaire and the rail/port authority must be clearly delineated. BOT schemes typically work best when the assets under consideration can be separated and operated as a separate commercial enterprise. These include: fairways and channels, terminals, entire port complexes (master concessions) etc for ports, and the fixed infrastructure for the railways.

818. Concessions may be packaged with financing schemes such as Build Own Operate (BOO), Build Operate Transfer (BOT), Build Own Operate Transfer (BOOT), Build Transfer Operate (BTO) and other variations of the concept. The major variations are described in the following paragraphs:

Build Own Operate

819. The Build Own Operate scheme is a specialised form of concession designed to increase private financial participation in the creation of port infrastructure. It generally applies to Greenfield (new) terminals. Specifically, a BOO concession involves a private investor owning, financing, designing and constructing the terminal. The investor would then operate the railway line and port terminal. The unique features of a BOO concession are:

- The concessionaire owns the railway infrastructure and port terminal; and
- A BOO concession does not have a fixed term since the concessionaire has permanent ownership of the terminal.

Build Operate Transfer

820. The BOT has some similarities to the BOO arrangement, including the concessionaire financing, designing and constructing the terminal. The concessionaire would then operate the terminal for a fixed period of time (usually in the order of 20 to 30 years), after which the terminal would be handed over to the port authority. Throughout the concession, the land on which the terminal and

railway infrastructure sits would remain the property of the port and railway authorities.

821. A variant of this option is a Build, Transfer, Operate (BTO), in which the terminal would be transferred to the port authority immediately following completion of construction, after which the concessionaire would continue to operate the terminal for the term of the concession. BTO schemes are necessary in countries where legal structures do not permit private ownership of main port and railway infrastructure.

Build Own Operate Transfer

822. This type of concession could be viewed as a compromise between the BOT and BOO arrangements. As in the two previous arrangements, the private sector finances, designs and constructs the terminal/tracks. Also, as in the case of the BOT type of concession, the contract has a fixed term. The similarity to the BOO arrangement lies in the fact that the land on which the terminal sits is transferred to the concessionaire, who would have ownership rights, restricted only by the terms of the concession agreement. The essential difference represented by the BOOT option is that at the end of the concession term the terminal or track would be transferred back to the port authority at a pre-agreed price as well as the railway infrastructure.

General – Equipment

823. It should be noted that in all of the above options, with the exception of the Management Contract, the operator would be required to provide its own equipment. The manner of disposal of this equipment at the end of the agreement is normally a key condition of the contract between the port and railway authorities and the operator (s).

824. The **Advantages** of this option for Botswana and Namibia Railways/Ports Authority are**:**

- Provides opportunity for long-term private investment to improve productivity, in accordance with length of concession period.
- Better and efficient port management and operations performed by private operator.
- Application of private capital to socially and economically desirable projects, freeing up government funds for other priority projects.
- Under certain conditions, the creation of new revenue streams for government
- The transfer of risk for finance, construction and operation of a port facility to the private sector.
- The attraction and the use of foreign investment and technology.
- Opportunity to free Governments of Botswana and Namibia from responsibility for capital investment during concession agreement period – while keeping role of ensure adequate infrastructure maintenance.
- Integrated concession can increase value to prospective concessionaire due to preservation of network benefits.

- Opportunity for Governments of Botswana and Namibia to benefit from improvements to rail service by tying its revenues from the concession to traffic, revenue and profit levels.

825. The **Disadvantages** of this option for Botswana and Namibia Railways/Ports Authority:

- Can be challenging to resolve question of further investment in rail infrastructure after concessionaire's initial investments. This would depend on duration and flexibility of concession length.
- Governments of Botswana and Namibia would lose direct control of railway. Commercial markets would direct development of railway services and infrastructure development; however, concession agreement could potentially contain relevant conditions.

Open Access Overview (Multiple Train Operators)

826. This is another form of concession arrangement and consists of the railway being divided vertically into different functions (usually operations, maintenance and infrastructure) and each function can be concessioned to the private sector.

827. The key characteristics include:

- The separation of infrastructure and operations allows the creation of multiple operators who share the use of the track.
- Establishment of a track/infrastructure authority mandated with ownership and maintenance responsibility for track. . Non-exclusive franchises to operate freight and passenger trains over the railway are granted to multiple operators.
- The infrastructure and operating units can be sold outright or privatised through a medium or long-term concession.

828. The **Advantages** to both Governments are:

- Opportunity to introduce competitive rail operators, where transport competition does not exist. In Botswana and Namibia, significant truck competition and lack of natural rail monopoly reduces this as an advantage.
- Opportunity for unbundling of rail business to enable greater variety of owners/operators and greater local involvement.

829. The **Disadvantages** of this option for both Governments are:

- Significant regulatory involvement required by Governments of both Botswana and Namibia with respect to relationship between track authority and operators, to prevent infrastructure organisation from simply passing on its costs to operators and engaging in monopoly practices.
- Unattractive to potential operators due to increased competition, and because their interests are adverse to track authority.
- The operator of the infrastructure will be exposed to a considerable risk, namely the ability or lack of ability of the individual operators to operate

successfully and to pay the high fixed cost of maintaining the infrastructure. A viable long term open access policy will require the individual operators to pay the full cost of the equipment that they use and the full cost plus an adequate return on capital to the operators of the infrastructure.

- Requires complex regulations and sophisticated objective management.

9.6 Detailed Open Access Analysis

830. As interest has been shown in exploring the Open Access option by the Joint Technical Committee further analysis of this option is given below.

9.6.1 Definitions

831. Traditionally railways have functioned as vertically integrated organisations. That is to say that the railway is both the owner of the infrastructure and the operator of the trains that run over the network. Towards the end of the last century, an alternative model developed, that is vertical separation, whereby railway infrastructure was provided by one organisation, while train operations were provided by a separate organisation or organisations. Separation can begin with merely keeping the accounts for infrastructure and operations separate but it can extend to having different entities own, provide and control the infrastructure, and an entirely independent set of operators. Vertical separation often goes hand in hand with open access. The rationale for separation is to allow "on-rail competition", i.e. multiple operators offering services over the same track.

9.6.2 Rationale for Vertical Separation and Open Access

832. There are several reasons for the separation of infrastructure from operations. The first is to reduce costs. The more traffic a line carries, the lower is the unit cost. The infrastructure provider can allow a new operator on a line for a fee higher than its cost but lower than what it would cost the operator to provide its own infrastructure facilities.

833. Another reason is to create intra-rail competition. Structural separation may be used to facilitate greater competition:

- Between train operators and other modes.
- Between train operators for the same customer.
- This may be necessary to regulate the natural monopolistic elements of an operator who has control of the infrastructure.

9.6.3 How Could An Open Access Regime Work for the TKR?

834. There are several different models for structuring an open access regime. The following is only one possible model.

835. **Track infrastructure would be owned by the governments of Botswana and Namibia.** The governments would have no role in day to day operations, but might be required to subsidise the maintenance and improvements to the track infrastructure, if access fees are insufficient to cover these costs.

836. **Track infrastructure would be maintained and managed by a separate bi-national entity.** An entity owned by the governments of Botswana and Namibia would be responsible for maintaining track infrastructure. This entity may be publicly or privately owned. In addition to maintaining the track, the infrastructure manager would also be responsible for setting/negotiating access fees paid by operators, allocating track access slots, and coordinating and dispatching trains.

837. **Freight could be carried by a number of carriers.** Multiple entities could compete for customers in the railway catchment area. These operators would have to meet the entry requirements that would be set out by a Regulator, and negotiate rail slots and access fees with the TKR track company. Within the open access regime, new entrants could enter the system, upon being granted access through application to the Regulator and satisfying safety criteria.

838. **A Rail Regulator would be established.** This is required because track infrastructure will remain a natural monopoly. Anyone wanting to run rail service between a particular pair of points is faced with a single provider of infrastructure. Therefore the pricing of, and access to, infrastructure will need to be regulated. The regulator would grant entry to new operators, approve or set access charges and arbitrate any disputes between the infrastructure manager and operators, and between the operators.

839. The regulator must have the authority to make quick and firm decisions on poor performance by operators and ensure non-discriminatory access to slots. The regulator may also be required to set priority with respect to accessing the rail network. An independent regulatory authority is a prerequisite before any new operators will enter the market. The issue of safety and other operational standards would also have to be dealt with at the outset so that all parties were aware of the rules of the game.

840. **The two governments would receive payments but also be liable for shortfalls**. A formula would be required to allocate revenues between the two countries. Access fees would need to cover: (i) contribution to fixed costs; (ii) payment for new capital for new investments; (iii) return on invested capital; and (iv) increased operating costs incurred as a result of new entrants. The pricing of track access is a vital element in determining whether open access can actually work. Access fees typically include a variable charge (e.g. per train-km), intended to recoup the cost of an additional train on the route, and a fixed annual charge, intended to recoup the infrastructure company's fixed costs. Note that even if access charges are structured so as to cover the costs mentioned above, these fees may be too high, discouraging new entrants and limiting competition. If access charges are non compensatory, the two governments would have to make up the shortfall, or face problems caused by inadequate maintenance.

841. In terms of the train operations the section on railways (Section 5.1.5) briefly outlines the allowances made for an Open Access system to.

9.6.4 Impact of an Open Access Regime

842. The introduction of an open access regime is likely to have the following positive and negative impacts.

Possible Positive Impacts

- Shippers wishing to use the TKR could have alternative railway carriers to choose from in moving their products to market and would not be "captive" to the monopoly rents extracted by a single operator.
- Some shippers currently using road haulage services may be encouraged to switch to rail, as they will benefit from competitive pricing and other service incentives.
- Some shippers with significant traffic volumes may decide to enter the market, either by directly operating services or contracting with a third party.
- Barriers to entry and exit in rail transport services would be dramatically reduced, as the high fixed costs associated with infrastructure would be the responsibility of another body, as is the case with trucks operating on publicly funded roads.
- The separated structure, with competition in rail service, would mean that policy makers would only need to regulate where the market does not provide competition – in track infrastructure.

Possible Negative Impacts/Risks

- The threat of competition would reduce the value of the operation to potential investors in the railway, as compared to the option of a unified concession.
- It is possible that freight operators will engage in "cherry picking", competing for the most attractive customers and providing inadequate service for smaller customers.
- Access fees charged by the track infrastructure provider may not cover all costs, particularly later on when the track infrastructure requires cyclical capital renewal. The infrastructure manager would need to have a good understanding of railway economics to set access fees in such a way as to balance the needs of the various stakeholders.
- It is difficult to align the interests of the operators and the infrastructure provider, who is largely driven by a need to reduce expenses, often at the expense of maintenance.
- The provision of some innovative and market-responsive services by train operators may require specific investment in infrastructure which the track manager may be unwilling to provide.
- Open access could result in transparency and fragmentation problems owing to bureaucratic administration and complicated information requirements, as has occurred both in Australia and the UK.
- There may be coordination problems between the infrastructure manager responsible for dispatching and scheduling, and train operators.

9.6.5 Outright Sale of Business (Full Privatisation)

843. All assets of Botswana and Namibia Railways and Namport, including the infrastructure, land, building and equipment would be sold through public listing or through sale to a group of investors or single investor.

844. Other key features of this option include:

- Surplus (non-core) assets may be separated prior to sale.
- Safety and environmental issues regulated by an authority that is established independently from Government.
- Payment normally in one lump sum.

845. The **Advantage** of this option for the railway and port operators of both Botswana and Namibia are:

- Opportunity for both Governments to divest of the Botswana and Namibia Railways and Ports will result in elimination of all future financial obligations.

846. The **Disadvantages** of this option for the railways and ports operators of both Botswana and Namibia are:

- Requires substantial political will and support.
- Results in significant loss of public control over rail infrastructure development.
- Legal impediments to transfer of title may exist, significantly slowing down implementation.

847. Totally private railways have been the exception. In fact, until the end of the 1980s, the U.S. freight railways and the Canadian Pacific railway in Canada were the only major privately owned and operated railways in the world. Though the spectrum range from wholly public to wholly private, experience shows that the ownership decision is not an either/or matter. Mixtures of ownership are quite possible and, in many cases, may be the best approach.

848. As each of the options has different advantages and disadvantages a full analysis would require a clear set of objectives and evaluation criteria from the Governments of Botswana and Namibia. These criteria have not been defined up to now and thus limit our analysis. If the criteria are an efficient transport system, maximum return to the Governments of Botswana and Namibia, and ease of implementation and ongoing regulation, then the best option is a long-term unitary concession. This is the option that has been selected by most of the governments in Africa and Latin America which have privatised railways similar to the proposed TKR.

849. In terms of Port Terminal the other PPP options available are:

9.6.6 Outsourcing and Management Contracts

850. These are typically used as interim measures to improve the management of a publicly owned port or terminal, while a longer term PPP option is introduced. Management Contracts do not resolve the issue of the need for investment to improve terminal efficiency because under Management Contracts, funding of investments remains the responsibility of the public sector. Hence, a Management Contract is not a viable long term option for the Container Terminal. It should be noted that this option was attempted at the Mombasa Container Terminal (MCT) in the 1990s but without success mainly for the reasons suggested above.

851. In general, outsourcing and management contracts are primarily a tool to improve the efficiencies of entire ports, rather than individual terminals.

852. The major benefit arising from outsourcing and management contracts is that they require private sector bidders to employ the existing staff of the public corporation. This would tend to reduce the potential labour problems associated with most forms of privatisation, although it is generally on this point that such contracts run into difficulties, since the management company has little flexibility to manage its human resources efficiently. Other benefits associated with outsourcing and management contracts are:

- They allow the Government to introduce Public/Private Participation (PPP) in sectors that were previously the exclusive domain of the public sector at a pace that may be more acceptable to the general public.
- The limited duration of such contracts allows the Government to revise its strategy in case the policy is a failure.

853. In contrast to the above, points opposed to outsourcing and management contracts revolve around the "specialty" nature of the service being outsourced – Terminal Management. As such, in countries where Port or Terminal management has been an exclusive domain of the public sector since its inception, it may be difficult to find a large pool of domestic bidders for the service. This tends to either restrict the bidding pool, increasing the chances of uncompetitive bids or limit opportunities for domestic participation, if this is an objective of the Government. In developing countries the availability of domestic management companies with sufficient experience in modern container terminal management is very low, and it is almost inevitable that the best applicants will be foreign-owned and managed.

854. Other counter indicators of outsourcing and management contracts are presented below:

- If the number of potential bidders is limited, meaningful comparison of bids may not be possible.
- Retention of existing staff is often the main cause for the failure of management contracts, since as often as not the efficiency problems the management contract is meant to resolve arise from existing labour arrangements.
- Contracting may create a monopoly which would be contrary to public interest (although this is unlikely to be a problem in the Port of Walvis Bay, where there is already an operational container terminal).

855. We note that this type of arrangement has been tried at the MCT in the past, with poor results. In our opinion a Management Contract would not satisfy many of the root objectives of the privatisation program; however, for sake of completeness, we have included this option in our analysis.

9.6.7 Lease and Rent Contract

856. This is a widely used form of PPP, but it applies generally to fully developed terminals that have generally been constructed by the port authorities themselves. In the case of the proposed new coal terminal, there will be a significant level of

investment required in order to construct a new berth structure, as well as to level and pave the container stacking area, construct various buildings, etc. A decision will have to be made as to whether both governments are willing and able to invest in the civil works to develop the terminal. If the Governments of Botswana and Namibia are prepared to make this investment, then a lease and rent contract would be appropriate.

857. Lease or rent contracts belong to the category of privatisations covered by the blanket term "concession". In a concession, the government transfers the operating rights for a public asset to a private enterprise, which then engages in operating activities contingent on government approval, and subject to the terms of the concession contract. In a concession contract a private enterprise may or may not be required to construct infrastructure.

858. In a lease contract, the private enterprise enters into a long term lease for a port land and assumes responsibility for the provision and maintenance of equipment, and the maintenance of the superstructure. There are two basic forms of lease contract:

1. Flat rate lease – assigns to the lessee the right to use a fixed asset for a specific period of time for a fixed rate paid at periodic intervals.
2. Shared revenue lease – assigns to the lessee the right to use a fixed asset for a specific period of time for a variable amount of money. In a shared revenue lease, there is a minimum payment but no maximum payment.

Figure 9-8 presents the main features of either form of lease and rent contracts.

Figure 9-8: Features of Lease and Rent Contracts

Flat Rate Lease Contract	Shared Revenue Lease Contract
1. A specific sum of money is paid per square meter of port area for a specific period of time. 2. In principle, the lease represents a fair return to the port authority on the value of the property. 3. Lease payments maybe adjusted for inflation over the life of the lease	1. A minimum level of compensation. 2. No established maximum level of compensation. 3. Maximum compensation depends on facility capacity. 4. Minimum compensation may not fully cover the interest and amortization of the port authority for the lease area.

Licensing

859. In licensing arrangements, private companies are "licensed" by the port authority to provide specific port services, such as stevedoring, cargo handling, or other services on the port authority's property. The "license" is not established by any statute or government regulation, it is merely the term commonly applied to this type of contract between private enterprises and port authorities. In this type of arrangement, licensed companies at the port may compete to obtain assignments from shipping lines or agents, and these assignments are carried out at the berths to which the individual vessels are assigned by the port authority.

860. This type of arrangement, while relatively common in the handling of conventional cargoes, is not appropriate to the operation of a container terminal, and is not therefore discussed further at this time.

9.7 Legal Frameworks

9.7.1 Botswana

Botswana Railway Act

861. The Botswana Railway Act provides for the establishment of the Botswana Railways (BR) for the provision and operation of railway services and for matters connected to railway services. The Act further delineates the functions, powers and duties of the Organisation including:

- Section 12(1)(a): provide efficient and cost effective railway transport over all its railways within the borders of Botswana.
- Section 12(3): The Organisation shall not, without the approval of the Board after consultation with the Minister, construct a new line of railway at any point outside the recognized railway reserve not previously served by the Organisation, neither shall it close nor remove any existing line of railway other than a connexion to a private siding.[12]
- Section 12(4): The Organisation shall have all powers necessary or convenient for the performance of its functions and duties and without prejudice to the generality thereof, shall have the power, on behalf of the Government, to –
    - (a) acquire, maintain, improve and operate the railways at present existing within Botswana or outside Botswana as may be directed by the Government from time to time;
    - (b) acquire, maintain and use any kind of property, right or privilege and dispose of the same by public auction or such other method as the Board may approve, to any person;
    - (c) form one or more companies or acquire shares, for the purpose of restructuring its activities, carrying on business or carrying out any purpose, which it may carry out in terms of this Act;
    - (d) enter into such contracts as may be necessary for the performance of its functions and duties;
    - (g) sell, exchange, lease, dispose of, turn to account or otherwise deal with any of its assets or any part thereof; whether movable or immovable, not required for its purpose: Provided the Organisation may not sell any of its immovable property without the approval in writing of the Minister for the time being responsible for finance;
    - (j) purchase or sell any materials and stores used in the performance of its functions; and
    - (k) carry on any activity which is reasonably requisite or convenient for or in connection with the discharge of its functions under this Act.

[12] According to Section 2 of the Act, "Private Siding" means any line of railway which is connected to, or is contiguous with, Botswana Railways, other than such connections at the national borders, which has been constructed on land not owned or leased by Botswana Railways, for the specific purpose of facilitating rail transport access to premises or works situated on that land.

862. Under Section 13(1), the Act stipulates that the Organisation shall have the exclusive privilege of operating railway services in Botswana. Further, Section 13(2) states that the Board may permit any person to construct a private siding.

863. From the provisions above, it is clear that BR does not have the power or authority to sell any of its immovable assets. To conduct such transaction, it must get approval in writing from the Ministry of Finance. Further, BR has the exclusive right to operate railway services in Botswana.

864. However, Section 12(4)(d) as indicated above, gives BR the authority to enter into contracts as may be necessary for the performance of its functions and duties. This means that, BR can enter into contract with individuals or firms for the performance of its functions including railway operation.

Botswana PPP Policy

865. Botswana has a good PPP policy framework. It also has an established PPP institution charged with the responsibility of evaluating the performance of parastatals and advising on the commercialisation and privatisation processes. This institution, the Public Enterprises Evaluation and Privatisation Agency (PEEPA), provides advisory services to government on privatisation and identifies services/infrastructure for privatisation or commercialisation/corporatization while also deciding on the appropriate course of action. The following section details the existing PPP policy framework in Botswana.

Privatisation Policy for Botswana

866. In 1998, the Government of Botswana through the Draft White Paper approved the privatisation policy and in 2000 the Privatisation Policy was adopted. The Privatisation Policy for Botswana is a policy framework which defines and outlines private sector participation in the development of Botswana. According to the policy, the impetus for privatisation in Botswana has come from the desire to improve efficiency in the delivery of services, to raise the country's growth potential by securing strong flows of foreign direct investment and technology transfer, and to create further opportunities for the development and growth of the citizen business sector.

867. The Policy provides a guide for privatisation in Botswana and also highlights the methods and processes for privatisation.

Privatisation Master Plan

868. The Privatisation Master Plan discusses the various constituent elements of the two general criteria for privatisation namely desirability and feasibility. The scope of the Master Plan covers the implementation of the Policy established in the Privatisation Policy for Botswana using various methods of privatisation including the divestiture of assets and/or operations of public enterprises, commercialisation and/or contracting out of public services, and private sector provision of infrastructure and services through public-private partnership. The Master Plan equally provides privatisation implementation strategies.

Public Private Partnership Policy and Implementation Framework

869. The Public-Private Partnership Policy and Implementation Framework highlights the PPP framework and processes including the changes that needs to be made to existing legal and regulatory framework to ensure a smooth private sector participation.

Public Procurement and Asset Disposal Act

870. This Act, alongside the Public Procurement and Asset Disposal Board, make up the regulatory and legal framework governing procurement in Botswana. It contains detailed procurement processes. The Act is being improved upon as relevant regulations to govern Central Government PPP projects have been developed and recommended for adoption.

Needed Legislation in Botswana

871. The Botswana Rail Act grants the Botswana Rail exclusivity on the operation of railways within Botswana. Botswana also owns and maintains the rail infrastructure. For private sector participation therefore, some legislation would need to be enacted including:

- Legislation to allow the Botswana Rail to sell/concession immovable assets;
- Legislation to allow Private Sector involvement in the operation of railways; and
- Repeal of the exclusivity section of the BR Act which grants BR exclusive right to operate railways in Botswana.

9.7.2 Namibia (Rail)

PPP in Namibia

872. Namibia had the first PPP experience in 2000 associated with the delivery of some of its urban services. The Government of Namibia started the capacity development of the National PPP development programme with the assistance of the UNDP with the aim of improving delivery and equitable provision of basic services. The overall goal was to support local authorities with technical advisory and support services to identify, select and implement pro-poor PPP initiatives.

873. A National Task Force for PPP was formed to enable the policy environment for PPP within the urban sector in Namibia. This also developed the policy and legal framework for the PPP environment.

874. PPP initiatives have been undertaken successfully and these include the Power sector and the Walvis Bay Corridor schemes.

875. Lessons learnt in Namibia to date on PPPs include:

- Need to improve the regulatory environment with the Government taking the lead;
- Need for comprehensive capacity building strategies to support PPPs;

- Lack of understanding of each other's needs and interests among partners can be eliminated through active stakeholder engagements, open dialogues and discussion of roles and risks; and
- Strong political support for PPPs should be ascertained prior to each PPP arrangement being entered into. Unless there is political will and commitment at both national and local levels to support such PPP initiatives the arrangements would be difficult to implement and operate.

National Transport Services Holding Company Act, 1998

876. The National Transport Services Holding Company Act (Act No. 28, 1998) provides for the incorporation of a holding company to undertake, either by itself or through any subsidiary company, transport services in Namibia or elsewhere; and to provide for matters incidental thereto. TransNamib Holdings Limited was thus established in terms of this Act and is wholly owned by the Government of Namibia.

877. The Act specifies the following:

- Section 13(1) The railway vesting in the Corporation is, with effect from the transfer date, transferred to the State, and the railway shall from that date vest in the State whereupon the total shareholding of the State in the Holding Company shall be reduced in accordance with the book value of the railway on the date immediately before the transfer date as estimated by the Minister in accordance with the values reflected in the asset register of the Corporation.
- Section 13(2): Subject to the other provisions of this section and to such terms and conditions as the State and the Holding Company may in writing agree upon, the railway transferred in terms of subsection (1) *shall, with effect from the transfer date, be managed by the Holding Company which may, for its own account, conduct the business of transporting passengers or goods on or by means of the railway.*
- Section 13(3): The Holding Company may, after consultation with the Minister, grant a concession to any person to conduct the business referred to in subsection (2) on any part of the railway.
- Section 13(4) The Minister may in writing issue directions to the Holding Company relating to –
    - (a) anything connected with, or necessary to perform any of the functions of, the railway, which is reasonably necessary to achieve and maintain a safe and functional railway system and, to protect the environment.

878. From the provisions above, the Holding Company has the responsibility of managing the railway. The Act is not clear on the disposal or sale of assets. However, the Act specifies that the Holding Company may, after consultation with the Minister, grant a concession to any person to conduct the business of transporting passengers or goods on or by means of railway.

879. With respect to the construction of new lines for the transport of passengers or goods, the Act grants private company or individuals to do so only with the written approval of the Minister and subject to such conditions as may be agreed upon by the Minister and the private company or individuals as the case may be.

880. An agreement with the Minister for the construction of new lines would include conditions relating to the financing, operation and maintenance of such line and the rights (including propriety rights) and obligations of the parties to such agreement.

Needed Legislation

881. According to the National Transport Services Holding Company Act, the Holding Company manages the rail assets and is also responsible for conducting the business of transporting passengers or goods on or by means of the railway. For private sector participation in the transportation of goods within Namibia therefore, legislation allowing for private sector operation of railway in Namibia is required.

9.7.3 Namibia (Ports)

Namibia Ports Authority Act, 1994

882. Ports operation and management in Namibia is governed by the Namibian Ports Authority Act, 1994 (Act 2 of 1994). Namport is the Port Authority that has been managing the ports in Namibia since 1994 and its key role is to manage the port facilities to cater for current trade needs and develop the ports for future demands. According to the Act,

883. Section 3(1) It shall, subject to the provisions of this Act, be the object and general duty of the Authority –

- (a) to manage and exercise control over the operation of ports and lighthouses and other navigational aids in Namibia and its territorial waters;
- (b) to provide facilities and services normally related to the functioning of a port;

884. The Act also grants the Authority the right to let or sub-contract facilities or services. According to the Act,

885. Section 18(2)(a) Where, under subsection (1)[13], the Minister requires any power or function to be exercised or performed in accordance with specified limitations, the Minster may direct that such power or function be exercised or performed by the Authority itself and not through any person, body, organisation or authority contemplated in Section 19.

[13] Section 18(1) If the Minister considers it necessary or expedient in the national interest or for the discharge of an international obligation of the State, the Minister may, by notice in writing to the Authority, direct the Authority to – (a) exercise any power or perform any function conferred or imposed on it by the Authority by this Act, and specified in the notice, or exercise or perform such power or function in accordance with limitations so specified; or (b) discontinue any activity specified in the notice.

- Section 19(1) Subject to any direction of the Minister given under section 18(2)(a), the Authority may enter into any contract with any person, body, organisation or authority to perform a particular act or render a particular service on behalf of or in favour of the Authority, and may let or subcontract any facility or service it is required or entitled to provide or render, but any such contract shall not be inconsistent with the objects of the Authority.
- Section 19(3) Subject to subsection (4), the Authority may sell, lease or transfer to any person, body, organisation or authority with whom a contract has been concluded in terms of subsection (1), such of its property or assets as may be necessary to enable such person, body, organisation or authority to perform the obligations assumed by it in terms of such a contract.
- Section 19(4) No immovable property of the Authority shall in terms of subsection (3) be sold or transferred without the approval of the Minister.
- Section 21(1) Except with the approval of the Minister, no person, other than the Authority, may construct, develop or operate any port.

886. Thus, while the Authority has the right to enter into contract with any person, body, organisation or authority to perform a particular service on *the Authority's behalf*, private sector involvement in infrastructure development or port operation is not conducted in proxy or on behalf of the instituted authority but rather independent of the authority subject to any agreed regulatory framework. Therefore, the Act does not give the Authority the right to get the private sector to conduct services which are within the purview of the Authority.

887. Further, subject to the approval of the Minister of Works, Transport and Communication, the Act confers on the Authority the right to sell, lease or transfer property or assets to any person, body, organisation or authority insofar as such transfer is to enable the person, body, organisation or authority to perform functions on behalf of the Authority. The Authority does not have the power to sell or transfer any immovable assets without the approval of the Minister.

888. Equally, as stipulated in Section 21(1), the approval of the Minister is needed for any person to construct, develop or operate any port. The Act is not clear on whether 'the person' could be an indigene or a foreign individual or firm.

Needed Legislation

889. Current Namibia Ports Authority Act is not very clear on private sector involvement in the operation or development of ports in Namibia. As such, some clarity will be needed in form of new legislation and amendment of existing one. The following is needed:

- Amendment of the Namibia Ports Authority to allow for private sector involvement in the operation and construction of port facilities in Namibia.

9.8 Cross Border Issues

890. This section addresses requirements for ensuring a seamless cross-border operation. The issues discussed here include: a single operator run rail service, a single ownership of the railways, one stop versus joint stop border clearance procedure, agreement on customs and immigration processes and procedures.

Putting these requirements in place removes delays and bottlenecks in the operation of railways as well as ensures the attractiveness of the project to private sector investors. The case for ports is more simplistic as this affects only Namibia.

9.8.1 Single Ownership of the Railways

891. The ownership/concession of the railways is a critical element in structuring a PPP in the rail sector. Ordinarily, the existence of more than one owner of the rail infrastructure means there will be more complexities with respect to agreements and policies, etc. For this project, having the railway running between two countries creates an extra layer of policies and agreements that need to be in place between both countries. As evidence from most countries in Europe and North America (Canada in particular), single ownership of the railways would ensure smooth and seamless operation as the operator of the railway will be dealing with one entity (the railways owner) rather than two entities which may include the governments of both Botswana and Namibia.

9.8.2 Single Rail Operator

892. A single operator for the railway running between Botswana and Namibia will also ensure a seamless railway operation. This is because there will be limited or no disruptions at the border. With a single operator, signalling and other requirements would be unified on both sides of the border. In some countries the rail operator is also the owner of the rail infrastructure. This is the case in Canada where Canadian National Railway Company (CN) owns its railway infrastructure between Canada and the U.S. and also operates the rail. In Europe, there the operators of the rail service are different from the owners of the rail infrastructure.

9.8.3 One Stop or No-Stop Border Clearance Procedure

893. A seamless cross-border operation of rail service between Botswana and Namibia would require either a one stop or a no-stop clearance procedure. A stop clearance procedure would mean literally one stop where offices of the requisite government agencies of both countries are situated. This allows for quick document processing and validation.

894. A no-stop clearance procedure would require changes in the immigration and custom requirements of both countries to allow trains to run through without making a stop at the border.

9.8.4 Customs and Immigration Processes Agreements

895. A seamless operation of rail service between Botswana and Namibia would require agreements between both governments and policies passed by each government. The agreement and policies should include but not be limited to custom clearance at the border (the fewer documents are required, the faster services would be), immigration issues, operator’s licenses, and rail operations. Agreements and policies should be in place before invitation to the private sector.

9.8.5 A typical Customs and Immigration Scenario

896. A typical scenario would provide for Customs inspection by Botswana officials on the Botswana 'side' of the post and Customs processing for Namibian at Namibian 'side' of the post . Thus there are two variants to each of the four options below: There will be rail terminus on one side of the border and rail wagons will have the seals inspected at the station yard and will then proceed across the border without inspection of the contents (except in special cases) for inspection in either country by Government officials.

897. In the first case there can be joint inspection of road vehicles under Option A, B or D for intermodal traffic. Joint inspection cannot take place under option C, since facilities are physically separated. In the 2nd case there can be no future opportunity for joint inspection of transit traffic carried by rail, since no Customs facilities for rail traffic are proposed for the border (or for the Customs post inland from the border gate). .

898. It is essential for both Governments to discuss as soon as possible the location of new Customs facilities for both road and rail traffic, including design parameters, and the potential for 'joint' inspection, whether immediately upon opening of the new facility or at some point in the future.

899. Based on recent "best practice" experience elsewhere, we have identified four configurations that are physically possible.

900. **Option A: Joint Processing Straddling the Common Border** is our preferred design in principal. It would most likely not require changes to national law of Botswana or Namibia. . It would immediately eliminate the inefficiencies that would arise from the practice of consecutive processing associated with regional crossings. The design provides for a single set of truck/truck transfer bays, which would permit joint physical inspection of goods as they are transferred between Botswana and Namibia trucks, and processing of paperwork in separate sections of a common building. It would require prior agreement on all details of the design, so that each country can construct the facilities physically located on their own side of the border, based on an agreed single design.

901. This Option eliminates any risk of loss of cargo between the point of Customs inspection/verification and the border gate. . However since the facility would straddle the border, development requires both prior agreement on the precise location of the border and agreement to conduct joint inspection from day one.

902. Since there is only one set of inspection platforms, at which joint inspection takes place in a common area under joint jurisdiction, there is no effective way of operating initially with separate or sequential inspection.

903. **Option B: Joint Processing located entirely within Botswana or Namibia**. This would also eliminate consecutive processing, and also requires prior agreement to conduct joint processing from day one. It does not require agreement on border location (so long as the site chosen is clearly inside the agreed territory of Botswana or Namibia) but would require agreement that from inception all inspection by both countries will be carried out within Botswana's territory. It would in all probability require Botswana to design, finance and construct the entire facility. . It would require a secure access between the border

gate and the customs processing facility, as well as a change in Namibia law to permit inspection and valuation of imports to take place within Botswana, and changes to Botswana law to permit the return of unacceptable Namibian exports to Namibia.

904. As with Option A, there is no effective way of operating initially with separate or sequential inspection.

905. **Option C: Replicated Facilities: Separate Processing** provides a modernisation of the current approach, with separate facilities on each side of the border. The post on the Botswana side will handle all processing by Botswana officials of imports and exports. A functionally equivalent (but not necessarily physically similar) post on the Namibian side will handle all activities by Namibian officials. This would require a secure access from each inspection point to the border gate. It would continue the present practice of separate consecutive inspection, and risks providing no reason to change from the inefficiencies of the present approach of 'ferrying' cargo between two Customs posts, which means that cargo is not only inspected twice but is also transhipped twice within a few km.

906. **Option D: Juxtaposed Facilities: Joint Processing** provides for all processing of imports to Botswana at a single post within Botswana manned by Botswana and Namibia government officials. A similar (but not necessarily identical) post on the Namibian side of the border would handle all processing of goods inbound to Namibia, including Botswana's export formalities. This avoids the need for agreement on the precise location of the border gate, but involves some additional facilities and the need for officials from each country to cross the border every day.

907. At low traffic levels this configuration may well reduce delays to traffic compared with separate processing by each country, but will probably require an increase in overall staffing. Each country must man two processing areas, one in each country. Like Options B and C. This Option requires a secure roadway from each inspection point to the border gate.

908. These four options are shown schematically in Figure 9-9, where the arrows indicate flow of traffic. While the overall differences in capital cost are small, the potential differences in operating savings could be substantial. Option C provides no efficiency savings relative to the current situation, since it effectively replicates that situation, albeit with new facilities. Option C simply provides more for a comfortable and somewhat more secure building that replicates the current need for consecutive inspection (and probably perpetuates double transhipment). Options A, B or D would each permit a single (joint) inspection of the cargo. They thus all eliminate one complete inspection.

909. Option A would replace one border gate and two processing areas with one processing area and two border gates, one in each country. Option B provides one processing area and two control gates, both within Botswana, along with a controlled access linking the processing area with the border gate. From this point of view options A and B are in effect minor variations on the same alternative, with the difference related only to the ownership of the land on which the integrated facility for joint inspection is located and the need for a controlled access road under Option B.

Figure 9-9: Cross Border Scenario Option A

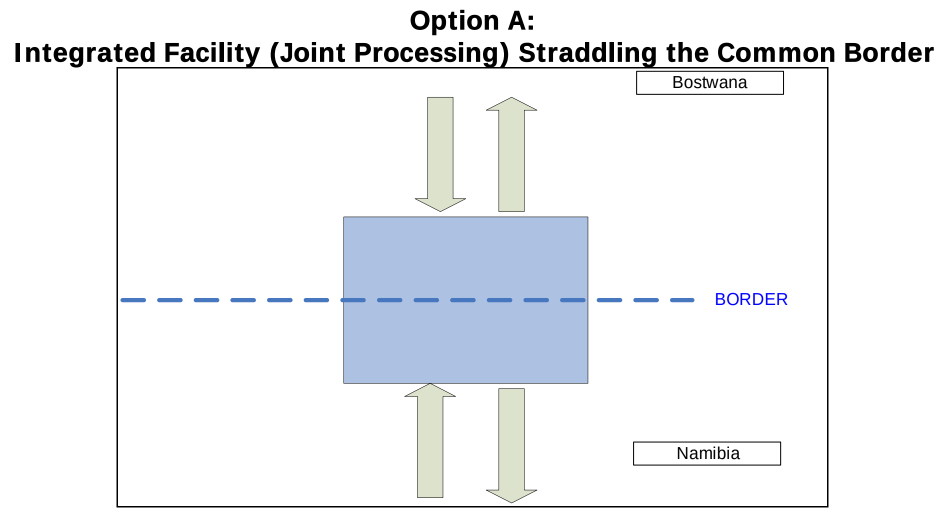


Figure 9-10: Cross Border Scenario Option B

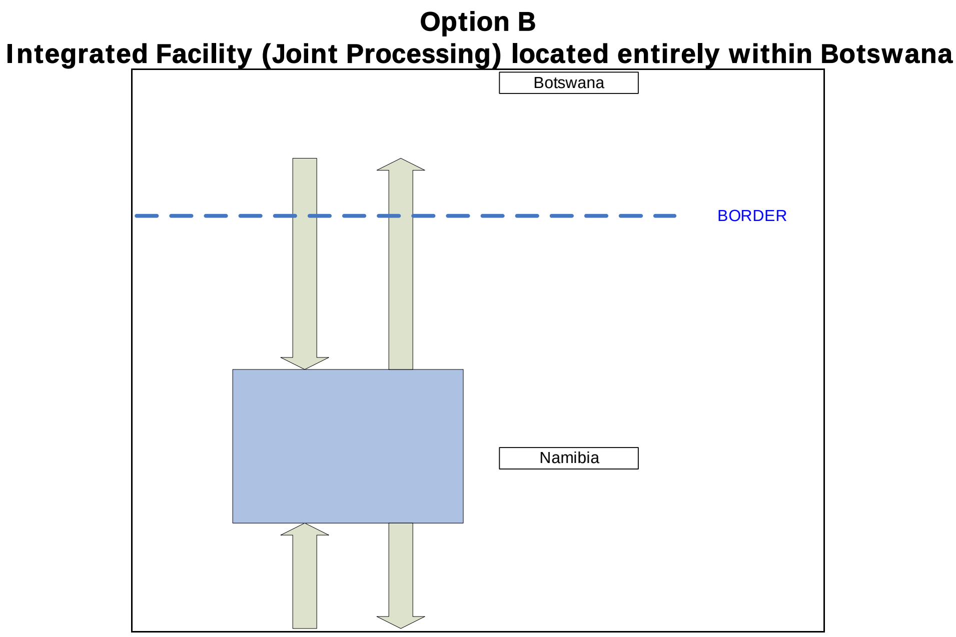


Figure 9-11: Replicated Facilities (Separate Processing) Option C

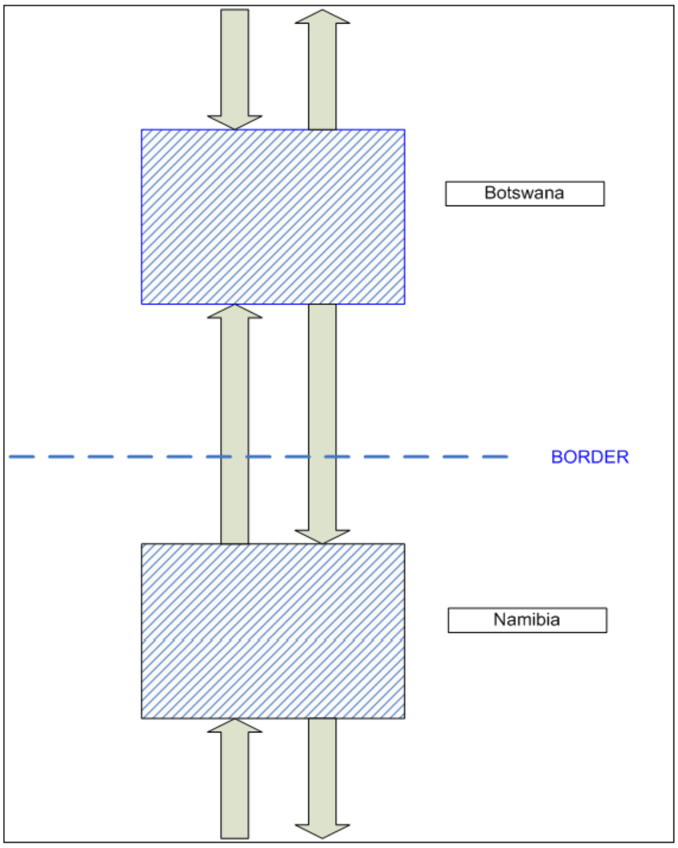
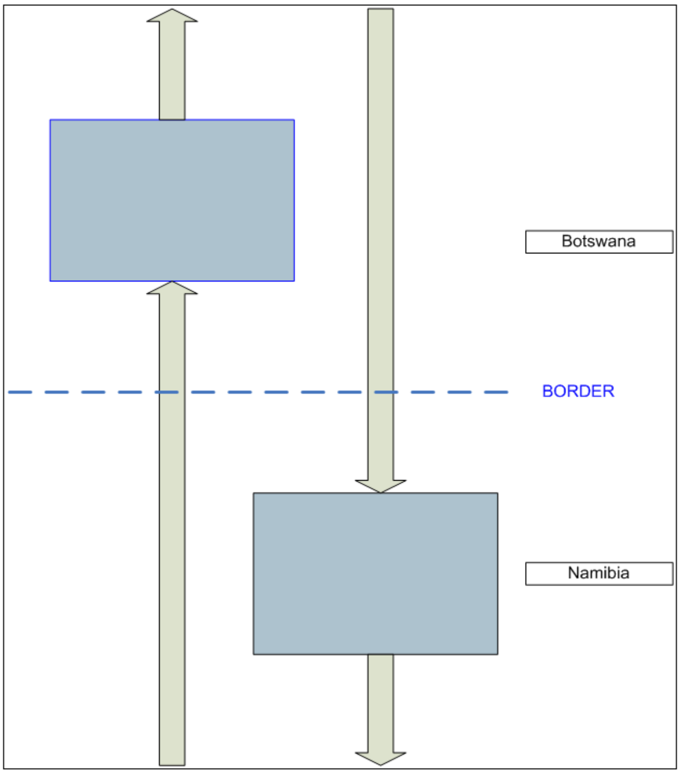


Figure 9-12: Juxtaposed Facilities (Joint Processing), Option D



9.9 Choice of Strategic PPP Option

9.9.1 TKR Delivery Options

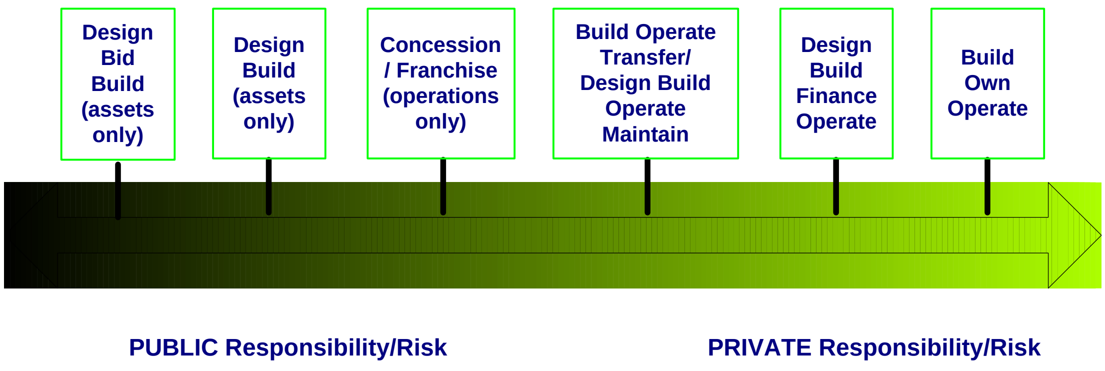
910. The TKR project may roughly be broken down into four principal 'tasks':

- Define and design the project: establish project objectives and governance structure, set the project concept and prepare preliminary designs and performance parameters.
- Finance the capital costs of the project: confirm the sources of funding, including government's level of commitment.
- Build and procure the physical assets: select the project delivery method(s).
- Operate and maintain the assets in order to deliver the public service: select the private operator.

911. Historically, rail and port projects have been developed in a process whereby the government awards a construction contract to a firm that builds the infrastructure according to design specifications. The completed infrastructure is passed on to the government for operation and maintenance. Project funding comes from taxpayers and/or direct user fees (tariffs). Private sector participation has thus been limited to separate planning, design or construction contracts. PPPs aim to take advantage of the private sector's potential advantage in certain aspects of the public infrastructure delivery process, from infrastructure delivery to, increasingly, operations and maintenance (O&M) and access to financing.

912. The arrangements presented in this section show the ways in which private sector responsibilities can be expanded through the use of PPPs. The figure below depicts how the range of responsibilities shifts from the public sector to the private sector with different project delivery (service and asset provision) options.

Figure 9-13: Project Delivery Options for TKR Rail



913. The project delivery options follow a continuum from traditional public agency development, funding and operation at one end of the spectrum, to private design, construction and operation with no public subsidy at the other. The options expand across a spectrum of increased private responsibilities, and range from transferring tasks normally done in-house to the private sector, to combining

typically separate services into a single procurement or having private sector partners assume owner-like roles. Intermediate options include varying roles for the public and private participants in project definition, work responsibility, risk allocation and funding.

914. Figure 9-14 presents the four main project delivery options for the TKR project. The attributes of the various contract arrangements have been described above generalised form, it should be recognised that variations are usually negotiated in actual project contracts which explains why the assignment of acronyms (e.g. BOT, DBOM, and DBFO) to projects vary considerably.

Figure 9-14: TKR Project Delivery Options

Project Delivery Options	Sources of Finance		Contractual Options
	Government	Private sector	
1. Design and build civil works	Government financed	Private sector unlikely to finance asset that it does not own	Bid-Build-Design/ Design-Build
2. Provide O&M, procure and partly finance rolling stock and rail and port systems	Private sector may seek government credit enhancements to procure rolling stock and to subsidise services	Private sector more likely to finance asset that it does own if risks are mitigated.	Operating concession/ franchise
3. Design and build civil works, rolling stock, rail and port systems and provide O&M (mixed financing)	Government financing and credit enhancement	Depending on balance of risks it may be willing to accept more financing responsibility.	Design-Build-Operate Design-Build-Operate-Finance Build-Lease-Operate
4. Design and build civil works, rolling stock, and rail and port systems and provide O&M (100% private sector financed)	No government financing Private sector may seek government credit enhancements	100% private sector finance	Build-Operate-Own

915. As a largely greenfield with partially existing infrastructure or new-build system project, TKR's infrastructure delivery method will be based on a turnkey procurement mechanism. Three broad options are available to both Governments: option 1 assumes that primary financial responsibility lies with the public agency and does not include O&M; option 4 shifts all financial responsibility to the private sector and includes O&M; option 3 is the "in between" or mixed option which has hybrid features of public-private financing and includes O&M. Option 2 assumes that the infrastructure is in place and an operating concession or franchise is tendered to the private sector on a risk sharing basis which includes private provision of rolling stock and rail and port systems. The four options are reviewed below:

916. **Option 1: Traditional DB public works procurement.** Employs design/build contract with public funding. The private company provides final design bundled together in one contract with construction. Under DB the public agency solicits

bids at typically 30 percent of design with detailed designs prepared by the successful contractor. A single contractor takes entire responsibility for the project allowing for the owner to simply `turn the key' to begin operations. Government remains responsible for financing construction.

917. **Option 2: Provide O&M, procure and partly finance rolling stock and rail systems.** The TKR line can be concessioned or franchised once the system is at or near completion. The procurement and financing of rolling stock may be the sole or joint responsibility of the public agency or the private sector depending on the project's financial viability and bankability. Under private sector procurement and financing, government credit enhancements may be sought. If revenues cannot meet operating costs, the private sector will seek subsidies from government for operations and maintenance. Instead of ongoing subsidies we recommend an upfront, once only, grant payment.

918. **Option 3: Design and build civil works, rolling stock, rail systems and provide O&M (public-private financing).** The private sector design-builds the fixed infrastructure, procures the rolling stock and related systems, and operates the system. The design/build/operator bids on a fixed price basis. Tariffs may be collected by the public agency or shifted to the private operator who receives an interest in the operating profits of the enterprise. Government provides defined financial assistance, this could include development period cost-sharing, loans, or credit enhancement. Private financing may secured by the government agency's obligation to make scheduled payments under the contract to cover loan obligations. However, as in 2 above, we strongly recommend a once only, up front, carefully calculated grant payment.

919. **Option 4: Design and build civil works, rolling stock, rail systems and provide O&M (100% private sector financed).** A private contract to design, build and operate the project with no public funds or other government financial commitment. These contracts are usually long term (20 to 30 years being common); have detailed provisions on payment, service standards and performance measures; provide an objective means to vary payment depending on performance; and, the concessionaire usually has to assume substantial risk.

920. The private sector would not seek subsidies for O&M although the lenders may seek some government credit enhancements and the borrowers may seek Partial Risk Guarantee insurance against for instance regulatory failure. Such insurance is now offered by the World Bank.

9.9.2 Assessment of TKR Project Delivery Options

921. In this section the evaluation criteria are applied to the four project delivery mechanisms with the objective of identifying the most appropriate options.

9.9.3 Meet Governments Objectives

922. Both Governments are seeking to involve the private sector in the development of the TKR from the earliest practicable stage. Each project delivery option can deliver substantial advantages when properly structured.

923. Governments should seek the following benefits from private sector involvement:

924. Innovation and affordability: accessing the most recent developments in transit systems worldwide to reduce overall cost, improve the product and meet market demand.

925. Private sector financing: The private sector would be responsible not just for designing and building the line/port terminal and maintaining it over a long period but for mobilising a substantial part of the project financing for the PPP component of the TKR. [NB. The PPP component is expected to be the Operations and Maintenance phase of the TKR project.]

926. Efficiencies gains: The private sector will optimise costs over the life of the project, while meeting the policy requirements of the public sector.

Figure 9-15: Assessment: Meet Government Objectives

Project Delivery Options	Advantages	Disadvantages
1. Design and build civil works	• Innovation objectives met through a well structured bidding process • Efficiency gains are met through private provision of construction services tendered on quality and price	• Does not offer private sector financing • Does not offer potential efficiencies found in bundling DB with O&M
2. Provide O&M, procure and partly finance rolling stock and rail/port systems	• Innovation objectives met (same as 1) • Efficiency gains are met by private provision of O&M • Private sector can finance part of rolling stock capital costs	• Government co-financing and guarantees required for rolling stock and rail/port system capital costs • Does not offer potential efficiencies found in bundling DB with O&M
3. Design and build civil works, rolling stock, rail/port systems and provide O&M (mixed financing)	• Innovation objectives met (same as 1) • Efficiency gains are met (same as 1) for DB and O&M • Private sector can finance part of rolling stock capital costs	• Government co-financing and guarantees required for rolling stock and rail/port system capital costs
4. Design and build civil works, rolling stock, rail/port systems and provide O&M (100% private sector financed)	• Innovation objectives met (same as 1) • Efficiency gains are met (same as 1) for DB and O&M • Private sector financed	• Government guarantees may still be sought •

Source: CPCS Transcom analysis

Each of the four options meet most of the Governments' objectives. A mix of Government financing and guarantees is inevitable. Governments of Botswana and Namibia's financing will be needed to cover all of the Civil engineering phase and much of the signalling and rolling stock acquisition phase. This should therefore not necessarily be counted as a factor in eliminating any of the options except option 4.

9.9.4 Generate Private Sector Interest

927. Ultimately, a successful procurement for the TKR Project will depend on how the private sector bids, based on their internally generated capital and operating cost

estimates and estimates of the ridership and revenue. Without the rail line, it is not economically feasible to export coal. The rail line is also of interest to other groups, such as the Walvis Bay Corridor Group. The considerable distance between the Namibian Ports and Gaborone/Johannesburg means shipping costs are high by road and a rail line would present substantial savings. Organisations such as CIC Energy, Debswana, Nambot Railway and Harbour, and WBCG have indicated their interest in building and/or using the rail line. These firms were approached during the Inception Missions and the preparation of the Traffic Studies Report with all expressing strong desire to be involved. An India based organisation, Reliance Power also approached the consultant expressing interest to get involved. A notice was subsequently issued by Governments of both Botswana and Namibia requesting interested firms to Express Interest in developing the TKR and up to 36 firms have since made submissions globally. This is a good indication of the willingness to participate in this venture.

Figure 9-16: Assessment: Generate Private Sector Interest

Project Delivery Options	Advantages	Disadvantages
1. Design and build civil works	• Fully Government funded • Attractive to private vendors who are reluctant to take on long term Botswana/Namibia risk	• No real role for private sector in operations
2. Provide O&M, procure and partly finance rolling stock and rail systems	• Fully Government funded infrastructure and significant % of rolling stock • Risk of private sector operators partial mitigated	• Potential role for private sector in O&M but may be purely contractual with no "upside" potential and still plenty of operational risk
3. Design and build civil works, rolling stock, rail systems and provide O&M (mixed financing)	• Same as 1 and 2 but with a significant role for private sector in both financing and operations • Some "upside" potential also if well managed	• Few if degree of public grant finance is sufficient to mitigate risk and leave some profit potential for a well managed project
4. Design and build civil works, rolling stock, rail systems and provide O&M (100% private sector financed)	• Would be the best option if the financial viability was attractive without any grant and subsidised funding	• Like most inter-urban railway & port projects TKR is not financially viable as a "free standing" entity financed without concessional funds

9.9.5 Ease of Implementation and Management

928. In general public sector entities will have an easier time enforcing their rights over the existing rights of way. On the other hand private sector companies, because of their profit seeking nature, are better and more efficient managers of funds, expenditures and implementation.

Figure 9-17: Assessment: Ease of Implementation and Management

Project Delivery Options	Advantages	Disadvantages
1. Design and build civil works	• Only state agencies with power of eminent domain can hope to clear the rights of way within a reasonable time	• Public sector has generally failed to provide good efficient management of public assets anywhere in the world

	frame	
2. Provide O&M, procure and partly finance rolling stock and rail/port systems	• 1 above • Slightly more motivated private sector partners	• 1 above • Still quite high involvement of public sector in managerial decision making
3. Design and build civil works, rolling stock, rail/port systems and provide O&M (mixed financing)	• 1 above • If well structured private sector partners will be well motivated and profit seeking	• 1 above • Still some involvement of public sector in managerial decision making
4. Design and build civil works, rolling stock, rail/port systems and provide O&M (100% private sector financed)	• 100% private sector financed and implemented project would be most motivated to get full value from and prompt implementation from suppliers in procurement process	• Private sector will have a major problem clearing the rights of way

9.9.6 Achieve Financial Viability and Bankability

929. The TKR project is not a project that can be implemented by the private sector on its own. It is not possible for the private sector to access very low interest, very long term loans such as those provided by the World Bank's IDA window, that in our view, based upon our analysis, are essential if the TKR project is to have any hope of structuring a potentially attractive PPP.

930. Both the Botswana and Namibian banking sectors, that are robust and expansionary, have very little experience in infrastructure finance. Further, as stated above, examples of well run cost effective state owned enterprises are extremely rare anywhere in the world. In Sub Saharan Africa, the state owned sector has generally a well justified reputation for inefficient management and extravagant expenditure.

931. In order to have a TKR project that is strongly attractive for private sector participation, a significant part of the infrastructure and rolling stock expenditure must be funded by the state with very low interest or grant funds. Private sector participation will be encouraged to the extent the governments of Botswana and Namibia remove the main items of risk from the table.

932. If this is done, again based upon CPCS Transcom's analysis, it is highly likely that a jointly owned PPP between the Botswana and Namibia Governments (minority shareholders) and a private consortium (majority shareholders) could establish a "for profit" company that could raise the balance of the finance from themselves and from domestic and international banks.

Figure 9-18: Assessment: Achieve Financial Viability and Bankability

Project Delivery Options	Advantages	Disadvantages
1. Design and build civil works	• Access to extremely low cost extremely long term finance	• No entrepreneurial incentive
2. Provide O&M, procure and partly finance rolling stock and rail/port systems	• 1 above • Some grant funding and some entrepreneurial incentive	• Not enough entrepreneurial incentive
3. Design and build civil works, rolling stock, rail/port systems and provide O&M (mixed financing)	• 1 above • More grant funding and more entrepreneurial incentive	• Fewest disadvantages
4. Design and build civil works, rolling stock, rail/port systems and provide O&M (100% private sector financed)	• Entrepreneurial incentive in abundance	• No access to extremely low cost extremely long term finance

933. A Risk Assessment for the project has been undertaken in Section 11. At this juncture it is not possible to rank the risks but a full two day comprehensive Risk Workshop is recommended to be undertaken. An independent facilitator would be required to moderate the event.

9.10 Recommendations

934. Both the Governments of Botswana and Namibia should seek the option that meets their prime objectives bearing in mind how each strategy allocates tasks between the public and private sector and the likelihood of private sector financing of capital investments.

935. The above analysis has demonstrated that a 100% private sector financed "design and build civil works, rolling stock, rail systems and provide O&M" mechanism is not bankable. Experience elsewhere has shown that the private sector is in general not willing to assume all of the financing costs. Therefore this option has been eliminated from further evaluation.

936. A model in which the private sector would, in partnership with the public sector, design/build/operate/maintain and partly finance the service over an expected long term concession, with periodic performance reviews, has been shown to be on balance suitable to both the Botswana and Namibian contexts. Our preliminary recommendation is to adopt this option (Option 3-Mixed Financing). This is basically a Design, Build, Operate and Transfer option. Its advantages outweigh the other options and it has fewer disadvantages. Another consideration is that of cross border issue given that the project involves two countries and ideally a single operator would be more efficient. However the Open Access option should be examined further to allow some limited access by third parties. Outright ownership and operations by both Governments is an option but is not recommended due to the high Capex and Opex investments required. Already (Section 10) some of the route options would require heavy subsidies if they are to be implemented. Throughout the history of railways it is apparent that most

Governments are no longer able to pay their railway losses. Far from being able to afford continuing financial drains, national treasuries have been wanting to bring some money in for a change, not pay it out, and they are looking to private sector involvement as a way to reverse (or at least stem) the outflow. Many of the governments also have now recognised that the massive losses were due to inefficiency and poor response to competition (loss of market share), neither of which seemed particularly deserving of public support. The political rationale for rail subsidies has further been undermined by the inevitably poor service of capital starved public sector enterprises.

10 Economic and Financial Aspects

10.1 Introduction

937. This chapter presents the results of the preliminary financial and economic analysis of the options analysed in this report. We developed a financial and economic model, at an appropriate degree of detail for a pre feasibility study, in order to carry out the economic and financial assessment of the various route/gauge/port scenarios, as per the TOR of the project. The key objective at this stage was to screen the scenarios to identify the most promising ones from a financial and economic perspective, rather seeking an optimal financial implementation/transaction strategy for each possible scenario.

10.2 Financial Analysis

10.2.1 Approach

938. We estimated the financial returns for each scenario, using the financial model, based on our assessment of the most likely capital structure and required rates of return for a project of this nature in developing economies (base case scenarios) and the Capex and Opex estimates presented in chapter 5 and 6, respectively.

939. The scenarios were grouped according to rail gauge; routing; and port. The financial returns were analysed both including (1-6, 11-20) and excluding the ports (7-10), so that each major component of the project could be assessed separately. The initial scenarios assumed no government financial support for project Capex (1-10), while this assumption was relaxed in scenarios 11-20. The scenarios are presented in Figure 10-1.

Figure 10-1: List of Scenarios

Scenario	1	2	3	4	5	6	7
Port	WB	WB	WB	WB	L	L	WB
Routing	M	M	G	G	M	M	M
Gauge	SG	CG	SG	CG	SG	CG	SG
Port in Financial Analysis?	Y	Y	Y	Y	Y	Y	N
Govt Support - Rail Infrastructure?	N	N	N	N	N	N	N
Govt Support - Port Capex?	N	N	N	N	N	N	N

Scenario	8	9	10	11	12	13	14
Port	WB	L	L	WB	WB	WB	WB
Routing	M	M	M	M	M	G	G
Gauge	CG	SG	CG	SG	CG	SG	CG
Port in Financial Analysis?	N	N	N	Y	Y	Y	Y
Govt Support - Rail Infrastructure?	N	N	N	N	N	N	N
Govt Support - Port Capex?	N	N	N	Y	Y	Y	Y

Scenario	15	16	17	18	19	20
Port	L	L	WB	WB	L	L
Routing	M	M	M	M	M	M
Gauge	SG	CG	SG	CG	SG	CG
Port in Financial Analysis?	Y	Y	Y	Y	Y	Y
Govt Support - Rail Infrastructure?	N	N	Y	Y	Y	Y
Govt Support - Port Capex?	Y	Y	Y	Y	Y	Y

Notes: WB = Walvis Bay; L = Luderitz; M = Mariental; G = Gobabis

940. In this first phase of the study, as instructed, we did not analyse the impacts of inclusion of the Mmamabula-Ellisras link. This will be considered in Phase 2 and may materially affect the economics of the TKR.

941. For the financial analysis, we set the Weighted Average Cost of Capital based on our experience of expected returns on infrastructure projects in emerging markets, particularly for middle income economies. The key assumptions were: debt/equity ratio of 70%; required return on equity of 20%; cost of debt 8%. This translates to a cost of capital of 11.6%, which was used as the financial discount rate for the base case scenarios.

942. Revenues were estimated on a commodity by commodity basis through estimation of tonnage, average lead and tariff per net ton km, based on the analysis already presented in the Traffic Report. Both coal and non-coal traffic were included in the analysis. Tariff levels for each commodity were set based on a combination of factors: the rail tariff rates currently applied in the region, the road tariffs in the region for commodities that have the potential to move by road, as verified from commercial trucking web sites, and tariffs practised on world standard heavy haul railways for coal traffic at the volumes of traffic anticipated for the TKR. The default values were 1.5 cents/tkm for coal traffic and 5 cents/tkm for other traffic (assuming trucking rates in the range of 6-7 cents/tkm). Port terminal revenues per ton for handling coal were set at $6/ton, based on levels required to cover costs and analysis of handling charges in other world coal terminals.

943. The Capex and Opex were as reported in Chapters 5 and 6 above. Depreciation charges were based on industry standards for PPP infrastructure projects, as summarised in the following figure.

Figure 10-2: Assumed Depreciation Rates

Asset Class	Rate
Track	2.5%
Rolling stock	3.5%
Machinery & Equipment	3.0%
Other assets	2.0%
Port Assets	3.0%

944. Interest charges were calculated based on the assumptions stated above concerning capital structure and cost of debt. Corporate income tax of 15% was assumed, based on data on Botswana and Namibia tax rates as reported in the World Bank's *Doing Business: 2010.* No tax holiday was assumed at this stage, although the model has the capability of incorporating various assumptions about the fiscal regime. Such financial engineering should be explored once a preferred configuration for the TKR has been agreed.

945. For each scenario, we carried out discounted cash flow analysis to assess the financial attractiveness of the project, as per standard practice in project evaluation, focusing on the following metrics:

946. Project financial net present value (FNPV) – this is the difference between the present value of the future cash flows from the project and the investment of the project, discounted at the weighted average cost of capital. A positive FNPV indicates that the scenario achieves a return in excess of the Weighted Average Cost of Capital (WACC), i.e. it is financially attractive.

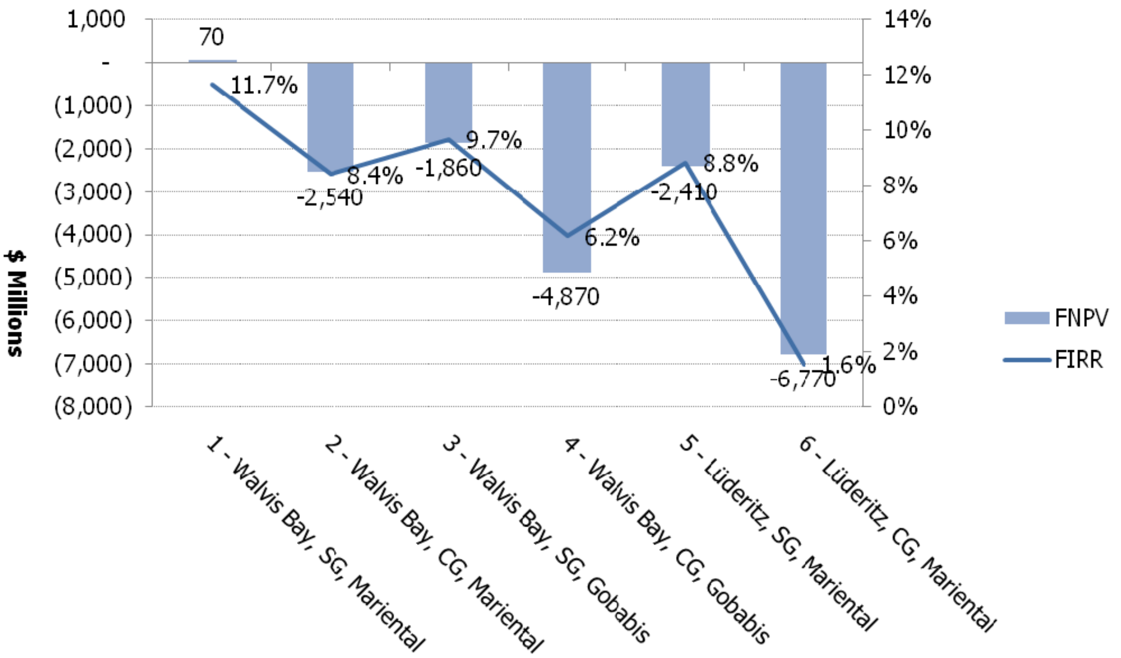
947. Financial internal rate of return (FIRR) – this is the rate of return at which the FNPV equals zero. In cases where the IRR is greater than the financial discount rate, the project is financially attractive.

948. Modified internal rate of return (MIRR) – instead of assuming that the project's returns are to be invested at the internal rate of return, this assumes that they are invested at the investor's weighted average cost of capital. Hence it is designed to present a more realistic assessment of how cash flows are reinvested than traditional FIRR.

10.2.2 Financial Results

949. The following figure summarises the financial results for the entire project assuming no government subsidies and without the implementation of the Mmamabula-Ellisras link. Currency used is USA Dollars.

Figure 10-3: Financial Results of Integrated Options: No Subsidy, Without ME Link



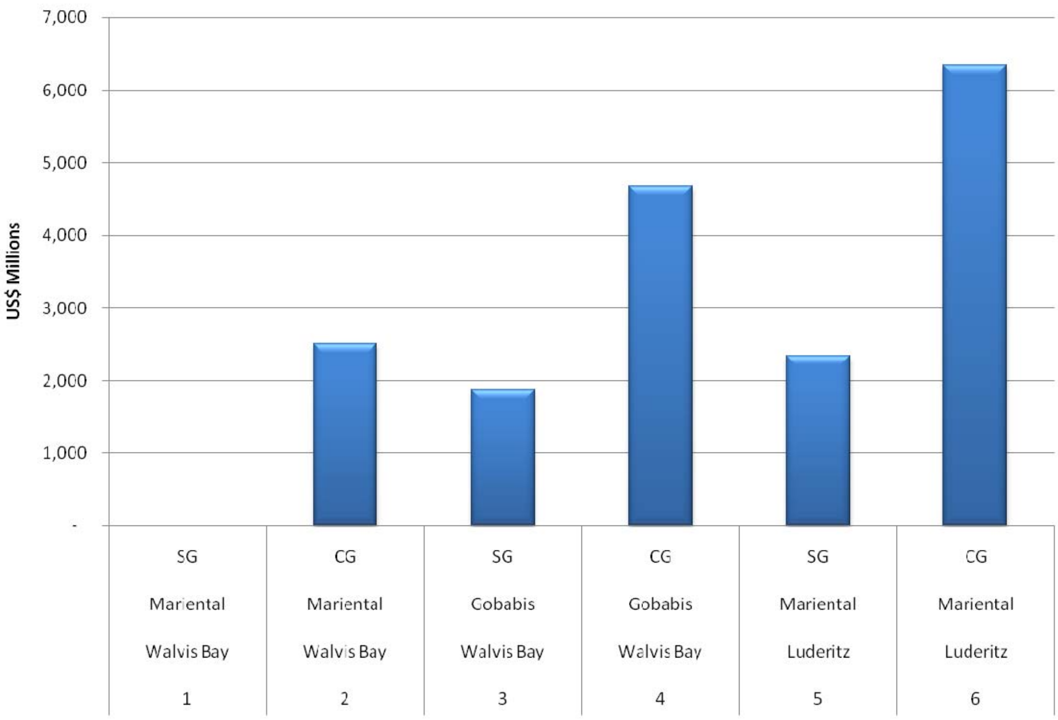
950. The following conclusions can be drawn:

- Only option 1 (just) passes the hurdle rate of 11.6% IRR, based on this result, this option would not require any public funding.
- The standard gauge options are more attractive than the cape gauge options. This is because while the capital costs are similar, the operating costs are significantly higher for CG because of the need to run more, shorter trains to accommodate the projected traffic
- The Walvis Bay options provide better financial results than the Lüderitz options. This is attributable to the shorter distance of the rail route from Mmamabula, rather than the costs of the respective port installations. The shorter rail distance to Walvis Bay (and the lack of tunnelling) drives the Capex and Opex cost estimates and more than compensates for the higher Capex costs of the Walvis Bay terminal
- The routing via Mariental produces better financial results than the routing via Gobabis, again because of the impact of the shorter distance on both the rail Capex and Opex
- The most financially attractive option is Scenario 1, the standard gauge routing via Mariental to Walvis Bay. Under the default assumptions, it is projected to achieve an FNPV of US$70 million, and an FIRR of 11.7% (MIRR of 11%), slightly above the estimated cost of capital. The second most attractive option is the SG routing via Gobabis to Walvis Bay (Route Option 1), with an FNPV of -$1.9 billion, and an FIRR of 9.7% versus the hurdle rate of 11.6%.

951. Again using the base case financial assumptions, we estimated the magnitude of the one-time Capex subsidy (contribution from government) required to allow each scenario to achieve the target project IRR. The required subsidy is shown in

Figure 10-4. The subsidy requirements range from zero in the case of the Mmamabula-Walvis Bay SG route via Mariental to $6.8 billion for the Mmamabula-Lüderitz CG route via Mariental. In the next section, we will discuss whether the economic benefits of the project are sufficient to justify public funding.

Figure 10-4: Government Subsidy Required to Achieve Target Return ($ Billions)



10.3 Economic Analysis

10.3.1 Approach

952. The purpose of economic analysis is to allow decision-makers to evaluate the different scenarios in terms of their economic feasibility, i.e. from the societal perspective of the Botswana and Namibia governments based on the efficiency of use of national resources. This is different from financial feasibility, which considers a project from the particular perspective of the project entity or entities, in the present case the prospective operators of the transport facilities.

953. The economic analysis requires both financial cost and financial revenues to be adjusted. On the cost side, conversion factors must be used to reflect the opportunity cost of the resources that are utilized. On the benefit side, the effects of the project on transport cost savings and production value added must be considered. The streams of costs and benefits must then be discounted using a social discount rate.

954. Three metrics were used to evaluate the different scenarios:

- The Economic Net Present Value (ENPV) of the investment
- The benefit cost ratio (BC ratio)
- The economic internal rate of return (EIRR)

955. The ENPV is simply the discounted value of a cost or a benefit. The ENPV of the project is the difference between the discounted total social benefits and costs. Projects with larger ENPV are more valuable to society. It is hard to compare options since ENPV generally grows with the size of the initial investment, i.e. there is no denominator which reflects the scale of the necessary investments. The ENPV is also sensitive to the discount rate.

956. The BC ratio resolves the issue of scalability. The BC ratio is the ratio of discounted total social benefits to discounted total social costs. Projects with higher BC ratios indicate that for each unit of social cost, more benefits are generated. Options of differing scale can be meaningfully compared, as the BC ratio appropriately reflects the "social return per social cost". The key issue with the BC ratio is that the exact definition of benefits and costs, and how they are allocated, matters greatly. Moreover, the BC ratio is also sensitive to the discount rate.

957. Finally, the EIRR represents the social return on investment of the project. It also represents the discount rate at which the discounted total costs and benefits are equal (ENPV = 0). It can be compared to a benchmark to evaluate the project performance from a social perspective. The EIRR, however, is insensitive to the discount rate and does not, however, provide much perspective on the timing of the costs and benefits.

10.3.2 Social Discount Rate

958. The choice of the discount rate can be quite controversial, and rightly so since it can have a significant impact on results. Unlike the financial discount rate, which reflects the opportunity cost of capital, the economic discount rate (or social discount rate) should reflect how society value current costs and benefits versus future one.

959. We assessed recent practice in setting social discount rates, notably as reviewed by Juzhong Zhuang et. al (ADB, 2007), where the authors find significant variations in social discount rate policy around the world. The two most frequently used approaches are the Social Opportunity Cost (SOC) of capital and the Social Rate of Time Preference (SRTP). The former is based on the premise that public and private investments are competing for the use of scarce resources, that public investments can squeeze out private investments and that therefore public investments should yield a return at least equal to that of private investments, otherwise welfare can be increased by reallocating resources to the private sector. Discount rates using the SOC method, as used in developing countries particularly in Asia, can yield discount rates in the range of 10-15%. The African Development Bank assumes the social discount rate for Botswana to be 12%, using this approach. The World Bank also applied a social discount rate of 12% for its evaluation of the Integrated Transport Project in Botswana, without specifying the basis for this rate. It is assumed that it is based upon their assessment of the SOC.

960. A consensus is growing around the social rate of time preference approach. Among individual countries, most developed countries follow this approach and apply much lower discount rates, mostly in the range of 3–7%, with many revising the rates downward in recent years. The formula most used to measure the SDR based on that approach is as follows:

- SDR = growth rate of public expenditure*elasticity of marginal social welfare + rate of pure time preference

961. Applying this to Botswana and Namibia, the average annual growth rate in real public expenditure, applying the implicit GDP deflator has been 4.6% and 2.9%, respectively[14]. The pure rate of time preference is fairly stable across countries, around 1-1.5% and it was decided to adopt a benchmark value of 1.3% for the rate of pure time preference, following the approach adopted recently by Humavindu in his research on Namibia. Finally, the elasticity of social welfare, which reflects the aversion to income inequality and can be based on the progressiveness of the tax structure, is generally between 1 and 2. Since no detailed data on tax receipts are available for Botswana and Namibia, we assume a central value of 1.5, with a lower-bound of 1 and an upper-bound of 2.

962. Applying the formula implies a social discount rate of 7.5% for Botswana and 5.2% for Namibia. Consequently, we decided to use a social discount rate of 6.4% (mid-point of Botswana and Namibia SRTP discount rates) and to test at 12% rate (as per WB and AfDB) in sensitivity analysis.

10.3.3 Converting Financial Costs to Economic Costs

963. For the purpose of economic analysis, costs can be separated into capital and maintenance and operating costs. Capital costs include land acquisition, infrastructure, and equipment. Maintenance and operating costs include everything from labour, materials, fuel and energy and other. The financial cost estimates include allowances for depreciation and amortisation, based on generally accepted accounting principles. However, in economic analysis, we estimate the stream of real investment required to realize and maintain project benefits, together with a residual value for these assets at the end of the project.

964. The financial costs need to be adjusted so that they reflect their actual economic value (i.e. the social opportunity cost of the resources), rather than their market price. Indeed, markets often incorporate significant price distortions created, for example, by market barriers (e.g. tariffs or subsidies), social policies (e.g. minimum wages) or simply due to market imperfection, macroeconomic unbalances or rigidities (e.g. wage rigidities). Financial estimates are transformed into economic values by applying appropriate conversion factors.

965. Because of the macroeconomic nature of conversion factors, and in order to maintain consistency across different projects, these factors are generally produced by a planning office of the State, rather than project-by-project. However, relatively standard factors have not been developed for the study region. Humavindu (2008) has estimated conversion factors for Namibia based on his analysis of the macroeconomic environment.

966. The Standard Conversion Factor was based on the trade weighted average tariff for Botswana and Namibia as reported by the World Trade Organisation. For Namibia, this is 10.8%. The latest country report for Botswana does not specify this indicator, but based on the underlying data provided in the report, the rate appears to be similar. As such, the SCF, which will be applied to traded equipment

[14] Based on IMF country reports.

and goods to be used in the construction and operations phases, is assumed to be 0.90 (100/110.8).

967. Land costs were estimated based on market prices. The conversion factor was thus estimated at 1.0.

968. Labour cost factors were estimated separately for unskilled, skilled and specialist labour because of the differences in labour market characteristics for these broad categories. Both Namibia and Botswana are characterized by: significant underemployment (especially for unskilled workers); major wage differentials between skilled and unskilled; minimum wages in the formal sector. . These factors lead to wages being set higher than the economic opportunity cost of labour and therefore justify adjustment factors being applied to correct for imperfections in the labour market. On this basis, we have applied conversion factors of 0.40 for unskilled labour, 0.90 for skilled labour and 1.0 for specialist (i.e. primarily expatriate) labour. The overall labour conversion factor, based on the estimated mix of labour skills types, was 0.6.

969. Raw materials and equipment, which are traded goods, are attributed the SCF of 0.90. Infrastructure development is assumed to be composed of 50% raw materials, 25% unskilled labour, 15% skilled labour and 5% specialist labour. The conversion factor based on its composition is estimated at 0.76. Finally, all other expenses are assumed to be composed of 50% unskilled labour and 50% equipment or raw materials, with an estimated conversion factor of 0.65. The conversion factors used in this study are summarised in the following table.

Figure 10-5: Standard Cost Factors Used in the Economic Analysis

Type	Conversion factors	Notes
Standard	0.90	SCF measured based on average tariffs
Land	1.00	Land acquisition was made at market prices
Labour unskilled Labour skilled Labour specialist	0.40 0.90 1.00	Estimated shadow wage for non-competitive labour market Shadow wage for semi-competitive labour market Competitive labour market
Raw materials	0.90	Traded good; Standard conversion factor
Equipment	0.90	Traded good; Standard conversion factor
Works	0.76	30% unskilled labour; 15% skilled labour; 5% specialist labour; 50% Raw Materials
Other	0.65	50% unskilled labour; 25% materials; 25% equipment

Source: CPCS analysis based on various sources.

10.3.4 Economic Benefits

970. The two broad categories of economic benefits are the producer surplus and the consumer surplus.

971. **Producer Surplus:** The gross producer surplus simply reflects revenues, which were calculated in the financial model as described above. To obtain a net measure of the producer surplus, however, we must remove maintenance and operating costs. In financial terms, revenues minus operating costs are called operating profits, or EBITDA (earnings before interest, taxes, depreciation and amortization). In economic terms, however, the costs must be multiplied by the appropriate conversion factors (as presented above). Net economic producer

surplus was calculated as revenues minus the economic cost of operations and maintenance.

972. The key issue is to compare the project case to the no project case for each class of traffic. For coal traffic, the implementation of the project is the precondition for the future development and expansion of the mining industry in the project catchment area. In other words, the overwhelming proportion of the projected rail coal traffic will be generated as a result of the project. For the remaining categories of traffic, the key benefit is the transport cost savings as a result of diversion of traffic from road to rail.

973. For **coal** traffic, without the project, it is not economically feasible to produce coal in the study catchment region: the cost of transport is too high. The coal transported as a result of the implementation of the project can therefore be considered as "induced demand". The calculation of the benefits associated with induced demand is quite complex. It requires information about the cost structure of each individual mine to which we do not have access, as this information is not in the public domain. A short-hand approach exists for calculating the transport benefits of induced demand exists, but it is generally regarded as extremely unreliable in cases when virtually all the traffic is induced, and therefore we have not incorporated it into the calculation of ENPV and EIRR of the project[15]. Instead, we have provided separately a preliminary estimate of the economic impact of the coal production generated as a result of the project.

974. For **other** traffic, one of the key potential benefits of a new railway is the cost savings that would accrue to shippers when the service is compared to existing truck services. In the financial model, rail tariffs are set so that total logistic costs for the rail option is 15% lower than that measured for the relevant truck option. A priori, this suggests that all rail traffic captured will benefit from a surplus equivalent to 15% of the trucking cost.

975. There are, however, two main reasons why this estimate may be incorrect. Rail transport is generally slower than truck transport for point-to-point transport. For some goods, the cost in terms of inventory can be significant. Second, since the trucking industry in the study catchment area experiences periodic over-supply, pricing in the trucking sector may be lower than modelled. This explains why rail pricing must be significantly lower than truck pricing to ensure the competitiveness of the rail service. As a result, rather than assuming that the consumer surplus is equivalent to a 15% difference in price, we assume a difference of only 7.5%. This lower estimates accounts both for the additional transit time necessary for rail service, and the potential for a lower trucking price related to over-supply which would lower consumer surplus.

10.3.5 Economic Results

976. The economic results are broadly similar, in terms of ranking of alternatives, to the financial results. At the recommended social discount rate of 6.4%, all the six scenarios are economically beneficial and partial public financing is therefore justified. The results for the SG options are superior to those for the CG options.

[15] The technical issues and policy advice is set out in World Bank Transport Research Note 11 on *Treatment of Induced Traffic* (World Bank, 2005). It can significantly overstate transport benefits.

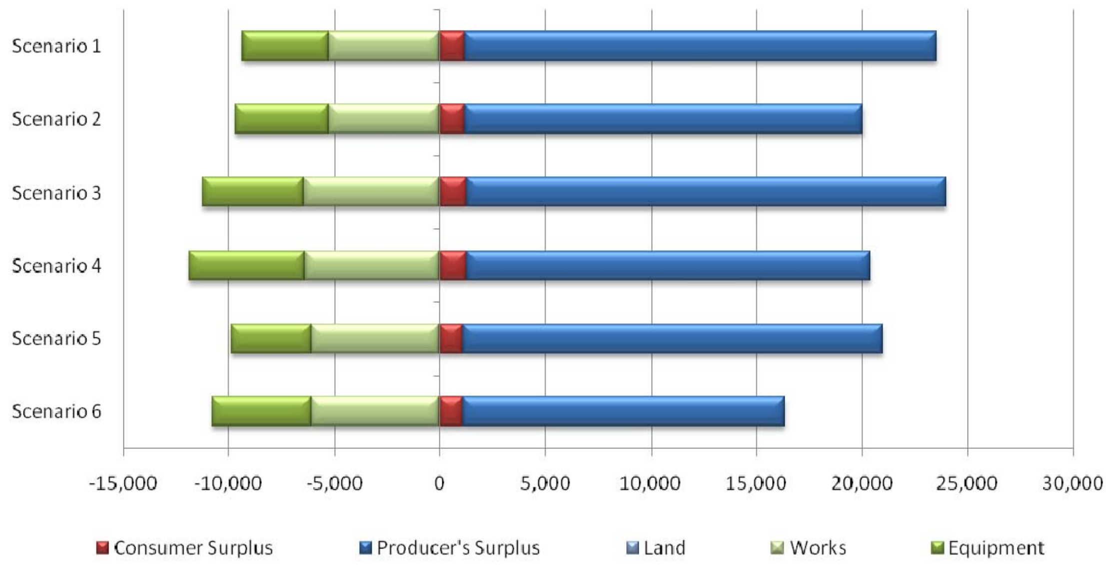
977. The summary economic results and the scenario rankings are shown in Figure 10-6. They confirm that the preferred option is the Walvis Bay SG routing via Mariental. Only one minor change in the scenario ranking was observed based on the selected metric. Note that should the more demanding 12% social discount rate be applied, based on the Social Opportunity Cost concept, only scenario 1 would be deemed economically attractive and the second best would Scenario 3, (Standard Gauge Walvis Bay via Gobabis). As discussed above, we strongly believe that the SRTP approach, as increasingly practised in Europe, is more appropriate for guiding decisions on projects such as this.

Figure 10-6: Economic Ranking of Scenarios: Base Case

Scenario	ENPV $, mil	Rank	EIRR %	Rank	BCR Ratio	Rank
1 - Walvis Bay, SG, Mariental	5,735	1	12.8%	1	1.66	1
2 - Walvis Bay, CG, Mariental	3,563	4	10.5%	4	1.39	4
3 - Walvis Bay, SG, Gobabis	4,392	2	10.7%	2	1.42	2
4 - Walvis Bay, CG, Gobabis	2,025	5	8.4%	5	1.18	5
5 - Lüderitz, SG, Mariental	3,797	3	10.6%	3	1.41	3
6 - Lüderitz, CG, Mariental	514	6	7.0%	6	1.05	6

978. The distribution of economic costs and benefits under the base case scenarios is indicated in the following figure. The results are fairly consistent across the board. On the benefit side, producer's surplus accounts for over 90% of total benefits in all scenarios, while on the cost side, works generally account for between 55 and 60%, equipment for 38-44% and land the rest (see Figure 10-7).

Figure 10-7: Discounted Costs and Benefits by Category, Base Case Scenarios



979. The economic returns presented here are conservative because of the (correct) decision to exclude the coal transport benefits because of the lack of supportable quantifiable data. Our assessment is that if the benefits could be measured accurately, the overall impact would likely overwhelm the other factors in the economic analysis and increase the EIRR considerably.

980. As an alternative to attempting to calculate the benefits of coal transport induced demand, we made a tentative estimate of the annual benefits of production value added from coal production (i.e., addition to GDP) brought on stream as a result of this project. The estimate indicates a peak annual production value added of $195 million (present value of $1.9 billion at the social discount rate of 6.4%), assuming gross value added per ton of approximately $3, the recent estimate derived from an analysis of the Botswana national accounts[16]. Clearly, this is only an indicative estimate: there is no guarantee that the value added per ton for new production will be the same as for existing production – we would need to have access to proprietary mine-specific cost information; also, the result is extremely sensitive to coal prices, as increases or decreases from current levels go straight to the bottom line. Still it implies an increment of 1-1.5% to Botswana GDP.

10.4 Sensitivity Analysis

10.4.1 Financial Sensitivity Analysis

981. The results of the financial analysis were tested for their sensitivity to key assumptions, notably to guard against the danger of "optimism bias" in the financial analysis[17]. The main tests were:

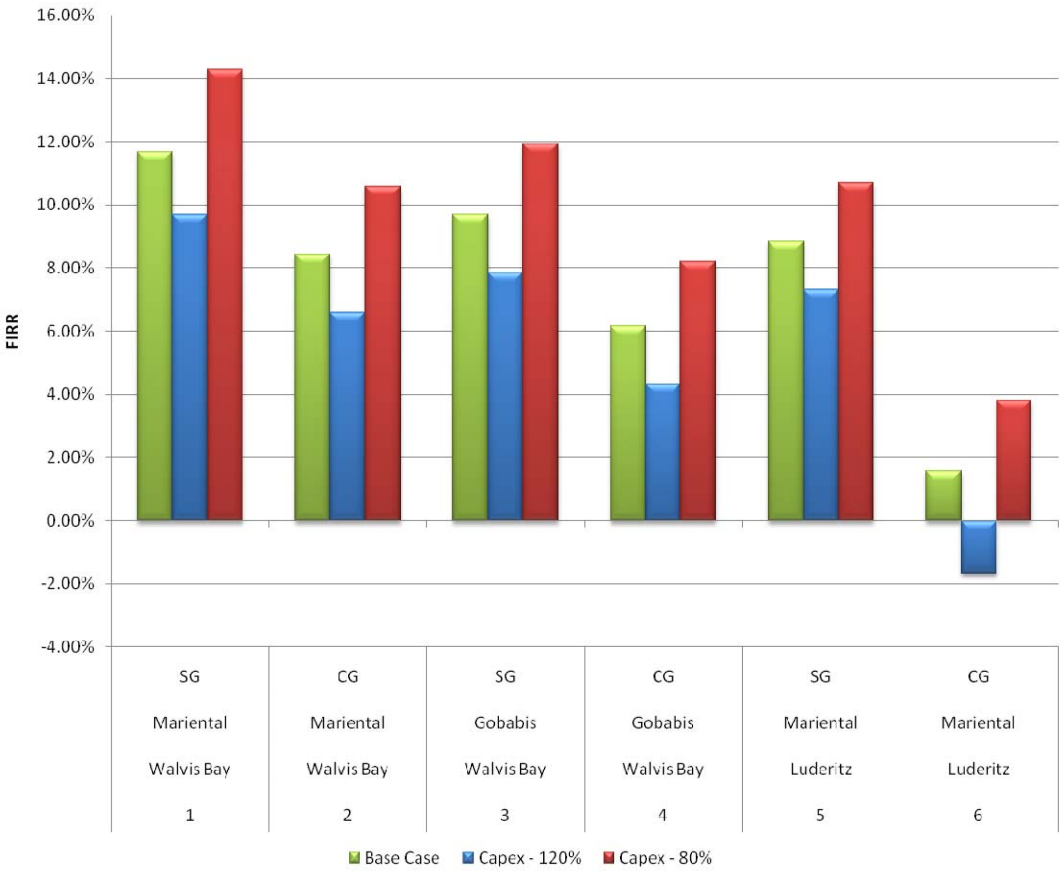
- Actual capital costs are 80% and 120% of the estimates presented in this report;
- Actual traffic volumes and revenue are 80% and 120% of the estimates presented in this report; and
- Pessimistic scenario: capital costs 20% higher and revenues only 80% of the forecasts presented in the base case scenario.

982. As is typical with capital-intensive infrastructure projects, the financial attractiveness of the project is relatively sensitive to variances in capital costs, compared to base case estimates, as indicated in Figure 10-8. For example, in the case of the most attractive option, if Capex were to exceed estimates by 20%, project IRR is projected to decrease from 11.7% to 9.7% (-17.1%). The ranking of the options is not affected.

[16] CSO, National Accounts Statistics of Botswana, Quarterly Domestic Product, 1997/98 to 2007/08; US Energy Information Agency, International Energy Statistics, www.eia.doe.gov

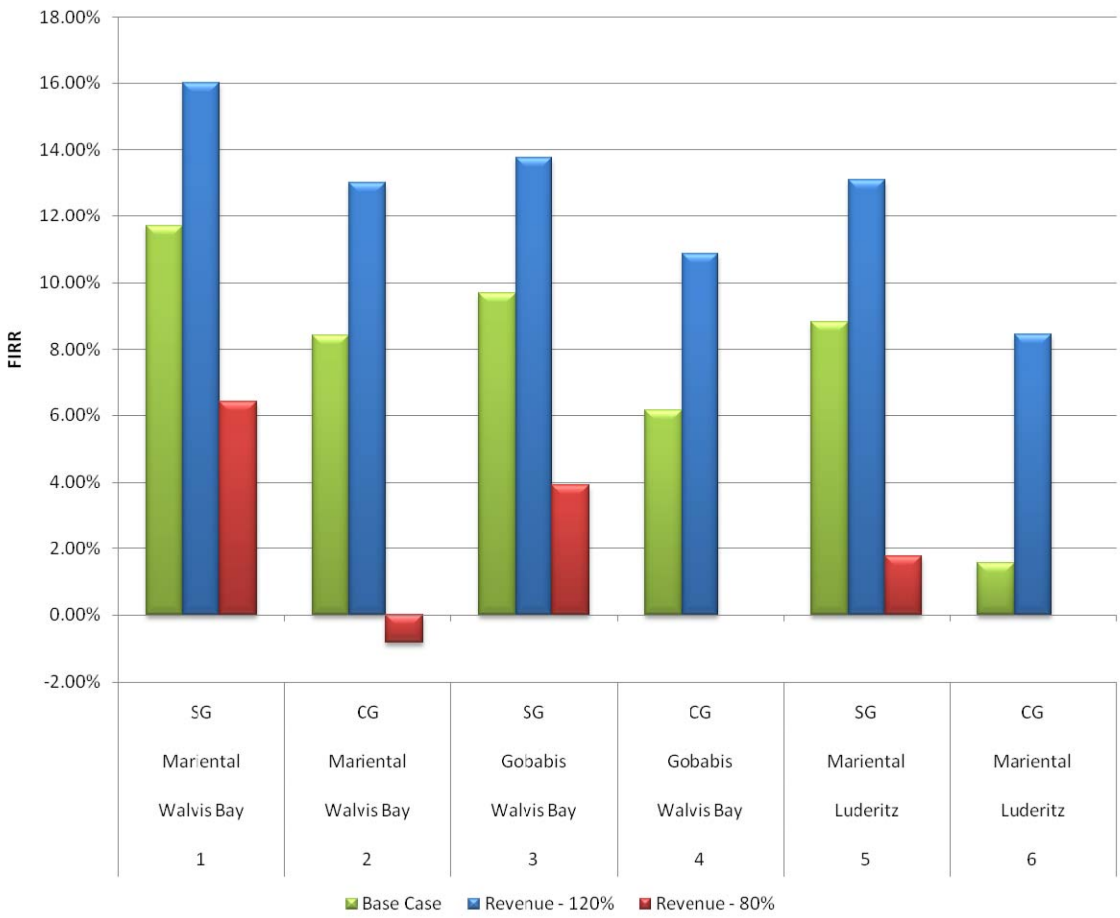
[17] As per the results of analysis reported in Bent Flyvberg, Policy and Planning for Large Infrastructure Projects: Problems, Causes, Cures (World Bank Policy Research Working Paper 3781, 2005).

Figure 10-8: Sensitivity of FIRR to Capital Cost Variances



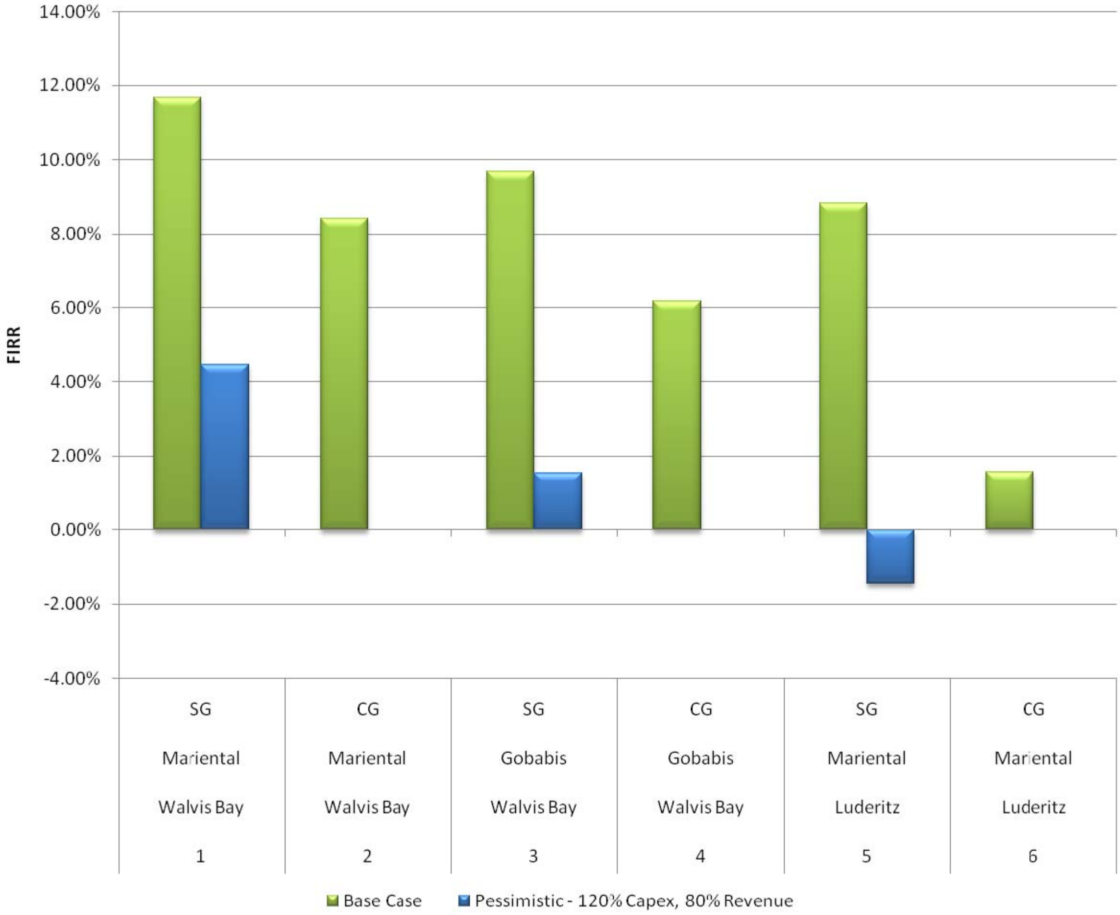
983. The financial results are even more sensitive to revenue forecasting errors. Figure 10-9 indicates the predicted impact on FIRR if revenues are 80% and 120% of the base case levels. In the case of the most attractive option, if revenues only achieved 80% of the forecast level over the life of the project, the FIRR would drop from 11.7% to 6.4% (-45%). For the least attractive option (CG route to Lüderitz via Mariental) FIRR drops below zero if revenues only achieve 80% of forecast levels. Again, the ranking of the options is not affected.

Figure 10-9: Sensitivity of FIRR to Revenue Variances



984. Further, we developed a pessimistic case, where capital costs exceed forecasts by 20%, but revenues only reach 80% of the forecast level. Typically infrastructure funders apply such tests when selecting projects. Under such circumstances, the FIRR of the most attractive option is projected to slip by 62%, from 11.7% to 4.5%, and the project, from being close to commercially viable would appear financially quite unattractive. This highlights the importance, when it comes to the transaction stage, to ensure: a) that the capital costs are based on rigorous feasibility studies and b) that traffic and revenue forecasts, particularly for coal, are locked in through mechanisms such as take-or-pay contracts.

Figure 10-10: FIRR under Pessimistic Case



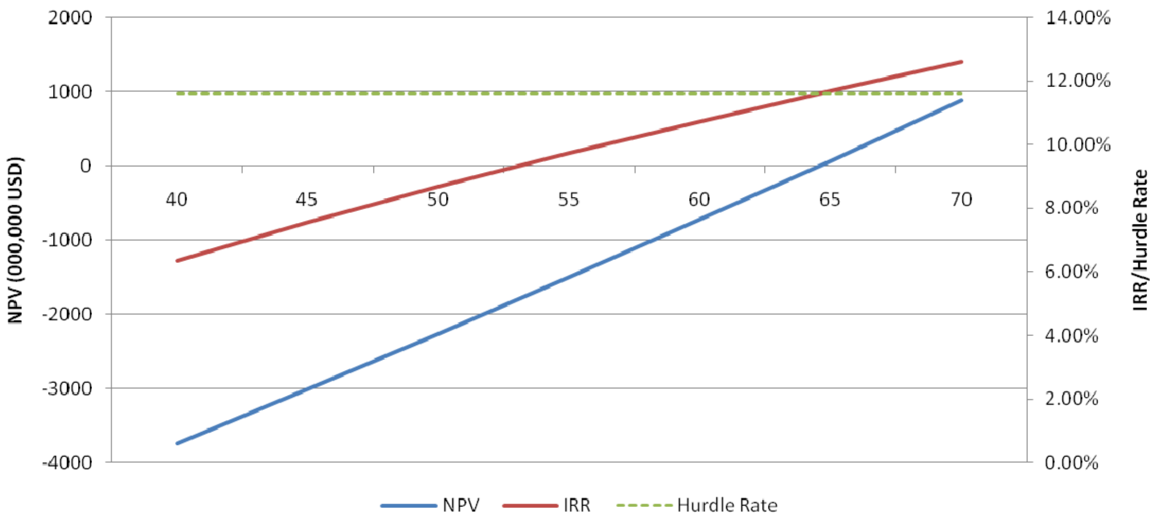
10.4.2 Ramp-up, Intermodal, and Tariff Sensitivity

985. We also assessed the impact on financial performance of delays in achieving the revenue forecasts. In the Base Case, it was assumed that traffic would "ramp up" to peak levels over three years. In the sensitivity analysis, we assessed the impact of delaying the growth in traffic to four years, five years and six years. For the financially preferred option, the impact on FIRR was as follows: ramp up period of three years, FIRR was 11.7%, four years: 11.2%, five years: 10.8%, six years: 10.4%.

986. We also, at the request of the Project Steering Committee, assessed the impact on financial performance of a scenario in which only coal traffic was considered. The results of this scenario are indicated in the figure below for the Walvis Bay via Mariental SG option. The key finding is that annual traffic volumes of slightly more than 70 million tons would be required for the project to reach the financial hurdle rate.

987. The Revenue sensitivity test is equivalent to testing various tariffs and examining their affect on the project viability. 20% increase/decrease in revenue represents an increase/decrease in the coal tariff of US$0.003/tkm. Similarly the intermodal tariff increases/decreases by US$0.01/tkm.

Figure 10-11: Sensitivity of FIRR to Volume of Coal Traffic

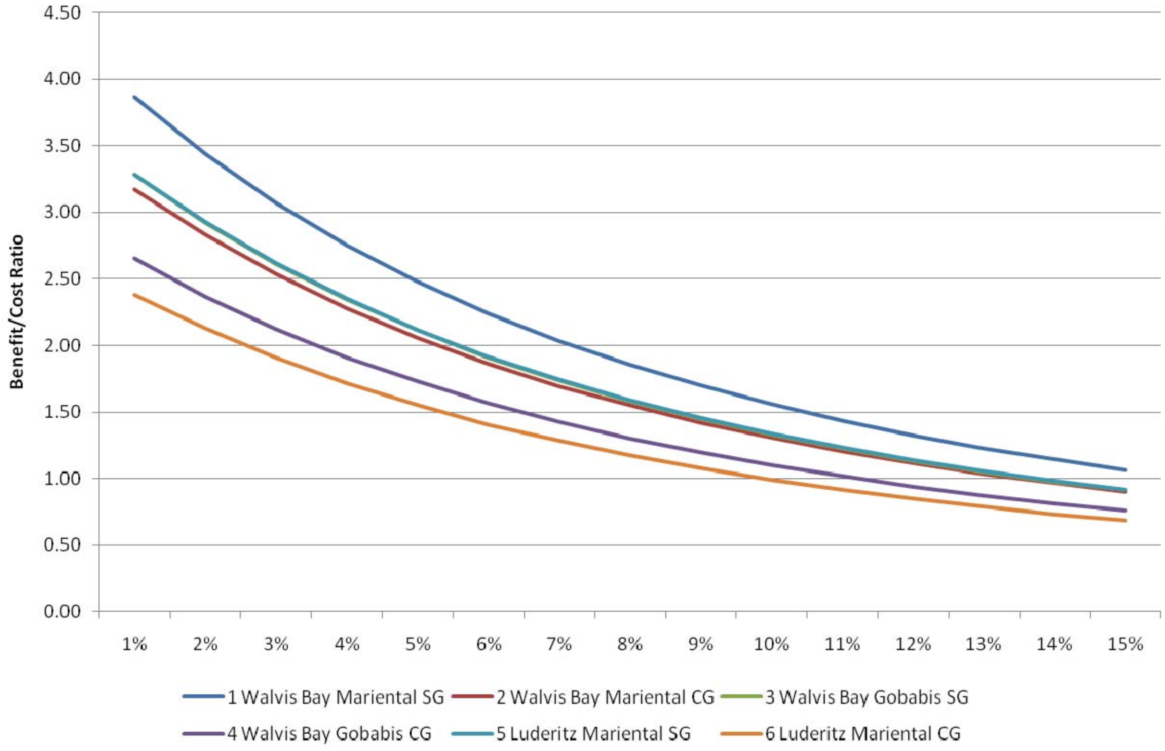


10.4.3 Economic Sensitivity Analysis

988. Similar analysis was carried out on the sensitivity of the economic analysis to variances on the base case assumptions. At the recommended 6.4% social discount rate, the most attractive option "passed" under all cases, even the pessimistic case (EIRR of 8.2%, compared to 12.8% under the base case). This indicates that, even under the conservative transport benefit approach that we adopted, there is at least one possible option that appears economically beneficial under a wide range of circumstances.

989. As indicated earlier, the choice of social discount rate is critical and the range of discount rates used can vary from 3% in certain European countries to as high as 15% in certain Asian countries. Figure 10-12 illustrates the benefit cost ratio for each of the main options reviewed in this report, indicating the range under which each option can be considered economically beneficial.

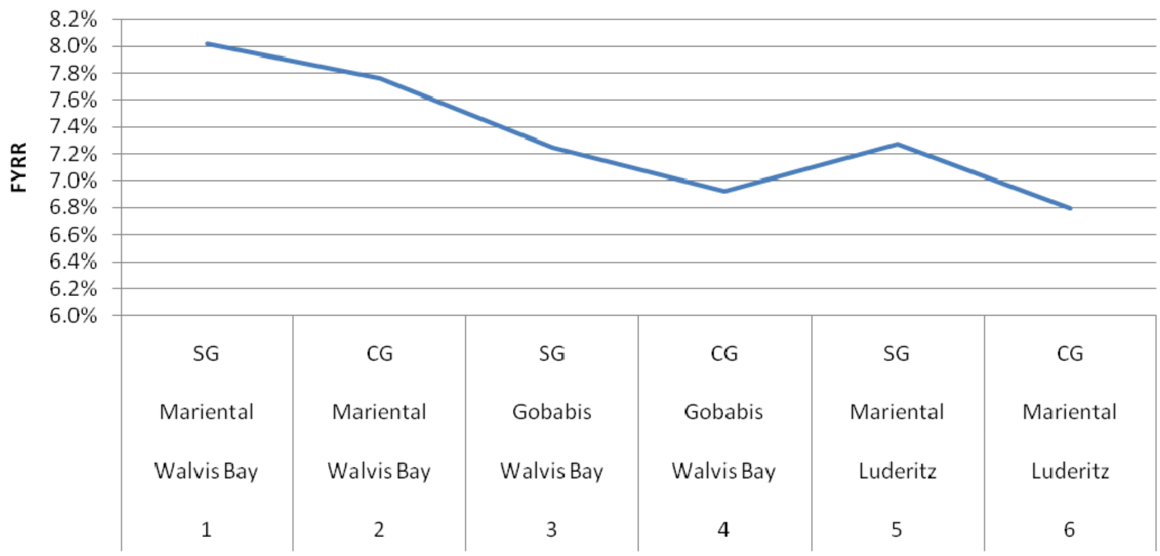
Figure 10-12: Benefit Cost Ratio of Project at Various Social Discount Rates



10.5 First Year Rate of Return

990. The following figure plots the first year rate of return. Option 1 (SG, Walvis Bay, Mariental) is the highest with a calculated value of 8.0%. The lowest (CG, Lüderitz) value is calculated at 6.8%. Note that all options are lower than the weighted average cost of capital.

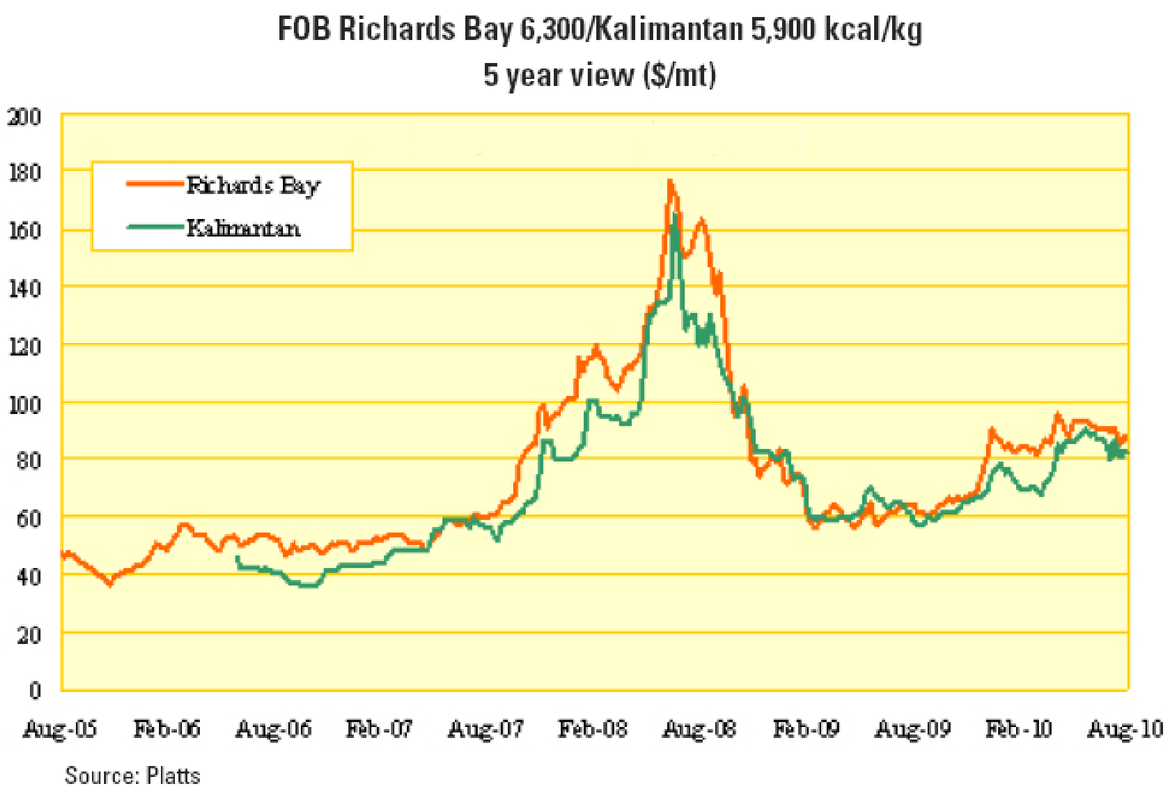
Figure 10-13: First Year Rate of Return



10.6 Free on Board and Maritime Costs

991. Using the currently available information, at best a range of Free on Board (FOB) cost of coal from a coastal port in Namibia can be estimated. This is due to a variety of reasons, primarily the fact that the proprietary costing information of coal mine operations in the project catchment area is not available. Costs will also vary depending on the type of mine to be constructed and the tariff agreements. Based on other historical data, we believe it is reasonable to assume productions costs (including capital outlay) in the range of US$10-40/ton. At projected rail tariffs, estimated in the model (US$0.015/tkm), the shipping cost to a port in Namibia is estimated at approximately US$21/ton. By these estimates, the FOB cost of coal at a Port in Namibia is likely to range between US$31-61/ton. Figure 10-14 provides comparative FOB costs from Richards Bay terminal in South Africa.

Figure 10-14: FOB Richards Bay



10.7 Marine Cost Comparison

992. As shown in the Inception Report, rail, truck, and ship costs per net tonne kilometre can be estimated as follows:

- Rail – US$0.01-0.05 per net tonne kilometre;
- Truck – US$0.06-0.10 per net tonne kilometre; and
- Ship – US$0.001-0.005 per net tonne kilometre.

993. To compare the cost savings to transport coal from Namibia as opposed to Richard's Bay, a handful of assumptions are required. Using the worst case

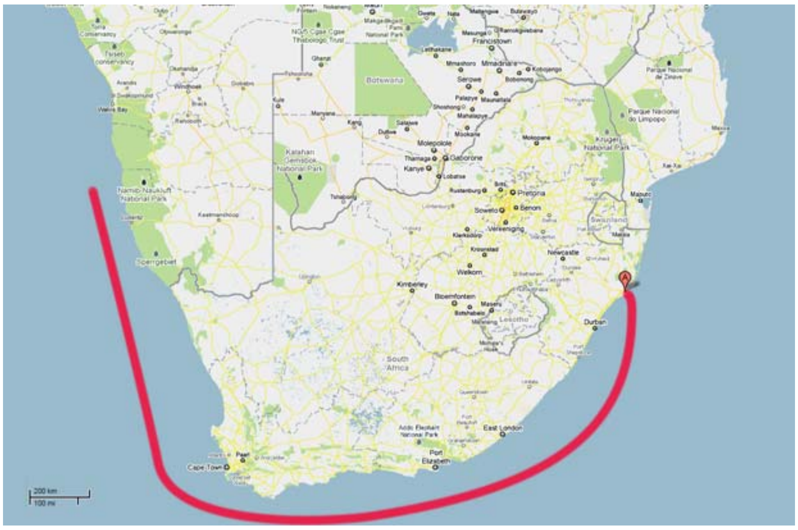
assumption above of US$0.005/tkm and an estimate of the route distance between Richard's Bay and the Namibian Coast, we can approximate what a customer may pay for coal destined to Europe. If we estimate the distance at 4000km, the marginal cost difference for 65MTpy of coal is US$1.3billion per year ($20/ton), quite a substantial figure (*note: this does not include rail costs*).

994. It is critical to note that these figures are only indicative as many of the variable required to prepare a more in-depth FOB analysis are not available, such as:

- mine operating and capital costs
- quality of the coal
- port and rail tariffs
- actual vessel size
- actual sea route
- railway operations and maintenance costs
- rail line congestion

995. A full feasibility study would provide additional level of detail, as currently the final route/port and exact operational details are unknown. This analysis is also of very limited use as the cost of shipping on the rail lines in South Africa would need to be factored into the equation. As the rail distance from the mines to the port would be less than in Botswana/Namibia, the actual advantage would be less.

Figure 10-15: Approximation of a Sea Route from Richards Bay to a Namibia Sea Port



Source: Google Earth

10.8 Comparison to Local Tariffs

996. Tariffs were received by email from Botswana Rail and TransNamib. A summary of these is provided in Figure 10-16. As previously indicated, a tariff of $US 0.015/tkm was assumed for coal on the TKR line. This conservative assumption was required because the current tariffs may not be feasible given with large volumes of coal over a long distance such as the TKR. The tariff used in the analysis is assumed to be at the low end of a range of potential tariffs (see 10.7). Economies of scale are also a factor here, which would provide for lower costs and a significantly reduced tariff.

Figure 10-16: Current Tariffs for Coal

Botswana					
Origin	**Destination**	**BWP/ton**	**Distance (km)**	**BWP/tkm**	**USD/tkm**
Morupule (Palapye)	Ramatlabama	156	400	0.390	0.062
Namibia					
Origin	**Destination**	**NAD/ton**	**Distance (km)**	**NAD/tkm**	**USD/tkm**
Namibia Border	Walvis Bay	478.74	1200	0.399	0.060

Source: Emails from Botswana Rail, TransNamib

10.9 Conclusions

997. Based on the financial and the economic analysis carried out at the pre-feasibility level and reported in this chapter, the most attractive scenario is clearly the SG routing from Mmamabula to Walvis Bay via Mariental. The results are quite robust. This is ranked as the most attractive option under both the financial and economic analysis.

998. The project has significant economic benefits and the preferred option has a positive benefit cost ratio under a wide range of social discount rates. The transport benefits of the project have been estimated conservatively, following the guidelines of the World Bank, and could be enhanced significantly provided that we are able to access estimates of the cost structure of proposed coal mines that are not currently in the public domain.

11 Risk Assessment

11.1 Types of Risks

999. The success of any project involves major unknown variables regarding construction, costs, markets (traffic and revenues), and development and delivery processes. The project delivery method must be structured to identify and analyse those risks, assign the risks and related activities to the party (public or private) best able to control and mitigate them, and utilize the best available risk mitigation strategies.

1000. Risks are fundamental to all projects – there is no way in which all risks associated with a particular project or endeavour can be eliminated. They arise from the very nature of project work, in that projects are ventures into the unknown. Whether it is an infrastructure or a services project or a combination of both, we cannot know everything about the finished state of that project at the outset. This is purely because we are starting only with ideas and progressing to (in most cases) a highly detailed, complex and expensive piece of work or system. The process of progression from idea to reality (and eventual success or failure) is an exploratory process – the ideas we have at the outset must be tested; analysis must be done of feasibility, practicality and acceptability; judgments must be made as to whether to proceed or rethink. In some cases, our very social systems (legislative, regulatory, and community/sector organisation) must be modified to accept the new project and the supposed benefits it brings.

1001. We have categorised the risks intrinsic to the project under the four main project tasks: 1) design, 2) finance, 3) construction, and 4) traffic and operations.

1002. Figure 11-1 distinguishes risks intrinsic to the project from exogenous project environmental risks.[18] Two critical factors determine whether a particular risk should be shifted to the private sector: the degree to which it is able to influence or control the outcome that is risky, and its ability to bear the risk. The government should transfer a particular task or risk to the private sector if such a transfer of responsibility or property rights leads to a net efficiency improvement.

[18] Exogenous Project Environmental Risks usually do not pertain to either of the two parties, yet may have serious repercussions on various aspects of the project. They include risks of force majeure (acts of God), macroeconomic risks as well as risks of changes to the legal and regulatory environment that are not specific to the sector.

Figure 11-1: Risk Sharing between Public and Private Partners

Nature of risks	Risks better allocated to private sector	Risks better allocated to the public agency
Exogenous project environmental risks		
Macroeconomic risks	Shared through negotiations	Shared through negotiations
Force majeure risks		
Legal and Regulatory risks		
Appropriation risks	No	Yes
Expropriation risks	No	Yes
Risks intrinsic to the project		
Task 1 Design		
Change orders risk	No	Yes
Untested technology risk	Yes, Contract specific	No
Task 2 Finance		
Interest rate risk	Yes	No
Exchange rate risk		
Intra consortium counterparty risk		
Task 3 Construction and procurement		
Property acquisition and right of way delays risk	No	Yes
Construction delays risk not attributable to public sector	Yes	No
Intra consortium counterparty risk	Yes	No
Health and safety risks	Shared	Shared
Unforeseen construction cost overruns risk	Shared	Shared
Task 4 Traffic, Operations and Maintenance		
Freight volume revenue risk	Yes	No
System performance risk	Yes	No
Risk of operating and maintenance costs overruns not attributable to public sector	Yes	No

Source: CPCS Transcom analysis

Exogenous Risks (including Regulatory). Exogenous Project Environmental Risks usually do not pertain to either of the two parties, yet may have serious repercussions on various aspects of the project. They include risks of force majeure (acts of God), macroeconomic risks as well as risks of changes to the legal and regulatory environment that are not specific to the sector.

Design. The public agency must define the project, carry out preliminary design and engineering and develop performance specifications. Risks arising during the design stage include change order risks; these should be borne by the public sector partner. Untested technological innovations should be treated as private sector risk, although this would be contract specific.

Finance. Financial risks are parameters inherent in the project's financial set-up and include interest rate risk and exchange rate risk. Increases in interest rates and depreciation of the local currency inflate project costs and reduce profits; the private sector parties can mitigate some of these risks through appropriate guarantees and insurance. The risk of one party not upholding its financial commitments is shared.

Construction. The risks at the construction stage include property acquisition and right of way delays risk, health and safety risks, counterparty risks, construction delays risk, and unforeseen construction cost overruns risk arising from, for example, uncertain tunnelling and geological conditions. The private sector can take on most of the construction risk and it holds the greatest incentives to minimise construction delays and costs overruns. When assessment of geological risks is overly uncertain, it is appropriate for the public sector to bear part of the risks of delays and overruns.

Traffic and Operations. The two main sources of risks at the operations stage are freight volume revenue (demand) risk and the risks of operating and maintenance costs overruns. Most of the operating cost risk should be appropriately allocated to the Concessionaire. The Government may retain ridership revenue risk in the event passenger service is included.

Operating cost increases that can be ascribed to the private sector should be allocated to the private sector parties. The private sector parties should also be compensated for cost increases that result from changes to sector specific regulations (e.g. safety, quality of service).

Figure 11-2: Assessment: Appropriate Risk Management

Project Delivery options	Advantages	Disadvantages
1. Design and build civil works	• Contractor assumes design risk and responsibility. • Private sector would indemnify the public agency against design defects. • The price may be fixed, or there may be provisions for cost reimbursement up to a fixed ceiling.	• Public agency responsibility for financing, operating and maintaining the project. • Public agency responsible for assuring integration of the design-build contract work with remaining system elements, and enforcing contract warranties and guarantees.
2. Provide Operation & Maintenance (O&M), procure and partly finance rolling stock and rail systems	• Private operator assumes operations risk. • Depending on tariff policy and tariff collection system private sector may hold minimal share of revenue risk.	• Separating DB from O&M means losing incentive of tying design-builder to the operation of the system, this usually provides an implicit incentive to build a better system as it would eventually be responsible for O&M.
3. Design and build civil works, rolling stock, rail systems and provide O&M (mixed financing)	• Private sector would hold design-build responsibilities. • By committing to a fixed fee for operations and maintenance, private sector essentially provides to the public agency a long-term warranty on its design and	• Responsible for tariff setting and the determination of service levels; as a result, usually retains operating revenue risk. • Government financing and credit enhancement necessary.

Project Delivery options	Advantages	Disadvantages
	construction work. • Depending on balance of risks private sector may be willing to accept more financing responsibility.	
4. Design and build civil works, rolling stock, rail systems and provide O&M (100% private sector financed)	• Same advantages as 3, except that all financing provided by private sector	• Depending on the revenue sources used and revenue risk allocation, private partners are not likely to be exposed to revenue risks. • Private sector may still seek government credit enhancements.

Source: CPCS Transcom analysis

1003. On balance wrapping DB and O&M offers a substantial benefit in incentivising the design-builder to contract a high quality railway and port system that it would eventually have to operate. It could also lead the high balling on price by bidders.

1004. In addition to project risks there are 'Country Risks' which we should highlight. Country risks include all those risks inherent with the project location. They can include:

- **Risks generated by poor investment climates.** Security of capital (either financial or physical) is dependent at least partially on the location of that capital. Investors want to be sure they can retrieve their capital in the event of either project failure (retrieval or sale of equipment, real estate, etc.) or project success (repatriation of profits or implementation of project exit strategies).
- **Risk of political interference and corruption.** This can be an overriding concern in many countries around the world. Corruption is a particularly difficult risk to assess as it is by nature secretive. The eventual cost of corruption can be huge and potentially debilitating to a project. Political interference hampers projects by imposing interests not necessarily congruent with the interests of the project. Examples include political direction of project staffing, interference with scheduling to match a political term of office and interference with the procurement process due to kickbacks (a combination of both political interference and corruption).
- **Economic risk.** The economic fortunes of a country can interfere with the success or failure of individual projects. One example would be a recession, which could reduce the ridership of a new transit system due to job losses.
- **Exchange risk.** This risk is closely related to economic risk, in that a country's exchange rate can be dramatically affected by its economic performance in relation to the rest of the world. As project financing is often in a currency foreign to the country, a poor exchange rate can actually raise the overall cost of a project to the extent that the project is financially not attractive.

- **Supply risk**. There is a risk that the goods that form the anchor traffic on the planned railway line might be in short supply and this would negatively affect the financial viability of the project. As evaluated in the Traffic Studies Report, coal is the main commodity to be moved and already there are about 200 billion tonnes of coal deposits within the Botswana, which would last the 50 year planning horizon of the TKR. In addition there are other commodities that have been identified within the agricultural and mining sectors which would continue to augment the anchor traffic.

1005. As well as Country Risks there are Sector Risks. These risks include:

- **High fixed costs.** Rail projects are high cost schemes. This comparatively high cost is exacerbated if there are frequent bridges and culverts due to existing topography or physical development. The high fixed costs mean less capacity of the project to adapt to operational issues such as changes in freight volumes and labour costs.
- **Long Payback Period.** Although related to the high fixed costs, long payback period is a risk in itself in that it lengthens the period in which the capital is at risk. This is important in that when investors compare an extensive rail project to one in another sector with a shorter payback period, the other project may be chosen or a higher hurdle rate may be required to undertake the rail project.
- **Inter-Modal Competition.** The rail system will generally require feeder services, which the other systems would have to provide, especially where it traverses long inter-country distances. However, poor coordination and communications in the planning and implementation process can cause the other modes to offer competition rather than coordination and cooperation – the modes compete rather than interact positively. This can be a substantial risk and can cause project failure.
- **Demand risk.** Demand can be volatile in some sectors thereby rendering some projects very high risk in terms of financing. However the Traffic Studies Report has outlined the demand for the coal anchor traffic for up to 2030 which shows that demand will continue to be sustained from the Far East countries, especially India and China.

11.2 Mitigating Risk

1006. Risk mitigation involves concerted action in the planning and implementation phase to actually reduce the level of risk perceived to be in the project. By replacing risk (uncertainty) with knowledge, the level of overall risks are lowered, leading to lower costing of risk within the project and a lower cost project overall.

1007. The cost of the project and its sustainability depends substantially on the reduction or mitigation of risk. We feel that this is by far the most effective way of controlling project costs and raising the sustainability of a project. It does, however, require a higher level of planning and implementation efforts – this denotes more early stage expenditures on planning, analysis and design of both infrastructure and the social/political institutional framework in which the project operates. It requires a higher involvement and an active advocacy role to be played by the public sector stakeholders.

11.2.1 Mitigating Country Risk

Investment Climate Improvements

1008. Investors and lenders love a stable, appropriate legal and regulatory framework. This goes a long way towards assuring them that their rights as investors are protected, and their capital will not be subject to arbitrary appropriation or other untoward attention. Having appropriate Public-Private Partnership (PPP) and Foreign Direct Investment (FDI) legislation in place is recommended. This may have to be drafted from scratch, or existing legislation may have to be amended to suit the PPP format for TKR under preparation.

1009. A strong and appropriate legal and regulatory framework for operations is also highly recommended. Although this legislation and its associated regulations often is oriented towards regulation of the operators to protect the public, having the environment known and being able to price the project within that context is in fact a reduction of risk.

1010. A strong and supportive railways transport policy, accepted by both Governments, is a clear signal to private sector investors that the Governments are behind the concept of long distance rail transport and has a "roadmap" in mind for development of the sector.

1011. Related to the railway transport policy and no less important is a well-integrated transport master plan. This document, based on the policy as developed, indicates the near and medium term infrastructure developments to be undertaken in the transport sector. This strong indication of where the Governments wish to go with infrastructure development allows reduction of risk/uncertainty associated with future government actions and is very helpful in improving the investment climate for potential investors.

Political Risk Mitigation

1012. For better or worse, the vast majority of railway transport projects are instigated by the public sector – by the government of the day. This means that these projects can be subject to considerable political interference, which can include:

- Interference in the procurement process;
- Setting of unreasonable schedules to meet a political term of office;
- Delays in public sector funding of projects due to annual budgetary considerations;
- Politicisation of and interference with the regulatory authorities; and
- Risk of project cancellation or dramatic changes in the event of a change in Government.

1013. Reduction of perception of political risk depends strongly on the political entities themselves. Strong statements have to be made that corruption and interference in the procurement process will not be tolerated. These statements must be followed up on and must be seen to be followed up on. Project planners must be allowed to plan what is best for the project, without influence from politicians pursuing a different mandate. This applies both to the project schedule and the final product of the project.

1014. The World Bank recognises that implementation of an effective regulatory agency is best achieved by ensuring separation from the political environment in both operations and funding. Suggested methods of achieving this include creation of an arms-length regulatory body funded, where possible, by proceeds of the project itself – transit system revenues.

11.2.2 Mitigating Sector Risk

Intermodal Competition

1015. As noted earlier, existing transport modes can and will compete with a new railway system unless project planners make specific efforts to avoid such competition. These efforts can include:

- Early communication and exploration of concerns with existing transit operators. A consultative process can actually add to the viability of a new rail project in that input from other stakeholders can provide valuable insight into the industry and what changes will ensue. This information can be used to improve the project at hand. However, the primary reasons for consultation are:
  - To alleviate concerns and quell rumours in the existing industry; and
  - To discuss the possibility of absorption of existing transit workers into the new organisations (the operator's technical and operations staff, station staff, the regulator, etc.).
- Explicit planning of feeder services for intermodal traffic. Discussions with informal operators should be held to see where accommodation of their activities can be made.
- A strong public relations programme. If the public can be convinced of the merits of the new system, acceptance by both the public and the existing industry is more readily obtained.

1016. Involvement by the Government and its transport planners is crucial in these initiatives to send a message to the existing transport industry that their concerns are being considered and dealt with. Personal contact between the stakeholders is vital in ensuring harmonious and productive relations between the existing transport sector and the transport authorities.

11.2.3 Mitigating Project Risk

Market Risk

1017. Demand and freight studies can be considered potential maximum estimates of the forecast ridership, as they implicitly assume that goods will be able to be loaded with ease onto the trains. Provision of a robust system with good intermodal interchange is one of the best ways of ensuring that expected traffic volumes (and revenue) are realised.

Implementation Risks – Mitigation by Public Sector

1018. Some of these risks and mitigation measures were dealt with under Country Risks. Political interference in project planning and implementation can seriously harm the prospects of a project, and disconnection of the project from the political cycle (for schedules) and annual budget line items (for funding) can be very helpful. In the case of TKR the private sector investors have to be cushioned against too much political interference.

Implementation Risks – Mitigation by Private Sector

1019. The private sector can also benefit from the use of schedule incentives. A prime contractor could, for example, provide or pass on schedule incentives to its subcontractors.

1020. The PMC, project consultants and the private sector contractors are usually responsible for project schedules. These must be planned early, planned thoroughly and revisited often in order to maintain adequate project management information. Frequent updates can assist in mitigating the effects of day-to-day delays as well as the major delays sometimes encountered in project work.

1021. One important factor in risk mitigation is getting the right information. The proper preparatory studies (hydrological and geotechnical analysis, topographic mapping, cadastral mapping, legal/regulatory analysis, institutional appraisal) should be carried out if this information is not known. This is generally delegated to consultants by the public sector, or could be included in the PPP contractor's TOR. Care should be taken in the latter case to avoid conflict of interest.

Transition Risk – Getting from the Old to the New

1022. All the planning in the world will come to naught if the transition from the old to the new is not carefully planned and implemented. Transition risk – the risk of not even achieving the state that was envisioned in project design – can be very high.

1023. Project planners must be realistic about resistance to change in institutions and their personnel. If institutional strengthening, organisation or bolstering is required, the change process in going from the existing state to the final state should be carefully assessed, not only in terms of the needs of the new organisation, but the capability of the existing arrangements to absorb the change.

1024. A full Risk Register has been developed for the project and is provided as Appendix A. This outlines the Mitigation Initiatives as well. It is recommended that a Risk Assessment Workshop be held at some point before Phase 2 of the project is completed. This will enable the risks to be ranked and should be carried out by an independent facilitator.

12 Plan for Further Project Preparation

1025. This section summarises the conclusions from the various assessments and gives an outline Implementation Plan as well as the Action Plan for privatisation.

12.1 Conclusion of Rail Assessment

1026. An investigation of the existing rail infrastructure in both Namibia and Botswana has shown that geometrical standards such as horizontal curvature and ruling grades do not fall within the design criteria requirements for a high volume haulage line such as coal.

1027. The three alignment options have been assessed taking into account SG and CG scenarios for each alignment. A major advantage that SG has over CG is that it can accommodate higher axle loads, thus allowing for heavier trains. Economy of scale plays a vital role when addressing the costing of the two gauge scenarios. The assessment was based on a cost point of view, and did not take interconnectivity into account. Interconnectivity shall be looked at during the assessment of Mmamabula-Ellisras and Mosetse-Kazungula, which is Phase II of this Prefeasibility Study.

1028. The option to convert to a Dual Gauge system was investigated. An important consideration when opting for a dual gauge system is the impact of running trains over long distances at different speeds. The clashes in terms of services patterns and the increased overall waiting time incurred by differential train speed profiles will cause a cumbersome and inefficient service programme, thus compromising the full benefit of a single gauge option. The advantages that SG has over CG are substantially minimized when a dual gauge system is adopted over a long distance and with the capacities that are required of the system.

1029. The topography along Option 2 route (Mmamabula to Walvis Bay via Mariental) is less severe than the other two route alignments. Total earthworks for Option 2 is less than the other two proposed routes by approximately 24% for the CG option, and approximately 22% for the SG option.

1030. The sand dune encroachment and entrance constraints to possible harbours near Lüderitz will have the most severe effect on the construction cost of alignment Option 3. Sand-laden winds are able to form dunes that are 30m high and dunes move at a rate of 50m to 300m per year. This makes engineering solutions such as tunnels very costly.

1031. The provision of about 13 km of tunnels due to the dynamic sand dunes and several cuttings due to the severe topography makes Option 3 (Mmamabula to Lüderitz) route for coal transport not favourable. Approximately 15 km of tunnels is required on Option 1 due to severe topography. Option 2 does not require any tunnelling.

1032. The rail infrastructure capital cost for each alignment option was estimated using our experience in costing similar rail projects. Option 2, CG scenario was marginally lower in terms of 'Below Rail' capital costs. However, due to SG requiring smaller fleet sizes and cheaper rolling stock, the 'Above Rail' capital cost for CG turned out to be slightly more than for SG.

1033. Figure 12-1 summarises the total Capex for CG and SG scenarios.

Figure 12-1: Total Capex for CG and SG scenarios in Million USD

Standard Gauge	Mmamabula to Walvis Bay via Gobabis (Option 1)	Mmamabula to Walvis Bay (Option 2)	Mmamabula to Lüderitz (Option 3)
Above Rail Capex	4,148	3,262	3,837
Below Rail Capex	7,031	5,347	6,598
TOTAL	11,179	8,609	10,435
Cape Gauge			
Above Rail Capex	5,087	3,739	4,972
Below Rail Capex	6,809	5,264	6,504
TOTAL	11,896	9,003	11,476

1034. Total operating costs for the railway line over a 30 year period, including all intermodal operations are summarized below.

Figure 12-2: Total Opex for CG and SG scenarios in Million USD

Standard Gauge	Mmamabula to Walvis Bay via Gobabis (Option 1)	Mmamabula to Walvis Bay via Mariental (Option 2)	Mmamabula to Lüderitz (Option 3)
Above Rail Opex	24,292	19,908	25,872
Below Rail Opex	2,321	2,126	2,322
TOTAL	26,613	22,034	28,194
Cape Gauge			
Above Rail Opex	31,907	27,038	37,044
Below Rail Opex	2,431	2,256	2,547
TOTAL	34,338	29,294	39,591

12.2 Conclusions on Ports Assessment

1035. The two port options assessed included Lüderitz and Walvis Bay. The design vessel selected for both stages of the trade forecast was a Cape Size vessel with loading capacity in the order of 250,000 metric tonnes.

1036. The sites for the on-land coal terminals in each case were located in a position that should allow future expansion, while also being relative close to a berthing site.

1037. The selection of the coal terminals were therefore a combination of factors that included:

- Sufficient water depth or sites that could be dredged to provide the required depth for access and berthing; and
- Proximity to on-land sites suitable for the coal terminal stock yards.

1038. In both cases, the sites require overland conveyors between the stock yards and the trestle to the berths. Open piled berthing structures were assumed to provide a sub-structure to the conveyors feeding material over water up to the berthing platform, and supporting rail mounted travelling shiploaders.

1039. For non-coal cargo the required facilities were priced at component level based on previous similar facilities. Where possible, the cargo was routed to existing facilities, e.g. for the Walvis Bay option the salt and container cargo were routed to the existing terminals. Grain was routed to the future terminal being planned for Namport.

1040. Costing of the port terminals for sites were based on similar projects with allowances for contingencies, however, the relative cost is expected to be fairly well defined.

1041. From an off-site infrastructure point of view, further studies would be required to determine the investments required for sufficient electricity and water supply. Allowances have been made for Lüderitz at a higher input cost than for Walvis, due to the Lüderitz region being less developed in terms of infrastructure.

1042. The natural features of the two sites resulted in the following salient differences in the quantities:

- The overland conveyors in Walvis are considerably longer than in Lüderitz.
- The dredging requirement in Walvis was higher than Lüderitz.
- The trestle length from the coastline up to the berth for Walvis is longer than for Lüderitz.
- Lüderitz will require more blasting and earthworks to prepare the on-land terminal site and access routes due to the uneven nature and the presence of very hard rock.

1043. The costing summary for the port options are presented below.

Figure 12-3: Total Capex summary for Luderitz Port Terminal

	Phase 1 – 16.8 Mtpa	Phase 4 – 65 Mtpa
ON-SHORE CAPEX		
TOTAL – ON-SHORE CAPEX	$872,749,655	$1,038,037,328
OFFSHORE CAPEX		
TOTAL – OFFSHORE CAPEX	$375,358,824	$493,266,283
GRAND TOTAL (for each phase)	$1,248,108,479	$1,531,303,612
GRAND TOTAL (project completion)	$2,779,412,091	

Figure 12-4: Total

	Phase 1 – 16.8 Mtpa	Phase 4 – 65 Mtpa
ON-SHORE CAPEX		
TOTAL – ON-SHORE CAPEX	$948,905,908	$1,473,357,454
OFFSHORE CAPEX		
TOTAL – OFFSHORE CAPEX	$655,483,594	$560,249,118
GRAND TOTAL (for each phase)	$1,604,389,502	$2,033,606,572
GRAND TOTAL (project completion)	$3,637,996,073	

Figure 12-5: Total - Lüderitz

	Phase 1 – 16.8 Mtpa	Phase 4 – 65 Mtpa
ON-SHORE OPEX		
Fixed OPEX	$29,040,000	$112,357,143
Variable OPEX	$4,065,600	$15,730,000
TOTAL – ON-SHORE OPEX	$33,105,600	$128,087,143
OFFSHORE OPEX		
Fixed OPEX	$12,018,066	$36,054,198
Variable OPEX	$51,857	$155,571
TOTAL – OFFSHORE OPEX	$12,069,923	$36,209,770
GRAND TOTAL (for each phase)	$45,175,523	$164,296,912

Figure 12-6: Total - Walvis Bay

	Phase 1 – 16.8 Mtpa	**Phase 4 – 65 Mtpa**
ON-SHORE OPEX		
Fixed OPEX	$29,040,000	$112,357,143
Variable OPEX	$4,065,600	$15,730,000
TOTAL – ON-SHORE OPEX	**$33,105,600**	**$128,087,143**
OFFSHORE OPEX		
Fixed OPEX	$24,183,751	$72,551,253
Variable OPEX	$51,857	$155,571
TOTAL – OFFSHORE OPEX	**$24,235,608**	**$72,706,824**
GRAND TOTAL (for each phase)	**$57,418,249**	**$200,871,008**

12.3 Recommendations

1044. Based on the technical and financial conclusions, CPCS recommends that **Option 2** (Mmamabula to Walvis Bay port via Mariental) alignment to be the best from a Capex and Opex point of view.

1045. We further recommend that the most favourable gauge option for a heavy haul line that traverses great distances, as the TKR does, would be the **Standard Gauge option**. This is only from a cost perspective and does not take into account interconnectivity. This is a subject that may be debated further.

1046. The study has shown that Lüderitz port is preferred over Walvis Bay port as a location for coal terminal and coal shipping facility. However, the high cost due to length of railway, tunnelling, and environmental constraints, of a TKR railway line to Lüderitz reduce the benefits of expanding the Lüderitz port.

1047. The detailed alignment plans for Option 2 route (Mmamabula to Walvis Bay port via Mariental) on a scale of 1:50,000 are shown in Appendix B.

12.4 Finance, Construction and Operations

1048. The strategy for financing, construction and operating the TKR can be summarised as follows:

- Build new lines and port terminal only through Build-Operate-Transfer (BOT) schemes with some Government financial support.
- Set-up an international competitive tender for the selection of a private concessionaire to manage operate, manage, maintain and rehabilitate the rail and port infrastructure and operate the freight services under a rail concession scheme.
- Set-up a franchise for passenger services[19], private operators would be selected under an international competitive tender process. While some services may be considered commercially viable for the most part the operator would receive a subsidy in the form of a public service obligation (PSO) payment from the Government.
- Sell or lease all non-core existing facilities and activities.
- Set-up a regulatory body to monitor the concessions and administer the track access regime in which a track access fee is paid for by passenger franchise operators.

1049. The following processes are a summary of our best practices learnt in similar projects. The best practice would then be assessed by the Transaction Advisor and the governments of Botswana and Namibia.

Figure 12-7: Government of Botswana and Namibia (GBN) Concession Configuration and Design Consideration

Concession Element	Best Practices	Assessment Requirements
Capital Structure and duration of the concession	• 25 years 'rolling concession'. • At least 51% reserved for the strategic shareholder. • Up to 10% for GBN rail/port employees. • Portion of remaining shares	• What percentage of GBN rail & port operators should be reserved for the strategic shareholder, Botswana and Namibia nationals, Government, employees

[19] Alternatively the passenger services can be integrated into one concession bid package. Either way, investors are typically reluctant to provide non-remunerative services, the Government will be obliged to sign Public Service Obligation (PSO) contracts for specific passenger services.

	can be sold on the stock market.	etc. • What are the stock market rules on listing? • How will the employees acquire their shares?
Rail Transport Services	• Unitary concession. • Operated as a commercial activity by the concessionaire. • Can also design passenger service franchises. • GBN may provide Public Service Obligation (PSO).	• How long is the concessionaire granted exclusive rights to operate? • Define Public Service Obligation (PSO) scheme (maximum tariff, stopping points, service requirements). • Will the GBN decide to drop certain freight services to change the service level to a minimum?
Rail Infrastructure	• Ownership retained by GBN. • Operation, maintenance and investment sole responsibility of the concessionaire. • GBN has option to provide loan guarantees.	• How much rehabilitation of existing infrastructure and new terminal provision needs to be completed before the start of the concession? • How will the governments ensure the terminal infrastructure will be maintained to the right condition (enforcement of standards or reliance on safety regulation).
Port Terminal Infrastructure	• Ownership retained by GBN. • Operation, maintenance and investment sole responsibility of the concessionaire. • GBN has option to provide loan guarantees.	• How much rehabilitation of existing infrastructure and new terminal provision needs to be completed before the start of the concession? • How will the governments ensure the terminal infrastructure will be maintained to the right condition (enforcement of standards or reliance on safety regulation).
Motive Power and Rolling Stock	• Existing equipment to be bought by concessionaire. • Free to dispose of obsolete equipment. • New equipment can be bought or leased.	• Any restrictions on the disposal, purchase and leasing of rail and port equipment? • How much will the concessionaire pay for motive power and rolling stock?
Labour Arrangements	• Staff subject to laws applicable to private sector employees. • Concessionaire free to hire its employees. • Retrenchment programme	• Should a minimum number of GBN rail and port operations employees be hired? • Policy for hiring expatriates (numbers, work permits).

	must be implemented.	• How to pay for the staff reduction programme?
Concession Fee	• Fixed yearly fee. • Variable yearly fee as a percentage of revenue or another financial indicator.	• How to set the terms of the fixed and variable amounts. • Should the variable amount of the concession fee be based on revenue or profit?
Regulatory Framework	• Regulation by contract. • Freedom for the Concessionaire to define service configuration, set tariffs, contract with customers. • PSO offered at Government request under "PSO Contract".	• How to regulate health, safety, environmental protection, rate setting, reduction in services, liabilities, and operating standards? • What shape will both the Railway and Port Regulators take and how will it be funded?
Botswana Railways, Namibia Railways and Namport	• Forego interim arrangements to "increase" the value of the concession • Former Botswana Railways and Namibia Railways are turned into a patrimony company charged with the task of regulating the RS contracts, collecting the concession fee etc. • Review status of Namport in terms of preferred port terminal.	• What effect will this have on the current arrangements within Botswana Railways and Namibia Railways? • Will Botswana Railways and Namibia Railways have title under the relevant Railway Acts to assets of the railway, and can this title be transferred to government or an independent railway authority/regulator? • Will there be any residual responsibilities?

12.5 Privatisation Action Plan

1050. Figure 12-8 presents an indicative timeline for completing a 6-phase privatisation process. The Governments of Botswana and Namibia have already started on implementing Phase A. Phases B through F form the core activities of privatisation transaction. Figure 12-9 presents a conceptual flowchart of implementation activities.

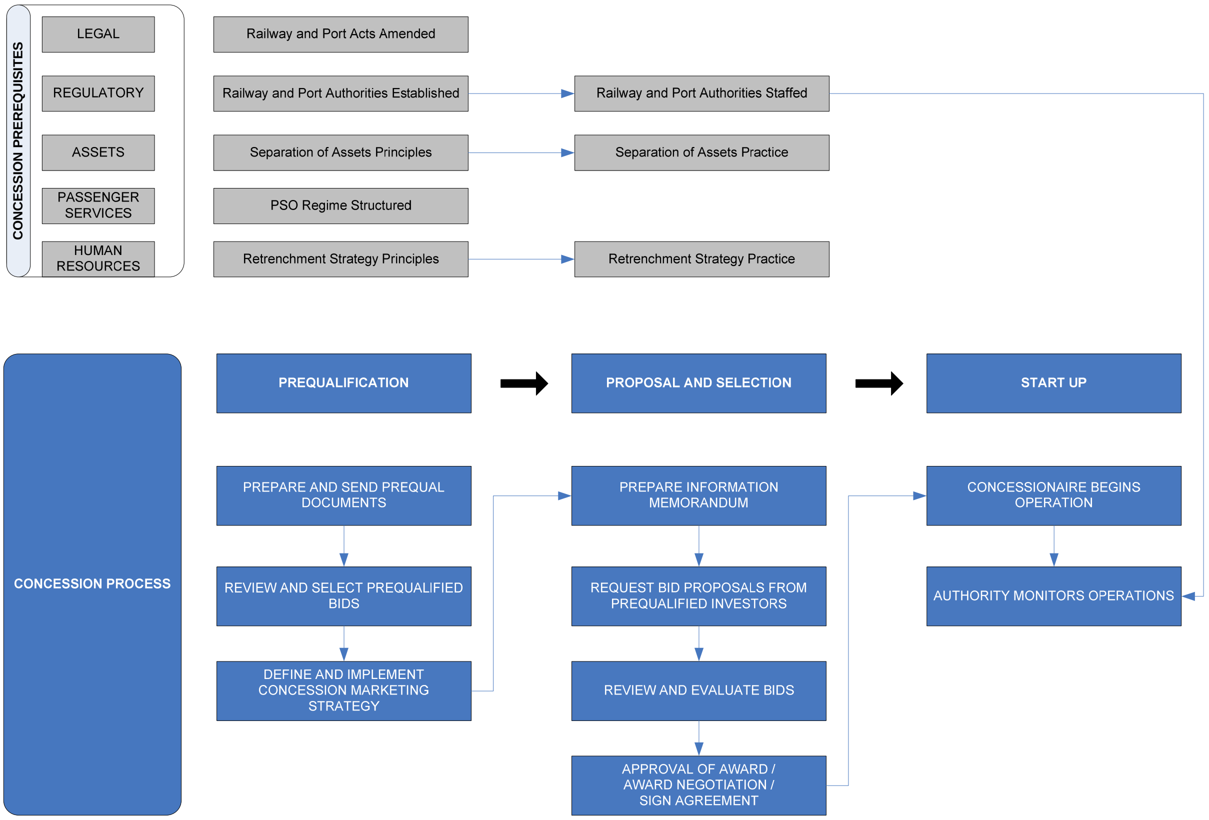
1051. The selection of a concessionaire will require a full-scale competitive bidding process. While it varies from country to country, the privatisation timeframe is generally a minimum of 18 months. It is often much simpler to decide on the ultimate objective than it is to get there.

Figure 12-8: Privatisation Timeline

Phases	Months to Complete	Man-Months of Effort
A. Get government approval, prepare terms of reference and identify the funds for the Transaction Advisor	5	
B. Prepare shortlist, invite proposals and contract with a Financial Advisor	4	
C. Define the concession scheme, prepare a labour restructuring plan, prepare a business plan/financial model, prepare the bidding documents and concession agreement	12	20
D. Promote the investment opportunity and complete the	6	6

bidding process		
E. Negotiate the agreement, complete the arrangements for the takeover and achieve financial closure.	6	8
F. Complete the social restructuring	3	6
Total	**36**	**40**

Figure 12-9: Privatisation Implementation Activities



1052. The project Implementation plan is shown in the following Figure 12-10 under Section 12.6. This gives the timeline for the infrastructure construction and the important milestones.

12.6 Project Implementation Plan

1053. The draft project Implementation Plan (see Figure 12-10) is a high level programme of the approximate duration for construction to complete the TKR to allow for the first production of coal to be exported, as per the traffic forecasts set out in the Traffic Studies Report.

1054. The assumption is made that all enabling studies (including environmental and social processes) have been finalised.

1055. Early procurement of long-lead items has been factored into the programme. Long lead items include the determination of supply chain times and costs. Suppliers of rolling stock to be identified early in the process. This process will also include the rate of production (wagons/time period), shipping schedules and frequency and post of destinations in Southern Africa. The provision of pre-stressed concrete sleepers and the release tempo of sleepers are also very important and have been taken into account in the programme. The material handling equipment for the stock yard and the port terminal also requires early procurement.

1056. The construction of the railway may take place under five contracts (separate sections). These will run concurrently to facilitate in shortening the duration of the construction. The length of track for each contract will be roughly as follows:

- Mmamabula – Gaborone 145 km
- Gaborone – Border 600 km
- Border – Stampriet (Option 2 and 3 alignments) 170 km
- Border – Windhoek (Option 1 alignment) 310 km
- Stampriet – Walvis Bay (Option 2 alignment) 480 km
- Stampriet – Luderitz Bay (Option 3 alignment) 510 km
- Windhoek – Walvis Bay (Option 1 alignment) 340 km

1057. These construction contracts are indicative and may be further split into smaller contracts. This allows for concurrent work to take place, therefore utilizing more labour and reducing overall construction duration.

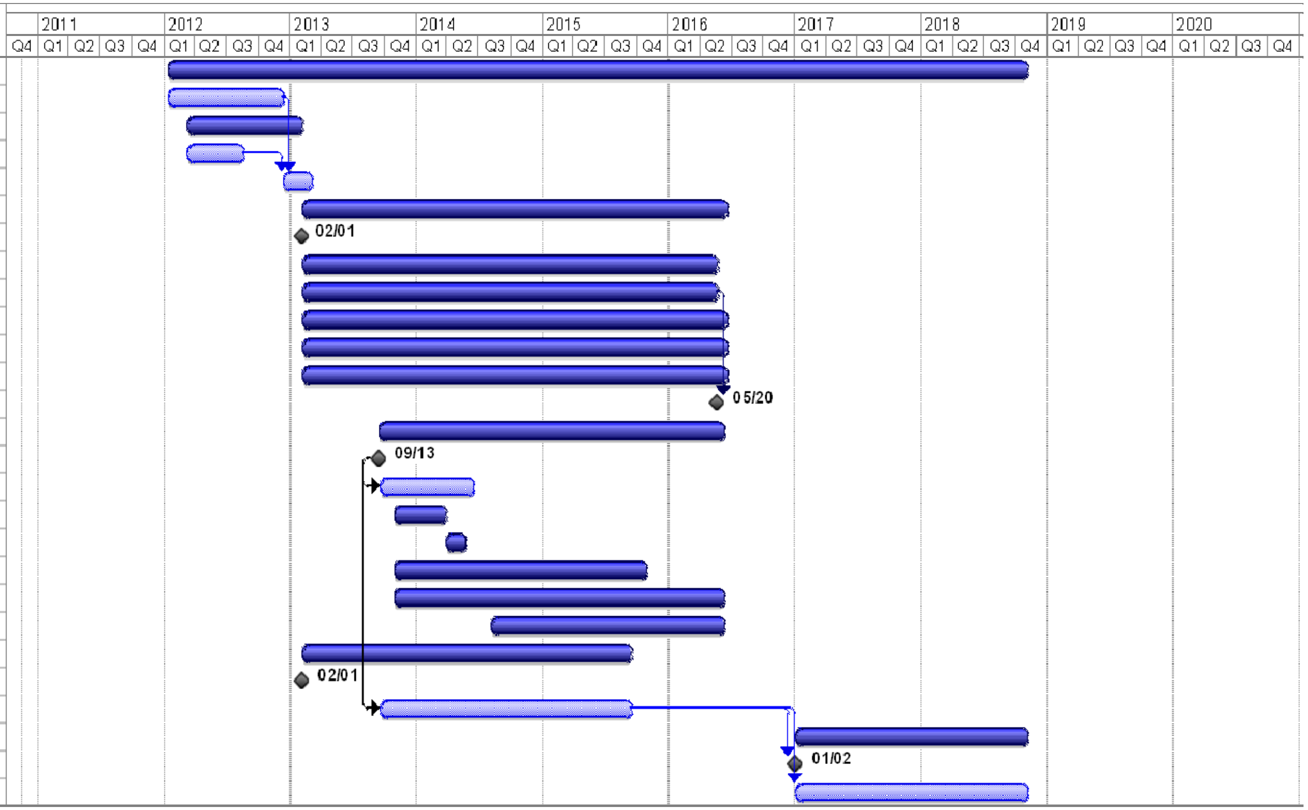
1058. The terminal construction will be split into at least the following: Dredging, Marine structures, Stock Yard, Material Handling.

1059. Key milestone dates show that construction of railway should begin early 2013, and the estimated duration will be approximately 40 months. This allows for testing and commissioning and first productions from the Mmamabula to begin in 2016.

1060. Construction of port and coal terminal will commence in 2013. Phase 1 of the coal terminal (16.8 Mtpa) to be completed in 2015, and Phase 2 (65 Mtpa) to be completed in 2018, in order to meet the export schedule as per the traffic forecast.

Figure 12-10: Draft Project Implementation Plan

ID	Task Name	Duration
1	**TKR PROJECT IMPLEMENTATION PROGRAMME**	**85 mons**
2	Contractor appointments	12 mons
3	**Financial Closure**	**11 mons**
9	Design and Tender Documents	6 mons
10	Tenders and award	2 mons
11	**CONSTRUCTION OF RAILWAY**	**41 mons**
12	Place Contractor Order	0 mons
13	**Mmamabula - Gaborone**	**40 mons**
16	**Gaborone - Border**	**40 mons**
20	**Border - Stampriet**	**41 mons**
24	**Stampriet - Kuiseb Canyon**	**41 mons**
28	**Kuiseb Canyon - Walvis Bay**	**41 mons**
32	Mmamabula coal production commences	0 mons
33	**CONSTRUCTION OF PORT UPGRADE**	**32.6 mons**
34	Place Contractor Order	0 mons
35	Contractor Structural Design	173 days
36	**Mobilisation**	**4.35 mons**
41	**Dredging**	**2 mons**
44	**Pile Yard**	**24.05 mons**
48	**Causeway**	**31.1 mons**
57	**Pier**	**22.05 mons**
68	**CONSTRUCTION OF COAL TERMINAL (16.8 Mtpa)**	**32 mons**
69	Place Contractor Order	0 mons
70	Contractor Structural Design	24 mons
71	**CONSTRUCTION OF COAL TERMINAL (65 Mtpa)**	**24 mons**
72	Place Contractor Order	0 mons
73	Contractor Structural Design	24 mons



13 Conclusions

1061. Based on this Pre-Feasibility Study Report for the TKR the following can be concluded:

1062. In terms of rail options the Mmamabula to Walvis Bay via Mariental (Route Option 2) is the recommended option in terms of Capex and Opex (the option had the lowest 'Above' and 'Below' Rail costs). The option has the shortest route in terms of track kilometres, the least escarpment elevation to overcome, the least amount of earthworks, and no tunnelling was required along its route, as opposed to the other two routes. However on the work done for the Scoping of environmental and socio-economics Route Option 1 (Mmamabula to Walvis Bay via Gobabis) had the least impacts of the three route options.

1063. It should be noted that the route alignments are first order indicative alignments and represent a "preferred" corridor. The corridor, usually 2km wide, thus forms the basis for the aerial survey. Further detail in the form of aerial survey, geotechnical and environmental studies will cause further refinement of the preferred alignments within the corridor. Some of these refinements have already been highlighted in Section 7-Consultations. However, only when all the related studies have been conducted and survey carried out, can the refinement process begin.

1064. Other issues to be taken into consideration include the carrying out of a full Environmental Impact Assessment as well as a comprehensive geotechnical study as part of a full bankable Feasibility study for the project as well as costing the measures.

1065. Walvis Bay port is the recommended port for the coal terminal. The study has shown that Lüderitz port is preferred over Walvis Bay port as a location for coal terminal and coal shipping facility. However, the high cost due to length of railway, tunnelling, and environmental constraints, of a TKR railway line makes the Lüderitz port option economically unattractive and therefore Walvis Bay port is recommended instead.

1066. Based on the financial and the economic analysis carried out at the pre-feasibility level and reported in this chapter, the most attractive scenario is clearly the standard gauge routing from Mmamabula to Walvis Bay via Mariental (Route Option 2). The project has significant economic benefits and the preferred option has a positive benefit cost ratio under a wide range of social discount rates. Under the default assumptions, Route Option 1 is projected to achieve an FNPV of US$70 million, and an FIRR of 11.7% (MIRR of 11%), slightly above the estimated cost of capital. The second most attractive option is the standard gauge routing via Gobabis to Walvis Bay (Route Option 1), with an FNPV of -$1.9 billion, and an FIRR of 9.7% versus the hurdle rate of 11.6%.

1067. In terms of financing and operating the TKR and the port terminal, our preliminary recommendation is for a Design, Build, Operate and Transfer- "Design and build civil works, rolling stock, rail and port terminal systems and provide operation and maintenance (O&M)" as a public-private financing option.

1068. Due to the conflicting rankings in terms of engineering and financial aspects on one hand and environmental and socio-economics on the other, it is recommended that both Route 1 and Route 2 be taken forward to a full Feasibility Study with Route Option 2 (Mmamabula to Walvis Bay via Mariental) being the preferred option in financial and engineering terms

Appendix A: Comprehensive Risk Register

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
1	**Design Risk**					
1.1	Failure to Adequately specify the employer's requirements	Employer's requirements not accurately translated into Tender Documents	*			No
1.2	Continuing development of design/design work not being completed on time	The detail of the design should be developed within an agreed framework and timetable. Failure to do so may lead to additional design and construction costs		*		Yes through Contract
1.3	Change in design requirements of both Governments	Both Governments may require changes to the design, leading to additional design costs		*		No but can control through careful project management
1.4	Change in design requirements due to external influences specific to the Governments of Botswana & Namibia	There is a risk that the designs will need to change due to legislative or regulatory change specific to the Governments of Botswana & Namibia			*	No but can minimise
1.5	Failure to build to brief	Misinterpretation of design or failure to build to specification during construction could lead to additional design and construction costs		*		Yes through the Contract, careful development of the project brief and ongoing liaison between the Employer's Agent and the Contractor's designer will help remove the possibility

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
						of misinterpretation of the Employer's requirements
1.6	Changes in design as a result of the Rail and Port Safety Audits	The Employer's requirements will contain a requirement for the Contractor to undertake relevant rail/port Safety Audits in. As a result of these Audits the proposed design or the permanent works may require modification in order to improve the safety in operation of the permanent works		*		The Private Sector will be responsible for the detailed design and will be responsible for any costs associated with design changes () or changes to the permanent works prior to opening ()
1.7	Governments' concession programme	The speed of the Governments' programme leading to design inadequacies if Contractors are required to undertake the completion of the works within a timescale that is unreasonable or shortened	*			This can be eliminated through adequate allocation of time and avoidance of delay at the initial stages and consideration of the use of Early Contractor Involvement (ECI)
1.8	Inaccurate traffic forecasts	Inaccurate traffic forecasts may result in the benefits identified by the preferred TKR link/port option being incorrect.		*		Already minimised through use of robust traffic model

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
1.9	Survey information is inaccurate/inadequate	Inaccurate survey information may result in insufficient land take or inadequate design			*	Ensure quality sub-consultant is employed to conduct surveys and main contractor verifies the work undertaken
1.10	Inadequate liaison with stakeholders	Inadequate liaison may lead to third party requirements or accommodation works being omitted from the Employer's Requirements			*	Yes, through the contract
1.11	Scheme objectives not met		*			No, but can minimise through careful development of scheme proposals
1.12	Data availability	Information coming from Governments of Botswana and Namibia and their other key stakeholders might be slow		*		Make early contact with all parties. Be prepared to adjust presentation to address shortcomings.
1.13	Tender Capacity	There may be lack of tender capacity, or collusion between tenderers which may cause an annulment of the tender and time delays in the tender process			*	No

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
1.14	Construction Costs	Cost estimates to be based on preliminary design which would not be adequate		*		Need for a peer review
1.15	Substandard design	The design may have shortfalls in terms of adequate engineering principles and its addressing of problem areas with cost effective engineering solutions		*		Need for a peer review
2	**Construction and Development Risks**					
2.1	Incorrect time estimate	The time taken to complete the construction phase may be different from the estimated one			*	Yes, ensure estimate is reasonable and control through the Contract
2.2	Delay in gaining access to the site	A delay in gaining access to the site may delay the entire project	*			No but can minimise through project management
2.3	Access to land not available for surveys, construction and raw materials (borrow pits)	Access to land for verification surveys or construction of the permanent works may not be available to the whole of the site by the Contract starting date			*	No but can minimise through careful forward planning
2.4	Poor coordination with other works	Interference from other third party works, particularly on the existing railway network may lead to a delay in starting some elements of the permanent works			*	No but can minimise through project management and careful liaison
2.5	"Compensation events"	An event of this kind may delay or impede the performance of the contract and cause additional expense			*	No but can minimise through Contract and project management

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
2.6	Force Majeure	In the event of Force Majeure, additional costs will be incurred.	*			No
2.7	Contractor Default	In the case of contractor default, additional costs may be incurred in appointing a replacement, and may cause delay		*		
2.8	Poor project management	There may be a risk that poor project management will lead to additional costs			*	No but can minimise through careful selection of project management
2.9	Contractor/sub-contractor industrial action	Industrial action may cause the project to be delayed as well as incurring additional management costs			*	No but can minimise through careful election of reputable contractor and could seek to recover any costs incurred
2.10	Key subcontractor becomes bankrupt	Bankruptcy of a key contractor may lead to a delay until a replacement sub-contractor can be appointed		*		Costs associated with appointing a replacement will be borne by the Principal Contractor. Delay damages will be repaid to the Employer in the event of the works overrunning the allocated time
2.11	Abnormal weather and/or ocean	Excessive periods of inclement weather			*	The risk can be

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
	conditions	are normally considered to be compensation events				transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices
2.12	Material supply difficulties	There may be difficulties in obtaining specialised or proprietary materials		*		There are no specialist materials proposed at this time
2.13	Material lead times	Estimated lead times on long-lead items may be underestimated.		*		No but may be minimised through careful planning
2.14	On-track maintenance machinery	Availability and timely delivery of on-track maintenance machinery may not be possible		*		No but may be minimised through careful planning
2.15	Substandard construction methods	The contractor may use substandard methods of construction which may compromise the delivery and quality of the project		*		No but may be minimised through careful monitoring
3	**Health and Safety Risk**					
3.1	Contractor does not adhere to current regulations	The Contractor may breach current Health and Safety legislation or accepted codes of practice		*		
3.2	Changes to regulations	Legislation or accepted codes of practice may change during the period of the contract	*			No
3.3	Responsibility for maintaining on-site	Theft and/or damage to equipment and		*		

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
	security	materials may lead to unforeseen costs in terms of replacing damaged items, and delay				
3.4	Responsibility for maintaining site safety	The Construction, Design and Management Regulations and Occupational Safety Health and Safety at Work regulations must be complied with		*		
4	**Environmental**					
4.1	Unexpected protected species found on site	Verification surveys will be required prior to start of construction works but an unexpected protected species may be found on site later in the works			*	The risk can be transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices
4.2	Mitigation does not match environmental objectives	Suggested mitigation measures to alleviate environmental impact of the proposals may not adequately protect the environment as intended and hence may need to be amended leading to time and cost implications			*	No but can be minimised through careful planning of mitigation measures
4.3	Contamination of ground water	Accidental contamination of the ground water may lead to delay in the works being completed		*		
5	**Public Inquiry**					
5.1	Number of objections greater than anticipated	Dealing with a greater than anticipated number of objections may lead to	*			No

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
		additional management costs and delay				
5.2	Protester action	Protester action against the scheme may incur additional costs, such as security costs		*		Yes, can be transferred through the Contract
6	**Finance**					
6.1	Failure to obtain adequate funding	Failure to obtain adequate funding may lead to indefinite delay	*			No
6.2	Target cost exceeds budget (Budget to include optimism bias)	Tender prices may exceed the pre tender estimate and allocated budget	*			No but can be minimised through independent cost check
6.3	Commodity pricing	Forecast of commodity pricing may be incorrect				No
6.7	Currency / Foreign exchange	Unforeseen fluctuations in currency may change budget costs dramatically	*			No
7	**Legislation**					
7.1	Legislative/regulatory change	A change in non specific legislation/regulations taking effect during the construction phase, leading to a change in the requirements and variations in cost	*			No
7.2	Changes in taxation	Changes in taxation may affect the cost of the project			*	No
7.3	Changes in the rate of Value Added Tax (VAT) or VAT legislation	Changes in the rate of VAT or VAT legislation may increase the cost of the project	*			No

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
8	**Performance Risks**					
8.1	Latent defects in new build	Latent defects to the new build, which require repair, may become apparent			*	No, but can minimise through adequate planning and supervision
8.2	Change in specification initiated by both Governments	There is a chance that, during the construction phase of the project, the Governments of Botswana and Namibia will require changes to the specification	*			No but can minimise through careful project management and internal coordination.
9	**Termination Cost Risks**					
9.1	Termination due to default by the both Governments	The risk that the both Governments defaults, leading to contract termination and compensation for the private sector	*			No
9.2	Default by external funding sources	The risk that the external funding defaults and the project is not completed	*			No
9.3	Termination due to default by the rail & port operator	The risk that the operators default and step in rights are exercised by the financiers, but they are unsuccessful, leading to contract termination			*	Both Governments could recover costs for default but would incur additional costs associated with appointing another operator
10	**Technology and Obsolescence Risks**					
10.1	Technological change	Technical changes that require both Governments to revise their output	*			No

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
		specifications				
11	**Land Risks**					
11.1	Cost of land	Land costs could be greater than expected			*	No
12	**Geotechnical**					
12.1	Unexplained archaeology discovered on site	Archaeological finds may require changes to the programme of works and may incur delay and additional costs, particularly if on the critical path	*			No
12.2	Water table higher than expected			*		Verification surveys required by the Employer's Requirements and risk transferred to Contractor through Conditions of Contract
12.3	Unforeseen ground conditions	Unforeseen ground/site conditions may lead to variations in the estimated cost			*	No, but can minimise by verification ground investigation surveys. The risk can be transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices
13	**Statutory Undertaker Risk**					

No	Risk Heading	Definition	Allocation			
			Public Sector	Private Sector	Shared	Ability to Transfer Risk
13.1	Unforeseen STAT's apparatus	The possibility exists that statutory utilities apparatus may be found that will require diversionary works or changes to the design	*			Yes, can be transferred with onerous Conditions of Contract but this may lead to higher than anticipated tender prices
14	**Other project risks**					
14.1	Delayed planning approval	A delay in receiving planning permission may have broader cost implications for the project, as well as the loss of potential savings	*			No but can minimise
14.2	Inadequate Resources	Human resources or allocated time may be inadequate for satisfactory project management			*	
14.3	Critical staff (train drivers) appointment / competencies / certification	Difficulty in obtaining the required number of critical staff for efficient operations, and/or inadequate certification obtained			*	No
14.4	Insufficient project capacity	Possible fatalities or interruptions in operations, or damage to assets			*	No but can be minimised through internal co-ordination

Appendix B: Alignment Plans and Maps

Please see the attached document, "Appendix B – Alignment Plans and Maps".

Appendix C: Financial Model Output and Assumptions

Please see the attached Microsoft Excel spreadsheet, titled "Appendix C - Financial Model Outputs and Assumptions".

Appendix D: References

Botswana Railways Act, Government of Botswana (1 October, 1987)

Botswana Railways Bye-Laws, Government of Botswana (7 July, 1989)

East African Railways Master Plan Study, CPCS, January 2009

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National Transport Services Holding Company Act, 1998, Government Gazette of the Republic of Namibia (23 September, 1998)

Privatization Policy for Botswana, Government Paper No. 1 of 2000, Republic of Botswana

Public-Private Partnership Policy and Implementation Framework, Republic of Botswana (August, 2009)

Railways Africa. 31 May 2008

Transnet Integrated Port and Rail Masterplan, April 2007

Appendix E: Response Matrix

Please see the attached document, "Appendix E – Response Matrix".