BOEGOEBAAI PORT FEL 1 PHASE 1

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

REV 0

15 October 2019

TM Consulting and Nelutha Consulting
Boegoebaai, South Africa

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FEL 1

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LIST OF ABBREVIATIONS

AASTHO	:	American Association of State Highway and Transportation Officials
AADT	:	Annual Average Daily Traffic
BMM	:	Black Mountain Mine
BS	:	British Standards
CAPEX	:	Capital Expenditure
CPA	:	The Richtersveld Sida !Hub Community Property Association
DR&PW	:	Department of Roads and Public Works
EIA	:	Environmental Impact Assessment
EMP	:	Environmental Management Plan
EPC	:	Engineering, Procurement and Construction
FEL1	:	Front-End Loading Stage 1
ISO	:	International Standards Organization
K	:	Minimum Vertical Curve Radius
kg/m	:	Kilogram per meter
km	:	Kilometer
km/hr	:	Kilometer per hour
kN	:	Kilonewtons
L	:	Length
m	:	Meter
mm	:	Millimeters
m^3/km	:	Cubic meters per kilometer
MCA	:	Multi-Criteria Assessment
MPT	:	Multi-Purpose Terminal
Mtpa	:	Million metric tonnes per annum
No	:	Number
OPEX	:	Operational Expenditure
R	:	Radius
SANS	:	South African National Standard
TNPA	:	Transnet National Parts Authority
TFR	:	Transnet Freight Rail
TPT	:	Transnet Port Terminals
Vpd	:	Vehicles per day

ANNEXURES - DRAWINGS

Drawing No	Drawing Title
1500103-TRANS-9006-P	External Roads General Layout
1500103-TRANS-9007-P	External Roads Typical Cross-sections
1500103-TRANS-9008-P	Port Access Interchange
1500103-TRANS-9009-P	Boegoebaai Main Interchange Bridge: General Arrangement

EXECUTIVE SUMMARY

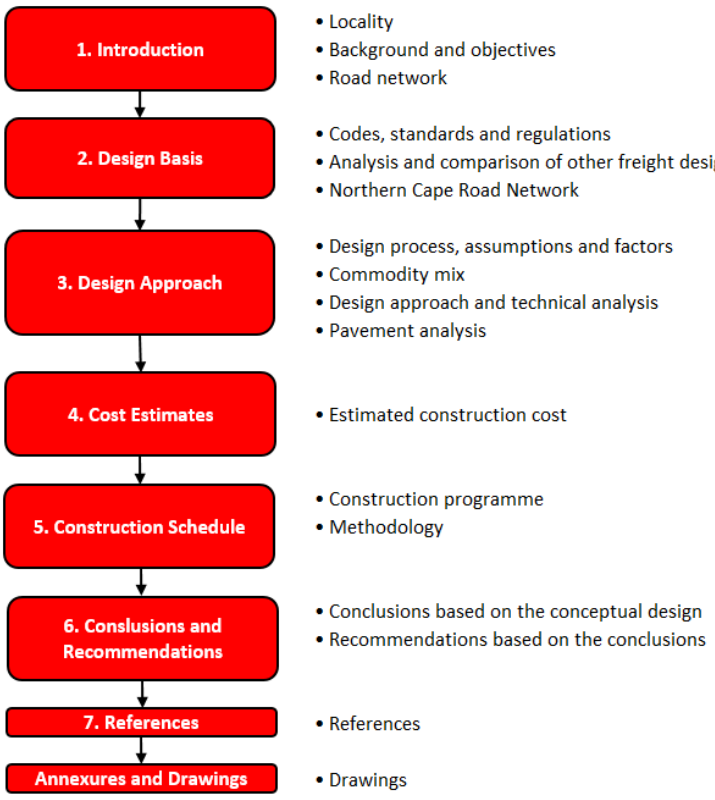
Introduction

The Boegoebaai Port is located 20km south of Alexander Bay and 60km north of Port Nolloth and developed as part of the Landside FEL2 Report.

The port has been divided into two stages of development, Phase 1A and Phase 1B. Completion of these phases is anticipated to span over the next 10-years and 20-years, respectively. Phase 1A will include all roads (including the interchange and road-over-road bridge as well as the road-over-rail bridge on the main boulevard internal road) and platforms. Phase 1B will comprise of a railway line, platforms for the marshalling yards, and tippler infrastructure and a road over rail bridge.

Report Flow

The following diagram provides a summarized flow that the report will follow.



Design Basis

Codes, Standards and Regulations

The South African Standards used were taken from numerous SANS documents.

Other standards used include the Road Drainage Manual, ISO and COLTO.

Design Approach

Design Process, Assumptions and Factors

The mining activities in the Northern Cape were first investigated. The existing roads (N14, N7 and R363) were found to be the connecting routes between the proposed Boegoebaai Port and the Northern Cape mining belt. The largest constraints to the design were found to be along Anenous Pass, on the R382, west of Steinkopf.

Commodity Demand

The commodity demand report determined that the port will attract between 5 and 13 Mtpa. This translates in approximately 800 trucks arriving at the port daily, at an interval of 2 minutes per truck arrival.

Construction Schedule

Phase 1A, including the Marine Port Development and Landside Port Infrastructure, is expected to be operational from the year 2025. Phase 1B is envisaged to become operational after 2035, 10 years after Phase 1A has been completed.

Cost Estimate

The construction cost to rehabilitate R382 was estimated at R 1,75 billion, with an expected FEL1 approximate accuracy of $\pm$50%.

TERMS OF REFERENCE

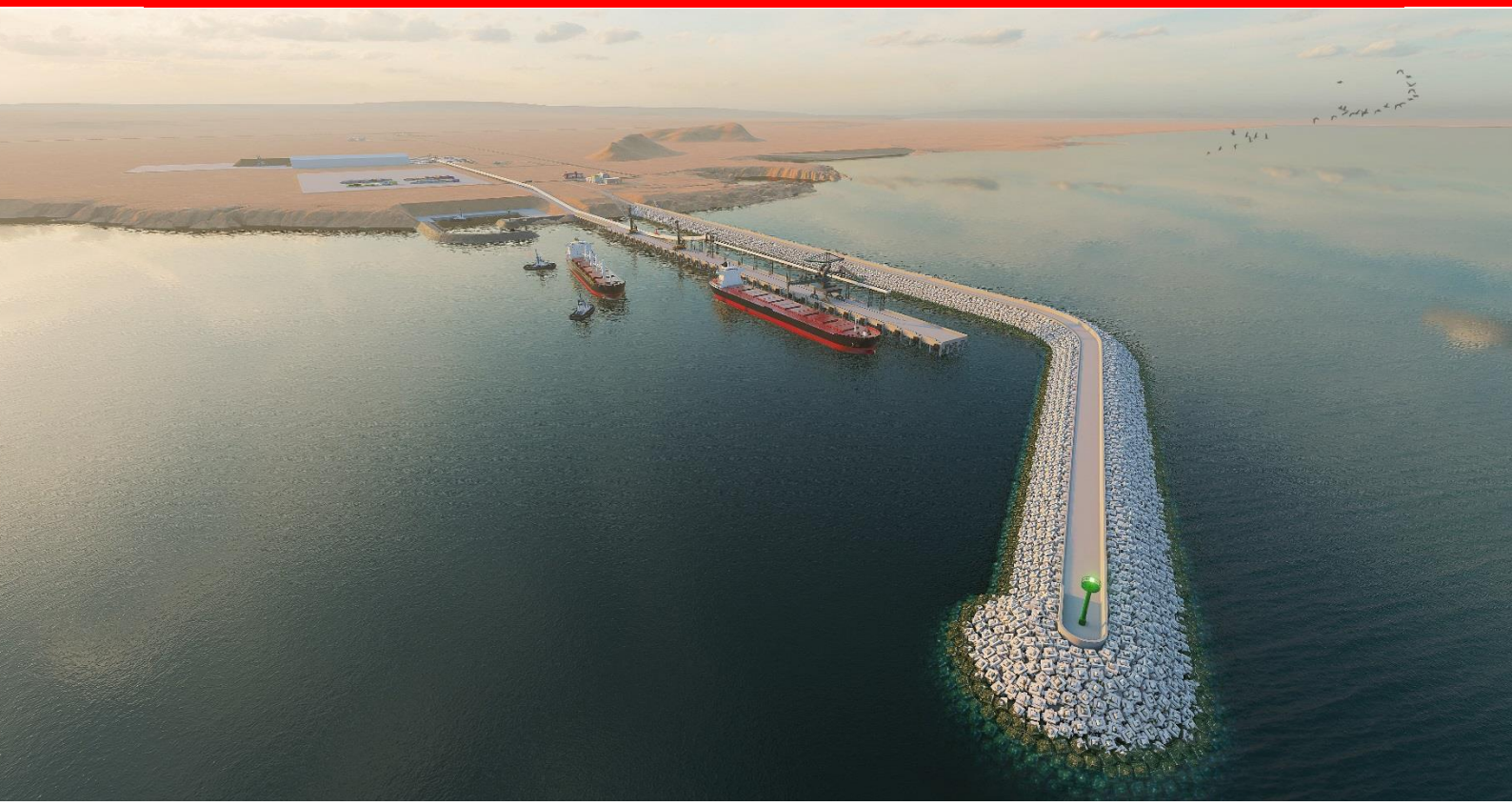
A study was completed to determine the feasibility of implementing a port in the Northern Cape Province. TM Consulting and Nelutha Consulting appointed PRDW to design the marine side of the port, and NAKO ILISO were appointed to design the landside and railway engineering. This report focuses on the external road corridor from the Northern Cape mining belt to Boegoebaai port.

The following documents form an integral part of the Boegoebaai Port Development:

- Port and Marine design – FEL2 Report
- Landside Infrastructure – FEL2 Report
- Rail Connection Book of Drawings – FEL1
- External Road Corridor from Northern Cape Mining Belt to Boegoebaai Port – FEL1
- Business Case for TA1
- Commodity Mix Report
- Economic and Financial Model

BOEGOEBAAI PORT FEL 1 PHASE 1

INTRODUCTION



EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

1 INTRODUCTION

NAKO ILISO were appointed for the Landside Boegoebaai Port Development (FEL2). This FEL1 report deals with the Road network of the Northern Cape Roads leading from the mining belt to the Boegoebaai port, and subsequent road infrastructure improvements required to serve the port by road freight.

1.1 Location

Boegoebaai is located on the west coast of South Africa, between Alexander Bay and Port Nolloth. The roads leading to Boegoebaai from the Northern Cape mines consists of National and Provincial bituminous surfaced roads. The road network that links Boegoebaai to the interior consists of the connectivity to Namibia via the N7, north of Springbok to Keetmanshoop via B1. (Refer to Figure 1-1 below).

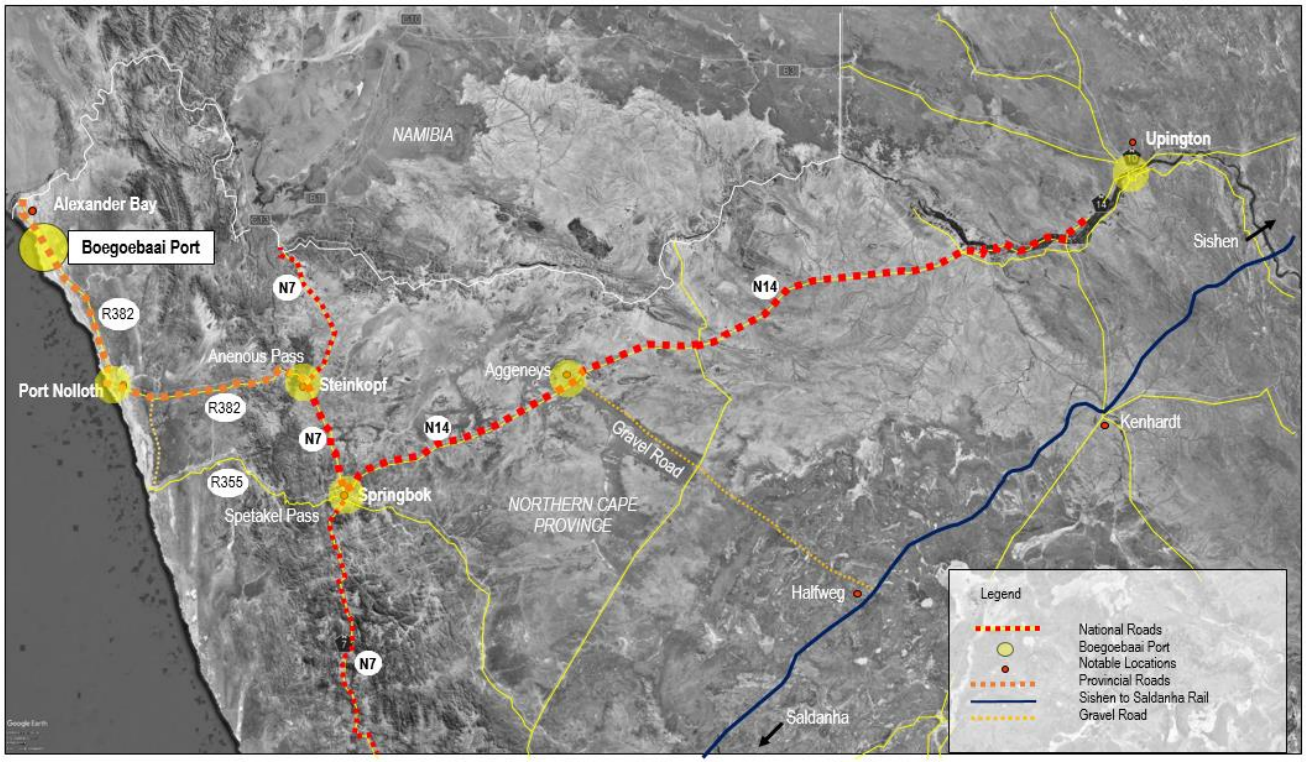


Figure 1-1: Road corridor linking the Northern Cape Mines with Boegoebaai Port

1.2 Background

Studies have shown that the Northern Cape Province will become the new mining boom province. The Northern Cape, more so than any other province within South Africa, has the potential to exponentially increase the number of exports of new-tech minerals. This includes zinc, nickel, lead, copper and cobalt. These minerals are used to manufacture smartphones, electric vehicles and renewable power systems.

The port has been divided into two stages of development, Phase 1A and Phase 1B. Completion of these phases is anticipated to span over the next 10-years and 20-years, respectively. Phase 1A, Figure 1-2, will include all roads (including the interchange and road-over-road bridge as well as the road-over-rail bridge on the main boulevard internal road) and platforms.

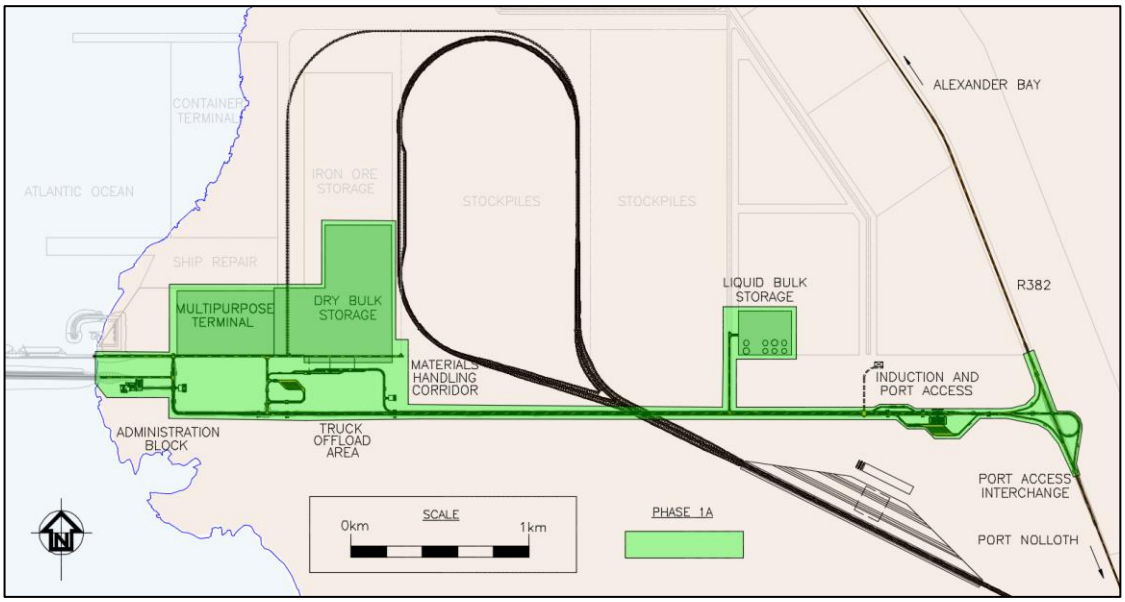


Figure 1-2: Phase 1A Internal Port Road and Terminals

Phase 1B encompasses both the External Rail that aims to connect the Boegoebaai Port to the Sishen to Saldanha rail, and the Internal Rail within the Boegoebaai Port Development, see Figure 1-3.

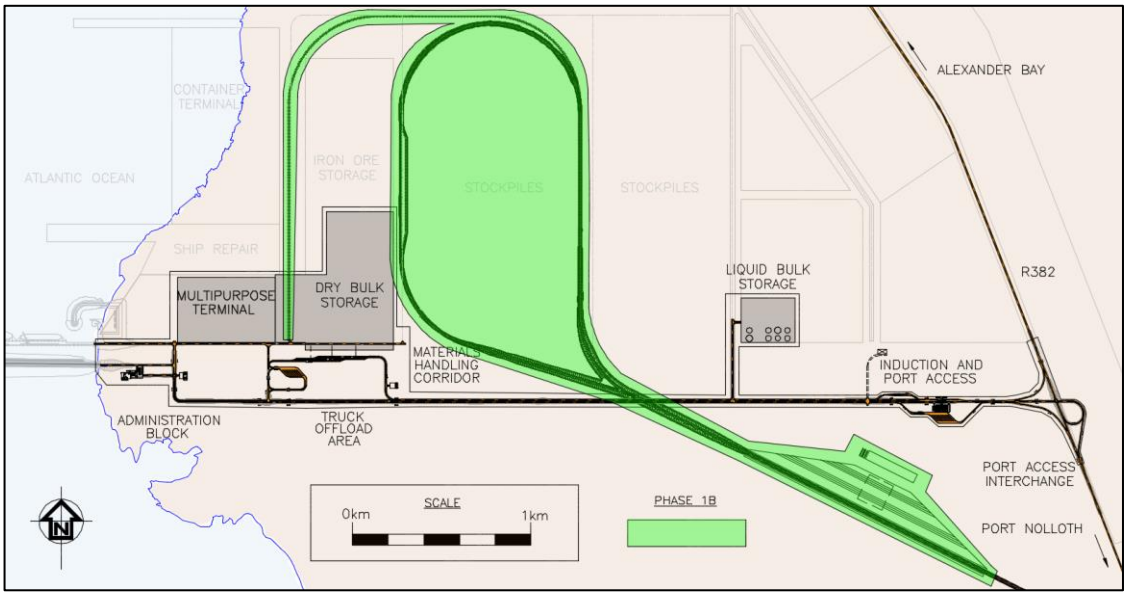


Figure 1-3: Phase 1B Internal Port Rail

1.3 Objectives

Objectives include the determination of the scope of works, investigation of the linkage between the Northern Cape mines and possible further extensions, and the review of historical road condition data, commodity mix and relevant reports.

1.4 Engineering analysis

The technical project has been developed up to FEL1 level with a target costing accuracy range of approximately 50%.

1.5 Road Network

The Northern Cape road network consists of national routes and provincial roads. The corridor leading from the mining belt to Boegoebaai Port traverses along the N14 (Sishen, Upington, Aggenheys) to the N7 (Springbok to Steinkopf) and R382 (Steinkopf, Port Nolloth and Boegoebaai).

1.5.1 National Roads

The South African National Roads Agency SOC Limited (SANRAL) was established in 1998 as an independent, statutory company registered in terms of the Companies Act (Act No 71 of 2008). The South African government, represented by the Minister of Transport, is the sole shareholder and owner of SANRAL.

SANRAL has a mandate to finance, improve, manage, maintain and upgrade the national road network. The South African national road network consists of 21 490 km of roads. This network seamlessly connects major cities, towns and rural areas, supporting economic growth and social development and contributing to job creation in the country.

SANRAL has two primary sources of income. It receives funding for non-toll roads (comprising 85.5 percent of the national road network) from National Treasury.

Figure 1-4: National route N7 north of Springbok

Toll roads (constituting 14.5 percent of the total national road network) are funded either through public-private partnerships or from capital market borrowings. SANRAL adds value to developmental initiatives in the fields of transport, education, health and development of communities.

SANRAL makes a significant contribution to road safety by maintaining and improving our road environment and by identifying and addressing road safety concerns.

The N7 and N14 are not tolled, however the mining activities and hauling of the commodity to the port for export has had an impact on the National Road network in the Northern Cape Province.

Figure 1-5: National route N14 west of Aggeneys

1.5.2 Provincial Roads

Provincial road R382 from Steinkopf to Port Nolloth (TR8201), and from Port Nolloth to Alexander bay (MR731) connects the port to the Northern Cape mining belt. The Northern Cape Provincial Department of Roads and Public Works (DR&PW) is the road authority responsible for maintaining an asset of 27,348 km of its road network.

Figure 1-6: R382 between Steinkopf and Port Nolloth (Anenous Pass)

Only 13% (3,500 km) of the Northern Cape Province has been upgraded to bituminous (tarred) surfaced standards. The balance of the roads can be categorised as lower order class 4 gravel roads.

Traffic volumes on the paved network are predominantly low, with 60% of these roads carrying less than 500 vehicles per day, and only 23% carrying more than 1,000 vehicles per day. For unpaved roads, 70% carry less than 50 vehicles per day, and only 3% more than 250.

Figure 1-7: R382 between Port Nolloth and Boegoebaai

According to the Northern Cape Provincial *RAMP*[(1)] report; the overall condition of paved DR&PW roads can be classified as on the border between fair and good. The 14% poor and very poor roads have high investment needs and high associated road user costs. 32% of the paved roads are now in a fair condition requiring preventive maintenance whereby their useful lives could be extended to postpone expensive future rehabilitation costs. The overall gravel thickness of the DR&PW unpaved road network is 17mm with 31% of these roads having no gravel wearing course material on them.

This analysis determined the impact of the current DR&PW funding levels considering the following intervention treatments: reseal, rehabilitation, re-gravelling and upgrading of unpaved roads to paved standards. The funding level for the DR&PW road network, according to the current DR&PW allocation, is estimated at R740 million annually (*RAMP*[(1)]).

The analysis derived at the following outcomes regarding the current MTEF funding:

- The current funding level for the DR&PW roads is not sufficient to maintain the road network, whether paved or unpaved, at current condition, nor increase the performance levels
- The paved roads will deteriorate to levels worse than the current condition due to insufficient funding, and the optimal allocation of funds between road types and treatments will also not improve the situation. The paved network already has a high rehabilitation need that will continue to increase, unless specifically addressed through additional funding. The average network condition is expected to deteriorate to the mid fair condition category in 10 years.

RAMP[(1)]*. Road Asset Management Plan, DR&PW, 2017/2018*

1.5.3 Other Roads

Black Mountain Mine (BMM) at Aggeneys utilises a 145 km gravel haul road to transport its mined material to Halfweg (Loop 10) railway station linking the Sishen Saldanha Rail Line. The distance between Aggeneys and Boegoebaai is 316 km which traverses bituminous surfaced roads. The development of Boegoebaai port would be an economic benefit to the mine (BMM).

Alexkor is currently mining the area between Port Nolloth and Alexander Bay. The internal mine roads are of an unpaved standard.

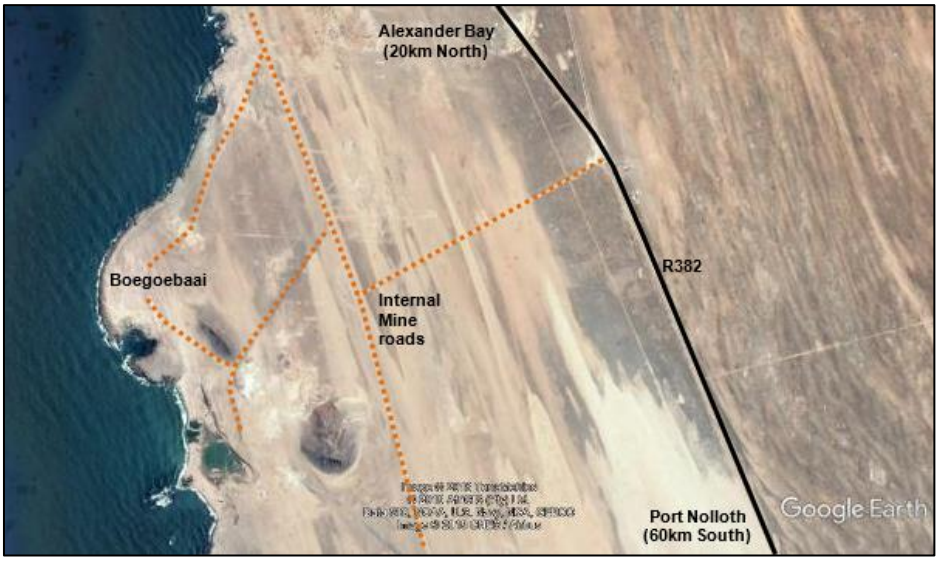


Figure 1-8: Internal access road to Boegoebaai

Figure 1-9 below shows the location of the Northern Cape mines in proximity of the Boegoebaai port.

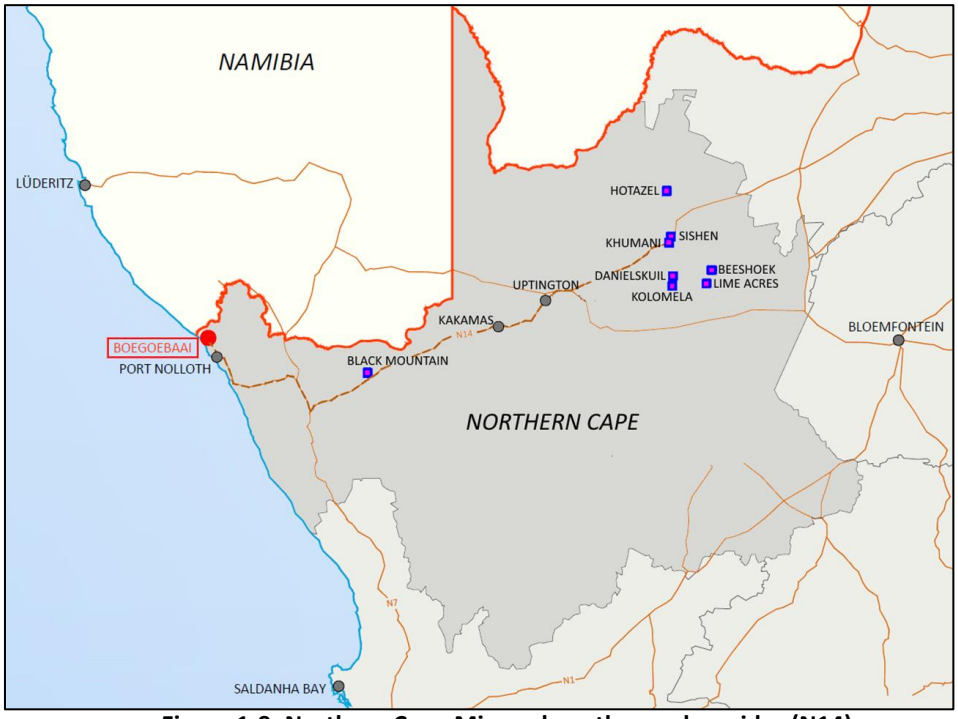


Figure 1-9: Northern Cape Mines along the road corridor (N14)

BOEGOEBAAI PORT FEL 1 PHASE 1

DESIGN BASIS

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

2 DESIGN BASIS

This chapter briefly summarizes the base information used in order to approach the design. It comprises of the codes/ standards used, the analysis and comparison of similar railways and discusses the existing road corridors existing within the Northern Cape Province.

2.1 Codes, Standards and Regulations

2.1.1 SA Standards

- COLTO (1998): Standard Specification for Road and Bridge Works for State Road Authorities
- Design Standard Drawings from Provincial and National Road Authorities
- TRH 3 (2007): Design and Construction of Surfacing Seals
- TRH 4 (1996): Flexible Pavement Design
- TRH 11 (2009): Guidelines for Conveyance of Abnormal Loads
- TRH 12 (1997): Flexible Pavement Rehabilitation Design
- THR 13 (1986): Cementitious Stabilizers in Road Construction
- TRH 14 (1985): Guidelines for Road Construction Materials
- TRH 16 (1991): Traffic Loading for Pavement and Rehabilitation Design
- TRH 17 (1988): Geometric Design of Rural Roads
- SAPEM (2013): South African Pavement Engineering Manual
- SARTM (2012): South African Road Traffic Signs Manual

2.1.2 Other Standards

- Road Drainage Manual 5th Edition 2006 by the South African National Roads Agency Limited
- Guidelines for Human Settlement Planning and Design by the Department of Housing 2003
- COLTO: Standard specifications for Road and Bridge Works for State Road Authorities (1998 Edition)
- ISO 9001:2000: Quality management system: Requirements
- AASHTO American Association of State Highway and Transportation Officials Standards

2.1.3 Legal and Safety requirements

- National Road Traffic Act 93 of 1996
- Road Ordinance No.19 of 1976

2.2 Northern Cape Road Network

The basis of the design will incorporate appropriate standards applicable to the existing conditions, with the provision of suitable localised geological material to rehabilitate the road infrastructure to prolong the residual life of the network.

National Road N7, from Cape Town to Namibia, and N14, from Springbok to Upington, in the Northern Cape fall under the South African National Roads Authority (SANRAL).

Provincial road (R382) leads off the N7 from Steinkopf (70km north of Springbok) to Port Nolloth, a length of approximately 90 km of bituminous surfaced road. The road from Port Nolloth to Alexander Bay (R382) is a bituminous surfaced road. Boegoebaai is approximately 60 km north of Port Nolloth.

Table 2-1: Road network between the Northern Cape Mines and Boegoebaai (external to port)

Route	Road	Length	Comments
Sishen to Upington	N14	230 km	National Route, Class 1, surfaced
Upington to Springbok	N14	370 km	National Route, Class 1, surfaced
Springbok to Steinkopf	N7	50 km	National Route, Class 1, surfaced
Total National Routes		**650 km**	-
Steinkopf to Port Nolloth	R382	90 km	Provincial Trunk Road, surfaced
Port Nolloth to Boegoebaai	R382	60 km	Provincial Road, surfaced
Total Provincial Roads		**150 km**	-
Total length of Road Network		**800 km**	

Based on the commodity demand and the locality of the Northern Cape Mines, it is envisaged that the first phase of the development of the port will attract the mining ore via vehicular truck transport along the N14/N7/R382 corridor, shown in Figure 1-1 above and Figure 2-1 below.

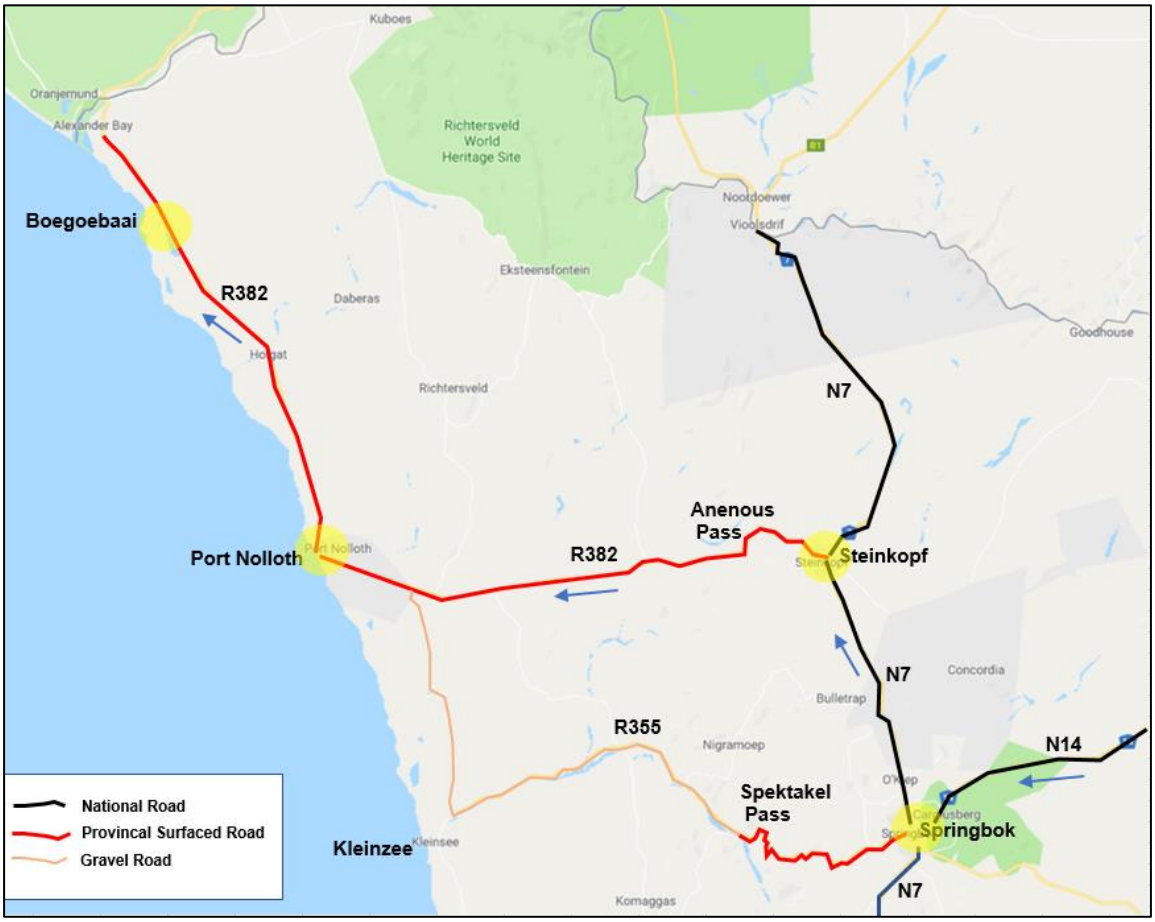


Figure 2-1: Route of freight to port by road

BOEGOEBAAI PORT FEL 1 PHASE 1

DESIGN APPROACH

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

3 DESIGN APPROACH

This chapter discusses the approach taken in order to provide a sustainable road corridor for the road freight from the Norther Cape mines to Boegoebaai Port. It comprises of the design process, design factors, commodity mix and pavement design.

3.1 Design Process

The road freight corridor was investigated in order to determine the most suitable route. Then, the existing national and regional routes (N14, N7 and R363) were found to be the ideal connecting routes between the port and Groblershoop. From here, it was found that Anenous Pass, on the R382 West of Steinkopf and on the link from Steinkopf to the N14, had the most design constraints due to the numerous changes in topography.

3.2 Design Assumptions

It was assumed that the road pavement data received was accurate and that no subsequent road improvements and rehabilitation has been done on the R382. Furthermore, it was assumed that the current AADT on R382 is negligible in relation to the future truck traffic volumes.

It was assumed that an EIA will be required for the next phase.

3.3 Design Factors

Multiple factors influenced the proposed design. These factors primarily affected the current alignment of the R382 and the limited number of available routes.

The existing topography guided the road alignments. The existing road network will be used by road freight for the initial stages of the operations of the port. The current alignment will follow the existing road corridor of the N14, N7 and R382.

The locality of the different mines within the Northern Cape Province affect the route since the roads are ultimately designed to connect and serve the mines.

The type of commodities produced at the different mines also affect the road design. The Boegoebaai Port will primarily export manganese and the road network will therefore aim to serve mines that primarily produce this commodity.

The pavement design will be influenced by the commodity demand. The commodity mix report has forecast an initial yield of 5Mtpa. The E80 equivalent factors will be calculated to determine the imposed loading on the existing road network resultant from the commodity demand and future road freight.

3.4 Commodity Mix

Figures 3-1 and 3-2 express the freight demand volumes, in tons, within the Northern Cape.

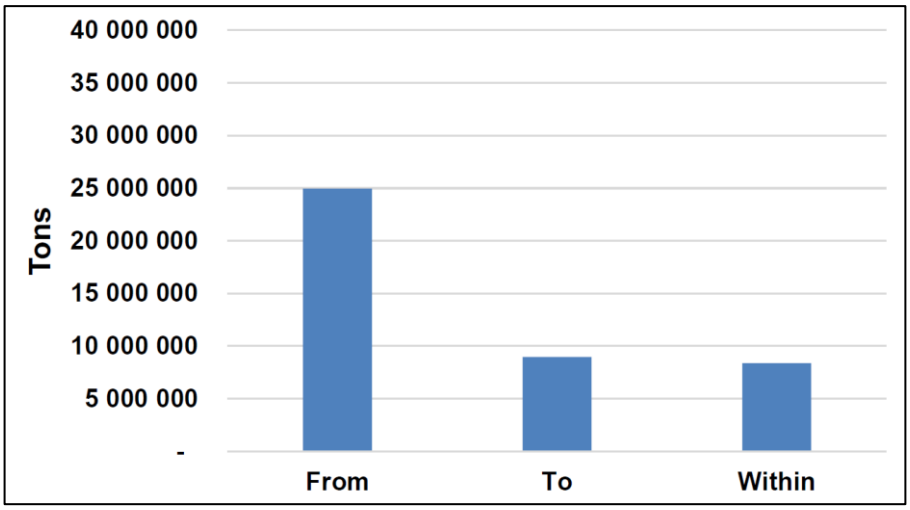


Figure 3-1: Movement of freight flows through the Northern Cape (GAIN Group, 2017)

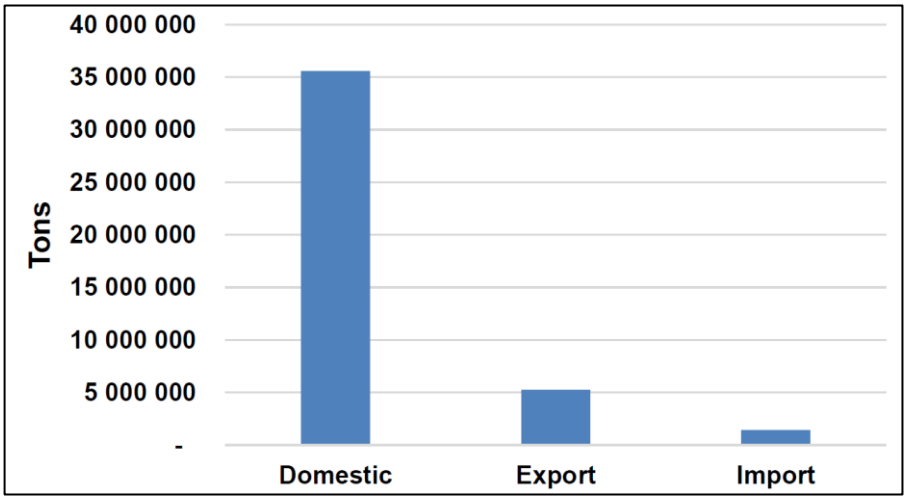


Figure 3-2: Global freight flows through the Northern Cape (GAIN Group, 2017)

Table 3-1 indicates that the mining sector makes up almost 2 thirds of the total commodities traded within the Northern Cape. Furthermore, Figure 3-1 indicates that approximately 25 million tons of general freight is moved from the Northern Cape.

Table 3-1: Commodities percentage traded within the Northern Cape

Commodity	Percentage
Agriculture	8%
Manufacturing	28%
Mining	64%

Once the project is completed, more commodities will be transported which will allow for the surrounding mines to operate at a larger capacity.

Due to the large weight and long distances required to transport the ore from the mines mentioned, heavy haul carriers are required. However, with the implementation of the Boegoebaai Port, the total cost of exporting bulk cargo will be reduced, increasing the ore export capacity.

As per Figure 3-3, the major mining developments within the Northern Cape Province include the following:

Table 3-2: Distances from the Northern Cape Mines to Boegoebaai Port

Location	Mine	Distance to Boegoebaai (km)	Duration by vehicle/ road
Vedanta - Black Mountain - Zinc	Zn, Pb, Cu, Ag	314	3h9min
Anglo America (Kolomela)	Fe	798	7h57min
Assmang - Khumani Iron Ore Mine	Fe	770	7h25min
Assmang - Beeshoek Iron Ore Mine	Fe	785	7h48min
PPC - Lime Acres Limestone Mine	Limestone	835	8h26min
Idwala _ Danielskuil Limestone Mine	Limestone	914	9h14min
Hotazel Manganese Mines	Mn	851	8h22min
Anglo American - Sishen Iron Ore Mine	Fe	782	7h41min
Afrisan - Ulco Limestone Mine	Limestone	915	9h1min
Upington		584	5h44min
Veddanta - Gamsberg		329	3h30min
Postmasburg - Manganease	Mn	790	7h53min

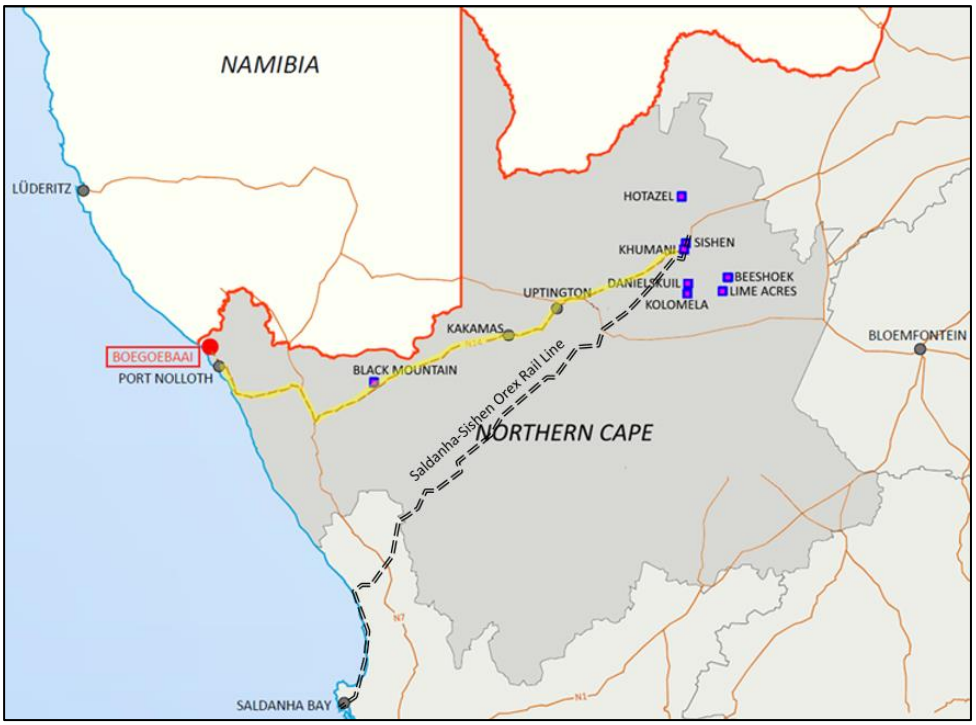


Figure 3-3: Major Mining Developments in the Northern Cape Province

The Sishen to Saldanha Bay (i.e. the OREX Line) is currently the only heavy haul rail line that passes through the Province. However, this line will eventually reach capacity and require major upgrading in order to provide additional capacity.

The only port that currently exists within the Northern Cape is Port Nolloth. However, this port cannot support large vessel cargo operations. Furthermore, most Northern Cape exports currently run through the Sishen to Saldanha Line.

Manganese is exported from the Northern Cape via the Port Elizabeth and Ngqura Line. Ideally, a large amount of manganese could be exported through the Boegoebaai Port instead. Figure 3-4 shows the locality of the freight rails that export iron ore and manganese from the Northern Cape Province.

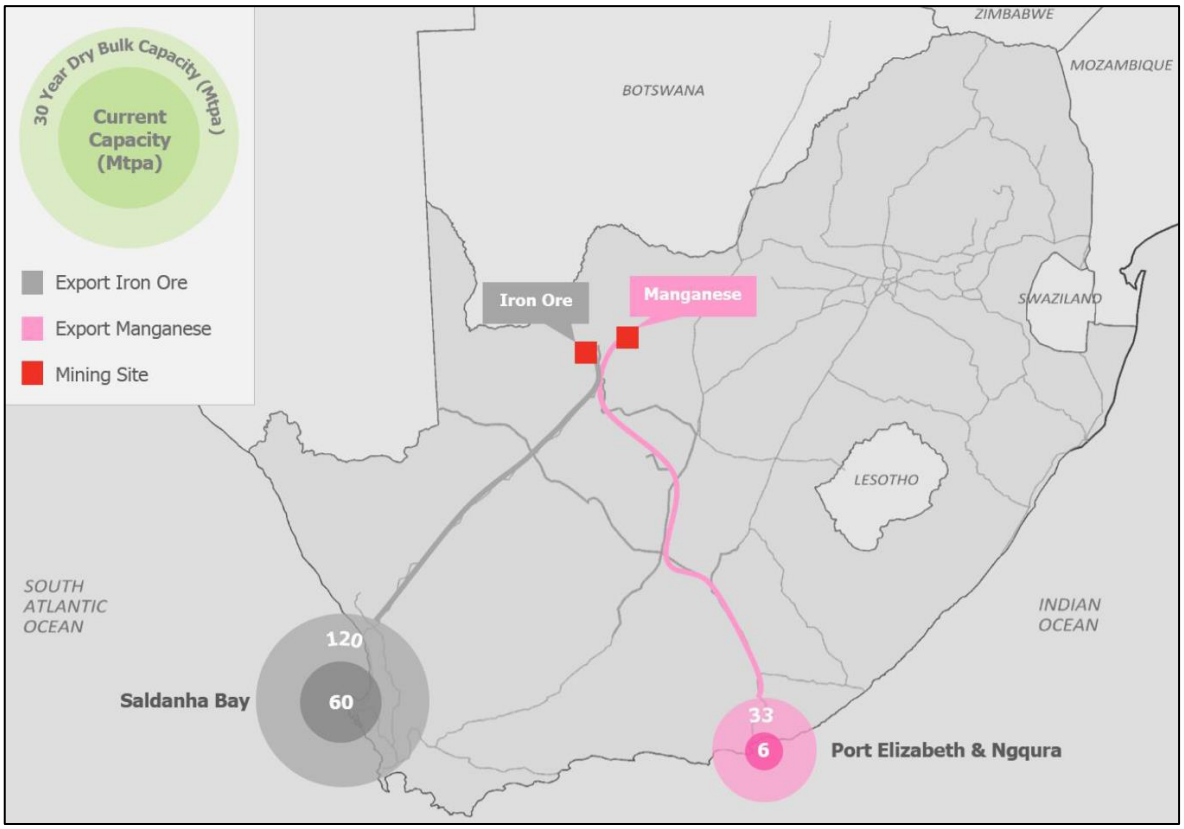


Figure 3-4: Current National Iron Ore and Manganese Rail Links (Transnet, 2015)

A low case commodity demand study was completed; where it was assumed that the manganese currently being transported to the Port of Durban and Saldanha Bay will be rerouted to the Boegoebaai Port to reduce transportation costs and create additional capacity. The low case demand study shown in Table 3-3 shows the current demand in 2019 and the demand for the proposed port commissioning date assumed for the study (i.e. 2025).

Table 3-3: Low Case Commodity Demand – Boegoebaai

Cargo Type – Commodity	Volume (Mtpa) 2019	Volume (Mtpa) 2025	Volume (Mtpa) 2050
Dry bulk – Iron Ore	1.0	1.13	1.85
Dry bulk – Manganese	4.5	4.5	4.5
Break bulk – Lead/ Zinc	0.25	0.60	0.60
Break bulk – Magnetite	0.3	0.3	0.3
Break bulk – Ilmenite	0.1	0.25	0.50
Liquid bulk – Diesel Oil	1.3	1.38	1.77
Containers – Agricultural Products	0.15	0.16	0.20
Containers – Salt	0.03	0.03	0.03
Containers – General Cargo	0.75	0.80	1.02
Total Demand	**8.38**	**9.15**	**10.77**

Table 3-3 indicates that the Boegoebaai Port is envisaged to be a predominantly dry bulk commodity port.

A high case commodity demand study was completed; where it was assumed that the manganese currently being transported to the Port of Durban, Saldanha Bay, Richards Bay, Cape Town and the Port of Lüderitz will be rerouted to the Boegoebaai Port. The results from the high case demand study can be seen in Table 3-4.

Table 3-4: High Case Commodity Demand – Boegoebaai

Cargo Type – Commodity	Volume (Mtpa) 2019	Volume (Mtpa) 2025	Volume (Mtpa) 2050
Dry bulk – Iron Ore	1.0	1.13	1.85
Dry bulk – Manganese	6.5	8.5	16.5
Break bulk – Lead/ Zinc	0.7	0.7	0.7
Break bulk – Magnetite	0.3	0.3	0.3
Break bulk – Ilmenite	0.1	0.25	0.50
Liquid bulk – Diesel Oil	1.3	1.38	1.77
Containers – Agricultural Products	0.15	0.27	2.88
Containers – Salt	0.03	0.03	0.03
Containers – General Cargo	0.75	0.95	2.53
Total Demand	**10.83**	**13.51**	**27.10**

For the high case study, the Boegoebaai Port will predominantly export dry bulk and minor bulk commodities, with only 12% of the cargo demand utilizing containers.

Through analysing the two scenarios, a base commodity demand was determined, and the following was concluded:

- No current Port Elizabeth volume will be re-routed to Boegoebaai,
- No iron ore will move through Boegoebaai,
- Other minerals such as zinc, lead, Ilmenite and magnetite will be routed through the lowest cost solution,
- Diesel volumes are linked to general economic activity rather than other factors,
- For the remaining commodities, additional capital expenditure will be required to increase the port capacity to accommodate the high case commodity demand.

The base case commodity demand for Boegoebaai Port is presented in Table 3-5 below.

Table 3-5: High Case Commodity Demand – Boegoebaai

Cargo Type – Commodity	Volume (Mtpa) 2019	Volume (Mtpa) 2025	Volume (Mtpa) 2050
Dry bulk – Iron Ore	0	0	0
Dry bulk – Manganese	4.5	6.0	9.0
Break bulk – Lead/ Zinc	0.7	0.7	0.7
Break bulk – Magnetite	0.3	0.3	0.3
Break bulk – Ilmenite	0.1	0.1	0.50
Liquid bulk – Diesel Oil	1.3	1.37	1.70
Containers – Agricultural Products	0.15	0.21	0.42
Containers – Salt	0.03	0.03	0.03
Containers – General Cargo	0.75	0.90	1.28
Total Demand	**7.83**	**9.61**	**13.93**

For more information on the commodity mix, refer to the 'FEL2 Boegoebaai Port Phase 2 – Analysis of Commodity Mix' report.

3.5 Boegoebaai Port Access

An interchange has been designed at the Boegoebaai Port Access, located 60 km north of Port Nolloth. Refer to Annexures of the report for further detailed drawings.

3.6 Design Approach

The design approach will incorporate the assessment of the current road network and ascertain the residual and remaining serviceability condition prior to intervention of rehabilitation or reconstruction. The port will result in the growth of heavy vehicular volumes. The impact of this increased traffic volume will be assessed to determine the intersection strategy on the existing road infrastructure.

The geometric design standards considered are indicated below.

Table 3-6: Geometric design standards

Description	Design Manual	50 km/h Design Speed	80 km/h Design Speed	120 km/h Design Speed
Min. desirable passing sight distance	WCG	350 m	560m	800 m
Min. stopping sight distances	WCG	65 m	115 m	210 m
Min. radius of horizontal curve	TRH17	80 m	210 m	530 m
Min. crest K-value	WCG	10	33	105
Min. sag K-value	WCG	11	26	50
Absolute min length of vertical curves	WCG	30 m	30 m	72 m
Max vertical grade	WCG	6%	6%	6%
Min. vertical grade	WCG	0.35%	0.35%	0.35%

The table above indicates the geometric design criteria which will be applied during the detail design phase.

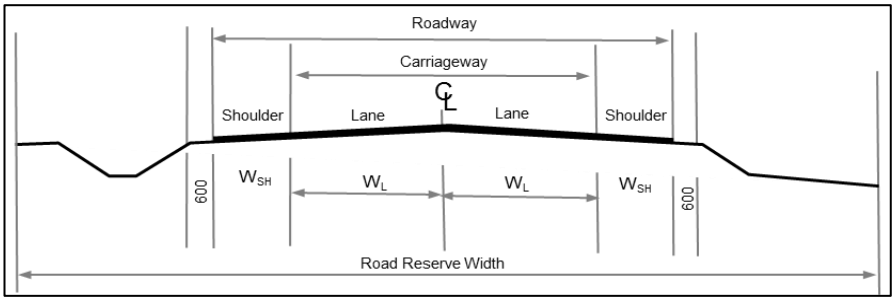


Figure 3-5: Standard cross-sections for road classes

Table 3-7 below and Figure 3-5 above show the various cross-sectional road classifications. The National Roads are classified as Class 1, whereas R382 can be classified as Class 3 road.

Table 3-7: Road class cross-sectional dimensions

Class	1	2	3	4 (not surfaced)
Roadway width (m)	11.4m	9.8m	8.6m	8.6 or 9.8m
Carriageway width (m)	7.4m	6.8m	6.8m	
Lane W_L (m)	3.7m	3.4m	3.4m	
Shoulder W_{SH} (m)	2m	1.5m	0.9m	
Road Reserve	30m	25m	20-25m	20-25m

Whilst a detail assessment of the road network needs to be conducted on a project level, it is envisaged that the road alignment will follow the existing roads; R382, N7 and N14.

3.7 Technical Analysis

According to the RAMP[1] report the Northern Cape Provincial Roads are in a fair condition. The traffic volumes on the current surfaced road network is low (<500 vpd). The RAMP[1] report indicates that FWD measurements were done on the road network.

3.8 Road R382 between Steinkopf and Port Nolloth

R382 (TR82/1) between Steinkopf (N7) and Port Nolloth (90km), including Anenous Mountain pass was initially constructed in 1979 to bituminous standards, more than 40 years ago, with probable routine and periodic (re-seal) maintenance interventions. Indications are that the road has reached its residual design life and is due for improvements.

Figure 3-6: Visual Inspection R382 (TR82/1 km 4)

3.8.1 Geometric design parameters

R382 traverses the Anenous Pass has gradients greater than 6%. (Refer to Figure 3-8 below).

Figure 3-7: Anenous mountain pass longitudinal section (TR82/1 km 13)

Whilst fully laden trucks from the mines will be descending the pass to the coast, the return trip to the mines may require climbing lanes to be built on the steep sections of Anenous Pass. The pass stretches over a 6 km section with an elevation ranging from 605 m to 875 m above MSL; a rise of 270 m.

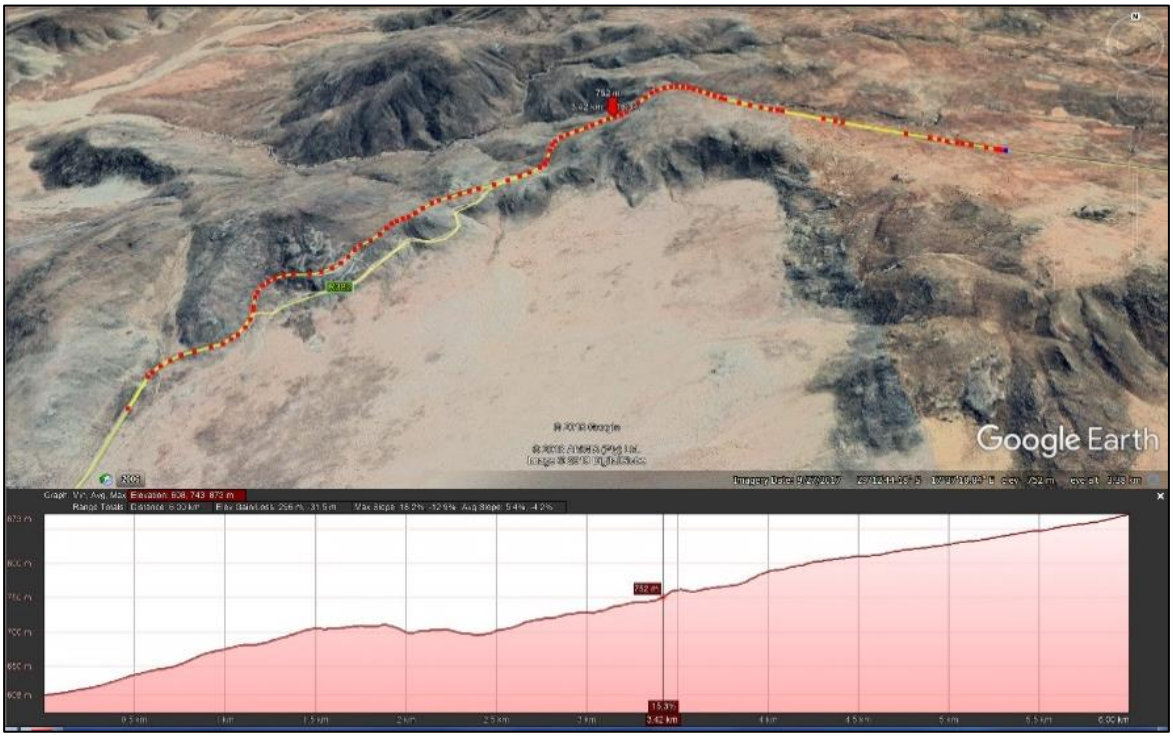


Figure 3-8: Anenous mountain pass

3.9 Road R382 between Port Nolloth and Alexander Bay

R382 (MR731) between Port Nolloth to Alexander Bay was built in 1991 to a class 3 road, probably receiving routine and periodic (re-seal) maintenance interventions.

The entire section of the existing road has reached its design life and will require rehabilitation and/or reconstruction, concurrent with Phase 1A of the port development.

Figure 3-9: R382 (MR731) between Port Nolloth and Alexander Bay at Holgat

3.10 Pavement analysis

In terms of the structural capacity analysis of a road pavement or layer works, the existing road condition should be assessed by means of either non-destructive tests, such as the Falling Weight Deflectometer (FWD), which measures the deflection under an imposed load, or by means of test pits and laboratory testing.

According to TRH4 (Structural Design of Flexible Pavements for Interurban and Rural Roads) and TRH16 (Traffic Loading for Pavement and Rehabilitation Design) the different road traffic classifications determine the structural capacity requirements of a Pavement Design.

It is envisaged that Boegoebaai Port will initially attract 5Mtpa from the Northern Cape Mines. This is substantiated by the Commodity Report. It is further assumed that during the first five years, after the port is operational, that the commodity will be transported by road from the Northern Cape Mines, after which a rail may be implemented.

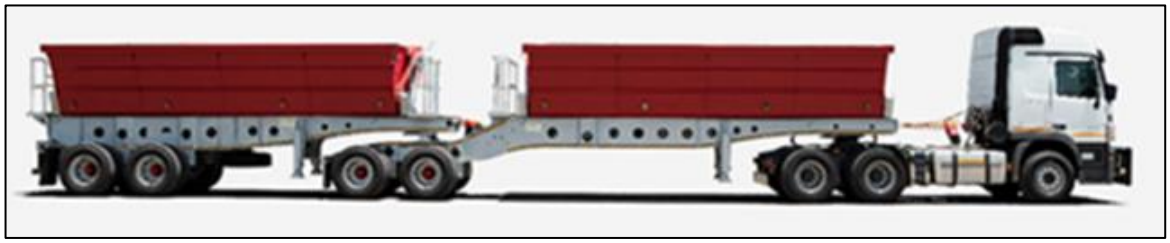


Figure 3-10: Typical truck transporting raw mining ore to the port

According to TRH4, traffic loading is measured in standard equivalent axle loads (E80). The expected 5Mtpa to 10Mtpa will generate approximately 26 million E80 over a twenty-five-year period. This categorises the traffic loading class as an ES30 (10-30 million 80 kN axles/ lane pavement design bearing capacity).

Table 3-8: Classification of traffic for structural design purposes (TRH 12)

Pavement class	Pavement design bearing capacity (mil 80kN axles/ lane)	Volume and type of traffic	
		Approx. vpd per lane	Description
ES 0.003	< 0.003	< 3	Very lightly trafficked roads; very few heavy vehicles. These roads could include the transition from gravel to paved roads and may incorporate semi-permanent and/or all-weather surfacing.
ES 0.01	0.003 - 0.01	3 - 10	
ES 0.03	0.01 - 0.03	10 - 20	
ES 0.1	0.03 - 0.10	20 - 75	
ES 0.3	0.10 - 0.30	75 - 220	
ES 1	0.3 - 1	220 - 700	Lightly trafficked roads, mainly cars, light delivery and agricultural vehicles; very few heavy vehicles.
ES 3	1 - 3	> 700	Medium volume of traffic, few heavy vehicles.
ES 10	3 - 10	> 700	High volume of traffic and/ or many heavy vehicles.
ES 30	10 - 30	> 2200	Very high volume of traffic and/ or a high proportion of fully laden heavy vehicles.
ES 100	30 - 100	> 6500	

Table 3-9 indicates the expected commodity mix, as determined in the financial model, submitted under a separate report included in the Business Case for the TA1 submission. It is expected that the road-based commodities would be 10Mtpa. This would translate into about 26 million E80's over the design life of 25 years, as indicated in Table 3-10, below.

Table 3-9: Projected commodity demand and associated truck traffic to port

Projected Commodity Mix Truck Traffic	Year 0 2025	Year 5 2030	Year 10 2035	Year 15 2040	Year 20 2045	Year 25 2050
Commodity Demand (Mtpa)	7 128 000	9 778 000	10 278 000	10 528 000	10 528 000	10 528 000
Trucks per annum	204 945	281 139	295 515	302 703	302 703	302 703
Trucks per month	17 079	23 428	24 626	25 225	25 225	25 225
Trucks per day	561	770	810	829	829	829
Trucks per hour (20hr day)	28	39	40	41	41	41
Interval Minutes per truck	2.1	1.6	1.5	1.4	1.4	1.4

Table 3-10: Proposed pavement design based on commodity demand

Pavement Design	Year 0 2025	Year 5 2030	Year 10 2035	Year 15 2040	Year 20 2045	Year 25 2050
E80 per annum	901 760	1 237 010	1 300 265	1 331 892	1 331 892	1 331 892
E80 Accumulative		5 533 525	11 971 593	15 992 806	21 098 216	25 802 762
Pavement Design	ES30					
Wearing Course	50 AC					
Base	150 G1					
Subbase	300 C3					

It is proposed to rehabilitate/reconstruct the R382, with a pavement design life of 25 years, requiring an ES30 pavement design that would be able to carry 30 million E80's over 25 years.

The determination of the current provincial road R382 residual design life prior to rehabilitation would involve further investigation. The RAMP[(1)] report indicates that the Northern Cape Provincial Roads are in a fair condition. It is likely that R382 has reached the end of its design life and requires to be rehabilitated. It is unlikely that the existing R382 will last for the duration of the envisaged loading by the commodity demand transported to Boegoebaai port by road. The proposed pavement design, as shown in Figure 3-11 below, is based on the commodity demand, will be as follows:

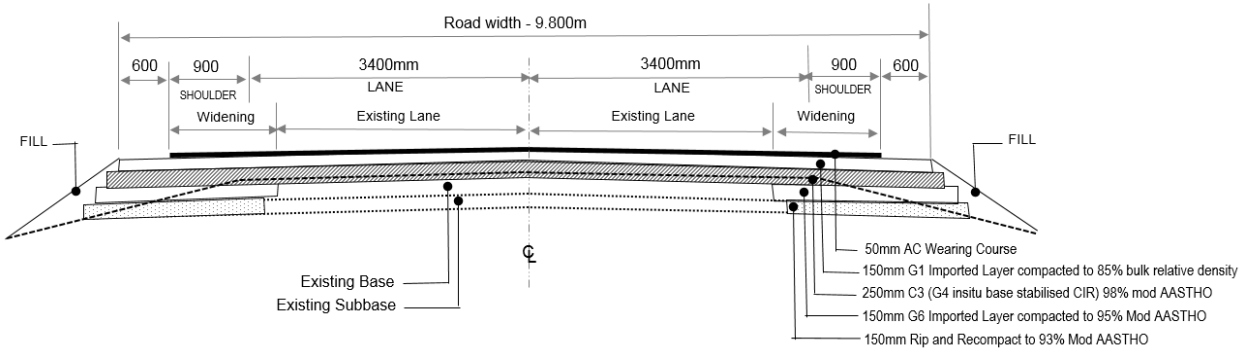


Figure 3-11: Proposed pavement design

In addition to the higher pavement design specification, some climbing lanes would be required on the Anenous mountain pass between Steinkopf and Port Nolloth.

3.10.1 R382 Existing pavement conditions TR8201 (Steinkopf to Port Nolloth)

Pavement management data was obtained from the Northern Cape Provincial Department of Roads and Public Works (DR&PW). The data consisted of Falling Weight Deflectometer (FWD) Deflection measurements, International Roughness (IRI) Riding Quality, Rutting depth and Visual Condition Indices (VCI).

The Y_{max} (D_0) deflection measurements are shown on Figure 3-12, below. The indicative condition indices for granular bases (Horak) are shown in Table 3-11, below.

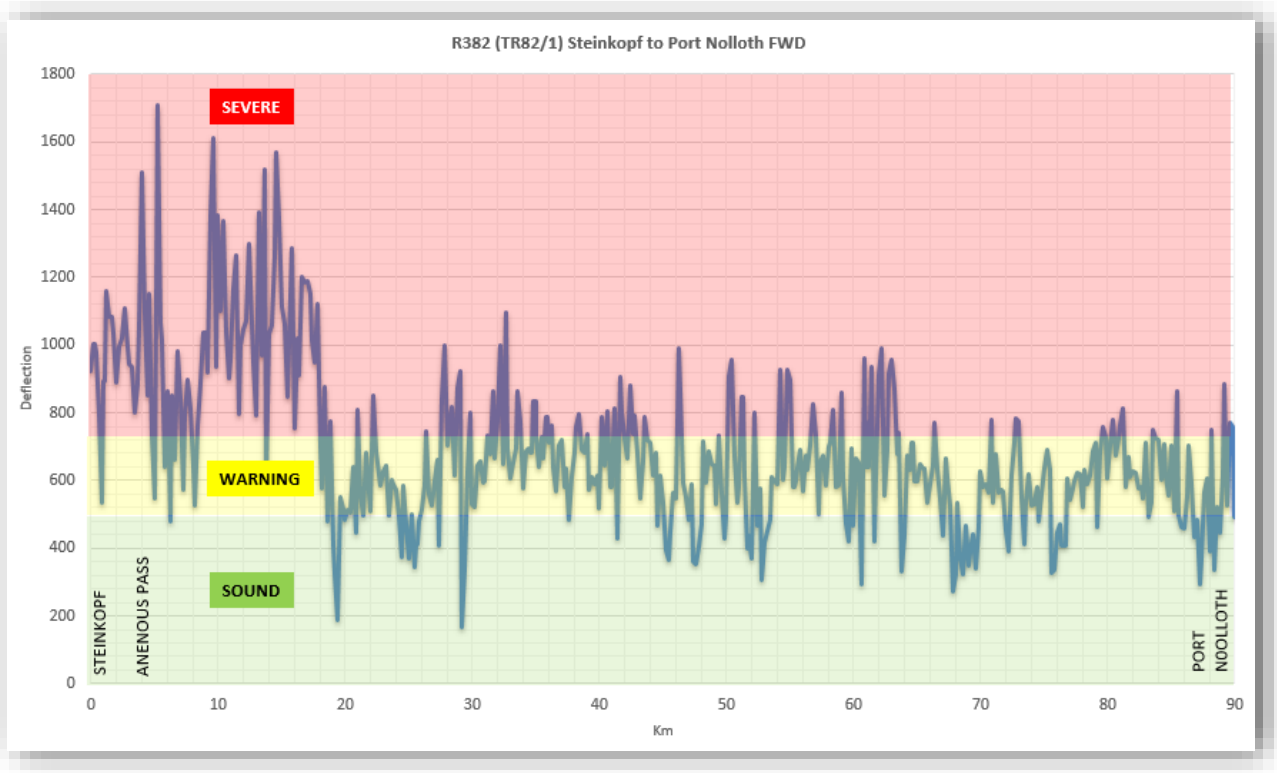


Figure 3-12: FWD test results along R382 (Steinkopf to Port Nolloth)

From the above graph it is noted that the section of R382 (TR8201) from Steinkopf past the Anenous mountain pass towards Port Nolloth is in severe condition. It is further observed that only 18% of the road is in a sound condition. The remainder 82% is in a warning to severe condition and will require strengthening.

Table 3-11: Road condition between Steinkopf and Port Nolloth

Deflection	Sound	Warning	Severe	Total
Y_{max} (D_0) (µm)	<500	500-750	>750	
km	16.6	46.3	28.5	91.4
% of road	18.2%	50.6%	31.2%	

3.10.2 R382 Existing pavement conditions MR731 (Port Nolloth to Alexander Bay)

R382 (MR731) between Port Nolloth to Alexander Bay was reconstructed in 1991 to a class 3 bituminous surfaced road.

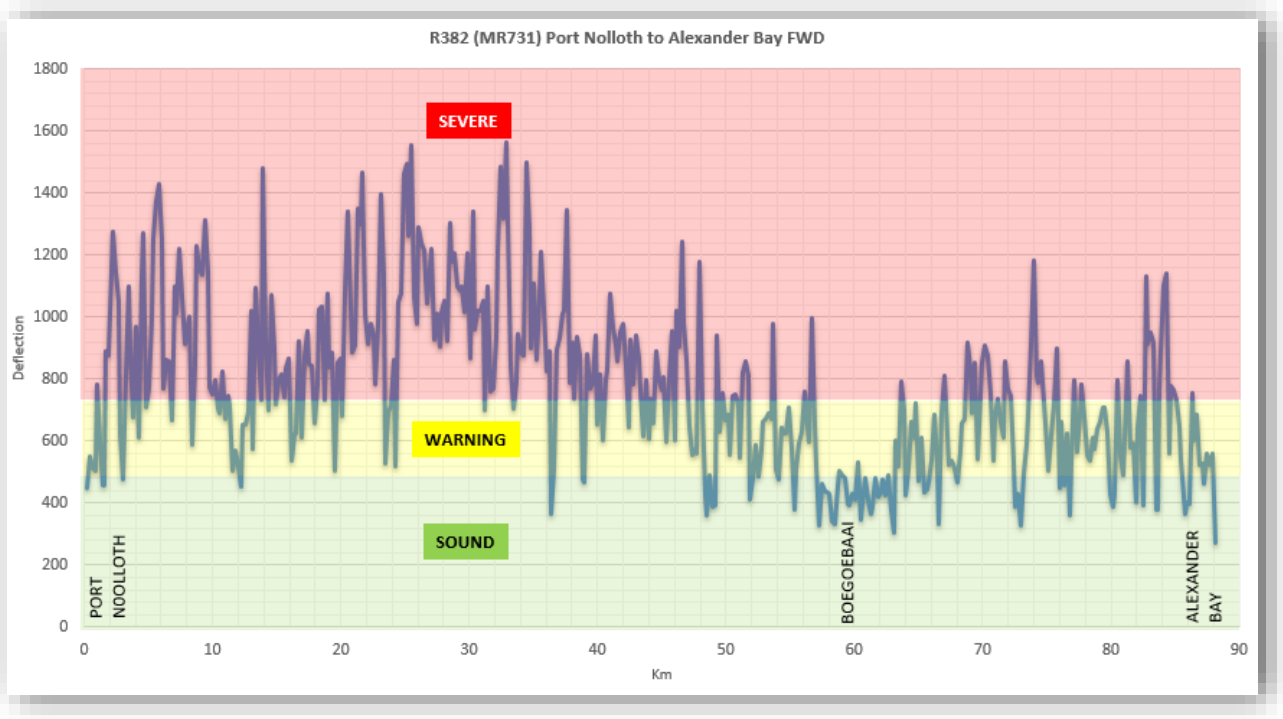


Figure 3-13: FWD test results along R382 (Port Nolloth to Alexander Bay)

Figure 3-13 above, shows that most of the road has high deflection (D_0) readings which translates in the road pavement being in warning to severe condition.

Table 3-12: Road condition R382 between Port Nolloth and Alexander Bay

Deflection	Sound	Warning	Severe	Total
Y_{max} (D_0) (µm)	<500	500-750	>750	
km	14.6	30.0	43.5	88.1
% of road	16.6%	34.1%	49.3%	

The entire section of the existing road has reached its design life and will require rehabilitation and/or reconstruction, concurrent with Phase 1A of the port development.

BOEGOEBAAI PORT FEL 1 PHASE 1

COST ESTIMATE

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

4 COST ESTIMATES

4.1 Capital Cost Roads External to the Port Boundary

4.1.1 Introduction

This FEL 1 construction cost estimate was prepared taking into consideration the layouts and basic engineering information presented in the Design Report.

4.1.2 Scope Exclusions and Assumptions

The estimate is based upon the following exclusions and assumptions:

- Budgets are available to procure the services;
- The road works are based on rehabilitation works for the R382, excluding the N7 and N14;
- No deviation routes will be investigated, the road works will be done in half widths;
- Suitable material is available; and
- Professional fees, EPC Project Management Costs, Owner's Engineer's Costs, VAT are excluded from the construction cost estimate.

4.1.3 Construction cost estimate summary

The estimated construction cost for the roads external to the port boundary for the Boegoebaai study are summarised in **Error! Reference source not found.** below. These cost estimates only include intervention on the Provincial roads R381 (TR8102) between Steinkopf to Port Nolloth, and R381 (MR731) between Port Nolloth and Boegoebaai.

Table 4-1: Road External to Port Construction Estimate

Route	Road	Length	Description	Cost Estimate
Steinkopf to Port Nolloth	R382	90	Road Rehabilitation	R 900 000 000
Port Nolloth to Boegoebaai	R382	60	Road Rehabilitation	R 600 000 000
Steinkopf to Boegoebaai	R382	150	Bridges and structures	R 75 000 000
Steinkopf to Boegoebaai	R382	150	EIA, Geotech, Surveys	R 50 000 000
Steinkopf to Boegoebaai	R382	150	Services Fees and CPA	R 162 250 000
Provincial Roads	R382	150		R 1 787 250 000

4.2 Funding Models

A business case was prepared for TA submission which included an economic and financial model in consideration of the viability of the Boegoebaai port development. In essence, the proposal was to attract port terminal investors and operators via a PPP process.

It is unlikely that the Northern Cape Provincial road authority has sufficient budgetary allocations to rehabilitate the R382 to sustain the residual pavement life with the expected road freight that the port will attract.

It is for the above reasons that alternative funding needs to be sourced to finance the rehabilitation of the R382. This funding model could be implemented through different mechanisms; such as tolling of the road, levies imposed on trucks, and or OPRC type contracts.

Whilst the scope of this report does not cover the details of the above funding mechanisms, it should be noted that the rehabilitation of the R382 forms part of the Boegoebaai Port development Phase 1A.

BOEGOEBAAI PORT FEL 1 PHASE 1

CONSTRUCTION SCHEDULE

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

5 CONSTRUCTION SCHEDULE

5.1 Construction Programme

The following critical tasks will make up most of the construction during Phase 1A external port roads:

- Accommodation of Traffic
- Shoulder strengthening and widening
- Road construction on half-widths
- Rehabilitation, stabilisation and base construction
- Drainage structures

The phasing envisaged for the various work packages is planned as follows.

Table 5-1: Construction Schedule for the Boegoebaai Port Development

	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Port Marine	Design	Tender		Construction			First ship at berth				
Port Landside	Design		Tender	Construction							
Ext Roads	Design		Tender	Construction			⇦	Road Freight (10 years)			⇨
Future Rail	Planning		Design				Tender	Construction			

Table 5-1 surmises that Phase 1A, the Marine Port Development and Landside Port Infrastructure, will become operational from 2025. Phase 1B is envisaged to become operational after 2035, 10 years after Phase 1A has been completed.

5.2 Construction Materials

Road construction materials will be sourced both commercially and from approved quarries and borrow pits. The material investigation will form part of the detail design stage of the road rehabilitation of R382.

Table 5-2: Estimated Quantities of Road Construction Material

Construction material	Quantity
G1: Granular graded crushed stone base	220 500 000 m^3
C3: Stabilised subbase	248 000 000 m^3
AC: Asphalt road surfacing	174 195 tonnes

5.3 Construction Methodology

It is envisaged that road R382 will be rehabilitated accommodating traffic in half width construction over 6km sections. Since the road will be rehabilitated with additional imported material and some minor improvements to the geometric vertical alignment, the extent of earthworks will not require any expropriation and construction activities will remain in the proclaimed road reserve. The diagrams below show the sequence of the half width construction.

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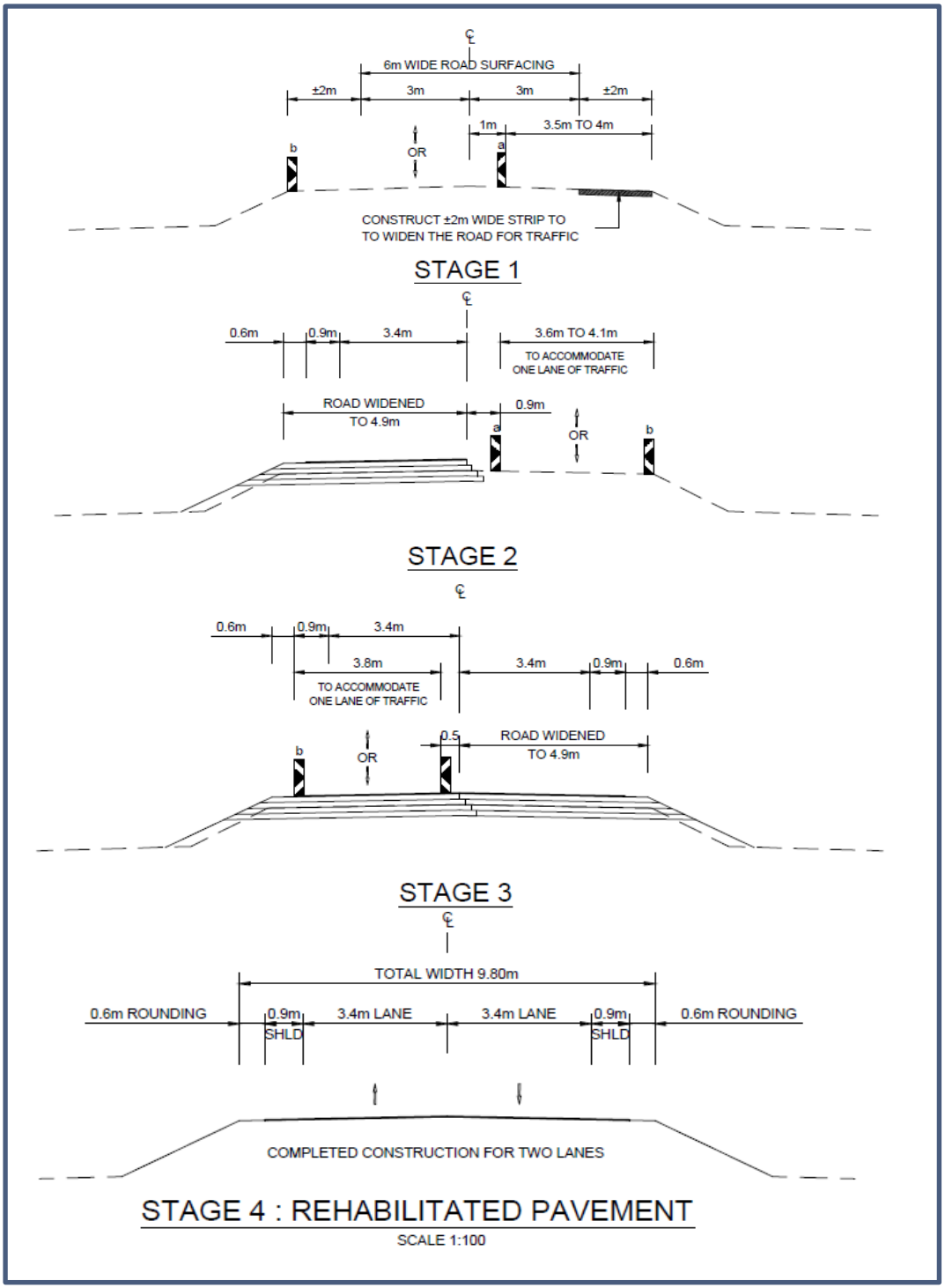


Figure 5-1: Half-width construction methodology R382 (Port Nolloth to Boegoebaai)

5.4 Construction Period

Since the accommodation of traffic forms part of the half width construction it is imperative that the road is rehabilitated prior to the first ship at berth, as the expected truck traffic flows will be at a rate of 2-minute intervals of arrival time of trucks at the port. The rehabilitation should therefore be completed by 2025.

BOEGOEBAAI PORT FEL 1 PHASE 1

CONCLUSIONS AND RECOMMENDATIONS

EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

6 CONCLUSIONS AND RECOMMENDATIONS

In view of the findings of the report the following conclusions drawn.

6.1 Conclusions

This report forms part of the Boegoebaai Port FEL2 landside design documents and drawings.

Whilst the road corridor from the Northern Cape Provincial mining belt was identified from Upington (N7) to Springbok (N7), to Steinkopf (N7); it further investigated the R382 between Steinkopf, Port Nolloth and Boegoebaai.

The commodity demand report determined that the port will attract between 5 and 13 Mtpa. This translates in approximately 800 trucks arriving at the port daily, at an interval of 2 minutes per truck arrival.

The FEL2 Boegoebaai Port Development report refers to a Phase 1A, where the port will be served by commodities being delivered by road; and Phase 1B, where rail will be introduced.

It is planned that the first ship at berth will arrive in 2025. This would require the road to be rehabilitated by 2025 to avoid any road freight delays as a result of accommodation of traffic during road half width construction.

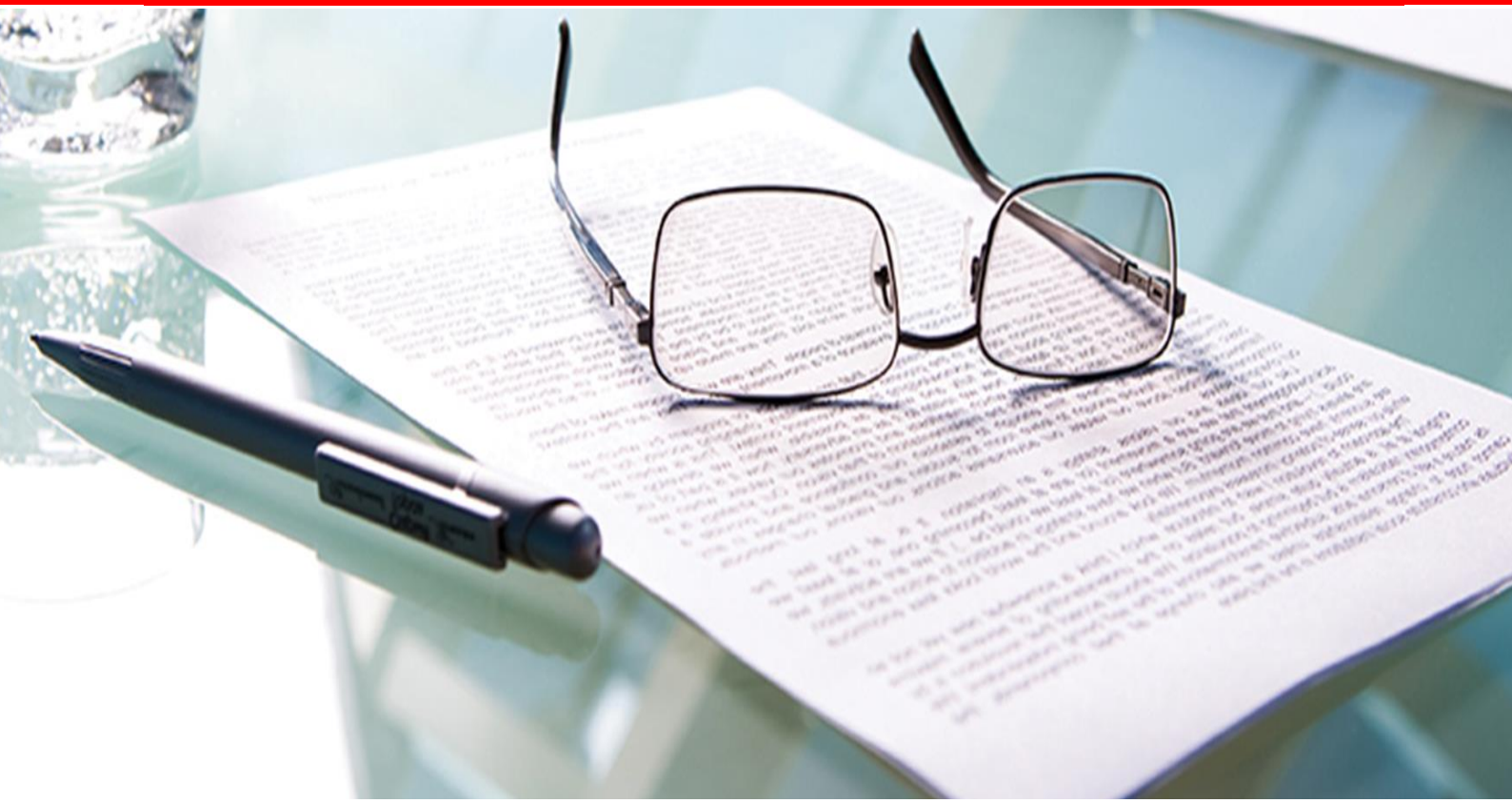
6.2 Recommendations

In view of the conclusions the following recommendations are made:

- An EIA should be commissioned for the rehabilitation of the R382.
- A detailed geotechnical and material investigation should be conducted along the R382 between Steinkopf and Boegoebaai.
- The FEL 2 and FEL3 stages should commence by 2020.
- A detailed topographical survey be undertaken of the R382 between Steinkopf and Boegoebaai.

BOEGOEBAAI PORT FEL 1 PHASE 1

REFERENCES AND ANNEXURES



EXTERNAL ROAD CORRIDOR FROM NORTHERN CAPE MINING BELT TO BOEGOEBAAI PORT

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ANNEXURES - DRAWINGS

Drawing No	**Drawing Title**
1500103-TRANS-9006-P	External Roads General Layout
1500103-TRANS-9007-P	External Roads Typical Cross-sections
1500103-TRANS-9008-P	Port Access Interchange
1500103-TRANS-9009-P	Boegoebaai Main Interchange Bridge: General Arrangement

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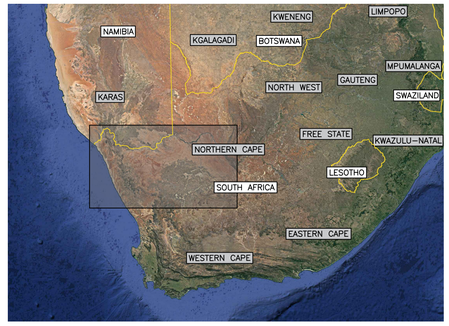
KEYPLAN



LEGEND

	COASTLINE		OTHER ROADS
	NOTABLE LOCATION		SISHEN–SALDAHNA RAILWAY
	NOTABLE TOWN		SOUTH AFRICAN – NAMIBIAN BOUNDARY
	NATIONAL ROUTE		REGIONAL ROUTE

SCALE

0km 10km 20km 30km 40km 50km

REFERENCE DRAWINGS

DRAWING NO.	REFERENCE

NOTES:

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REVISIONS

	NAME	SIGNED	DATE
DRAWN BY	M.MOORE		
DRAWING CHECKED	U.MARTZ		
DESIGN CHECKED	U.MARTZ		
APPROVED	H.HARTUNG		
FILE NAME	External Road Layouts.dwg		
TIME STAMP	10 October 2019 06:19:56 PM		

CLIENT

NAKO ILISO

PROJECT: BOEGOEBAAI FEL 2 PHASE 2

DRAWING TITLE: EXTERNAL ROADS GENERAL LAYOUT

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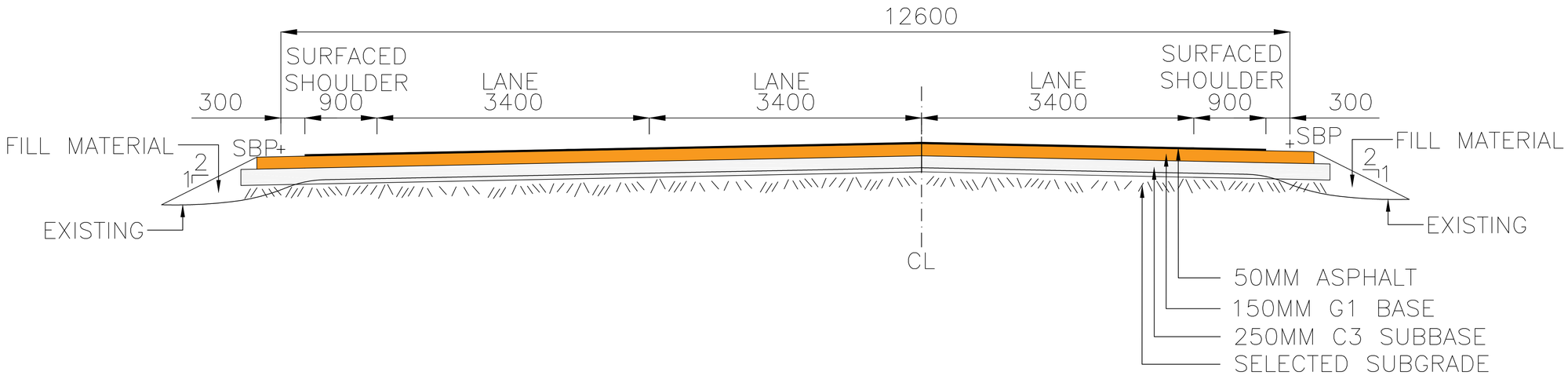
ADDITIONAL CLIMBING LANE



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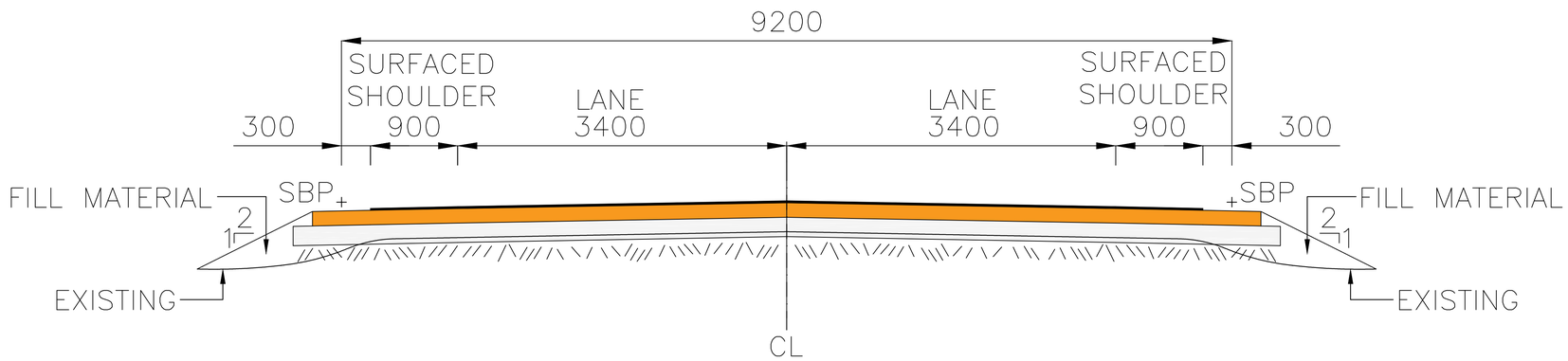

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REVISIONS

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DESIGN CHECKED	U.MARTZ		
APPROVED	H.HARTUNG		
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PROJECT
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TYPICAL CROSS-SECTIONS

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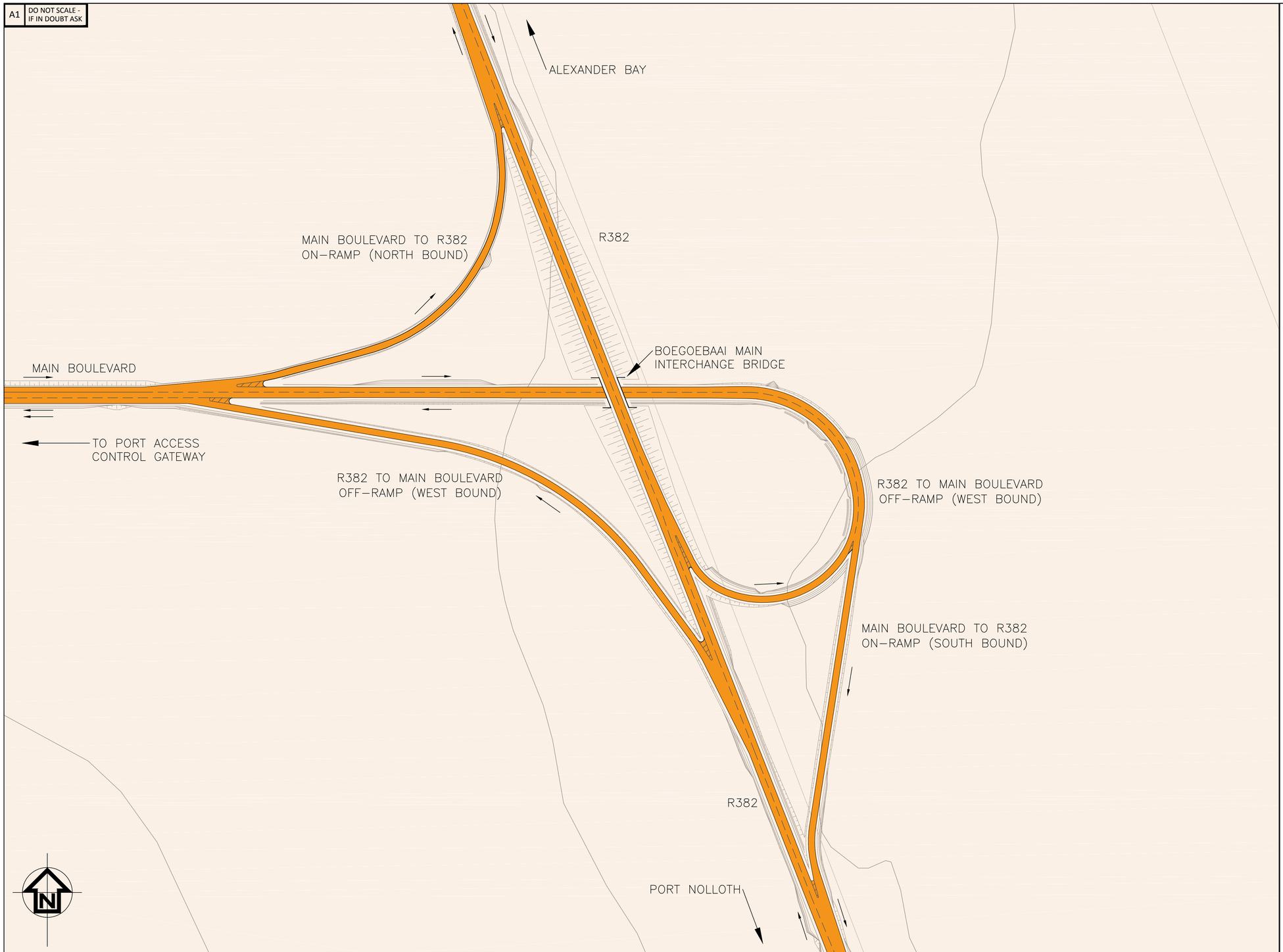

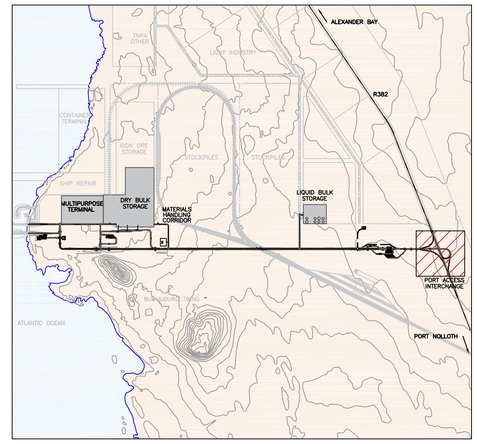

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REVISIONS

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PROJECT
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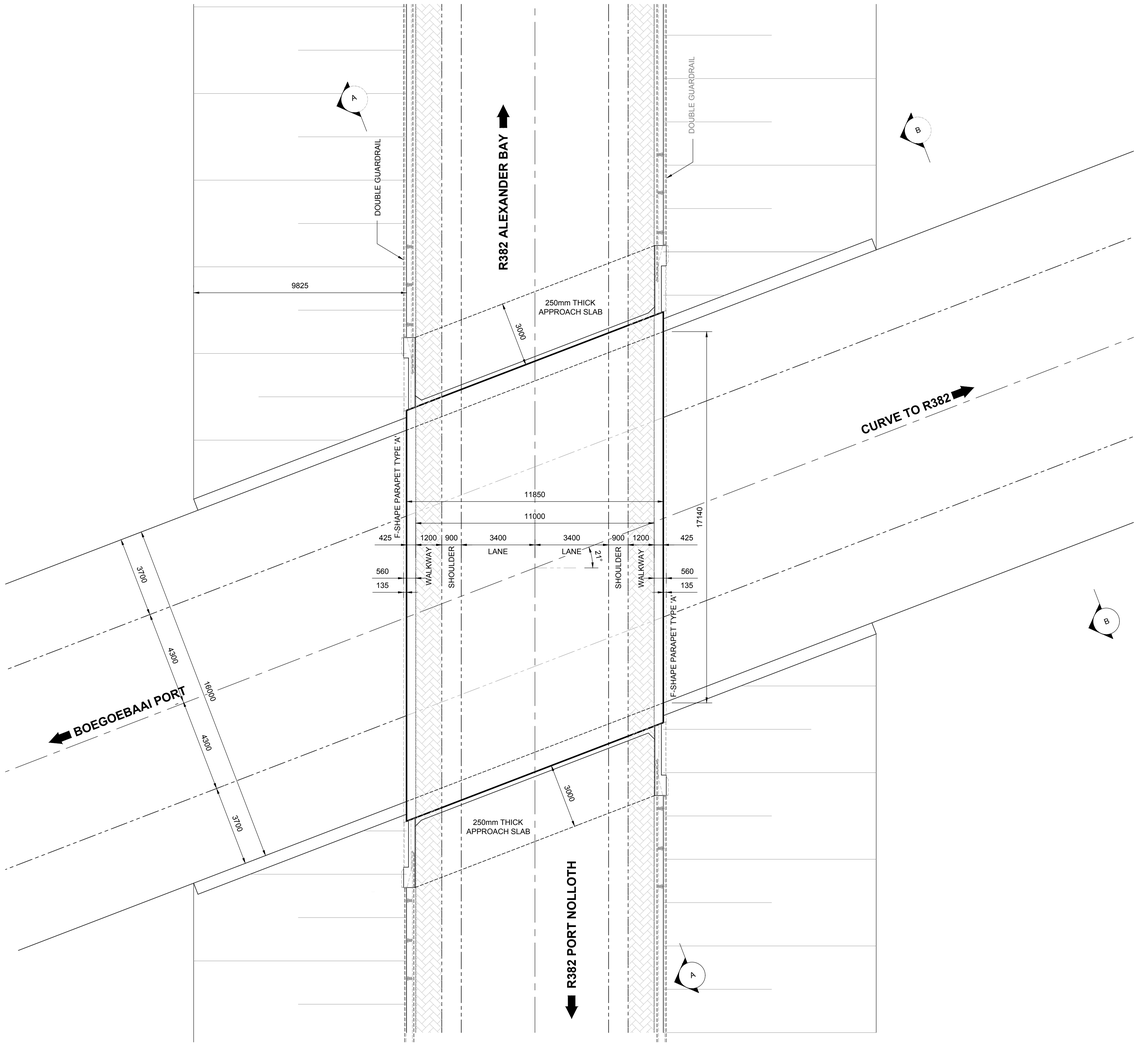
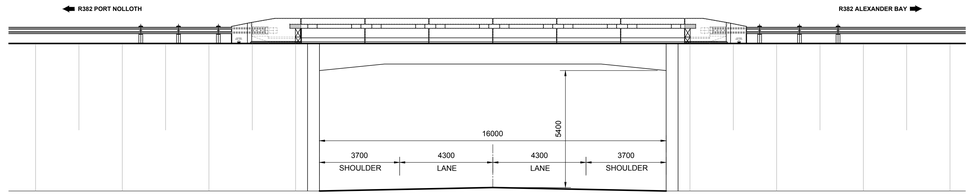
DRAWING TITLE
PORT ACCESS INTERCHANGE

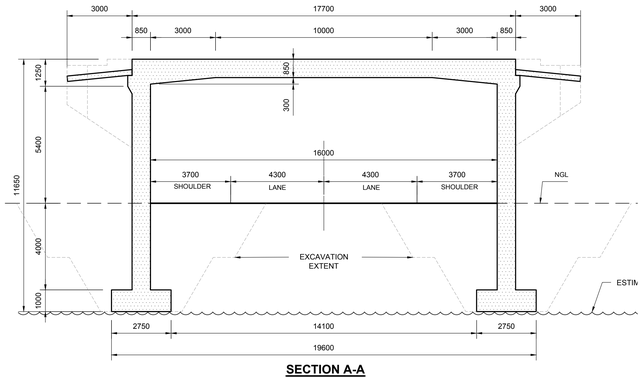
SCALE	PROJECT NUMBER	DISCIPLINE	DRAWING NUMBER		REVISION
	1500103-TRANS-9008-P				-00
	CLIENT NUMBER				



PLAN ON DECK
SCALE 1 : 100



ELEVATION B-B
SCALE 1 : 100



SECTION A-A
SCALE 1 : 100

DESIGN DATA

A. GENERAL DESIGN NOTES:

1 THIS BRIDGE HAS BEEN DESIGNED IN ACCORDANCE WITH TMH 7 (PARTS 1 AND 2) 1981, AS REVISED IN 1988,TMH 7 (PART 3) 1989 AND BS 5400 (PART 4) 1984.
LIMIT STATE DESIGN DESIGN PACKAGE :
PROKON AND SOFISTIK (FINITE ELEMENT)

2 DESCRIPTION OF THE STRUCTURE:

2.1 FOUNDATIONS:
ABUTMENTS - CAST IN-SITU SPREAD FOUNDATIONS

2.2 SUBSTRUCTURE:
ABUTMENTS BUILT INTEGRAL WITH DECK

2.3 SUPERSTRUCTURE SINGLE SPAN IN-SITU CONCRETE PORTAL FRAME.

B. DESIGN NOTES:

1. DESIGN LIVE LOADING:
1.1 NA LOADING
1.2 NB LOADING (TYPE NB36)
1.3 NC LOADING (TYPE NC-30x5x40)

2. UNIT WEIGHT OF MATERIALS:
2.1 FILL MATERIAL = 20kN/m3
2.2 REINFORCED CONCRETE SUBSTRUCTURE = 25 kN/m3
2.3 ASPHALT = 21kN/m3 (DESIGN FOR 50mm THICKNESS)

3. SOIL PRESSURE:
SOIL PRESSURE AGAINST RETAINING STRUCTURES IN ACCORDANCE WITH TMH 7 (PART 2) PARAGRAPH 2.4.2:
TYPE II EARTH PRESSURE AND NA, NB AND NC SURCHARGE.

4. LOADING ON PARAPETS:
IN ACCORDANCE WITH TMH 7(PART 2) PARAGRAPH 3.5.1.2

5. SECONDARY DECK LOADING:
AS PER TMH 7 (PART 2)

C. CHARACTERISTIC STRENGTH OF MATERIALS:

1. CONCRETE:

ELEMENT	CHARACTERISTIC STRENGTH (MPa)	CLASS (MPa/mm)	YOUNG'S MODULUS (GPa)
BLINDING	15	15/19	24
ABUTMENTS	35	W 35/19	28
DECK	40	W 40/19	31
FOUNDATIONS	35	35/19	28

2. REINFORCEMENT:

TYPE	CHARACTERISTIC STRENGTH (MPa)	YOUNG'S MODULUS (GPa)
MILD STEEL	250	200
HIGH TENSILE STEEL	450	200

D. FORMWORK AND CONCRETE FINISH

1 CONCRETE FINISHES TO FORMED AND UNFORMED SURFACES

a) FOUNDATIONS - F1, U1
b) ABUTMENTS (CONCEALED) - F1, U1
c) ABUTMENT (EXPOSED) - F2, U2
d) PIER - F2, U2
e) DECK TOP SLAB - - - U2
f) DECK SIDES AND SOFFIT - F3, U2
g) BALUSTRADE - F3, U3

E. CONCRETE COVER TO REINFORCEMENT

1 a) CAST AGAINST EARTH - 75mm
b) FOUNDATIONS (SHUTTERED) - 50mm
c) EXPOSED SURFACES - 40mm
d) ABUTMENTS - 50mm
e) PIERS - 50mm
f) DECK - 40mm

2 ALL SHARP EDGES TO HAVE A 25mm x 25mm CHAMFER

F. APPROVED ROAD DRAWINGS

1. ROAD DRAWINGS:
REFER TO DRAWING No. -XXXX

FOR DISCUSSION

No.	DESCRIPTION / REVISIONS	DATE
A	ISSUED FOR CONCEPTUAL	2019-01-10

COMPUTER FILE NAME:

DATE DATUM	2018-12-11	CLIENT
SCALE SKAAL	1:50, 1:100	
DESIGNED BY ONTWERP DEUR	M. NDLOVU	FOR ILISO CONSULTING
CHECKED BY NAGESIEN DEUR	C.G. KOOPMAN	
DRAWN BY GETEKEN DEUR	M. NDLOVU	PROJECT ENGINEER
CHECKED BY NAGESIEN DEUR	C.G. KOOPMAN	

QUALITY CHECKS	CONTENT AND ACCURACY	DESIGN COMPLIANCE	PROJECT COMPLIANCE

NAKO ILISO

PROJECT
BOEGOEBAAI MAIN INTERCHANGE BRIDGE

TITLE
GENERAL ARRANGEMENT 1

PAPER SIZE	PROJECT NO. DRWG. NO.	REV.
A0	1500103-TRANS-9009	A