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BEIT BRIDGE DEVELOPMENT OF MASTER PLAN REF: 17/1/4/1/6022/10

ELECTRICAL ENGINEERING REPORT

FINAL REPORT
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1 INTRODUCTION

1.1 BACKGROUND

Beit Bridge Border Post is the port of entry and a customs and immigration post between Zimbabwe and South Africa situated in the Musina Local Municipality in South Africa.

The project is initiated by the client of the National Department of Public Works which is the Border Control Operating Coordinating Committee (BCOCC). The National Department of Public Works (DPW) appointed Delta Built Environment Consultants (Delta BEC) to develop and compile a Master Plan for the Beit Bridge Port of Entry. The approved Master Plan will be cost-effective, provide the required facilities for tenants and ensure world class cross-border operations.

The project entails the preparation of a comprehensive master plan for Beit Bridge Port of Entry. The master planning is undertaken to provide better planning of the port of entry to address land use and transportation effects of the border post. The master plan will seek to achieve the promotion of the government's objectives of economic development, good governance and rising living standards and prosperity by providing and managing the accommodation, infrastructure needs of national departments, by leading the national Expanded Public Works Programme and transformation of the construction and property industries.

The objectives of the Master Plan are:

- The master plan will be based on an area of between 120 hectares and is undertaken to provide better planning of the port of entry to address land use and transportation effects of the border post.
- The Master Plan will therefore serve as a blueprint informing the structuring of the port of entry environment which includes the operational flow and dynamics, the placement and positioning of buildings, facilities and infrastructure as well as the alignment of roads.

The project will be executed through implementation of three project phases comprising of twelve main tasks:

- Phase One : Inception and Status Quo analysis
- Phase Two : Preparation of Spatial Development Concept
- Phase Three: Master Plan Finalisation

The tasks to be executed during implementation of the above project phases include the following:

- Task One: Inception and Status Quo Analysis
- Task Two: Preparation of Spatial Development Concept
- Task Three: Master Plan Finalisation

- Task Four: Land Surveying and Orthophoto Mapping
- Task Five: Environmental Screening and Impact Assessment
- Task Six: Civil Engineering Investigation
- Task Seven: Electrical Engineering Investigation
- Task Eight: Geotechnical Investigation
- Task Nine: Conveyancing
- Task Ten: Heritage Assessment(HIA)
- Task Eleven: Traffic Impact Assessment
- Task Twelve: Urban Design

1.2 PURPOSE OF REPORT

The purpose of this report pertains to the analysis and review of the current electrical engineering Status Quo of the border post as well as the surrounding area. This report will contextualise the current electrical engineering infrastructure of the border post as well as provide an overview of the most salient electrical engineering considerations influencing the conceptualisation of a new master plan.

1.3 STRUCTURE OF REPORT

The report comprises the following sections:

- Section 2: Description of the site
- Section 3: Infrastructure and bulk services
- Section 4: Demand
- Section 5: Conclusion

2 APPROACH AND METHODOLOGY

The methodology that will be adopted during the electrical engineering status quo assessment is outlined below:

- Firstly, analyse and review the current electrical engineering operations at the border post.
- Secondly, contextualise the current electrical engineering operations of the border post in terms of capacity and demand.
- Thirdly, provide an overview of the most salient electrical engineering considerations influencing the conceptualisation of a new master plan.

3 SITE LOCATION

The Beit Bridge Border Post is the main point of entry into South Africa from Zimbabwe. The Border Post is classified as a National Key Point and is operated by the Department of Public Works. The Beit Bridge Border Post is situated within the Musina Local Municipality in Limpopo Province. The Beit Bridge Border Post can be accessed by the N1 National Road which runs in a south to north direction. The N1 connects the central parts of South Africa with Zimbabwe and also further north.

The Beit Bridge Border Post is situated approximately 15km north of Musina and just south of the Limpopo River. The Beit Bridge Border Post is the busiest of the country's point of entries in South Africa.

The locality plan is indicated in **Figure 3-1**.

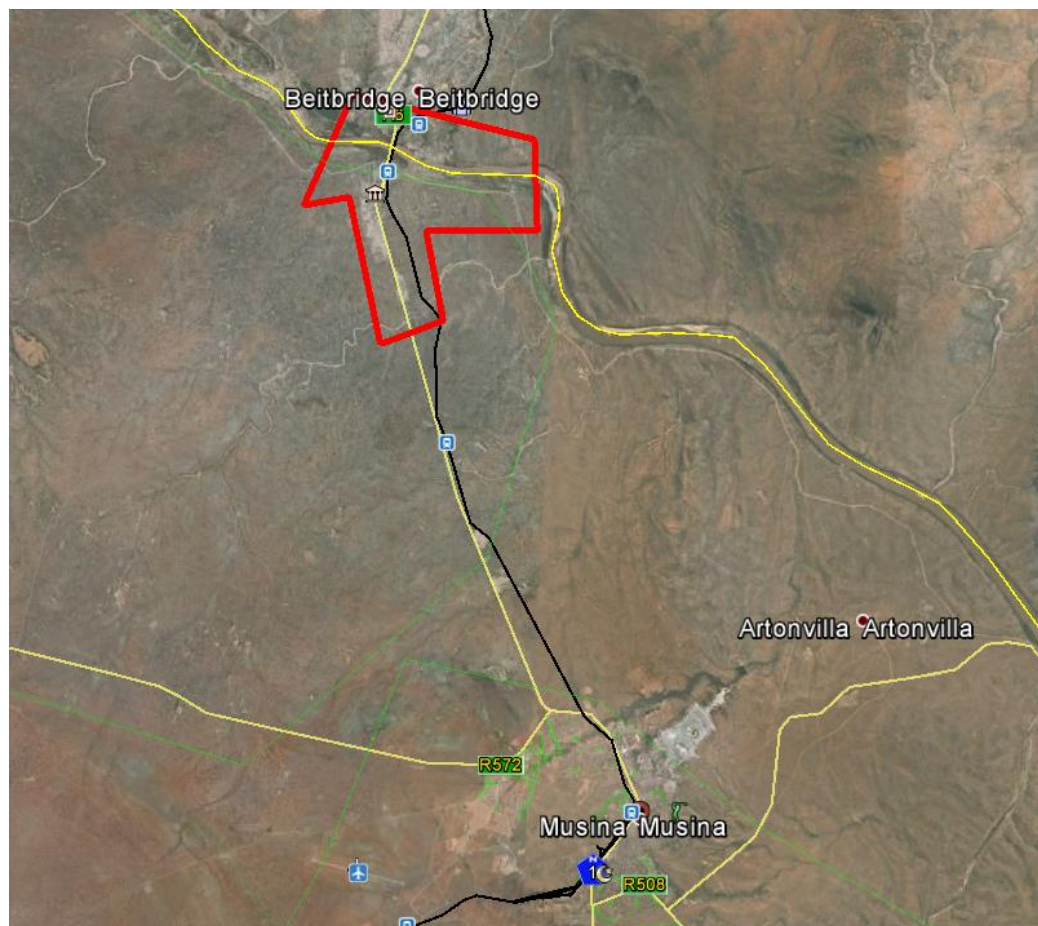


Figure 3-1 Locality Plan

A study area of approximately 1088 Ha has been delineated as a larger area of interest. The area which will be focussed on in more detail and be known as the Master Plan area will be delineated in the following phase. The larger study area is indicated in **Figure 3-2**.

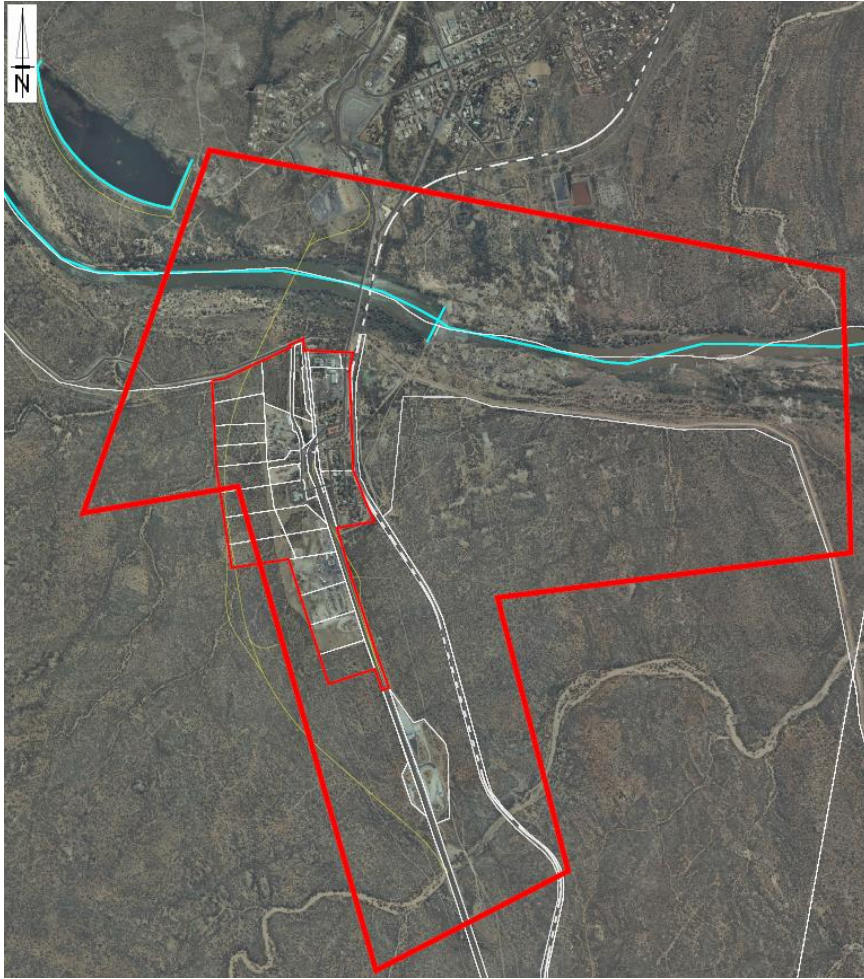


Figure 3-2 Larger Study Area

4 INFRASTRUCTURE AND BULK SERVICES

The services included in this project scope are the 22kV, 11kV and 400V electrical infrastructure in the area. This will be divided into Eskom responsibility, DPW responsibility and private properties.

Information required to complete the Status Quo Report was gathered from a site visit that took place on 9 April 2014. Delta BEC engineers also met with the local municipal engineer, Mr du Toit. Unfortunately Eskom was not available on short notice, but contact was made with the responsible manager, Mr Shumani Maladzhi.

This was done in order to obtain information regarding the existing electrical infrastructure network. The team did a site walk-about on 9 April to familiarise themselves with the general arrangement and condition of the reticulation and distribution of the electrical installation.

The inspection and Status Quo Report will serve as baseline for determining the current condition and discussions between Delta BEC and DPW. The status quo and subsequent discussions will then be used to formulate a Preliminary Design Report.

4.1 ELECTRICITY

4.1.1 GENERAL ASSESSMENT

The existing use of land consists of government (Port of Entry), residential, social, educational, historical and commercial buildings. Eskom is the supplier of electricity for the area. The existing electrical infrastructure network consists of 22 kV and 11 kV (medium-voltage) distribution and 400V low voltage reticulation to metered supply points. According to visual inspections and reports from individuals interviewed during the site walkabout, the electrical infrastructure is generally in good condition.

Eskom has a 132/22 kV substation just north of Musina from where 22kV lines are distributed towards the Beit Bridge area.

Existing 132kV overhead lines pass through the area east and west of the port area. These 132kV overhead lines belong to Eskom and cross the border to Zimbabwe.

This assessment excludes any infrastructure located within individual properties. It also excludes the aforementioned 132kV and 22kV lines.

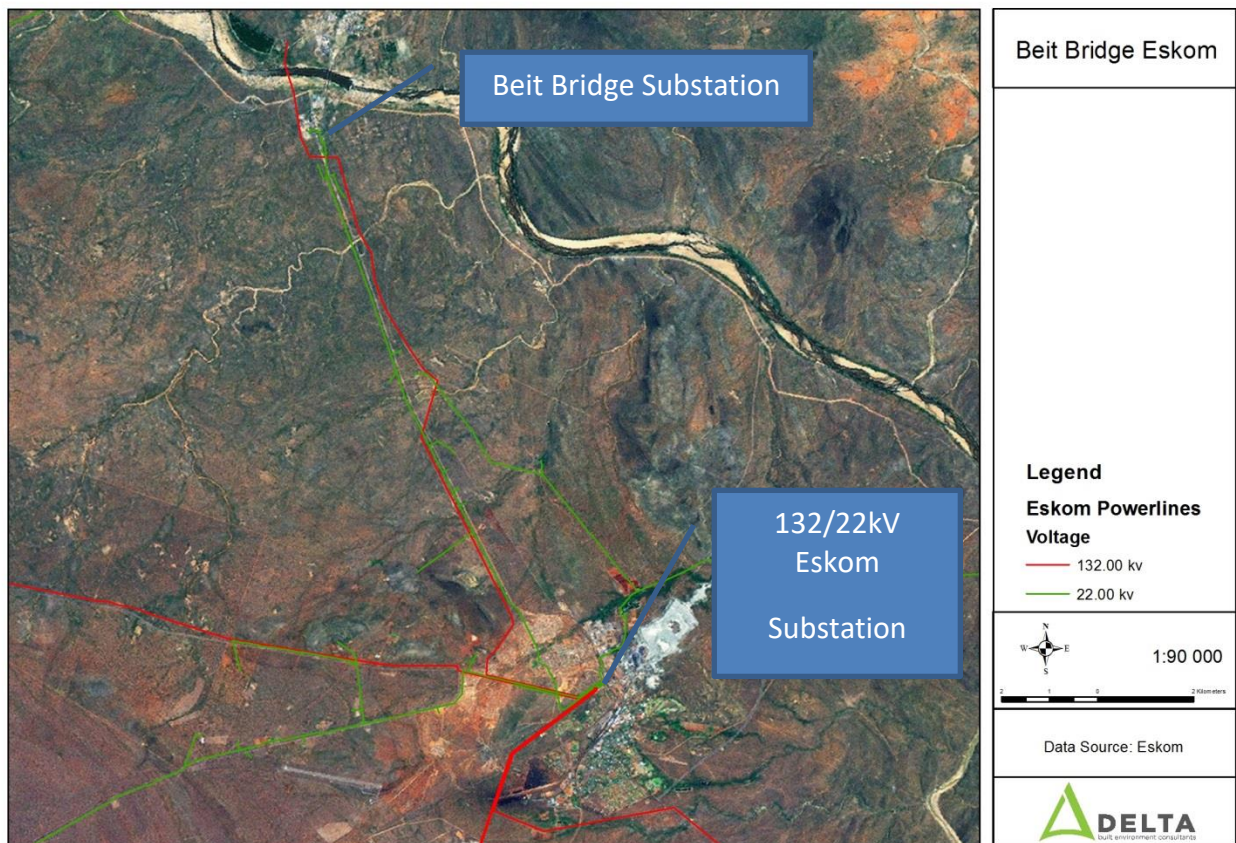


Figure 4-1 Musina Eskom Transmission and Reticulation

4.1.2 ESKOM CAPACITY AND AREA DEMAND

Information relating to the network capacity in the area was provided by Eskom and is assumed to be accurate.

The following information was gathered during the site inspection and subsequent discussions with Eskom. Njabulo Hadebe, a senior master planner at Eskom (Email: HadebeNj@eskom.co.za, Telephone: 015 299 0117) provided Delta BEC with information the information below. It is strongly advised that he be included in future discussions.

According to Mr Hadebe, Eskom has a 132kV transmission line to the Musina area with an allocated capacity of 146MVA from the upstream Thabo MTS (Main Transmission Station). The line is approximately 200 kilometres long. The current spare capacity is approximately 10 MVA. The line feeds several towns and mining activities. The line is scheduled for an upgrade with commissioning expected in 2019.

The 132/22kV substation outside of Musina has an installed transformer capacity of 10 MVA. This substation feeds the Beit Bridge border post and several other

rural areas. It currently exceeds its designed capacity and is scheduled for an upgrade, resulting in a total capacity of 30 MVA after the upgrade.

The 10MVA capacity of the 22kV line to the Beit Bridge area is fully allocated at present. Capacity on this line would need to be increased once the substation capacity has been upgraded.

According to Eskom, the current estimated network access demand of the Beit Bridge Border Post Area is 200 kVA.

Eskom did indicate that it must remain part of the Master planning process and, with the current constraints on the network, it is vital that any changes to the border post be coordinated with Eskom.

4.1.3 22kV AND 11kV NETWORK

Overhead and underground cables distribute 11kV into the DPW-owned area from the Beit Bridge Substation located south of the residential area.

All 22KV lines are owned and maintained by Eskom.

All 11kV lines are owned and maintained by DPW.

Four well-placed termination points were identified where the 11kV terminates onto 11000/400V transformers for the supply of buildings and area lighting:

1. Supply point for the residential area
2. Supply point for the immigration building and surrounding area.
3. Supply point for the truck stop and commercial area.
4. Pump station at the river (From information received this line is DPW owned).

From visual inspections and discussions with relevant people, Delta BEC is of the opinion that the current installation is in good condition.

The capacity of the internal reticulation is sufficient for the existing layout and port operations.

The remainder of the Beit Bridge area is reticulated by a 22kV Eskom-owned overhead line. This area is mainly to the south and west of Beit Bridge.

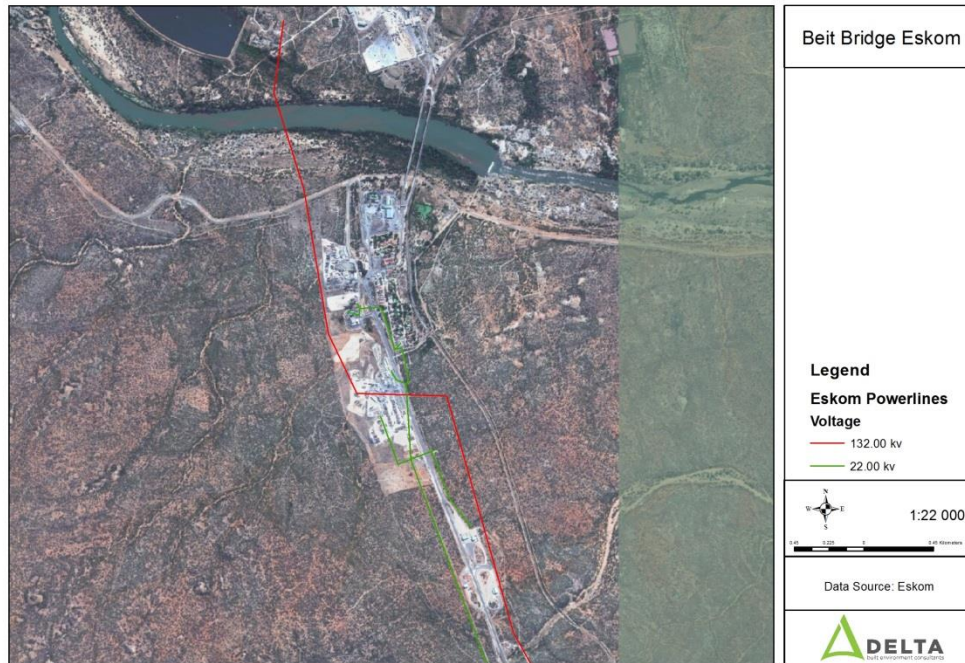


Figure 4-2 Beit Bridge area Eskom lines

4.1.4 LV RETICULATION NETWORK

Underground cables low voltage distribution cables link the transformers to the buildings. There were no reports of problems relating to the low voltage network.

Delta BEC identified two standby diesel generators:

1. Immigration office: a 160kVA generator was installed in 1970 for the supply of critical equipment and lights. This generator has a connected load 135kVA, approximately 80% of its capacity.
2. Truck Stop/ Commercial Area: a 150kVA generator was installed in 2005 for the supply of area lighting and certain office equipment in adjacent buildings. The generator has a connected load of approximately 120kVA.

In both cases, it appears that the generators are being maintained and they both seem to be in a fair condition.

4.1.5 Area Lighting

The Port area is well lit with various types of and configurations of high mast lighting, street lighting and area lighting.



Figure 4-3 Various Area Lights

4.1.6 ENERGY EFFICIENCY

Delta BEC did not find evidence of particularly energy efficient equipment inside the Port area, such as light fittings, building management systems, modern HVAC systems, occupancy sensors, variable speed drive pumps, etc. However, the equipment used is not inefficient and is well suited for use at a national key point.

Cognisance must also be taken of the remoteness of the area with regards to using energy efficient technology which is sometimes complex and proprietary in

nature. Being a national key point, repair time on failure is critical. Timeous sourcing replacement parts for complex, proprietary equipment can be a challenge.

4.1.7 DRAWINGS

The following drawings are available and attached to the report (Appendix A):

1. Musina overhead line network.
2. Beit Bridge Port Area internal reticulation and area lighting.

4.2 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

4.2.1 COMMUNICATION

Communication was listed as a major challenge for all the departments. This includes insufficient access the internet, insufficient access to telephone services, a lack of inter-department communication systems and a lack of two-way speaker phones.

An EMCS (Excise Movement and Control System) was reported to be shared between the SAPS and the Department of Home Affairs (Immigration).

The SAPS currently has a Telkom internet connection and is in the process of installing a satellite internet system.

The Beit Bridge SAPS radios are antiquated and do not provide good range nor battery life.

SARS and the Department of Home Affairs have indicated that they currently have an internet connection.

4.2.2 CELLULAR PHONE NETWORK (GSM NETWORK) COVERAGE

The websites of Vodacom, MTN, Cell C and Telkom Mobile indicate that the Beit Bridge area has GSM coverage for voice services as well as low-speed data services (GPRS, EDGE, 2G). The Virgin Mobile website indicates that only GSM-based voice services are available.

3G data connection is not shown to be available for any network in the Beit Bridge area.

5 DEMAND FOR INFRASTRUCTURE AND BULK SERVICES

5.1 ELECTRICAL INFRASTRUCTURE

5.1.1 ELECTRICITY DEMAND

The bulk electrical demand for Beit Bridge Port Area was determined utilising the forecasted areas.

The parameters utilised are shown in Table 5-1, and a summary of the demand requirements in Table 5-2. For detailed calculations please refer to Annexure A.

Table 5-1: Design parameters

Design parameter	Value
Average power demand per m ² for buildings	110 VA/m ²
Average power demand per m ² for all other areas	0.5 VA/m ²

Table 5-2: Electrical Demand requirements (MVA)

Electricity Demand	Demand (MVA)	
	Max.	Typ.
Current	2.96	0.95
2024	3.82	1.19
2044	3.82	1.19

5.1.2 NEW BULK SUPPLY POINT

A single bulk supply point shall be provided at the border post. It is expected to have 22 / 11 kV transformers that distribute two 11 kV MV rings throughout the border post precinct. The substations shall be designed such that future expansion is possible, including additional transformers, primary MV switchgear and secondary MV switchgear.

5.1.3 SUBSTATIONS AND TRANSFORMERS

It is estimated that approximately ten miniature substations (minisubs) will be required to implement the 2024 / 2044 master plan. Sizes will range from 315 kVA to 630 kVA.

5.1.4 STANDBY DIESEL GENERATORS

Each minisub shall be accompanied by a standby generator to ensure partial backup power to essential equipment. This is to ensure that the generator system is decentralised, allowing key buildings to have power even when there are faults in the internal MV distribution system at the border post.

Essential equipment includes computers, truck scanning equipment, X-ray scanners, metal detectors, communication equipment, telephone systems and radio systems. All internal and external lighting shall also be generator powered.

5.1.5 UNINTERRUPTED POWER SUPPLY

Uninterrupted Power Supply (UPS) units are recommended for dedicated loads, including key computers, operator terminals, communications equipment, telephone systems and radio systems.

UPS units shall be installed in each building where they are required.

In addition to the common UPS systems in each building, a separate, independent UPS system shall be provided for server room(s) or datacentre(s).

Emergency light fittings shall have on-board battery packs, and shall be placed in accordance with SANS 10114.

5.1.6 LOW VOLTAGE RETICULATION

Low voltage distribution shall be implemented using a combination of LV panels inside minisubs, LV distribution kiosks and armoured underground cables.

5.1.7 PUMP STATIONS

To reduce cable size and electrical distribution losses, it is recommended that a minisub is placed near pump stations to minimise low voltage cable runs. This is particularly important when large motors are involved, for example fire water pump motors.

Motor control centres for all pumps shall be designed by specialists, particularly in cases when advanced controls are required (e.g. waste water treatment works). Although variable speed drives could be considered to improve the efficiency of pump stations, care must be taken to ensure the systems are robust in an environment where maintenance levels are likely to be suboptimal.

5.1.8 ENERGY EFFICIENCY SYSTEMS

Although care must be taken when implementing energy efficient technologies (see Section 4.1.6 on page 14), a basic level of simple and easily maintainable energy efficient equipment is recommended. This could include occupancy sensors, readily available LED luminaires that have a standardized form factor and daylight harvesting sensors in public areas.

Combination solar and heat pump hot water systems are also recommended, particularly for residential buildings and food preparation areas.

5.1.9 LOAD MANAGEMENT SYSTEMS

Due to the complexity of load management systems, it is not recommended that such a system is installed at Beit Bridge. However, in the event that Eskom supply constraints have a negative impact on the development of the border post, a load management system should be considered. Several manufacturers of industrial

building management systems have products that allow for the integration with hot water systems, mechanical HVAC systems, generator systems and energy measurement devices. This allows for internal load rolling and load shedding techniques to be implemented in order to reduce the overall maximum demand of the site.

5.1.10 ALTERNATIVE ENERGY SOURCES

Alternative energy sources should be considered, particularly solar photovoltaic (PV). The Musina area has one of the highest annual solar irradiance levels in the country, approximately 2000 kWh/m². As of 2014, rooftop and carport solar PV installations are increasingly becoming financially viable.

In the event that solar PV installations are not immediately incorporated into the development of the border post, all buildings should be designed to accommodate rooftop PV modules in future. Similarly, carport structures should be designs with future PV systems in mind.

Surplus energy can be exported to the Eskom grid when the power produced by the PV installations exceeds the border post's electricity demand.

It is unlikely that other renewable energy sources will be feasible on a meaningful scale at the border post, including wind energy and biogas.

5.2 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

5.2.1 COMMUNICATION

Access to fast, reliable internet and telecommunications systems is a key requirement for the proper functioning of any institution, particularly a national key point such as the Beit Bridge border post. It is therefore important that sufficient resources are allocated for the upgrade and expansion of existing services, in partnership with relevant service providers.

It is strongly recommended that a bulk fibre connection is brought to the Beit Bridge border post.

5.2.2 CELLULAR PHONE NETWORK (GSM NETWORK) COVERAGE

It is expected that the larger cellular network operators will upgrade their networks in future to enable high-speed mobile data connections at the Beit Bridge border post. They should be actively engaged and encouraged during the implementation of the master plan.

6 CONCLUSION

Beit Bridge currently obtains electricity through a 22kV line from Musina and two generators used for power failures. The following main aspects are evident from the status quo and demand analysis:

- **Eskom 132 kV line feeding Musina**
 - Currently has an allocated capacity of 146 MVA
 - Currently has spare capacity of 10 MVA
 - Capacity upgrade schedule for 2019
- **Eskom 132/22 kV substation outside Musina**
 - Currently has a capacity of 10 MVA
 - Currently exceeds capacity. Zero spare capacity
 - 20 MVA additional capacity planned, total capacity will be 30 MVA
- **Eskom 22 kV line between Musina and Beit Bridge**
 - Currently has a capacity of 10 MVA
 - Current has zero spare capacity
 - Must be upgraded when 132/22 kV substation is upgraded
- **Beit Bridge Demand**
 - Current maximum demand is approximately 0.2 MVA.
 - Projected future demand is 3.82 MVA (2024 – 2044)

APPENDIX A: EXISTING ESKOM POWERLINES LAYOUT

APPENDIX B: EXISTING EXTERNAL LIGHTING LAYOUT

APPENDIX C: PROPOSED LIGHTING AND SUBSTATION LAYOUT

APPENDIX D: ELECTRICAL DEMAND CALCULATIONS

	Current					2024					2044				
	Area	Demand	Maximum Demand	Site Diversity	Average Demand	Area	Demand	Maximum Demand	Site Diversity	Average Demand	Area	Demand	Maximum Demand	Site Diversity	Average Demand
	m ²	kVA/m ²	kVA		kVA	m ²	kVA/m ²	kVA		kVA	m ²	kVA/m ²	kVA		kVA
LIGHT VEHICLE CONTROL FACILITIES	3,703	110.0	407.3	0.3	122.2	4,451	110.0	489.6	0.3	146.9	4,451	110.0	489.6	0.3	146.9
Open Area	14,810	0.5	7.4	1.0	7.4	17,804	0.5	8.9	1.0	8.9	17,804	0.5	8.9	1.0	8.9
FAST LANE CONTROL FACILITIES	554	110.0	60.9	0.3	18.3	1,500	110.0	165.0	0.3	49.5	1,500	110.0	165.0	0.3	49.5
Open Area	2,216	0.5	1.1	1.0	1.1	6,000	0.5	3.0	1.0	3.0	6,000	0.5	3.0	1.0	3.0
FREIGHT HANDLING FACILITIES	6,615	110.0	727.7	0.3	218.3	14,494	110.0	1,594.3	0.3	478.3	14,494	110.0	1,594.3	0.3	478.3
Open Area	73,920	0.5	37.0	1.0	37.0	57,976	0.5	29.0	1.0	29.0	57,976	0.5	29.0	1.0	29.0
PEDESTRIAN & BUS CONTROL FACILITIES	2,176	110.0	239.4	0.3	71.8	5,409	110.0	595.0	0.3	178.5	5,409	110.0	595.0	0.3	178.5
Open Area	8,704	0.5	4.4	1.0	4.4	21,636	0.5	10.8	1.0	10.8	21,636	0.5	10.8	1.0	10.8
RAIL CONTROL FACILITIES	9,974	110.0	1,097.1	0.3	329.1	2,656	110.0	292.2	0.3	87.6	2,656	110.0	292.2	0.3	87.6
Open Area	39,896	0.5	19.9	1.0	19.9	10,624	0.5	5.3	1.0	5.3	10,624	0.5	5.3	1.0	5.3
SUPPORT FACILITIES	3,146	110.0	346.1	0.3	103.8	5,575	110.0	613.3	0.3	184.0	5,575	110.0	613.3	0.3	184.0
Open Area	22,300	0.5	11.2	1.0	11.2	22,300	0.5	11.2	1.0	11.2	22,300	0.5	11.2	1.0	11.2
TOTAL			2,959.4		944.5			3,817.5		1,193.0			3,817.5		1,193.0