

3 DESCRIPTION OF THE PROJECT INDICATING THE VARIOUS PROJECT COMPONENTS

3.1 INTRODUCTION

This *Chapter* provides a general overview of the technical features of the proposed Batoka HES. The information in this chapter was sourced from the Batoka HES Phase II _layout - Options Assessment Report of March, 2015, prepared by Studio Pietrangeli Consulting Engineers (SP).

SP has been contracted by ZRA to update the previous feasibility studies (1993 and 1998) for the Batoka HES.

3.2 PROJECT LOCATION

The proposed Batoka HES is to be located at 17° 55' 38.55" S and 26° 6' 28.38" E ⁽¹⁾, in the central portion of the Zambezi River Basin, and will extend across the international boundary between Zambia and Zimbabwe. It will be situated upstream of the existing Kariba Dam hydroelectric scheme on the Zambezi River and approximately 50 km downstream of the Victoria Falls (see *Figure 3.1* and *Figure 3.2*).

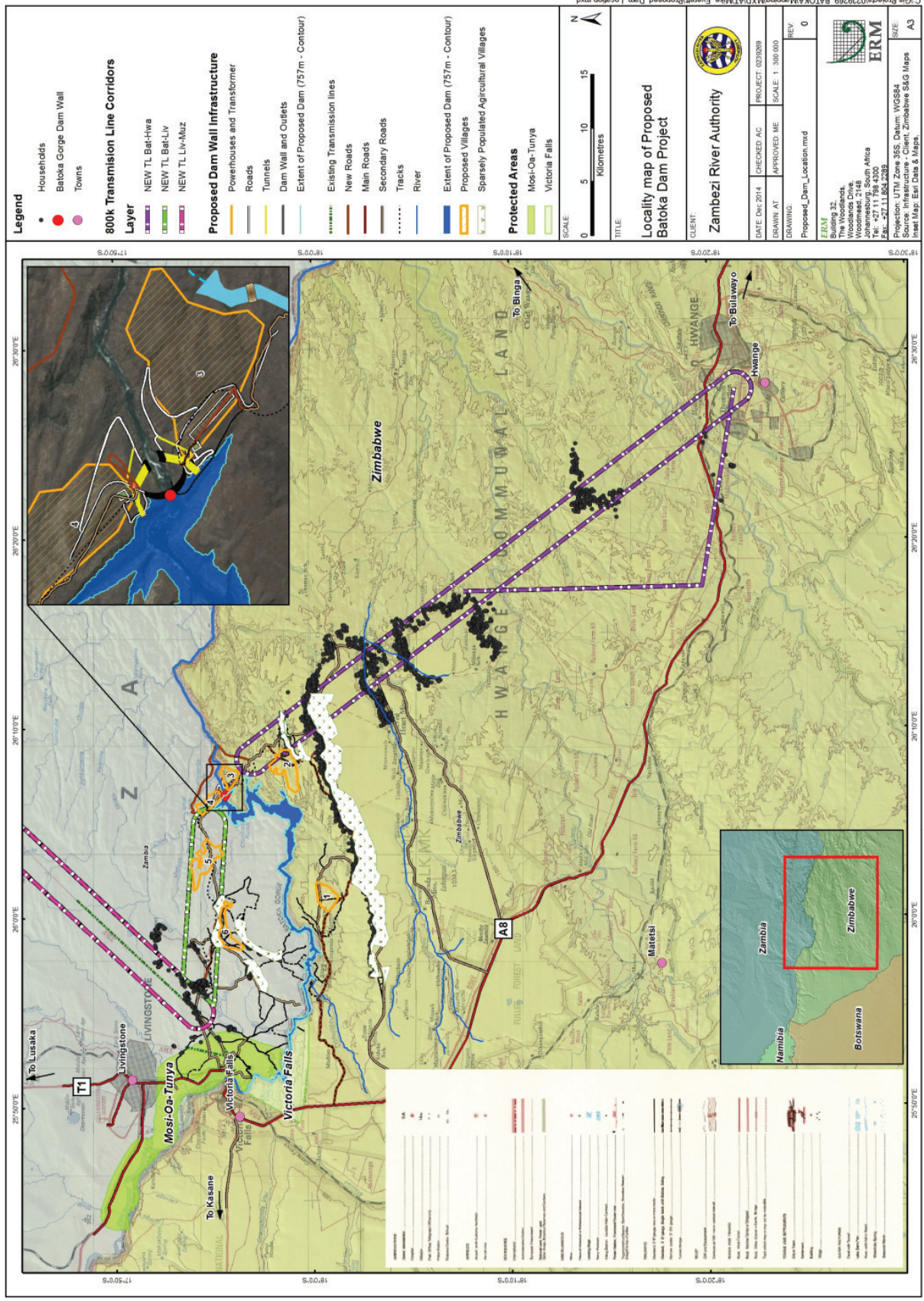
In Zimbabwe, the proposed scheme falls within the province of Matabeleland North and in the Hwange Rural District. It includes the wards of Matetsi, Chidobe, Katchecheti, Nemanhanga, Mbizha, Jambezi, Sidinda, Mashala and Simangani. The traditional authorities in the area of impact in Zimbabwe include chief Shana, Bishop Matata Sibanda (who is Acting Chief for Mvutu who has recently deceased) and Chief Hwange. In Zambia, the main area of direct impact falls under the Southern Province in the Kazungula District, most notably the wards of Mukuni Ward and Katapazi, which fall under Chief Mukuni's jurisdiction. However, impacts will also be felt in Livingstone District, Zimba District and Choma District and downstream impacts are likely to be experienced in the District of Kalomo.

The proposed dam site is provided in *Figure 3.1*, (which is based on the map of the Surveyor-General, Zimbabwe Rhodesia, Batoka Gorge 1726 C3, Edition 2, Scale 1:50 000) and *Figure 3.2*.

(1) More accurate coordinates (in ITRF2008 Geographic) are provided by SP (2015) for the proposed site on both the Zambian and Zimbabwean banks of the river.
UTM Coordinates are 8017623.076 (Y) and 405516.5006 (X)

Figure 3.1

Proposed Dam Site Location (1)



Proposed Dam Site Location (2)



The following constitute the key components of the Batoka HES project:

- Dam wall and impoundment, also including a spillway;
- Power houses;
- Transmission lines in Zambia and Zimbabwe;
- Access roads in Zambia and Zimbabwe; and
- Permanent villages and other ancillary infrastructure (such as quarries, spoils area, construction camps and batching areas).

The following sections reference the dam design that was proposed in the 1993 Batoka Gorge Hydro Electric Scheme Feasibility Study (BJCV, 1993, but which has now been updated, as outlined in Studio Pietrangeli's (SP) March 2015 Phase II Option Assessment Report.

3.3.1 Dam Wall and Impoundment

The proposed Batoka HES has been proposed in the central portion of the Zambezi River Basin, at a site 50 km downstream of Victoria Falls and will extend across the international boundary between Zambia and Zimbabwe. The proposed high gravity arch dam wall will be 181 m in height (1993). The full supply level (FSL) of the reservoir is tentatively set at 757 m above mean sea level (amsl). After impoundment to the Full Supply Level (FSL), the reservoir surface area will cover approximately 25.6 km² (*Figure 3.2*). The FSL of 757 m has been tentatively selected so as to ensure the backwaters from the resulting impoundment do not reach the base of the Victoria Falls or flood the outlets of the existing Victoria Falls Power Station, located in the region of Silent Pool. An analysis of the optimum dam height will be carried out by SP during this feasibility phase.

SP (2015) is proposing a "compact" layout for the arch gravity dam (waterways and powerhouse) obtained through a separated spillway on the right abutment the design of the dam. SP have moved the spillway from the body of the dam, to a saddle on the right abutment located approximately 2 km from the dam site. This means that the waterways are greatly shortened, replacing the long power tunnels with short penstock in the dam body.

The spillway has the advantage of safety during operation (as it avoids any risk of under-cutting at the dam wall), it avoids the need for artificial works (plunge pool and other protection/dissipating structures) aimed at minimising erosion in proximity of the dam and Power Houses. Furthermore, the total excavated volume of the spillway during construction may be used as quarry materials and used as aggregate for use in the arch gravity dam wall, minimising the requirement for rock quarries and/or borrow pits.

3.3.2 Power Houses and Switchyards

In the 1993 Feasibility Study it was planned that two power houses, each with an installed capacity of 800 MW, would be constructed on each river bank, with a total capacity of the scheme being approximately 1600 MW. However, the 2015 SP study undertook an analysis on the optimum installed power, which considered that capacity that minimises the unit generation cost, that maximizes the Internal Rate of Return (IRR), and which ensured the optimum installed power was acceptable from an environmental flow point of view. Based on the results of the SP (2015) review, the optimum installed capacity that maximises the IRR and minimizes the unit generation costs is 2,400MW. As the proposed plant will operate as a run-of-river scheme, the environmental constraints do not affect the selection of the optimum installed power.

Two independent power houses are proposed at the dam toe, which has the advantage of obtaining a very compact layout of the dam, power waterways and power house. The power houses are outdoor and accessible from both the right and from the left banks. The two power houses are identical and each of them includes:

- Six Francis Turbines, each one of about 200MW of installed capacity;
- Six Generators having rated voltage 15kV;
- Main and auxiliary cranes, draft tube gates, auxiliary equipment;
- One erection bay; and
- Step-up transformers feeding the out-coming overhead lines directed to the Switchyards.

The project has no underground works, and allows for a minimal construction period (which substantially improves the financial conditions of the proposed project).

Due to the small storage capacity of the planned reservoir (~1,392 Mm³ at FSL), the Batoka HES will be operated as a run-of-river project with storage only sufficient to allow daily and weekly peaking but not for monthly or seasonal flow regulation. Further details of the Batoka HES, as per the 2015 Option Assessment Report (SP, 2015) are provided in *Table 3.1* below.

Two switchyards are located on each bank of the river, at elevation 800 m, where the ground is flatter and more suitable for this infrastructure. Switchyard dimensions are 130 m by 240 m, and are connected by 400 kV overhead lines from the main transformers, housed behind the power houses.

Table 3.1 Batoka HES Project Description

Project Description	
Reservoir	
Catchment Area	508, 000 km ²
Average Annual Runoff (m ³ /s)	1,070

Project Description	
Minimum Operating Level (MOL)	746 m asl
Full Supply Level (FSL)	757 m asl
Surface Area @ FSL	23 km ²
Total Storage	1,392 Mm ³
Dam	
Type	Arch-Gravity
Crest el.	766 m asl
Foundation min. el.	585 m
Max Height (u/s)	181 m
Crest length	720 m
Spillway	
Type	Gated
Spillway width	118 m
No. of Bays	7
Sill elevation (masl)	743.5 m
Energy dissipater	Plunge pool
Power House	
Type	Outdoor
Number	2
Turbine number and type	12/Francis, each of 200MW of installed capacity
Installed Power	2,400 MW
Annual Energy Production	10,215 GWh/y

Source: SP, 2015. Option Assessment Report

The proposed layout of the Batoka HES is provided in *Figure 3.3*.

3.3.3 Transmission Lines

It is proposed that in Zimbabwe, the transmission lines will comprise 2 x 70 km 330 kV lines, running in parallel, and sharing a common right-of-way, to the existing Hwange 330 kV substation. The 330kV transmission lines will have a way-leave of 50 meters (25m on either side).

An alternative has been identified, to take advantage of the existing A8 national road for the future construction and maintenance of the line infrastructure. In view of this, the alternative deviates approximately 30 km from the starting point towards the A8 motorway, and increases the route length by approximately 20 km.

In Zambia, two 330 kV transmission line routes are proposed, each comprising two outgoing lines. The first routing is from Batoka, terminating at a proposed new 330 kV ZESCO substation to be constructed in Livingstone; this route will be 21 km long. The second line will run in parallel to the existing 220 kV line, terminating at the Muzuma substation in Choma, a distance of approximately 160 km.

At this stage of the project, transmission line corridors of 3km in width will be investigated for possible environmental and social constraints, such as villages

and homesteads, agricultural fields, industrial sites, pipelines, settlements and other infrastructure, including protected areas (see *Figure 3.4*). A way-leave of 50m will be recommended within these 3km corridors, being investigated as part of the ESIA process.

3.3.4 Access Roads

The upgrading of existing roads and construction of new roads to access each bank from the main roads linking Livingstone to Lusaka (Zambia) and Victoria Falls to Bulawayo (Zimbabwe) will be required. In the 1993 Feasibility Study, this included the rehabilitation of 9 km of road and the construction of 22 km of new road in Zambia, and the rehabilitation and upgrading of 40 km of road and the construction of 14 km of new road in Zimbabwe, respectively.

The major modification to the 1993 study concerns the type of intervention. Instead of building new roads, SP (2015) advocate the upgrade of the existing roads as much as possible.

In Zambia, the network commences in Palmgrove, passes through Mukuni village and reaches the North bank of the dam site. The existing dirt road is viable for vehicles and is 29 km long. A 1.2 km long new road alignment will start from this point and reach the Batoka dam site (*Figure 3.5*). The overall access length is about 30 km.

In Zimbabwe, the Sizinda Road will bring vehicles 5km East of the Jabula School (Victoria Falls - Jabula School, Trunk A and Trunk B), where an existing secondary road leads firstly to Kasikiri Village (Jabula School - Kasikiri Village), secondly to Batoka Airport and, thereafter, to the Batoka dam site (Kasikiri Village - Batoka Airport). The full alignment will cover a length of approx. 54 km. This proposed alignment requires a new road link (1.8 km long) between the proposed South Township and the main access road to the dam site (i.e. Township - Batoka Airport); (*Figure 3.5*). This alignment was recommended by ERM, and the various road alternatives examined, are discussed more fully in *Chapter 8: Alternatives*.

With regards to the width of the roads, it is suggested to use best standards; given that main roads with permitted travelling velocity of 100 km/h will consist of 3.75 m wide lanes for each direction of travel and 1.5 m quays on each side of the road. Where necessary, in the proximity of villages and inhabited areas, 1.5 m pedestrian pavements will be added on each side of the road.

3.3.5 Permanent Villages and Other Ancillary Infrastructure

Permanent villages will be located on each side of the river. Six alternatives for the locations of these permanent villages were proposed (see *Figure 3.5*). The location of each proposed permanent village was finalised after environmental and social baseline studies, and the alternative suggested was based primarily so as to reduce the likelihood or extent of resettlement

required, and on impacts to identified sites of cultural heritage importance. The permanent village locations in each of Zambia and Zimbabwe are identified as Site A on *Figure 3.5*, and the alternative locations discussed in more detail in *Chapter 8*.

Construction camps will house approximately 3,000 staff in total (including security and support staff), but this will be only after two years, where initially 500 construction workers will be involved with the construction of access roads, infrastructure and the camps. Thereafter 3,000 staff in total will be required for the rest of the construction phase (up to six or seven years).

It is proposed that the construction camps will be converted into permanent villages during the operational phase of the dam, for housing staff, their families, and support services personnel (customs, police etc.). The 1993 feasibility study predicted approximately 9,000 people to be housed (assuming 4,500 on each side of the river).

Quarries, spoils areas, construction and batching camps will also be required in Zambia and Zimbabwe (see *Figure 3.5*).

The construction of the spillway and material stemming from this have been identified as suitable sources of aggregates to be used in the construction of the dam wall, which will reduce the volumes of quarrying and spoils areas required.

Figure 3.3 Proposed Layout of the Batoka HES

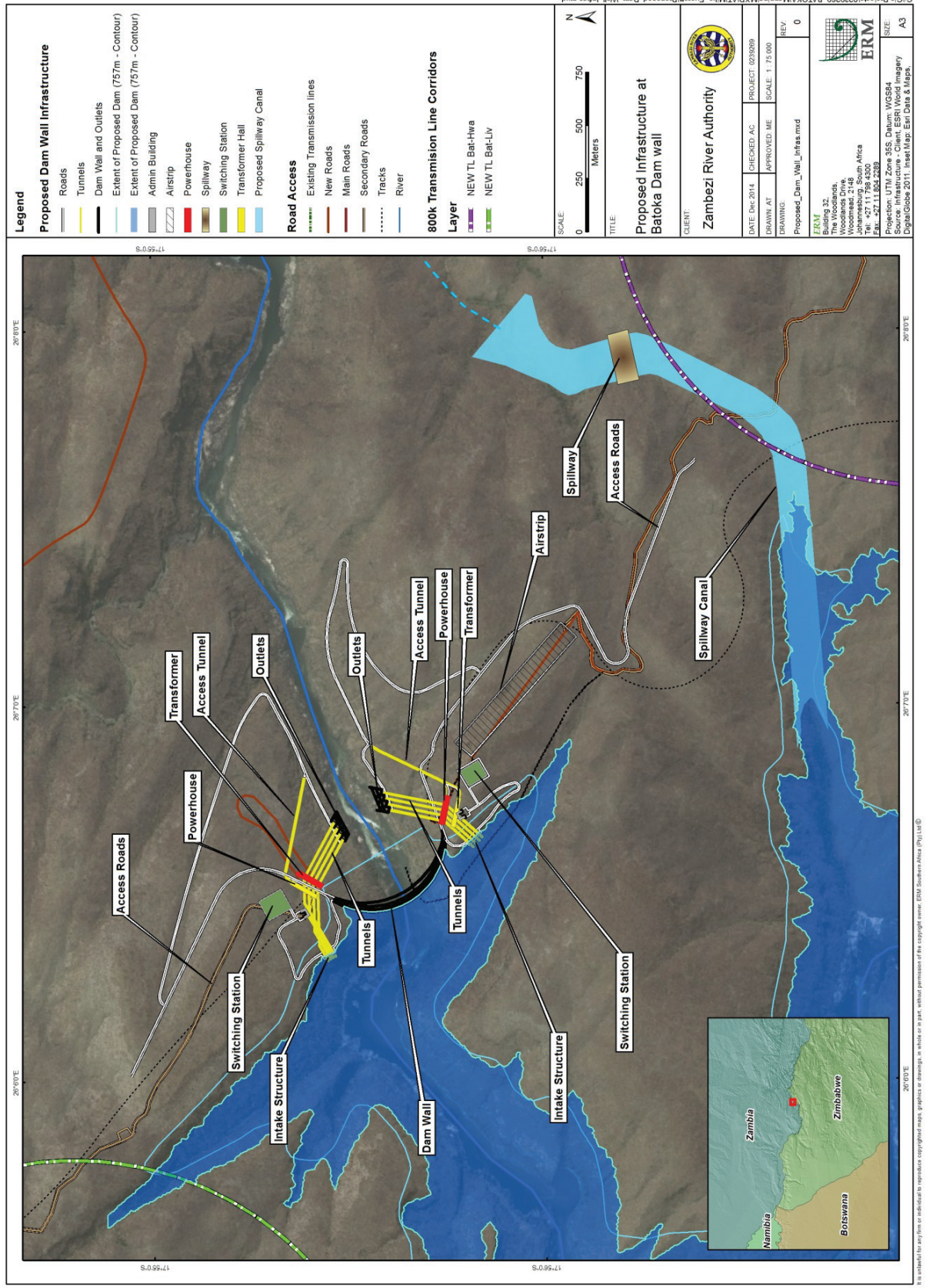


Figure 3.4 Areas to be Investigated for Proposed Transmission Line Corridors

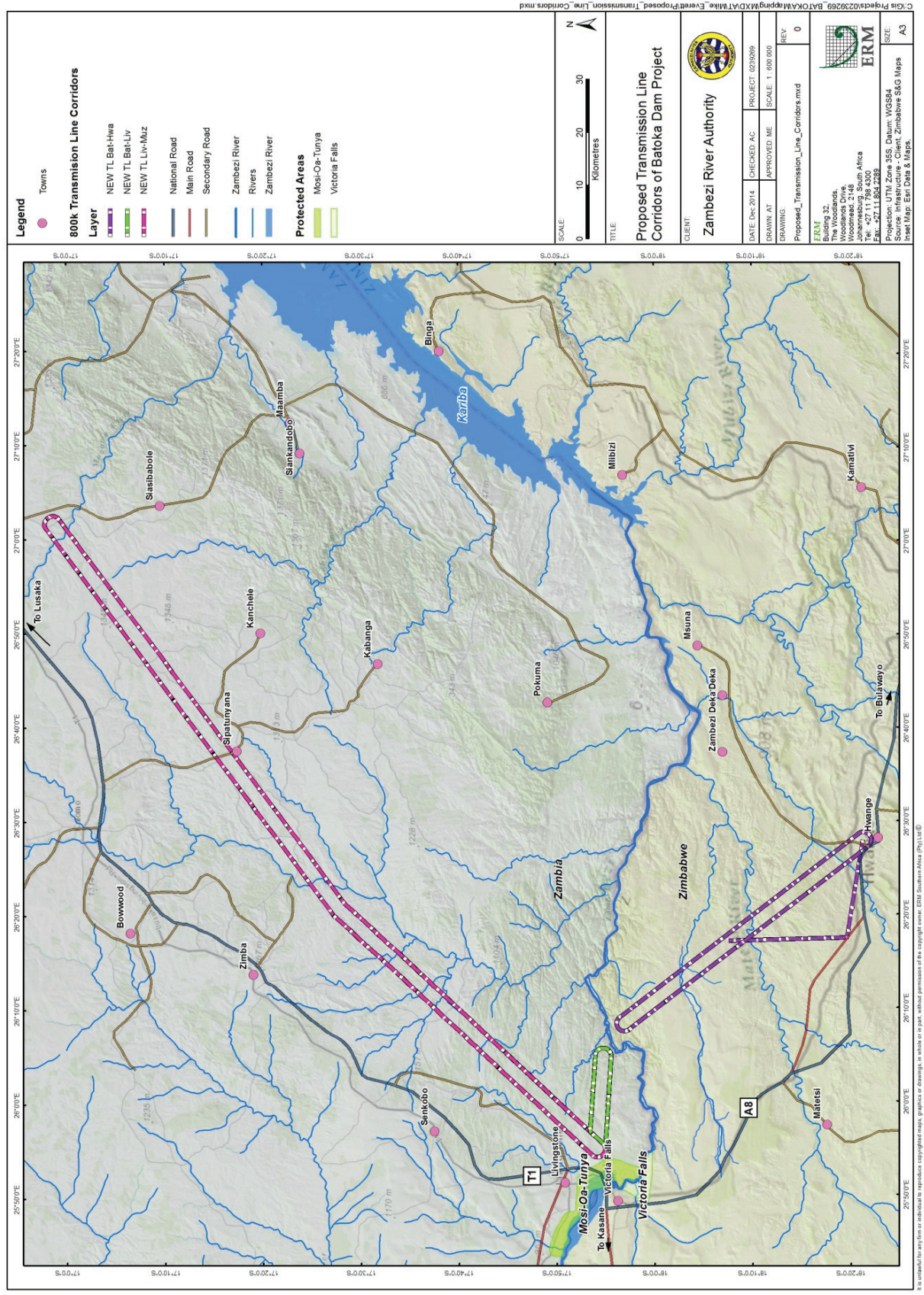


Figure 3.5
Proposed Villages and Roads

