AES SONEL

Kribi Power Project

150MW Gas Plant
& 225kV Transmission Line

Environmental and Social Impact Assessment Report

October 2006

Report Control Form

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Authors	Julie Raynor Edda Ivan-Smith (name)		2.11.06 (signature & date)	
Reviewer	Jeremy Short (name)		2.11.06 (signature & date)	
Project Manager Approval	Julie Raynor (name)		2.11.06. (signature & date)	
Director Approval	Stewart Cale (name)		2.11.06 (signature & date)	

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Scott Wilson
3 Pemberton House, Stafford Court
Stafford Park, Telford, Shropshire, TF3 3AP
United Kingdom
Tel: +44 1952 235600
Fax: +44 11952 235650
environment@scottwilson.com

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ABBREVIATIONS

ARSEL	Agence de regulation du secteur de l'électricité
CPF	Central Processing Facilities
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EMP	Environmental Management Plan
ECC	Environmental Conformity Certificate
EPC	Engineering Procurement and Construction
ESIA	Environmental and Social Impact Assessment
EU	European Union
GDP	Gross Domestic Profit
GOC	Government of Cameroon
HFO	Heavy Fuel Oil
HIPC	Heavily Indebted Poor Countries
ICE	Interministerial committee of Environment
ICNIRP	International Commission on Non-Ionising Radiation Protection
IFC	International Finance Corporation
IHT	Institute of Highways and Transportation
IUCN	International Union for the Conservation of Nature and Natural Resources
LDCs	Least Developed Countries
MDG	Millennium Development Goals
MINT	Ministry of Transport
MoE	Ministry of Environment and Protection of Nature
NGOs	Non Governmental Organisations
NIS	National Institute of Statistics
NRPB	National Radiological Protection Board
OD	Operational Directive
PPA	Power Purchasing Agreement
PUD	Public Utility Decree
RAP	Resettlement Action Plan
SIA	Social Impact Assessment
SIG	Southern Interconnected Grid
SMP	Social Management Plan
SNH	National Hydrocarbons Company
SOP	Standard Operating Procedures
STI	Sexually Transmitted Infection
SW	Scott Wilson
WHO	World Health Organisation

SECTION 1 : INTRODUCTION

1.1 BACKGROUND

AES SONEL, the national power utility in Cameroon, is currently developing the Kribi Power Project (see Figure 1.1.1) in order to meet the expanding electricity requirements of the country (5% growth per annum) and as part of the medium-term strategic development programme. Further details on the project are provided in Section 3.

The Kribi Power Project comprises the construction of a 150 MW power plant fuelled with natural gas approximately 9 km north-east of Kribi in the South Province and the erection of a 225 kV transmission line between the plant and the existing Mangombe 225/90 kV substation at Edéa in the Littoral Province (see Figure 1.1.2). In addition, there will be a step-up substation at the new plant site (11 kV to 225 kV) and a new 225 kV bay for connection at the Mangombe substation.

The project will be fuelled with gas from the Sanaga Sud gas field located at approximately 14 km offshore north-east of Kribi. This has been selected by SNH (National Hydrocarbons Co) to be developed in parallel for the supply of gas to the power plant. Therefore, PERENCO CAMEROUN S.A. will be the operator and is negotiating a Production Sharing Contract with the State and a Gas Sales Agreement with AES SONEL. A separate Environmental Impact Assessment (EIA) is to be undertaken for the gas project and pipeline to the plant site.

The Kribi Power Project will be owned by AES SONEL through a subsidiary, and all the electricity produced will be delivered to the Southern Interconnected Grid (SIG) (see Figure 1.1.3) and sold to AES SONEL through a Power Purchasing Agreement (PPA).

1.2 TERMS OF REFERENCE

Scott Wilson Limited has been engaged by AES SONEL to undertake an Environmental and Social Impact Assessment (ESIA) for the Kribi Power Project.

The project excludes the gas supply to the plant, which is to be subject to a separate EIA.

The ESIA process for the proposed Kribi Power Project commenced with the preparation of the scoping report, which set out the terms of reference for the ESIA (Scott Wilson, February 2006). The proposed project was formally registered by the submission of the scoping report and payment of the required fees to the Ministry of Environment and Protection of Nature. This report documents the process and findings of the ESIA. Both the scoping and ESIA reports have been prepared in accordance with Cameroonian legislation and internationally recognised guidance and standards as adopted by the World Bank and International Financial Corporation (IFC).

The World Bank Operational Directive 4.01: *Environmental Assessment* illustrates clearly the framework for Environmental Assessment and identifies its prime purpose as "*ensur[ing] that the project options under consideration are environmentally sound and sustainable*".

It is considered that the Kribi Power Project is classed as a Category A Project under the World Bank OP 4.01. This classification is based on the project that will entail some economic or physical displacement as well as land acquisition.

As such the ESIA has been undertaken in accordance with the principles of these guidelines and this ESIA report covers the following aspects appropriate to a feasibility level study:

- An executive summary;
- A description of the project;
- Policy, legal and administrative framework;
- Baseline conditions relevant to the project;
- Prediction of potential environmental impacts;
- Identification of appropriate mitigation measures;
- Assessment of the significance of the potential impacts;
- Analysis of alternatives; and
- Development of appropriate frameworks for environmental monitoring and an Environmental Management Plan.

The scoping and ESIA reports have been prepared in English; however it will be translated into French, if required.

1.3 METHODOLOGY AND REPORTING

1.3.1 Methodology

The overall methodology adopted for undertaking the Kribi Power Project ESIA has been based on the requirements of Cameroonian Legislation as set out in the EIA Decree N° 2005/0577 of 23rd February 2005 and summarised in Table 1.3.1 together with international best practice, including OP4.01. Preparation of this report has included the following stages, which are not independent but in many instances have been undertaken in conjunction:

(i) **Scoping exercise** - The scoping exercise was undertaken in January/February 2006 (Scott Wilson, Feb 2006). This involved field visits (see below) and the gathering and review of published and unpublished baseline/project data. The scope identified the key environmental and social impacts (see Section 4.1) and directed the detailed assessment for the project. This ESIA therefore considers the potential environmental and social impacts of the proposed project activities, as identified within the scoping stage of the project, through construction, operation and decommissioning. Consideration has also been given to project alternatives, including the "without project" option (i.e. no project option).

(ii) **Field Visits** to view first hand the project proposals in the field and to allow input to and development of the project proposal in line with best practice. A preliminary visit was undertaken between 12th to 20th January 2006 by a Scott Wilson team and additional site visits were undertaken from 26th February to 3rd March, 21st to 31st March and 3rd to 8th April to undertake baseline studies and public consultation.

Reconnaissance fauna and flora and socio-economic survey work was also undertaken along the route of the proposed power line route by SW scientific specialists during this period.

The base case project, which was subject to the ESIA, together with other alternatives considered, is set out in Section 3 of this report.

(iii) Identification of appropriate **Cameroonian legislation and guidelines as set out in Section 2.**

(iv) **Consultations** have been held with the Ministries, government authorities and affected communities. The methodology followed for this process and the results are presented in Section 4. The issues raised have been addressed in the preparation of this report.

(v) **Baseline Data -** Gathering and review of published and unpublished data pertinent to the project site. Baseline data, which exists for the study area, have been used for this ESIA and all key documents utilised in the preparation of the ESIA report are listed in References at the end of this report. The results of baseline studies commissioned for the project, together with information gathered in the data review, are presented within each of the environmental and social disciplines examined in Sections 5 and 6 of this report.

(vi) **Potential Impacts** were identified from critical analysis of the proposed operation in relation to their environment setting. This drew on data from the baseline studies and on the experience of the SW study team and the results are presented in Sections 5 and 6.

(vii) **Mitigation measures** are proposed programs or processes to be implemented to eliminate or minimize the potential impacts identified for each system studied. Mitigation includes preventive engineering implemented during the design phase of the proposed project, ongoing and planned programs to eliminate or minimize impacts during development of the project, and monitoring plans to evaluate the success of the mitigation. An evaluation of the level of predicted impacts that will remain after the implementation of all proposed mitigation measures has also been undertaken. The nature of the predicted impact is described and its significance determined by reference to appropriate standards or guidelines.

(viii) **Environmental and Social Management** encompasses all aspects of mitigation, management, monitoring, and institutional measures, and the provisional Environmental and Social Management Plans for the project are set out in Sections 7 and 8.

Table 1.3.1: Cameroon EIA Procedures[1,2]

Article	Issue	Requirements
1 - 3	**EIA**	• The general provisions and requirements for the EIA if a development is determined to have a potentially significant impact on the environment.
4 & 5	**EIA Contents**	• Requirements for the contents of a brief and detailed EIA report, respectively.
6	**Activities**	• The activities that will be subject to an EIA.
7	**Initiation of the EIA Procedure**	• Preparation of a report containing the project description, justification for the project and the Terms of Reference (ToR) for the EIA by the proponent. • Submission of report and supporting fee to Ministry responsible for Environment (the Ministry of Environment and Protection of Nature (MoE)). • Within 10 days, MoE submits its opinion to the Minister in charge of the Environment (The Minister). • Within 20 days report receipt, the MoE confirms EIA requirements to the proponent. • If the proponent receives no feedback within 30 days of submission, the ToR is deemed satisfactory.
8	**Preparation of EIA Report**	• The EIA is prepared by the proponent in line with the ToR agreed with the MoE. • The proponent can utilise consultants for the EIA reporting, with preference being given to Nationals.
9 & 10	**Acceptability of EIA Report**	• The proponent submits 20 copies of EIA report to the MoE together with the fee. • The competent Administration and the MoE form a team to undertake a site visit to verify the ESIA report findings in the field and collect opinions of the local communities on the project.The team will then prepare an evaluation report within 20 days of receipt of the ESIA report on its opinion to the . • adminstrationA decision on the acceptability of the ESIA report is provided 20 days by the MoE. If acceptable the MoE will publish information within the media or, if not acceptable, the proponent will advise accordingly. • If a decision is not received after 20 days the EIA report is deemed acceptable.
11 - 14	**Consultations and Public Hearings**	• The determination of the acceptability of the EIA, then involves consultation and public hearings, which will also include meetings with communities undertaken during the study. • The proponent must provide 30 days notification prior to the first consultation meeting. • Public consultation and public hearings are then undertaken. Minutes of the meetings must be sanctioned by the proponent and the population representatives. These Minutes must also be included in the EIA report. • An ad hoc Commission presents a report of the findings to the MOE and the ICE within 30 days.
15 - 17	**Study Approval**	• The administration in charge of the environment submits to the ICE, the EIA report, opinions on the EIA and the registers of the consultation. The ICE has 20 days to give an opinion, if there is a delay the EIA is considered approved. • The Minister of Environment then has a further 20 days to make its decision on the EIA. • On approval an Environmental Conformity Certificate (ECC) is issued, this is required before construction of the project can commence. • If the project is not commenced within 3 years of issue of the ECC, the certificate is deemed obsolete.
18 – 20	**Monitoring and Environmental Follow Up**	• Requires the effective implementation of the EMP (included separately in the EIA). • Additional measures can be required if not considered in the EIA report.
21 - 23	**Subsequent Reporting**	• Within 36 months of ECC an environmental audit is required to assess the EMP implementation, which must be submitted to the MoE for approval.

[1] EIA Decree of Cameroon, 2005 / 0577, 23rd February 2005 [2] For the Kribi Power Project an ESIA has been undertaken, which will follow the same procedures as an EIA

1.3.2 Reporting

This report provides an appraisal of the proposed Kribi Power Project from construction through operation to decommissioning. The ESIA report is presented in a grouped format with the baseline, potential impacts, mitigation measures and evaluation of mitigated impacts presented within a single section for each environmental and social issue within the Chapters for EIA and Social Impact Assessment (SIA) respectively (see Sections 5 and 6). The report structure, which takes into the requirements of Article 5 of Decree 2005/0577, outline is:

Executive Summary - concisely discusses significant findings and recommended actions.

Section 1 - Introduction - background to the study, the terms of reference, terminology, outline of the methodology to the ESIA and the report structure.

Section 2 – Legislative Background - relevant legislative background.

Section 3 - The Project - a description of the project with emphasis on identification of those elements that have particular relevance to the environment and overview of alternatives including the "zero or without project" option.

Section 4 - Scoping & Consultation - outline of the terms of reference for the ESIA as defined and consultation undertaken.

Section 5 - Environmental Impact Assessment - description of baseline environmental conditions, identification of the important environmental issues and assessment of potential impacts on the environment, mitigation measures and residual impacts (impacts remaining after mitigation).

Section 6 – Social Impact Assessment - description and analysis of general social and economic conditions, analysis of potential impacts on the affected communities, mitigation measures and projected analysis of these mitigation measures.

Section 7 –Environmental Management Plan - a framework of the mitigation measures and environmental controls that AES SONEL will use to manage the potential impacts to the environment from the proposed project.

Section 8 – Social Management Plan - a framework for managing key social aspects of the project including relationships with the local community, community development strategies and how to deal with potential conflicts.

Figures – plans showing overview and details of project components.

Photos – providing a pictorial appreciation of the project components and existing setting.

Appendices – which include a list of persons involved in the preparation of the ESIA and references (a listing of documents used within the preparation of the ESIA) (see Appendix A and B respectively).

1.4 PUBLIC CONSULTATION AND DISCLOSURE

Public consultation in environmental decision-making is an important element of the ESIA process. The consultation process of the Kribi Power Project adheres to World Bank and International Finance Corporation (IFC) guidelines, as specified in the terms of reference. A good consultation strategy that is both consistent and transparent ensures that concerns or problems for all stakeholders can be identified and addressed early in the process.

OP4.01 Environmental Assessment emphasises this concept and notes that the project sponsor (AES SONEL) should consult project-affected groups and local non-governmental organisations (NGOs) about the project's environmental aspects and take their views into account. Consultations should be initiated as early as possible, and at least twice, shortly after the environmental screening and before the terms of reference for the ESIA are prepared and once the draft ESIA report is prepared. In addition, the project sponsor consults with such groups throughout the project implementation, as necessary to address ESIA related issues that affect them. For a Category A project, the project sponsor provides a summary of the project objectives and potential impacts for the initial consultation. Once the draft ESIA report is prepared, AES SONEL will need to make the draft report available in a public place accessible to affected Groups and local NGOs.

An additional fundamental requirement in World Bank/IFC policies on resettlement, land acquisition and compensation is a framework for public consultation, participation, and the establishment of a process to redress the grievances of affected people. Consultation with the affected population and with officials of local government, civil society and other representatives of the affected population is essential for gaining a comprehensive understanding of the types and degrees of adverse effects. This has been undertaken for Kribi Power Project by working through the local political structures and protocols.

The IFC's *Doing Better Business Through Effective Public Consultation and Disclosure: A Good Practice Manual* (IFC, 1998), provides action oriented guidelines aimed at ensuring that consultation with the affected population and with officials of local government, civil society organisations and other representatives of the affected population is both effective and meaningful. The guidelines emphasise the need for the project sponsor to ensure that the process of public consultation is accessible to all potentially affected parties, from national to local level. Emphasis is placed on the engagement of local stakeholders, namely people who are likely to experience the day-to-day impacts of a proposed project. On a practical level, the sponsor has to ensure that:

- All stakeholders have access to project information;
- The information provided can be understood;
- The locations for consultation are accessible to all who want to attend;
- Measures are put in place, which ensure that vulnerable or minority groups are consulted.

The consultation requirements for projects requiring physical or economic displacement are covered by *OP 4.12, Involuntary Resettlement* and outlined in the IFC's '*Handbook for Preparing a Resettlement Action Plan'* (IFC, 2002).

This ESIA Report will be submitted to the Ministry of Environment and Protection of Nature for their distribution. AES SONEL will, as necessary, provide additional copies and assistance with distribution. The main ESIA report will be in English, whilst the executive summary will be in English and French.

Details of the consultation undertaken for the project are presented in Section 4 of this ESIA report.

1.5 TERMINOLOGY

With regard to terminology used in the ESIA, specific technical terms are explained in the appropriate section of the text. However, in the interests of clarity and consistency, a number of terms defined in the text are defined in Table 1.5.1 and shown in Figure 1.1.2. A listing of abbreviations used in the ESIA is presented at the front of this report.

Table 1.5.1: Kribi Power Project - ESIA Terminology

Term	Definition
Site and surrounding area	
Mpolongwe site	The 16 ha search area identified for the location of the plant site (the full 16ha to be fenced).
Plant Site	The area (4 ha), which will be surrounded by internal fencing, encompassing the gas fired power plant, ancillary buildings and equipment.
Wayleave	The corridor within which the transmission line is centrally located.
Project Area	The entire area to be utilised for the project encompassing Mpolongwe Site, Transmission Line Wayleave and the Mangombe substation in Edéa.
Nature of predicted impacts	
Neutral	No overall environmental impact.
Adverse	Negative environmental impact.
Beneficial	Positive environmental impact.
Significance of predicted impacts(1)	
Insignificant	An impact which is either too small to be measured or, even if quantifiable, does not give rise to any material change in the environment.
Minor	An impact that is capable of causing change in the environment but does not fundamentally affect the status, potential productivity or usage of the environment.
Significant	An impact that is capable of causing sufficient change in the environment to affect the status, potential productivity or usage of the environment.
Duration of predicted impacts[1]	
Short term	An impact that persists for 15 months or less i.e. during construction period.
Medium term	An impact that persists for between 15 month and five years (i.e. during initial operations)
Long term	An impact that persists for longer than five years .

[1] *The classification of an impact as temporary, short-term or long-term is purely descriptive and does not, of itself, imply a degree of significance or acceptability (thus, a temporary impact may also be a significant impact, whilst a long-term impact may be insignificant).*

SECTION 2 : LEGISLATIVE BACKGROUND

2.1 INTRODUCTION

In line with World Bank OP4.01 EIA requirements, this section of the Kribi Power Project presents a policy, legal and administrative framework.

For this ESIA, particular reference is made to Cameroon environmental and social legislation and standards. In addition, where appropriate, due reference is made to international standards in order to establish the regulatory framework within which this ESIA for the project has been undertaken. The relevant international environmental and social agreements to which the country is a party are also identified.

2.2 CAMEROON LEGISLATIVE FRAMEWORK

2.2.1 Introduction to Cameroon's Legislative Framework

The legal framework in Cameroon is made up of legislative and regulatory instruments:

- *Legislative instruments* are made up of Laws; and
- *Regulatory Instruments* are composed of Decrees and Rules.

Laws are prepared by Sectorial Ministries and forwarded to the national assembly. During working sessions, these are adopted by members of parliament and later on enacted by the head of state.

A law is generally a framework of intervention within a specific sector. To be implemented, it needs regulatory instruments, which are called decrees of application. Ministries who have prepared the concerned law prepare decrees, which are then signed by the Prime Minister Head of Government.

To be more detailed, a Decree sometimes needs implementation Rules. The Rule is prepared by the Ministry and signed by the Minister, after a visa from the Services of Prime Minister.

The application of all legislative and regulatory instruments is compulsory for all citizens and project promoters. These instruments are therefore provided with sanctions for defaulters, which vary from prison sentence to fine payment, dependent on the gravity of the fault.

2.2.2 Cameroon Legislation, Standards and Guidelines

The main laws and regulations of relevance to the ESIA for the Kribi Power Project are summarised in Table 2.2.1 below. Discussion on Cameroon's EIA procedure and reporting is presented in Section 1.3 of this report.

There are currently no specific national standards for water quality, air quality and noise limits. Acceptable levels for environmental noise are in preparation. In the absence of national standards, recognised international standards have been adopted as detailed in the relevant sections of this ESIA document (Sections 5 to 8).

Table 2.2.1: Relevant Cameroonian Legislation	
Subject	**Law/Decree/Order**
Environmental Management	***Law N° 96/12 of 5th August 1996*** *Relating to Environmental Management in Cameroon* • ***Decree N° 2001/718/PM of 3 September 2001*** *The organization and functioning of the Interministerial committee on the Environment* • ***Decree 94/259/PM of 31 May 1994.*** *Creation of a National consultative Commission on the Environmental and sustainable Development.* • ***Decree N° 2005/0577/PM of 23 February 2005*** *Defining the conditions for undertaking EIA* • ***Ministerial Order N° 0069/MINEP of 08 March 2005*** *- Defining the categories of operations subject to EIA* • ***Rule n° 0070/MINEP of 22nd April 2005*** *fixing the different categories of operations submitted to the realization of an EIA (article 19 of the law)*
Cultural Heritage	***Law N° 91/008 of 30 July 1991*** *- The protection of cultural and national heritage.* This law identifies the procedures for protection of sites and materials of cultural and national heritage. It applies to cultural sites that may be found along the projected line corridor.
Dangerous Substances	***Law n° 98/015 of 14 July 1998*** *- Relating to installations classified as dangerous, insalubrious, and inconvenient* • ***Decree N° 98/818/PM of November 1999*** *- Laying down conditions for construction and operation of installations classified as dangerous, insalubrious, and inconvenient*
Water	***Law No. 98/005 dated 14 April 1998*** – relating to water (the "Water Act"); • ***Decree No. 2001/164/PM dated 8 May 2001*** – "Decree on Utilisation of Water", *which sets the conditions of utilisation of water for business or industrial purposes* • ***Decree No. 2001/165/PM of 8 May 2001*** decree on the "Protection of Water", which sets the conditions of the protection of surface and groundwater against pollution
Wildlife and Forestry	***Law N° 94/01 of 20th January 1994 to lay down Forestry, Wildlife and Fisheries Regulations*** This law and the implementing instruments thereof lay down forestry, wildlife and fisheries policy, within the framework of an integrated management ensuring sustainable conservation and use of the said resources and of various ecosystems. Under this law, forests means any land covered by vegetation, with a predominance of trees, shrubs and other species capable of providing products other than agricultural produce. Wildlife within the context of this law means all the species belonging to any natural ecosystem as well as all animal species captured from their natural habitat for domestication purposes. Fisheries or fishing, within the context of this law, means the act of capturing or of harvesting any fishery resources or any activity that may lead to the harvesting or capturing of fishery resources, including the proper management and use of the aquatic environment, with a view to protecting the animal species therein by the total or partial control of their life cycle. Fishery resources within the context of this law, means fish, seafood, molluscs and algae from the marine, estuarine and fresh water environments, including sedentary animals in such environments. • ***Decree n° 95-531-PM of 23rd August 1995 to determine the conditions for implementation of Forestry Regulations*** • ***The Decree n° 95-466-PM of 20th July 1995 to lay down the conditions for the implementation of Wildlife Regulations*** • ***Decree n° 95-678-PM of 18th December 1995 to establish an indicative framework for land use in the southern forested areas.***

Table 2.2.1: Relevant Cameroonian Legislation	
Subject	**Law/Decree/Order**
Electricity	***Law N° 98/022 of 24 December 1998.*** *The Regulation of the Electricity Industry.* The law enables the government to operate the electricity generation and supply industry through a concession and establishes the Agence de Regulation du Secteur Electricité – ARSEL (the Electricity Regulation Agency) to regulate the industry. ARSEL is required to ensure that electricity operations respect environmental legislation. • ***Decree N° 99/125 of 15 Jan 1999;*** *The Organization and functioning of the Agency for the Regulation of the Electricity Industry;* • ***Decree 2000/464 of 20 June 2000*** *Register of Activities of the Electricity Industry.*
Land	***Ordinance No. 74-2 dated 6 July 1974*** *– relating to the status of the public domain in Cameroon (the "Land Code").* • ***Decree No. 76-166 dated 27 April 1976****-relating to the management of the national domain (the "National Domain Decree");* • ***Decree No. 76-167 dated 27 April 1976*** *– relating to the management of the private domain (the "Private Domain Decree").*
Compulsory Acquisition	***Law n° 85/009 of 4 July 1985*** *- Compulsory Acquisition of a Public Utility Decree (PUD) and payment of compensation the Environment.* • ***Ministerial Order N° 0136/Y.14.4/MINDAF/D220*** *and* ***0137/Y.14.4/MINDAF/D220 of 26th August 2005*** *- Declaring Public Utility for the Construction of the Kribi Gas fired power plant and the 225KV Transmission line from Kribi to Edéa respectively.*
Valuation	• ***Rule n° 00832/4-15-1/MINUH/D.000 of 1985*** providing the basis for calculation of constructions values • ***Rule n° 13-MINAGRI/DAG of 19th February 1982 modifying the Rule n° 58/MINAGRI of 13th August 1981*** fixing the indemnity tariffs to owners of crops and houses destroyed during a project implementation

The relevant institutions involved in the implementation and monitoring of environment law in Cameroon are:

- *ARSEL (Agence de régulation du secteur de l'électricité* – authority responsible for regulation of the energy sector;
- *The Inter-Ministerial Committee of Environment* which is under the responsibility of Ministry of Environment and Protection of Nature;
- *Consultative national commission of environment and sustainable development*;
- *The Minister in charge of Energy and Water Resources*; and
- *The Minister in charge of Environment:* Ministry of Environment and Protection of Nature (MoE).

In addition, other ministries of relevance include the Ministry of Agriculture, Ministry of Transport (MINT), which is responsible for the transportation of people and goods by sea, air and land, the Ministry of Culture and the Ministry of Town Planning and Housing.

2.3 INTERNATIONAL LEGISLATION

Where appropriate for the ESIA study, due reference is made to international standards in order to establish a regulatory framework for the project, which is line with local and international requirements.

In addition to satisfying the requirements of Cameroonian permitting process, it is acknowledged that AES SONEL envisage financial support from the World Bank. Consequently this report has been prepared with reference to the World Bank and International Finance Corporation (IFC) guidance.

The undertaking of a comprehensive ESIA is seen by international funding agencies as fundamental to the promotion of a sustainable and economically viable power operation. The ESIA is considered as an integral part of the project development and a precursor to the formulation of a practical and effective environmental management strategy rather than as an end in itself. This approach is intended to ensure that the inter-relationship between the proposed development and the potential environmental consequences of that development are managed in a way, which promotes the maximum benefit to the developer whilst ensuring the highest degree of protection of the environment.

The IFC is the largest multilateral source of loan and equity financing for private sector projects in developing countries. The IFC has various policy and procedural requirements designed to ensure that the projects in which it invests are implemented in an environmentally and socially responsible manner.

The IFC has developed ten safeguard policies, which are designed to improve project sustainability. These are summarised in Table 2.3.1 together with their relevance to the Kribi Power Project.

In addition, the following documents and policies which have been referred to in the preparation of this ESIA include:

- IFCs 1998 Procedure for Environmental and Social Review Projects;
- IFCs Policy on Social and Environmental Sustainability (30 April 2006);
- IFCs Performance Standards on Social and Environmental Sustainability (30 April 2006);
- IFCs Policy on Disclosure of Information (30 April 2006); and
- World Bank Pollution Prevention and Abatement Handbook (1998).

Table 2.3.1: IFC Environmental and Social Safeguard Policies		
Title		**Relevance**
OP 4.01 Environmental Assessment, January 1999	Requirements for Environmental Assessment and includes project classification, report and environmental action (management) plan content.	Applicable, as considered to be a Category A Project, and therefore subject to an ESIA.
OP 4.04 Natural Habitats, November 1998	Requirements for project design, implementation and consultation to ensure opportunities for environmentally sustainable development during natural resource management.	Applicable, as the transmission line will pass through areas of secondary rainforest. Specific baseline surveys and consultation have been conducted.
OP4.09 Pest Management, November 1998	Assists project sponsors manage pests that affect either agriculture or public health.	Not Applicable.
OP 4.36, Forestry, November 1998	IFC's overall aim is enhance environmental contribution to forested areas and policy is described.	Not Applicable, as project does not involve primary forest areas.
OP 4.37, Safety of Dams, September 1996	Guidance on construction of new dams.	Not Applicable.
OP 7.50, International Waterways, November 1998	Provides guidance on applicability.	Not Applicable.
OD 4.20 Indigenous Peoples, September 1991	Provides guidance to ensure indigenous peoples benefit from development projects and avoid or mitigate potentially adverse impacts.	Applicable.
OD 4.30 Involuntary Resettlement, June 1990, Superseded by OP 4.12 December 2001	Describes policy and procedures involved for resettlement. Provides guidance on definitions, required approach, benefit eligibility, resettlement planning and instruments.	Applicable, as the project will require resettlement both at the plant site and along the wayleave of the transmission line.
OP 11.03 Cultural Property, September 1986	Policy guidance on sites having archaeological, paleontological, historical, religious and unique natural values.	Applicable.
Child and Forced Labour Policy Statement, March 1998		Not applicable.
Source: www.ifc.org, May 2006		

2.3.1 International Protocols, Agreements and Treaties

In line with OP4.01, Tables 2.3.2 and 2.3.3 identify the international environmental and social Protocols, Agreements and Treaties to which Cameroon is a party respectively. In addition, Cameroon is a party to the following regional agreements:

- African Convention on the conservation of Nature and Natural Resources (Maputo Convention of 11th July 2003)
- Bamako Convention on the ban of the import into Africa and the control of transboundary movement and management of hazardous wastes within Africa (or Agreement of implementation of Basel convention in Africa).
- Treaty relative to the conservation of biodiversity and sustainable management of forest ecosystems in Central Africa (April 2006).

Table 2.3.2: International Environmental Agreements relevant to Cameroon

Issue	Convention and Objective	Cameroon Status
Biodiversity	*Convention on Biological Diversity* Objective: To develop national strategies for the conservation and sustainable use of biological diversity (Opened for signature: 5 June 1992, in force as of: 29 December 1993)	Ratified 19 October 1994
Climate Change	*United Nations Framework Convention on Climate Change* Objective: To achieve stabilization of greenhouse gas concentrations in the atmosphere at a low enough level to prevent dangerous anthropogenic interference with climate system (Opened for signature: 9 May 1992, in force : 21 March 1994)	Ratified 19 October 1994
Desertification	*United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa* Objective: to combat desertification and mitigate the effects of drought through national action programs that incorporate long-term strategies supported by international cooperation and partnership arrangements (Opened for signature: 14 October 1994, in force as of: 26 December 1996)	Ratified, 1994
Endangered Species	*Convention on the International Trade in Endangered Species of Wild Flora and Fauna (CITES)* Objective: to protect certain endangered species from overexploitation by means of an import/export permits (Opened for signature: 3 March 1973, in force: 1 July 1975)	Party to.
	Convention on the Conservation of Migratory Species of Wild Animals	Party to
Hazardous Wastes	*Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal* Objective: to reduce transboundary movements of wastes subject to the Convention to a minimum consistent with the environmentally sound and efficient management of such wastes; to minimize the amount and toxicity of wastes generated and ensure their environmentally sound management as closely as possible to the source of generation; and to assist Least Developed Countries (LDCs) in environmentally sound management of the hazardous and other wastes they generate (Opened for signature: 22 March 1989, in force as of: 5 May 1992)	Party to.

Table 2.3.2: International Environmental Agreements relevant to Cameroon		
Issue	**Convention and Objective**	**Cameroon Status**
Law of the sea	*United Nations Convention on the Law of the Sea* Objective: to set up a comprehensive new legal regime for the sea and oceans; to include rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment (Opened for signature: 10 December 1982, in force as of: 16 November 1994)	Party to.
Natural and Cultural Heritage	Convention on Protection of Natural and Cultural Heritage	Ratified 1982
Nature and Natural Resources	*African Convention on the Conservation of Nature and Natural Resources* Objective is to ensure the conservation, utilisation and development of soil, water, flora and faunal resources in accordance with scientific principles and with due regard to the best interests of the people (Algiers, 1968)	Ratified 29 September 1978
Ozone layer protection	*Montreal Protocol on Substances That Deplete the Ozone Layer* Objective: To protect the ozone layer by controlling emissions of substances that deplete it (Opened for signature: 16 September 1987, in force as of: 1 January 1989)	Ratified 30 August 1989
Timber	*International Tropical Timber Agreement, 1994* to ensure that by the year 2000 exports of tropical timber originate from sustainably managed sources; to establish a fund to assist tropical timber producers in obtaining the resources necessary to reach this objective (*opened for signature* - 26 January 1994, *entered into force* - 1 January 1997)	Party to
Wetlands	*Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar)* Objective: to stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value (Opened for signature: 2 February 1971, in force as of: 21 December 1975)	Ratified 2006

Table 2.3.3: International Social Development Agreements relevant to Cameroon		
Issue	**Convention and Objective**	**Status**
Women's Rights	*United Nations Convention on the elimination of all Forms of Discrimination against Women 1979* 'For the purposes of the present Convention, the term "discrimination against women" shall mean any distinction, exclusion or restriction made on the basis of sex which has the effect or purpose of impairing or nullifying the recognition, enjoyment or exercise by women, irrespective of their marital status, on a basis of equality of men and women, of human rights and fundamental freedoms in the political, economic, social, cultural, civil or any other field.'	Ratified, 23 August 1994
Rights of Children	*United Nations Convention on the Rights of the Child 1989.* This outlines children's civil, political and basic human rights and includes their right to education and to end child labour and other forms of economic and or sexual exploitation.	Ratified, January 1993
Torture	*The Convention Against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment (1984)* Objective to achieve the abolition of torture and ill treatment worldwide	Acceded, 19 December 1986

SECTION 3 : THE PROJECT

3.1 NEED FOR THE PROJECT

3.1.1 Overview of Electricity Sector in Cameroon

The late 1990s marked the beginning of reforms in the Cameroonian electricity sector; the Law n° 98/022 of December 24th 1998 organised the electricity sector in Cameroon by redefining the role of the administration to be in charge. According to Sonel annual report of 2000-2001, the Sonel privatisation process started in 1997 and ended in July 18th 2001. But the decision to privatise was taken in October 1999. Alongside the implementation of the aforesaid law, some other measures were taken:

- *the creation of ARSEL* (Electricity Regulatory Boards) in charge of regulating, controlling, and follow-up electricity sector operators;
- *the creation of AER (Rural Electrification Agency)* in charge of rural electrification promotion and to provide technical assistance to customers and sector operators;
- *the Law n° 99/06 of December 22nd 1999*, on general status of public establishments and state owned enterprises;
- *the Decree n° 2000/464/PM of June 30th 2000*, organising the electricity sector activities; and
- *the partial privatisation of Sonel*: as from July 2001, the current ownership structure is the result of a partial privatisation which is 56% owned by AES Corporation and 44% by the Government of Cameroon.

In Cameroon, electricity generation is predominately produced from hydro. Cameroon has the second highest hydroelectric potential in the African continent (55.2 GW). Before AES SONEL's development in Cameroon, diesel plants totalled 121 MW whilst AES SONEL has built several others plants totalling 132 MW (of which, small high speed diesel plants totalling 47 MW and an 85 MW HFO are in Limbe). In addition, there are some autonomous private companies that have also installed capacity of about 74 MW to generate electricity for their personal consumption (Projet de politique et de plan énergétiques pour le Cameroun, Ministère des mines, de l'eau et de l'énergie published by the National Institute of Statistics, Direction de l'énergie/ SNC Lavalin International Inc, Montréal, Canada, December 1990).

The hydro plants are located at Song Loulou and Edéa on the Sanaga river and at Lagdo for the Northern Interconnected Grid. These hydro plants have an installed capacity of approximately 723 MW. At present there are three reservoir dams at Mbakaou, Bamendjin and Mape to regulate the flow in the Sanaga River. These reservoirs have a combined capacity of 7.6 billion cubic metres.

It is understood, there has not been a significant alteration in the transmission line network (225 kV, 110 kV and 90 kV) since the establishment of AES SONEL (only 11.6 km of 90 kV line in the Limbe project constructed in 2004). For transmission, there are in total, 480 km lines of 225 kV, 337 km of 110 kV and 1064 km of 90 kV. The medium voltage lines (5.5kV to 33 kV) increased from 10316 km to 11450 km, and the low voltage lines increased from 10017 km to 11158 km following the reform of the electricity sector.

AES SONEL has three different categories of customers: High, medium and low voltage. The high voltage usually consumes about 54% of the total production due to their dependency on electricity. From the 1998 dry season, power rationing was introduced for industrial customers. Grid expansion is required to provide electricity to all communities. Figures on access to electricity between 1996 and 2001 are summarised in Table 3.1.1 according to National Institute of Statistics (ECAM I and II).

Table 3.1.1: Access to electricity in Cameroon (%)

	1996		**2001**	
	Urban	**Rural**	**Urban**	**Rural**
Poor	61.4	9.6	68.2	14.9
Non-poor	82.9	13.6	91.0	29.0
Total	76.3	11.7	88.2	23.4

Source: National Institute of Statistics (ECAM I and II).

According to a survey carried out in 2003 for the Rural Electricity Agency, all the Division Chief-towns were connected to an electricity line, whereas only 88 out of 272 Subdivision Chief towns were connected, and 44 out of 56 Districts were connected. Since the beginning of the 2000s, AES SONEL has been aiming to increase the production level to match the current demand and to provide for future demand that is growing at an estimated 5% per year due to the increase in the number of subscribers and increased demand of existing customers due to increased economic growth.

3.1.2 Need for the Project

The electricity infrastructure in Cameroon is dominated by the Southern Interconnected Grid (SIG). There is also an independent northern grid as well as a significant number of off-grid 'remote' generating stations supplying power to major townships. The existing electricity network is illustrated in Figure 1.1.3. Generation within the SIG is predominately produced from the hydro producing facilities. Between them they generate circa 90% of the power requirements of the SIG. The SIG has a daily average demand of circa 475 MW with a peak demand around 610 MW. Because of the large variability of natural flows on the river (over 6000 m^3/s during the wet season and less than 100 m^3/s during the dry season), three upstream storage dams have been built to regulate flows during the dry season. In addition to the hydro capacity of circa 665 MW on the southern grid, the SIG has six thermal plants with a total installed capacity of circa 170 MW to provide additional power mainly for system security and peaking.

The demand growth on the SIG in conjunction with lower than average hydrology resulted in severe power shortages and recurrent dry season load shedding during the three years up to 2004. To help solve this problem, in 2002 - 2003 AES SONEL built several small high speed diesel plants totalling 47 MW and an 85 MW heavy fuel oil (HFO) plant at Limbe. They were commissioned in September 2004.

Various additional hydro projects, including Lom Pangar reservoir to further regulate the flow in the Sanaga river, are under consideration by the Government. Other projects for the longer term are also under consideration but, with an increase in demand of about 5% per

year, there is a need to build new production facilities in order to satisfy the mid-term demand and provide greater security for the electricity supply.

Therefore, the Kribi gas-fired power project is proposed to meet the demand and provide greater grid security and the project is currently scheduled for commissioning in early 2008.

The Sanaga Sud gasfield located at approximately 14 km offshore northwest of Kribi has been selected by SNH (National Hydrocarbons Co) to be developed in parallel for the supply of gas to the power plant. Therefore, Perenco Cameroun S.A. will be the operator and is negotiating a Production Sharing Contract with the State and a Gas Sales Agreement with AES SONEL.

The Kribi power project will be owned by AES SONEL through a subsidiary, and all the electricity produced will be delivered to the SIG and sold to AES SONEL through a Power Purchasing Agreement (PPA).

3.2 PROJECT SETTING

3.2.1 Location

The entire project will be located in the equatorial region of Cameroon (see Figure 1.1.1).

The power plant will be located near Mpolongwe, a village situated approximately 9 km north-east of the coastal city of Kribi. The energy produced will be distributed via a 100 km, 225 kV transmission line linking the power plant to the Mangombe substation at Edéa. The new line has been designed, to the extent possible, parallel to the existing 90 kV line that also runs from Edéa to Kribi.

As shown on Figure 1.1.2, the project lies within the Littoral and South Provinces, as follows:

- *Power Plant and 65% of southern stretch Transmission line* will lie within the Kribi Subdivision of the Ocean Division in the South Province; and

- *The northern 35% of the transmission line and connection with the SIG at Mangombe substation* at Edéa lie within the Edéa Subdivision in the Sanaga-Maritime Division in the Littoral Province.

3.2.2 Topography

The project area is entirely within the coastal lowlands of southwest Cameroon (see Figures 1.1.1 and 1.1.2). This area consists of flat alluvial coastal plans with mangrove and forest cover leading into slightly higher gently undulating lowland hills.

The project area itself is primarily within the lowland hills with a rural landscape of secondary rainforest and intermittent farming activity. The topography is one of very low rolling hills or hillocks and shallow valleys. The plant site itself lies at approximately 10 m to 20 m above sea level with the entire 100 km transmission line generally below 100 m above sea level. Villages and associated land clearance are present along the transmission line route however; the natural forest vegetation dominates the landscape character of the area.

3.2.3 Climate

The entire project will be located in the equatorial region of Cameroon, characterised by primary and secondary forests, with average temperatures of about 28°C and humidity between 60 and 100%.

Generally the area has a dry season from approximately November to March, light rains from April to May and a rainy season from June to October (West, 2004). Overall the project area is within a region of high average annual rainfall with total of approximately 3,000 mm.

3.2.4 Geology and Soils

The project area is predominantly within the metamorphic formations of the Precambrian to Cambrian era (Bernard, Yerima & Van Ranst; 2005). These consist of mica schists, gneiss, migmatites or granites. Within the project area the dominant rock type is gneiss.

The soils are generally deep intensively weathered materials with sandy surface horizons becoming more clayey with depth. Soils are physically stable and well structured giving good drainage characteristics with relatively high permeabilities. However chemically the soils are poor with low pH values, poor nutrient status and low cation exchange capacities. Nutrients are therefore easily leached from these soils. Iron and aluminium oxides concentrations exist leading to the yellowish or reddish soils colours. In the valleys more waterlogged gley soils exist.

Due to this poor nutrient status, soils tend to be used for shifting agricultural and need artificial fertiliser if permanent farming is to be practised. Land use capability is therefore low.

3.2.5 Hydrology and Hydrogeology

The Kribi / Edéa area is characterised by low-lying, gently rolling countryside with numerous small streams and rivers running within shallow valleys. Due to the relatively high rainfall in the region and low lying topography an extensive network of small tributary streams and rivers exists discharging to the main channels. The catchment draining the largest part of the project area is that of the Nyong River which crosses the transmission line route at approximately 35 km south of Edéa, before discharging to the Atlantic Ocean north of Kribi. The Sanaga River, one of the countries main watercourses, passes through Edéa although only the final sections of the transmission line route cross the catchment of this river. The more minor catchment of the Lokoundje River drains much of the southern section of the project area and crosses the transmission line route approximately 16 km north of the proposed plant site area

As noted above, the project area is predominantly low lying, gently undulating ground bisected by numerous small streams and rivers. Soils in the coastal belt are in part sandy in texture with high permeabilities. Taking account of the low lying nature of the area, the presence of permeable soils, the prevalence of surface water system and the high rainfall of the area, it is concluded that shallow groundwaters will be present across the whole project area. Data from boreholes on the plant site show that the groundwater is present at approximately 8 m below surface although seasonal fluctuation of the water table may occur in response to rainfall.

3.2.6 Land use

Land use, both within the plant site area and along the wayleave for the transmission line, is dominated by forest cover. This cover has been impacted by human activity (clearing or partial clearing) to a varying degree and is considered to comprise secondary rain forest.

The secondary land use is subsistence agriculture with small areas of cleared forest used for growing banana, palm oil trees, cassava and other staple crops. Within the plant site one small clearing for agricultural use was evident and areas of clearance are common around the villages that exist along the transmission line wayleave. Initial estimates indicate that approximately 80% of the project area is secondary rainforest with the remaining being primarily agricultural clearing.

The main exception to this general pattern of subsistence farming is the presence of one large, commercial scale oil palm plantation run by Ferme Suisse, approximately 35 km south of Edéa. Around the outskirts of Edéa, the land use is predominantly agricultural in nature with most forest cleared for generally small-scale subsistence farms and occasional plantation.

3.2.7 Flora and Fauna

With the exception of the northern most section of project area, which lies within the outskirts of the Edéa Township, both the line and plant site lie within the equatorial forest area. The majority of the route (over 80%) lies within forested areas. Due to the evidence of pioneer species it was considered that the area is predominantly secondary forest of varying densities. A small section of the route (<1%) passes through an existing commercial palm plantation, which is a monoculture. The remainder of the route passes through the subsistence farming areas that are found adjacent to scattered village and hamlet communities. The plant site area itself is also dominated by secondary forest with scattered areas of subsistence farming found adjacent to the dwellings.

3.2.8 Archaeology and Cultural Heritage

A review of the topographic (1:500,000) and tourist mapping of the area was undertaken along with a site visit to provide an initial overview of any identified areas or features of archaeological and cultural heritage importance.

Based on the maps used no features are recorded within the project areas that would indicate the presence of any areas or features of regional, national or international importance.

Cultural heritage features of local importance may, however, be present.

These will include gravesites usually close to houses and areas of Sacred Forest that exist between Edéa and Kribi. Gravesites tend to be close to houses and therefore, where properties are affected, the potential exists for graves in the vicinity. On the power plant site, at least 2 graves are visible and will be affected (see also Section 6.3).

3.2.9 Socio-economic Framework

National Socio-economic Context

Cameroon is situated in Central Africa, located between 2 to 3 degrees of latitude north and 9 to 16 degrees longitude east. It has a total surface area of 475,650 km² and a population estimated at 16 million in 2003 which gives a density of about 33 inhabitants per km² (National Institute of Statistics (NIS) estimations). The population has an average growth rate of 2.6% per annum. The life expectancy was estimated at 52 years in 1999 by the NIS. Cameroon has a youthful population with more than half of the population being below 25 years.

The country has about 276 ethnic groups. There is a wide range of geographical diversity with three main ecological zones: the forest zone, the western highlands and Saharan zone.

Although of the country is based on agriculture, livestock, fishing, industry and services, agriculture has been, and is still, the key sector of the Cameroonian economy; it always accounts for about 30% of the GDP. However, agriculture still employs about 75% of the total population, generates about 25% of export earnings, and contributes to about 17% of state revenues according to the annual statistics published by the NIS.

Cameroon experienced an economic boom in the 1980s due essentially to the exportation of agricultural products and petroleum. However this was followed by a serious economic downturn resulting from the devaluation of the CFA franc in 1994 leading to reduction of export prices, the difficulties faced by private and state-owned enterprises, etc.

Some of the major consequences of the economic crisis included the withdrawal of administrative authorities from many sectors of activities, the increase in number of people living under the poverty threshold and the failure of many enterprises. Also, during that same period of crisis, per capita income halved and poverty increased sharply. Due to lack of financial means for investment, the country experienced deterioration in its educational and health systems. Consequently, education quality and enrolment rates significantly deteriorated and the health indicators worsened.

A number of measures centred on monetary adjustments like currency devaluation and, public sector reformation were taken to fight against the economic crisis. As a result, the economic situation began to improve from 1994, with the growth rate returning positive to 5% in 1996 (NIS Annual Statistics, 1997). However the economic situation remains unsatisfactory because the growth rate is still low and there is no trickle down effect. With the support of international donors and other development partners, the Government of Cameroon (GOC) is developing a strategy to fight poverty and boost growth. The aim through the Poverty Reduction Strategy Plan, is to effectively improve the living conditions of the population in a sustainable manner. In this way the GOC intends to implement an economic growth and poverty reduction policy that will help reach the United Nations Millennium Development Goals (MDG)s. Cameroon was admitted to the HIPC initiative[1] on 27 April 2006.

[1] *HIPC was proposed by the World Bank and IMF and agreed by governments around the world in the fall of 1996. It is the first comprehensive approach to reduce the external debt of the world's poorest, most heavily indebted countries.*

Political Structure

Cameroon is organised into different administrative structures ranging from provinces to villages. There are:

- 10 Provinces headed by the Governors;
- 58 Divisions headed by Senior Divisional Officers;
- 260 Subdivisions headed by Subdivisional Officers;
- 54 Districts are headed by District Heads; and
- Villages headed by Traditional Chiefs.

With regard to villages, there are three classes of Chiefdoms: first, second and third class. The first and second-class Chief can cover more than a village, whilst the third degree Chief covers either a village or a quarter of a higher-class village.

Councils, headed by mayors, are the representatives of de-centralised local communities that fit into Districts, Subdivisions and some big towns. The Cameroon 1996 constitution makes provision for the transformation of provinces into autonomous regions with representatives being elected locally to conduct their respective duties.

The study area is located between two provinces:

- the Littoral for the northern part; and
- the South for the southern part.

The Littoral Province made of four divisions (Moungo, Nkam, Sanaga-Maritime and Wouri) has a total surface area of 20,248 Km², a population estimated in 2003 at 2, 140, 880 inhabitants (estimations by NIS) with a density of 106 inhabitants per km²). The main economic activities of the rural populations in the province are palm oil, banana, tea, cocoa and coffee production and fishing. Edéa is a major industrial city and Douala is the main economic city of the country, both are located within the Littoral Province.

The South Province is made of four Divisions (Dja and Lobo, Mvila, Ntem Valley, and Ocean). It covers a surface area of 47,191 km² with a population estimated at 519,928 inhabitants (NIS 2003) and a density of 11 inhabitants per km². The main economic activities of the rural populations in the South Province are palm oil, rubber, cocoa, cassava, banana production and fishing.

In the South, part of the project (plant and most part of transmission line) is located in Kribi Subdivision in the Ocean Division. In the Littoral, the remaining part of the project (transmission line and connection with SIG) is located in the Edéa Subdivision in the Sanaga-Maritime Division.

The Plant is located at Mpolongwe, third class chiefdom inhabited by the Mabi tribe that has their paramount chief situated at Bikondo (a village outside of the project area). The transmission line crosses sixteen villages in the South province; amongst them, the most

important are Fifinda (inhabited by Ewondo tribe) and Elogbatindi (inhabited mainly by Bassa/Bakoko tribe). There is also Batanga Tribe alongside the transmission line, whose Paramount Chief lives outside of the Project Area. In the Littoral Province, the lines crosses eight villages mostly inhabited by Adié and Bassa/Bakoko tribes.

3.2.10 Chad-Cameroon Pipeline

There have been a number of major infrastructure projects in the area during the last five years. The largest of these projects has been the Chad-Cameroon Pipeline.

The Chad-Cameroon Petroleum Development and Pipeline Project involved the construction of a 1,070 km pipeline to transport crude oil from three fields in south-western Chad to a floating facility 11 km off the Cameroon coast. Construction began in October 2000. The pipeline has been completed and "first oil" was achieved in July 2003, several months ahead of schedule. Revenues began to accrue in late 2003. The Chad Oil and Pipeline Project is a $3.7 billion development project comprising some 300 oil wells extracting 225,000 barrels of oil per day (peak production). Project ownership is made up of a three-company oil consortium (Exxon/Mobil 40%, Petronas Malaysia 35% and Chevron 25%). The governments of Chad and Cameroon hold a combined 3% stake in the pipeline portion of the project. The World Bank provided the funds used to secure the investment share of the two countries in the form of a loan. Exxon/Mobil, operating under the name *Esso Chad*, is the project's construction and operations manager. The part of the project located in Chad is managed by *TOTCO* (Tchad Oil Transportation Company) whilst the other section located in Cameroon is managed by *COTCO* (Cameroon Oil Transportation Company).

The pipeline route cuts through farmland and natural forests (including the territory of indigenous peoples in southern Cameroon), en route to an offshore terminal in the Atlantic Ocean, where the oil is loaded onto tankers for transportation to consumption in Europe and North America markets.

In June 2000, the World Bank's Board of Directors gave its final approval for loans to the Chadian and Cameroonian governments. This was the final component necessary to move the project forward. Many international environmental and human rights NGOs and activists opposed the Bank's approval. Critics have raised concerns about the anticipated environmental and social impacts. In response to these criticisms, some changes have been made to the project design, but significant problems remain. As a precondition to the two governments' loan request, the World Bank required the oil consortium to prepare a comprehensive environmental impact assessment and risk management plans, which has subsequently been produced. The project promoters applied World Bank Group safeguard policies to the project, and related infrastructure, to ensure that the pipeline avoided areas of high biodiversity, wherever possible. Other conservation efforts included the creation of two new large national parks in Cameroon to compensate for a small but unavoidable loss of forest. The parks, which will help protect biodiversity, are being independently managed.

During construction, the project had a health and safety record similar to operations based in the United States i.e. work was carried out to the highest international standards. In addition to direct supervision of project implementation by the World Bank Group, a quarterly external environmental consultant review ensures compliance with the project's Environmental Management Plan (EMP).

Finally the project generated employment for over 13,000 local people in Chad and Cameroon; had over $400 million infrastructure improvements; and over $680 millions worth of procurement contracts. Affected people received, individual, community and regional compensations both in cash and in nature to compensate the losses occurred because of the project implementation. A project was also put in place in Cameroon to support vulnerable indigenous people. Other significant benefits are expected in both countries.

3.3 PROJECT DESCRIPTION

3.3.1 Project Components

The project comprises two components to be developed in parallel: the power project and the gas project.

Power project

The Kribi Power Project shall comprise:

- the construction of a 150 MW power plant fuelled with natural gas at the Mpolongwe Site; and
- the construction of energy transmission facilities comprising:

  (i) a step-up substation at the plant site (11 to 225 kV) at Mpolongwe;

  (ii) a circa 100 km 225 kV double circuit transmission line between the plant and the Mangombe 225/90 kV substation at Edéa;

  (iii) the connection of the transmission line at the Mangombe substation with installation of new 225 kV line bays.

Gas project

The gas project, which is to be subject to a separate EIA, will comprise:

(i) the drilling of 2 wells (at initial stage);

(ii) the construction of a light platform (not inhabited);

(iii) the construction of an 8" pipeline to the gas central processing facilities (CPF) on shore (14 km long) and then to the Plant Site (15 km);

(iv) the installation on shore of a slug-catcher;

(v) the installation of the gas CPF; and

(vi) the installation of a flaring stack.

The power plant being the sole gas consumer at this stage, the gas installations will be designed to operate safely in case of emergency shut down of the plant.

3.3.2 The Plant

The Site

Mpolongwe 1 area (see Section 3.4 – Consideration of Project Alternatives), which contains the proposed plant site, is located close to the main road, approximately 1 km from the coastline and 9 km north of the town of Kribi (see Figure 1.1.2).

The overall Mpolongwe site occupies an area of approximately 16 hectares although the power plant site itself will only require approximately 4 ha once constructed (see Figure 3.3.1). However, the overall larger site also allows for the development of a construction compound as well as the plant itself and also allows the flexibility for the plant site to be located to best reduce the potential impacts.

The land surface is gently undulating with a height varying between approximately 10 m and 20 m above sea level. The site is predominantly forested although there are a number of buildings, constructed of local materials, which are understood to house three families. These primarily occupy the western edge of the site within the wayleave of the existing 90 kV transmission line.

Three watercourses drain this site, the largest is Mpolongwe River the two minor streams being tributaries of this river. The river and tributary streams are understood to flow throughout the year and, where they flow adjacent to the site boundary, are used by local inhabitants as a water supply.

The land of the plant site is untitled and the State has granted to AES SONEL the right to use it for the power project through a Public Utility Decree (PUD), signed in August 2005 (copy attached as Appendix C).

Access Road

The selected plant site is located along the Edéa – Kribi main road, which is fully tarred and in very good condition. This road has a carriageway width of 7 m and tarred verges of up to 1 m. Current traffic volumes are relatively low (see Section 5.7) with an average day flow of 410 vehicles comprising approximately 15% lorries (all sizes), 19% buses with the remaining being private cars and small vehicles (data for years 2000 to 2005).

There will be a need to construct a new access road from the main road to the plant site. This will involve the upgrading of an existing dirt track for the first 120 m (see Photo 3.3.2), with the reminder (approximately 150 m) being new construction across a currently forested area to the proposed plant site boundary.

For the construction phase all main plant and equipment will be imported via the port at Douala. Cement and other manufactured construction materials that cannot be sourced from Kribi will also be supplied from Douala. The vehicles carrying equipment and materials will therefore travel from Douala to Edéa and then onto to Kribi.

Power plant equipment

The base case design for the power plant will involve the installation of four simple cycle gas turbines. The plants total site output will be approximately 150 MW, with unit sizes ranging between 30 MW and 50 MW for the gas turbines.

The four gas turbines will have individual emission stacks at each plant. These will be approximately 22.5 m in height.

The plant will burn natural gas supplied from the off-shore Sanaga Sud gas field which is being developed in parallel with the power plant. Gas will be supplied to the site via an 8" (200 mm) gas main coming ashore approximately 1 km west of the power plant. The overland section of the pipe will be buried and designed to follow the line of the river that runs from the coast up past the plant site. This line is planned to enter the site along the southern boundary. Note: As discussed in Section 1 of this report, the gas pipeline is not part of this project and is subject to separate EIA.

There will be no gas storage at the site and as such the gas turbines will be dual fuel to allow firing using diesel during periods of gas unavailability. On-site storage tank capacity for diesel oil is based on running the plant for 7 to 8 days at full capacity (about 2000 m^3). The maximum delay anticipated for continuous operation with diesel oil is 8 days per year at 30% load factor maximum. It is not anticipated at this stage that demineralised water will be used during these periods for NOx emissions suppression. The process for final NOx suppression will be confirmed during detailed design. For the base case assessment, no suppression systems are included.

Step-up substation

Power will be exported from the site via a new 225 kV transmission line running north to the Mangombe substation at Edéa. A step-up substation equipped with 11/225 kV power transformers will be constructed within the switchyard at the power plant, (see Figure 3.3.1) for connection to the transmission line. There will also be a provision for connecting this substation to the existing 90 kV line, which will be used as partial backup in case of failure or maintenance of the 225 kV line. It will therefore be necessary to disconnect the existing 30 kV connections and build new 30 kV lines. This will be undertaken by AES SONEL but is outside of the scope of the Kribi Power Project.

At the Mangombe substation at Edéa, new 225 kV bays will be added to connect the new line to the existing grid. This will include an extension of the existing 225 kV busbars system. This will not involve any new land take, as sufficient space is available within the existing substation site for this development.

Ancillary buildings

The plant site (see Figure 3.3.1) will also include an office building, staff changing and welfare facilities and equipment works shops and stores. These buildings are anticipated to be single storey structures located to the eastern section of the site.

Load demand

The peak daily load demand on the SIG occurs between 18:30 hrs to 22:30 hrs. On a seasonal basis the main load period is the dry season, from December to June, with lower demand during the rains (July to November).

The power plant will therefore be designed to operate a minimum load of 45 MW to 50 MW and provide peak load to the grid up to the maximum 150 MW. As currently envisaged the intention is to run the plant at its peak load almost continuously during the dry season. For the purposes of this assessment it is therefore assumed that 24hr operation at 150 MW will occur for up to 6 months of the year. For the remaining period the plant will be operated at minimum load and used to satisfy temporary peak demand.

3.3.3 The Transmission Line

The main features of the transmission line, which will be used to export the produced energy to the interconnected grid, are summarised in Table 3.3.1.

Table 3.3.1: Transmission Line Specifications (base case design)

Item	Specification
Voltage	225 kV
Type	Overhead double circuit
Pylons	Self supporting steel towers
Phase Conductors	3 x 366 mm^2 (ASTER)
Earth Conductors	Fibre optic OPGW cable
Total Length	99.5 km
Width of Wayleave Corridor	30 m
Number of Summits	38

The towers to be used will be approximately 40 m in height, which will be sufficient for road crossings, flyover points, etc. The tower design is as shown in Figure 3.3.2. The nominal spacing of the towers will be 350 m, although this may be varied by up to 50 m either way depending upon the terrain.

The new transmission line will follow the general route of the existing 90 kV line for approximately 90% of its length and runs directly parallel to it for 40% of the route as illustrated in Figure 1.1.2. It also follows the route of the Kribi to Edéa main road, which it crosses at 24 locations. This new road was built after the 90 kV line, and followed the former road, thus some crossings might have been avoided. In addition, it crosses minor tracks 21 times.

Access to the majority of the line corridor will therefore be easily undertaken from the main road. However, a few new, short access tracks to some tower locations will need to be constructed and trafficking from tower to tower will be via an internal haul route aligned along the wayleave corridor.

The selected route passes through secondary tropical forest (approximately 30-40% of the route), fallow lands for 40 – 50% and subsistence style farm land for approximately 20%. The line does however pass close to a large commercial palm oil plantation. The area is sparsely inhabited, and this route was selected to avoid as far as possible crossing the villages, protected forest (Douala-Edéa reserve), etc. A total of 25 villages have been identified along the route however the only urban area to be crossed will be close to the Mangombe substation at Edéa, where the existing lines over fly some houses that were built after the existing 90 kV line was constructed. The 225 kV line will cross the existing 90 kV line in five locations (mainly to avoid villages), and it is planned to install a ground wire on the 90 kV line at the crossings so as to avoid any potential contact of both phase conductors in case of 225 kV cable break.

The existing 90 kV line, currently operating at 30 kV, is planned to be upgraded to 90 kV so that it can be used as emergency spare circuit for the export of energy from the power plant. There will therefore be a need to construct new 30 kV lines for the supply of energy to the populations along the Edéa-Kribi road. This shall be undertaken by AES SONEL in parallel and is out of the scope of the Kribi Power Project.

3.3.4 Construction Phase

Timeframe

The overall construction timeframe for the whole project is estimated at 15 months. The plant site and transmission line will be constructed at the same time. Therefore each element has a similar 15 month construction period.

At the plant site all construction operations will focused in the one area. However for the transmission line operations will move as sections are completed. Typical construction methods involve erection and stringing of up to 10 towers in one section (approximately 3.5 km) before moving on to the next section. Each section will take approximately two to three weeks to complete.

Construction overview

During the construction phase the key operations to be conducted at the Mpolongwe site are as follows;

- *Land clearance* – Including removal of vegetation from the construction areas and resettlement of property within the site. Land grubbing operation will be either by hand or by machinery, such as bulldozers;

- *Site access and construction compound* – Establishment will involve land levelling and construction of temporary building, fencing of the site and grading and surfacing of the new access road to the site from the main Kribi / Edéa highway.

- *Groundwork and foundation* - Including land levelling and excavation to provide appropriate foundation and constructions levels, erecting of shuttering, etc. for raise concrete structures and placement of concrete;

- *Plant and equipment* - Importation of main electrical and mechanical plant (turbines, switch gear, transformers, etc.) and installation on site. All main equipment to be imported via the port at Douala.

- *Construction of office, workshops, plant housing, car parking and ancillary building;*

- *Commissioning of the power plant*;

- *Decommissioning* of the construction compound and revegetation of the compound area.

Along the transmission line the main construction activities are as follows;

- *Clearance of the wayleave and access tracks* of all trees and tall vegetation and relocation/compensation of any buildings and farm land (see Section 6);

- *Excavation for and placement of concrete pads* for tower foundations (one concrete pad at base of each leg);

- *Importation of steel works*, isolator etc and erection and fitting of tower at each site (constructed in as series of sections, typically up to 10 tower per section).

- *Stringing and tensioning of tower sections* with conductors and earth wires using equipment and methods to ensure conductors are not damaged or come into contact with the ground.

- *Clearance of equipment and waste materials* from site once works complete.

Employment

During the construction phase employment levels will vary but are anticipated to peak at around 550 - 600 workers. These will range from manual labourers, through electrical, mechanical and civil technicians and engineers, to site managers. The anticipated split between national and expatriate workers is 95% to 5% respectively with 10% of the workforce are expected to be sourced locally.

Employment from the local area will be encouraged, and will almost certainly be necessary on the transmission line route. However, given the quantity and skills of workers needed during the construction phase, it will be necessary to import some manpower from neighbouring cities where the appropriate skill base exists.

Accommodation and logistics

Due to the vicinity of the town of Kribi (9 km from plant site), and the northern end of the transmission line being at Edéa, it is anticipated that the majority of the construction workers will live in these two towns, predominantly in existing accommodation in Kribi. It is assumed for the purposes of this ESIA that no new accommodation will be required. The contractors will organise the transportation of their staff from their homes to the work places, as there is no formal public transportation organised in the area. Whilst on site the contractor will ensure that suitable welfare facilities are provided for all workers.

Works compound and materials storage

Given the size of the plant site (16 hectares), sufficient space exists for all the construction materials to be stored at the site itself, whilst there will be a temporary storage depots for materials at either end of the transmission line route. The actual plant site itself will occupy an area of approximately 4 ha and the area to the west of the site (between the plant site and the main road – see Figure 3.3.1) will be cleared for use as a construction compound. This will provide a suitable area (approximately 3.5 ha) for both the necessary temporary buildings and materials storage. Materials for the expansion of the Mangombe substation at Edéa will be transported directly to, and stored there.

At site establishment all vegetation from the plant site itself and the construction compound will be cleared and removed from site. Any useable timber will either be sold or given to local residents, whilst other unusable vegetation materials will be left on the periphery of the site to naturally degrade. Works will be set out to keep the area of land utilised for the project to the minimum and, where practical, mature trees and a vegetation screen to the road and properties to the west will be maintained.

Any excess materials resulting from site levelling, landscape and backfill will be stockpiled on the periphery of the site at a designated area. For the transmission line, it is planned that surplus natural soils will be spread over the adjacent area as only small volumes will be involved or be removed to appropriate disposal sites. The details of these areas will be included within the Environmental Management Plan (EMP) and form part of the contractual obligation of the Engineering, Procurement and Construction (EPC) contractor. Items, such as wood, will be recycled as firewood for the use of local people, or to be sold by them to form a source of revenue.

Construction water

Water for the construction phase of the project will be taken primarily from surface water sources. For the plant site this will come from the adjacent stream, whose quality will be analysed before final decision of use. The site has two minor streams on the north and south boundaries which flow into the Mpolongwe River to the northwest boundary (see Figure 3.3.1). This river flows all year round and it is anticipated it will easily provide the relatively low water demand for the construction phase. The impact on the resource will be minimal (see Section 5.4).

Three large rivers (Sanaga, Nyong and Lokoundje) and over 50 small rivers/stream or drainage channel cross the wayleave route of the transmission line. The main construction water demand will be for the production of the concrete for the tower foundations. The foundations consist of a single concrete pad cast at the foot of each leg (four per tower). This is again a low volume and supply from local surface water sources during construction will be sufficient and have minimal impact on the resources. Most construction activity at the transmission line will be the assembly of the tower, fitting of isolators, stringing, etc all activities where no construction water demand exists.

Potable water will be provided either as bottled water or from available existing potable water sources along the route. In addition, appropriate sanitation facilities such as pit latrines will be provided at construction sites.

Wayleave clearance

As set out within Table 3.3.1 the wayleave for the new 225kV line will have a total width of 30 m i.e. 15 m either side of the centre of the power line. At construction, this wayleave will need to be cleared of all trees and tall vegetation with clearance to ground level. In addition, there will be a need to fell all trees greater than 15 m that are located along the boundary of the wayleave. All clearance will be undertaken by hand or using clearance machinery with no use of chemical methods. Vegetation clearance will be undertaken to ensure that no significant areas of bare ground are created.

In addition to vegetation clearance, all buildings that exist within this wayleave and any farming areas will be relocated. Procedures for the valuation, assessment and administration of any compensation to local property or land owners for this relocation will be in accordance with international guidance. Details of these procedures are set out within the Social Impact Assessment (Section 6.3).

As the route is predominantly forested most clearance will involve removal of trees and under storey vegetation. As for the compound area, all timber created during this clearance will either be made available to the local population and, if of commercial timber value, may be given to local population for their own use or to be sold off site.

3.3.5 Operational Phase

Employment

The operation of the power plant will require approximately 60 specialised staff, mainly engineers and technicians. As this will be a new technology in the country, AES SONEL will recruit new staff early in the construction process for the purpose of providing them with extensive training during all phases of the project. The selection process will be countrywide. However, some non-specialised jobs such as guards, cleaners etc. will be filled locally.

The power plant will operate 24 hours per day and will be run on a three, eight hour shift basis. Approximately 10 to 15 staff per shift will be required to run and maintain the plant with a further 15 or so staff required for management and administration on site during the day shift. Peak staff numbers on site during the operating phase will be during the day shift (approximately 30 people). This does not include employment associated with the maintenance of the wayleave, which is discussed below.

Accommodation and logistics

There will be no staff housing provided at the plant site as the neighbouring town of Kribi is only 9 km to the south of the site. All permanent staff will therefore be housed in existing accommodation within Kribi town. The company will provide staff transportation to and from the site at the beginning and end of each shift.

The plant will have office accommodation and staff welfare facilities, toilets, washing facilities, canteen/eating area, etc. on site. These will be single storey buildings constructed on the southeast boundary of the site, see Figure 3.3.1.

Water Supply

Water supply at the site will be designed to satisfy the potable and staff welfare requirements at the plant as well as process water demand.

There is no local potable water distribution system close to the site. As a consequence potable water will be provided primarily via groundwater boreholes constructed on site. Groundwater levels, quality and volumes will be established prior to final design of the supply system. Groundwater investigations were being undertaken at the time of reporting. Water quality analysis will identify the need for any water treatment to meet drinking water standards. Final design of the potable system has not been completed. However based on the staff numbers predicted to be on site and the facilities to be provided, initial potable water demand is anticipated to be in the order of 2 m^3 to 2.5 m^3 per day (see Section 5.5). Potable water demand is therefore very low.

There is also no major water demand required for the power generation operations on site. The cooling systems for the gas turbines will be with air or by water in closed circuits. Therefore, the closed circuits system will only require make up water. Overall water demand for the process operations is estimated at approximately only 2 m^3 to 3 m^3 per month. Process water for the system can be supplied either from the streams adjacent to the site or from on-site boreholes.

The water system will be covered within the scope of the EPC contractor. It is envisaged that potable water shall also be provide for use by the neighbouring inhabitants.

Waste water management

All potentially contaminated water will be collected and treated prior to being discharged to a soak-away system or to the streams surrounding the plant site. For the on-site welfare facilities, foul drainage will be feed to a septic tanks system or similar for treatment prior to discharge to a soak-away system.

Wayleave Management

During the operational phase, vegetation within the wayleave must be managed to ensure that it does not interfere with the line (see Section 3.3.6). This operation will be conducted under contract to AES SONEL with contractors utilising local labour for the works in accordance with good industry practices.

3.3.6 Wayleave management

There are currently no set guidelines in Cameroon for the management of vegetation and permitted land uses within the transmission line wayleave. In addition AES SONEL have not developed in-house rules for this management. Recent practice is identified within the Limbe EIA (AES SONEL, September 2003) in which it was noted that no structures or crops would be permitted within the wayleave and vegetation above 4 m in height would be cleared.

In the absence of statutory guidance on wayleave management within Cameroon industry standards, proposals within this ESIA are based on experience within other countries and on the basis of management requirements to ensure the power lines are not impacted by land

use within the wayleave. These take account of the standards set out within the Limbe report but develop these further and propose modifications. These are set out below.

Vegetation management

Within this wayleave all tall (suggested as greater than 2 m) vegetation must be cleared. At the establishment phase all woodland and tall scrub will therefore be cut and removed. Once cleared and the line constructed, vegetation management is usually undertaken once per year with the vegetation cut back to a minimum height of approximately 4 cm to 6 cm above ground surface, where necessary. The clearance will be undertaken in such a manner so as to ensure that the vegetation cover survives and re-grows. Excess bare ground resulting from vegetation failure could lead to soil erosion problems.

No burning of vegetation will be permitted within the wayleave as the soot and carbon can affect the power transmission lines. Good practices would be for all cut vegetation to be removed from the wayleave during clearance so as to reduce the build up of dry matter under the lines which may inadvertently be ignited and cause large fires. However, within the warm humid climate of the project site vegetation may be left to rot and degrade within the wayleave. However, as part of the operational environmental plan (OEMP), a review of build up of dry matter will be undertaken each year to ensure this degradation process is effective.

Permitted land uses

Within these guidelines formal land uses, such as agriculture, would be permitted within the wayleave. However, this would be subject to the following conditions:

- crops greater than 2 m in height cannot be grown;
- no burning activity for land clearance prior to planting etc, is allowed;
- no irrigation, overhead or low level, is allowed;
- grazing by agricultural stock is permitted.

In effect these conditions would allow most normal agricultural activities to continue within the wayleave. However fruit crops or other produce from trees or shrubs of greater than 2 m in height, such as bananas, oil palms, etc would not be allowed. It should be noted that as the wayleave area will have been subject to a full resettlement action plan (see Section 6.3), the farmers currently occupying this land will have been compensated prior to the power project by AES SONEL. Any subsequent farming undertaken during operation of the proposed line would be at the risk of the farmer as AES SONEL will reserve the right to clear the land as required for safety of the project.

No construction development of any sort, residential or otherwise, is permitted within the wayleave. All property must be constructed outside the 30 m wayleave and where resettlement is being undertaken, new property should aim to be located away from the wayleave margins so as to allow for potential future development. However local circumstances will dictate the actual relocation site of any property that needs to be moved.

3.3.7 Decommissioning

Power plant

The plant has a design life of 25 years after which time the future of the development will be defined, i.e. either to undertake repair and replacement to extend the life or to decommission the plant. At this stage a detailed decommissioning plan will be developed. At this current stage of the development only general decommission activities can therefore be presented.

The first stage of decommissioning will be to identify if any of the structures or buildings on site have an alternative long-term use. This may apply to the offices, workshops, plant houses etc. that may be converted to new industrial and commercial use. This decision process will be undertaken in consultation with the government and local communities and any buildings and structures to be retained will be identified and transferred to a suitable new owner. Any conversion works to be undertaken will be specified at the time of decommissioning.

Following this process the main power plant and electrical equipment will be dismantled and all steel and other reusable materials removed from site and recycled. All unwanted concrete foundations, car park areas, etc. will then be broken up and removed from site. Where volumes and demand allows these may be crushed (with reinforcing bar recovered) and reused as a construction aggregate. If this is not practical then all materials will be removed from site and disposed of to a suitable designed waste disposal site.

Following dismantling and removal of building, etc, soils will be tested for any contamination arising from the activities conducted on site. Where contamination is identified then these soils will either be treated to remove the contamination or disposed off to a suitable waste disposals facility. The regrading and earthworks associated with the development of this site will result in the loss or damage of the topsoil layers. Following decommissioning the soil surface will be ploughed to aerate the soils in preparation for re-planting. Soils will be in a relatively poor state and therefore the site is likely to be returned to a forest cover.

Final decisions on land use at the site, post closure, will be taken nearer the time of decommissioning and in light of any decisions on the retention and conversion of any structures on site. The water supply borehole(s) at the plant site will be made available to the local community.

Transmission line

The typical life of a transmission line is 50 years and therefore decommissioning is not defined in detail at this stage. The potential exists for repair and replacement and therefore this timescale may be extended.

At decommissioning the conductors will be lowered and removed from site for recycling and reuse. Following this the tower will be dismantled and the steel again removed from site and recycled. Limited waste should be produced during this operation although some isolators, camps etc. may need to be disposed of. This will be removed from site and then disposed of to a suitably designed facility.

The need to remove the concrete tower foundation will be dependent on the future land use of the site following decommissioning. Where the wayleave is to be returned to forest cover these foundations may be left in place. If agriculture is to be practised then it will be more appropriate for them to be removed. This will need to be defined nearer the time of decommissioning.

As the development involves little disturbance of the actual soils and land within the wayleave (only at the tower sites), final land uses following decommissioning are not restricted.

3.4 CONSIDERATION OF PROJECT ALTERNATIVES

3.4.1 Plant alternatives

A study of plant alternatives was carried out in 2005 by Power Planning Associates Limited (PPA), a consultant hired by AES SONEL. This study included:

Location alternatives: *Limbe, Douala and Kribi*

Plant types alternatives: *simple cycle gas turbines and gas reciprocating dual-fuel engines*

Fuel alternatives: *Gas, HFO and diesel*

Gas sources alternatives: *Rio-del-Rey and Sanaga Sud*

The conclusion of the study was that a gas-fired power plant located at Kribi and equipped with simple cycle gas turbines fuelled with natural gas supplied from Sanaga Sud was the least costly option. A copy of this report is attached as Appendix D to this report.

3.4.2 Plant Site

Following the initial decision that a gas power plant around Kribi, fuelled with gas coming from the Sanaga Sud gas field, the Energy Steering Committee requested that a site selection survey be undertaken for the potential plant site. An AES SONEL team undertook this survey in November 2004.

The location of the plant site is significantly influenced by the requirement of a supply of gas. Five potential sites, all on the outskirts of Kribi, and therefore in the vicinity of the Sanaga Sud gas field were investigated:

- EBOME, located 4 km south of Kribi;
- GRAND BATANGA located 9 km south of Kribi;
- MPOLONGWE, located 9 km north-east of Kribi where two potential sites were pre-selected; and
- BIPAGA 2, located 29 km north of Kribi.

The sites were assessed with respect to size, flatness, quality of soil, access roads, availability of fresh water, use of land, facilities, construction costs, etc. The conclusion of

the survey was that Mpolongwe 1 was the preferred site. A copy of this survey is presented in Appendix E.

3.4.3 Transmission Line

The route of the line is dictated by the location of the plant and substations at Kribi and Edéa and the need to minimise the overall length wherever practicable.

However, various deviations along the route were investigated to minimise, and where possible, avoid existing houses, plantations and farmland falling within the wayleave. The area is lightly inhabited, except when crossing the city of Edéa. As shown on Figure 1.1.2, the line has been designed to cross the minimal number of properties. A framework Resettlement Action Plan (RAP) will be developed as part of the ESIA requirements (see Section 6.3). From Edéa, the selected route follows the existing 90 kV line, where possible, but deviations are evident to avoid villages, farmlands, plantations and protected forests.

Options for double or single circuit transmission lines were also considered for this initial stage of development. The double circuit option provides greater flexibility and allows for future expansion but increases initial cost and required construction of larger towers. As the base case for this development a single circuit system is therefore adopted.

3.4.4 Assessment of Alternatives

As the Plant Site locations and transmission line route alternatives have been considered in detail and reported separately, these are not considered as alternatives in the ESIA. The main alternatives are therefore:

- *single circuit power transmission line*, as oppose to double circuit in the base case; and
- *the use of reciprocating gas engines,* as oppose to gas turbines in the base case.

The ESIA will also examine the zero option (or no-go) project option (see Sections 5 and 6).

SECTION 4 : SCOPING AND CONSULTATION

4.1 INTRODUCTION

Scoping and consultation is typically a cyclical or iterative process involving feedback and further consultations with relevant parties. The process, which is undertaken throughout the production of the ESIA, has two principal functions:

- to identify and clarify the key issues which must be addressed by the ESIA;
- to ensure an adequate flow of information to regulatory authorities, interested parties and the general public, which is not only a necessary pre-requisite of the identification of the key issues, but is also an integral part of the permitting and approval processes practised by many permitting authorities and international funding agencies.

4.2 REQUIREMENTS FOR SCOPING AND CONSULTATION

4.2.1 Cameroonian Requirements

As discussed in Section 1, and summarised in Table 1.3.1, Cameroon's EIA regulations are defined in *EIA Decree of Cameroon, 2005 / 0577, 23rd February 2005*. In line with international EIA best practice, the regulations require a two-stage process to the EIA. The first stage (also referred to as scoping) requires the proponent to provide the terms of reference for the ESIA.

The decree also provides the following requirements for consultation:

- The determination of the acceptability of the EIA involves consultation and public hearings, which will also include meetings undertaken during the study.
- The proponent must provide 30 days notification prior to the first consultation meeting.
- Minutes of meetings must be included in the EIA report.
- After confirmation of acceptability of the EIA report, public consultation is undertaken. Following 30 days, a report of the findings is presented to the Minister

In line with these requirements public consultation has been undertaken for the Kribi Power Project as discussed in Section 4.4.

4.2.2 Requirements of International Agencies

Scoping

Scoping is a specific requirement of the World Bank (*World Bank Operational Directive 4.01).* It is considered best practice to initiate scoping during the early stages of an EIA (and SIA) in order to provide a focused EIA (and SIA) that meets the requirements of the relevant planning authorities.

Consultation

Scoping should be undertaken with the involvement of relevant government agencies; non-governmental agencies and affected groups to ensure all the issues of significance to the community are considered *(World Bank Sourcebook Update No. 5, 1993)*. Consultation on the draft EIA (and SIA) report is also required. Once consultation has been initiated, it is considered best practice to continue consultation throughout the project life.

4.3 SCOPING OF THE ESIA

4.3.1 Scoping Methodology

The overall objective of the scoping exercise was to provide project and site familiarisation and to gather and review existing baseline data in order to be able to identify the potential environmental and social impacts of the project, which needed detailed examination in the second phase – the ESIA itself.

Environmental and social impact scoping work was undertaken during and following visits to the site by the study team in January 2006. The site visits included discussion with the Ministry of Environment and Protection of Nature, AES SONEL's staff members within the environmental and survey department to ensure the history of the project was understood and all available existing baseline data was collated. This initial study phase considered the potential environmental and social impacts of the project through its construction, operation and decommissioning phases. Consideration was also given to project alternatives, for example, options for the location of the power plant and the transmission line route.

Information from the scoping stage was fed back to the design team for the project in order for provision to be made for optimising design with due regard to potential significant environmental effects. This included input to the Compensation Commission Survey that was to be undertaken to identify Project Affected Persons, as discussed in Section 6.3.

4.3.2 ESIA Terms of Reference

The scoping report presented the terms of reference for the ESIA, i.e. the potentially significant environmental and social issues that were to be considered in the ESIA. The Terms of Reference is reproduced as Table 4.3.1 below.

It is emphasised that these are *potential impacts* and not necessarily those that are bound to be experienced. Identification of the potential impact allows the main environmental and social issues to be identified and early consideration given to mitigation of the impact via appropriate project design.

The scoping report (Scott Wilson, February 2006) was submitted to the Ministry of Environment and Protection of Nature in February 2006 and confirmation of their approval of the scoping report and proposed terms of reference was received on 19 April 2006. A copy of this letter is provided in Appendix F. The World Bank also approved the scoping report (Ref. Email dated 9th March 2006).

Table 4.3.1: Potentially Significant environmental issues for inclusion in the EIA

Issue	Potentially significant issues for the EIA
Air quality	Minor potential impacts during constructions arising from dust generated by site traffic and plant movements. Potential local, regional and wider scale air quality impacts from power plant stack emissions during the operational phase.
Surface Water	Potential minor impacts on surface water quality during construction arsing from possible soil erosion and construction site discharges. Due to very low water demand no impacts on water resources identified. Minor potential for water pollution from oils stored on site during operations.
Groundwater	No construction impacts on groundwater quality identified and due to low water demand no impacts on overall groundwater resources. Minor potential for groundwater pollution from oils stored on site during operations
Noise	Minor potential impacts during construction from on site activity and materials transport to construction sites. No significant operational impacts along the transmission line but potential impacts on local inhabitants close to the plant site due to power plant noise.
Traffic	Minor potential impacts during construction from delivery of equipment and materials to the construction sites. No potential impacts identified for the operational phase.
Soils and land use	Potential impacts resulting from loss of current land use and soils at the power transmission line towers and the plant site. Potential for change of land use within the way leave of the transmission line.
Flora and fauna	Potential impacts on flora and fauna resulting from loss of natural habitats as a result of land-take for the power transmission line route and plant site and increased access to wayleave area.
Socio-economic	Potential impacts principally resulting from change of land-use and land take for the power transmission line route and plant site and relocation of properties within the way leave. Potential benefits of more secure electricity power supply increased local employment.
Archaeology and cultural heritage	Potential impacts on sites of archaeological and/or cultural heritage significance as a result of land-take and construction activity.
Landscape and visual impact assessment	Minor potential for alteration to views to local communities along the transmission line route and at the plant site

4.4 CONSULTATION

4.4.1 Introduction

This section provides an overview of the consultation carried out for the ESIA at the time of preparation of this report. It also highlights some of the key issues raised and recommendations on the way forward.

4.4.2 Approach

Public consultation, according to the International Finance Corporation (IFC), "*…is a tool for managing two-way communication between the project sponsor and the public. Its goal is to improve decision-making and build understanding by actively involving individuals, groups and organisations with a stake in the project. This involvement will increase a project's long-term viability and enhance its benefits to locally affected people and other stakeholders.*" (IFC, 1998). In accordance with IFC and World Bank guidelines the project, has placed consultation at the centre of its activities that affect the local community. The project's philosophy is to regard consultation as an organic and dynamic process rather than a single event. A fundamental requirement in World Bank/IFC policies on resettlement, land acquisition and compensation is a framework for public consultation, participation, and the establishment of a process to redress the grievances of affected people. Consultation with the affected population and with officials of local government, civil society and other representatives of the affected population is essential for gaining a comprehensive understanding of the types and degrees of adverse effects.

Stakeholder involvement in both the project development and environmental decision-making provides valuable information on its social, economic and environmental implications. Through early, proactive and continual engagement of stakeholders, negative impacts can be minimised or eradicated and positive impacts can be maximised. Ensuring that all stakeholders and affected groups have been identified and consulted has therefore been the emphasis of the consultation process for the Kribi Power Project, with opportunities to obtain a wide range of views and to ensure a widespread understanding of the project.

4.4.3 Method

As discussed above, public participation in environmental decision-making is an important element of the Environmental and Social Impact Assessment (ESIA) process. In line with this, consultation has been an integral and on-going part of the ESIA process for the Kribi Power Project. This commenced in January 2006, with informal consultation taking place during the initial scoping visit by the Scott Wilson ESIA Team and continued during subsequent visits in February and March 2006. Ongoing consultation has continued throughout the preparation of the ESIA report and will continue throughout the project life from initial construction, through operation to decommissioning. Consultation of a range of stakeholders has been conducted both formally and informally.

Stakeholder Identification

Involving the right stakeholders during appropriate stages of the consultation process has been a key concern of the project ESIA process. This has been best achieved using appropriate stakeholder identification techniques. "Stakeholder identification is undertaken

to determine who will be directly or indirectly affected, positively or negatively, by a project (commonly called project affected people or project-affected groups), and who can contribute to or hinder its success (commonly called other relevant stakeholders). It is important for the project sponsor to be comprehensive in identifying and prioritizing all project stakeholders, including the disadvantaged and voiceless. Those identified will then need to be consulted to varying degrees, depending on level of impact, at strategic points during the life of the project.

It should be noted that stakeholder identification and involvement are often context-specific, i.e. what works with one project may not be appropriate for another (IFC, Doing Better Business Through Effective Public Consultation and Disclosure: A Good Practice Manual, 1998). With these principles in mind the project used the following methods for stakeholder identification:

- Formal and informal public consultation meetings;
- Document and literature review;
- Household surveys;
- Informal unscheduled discussions;

By using the above approaches the project was able to gauge the views of a wide range of people. A list of those consulted can be found in Table 4.4.1.

Formal Public Consultation

Objectives of Formal Public Consultation

The main objectives of the formal public consultation undertaken with the ESIA process has been to:

- formally introduce the project to key stakeholders;
- adhere to the public consultation requirements of Cameroon legislation and the IFC (see Section 2);
- hear stakeholder issues and concerns and to try to address them, as appropriate with provision of information in the meetings and through the ESIA report.

The project team sought the advice of local and national government during the ESIA scoping phase of the project. Initial introductory meetings were therefore held in January with the Ministry of Environment and Protection of Nature and the Divisional officers of Kribi and Edéa to discuss the project and to obtain advice on the best approach to consulting with project affected people. As a result, it was agreed with government and AES SONEL to have 2 public meetings with the Divisional Chiefs of Edéa and Kribi respectively and several public meetings with communities in the affected villages over the course of a 2-week period in February and March 2006 as set out in Table 4.4.1 (see Figure 1.1.2 for locations of villages). This protocol ensured that the main chiefs of the area were briefed first and therefore were involved at the initial stages of the formal consultation process and were an integral part of the process.

Invitations were jointly drafted by the divisional officers, AES SONEL and Scott Wilson and were then sent out to the Chiefs by the divisional officers. In line with Cameroon legal requirements the invitations were sent out a month before the meetings.

Meetings with Kribi and Edéa Divisional Chiefs

Divisional chiefs are the most senior members of the traditional local political structure and are often responsible for several villages. Invitations were sent out to the Divisional Chiefs, responsible for the project area (i.e. districts of Kribi and Edéa), one month in advance of the meetings. A copy of these letters is provided in Appendix G.

Two formal consultation meetings were held, one with each Chief, which were also attended by AES SONEL and members of SW's ESIA Team. During these two meetings the Chiefs were informed about the project and the consultation process, and were requested to inform their individual villagers of the February consultations with affected villages and the proposed household survey.

Public Meetings

Public consultation meetings were conducted with the 25 affected villages (see Table 4.4.1) in the project area that will be affected by the project. As discussed above, the chiefs were requested to inform their respective villages of the public meetings with communities a month in advance of these taking place. Detailed schedules of meetings in the villages were given to the chiefs after the meetings, so as to communicate them to their population. In the meantime AES SONEL members of staff informally reminded villagers of these meetings two weeks before they took place.

The objectives of these meetings were to explain the project to local people including the compensation process and to provide an opportunity for local people to raise their concerns about the project.

A local divisional government officer as well as a member of AES SONEL and Scott Wilson attended all the meetings. The exception was those at the plant site (Mpolongwe II in Kribi subdivision), which was chaired by the Senior Divisional Officer and Ekite II and Ekite III in Edéa subdivision.

Meetings were conducted mainly in French and there were translations into local languages when necessary. The generic structure of the meetings was as follows:

- introduction and explanation of meeting by Divisional officer;
- presentation by AES SONEL of project description;
- presentation by Scott Wilson on the process of the ESIA and World Bank guidelines on compensation;
- Questions and answers

This exact format was not always followed and in some instances the meetings commenced with a very brief introduction, where there was an existing knowledge of the project, and then a question and answer session.

Attendance at each village meeting varied depending on the size for the village but ranged from 20 to 70 people. Copies of the lists of attendees and minutes are presented in Appendix H of this report.

Informal Consultation

Informal consultation and meetings with various stakeholders have been an ongoing process in the project. Members of the ESIA team have had informal discussions with local affected communities, NGOs, health centre staff and local government officials between January and April 2006. The household survey, which was carried out in March 2006, provided a further opportunity for discussions with villagers about their issues of concern.

Timing

AES SONEL commenced consultation during discussions with government authorities regarding the need for new power sector development in Cameroon, the purchase of the land and obtainment of the Public Utility Decree. AES SONEL held meetings with The World Bank's energy sector (Environment, Engineering and Infrastructure departments), The Cameroon Ministries of Energy and Environment between June and December 2005.

In addition, the Scott Wilson ESIA team, during four site visits between January 2006 and April 2006, formally and informally consulted a number of different individuals and groups with an interest in the project.

During the third site visit by the ESIA team in February 2006, formal consultation meetings were held. The meetings with the paramount chiefs of Kribi and Edéa were conducted on 21and 22 February. The meetings with the affected villages were carried out between February 21 and March 10 2006. Additionally, the visit in March to carry out the sample household survey also included informal consultation with a number of stakeholders. A full list of people met and dates can be found in Table 4.4.1.

Consultation will be on-going through the project and inline with both Cameroonian legislation and World Bank guidance a further stage of formal consultation will be undertaken once the draft ESIA report is complete and made available for review as discussed in Section 8.

Table 4.4.1: Summary of Stakeholders Consulted up to April 2006		
Date	**Stakeholder and Affected Groups**	**Purpose of Consultation**
Ministries and Government Agencies		
December 2004	Energy Steering Committee (included representatives of all government bodies in the energy sector and major energy customers)	To investigate potential options to improve the power supply to Cameroon, these involved the early examination of the potential of a gas fired power station in the Kribi region.
17 January 2006	Kribi Divisional Officer Edéa Sub Divisional Officer	To introduce the project and to discuss the most appropriate approach for carrying out public consultation with villagers and key community leaders.
18 January 2006	Ministry of Environment and Protection of Nature	To introduce project and Scott Wilson to the Ministry and to discuss the public disclosure after the delivery of the ESIA
Kribi-Edéa – Community		
15-19 January 2006	Informal discussions with a random selection of individual villagers at plant site in Kribi district.	To gauge people's knowledge of AES SONEL project and to identify villagers' concerns about the project.
21 - 22 February 2006	Kribi Chiefs Mpolongwe 2 Edéa Chiefs	To introduce the project to local leaders and to inform them about the consultation process and to request them to inform the affected villages about the forthcoming village consultations.
23 February 2006	Bebambwe 1 village Bebambwe 2 village	Public meetings open to all villagers to introduce the project and to discuss the process of consultation and compensation. Also an opportunity for village communities to raise issues of concern.
24 February 2006	Londji 1 village Bipaga 1 village	
28 February 2006	Ebea Pama Bivouba	
1 March 2006	Mbebe Elogbatindi Bonguen Dehane	
6 March 2006	Appouh Koukoue	
7 March	Malimba Farm Ekite 1	
March 9	Ekite Pilote Malimba Urbain	
March 10 2006	Ekite 1 village Ekite 3 village	
March 28 2006	Londji Health Centre Staff	To obtain information on the health baseline of the project area and the health facilities of the area.
April 3-7 2006	Residents located at the current plant site	Informal discussions about access to potable water.

4.4.4 Key Results of Consultation Process

From the feedback obtained at the village and chiefs' meetings (see Minutes of Meetings in Appendix H) there appears to be a general endorsement of the project, but with some key caveats. These being better consultation; fair compensation, increased access to electricity and preferential employment. These issues are discussed in detail in Sections 6.3 and 6.4 and the following Tables 4.4.2 and 4.4.3 provide a summary of the key issues raised at the meetings.

Some of the concerns that have been raised are a result of the experience of past projects and are not necessarily as a result of the AES SONEL project process. However, villagers do seem to be distrustful of large corporations and some local officials and therefore the importance of good consultation cannot be overstressed.

Table 4.4.2: Key Issues Raised at Kribi and Edéa Chiefs' Meetings – 21, 22 February 2006

Area of Concern	Issue	Response[1]	ESIA Report Section[2]
General Project	Risks about pollution associated with the plant site, gas production and the transmission lines	Issues that are considered in the ESIA.	6.3.6
Community Relations and Consultation	Information dissemination: There was concern that AES SONEL has undertaken preliminary works without informing the chiefs or communities concerned.	AES SONEL is committed to a transparent and timely consultation process.	4.4
Resettlement and compensation	There were concerns about the levels of compensation how rates and values for land and crops were to be evaluated. Participants wanted more information. There was also concern about possible inconsistencies in compensation rates. The Chad-Cameroon Pipeline was cited as an example of a project with inconsistencies in compensation and where agreements were not honoured by the project sponsor. There was also a concern about the payments (directly to PAPs or through administration representatives?)	AES SONEL will carry out a fair compensation programme in accordance with WB OP4.12.	6.3
Employment	Participants wanted to know if local people would be given priority during the recruitment process	AES SONEL is committed to ensuring local people are involved in the project.	6.4

[1] *Response from AES Sonel*

[2] *Section within ESIA, which deals with this issue*

Table 4.4.3: Key Issues Raised at village meetings February 24- March 10 2006			
Area of Concern	**Issue**	**Response[1]**	**ESIA[2]**
Electricity	Electricity provision. It was felt that villages or individuals that did not have power before the project should as part of the project. People felt that electricity should be provided for free or heavily subsidised.	AES SONEL said it would look into it, as a country wide electrification program is underway	6.5
Potable Water:	Potable water provision. The majority of villages do not have accessible potable water. Communities would like provision of potable water as part of their community compensation package.	This is outside the remit of the ESIA.	
Employment	People requested that local populations be given sufficient and relevant training opportunities to enable them to compete for project jobs. They also requested that they be given priority during the AES SONEL recruitment process.	AES SONEL said it would do all it can to ensure local people are able to be involved in the project.	6.4
Compensation and Resettlement	Compensation requested for damage done during preliminary works of the project in October 2005. Compensation for fallow land where the soils has been destroyed as a result of clearing for the transmission line. Will lands without legal title get compensation?	AES SONEL will carry out a fair compensation programme in accordance with WB OP 4.12.	6.3
Community Relations and Consultation	Poor information dissemination. Communities wanted assurance that consultation would be carried properly and that they would receive written explanation about the project. Maps and project documents explaining where the transmission line will cross were requested.	AES SONEL is committed to a transparent consultation process. Consultation will be carried out with respect to the environmental decree	4.4
Community Development	Village project committee to liaise with AES SONEL requested.	Local mayors and chiefs and village representatives are already involved in the project process.	4.4
Health	Concern about the effects of possible radiation from the transmission lines on human health.	All the correct safety checks will be carried out	6.6
Cultural Property	Medicinal and Sacred Trees: There was a concern about what would happen to these properties in the plant site and the along the transmission line.	The project will try to avoid sacred forests and trees with medicinal value. Where destroyed, a fair compensation will be provided	6.3

[1] *Response from AES Sonel*

[2] *Section within ESIA, which deals with this issue*

4.4.5 Conclusion

Generally, the consultation process has been well received by the affected communities. However, in order to maintain this goodwill the distribution of non-technical project summaries and maps to the affected people needs to be done. Furthermore plans need to be made for the required public audience in conformity with article 13(1) of the Decree no 2005/0577/PM. This will entail the distribution of the executive summary of the ESIA report in French and English in public reading rooms throughout the project area.

The following IFC guidelines should inform the ongoing consultation process.

The IFC's *Doing Better Business Through Effective Public Consultation and Disclosure: A Good Practice Manual* (IFC, 1998), provides action oriented guidelines aimed at ensuring that consultation with the affected population and with officials of local government, civil society organisations and other representatives of the affected population is both effective and meaningful. The guidelines emphasise the need for the project sponsor to ensure that the process of public consultation is accessible to all potentially affected parties, from national to local level. Emphasis is placed on the engagement of local stakeholders, namely people who are likely to experience the day-to-day impacts of a proposed project. On a practical level, the sponsor has to ensure that:

- All stakeholders have access to project information;
- The information provided can be understood;
- The locations for consultation are accessible to all who want to attend;
- Measures are put in place, which ensure that vulnerable or minority groups are consulted.
- Managing Distrust with consultation:

In addition to these IFC guidelines the project should be particularly sensitive to some of the feelings of mistrust amongst local communities. This will involve choosing village representatives carefully and constantly reviewing the consultation strategy. One approach could be to rotate the group of village representative so that there is a good representation of people, including women and those of a lower economic status. These types of measures will help to mitigate the perception that it is only those with power who will be consulted and therefore compensated.

SECTION 5 : ENVIRONMENTAL IMPACT ASSESSMENT

5.1 INTRODUCTION

The following section of the report has been based on the outcome of the Scoping exercise for the Kribi Power Project (Scott Wilson, February 2006, see also Section 4) and presents the results of the EIA for the project on a discipline basis as follows:

- Air Quality;
- Surface Water;
- Groundwater;
- Noise;
- Traffic;
- Soils and Land Use;
- Flora and Fauna; and
- Landscape and Visual.

5.2 EIA METHODOLOGY

The overall approach to the EIA is set out in Section 1.

The terms of reference for the EIA, which were determined during the scoping study (Scott Wilson, February 2006), established the environmental impacts considered to be potentially significant and therefore requiring detailed assessment. As such, the specific methodology for the EIA has been developed to ensure sufficient baseline data has been available in order to assess the potential environmental implications of the proposed project.

Wherever possible, existing secondary data has been utilised to provide an understanding of the existing baseline conditions. However, where there has been considered to be insufficient specific primary data collection has been undertaken. This has included, in particular, the undertaking of ecological field surveys, air quality monitoring and noise monitoring during April 2006. Details of the baseline data and specific field surveys undertaken are presented on a discipline-by-discipline basis in Sections 5.3 to 5.10 respectively.

To assess the impacts of the plant the following has been assumed. The load profile for the power station in the rainy season is expected to be a base load of 40 to 50 MW, with a peak output of 150 MW lasting for 4 hours per day. However, during the dry season, when production from hydro plant is limited due to low water regulated flows, the plant is expected to run continuously at full load. The assessment of impacts of the proposed plant have therefore been undertaken on a worst-case basis, with the plant assumed to be operating on natural gas at continuous 100% output.

5.3 AIR QUALITY

This section discusses the current and future ambient air quality in the airshed around the proposed power plant and transmission line route. The potential effects on air quality are considered with regard to World Bank ambient air quality guidelines.

A qualitative assessment has been made of the potential impacts of fugitive releases of dust around the proposed plant site and transmission line route during the construction phase of the project. Operational emissions from the power plant stacks have been modelled to select a suitable stack height and determine the magnitude of the change in air quality statistics of nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and fine particulate matter (PM_{10}) in the area around the proposed plant.

5.3.1 Baseline Conditions

There is no existing large-scale industrial developments or other major point sources of emissions in the vicinity of the proposed power plant. The main local sources of combustion emissions are the nearby Kribi to Edéa main road and domestic emissions from local housing. Traffic travelling along the main road is light, averaging between 400 and 450 vehicles per day. Traffic and domestic emissions are unlikely to be significant.

The transmission line follows the route of the Kribi to Edéa main road and passes through an area that is predominantly rural in character. Baseline pollutant levels are likely to be similar to those in Mpolongwe. There is however a large aluminium smelter, located adjacent to and powered by, the Edéa hydroelectric facility. This is the only major potential air pollution source within the vicinity of the project footprint, but it affects only the zone of the termination of the power transmission line at the Edéa substation.

Cameroon does not have a systematic network of air quality monitoring stations, therefore there are no readily available source of baseline air quality data for the Kribi area. A diffusion tube survey at two sites adjacent to the proposed plant site (see Figure 5.3.1), to establish indicative background levels of NO_2, SO_2 and ozone (O_3), has therefore been initiated as part of this assessment. Monitoring commenced at the beginning of April 2006. The preliminary results from the study are detailed in Table 5.3.1, the study is currently on-going and will build up a picture of long-term average background levels of NO_2, SO_2 and O_3.

Table 5.3.1: Background Pollutant Concentrations (µg/m^3)

Pollutant	Site 1: Background Concentration (µg/m^3)	Site 2 Background Concentration (µg/m^3)	Average (µg/m^3)
NO_2	1.7	1.0	1.4
SO_2	1.1	1.1	1.1
O_3	29.3	27.6	28.5

For evaluation purposes these concentrations are compared to the World Bank Standards, as set out in Table 5.3.2.

Table 5.3.2: World Bank Air Quality Guideline Values		
	Reference Period	**Recommended maximum ground level concentration values (µg/m^3)**
NO_2	24 hour average	150
	Annual average	100
SO_2	24 hour average	150
	Annual average	80
Total Suspended Particulate	24 hour average	230
	Annual average	80
PM_{10}	24 hour average	150
	Annual average	50

The World Health Organisation (WHO) have also published air quality guidelines, these are listed in Table 5.3.3. The limits are not mandatory, but are broadly similar to EU Limit Values and are considered valid assessment criteria for the Kribi Power Project. The WHO guideline values have been set at a level that provides protection of human health for all members of the public.

Table 5.3.3: WHO Air Quality Guideline Values		
	Reference Period	**Recommended maximum ground level concentration values (µg/m^3)**
NO_2	1-hour average	200
	Annual average	40
SO_2	10-minute average	500
	24-hour average	125
	Annual average	50

As is shown, background concentrations in Table 5.3.1 of NO_2 and SO_2 are far below both World Bank and WHO guideline values, reflecting the very low level of current emissions of these pollutants in the area around the proposed site. Background levels of ozone are typical of equatorial latitudes. The photochemistry of the region is limited by low levels of NO_2 and as a result any emissions of nitric oxide would be rapidly converted to nitrogen dioxide. Measured concentrations of oxides of nitrogen would be composed almost entirely of nitrogen dioxide.

Overall, baseline air quality in the vicinity of the proposed plant site and transmission line route is good but with some possible deterioration within Edéa.

5.3.2 Potential Impacts

Potential significant air quality impacts from the proposed development relate primarily to point source gaseous emissions from the power plant stacks during operations. However, short term local impacts may arise from fugitive dust and gaseous emissions from plant and vehicles during the construction phase.

The main impacts include:

Construction

- *Exhaust fumes* from construction traffic and plant at the plant site and along the transmission line route.

- *Dust generation* from construction activity and trafficking of construction vehicles across unsurfaced roads and cleared sites areas;

Operation

- *Power Plant Emissions* from power generation plant stacks arising from the burning of the main fuel source (gas) and short term stack emissions arising from the burning of back up fuels (diesel) during any shut down period of the gas supply.

Exhaust fumes

Construction

The anticipated volumes of construction traffic and plant activity will represent a large increase over current traffic movements on the Edéa / Kribi road (see Section 5.7). However, overall traffic flows are relatively low. Therefore the impact of additional vehicle emissions during the construction phase on air quality, taking into account very low levels of baseline air pollution, would be insignificant. This impact is not therefore assessed further within the ESIA.

Operation

Traffic volumes during the operational phase are very low (see Section 5.7) and therefore no air quality impacts will arise from this source. This impact is not therefore assessed further within the ESIA.

Dust Generation

Construction

The primary potential air quality impact arising from the construction phase is dust generated from construction activity and the movement of construction vehicles on unsurfaced areas.

Site preparation, construction works and the movement of site vehicles can generate dust emissions. Dust is particulate matter in the size range 1-75 micrometres (µm) in diameter, and is produced through the action of abrasive forces on materials. Fine particulate matter

(PM_{10}) is defined as particles less than 10 µm in diameter, and is of the most concern regarding health effects. Construction dust is generally larger in diameter than 10 µm and, therefore, does not necessarily increase existing levels of PM_{10} considerably. Particles between 10 and 75 µm in diameter are not typically associated with adverse effects on human health, their main potential effects being the soiling of surfaces. (Soiling is the cumulative deposition of airborne particles on to a surface.)

During the construction of the power plant and transmission line, some activities would have potential to generate emissions of fugitive dust. These include:

- vehicle movements on unsurfaced areas;
- land clearance to remove vegetation from construction areas and excavation;
- land levelling and grading of the site and access road route;
- the storage on site of surplus excavation materials and dusty building materials;
- construction of site buildings and installation of plant and equipment;
- clearance of the wayleave and access tracks, plus excavation for and placement of concrete pads along the transmission line route.

In the wet season it is likely that the regular and intense rainfall in the area would significantly reduce the frequency and severity of impacts from to dust generated by the works, by maintaining a high level of moisture within exposed soils and by washing deposited material from surfaces.

At the present time there are no statutory World Bank or EU standards relating to either ambient concentrations of airborne dust or to rates of surface soiling by dust particles. In the absence of agreed standards for construction dust levels with the potential to cause annoyance, the emphasis of the control of construction dust should be the adoption of best practices on site. However, even where mitigation measures are employed some dust is likely to disperse off-site and has the potential to impact local residents.

Operation

There will be minimal maintenance activities during the operational phase that will generate fugitive dust at the plant and during wayleave maintenance. These will only entail trafficking of one or two vehicles every few months there will be no significant air quality impacts arising from this source. This impact is not therefore assessed further within the ESIA.

Power Plant Emissions

This is purely an operational impact, as the power plant will not be functioning during the construction phase.

The main air quality impact during the operation of the proposed power plant will be emissions to air from the combustion of fuel within the gas turbines. The primary fuel for the plant will be natural gas from the Sanaga Sud gas field. However, it is not planned to

build a gas storage facility at the proposed power plant site, therefore it is intended to fire the plant with diesel oil during periods when the gas supply is interrupted.

Emissions to air from the burning of natural gas and diesel will include carbon dioxide (CO_2), oxides of nitrogen (NOx), SO_2, and particulate matter, a proportion of which will be PM_{10}. The particulate matter emitted to atmosphere may include small quantities of trace metals.

There are currently no national limits for emissions from power plants in Cameroon. Therefore emission guidelines for the new thermal power plants burning fossil fuels, as detailed in the World Bank Pollution Prevention and Abatement Handbook; 1998, are employed in the design of the plant. The appropriate emission standards relating to the proposed plant are detailed in Table 5.3.4.

Table 5.3.4: World Bank Emission Guidelines for New Thermal Power Plants

	Emission Guideline (mg/Nm^3)	
Fuel	Natural Gas	Diesel
Particulate Matter	50	50
SO_2	0.2 metric tonnes/day/mw or 2000 mg/Nm^3	0.2 metric tonnes/day/mw or 2000 mg/Nm^3
NO_x	125	165

Reference conditions: 15% O2, dry.

It is anticipated that the gas supply will be unavailable for a maximum of 8 continuous days per year. During this time the plant would run on diesel fuel typically at 30% load for twenty hours a day and fours hours at 100% load. It is not currently intended to use demineralised water injection during diesel firing to reduce emissions of NO_x. This decision is based on the limited operational period each year when diesel will be used, and therefore low potential for impacts, and the operational difficulties of maintaining a water treatment plant that only operates occasionally. This approach has been adopted for other projects using similar technologies. Where water injection is not employed for technical reasons, emissions of NO_x up to a level of 400 mg/Nm^3 are considered acceptable, provided there are no significant environmental concerns associated with ambient levels of air pollutants.

An assessment of the potential impacts has been undertaken through an air quality modelling exercise. This assessment is based on a power plant configuration consisting of 4 GE Frame 6B gas turbines, fitted with dry low NO_x (DLN) combustors. Discharge to atmosphere from the plant occurs via 4 stacks, one for each turbine.

Model Scenarios

The load profile for the power station in the rainy season is expected to be a base load of 40 to 50 MW, with a peak output of 150 MW lasting for 4 hours per day. However, during the dry season, when production from hydro plant is limited due to low water regulated flows, the plant is expected to run continuously at full load. The emissions from the proposed plant have therefore been modelled on a worst-case basis, with the plant assumed to be operating on natural gas at continuous 100% output.

The plant may burn diesel at up to 100% output for around 8 days per year. A consideration of the possible worst-case short-term impact of operating the plant in this way has been

made by modelling NO_x and SO_2 emissions from the power station at 100% output when burning No. 2 distillate (diesel/heating oil), enabling 1-hour / 24-hour maximum NO_2 and 10-minute / 24-hour maximum SO_2 concentrations to be predicted in the vicinity of the closest sensitive receptors. Long-term statistics have not been modelled as the plant would only burn diesel fuel for short periods of time and not throughout the year.

A summary of the emissions modelled is provided in Table 5.3.5.

Table 5.3.5: Turbine Emission Data

Scenario	100% load (natural gas)	100% load (No. 2 distillate)	Notes
Stack Internal Diameter (m)	2.60	2.60	Calculated, based on a 146.94 m^3/s volumetric flow rate (actual).
Exit Velocity (m/s)	27.65	27.26	-
Stack Exit Temperature (K)	821	823	548°C
H_20 emission rate (kg/s)	6.52	4.32	-
CO_2 emission rate (kg/s)	7.06	9.53	222,644 tonnes per year
CO emission rate (g/s)[1]	1.44	1.36	-
NO_x emission rate (g/s)[1]	5.93	11.32	Based on 25 ppmv (gas) / 50 ppmv (distillate) as NO_2
SO_2 emission rate (g/s)[1]	9.93	30.03	Based on 0.04% H_2S (gas) / 0.5% S (distillate)
PM_{10} emission rate (g/s)[1]	0.56	0.56	PM_{total}, assumed to be PM_{10}

[1] *Emission rates are per turbine stack; there are 4 stacks in total.*

The effect of stack height on ground level concentrations of the pollutants emitted has been evaluated as part of the sensitivity analysis, by running AERMOD with stack heights of 20, 22.5 (standard), 25 and 30 metres. Annual mean ground level concentrations are compared with the air quality guidelines in Tables 5.3.2 and 5.3.3.

The air quality impacts on the surrounding area resulting from the operation of the proposed plant, as calculated by the dispersion model, are combined with existing ambient air quality statistics and compared with the assessment criteria to establish the significance of effects.

Hazardous Air Pollutant (HAP) Emissions

The emission of unburned hydrocarbons and NO_x may contribute to the formation of ground level O_3. Reactive plume modelling would be required to assess the impact of these pollutants in forming O_3. No such modelling has been performed as part of this assessment, as there is very limited potential for the proposed plant to significantly effect local or regional ground level O_3 concentrations.

CO_2 emissions for the proposed power plant, based on the data provided in Table 5.3.5, would be approximately 222,644 tonnes per year. This figure is based on the plant operating at 100% output for the whole year, which is unlikely to occur and so therefore represents an absolute maximum emission. No further modelling of CO_2 emissions has been carried out.

Dispersion Model Selection

The air quality impacts of the proposed power plant are best evaluated using a refined, near-field (less than 50 km from the emission source) Gaussian Plume Dispersion Model, which is able to calculate maximum ground level concentrations at receptors close to the plant boundary. Gaussian models assume that pollutants do not decompose in the atmosphere, and therefore do not account for the long-range transport of atmospherically reactive pollutants. They are designed to produce results that are close to monitored values.

The assessment has been undertaken using the US EPA preferred model AERMOD, developed by the American Meteorological Society and U.S. Environmental Protection Agency Regulatory Model Improvement Committee (AERMIC). AERMOD is an advanced plume model that incorporates the latest understanding of the atmospheric boundary layer, and includes the PRIME downwash algorithm for the assessment of structure effects.

In addition to AERMOD, there are two input data processors that make up the regulatory components of the modelling system. AERMET is a meteorological data pre-processor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, while AERMAP is a terrain data pre-processor that allows the incorporation of complex terrain effects within the model.

During its development, AERMOD has undergone a number of validation studies, the most recent of which was published in 2003. Comparisons with the previous ISC-PRIME model show similar results for most databases, with occasional notable improvements.

Terrain Data

The area around the proposed plant location is gently undulating at an altitude of 10 m to 20 m above sea level. The land between the stacks and the receptors does not slope sufficiently to justify the consideration of terrain effects within the model, and for the purposes of this assessment the terrain has been regarded as flat or simple terrain.

Building Downwash Effects

Nearby buildings and structures have the potential to effect the dispersion of emissions from the plant stacks. As the wind blows over and around these buildings the airflow will be disrupted and pollutants may become entrained within the eddy (cavity) near to the building or within the associated zone of turbulent air (wake), resulting in higher near-field ground level concentrations.

The only planned building on the proposed site is the administration centre, which would be single storey and unlikely to have any effect on dispersion. The gas turbines would be located outside, and protected only by an open-sided rain shelter. The dimensions of buildings on site have not therefore been considered within the model.

There are no existing tall structures close to the site that may affect dispersion.

Meteorological Data

Discussions were held with the UK Met Office, to establish the most representative source of meteorological data for use in the dispersion modelling assessment. Three options were considered:

- Kribi (WMO reference 64971);
- Douala (WMO 64910) 165 km to the north;
- Libreville in Gabon (WMO 64500), 230 km to the south.

All three sites are close to the coast and experience similar meteorological conditions.

Ideally hourly sequential meteorological data is used for dispersion modelling purposes, however in this case this has not been possible. Of the three sites considered, none collect readings on an hourly basis. Libreville data is 3-hourly, while Kribi and Douala report on a 6-hourly basis. For this reason, data from Libreville for the years 2003 to 2005 has been recommended and supplied by the UK Met Office as the most appropriate for use in dispersion modelling for this assessment. Additionally, the Libreville site also has a higher data coverage rate than the other two locations.

The data was supplied in ADMS format, and was converted to SAMSON format using the built-in converter within AERMET. The data was then pre-processed in AERMET, using the input variables in Table 5.3.6.

Table 5.3.6: AERMET Input Data

Parameter	Variable
Station Location	0.50°N 9.41°W
Site Location	2.57°N 9.56°W
Upper Air Data	Upper Air Estimator within AERMET
Wind Direction Sectors	1
Surface Parameters	Albedo: 0.215 Bowen: 0.875 Surface Roughness: 1.3
Anemometer Height	10 m

Receptors

The closest sensitive receptors are located in the village of Mpolongwe, to the north and northwest of the proposed plant. The closest existing receptors are 115 m, however these dwellings are expected to be relocated (see Section 6). The closest receptors during plant operations would therefore be residential properties 170 m from the plant boundary.

Ground level concentrations of the pollutants modelled have been calculated using a site-centred polar grid at 10° radial increments, with 20 m distance increments from the origin up to 1 km, then 250 m increments up to 4 km and thereafter at 500 m increments up to 10 km. Additionally, the change in air quality statistics at selected residential properties

within Mpolongwe has been considered by including their locations as discrete receptors. Each receptor represents the level of exposure that would also be experienced at other receptors in their vicinity. The location of each discrete receptor is illustrated in Figure 5.3.1, and listed in Table 5.3.7. The x and y coordinates listed are specific to the modelled grid and do not relate directly to national or international co-ordinate systems. The concentration of pollutant at each receptor was modelled at a height of 1 m above ground level.

Table 5.3.7: List of Discrete Receptors

Receptor	X Coordinate	Y Coordinate	Receptor	X Coordinate	Y Coordinate
R1	1511	876	R6	1482	991
R2	1404	847	R7	1515	1039
R3	1351	731	R8	1618	1060
R4	1358	907	R9	1385	557
R5	1407	978	R10	1372	496

NO to NO_2 conversion

NO_x emissions from the gas turbines will consist of both NO and NO_2, however NO_2 is of the most concern regarding health effects. At the point of emission into the atmosphere NO will be the predominant species, around 95% of NO_x produced by combustion is NO. In rural areas, with low background levels of pollution, oxidation to NO_2 will rapidly occur in the presence of O_3.

As shown in Table 5.3.1, background concentrations of O_3 in the region are relatively high. It can be assumed, therefore, that the conversion of NO to NO_2 in the area around the proposed plant will not be O_3 limited and occur within a very short distance of the emission point. The dispersion of emissions of NOx has been modelled from source to receptor without applying any mechanism for the conversion of NO to NO_2. Instead the robust approach of assuming all NOx is present, as NO_2 has been adopted.

Sensitivity Analysis

The results of the sensitivity analysis are presented in Tables 5.3.8 to 5.3.10.

Air quality statistics have been calculated for all pollutants using meteorological measurements for three different years: 2003, 2004 and 2005. The results for NO_2 are represented in Table 5.3.8. As expected the model proved sensitive to differences in meteorological conditions, with the 2003 dataset returning significantly higher impacts than the other years. By including the high 2003 predictions in the assessment it is likely that worst case conditions for atmospheric dispersion have been considered in the assessment of mitigated impacts.

The importance of stack height has been considered for an option of 22.5 m for the height of release and variants of 20 m, 25 m and 30 m (see Table 5.3.9). The diameter of the release, volumetric flow rate, velocity of release and the temperature of the exhaust gases was the same for each model run. For all options the model predicted impacts on air quality that are regarded as minor in magnitude and no significant additional benefit was observed from the use of a higher stack given that the ambient air quality for all options remain very good.

The model returned a proportional worsening in the effectiveness of pollutant dispersion for a lower stack. Advanced dispersion models are not designed to model the dispersion of plumes through the structure of forests and as the forest canopy is understood to approach 20 m in height the minimum effective stack height has not been calculated. A height of 22.5 m has been used for the main assessment.

The terrain surrounding the site is largely forested by broad leaved trees and the effect of turbulent mixing in the airflow over this surface has been represented in the assessment of impacts through the use of a surface roughness coefficient of 1.3. As there is some uncertainty as to the density and structure of the forest an alternative average surface roughness value for broad leaved forest of 0.9 was also considered. Overall the model predicted (see Table 5.3.10) impacts of greater magnitude at all receptors when the higher roughness coefficient of 1.3 was used. One exception to this was predictions for the combination of 2003 data and the lower surface roughness value which reported much higher impacts to the west of the site (receptors R9 and R10) than for other conditions.

Overall the model has demonstrated it's sensitivity to model conditions and in each case the worst case option has been selected for use in the assessment.

Table 5.3.8: Effect of Meteorological Data Year on 1-hour NO_2 Concentrations

Receptor	Year		
	2003	2004	2005
R1	42.6	7.9	3.6
R2	51.0	18.1	18.6
R3	27.3	14.2	23.2
R4	53.6	28.7	23.2
R5	64.8	31.8	7.2
R6	55.5	19.2	3.1
R7	34.0	22.0	5.8
R8	33.2	40.7	25.3
R9	67.8	30.2	4.0
R10	60.9	38.3	9.7
Maximum	129.9	118.7	123.8

Table 5.3.9: Effect of Stack Height on 1-hour NO_2 Concentrations

Receptor	20 m Stack			22.5 m Stack			25 m Stack			30 m Stack		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
R1	56.7	10.8	5.0	42.6	7.9	3.6	31.4	5.7	2.5	17.4	2.8	1.7
R2	58.0	22.7	23.4	51.0	18.1	18.6	43.2	14.2	14.7	27.7	8.5	8.8
R3	31.1	18.0	28.6	27.3	14.2	23.2	23.6	11.2	18.7	14.6	6.7	11.8
R4	59.1	34.5	28.2	53.6	28.7	23.2	48.3	23.7	19.0	38.1	15.8	12.4
R5	70.1	38.1	9.3	64.8	31.8	7.2	59.2	26.3	5.6	48.3	17.6	3.4
R6	62.1	24.1	3.7	55.5	19.2	3.1	49.1	15.2	2.6	36.4	9.2	1.7
R7	38.5	27.2	7.5	34.0	22.0	5.8	29.7	17.6	4.5	21.2	10.8	2.6
R8	36.3	43.6	29.5	33.2	40.7	25.3	30.0	37.6	21.3	23.9	31.3	13.4
R9	69.3	35.6	4.7	67.8	30.2	4.0	65.8	25.3	3.4	60.2	17.0	2.3
R10	61.5	43.1	11.8	60.9	38.3	9.7	59.7	33.1	7.9	56.1	23.9	4.8
Maximum	160.0	139.6	146.8	129.9	118.7	123.8	110.9	101.9	106.0	83.6	76.9	79.4

Table 5.3.10: Effect of Surface Roughness on 1-hour NO_2 Concentrations						
Receptor	Surface Roughness = 0.9			Surface Roughness = 1.3		
	2003	2004	2005	2003	2004	2005
R1	22.9	3.0	1.8	42.6	7.9	3.6
R2	21.8	3.3	3.4	51.0	18.1	18.6
R3	18.4	2.0	4.0	27.3	14.2	23.2
R4	26.3	5.3	3.4	53.6	28.7	23.2
R5	37.0	6.0	1.8	64.8	31.8	7.2
R6	20.3	3.2	1.5	55.5	19.2	3.1
R7	9.9	4.9	1.6	34.0	22.0	5.8
R8	25.7	37.0	6.2	33.2	40.7	25.3
R9	78.4	6.2	2.0	67.8	30.2	4.0
R10	73.7	8.8	1.7	60.9	38.3	9.7
Maximum	136.3	106.7	122.0	129.9	118.7	123.8

Dispersion Modelling Results

The results of the dispersion modelling with emissions data for the power station burning natural gas are presented in Tables 5.3.11 to 5.3.13. In addition the spatial distribution of the contribution of the plant's emissions to annual mean concentrations of each pollutant are illustrated for oxides of nitrogen in Figures 5.3.2a-c, for sulphur dioxide in Figures 5.3.3a-c.and for fine particulate matter in Figures 5.3.4a-c.

Table 5.3.11: Dispersion Modelling Results, Natural Gas Fuel, NO_2

Receptor	1-hour average (µg/m^3)			24-hour average (µg/m^3)			Annual average (µg/m^3)		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
R1	42.6	7.9	3.6	2.4	0.4	0.2	0.1	0.1	0.1
R2	51.0	18.1	18.6	2.8	1.0	1.1	0.2	0.1	0.1
R3	27.3	14.2	23.2	1.5	0.8	1.3	0.2	0.1	0.2
R4	53.6	28.7	23.2	3.0	1.6	1.4	0.2	0.1	0.2
R5	64.8	31.8	7.2	3.6	1.8	0.5	0.2	0.2	0.1
R6	55.5	19.2	3.1	3.1	1.1	0.2	0.2	0.2	0.1
R7	34.0	22.0	5.8	1.9	1.2	0.3	0.2	0.2	0.1
R8	33.2	40.7	25.3	2.5	2.3	2.4	0.4	0.5	0.4
R9	67.8	30.2	4.0	3.8	1.7	0.2	0.2	0.1	0.1
R10	60.9	38.3	9.7	3.4	2.1	0.5	0.2	0.1	0.1
World Bank Standard (µg/m^3)	-			150			100		
WHO Standard (µg/m^3)	200			-			40		

Table 5.3.12: Dispersion Modelling Results, Natural Gas Fuel, SO_2

Receptor	10 minute average (µg/m^3)*			24-hour average (µg/m^3)			Annual average (µg/m^3)		
	2003	2004	2005	2003	2004	2005	2003	2004	2005
R1	92.7	17.2	7.8	4.0	0.7	0.4	0.2	0.1	0.1
R2	111.2	39.4	40.6	4.7	1.7	1.8	0.3	0.2	0.2
R3	59.4	30.9	50.4	2.5	1.3	2.2	0.3	0.2	0.3
R4	116.7	62.5	50.4	5.0	2.7	2.3	0.4	0.3	0.3
R5	140.9	69.2	15.7	6.0	3.0	0.8	0.3	0.3	0.2
R6	120.9	41.9	6.8	5.2	1.8	0.3	0.3	0.3	0.2
R7	74.1	47.8	12.6	3.2	2.1	0.6	0.3	0.4	0.2
R8	72.2	88.5	55.1	4.3	3.8	4.0	0.7	0.8	0.6
R9	147.7	65.8	8.7	6.3	2.8	0.4	0.3	0.2	0.2
R10	132.5	83.3	21.1	5.7	3.6	0.9	0.3	0.2	0.2
World Bank Standard (µg/m^3)	-			150			80		
WHO Standard (µg/m^3)	500			125			50		

**Derived from 1-hour averages, correction factor of 1.3 applied.*

Table 5.3.13: Dispersion Modelling Results, PM_{10}						
Receptor	24-hour average (µg/m^3)*			Annual average (µg/m^3)		
	2003	2004	2005	2003	2004	2005
R1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R2	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R3	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R4	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R5	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R8	0.1	0.1	0.1	<0.1	<0.1	<0.1
R9	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
World Bank Standard (µg/m^3)	150			50		
WHO Standard (µg/m^3)	-			-		

**4th highest 24-hour value*

Predicted Impacts - Natural Gas Fuel For each pollutant it is evident that the maximum impact occurs to the North East of the plant and that impacts to the west of the site are minimal. The largest emissions for a locally important pollutant are those of oxides of nitrogen and these disperse to raise annual mean concentrations of nitrogen dioxide above baseline levels by less than 5 µg/m^3, to about 6 µg/m^3. This concentration represents just 6% of the World Bank criteria of 100 µg/m^3 and 15% of the WHO Guideline value of 40 µg/m^3. The predicted impact on levels of fine particulate matter and sulphur dioxide achieve the respective threshold values by an even larger margin.

The magnitude of short term impacts have also been predicted at selected receptors located close to the Plant. Maximum one hour impacts in the range of 27 – 68 µg/m^3 were predicted using the meteorological dataset for 2003, with values of between 3 µg/m^3 and 41 µg/m^3 predicted using data for the period 2004 to 2005. All of these predicted hourly average concentrations are within the WHO Guideline value of 200 µg/m^3 by a considerable margin. Levels of nitrogen dioxide are also predicted to meet the World Bank 24 hour criteria.

Overall the impact of the plant emissions will be less than predicted as the values are based on an assumed operating condition of 4 turbines at maximum load. In practice the emissions from the plant would be less than the value modelled and the impact on local air quality will be smaller than discussed above.

Predicted Short-term Impacts – Diesel Backup Fuel

The maximum predicted short-term impacts associated with burning diesel as a back-up fuel are presented in Tables 5.3.14 and 5.3.15.

Table 5.3.14: Dispersion Modelling Results, No 2 Distillate, NO_2

Receptor	1-hour average (µg/m^3)			24-hour average (µg/m^3)		
	2003	2004	2005	2003	2004	2005
R1	84.0	15.8	7.2	4.7	0.9	0.5
R2	99.5	36.0	37.1	5.5	2.0	2.2
R3	53.2	28.4	46.1	3.0	1.6	2.6
R4	104.0	56.9	46.0	5.8	3.2	2.7
R5	124.9	62.9	14.5	7.0	3.5	0.9
R6	107.6	38.2	6.0	6.0	2.1	0.4
R7	66.0	43.7	11.6	3.7	2.4	0.7
R8	63.6	77.9	49.2	5.0	4.4	4.6
R9	129.6	59.6	7.8	7.2	3.3	0.5
R10	116.3	75.0	19.2	6.5	4.2	1.1
World Bank Standard (µg/m^3)	-			150		
WHO Standard (µg/m^3)	200			-		

Table 5.3.15: Dispersion Modelling Results, No 2 Distillate, SO_2						
Receptor	10-minute average ($\mu g/m^3$)*			24-hour average ($\mu g/m^3$)		
	2003	2004	2005	2003	2004	2005
R1	289.8	54.4	25.0	12.5	2.3	1.3
R2	343.2	124.1	127.8	14.7	5.3	5.8
R3	183.4	97.9	158.8	7.8	4.2	6.8
R4	358.6	196.4	158.7	15.4	8.5	7.2
R5	430.8	216.8	50.0	18.5	9.3	2.5
R6	371.0	131.8	20.9	15.9	5.6	0.9
R7	227.6	150.6	40.0	9.7	6.5	1.8
R8	219.3	268.6	169.7	13.3	11.5	12.2
R9	447.0	205.5	26.8	19.2	8.9	1.2
R10	401.0	258.6	66.2	17.2	11.1	2.9
World Bank Standard ($\mu g/m^3$)	-			150		
WHO Standard ($\mu g/m^3$)	500			125		

**Derived from 1-hour averages, correction factor of 1.3 applied.*

The magnitude of short-term impacts in the area around selected receptors has been determined with the plant running on diesel fuel. The maximum predicted impacts do not exceed the limit criteria for concentrations of NO_2 or SO_2 at any receptor. Maximum short-term NO_2 and SO_2 impacts were predicted using the meteorological dataset for 2003. Maximum 1-hour average values of between 53 $\mu g/m^3$ and 130 $\mu g/m^3$ were predicted for NO_2, and maximum 10-minute average values of between 184 $\mu g/m^3$ and 447 $\mu g/m^3$ for SO_2 All of these predicted short-term average concentrations are within the World Bank and WHO standards. Levels of NO_2 and SO_2 are also predicted to meet the 24-hour criteria by a large margin.

5.3.3 Mitigation Measures

Dust Generation

Fugitive emissions of dust during the construction phase would be minimised and controlled by the implementation of an Environmental Management Plan for the project (see Section 7). Mitigation measures to reduce construction dust emissions could include:

- Wherever possible materials arising from site earthworks will be stored and used within the redevelopment of the site. This will reduce the number of off-site vehicle movements required.

- Site roads and the site access route will be inspected, swept and sprayed with water as required to prevent dust causing a nuisance off site. An appropriate site speed limit will reduce dust generation from vehicles travelling over unmade surfaces.

- No mitigation measures will be required to control emissions from on site vehicles beyond accepted good practice. For example, maintaining vehicles in good working order, parking vehicles away from sensitive receptors and not running engines for longer than is necessary.

- All plant and stockpiles will be thoughtfully located, so as to minimise impacts on sensitive receptors. Where practicable to do so, storage areas should be located at least 50 m from sensitive receptors. Surplus excavation materials from the transmission line route will be moved if necessary to designated areas, away from sensitive receptors.

- The unnecessary handling of dusty materials will be avoided. During the processing of dusty materials, methods to mitigate the generation of dust emissions will be employed, such as minimising drop heights and dampening materials and surfaces with water.

- The area cleared for construction activities will be kept to a minimum, retaining ground cover where possible, including a screen of vegetation and mature trees between the power plant site and the main road and residential housing.

- Completed earthworks will be landscaped and vegetated or covered with hard standing as soon as practicable.

- A record will be kept of complaints received and actions taken.

Power Plant Emissions

No specific measures are employed to limit stack emissions. However stack height will be specified to minimise impacts at ground level.

5.3.4 Evaluation of Mitigated Impact

Dust Generation

Construction

The potential magnitude of dust impacts without mitigation is not considered within this assessment, as standard mitigation techniques for the control of dust emissions, including those identified in Section 5.3.3 above, will be included in the EMP for the project.

Construction dust can only have a significant impact on sensitive receptors if it is located in fairly close proximity to the activity. The potential for dust to be transferred off site, to affect PM_{10} levels or cause a perceptible increase in soiling rates, is likely to be limited to around 100 m from a construction process such as this, which involves considerable earthworks.

There is a distance of around 170 m between the nearest residential properties and the power plant boundary. As such, the impact of dust emissions due to construction activities occurring on the power plant site would be insignificant. Earthworks associated with the installation of the access road could potentially cause a perceptible increase in surface soiling rates and PM_{10} levels at residential housing close to the access road entrance. Such impacts would be short term and minor adverse in significance.

An area of approximately 3.5 ha, between the proposed power plant site and the main road, would be cleared and used as a construction compound. The storage of loose, dusty materials and the movement of construction vehicles within this area could result in emissions of fugitive dust across the site boundary affecting the closest residential properties. The impact of such emissions would be short term and minor adverse in significance

The incorporation of effective site management procedures and mitigation measures to control dust would ensure that the impact of construction works on nearby sensitive receptors would be minimised. Episodes of enhanced dust deposition should be restricted to periods of unusually dry and windy weather, during which background levels of dust would also become elevated.

The construction of the transmission line occurs over a short time period with each section taking two to three weeks to complete. Dust impacts at residential properties, where they occur, would be short term and minor adverse in significance.

A small proportion of the dust generated by construction activities will be PM_{10}. Under normal meteorological conditions, receptors located more than 50 m from the emission source are unlikely to experience a perceptible increase in PM_{10} concentrations. It is therefore unlikely that a measurable change in PM_{10} concentrations will be observed during the construction of the power plant. The impact of PM_{10} emissions on sensitive receptors during the construction of the site access road and the transmission line would be adverse short term in nature and minor in significance.

Power Plant Emissions

The principal control on operational emissions from the plant is in the form of stacks, of sufficient height to facilitate adequate dispersion of the exhaust plume before the pollutants reach ground level. The assessment has been based on the assumption that all four stacks would be 22.5 m high and it has been confirmed that stacks of this height provide a good level of protection at local air quality sensitive receptors.

The sensitivity analysis also considered the impact associated with the use of higher stacks of 25 m and 30 m. The additional height did not result in significant improvements in the magnitude of impacts at ground level (z = 1 m), principally because the magnitude of the impact is already minor with a 22.5 m stack. A shorter stack is not considered appropriate due to the height of the surrounding forest, as it would be likely to impair the dispersion of the emissions from the plant. An assessment of the height of the surrounding vegetation will however be undertaken to ensure the final stack height is above the upper forest canopy to ensure adequate dispersion.

Overall the impact from the operation of the plant on air quality is therefore assessed as adverse, long term, but minor in significance.

5.3.5 Evaluation of Alternative Development Options

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project however no significant impacts have been identified.

The only alternative considered within this ESIA that would affect the impacts on air quality would be the use of gas engines instead of the gas turbines. This alternative would require up to 10 units to provide the necessary output and gas engines produce higher NO_x emissions than turbines. Impacts of this alternative are therefore likely to be greater than for the base case. Should this option be adopted, following final engineering design, then the impacts from stack emissions would be remodelled to define significance.

5.3.6 Conclusions

The overall conclusion from this assessment is that the construction and operation of the Kribi Power Plant will not have any significant impacts on the air quality of the project area.

During the construction phase dust generation, particularly at the construction site compound, has the potential to cause dust impacts at adjacent properties however simple and effective control measure for containing dust generation are available. In addition this will be a short term impact.

During operation the gas turbine emissions result in ground level pollutant concentrations well below the guidelines values for the World Bank and the WHO. During running on diesel, emissions will be higher however this operation is for very short term period up to a maximum of approximately 8 days per year at 30% load. Short-term impacts from this temporary operation are still predicted to meet World Bank and WHO guideline criteria.

A summary of the impact evaluation is presented in Table 5.3.16.

Table 5.3.16: Summary of Impact Evaluation – Air Quality							
Project Location	**Phase[2]**	**Impact**	**Nature of Impact**	**Receptor**	**Nature[1]**	**Duration[1]**	**Significance[1]**
Plant site	C	Dust nuisance / heath risk	Dust rise from on site activity	Local population	Adverse	Short-term	Minor
	O	Reduced local air quality	Emissions from power plant (gas)	Local population	Adverse	Long-term	Minor
	O	Reduced local air quality	Emissions from power plant (Diesel)	Local population	Adverse	Short-term	Minor
	C	Reduced local air quality	Vehicle exhaust emissions	Local population	Adverse	Short-term	Insignificant
Transmission line	C	Dust nuisance / heath risk	Dust rise from on site activity	Local population	Adverse	Short-term	Minor
	C	Reduced local air quality	Vehicle exhaust emissions	Local population	Adverse	short-term	Insignificant
1 – see Table 1.5.1 for definition 2 – Phase - C -= Construction / O = Operation / D = Decommissioning.							

5.4 SURFACE WATER

5.4.1 Baseline Conditions

The Kribi/Edéa area is characterised by low-lying, gently rolling countryside with numerous small streams and rivers running within shallow valleys. Due to the relatively high rainfall in the region, an extensive network of small tributary streams and rivers exist discharging to the main channels. The main catchment within the project area is that of the Nyong River which crosses the transmission line route at approximately 35 km south of Edéa before discharging to the Atlantic Ocean north of Kribi. The more minor catchment of the Lokoundje River drains much of the southern section of the project area and crosses the transmission line route approximately 16 km north of the proposed plant site area. The Sanaga River, the country's main watercourses, passes through Edéa where a short length of the final sections of the transmission line route crosses the catchment of this river.

In addition to these three main rivers in excess of 50 smaller rivers, streams and drainage ditches cross the main transmission line corridor.

Plant site

The proposed plant site is bordered on its northern and southern sides by two small streams as shown on Figure 3.3.1. To the north is the Gongoyima stream, which joins the Mpolongwe River that runs along the northwest boundary. To the south is the Mayinga stream, which also joins the Mpolongwe River approximately 200 m west of the plant site (see Photos 5.4.1 and 5.4.2). These streams were flowing during the time of the site visit in January 2006 and it is understood that they contain water all year round. The Mayinga and Gongoyima streams are minor watercourses of only a few metres in width.

No regular flow gauging or water quality assessments are undertaken on any of these watercourses and as such no existing baseline data have been identified. Water quality monitoring is to be conducted as part of the overall project development but as potential impacts on surface water were assessed as potentially minor within the scoping study a specific baseline monitoring programme has not been set up as part of the ESIA.

The only current impact on water quality in the project area is from the washing of clothes and preparing of food, which is often conducted within the local streams. As the villages tend to be located close to the main road and thereby close to the project area, the upstream catchments of the minor streams will have little or no anthropogenic influences on quality.

Transmission Line route

The transmission line route crosses the Sanaga River at Edéa and the Nyong River at approximately 35 km south of Edéa, this river forming the provincial boundary, and the Lokoundje River at approximately 70 km south of Edéa (16 km north of the proposed plant site). There are also a large number of small tributary streams that cross the wayleave at regular intervals, which themselves feed into these main rivers.

Again no flow gauging or water quality data are available for these watercourses and as impacts were assessed during the scope as of only minor significance no baseline survey has been conducted as part of this assessment.

Water use

General water use within these streams has been established from on-site interviews and information gathered during the household surveys conducted as part of the social impact assessment (SIA) (see Section 6.2 SIA methodology).

Surface water resources are the main water supply for local inhabitants for all domestic purposes (approximately 65% of households use surface water acting as the primary water source for both drinking and bathing/washing/cooking). The general practice for villages using surface water sources is to collect drinking water from areas upstream of the settlements and to use the watercourse within the settlements, or downstream, for washing, etc. Approximately 16 villages exist close to the plant site area and along the transmission line route all of which are likely to use surface water for some purpose even where groundwater drinking supplies are available.

The use of surface water for drinking supplies has resulted in the most significant cause of illness (see Section 6.5) within local inhabitants particularly children. Therefore it is apparent that surface streams are polluted.

At the plant site local villages use the streams to both the north and south of the proposed site area and a track used for access to the Gongoyima stream exists across the proposed plant site.

Surface water is therefore an important resource for the local communities.

5.4.2 Potential Environmental Impacts

The key potential impacts on water resources that can arise from a power plant development relate to:

- *contamination of rivers and streams* either by soil erosion and silt discharge or via spillage of potentially contaminative materials; and
- *alteration of the available water within the river system* either by affecting catchment run-off characteristics or by over abstraction.

Soil erosion and silt discharge to river

Construction

The creation of access tracks and general site activity during construction has the potential to result in the creation of bare ground and therefore increased soil erosion potential, particularly in areas of sloping ground. This will be of particular importance at the plant site where large areas of clearance and regrading will be required to facilitate the construction activity. Along the transmission line route construction areas at the base of the pylons will be relatively small, typically 25 m^2 to 50 m^2 allowing for working areas, so erosion risk will be low. In addition it is not the intention to remove vegetation and strip soils to create an access track along the wayleave route but to traffic over cleared vegetation. However, the project area is subject to high rainfall and ponding in rutted areas of tracks may occur. This can lead to increased soil erosion.

Where erosion occurs in close proximity to a river system, heavily silt-laden water can be discharged to stream during heavy rainfall events. If not adequately controlled this can result in high turbidity within the river affecting aquatic vegetation and fish activity as well as coating the bed of the river so impacting on river habitats (benthic species). In addition, reduced water quality will affect the local population who use rivers for water supplies.

The greatest sensitivity to such impacts relates to areas where little current disturbance exists and particularly within the forest areas where current erosion potential is very low.

Operation

Following the construction phase disturbed areas will be revegetated. Maintenance of the transmission line does not require a dirt road along the wayleave. Therefore there are no identified impacts from soil erosion during the operational phase of the project.

Decommissioning

Decommissioning is effectively a reversal of the construction process and therefore potential impacts will be the same. Removal of buildings and structures will create bare ground that may erode during heavy rainfall events and trafficking along the wayleave may result in rutted tracks leading to accumulation and concentration of rainwater, run-off and potential erosion.

Contamination of surface water

Construction

The storage and use of oils and chemicals has the potential to result in spillage, which may in turn run off and discharge to surface water systems. This is of main concern at the plant sites where temporary storage of fuel oils for the construction fleet will be required, but spillage from vehicles at the transmission line construction site may also occur. Contamination of surface water has the potential to affect local community water supplies and to impact on the aquatic flora and fauna of local watercourses.

In addition poor control of on-site sanitary facilities for workers may result in human waste being discharged to stream with a resultant increased risk of illness within communities using streams as drinking water sources.

Operations

The main risk during the operational phase is from a potential spill from the bulk diesel fuel storage required to provide a back up fuel supply during breaks in the gas supply. This storage consists of a bulk tank holding a total capacity of 2,000 m^3.

In addition the uncontrolled discharge of foul water from the staff welfare facilities on site may result in pollution of the surface water system.

Decommissioning

As set out for soil erosion above, decommissioning being a reversal of the construction process results in the same or similar potential impacts as from that phase. Use of fuels and oils and the presence of a large work force leads to potential discharges of contaminative materials to surface water.

Alteration in the flow of local watercourses

Construction and operation

Flows in river can be impacted in two primary ways; abstraction causing a reduction in overall river flows and alteration of the ground surface vegetation cover of a river catchment so impacting run-off characteristics.

During the construction phase it is intended that the main water source for site operations, concrete production, etc., particularly along the transmission line, will come from surface sources. The construction phase is however short term, 15 months in total, and for the transmission line in particular, the location of the activity and therefore the water supplies used, will vary from month to month. Overall demand for construction activity has not been finally determined but for a construction project of this type main demand is for concrete production. This will be a short-term activity, whilst foundation, hardstandings, etc. are being created and will not require long term or large scale abstraction.

As the management of the wayleave for the power line will require the cutting of vegetation on a regular basis, so removing any woodland areas, the potential exists for the characteristics of the river catchments to be altered. This is of particular relevance to the forest areas, this vegetation cover having a large effect on river catchment characteristics. Heavily forested areas have large canopy storage capacities, trees increase soil moisture deficits within soils so enhancing absorption of rainwater, and the root and ground flora systems provide soil cover and help to stabilise and protect soils. Therefore removal of tree cover can greatly increase run-off rates and therefore flow characteristics in streams.

However in the case of the Kribi power projects the power line wayleave and the plant site occupy very minor percentages of overall river catchments of the area. Therefore no significant effect is predicted to arise.

Decommissioning

At and post decommissioning the wayleave will be allowed to return to its former land use, or suitable alternative uses, and the minor abstractions from surface water will no long be required. As such decommissioning acts will mitigate some of the operational impacts. There are therefore no additional impacts associated with decommissioning

5.4.3 Mitigation Measures

Soil erosion and silt discharge to river

The control measures to mitigate the potential impacts of soil erosion are set out within Section 5.8 in relation to soil resources. These measures, designed to protect soil resources from erosion, also apply to the mitigation of impacts on the water environment.

In addition, during final selection for the location of each transmission line tower, sites on or close to the bank of stream and river systems will be avoided. At the river crossings, taller towers may be used to allow a greater span between transmission line towers so as to ensure they are not constructed close to the riverbank. No specific guidance is available on the minimum distance towers should be located away from the riverbank. However distances should be sufficient to ensure that neither construction nor operational works is conducted in a manner that would cause bank collapse or vegetation damage or removal. Works are therefore likely to need to be a minimum of 20 m to 30 m from the banks, dependent on the bank topography and soil conditions.

Contamination of surface water

As above, the control measures to mitigate the potential impacts of soil contamination are set out within Section 5.8 in relation to soil resources. These same measures therefore also apply to the mitigation of impacts on the water environment.

For all staff accommodation areas and on construction sites, suitable sanitary facilities will also be installed. On construction sites these may be simple pit latrines. On the plant site all staff welfare facilities will have septic tank drainage or similar systems installed to ensure foul water is treated prior to discharge to surface or groundwater.

Alteration in the flow of local watercourses

Overall water abstraction for the project is very low and therefore no specific mitigation measures are proposed for this aspect of the works.

Within the forest area and other areas of tree and scrub vegetation, the need to keep vegetation below 2 m will alter the current status of the areas in terms of their hydrological properties. To minimise impacts vegetation clearance will be conducted in such a way as to ensure that the vegetation system is not fully removed and will therefore re-grow. This will be ensured by controlling clearance to retain at least 40 mm to 60 mm of vegetation height above the ground. A full surface cover will therefore be retained. In addition vegetation clearance will be undertaken at the start of the dry season and therefore some degree of re-growth will occur before the rainy season begins.

These two main measures i.e. maintaining a vegetation cover and working in the dry season will ensure that the maximum vegetation cover is maintained over the wayleave.

5.4.4 Evaluation of Mitigated Impact

Soil erosion and silt discharge to river

Construction / Decommissioning

The overall potential significance of this impact relates to the risk of erosion from current land uses and the alteration that will be created by the proposed development.

In terms of current erosion risk, the farming areas have the greatest potential significance. Erosion with forest areas is negligible. In any farmed areas bare ground cleared for planting at the beginning of the rains will result in an increased risk of erosion and subsequently a potential silt discharge to stream. However farming activity in the project area is very limited and no large areas of cultivation were identified. Farming tends to consist of shifting agriculture with small areas hand worked for a few years before new areas are moved on to. Erosion risk is therefore low. This limited erosion risk within the farming areas and the fact that a majority of the project area has a forest cover results in the overall erosion risk of the current area being very low.

On the transmission line the risks of increased erosion are relatively low. The individual construction sites at each tower or pylon are small and these will be located at an average of 350 m apart. There will therefore be no large concentrated areas of bare ground created. On the traffic routes along the wayleave, the trafficking of vehicles over the cut vegetation, rather than on stripped bare ground, will greatly reduce any potential for creating erosion pathways within vehicle tracks. In addition time spent at each section (assumed to be 10 towers per stringing) will be only a matter of two to three weeks and therefore heavy, ongoing trafficking of any one area will not occur. This together with the basic mitigation measures set out within Section 5.4.3, will result in an assessment of the erosion risk with impacts on the surface water system along the transmission line corridor being insignificant.

At the plant site relatively large areas of bare ground will be created during the construction process and this site is bordered on each side by streams that are utilised by the local population. As the area is subject to high rainfall the combination of this bare ground and heavy rains leads to a short-term, significant potential for erosion. However, timing of main earthworks to occur over the dry season and bunding and control of run-off to limit concentration of water in any one area, will allow effective control of this impact. In addition the period over which earth works and foundation construction occurs is only a few months within the overall 15 months construction period and therefore very short term.

Based on these factors the potential impacts on water resources from erosion of soils at the plant site are assessed as adverse, short-term and minor in significance.

Operation

There are no identified potential impacts from soil erosion during the operational phase.

Contamination of surface water

The main potential impact from the proposed development is the risk of surface water pollution from either fuels and oils used and stored on site and from release of untreated foul sewage water. As surface water is a valuable resource its protection is important.

Construction / Decommissioning

Impacts for construction and decommissioning are effectively the same in relation to the potential risk of pollution of surface water resources.

Whilst the surface water resources of the area are vulnerable to pollution from contamination, volumes of fuels and oils held on either the plant site or along the transmission line corridor during construction and decommissioning will be small (equipment fuel tanks, mobile bowers, etc.). Any spillage is therefore likely to be absorbed into the soils and risk of run-off to surface water is low.

Lack of appropriate welfare facilities for site workers can also lead to discharge of foul drainage to river and consequential impacts on water quality and downstream water users. However, appropriate welfare/treatment facilities will be provided to ensure all discharge is of a suitable quality.

Overall risk to surface water resources is therefore assessed as adverse, short term but minor in terms of significance.

Operation

Large scale fuel storage on site (up to 2000 m^3) represents the major potential risk. However control systems for bulk fuel storage and handling are in common use throughout the world and if correctly managed are fully effective at preventing spillage to the environment. The main risk period is during delivery and discharge from store and, in addition to the physical control measures to be constructed, operating procedures for these will be developed.

The second risk is from untreated foul water from the site discharging to surface water. Again treatment of foul water is commonly practised at sites across the world and a range of effective treatment systems exists. At the plant site all foul water from the welfare facilities will be directed to a treatment system prior to discharge of the treated water via soakaways.

Whilst pollution sources will be introduced by this development, fully effective control and mitigation measures are available and will be installed on site to minimise any risk to the surface water environment. The potential impacts on water resources from pollution are therefore assessed as adverse, long term but minor in significance.

Alteration in the flow of local watercourses

Construction / operation

As discussed, the overall water demand for this project is low and therefore potential for impact from abstractions on surface water supplies, either during construction or operation is insignificant.

In relation to altering catchment characteristics by the removal of forest vegetation along the wayleave, the area of land affected (approximately 280 ha) as a proportion of the total catchment of the major rivers that flow across the project area, is insignificant. No significant impact will therefore arise during either the construction or operational phase of the development in relation to effects on river flows.

Decommissioning

At decommissioning no abstraction will be required and land use within the wayleave will be unrestricted and therefore a forest vegetation cover can be re-established. Therefore there are no impacts identified during the decommissioning phase.

5.4.5 Evaluation of alternative development options

None of the project alternatives have a significant effect on the overall potential impacts on surface water from the proposed development.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However no significant impacts have been identified.

5.4.6 Conclusions

The overall conclusion is that the only identified impact on surface water resources is from the potential for pollution, either from soils erosion, fuel oils spillage or foul drainage, to impact on local rivers and streams. Water demand for the project is too low for impacts on available water resources to occur. Potential impacts are summarised in Table 5.4.1

Table 5.4.1: Summary of Impact Evaluation – Surface water Resources

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	C/D	Water quality	Soil erosion	Surface water users	Adverse	Short-term	Minor
	C	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Short-term	Minor
	O	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Long-term	Minor
	C/O	Reduced surface water resources	Abstraction for site water supply	Surface water users	Adverse	Long-term	Insignificant
Transmission line	C/D	Water quality	Soil erosion	Surface water users	Adverse	Short-term	Insignificant
	C/D	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Short-term	Minor
	C	Reduced surface water resources	Abstraction for site water supply	Surface water users	Adverse	Long-term	Insignificant

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

5.5 GROUNDWATER

5.5.1 Baseline Conditions

Groundwater resources

The project area is predominantly low lying, gently undulating land bisected by numerous small streams and rivers. Soils in the project area are generally stable and well structured with sandy surface textures but becoming more clayey with depth (see Section 5.8). These sandy soils are reported to have relatively high permeabilities whereas the underlying clays and silts have very low permeability (Labogenie, 2006). The project area is also subject to high annual rainfall and therefore there is the potential for high recharge of aquifers.

Taking account of the low lying nature of the area, the presence of permeable soils, the prevalence of surface water systems and the high rainfall, it is concluded that shallow groundwater is likely to be present across the entire project area. This conclusion is supported by the survey on water use (see below) and ground investigation conducted at the plant site.

At the plant site geotechnical investigations have been undertaken including the installation of eighteen piezometers to monitor the depth of groundwater in this area. Results from these indicate that the groundwater level is between 3m and 11m below ground surface level. This is at, or slightly above, river water level, in places and therefore suggests that the groundwater system provides some base flow to these rivers. Results from piezometer tests, at the time of the site investigation, showed that the water-table fluctuated between 0.01m and 0.71m (Labogenie, 2006). Overall the plant site is low lying ranging from 5 m to 20 m above sea level.

Data on groundwater quality have been collected as part of the ongoing site investigations at the Plant. However as most of the project area is within a rural setting significant groundwater pollution from human activity is unlikely to have occurred. However, there is potential for point source pollution.

Groundwater use

At the plant site and along much of the transmission line route water supply for the local villages is primarily from surface water sources. However data from the household survey (part of the Social Impact Assessment see Section 6) indicates that approximately 35% of the supplies to villages is from wells fitted with hand or foot pumps. Groundwater is therefore the predominant water supply for some villages, primarily being used for drinking water.

The household survey also noted that water borne diseases are a major factor in the health of villages along the transmission line route and at the plant site. These diseases are understood to arise primarily from pollution of the surface water system by human activity. The groundwater resources that are present are therefore very important to the villages they supply.

No wells are present at or near to the plant site.

5.5.2 Potential Environmental Impacts

From a development of this type there are two main sources of potential impact on groundwater resources. These are the potential to:

- *reduce the overall groundwater resources* of an area as a result of abstraction; and
- *to cause pollution to existing groundwater supplies* so impacting their potential use.

Depletion of groundwater resources

Over abstraction (removing greater qualities of water than are being recharged to the system) of groundwater resources can lead to reduced groundwater levels in local wells, so restricting local supply. This may cause impacts on long-term availability of the resource. However the project water demand for the power plant is low.

Construction

During the construction phase it is intended that the main water source for site operations, concrete production, etc., particularly along the transmission line, will come from surface sources. The construction phase is also short term, 15 months in total, and for the transmission line in particular, the location of the activity and therefore the water supply used, will vary from month to month. Activity in any one construction section, (assumed to be 10 towers along a section length of approximately 3.5 km) will last only two to three weeks.

Therefore no potentially significant impacts on groundwater resources have been identified for the construction phase of the Kribi power project. Therefore, groundwater is not assessed further within the ESIA.

Operation

As set out in the section on surface water (see Section 5.4) the technology to be used for this project has a low total water demand. Cooling will use air system or closed circuit water cooling with very limited make up water demand and other demands, such as for compressor wash, exist. Total process water demand is likely to be only 2 m^3 to 3 m^3 per month. Therefore the main water demand will be for staff welfare use and domestic purposes at the plant site. The intention is to use groundwater sources for this supply. Detailed water demand figures have not been established at this stage but demand can be estimated from staffing levels. The site will operate three 8-hour shifts with 10 to 15 operational and maintenance staff per shift. In addition during the daytime shift approximately 15 management and administration staff will be on site.

To establish a potential demand for this project a typical daily demand per person (domestic) would be in the order of 60 to 150 l/day (UNESCO, Water Use in the World: Present Situation/Future Needs, 2000). Management and administration use very little water therefore estimates are based on 15 shift staff at the higher use rate estimate. On this basis the total daily demand will be in the order of 2.25 m^3 or a pumping rate of less than 0.03 l/s. Thus, demand and pump rates are therefore very low.

During the operational phase there will be no demand for water use along the transmission line.

Due to this low demand, the potentially high recharge in the area and the absence of other existing groundwater users at the plant site, there are no identified potentially significant impacts on groundwater resources arising from the operational phase of this project. This potential impact is therefore not considered further within the ESIA.

Decommissioning

The potential impacts during and post decommissioning will be dependent on the nature of the closure strategy developed for the site. Should the water supply be made available to local residents post closure then the abstraction would continue and no change from the operational status would be anticipated. Should new development come on to the site then the water use will be dependant on the type of development. However this would be subject to separate assessment at the time of the detailed decommissioning planning.

On the basis of the closure and removal of all current planned operations at decommissioning the demand for potable and process water will no longer exist and therefore potential impacts on depletion of groundwater resources will be removed.

Pollution of groundwater resources

Groundwater resources are vulnerable to potential impacts from pollutants leaking or spilt on the ground surface that may seep into an aquifer. In relation to the Kribi power project this potential relates primarily to the storage of fuels and oils and the discharge of domestic effluent from the site.

Construction

During the construction phase only small volumes of fuels and oils will be required on site. These will consist of fuel storage for on-site vehicles either in mobile bowser or within small on-site storage tanks. The transport fleet will refuel at normal roadside fuel stations and will not require on-site storage. The construction will also involve the storage and use of greases, cleaning agents, etc. but these will only be required in small quantities and are not anticipated to represent a significant risk to the water environment.

Mobile and construction plant also have fuel tanks that represent a potential source of pollution if rupture or spillage occurs during refuelling. However volumes of these tanks are relatively low and even a major rupture, which is a very rare event, is unlikely to cause pollution of the groundwater as these volumes would tend to be absorbed by the soils (see Section 5.8).

During the construction phase it is anticipated that at its peak, approximately 550 to 600 workers will be employed at the plant site and along the transmission line corridor. Whilst peak work activity will only occur for a short period, this number of staff has the potential to cause discharge of untreated sewage and wastewater, via soakaways, to groundwater. This may cause organic pollution of the groundwater with commensurate increase in risk of illness where groundwater supplies are utilised.

Operation

During the operational phase the plant site will store back-up diesel fuel supplies to fire the power plant during periods of planned gas supply shut down. Total storage volumes are estimated at 2000 m^3 and will be held in a single storage tank within the plant site, (see Figure 3.3.1). Any major spill or long-term leakage from a tank of this capacity could have a significant impact on groundwater resources.

At the plant site a new switchyard will be constructed with step up transformers, circuit breakers, etc. Modern circuit breakers are now gas filled (SF6) and pose no risk to groundwater. Transformers are, however, oil filled and leakage of this may result in contamination of ground with potential seepage to groundwater. At the Edéa substation no new transformers will be installed and as such no new risk of impacts on groundwater will arise from development at this site.

During the operational phase there will be no activity along the transmission line that will require the storage and use of any potentially contaminative materials. There are, therefore, no identified potential impacts along the transmission line during this phase.

Domestic foul water will only be generated at the new plant site. At the Edéa substation facilities already exist and there will be no requirement for welfare facilities along the transmission line route. As noted in Section 5.5.2, it is planned to have up to 15 staff permanently on site to oversee the operation with a further 15 or so during the day for management and administration. Overall staff numbers at the site are therefore relatively low. However, uncontrolled release of foul water from the welfare facilities on site could result in the pollution of the groundwater.

Decommissioning

During the decommissioning activities the potential impacts on groundwater pollution will be similar to those of the construction phase. Post closure all sources of potential pollution will be removed and no further risk of impacts on groundwater quality will exist.

5.5.3 Mitigation Measures

As set out within Section 5.5.2 the only potentially significant impact on groundwater identified as part of this assessment is the risk of pollution of groundwaters from on-site storage of contaminative materials and from foul water discharge.

Pollution of groundwater resources

The controls for the storage and handling of potentially contaminative materials are well established and widely used. For the Kribi project this will include the following:

Construction phase

- Installation of portable or pit latrines for workers during the construction phase to ensure control of discharge of foul water.

- Installation of temporary bunding around oil storage tanks used on site during construction.

- Storage of all grease, cleaning agents, etc. within a secure container (metal hut or similar) to stop theft and tampering. Container to have a solid watertight floor and raised lip to contain any minor spillage.

Operational phase

- Back up fuel oil storage tank at the plant site to be constructed within a fully water tight containment bund. The basic design standard will require a bund to retain a minimum of 110% of the volume of the contained tanks, will have a sump for removal of rainwater and all feed and delivery pipe works and pumps will be within the bund. All delivery areas will be on hard standing with slopes to a collection sump to contain any spillage during delivery.

- All delivery and discharge pipe work for fuels will be installed above ground to allow full inspection for damage or leaks.

- Transformers will be constructed with catch pits below each unit designed to hold the full capacity of the oils contained within the unit. Catch pits will have drainage sumps to allow removal of rainwater and any oil spills.

- Drainage running from maintenance workshops will be fitted with an oil separator.

- All foul sewage from the site will be fed to a septic tank system or similar for treatment prior to discharge via a soakaway system.

Decommissioning

- Control measures as per the construction phase will be implemented;

To ensure full maintenance and management of these systems once constructed, an environmental management plan (EMP) will be implemented at the site. A framework for this plan is included within the EMP report (see Section 7).

5.5.4 Evaluation of Mitigated Impact

Due to the overall low water demand for this project and the limited use and storage of potentially contaminative materials the potential for impacts on the groundwater environment is low.

Depletion of groundwater resources

Water demand is only required to service on-site welfare provision for the operating staff with no large-scale supply required for the plant. Supplies will be obtained from on-site boreholes. No potentially significant impact on groundwater resources was identified for the following reasons.

(i) There are no existing boreholes close to the site;

(ii) Water demand is low; and

(iii) The site is in an area of high rainfall (and therefore high potential aquifer recharge).

Pollution of groundwater resources

The main identified potential impact from the proposed development is the risk of groundwater pollution from either fuels and oils used, and stored on site, and from release of untreated foul sewage water. As groundwater is a valuable resource with potential to be used for drinking water supplies (as some surface water systems are polluted), its protection is critical. In addition, as groundwater is known to exist within the plant site at relatively shallow depth (down to 7 m to 8 m) and the surface soils are relatively permeable, the groundwater resources of the area are vulnerable to surface pollution incidents.

Construction / Decommissioning

Impacts for construction and decommissioning are effectively the same in relation to the potential risk of pollution of groundwater resources.

Whilst the groundwater resources of the area are vulnerable to pollution from surface contamination, volumes of fuels and oils held on either the plant site or along the transmission line corridor during construction and decommission will be small (equipment fuel tanks, mobile bowers, etc.). Overall risk to groundwater resources is therefore assessed as insignificant.

Operation

Large scale fuel storage on site (up to 2,000 tonnes) represents the major potential risk. However, control systems for bulk fuel storage and handling are in common use throughout the world and if correctly managed are fully effective at preventing spillage to the environment (see Section 7). The main risk period is during delivery and discharge from store. In addition to the physical control measures that will be constructed, operating procedures will be developed. It is estimated that delivery of fuel oil will only take place on 7 or 8 days per year.

The other risk is from untreated foul water from the site entering the groundwater. Again treatment of foul water is commonly practised at sites across the world and a range of effective treatment systems exist. At the plant site all foul water from the welfare facilities will be directed to a treatment system prior to discharge of the treated water via soakaways. Based on local regulation, this treatment plant will include the use of a septic tank system and sump.

Whilst pollution sources will be introduced by this development, fully effectively control and mitigation measures are available and will be installed on site to minimise any risk to the groundwater environment. The potential impacts on groundwater resources from pollution are therefore assessed as adverse, long-term but minor in significance.

5.5.5 Evaluation of alternative development options

Comparing the proposed development with the project alternatives the potential impacts on groundwater are similar i.e. of low significance.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However no significant impacts have been identified.

5.5.6 Conclusions

The overall conclusion is that the only potential identified impact on groundwater quality is from the potential for pollution, by either fuel oils or foul drainage. Water demand for the project is too low for impacts on the quantity of groundwater to occur. Potential impacts are summarised in Table 5.5.1

Table 5.5.1: Summary of Impact Evaluation – Groundwater Resources

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	O	Reduced groundwater resources	Abstraction for site water supply	Groundwater users	Adverse	Long-term	Insignificant
	C/D	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Short-term	Insignificant
	O	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Long-term	Minor
Transmission line	C	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Short-term	Insignificant
	O	No impacts					

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

5.6 NOISE

5.6.1 Baseline Conditions

Plant site

As noted within Section 3.2 and shown on Figure 1.1.2, the plant site and the surrounding areas are rural in character with the Atlantic coastline only some 1.5 km to the west. The area is predominantly secondary rainforest with scattered small villages. Within this setting there are no significant noise sources. The most significant noise source identified is the main Kribi / Edéa road which lies within 250 m from the western limit of the plant site boundary (see Figure 1.1.3). Whilst this is the main noise source, overall traffic volumes are low (see Section 5.7) and therefore background noise levels are also low.

The existing 90 kV transmission line between Edéa and Kribi also crosses the western end of the plant site. High voltage lines can generate noise (corona discharge), particularly in wet conditions, and therefore will form a significant factor in background levels for properties close to this line. Background noise levels within this plant site area will be typical of a quiet rural setting with the exception of corona discharge.

The plant site area does have residential settlements (rural dwellings) within the western and northern boundary of the site. However it is proposed these will be resettled as part of the project development (see Section 6.3). The nearest properties are to the west of the proposed access road, approximately 200 m from the western boundaries of the plant site. These properties generally lie along, or close to, the road line.

Transmission Line route

The majority of the transmission line is also within a rural setting with scattered village settlements along the route, as shown on Figure 1.1.2. The line follows the approximate route of the main road and the existing 90 kV supply and therefore the key impact on existing background noise levels will be traffic on this highway and noise from the transmission line. As noted above, traffic volumes are low and power line noise tends to be intermittent and low on a 90kV system. Therefore overall impacts on the background noise levels will be minor.

Background noise levels within this area are typical of a rural setting apart from the short section leading to the Edéa substation, which passes through the town's outskirts.

Baseline noise monitoring

To establish the exiting noise levels around the plant site a baseline noise survey was conducted over the period 3rd to 6th April 2006. Readings were taken at three locations (see Figure 5.3.1) using a type 1 integrating sound level meter. The meter was calibrated before and after each monitoring session and was set up to read free field noise levels (i.e. a minimum 1.5 m above ground level and 3 m from any building). As the proposed power plant will run continuously throughout the day and night for part of the operational year, readings were taken to represent a full 24 hour period.

The three locations were selected to represent key sensitive properties close to the proposed development. Location 1 is set back from the main road but close to the property nearest to

the proposed plant site. Location 2 is at properties closer to the main highway. This is, therefore, representative of the background noise at a majority of the village properties along the transmission line route (which tend to be close to the highway) as well as for the specific properties at the plant site. This location was influenced by a local bar and was near the centre of the small settlement of Mpolongwe. Location 3 was away from the main properties and therefore typical of more isolated houses but is also within the general vicinity of the Mpolongwe Chief's residence.

Monitoring results (see Appendix I) show little variation between day and night periods. The baseline monitoring survey showed the average daytime L_{eq}[1] to be 50 dB(A), with the average night time L_{eq}[2] as 51 dB(A). However, the sources of noise changed between the time periods. During the day the dominant noise sources are traffic on the nearby road and the noise produced by the local residents. During the night, the noise is dominated by the sound from wildlife within the forest cover. This change in character is illustrated by the values of the L_{90} levels (environmental background noise level), which are 41 dB(A) during the day but averaging 47 dB(A) during the night. The reduced difference between the L_{eq} and the L_{90} during the night indicates that noise levels are relatively constant during this period.

Data sets for locations 2 and 3 are more limited than at location 1 but provide an indication of the variation in background noise levels at properties close to the road (within 30 m) as compared to location 1 (approximately 100 m). The overall levels at properties closer to the road are approximately 2 dB_{Aleq} higher than at location 1. There is, however, no discernable difference between location 2 and 3.

5.6.2 Potential Impacts

Potential noise impacts from the proposed development arise from the construction activity for all components of the project and from the power plant during the operational phase. The main noise generating activities that may cause impacts will be:

- *traffic noise* from delivering materials to the transmission line and plant area construction sites. A majority of this will be on the existing main highway network and will involve only short sections of access tracks to access final construction sites;
- *corona discharge* during wet conditions from the high voltage transmission lines;
- *on-site activity noise* generation both from construction activities and from the operation of the main power plant.

As noted, there are villages along the transmission line route and a limited number of dwellings both within, and close to, the plant site. In addition, the existing noise environment within the project area is primarily one of a quiet rural area. Sensitive receptors are therefore present within the project area and the construction and operational phase will introduce a new noise source. The main potential impact is likely to arise from the introduction of the power plant into the rural environment.

[1] WHO definition of daytime is 07:00 to 23:00 and use L_{eq} values
[2] WHO definition of nighttime 23:00 to 07:00

Traffic noise

Construction

Traffic impacts arising from the proposed development have been assessed within Section 5.7 of this report. This includes an assessment of the potential for the additional traffic associated with the construction phase to impact the noise environment along the haul routes. This concluded that overall noise levels would be within WHO guidelines although elevated noise levels will occur at properties close to the road. As this impact is set out within Section 5.7, no further assessment is conducted here.

Operation

As set out in Section 5.7, traffic generation associated with the operational phase of the site is very low and will not have any significant impact . Therefore the operational phase will not be assessed further within this section of ESIA.

Corona discharge

Corona discharge occurs from operating high tension power lines, therefore this potential impact relates only to the operational phase.

Fixed figures for power transmission line noise generation in wet or dry conditions are not available for a 225 kV system in the specific atmospheric conditions applicable in the project area. Line voltage and climatic conditions are key factors in how much noise a line will generate. However total noise generation from a high voltage power line during wet condition has been assessed in South Africa and potential audible noise level determined (Roets 1997). This research indicated that for wet conditions the audible noise is up to 12 dB to 15 dB higher than for dry conditions.

The project area has a dry season from November to March, the small rainy season from April to May and the main rains from June to October (West, 2004). Dry weather noise levels from high voltage power lines are generally lower, assuming the conductors are in good condition and will not be a significant influence on the noise environment. Whilst these increase during rain, most of the properties in the project area have aluminium sheet roofs and the rain impacting on these sheets has a significantly greater impact on noise within properties than arising from the power line. During the baseline monitoring survey, noise levels below a metal sheet roof were recorded at in excess of 80 $dB(A)_{leq}$.

This effect will not therefore have a significant impact on noise at residential properties along the line and is not assessed further within the ESIA.

Site activity

Construction

At the plant site the construction activity will be ongoing for approximately 15 months and will generally be confined to the construction compound and the plant site itself. Construction activity that will involve noise generating activities including chain saw and logging truck movements during initial clearing, plant and machinery movements around the site, materials handling (particularly steel work), excavation and grading, concrete

mixing, etc. Actual noise generation will be dependent on the types of equipment used, especially the use of any pile foundation equipment, the duration of "on-time", i.e. the period they operate for over the working day, and the location of the activities. These will be defined once the EPC contractor is appointed and the detailed design completed. A quantitative assessment of actual noise impact cannot therefore be undertaken at this stage.

However, construction works of this nature will use plant and equipment with similar noise outputs to the operating power plant and therefore noise generation and potential impacts can be similar. The nature of the noise is however significantly different with greater variation in noise levels both during any given day and over the course of the 15 month construction programme. Sensitive receptors are located close to the construction activity (within 75 m of the construction compound and 20 m of the access road) and therefore the potential for impacts is present.

Operation (power plant noise)

The key noise generating activity during this phase will be from the operation of the gas turbines. To assess the significance of this impact, quantitative noise modelling has been undertaken and the results compared to international standards.

Assessment Method

The power plant will have four 40 MW gas turbine generators, all of which will be operational for 24 hours a day during periods of dry season peak demand. Noise assessment is therefore based on the worst case scenario, i.e. all four plant gas turbines in operation. The noise output from each of these turbines has been taken from manufacturer's data and is defined as 84 dB(A) at 1 m, and 63 dB(A) at 110 m from the turbine.

Using the site layout (see Figure 3.3.1), the configuration of the gas turbines and the locations of other buildings outside the perimeter of the power station have been determined. The distances of these buildings from the gas turbines have been measured and the three nearest noise receptor locations determined. The locations of the receptors are shown in Figure 5.3.1.

The supplied noise source levels have then been used to calculate the contribution from each of the gas turbines at each receiver location using the methodology specified in ISO 9613-2. These have then been added together to produce the overall expected noise levels arising from the operation of the power station. This methodology allows the sound propagation from source to receiver to be calculated taking into account the source characteristics and the nature of the ground coverage (i.e. either hard ground, concrete, etc. or soft ground, fields etc) between source and receiver.

To assess the significance of potential impact arising from the site operations on the surrounding areas, the criteria recommended in the World Health Organisation (WHO) report 'Guidelines for Community Noise', April 1999, have been be used. This report recommends environmental noise levels of 55 dB(A) for day and evening (07:00-23:00) 'to protect the majority of people from being seriously annoyed' and 45 dB(A) 'outside bedroom windows' at night (23:00-07:00) to avoid sleep disturbance.

This report specifies that assessments be made using the Leq noise levels. To produce an assessment in line with the recommendations of this report, the predicted operational noise

levels of the power plant have been compared with the measured background Leq levels. Total noise levels at these receptors is then also compared with the recommendations of the WHO report to assess if the operation of the site is likely to give rise to annoyance to the local population.

Calculated Noise Levels

Calculated noise levels at the three receptors locations are given in Table 5.6.1.

Table 5.6.1: Predicted noise levels at the nearest receptor locations

Receptor	Location	Distance to nearest gas turbine (m)	Predicted L_{Aeq} (dB) Gas Turbine Only	Predicted L_{Aeq} (dB) Gas Turbine and Stack Emissions
1	Nearest property	280	65	67
2	Chief's House	400	63	65
3	Next closest property	360	59	61

Note: WHO Guideline values are Daytime 55 db(0700 – 2300) and nighttime 45db (2300 – 0700)

Receptor 3 is located such that there is approximately 6 m of topographical screening from the power station site. A conservative estimate of this screening has therefore been included in the calculations for receptor 3.

The noise levels considered in these calculations are based on the noise generated by the casing of the gas turbine enclosure. A significant source of noise that has not been included is that from the air intake and exhausts. These typically produce higher noise levels than from the enclosure casing. To obtain an estimate of the effects of these noise sources, typical data has been obtained for an un-silenced gas turbine. When the noise levels for the air intake and exhaust are considered, the predicted noise levels in Table 5.6.1 increase by 2 dB(A) at each receptor.

The noise levels at these receptor locations all exceed the background noise levels and the WHO guidance values.

5.6.3 Mitigation Measures

Construction works

For the construction activity a series of site controls can be implemented that limit the noise generations. These include the following;

- regular maintenance of all plant and equipment;
- not allowing engines to run unnecessarily;
- undertake cutting, grinding, and other such operations within an enclosure;
- controlling loading and offloading of materials (especially steel work);
- locating noisy operations at the maximum distance from noise sensitive receptors;

- controlling and limiting traffic movements around the sites.

Power plant operation

The noise levels predicted exceed both the current ambient noise levels, and the WHO recommended noise levels. To ensure that adequate protection of the local residents is achieved, noise mitigation measures are required.

For the noise sources that are located at ground level, such as the turbine enclosure casing, it is recommended that a noise barrier is used to screen the affected properties. This should be constructed close to the source of the noise so providing attenuation of noise propagated in all directions. To achieve the noise reduction required to achieve WHO guidelines (up to 14 dB reduction) this screen should be a concrete block wall or an acoustic turbine enclosure with similar noise attenuation potential.

For the noise sources that will be elevated, such as the exhaust stack, it is recommended that attenuators or silencers be used. These should be fitted to both the intakes and exhausts of the turbines. These are standard items of equipment and are very effective at reducing noise generation.

5.6.4 Evaluation of Mitigated Impact

Site activity

Construction

The site activity, particularly within the construction compounds, will involve periods of high noise generation and this compound is close to properties within Mpolongwe. Good practice in site management as set out within Section 5.6.3, will assist to minimise noise generation but impacts will occur within the village at the plant site.

Activity will however only be undertaken during the daytime with no planned night-time working. In addition the construction phase is limited to 15 months and periods of high activity will only occur for short periods within this overall timeframe. Daytime noise impacts will however occur at properties near the plant site for several months during this phase. Short-term noise impacts during construction of a new development are often unavoidable and this is recognised in general guidance with higher allowable limits for this phase of the operation. Impacts of construction noise at the plant site are assessed as adverse, short term and significant in nature.

Along the transmission line impacts will only arise during the delivery of materials and construction of each tower. The typical practice is for a 10-tower section to be erected and strung at a time with an estimated timeframe for each section of two to three weeks. Each 10 tower section will be approximately 3.5 km in length. The operation of trucks and cranes for delivery of materials and erection of towers will lead to noise generation; the power line does run close to some properties. However this is not an intrinsically noisy operation and the overall noise levels will be relatively low. In addition the duration of noise at any one property will be a matter of weeks only.

The construction activity along the transmission line route is therefore assessed as adverse, short term but of minor significance.

Operation

To assess the significance of the impact of the power station on the residents at the selected receptor locations, the World Health Organisation (WHO) criteria, as specified in the 'Guidelines for Community Noise' report have been applied. This report sets environmental noise levels of 55 dB(A) for day and evening 'to protect the majority of people from being seriously annoyed' and 45 dB(A) 'outside bedroom windows' to avoid sleep disturbance. However as noted in Section 5.6.3, background nighttime noise levels at the site (51 dB_{Aleq}) already exceed the WHO criteria and therefore operational nighttime noise criteria will be set for management purposes so as not to exceed the current baseline (i.e. 51 dB_{Aleq}).

Without any mitigation measures in place it is evident from the comparisons of the modelling results (Table 5.6.1), with the WHO (and site specific nighttime) criteria that the proposed power plant would exceed these criteria during both the day and nighttime periods. However standard mitigation measures are available to control noise generated both by the turbine, fans, etc. operating at or close to ground level and for noise from elevated sources such as the stacks. During detailed design these measures will be fully specified and installed during construction.

On the basis of the application of simple mitigation measures that can easily achieve the 14 dB reduction required, the power plant can operate within the WHO guidelines. Impacts from the plant on the noise environment are therefore assessed as adverse, long term but of minor significance.

5.6.5 Evaluation of Alternative Development Options

The main alternatives that are likely to affect overall impacts on noise is the option for using gas engines as opposed to gas turbines. In this case a greater number of units would be required, up to 10, and these units can generate higher levels of noise than turbines. Overall impacts are therefore likely to be greater with the use of gas engines.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However, on the basis of the installation of noise control measures, significant impacts have only been identified for the short term construction phase.

5.6.6 Conclusions

The principal impacts identified on the noise environment, following installation of suitable mitigation measures during the operational phase, is the short term impacts on properties close to the site caused by the construction activity.

Table 5.6.2: Summary of Impact Evaluation – Noise

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	C	Increased noise levels	Construction activity at site	Local residents	Adverse	Short-term	Significant
	O	Increased noise levels	Turbine operation	Local residents	Adverse	Long-term	Minor
Transmission line	C	Increased noise levels	Construction activity at site	Local residents	Adverse	Short-term	Minor
	O	Increased noise levels	Corona discharge	Local residents	Adverse	Long-term	Insignificant

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation

5.7 TRAFFIC

5.7.1 Baseline Conditions

Transport routes

The transport routes to and from the Kribi power project site, particularly during the construction phase where traffic generation will be at its greatest, will be along the main road from Douala to Edéa and from Edéa to Kribi (see Figures 1.1.1 and 1.1.2). This first section of road is part of the main route from the major port at Douala to Yaoundé and through to the rest of the central and eastern regions of the country and the border with the Central African Republic. This is therefore one of the major route-ways within the country. The second section, to Kribi, services only the coastal area near the town and inland parts of the southern province. There are no major ports or heavy industry in this area and as such this is not a major transport route.

Both routes are constructed to a high standard with roads at a minimum width of 7 m with hard verges up to 1 m in width (see Photo 5.7.1). Surfaces are in good condition with very few potholes or ruts and routes are graded to avoid any steep inclines. The route through Douala to the port is general dual carriageway within the urban area (see Photo 5.7.2) although there are currently road works near the port area that will temporarily restrict traffic flows. On the outskirts of Douala the route passes a market area with workshops, market stalls, hotels, etc, along the carriageway (see Photo 5.7.3). The heavy traffic and vehicles turning on and off the main carriageway cause traffic congestion although again roadworks are being undertaken to upgrade the route.

Through Edéa the route crosses the Sanaga River on an old bridge and passes through the centre of the town. The main route in the town is dual carriageway (see Photo 5.7.4). However, a single carriageway section, junctions and high traffic volumes can lead to congestion within the town.

Outside the main towns the route is generally through open countryside with occasional villages and ribbon development at main road intersections. Intersections are, however, only present on the Douala section of the route and only one main junction exists. As the project site is north of the town of Kribi the traffic route does not pass through the town itself. The only traffic likely to be generated from the town will be for transport of workers to and from the site, as most staff will be housed in Kribi.

Traffic Data

Baseline data for traffic flows on the main road sections to be used during the project life have been collated from published data.

For the Douala / Edéa route published data was obtained from the Minister of Public Works, Department of Programming report on the campaign for traffic counting (November 2005). The count was conducted at a location approximately 20 km outside Douala. Data are presented in Table 5.7.1.

Table 5.7.1: Average Daily Traffic - Douala / Edéa									
Year	**Car**	**Pick up**	**Mini Bus**	**Bus**	**Small Lorry**	**Medium lorry**	**Articulated lorry**	**Timber lorry**	**Total**
1999	1613	654	647	201	390	327	405	266	4503
2000	1620	657	648	205	391	330	406	271	4528
2001	1705	662	651	277	407	35	411	272	4720
2002	1363	291	549	111	186	127	311	64	3003
2003	1673	366	644	125	233	169	421	57	3689
One week data (daily average traffic) for 2005									
2005	1704	322	521	139	195	204	509	69	3664

These data show that overall traffic volumes on this road are moderately high with approximately 20% of the traffic consisting of medium or heavy lorries and over 25% consisting of small lorries, buses and mini buses. Average daily traffic movements for these two general categories are 775 and 1080 respectively.

For the Edéa / Kribi road section, data are taken from the same source. However the data set is more limited. Table 5.7.2 presents the total average daily traffic for this section of road for the years 2000 to 2004 and daily traffic by vehicle type for 2005. The survey point is at the village of Fifinda approximately 35 km north of Kribi. As there are no main road junctions on this route and only 16 small villages, these data are considered representative of the entire route.

Table 5.7.2: Average Daily Traffic - Edéa / Kribi									
Year	**Car**	**Pick up**	**Mini Bus**	**Bus**	**Small Lorry**	**Medium lorry**	**Articulated lorry**	**Timber lorry**	**Total**
May 05	196	65	77	6	21	12	31	1	410
Aug 00	-	-	-	-	-	-	-	-	395
Jul 01	-	-	-	-	-	-	-	-	410
Aug 02	-	-	-	-	-	-	-	-	413
Dec 03	-	-	-	-	-	-	-	-	487
Aug 04	-	-	-	-	-	-	-	-	499

As shown, traffic volumes on this section of road are very low and an order of magnitude less than the main Douala / Edéa road. The percentage of lorry traffic is also less with medium to heavy lorries at 44 movements (approximately 11%) but buses and small lorries a similar proportion, 105 movements (approximately 25%).

Traffic data was also collated during the one-hour baseline noise monitoring session conducted at site in April 2006 as outlined in Section 5.6. These were conducted both in the morning and afternoon with traffic movements averaging 50 to 55 vehicles per hour. Most traffic is during daylight hours.

5.7.2 Potential Impacts

Traffic impacts can arise during all phases of the project although the greatest impacts will be during the construction phase. Three principal impacts that can arise are;

- increased road congestion;
- noise, vibration and air quality impacts;
- increased accident and safety risks.

Each of these impacts is directly related to the volume of traffic generated by the proposed development. An overview of access routes and traffic flows is set out in Section 3.3. A more detailed discussion on traffic generation is provided below.

Construction

Detail traffic movements that will be generated during the construction phase have yet to be developed, as they will be dependent on the final detailed design of the plant to be installed and operational practices adopted by the EPC contractor. However, initial estimates based on a typical project of this nature have been defined to give an order of magnitude assessment of potential impacts.

During the construction phase most operations will be undertaken in sequence although some will be continuous for most of the construction period. Key sequential phases are:

- initial site clearance and land grading – traffic to bring staff to site and delivery of machinery;
- access road, foundations and hard standing and building construction – import of materials (sand, gravel, cement etc) and labour (peak activity);
- installation of main plant and equipment – importation and haulage of equipment from the port at Douala;
- commissioning of plant – limited technical staff traffic to site;
- construction of transmission line – continuous 15 month importation of steel works, sand gravel and cement and site along the wayleave area, although work sites will move as sections are complete (2 to 3 weeks per 10 tower section).

The greatest traffic generation will be during the main construction of the access road foundations, etc. as this will require the greatest importation of materials and labour. Estimated peak lorry movements for importation of materials during this phase will be in the order of 200 to 300 movements per day. For the same period staff transport to and from construction sites (at the plant site and along the transmission line) will be undertaken and will generate up to 100 movements per day.

During the main construction works the plant equipment importation will be undertaken. A total of some 200 lorry loads will be generated during this phase but this will be spread over

the 9 month installation period. Estimated peak movements for this phase are 10 to 20 loads per day plus staff movements.

For the transmission line, each tower site will involve approximately 10 lorry loads of materials with completion of approximately one tower per day. Prior to erection of the tower, foundations will be excavated and concrete foundations laid. Foundations are small and therefore this will result in only a few vehicle movements per day.

For the construction phase, peak traffic movements will therefore be during the placement of the foundations and initial building works at the plant site, with overall traffic movement reducing during the installation and commissioning phase. Along the transmission line traffic movement will be more constant over the 15 month construction period but overall movements will be significantly less than at the plant site.

Operation

During the operational phase no major delivery of staff or materials to the site will be required. The power plant will be fired on gas delivered to site by pipeline and will only be run on diesel during periods of gas supply shut down. This is estimated to be a maximum of 8 days per year requiring delivery of approximately 2350 tonnes of fuel. The tank will be filled before commissioning of the plant. Traffic movements will be dependent on the topping up requirements (to refill the tanks after usage) and the tanker size but this is likely to require approximately 150 to 200 loads over the course of the year. Minor delivery of maintenance equipment and materials will also be required from time to time.

The main regular traffic movement at the site will be for the transport to and from the plant of the site staff. This will be at the beginning and end of each 8-hour shift with a total of 60 staff to be transported each day. It is planned that shift staff will be provided with bus transport from Kribi, where permanent staff will be based. Total daily traffic is therefore estimated to be in the order of only 15 to 20 movements.

There will be no regular traffic movements associated with the transmission line during the operational phase.

Traffic generation associated with the operational phase of the site is very low and will not have any significant impacts. The operational phase will not therefore be assessed further within this ESIA.

Decommissioning

The level of traffic generation created during the decommissioning phase will be totally dependent on the final decision on the use of the plant site and buildings. This cannot be assessed at this stage. However, it is most unlikely that overall traffic volumes can be greater than for the construction phase. As such the assessment of impacts for construction will represent the worst case for decommissioning.

Increased road congestion

Construction

During the construction phase vehicle movements will be on both the local Kribi / Edéa road (local materials – sand, gravel, etc. and staff/worker transport), and the route from Douala (imported and processed materials – cement, plant and equipment, etc). At the peak working phase total traffic movements generated by the development are likely to be in the order of 300 to 400 movements per day for material and labour, although some of these will be over very short distances only. This will be comprised approximately 25% small vehicles and buses and 75% lorries.

All traffic will need to use the Kribi/Edéa road to allow access to the site. As the current baseline is in the region of 400 vehicle movements per day, this will represent a significant increase although only over a relatively short period.

Movements on the Douala / Edéa road will only be for the importation of material. During the peak period this will be in the order of 200 movements per day primarily of lorry traffic. This route is however currently carrying approximately 3,500 to 4,000 movements per day therefore these additional flows represent only a 5% overall increase and a 20% increase in lorry movements. Again this level of impact will only occur for a short time during the overall 15 month construction phase.

Noise, vibration and air quality

Construction

Increasing the total number of traffic movements along a section of highway has the potential to impact properties along the route by increasing the overall levels of noise and vibration and by reducing air quality due to increased exhaust gas emissions. This is particularly the case where heavy good vehicles are involved and where properties are close to the highway.

As defined in the IHT Guidelines (UK Institute of Highways and Transportation, 2000), any road within the assessment area where traffic flows will increase by more than 25% as a result of development traffic would normally be regarded as the starting point to consider environmental issues such as noise, vibration. For air quality a trigger value of 10% is used. During the construction phase on the Douala / Edéa section, increases will be below these figures and therefore no significant impacts are predicted. However, on the Edéa / Kribi section increases will be greater than this (up to 100% during peak period) and therefore the potential for impacts will arise.

Increased accident and safety risk

Construction

Increases in traffic volumes on any section of road has the potential to increase the risk of accidents with potential injury to other road users and pedestrians. The degree of risk is related to the level of increase in the volume of traffic and the nature of the highway network being used. Particular areas of risk are at road junctions and within urban areas with high local traffic and pedestrian use.

On the routes identified for this development most sections are within open countryside and occasional villages. The only urban areas are within Douala and Edéa which are both on the current major road network. However traffic increases on the Edéa / Kribi section are large and therefore potential risk of increased accidents will exist.

5.7.3 Mitigation Measures

Increased road congestion

Within the context of the road network used by this project and the nature of the development, there are few mitigation options in relation to the potential for increased congestion. Proposed mitigation is as follows:

- *Selection of route* – There is only one available route from Douala to Kribi and this cannot be altered. However, through Douala itself only the main road route from the port direct to the main highway to Edéa will be used with no trafficking into the main town centre.

- *Reduction in traffic movements* – Limited options exist as the construction requires set quantities of materials and labour delivered to site. However, bus transport for workers will be provided to maximise numbers of persons per trip and lorry loads delivering to site will be maximised, i.e. full loads only where practical, to reduce overall movements.

- *Planned convoys* - Special convoys will be used at off-peak periods to avoid the increase of congestion when traffic is heavy.

Noise, vibration and air quality

The main mitigation measures that can be implemented for these impacts include the following:

- traffic speed in built up areas will be restricted (primarily through villages along the route);

- the transport fleet will be well maintained to ensure emissions are minimised and that silencing equipment is correctly fitted and in full operating condition.

As with congestion, there are limited options for altering haul routes to avoid built up areas. However routing within Douala will be controlled to avoid the main centre.

Increased accident and safety risks

Increased risk to road users is related to the increase in volume of traffic and the route the haulage takes. As noted above, limited options exist for altering either of these. Therefore the main mitigation measures to be implemented to reduce accident risk are as follows:

- control traffic speed through villages;

- provide driver training to ensure competence and provide operating procedures re routes, speeds, etc.;

- implement appropriate driver safety procedures including limiting hours of working, ensuring no alcohol or other substances are consumed prior to or during shifts;
- vehicles will be maintained to ensure breaks, lights and warning signals are fully functioning;
- design of the access road junction will ensure adequate visibility on to the main highway for vehicles leaving the site and suitable turn in lanes for access off the highway;
- signage to be erected on the main road leading up to site access and before each village to provide advanced warning to site traffic and other motorists;
- consultation with villagers to inform them of the increased traffic and duration of works.

5.7.4 Evaluation of Mitigated Impact

Increased road congestion

Construction

The transport routes to the site during the construction phase use two main road sections - the route from the port at Douala to Edéa and from Edéa to the plant site just north of Kribi.

The Douala / Edéa section is part of the main road network within the country and already carries a moderately high level of traffic with approximately 20% of this traffic being medium to large lorries and a further 25% small lories and buses. This road is designed and constructed to a high standard and capable of carrying heavy traffic loads. The main areas of current congestion are within Douala itself, within the market area on the outskirts of Douala and within Edéa.

In relation to the traffic generated by the proposed project, estimated additional traffic movements on this section of road will equate to approximately 5% increase over current volumes for the peak period of the construction programme. This peak period for importation of bulk construction materials will last 9 months within the overall 15-month construction programme.

Due to the low overall increase in traffic during the construction phase on the Douala / Edéa section of the route and the short duration of the peak importation of materials, impacts on congestion are assessed insignificant.

On the Edéa / Kribi section existing traffic loads are much lower and overall traffic movement arising from the proposed development will be greater as all material and labour transported to the plant site and the transmission line will use this road. During the peak construction period the development will potentially double the current traffic volumes on this route.

However current traffic volumes on this route are very low at only some 400 per day and therefore total movements at the peak period will still be relatively low at only some 800 movements per day. This road section has recently been upgraded and is now a good

quality road with a full 7 m carriageway and no major intersections where traffic flows may be impeded. The total predicted peak traffic flows are therefore well within the overall design capacity of a highway of this nature.

Impacts on both sections of highway, i.e. through Douala and Edéa, particularly at the junction onto the Kribi road, will be increased when convoying is employed. This will result in periods of higher peak lorry movements. However, these will be for very short durations only and reduce impacts at other times.

Based on the design and construction of this section of highway, the relatively low overall traffic movements and the sort duration of this peak period, impacts on congestion on the Edéa / Kribi section of the route are assessed as adverse, short term and minor in significance.

Operation

As noted within Section 5.7.2 there are no identified potential impacts on congestion on any of the routes during the operational phase.

Noise, vibration and air quality

Construction

As set out within Section 5.7.2, a guideline figure of a 25% increase in traffic volume over current baseline is used to assess whether potential impact on noise and vibration may occur from additional traffic generated by the proposed development. An increase of 10% or more is used as a guideline for air quality. For the Douala / Edéa section of the route the overall traffic increase is approximately 5% and therefore there are no predicted impacts on this section of the route. However for the Edéa to Kribi section traffic increase over current baseline is approximately 100%. This route will therefore be affected.

The Edéa / Kribi road passes primarily through rural areas comprising forest vegetation and occasional areas of subsistence or low intensity agriculture. Population density in this area is very low however there are 16 villages identified within the project area. These villages are located along the road with properties often within 50 m of the carriageway. Therefore although the number of people affected will be low there are sensitive receptors.

Traffic movements related to the proposed development will only occur during daylight hours and therefore impacts will arise only over this period. In addition the peak construction period will be over a relatively short time period, 9 months within the overall 15 months time period. Once the main civil works are complete and the construction moves to installation of major equipment, erection of building and on-going transmission line construction, overall daily movements are estimated to reduce to movements in the order of 150 to 200 per day.

Overall traffic volumes at the peak are still relatively low (in the order of one vehicle per minute over a 10 hour day) and therefore impacts on air quality will be insignificant (see Section 5.3). However this rise in traffic will have more effect in terms of noise at properties and as a majority of the new traffic will be lorries the potential for vibration in properties close to the road also arises (see Section 5.6).

As a general guideline, doubling of the traffic volumes on a section of road increases noise levels by approximately 3dB. In this instance, as a majority of the traffic will be lorries, the increase will be slightly greater than this. Background noise monitoring at properties along the road show typical daytime levels of 40 dB. Increases from traffic will be noticeable by local residents but overall levels, when added to this background, will be within international guidance values (see Section 5.6). As noted within Section 5.7.3 option for mitigation for this short term impact are limited however the basic measures proposed will reduce to a minimum the level of impact.

Impact from traffic, primarily on the noise environment, during the construction phase are therefore assessed as adverse short term, but significant in nature.

Operation

As noted within Section 5.7.2 there are no identified potential impacts on noise, vibration and air quality on any of the routes during the operational phase.

Increased accident and safety risk

Construction

The potential for increased risk of accidents is related in part to the level of increase in the traffic travelling along a section of road but also to routing of the traffic in terms of use of junctions where accident risk may increase.

On the Douala / Edéa section increases in traffic are too low to have a significant effect on the overall risk of accidents. This road already carries approximately 4000 vehicles per day and therefore the small increase (5%) over the peak construction period only is not significant.

On the Kribi road the potential impact is significant as the increase in traffic volumes is large. Doubling of the traffic through the villages for the short peak construction period creates a proportionately greater risk of injury to pedestrians within the villages and vehicle accidents on the road. However this road is a main, well designed carriageway through the villages and existing traffic include lorries, buses and cars. As such this is not a new hazard and villagers are familiar with the risks.

A new junction leading from the main road on to the access road for the plant site will be constructed. Vehicles slowing to turn right into the site, or stopping in the centre of the carriageway to turn left into the site, leads to an increased traffic hazard and risk of accidents. This is the only main junction that traffic will use on the section of road and no other similar risk areas exist.

Good practice in terms of the mitigation measures set out within Section 5.7.3 can be very effective in controlling the risks to local road users from the increase in traffic associated with the proposed development. Overall this impact is assessed as adverse, short term but significant in nature.

Operation

As noted within Section 5.7.2 there are no identified potential impacts on accident and safety risks on any of the routes during the operational phase.

5.7.5 Evaluation of Alternative Development Options

None of the project alternatives have a significant effect on the overall potential impacts from traffic arising from the proposed development.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However, only short term significant impacts have been identified.

5.7.6 Conclusions

The overall conclusion is that the only identified impact from traffic arsing from the proposed development relates to the construction phase of the project. However, depending on the final scheme for decommissioning, impacts during this phase may be similar in quantum and duration to the construction phase. Potential impacts are summarised in Table 5.7.3.

Table 5.7.3: Summary of Impact Evaluation – Traffic

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Douala - Edéa road	C/D	Increased road traffic	Congestion	Local road users	Adverse	Short-term	Minor
	C/D	Increased road traffic	Noise, vibration and air quality	Residents near the road	Adverse	Short-term	Insignificant
	C/D	Increased road traffic	Accident risk	Local residents and road users	Adverse	Short-term	Minor
Edéa – Kribi road	C/D	Increased road traffic	Congestion	Local road users	Adverse	Short-term	Minor
	C/D	Increased road traffic	Noise, vibration and air quality	Residents near the road	Adverse	Short-term	Significant
	C/D	Increased road traffic	Accident risk	Local residents and road users	Adverse	Short-term	Significant

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

5.8 SOILS AND LAND USE

5.8.1 Baseline Conditions

Soils

The baseline conditions within the project area were established by reference to published materials (Bernard, Yerima and Van Ransy, 2005) and via on-site observations. Additional information on site-specific sub-surface ground conditions, for the plant site location, was obtained from the geotechnical investigation undertaken by National Civil Engineering Laboratory (Labogenie, 2006).

The project area, as shown on Figure 1.1.2, stretches from near the coastline 9 km north of Kribi into the existing substation at Edéa. The published data indicates that the entire project area is classified as being within the Haplic Ferralsols soil group associated with humic gley soils.

The ferralsols are deep intensively weathered materials with sandy surface horizons becoming more clayey with depth. These soils are physically stable and well structured giving good drainage characteristics with relatively high permeabilities. Chemically the soils are poor with generally low pH values, poor nutrient status and low cation exchange capacities. Nutrients are therefore easily leached from these soils. Iron and aluminium oxides concentrations exist leading to the yellowish or reddish soils colours. Due to this poor nutrient status soils tend to be used for shifting agricultural and need artificial fertiliser if permanent farming is to be practised. Land use capability is therefore low.

In the low-lying areas and along rivers, gley (temporarily or permanently waterlogged soils) exists as a secondary soil group within the project area. These are generally sandy or silty soils with often-high organic matter content. Soils are very variable but may have high cation exchange capacities and neutral pH values. However in some areas they can be acidic and may be subject to long periods of water logging. Agricultural use is dependent on the local characteristics of the soils but may have greater land use capability than the ferralsols although are limited in extent within the project area and soil use will be restricted by the degree of waterlogging.

Site observations, including trial pits on the plant site, indicate that the soils are generally reddish (iron oxide) in colour with deep, highly weathered profiles. Parent rock materials were occasionally present at the surface and weathering of these materials has resulted in coarse sand and stone. Within the trial pits observed at the plant site soil depths above parent rock were greater than 3 m (see Photo 5.8.1) with borehole data indicating soil depths greater than 7 m.

Geotechnical Investigation

The geotechnical investigation was undertaken for the proposed power plant site (Labogenie, 2006). The purpose of the investigation was to assess the sub-surface conditions, the engineering properties of the rocks and soils, and the significance of these for the proposed structures. In addition, data was used to determine a strategy for a safe working environment during construction and for issues such as slope stability in cuttings.

The testing programme was defined in the Terms of Reference and Scope of Works of the geotechnical report and was compiled with relevant standards including ASTM, AFNOR and ASCE 83 environmental site investigation guidance manual, and the Uniform Building Code standard 18-1, soils classification. The results of *in situ* and laboratory testing were analysed and used to determine *inter alia*:

- allowable bearing capacity of soils;
- any settlement risks;
- depth to the water-table;
- types of materials to be used for construction; and
- procedures of works.

Two areas were identified on the plant site area for investigation:

Option 1 lies on the northeast section of the land. The Mpolongwe River flows adjacent to the area and the stream Gongoyima defines the boundary. There is abundant vegetation which includes fallow areas and some palm tree seedlings.

Option 2 partly overlaps Option 1. The northeast and southwest boundaries are defined by the Gongoyima River and the Mayingui Stream. This area also comprises primarily fallow lands together with forest.

The geotechnical investigation included field and laboratory tests to assess the sub-surface conditions. Soil samples were taken for laboratory testing and hard rock was sampled using rotary drilling; down-the-hole tests were undertaken.

A total of 16 trial pits were excavated. The sub-surface profiles in all pits were recorded and from these, typical profiles for Option 1 and Option 2 areas were derived. *In*-situ falling head permeability tests were carried out and show that, in general, very low permeability silts underlie the area.

The following conclusions and recommendations were made about the two areas investigated and Table 5.8.1 summarises the average soil profiles determined:

- in both areas topsoil is underlain, in turn, by yellowish clay, lateritic gravels, and saprolite that gives way to fresh rock with depth;
- seismic activity is low;
- laboratory analysis of soils and permeability tests confirm the area is characterised by very low permeability silts;
- the depth to groundwater varies from 3 to 11 metres (below natural ground level);
- piezometers have been installed in exploration holes to record fluctuation in the water-table. It is concluded that monthly readings will be sufficient for monitoring the water-table;

- the clayey lateritic gravel underlying the site will be suitable for use in engineered fill, sub-base, base course (if they are stabilised with 3 – 4% cement and given adequate compaction (≥ 95% OMC);

- to minimise the potential for instability in road cuttings, the cuts should not be steeper than 45%; and

- fill slopes should not exceed 1.5H:1V.

Table 5.8.1: The average soil profiles for Option 1 and Option 2 areas

Characteristics	**Trial Pits and Trenches Thickness (m)**	
	Option 1	**Option 2**
Vegetable topsoil	0.25	0.25
Yellowish clay	0.65	0.65
Clayey lateriric gravel with quartz nodules	1.45	0.80
Hard pan with elements of decomposed rock	1.35	2.00

Source: Labogenie, 2006

Land use

The project area is also subject to high rainfall with two (minor and major) wet seasons each year (see also Section 3.2.3). This, combined with the poor agricultural potential of soils, has a major influence on the pattern of land use and vegetation cover.

Land use has been recorded as part of a topographical survey undertaken of the project area by AES Sonel in 2006. In addition, a land use survey has also been undertaken of the areas directly affected by the construction, which will be used as the basis of the compensation assessment for affected persons (see Section 6.3). These surveys have shown the following land use cover along the wayleave of the proposed transmission line route:

- 20% agriculture;

- 40 – 50% fallow lands; and

- 30 – 40% forest.

Land use within the plant site area is dominated by forest cover.

At the plant site and along the transmission line route, the forest cover has been impacted by human activity (clearing or partial clearing) to a varying degree and was predominantly considered to comprise secondary rain forest (see Section 5.9). The secondary land use is shifting and subsistence agriculture with small areas of cleared forest used for growing banana, oil palm, cassava and other staple crops. Within the plant site, one small clearing for agricultural use was evident and areas of clearance are common around the villages that exist along the transmission line wayleave (see Photos 5.8.2 and 5.8.3).

The main exception to this general pattern of subsistence farming is the presence of one large, commercial scale oil palm plantation run by Ferme Suisse, at approximated 35 km south of Edéa. Also around the outskirts of Edéa, the land use is predominantly agricultural in nature with most forest cleared but again this is generally small-scale, shifting, subsistence style farming with occasional plantation.

5.8.2 Potential Environmental Impacts

The primary impacts on soils and land use arise from the need for land take and land clearance to facilitate the development of the proposed power plant and transmission line. Impacts arise during both construction and operation with most changes being permanent in nature.

Secondary impacts can also arise from the disturbance of soils and vegetation, leading to erosion, and spillage of oils and other potentially polluting substances leading to ground contamination.

Direct loss of soils and land

Construction

Direct loss of land occurs only at the power station plant site and at the base of the towers on the transmission line. As noted within the project description, the step down transformers at Edéa will be within the existing substation compound and therefore no new land take will be required at this site.

Final design of the tower is to be fixed but the land take required at the base of each tower will be an area approximately 5 m by 5 m (total land take 25 m^2). The towers will be spaced at a nominal distance of 350 m. Therefore actual land take over the wayleave area between each tower (30 m x 350 m) equates to less than 0.3% of the total wayleave land requirements. On the basis of a 99.5 km line, resulting in approximately 270 to 280 towers, the total land take for tower construction will be less than 0.75 ha.

The area designated for the construction of the plant site is approximately 16 ha in total. However as illustrated in Figure 3.3.1 the full site is not required for this phase of the development. Land take to allow for project construction, including the plant site itself and temporary construction compounds, will be approximately 7.5 ha . This area will be fully fenced and the site cleared of most vegetation and the ground surface regraded as required for the construction of the access road, temporary site accommodation, power plant and ancillary buildings. This will therefore result in the permanent loss of the current land use at the plant site (approximately 4 ha) and temporary loss at the construction site compound (approximately 3.5 ha).

The existing 90 kV power line crosses the northwest boundary of the proposed plant site. This area is already clear of tall vegetation as part of the management of the wayleave for this power line. This area of land is not therefore included within the potential loss of current land use at the plant site.

Operation

During the operational phase all land taken directly for the construction of the power plant site and transmission line towers will be permanently lost. This equates to an area of approximately 4.75 ha. In, addition the total 16 ha site will be fenced and local communities will not be allowed into the area during the operational phase.

Decommissioning

At decommissioning the plant site and the tower base foundation areas can be returned to their current land use following removal of all buildings and structures. At the plant site the soils will be in a poorer condition (compaction, loss of top soils, etc) than their current state and therefore agricultural activity may not be practical. This area is therefore likely to be suitable for return to a forest cover. At the tower foundation no restriction of final land use will be imposed following decommissioning and removal of the towers.

Overall decommissioning allows mitigation of the impacts caused during construction and operation, via the restoration works. Therefore there are no identified impacts during this phase.

Land use change

Construction

At the plant site it has been assumed for the base case for the ESIA that the 16 ha area will be fenced and access controlled. Therefore current land uses will be restricted under ownership by AES SONEL for the purposes of the project. Therefore in addition, to the direct loss of land at the plant site (4 ha – Plant Site and 3.5 ha – construction compound), a further 8.5 ha will have restricted land uses into the future.

During the construction phase along the transmission line vehicle access by plant and machinery will be required both to remove timber, etc. during wayleave clearance and for delivery of men and materials. This access will result in the removal of existing land uses including the loss of any crops that are present. The full 30 m wayleave strip may not be required for this construction access. However farming activity is likely to be restricted over the entire width during this phase. All current land uses would therefore be lost during construction.

Overall estimated construction time is approximately 15 months for the entire project i.e. the plant site and the transmission line. On the transmission line occupation time at any one construction section (based on construction and stringing of 10 towers per section), will be in the order of two to three weeks. The significance of the disruption will therefore be dependent on the time of year works are conducted. During the out-of-crop season limited impacts will occur. During planting and harvesting, activities may be restricted and during the growing season crops may be lost due to trafficking, etc.

Where forest is present all trees, shrubs and other standing vegetation within the wayleave will be removed to ground level. The existing forest cover will therefore be lost. The significance of this impact is discussed in Section 5.9.

Construction also requires the removal of any built development within the wayleave. However, impacts in relation to resettlement are dealt with within Section 6 (Social Impact Assessment).

Operation

As noted within Section 3.3, vegetation within the wayleave has to be managed to ensure protection of the line. In general this involves maintaining all vegetation at or below 2 m in height. During the operational phase tall forest vegetation cannot be permitted to re-grow and this land cover will be permanently lost. As the proposed new transmission line runs parallel to the existing 90 kV line for approximately 40% of the route, new wayleaves in these areas may only be required on one side of the line as the existing wayleave can serve to create the full 30 m. However in most areas separation distances are greater than 15 m therefore for the purposes of this ESIA a new 30 m wayleave has been assumed. Total new landtake for the 225 kV wayleave will be approximately 285 ha.

As discussed in Section 3.3.6, there are currently no national Cameroonian guidelines for permissible land uses within the wayleave area. Regulations in other African countries tend not to allow agricultural activity to be undertaken within the wayleave area although enforcement difficulties have meant that this tends to be a common land use. On the basis of this approach being adopted, i.e. no agriculture, the entire agricultural activity within the wayleave would be lost with the consequential impacts on livelihoods and household incomes as discussed in Section 6.1.

Farming is practised within the wayleave in many areas (including beneath existing power lines within Cameroon), and is a permissible land use within many European countries and North America. If controlled it has no serious detriment to the power line, and the option for farming under the transmission lines has been considered (as discussed in Section 3.3). If allowed this would be subject to strict conditions as set out in Section 3.3.6. The primary control, i.e. the restriction of vegetation height to 2 m will not affect the main staple crops such as cassava and as such limited land use change would be required under these restrictions. These crops could therefore continue to be farmed, along with low shrub crops although tall tree crops would not be permitted. Burning within the wayleave is also not permitted.

The only agricultural land use that would be affected by the development (if farming were permitted) would therefore be tall crops, primarily being fruit trees, oil palms and bananas. Where these types of crop were originally identified they will not be allowed to be regrown during the operational phase.

However, as discussed in Sections 3.3.6 and 6.3, the project area is to be compensated in its entirety for land ownership and existing use. Therefore the right to use the land will lie with AES SONEL for the Kribi Power Project. Any farming that is undertaken within the line will be undertaken at the risk of the farmer as AES SONEL will have the right to remove crops and vegetation cover within the designated wayleave if necessary for maintenance. As such the base case assessed for the ESIA is that all existing land uses within the wayleave and the 16 ha for the plant area will be lost.

Decommissioning

At decommissioning there will be no on-going restriction on land use within the wayleave and the area can revert to the current or other desirable uses.

Decommissioning allows mitigation of the impacts caused during construction and operation, via removal of land use restrictions. Therefore there are no identified impacts during this phase.

Soil contamination

Where oils and chemicals are being used or stored the potential exists for spillage to occur and soil contamination to result. Where this occurs, future land use potential will be reduced as the ground will not be productive or be in a suitable state for future built development. In addition such spillage has the potential to impact on both ground and surface water systems.

Construction

A majority of the equipment and materials used during the construction of this project are not potentially contaminative (steel for towers, conductors, concrete, etc.). The main sources that do exist are fuels and oils held at the construction compound and any mobile fuel bowsers (or large equipment fuel tanks) operating at the construction sites.

Contamination may also arise by the uncontrolled disposal of waste material at the plant site compound or construction sites. This may include off-cuts of wire, waste oil containers, packaging, etc. This can impact the current land use and may also affect local wildlife.

Operation

During operations the only significant potential sources of soil contamination are the fuel oil storage tanks used to hold the diesel required for firing the turbines during gas shut off, oil filled transformers and other oil filled equipment at the substation sites. Any large scale discharge or long-term, low volume leakage from these could result in ground contamination.

Decommissioning

The decommissioning works will in effect be a reverse of the construction operations. As such, the use of machinery on the plant site and along the transmission line to facilitate dismantling and removal of buildings and materials, results in a potential for spillage of fuels and oils and therefore further soil contamination.

Soil erosion and loss

Construction

The principal risk from soil erosion on a power line project derives from the access roads that are created to, and along, the wayleave. These are usually cleared of vegetation and as they will generally be lower than the surrounding ground, either due to soil removal or compaction of soil by heavy traffic, they tend to act as channels so concentrating surface water flows. This concentration of flows and the removal of surface protection, i.e. the vegetation, result in risk of erosion.

At the plant site the re-grading of the site will be required to provide suitable foundation levels for the construction works. This will involve removal of all vegetation and disturbance of the surface soils. Where bare ground is left exposed to rain, the potential exists for run-off and erosion with discharge of silt off site.

Where erosion occurs the long-term use of the land can be reduced due to depletion of the soil resources and silts can run off into surface water streams causing sedimentation and turbidity problems. However, as the maintenance of permanent tracks along the wayleave is not planned and the plant site will be built on, with any large areas of bare ground either covered with hard standing or allowed to naturally re-vegetate, these potential impacts relate only to the construction phase.

Operation

There are no identified impacts on soil loss through erosion during the operational phase of the project.

Decommissioning

As discussed for soil contamination, the decommissioning works will in effect be a reverse of the construction operations. As such the creation of bare ground following removal of plant and building, particularly at the plant site, creates the potential for erosion and further soil loss and impacts on the surface water resources of the area.

5.8.3 Mitigation Measures

Direct loss of land

The land take at the plant site and at each of the transmission line tower sites is fixed by the basic design requirements of the power project. Therefore there are no specific mitigation measures in relation to restricting the area of permanent land take by the project. However the transmission line route and the siting of the power plant site has been undertaken to avoid existing properties and important land uses, such as the palm oil plantations, so as to minimise the overall impact.

In relation to the impact on the land take that is required for the transmission line towers, there is flexibility in the final location of each structure. Therefore should a transmission line tower be in a sensitive location in terms of land use (restricting agricultural access or within the middle of a small field system), then the transmission line tower may be moved

by up to 50 m from the basic 350 m spacing. During final siting of the tower existing land uses will therefore be taken into account to minimise disturbance.

At decommissioning all land will be restored to its current, or suitable alternative, land use and therefore reverse the construction and operational impacts.

Land use change

During construction, the area of land to be occupied for the project will be minimised by controlling access routes to each individual transmission line tower construction site and by educating workers to be aware of cropping areas so controlling the total area of disturbance. This requires good on-site management to ensure trucks, etc. are not indiscriminately driven around site and materials are held in single locations and not spread about.

During operation the general practice from other power projects undertaken in Africa is that agricultural activity should not be conducted within the wayleave. This is the base case for this assessment and has the potential to impact on rural livelihoods, family incomes, etc. These impacts will be mitigated via compensation payments (see Section 6.3). However, a potential further mitigation measure would be to allow agriculture to continue within the wayleave but within the guidelines set out for vegetation management within the wayleave (see Section 3.3.6).

As noted above a total of approximately 285 ha of new land take within the wayleave will be subject to this restriction.

Soil contamination

The main method for the mitigation of potential fuel and oil contamination is to contain all bulk storage (suggested as any container greater than 200 l) within a sealed bund with a capacity sufficient to contain any spills. Where single bulk tanks are used (such as for the fuel oils) then the bunded area will have a minimum capacity of 110% of the volume of oils contained within it. If multiple small containers are being stored and these are not interconnected, then the bund will have a capacity equivalent to, at least, 25% of the total volume being stored, or 110% of the largest tank, whichever is the greater. All bunds will be regularly inspected to ensure they do not become full of rainwater and to ensure their integrity. All delivery and discharge pipe work and pumps will also be enclosed within the bunds and delivery points will be on hard standing with drainage to a collection sump. Where pipework leads from the storage tanks to the turbines all pipework will be above ground to allow easy inspection.

In the case of waste management, all materials delivered to site will either be utilised or removed following completion of each section. The site operations will be controlled by an environmental management plan (EMP) which will identify the key types of waste that will be generated and their appropriate handling and disposal. A framework EMP for the project is included in Section 7 of this report.

At the substation sites all transformers will be constructed on oil catch pits capable of holding the entire volume of oils contained within the equipment. These pits will be regularly inspected to ensure no accumulation of rainwater.

At decommissioning the sites will be investigated to identify any soils contamination and where present will be remediated or removed from site to a suitable disposal facility.

Soil erosion and loss

A number of options are available for the control of soil erosion during the construction phase of the operations. These include:

- minimising the area of ground clearance that is required for the operations;
- restricting activities during the rainy season when soils are in a saturated condition;
- controlling run-off from working areas into soakaways or retention ditches to restrict concentration of flows;
- grading of tracks to avoid long runs down gradient without regular run-off discharge points;
- preserving all topsoils that are stripped for reuse in revegetation post construction;
- rapid revegetation of areas following construction;
- use of geotextile, gravel surfacing or other physical methods to cover bare ground where areas of high risk occur.

The ground condition at each site will vary and as such the measures appropriate to each site will differ.

5.8.4 Evaluation of Mitigated Impact

Direct loss of land

Construction / Operation

There are no impacts on direct loss of land arising from the decommissioning phase. Therefore impacts relate only to construction/operation.

The total, temporary, direct land loss (for the 15 month construction period) and permanent direct loss of land to this project are approximately 8.25 ha and 4.75 ha respectively. On the basis of the overall land use within the area this would split into approximately 30 - 40% loss of forest cover, 40 – 50% fallow lands and 20% loss of farmland.

The main soil types of this region are intensively weathered, nutrient poor, low pH and of limited agricultural capability. This has resulted in mainly subsistence farming and shifting agriculture to allow soils to recover following a period of cropping. The area therefore has a low overall land use capability. Survey data on land use support this status. Apart from the commercial oil palm plantation, most formal land uses within the project area are low intensity subsistence farming.

Land availability is not a limiting factor in the region as population densities are low and the poor soils of the region have not attracted large-scale agriculture. Therefore the small scale

loss of land use to this development will not result in a significant impact on the overall soil and land resources within the district. However where farm land is taken then the livelihood of the local population may be affected. This impact will be assessed as part of the socio-economic studies (see Section 6.3).

Due to the poor soils, the low land use capability of the affected area and the small-scale overall permanent loss of land, impacts from the direct loss of soils and land use are assessed as insignificant.

Land use change

Construction / Operation

Overall approximately 285 ha of land within the wayleave and the full 16 ha within the plant site will be subject to land use change. As approximately 80% of the wayleave and plant site is within areas of forest cover the principal impacts of wayleave clearance will be on the flora and fauna of the district. This is assessed within Section 5.9.

Within the remainder of the area the main impact is on subsistence farming communities and a small area of a large scale oil palm plantation. In terms of impacts on farming the loss of potential revenue and the need to relocate properties and land will be the most significant impacts. These are discussed within the social impact assessment (see Section 6.3).

In terms of the current soils and land resources of the area the loss of land use within the project area is small and the availability of alternative areas large. Therefore the overall impact of wayleave clearance on soils and land use is defined as insignificant.

Soil contamination

Construction / Decommissioning

During construction the volumes of fuels and oils held in any one place will be relatively low as bulk storage is not required. Whilst a spillage will cause soil contamination the overall area affected will be limited and clean up of any spills will not be problematic. In addition basic measures will be taken in terms of bunding and containment of any stored materials so as to stop direct discharge to the environment.

Operation

As a gas-fired power plant with fuel oils used only as back up ongoing large scale storage and use of fuels will not occur. However large scale fuel storage will be required on site (up to 2,000 m^3) and this represents the main potential risk. However control systems for bulk fuel storage and handling are in common use throughout the world and if correctly managed are fully effective at preventing spillage to the environment. The main risk period is during delivery and discharge from store and, in addition to the physical control measures to be constructed, operating procedures for these will be developed. However delivery and discharge will only occur a few times per year.

The overall potential for impacts from soil contamination is therefore assessed as adverse, long-term but minor in terms of significance.

Soil erosion and loss

Construction / Decommissioning

The risk of soil erosion applies only to the construction and decommissioning phase of the project.

The current intention is not to create cleared access roads with stripped soils leading to the wayleave or along the wayleave itself. The transmission line runs close to the main Kribi Edéa road for its entire length and therefore the need for long access tracks does not exist. However trafficking of vehicles off road, particularly in the wet season may result in rutting and areas of bare ground that may be subject to erosion.

At the plant site a large area of ground will be cleared with bare soils left exposed prior to completion of construction. Whilst the duration of the construction will be relatively short, as the site is within an area of high rainfall short-term erosion potential does exist. However by restricting the main earth works and site clearance to the dry season risk can be minimised.

The overall potential for impacts from soil erosion is therefore assessed as adverse, short-term but minor in nature.

5.8.5 Evaluation of alternative development options

The adoption of any of the proposed project alternatives would not significantly alter the overall impacts on soils and land use of the proposed development.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project, however during the environmental assessment of the project no significant impacts on soils and land use have been identified.

5.8.6 Conclusions

There are no identified potentially significant impacts on soils and land use arising from the development of this project. Overall land take for the plant site and transmission line are relatively low and impacts that have been identified have all well developed and tried and tested mitigation strategies available. A summary of the overall identified impacts is set out in Table 5.8.2.

Table 5.8.2: Summary of Impact Evaluation – Soils and Land use

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	C/O	Land take	Construction of the plant site	Land use and soils	Adverse	Long-term	Insignificant
	C/O	Soil contamination	Use of fuels and oils	Soils	Adverse	Long-term	Minor
	D	Soil contamination	Use of fuels and oils	Soils	Adverse	Short-term	Minor
	C/D	Soils erosion	Construction activity	Soils	Adverse	Short-term	Minor
Transmission line	C/O	Land take	Construction of towers	Land use and soils	Adverse	Long-term	Insignificant
	C/O	Land use	Change of land use in wayleave	Forest areas, farm land	Adverse	Long-term	Insignificant
	C	Soil contamination	Use of fuels and oils	Soils	Adverse	Long-term	Minor
	D	Soil contamination	Use of fuels and oils	Soils	Adverse	Short-term	Minor
	C/D	Soils erosion	Construction activity	Soils	Adverse	Short-term	Minor

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

5.9 FLORA AND FAUNA

5.9.1 Baseline Conditions

General Setting - Coastal Belt

The Kribi Power Project is located in the Biafreen district of the Nigero-Camerouno-Gaboneese, Evergreen Forest Sector (Letouzey 1985). The sector lies as an arc around the Bay of Biafra. Floristically, this forest is known to be part of one of the most species-rich areas in Africa and therefore is very important for conservation (Tchouto 2004). The sector is unique in the world, hosting species of high conservation priorities (e.g. endemic, rare, new and threatened plant species).

This forest has been studied by many authors and in various aspects. Recent intensive botanical and ecological surveys have been undertaken within the coastal forests, such as within the Campo Ma'an National Park. Tchouto (2004) recorded 114 endemic species, 29 of which are only known from this area. The site is also known for its rich fauna, with four endemic fish species and 2 endemic bat species (Vivien, 1991). The explanation for this high incidence of endemism and richness stems partly from the fact that the sector is close to the series of rain forest refuge areas in Central and West Africa (Hamilton, 1982; Maley 1987. Sosef 1994, Achoundong 1996, 2000) and is within an area of under high humidity with more than 3000 mm of rain.

The coastal section of the district is a vulnerable ecosystem due to its limited area and ease of access. From north to south the coastal forest extends from Nigeria to Gabon. From west to east the width rarely exceeds 150 km. However the first roads in this region were built along this belt and in the century since the road building started, a large proportion of the suitable land along the road network has been disturbed (Dames and Moore, pers.comm. 1999). This easy accessibility has resulted in intense human pressure on the habitat and the natural vegetation has been heavily disturbed by human management (economic investment, farm and industrial plantation). This disturbance has created a new vegetation unit within the district, mapped by Letouzey as "unit 251".

This unit represents the degraded littoral forest. It extends along towns and roads with the main habitats being permanent settlement, rare perennial industrial farms, newly cultivated areas, shrub fallows, old fallows and fragments of natural forest. The main vegetation comprises: *Eupathorium odoratum, Lantana camara, Cnestis ferruginea, Desmodium adscendens, Haumania danckelmanniana, Hekistocarpa minutiflora, Megaphrynium macrostachyum, Nephrolepis biserrata, Scleria boivinii, Selaginella myosurus.*

Trees appearing in this habitat are: *Harungana madagascariensis, Albizia adianthifolia, Anthocleista schweinfurthii, Cleistopholis patens, Discoglypremna caloneura, Duboscia macrocarpa, Homalium letestui, Pycnanthus angolensis, Xylopia aethiopica.*

General Setting – Project Area

The plant site and the transmission line corridor are both situated within the disturbed habitats along the corridor of Edéa / Kribi road and the exiting 90kV transmission line. Along the new transmission line route, shifting agriculture is widespread, occupying most of the road corridor with only a few patches of natural forest occurring. These are restricted to

deep valleys, rocky hills, riparian forest, forest on swampland or within patches of sacred forest.

This area will therefore be typical of degradation of littoral forest (Letouzey unit 251) and important wildlife species and sensitive plants are likely to have disappeared or be reduced in number.

To confirm the status of the project area baseline ecological surveys were undertaken.

Project Area - Flora

Method

Two methods were applied to establish the flora status of the project area. These were:

- Rapid Botanical Survey (RBS); and
- Tree plots survey.

For the tree plots survey plots, measuring 0.25 ha each (50 m x 50m), were delineated in order to understand the structure of the natural vegetation, the characteristic species and to quantify key forest resources such as timber species and Non-Timber Forest Products (NTFPs). Within the plot, all trees over 10 cm diameter at breast height were measured and identified. The plot data therefore provided density measurements of important species.

To complement the survey, tree inventories within each plot were undertaken and botanical collections made for identification at the National Herbarium. During this collection, emphasis was given to shrubs and herbaceous species.

Applying the RBS method, four tree plots were selected within the Plant site and nine plots selected along the transmission line - at Sonkoare, Fifinda II, Finfida I, Bivouba, Appouh, Koukoue, Edéa.

Plant site

The plant site covers an area of 16 ha consisting of recent scrubby fallows, old fallow and patches of disturbed forest. A small proportion of the site is occupied by cultivated crops including banana and cassava. Fallow areas are generally covered with pioneer vegetation and have a low conservation value.

The patches of natural forest have been heavily disturbed. Logging operations have extracted big selected timber with the last logging operation occurring in 1984. Signs of logging such as old logging roads are still visible. However by contrast to the fallows, the disturbed forest still has some ecological value. They support habitats with rare plants and are habitats for small animals but have little importance for larger wildlife species.

To assess what natural value might remain in these degraded habitats, four tree plots with a total surface sample area of 1 ha were surveyed. Within the sampled area a total of 499 trees of diameter bigger than 10 cm were recorded with a total of 94 species. The average diameter was 19.5 cm with the largest at 90 cm *(Desbordesia glaucescens)*. *Coelocaryon preusii* is the most abundant species with a total of 53 stems. The others abundant species

were *Tabernaemontana crassa, Santiria trimera, Anthonotha macrophylla* and *Dichostemma glaucescens.*

Appendix J shows the list of 94 most common trees in the forested part of the Plant Site. In addition to the species recorded within plots, some important species with diameter less than 10 cm have been collected. These are *Rinorea verrucosa, Rinnorea longisepala* and *Rinorea mezilii.*

Transmission line

From Kribi to Edéa, the transmission line will cross several habitat types. The most common are: disturbed Riverine forest, disturbed swamp forest, disturbed Raphia forest, fallows of various ages and mature forest on rocky soil. Table 5.9.1 summarises their characteristics.

Table 5.9.1: Plots Sampled Along the Transmission Line

No	Plot Id.	Place Name	Location	Biggest Tree	Species with Conservation Value
1	BA 10/7	Sonkoare	Riverine forest	Hallea ciliata 95 cm	Rinorea mezilii Rinorea verrucosa Rinorea longisepala
2	KE 06/7	Fifinda	Swamp vegetation	Hallea ciliata 27 cm	Cola hypocresea Cola filicifolia
3	BA 10/7	Fifinda	Raphia forest	Beischmiedia obscura 90 cm	Rinorea kamerunensis
4	KE 13/5 KE 13/6	Bivouba	Riverine forest	Coelocaryon preussii 63 cm	Rinorea kamerunensis
5	KE/9	Sah	One old fallow		
6	P21/2	Bonguen	Fallow		
7	BR 33/1 BR 3		Home garden		
8	KE 30/6		Home garden		
9	P/166=KE P/164 = KE 33	Dizangue Road	Old fallow	Anthocleista schweinfurthii 24 cm	
10	KE/28/1 BA 28/9	Koukoue	High forest	Antrocaryon micraster 93 cm	Allexis cauliflora Podococcus barteri Rinorea longisepala
11	KE/25 P25/1	Appouh	High forest on rocky soil	Antrocaryon micraster 119 cm	Rinorea caudata Rinorea sp

Table 5.9.1 demonstrates that despite severe degradation, some large trees are still present as is the case for *Antrocaryon micraster* and *Hallea ciliata*. Some areas are still relatively well forested with rich flora (plot 10 and plot 11). These patches of forest still host a few species

of important conservation value e.g. *Cola hypochrysea, Cola filicifolia* and many species belonging to the genus Rinorea. These two plots show the best structure of natural forest within the survey area. Within plot 11, three stems with diameter exceeding 100 cm were recorded. These trees are: *Antrocaryon micraster, Celtis tessmannii, Piptadeniastrum africanum*. *Rinorea caudate*, which is typical of "Nigero-Camerouno-Gabonais" as well as *Rinorea sp*. which is a new species. Pioneers were rare within this plot. This area has escaped being cleared for farming because the soils are too rocky and the area is not easily accessible to loggers.

The total surface sampled along the Transmission Line was 2.75 ha. 635 stems of diameter greater than 10 cm and 114 species were recorded. *Antrocaryon micraster* was the biggest tree identified with a 119 cm diameter. The structure of the forest is as follows:

- 3 stems >100 cm;
- 21 stems 100 cm to 50 cm;
- 61 stems 50 cm to 30 cm;
- 130 stems 30 cm to 19 cm;
- 420 stems 19 cm to 10 cm.

Appendix K shows the 114 most common tree species sampled along the transmission line. *Allexis caulliflora, Rinorea kamerunensis, Podococcus barteri*, are smaller plants but with important conservation value and diameter less than 10 cm.

Biodiversity evaluation

Merging the plant list of Appendix J and Appendix K, a list of plants that may be affected by the Kribi power project can be established. A total of 150 species with diameter bigger than 10 cm have been recorded, 94 within the Plant Site and 114 along the Transmission Line, some species being common to both. A complete list is presented in Appendix L along with their conservation status.

To define the floristic richness, bio-indicators in the distribution area in Africa and the conservation value have been identified. It is noted that species of the genus Rinorea are excellent indicators of forest type and are useful for evaluation (Achoundong 1996, 2000). The following key bio-indicator groups are set out below:

- **Endemic to Cameroon: 2 Species.** - *Rinorea mezili* sp. This is a new species found in the plant site and in some plots along the transmission line. It is in the process of being published in Adansonia, a specialised review of Museum National de Paris, and has not yet been recorded outside of Cameroon. It is, however widespread in the south part of Cameroon's littoral forest. The species has been identified in Sole forest reserve and Edéa-Douala forest reserve.

  Rinorea sp. This species is present from the Edéa area down to Sole near Yabassi and is therefore also widespread in this part of Cameroon.

- **Sub-endemic: 5 species** - *Drypetes preussii*: found in Cameroon and SE Nigeria, *Leonardoxa africana*: Found in SE Nigeria, Cameroon, North Gabon, and *Rinorea verrucosa, Rinorea longisepala, Rinorea kamerunensis*.

Conservation potential

This evaluation has been conducted using the IUCN categories: l'UICN (2001), version 3.1.

Critically endangered (**CR**): None found.

Endangered species *(*EN*)* : 1 species - *Diospynos crassiflora* Assessed by Tchouto (2004).

Vulnerable species (VU) : 15 species - *Allexis cauliflora, Afzelia bipindensis, Erythrophleum suaveolens, Lophira alata, Rauvolfia vomitoria, Coula edulis, Cola hypochrysea, Irvingia gabonensis, Antrocaryon micraster, Daniellia oblonga, Drypetes preussii, Pausynistalia yohimbe, Guarea thomsonii* and *Xylopia Africana.*

It is noted that only 15 species from the 150 identified (10%) are vulnerable, with moderate impacts from loss and only 1 endangered. The impact is attenuated in this area by the presence of these species in all Lower Guinea forest.

Figure 5.9.1 shows the percentage of each IUCN category within the plant species recorded in the Plant Site and the Transmission Line corridor. This shows that very few species of important conservation value occur within the project area.

Conservation value

To evaluate the conservation value of species, the indices method of Hawthorne based on "star rating" which is adapted in Cameroon by Tchouto (2004) has been used. The 150 species recorded within the survey are classified as follows:

- **Black star** (GHI Weighting = 27): endemic to the site and neighbouring area. High conservation value: **0**.

- **Gold star** (GHI Weighting = 9): endemic to Cameroon and present within the area. Critical danger of extinction. High conservation value : **5.**

- **Blue star** (GHI Weighting = 3) : not endemic, rare, in danger of extinction or vulnerable. Intermediate conservation value: **21.**

- **Red star**, **Pink star, Green star**: (Weight = 1: not endemic, wide spread, not threatened, no particular conservation importance (Red : 3, SC : 3 ; Pink : 18 ; Others : 100).

The great majority of the species have very low important conservation value. Figure 5.9.2 presents the percentage of each star category within the plant species recorded in the project area. It shows that very few species of important conservation value occur within the area.

Useful plants

Plants are used as food, medicine and construction materials within the project area. The presence of plants within each category is set out within Table 5.9.2 and Table 5.9.3.

Table 5.9.2: Edible Plants Sold at Kribi Markets

Scientific Name	Local Name	Plant Family	Part Used
Baillonella toxisperma	Adzap	*Sapotaceae*	Seeds
Irvingia gabonensis	Ndo'o	*Irvingiaceae*	Seeds
Santira trimera	Ebap	*Burséraceae*	Fruits
Monodora myristica	Nom Nding	*Annonaceae*	Seeds
Ricinodenron heudelotii	Djassan	*Euphorbiaceae*	Seeds
Gnetum Africana	Eru	*Gnetaceae*	Leaves
Gnetum buchholziamum			
Treculia africana	Etup	*Moraceae*	Seeds
Xylopia aethiopica	Akui	*Annonaceae*	Fruit
Vitex grandifolia	Evoula	*Verbnaceae*	Fruit
Canarium schweinfurtii	Aele	*Burseraceae*	Fruit
Coula edulis	Ewomé	*Olacaceae*	Seeds

Table 5.9.3: Medicinal Plants Sold in the Area

Scientific Name	Name	Family	Part Used	Therapeutic
Pausinystalia yohimbe		*Rubiaceae*	Bark	Afrodisiac
Annickia chlorantha	Mfol	*Annonaceae*	Bark	Virus attack
Mammea africana	Abotzok	*Clusiaceae*	Bark	Infection
Rauvolfia vomitoria	Medjanga medjanga	*Apocynaceae*	Bark	Malaria, hypertension
Morinda lucida	ikeng	*Rubiaceae*	**Bark**	Indigestion
Alstonia boonei	Ekuk	*Apocynaceae*	**Bark**	Malaria
Hallea stipulosa	Afropzam	*Rubiaceae*	**Bark**	Hypertension

For house construction, *Coula edulis* and *Distemonanthus benthamianus* are very good wood materials. Authers timber trees are*: Piptadeniastrum africanum, Antrocaryon micraster, Pycnanthus angolensis, Staudtia stipitata, Pterygota milbraedii Carapa procera, Afzelia bipindensis, Erythrophleum suaveolens, Lophira alata, Pterocarpus soyauxii.*

Ratangs: *Calamus doeratus, Ancistrophyllum secundiflorum* and *Eremospatha wendiana* are quite valuable plants in the area with multiple uses. These species are encountered in very limited quantity within the corridor, restricted mainly to riparian forests. However active trading of this material between Kribi and Edéa exists.

The bark of *Cleistopholis patens* (Annonaceae) and raphia leaves are used as fibres and **e**xtract from ***Morinda lucida*** (Rubiaceae) bark give colorant.

Conclusion

A large majority of the plant species identified within the project area are common in littoral forests and all are found in Douala Edéa reserve. Most of them are also present within Mankombe proposed Reserve.

Overall the conservation value of the project sites is very low due primarily to the level of existing disturbance resulting in a severely degraded habitat. It is very poor in bio-indicators of important value and none of the species identified require special protection.

Baseline – Fauna

Background

The Plant Site and the Transmission Line are situated in an area of disturbed habitat along the existing road and transmission line corridor. Due to the level of disturbance and the presence of villages along this route the fauna of this zone is restricted to small mammals, snakes and insects. There are no faunal species specifically associated with this disturbed habitat, most animals found usually being associated with the neighbouring forest.

Hunting in the area is also common, although this tends to be restricted to traditional traps. Most of this hunting is within the neighbouring forest habitats as animal species are rare within the project area.

Survey Method

The assessment of the fauna of the project area was undertaken primarily through discussion with local hunters. This was supported by observation along the route to aid confirmation of some of the information collected. Visits were also made to restaurants and bush meat markets.

The main data came from 3 hunters from Mabi tribe at Mpolongwe, 3 hunters from Ewondo tribe at Fifinda village, 3 from Bakoko and 3 from Bassa.

Data

From the information received species common to at least two tribes were selected. These species are present in Table 5.9.4 below.

Table 5.9.4: Fauna Species Identified During the Survey							
Scientific Name	**Common Name**		**Local Name**				
	Anglais	Français	Mabi	Ewondo	Pygmées	Bakoko	Bassa
Lepus crawshayi	Hare	Lièvre a oreilles de lapin	Okoun	Opkweng	Nkouan		Hisee
Cricetomys gambianus		Rat de Gambie	Kou	Koussi	Kou		Koossi
Atherurus africanus	Hedgehog	Athérure	Foula-ngoubo	Mvep	Ngoubo		Mbep
Manis tetradactyle	Long-tailed pangolin	Pangolin à longue queue		Nka'a			Ka
Manis gigantea	Giant pangolin	Pangolin géant		Zokka Avil			Njock ka
Cercopithecus nictitans	White-nosed monkey	Singe noir nez blanc hocheur	Jigué				Bidé
Varanus sp		Varan		Nka			Ngomb
Cercopithecus neglectus		Singe de marécage et d'eau		Ndoua Mbi poun			
Cercopithecus mona	Mona monkey	Mone Queue noire				Ekouen	Bida
Cercopithecus erythrotis		Singe queue rouge				Ntet	Ntet koi
Vipera sp		Vipère		Apkwe			Péé
Viverra civetta		Civette		Zué			
Hystrix cristata	Crested porcupine	Porc-épic					Nyik
Singularis porcus		Sanglier	Ngou	Ngoué afane			Ngoi bikaï
Cephalophus rufitatus	Red-bellied dulker	Céphalophe à ventre blanc		Nzip			
Cephalophus cailipygus		Céphalophe à bande dorsale noire		Mvin			Limbo
Cephalophus leucogastar	Red-flanket dulker	Céphalophe à flanc blanc					
Neotrocus pygmaeus		Antilope royale		Ojoué Ojoé			Hitone Makon-do
Cephalophus sylvicultor	Yellow blacked dulker	Céphalophe à dos jaune		Zip			Ndjip
Crassarchus obscurus		Mangouste brune					
Ichneumia albicaula	Mongoose	Mangouste à long museau					
Myosciurus pumillio	African pygmy squirrel	Ecureuil petite queue		Osseng			
Funiscirus isabella		Ecureuil à quatre rayes		Assen kirimbeing			
Francolinus sp		perdrix					Hikwaa
Psittacus erithacus		perroquet					
Naja nigricolis		Cobra		Mkaa			

Some animals killed in the neighbouring forests were also being sold along the roadside. The most common were:

- *Cercopithecus erythrotis* - a small monkey with red tail. Five specimens were seen. This appears to be the most frequent in the area.
- *Cercopithecus mona* - a small monkey with black tail.
- *Cercopithecus patas* - a black monkey with white nose. Only one specimen was found.
- 4 - *Varanus sp (varan)* - a monitor lizard.
- 5 - *Lepus crawshay* - a hare.
- 6 - *Atelerix albiventrix (hérisson)* - This small mammal may be present within the corridor.
- 7 – *Vipera sp*. - This dangerous reptile (snake) can also be found in the corridor.

Evaluation

None of the animals identified during this survey are protected species and as such they do not have direct importance in terms of their conservation value. In terms of their fauna, the plant site and the transmission line therefore have a low conservation value. Most species recorded were also from the surrounding forest and not directly from the habitats within the project area. However they are used by the local population for both food and as a source of income (sale of meat). Most of the endangered larger mammals, reptiles and birds are absent even in the neighbouring forest.

5.9.2 Potential Impacts

The development of the Kribi power project will require the land take for the construction sites and vegetation clearance and on going management within the transmission line corridor. These requirements have the potential to cause a series on impacts on the flora and fauna of the area. These are summarised as follows:

- permanent loss of existing habitats and related biodiversity due to land clearance for construction;
- loss or alteration of habitat types due to clearance for the transmission line wayleave;
- habitat severance due to clearance of the 30 m wayleave through forest areas;
- potential for increased hunting, firewood collection and timber collection due to provision of new access to forest areas;
- disturbance of wildlife and potential increase in road kills, etc. due to project construction and operation activities.

Loss of habitats

Construction and operation

The construction activity for the Kribi power project will require a permanent land take at the plant site of 4 ha and a further 0.75 ha for tower construction along the transmission line wayleave. In addition to this a further 3.5 ha will be cleared during the construction phase for the establishment of a construction compound.

Within these sites the existing habitats, and any associated biodiversity and species of conservation value, will be lost. In the case of the construction compound this will be allowed to revegetat following completion of the construction works, but this area will be totally lost for the 15 month period and may not regain its former habitat type. Therefore for the purposes of this assessment this area is also assumed to be total loss of habitat.

Decommissioning

At decommissioning the potential exists for land taken for the development to be cleared of all construction and the vegetation cover allowed to regenerate. However, in terms of regeneration of the forest habitats, which are of most value, this would be a very long process. Decisions on the nature of the closure works cannot be defined until nearer the time of decommissioning and therefore the potential habitat regeneration cannot be defined at this point.

Alteration of habitat

Construction and operation

Along the wayleave for the transmission line the vegetation will need to be cleared at construction and then managed during the operational phase to ensure vegetation height does not exceed 2 m. This will therefore significantly alter any existing forest habitat and effectively result in the loss of any forest cover within the wayleave. In addition, tall trees (>15 m) on the edge of the wayleave will also need to be cleared.

The new power line will run parallel to the existing 90kV line for up to 40% of its route and therefore may share part of the existing wayleave, so reducing total new wayleave land requirements. However current design shows up to 30 m separation distances between lines and therefore a full new wayleave will be required for a majority of the new line route. For the purpose of this assessment it is assumed that a full 30 m wayleave will be required for the new line, so presenting a worst case scenario. In this case the total area of land within which the vegetation will be managed is approximately 280 ha to 300 ha.

Decommissioning

At decommissioning the power line will be removed and the vegetation allowed to grow back to full height, unless alternative land uses are proposed. If regrowth of the vegetation is permitted then following decommissioning the former habitats can regenerate. Decisions on the nature of the closure works cannot be defined until nearer the time of decommissioning. However, regeneration of the forest habitat will be a slow process.

Habitat severance

All phases

The clearance of a near 100 km, 30 m wide corridor of all tall vegetation can lead to habitats being bisected and passage across the wayleave restricted, particularly for tree dwelling mammals. For the Kribi power project, the wayleave may be up to 60 m in width where the new line runs parallel to the existing 90kV system but is not utilising that system's wayleave. Where this occurs, habitats can be effectively cut in half and the remaining areas within each half may be too small to support populations of fauna that previously existed within the larger unit.

However, within the context of the Kribi power project area, this potential impact is deemed insignificant. The wayleave corridor has been designed to follow the existing highway from Edéa to Kribi and, as noted above, to follow the line of the current 90kV system. In addition to this, all villages and remote settlements within the project area are located along the main road. These settlements rely largely on agriculture for subsistence and therefore a significant degree of forest clearing has been undertaken. As set out within the baseline, the forest is also degraded in nature due partly to this farming, but also due to logging activity.

The road, transmission line and agricultural clearance along the road have therefore caused a major severance between the forest to the west and east of this corridor. In addition the degradation of the forest means that the habitat in this area is already relatively poor. Impacts on habitat severance are therefore assessed as insignificant and are not assessed further within the ESIA.

Increased access for hunting, etc

All phases

The creation of new road access into forest areas and the clearance of wayleaves allowing easier pedestrian access can result in increased hunting and forest clearance activities within areas previously undisturbed. This is a common potential impact from power line development where routes pass through areas with poor access or undisturbed areas.

However, as with the potential effects of severance, the location of the wayleave route will effectively remove this potential impact. The construction follows the existing main highway and few new access roads from this highway to the wayleave are required. In addition the new line follows the route of the existing 90kV system. Full access therefore already exists into the areas that will be affected by the wayleave and therefore no new impacts will be caused. This potential impact is not therefore evaluated further within the ESIA.

Disturbance of wildlife

Construction

During the construction phase the physical activity on both the transmission line and plant sites will create noise and general disturbance which has the potential to disturb local fauna. This may lead to animals leaving an area. In addition construction traffic on roads has the potential to increase the risk of road kills for any animal crossing the transport routes. This

applies only to the Edéa / Kribi section of the route as the Douala / Edéa section has a moderately high existing traffic volume and the project will increase this by only some 5%. On the Kribi section traffic volumes may increase by up to 100%.

Operation

During operation there will be no significant increase in traffic on the road network and no regular activity along the transmission line corridor. Potential impacts therefore relate only to the plant site.

At the plant site the main disturbance will be from noise generated by the power plant itself. Traffic will enter the site each day but volumes will be very low and maintenance and operational activity will be undertaken, but again these are relatively minor in terms of potential impacts on wildlife. However, as set out in Section 5.6, the power plant will generate increased noise levels within the site and therefore within the forest habitats surrounding the site.

Decommissioning

Decommissioning activity has the potential to have similar impacts to those from the construction activity. However, as decisions on the nature of the closure works cannot be defined until nearer the time of decommissioning the actual level of activity and traffic generation cannot be defined.

5.9.3 Mitigation Measures

The only potential impacts that may arise from the proposed Kribi project relate to the loss or alteration of habitats and disturbance to wildlife. The principal measures for the mitigation of these impacts are as follows:

Loss of habitats

- minimise the area of land take during the design process;
- locate project elements within already disturbed areas such as use of existing road and wayleave corridor for transmission line.

Alteration of habitat

- management of the vegetation within the wayleave to maintain the maximum cover permissible (up to 2 m);
- as for habitat loss, locating project elements within already disturbed areas such as use of the existing road and wayleave corridor for transmission line will reduce the area of good habitat affected.

Disturbance of wildlife

- control of noise and areas of operation as far as is practically possible;
- control of vehicle traffic speeds.

5.9.4 Evaluation of Mitigated Impact

Loss of habitats

Construction and operation

The total loss of habitat, i.e. land cleared for construction of the plant site (including the construction compound) and the transmission line towers, equates to approximately 7.75 ha in total. In overall habitat terms for this part of Cameroon this represents a small area. The project is located in an area of extensive forest and there are protected forests reserve (none of which will be directly affected) to both the east and west of the project area.

In addition, the project area is located along the existing main road networks and close to existing power lines. The presence of this road and the villages along it have resulted in significant degradation of the original forest habitats. Although some species of conservation importance were identified during the baseline survey, overall, the conservation value of the area affected is assessed as low.

This combination of a relatively small area of loss, the low conservation value of the areas affected and the extensive forest habitat within this part of Cameroon, result in an assessment of the impacts of the loss of habitat as being adverse long term, but minor in significance.

Decommissioning

At decommissioning, assuming all areas are cleared of built development and the land restored to its former use, then the loss of habitat can be reversed. However, this would be a long term process and impacts cannot be evaluated until decisions on final land use are made. However this phase has the potential to provide partial mitigation to the impacts of the former phases.

Alteration of habitat

Construction and operation

The alteration of habitat relates entirely to the clearance of vegetation within the 30 m wayleave for the transmission line. Within this zone all vegetation has to be managed to ensure it does not exceed 2 m in height. Therefore any existing forest vegetation will be removed and the habitat effectively lost.

On the basis of the worst-case assumption regarding new clearance for the wayleave, then the total area affected will be between 280 ha to 300 ha. The land use survey undertaken by AES SONEL has identified that approximately 20% of the transmission line route is occupied by agricultural land, 40 – 50% with fallow lands and the remaining 30 – 40% is forest. On that basis approximately 110 ha to 120 ha of forest cover will be affected.

Whilst this represents a relatively large area of forest, the significance of the impacts relates primarily to the current conservation value of the area lost. As noted within the baseline section, the forest cover within the project area has been subject to severe degradation as a result of logging activity, clearance for agriculture and timber and fire food collection by the local population. The location is along a good transport route allowing easy access into the

areas affected by the project and therefore the degree of degradation from these activities is significant. The overall conservation value of the area is therefore defined as low.

On the basis of the level of existing disturbance, the resultant low conservation value of the forest within the project area and the extensive forest that exists within this part of Cameroon, the overall impacts is assessed as adverse long term, but minor in significance.

Decommissioning

At decommissioning, assuming all areas are cleared of built development and the land restored to its former use, then the loss of habitat can be reversed. However, this would be a long term process and impacts cannot be evaluated until decisions on final land use are made. However this phase has the potential to provide partial mitigation to the impacts of the former phases.

Disturbance of wildlife

Construction

The potential for disturbance of wildlife and risk of road kills relates to two main factors: first the degree of additional activity that will be introduced by the proposed development and second the presence of faunal species within the area that may be affected.

For the construction phase the works will affect both the plant site and along the transmission line. At the plant site significant activity will be undertaken for the full 15 month construction phase. However works on the transmission line will move from area to area as sections of the line are complete. Therefore the duration of disturbance at any one location will be short. In addition to the general construction activity, additional traffic on the Kribi / Edéa road, up to 100% increase at peak period, will create a greater risk of road kill. Significant new activity, and therefore potential for disturbance to wildlife, will therefore be introduced during the construction phase.

However, the faunal species in the area do not include any large mammals and the degraded nature of the forest along the road network, the disturbance of the area by farming activity and existing traffic and the relatively short period of the construction phase act to reduce the significance of these impacts. During the baseline line survey no endangered or protected faunal species were identified. In addition, most of the species recorded were present within the forest away from the main corridor, not within the project area itself.

The overall impacts from this phase of the operation are therefore assessed as adverse short term, and minor in significance.

Operation

The impacts from the operational phase relate only to the noise and periodic maintenance activity at the plant site. No regular works are conducted along the transmission line that would have any major impacts on wildlife.

The power plant will generate elevated noise within the forest areas surrounding the plant site during the operational phase. This does therefore have the potential to impact on wildlife. However, the noise will tend to be continuous in nature rather than with

fluctuations in both volume and character. Constant noise generation has less impact on wildlife than highly variable noise sources.

As noted within the baseline section, the faunal diversity of the area is low and no protected species were identified within the survey. As such the impact on faunal species during the operational phase is assessed as adverse long term, but insignificant in nature.

Decommissioning

During the actual decommissioning activity the disturbance cause by noise etc. will be similar to that of the construction phase. Once decommissioning is complete, all disturbance from the power project will be removed and no further impacts will arise.

5.9.5 Evaluation of Alternative Development Options

None of the project alternatives has a significant effect on the overall potential impacts on the flora and fauna of the area arising from the proposed development.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However no significant impacts have been identified.

5.9.6 Conclusions

The flora and fauna assessment for these studies have identified the habitats within the project area to be either subsistence agricultural areas or severely degraded forest. The access into the area created by the road, the presence of local villages, former logging activity and the existing transmission line wayleave all contribute to this degradation. The overall conservation status of the areas, for both flora and fauna, is therefore low.

Whilst the development will result in the loss and alteration of this habitat, and has the potential to cause disturbance to wildlife, the overall area of impact is relatively low and due to the current level of disturbance within the area, overall impacts are minor (see Table 5.9.5).

Table 5.9.5: Summary of Impact Evaluation – Flora and Fauna

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	C/O	Land take for construction	Destruction of existing habitat	Flora and fauna	Adverse	Long-term	Minor
	C/O	Noise from site activity	Disturbance of wildlife	Fauna	Adverse	Long term	Insignificant
	C	Increased traffic	Risk of road kills of local fauna	Fauna	Adverse	Short term	Minor
Transmission line	C/O	Land take for construction	Destruction of existing habitat	Flora and fauna	Adverse	Long-term	Minor
	C/O	Clearance of wayleave	Alteration of existing habitats	Flora and fauna	Adverse	Long-term	Minor
	C	Noise from site activity	Disturbance of wildlife	Fauna	Adverse	Short term	Minor
	C	Increased traffic	Risk of road kills of local fauna	Fauna	Adverse	Short term	Minor

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

5.10 LANDSCAPE AND VISUAL

5.10.1 Baseline Conditions

The project area is located entirely within the coastal lowlands of southwest Cameroon (see Figure 1.1.2), which consists of flat alluvial coastal plains with mangrove and forest cover leading into slightly higher gently undulating lowland hills.

The project area itself is primarily within the lowland hills with a rural landscape of secondary rainforest and intermittent farming activity. The topography is one of very low rolling hills or hillocks and shallow valleys. Villages and associated land clearance are present along the transmission line route (which follows the main Kribi/Edéa road) and in the vicinity of the plant site. However, the natural forest vegetation dominates the landscape character of the area (see Photos 5.10.1 and 5.10.2) with settlement and agricultural clearings being secondary landscape features.

The major introduced features within this setting, that influence the landscape character of the project area, are the main Kribi/Edéa road and the existing 90 kV power transmission line that follows the approximate alignment of this road. The road has been recently improved and now comprises a 7 m wide carriageway with up to 1 m tarmac verge (see Photo 5.10.3). The 90 kV power line consists of self-supporting steel lattice towers of between 27 m and 33 m in height with a nominal 30 m wide wayleave within which all tall vegetation is removed (see Photo 5.10.4). Within the villages along the route low voltage local distribution power line poles are also present.

The general landscape character is therefore one of secondary forest vegetation with mature trees in excess of 30 m in height, on gently rolling low hills interspersed with human settlements, subsistence farming activity and a main road and power line infrastructure corridor. There are a total of 24 villages identified along the 99 km transmission line route.

In general terms the combination of tall forest vegetation and the low hills, presenting no high vantage points, results in very limited long distance views across the landscape from either the road or from houses within the villages along the transmission line route. From road and house level all main views are therefore limited to the close surroundings or occasional long views along the current road line.

The main change in this landscape character is around Edéa at the northern end of the transmission line route. Here the town and development around the urban fringe dominates the landscape character. The forest vegetation in this area has been cleared to a greater extent than along the rest of the route. Therefore the transmission line route, although avoiding the main developed area, will run through an area more suburban in nature for this final section. Due to the greater degree of clearing and the higher population density more extensive views are present from properties around Edéa.

At the plant site itself the forest vegetation cover is relatively dense with a good proportion of mature trees. A small clearing, heavily overgrown at the time of the site visit, is used for agriculture. The village close to the site (Mpolongwe) is also within tall vegetation and views are limited to the close surroundings of the properties (see Photos 5.10.5 and 5.10.6).

No areas of specific landscape protection, either international or national, were identified during the baseline assessment.

5.10.2 Potential Impacts

The baseline conditions defined as part of this assessment identified the main transmission line route and plant site as being primarily rural in character but including an existing 90 kV transmission line and the main road corridor. The current landscape therefore includes features of similar character to those that will arise from this development, i.e. a second transmission line, although the power plant will be a totally new element.

As a result of the current baseline the potential for the development to significantly impact the landscape and visual setting of the transmission line is limited in extent. However more significant impacts may arise from the development of the plant site. In relation to this issue impacts are only assessed for the operational phase. The main impacts are as follows:

- Clearance of vegetation along the wayleave for the transmission line route altering the landscape and visual setting of the area;
- Construction of new 40 m high voltage towers along the transmission line adding to the current landscape influence of the 90 kV lines; and
- Clearance and construction of the power plant, including emissions stacks, at the plant site, so altering the current rural nature and visual influence of the area.

Overall landscape and visual impacts are assessed on two basic levels. Firstly via an assessment of the alteration of the intrinsic landscape character of an area irrespective of whether there are views of that landscape. Secondly visual impacts, i.e. impacts on people's views either from residential properties or areas of public access such as along roads and paths, are assessed.

Impacts on landscape character

Impacts on landscape character are assessed against the baseline of the general landscape setting as well as any specifically designated areas of landscape protection. Such designated areas are of high sensitivity and require greater consideration in terms of mitigation. However in relation to the Kribi Power Project, no areas of specifically protected landscape exist, therefore impacts are set only against the general landscape character.

As noted within the baseline section, most of the route consists of low rolling countryside with forest vegetation cover, river valleys and scattered settlements with areas of agricultural clearance. Onto this has been imposed the upgraded Kribi/Edéa road and the existing 90 kV power transmission line.

The impacts of this project on this existing landscape character result from three main elements, first the clearance of a 30 m linear strip of vegetation for the wayleave, second the construction of a 40 m high[3] 225 kV towers with the power line strung between them, and finally the clearance for the plant site and construction of the power plant building. Whilst final design is not yet complete the main turbine houses, which will be the largest buildings at the plant site will be in the order of 11 m to 12 m in height. The tallest structure will be the stacks for discharges of spent gas from the turbines. These will consist of four individual stacks located alongside each turbine (see Figure 3.3.1) each stack having a total

[3] This is the typical height but will increase by up to 6 m at river crossing, and flying over obstacles

height of 22.5 m but will be designed to extend just above the existing vegetation whichever is the higher.

Visual impacts

The transmission line route has been designed to avoid crossing over the main villages along the route but does follow the main road. The main populations are located along and close to the road and the line will therefore pass close to most of the settlements along this route. The line also passes round the southern and western sides of Edéa so will be visible from properties within the town. This route does therefore take the line along the areas of greatest population density although overall, relatively few settlements exist within this district. Occasional views will also be afforded to occupants of vehicles travelling along the main Edéa/Kribi road.

The main elements that may be visible will be the pylons. Whilst the vegetation clearance, will be visible, this will tend to have a green vegetated backdrop will be adjacent to the existing wayleave for the majority of the line. The vegetation clearance will not therefore be as visually intrusive as the new 40 m high tower structures.

At the plant site the properties closest to the site will be relocated as they are within the wayleave of the current 90 kV line and within the boundary of the proposed development area. However, residential properties, a chapel and local bars will still be present within relatively close proximity (closest house within 200 m of the plant site boundary) of the proposed new site and therefore will have potential views. The most visual element of the plant will be the stacks, which will be a minimum of 22.5 m in height and will stand just clear of the existing vegetation.

5.10.3 Mitigation Measures

Impacts on landscape character

The primary cause of impacts on the landscape character of the area relates to the introduction of new visual elements into the existing landscape setting. To mitigate this the route selection for the transmission line follows the existing areas of landscape disturbance caused by the current 90 kV line, the main road and associated settlements. These elements already detract from the natural landscape of the area and therefore selecting this route has provided partial mitigation of the overall impact. This is particularly relevant as the new features to be introduced will be of a similar nature to the existing elements.

In addition the selection of the design of the tower influences overall impacts. Double circuit towers have been selected for the base case option allowing a relatively low tower design to be adopted.

The plant site is an entirely new form of development within the existing setting. The area of land required for the development and the height and size of the buildings cannot be significantly altered. As such there are no specific mitigation measures developed to offset the alteration on the landscape character of the plant site.

Visual impacts

The primary method for the mitigation of visual impacts relates to the route selection for the transmission line, the site location for the plant site and the design of the structures being introduced.

The route selection process has a number of criteria that need to be satisfied and the final selection is a balance between the various potential impacts on other environmental e.g. ecology, landscape, land use, etc. and operational factors. This balance has resulted in the line being designed to follow the existing 90 kV lines and the main road. This does however potentially bring the line into close proximity to the main settlements in the area, which are located along the road. Selection has been modified, where practical, to provide the maximum separation distance to existing settlements so as to reduce visual intrusion as well as avoid property and cultivated land.

At the plant site the location of the actual power plant within the overall 16 ha site has been selected to provide a good separation distance to the main properties in the area and the main road. As shown on Figure 3.3.1 the plant site compound boundary is set back approximately 200 m from the nearest property and 250 m away from the road.

This site selection also provides the opportunity to retain a belt of mature vegetation within the area between the site and the properties and the main road, although much of this will need to be cleared for the construction compound. In addition, once construction is complete, this area can be left to naturally re-vegetate. A partial visual screen to the plant site can therefore be developed.

5.10.4 Evaluation of Mitigated Impact

Impacts on landscape character

The project does not involve any major remodelling of the landscape, such as may arise from say a mining project, the main impacts on the landscape character being only the introduction of an additional transmission line along the existing road corridor and the construction of the plant site.

In relation to the transmission line the selected route follows that of the existing 90 kV line and the main road. Transmission line towers and clearance of vegetation for the wayleave is therefore an existing element of the landscape. The introduction of a second transmission line will increase this existing impact but does not introduce a new element into the landscape. However, the towers to be used for the new line are 40 m in height, approximately 10 m taller than the existing towers, will therefore stand above these throughout the length of the route. The natural forest vegetation of the area is of a similar height to the towers, although in some instances the towers may stand above the existing tree cover.

Overall the introduction of a second transmission line within the existing disturbed landscape along the main transport corridor is assessed as having an adverse, long-term but minor impact on landscape character.

For the power plant, a completely new element of an industrial nature will be introduced into what is currently a rural setting. However the overall area of development

(approximately 4 ha within an overall 16 ha fenced area) is small-scale in terms of the extensive nature of the forest landscape within this district. Whilst this new element will alter the current landscape character, this area is not specifically designated as a protected landscape and the small area of impacts is not significant in terms of the overall landscape setting. This impact of the plant site on the landscape character of the area is therefore assessed as having an adverse, long-term but minor impact on landscape character.

Visual impacts

The visual impact from the development will differ for the transmission line and the power plant.

Transmission line

The route of the new transmission line runs directly alongside the current 90 kV line for approximately 40% of its length and in close proximity for the remainder. The towers are 40 m in height, therefore extending some 10 m above the current 90 kV system, and the wayleave clearance width is the same at 30 m. In addition the zone of visual influence of any one property is limited due to the low rolling landscape (no high vantage points) and the high level forest vegetation cover which results in very limited long distant views from villages or along the road.

By following the main road the line will run close to properties, occupants of which will have views of the system as will road users on the main Kribi/Edéa highway. However, due to the presence of the forest vegetation cover, views from any one property will be very limited in extent. It is of note that the existing 90 kV line is only visible clearly for short distances along the route giving an indication of the degree of screening provided by the existing forest cover. The most visible points are, as is obvious, at points where it crosses the road or is taller than the surrounding vegetation cover although this is considered to be at relatively few points along the line.

The overall impact on visual amenity of people along the transmission line route is therefore assessed as adverse, long-term but minor in significance.

Power Plant

The power plant site is a totally new element in the visual landscape. However the selected location for the plant is within the centre of the available area and therefore set back approximately 250 m from the road at the site entrance. The plant will also be approximately 200 m from the nearest property. The road level and most of the properties in the area are also set at a lower elevation than the plant with a raised plateau between most properties and plant (see Photo 5.10.6). There is therefore natural topographic screening of parts of the site. In addition to this the properties are set within relatively dense tall forest vegetation cover (see Photo 5.10.6) which further screens views. The plant site also has approximately 100 m of ground between its western boundary and the existing 90 kV line wayleave, which lies between the road and the plant site. This area will be subject to a degree of clearing during the construction phase but, where practical, vegetation will be retained to provide a screen to the works. This area can also be left to revegetate following construction to provide long-term screening from adjacent properties and the road. The main buildings are only some 12 m in height. Taking account of the screening effect of the raised topography behind local properties, the potential retention of a screening belt to the

western edge of the plant site compound and the climate of the area, which leads to rapid vegetation growth, a good visual screen will develop relatively quickly. Even if this vegetation screen is not developed tall vegetation to either side of the plant will limit views into the area. The plant site will be surrounded only by a fence, which will be approximately 5 m height, so limiting any views. The main element that will be visible will be the four emission stacks from the turbines. These are approximately 22.5 m in height and will therefore be visible from nearby properties. However, they will not stand significantly above the vegetation canopy so will not be visible from any long distant views.

Taking account of the selection of the plant site, the limited number of properties in close proximity to the plant and the ability to screen the plant from public views, the impact on the visual amenity of the area is assessed as adverse, long-term but minor in significance.

5.10.5 Evaluation of alternative development options

The main alternative that would affect the visual impact is the selection of single circuit transmission line towers and the setting of the plant site back from the road.

The option of a single circuit power line was developed and outline designs for suitable towers produced. These would be in the order of 25 m in height (increasing by up to 6 m at river crossings, etc.). As these would be a similar height to the current 90 kV systems, these would have a slightly reduced impact on the landscape character than the selected option.

The main option for the plant site was to construct the plant closer to the roads and properties with the site boundary some 150 m further west. This would position the plant close to the top of the topographic ridge behind the main properties and would remove the availability of an area for a screening belt between the plant and the properties/road. The plant would therefore be more visually intrusive than for the selected option.

The option for Reciprocating Gas Engines (RGE), as apposed to the gas turbines has also been considered. RGEs will have a maximum capacity of approximately 17 MW. To provide the full 150 MW load from the site 10 units would be needed. However, the number of stacks would not be increased and with this, the overall potential visual impact on adjacent properties would be the same as for gas turbines.

The zero (no project) option would remove the potentially negative impacts that may arise from the construction and operation of the project. However no significant impacts have been identified.

5.10.6 Conclusions

In overall terms the introduction of an additional power line along the route of the main road and the existing 90 kV system, and the construction of the power plant, are assessed as having only minor impacts on the landscape character and the visual amenity of the local population.

The project area is heavily forested, views from road and house level are limited and vegetation screening, particularly of the plant site, provides effective mitigation. The area of land take is also relatively small in terms of the overall forest landscape of the district and therefore impacts are at a small scale.

Table 5.10.1: Summary of Impact Evaluation – Landscape and Visual

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site	O	Landscape character	Industrial feature in rural setting	Landscape	Adverse	long-term	Minor
	O	Visual amenity	Industrial feature in rural setting	Local population	Adverse	Long-term	Minor
Transmission line	O	Landscape character	Additional power line	Landscape	Adverse	Long-term	Minor
	O	Visual amenity	Additional power line	Local population	Adverse	Long-term	Minor

1 – See Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

SECTION 6 : SOCIAL IMPACT ASSESSMENT

6.1 INTRODUCTION

The following section is based on the outcome of the scoping exercise, carried out in January and February 2006 (Scott Wilson, February 2006), public consultations and a detailed sample household survey of the project area in March 2006, and presents the results of the social impact assessment (SIA) for the Kribi Power Project.

The SIA contains the following sections:

- population and demographics;
- economic environment;
- social services and infrastructure; and
- electromagnetic fields and community health.

Potential environmental impacts that can affect communities, such as water supply, air quality, land use, noise and traffic are dealt with in the Environmental Impact Assessment (EIA), see Section 5 of this report.

6.2 SIA METHODOLOGY

The overall approach to the SIA is set out in Section 1.

The terms of reference for the SIA, which were determined during the scoping study (Scott Wilson, February 2006), established the social impacts considered to be potentially significant and therefore requiring detailed assessment (see Section 4.3). As such, the specific methodology for the SIA has been developed to ensure sufficient baseline data has been available to assess the potential social implications of the proposed project.

Information gathered for the SIA included a mixture of primary and secondary data. Existing secondary data such as census records and background information on Cameroon was reviewed. As the majority of secondary data on the project area was either incomplete or out of date, a sample household survey was carried out to capture up to date project-relevant information and to provide an accurate baseline against which the significant potential impacts could be measured.

The aim of the survey was to provide quantitative and qualitative information useful for the SIA component. The general methodology combined participatory research approaches with traditional questionnaire surveys to generate primary information on the various socio-economic indicators.

The following methodology was used. To produce a statistically valid sample that represents the target population in the project affected areas, sampling was done in a stratified manner as follows: firstly, 21 villages out of 26 were selected randomly and secondly two to four households per village were chosen randomly for interviews. Fifty-three households were interviewed. Such a sampling approach is designed to guarantee that the number of villages is statistically valid. The programme for the survey is presented in Table 6.2.1.

Once the questionnaire was completed it was tested on a small number of households in the plant site. After this 'test' the questionnaire was refined to better represent the issues and concerns of the affected communities.

As the sample households surveyed covered the length of the transmission line two teams of surveyors were employed so that affected villages at either end of the transmission line could be surveyed concurrently. The team consisted of three men and two women in order to obtain a good gender balance. This gender balance was struck in order to allow both male and female respondents to be equally comfortable answering questions. For example, men may feel more comfortable discussing issues with men and women may feel better able to discuss certain concerns only with women. Furthermore one of the team members was conversant in Batanga, one of the predominant local languages spoken in the Kribi subdivision section of the project area. It was felt that someone who spoke the local language would be more readily received in some Batanga-speaking households and therefore people would be more forthcoming with their answers to the questionnaire.

Prior to interviewing households, consent was obtained from the household and village chief, if available. Interviewees were given an overview of the Kribi power project and the purpose of the household interview. Many interviewees remembered some members of the survey team from public consultation village meetings. These people were aware that a household survey would be undertaken in March as this was discussed in the February village meetings.

After the data from the questionnaires was analysed, two members of the survey team went back to three affected villages to verify the data analysis. This was done in order to quality check the information and to ensure that the team's analysis of data was a true reflection of people's situations. Following the data verification the results of the questionnaire were processed in an SPSS database. The results of this analysis formed the basis of some of the baseline and potential impact projections in the SIA.

Table 6.2.1: Programme for Household Survey[1]

Days (2006)	**Villages**	**Task**
Friday March 24th / Saturday 25th	Mpolongwe I	Household survey
Monday March 27th	Mpolongwe I and Bebwambe I	
Tuesday March 28th	Malimba Urbain and Ekite Pilote	
	Bebwambe II and Londji II	
Wednesday March 29th	Ekite III and Ekite II	
	Bipaga II and Fifinda 1	
Thursday March 30th	Ekite I and Malimba Farm	
	Fifinda 2 and Pama	
Friday March 31st	Beon, Koukoue and Apouh	
	Bivouba, Elogbatindi and Dehane	
April 7th	Mpolongwe II, Fifinda II and Malimba Urbain	Data verification

[1] *Survey undertaken by Scott Wilson SIA team*

6.3 POPULATION AND DEMOGRAPHICS

This section provides an introduction to the main demographic characteristics of the project area and the potential impacts of the project on the local communities and their land and property.

6.3.1 Baseline Conditions

Overview

The project area is located between two provinces: the Littoral Province to the north and the South Province to the south.

Littoral Province

The Littoral Province has a total surface area of 20,220 km, accounting for 4.35% of the total surface area of Cameroon. It has four Divisions: Moungo, Nkam, Sanaga-Maritime and Wouri, 24 Subdivisions and 5 Districts. In 1976, the Province had a population of 935,166 inhabitants rising to 1,352, 833 in 1987 according to the National census by the National Institute of Statistics, with an annual growth rate of 3.41% per annum. The Littoral Province population was estimated at 2,704,131 inhabitants in 2005 and is estimated to reach 3,973,101 in 2015 (National Institute of Statistics, 1987).

Eighty-two per cent of the Littoral's population are urban dwellers. The majority of the urban population can be found in Douala. The population densities range from highly populated subdivisions with more than 2,000 inhabitants per sq km in Douala (Wouri Division) to less than 7 inhabitants per sq km in Yabassi and Yingui (Nkam Division) and Mouanko and Ngambe (Sanaga-Maritime Division). This population is very young with the average age being 21.9 years and 50% of the population is under 15 years old. The birth rate is lower in rural areas (34,60%) than in urban areas (35,98%), but the gross mortality rate is 9% in urban areas against 12% in rural areas. The Province's main town of Douala is also Cameroon's commercial centre. Douala is perceived to have the most employment opportunities in Cameroon because of its relatively sophisticated infrastructure, which includes a port on the Wouri River an international airport, a major railway and numerous roads linking Douala to other parts of the country and Africa.

The Bassa and Douala people were the first Bantu-speaking people of the Littoral Province and are now two of the major ethnic groups. In the Sanaga-Maritime Division, the settlements are made up of the following subgroups: Babimbi in Ndom and Ngambé Subdivisions, Bakokos in Mouanko and Edéa, Adié in Edéa, and Bikoks in Pouma, their main livelihood activities are fishing and subsistence agriculture.

South Province

The South Province covers a surface area of 47,191 km, accounting for 9.93% of the total surface area of Cameroon. It has four Divisions (Dja et Lobo, Mvila, Ntem Valley and Ocean), 21 Subdivisions and one District. This Province had, in 1987, a population of 373, 798 inhabitants. In 1997, this population was estimated at 480,266 inhabitants and at 519,928 inhabitants representing a density of 11.02 inhabitants per km by the National Institute of Statistics (former Statistics and National Accounts Department). Its birth rate is 1.9% per year, below the national rate of 2.9% per year.

According to the data of the population census (National Institute of Statistics) of 1987, 27.83% of the population is urban. The urban population is mainly found in the towns of Ebolowa, Kribi and Sangmélima. The population densities range from low populated subdivisions with 17 inhabitants per sq km in Mvila Division to very low density with less than 12 inhabitants per sq km in the other Divisions. Similar to the Littoral Province, the population is very young with 43.62% of the population being under the age of 15 years old.

The Province's inhabitants consist of two main ethnic groups: The Bantou group and 'Pygmies' Group. The Bantou group comprises the Fang (made of Bulu, Zaman, Ntoumou and Nvae), the Beti (made of Fong, Yanda, Omvang, Evouzok and Ewondo), Batanga, Mvumbo (made Mabi and Ngoumba) and Bassa/Bakoko. The 'Pygmies' group is made of the Bakola/Bagyeli and Baka people.

Project Area

In the South Province, part of the project (the plant site and most part of the transmission line) is located in Kribi Subdivision in the Ocean Division. In the Littoral province, the remaining part of the project (transmissions lines and connection with SIG) is located in the Edéa Subdivision in the Sanaga-Maritime Division.

The Plant is located at Mpolongwe II, a third class chiefdom inhabited by the Mabi ethnic group that have their paramount chief situated at Bikondo (a village outside the project area). The transmission line passes in the vicinity of 16 villages in the South province; of these, the most important are Fifinda (inhabited by the Ewondo people) and Elogbatindi (inhabited mainly by the Bassa/Bakoko). There is also the Batanga tribe who reside alongside the transmission line route, however their Paramount Chief lives out of the project corridor.

In the Littoral Province, the line passes in the vicinity of eight villages mostly inhabited by Adié and Bassa/Bakoko ethnic groups.

The project area's poverty indicators are slightly better than Cameroon's as a whole. The percentage of people living below the poverty line is as follows: Littroral province 19.1%, South Province 31.5% and Cameroon 40.2% (2000 Census National Institute of Statistics). House sizes and household density also vary from the national norm. According to the Scott Wilson survey of March 2006 the average size of houses in the project area is 4 rooms per house, the national average is approximately 2.1 rooms. The average number of people per household is 8 whereas the national household size is 5. It is normal practice for graves to be located close to houses and for there to be no large graveyards.

Land tenure is characterised by customary land ownership (see Section 6.4 for a detailed explanation of Cameroon land tenure and laws).

Project Area Socio-Economic Indicators

The following data on population living standards are provided by the second Household Surveys (ECAM II: Enquêtes Camerounaises auprès des Menages) produced in 2001 by the National Institute of Statistics. The project area is sparsely populated - in 1987, the date of the last census, the Edéa Subdivision population was 68,794 with about 19 inhabitants per km² while for the Kribi Subdivision, it was 40,706 inhabitants with 6 inhabitants per km. Table 6.3.1 gives the population of some of the villages adjacent to the proposed transmission line according to the 1987 national Cameroon census:

Table 6.3.1: Population

Kribi Subdivision, Ocean Division, South Province		**Edéa Subdivision, Ocean Division, Littoral Province**	
Villages	**Population in 1987**	**Villages**	**Population in 1987**
Mpolongue II	177		
Londji	481	Appouh	1290
Bipaga I	46	Koukoué	222
Bipaga II	106	Malimba I	685
Ebéa	67	Malimba II	534
Fifinda I	166		
Fifinda II	127		
Pama	171		
Bivouba	134		
Bebe	43		
Elogbatindi	575		
Bonguen	537		

The inhabitants of the project areas, from Kribi to Edéa, consist of the following ethnic groups: Batanga, Mabi, Ewondo, Bakola/Bagyéli, Bassa, Baka and Bakoko. According to the survey (Scott Wilson household survey March 2006) the average household size of eight is considerably higher than the national average of 5 people per household. This is often because there are several families living within the same household (cf. Surveys made in rural areas by the former Ministry of Agriculture and published in various numbers of Agri-Stat 2000). The majority of the project affected people sampled in the survey live by subsistence farming with some cash income gained from informal roadside business, such as fruit-selling, or taking up casual labour in the larger towns, such as Kribi and Edéa. The project-affected area has a good number of schools, health centres and churches. Current estimates suggest that it is unlikely that all of these facilities will be affected (see Section 6.5 for social infrastructure etc).

The population is also very young with people less than 15 years representing 39% of the population, against 43.70% at the national level for the year 2000 (cf. Annuaire statistique

du Cameroun 2000, published in 2001 by the National Institute of Statistics). Households headed by women older than 65 years represent 5.6% of those households surveyed. People with physical and mental disabilities were found in 39% of the households (Scott Wilson Household Survey March 2006); these population characteristics indicate that a large number of the affected population could be vulnerable and require additional assistance in the event of resettlement and land acquisition.

6.3.2 Potential Social Impacts

From a development of this type where there will be a corridor of land that needs to be appropriated the one significant potential impact on the local population and demographics will be land requisition, which will in turn potentially cause:

- Land Requisition and Resettlement;
- Conflict with host populations;
- Loss of Cultural Property; and
- In-migration.

Land Requisition and Resettlement

Construction

Potentially, the most significant social impact of the project will be land requisition and physical resettlement of people and businesses. At the start of the construction phase, it will be necessary to remove properties from the 16 ha footprint for the plant site, and the wayleave for the power line prior to mobilisation of construction crews.

There are 25 villages in the project area, which comprise 24 villages along the transmission line from the plant site to Edéa and the village of Mpolongwe at the plant site itself. It is understood that there is potential for all of these villages to have properties that will be within the project footprint, which will need to be resettled.

Independent of the SIA and in line with Cameroonian legislation, a full land and property census was undertaken by the Compensation Commission established by the Kribi and Edéa Divisional Officers as specified by the Public Utility Decrees signed by the Minister of State Property and Land Tenure for the project (May to June 2006). A detailed survey of project-affected land and property located in the footprint of the proposed plant site and wayleave has been undertaken by the Commission.

The results of this survey identified the following categories that will be affected by resettlement and land acquisition:

On the plant site:

- 8 households, including crop owners;
- 17 crop owners;

- 2 graves; and
- 0 titled lands.

On the transmission line route:

- *86 households* (18 and 68 in the Kribi and Edéa subdivisions respectively)
- *665 crop owners* (342 and 323 in the Kribi and Edéa subdivisions respectively)
- *55 graves* (12 and 43 Edea in the -Kribi and Edéa subdivisions respectively) an additional 5 graves have been reported inside a house in Edea, but these have not been formally identified by the Commission. The existence of these graves will be verified during the Resettlement Action Plan (RAP) process (see Section 6.3.3).
- 34 Titled lands (4 and 30 in the -Kribi and Edéa subdivisions respectively).

As shown above, at the plant site and wayleave there are 8 and 86 households respectively, which will be directly affected. In addition to these households there are a further 17 and 665 crop owners who will lose access to the land they currently farm that is located within the project area. . Within the project area crop owners are individuals who will lose land their cultivate on and some crops (they'll be given time to harvest for seasonal crops, but not be allowed to plant again), and households owners are those who will lose their residences, and, in some cases, their land and crops as well. Land take will also include tracts of agricultural land, the majority of which is held by customary land tenure rather than legal title. Resettlement will also potentially affect 57 graves (see also Loss of Cultural Property below).

As the affected population's livelihoods are largely land-based, the Kribi Power Project may have a considerable effect on people's livelihoods and community. Impacts on land tenure and livelihoods are discussed in Section 6.4.

Operation

Resettlement will be completed before the physical construction of the line and therefore there should be no ongoing impacts during operation.

Conflict with host populations

Construction

The project will require the resettlement of and/or land requisition from up to 710 affected people, this includes households, crop owners, and those with and without legal title, during the initial stages of the construction phase, i.e. prior to physical construction.

However, if residents are required to relocate to another village or district the influx of these people in a resettlement site could create some conflict because of the lack of familiarity between the two groups. Additionally there is some anecdotal evidence that suggests that there has been social tension between different villages and ethnic groups in the project area. These tensions could be exacerbated if not well-managed during the resettlement process.

Operation

Any dissatisfaction between the host and resettled communities that was initiated prior to and during the construction phase has the potential to continue into the operational phase of the project.

Loss of Cultural Property

Construction

With respect to cultural property, it has been identified from site visits, consultation and the household survey that the project has the potential to impact:

- medicinal trees;
- sacred trees, places and forests; and
- graves.

The construction of the plant site and clearance of the wayleave will involve the potential loss of some species of medicinal trees (see also Section 5.9).

During the household survey, some “sacred trees” and a sacred place were identified in the village of Elogbatindi.

A traditional doctor has been using this sacred place for treatment and, according to local people, there are many medicinal items that are used for treatment of a variety of ailments scattered on this site. These may need to be lost during construction. Local people, and in particular, traditional doctors, believe that the ‘project’s presence’ will have a negative effect on their livelihoods as local and international patients come to be cured of disease at the sacred place. This represents a good income that could disappear if the sacred place is destroyed or radically changed by the project.

A sacred forest was also identified in the vicinity of the project area during the scoping phase, however the route of the line has been designed to avoid this area. This impact is therefore not assessed further.

Forty graves, which are in the wayleave, will potentially be affected, by resettlement, if relatives wish to resettle them. According to the March 2006 social survey some families of the deceased believe that if the graves were destroyed, the spirits of dead people would affect the villagers and those who have destroyed the graves.

In-migration

Construction

The construction phase of the project requires approximately 550 - 600 workers (see Section 3.3.4). The majority of these workers will be carrying out manual labour and therefore, where practicable will be sourced locally. However, there will be the requirement for specialist staff from other parts of Cameroon and potentially expatriate staff moving to the project area for the construction and operational phase; not more than 75 such people are expected.

A sudden influx of predominantly male contract workers could have a number of different impacts on the local population, including the transmission of sexually transmitted infections (STIs). Anecdotal evidence suggests that previous projects have led to the increase of STIs, including HIV/AIDS, as a result of unprotected sexual activity between contract workers and local women and girls. This could also lead to social tension.

During the household survey (Scott Wilson March 2006) several villagers said they were concerned that young women would not want to marry local men as the young men could not compete with the wages of the contract workers. However, there were also villagers who welcomed the prospect of their children finding husbands and wives as a result of the project.

There will also be potential pressure on local resources from the influx of workers during construction.

Operation

It is estimated that the operational phase will require approximately 60 staff to be employed at the Plant Site. Wherever possible, it is planned that the employees sourced during construction will be trained and retained for the operational phase.

In addition, there will be the labour requirement for annual vegetation clearance of the wayleave. This will be carried out by specialised companies, who will use a small number of local people for the manual cutting of bush. This may present some employment opportunities for local people. There will, therefore, be no immigration associated with this assignment and this is not assessed further.

6.3.3 Mitigation Measures

Land Requisition and Resettlement

The key mitigation measure to limit the impact of resettlement is project design and the locating of the Plant and Transmission Line in uninhabited areas. As such, a detailed assessment was undertaken of five alternative sites for the plant site, and the location has been chosen to minimise resettlement requirements. The line has also been designed to avoid residential properties wherever possible. This has resulted in the line not passing straight between the Substation in Edéa and the proposed Plant at Kribi. As shown on Figure 1.1.2 the line at Edéa travels north and then north-west to ensure that it bypasses the town and the built up residential areas. The large number of road crossings (see Section 3), was designed to avoid as many residential settlements as possible whilst following the wayleave of the existing 90 kV power line.

As identified in Section 6.3.2, there will be the requirement to resettle possibly up to 94 households. To mitigate the impact on the households that will be affected a Resettlement Action Plan (RAP) will be implemented in accordance with World Bank Operating Policy 4.12 on involuntary resettlement.

The objectives of the World Bank's policy on involuntary resettlement are that it should be avoided, where feasible, or minimised – all viable alternatives should be explored. As noted above, for the Kribi Project this has been undertaken with reference to both the siting of the line and the plant site. Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programmes, providing sufficient investment to give people displaced by the project the opportunity a share in project benefits. Displaced people should be meaningfully consulted and have opportunities to participate in resettlement programmes. Project affected people (PAPs) should be assisted to improve their livelihoods and standards of living. One of the key objectives of the guidelines is to restore the income earning capacity of PAPs. The aim is to improve or, at the very least, sustain the living conditions of the PAPs prior to project operations or to resettlement.

It is therefore proposed that AES SONEL develop a full RAP for the Kribi Project. In order to provide guidance on the requirements for this plan, a detailed outline of a RAP can be found in Appendix M. A key feature of the RAP will be the fair and transparent compensation procedures that will ensure that each project-affected person is adequately compensated for his/her loss of property/land and income as a result of the project.

In summary, the key stages of a RAP are:

- **Preliminary RAP preparations** – data review and research, and inception meetings with AES SONEL and relevant stakeholders, a lot of this preliminary work has been undertaken as part of the SIA;
- **Technical Design and RAP preparation** – this would involve sensitisation meetings / public consultation. This process has been initiated in the SIA;
- **Field Surveys** – which would involve detailed data collection on the affected households. For Kribi this is to be undertaken through detailed census by the

Compensation Commission. It will need to be supplemented by household surveys of properties not surveyed as part of the SIA;

- **Preparation of the RAP** – the outline is presented in Appendix M; and
- **Implementation of the RAP –** the RAP should be implemented, and therefore compensation agreed and paid and/or physical resettlement undertaken, before physical construction of the project commences.

Preparation for the RAP has already commenced with data collection undertaken during the SW household survey and a census survey undertaken by a Compensation Commission in July 2006, which identified the project affected people that are summarised in 6.3.2. The results of the survey are currently being thoroughly analysed and will form the basis of compensation criteria and assistance in the RAP. The Commission is a government-appointed body, tasked with evaluating, inspecting and delimiting land and property affected by a public utility decree (see Appendix C for the Public Utility Decree for Kribi). The requirements for the Kribi Project (remit and composition) are defined in Appendix O. The Commission comprises of the following members or their representatives from the following organisations:

- The Senior Divisional officer;
- The Divisional chief of service of state property;
- The Divisional chief of service of Land Registry;
- The Divisional chief of service of Housing and Urban affairs;
- The Divisional chief of service of Agriculture;
- The Divisional chief of service of mines, power and energy; and
- The representative of AES SONEL.
- The mayor and/or member of parliament
- The chief of each affected village

Loss of Cultural Property

The key mitigation measure is to design the route of the line and the location of the plant site to avoid cultural property. As noted in the impact section (see Section 5), the route has been selected to by-pass the sacred forest.

However, where there is potential for cultural property to be affected the following mitigation measures are proposed.

The medicinal trees identified are endemic to the area, and therefore their loss will not significantly affect the overall population of these species in the area (see Section 5.9). If any medicinal or sacred trees or sacred places are to be lost as a result of the project the

beneficiaries of these trees, be they individual owners or community users, should receive compensation as necessary in line with the proposed RAP.

The project will impact upon 55 graves located either at the Plant Site or along the proposed way leave. For these graves the relevant family should be consulted about their wishes.

The villagers think that there are two different ways to mitigate these negative impacts: for the first group of families they would like their deceased relatives to remain on site the second group would like their relatives to be reburied at a site to be chosen but at the expense of the project promoter. During the SW household surveys and village meetings none of the families that will be potentially affected asked for financial compensation for a grave disturbance.

Conflict with host populations

The key mitigation measure will be to resettle households, wherever possible, within their existing villages.

However, where this is not possible, there could be potential conflict and tension arising between those who are resettled and the host population. The World Bank's policy on involuntary settlement (OP 4.12) provides guidance on facilitating affected people's transition to resettlement sites that should be adhered to for planning the resettlement process. The suggested mitigation measures for minimizing the impact of resettlement on host communities are as follows:

- consultations with host communities and local governments;
- arrangements for prompt tendering of any payment due to the host communities for land or other assets provided to resettlers;
- arrangements for addressing any conflict that may arise between resettlers and host communities; and
- any measures necessary to augment services (e.g. education, water, health, and production services) in host communities to make them at least comparable to services available to resettlers (paragraph 16, WB OP 4.12).

Additionally the outline RAP (see Appendix M) details some of the actions that need to be taken. Most notable of these is ample and prior consultation of both affected people and host communities on the process of the RAP. It is also important that project affected people are consulted early in the process about possible resettlement and whether the proposed resettlement sites are acceptable to them, both economically and socially.

In-migration

The key mitigation measure will be to minimise in-migration through the employment of people from the local communities, wherever appropriate and practical.

The impact of in-migration of workers during the construction phase will be mitigated by locating workers into the existing towns in the project area (Kribi and Edéa), which have

existing suitable accommodation and resources. This will enable workers to reside in comfort without depleting the scarce resources of the project-affected villages.

Contract workers should be sensitised and briefed on appropriate behaviour while working in the project area. Contract staff should also be made aware of the local culture and mores. Local communities and contract workers should be given information on safe sex practices. This should be done in consultation with the local health centres and in line with their safe sex campaigns. The project planners should plan the arrival of contract workers so as to mitigate the impact of a large inflow of people.

6.3.4 Evaluation of Mitigated Impact

Land Requisition and Resettlement

The project design has limited the requirement of resettlement through the routing of the line and siting of the plant. As discussed in the impacts section, it is estimated that a maximum of 94 households will need to be resettled. The implementation of a well-planned RAP with fair compensation procedures will mitigate the most significant short-term impacts of resettlement and land requisition. If undertaken in accordance with OP 4.12, which requires betterment, long-term impacts can also be mitigated. Robust monitoring and reporting plans will also be implemented as part of the plan,

The impact of land requisition and resettlement is therefore considered to be long-term and minor. The impact will be adverse in that it will cause disruption to the individuals involved. However there is the clause for better properties to be provided in compensation and this has the potential to be beneficial.

Land requisition and resettlement will be required during the initial stages of construction and therefore there will be no direct impacts during the operational phase.

Conflict with Host Populations

Wherever practicable, resettlement should be undertaken within the same village to mitigate against conflict with host properties. With the exception of the plant site, the resettlement will only need to be to outside of the 30 m wayleave and, due to low population densities; land should be available in villages. Therefore local resettlement within existing communities, in most cases, should be feasible.

Where this is not possible, careful consultation of all PAPs, including host communities of resettlement sites, should be implemented early for social tensions to be mitigated and to facilitate the smooth implementation of the RAP.

Given the unlikely requirement for resettlement of communities outside of their existing village, and with the implementation of the RAP it is considered that the impact of conflict with host populations will be adverse, insignificant and short-term.

Loss of Cultural Property

The project has been designed to minimise the loss of cultural property. Where it is unavoidable sensitive consultation with local communities will be crucial so that suitable mitigation can be agreed.

However, it needs to be noted that the destruction of cultural property can affect the cultural and social cohesion of a community as well as its physical appearance. This needs to be borne in mind when discussing these issues with the project-affected communities. Good consultation and communication strategies will minimise bad feeling and mistrust amongst the community. However, if this is not done it could exacerbate existing ill feeling and lead to delays in the project commencement. Local authorities need to be given clear guidelines on how AES SONEL would like project information to be communicated to local people.

With the implementation of the proposed mitigation measures, together with comprehensive planned consultation, the impacts on the loss of cultural property are considered to be adverse, long-term and minor.

In-migration

It should, however, be noted that the in-migration will primarily be in the construction phase. There will be 550 to 600 employees required for the construction at the peak of this phase and it is anticipated that approximately 10% will be recruited locally.

Sensitisation of both the local communities and the contract workers about issues of safe sex and general behaviour should minimise the negative impacts of a swift temporary increase in the local population.

The short-term overall impact of in-migration could be significant. An influx of over 500 people could have an impact on the social mores of the community as well as being a strain on local resources.

6.3.5 Evaluation of Alternative Development Options

The adoption of any of the proposed project alternatives would not significantly alter the impacts of resettlement, as land requisition would still be necessary.

The zero option would remove the significant negative impacts of resettlement and land requisition and the impacts of in-migration during construction. However, if mitigation measures are carried out the project could have a positive impact by creating job opportunities and better housing for local people that would not occur in the absence of the project.

6.3.6 Conclusions

The potential impacts on population and demographics, as discussed in Sections 6.3.2 to 6.3.4 are summarised in Table 6.3.2.

Table 6.3.2: Summary of Impact Evaluation – Population and Demographics

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site/ Transmission line	C	Land requisition and resettlement	Land requisition and resettlement	Local communities	Adverse / Beneficial	Long-term	Minor
	O		Land requisition and resettlement	Local communities	Adverse	Long-term	In-significant
	C/O	Conflict with host population	Conflict	Host and resettled populations	Adverse	Short-term	Insignificant
	C	Destruction of cultural property	Land requisition	Local communities	Adverse	|Long-term	Minor
	C/O	In-migration	STIs/Social conflict	Local communities and contract workers	Adverse	Short-term/ Long-term	Significant

1 –for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

6.4 ECONOMIC ENVIRONMENT

6.4.1 Baseline Conditions

This section provides an overview of the economic characteristics of the areas, which will be affected by project activities (i.e. the Project Area as shown on Figure 1.1.2). These data were gathered from official sources and from interviews and meetings with local communities at the proposed plant site area and within the villages that will be affected by the proposed transmission line, and the household survey interviews with a selected sample of villagers undertaken by SW in March 2006 (see Section 6.2). As discussed in Section 3.2.1 and shown on Figure 1.1.2, the project lies within the Littoral and South Provinces, as follows:

- *Power Plant and 65% of southern section of the Transmission line* will lie within the Kribi Subdivision of the Ocean Division in the South Province; and

- *The northern 35% of the line and connection with the SIG at Mangombe substation* at Edéa lies within the Edéa Subdivision in the Sanaga-Maritime Division in the Littoral Province.

The Littoral Province has quite a vibrant local economy with urban and rural markets being found throughout the Province. Rural markets are held in Subdivisions and villages. The Province, through Douala, lies at the hub of the export and import of products going to and coming from the other regions of Cameroon and neighbouring countries (Chad and The Central African Republic). The province has a large capacity for producing electricity through hydroelectric plants. The two main hydroelectric plants (Edéa and Songloulou) are located in Sanaga-Maritime Division on the Sanaga River. The populations of Douala city and Douala Edéa consume approximately 46% of the region's electricity production (Plan Directeur d'Electrification Rurale (Rural Electrification Agency), 2003). However, when taking into account the province's total population and the proximity of electricity plants, the number of electricity subscribers is low. According to the Scott Wilson household survey, poverty, and some local level inefficiencies and poor access to services are largely to blame for the low subscription to electricity.

Douala is the main town within the Littoral Province. It has the highest urban density in the Province, as a result of the potential employment opportunities and the concentration of good infrastructure such as the port, international airport, roads and railways. The project area is characterised by moderate to severe poverty. Observations made during the household survey confirmed this status. Many people interviewed lived by subsistence farming or informal sporadic roadside business activities. In this context, informal sector business activities are those which lie outside the rules, regulations or fiscal demands of Cameroon's economy and are essentially illegal or illegitimate businesses but not necessarily criminal. The sample household survey showed that in the affected villages, over 50% of inhabitants are living below the poverty line. The main sources of income in those villages were, in descending order of importance, agriculture (40%), informal sector (24%), formal sector (23%), hunting and fishing (7%), allowances from relatives (3%) and others (3%). The population in the rural areas of the project, in the Littoral Province, are predominantly farmers, fishermen or workers with the company Fermes Suisse, which operates a commercial palm plantation approximately 35 km south of Edéa. The population living in Edéa town are involved in various sectors of the economy, including the

hydro-electric plant, the aluminium factory, trade, the civil service and the industrial sector etc.

The population within the South Province part of the project, derive their livelihoods mainly from subsistence farming and fishing and from working within the tourist industry. Kribi town itself is a coastal tourist area with many hotels and guesthouses. A new fishing harbour is also being constructed in the town to facilitate development of this industry. The agricultural production system in the Province can be categorised as follows:

- *The modern system*: This is dominated by foreign companies who produce rubber, palm oil, fruits and legumes. These large-scale plantations use modern techniques and provide employment and social services to a large number of local workers.

- *The traditional system*: This system relies on traditional agricultural tools and animals with very little use of mechanised implements. The main crops are cassava, banana, and cocoa; as the majority of farming is for subsistence use only the surplus is sold in markets when there has been a good harvest.

Land use in the area, as discussed in Section 5.8 of this report, is dominated by forest and land adjacent to villages is used for agriculture. Villagers also practise livestock production and some small-scale business activities.

Land Tenure

In Cameroon there are three main legal definitions of land ownership (Limbe Power Project Compensation Action Plan, AES SONEL, 2003):

- Private Property of the State (PPS);

- Private Property belonging to Individuals (PPI); and

- National Land (NL).

Private Property of the State

Private property of the State is moveable and immovable property acquired by the State for reasons of public use and private purposes (purchase and gift) following the rules of expropriation. The land title is held by the State (articles 10 and 11 of ordinance No. 74-2 of July 6th, 1974), which lays down the rules governing land ownership and its amendments. According to the Scott Wilson survey a small proportion of the sampled land comes under this category.

Private Property belonging to Individuals

Private property belonging to individuals is registered and has title. It is land that is subject to an order allocating State land as compensation, an order approving a sale by mutual agreement, an act of disposal of a piece of State landed property held as private property or an order allocating a piece of the national land to be developed (Limbe Power Project Compensation Action Plan, AES SONEL, 2003) (see articles 2 to 15 of Decree No. 76-167 of April 27th, 1976, which lay down the modalities relating to the management of the

private property of the State). According to the survey about 24% of respondents have legal title to land.

National Land

National land is made up of lands that do not fall in the public domain, the domain of the State held as private property, or in private property of individuals (see article 14 of ordinance No. 74 of July 6th 1974 in Limbe Power Project Compensation Action Plan, AES SONEL, 2003). This type of "customary" ownership of National Land is typical of the land tenure of the householders surveyed, with 53% of respondents claiming to own 'ancestral' land. This type of land is often acquired by inheritance, gifts, and purchase (Scott Wilson Survey, March 2006). Inheritance in the Cameroonian context is transferred through a lineage system following the traditional customs and norms. Men normally inherit land from their fathers, while women traditionally do not inherit but can own land through purchase. For non indigenes, ownership and access to land is through purchase from the landowner and has to be channelled through the village authority that has the powers to declare control over a piece of land. A sales agreement is then issued to the new landowner (Limbe Power Project Compensation Action Plan, AES SONEL, 2003).

Land Rental

Land rental is an informal process where land is occupied for free and tenants are obliged to give a percentage of their product from the land to the landowner. The exact arrangement differs from village to village. There were a few, perhaps 1 or 2, cases of land rental found during the survey. As it is an arrangement that cannot always be verified, as there is no document exchange, and this type of tenure attracts minimum compensation, people were not always prepared to provide details of their land ownership situation.

Employment and Labour

The household baseline survey revealed that unemployment is very high among the affected people, especially amongst young men. During interviews and village meetings, the main concern about the project's impact was employment for young people. According to ECAM II, the unemployment rates in 2000 among young people aged 15 to 24 were 38.6% in the Littoral 8.9% the South Provinces, and 14.4% at the national level.

The youth of the affected villages have very high expectations of the project. The communities as a whole believe that employment opportunities for the young will have a significant impact on the local economy and individual households. In some of the public consultation meetings and discussions during the household survey, people suggested that preferential employment policies from AES SONEL should be regarded as another form of compensation. Farming, fishing, hunting and small scale trading are the main livelihood activities for men and women in the affected villages. However, the survey found that a sizeable number of those surveyed had under-utilised skills such as, carpentry, bricklaying and plumbing. A smaller number of people had trained as electricians or mechanics. The remote rural location of some of the villages means that finding local work where these skills can be used is not possible.

6.4.2 Potential Social Impacts

The key potential impacts on the economic environment that can arise from the proposed Kribi Power Project are:

- loss of land;
- compensation discrepancy through land right disputes;
- employment opportunities;
- increased National Power Supply; and
- economic benefits.

Loss of Land

The base case for the project assumes that all formal land uses and any built development at the 16 ha Mpolongwe site and along the wayleave will be lost to the current land occupiers.

The project area is estimated to be 80% forest cover, and 20% agricultural. As discussed, in Section 6.4.1, the main source of income is from the land and in the villages along the wayleave is derived from subsistence and minor cash crop agriculture. The construction of the line will require the loss of agricultural land that is located within the 30 m wide wayleave (see also Section 6.3), which has the potential to represent a significant economic loss for the affected population.

Compensation discrepancy through land right disputes

As discussed in Section 6.3, the project will affect the homes and farms that lie directly within the wayleave and at the plant site area. These homes (households) and crop owners (land use) are to be compensated through the implementation of a comprehensive Resettlement Action Plan (RAP). This will require land ownership within the area to be verified, to ensure that satisfactory compensation payments are met and that the rightful owners and users of land are compensated.

The issues of legal land titles and disputes over the legality of land ownership could be a significant issue in the project area during the compensation procedures. Anecdotal evidence gathered during the household survey in March 2006 suggests that the local people are concerned about corruption in obtaining legal title. Additionally, discussions with local people revealed that the majority of people couldn't afford to obtain legal title, as the process is both time-consuming and costly.

On a national scale only 6.1% of the population have legal title to their land of which the majority are in urban areas (cf. Annuaire statistique du Cameroun, 1997). In the project-affected villages, 24% (12 households) of the sample households surveyed claim to have legal title while 16% (8 households) are in the process of obtaining legal title (Scott Wilson household survey; March 2006); many of those households were found in the Sanaga-Maritime Division in the Littoral Province. Additionally, 53% of people interviewed have declared that the lands they occupied were ancestral ones. The result of

the census provided different results, where only 34 households over the 710 affected people had or were in process of acquiring title on their land.

In the affected villages, the land is generally the property of the family. People become owners of a plot of a land after having cleared the "*wild forest*". Affected people also expressed concern about ancestral land that has been given away by local government officials. Ancestral or customary land does not have legal title but can often be quite valuable and is recognised under Cameroon law.

If not managed, long-running land disputes between individuals and communities could be exacerbated if the compensation is not fair and transparent and if it fails to meet the World Bank standards, which require payment of compensation to people without legal title. This approach will be employed for the Kribi Power Project RAP.

Employment Opportunities

The project will create some limited direct and indirect employment opportunities, primarily within the 15-month construction phase (approximately 600 employees at its peak), but also to a lesser extent during the operational phase (approximately 60 employees at the Mpolongwe Plant Site) and through additional annual vegetation maintenance (see Section 3.3.5).

During construction, employment opportunities will range from manual labourers, through electrical and civil technicians and engineers, to site managers. The anticipated split between national and expatriate workers is 95% to 5% respectively. Employment from the local area will be encouraged, and will almost certainly be necessary on the transmission line route. However, given the quantity and skills of workers needed during the construction phase, it will be necessary to import the majority of manpower from neighbouring cities where the appropriate skill base exists.

With regard to the operation of the plant, this will require approximately 60 specialised staff, mainly engineers and technicians. As this will be a new technology in the country, AES SONEL will recruit new staff early in the construction process for the purpose of providing them extensive training during all phases of the project implementation. The selection process will be countrywide. However, some non-specialised jobs such as guards, cleaners etc. will be filled locally.

There is currently high unemployment amongst the young men within the communities of the project area, this section of the community therefore has very high expectations of the potential job opportunities that the project will provide. These opportunities will help to reduce unemployment and poverty. In addition, employment of local people, during construction and operation, will have a beneficial knock-on effect on potential employment in the secondary sector, e.g. service industries such as hotels, supply of goods and services.

However, the majority of jobs will be short-term and unskilled. During construction, farmers may abandon farm work in favour of short-term lucrative work on the project. At the end of the construction, there is a high potential risk that they will become unemployed and some who have acquired skills will not necessarily be able to use them in villages. As demand for jobs outstrips supply, there will be inevitable disappointment, resentment and possible conflict between those who have secured jobs and those who have not. The level of competition could lead to corruption and unfair recruitment. Those with connections to

the local authorities and the better educated are likely to be in an advantaged position to secure jobs either from sub-contractors or AES SONEL. However AES SONEL's code of conduct for fairness and transparency, which it imposes on its subcontractors should mitigate against this potential negative impact.

At the end of the construction phase, there will unskilled unemployment as well as skilled unemployment. However, there will have been opportunity for employees to gain transferable experience and skills.

Increased electricity supply

During recent years households have been negatively affected by the insufficient supply in energy; which has hindered the development of economic activities. This project, by increasing the supply in energy, should help boost economic activities.

It should be noted that the project involves the installation of a power plant and a 225 kV line only. It does not cover local power distribution. Transmission from this high voltage line to villages within the project area is not practical and is outside of the scope of this assessment although, as discussed in Section 4, provision of electricity is a key concern of the local communities.

The majority of affected villages are now supplied with electricity, and AES SONEL is setting out a separate programme to increase the number of customers (about 50,000 per year) as part of the concession agreement. Most of the population will benefit from this programme.

As part of this AES SONEL plans to build new 30 kV lines from the existing 90 kV line.

Economic Benefits

The project, through increased employment, will provide increased national revenue through the payment of taxes by employees.

During both the construction and operational phases the project will also help boost activity in the secondary sector through the demand for goods and services. This will further increase employment and national and local government revenue.

The rapid influx of money and demand for goods and services, primarily through the construction phase, could lead to an increase in the prices of some scarce goods such as bush meat. This will have a negative impact on local communities that experience an increase in the cost of produce, but a positive impact on local small businesses selling these goods.

6.4.3 Mitigation Measures

Loss of Land

As discussed in Sections 5.8.3 and 6.3.3, the key mitigation for the loss of land, and therefore income from that land, occupied and used by local populations, is through project design. As such, the location of the plant site and route of the line has been designed to avoid existing settlements, wherever practicable.

Although the project requires the acquisition of lands within the wayleave, as discussed in Section 3.3.6, with the exception of the siting of the towers (total area of 0.75 ha), only vegetation cover greater than 2 m in height will be cleared where practicable. However, sufficient vegetation will need to be cleared to enable vehicle access between the towers. By minimising disturbance to vegetation and crops less than 2 m in height, it may therefore be possible for affected farmers to harvest and continue to farm crops in this area. This would, however, only be wherever practicable as the land would be the property of AES SONEL for this project and any farming would be undertaken at the risk of destruction should AES SONEL require access to the land for construction or operational purposes.

Where land and farms are located within the area of land take, compensation in accordance with the World Bank 4.12 operation policy, needs to be given to those people who suffer loss of land and/or income as a result of the project. Where appropriate, people should also be given assistance in finding alternative livelihoods. The categories of assets that may be lost are mainly fallow, crops, trees and houses.

Compensation should be provided within a formalised Resettlement Action Plan (RAP) for the project, explanation on requirements of RAP and compensation procedures are provided in Section 6.3 and a framework RAP is provided in Appendix M.

Compensation discrepancy through land right disputes

The potential impact of compensation discrepancy through land right disputes will be mitigated through comprehensive resettlement / compensation procedures, as discussed in detail in Section 6.3.

Rigorous data gathering and land inventory will be required to provide people with adequate compensation for loss of land and crops during resettlement. The Compensation Commission to be used for the Project (see Section 6.2) will need to be able to verify the ownership of land, as the majority of affected people do not have legal land title. Another potential difficult issue to address is that a small minority of landowners are absent on a seasonal basis or live permanently abroad. The identities and addresses of these people will need to be confirmed.

The compensation process should be undertaken in accordance with the World Bank's OP 4.12 guidelines, which provide for the compensation of people without legal title. It should also be noted that those without legal title who are on ancestral land should be regarded as landowners with full rights and not squatters. The World Bank's policy does insist that squatters should be given compensation for crops lost as well as providing for assistance with moving if appropriate. Any ongoing land disputes will need to be investigated and moderated by an impartial third party. Regular consultation with project-affected people will also invoke trust and understanding of the project process. Project affected people should be compensated for loss of land, loss of income and potential income. This could involve providing training or assistance to develop new livelihoods skills, if necessary. This should assist to mitigate any disputes or perceptions of mistreatment and corruption.

Employment Opportunities

A good local employment policy needs to be enforced to ensure fair allocation of jobs within the project area and to provide local people with transferable skills that can be used after the construction and operation phase of the project. Specific training programmes for local people would enable people to gain these skills. Small business grants or loans could also facilitate the growth and maintenance of local small businesses that could be sustained after decommissioning.

Increased national power supply

As this is a positive impact, there is no need for mitigation measures.

Economic benefits

Although this is a largely positive impact there is a risk that new revenue will fuel inflation. Mitigation will be largely dependent on national Government policies that are tailored to protect the poor, such as progressive tax rates and exemptions or assistance with micro credit loans.

6.4.4 Evaluation of Mitigated Measures

Loss of Land

Construction

If the RAP is produced and implemented as recommended, the short-term impacts of the project should be neutral to positive. The impact would be potentially positive if people are located to land, which may yield better quality crops. It is very important that people get adequately compensated not just for loss of land and crops but also for temporary loss of livelihoods and incomes or business derived from land or businesses that have been relocated. When compensation is carried out, AES SONEL will need to manage the social strategy as carefully as the financial strategy. According to the survey the average landholding of those surveyed is approximately 1-1/2 acre. Therefore, it is estimated that land take may not always affect the entire landholding of a household but nonetheless affect their crop yield even if only part of the land is taken. Although, available land nearby may be available, it was found during the household survey, that people will not necessarily always want to move to the nearest landholding if they feel it is inferior to their current land, or is in a socially hostile area. Therefore land requisition for some people may be adverse, long-term and significant.

Operation

Resettlement will need to be complete before physical construction commences and therefore no further impacts are predicted. There will therefore be no resettlement in the operational phase.

Compensation discrepancy through land right disputes

Construction

The management of the RAP will be crucial as land disputes and employment are very emotive and can lead to social conflict. If compensation is fair and transparent this should mitigate potential social conflict.

Within the project area, over 50% of the sampled landowners that may be affected claim to have customary land rights and only 24% of those sampled declared having legal title. Due to this low percentage of owners with clear legal title the potential for rights disputes is high. Whilst customary rights are recognised by Cameroon law and by the World Bank, the potential for disputes exist. People with customary land often do not have documentation. Equally, those who are in the process of obtaining title may have sent their documents as part of an application process that have not been returned.

Operation

Resettlement will be required prior to the physical construction of the project. Once construction is complete, and the project is operational, resettlement should have been complete and therefore no further impacts are predicted.

Employment opportunities

Construction

During the construction phase, up to 600 jobs will be created at the plant site and along the power transmission line. However these will be short term (maximum 15 months but many shorter than this) and most will be low-skill labouring jobs. These will provide some temporary increase in income but limited opportunities for long-term skills training. The construction will require some skilled labour, which may be sourced locally but due to the short construction period up to 90%, will need to be imported into the local area.

However to maximise potential benefits during this phase, a sound recruitment, training and employment policy by the contractor and AES SONEL will mitigate the negative aspects of job competition and enhance the job opportunities created by the project. Where possible longer terms skill for some local personnel will be provided.

If the mitigation measures are carried out adequately, the impact of the construction phase on the local community will be beneficial, with short term, significant effect and lower significant long-term effects.

Operation

During the operational phase a maximum of only some 60 jobs will be created. This will include management, administration, technical personnel, security and cleaning staff. Technical staff will be selected and trained up by AES SONEL as set out in Section 3 and provide increased local skilled labour. In addition all unskilled staff shall be sourced locally, where practical.

Overall the scale of potential employment from the operational phase of this project is relatively low but will provide a degree of benefit to local people. In an area of high unemployment such as within the project area, even the relatively small number of jobs created should provide a beneficial, long term (25 year project life) significant impact.

Economic benefit

Construction

As noted in Section 6.4.2 the increase in employment of up to 600 people during this phase will increase income to local businesses and government. However this phase represents a short term but relatively large scale influx of people and therefore has the potential to cause local cost inflation for scarce goods. This will have beneficial effects for those involved in selling these products but negative impacts on local population who have to buy at the inflated price.

However these impacts will only occur over the construction period (maximum 15 months) and therefore any impacts will be very short term in nature. Impacts will be potentially both adverse and beneficial although significant and short term in nature.

Operation

During the operational phase the overall level of economic activity will be lower but long term in nature. Employment of 60 permanent staff and the need to provide goods and services to the site will increase the overall economic activity within the Kribi area. As such impacts are assessed as beneficial, long term and minor in nature.

6.4.5 Evaluation of Alternative Development Options

The adoption of any of the proposed project alternatives would not significantly alter the overall impacts on the economic situation of the local communities.

The zero option would remove the potentially negative impacts that may arise from the construction and operation of the project.

The effect on employment opportunities of the zero option would be potentially negative as the 700 and 60 jobs expected to be generated by construction and operation, respectively, of the project will not result.

6.4.6 Conclusions

Concerning the economic environment, the impacts will be positive during a limited period of time on the local population despite some minor negative impacts that can be mitigated

through good compensation strategies and information and sensitisation campaigns. At the national level, the impacts will be positive during a longer period. The impacts are summarised in Table 6.4.1.

Table 6.4.1: Summary of Impact Evaluation – Economic Environment

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature	Duration	Significance
Plant site/ Transmission line	C	Loss of Land	Acquisition of land	Local PAPs	Adverse	Long-term	Significant.
	C	Compensation discrepancy through land right disputes	Conflict/reduced social capital	Local PAPs	Adverse	Medium-term	Significant
	C/O	Employment opportunities	Increased no of jobs	Local communities and contract workers	Beneficial / adverse	Short-term/long term	Significant
	C/O	Increased National Power Supply	Increased National Power Supply	Local and national	Beneficial	Long-term	Significant
	C	Economic Benefits	Economic Benefits	Local communities	Beneficial / Adverse	Short-term	Significant
	O				Beneficial	Long-term	Significant

1 - Project Affected People
2 – Phase – PC= Pre Construction C -= Construction / O = Operation / D = Decommissioning.

6.5 SOCIAL SERVICES AND INFRASTRUCTURE

6.5.1 Baseline Conditions

This section provides an overview of the use and existence of key services such as schools, health centres, hospitals, water and electricity in the project area. The information presented is taken from the household survey interviews undertaken by Scott Wilson within a selected sample of villages in March 2006.

Education

Children commence school at 6 years old in the project area, if their parents are able to pay for the uniforms and books. There are a number of primary schools in the project area. Information provided to the survey team would suggest that there are no schools in the wayleave and therefore none will be demolished as a result of the project. This will need to be confirmed by the full land census survey. Many of the children in the project-affected areas attend schools in the neighbouring towns of Kribi or Edéa, which are beyond the project area.

In the project-affected villages, the level of literacy is high. The household survey found that of those over 15 years of age, only 8% were unable to read and write. The percentage of people who had some form of formal schooling was also relatively high. Of those interviewed only 12% of adult men and 14% of adult women had never attended school. This is despite the fact that primary schools are not very accessible for many of the affected villages.

Health

There are two health centres in the Kribi subdivision in the rural project area, one in Londji and one in Elogbatindi. There are also a number of government and private hospitals and health clinics in Kribi and Edéa. The Londji Health centre, which is located in Kribi subdivision, serves 18 of the 21 affected villages in the project area. It is a government health centre where consultation is free and drugs are heavily subsidised. It provides free condoms and has testing facilities for Malaria and the main sexually transmitted infections (STIs) except HIV/AIDS (Pers. comm., Mr Ekamo Gaston, chief nurse at Londji Health Centre - please see Appendix N for Health Centre meeting notes). According to health centre staff, the Londji Health Centre has the capacity to serve additional patients during the project construction and could cope with an increase in e.g. STIs or other diseases. However, as the centre also services Kribi residents who come to the centres because medicines are cheaper than in Kribi, there would probably be considerable strain on the centre in the event of a major disease outbreak or population increase. The surveyed villages have good access to health centres. For 68% of the households interviewed the nearest one is situated less than 5 Km away.

Only 36% of surveyed households have access to potable water as compared with 49.5% at national level, 26.3% in the Littoral province and 67.4% in the South province (Cf. ECAM II in 2000). The most prevalent diseases amongst those surveyed are malaria and diarrhoea; the incidence of Malaria found during the surveys was 85% which is very high compared to the national level of 45.9% and the provincial level of, 45.8% for Littoral and 75.7% for the South province (Cf. ECAM II, 2000). Only 30% of sampled households are in possession of treated mosquito bed nets. The incidence of diarrhoea was found to be 81%. Infant

mortality was also found to be relatively high. Within the past three years 23% of all households surveyed had suffered at least one death of a child under 5. The primary cause of death was diarrhoea and malaria.

The National (Cameroon) Committee Against AIDS 2004 found that the national HIV prevalence was 5.5%. In the Littoral province, the prevalence was 4.4% for men and 6.5% for women and in the South province; the prevalence was 4.5% for men and 8.4% for women. According to The Londji Health Centre (see Appendix N), which serves a large proportion of the project affected villages, Sexually Transmitted Infections (STIs) are the second most prevalent category of disease presented to them after malaria. As the Londji Health Centre does not have HIV testing facilities, their recorded incidence for AIDS was lower than the national average.

Infrastructure

With a few exceptions in the Sanaga-Maritime Division, all the affected villages have access to tarred roads; Edéa-Kribi, Edéa-Douala and Edéa-Kopongo. However, as very few people own or have access to cars, the roads are used mainly for walking or 'hitching a ride' to the larger towns, such as Kribi and Edéa. The roads are, however, heavily used by local buses that travel between Kribi and Edéa.

Relatively wealthy people use shared taxis to take them to local markets where they buy and/or sell goods.

Water

General water use within the streams at the Plant Site has been established from on-site interviews and information gathered from the household surveys. Surface water resources are the main water supply for local inhabitants for all domestic purposes (approximately 65% of households use surface water acting as the primary water source for both drinking and bathing/washing/cooking (see Section 5.4 for further detail on water use). A number of households reported having suffered from water-borne diseases. Several child deaths were reported as a result of diarrhoea and other water-borne diseases. This would suggest that current water supply is not entirely safe for human use. All of the houses surveyed only have access to open pit toilets.

Communications

Mobile phones are the most common form of communication in the project area. None of the surveyed households had fixed landlines, but observations would suggest that a good proportion of households had access to mobile phones. There is a mobile phone mast owned by the Cameroonian mobile phone company, MTN, in Fifinda 2 village in Kribi subdivision. Fifinda 2's chief is employed by MTN to maintain the undergrowth and to ensure security of the mast.

Electricity

The availability and use of electricity is very varied in the project area. A large number of villagers have access to electricity although not all the houses are connected to electricity networks. According to the survey and site observations, the majority of villages have the capacity to access electricity. What is meant by capacity is that many households may have

the technology to connect to pylons, but they may not have the money to pay electricity bills or the pylons have gone into disrepair and have ceased to be connected to a national grid. Some wealthier households may have their own generators thus making them independent of the local electricity infrastructure. The village of Dehane has no electricity capacity at all.

6.5.2 Potential Social Impacts

The key potential impacts on the infrastructure are:

- *Pressure on health services*
- *Degradation of water supply at the plant site.*

In addition, there may be more minor impacts on the local education, communication and electricity services.

Pressure on health services

The health centres found in the project areas will face a potential increase in the number of patients using their services. During the construction phase up to 600 workers will be employed all of whom may require access to medical services. In addition, given the nature of the construction works and associated traffic (see Section 5.7), the incidence of accidents may increase.

It is possible that with an influx of predominately male contract workers, a rise in sexually transmitted disease, including HIV/AIDS could occur (see Section 6.3). The project area already has quite a high rate of STIs People with STIs are at greater risk of contracting HIV/AIDS, so the project area residents are particularly vulnerable to acquiring HIV. This could place greater pressure on the health facilities.

Degradation of water supply in plant site

During construction there will be project staff in and around the plant site who will need sanitary facilities. Without proper measures this increased sanitary use could lead to the contamination or degradation of the surface water. This impact is dealt with in Section 5.4 and therefore is not assessed further in this section of the report.

Education

As noted in the baseline there are no schools within the wayleave or at the plant site, which was confirmed during the Compensation Commission Survey (pers.comm). AES SONEL) and as such there will be no need to remove school buildings.

Access to existing schools should not change significantly. However if resettlement of a household with school age children requires movement away from their current village this may occur. However, as set out Section 6.3, due to the need to only move property outside of the wayleave (potentially only 15 m from existing location) it is not anticipated that relocation to different villages will be required. Access to school is not therefore anticipated to change.

The project will also not involve a large influx of new families that may include children requiring school facilities. During construction most labour will be local or unaccompanied/single men. This is a short term phase (maximum 15 months). During operations permanent posts will be created. However the overall level of employment (approximately 60) is low. Where practical these will be employed from the local population. Therefore the potential increase in children moving to the area and requiring school facilities is low. Therefore this impact is not assessed further within the SIA.

Communications and electricity

The impact on communications will be neutral to positive. There maybe an indirect positive impact if the project generates income and more people are able to afford mobile phones. Similarly with electricity, increased local income generated by the project would mean that more people could be expected to afford to pay for electricity. However overall additional long-term employment is relatively low and therefore major increases in access to local services is unlikely. This impact is not therefore assessed further within this SIA.

6.5.3 Mitigation Measures

The only issue where potentially negative impacts arise is in relation to the local medical services.

Pressure on health services

During the construction phase the influx of workers has the potential to put considerable strain on the local medical services. Therefore, as part of the construction works additional provision will be made by the contractor to provide basic medical services, such as an on-site health post. During the operational phase staff numbers will be approximately 60. These workers will be located in towns where there are existing facilities.

Effective mitigation will also involve good sensitisation about STIs and HIV/AIDS as mentioned in Section 6.3. Additionally, the local health centres should be involved in any HIV/AIDS campaign that AES SONEL offers to its staff and the project affected communities. This ensures that local issues and mores are taken into account and that local solutions can be developed.

6.5.4 Evaluation of Mitigated Measures

Potential impacts on education facilities and local infrastructure have been assessed as insignificant and are not evaluated further. Impact on local water sources have been fully evaluated within Sections 5.4 and 5.5 of this report and therefore these impacts are not assessed further within this section. The main potential impacts on Social Services and Infrastructure therefore relates to the healthcare.

Pressure on health services

Construction

Concerted and coordinated planning by AES SONEL, the construction contractor, the local communities and the health services will be able to minimise the impact on peoples' health and the resources of the local health facilities. This will include provision of basic health

care services for the work force by the contractor (either directly or via support to the existing services) to over-come potential peak demand for medical assistance.

The impact will be greatest during the construction phase when up to 600 employees will be involved on site, a period of 15 months. However work force numbers will vary over this period with average numbers being considerably below the 600 estimated peak. The potential impact on health facilities during this time is therefore considered to be adverse, short-term and minor in significance.

Operation

During the operational phase of the project, there will only be 60 people employed on a full-time basis at the plant site. There will be occasional employment for vegetation clearance. The latter will primarily involve small numbers of the local population, who already use the local health resources. The introduction of the additional staff at the Plant Site will therefore provide an adverse, long-term but insignificant impact on health services in the project area.

6.5.5 Evaluation of Alternative Development Options

The adoption of any of the proposed project alternatives would not significantly alter the overall impacts on the health or social services of the local communities.

The zero option would remove the potentially negative impacts on health that may arise from the construction and operation of the project. However, the positive impacts on communications and electricity would also not occur.

6.5.6 Conclusions

Generally, projects, which involve a large influx of contract workers, can have a negative impact on the health and social well-being of communities. With mitigation measures in place these impacts can be minimised. If this does occur then the potential positive economic impacts of the project would outweigh temporary social 'adjustment' impacts. Table 6.5.1 summarises the impacts on the infrastructure.

Table 6.5.1: Summary of Impact Evaluation – Social Services and Infrastructure

Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Plant site/transmission line	C	Pressure on health facilities	Pressure on health facilities	Health facilities, local communities contract staff	Adverse	Short term	Significant
Plant site/transmission line	O	Pressure on health facilities	Pressure on health facilities	Health facilities, local communities contract staff	Adverse	Long term	Insignificant

1 – see Table 1.5.1 for definition
2 – Phase - C -= Construction / O = Operation / D = Decommissioning.

6.6 ELECTROMAGNETIC FIELDS – COMMUNITY HEALTH

6.6.1 Baseline Conditions

Background

Electric and magnetic fields are present wherever electricity is used. For the last twenty years it has been widely debated if these fields are damaging to human health. There is a range of divergent views, but the balance of scientific evidence to date suggests that Electromagnetic Fields (EMFs) do not cause disease. However, international organisations such as the International Commission on Non-Ionising Radiation Protection (ICNIRP) and independent states have set guidelines on exposure limits on EMFs to minimise the potential for shocks and interference with the body's nervous system.

For the purposes of this study a comprehensive literature review was undertaken of the most relevant and up to date information on this topic. From this the potential for impacts to arise from the proposed power transmission line were assessed and the conclusions reported below.

EMF Fundamentals

Electromagnetic fields are produced both naturally and as a result of human activity. Wherever electricity is used there will also be electric and magnetic fields. A key characteristic of a field is the frequency (measured in hertz, Hz). The earth's magnetic and electric fields do not oscillate at all, but most electricity systems in the world produce fields at 50 Hz, apart from USA at 60 Hz (Electricity Association, 2001).

An electric field is generated by voltage, the pressure behind the flow of electricity. The strength, or amplitude, of the electric field depends on the voltage, which remains more or less constant as the line is energised.

Current, the flow of electricity produces magnetic fields, which in the case of a power line would vary according to the demand of power at any given time.

One difference between electric and magnetic fields is that electric fields are easily screened, while magnetic fields pass readily through most buildings.

6.6.2 Potential Impacts

Electromagnetic Field and Distance to Transmission Lines

Transmission lines generate both electric and magnetic fields, which show the highest ground level values straight beneath the line.

The magnetic field produced by a current in a conductor falls with distance from the conductor. Where there is more than one current forming part of one or more electrical circuits there would be partial cancellation between the magnetic fields produced by the individual currents. That cancellation increases at greater distances, leading to the strongest magnetic field at the point closest to the conductors. This field however reduces rapidly with distance. Similarly, there is partial cancellation between the electric fields produced by the voltages on individual conductors, and the electric field is usually highest at the point of

closest approach to the conductors and again falls quite rapidly with distance (National Grid EMF, 2003). A schematic of the magnetic and electric fields around power transmission lines is presented in Figure 6.6.1.

The actual magnetic field depends on the current, the clearance of the line above the ground and the relative phasing of the two circuits. High spans of the transmission lines and transposed phasing, as opposed to 'un-transposed' phasing, produces lower magnetic fields.

In theory, the magnetic field decreases with the inverse square of the distance from a transmission line, with either single or double circuits, but with untransposed phasing. For transmission lines with transposed phasing, the magnetic field declines with the inverse cube of the distance.

The steady-state maximum ground-level magnetic field beneath a transmission line is 100 microteslas (μT), but in practice fields are often below 10 μT (Table .6.6.1). Similar considerations apply to electric fields and the maximum ground-level electric field beneath a 400 kV line at ideal situations is 11 kilovolt per metre (kV/m) (National Grid EMF, 2003).

Table 6.6.1: Typical ground-level field levels from overhead power lines

		Magnetic Field (μT)	**Electric Field (V/m)**
The largest steel pylons (275 kV and 400 kV)	Maximum field (under line)	100	11,000
	Typical field (under line)	5-10	3000-5000
	Typical field (25 m to side)	1-2	200-500
Smaller Steel Pylons	Maximum field (under line)	40	4,000
	Typical field (under line)	0.5 – 2	1000-2000
	Typical field (25 m to side)	0.05-0.2	100-200
Wooden Poles (11 kV and 33 kV)	Maximum field (under line)	7	700
	Typical field (under line)	0.2 – 0.5	200
	Typical field (25 m to side)	0.01 – 0.05	10 - 20

Source: National Grid EMF, 2003

According to Figure 6.6.2, under a transmission line of up to 400 kV there would never be a magnetic field above the ICNIRP reference value of 100 μT and hence the basic restrictions of a current density of 2 mA/m^2 would not be exceeded. According to an EEC report, 2600 ampere on a 420 kV line gives a peak field of 55 μT (National Grid, 1996). It should be noted how quickly the magnetic field decreases with distance from the centreline of the power line.

Figure 6.6.3 is based on data from the US Department of Energy (2003) from a 345 kV transmission line also showing the rapid decline in magnetic field with distance from transmission line, showing slightly lower values than reported in Figure 6.6.2.

Household appliances powered from the mains electricity produce elevated magnetic fields whenever they draw current (Table 6.6.2). Such fields generally fall with the inverse cube

of the distance, and at approximately 30 m from a transmission line; the magnetic field would be similar to the field at 1 m from a normal household appliance.

Table 6.6.2: Typical magnetic fields from household appliances

	Magnetic Field (μT)	
	Close to Appliance	1 metre away
Electric razor	2,000	0.3
Vacuum Cleaner	800	2
Television	50	0.2
Washing Machine	50	0.2
Bedside Clock	50	0.02
Fridge	2	0.01

Source: National Grid EMF, 2003

Figure 6.6.4, also based on data from the US Department of Energy, shows the decline in electric field with distance from the transmission line.

For the proposed 400 kV Spalding overhead transmission line (National Grid, 1996), the calculated electric field at 1 m above ground level for a clearance of 7.6 m above ground were as follows:

Max. below line 7.86 kV/m

At 25 m distance 0.54 kV/m

At 50 m distance 0.33 kV/m

At 100 m distance 0.11 kV/m

At 200 m distance 0.03 kV/m

Health Effects

Concern about potential adverse health effects was initially brought to attention by an epidemiological report two decades ago from two American scientists on childhood cancer but have also included worries about the effect of EMF on the nervous and muscular system (Ahlbom *et al, 2001*).

Established Short-term Effects

At the quantum energy of 50 Hz, which is the frequency of most transmission lines, electromagnetic fields are too small to break chemical bonds. The main known way 50 Hz fields interact with people is by inducing currents. Current densities of about 100 mA/m^2 can stimulate excitable tissue and current densities above about 1000 mA/m^2 can cause ventricular fibrillation as well as producing heating. However, these current densities correspond to fields far larger than ever encountered at 50 Hz (National Grid EMF, 2003). The established effect observed in humans at the lowest magnetic field is the

magnetophosphene effect, where a flickering sensation is produced in peripheral vision by 50 Hz magnetic fields above about 10,000 μT.

In certain circumstances, a person exposed to a high electric field could experience small spark discharges on touching other objects, producing a prickling sensation similar to that caused by the static discharges commonly experienced in dry atmospheric conditions. According to the National Radiological Protection Board (2003) in the United Kingdom, the annoying effects caused by electric charge on the surface of the body will not occur at power-frequency electric field strengths below 12 kV/m.

Chronic Diseases

Ahlbom *et al* (2001) have reviewed the epidemiological literature on EMFs and risks of chronic diseases and have concluded that in the absence of experimental evidence and given the methodological uncertainties in literature, there is no chronic disease for which an etiological relation to EMF can be regarded as established.

Among all the outcomes evaluated in etiological studies of EMFs, childhood leukaemia in relation to exposure after birth above 0.4 μT is the one for which there is most evidence of an association. The relative risk has been estimated at 2.0, but may in part be due to bias since only 0.8% of the children in the pooled analysis were exposed to a magnetic field above 0.4 μT (Ahlbom *et al*, 2001). As an example, every year in Sweden 1 child in 25,000 develop leukaemia and the increased relative risk would as a result mean that 2 out of 25,000 children would develop the disease instead (SSI, 2003).

Biological laboratory research show that the low level EMFs of the type experienced by the public do not cause the diseases that have been claimed, such as cancer (Electricity Association, 2001).

The largest of all epidemiological studies of EMFs and childhood cancer was performed in the 1990s – the United Kingdom Childhood Cancer Study (UKCCS). In 1999 it was reported that the *"…study provides no evidence that exposure to magnetic fields associated with the electricity supply in the UK increases risk for childhood leukaemia, cancers of the nervous systems or any other childhood cancer*." In 2002 it was concluded *"…there was no evidence that either proximity to electrical installations or the magnetic field levels they produce in the UK is associated with increased risk of childhood leukaemia or any other cancer"* (Electricity Association, 2001).

Other Health Effects

Breast cancer, cardiovascular disease, suicide and depression remain unresolved issues as stated in the review report by Ahlbom *et al* (2001).

Other Effects

In the environmental statement of a proposed Welsh 132 kV transmission line crossing over open agricultural land, it is stated that there would unlikely be any agriculturally significant effects. In addition, by following the British Standard on Radio Interference Characteristics of Overhead Power Lines and High-voltage Equipment (BS5049:1994), the transmission line would not cause interference to radio or television services or to telecommunications systems (AES Barry Ltd, 1996).

Electric and magnetic fields due to high voltage overhead power lines constitute a possible source of interference with the operation of some types of implanted cardiac pacemakers (National Grid, 1996).

Fear Impact

EMF are not generally understood by the general public and therefore fear can be considered to be the most significant impact perceived with power transmission lines.

Exposure Guidelines and Legislation

Various bodies round the world have issued guidelines on safe levels of exposure to EMFs. Most of them are designed to prevent induced currents having effects on the body.

Cameroon

According to the WHO database for EMF World Wide Standards, there are currently no legislation or guidelines in place in Cameroon regarding exposure to EMF. In the absence of national guidance the Limbe Power Environmental Impact Statement (AES SONEL, September 2003) made reference to both the International Commission on Non-Ionising Radiation Protection (ICNIRP) and the National Radiological Protection Borad (NRPB), see discussion below.

ICNIRP

The International Commission on Non-Ionising Radiation Protection (ICNIRP) was established in 1992. The function of the ICNIRP is to investigate the hazards that may be associated with the different forms of non-ionising radiation, develop international guidelines on non-ionising radiation exposure limits and deal with all aspects of non-ionising radiation protection (ICNIRP, 1998).

All scientific literature on the health effects of EMF exposure was reviewed by ICNIRP. In general terms for EMF, the only adverse effects that were found to be fully verified were short term, immediate health consequences such as stimulation of the peripheral nerves and muscles (above 100mA/m^2 at 50Hz – which is well above power line current density), functional changes in the nervous system and other tissues, shocks and elevated tissue temperatures (1000mA/m^2 at 50Hz). Other data for chronic low-level exposure indicate that there may be other health effects. However, according to the ICNIRP the data is insufficient to allow an exposure guideline to be established to this (ICNIRP, 1999).

Limiting values are set as *basic restrictions*, which directly relate to established health effects, and *reference levels*, which are derived from the basic restrictions for worst-case exposure situations and are in quantities which are easily measured. The guidelines also differentiate between occupational and general public exposure – the general public guidelines levels for magnetic fields are set at a factor of 5 below the values set for occupational exposure (ICNIRP, 1999).

The following ICNIRP are in place for fields at 50 Hz:

- *Basic Restriction*
    - *Occupational exposure – Current density: 10 mA/m^2*
    - *General public exposure – Current density: 2 mA/m^2*
- *Reference Levels*
    - *Occupational exposure –*
        - *Electric Field Strength: 10kV/m*
        - *Magnetic Field Strength: 500μT*
    - *General public exposure*
        - *Electric Field Strength: 5kV/m*
        - *Magnetic Field Strength: 100μT*

European Union

A Recommendation to Member States of the EU on the limitation of exposure of the general public to EMFs in the frequency range 0 Hz – 300 GHz was passed on 12 July 1999 by the Council of the European Union and published in the Official Journal of the European Communities.

The recommendation is divided in two parts where, firstly, the *basic restrictions* on exposure to time-varying EMFs are based directly on established health effects and biological considerations. Secondly, the *reference levels* are provided for practical exposure-assessment purposes to determine whether the basic restrictions are likely to be exceeded. If the measured value exceeds the reference level, it does not necessarily follow that the basic restriction will be exceeded. However, it should be investigated if that is the case. Additionally, the restrictions are dependent on frequency of the fields.

The relationship between cancer and EMF exposure is considered not to be established. However, since there are safety factors of about 50 between the threshold values for acute effects and the basic restrictions, the recommendation should cover possible long-term effects.

The basic restriction for current density at 50 Hz (the frequency for most transmission lines) is 2 mA/m^2.

The reference levels are as follows:

- Electric field strength: 5 kV/m;
- Magnetic field strength: 100 μT.

UK National Radiological Protection Board (NRPB)

The National Radiological Protection Board (NRPB) is the independent body charged by the UK Parliament with giving advice on EMFs, including safe levels of exposure. There are no statutory regulations in the UK, which limit the exposure of people to power-frequency electric or magnetic fields.

The NRPB has recommended guidelines for exposure to EMFs. Guidelines for limiting exposure to electromagnetic fields are presently based on preventing established health effects, which for EMFs at 50 Hz are those related to induced currents in the tissues of the central nervous system and indirect effects such as micro-shocks. However, deciding on these guidelines the evidence for all suggested effects of EMFs, including cancer, was considered but the epidemiological evidence is currently not strong enough to justify a firm conclusion that magnetic field cause such effects.

The guidelines, expressed as *basic restrictions* (relates directly to the effect on the body of EMF exposure) and *investigation levels* (aid in assessing whether the basic restriction in exceeded or not), are as follows:

- Basic restriction;
    - Induced current density in the central nervous system: 10 mA/m^2;
- Investigation levels;
    - Magnetic fields: 1,600 μT
    - Electric fields: 12 kV/m

It is the policy of the UK electricity industry to remain within these guidelines (Electricity Association, 2001).

The WHO and European Union have launched an initiative aimed at achieving a harmonised international approach to the development of EMF guidelines. In May 2003, the NRPB published a consultation document proposing that exposure guidelines of the ICNIRP be adopted in the UK. The key implication of this proposal would be a five-fold drop in the basic restriction for the general public, reducing the current density for general public exposure from 10 mA/m^2 to 2 mA/m^2.

Italy

Italy differs from other countries on the issue of limiting EMF to the general public. The limits are set in the law and include details of how close residential buildings are allowed to be to power lines. The restrictions are as follows (EURELECTRIC, 2003):

- *Public*
    - *Electric field strength (E-field)*
        - *Exposure for significant periods of the day: 5kV/m*
        - *Exposure limited to a few hours per day: 10kV/m*
    - *Magnetic field strength –*
        - *Exposure for significant periods of the day: 100μT*
        - *Exposure limited to a few hours per day: 1000μT*
- *Residential buildings near power lines*
    - *Distance to conductors –*
        - *132 kV power line: 10 m*
        - *220 kV power line: 18 m*
        - *380 kV power line: 28 m*

USA

Apart from countrywide advisory limits in the United States there are also state limits specific to overhead power lines. In Florida the limits are related to distance from transmission line and line voltage. The limits in Florida are as follows (EURELECTRIC, 2003):

- *Limits applying to edge of right-of-way*
    - *Electric field strength: 2 kV/m*
    - *Magnetic field strength –*
        - *for 230 kV lined:15 μT*
        - *for 500 kV lines: 20μT*
- *Limits applying everywhere*
    - *Electric field strength*
        - *for 69-230 kV lines: 8 kV/m*
        - *for 500 kV lines: 10kV/m*

Switzerland

Switzerland is the only country in the world to have set national limits for power frequencies based on a precautionary approach to childhood cancer (National Grid EMF, 2003). It came into force in February 2001 and existing installations have three years to meet its requirements.

The basic limits are similar to many other countries with an electric field limit of 5 kV/m and magnetic field limit of 100 µT. In addition, for "sensitive use locations" only (rooms in buildings regularly occupied for significant periods of time, children's playgrounds etc), overhead transmission lines greater than 1 kV have a limit of 1 µT (some exceptions can be granted) (EURELECTRIC, 2003).

South Africa

South Africa follows the ICNIRP guidelines (see above), as stated by the WHO database EMF World Wide Standards (2003).

International Conference on EMF - From bioeffects to legislation

An international conference on EMF was held on 8-9 November 2004 at Ljubljana, Slovenia. The Conference was organized and sponsored by the following scientific and government organizations:

- Institute of Non-Ionizing Radiation (INIS)
- World Health Organization (WHO)
- International Commission on Non-Ionizing Radiation Protection (ICNIRP)
- European Commission (DG EMPL)
- COST 281
- EMF NET
- Forum EMS
- Ministry of Health
- Ministry of Environment
- Ministry of Information Society of the Republic of Slovenia

The Conference conclusions and recommendations were as follows:

- It is openly recognized that the international ICNIRP guidelines are based on the best and most updated available science and, thus, a very wide scientific consensus.
- An assessment of the scientific evidence to date suggests that no adverse health consequences have been established at exposure levels below current international ICNIRP guidelines.
- National authorities in the EU, particularly in the new EU member states and candidate Members of the EU should protect their citizens and workers by adopting international guidelines or use the WHO framework for developing EMF standards for limiting exposure from EMF sources and encouraging compliance with these standards.
- Additional precautionary measures can be adopted, provided they do not undermine the science-based guidelines. The measures could address aspects such as emission limits or technical measures to reduce fields from the EMF sources, but should not modify exposure limits established by international guidelines.
- The recommendations from WHO are to protect human health by adopting the ICNIRP exposure limits as a mandatory requirement and to address continuing public concerns about health effects of EMF exposure by adopting voluntary precautionary measures as follows:
    - Governmental/industrial/academic research program that leads to better health risk assessments;
    - Encourage manufacturers to keep exposures to the minimum needed for the technology;
    - Better risk communication;
    - Target messages to audience with honest and accurate information;
    - Public involvement in decision-making, especially when siting facilities, to minimize EMF exposures and public concern.

6.6.3 Mitigation Measures

There are no specific, physical mitigation measures proposed to offset potential impacts from EMF effects. However, EMF levels will be within recognised international limits below or close to the line.

The line will however be within a wayleave where no residential properties, or any built development, will be permitted. For the current design this will result in the nearest that any property can come to the line being approximately 15 m. Whilst no significant impacts are identified this separation distance will act as a mitigation measure by further reducing the potential exposure levels of any long term occupied buildings.

In addition to this the potential fear of EMF impacts should be considered within the mitigation measures. Whilst a specific campaign of information on EMF effects is not recommended, staff involved in line planning, survey and construction should be instructed in the effects set out within the EIA and therefore be in a position to answer questions or provide information should queries arise.

6.6.4 Evaluation of Mitigated Impacts

The International Commission for Non-Ionisation Radiation Protection (ICNIRP) advice the WHO, World Bank and independent states on the scientific basis for guidelines on exposure to electromagnetic fields. According to the ICNIRP, research evidence for EMF causing long-term, chronic, diseases such as cancer is not clear and therefore there are no guidelines based on this potential risk. The guidelines are based on short term, immediate health consequences such as stimulation of the peripheral nerves and muscles, and micro-shocks.

Only the higher voltage transmission lines at 400 kV would, under steady-state conditions, and directly beneath the lines, create a magnetic field maximum of 100 µT (the ICNIRP reference value). However, typical values are approximately a tenth of this field value. The same applies to electric field for 400 kV transmission lines, where maximum, steady-state, values could be above the reference value of 5 kV/m but the typical values might only reach this. The magnetic and electric fields drop rapidly with the distance from the centrelines of the power line.

In conclusion, transmission lines are highly unlikely to create an electromagnetic field above the ICNIRP guidance values even at the highest risk location, i.e. straight beneath the line. Nevertheless, there are countries with slightly different standards – including Italy, Switzerland and some states in the USA – which should be taken into consideration.

For the Kribi Power Project the wayleave will result in the nearest properties being at a minimum distance of 15 m from the centre of the power lines. With the rapid decay in EMF with distance, at the edge of the wayleave all international standards should be met. It is therefore concluded that the impacts of EMF on community heath is long term, local, but insignificant in magnitude.

6.6.5 Evaluation of Alternative Development Options

The adoption of any of the proposed project alternatives would not significantly alter the impacts of EMF, as the introduction of the 30 m wayleave would still be required.

The zero option would remove the negative impacts. However, research has shown that the impacts of EMF on community heath is long term, local, but insignificant in magnitude.

6.6.6 Conclusions

The potential impacts on EMF to community health are summarised below.

Table 6.6.3: Summary of Impact Evaluation – Population and Demographics							
Project Location	**Phase[2]**	**Impact**	**Nature of Impact**	**Receptor**	**Nature[1]**	**Duration[1]**	**Significance[1]**
Transmission Line	C	Electro-magnetic Field	Community Health	Local communities	-	-	-
	O			Local communities	Adverse	|Long-term	Insignificant
	D			Local communities	-	-	-
1 – See Table 1.5.1 for definition 2 – Phase - C -= Construction / O = Operation / D = Decommissioning.							

SECTION 7 : ENVIRONMENTAL MANAGEMENT PLAN

7.1 INTRODUCTION

This framework Environmental Management Plan (EMP) for the proposed project has been prepared as a standalone section of the ESIA report in accordance with both the requirements of Cameroonian and World Bank legislation.

The requirement for an EMP to be included in the ESIA report is stipulated in the *EIA Decree of Cameroon, 2005 / 0577, 23rd February 2005*, which requires that an EMP be included separately in the EIA report. The World Bank Environmental Assessment Guidance OP4.01, Appendix C provides guidance on the contents of the EMP (also referred to as an Environmental Action Plan (EAP)).

This framework EMP is structured as follows:

- Environmental Policy;
- Project Overview;
- Register of Environmental Impacts;
- Environmental Standard and Quality Objectives;
- Mitigation and Implementation;
- Monitoring and Evaluation;
- Management Structure;
- Data Handling; and
- Audits and reviews.

The framework Social Management Plan (SMP) is presented in Section 8 of this report.

Prior to the start of the power plant operations both the framework EMP and SMP will be developed into a full EMP and SMP that encompasses all aspects of mitigation, management, monitoring and institutional measures that will be undertaken by AES SONEL for the Kribi Power Project.

The construction phase will be undertaken by an Engineering, Procurement and Construction (EPC) Contractor who will need to have their own EMP, which will meet the requirements of the ESIA and it will be necessary to ensure the required mitigation measures are implemented.

7.2 ENVIRONMENTAL POLICY

AES SONEL's Environmental Policy is presented in Appendix P.

7.3 PROJECT OVERVIEW

A project overview is presented in Section 3 of this report.

7.4 REGISTER OF ENVIRONMENTAL IMPACTS

The purpose of the EMP is to ensure that appropriate control and monitoring measures are in place to deal with all significant potential environmental impacts of a project. An impacts register therefore provides a focus for environmental management. The potential impacts of the project are discussed in Sections 5.3 to 5.10 of this report and are summarised in Table 7.4.1 below.

Table 7.4.1: Summary of Impacts - Environmental

Issue	Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Air Quality	Plant site	C	Dust nuisance / heath risk	Dust rise from on-site activity	Local population	Adverse	Short-term	Minor
		O	Reduced local air quality	Emissions from power plant (gas)	Local population	Adverse	Long-term	Minor
		O	Reduced local air quality	Emissions from power plant (Diesel)	Local population	Adverse	Short-term	Minor
		C	Reduced local air quality	Vehicle exhaust emissions	Local population	Adverse	Short-term	Insignificant
	Transmission line	C	Dust nuisance / heath risk	Dust rise from on site activity	Local population	Adverse	Short-term	Minor
		C	Reduced local air quality	Vehicle exhaust emissions	Local population	Adverse	Short-term	Insignificant
Surface Water Resources	Plant site	C/D	Water quality	Soil erosion	Surface water users	Adverse	Short-term	Minor
		C	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Short-term	Minor
		O	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Long-term	Minor
		C/O	Reduced surface water resources	Abstraction for site water supply	Surface water users	Adverse	Long-term	Insignificant
	Transmission line	C/D	Water quality	Soil erosion	Surface water users	Adverse	Short-term	Insignificant
		C/D	Water quality	Fuel / foul water discharge	Surface water users	Adverse	Short-term	Minor
		C	Reduced surface water resources	Abstraction for site water supply	Surface water users	Adverse	Long-term	Insignificant

Table 7.4.1: Summary of Impacts - Environmental

Issue	Project Location	Phase[2]	Impact	Nature of Impact	Receptor	Nature[1]	Duration[1]	Significance[1]
Groundwater Resources	Plant site	O	Reduced groundwater resources	Abstraction for site water supply	Groundwater users	Adverse	Long-term	Insignificant
		C/D	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Short-term	Insignificant
		O	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Long-term	Minor
	Transmission line	C	Pollution of Groundwater	Oil spills and foul drainage	Groundwater users	Adverse	Short-term	Insignificant
		O	No impacts					
Noise	Plant site	C	Increased noise levels	Construction activity at site	Local residents	Adverse	Short-term	Significant
		O	Increased noise levels	Turbine operation	Local residents	Adverse	Long-term	Minor
	Transmission line	C	Increased noise levels	Construction activity at site	Local residents	Adverse	Short-term	Minor
		O	Increased noise levels	Corona discharge	Local residents	Adverse	Long-term	Insignificant
Traffic	Douala - Edéa road	C/D	Increased road traffic	Congestion	Local road users	Adverse	Short-term	Minor
		C/D	Increased road traffic	Noise, vibration and air quality	Residents near the road	Adverse	Short-term	Insignificant
		C/D	Increased road traffic	Accident risk	Local residents and road users	Adverse	Short-term	Minor
	Edéa – Kribi road	C/D	Increased road traffic	Congestion	Local road users	Adverse	Short-term	Minor
		C/D	Increased road traffic	Noise, vibration and air quality	Residents near the road	Adverse	Short-term	Significant
		C/D	Increased road traffic	Accident risk	Local residents and road users	Adverse	Short-term	Significant
Soils and Land use	Plant site	C/O	Land take	Construction of the plant site	land use and soils	Adverse	Long-term	Insignificant
		C/O	Soil contamination	Use of fuels and oils	Soils	Adverse	Long-term	Minor
		D	Soil contamination	Use of fuels and oils	Soils	Adverse	Short-term	Minor
		C/D	Soils erosion	Construction activity	Soils	Adverse	Short-term	Minor
	Transmission line	C/O	Land take	Construction of towers	land use and soils	Adverse	Long-term	Insignificant
		C/O	Land use	Change of land use in wayleave	Forest areas, farm land	Adverse	Long-term	Insignificant

Table 7.4.1: Summary of Impacts - Environmental								
Issue	**Project Location**	**Phase[2]**	**Impact**	**Nature of Impact**	**Receptor**	**Nature[1]**	**Duration[1]**	**Significance[1]**
		C	Soil contamination	Use of fuels and oils	Soils	Adverse	Long-term	Minor
		D	Soil contamination	Use of fuels and oils	Soils	Adverse	Short-term	Minor
		C/D	Soils erosion	Construction activity	Soils	Adverse	Short-term	Minor
Flora and Fauna	Plant site	C/O	Land take for construction	Destruction of existing habitat	Flora and fauna	Adverse	Long-term	Minor
		C/O	Noise from site activity	Disturbance of wildlife	Fauna	Adverse	Long-term	Insignificant
		C	Increased traffic	Risk of road kills of local fauna	Fauna	Adverse	Short-term	Minor
	Transmission line	C/O	Land take for construction	Destruction of existing habitat	Flora and fauna	Adverse	Long-term	Minor
		C/O	Clearance of wayleave	Alteration of existing habitats	Flora and fauna	Adverse	Long-term	Minor
		C	Noise from site activity	Disturbance of wildlife	Fauna	Adverse	Short-term	Minor
		C	Increased traffic	Risk of road kills of local fauna	Fauna	Adverse	Short-term	Minor
Landscape and Visual	Plant site	O	Landscape character	Industrial feature in rural setting	Landscape	Adverse	Long-term	Minor
		O	Visual amenity	Industrial feature in rural setting	Local population	Adverse	Long-term	Minor
	Transmission line	O	Landscape character	Additional power line	Landscape	Adverse	Long-term	Minor
		O	Visual amenity	Additional power line	Local population	Adverse	Long-term	Minor

[1] – See Table 1.5.1 for definition

[2]– Phase - C -= Construction / O = Operation / D = Decommissioning

7.5 ENVIRONMENTAL STANDARDS AND QUALITY OBJECTIVES

Wherever available, Cameroonian standards will be adapted to the project, which will be supplemented by international standards and guidance as necessary in consultation with the EPA. These will be supplemented by World Bank and other international standards and guidance as necessary and in consultation with the EPA.

As detailed monitoring programmes are developed, the standard applicable to each environmental media will be specified within the monitoring protocols.

7.6 MITIGATION AND IMPLEMENTATION

Mitigation measures are discussed in the EIA Sections 5.3 – 5.10 and are summarised together with Site Management (implementation of mitigation) in Table 7.6.1 below.

Control of most impacts is a function of correct operation and management of activities on site. Standard operating procedures (SOPs) for all plant and equipment that may have an impact on the environment will therefore be referenced within the plan. This applies to both the construction, operational and decommissioning phases of the project.

Specific operational control procedures will be developed to ensure on-going application of the EMP principles throughout the life of the power plant for non-standard operations.

Overall implementation in the construction phase will be the responsibility of the EPC Contractor.

Consultation is also a key mitigation measure and its implementation is considered key to the overall success of the implementation of the EMP. International best practice approach to consultation is presented in Section 8.6.1 of this report.

Table 7.6.1: Summary of Environmental Impacts – Mitigation, Implementation and Organisational Arrangements

Issue	Project Location	Phase[2]	Impact	Nature of Impact	Mitigation	Implementation	Organisational Arrangements	Monitoring
Air Quality	Plant site / Transmission Line	C	Dust nuisance / heath risk	Dust rise from on site activity	• Storage of materials on-site for reuse to reduce vehicular movement • Regular inspections to ensure roads are swept or sprayed to minimise dust generation • Appropriate site speed limit • Minimise area of clearance • Landscaping or hard standing cover on competed earthworks • Complaints record	Control procedures to be included within the EPC EMP	EPC Contractor	AES regular inspection and audits
			Reduced local air quality	Vehicle exhaust emissions	• Maintenance of vehicles in good working order	Standard maintenance and daily visual; inspections		AES audits of maintenance record and visual inspection of plant
		O	Reduced local air quality	Emissions from power plant (gas and diesel)	• Utilise specified stack height	SOP developed for all plant	AES SONEL	Continuous in stack monitoring for emissions
Surface Water Resources	Plant site / Transmission Line	C/D	Water quality	Soil erosion	• Avoidance of tower sites adjacent to water courses (>20-30m) • Minimise bare areas and vegetation clearance	Specified final design	Construction and decommissioning mitigation will be dealt with by the EPC Contractor. Design and operational issues by AES SONEL	Design checks and on site construction monitoring to design
		C/O		Fuel / foul water discharge	• Use of suitable sanitary facilities (e.g. simple pit latrines or septic tanks)	Specified within design		Design check and construction monitoring to design
		C/O	Reduced surface water resources	Abstraction for site water supply	• Minimise on site water use	Set EMP targets and objectives		Monitor on site water use

Table 7.6.1: Summary of Environmental Impacts – Mitigation, Implementation and Organisational Arrangements

Issue	Project Location	Phase[2]	Impact	Nature of Impact	Mitigation	Implementation	Organisational Arrangements	Monitoring
Ground-water Resources	Plant site	O	Reduced groundwater resources	Abstraction for site water supply	• Minimise on site water us	Set EMP targets and objectives	AES SONEL EMP	Monitor groundwater levels on site on a monthly basis
	Plant site / Transmission line	C/D	Pollution of Groundwater	Oil spills and foul drainage	• Installation of pit latrines • Temporary bunds around oil storage tanks • Safe storage of chemicals	Control procedures to be included within the EPC EMP	EPC Contractor	AES regular inspection and audits
	Plant site	O	Pollution of Groundwater	Oil spills and foul drainage	• Bunds on oil storage • Delivery and discharge pipe works above ground to allow inspection • Transformers in catch pits with sumps • Drainage from maintenance workshops to oil separator • Foul sewage to septic tank system	Specified within design. Inclusion within EMP procedures	AES SONEL	• Design checks and on site construction monitoring to design. • Daily inspection of oil bunds and separator • Quarterly groundwater sampling and microbiological testing
	Transmission Line	O	No impacts	Not applicable	-	-	-	
Noise	Plant site / Transmission Line	C	Increased noise levels	Construction activity at site	• Site controls, e.g. do not let engines run idly, undertake grinding within enclosure, locate noisy operations maximum distance from sensitive receptors	Control procedures to be included within the EPC EMP	EPC Contractor	Review complaints re noise via SMP liaison system
		O	Increased noise levels	Turbine operation	• Concrete block wall or similar • Attenuators or silencers on stacks	Specified within design	AES SONEL	Quarterly noise monitoring at sensitive sites for first year and if complaints received.
		O	Increased noise levels	Corona discharge	Not applicable	-	-	-

Table 7.6.1: Summary of Environmental Impacts – Mitigation, Implementation and Organisational Arrangements								
Issue	**Project Location**	**Phase**[2]	**Impact**	**Nature of Impact**	**Mitigation**	**Implementation**	**Organisational Arrangements**	**Monitoring**
Traffic	Douala - Edéa road	C/D	Increased road traffic	Congestion	• Route selection – use of existing main roads avoiding town centre • Reduce vehicle movements, e.g. workers use buses, full loads to be transported • Planned convoys at off-peak time	Control procedures to be included within the EPC EMP	EPC Contractor	AES regular review of compliance of operations
		C/D	Increased road traffic	Noise, vibration and air quality	• Restrict traffic speeds in built up area • Maintain fleet in good condition	Control procedures to be included within the EPC EMP	EPC Contractor	AES regular review of compliance of operations
		C/D	Increased road traffic	Accident risk	• Control traffic speed • Provide driver training and implement safety procedures • Maintain vehicles • Design access junctions to ensure adequate visibility • Signage • Consultation with villagers to inform them of increased traffic and works	Design and control procedures to be included within the EPC EMP	EPC Contractor	AES regular review of compliance of operations
	Edéa – Kribi road	C/D	Increased road traffic	Congestion	As Douala - Edéa road			
		C/D	Increased road traffic	Noise, vibration and air quality				
		C/D	Increased road traffic	Accident risk				

Table 7.6.1: Summary of Environmental Impacts – Mitigation, Implementation and Organisational Arrangements

Issue	Project Location	Phase[2]	Impact	Nature of Impact	Mitigation	Implementation	Organisational Arrangements	Monitoring
Soils and Land use	Plant site / Transmission line	C/O	Land take	Construction of the plant site and towers, and change of land use in way leave	• Routing of transmission line to avoid houses • Minimise disturbance to crops in area during construction	Specified within design and within EPC EMP	AES SONEL	Design checks and on site construction monitoring to design
		C/O/D	Soil contamination	Use of fuels and oils	• As mitigation for Groundwater Contamination from oil/fuel use	EPC and AES EMP procedures	EPC contractor AES SONEL	Design checks and on site construction monitoring to design. Daily inspection of oil bunds and separator
		C/D	Soils erosion	Construction activity	• Minimise land clearance area • Restrict activities in rainy season • Run-off to soak aways or retention ditches • Grading of tracks • Preserving top soils stripped for reuse in re-vegetation post closure • Use of geotextile, gravel surfacing or physical methods to cover bare ground	EPC EMP procedures	EPC Contractor	AES regular inspection and audits
Flora and Fauna	Plant site / Transmission line	C/O	Land take for construction	Destruction of existing habitat	• Minimise area of land take during design • Locate project elements within already disturbed areas	Specified within design	AES SONEL	Design checks and on site construction monitoring to design.
	Plant Site	C/O	Noise from site activity	Disturbance of wildlife	• Control of noise and areas of operation	EPC EMP procedures	EPC Contractor	AES regular inspection and audits

Table 7.6.1: Summary of Environmental Impacts – Mitigation, Implementation and Organisational Arrangements								
Issue	**Project Location**	**Phase[2]**	**Impact**	**Nature of Impact**	**Mitigation**	**Implementation**	**Organisational Arrangements**	**Monitoring**
	Plant site / Transmission line	C	Increased traffic	Risk of road kills of local fauna	• Control vehicle speeds	EPC EMP procedures	EPC Contractor	AES regular inspection and audits
	Transmission line	C/O	Clearance of wayleave	Alteration of existing habitats	• Maintain vegetation cover to minimise vegetation loss	Wayleave management procedures	EPC Contractor and AES during operation	AES regular inspection and audits
		C	Noise from site activity	Disturbance of wildlife	• Control of noise and areas of operation	Noise control measures specified within design	AES SONEL	Quarterly noise monitoring at sensitive sites for first year and if complaints received.
Landscape and Visual	Plant site	O	Landscape character	Industrial feature in rural setting	Not applicable	-	-	-
		O	Visual amenity	Industrial feature in rural setting	Not applicable	-	-	-
	Transmission line	O	Landscape character	Additional power line	• Use of existing power transmission line corridor	Specified within design	AES SONEL	
		O	Visual amenity	Additional power line	• Selection to maximise distance to property and cultivated land			

7.7 MONITORING AND EVALUATION

The full EMP will provide a detailed monitoring programme, which is essential to ensure the project achieves its operating standards. However, it is equally essential that the data collected is accurate and reliable. Protocols will therefore be developed to control this monitoring. These will include the following:

- sampling methods;
- sampling location and frequency;
- equipment types and calibration;
- data recording and logging;
- routine audits.

Where off-site laboratories are to be used, these will be checked to ensure appropriate standards are achieved.

Table 7.4.1 presents a summary of monitoring requirements for the project together with project phase, responsibility and organisational requirements.

7.8 MANAGEMENT STRUCTURE

As the national power provider in Cameroon, AES SONEL have an existing management structure to facilitate control of potential environmental and social impacts. As the Kribi Power Project will represent a new entity, there are no project specific management structures to set out, and as such this plan provides the framework for the systems that will be put in place within the existing company structure.

This plan provides the framework for the management systems that will need to be put in place within the existing environmental department.

The EPC Contractor will need to have an EMP compliant with AES SONEL's requirements and include procedures to cover all elements noted within this framework plan.

When setting up this management structure the key elements to incorporate are as follows:

- a single named individual who will be given overall responsibility for environmental matters on site;
- a staff structure below this individual that will be defined in order to control all aspects covered under the plan;
- staff within this structure that will be named individuals or be specific posts and a clear statement of their roles, responsibilities and competencies will be provided; and
- a clear line management and reporting pathway.

For an EMP to be effective there must be a formal responsibility for its implementation and as part of this an Environmental Manager should be appointed, reporting to the power plants senior management. The designated Environmental Manager should have the following terms of reference:

- to implement and develop the EMP as set out in this report, including over viewing the EPC contractors environmental controls;
- to liase with the regulatory authorities, obtaining and maintaining the necessary environmental permits, etc;
- to report to the project senior management on a regular basis;
- Assisting in define roles, responsibilities and competencies for all staff involved within the environmental management structure.
- to raise awareness of environmental issues and controls in the power project's workforce, especially in those areas that have a direct potential impact on the environment (e.g. the implementation of a compulsory induction course for all employees, contractors and subcontractors at the outset of the project will help ensure an overall understanding, which should be supplemented by specific training courses dependent on duties).

During construction, the management of the implementation of the detailed resettlement action plan will be a critical task to be managed and the environmental manager will need to work closely with RAP/resettlement unit team. In addition, the activities of the construction crew will need to be carefully monitored with respect to the requirements of the management plan.

Once constructed, the operation will have a relatively small-scale plant and the line will require minimal maintenance, during operation such staff may have dual responsibilities within the company.

7.9 DATA HANDLING

The management plan will include details of all data handling, storage and analysis requirements. The plan will identify the location where all data are to be held, staff responsibilities for data handling and analysis and appropriate reporting lines for ensuring management are aware of the current status of site operations.

This will include emergency procedures where monitoring indicates a failure of one of the on-site systems as well as routine reporting.

7.10 AUDITS AND REVIEWS

On a six monthly basis during construction and an annual basis during operation all monitoring activities and operating practices will be subject to external auditing to ensure compliance with the management plan. This will include a review of all monitoring data and any incidence of non-compliances occurring during the year.

The results of the audit will be submitted to management for review and action will be taken to upgrade or modify any systems as required. The audit report will identify any failings in the current system and make recommendation for any changes deemed appropriate.

In addition, routine internal audits will be undertaken, typically on a three monthly basis to monitor the implementation of the stipulated monitoring programmes and management controls, such as handling and storage procedures at the port.

SECTION 8 : SOCIAL MANAGEMENT PLAN

8.1 INTRODUCTION

This section presents a framework Social Management Plan (SMP) for the proposed project in line with international best practice. This document sets out all management action required to mitigate social impacts and includes an outline of the requirements for monitoring.

Prior to the start of construction AES SONEL will develop a detailed SMP in conjunction with the selected construction contractor.

8.2 SOCIAL POLICY

AES SONEL is committed to sustainable development and social responsibility. As such and as part of the detailed SMP, it will develop policies relating to employment and HIV/AIDS and other STIs. A copy of AES SONEL's environmental and social policy is presented in Appendix P.

8.3 PROJECT OVERVIEW

A project overview is presented in Section 3 of this report.

8.4 SOCIAL STANDARDS AND QUALITY OBJECTIVES

Wherever available, Cameroonian standards will be adapted to the project, which will be supplemented by international standards and guidance as necessary in consultation with the EPA.

The detailed Resettlement Action Plan, which will need to be developed, will provide the basis on which the resettlement and compensation of project affected people will be conducted. The key principles of involuntary resettlement according to the World Bank's Operations Policy 4.12 are income and livelihood restoration and consultation of affected people (please see Section 8.6.1).

8.5 REGISTER OF SOCIAL IMPACTS

The purpose of the SMP is to ensure that appropriate control and monitoring measures are in place to deal with all significant potential social impacts of a project. An impacts register therefore provides a focus for social management. The potential impacts of the project are discussed in Section 6.3 to 6.5 of this ESIA and are summarised in Table 8.4.1 below. Only impacts with a potential significance (minor to significant) require management action.

Table 8.4.1: Summary of Impacts - Socio-economics

Issue	Phase[1]	Impact	Nature of Impact	Receptor	Nature[2]	Duration[2]	Significance[2]
Population and Demographics	C	Land requisition and resettlement	Land requisition and resettlement	Local communities	Adverse / Beneficial	Long-term	Minor
	O				Adverse	Long-term	In-significant
	C/O	Conflict with host population	Conflict	Host and resettled populations	Adverse	Short-term	Insignificant
	C	Loss of cultural property	Land requisition	Local communities	Adverse	Long-term	Minor
	C/O	In-migration	STIs / Social conflict	Local communities and contract workers	Adverse	Short-term/long term	Significant
Economic Environment	C	Loss of Land	Acquisition of land	Local PAPs[2]	Adverse	Long-term	Significant.
	C	Compensation discrepancy through land right disputes	Conflict/reduced social capital	Local PAPs	Adverse	Medium-term	Significant
	C/O	Employment opportunities	Increased number of jobs	Local communities and contract workers	Beneficial / adverse	Short-term/long term	Significant
	C/O	Increased National Power Supply	Increased National Power Supply	Local and national	Beneficial	Long-term	Significant
	C/O	Economic Benefits	Benefits	Local communities	Beneficial	Long-term	Significant
Social Services and Infrastructure	C	Pressure on health facilities	Pressure on health facilities	Health facilities, local communities contract staff	Adverse	Short term	Significant
	O				Adverse	Long term	Insignificant
Electromagnetic Fields (EMF)– Community Health	O	Electro-magnetic Fields	Community Health	Local Communities	Adverse	Long-term	Insignificant

All issues apply to the project footprint, i.e. both power plant and transmission line with the exception of EMF, which applies to the transmission line only

[1] – Project Affected People

[2] – see Table 1.5.1 for definition

[3] – Phase - C -= Construction / O = Operation / D = Decommissioning.

8.6 MITIGATION AND IMPLEMENTATION

Mitigation measures are discussed in the SIA Sections 6.3-6.5 and are summarised together with Site Management (implementation of mitigation) in Table 8.6.1 below.

With regard to EMF, prior to the start of final line survey, transmission line tower set out and construction activities, all key site staff (site supervisors, contracts managers and site engineers) will be informed of the issues relating to EMF and be identified as key contact points by all site workers. Any questions arising from members of the public will therefore be directed to these individuals during the final planning and construction process. There are no physical environmental management issues relating to EMF effects other than ensuring the correct development and management of the wayleave.

Consultation of affected people is a key mitigation measure for the overall project, as experience has shown that when affected people are not adequately consulted a project runs the risk of being delayed and in some cases sabotaged. Thus, its implementation is considered key to the overall success of the implementation of the SMP as discussed below.

8.6.1 Consultation

Introduction

Public consultation is a key mitigation measure and general community approach that needs to be integral to all aspects of the project. The form that consultation takes will differ depending on the type of issue being raised, and the stage in the project cycle. AES SONEL and the project-affected community will devise the most appropriate method of consultation that is relevant and effective for the project. However, there are some core principles of consultation and key elements that need to be part of an effective consultation programme. Additionally, as has been mentioned in other parts of the ESIA, consultation and participation are crucial features of the RAP. Generally, the process for consultation for a RAP begins after the information from the relevant surveys has being finalised. Then resettlement planners can engage in consultation with the affected communities regarding the RAP strategy for livelihood restoration. Sometimes a committee of community representatives is appointed who can serve as a focal point for consultations on the types of assistance proposed as well as for the subsequent participation of the community in RAP implementation. Where host communities are affected by resettlement decisions, representatives of these communities should be included in these consultations. Therefore, what follows is a detailed framework, of principles and methods, for the consultation approach, which can be developed and augmented as specific issues arise during the lifetime of the project and the RAP.

Key Tasks

The following are international best practice approaches to consultation. These methods will be applied during the project development and operation, as necessary.

*Design of Public Meetings***:**

All public meetings will ensure that:

- people are well informed about the purpose of the meeting in advance;

- meeting venues are accessible to the attendees;
- meetings should be held at times that are convenient for people;
- clear, non-technical information should be presented in French and in local languages, as necessary, and there should be a good mixture of visual and written information;
- issues raised are answered at the meeting or followed up with a timeframe.

Hold Targeted Smaller Consultation Meetings:

Large public consultation meetings are useful but do have their limitations. Throughout the lifetime of the project specific issues emerging from particular groups will need to be addressed, e.g. women or older people may have particular needs The best way to do this is to have small focus groups with the people concerned, for example, a business group, a group of teachers, women or older people.

Document the Results of Meetings: The records should include:

- the location, dates of meetings, workshops and discussions and purpose of the meeting.
- an overview of the issues discussed;
- how issues were dealt with;
- details of outstanding issues.

Use local community groups such as NGOs:

- sometimes the most effective communicators are local. Use local NGOs, churches and other community-based groups to help facilitate meetings and disseminate information about the project.

Implement Formal Grievance Mechanisms:

- the contact person for grievances should be a specific person within AES SONEL (e.g. the community liaison officer, human resources officer);
- the existence of the complaints procedure and how it works should be well publicised among the community;
- the grievance procedures should be transparent and simple to understand;
- access to the procedures should be free;
- representatives of affected people should be part of the committee deciding how to respond to grievances;
- a third party should be available in case certain grievances cannot be resolved - this third party should be neutral, well respected and agreed upon by both AES SONEL and affected parties;

- where possible, grievances should be resolved through facilitation rather than arbitration.

Use Consultation as a Monitoring Tool

Despite good planning and good mitigation things can go wrong. Use consultation to determine the reasons for problems arising or grievances aired and how the project can be improved. It is also a good way to measure success, as key indicators will emerge.

8.7 MONITORING AND EVALUATION

The monitoring plan should be simple to use and effective in measuring the progress of any given mitigation measure.

As the effects of resettlement can persist long after the construction of the project the evaluation and monitoring of the RAP is a crucial element of a RAP. Small-scale sample social assessments or discussions with those resettled maybe required 6 months to a year after the implementation of the RAP and at subsequent regular intervals.

AES SONEL should gather baseline data against which to monitor future progress and to select two or three key indicators. As the most significant impact of the project is land requisition the principal monitoring activity will involve the implementation of the resettlement action plan and the monitoring of the success of its implementation. Details of this monitoring process will be provided within the Resettlement Action Plan (RAP), an outline of the RAP monitoring process can be found in the framework RAP in Appendix M. Monitoring should be an ongoing regular process that culminates in an evaluation every six months. The results of this evaluation should feed into the revised monitoring plan for the next 6-month session.

In addition to the RAP monitoring procedures a general monitoring plan of the key mitigation measures will help to ensure the appropriate measures are being taken.

A summary of proposed monitoring is presented in Table 8.6.1.

8.8 MANAGEMENT STRUCTURE

As the national power provider in Cameroon, AES SONEL have an existing management structure to facilitate control of potential environmental and social impacts. As the Kribi Power Project will represent a new entity, there are no project specific management structures to set out, and as such this plan provides the framework for the systems that will be put in place within the existing company structure.

When setting up this project-specific management structure the key elements to incorporate are as follows:

- A single named individual will be given overall responsibility for environmental and social matters on site;

- A staff structure below this individual will be defined in order to control all aspects covered under the plan (e.g. contractors during the construction phase);

- Staff within this structure will be named individuals or identified posts and a clear statement of their responsibilities will be provided; and

- A clear management and reporting pathway will be set out.

During construction, the management of the implementation of the detailed resettlement action plan will be a critical task to be managed. In addition, the activities of the construction crew will need to be carefully monitored with respect to the requirements of the management plan.

Once constructed, the operation will have a relatively small-scale plant and the line will require minimal maintenance.

Specific organisational arrangements are presented in Table 8.6.1 below. During the construction phase a dedicated community liaison officer should be appointed to consult the affected communities and respond to any grievances that may arise. When the implementation of the RAP commences a more formal management arrangement will need to be established. The RAP itself needs to identify and provide details on the roles and responsibilities of all organisations and individuals who will be responsible for resettlement activities. Typically there would be a **Resettlement Unit** whose members would have specific roles. The sample roles would be:

- *Resettlement advisory group*: This would comprise the project sponsor (AES SONEL) and relevant local government representatives;

- *Resettlement Manager*: Responsible for overall planning, coordination and management of resettlement unit activities and staff;

- *Community Liaison officer*: Responsible for negotiations and consultation with project-affected community groups;

- *Support Services Unit*: Responsible for technical expertise on health, water supply, etc

- *Community Resettlement Committee*: These are typically ad hoc bodies within each community of affected people including host communities, if appropriate. They often serve as channels for grievances between communities and the resettlement unit.

Table 8.6.1: Summary of Social Impacts – Mitigation, Implementation and Organisational Arrangements					
Issue	**Impact**	**Mitigation**	**Implementation**	**Organisational Arrangements**	**Monitoring**
Population and Demographics	Land requisition and resettlement	Resettlement Action Plan (RAP) (see Appendix M) in accordance with WB OP 4.12	RAP process as detailed in RAP framework in Appendix M will be followed Resettlement and Compensation to be completed in advance of construction	RAP /Resettlement Unit	Monitoring as per RAP outline but also roles and responsibilities of RAP Resettlement Unit
	Conflict with host populations	Consultations with host communities and local governments Arrangements for prompt tendering of any payment due to the host communities for land or other assets provided to resettlers Arrangements for addressing any conflict that may arise between resettlers and host communities any measures necessary to augment services (e.g. education, water, health, and production services) in host communities to make them at least comparable to services available to resettlers (paragraph 16, WB OP 4.12)	Consultation as outlined in 6.3 and 6.3.3 Resettlement sites programme as detailed in RAP outline in Appendix M Resettlement and Compensation to be completed well in advance of construction or operation	RAP Resettlement committee and representatives from resettled groups and host communities	Monitoring as detailed in RAP Outline and WB OP 4.12
	Loss of cultural property	If destruction of graves is unavoidable relatives need to be consulted on their wishes. If any medicinal trees are the beneficiaries/owners of these trees, be they individual owners or community users, they should receive compensation as necessary	Consultation as outlined in 6.3 and 6.3.3 Implement cultural property plan as specified in WB 4.12 and RAP outline (Appendix M)	RAP Unit to manage cultural property migration and consultation	Monitor as part of RAP monitoring process

Table 8.6.1: Summary of Social Impacts – Mitigation, Implementation and Organisational Arrangements					
Issue	**Impact**	**Mitigation**	**Implementation**	**Organisational Arrangements**	**Monitoring**
	In-migration during construction and operational phase	An ongoing induction plan to introduce workers to the social and cultural mores of the project area, and behaviour and social interaction between men and women Consultation with local community, including regular meetings with representatives of the local community	Ensure all new employees (including contractors and sub-contractors) receive induction briefing Ensure consultation programme is implemented (see 6.6.3)	Defined responsibilities required, e.g. human resources officer, community relations officer, village representatives	Employees induction programme throughout the project cycle. community complaints register (see 6.6.3)
Economic Environment	Loss of land	Compensation will be provided within a formalised Resettlement Action Plan for the project as discussed in Section 6.3 Compensation within the World Bank 4.12 guidelines needs to be given to those people who suffer loss of land and/or income as a result of the project	Resettlement and Compensation to be completed, in advance, of physical construction or operation	RAP Unit	Monitoring as per RAP Outline in Appendix M
	Compensation discrepancy through land right disputes	The compensation process will use the World Bank's OP 4.12 guidelines, which provide for the compensation of people without legal title Project affected people should be compensated for loss of land, loss of income and potential income	Resettlement and Compensation to be completed well in advance of construction or operation	RAP Unit	Monitoring as per RAP Outline in Appendix M
	Employment opportunities	Establishment of a community development plan for equitable opportunity of economic development to also be incorporated into the overall closure plan Preferential recruitment and training policies for locally project affected people	Measures should include: skills audit and gap analysis of local project area skills available	Project Social and Environmental Management team	Monitor implementation of and community complaints register
	Increased National Power Supply	N/A	N/A	N/A	N/A

Table 8.6.1: Summary of Social Impacts – Mitigation, Implementation and Organisational Arrangements					
Issue	**Impact**	**Mitigation**	**Implementation**	**Organisational Arrangements**	**Monitoring**
	Economic benefits	Fiscal measures to protect very poor from inflation generated	Tax exemption, micro credit loans	National and local government RAP/Community development team	Monitor as part of RAP monitoring process
Social Services and Infrastructure	Pressure on health facilities	Provision of on-site health first aid centre during construction (See national legislation) The most effective mitigation measure will be good sensitisation about STIs and HIV/AIDS as mentioned in Section 6.3 Use of health centres in Kribi and Edéa	Ensure on-site project specific health facilities are available from the start of construction!! Consultation, meetings and distribution of information about STIs and HIV/AIDS	RAP Unit's support services unit and community liaison officer	Monitor as part of community development plan
Electromagnetic Fields (EMF)– Community Health	Community Health	Resettlement of properties within the wayleave	Resettlement and Compensation to be completed in advance of physical construction or operation	RAP Unit	Monitoring as per RAP Outline in Appendix M

Photos

Photo 3.3.2: Current and location of proposed site access

Photo 5.4.1: Mpolongwe River

Photo 5.4.2: Use of surface water – Mayinga stream by site

Photo 5.7.1: Main road Kribi / Edéa

Photo 5.7.2: Douala Port access

Photo 5.7.3: Douala Edéa road – market area

Photo 5.7.4: Road through Edéa

Photo 5.8.1 Trial pit on plant site

Photo 5.8.2: Typical farming area

Photo 5.8.3: Wayleave clearance, also illustrating farming occurring within wayleave

Photo 5.8.4: Oil palm plantation

Photo 5.11.1: Typical forest vegetation cover within the project area

Photo 5.11.2: Village and agriculture

Photo 5.11.3: Kribi/Edéa road

Photo 5.11.4: 90kv pylon and wayleave at plant site

Photo 5.11.5: Chapel and housing adjacent to plant site

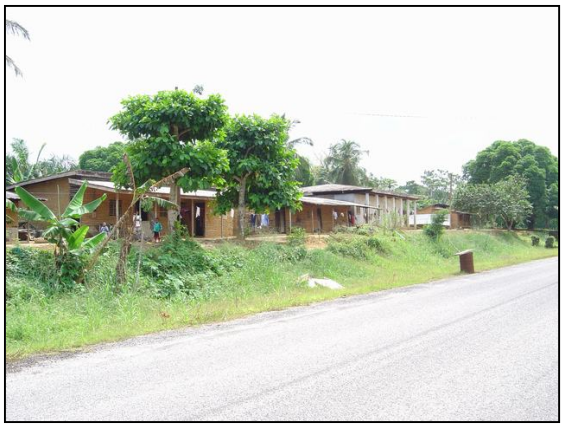
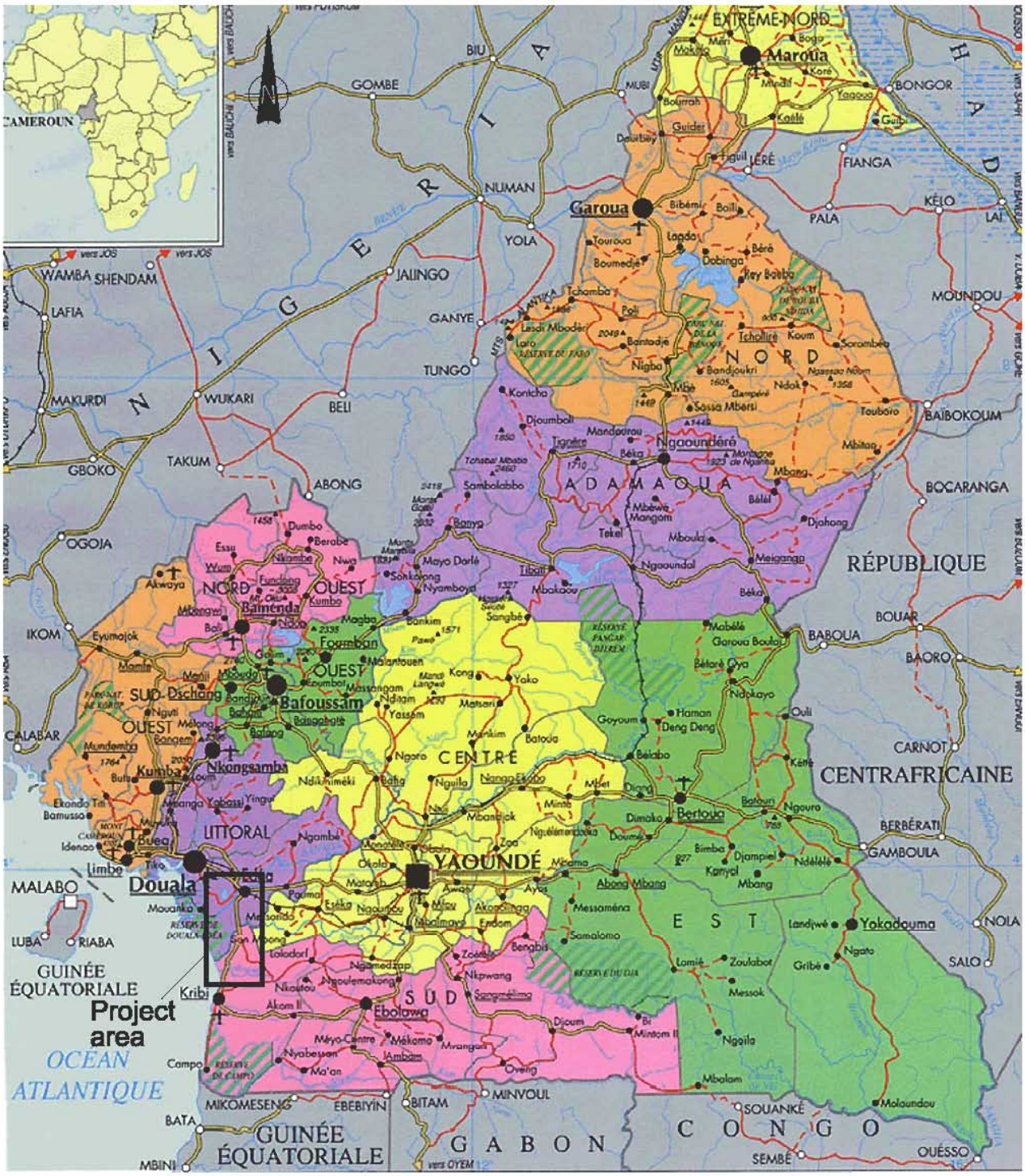


Photo 5.11 6: Properties along road side near plant site with ridge behind

Figures

FIGURE 1.1.1



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KRIBI POWER PROJECT ESIA

PROJECT LOCATION PLAN

D110687-101-1001 P2

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FIGURE 1.1.2

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DETAILED LOCATION PLAN

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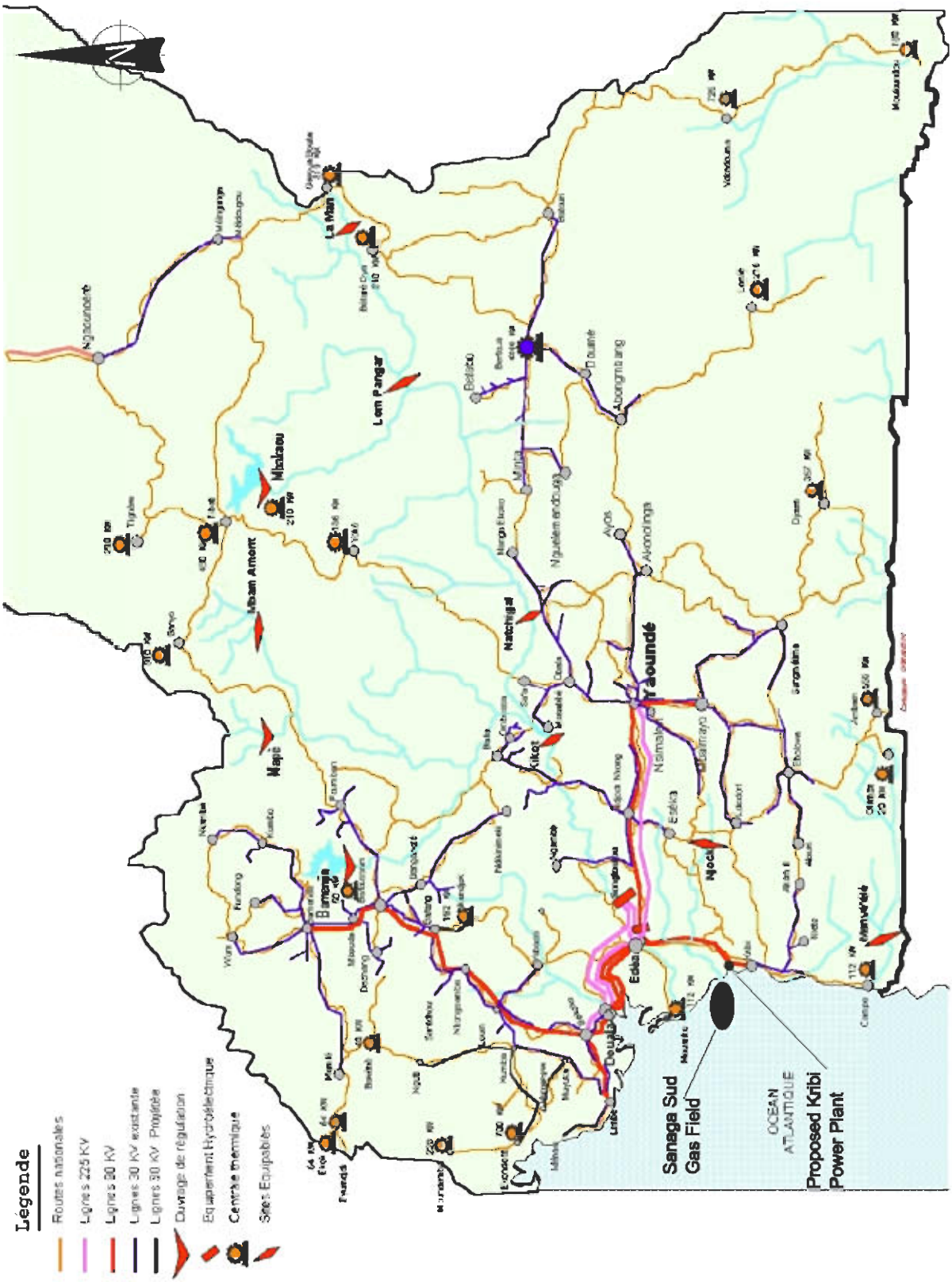
FIGURE 1.1.3



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EXISTING POWER NETWORK

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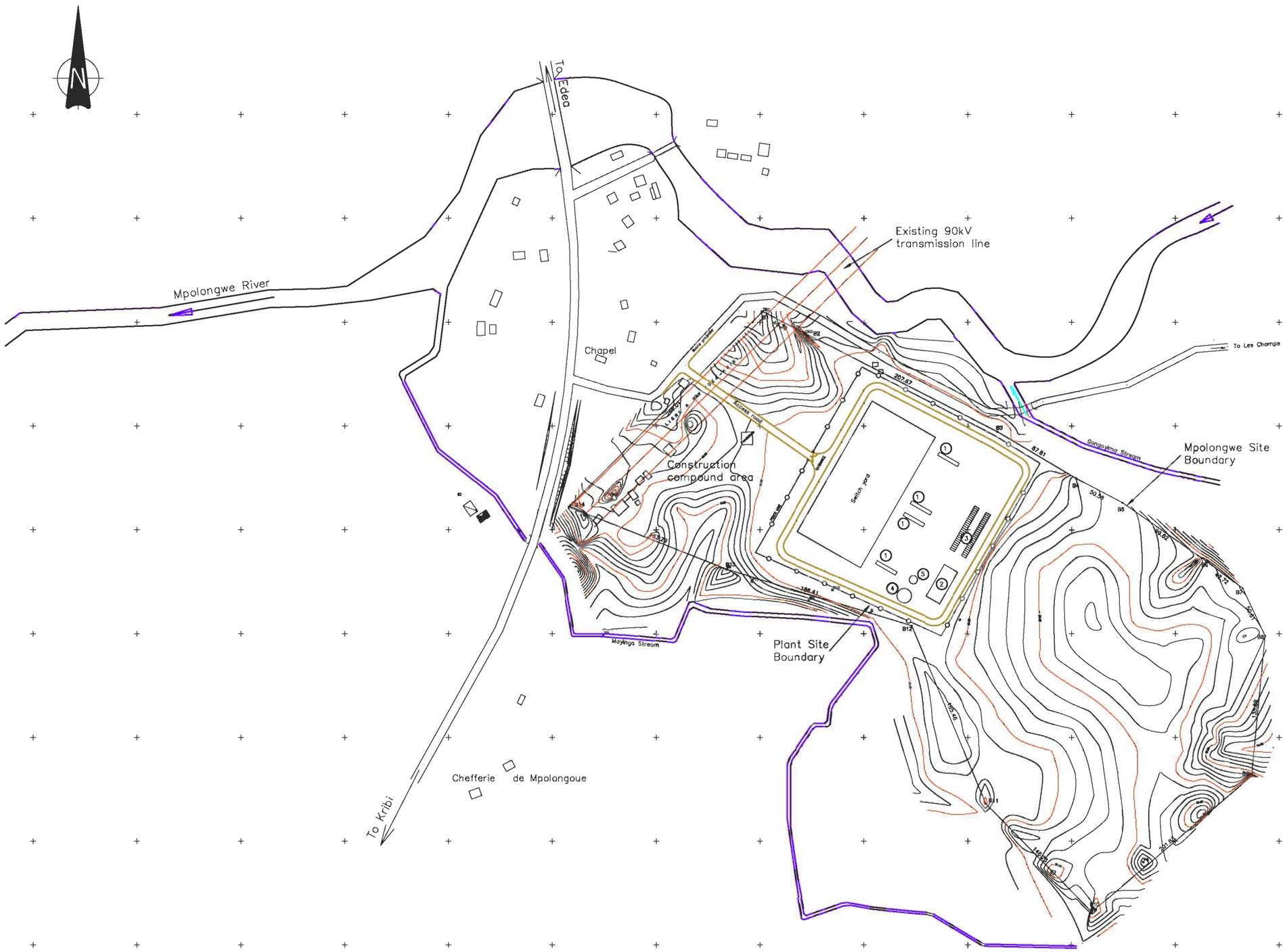
FIGURE 3.3.1

Notes:
1. Drawing is based on layout provided by Sinclair Knight Merz (Europe) Ltd.

Legend

1. Gas turbine
2. Admin, store, workshops
3. Parking
4. Fuel storage
5. Fire protection tank
- Existing buildings (outside plant site)



50 0 50 100 150 200m

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PLANT SITE LAYOUT AT MPOLONGWE

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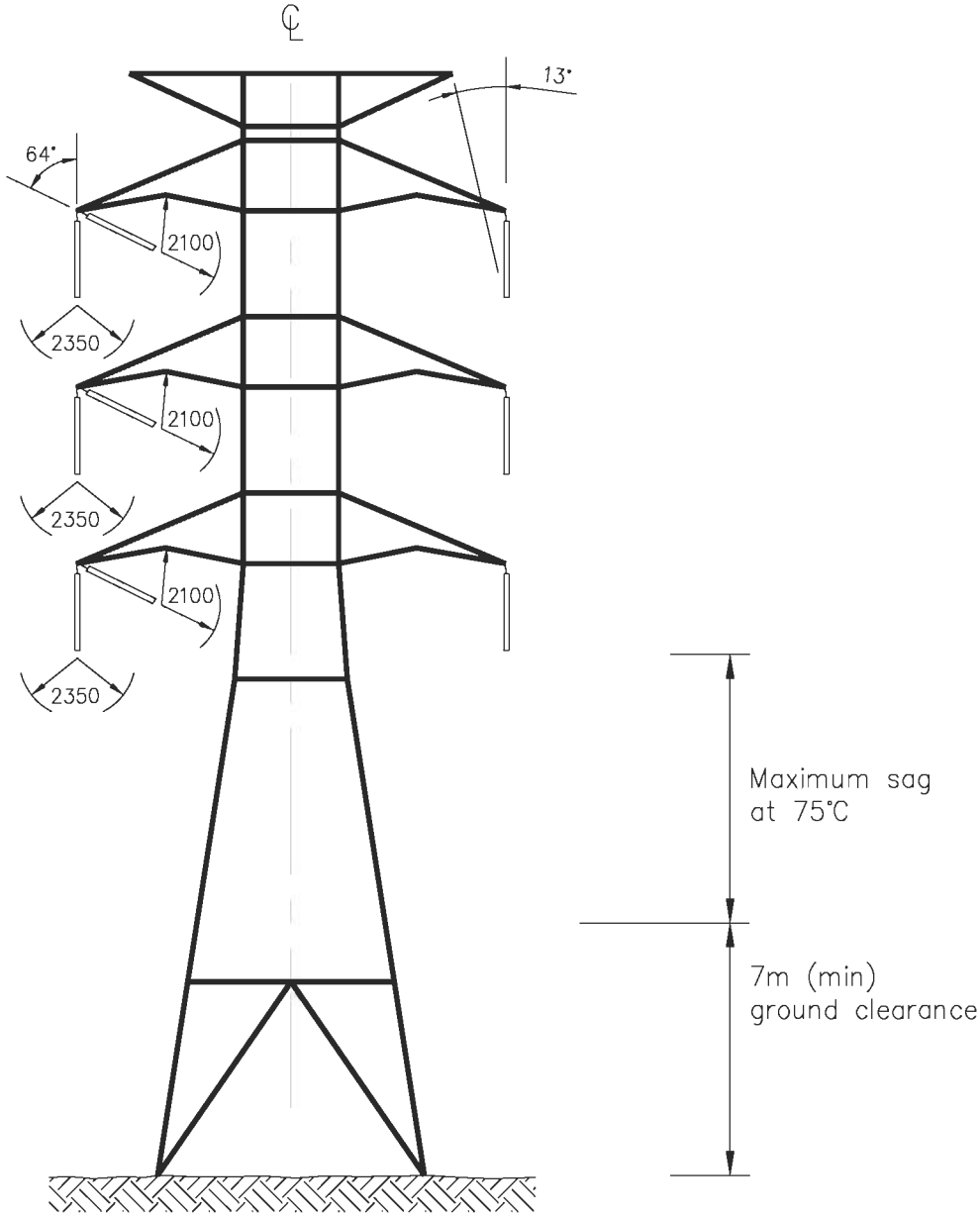
FIGURE 3.3.2

Notes:
1. Drawing is based on details provided by Sinclair Knight Merz (Europe) Ltd.



Not to scale

Tower type	:	Self supporting suspension double circuit
Voltage	:	225kV
Condutor	:	Single AAAC aster 366mm ^{2}
Standard span	:	350mm

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KRIBI POWER PROJECT ESIA
OVERHEAD TRANSMISSION LINE TOWER DETAILS

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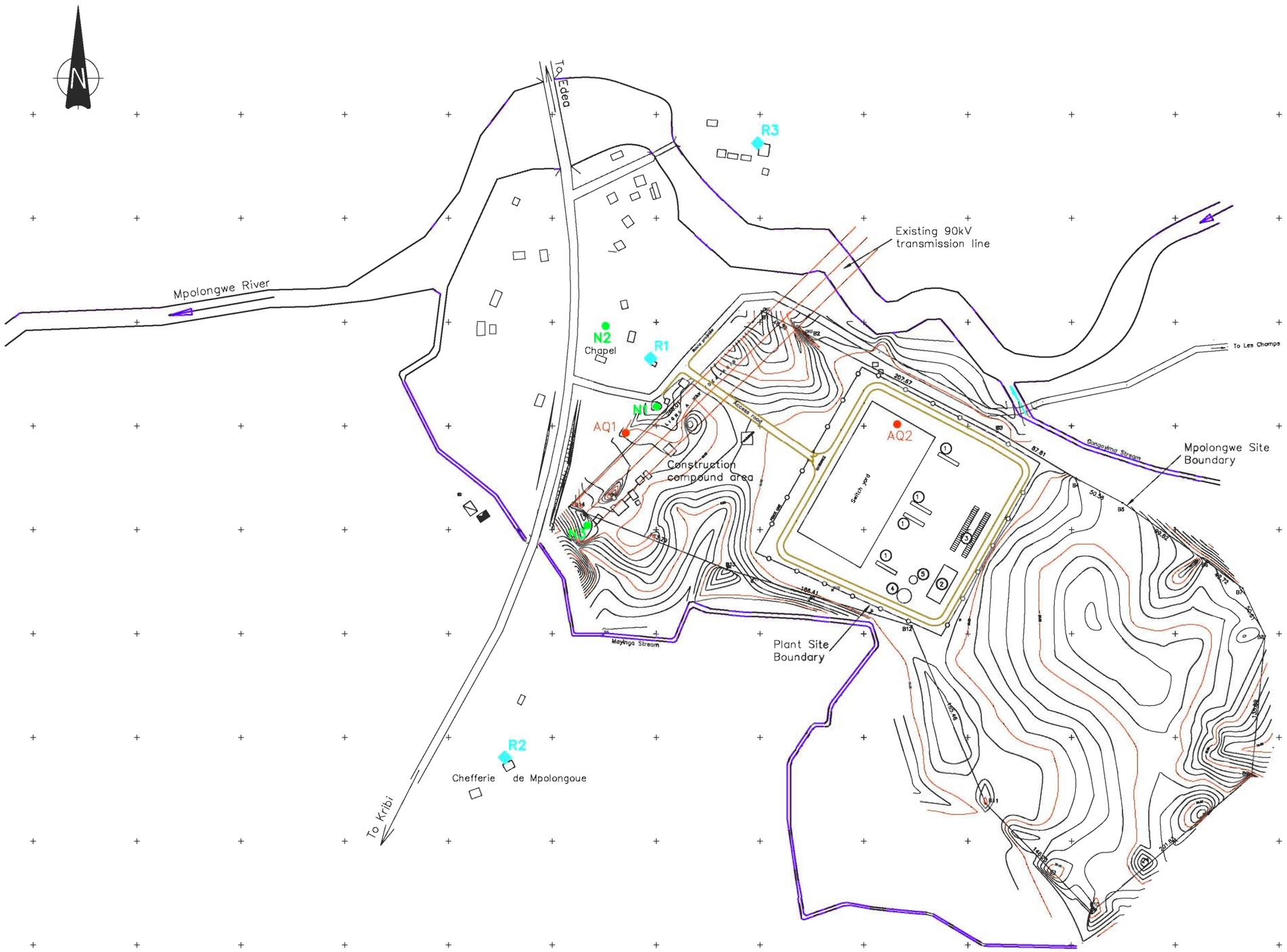
FIGURE 5.3.1



Notes:
1. Drawing is based on layout provided by Sinclair Knight Merz (Europe) Ltd.

Legend

- (1) Gas turbine
- (2) Admin, store, workshops
- (3) Parking
- (4) Fuel storage
- (5) Fire protection tank
- Existing buildings (outside plant site)
- N1 Noise monitoring station
- R2 Noise receptor location
- AQ1 Air quality monitoring station

50 0 50 100 150 200m

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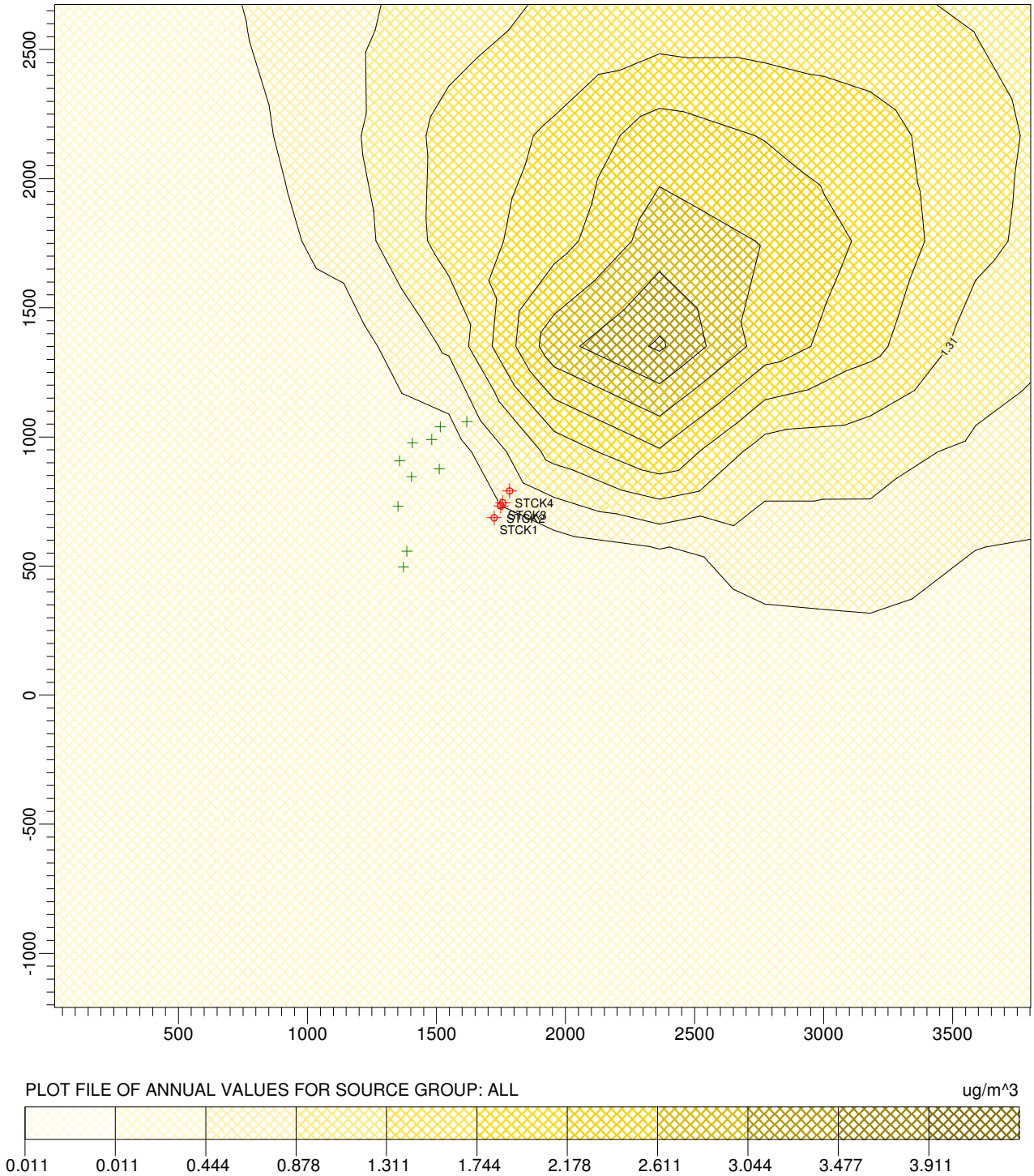
KRIBI POWER PROJECT ESIA
NOISE AND AIR QUALITY ASSESSMENT

D110687-101-1007

PROJECT TITLE:

Kribi Power Plant

Figure 5.3.2a: Annual Mean Nitrogen Dioxide Concentrations, 2003 meteorological data

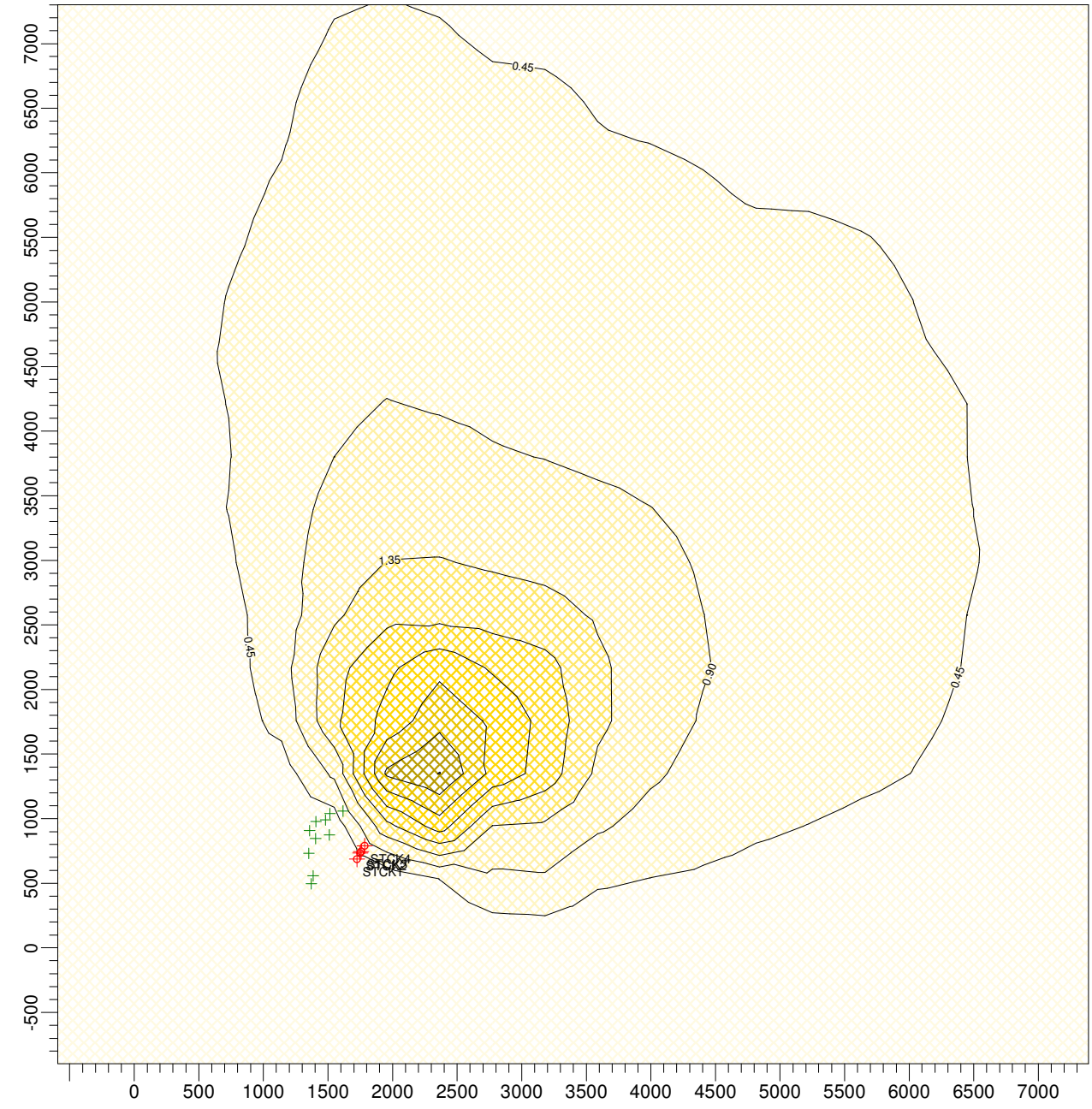


COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	
	OUTPUT TYPE: **CONC**	SCALE: 1:23,734 0 0.5 km	
	MAX: **3.91066 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

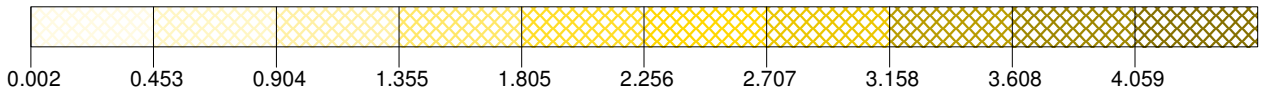
Kribi Power Plant

Figure 5.3.2b: Annual Mean Nitrogen Dioxide Concentrations, 2004 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

ug/m^3

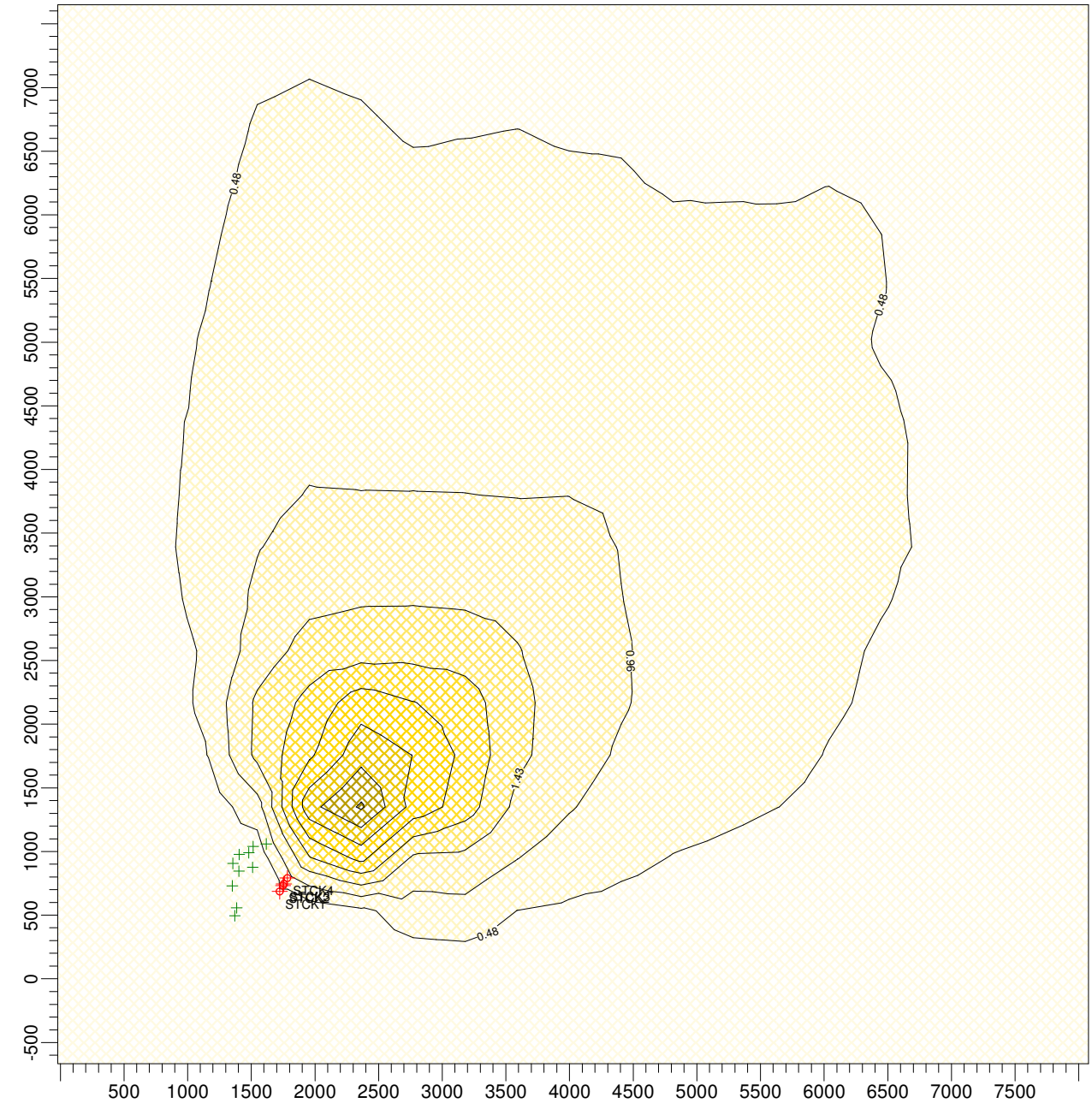


COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:50,086 0 2 km	
	MAX: **4.05924 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

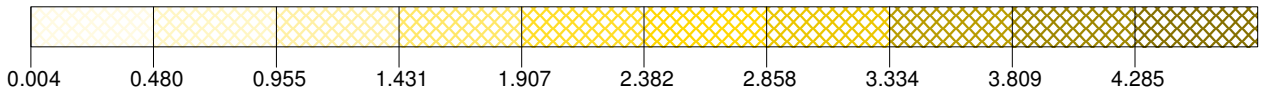
Kribi Power Plant

Figure 5.3.2c: Annual Mean Nitrogen Dioxide Concentrations, 2005 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

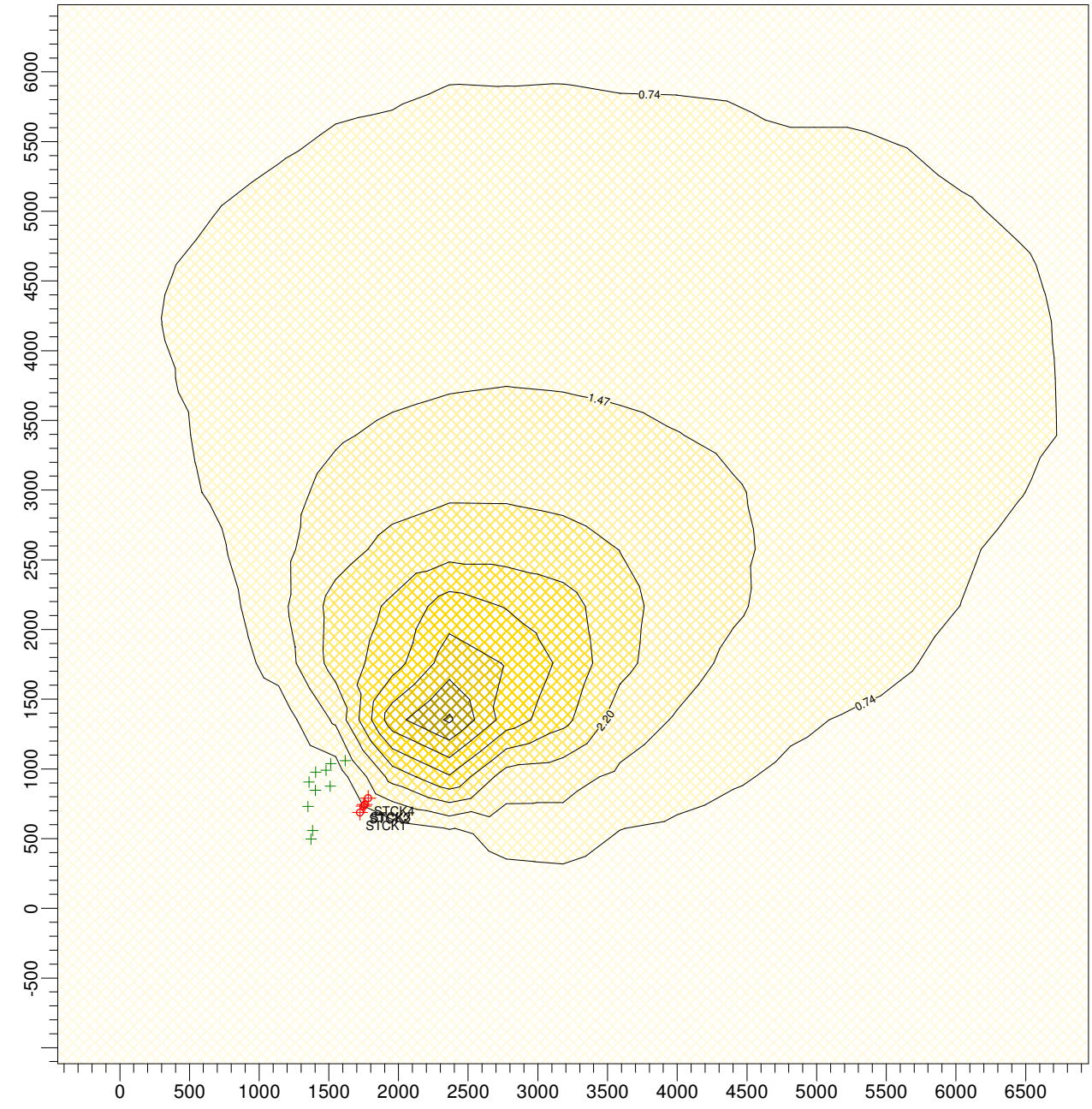
ug/m^3



COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:50,810 0 2 km	
	MAX: **4.28489 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

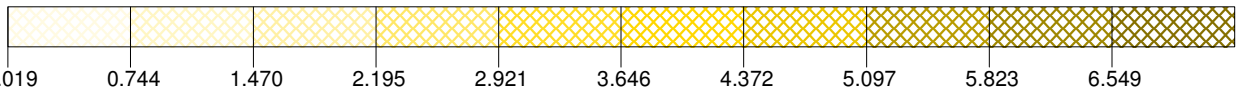
PROJECT TITLE:

Kribi Power Plant
Figure 5.3.3a: Annual Mean Sulphur Dioxide Concentrations, 2003 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

ug/m^3

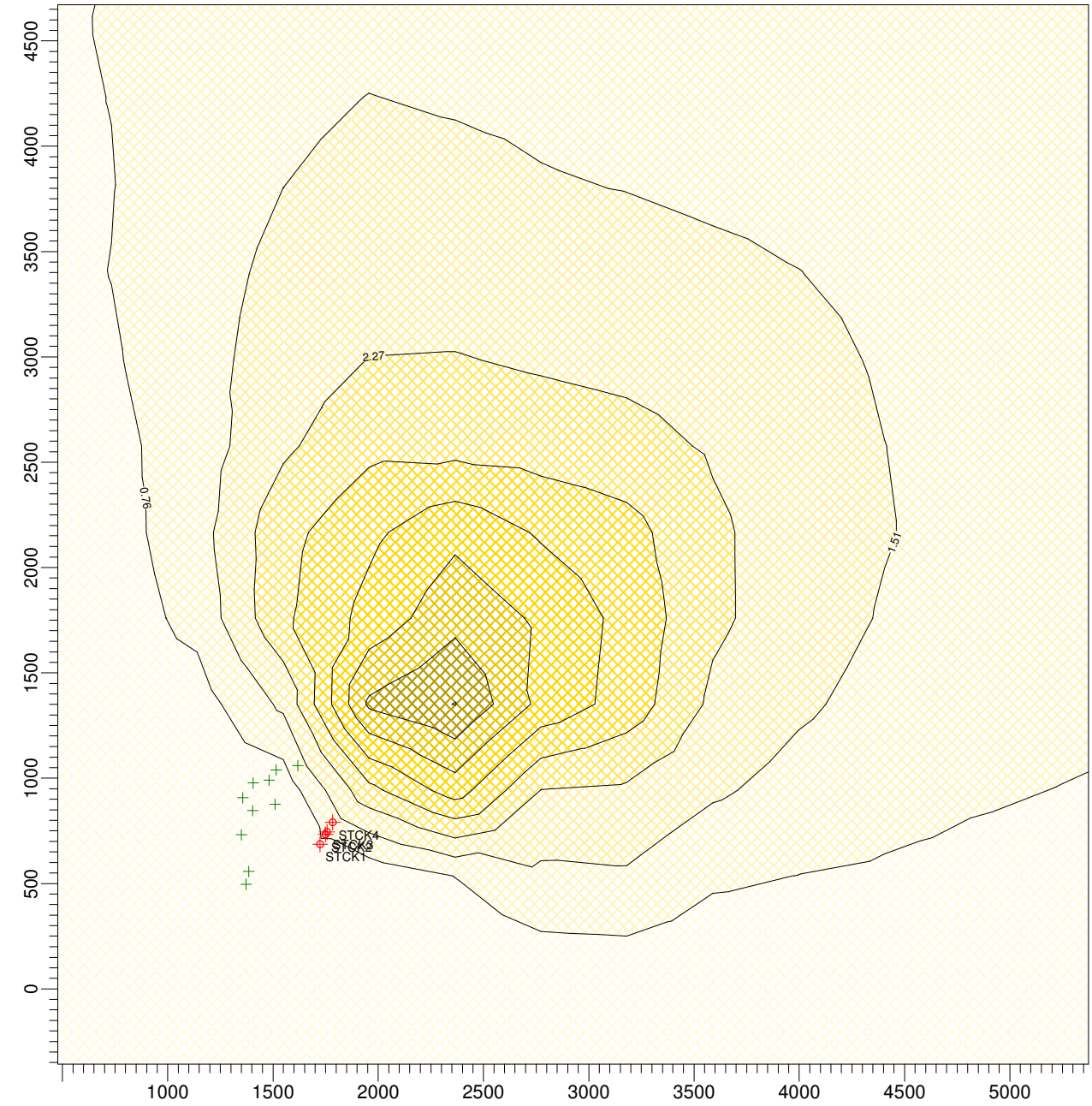


COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:46,413 0 1 km	
	MAX: **6.54851 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

Kribi Power Plant

Figure 5.3.3b: Annual Mean Sulphur Dioxide Concentrations, 2004 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

ug/m^3

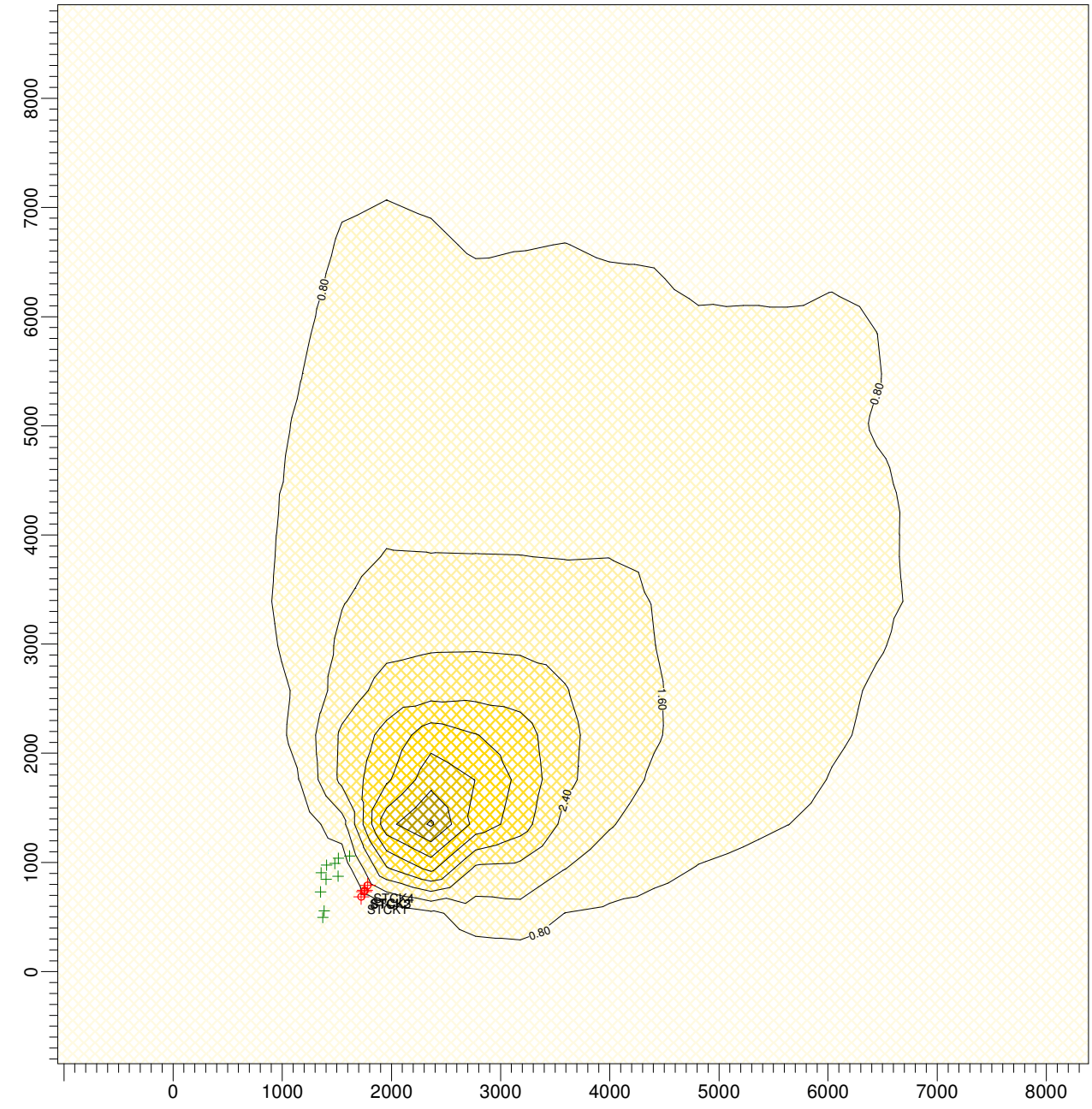
0.004 | 0.759 | 1.514 | 2.268 | 3.023 | 3.778 | 4.533 | 5.288 | 6.042 | 6.797

COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:30,725 0 — 1 km	
	MAX: **6.79731 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

Kribi Power Plant

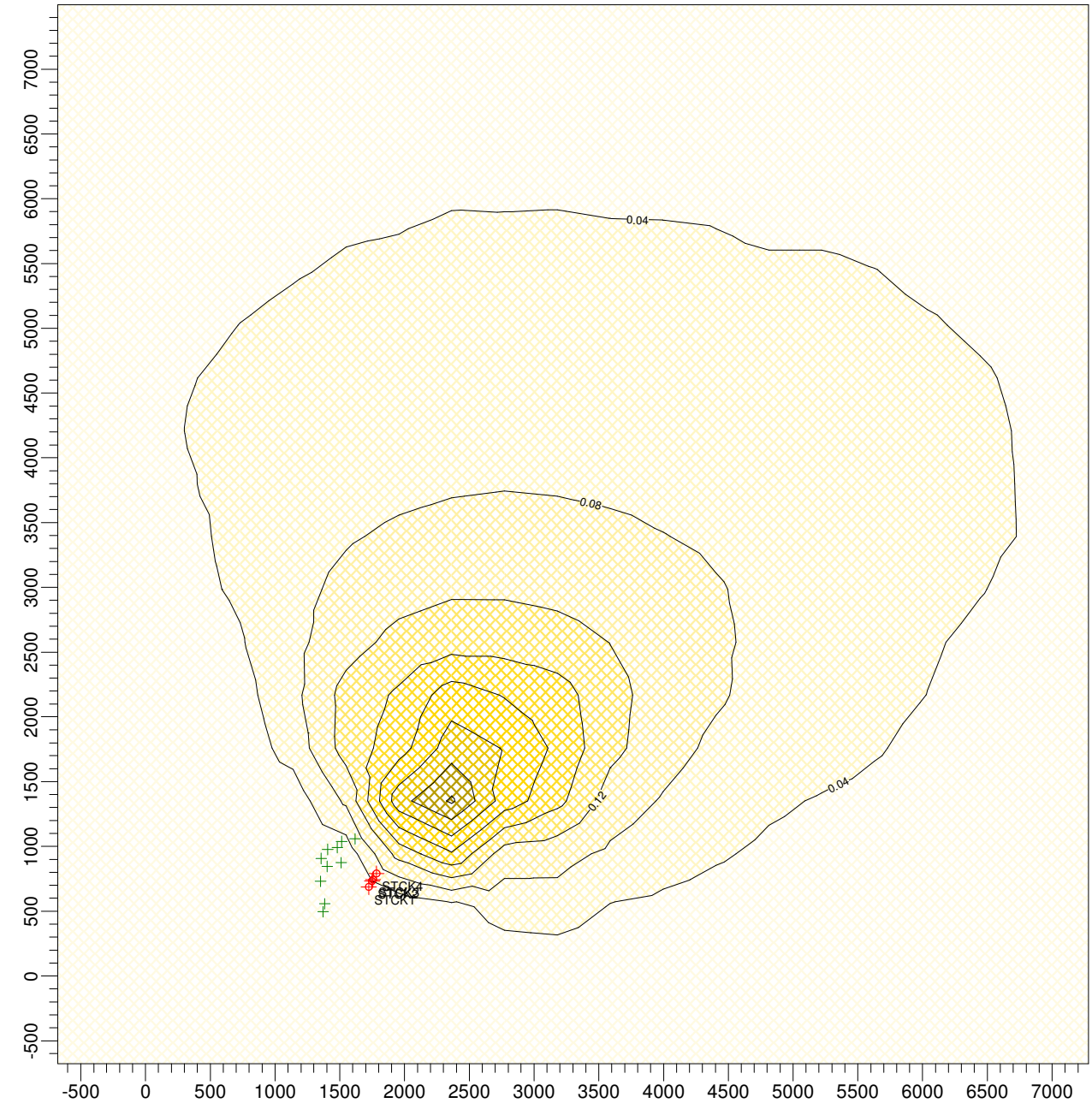
Figure 5.3.3c: Annual Mean Sulphur Dioxide Concentrations, 2005 meteorological data



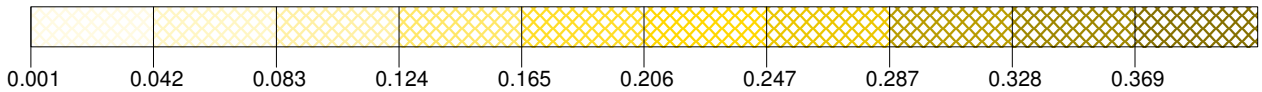
COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:59,254 0 — 2 km	
	MAX: **7.17518 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

Kribi Power Plant
Figure 5.3.4a: Annual Mean PM10 Concentrations, 2003 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL ug/m^3

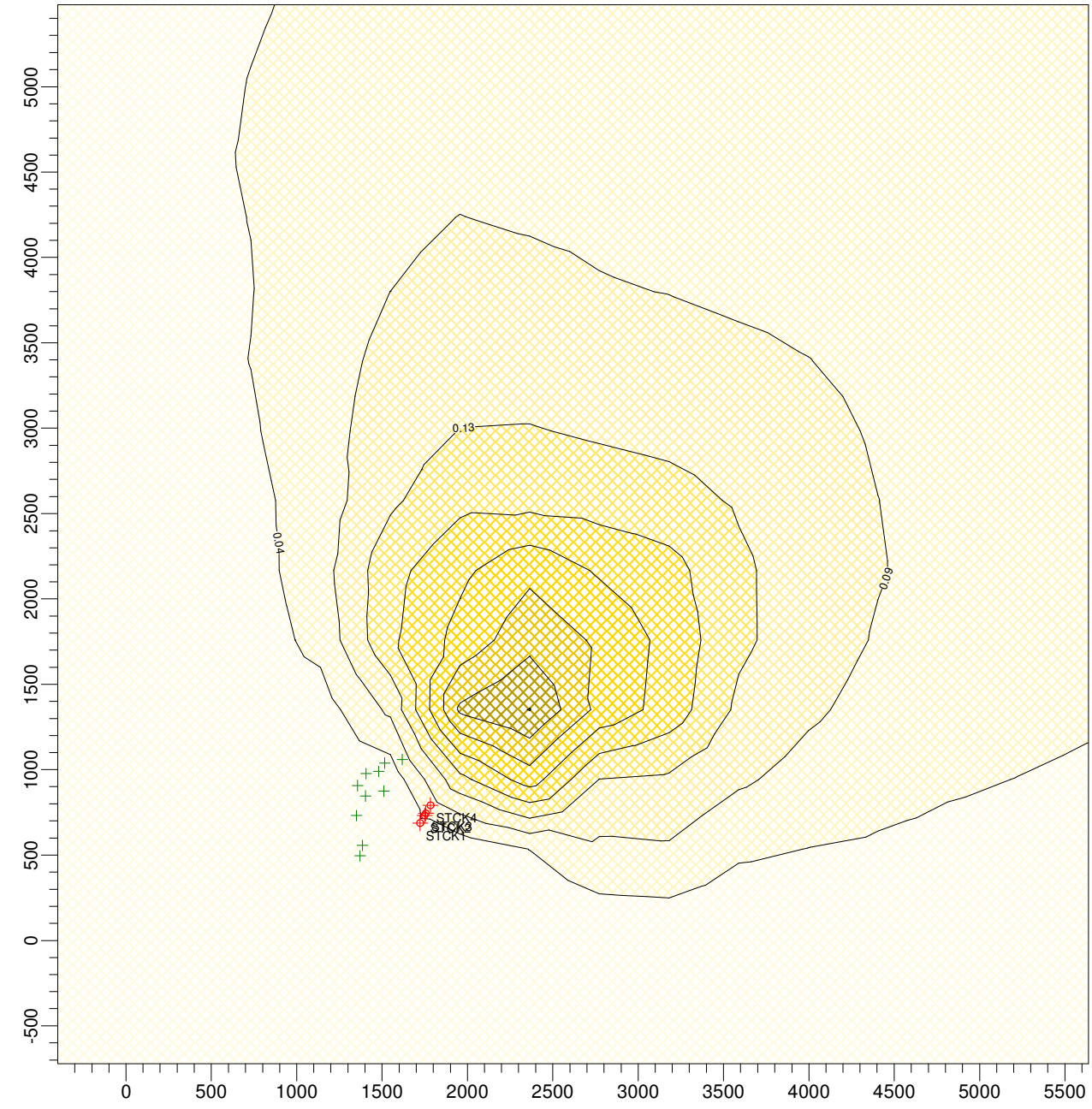


COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:49,945 0 1 km	
	MAX: **0.3693 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

Kribi Power Plant

Figure 5.3.4b: Annual Mean PM10 Concentrations, 2004 meteorological data



PLOT FILE OF ANNUAL VALUES FOR SOURCE GROUP: ALL

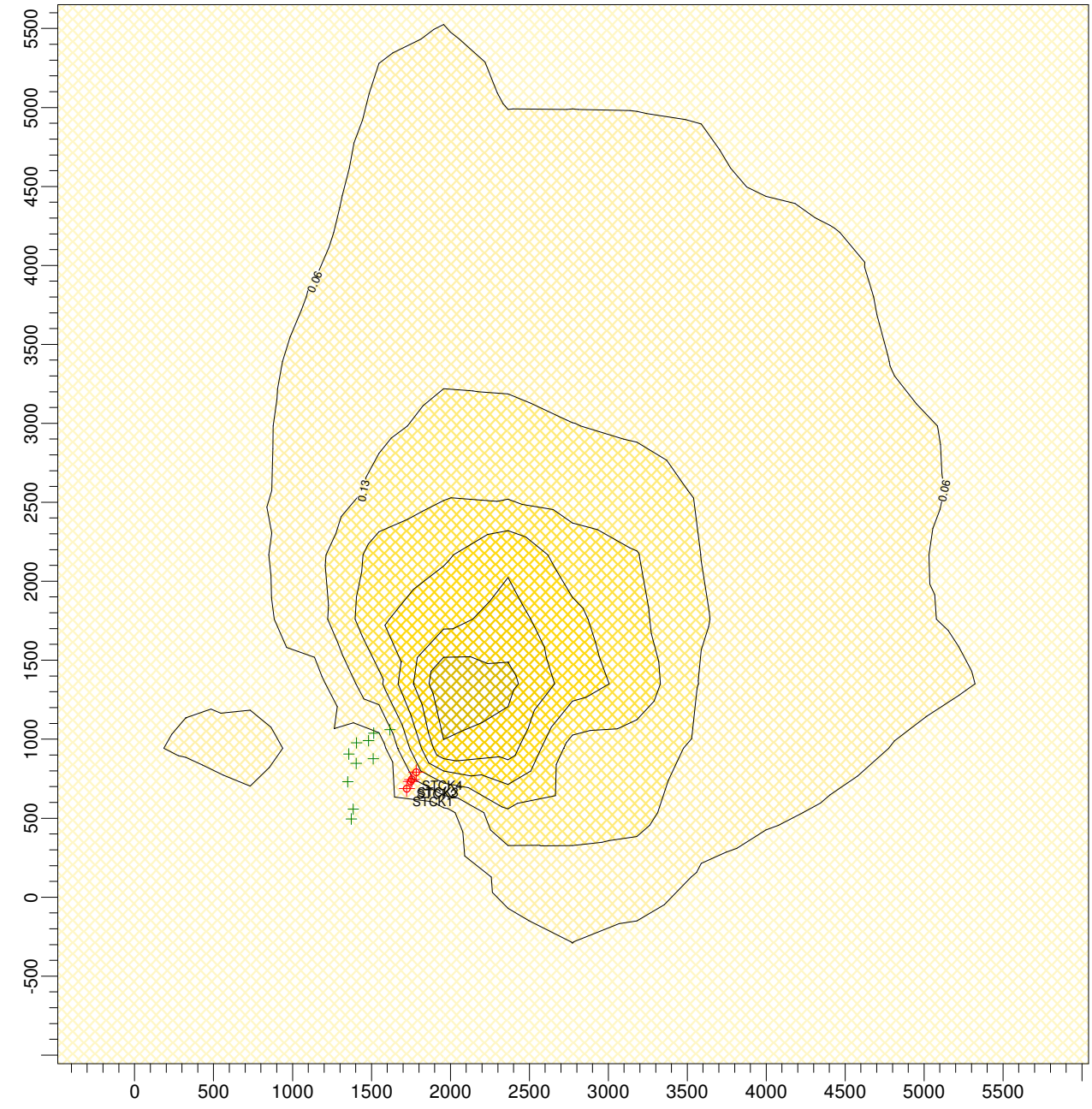
ug/m^3

0.000 0.043 0.085 0.128 0.170 0.213 0.256 0.298 0.341 0.383

COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:37,890 0 1 km	
	MAX: **0.38333 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

PROJECT TITLE:

Kribi Power Plant
Figure 5.3.4c: Annual Mean Nitrogen PM10, 2005 meteorological data

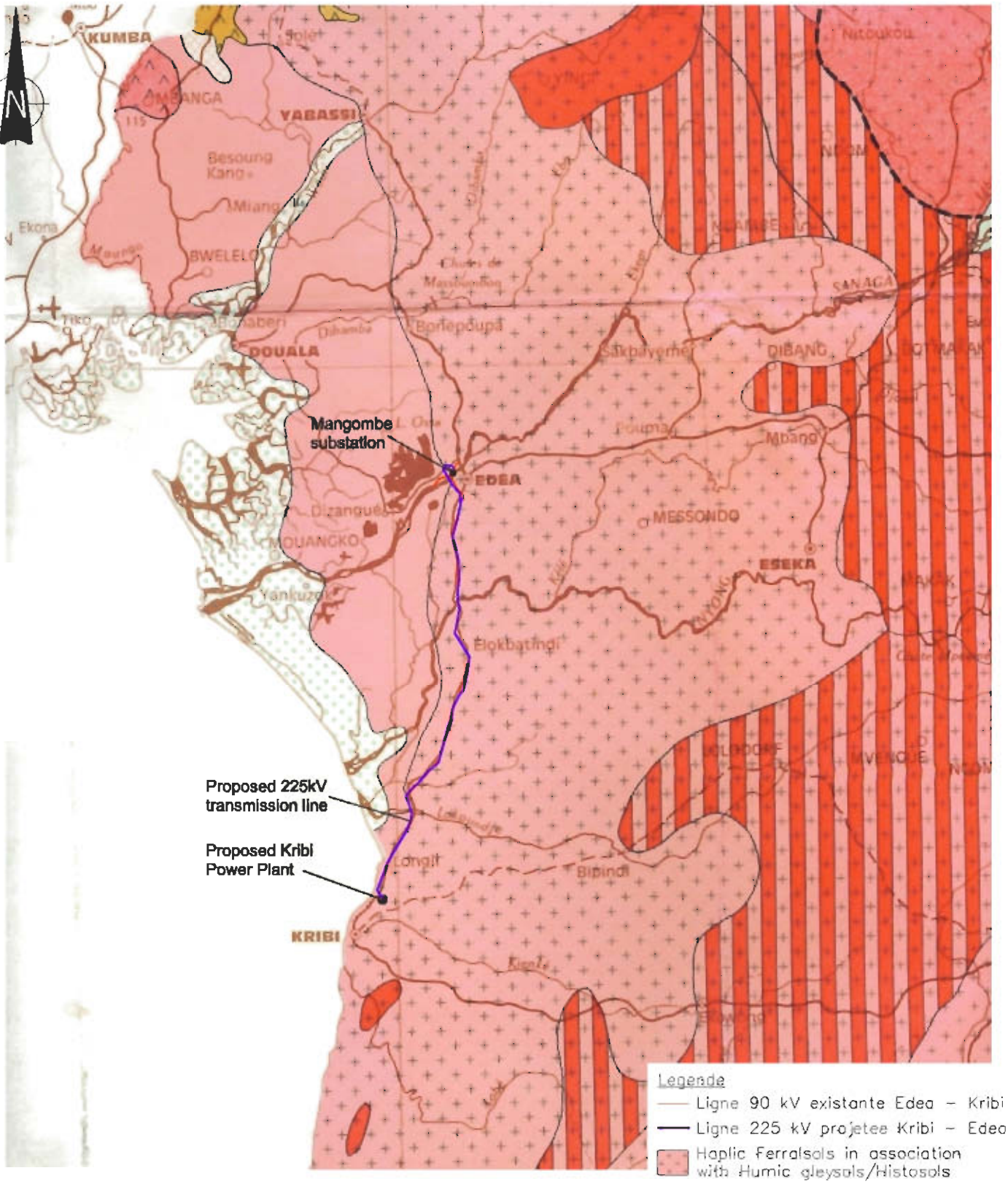


PLOT FILE OF AVERAGE HIGH 4TH HIGH 24-HR VALUES FOR SOURCE GROUP: ALL ug/m^3

0.000 0.000 0.063 0.125 0.188 0.250 0.313 0.375 0.438 0.501 0.563

COMMENTS: Drawn: DD Checked: GG Approved: GG	SOURCES: **4**		
	RECEPTORS: **2674**	MODELER: **DD**	Scott Wilson
	OUTPUT TYPE: **CONC**	SCALE: 1:40,966 0 1 km	
	MAX: **0.56305 ug/m^3**	DATE: **05/05/2006**	PROJECT NO.: **D110687**

FIGURE 5.8.1



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SOILS MAP

Scott Wilson

www.scottwilson.com

D110687-101-1006